APPENDIX A
GEOLOGIC, MINERALOGIC, AND ENVIRONMENTAL CONSIDERATIONS FOR SOUTH FORK COEUR D'ALENE RIVER BASIN DRAINAGES

Information contained in this appendix is based on data and information contained in Hobbs et al. (1965), Derkey et al. (1996), SAIC (1993b and c), Mitchell and Bennett (1983), Gott and Cathrall (1980), maps of mine waste deposits contained in Chapter 2 of this report, maps of mines and mills found in Chapter 2 of this report, and the surface water database (see Chapter 4). References for these sources are identified in Chapters 2, 4, and 10 of this report.

I. Upper South Fork Coeur d'Alene Basin

Ninemile Creek and Tributaries

Geology: East Fork Ninemile Creek cuts predominantly through the South and North Gem stocks. A small section drains the Prichard Formation. The West Fork Ninemile Creek does not intersect the stock at all and instead cuts through the St. Regis Formation near the mouth and the Wallace Formation for most of the central and upper reaches. The Wallace Formation is distinguished from the other Belt Supergroup rock by the presence of abundant carbonate-bearing rocks, including carbonate-bearing argillite and quartzite, dolomite and dolomitic quartzite (Hobbs et al., 1965). Downstream of the confluence of the east and west forks, Ninemile Creek runs through alternating sections (separated by a series of NW-SE-trending faults) of the St. Regis, Revett and Burke Formations upstream of the Osburn Fault (~1 mile from the mouth), and the Wallace Formation downstream of the Osburn Fault. Alluvial deposits (Quaternary alluvium) line the creek bed from the mouth almost to the headwaters of the West Fork and approximately 1/2 mile up the East Fork. The remainder of the East Fork lies directly on bedrock. Blackcloud Creek, a tributary of Ninemile Creek, predominantly drains the St. Regis Formation of the Ravalli Group. However, approximately a one-half mile section near the mouth cuts through the Wallace Formation, which is known to contain carbonate rocks, as noted above. The St. Regis Formation also contains some carbonate-bearing beds (Bennett and Venkatakrishnan, 1982, p. 1855). Many faults, including the Blackcloud fault and the Ruth fault, intersect Blackcloud Creek. Quaternary alluvium lines the lower one-half mile of the creek; the remainder of the creek lies directly on Belt Supergroup bedrock.

Mineralization: The headwaters of Ninemile Creek drain the North Gem Stock, and the Sunset and Carlisle-Hercules Mineral Belts cross this intrusion. Farther downstream, the Rex-Snowstorm Mineral Belt crosses the South Gem Stock and Ninemile Creek. Downstream of the confluence of the east and west forks, Ninemile and Blackcloud creeks drain the Dayrock Mineral Subbelt. There are numerous adits and mines on the East Fork of Ninemile Creek, including the Interstate-Callahan, Tamarack, Rex, Alameda, American, and Success Mines. In addition to subsurface veins, veins associated with the Success Mine outcrop on the eastern side of the drainage approximately one mile from the confluence with the West Fork. The Ninemile, Mayflower, and Treasure Vaults mines and associated adits are located on the upper mainstem Ninemile Creek. Downstream of the confluence of the East Fork and the mainstem Ninemile Creek, there are numerous mines and adits, including the Dayrock, Option, Thomas Consolidated, Silver Star and Panhandle Mines. All these mines are located north of the Osburn Fault, although there are some adits along Ninemile Creek south of the fault near the mouth. The Duluth and Ruth mines in the St. Regis Formation located in the headwaters area on the southern side of Blackcloud Creek. The Monarch, McDonald, Blackcloud No. 3 and Marshall No. 1 mines have underground workings on the northern side of Blackcloud Creek in the St. Regis Formation. The California No. 4 mine is also on the northern side but in the Wallace Formation.

Environmental: Floodplains along the mainstem and the East Fork of Ninemile Creek have been impacted by mining. There are two millsite areas located in upper East Fork Ninemile and another located on the mainstem downstream of the confluence with the mainstem Ninemile Creek. Several large rock dumps are also located along the creek. However, upstream of SF 289, the floodplain has not been impacted by mining and there are no major mine waste deposits. There is a waste rock dump associated with the Sunset mine upstream of SF 289, but it is 1/2 mile above the creek and does not directly drain to the creek. Discharge from the Sunset Tunnel had cadmium, lead and zinc concentrations of 150, 93.1, 24,300 µg/L, respectively on 14 November 1997. There are some mine adits on the upper mainstem Ninemile Creek but no major mine waste deposits, and the floodplain has not been impacted by mining. A number of adits from mines in Blackcloud Creek are located along the creek. However, the only sizable production was out of the Monarch and California mines. Discharge from the Duluth Mine had a dissolved zinc concentration of 109 µg/L on 15 November 1997; all other metal concentrations were low, and the flow was 0.0096 cfs. There are rock dumps along Blackcloud Creek, but no tailings. The floodplain has been impacted by mining along the lower mile of the creek, but this is from the waste rock dumps, not from tailings. A millsite is located near the mouth on the southern side of the creek downstream of SF 302. Samples at NM 289 in the upper reaches of the East Fork, samples in the upper mainstem (NM 299, 300) and samples in Blackcloud Creek did not exceed relevant criterion values. All other samples in the drainage exceeded for one or more aquatic life criterion value.

Canyon Creek

Geology: Upper Canyon Creek (upstream of O'Neill Gulch and O'Neill Gulch Fault) cuts predominantly through the Burke Formation, with the Revett and St. Regis formations underlying the upper headwaters area. Two sections of the Prichard Formation underlie the area just upstream of French Gulch and O'Neill Gulch. Canyon Creek downstream of O'Neill Gulch to Frisco is underlain predominantly by the Burke Formation, with a section around Burke and Frisco cutting through the Prichard Formation. Downstream of Frisco, Canyon Creek cuts through the South Gem Stock for approximately one mile. Downstream of this area, Canyon Creek cuts through alternating sections of the Prichard and Burke formations until it hits the Osburn Fault approximately one mile from the mouth. Like Ninemile Creek, Canyon Creek drains the Wallace Formation from the Osburn Fault to the mouth. Quaternary alluvium lines Canyon Creek from the mouth to approximately 1/2 mile upstream of O'Neill Gulch. Upstream of Sawmill Gulch, Pleistocene glacial and glaciofluvial deposits line the headwaters region of Canyon Creek.

