SOUTH FORK SAGE CREEK
IMPACT AND RESPONSE

Smoky Canyon Mine
South Fork Sage Creek Impact and Response

Introduction

South Fork Sage Creek is perennial in its upper drainage area and becomes intermittent where it flows over the outcrop of the Wells Formation in the lower part of the drainage. Just east of the mouth of the canyon the stream crosses the trend of the West Branch Sage Valley Thrust Fault. At this location a large spring complex, known as South Fork Sage Creek Spring, occurs and sustains perennial flow in the creek channel downstream of this location to its confluence with lower Sage Creek (**Figure 1**). The flow in this spring has been relatively constant over time with total low flow (summer through winter) in the 5 to 6 cfs range. Most of the flow from this spring is supported by groundwater discharge from the Wells Formation aquifer rising to the surface at the thrust fault (NewFields 2005, JBR 2007). Flow in South Fork Sage Creek has historically been measured at a site (USS) in the upper, perennial part of the drainage and another site in the stream channel just below the large spring complex (LSS) (**Figure 1**). Water quality samples obtained from USS have typically shown selenium concentrations less than 0.001 mg/L. Samples obtained from LSS in the past have ranged in selenium concentration from about 0.001 to 0.002 mg/L.

Water quality monitoring results, collected in the fall and winter 2006 and 2007 under the CERCLA Administrative Order on Consent for the Smoky Canyon Mine were presented to the Forest Service as lead CERCLA agency on January 29, 2007 (NewFields 2007a). The reported monitoring data indicated that selenium concentration at LSS measured in October 2006 was 0.0056 mg/L. This value exceeds the Clean Water Act and State of Idaho Criteria for surface water and is higher than previously measured at that location. Another surface water sample was collected at LSS in January 2007 to confirm results from the 2006 monitoring event. The selenium concentration at LSS was 0.0081 mg/L. The January 2007 selenium concentration is the highest observed at LSS to date.

A review of the Smoky Canyon Site Investigation Report (NewFields, 2005) and more recent site-specific information was conducted. Water chemistry at South Fork Sage Creek Spring and increasing but fluctuating concentrations at Hoopes Spring are explained considering a combination of site-specific factors related to the existing mining operations, the conceptual geologic model, understood hydrogeology at the site, and climate data collected at the Smoky Canyon Mine located immediately north of South Fork Sage Creek (NewFields 2007b). The Bureau of Land Management, U.S. Forest Service, and Idaho Department of Environmental Quality (collectively the Agencies) reviewed the recent work by NewFields and agree that it represents one possible interpretation of the available data. This document summarizes the information provided by NewFields (2007b) in the CERCLA technical memoranda from NewFields, *Water Quality Monitoring Data Report Fall 2006 and Technical Memorandum No. 2 Evaluation of Recent Water Quality Trends at Hoopes Spring and South Fork Sage Creek Springs*, *January 2007*, with additional interpretation by the Agencies where appropriate.

Under existing CERCLA orders and those anticipated in the future, the Forest Service and Simplot plan to further investigate the documented increases in selenium concentrations at LSS. The summary offered in this document may be modified in the future to include new information.

Hydrogeology

The hydrogeology of the Smoky Canyon Mine is described in the Smoky Canyon Mine Area A Site Investigation Report (NewFields 2005) and the groundwater reports prepared for the recent environmental impact statements for expansions of the Smoky Canyon Mine (JBR 2001, 2007). The conceptual hydrogeology of the area is dramatically different on opposite sides of the West Branch Sage Valley Thrust Fault, which is located approximately at the break in slope on the west side of Sage Valley (**Figure 1**). To the east of this fault the subsurface rocks consist of alluvial fan deposits discharged from the mouths of Pole Creek, Sage Creek, and South Fork Sage Creek overlying fine grained sediments and tuff of the Salt Lake Formation. Immediately west of the thrust fault the rocks in the overriding plate are comprised of an approximately 2,800 foot thick series of carbonates, sandstones and siltstones belonging to the Brazer Limestone and Wells Formation. As interpreted by Ralston (1980) groundwater in the Wells Formation Aquifer flows east from high elevation recharge areas in the Webster Range to the west. This groundwater intercepts the thrust fault and flows along the trend of the fault in a highly permeable fractured zone of rock to discharge as springs at low elevation points along the fault. Two of these locations, Hoopes Spring and South Fork Sage Creek Spring are located in the vicinity of the existing Smoky Canyon Mine operations. Groundwater movement is interpreted to flow from infiltration points along Pole Canyon south to Hoopes Spring where it discharges. Based on the interpretation of Simplot's environmental contractor water not captured by Hoopes Spring may flow south of Hoopes Spring to discharge from South Fork Sage Creek Spring (NewFields 2005). Groundwater flow across a much larger area extending south from South Fork Sage Creek to just north of Deer Creek, is interpreted as moving eastward and then north along the thrust fault toward South Fork Sage Creek Spring. Groundwater flow from the south is thought to make up the majority (about 4.5 cfs) of the discharge at South Fork Sage Creek Spring (JBR 2007). Flow measured during low flow conditions at LSS, downstream of South Fork Sage Creek Spring is believed to be a mixture of largely Wells Formation groundwater flow from the south of the spring with lesser amounts of Wells Formation flow from the north and some underflow within the stream channel deposits. It is impossible to distinguish these separate components of flow at LSS.

The stream reach above South Fork Sage Creek Spring and overlying the Wells Formation is called a losing reach meaning surface water in the stream infiltrates into the underlying materials. During high flow periods (spring runoff) surface water is present in this reach. During lower flow conditions, South Fork Sage Creek in this losing reach may be dry. In their hydrogeologic interpretation of groundwater conditions, NewFields proposes that a local groundwater flow boundary (mounding) is created by streambed water loss. During low-flow periods when South Fork Sage Creek is dry above the spring, this local flow boundary is less prominent and physical mixing of water in the fractured fault zone between Hoopes Spring and South Fork Sage Creek Spring, coupled with dispersion, could potentially result in transport of selenium to South Fork Sage Creek Spring from the north (NewFields 2007b).

The Phosphoria Formation overlies the Wells Formation west of the thrust fault and supports phosphate rock mining at the J.R. Simplot Smoky Canyon Mine just west and north (upgradient) of Hoopes Spring (sample point HS) and South Fork Sage Creek Spring (sample points LSS-SP1 and LSS-SP2) (**Figure 2**). The Site Investigation Report for Area A (NewFields 2005) describes overburden units encountered during mining that contain selenium and other constituents in concentrations greater than found rocks elsewhere in southeast Idaho. A portion of the selenium in these rocks is soluble in water and can be leached from the mine overburden by precipitation resulting in the release of contaminants in surface runoff and seepage. Groundwater quality in the Wells Formation aquifer is known to have been impacted by selenium contamination downgradient of the Panel A pit backfill and the Pole Canyon overburden fill (NewFields 2005). Selenium contamination in the aquifer downgradient of the Pole Canyon overburden fill has migrated eastward into Sage Valley and southward along the thrust fault to Hoopes Spring.

Selenium Trends

MC-WM-1 is a groundwater monitoring well installed into the upper Wells Formation aquifer west (upgradient) of South Fork Sage Creek Spring (see **Figure 2**). Water found in this well provides an indication of the background water quality (unaffected by phosphate mining) of the Wells Formation aquifer in the vicinity of the spring. Samples obtained from this well in 2003 through 2005 ranged in dissolved selenium content from <0.0002 to 0.00066 mg/L (BLM, USFS and IDEQ 2006); averaging 0.00035 mg/L (**Table 1**). A May 2006 sample from MC-MW-1 had a selenium concentration of 0.00034 mg/L.

Samples obtained from South Fork Sage Creek at USS before 2003 had selenium concentrations at the detection limit (at that time), typically 0.001 mg/L (**Table 2**). Since 2003, detection levels have been lower and samples obtained at this site from 2003 to 2006 had an average total selenium concentration of 0.00023 mg/L; less than one quarter of the historic detection limit value. An October 2006 sample from USS had a selenium concentration of 0.0002 mg/L. It is likely that the pre-2003 selenium concentrations at this site were in the range of the values measured since 2003.

The perennial portion of South Fork Sage Creek downstream of the canyon begins at the large spring complex known as South Fork Sage Creek Spring. A sample site (LSS) located in the stream channel a short distance downstream from the spring has been monitored since 1979. The stream channel immediately above the spring is typically dry during low flow season and carries water during the spring flood and other major runoff periods. Hence, during low flow, the water at LSS is comprised only of groundwater discharge at the spring whereas during runoff events, it is a mixture of groundwater from the spring with surface streamflow from upstream of the spring. The low flow monitoring data at LSS is likely representative of a combination of aquifer water discharged from the Wells Formation and underflow from within the stream gravels.

During the Panels F and G baseline studies another sample location was established in the stream near LSS. This was called SW-SFSC-800 and data from it are considered herein to be equivalent to LSS. Another sample location in the spring discharge area upstream from LSS was established during the EIS baseline studies and was called SP-SFSC-750. It is also essentially the same flow as LSS during low flows and data from it are also considered herein to be equivalent to LSS.

Low flow samples from LSS have typically had low selenium concentrations. The first low flow sample obtained in October 1979 had a selenium concentration reported at the detection level (0.001 mg/l) (**Table 3**). Similar to USS, the reported value at this site may have been lower if the detection level were lower. The next low flow sample was not taken until 1992 at which time the selenium concentration was 0.003 mg/L. With few exceptions all the low flow samples from 1992 through 2004 have had selenium concentrations of 0.002 mg/L with an average selenium concentration of 0.0018 mg/L. This suggests that some source of selenium affects the low flow water quality at LSS to a value higher than expected from the baseline water quality at MC-MW-1 and USS. This could be from natural causes, or it could be due to impacts from the Smoky Canyon Mine. A detailed understanding of the local hydrogeology is not currently available to adequately delineate the seasonal difference in selenium concentrations at LSS. Its unclear whether water quality is influenced by the dilution of a constant load from groundwater discharge at South Fork Sage Creek Spring or the seasonal influence on selenium loading from the same sources as Hoopes Spring. NewFields (2007b) suggests that selenium concentrations at LSS are influenced by the same sources as Hoopes Spring, but to a lesser degree. In their Site Investigation Report, NewFields correlates contamination with the Pole Canyon Overburden Disposal Area (ODA) source. Construction of the fill began in 1983. The influence of the Pole Canyon fill could potentially have been present at LSS in 1993.

In September and October 2005 the low flow selenium concentrations at LSS increased to 0.0043 and 0.0033 mg/L respectively. The October 2006 concentration was 0.0056 mg/L and the January 2007 concentration was 0.0081 mg/L.

The high flow samples from LSS had an average total selenium concentration of 0.0015 mg/L (**Table 3**). Many of the high flow samples at LSS from before 2003 were reported at the detection limit (0.001 mg/L). For the same reasons as were discussed for USS above, the values of some of these samples, using a lower detection limit, could have been lower. The May 2006 high flow sample at the site had a total selenium concentration of 0.0019 mg/L.

Hoopes Spring has also been monitored since 1979. The average selenium concentration at this site from 1979 through 1995 was 0.0023 mg/L (**Table 4**). During 1995 and 1996 the concentration increased to 0.003 mg/L. The concentration increased again in 1997 and began an upward trend that continues to the present time. The average from 1997 through 2000 was 0.0066 mg/L. The average from 2001 through 2003 was 0.0118 mg/L and 0.0145 mg/L for 2004 through 2006. The concentration for a January 2007 sample was 0.0192 mg/L. This increased selenium concentration at Hoopes Spring is attributed to leaching of selenium from the cross-valley overburden fill placed in Pole Canyon starting in 1983 (NewFields, 2005). It may also be attributed, in part, to the Panel E operations as discussed later in this report. This contamination apparently enters the Wells Formation aquifer downgradient of the overburden fills and migrates in the aquifer to Hoopes Spring where it discharges to the surface.

Figure 3 presents a graph of selenium concentrations in HS and LSS for a 7-year period (1991-1998) prior to any significant mining at the Smoky Canyon Mine Panel E. During that period, selenium concentrations at Hoopes Spring trended upward from about 0.003 to 0.005 mg/L; indicating some influence from the Smoky Canyon operations north of HS at that time. During the same period, a uniform selenium concentration pattern of about 0.002 mg/L or less during low flow and 0.001 mg/L or less during high flow periods can be observed for LSS.