Mineralization: Canyon Creek drains the Tamarack-Marsh, Rex-Snowstorm, Gem-Gold Hunter, and Golconda-Lucky Friday mineral belts. There are many veins known to contain base metals that are associated with the mines along Canyon Creek. Although most of these veins are subsurface, several of the veins outcrop in the Burke area and are on the Prichard-Burke boundary. These outcropping veins are associated with the Sherman, Hummingbird No. 4 and Hidden Treasure mines on the northern side of the creek. There is a concentration of mines between Gem and Dorn on the south side of the creek, including the Gem, Frisco, and Black Bear mines, and another grouping of mines between Mace and Burke both north and south of the creek, including the Hecla, Sherman, and Tiger-Poorman mines. Almost all the mines are located along the Prichard-Burke boundary. The Hercules and Ajax mines are located up Gorge Gulch. The Tamarack and Standard Mammoth mines are located between Dorn and Mace. Upstream of O'Neill Gulch there are several mines, including the Gertie, Ajax No. 3, Oom Paul, and Homestake Silver Lead mines, also in the Prichard or Burke formations, and the Mammoth, West Mammoth, Sonora, and Coeur d'Alene Champion mines in the Revett and St. Regis formations. However, the only producer in this area was the Ajax Mine, and there is no discharge from the Ajax Mine to the creek.

Environmental: Drainage from a mine in the Burke area had a pH of 6.97 and a flow of 1.44 cfs on 13 May 1998. Drainage from the Gem No. 3 Mine had a pH of 6.93 and a flow of 0.581 cfs on 12 May 1998; dissolved zinc and cadmium concentrations were 13,200 and 10.8 µg/L, respectively. Additional monthly data from ASARCO are contained in the Restoration Alternatives Plan (Gearheart et al., 1999). Drainage from the Black Bear adit had a flow of 1.13 cfs on 16 November 1997 and zinc and lead concentrations of 88.6 and 2.23 µg/L, respectively. Most of the floodplain downstream of O'Neill Gulch has been impacted by mining. There is a large tailings impoundment on the left bank of the creek approximately 2 miles upstream of the mouth. At least five millsites are located along the creek from the mouth to downstream of Gorge Gulch. Several rock dumps are located on tributaries and along the mainstem. There is discharge from the Oom Paul Mine, but it is relatively clean. There are fairly

big rock dumps at the Ajax and Gertie mines and a smaller dump at the Oom Paul Mine. Upstream of SF 290 the floodplain has not been impacted by mining. There is a municipal water supply intake at the mouth of Sawmill Gulch. Samples upstream of O'Neill Gulch did not exceed relevant water quality criteria. All other samples in the drainage did exceed relevant water quality criterion values.

Unnamed Creek (SF 201)

This unnamed creek is located on the south side of South Fork Coeur d'Alene River upstream of the Little North Fork. The drainage is not on the geologic map, so no geologic or direct mineralogic information is available. However, the Beacon Light metal mine is located in this drainage, and water quality samples do exceed aquatic life criterion values for dissolved zinc. Because of the presence of the Beacon Light mine, the drainage was considered mineralized.

Little North Fork (SF 202)

The Little North Fork is located north of the South Fork Coeur d'Alene and mostly north of the Osburn Fault. Quaternary alluvium overlies the Wallace Formation for the lower mile of the Little North Fork, and the remainder drains the St. Regis Formation. The eastern tip of the Gem-Gold Hunter Mineral Belt touches the creek near the mouth at the fault. A vein known to contain base metals outcrops at the surface in the Wallace Formation near the mouth of the creek, and the Pandora Mine is located approximately one-half mine upstream of the vein in the St. Regis Formation. There are several mine adits but no large mine waste deposits along the creek. Water samples did not exceed for any relevant aquatic life criterion values.

Unnamed Creek (SF 204)

This unnamed creek is located south of the South Fork Coeur d'Alene River and the Osburn Fault to the west of the Little North Fork. Most of the length of the creek drains the St. Regis Formation. The lower part of the creek drains the Wallace Formation, and Quaternary alluvium lines the creek for the lower 1/4 mile. An unnamed mine in the headwaters region has two sets of veins that are exposed at the surface for approximately 1/8 mile. An adit from that mine in is the drainage. No known mineral belts are located in the drainage, but a portion of the drainage has soil lead concentrations greater than the 60 mg/kg threshold value determined by Gott and Cathrall (1980). No major mine waste deposits are located in the drainage. Of the two sampling dates in November 1997 and May 1998, the 9 May 1998 sample had a dissolved copper concentration of 4.3 µg/L (CCC = 2.74 µg/L); however, the total copper concentration measured on that date was <3 µg/L. All other metal concentrations met water quality standards

Daisy Gulch (SF 206)

Daisy Gulch is located north of the South Fork and the Osburn Fault east of Gentle Annie Gulch. The gulch mostly drains the Wallace Formation and a small piece of the St. Regis Formation just upstream of the Idaho Silver Mine. Quaternary alluvium lines the lower half mile of the gulch. The lower portion of the gulch is in the Gem-Gold Hunter Mineral Belt, where the Idaho Silver Mine is located. This mine is on the Wallace-St. Regis contact zone. The upper part of the gulch drains the Rex-Snowstorm Mineral Belt, where the Snowstorm mines are located. The mines are in the Wallace, St. Regis, and Revett formations. An outcropping vein known to contain base metals is located on the eastern side of the drainage along a tributary. There is an adit associated with this vein, but no underground workings. A rock dump covers the gulch approximately 1/4 mile from the mouth, and another smaller rock dump covers the gulch near the headwaters of the upper east fork. Several mine adits are located along the gulch, and there is significant discharge from the Snowstorm mine. Drainage from the Snowstorm No. 3 had a pH of 6.76 and a flow of 4.89 cfs on 18 May 1998. A tailings pile area and the Snowstorm mill site are located near the mouth on the western side of the gulch. The water quality sample collected on May 8, 1998 exceeded the dissolved copper chronic criterion (5.76 µg/L) by a little over 1 µg/L (7 µg/L). Cadmium, lead, and zinc concentrations did not exceed chronic criteria.

Gentle Annie Gulch (SF 207)

Gentle Annie Gulch flows south into the South Fork Coeur d'Alene River and is located north of the Osburn Fault in the Gem-Gold Hunter Mineral Belt. The lower portion of the creek drains the St. Regis Formation, while the remainder of the gulch drains the Wallace Formation at the surface. Quaternary alluvium lines the lower one-half mile of the gulch. The Coughlin Mine was developed on an outcropping vein known to contain base metals in the St. Regis Formation in the lower part of the Gulch, while the Butte & Coeur d'Alene Mine and the Little Boy Mines are in the Wallace Formation in the middle portion of the Gulch. In the headwaters area there are a number of mines in the St. Regis Formation, on the contact between the St. Regis and the Wallace or in the Revett Quartzite, including the Lucky Calumet and the Snowshoe mines. A number of adits line the cliffs above the gulch. A large tailings impoundment covers the mouth of the gulch and the South Fork upstream and downstream of Gentle Annie Gulch. A small rock dump is located near the stream approximately one-third of the way up the gulch. Discharge from the Coeur d'Alene Mine had a flow of 0.0094 cfs on 19 November 1997; no other water quality information was available. The sample location SF 207 appears to be located upstream of the tailings impoundment and did not exceed relevant water quality criterion values.

Deadman Gulch (SF 209)

Located to the west of Gentle Annie Gulch, Deadman Gulch also flows south into the South Fork Coeur d'Alene River. The Gulch is located north of the Osburn Fault in the Gem-Gold Hunter Mineral Belt. At the surface, the gulch drains the St. Regis Formation in the headwaters and near the mouth, and the Wallace Formation in the middle section. Quaternary alluvium lines only the lower one-quarter mile of the gulch. Numerous underground mines are located along Deadman

Gulch, including the Hunter Creek Mine in the St. Regis Formation near the mouth; the Homestake, Lottie L., Alma in the Wallace Formation and the National Mine in the Wallace and St. Regis formations in the mid-section of the gulch; the Missoula Mine in the Revett and St. Regis formations along the east fork; and the Copper King, Pilot, and Copper Plate Mines along the west fork. A number of adits from these mines are located along the gulch. Most significantly, the National Mill was located in Deadman Gulch. The National Mine produced 170,800 tons of silver, copper, and gold ore (Mitchell and Bennett, 1983). Several rock dumps line or are adjacent to sections of the east and west forks in the headwaters area. Drainage from the Copper King Mine had a pH of 6.17 and a flow of 0.0564 cfs on 17 May 1998. Although no criterion values were exceeded in samples collected from near the mouth (SF 209), this creek was not used for mineralized baseline because of the presence of the mill and the sizeable production of silver and copper from the National Mine.

Willow Creek (SF 210)

Willow Creek is located south of the South Fork Coeur d'Alene River and the Osburn Fault east of Mullan and drains a portion of the Moe-Reindeer Queen Mineral Belt in the headwaters area and a portion of the Gem-Gold Hunter/Golconda-Lucky Friday Mineral Belts at the mouth. Most of the drainage is in the St. Regis Formation, although the exposed vein crosses the St. Regis-Wallace boundary. Quaternary alluvium and glacial and glaciofluvial deposits line most of the length of the creek. Terrace and channel gravels are located above the alluvium along the creek's lower reaches. The Carbonate Hill, Carney, Reindeer Queen and Copper Queen Mines are located in the drainage, mostly in the headwaters area and in the St. Regis Formation. Underground veins are located downstream of the confluence of the East and West Forks, and the headwaters of the East Fork drains a one-half mile long vein exposed at the surface along the Reindeer Fault (the Copper Queen Mine). One waste rock dump is located adjacent to the creek downstream of the confluence of the east and west forks. A number of adits are located along the creek. An adit from the Reindeer Queen Mine discharges along the east fork. Drainage from this adit had a flow of 0.011 cfs on 19 November 1997; no other water quality data are available. The Reindeer Queen produced only 147 tons of mostly copper ore (Mitchell and Bennett, 1983). Even though there are mines and waste rock deposits in the creek, there were no large producing mines and no mills on the creek. Therefore, this creek was considered mineralized baseline. No criterion values were exceeded in samples collected from near the mouth (SF 210).

Unnamed Creek (SF 211)

This unnamed creek is located between Boulder and Willow Creeks south of the South Fork Coeur d'Alene River and the Osburn Fault, east of Mullan. This creek also drains a portion of the Moe-Reindeer Queen Mineral Belt. The upper half of the creek drains the St. Regis Formation, and the lower part drains the upper part of the St. Regis and the lower part of the Wallace Formation. Quaternary alluvium and channel and terrace gravels line only the lowest 1/3 mile of the creek. Adits line the creek in both the headwaters area, where the Lower Giant Mine is located, and at the mouth, where the Atlas Mine is located. A large waste rock dump associated with the Atlas Mine covers the creek approximately 1/4 mile from the mouth. The Atlas Mine

produced 6,936 tons of ore (mostly lead), which is small compared to any of the major mines in the district (Mitchell and Bennett, 1983). Drainage from the Atlas Mine had a pH of 7.57 on 18 May 1998; no other water quality data were available for this sample. No criterion values were exceeded either in Fall 1997 or Spring 1998, and many concentrations were below detection.

Gold Hunter Gulch (SF 212)

Located north of the South Fork Coeur d'Alene east of Mullan and north of the Osburn Fault, Gold Hunter Gulch drainage is in both the Gem-Gold Hunter and Golconda-Lucky Friday Mineral Belts. The gulch cuts into the Wallace, St. Regis, and Revett formations. The gulch drains the Wallace Formation in the headwaters and near the mouth and the St. Regis in the center portion. A piece of the Revett also crosses the drainage between two of the faults that cut the gulch. Quaternary alluvium lines only the lower 1/4 mile of the gulch. The Lucky Friday Mine, which is still in operation, is located on the eastern side of the gulch near the mouth. The Gold Hunter Mine is located under much of the western side of the gulch, crosses a number of faults, and cuts through the Wallace, St. Regis, and Revett formations and a number of dikes. An outcropping vein 1/3 of a mile long and known to contain base metals is located in the upper western part of the drainage and is incorporated in the Silver Reef or Yolanda mines (underground workings for these and the Gold Hunter are continuous). A tailings impoundment covers the mouth of the gulch and the northern side of the South Fork mostly downstream of the gulch. A number of mine adits are located along the gulch. A large tailings pile from the Lucky Friday complex is located across the gulch and over the Lucky Friday Mine at the mouth. The Silver Reef Gold Hunter Mine adit discharges to the headwaters area. Both the Gold Hunter mill and the Lucky Friday mill are located near the mouth of Hunter Gulch. Dissolved copper exceeded the chronic criteria (4.28 and 5.35 µg/L) on both 9 November 1997 (12.1 µg/L) and 8 May 1998 (7 µg/L). Dissolved lead also exceeded the chronic criterion on 9 November 1997 (1.62 µg/L vs. 0.97); dissolved lead did not exceed the criterion on 8 May 1998 (0.6 µg/L vs 1.30). Dissolved zinc and cadmium did not exceed their chronic criterion values on either date.