Figure 4 highlights selenium concentrations in Hoopes Spring and LSS for the period from 1999 to 2004. Better paired flow and concentration data are available for this period and both are provided. During this period, LSS remained fairly consistent with prior years in terms of seasonal selenium concentrations. With a few exceptions, the HS selenium concentrations exhibited an obvious increasing trend. According to NewFields (2007b) closer examination of the fluctuations in selenium concentrations in Hoopes Spring indicates that the average selenium concentration increased to just over 0.010 mg/L and the observed fluctuations in concentration are not necessarily consistent with the steady seasonal pattern observed for LSS, suggesting that an additional source may be sporadically influencing selenium concentrations at Hoopes Spring. Review of mining history at Panel E during this period provides additional insight.

1998:

- Haul road was built to north end of E-1
- E-1 north was opened up
- E-1 overburden was used to construct roads, backfill D-panel, placed in external ODA
- Settlement basins were built around Panel E

1999:

- All mining took place in north end of E-1pit
- Middle wastes from the E-1 pit were placed in the D-panel backfill, in the middle and south of the Panel E external ODA. These areas on the ODA were capped with 50 feet of chert

2000:

- All mining took place in the E-1 pit
- Overburden was placed into the external ODA
- Middle wastes were used to backfill D-3 pit and placed in the northern end of E-1 pit
- Chert was used to cap the middle wastes with 10 feet inside the pit areas and 50 feet on the external ODA

2001:

- All mining took place in the Panel E
- Stripping and overburden removal took place in E-1 south, E-2 and E-3 pits
- Middle wastes were placed in the north end and the middle of E-1 pit
- The north end of E-1 was capped with a minimum of 10 feet of chert
- The middle section of E-1 was capped with chert ranging from 10 feet to 100 feet

2002:

- All mining took place in Panel E
- Middle waste were placed as backfill in the E-1 pit
- Chert was stockpiled for future capping material
- Chert and limestone were used for capping and road building
- The north end of E-1 was shaped, capped and topsoiled

2003:

- Mining took place in the E-2 pit and began in the E-0 North pit
- Middle wastes were placed in the E-3, E-2, and E-1 areas
- Chert from the Panel E was stockpiled for future capping material
- E-1 north was reclaimed. (Approx 20% of E-panel is reclaimed)
- External ODA – the north and south ends were reclaimed. (Approx 66% is reclaimed)

2004:

- Mining continued in the E-0 North pit
- Middle wastes were placed in the E-3, E-2, and E-1 areas
- Chert from the Panel E was stockpiled for future capping material
- E-2 and E-3, a portion of the southern end of the pits was reclaimed (7 acres)

2005:

- Mining commenced in the E-0 South pit and backfilling took place in E-0 North pit
- Chert from the south E-0 pit was stockpiled for future capping material
- Middle wastes were placed in the E-3, E-2, and E-1 areas
- Sloping continued on most of E-2, and E-3 pits

The mining pattern of working within the Panel E gradually from north to south provides a potential explanation as to why sporadic increases in selenium concentrations were observed at Hoopes Spring through 2004, but the same pattern is not evident at LSS during this period. During the initial period of Panel E development, the open pit area was in the northern portion of the Panel (E-1 pit and E-0 North pit). Northern E panel development is located more directly upgradient of Hoopes Spring than South Fork Sage Creek Spring. The E-0 South pit may be located downgradient of Hoopes Spring and upgradient of South Fork Sage Creek Spring. E-0 mining did not commence until 2005.

Figure 5 provides the same flow and concentration data as **Figure 4** for the years 2004 through 2007. The selenium concentration at LSS in September and October 2004 was 0.0018 and 0.001 mg/L respectively. In September and October of 2005 it was 0.0043 and 0.0033 mg/L respectively. This increased to 0.0056 mg/L in October 2006. The January 2007 concentration of 0.0081 mg/L is the highest reported at sampling location LSS. Based on available data, there appears to be a trend of increasing selenium concentration at LSS at low flow that started in 2005 and continued through 2007.

Panel E Source/Pathway Relationships

Panel E contains the closest mine disturbances at Smoky Canyon Mine to Hoopes Spring and South Fork Sage Creek Spring. Mining began in this area in 1998 and gradually disturbed 351 acres. Because of the faulted nature of the orebody in this panel, the mining occurred first in the western (upper) part in the E-1 pit and in the northern end of the Panel. Mining and backfilling proceeded southward in E-1 and then the E-2 and E-3 pits from 1998 through about 2004 (**Figure 2**). With the exception of the south E-2 and E-3 pits, and the southern tip of the ODA, all the disturbance prior to 2005 was located upgradient (due west or northwest) of Hoopes Spring and therefore more likely to affect it than South Fork Sage Creek Spring. According to NewFields (2007b), while the overall selenium concentration of about 10 mg/L at Hoopes Spring may be due to the Pole Canyon ODA, the erratic changes in selenium concentration at Hoopes Spring from about 2000 through 2004 may be due, in part, to local influences of Panel E mining operations.

The E-0 pit is potentially an important component of the selenium source at Panel E. It was the last pit opened in Panel E, begun in 2003 and mined through 2006. It is the closest pit to the West Branch Sage Valley Fault zone that conveys groundwater from the Wells Formation aquifer to Hoopes Spring and South Fork Sage Creek Spring; lying about a half mile west (upgradient) of the fault zone. Because it is located furthest east in the mine panel, it was a convenient location to dispose of runoff from the uphill mine disturbance to the west and this added to the water that collected directly on the pit area due to precipitation and snowmelt.

Significantly, a fault-zone is exposed along the entire high-wall (west side) of the E-0 pit, which was an unexpected occurrence. Stratigraphic offset is evident (E-1 is up thrust relative to E-0), and the fault damage zone caused problems with high-wall stability during mining in E-0. The fault penetrates into the Wells Formation in the pit bottom and could therefore act as a preferential flow path for mine water collecting in the pit bottom to percolate rapidly downward to the underlying Wells Formation aquifer. This would have the effect of accelerating the movement of dissolved selenium in the mine water to the Wells Formation aquifer and reducing the effectiveness of selenium attenuation due to the preferential flow path.

In 2005, mining in the E-0 pit continued to its southern extent. It could be that the southern portion of this pit lies far enough south that seepage may bypass Hoopes Spring and migrate in the Wells Formation aquifer to South Fork Sage Creek Spring.