Unnamed Creek (SF 213)

This unnamed creek is located north of the South Fork Coeur d'Alene River and the Osburn Fault between Mill Creek and Gold Hunter Gulch across the South Fork from Boulder Creek. The creek empties into the South Fork on the east side of Mullan. The creek is not located on the topographic maps or on the geologic maps (Hobbs et al., 1965), but based on topographic contours, the creek drains predominantly the St. Regis Formation and a portion of the Wallace Formation. The creek is most likely located entirely within the Golconda-Lucky Friday Mineral Belt. There does not appear to be any mining or mine waste deposits directly within the drainage. Water samples did not exceed relevant aquatic life criterion values.

Boulder Creek (SF 214)

Boulder Creek is located south of the South Fork Coeur d'Alene River and the Osburn Fault and also empties into the South Fork at Mullan. Most of the creek drains the St. Regis Formation, and Quaternary alluvium and terrace gravels are located in the lower 1/2 of the creek. The Moe Reindeer Queen Mineral Belt crosses Boulder Creek at about its midpoint. There are both outcropping and subsurface veins along the drainage approximately half way up the creek. The Banner Mine is located on Boulder Creek in the St. Regis Formation; adits are located in the drainage. There are a number of adits and prospects and one waste rock dump, but no major mines or waste deposits and no mills are located along the creek. Water samples did not exceed any aquatic life criterion values.

Mill Creek (SF 216)

Located north of the South Fork Coeur d'Alene River and the Osburn Fault, Mill Creek flows into the South Fork at Mullan. From the headwaters to the mouth, Mill Creek drains the St. Regis, Wallace, St. Regis, Revett, and St. Regis formations. Quaternary alluvium lines most of the creek, including the upper forks in the headwaters area. Mill Creek drains the Golconda-Lucky Friday Mineral Belt and the Gem-Gold Hunter Mineral Belt. Underground veins are located in the headwaters and on the bluffs on the west side of the stream and also in the headwaters region. The Sunshine Premier, Independence, and Morning No. 5 mines are located in Wallace Formation in the headwaters area. The North Franklin and Wall Street mines are also located in the headwaters area in the St. Regis Formation. A waste rock dump covers the creek in the upper west fork, and the floodplain of one of the western tributaries has been impacted by mining. Drainage from the Morning No. 5 adit had a pH of 7.52 and a flow of 0.0111 on 17 May 1998. Morning No.5 was the main producing adit for this large mine for a number of years; therefore, this creek was not used for baseline. However, SF 216 does not exceed relevant water quality criteria. Water quality samples and measurements were only collected on 9 November 1997; no aquatic life criteria were exceeded on that date.

Slaughterhouse Gulch (SF 218)

Slaughterhouse Gulch flows south into the South Fork Coeur d'Alene River and is located mostly south of the Osburn Fault. Most of the gulch drains the Wallace Formation, and Quaternary alluvium lines approximately half of the gulch. The rocks above the headwaters area drain the Golconda-Lucky Friday Mineral Belt. The Morning Mine No. 6 is located near the mouth of the gulch and connects by underground workings to the Morning Mine, two miles to the north. The Morning Mill was also located near the mouth. A large rock dump associated with the Morning mines covers the lower portion of the gulch and extends to the east and west along the north bank of the South Fork. At the mouth, water in the gulch flows under cribbing of the Morning Mine waste rock dump. Water quality samples collected at the mouth exceed for dissolved zinc on 9 November 1997 and 8 May 1998 (190 and 150 µg/L, respectively; CCC = 150.2 and 99.9 µg/L). Dissolved lead, cadmium and copper do not exceed criteria values. Hardness values were high for the basin, at 132 and 82 mg/L as $CaCO_3$ in November 1997 and

May 1998. Drainage from the Morning No. 6 Mine had a pH of 8.19 and a flow of 2.37 cfs on 17 May 1998, and a flow of 1.04 cfs on 8 November 1997; no other water quality data were available.

Dry Creek (SF 219)

Located south of the South Fork Coeur d'Alene River and the Osburn Fault, Dry Creek empties into the South Fork west of Mullan. The creek lies directly on the St. Regis Formation. The upper half of the creek is in the Moe-Reindeer Queen Mineral Belt. Underground workings from the Moe Mine and associated veins cross over into the west side of the Dry Creek drainage. There are a couple of adits along the stream, but they are not associated with a producing mine. Although it is marked as an intermittent stream on the geologic map, flows were measured both on 8 November 1997 and 6 May 1998 as 0.285 and 0.4 cfs, respectively. Hardness values on the same dates were 11.9 and 9.8 mg/L as $CaCO_3$. There are no known mine waste deposits located long the creek. Elevated stream concentrations were measured in the 1950s by the U.S.G.S. (USGS, 1960). Dissolved criterions values for cadmium, lead, and zinc were not exceeded at this location.

Gold Creek (SF 221)

Gold Creek is located south of the South Fork Coeur d'Alene River and the Osburn Fault west of Dry Creek and Mullan. The creek lies directly on the St. Regis Formation except for a small amount of Quaternary alluvium right at the mouth. The headwaters area drains a piece of the Wallace Formation. The lower part of the creek is in the Moe-Reindeer Queen Mineral Belt. The Moe Mine, in the St. Regis Formation, is located in the Gold Creek drainage near the mouth on the east side of the creek. A number of other subsurface veins and one surface vein not known to contain base metals are located in the drainage. There are a number of adits in the creek. No major mining activity has occurred in the drainage, although there are a few prospect pits along the eastern side of the creek near the headwaters. No criterion values were exceeded.

St. Joe Creek (SF 222)

St. Joe Creek is located south of the South Fork Coeur d'Alene River and the Osburn Fault west of Mullan. The headwaters region drains the Wallace Formation, while most of the rest of the creek drains the St. Regis Formation. A very small amount of Quaternary alluvium lines the creek at its mouth. The lower portion of the creek is in the Moe-Reindeer Queen Mineral Belt. A surface vein not known to contain base metals outcrops approximately half way up the drainage in the St. Regis Formation. Other subsurface veins not known to contain base metals and adits are located near the mouth. No major mine waste deposits are located in the drainage. There is a discharging tunnel in the drainage. No criterion values were exceeded in water quality samples.

Grouse Gulch (SF 223, 317, 318, 319, 320, 321)

Located north of the South Fork Coeur d'Alene River and split by the Osburn Fault, Grouse Gulch drains the Golconda-Lucky Friday Mineral Belt north of the fault. About 3/4 of drainage is north of the Osburn Fault. The Ivanhoe Mine is located in the headwaters area, along with adits and underground veins. The Star 1200 level, We Like and Grouse Mines (Ivanhoe Mine) are all in the Revett Formation. An outcropping vein known to contain base metals is part of the Grouse Mine workings. Two large waste rock dumps from the Star Mine cross the gulch in the headwaters area, and the floodplain is impacted downstream of the lower dump. Drainage from the Grouse Mine (SF 349) had a pH of 6.17 on 17 May 1998 and a flow of 1.82 cfs; dissolved lead and zinc concentrations (34.2 and 73 µg/L, respectively) did exceed chronic criterion values, but dissolved cadmium concentrations were below chronic criterion values. Drainage from the Star 1200 Level (SF 247) had a pH of 6.57 on 17 May 1998 and a flow of 0.695 cfs; dissolved cadmium, lead, and zinc concentrations in the discharge were high (72.3, 589, and 11,200 µg/L, respectively), and chronic criterion values for these three metals were exceeded. Although there were no mills in this drainage, the Star Mine was one of the biggest producers in the district. The Star Mine produced 6% of the total tonnage in the Coeur d'Alene district and was responsible for 17% of the total zinc production (Mitchell and Bennett, 1983). SF 223, at the mouth, exceeds for dissolved cadmium, lead, and zinc (8, 8, and 1350 µg/L, respectively). There are five other sampling locations upstream of the mouth. SF 317, 320, and 321 appear to be upstream of mining activity, while SF 319 and 318 are downstream of large waste rock piles that cover the gulch. Using a hardness of 25 mg/kg as $CaCO_3$ (hardness not measured), SF 318 and 319 exceeded for dissolved cadmium, lead, and zinc. SF 321 exceeded for dissolved lead, but SF 317, 320, and 321 did not exceed for any metal criterion values.

Ruddy Gulch (SF 224)

Ruddy Gulch flows south into the South Fork Coeur d'Alene River. The Osburn Fault crosses the drainage about one-half of the way up the gulch, and the drainage is in the Golconda-Lucky Friday Mineral Belt north of the fault. The gulch drains the Wallace and St. Regis formations south of the fault, and Revett and St. Regis formations north of the fault. Quaternary alluvium lines the gulch for the lower mile, mostly south of the fault. The Alice Mine is located north of the fault. Underground workings cross the gulch, and adits are located in the drainage. The Alice mill was located in the Ruddy Gulch drainage. The Alice Mine produced 49,419 tons of ore (mostly lead — 3,562,915 lbs of lead from 1909 — 1926) (Mitchell and Bennett, 1983). Discharge from the Alice adit had a pH of 7.66 on 18 May 1998; dissolved cadmium, lead, and zinc concentrations did not exceed chronic criterion values. Dissolved lead exceeded chronic criterion values on both 8 Nov 97 (9.96 µg/L, CCC = 1.24 µg/L) and 6 May 1998 (4.7 µg/L; CCC = 0.62 µg/L). Other metals did not exceed their criterion values.

Rock Creek (SF 225)

Rock Creek flows north into the South Fork Coeur d'Alene River about midway between Mullan and Wallace and is south of the Osburn Fault. The creek drains alternating pieces of the Wallace and St. Regis formations; a small amount of Quaternary alluvium exists only at the mouth. The lower portion of the creek is in the Moe-Reindeer Queen Mineral Belt. The Blue Jay (in Wallace/St. Regis formations) and Rock Creek (in St. Regis formation) mines, a number of subsurface and outcropping veins not known to contain base metals, and a number of adits are located in the drainage. Measured flows on 7 November 1997 and 5 May 1998 were 1.29 and 41.4 cfs, respectively. Hardness values measured on the same days were 60.8 and 38.7 mg/L as $CaCO_3$. There are several small prospect pits and adits along the creek and a waste rock dump at the mouth, but no other major mine waste deposits are located in the drainage and the Blue Jay and Rock Creek mines were not big producers. SF 225 appears to be located upstream of the waste rock dump. There is a large discharging tunnel on the south side of the South Fork between Rock Creek and Watson Gulch that discharges to the South Fork. No criterion values were exceeded in water samples collected at this location.

Trowbridge Gulch (SF 226)

Located north of the South Fork Coeur d'Alene River upstream of Dexter Gulch, Trowbridge Gulch is located in the Golconda-Lucky Friday Mineral Belt. The Osburn Fault crosses the drainage near its mouth. There is mining on both the west and east side of the drainage north of the fault. Veins known to contain base metals are located underground on the western side of the drainage and in the headwaters associated with the mines. The Wonder (in St. Regis-Revett transition zone) and Square Deal (in Burke formation) mines are located above the headwaters area, and portions of the Golconda Mine (in the Burke formation) are located on the west side of the drainage. The Golconda Mine was a relatively big producer, with 339,228 tons produced (mostly lead and zinc ore) (Mitchell and Bennett, 1983). However, the main Golconda working and the mill are located on the South Fork downstream of Trowbridge Gulch (see Figure 2-3; Ridolfi, 1998). The Mayflower (in Wallace-Burke transition zone) and United Lead Zinc (in Burke formation) mines are located in the headwaters area. A number of adits are located along the gulch, and a small waste rock dump is located on the eastern side of the gulch in the headwaters area. The adit from the Square Deal Mine is a flowing adit. Discharge from this adit had a pH of 6.7 on 19 May 1998 and a flow of 0.021 cfs. Flow on 20 November 1997 was 0.134; no other water quality information was available. No water quality criterion values were exceeded in this drainage.

Dexter Gulch (SF 229)

Dexter Gulch is located north of the South Fork Coeur d'Alene River upstream of Canyon Creek. The Osburn Fault crosses Dexter Gulch approximately two-thirds of the way up the drainage. The gulch drains Revett Quartzite and the Burke Formation above the fault and the Wallace Formation south of the fault. Quaternary alluvium lines the gulch downstream of the fault. The area north of the Osburn Fault is in the Golconda-Lucky Friday Mineral Belt. The Granada Mine

is located south of the fault in the Wallace Formation. An adit from the mine is located on the eastern side of the gulch. Veins known to contain base metals are located below the surface and one at the surface in the headwaters and approximately half way up the drainage associated with the Golconda Mine. Drainage from the Golconda Mine had a pH of 7.99 on 18 May 1998 and a flow of 0.0388 cfs; flow on 20 November 1997 was 0.022 cfs. No other water quality data are available for this drainage. Underground workings from the Golconda Mine in the Burke Formation are located in the headwaters area and cross over to Trowbridge Gulch to the east. No mine waste deposits are known to occur in or along the gulch, and, although the Golconda Mine was a relatively big producer of lead and zinc, its main workings open to the South Fork near the Golconda mill site (see above). No aquatic life criterion values were exceeded at this location.