There are potential Panel E source/pathway relationships to consider with regard to the 2006 increase in selenium concentration at LSS. In 2006, the configuration of the E-panel was generally as follows:

E-0: The middle of the E-0 pit was filled with seleniferous run-of-mine (ROM) material. This material was placed to facilitate access to the E-1, E-2, and E-3 areas. The E-0 South pit contained ramps built from ROM material. The ROM material present in the E-0 backfill is predominantly center waste shale with little chert.

E-1: E-1 was the largest of the pits in Panel E. E-1 was approximately 20 percent reclaimed; the reclaimed area was on the north end adjacent to Sage Creek. The majority of the E-1 pit was backfilled and ready for shaping. A large amount of chert was stockpiled in the middle of E-1 awaiting placement as a chert cap on E-2 and the remaining open portion of E-1. The very south end of E-1 was open to Wells Formation limestone. The open south end of E-1 received runoff water from upper slopes and the haul road areas.

E-2: E-2 was the second largest pit in the Panel E, although it was only slightly larger than E-0. E-2 was 95 percent backfilled and shaped. A chert cap had been placed over 40 percent of the shaped material, and the chert-capped area was ready for topsoil.

E-3: E-3 was the smallest pit in the Panel E. All of E-3 was backfilled, shaped and had a chert cap. E-3 was ready for topsoil and seeding.

Mining in the E-0 pit was completed in February 2006. E-0 was mined in two segments, “E-0 North” and “E-0 South.” E-0 North was mined out first. Roads were built on the very north end of E-0 North to gain access to the lowest ore in the pit. The roads were constructed of ROM overburden material. ROM material from mining in E-0 South was hauled to the southern end of E-0 North for disposal. Roads were then constructed on the very south end of E-0 South to gain access to the lowest ore in the pit. The E-0 South roads were also constructed of ROM material. Although parts of it were backfilled with ROM material, none of the E-0 pit area had been reclaimed through 2006. In fact, the E-0 South pit is not planned to be fully backfilled or reclaimed until overburden from Panel F is available.

Smoky Canyon Mine has experienced drought for a number of years. This began to change in 2004 with significant rainfall in May-June and August-October 2004 (**Figure 6**). The winter of 2004/2005 was dry and there was significant rainfall in May-June 2005. The winter of 2005/2006 was wet as was April-May 2006 when a large amount of runoff water reportedly was routed to the E-0 South pit for disposal and contacted center waste shale placed in the unreclaimed pit (NewFields 2007b). Water infiltrating through the center waste shale would have entered the Wells Formation through the pit floor. A similar scenario was observed and described for the Panel A and Culinary/Industrial Wells in 2005 (refer to 1/29/07 Technical Memorandum Attachments for the Technical Evaluation prepared by J.R. Simplot Company) and again in 2006. At Panel A in 2005, a rapid increase in selenium concentration was observed at the Culinary Well following a period of high precipitation, runoff, and direct recharge to the Wells Formation through ROM overburden in the unreclaimed Panel A. In comparison, the distance from the Panel A recharge area to the Culinary Well is less than the distance from Panel E to the South Fork Sage Creek Spring. In addition, the local drawdown associated with the pumping of the Culinary and Industrial wells near Panel A would likely speed transport from below the runoff recharge areas to those wells. According to NewFields (2007b), a slug of contamination traveled from Panel A to the Culinary Well within a few months. NewFields contends a slug of water from the floor of E-0 pit could travel to the South Fork Sage Creek Spring in less than a year.

Another potential source of selenium in the Panel E area is the seepage from the south end of the Panel E external overburden disposal area (ODA). The north part of this ODA is comprised of chert whereas the south end of the ODA contains seleniferous ROM overburden (**Figure 7**). This ODA is the closest potential source of selenium seepage to HS of any of the components of the Smoky Canyon Mine. The southern end of this ODA is also the closest source of selenium leachate to South Fork Sage Creek Spring and LSS. The northern chert portion of the ODA and the east half of the southern ROM portion of the ODA have been regraded; covered with a layer of chert; and topsoiled and revegetated. The rest of the ODA has not been reclaimed at the time of this report. Monitoring location ES-4 is a seep that developed at the topographic low on the east toe of the ROM portion of the ODA. Site ES-5 is another seep whose surface flow is to the south, towards the detention basin EP-5. Water from both ES-4 and ES-5 has high concentrations of selenium. This ODA is located over Wells Formation outcrop and seleniferous water seeping out of this fill can migrate to the Wells Formation aquifer. Table 5 shows the chemistry and flow rate for ES-4 and ES-5. Monitoring of these seeps began in 2002 and monitoring data is available through 2005 in the Site Investigation Report.

NewFields (2007b) suggests that the amount of seepage from this external ODA is relatively small in comparison to the amount of water that infiltrated through the bottom of the E-0 South and other pits in Panel E in 2006. They contend the transport pathway through the unsaturated Wells Formation under the ODA is less direct than through the fault zone in the E-0 pit.

In summary, according to NewFields (2007b), the information available to evaluate recent selenium concentration increases at LSS, and possibly HS, is consistent with a larger selenium contribution from Panel E sources than from the Pole Canyon ODA. Increased selenium concentration resulted from the construction of the E-0 pit in the last few years, combined with previous mining activities at E-1 and relatively higher precipitation in late 2005 and early 2006. The increase in selenium concentration at LSS started in 2005 and has continued into January 2007. The partially backfilled E-0 and E-1 pits in the southern Panel E are new and are receiving the bulk of the runoff from the unreclaimed portions of the Panel E. In the vicinity of the E-0 pit, the vertical distance for transport through the unsaturated zone (i.e., depth to the Wells Formation aquifer) is relatively short and seepage movement from the pit bottom to the water table may be accelerated by preferential flow through the fault zone along the base of the highwall. In addition, the lateral distance from the E-0 pit east to the West Sage Valley Branch Fault is relatively short. The potential for selenium transport from local sources is supported by recent observations at Panel A and the mine's Culinary Well during and after several months of high precipitation in early 2005.