Watson Gulch (SF 230)

Watson Gulch is located south of the South Fork Coeur d'Alene River and the Osburn Fault east of Canyon Creek. Watson Gulch lies entirely on the Wallace Formation; only a small piece of Quaternary alluvium lines the mouth. The drainage is not in any known mineral belt; however, a large portion of the drainage exceeds the threshold value of 60 mg/kg for lead in soil (Gott and Cathrall, 1980). An underground vein not known to contain base metals and an associated adit are located in the headwaters area. Metals concentrations were all very low. No mine waste deposits, large mines, or mills are located in the drainage.

Weyer Gulch (SF 231)

Weyer Gulch (also known as Anderson Gulch on the geologic map) is located south of the South Fork Coeur d'Alene River just upstream from Canyon Creek. The creek lies directly on the Wallace Formation for its entire length, and there is no known mining or veins along the gulch. The drainage is not located in any identified mineral belt; however, lead concentrations in rocks exceeded the threshold value of 60 mg/kg in an area near the mouth (Gott and Cathrall, 1980). The gulch has a much higher hardness than many of the streams in the area (101 mg/L as $CaCO_3$ in November 1997, the only sampling). There are no known mine waste deposits in the drainage, and no aquatic life criterion values were exceeded.

Placer Creek (SF 234, 236)

Placer Creek, an extensive southern tributary of the South Fork Coeur d'Alene River, lies entirely south of the Osburn Fault. Most of the creek drains the Wallace Formation, although the west side of the creek upstream of 1.5 miles from the mouth drains rocks of the St. Regis and Revett formations. The West Fork cuts through Revett and St. Regis formation rocks but again drains the Wallace Formation as it crosses the Placer Creek fault approximately one mile upstream of the mouth. Other western and eastern tributaries to Placer Creek, including Cranky Gulch, Experimental Draw (western tributaries), Red Oak Gulch and Trowel Gulch (eastern tributaries), also predominantly drain the Wallace Formation. The upper headwaters region lies outside the area that has been mapped geologically. Quaternary alluvium lines Placer Creek for nearly its entire extent. Although Placer Creek is not in any identified mineral belt, Gott and Cathrall

suggest that there may be a south-eastern extension of the Page-Galena Mineral Belt in the Placer Creek/Wallace area, as indicated by dispersion patterns of antimony, copper, manganese, arsenic, and boron (Gott and Cathrall, 1980). There are several areas in the drainage that exceeded the threshold value of 60 mg/kg for lead in rocks and soils. There are three mines in the drainage: the Peerless (War Eagle) Mine on the West Fork, the Wallace Tunnel near the mouth, and the Castle Rock Mine upstream of Experimental Draw. Only the Castle Rock had any production (Keith Long, USGS, pers. comm.). Some of the exploration tunnels are fairly long (up to ~1,500 ft.), and there are some fairly extensive waste rock piles up one of the tributaries. A number of veins not known to contain base metals outcrop in the drainage, and an outcropping vein known to contain base metals is associated with the Castle Rock Mine. A prospect pit is located on the western side of the creek approximately 1/2 mile upstream of the mouth, and there are adits located along the creek. The more upstream location (SF 234) had one out of three dissolved lead and zinc exceedences, but the location at the mouth (SF 236) did not have any metal exceedences.

II. Page-Galena and Silver Mineral Belts

Silver Mineral Belt

Lake Creek (SF 238)

Lake Creek is located south of the South Fork Coeur d'Alene River and the Osburn Fault in the Page-Galena Mineral Belt. The Galena Mine and mill are located approximately one mile from the mouth, and the Vulcan Mine is located on the western side of the drainage. Adits from these mines are in the drainage. There are tailings ponds at the mouth. Dissolved lead concentrations were below detection, but total lead concentrations were 4 µg/L on 2 October 1991. There were no exceedences for dissolved cadmium, lead, or zinc. However, because of the presence of the Galena mine and mill, this stream was not considered a reference stream. The Galena Mine produced 5,895,490 tons of ore between 1922 and 1990 (see Table 2-2), including high amounts of silver, lead, and copper (SAIC, 1993c).

Revenue Gulch (SF 20, 240)

Revenue Gulch is located on the north side of the South Fork Coeur d'Alene River west of Ninemile Creek. Approximately half of the gulch lies north and south of the Osburn Fault. The upper part of the gulch drains the Revett and Burke formations, while the lower portion drains the Prichard and Wallace formations. A wide swath of Quaternary alluvium lines the lower half mile of the drainage and extends upstream for about one mile. The drainage is not located in any known mineral belt. The Silverton Mines, in the Burke and Revett formations, are located on the eastern side of the gulch about 1.5 miles from the mouth. The Western Union Mine, in the Prichard Formation, is located downstream on the western side of the gulch. Adits from these mines are located in the drainage. Drainage from the Western Union lower adit had a pH of 8.24 and a flow of 0.000762 cfs on 15 May 1998; no other water quality data were available for the

adit drainage on that date. No major mine waste deposits are located in the drainage. Concentrations measured near the mouth (SF 20) did not exceed any criterion values; samples were only collected on 14 May and 2 October 1991.

Shields Gulch (SF 23)

Shields Gulch is located south of the South Fork Coeur d'Alene at the town of Osburn and south of the Osburn Fault. The gulch drains alternating sections of the Wallace Formation and the St. Regis Formation and is located in the Page-Galena Mineral Belt. The Rainbow Mine is located on the east side of the gulch, and the Coeur Unit Mine and Mill are also located in the drainage. Adits are located along the creek. Only cadmium, lead, and zinc concentrations were measured, and all dissolved concentrations were below detection on 14 May and 5 October 1991, the only sampling dates for SF 23, located near the mouth. SF 244, located just upstream of the mouth was sampled on 8 November 1997 and 8 May 1998. Although the water quality data indicate that there are no exceedences of water quality criteria at this location, the stream was not considered a control stream because of the presence of the Coeur Mill and Mine. The Coeur Unit (Coeur) Mine produced 2,251,910 tons between 1969 and 1990, including 36,234,399 ounces of silver and 31,933,191 pounds of copper (SAIC, 1993c).

Argentine Gulch (SF 242)

Argentine Gulch is located south of the South Fork and the Osburn Fault in the Silver Mineral Belt portion of the Page-Galena Mineral Belt. The Vulcan Mine is located under the creek and to the east; adits are located on the creek. Samples were collected on 8 November 1997 and 8 May 1998; there were no exceedences for dissolved cadmium, lead, or zinc. The stream floodplain area near the mouth is impacted by mining, but there are no major mine waste deposits other than that in the drainage.

Nuckols Gulch (SF 245)

Nuckols Gulch is located north of the South Fork and the Osburn Fault east of the town of Osburn. The gulch does not drain any known mineral belts, although there may be extensions of mineral belts in the Dago Peak area, and a portion of the drainage does exceed the 60 mg/kg threshold concentration for lead in rock (Gott and Cathrall, 1980). There are adits upstream of Dago Peak Gulch, a tributary of Nuckols Gulch that drains the Silverore-Inspiration Mine. The Western Union upper adit is located on Nuckols Gulch upstream of Dago Peak Gulch. SF 245 was sampled on 1991, 1997 and 1998; there was one exceedence for dissolved lead, but the median dissolved lead concentration did not exceed the criterion value. There were no other exceedences for dissolved lead, cadmium, or zinc. No major mines or mine waste deposits and no mills are located in the drainage.

Meyer Gulch (SF 246)

Meyer Gulch is located south of the South Fork and the Osburn Fault, east of the town of Osburn. There are prospects near the headwaters, and the Saint Elmo Mine and adits are located in this area. Meyer Gulch is located in the Silver Mineral Belt. The site was sampled on 8 May 1998 only; there were no exceedences for dissolved cadmium, lead, or zinc. No major mines and no mills are located in the drainage, but there are tailings-impacted floodplains near the mouth. The gulch appears to empty into a culvert or other man-made structure near the mouth.

Twomile Creek (SF 248)

Located north of the South Fork and the Osburn Fault, Twomile Creek is east of the town of Osburn. Although the creek is not located within any known mineral belt, it is directly west of and adjacent to the Dago Peak stocks, and a portion of the drainage does exceed the threshold value for lead in rock (Gott and Cathrall, 1980). SF 248 was sampled in 1991, 1997, and 1998; there was one exceedence for dissolved lead, but the median dissolved lead concentration did not exceed the criterion value. There were no other exceedences of dissolved cadmium, lead, or zinc. There are adits in the drainage, and the Capitol Silver Lead Mine is located on the upper east fork. No major mines or mine waste deposits and no mills are located in the drainage.

McFarren Gulch (SF 250)

McFarren Gulch is located south of the South Fork and the Osburn Fault in the Silver Mineral Belt portion of the Page-Galena Mineral Belt. There are many mines in the drainage, including the Merger, Coeur d'Alene, and American Silver mines and a portion of the Silver Summit Mine. There are veins below the surface. The Coeur d'Alene Mine and the Mineral Point Mine and Mill were located along the gulch. The Coeur d'Alene (Mineral Point) Mine produced 440,779 tons of ore between 1919 and 1952, including 5,859,581 ounces of silver and 10,011,481 pounds of copper (Mitchell and Bennett, 1983). The site was sampled in May 1991 and 1998; there was one exceedence each for dissolved cadmium, lead, and zinc, and median concentrations of all three metals exceeded criterion values.

Jewel Creek (SF 251)

Located north of the South Fork and the Osburn Fault, Jewel Creek empties into the town of Osburn. The drainage is not in any known mineral belt, but a portion of the drainage did exceed the threshold value of 60 mg/kg for lead in rocks (Gott and Cathrall, 1980). The site was sampled on 6 November 1997 and 8 May 1998, and there were no exceedences for dissolved cadmium, lead, or zinc. A rock dump is located near the mouth, but possibly not in the drainage.

Terror Gulch (SF 252)

Located north of the South Fork and the Osburn Fault, Terror Gulch is approximately one mile west of the town of Osburn. Terror Gulch is not located in any known mineral belt, although it is located due west of the Dago Peak stocks and does have exceedences of the threshold value of 60 mg/kg for lead in rock (Gott and Cathrall, 1980). There are underground veins and surface veins, and many mines in the headwaters area, including the St. Joe mines, RI#1&2, and Terror mines. SF 252 was sampled on four dates in 1991, 1997 and 1998. There was one exceedence for dissolved lead, but the median lead concentration did not exceed the criterion value. There were no other exceedences for dissolved cadmium, lead, or zinc. There are no major mines or mine waste deposits and no mills located in the drainage.

Rosebud Gulch (SF 255)

Located south of the South Fork and the Osburn Fault, Rosebud Gulch empties into the South Fork approximately two miles west of the town of Osburn. The Gulch is located in the Silver Mineral Belt portion of the Page-Galena Mineral Belt. The Nellie and Silver Summit mines and the Silver Summit and Polaris mills are located in the drainage (SAIC, 1993b). The Silver Summit (Con Silver) Mine produced 827,617 tons of ore between 1948 and 1990, including 20,278,248 ounces of silver and 10,139,506 pounds of copper (SAIC, 1993c). There are rock dumps in the drainage, and the creek ends in a tailings-impacted floodplain of the South Fork. SF 255 was sampled on 6 November 1997 and 7 May 1998, and there were no exceedences for dissolved cadmium, lead, or zinc

Spring Gulch (SF 256)

Also located south of the South Fork and mostly south of the Osburn Fault, Spring Gulch is in the Silver Mineral Belt portion of the Page-Galena Mineral Belt. There are adits in the drainage, and the Mineral Mountain Mine is also located in the gulch. SF 256 was sampled on 7 November 1997 and 7 May 1998, and there were no exceedences for dissolved cadmium, lead, or zinc. There are no major mines or mine waste deposits and no mills located in the drainage. The creek ends in a tailings-impacted floodplain of the South Fork.

Polaris Gulch (SF 257)

Polaris Gulch is located south of the South Fork and mostly south of the Osburn Fault in the Silver Mineral Belt portion of the Page-Galena Mineral Belt. The Polaris Mine is located in the drainage, as are adits and a waste rock pile. The Polaris Mine was considered part of the Sunshine Mine on Big Creek, and the Polaris Mill was located near the mouth of Rosebud Gulch (SAICb, 1993b; Keith Long, USGS, pers. comm.). The Polaris Mine produced 320,783 tons of ore between 1916 and 1943, including 7,368,759 ounces of silver and 3,682,340 pounds of lead (Mitchell and Bennett, (1983). SF 257 was sampled on 7 November 1997 and 5 May 1998, and there were no exceedences of dissolved cadmium, lead, or zinc. The creek ends in a tailings-impacted floodplain of the South Fork.

Prospect Gulch (SF 261)

Prospect Gulch is located north of the South Fork and the Osburn Fault between Moon Creek and Terror Gulch. The gulch is not in any known mineral belt, and the threshold value for lead was not exceeded in soil or rock samples collected in the drainage. There is one adit and no named mines in the drainage. SF 261 was sampled on 5 November 1997 and 8 May 1998, and all samples exceeded criterion values for dissolved cadmium, lead, and zinc. The gulch follows a tailings-impacted portion of the South Fork floodplain westward near its mouth until it empties into a pond or marsh area to the east of Moon Creek. The sample location for SF 261 is very close to the mouth of the gulch.