Effect of Pole Canyon Removal Actions and Closure/Reclamation of the Panel E on Selenium in South Fork Sage Creek and Hoopes Springs

Based on the above analysis, NewFields (2007b) provided one interpretation of the existing data, which the Agencies view as preliminary due to the limited amount of information available since the discovery of the elevated selenium concentrations at LSS. In their interpretation, NewFields suggested that the base selenium concentrations in South Fork Sage Creek and Hoopes Spring attributable to the relatively constant Pole Canyon source term are approximately 0.002 mg/L and 0.010 mg/L, respectively. Prior analysis provided by NewFields in the CERCLA Engineering Evaluation/Cost Analysis of the expected effectiveness for Pole Canyon Removal Actions on Hoopes Spring selenium concentrations predicted a 75% reduction in selenium load (June 2006 memo to Mary Kauffman). If this reduction is realized, the expected selenium load reduction translates into a corresponding estimate for reduction in selenium concentration at Hoopes Spring. By applying this reduction factor to the base selenium concentrations NewFields (2007b) estimated a future, long-term concentration of 0.0005 mg/L at South Fork Sage Creek Spring (LSS), attributable to the source at Pole Canyon and 0.0025 mg/L at Hoopes Spring (HS) roughly 10 to 15 years after the 2007 completion of the Pole Canyon Removal Actions, exclusive of the Panel E contribution. Future data collection at Hoopes Spring and South Fork Sage Creek Spring, following the initial removal actions implemented at the Pole Canyon ODA, will facilitate further understanding of the Pole Canyon ODA influence at Hoopes Spring and South Fork Sage Creek Spring.

The remainder of the selenium loading to Hoopes Spring and South Fork Sage Creek Spring was attributed by NewFields (2007b) to current contributions from infiltration at the Panel E. Using the recent maximum concentration for South Fork Sage Creek of 0.008 mg/L and subtracting the previous 0.002 mg/L low flow average, an increase of 0.006 mg/L was attributed to a slug of selenium-impacted infiltration from the Panel E. Using the same approach, NewFields (2007b) calculated with the recent maximum of approximately 0.018 mg/L and a baseline of 0.010 mg/L, the increase attributed to Panel E for Hoopes Spring is 0.008 mg/L. These values provide one basis against which to evaluate the expected improvements in selenium concentrations associated with closure of the Panel E. This is one interpretation of the available data and is subject to revision as additional field data is collected from the existing monitoring sites, and additional investigation is conducted as to the source(s) of the selenium contamination at LSS.

Figure 7 describes the general setting for the mining activities for Panel E in fall 2004 (pit back fill, open pit, external ODAs, and runon areas). Although all of these areas may contribute contaminated runoff and leachate water, which has contacted overburden prior to infiltrating to the Wells Formation, the focus of the NewFields analysis was on the effects of the Panel E pits. They stated that the leachate contribution for a given area of the Panel E could be defined by the annual infiltration rates developed (Knight-Piesold 2006) to support EIS impact assessment activities for the proposed Panels F and G. The Knight-Piesold analysis provides infiltration rates relevant to the current setting of the Panel E and at closure. Because the Knight-Piesold report does not provide a seepage rate for unconsolidated overburden present during active mining, an assumed value of the mid-point between the rates for open pit (21.5 in/yr) and overburden covered with 8 feet of chert (5.3 in/yr) was used by NewFields as an infiltration rate estimate for these areas. Additionally, a mid-point value of 4.0 in/yr between a chert cover (5.3 in/yr) and a mature chert and soil cover (2.8 in/yr) was selected by them for reclaimed areas with immature vegetation cover.

Setting	Average Infiltration Rate (in/yr)
Open Pit	21.5
8’ Chert Cover	5.3
8’ Chert Cover 2’ Soil Immature Cover Vegetation	4.0
8’ Chert 2’ Soil Mature Cover Vegetation	2.8
Unconsolidated Overburden	13.1

The above values were described by NewFields (2007b) to be conservative given the setting in 2005 and 2006, where much of the water moving through overburden was directed towards the open portions of the E-0 and E-1 pits. Additionally, E-0 intercepts a fault fracture zone that enhances vertical infiltration to the Wells Formation aquifer. Applying these infiltration rates to the Panel E areas identified in **Figure 8**, and accounting for run on to the open areas of Panel E from the mountain slope to the west, NewFields calculated the following conditions in 2006:

2006 Conditions	Average Net Percolation Rate (Acres in/yr)			
Open Pit/High Wall	53.2 Acres	X	21.5 in/yr=	1143.8
Unconsolidated Overburden/Chert	175.8 Acres	X	13.1 in/yr =	2302.98
8’ Chert Cover/Haul Roads	53.2 Acres	X	5.3 in/yr =	281.96
Soil Cover with Immature Vegetation Chert/ROM	68.8 Acres	X	4.0 in/yr =	275.2
Run On	142.7 Acres	X	3.0 in/yr =	428.1
Total				4432.04

Under the 2006 conditions it was estimated that 4432 acre in/yr of water were in contact with overburden infiltrated to the Wells Formation.

In contrast, at the time of closure and full reclamation, the expected infiltration conditions that could result in ongoing selenium transport were estimated as follows:

Reclaimed Condition	Average Net Percolation Rate (Acres in/yr)			
2 – 4’ of Chert and 2’ of Soil	321 Acres	X	2.8 inches/yr=	898.8
Panel E Test Program Deep Dinwoody Cover	30 Acres	X	0.7 inches/yr=	21
Total				919.8

Although chert capping was not required as part of the Panel E mine plan approval, Simplot plans to apply at least a 2- to 4-foot chert cap below 2 feet of soil as a Best Management Practice (BMP) in all reclaimed areas. This plus the 2-foot topsoil cover is expected to provide the same net average annual infiltration rate established by Knight-Piesold for the Proposed Action cover for Panels F and G (2.8 in/yr). In addition, a 30-acre, low infiltration store and release cover, described as Alternative D in the Panels F and G FEIS, is planned for the E-0 South pit backfill as part of the test cover program. Net infiltration analyses conducted for this cover design for Panels F and G indicated that this cover would have an average annual net percolation rate to the Wells Formation aquifer of 0.7 in/yr or less.

Much of the closure of Panel E is scheduled to be completed in 2007 and 2008 (E-1, 2, 3 and external areas). E-0 will not be fully backfilled and reclaimed until overburden from Panel F is available. The benefit of reclamation in terms of reducing infiltration will be incremental as the overburden is consolidated and covers are developed. The primary actions from reclamation on reduction of infiltration of water through the overburden are:

- Regrading all disturbed areas to more natural slopes with no internal ponding areas to collect runoff and allow it to infiltrate into the overburden;

- Consolidating and covering ROM overburden with chert and topsoil to minimize contact of surface water with seleniferous overburden and reduce infiltration rates directly into ROM material;

- Covering all regraded areas with topsoil that has a lower infiltration rate and moisture retention capacity than ROM overburden or chert, thereby increasing the runoff rate and reducing infiltration into the ground surface;

- Establishing perennial vegetation over all reclaimed areas to stabilize the topsoil from erosion and also provide evapotranspiration to seasonally remove water in storage from the rooting zone; and

- Constructing 30 acres of store and release cover on the backfilled E-0 South pit.

It is expected that 5 years after grading and seeding the vegetation cover will be fully established and the above infiltration goals will be achieved.

The NewFields analysis resulted in an estimated reduction in annual infiltration through the Panel E area of approximately 80% relative to 2006. Based on the knowledge that the near-term mass of selenium transported from overburden is proportional to the volume of water infiltrating through the overburden, the comparison provides a conservative basis for evaluating the expected decrease in selenium loading from Panel E closure. When the 80% reduction was applied to the portion of the selenium load attributed by NewFields to Panel E at Hoopes Spring (0.008 mg/L) and Sage Creek (0.006 mg/L), the expected future Panel E contributions are estimated to be 0.0016 and 0.0012 mg/L, respectively. In combination, the expected effectiveness of the Pole Canyon Removal Actions and the Panel E closure resulted in the following future concentrations:

Location	**Predicted Pole Canyon Post-Removal Action Contribution**	**Estimated Panel E Contribution Post-Closure**	**Estimated Future Concentration**
South Fork Sage Creek at LSS	0.0005 mg/L	0.0012 mg/L	0.0017 mg/L
Hoopes Spring at LS	0.0025 mg/L	0.0016 mg/L	0.0041 mg/L

NewFields considers their analysis to be conservative for the following reasons:

- Precipitation moving through unconsolidated overburden fills draining to open areas of the pit floors is likely to have a higher percolation rate than 13.1 in/yr;

- Unconsolidated ROM overburden fill is more susceptible to leaching than consolidated, covered and reclaimed overburden;

- The leaching potential of overburden is expected to diminish with time following covering with chert and topsoil;

- Attenuation of selenium in the unsaturated zone is likely more effective at lower flow rates dispersed throughout the vadose zone matrix and is also more effective at the lower concentrations expected following reclamation; and

- Using selenium concentrations observed at HS versus the downstream end of Hoopes Spring (HS3) substantially over estimates the average concentration for Hoopes Spring. HS represents only a portion of the flow for the Hoopes Spring discharge and is typically much higher in concentration than HS-3, which represents the entire discharge.

NewFields predicts that actual LSS and HS concentrations, within 5 to 10 years after closure of the Panel E, would be lower than indicated by the above analysis.

Future Fluctuations in Flow Rates at Hoopes Spring and South Fork Sage Creek Spring

Prior analysis indicates that large loads of selenium can be transported under active mining conditions during spring runoff and/or isolated brief periods of substantial precipitation. These events can result in relatively large volumes of water passing through uncovered or partially covered ROM overburden and entering the surface and groundwater systems. These conditions have been observed at the Pole Canyon ODA and at open Panels A and E. At the Pole Canyon ODA, a rapid increase in flow rate through the overburden is observed to result in an increase in selenium concentration and load. As flow in the overburden increases, the selenium load and concentration in the water as it exits the overburden also increases. A similar condition occurs when large volumes of water are introduced to a pit that contains overburden backfill, and has not yet been reclaimed. Flow of water through the ROM backfill and subsequent infiltration through the pit floor, which is likely open to the Wells Formation limestone under normal mining conditions, can be coincident with increases in precipitation and/or runoff. NewFields (2007b) said for open or partially reclaimed Panels A and E, the volume of water in contact with the overburden and subsequently infiltrating is disproportionately large in comparison to the overall increases in water in the system. For example, the infiltration rate of an open or partially reclaimed pit can be as high as 7 times that of adjacent native ground. At the same time, the concentration (relative mass of selenium) in these “slugs” of water can also be disproportionately high. The combined effect is to introduce a relatively large volume of higher concentration water into the system over a short period of time.

NewFields predicts that at the time mine closure/reclamation is accomplished, the relative infiltration rates will become roughly similar to or less than the surrounding natural terrain and therefore proportional to any increases or decreases in natural recharge water in the combined surface water and groundwater systems. In addition, the concentration of selenium in that infiltration can also be less than during active mining for the reasons stated above. This results in an even larger proportionate reduction in selenium loading, relative to any local or regional increase or decrease in the volume of water in the surface and groundwater systems from natural recharge. In the case of Panel E, pit closure is expected to substantially reduce infiltration and reduce the contribution to volume of flow at South Fork Sage Creek Spring and, at the same time, provide an even greater reduction in selenium loading to the spring under all flow regimes.

Suggested Near-Term Actions

The analysis provided by NewFields (2007b) is one interpretation of the available information. Further characterization of the South Fork Sage Creek area is warranted. Additional groundwater and surface water monitoring in the vicinity of South Fork Sage Creek should be included in the upcoming Effectiveness Monitoring Program for the Pole Canyon Removal Actions (NewFields, 2006) and considered in any future remedial investigation efforts. Action items under consideration related to the draft Effectiveness Monitoring Program include:

- More frequent water quality monitoring of South Fork Sage Creek at LSS, LSS-SP1, LSS-SP2 and Hoopes Spring (e.g., monthly); and

- Placement of at least one new monitoring well in the Wells Formation between the E-0 South pit and South Fork Sage Creek Spring.

These additional data will also be used to support the upcoming remedial investigation and feasibility study and final remedial decisions regarding the remainder of the source areas previously evaluated in the Site Investigation/Engineering Evaluation Cost Analysis (SI/EECA).

Other actions also appear warranted to minimize the potential for future transport from the un-reclaimed portions of the Panel E operations. Under current reclamation plans in Panel E, Simplot plans to:

- Divert the upslope runoff that currently enters the E-0 South pit to the chert overburden stockpile on the north end of Panel E; and

- Divert runoff that currently drains into the south end of the E-1 pit to the chert overburden stockpile.

Additional possible response actions or pilot work would include modifications to surface-runoff controls at Panel E to divert water around open pits. Work would include:

- Diversion of a portion of the runoff entering the E-0 pit to the adjacent natural slope with capture in down-slope detention basins.

These and similar actions are intended to limit infiltration of surface water through seleniferous overburden and footwall shales while pit backfilling and final contouring for reclamation are completed.

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Data Tables

Table 1
MC-MW-1 Selenium

		Se (d) mg/L		
MC-MW-1	10/30/2003	0.00049	0.00049	
MC-MW-1	5/19/2004	0.00066	0.00066	
MC-MW-1	6/24/2004	<0.0003	0.00015	
MC-MW-1	5/24/2005	<0.0002	0.0001	
MC-MW-1	5/19/2006	0.00037	0.00037	*0.000354 Avg 2003 - 2006*

Table 2
USS Selenium

			Se(t) mg/L	Low Flow Se(t) mg/L		
S Fk Sage Ck	USS	6/4/1979	0.01			
S Fk Sage Ck	USS	5/15/1992	0.001			
S Fk Sage Ck	USS	5/15/1993	0.001			
S Fk Sage Ck	USS	5/15/1994	0.001			
S Fk Sage Ck	USS	9/15/1995	0.001	0.001		
S Fk Sage Ck	USS	5/15/1996	0.001			
S Fk Sage Ck	USS	9/15/1996	0.001	0.001		
S Fk Sage Ck	USS	5/15/1997	0.001			
S Fk Sage Ck	USS	9/15/1997	0.001	0.001	*0.001*	*Avg 1992 to 2002*
S Fk Sage Ck	USS	5/15/1998	0.001			
S Fk Sage Ck	USS	5/15/1999	0.001			
S Fk Sage Ck	USS	5/15/2000	0.001			
S Fk Sage Ck	USS	5/16/2002	0.001			
S Fk Sage Ck	USS	5/21/2003	0.001			
S Fk Sage Ck	USS	5/22/2003	0.001			
S Fk Sage Ck	USS	10/26/2003	0.0002	0.0002		
S Fk Sage Ck	USS	5/7/2004	0.00088			
S Fk Sage Ck	USS	7/20/2004	0.0003	0.0003		
S Fk Sage Ck	USS	9/19/2005	0.0002	0.0002		
S Fk Sage Ck	USS	5/23/2006	<0.0002			
S Fk Sage Ck	USS	10/16/2006	0.0002	0.0002	*0.000225*	*Avg 2003 to 2006*
S Fk Sage Ck	USS-1	9/1/1997	0			
S Fk Sage Ck	USS-1	9/15/1997	1E-04			
S Fk Sage Ck	USS-2	9/1/1997	0			
S Fk Sage Ck	USS-2	9/15/1997	-0.00032			
S Fk Sage Ck	USS-2	5/1/1998	0.00071			
S Fk Sage Ck	USS-2	5/17/1998	0.00071			
S Fk Sage Ck	USS-2	9/1/1998	0.00055			
S Fk Sage Ck	USS-2	9/15/1998	0.00055			
S Fk Sage Ck	USS-2	9/16/1999	0.00036			
S Fk Sage Ck	USS-2	5/1/2000	0			
S Fk Sage Ck	USS-2	5/16/2000	-0.00017			
S Fk Sage Ck	USS-2	6/22/2000	0.001			

Table 3
LSS Selenium

			Se(t) mg/L		Low Flow Se(t) mg/L	High Flow Se(t) mg/L
S Fk Sage Ck	LSS	6/6/1979	0.01	U		
S Fk Sage Ck	LSS	10/2/1979	0.001	U	0.001	
S Fk Sage Ck	LSS	5/15/1992	0.003			0.003
S Fk Sage Ck	LSS	9/15/1992	0.003		0.003	
S Fk Sage Ck	LSS	5/15/1993	0.001			0.001
S Fk Sage Ck	LSS	9/15/1993	0.002		0.002	
S Fk Sage Ck	LSS	5/15/1994	0.001			0.001
S Fk Sage Ck	LSS	9/15/1994	0.002		0.002	
S Fk Sage Ck	LSS	5/15/1995	0.001	U		0.001
S Fk Sage Ck	LSS	9/15/1995	0.002		0.002	
S Fk Sage Ck	LSS	5/15/1996	0.001	U		0.001
S Fk Sage Ck	LSS	9/15/1996	0.002		0.002	
S Fk Sage Ck	LSS	5/15/1997	0.001	U		0.001
S Fk Sage Ck	LSS	9/15/1997	0.002		0.002	
S Fk Sage Ck	LSS	5/15/1998	0.001			0.001
S Fk Sage Ck	LSS	9/1/1998	0.002	A *	0.002	
S Fk Sage Ck	LSS	9/15/1998	0.001		0.001	
S Fk Sage Ck	LSS	9/15/1998	0.002	A *	0.002	
S Fk Sage Ck	LSS	5/15/1999	0.001	U		0.001
S Fk Sage Ck	LSS	9/15/1999	0.002		0.002	
S Fk Sage Ck	LSS	9/16/1999	0.0017	A *	0.0017	
S Fk Sage Ck	LSS	5/15/2000	0.001			0.001
S Fk Sage Ck	LSS	5/16/2000	0.00087	A *		0.00087
S Fk Sage Ck	LSS	6/22/2000	0.002			0.002
S Fk Sage Ck	LSS	9/15/2000	0.002		0.002	
S Fk Sage Ck	LSS	9/26/2000	0.001	U	0.001	
S Fk Sage Ck	LSS	5/15/2001	0.001			0.001
S Fk Sage Ck	LSS	9/15/2001	0.002		0.002	
S Fk Sage Ck	LSS	5/15/2002	0.004	J		0.004
S Fk Sage Ck	LSS	10/17/2002	0.002		0.002	
S Fk Sage Ck	LSS	5/21/2003	0.001			0.001
S Fk Sage Ck	SFSC-750	8/12/03	0.001		0.001	
S Fk Sage Ck	SFSC-800	8/12/03	0.00053		0.00053	
S Fk Sage Ck	LSS	10/26/2003	0.0023		0.0023	
S Fk Sage Ck	LSS	2/5/2004	0.002		0.002	
S Fk Sage Ck	LSS	5/7/2004	0.00068			0.00068
S Fk Sage Ck	SFSC-800	5/18/2004	0.0021			0.0021
S Fk Sage Ck	LSS	7/20/2004	0.003		0.003	

					Low Flow		High Flow	
			Se(t) mg/L		Se(t) mg/L		Se(t) mg/L	
S Fk Sage Ck	SFSC-750	9/28/2004	0.0018		0.0018			
S Fk Sage Ck	SFSC-750	10/13/2004	0.001		0.001	*0.0018*	*Avg Low Flow 1992 - 2004*	
S Fk Sage Ck	LSS	5/19/2005	0.0016				0.0016	
S Fk Sage Ck	SFSC-750	5/25/2005	0.0014				0.0014	
S Fk Sage Ck	LSS	9/19/2005	0.0043		0.0043			
S Fk Sage Ck	SFSC-800	10/19/2005	0.0033		0.0033			
S Fk Sage Ck	SFSC-800	5/22/2006	0.002				0.002	
S Fk Sage Ck	LSS	5/22/2006	0.0019				0.0019	
S Fk Sage Ck	LSS	10/16/2006	0.0056		0.0056			
S Fk Sage Ck	LSS	1/13/2007	0.0081	d	0.0081	*0.0053*	*Avg Low Flow 2005 - 2007*	
							0.0015	*Avg High Flow 1992 - 2007*

Table 4
HS Selenium

			Se(t) mg/L		
Hoopes Spring	HS	6/4/1979		0.01	not used
Hoopes Spring	HS	10/2/1979	0.001		
Hoopes Spring	HS	9/15/1982		0.02	not used
Hoopes Spring	HS	5/15/1984	0.002		
Hoopes Spring	HS	9/15/1984	0.005		
Hoopes Spring	HS	5/15/1985	0.003		
Hoopes Spring	HS	9/15/1985	0.002		
Hoopes Spring	HS	5/15/1986	0.003		
Hoopes Spring	HS	9/15/1986	0.002		
Hoopes Spring	HS	5/15/1987	0.002		
Hoopes Spring	HS	9/15/1987	0.001		
Hoopes Spring	HS	5/15/1988			
Hoopes Spring	HS	9/15/1988			
Hoopes Spring	HS	5/15/1989			
Hoopes Spring	HS	9/15/1989			
Hoopes Spring	HS	5/15/1990			
Hoopes Spring	HS	9/15/1990			
Hoopes Spring	HS	5/15/1991	0.002		
Hoopes Spring	HS	9/15/1991	0.001		
Hoopes Spring	HS	5/15/1992	0.003		
Hoopes Spring	HS	9/15/1992	0.002		
Hoopes Spring	HS	5/15/1993	0.003		
Hoopes Spring	HS	9/15/1993	0.002		
Hoopes Spring	HS	5/15/1994	0.002		
Hoopes Spring	HS	9/15/1994	0.003		
Hoopes Spring	HS	5/15/1995	0.001		
Hoopes Spring	HS	9/15/1995	0.003	*0.002263*	*Avg 1979 - 1995*
Hoopes Spring	HS	5/15/1996	0.003		
Hoopes Spring	HS	9/15/1996	0.003		
Hoopes Spring	HS	5/15/1997	0.003		
Hoopes Spring	HS	9/15/1997	0.004		
Hoopes Spring	HS	5/15/1998	0.004		
Hoopes Spring	HS	9/15/1998	0.005		
Hoopes Spring	HS	5/15/1999	0.007		
Hoopes Spring	HS	9/15/1999	0.008		
Hoopes Spring	HS	5/15/2000	0.01		
Hoopes Spring	HS	6/22/2000	0.012		
Hoopes Spring	HS	9/15/2000	0.01		
Hoopes Spring	HS	9/26/2000	0.003	*0.0066*	*Avg 1997 - 2000*
Hoopes Spring	HS	5/15/2001	0.01		
Hoopes Spring	HS	9/15/2001	0.012		
Hoopes Spring	HS	5/16/2002	0.011		
Hoopes Spring	HS	10/17/2002	0.013		
Hoopes Spring	HS	5/20/2003	0.015		
Hoopes Spring	HS	10/28/2003	0.0096	*0.011767*	*Avg 2001 - 2003*

Hoopes Spring	HS	2/5/2004	0.0119		
Hoopes Spring	HS	5/7/2004	0.0097		
Hoopes Spring	HS	7/21/2004	0.0137		
Hoopes Spring	HS	11/9/2004	0.0126		
Hoopes Spring	HS	5/19/2005	0.0148		
Hoopes Spring	HS	9/19/2005	0.0135		
Hoopes Spring	HS	5/17/2006	0.0189		
Hoopes Spring	HS	5/22/2006	0.0162		
Hoopes Spring	HS	6/22/2006	0.0168		
Hoopes Spring	HS	10/16/2006	0.0167	*0.01448*	*Avg 2004 - 2006*
Hoopes Spring	HS	1/13/2007	0.0192	d	

Table 5
ES-4, ES-5 Selenium

			Se(d) mg/L	Se(t) mg/L	cfs
Panel E ODA	ES-4	5/14/2002	5.3	4.2	0.145
Panel E ODA	ES-4	10/17/2002	3.13	3.4	0.01
Panel E ODA	ES-4	5/21/2003	12	12.4	0.004
Panel E ODA	ES-4	10/29/2003	7.8	10.6	0.0023
Panel E ODA	ES-4	5/18/2004	13.3	13.6	0.002
Panel E ODA	ES-4	7/23/2004	11.4	12.5	0.003
Panel E ODA	ES-4	9/19/2005	0.00052	0.00062	0.003
Panel E ODA	ES-4	11/30/2005	11.1	14.6	ND
Panel E ODA	ES-5	5/14/2002	1.6	1.27	0.709
Panel E ODA	ES-5	10/17/2002	1	1.21	0.05
Panel E ODA	ES-5	5/21/2003	1.51	1.43	0.014
Panel E ODA	ES-5	10/29/2003	1.67	1.62	0.005
Panel E ODA	ES-5	5/7/2004	1.61	1.66	0.013
Panel E ODA	ES-5	7/23/2004	2.62	3.26	0.01
Panel E ODA	ES-5	9/19/2005	11.4	15	0.001