Big Creek (SF 260)

Big Creek is a large tributary that runs north into the South Fork Coeur d'Alene. The Osburn Fault cuts Big Creek approximately 1.5 miles upstream of the mouth. The area north of the Osburn Fault drains the Prichard Formation, while the remainder of the creek drains a combination of the Wallace Formation and the Ravalli Group. The West Fork of Big Creek drains the Wallace Formation for the lower half-mile, while the remainder drains the Ravalli Group. The East Fork of Big Creek almost entirely drains the Wallace Formation, as does Big Creek from 1/2 mile downstream of the East Fork to its headwaters. The upper headwaters area is outside of the area geologically mapped. Quaternary alluvium lines Big Creek for nearly its entire length. The Page Galena Mineral Belt (Silver Mineral Belt) crosses the lower part of the Big Creek drainage south of the fault, and there is an extensive network of underground workings and mines associated with the mineral belt. The Silver Syndicate, Crescent, Crane, Gullickson, Sunshine, Yankee-Girl, Globe, Bismark, Metropolitan, Western Star, Wolfson, First National, and Lucky Boy mines and associated adits are located in the drainage. The Crescent Mine and mill and the Sunshine mine and mill are located in the drainage. The Sunshine Mine produced 11,453,874 tons of ore between 1904 and 1990, including 328,715,562 ounces of silver, 139,907,091 pounds of lead, and 98,846,004 pounds of copper (SAIC, 1993c). The Crescent Mine produced 962,252 tons of ore between 1924 and 1990, including 24,148,486 ounces of silver and 7,451,109 pounds of copper (SAIC, 1993c). There were two exceedences for dissolved lead, but the median concentration did not exceed the criterion value. There were no other exceedences for dissolved cadmium, lead, or zinc.

Moon Creek (SF 262)

Moon Creek is located north of the South Fork and the Osburn Fault, east of Elizabeth Park. Moon Creek is not located in any known mineral belt, although there may be mineralized areas west of the Dago Peak Stocks as continuations of mineral belts to the east of the stocks (Gott and Cathrall, 1980). There were a number of exceedences of the threshold value for lead in rocks (Gott and Cathrall, 1980), and there are veins on surface and below. There are adits in the drainage, and the Royal and Gogdill mines, as well as the Silver Crescent and Charles Dickens mines, are located here. The Charles Dickens mill is also located in the drainage. None of the mines were large producers. The Charles Dickens mine produced 4,604 tons of ore, including

734,921 pounds of lead (SAIC, 1993c). SF 262 was sampled on 40 occasions between 1991 and 1998. There were 4 chronic exceedences for dissolved cadmium (median did not exceed), 28 chronic exceedences for dissolved lead (median did not exceed), and 40 exceedences for both chronic and acute dissolved zinc.

Gold Run Gulch (SF 265)

Located south of the South Fork and split by the Osburn Fault, the upper headwaters of the gulch may be located in the Page-Galena mineral belt. Gold Run Gulch is west of Big Creek. There are veins on the surface but no named mines; there are adits in the drainage. A large portion of the drainage exceeded the threshold value of 60 mg/kg for lead in soil (Gott and Cathrall, 1980). SF 265 was sampled on 5 November 1997 and 9 May 1998, and there were no exceedences of dissolved cadmium, lead, or zinc. No major mines or mine waste deposits are located in the drainage.

Montgomery Creek (SF 266)

Montgomery Creek is located north of the South Fork and the Osburn Fault in no known mineral belt. However, the drainage is located west of the Dago Peak Stocks, and a portion of the drainage did exceed the threshold value for lead (60 mg/kg) in rock and soil (Gott and Cathrall, 1980). There are a few adits, but no named mines or mine waste deposits in the drainage. SF 266 was sampled in May 1991 and again in November 1997 and May 1998. There were two exceedences of dissolved lead, and the median concentration did exceed the criterion value. There were no other exceedences for dissolved cadmium, lead, or zinc.

Elk Creek (SF 267)

Elk Creek is located south of the South Fork and is split by the Osburn Fault. The headwaters areas are located in the Page-Galena Mineral Belt. A portion of the drainage exceeded the threshold value of 60 mg/kg for lead in soil (Gott and Cathrall, 1980). There are veins at the surface north of the fault, and the New Hilarity, Paramount, Alhambra, and Florence mines are located in the drainage. No major mines and no mills are located in the drainage. The creek ends in a tailings-impacted floodplain of the South Fork. SF 267 was sampled in November 1997 and May 1998, and there were no exceedences for dissolved cadmium, lead, or zinc.

Unnamed (SF 269)

This unnamed creek is located north of the South Fork and the Osburn Fault, west of Montgomery Creek and approximately two mines east of Kellogg. The drainage is not in any known mineral belt, but a portion of the drainage did exceed the threshold value for lead in soil. SF 269 was sampled only once on 5 November 1997, and there were no exceedences of dissolved cadmium, lead, or zinc. There are a few adits but no named mines in the drainage. There are no mills or mine waste deposits in the drainage.

Milo Creek (SF 183, 184, 185, 186, 187)

Milo Creek flows north into the South Fork Coeur d'Alene River just east of Kellogg. The creek mostly drains the Revett and St. Regis formations and a piece of the Wallace Formation just south of the fault. Quaternary alluvium lines the lower 1.5 miles of the creek. The Osburn Fault crosses Milo Creek approximately one mile from the mouth, and all the mines are located on or upstream of (south of) the fault. The Page-Galena Mineral Belt covers the upper portion of the creek south of the fault. A number of mines are located in the drainage, including the North Bunker Hill on the west side of the creek north of the fault in the Revett Quartzite, and the Bunker Chance Mine on the eastern side of the drainage south of the fault in the Wallace Formation. In the headwaters area, there are a number of mines related to the Bunker Hill and Sullivan mine complex (19 Level), including the Stem Winder, Reed, Phil Sheridan, Bluebird, and Sullivan mines and adits. These are in the Revett and St. Regis formations south of the Osburn Fault. There are several very extensive underground veins associated with these mines, but they are not shown to outcrop at the surface on the Hobbs et al. (1965) map. The North Bunker Hill Mill, the Wardner/Mil Gulch Mill, and the Sweeney Mine and Mill are located in the drainage. There are five surface water quality sampling locations on the creek (SF 183 – SF 187 from mouth to headwaters). All sampling locations except SF 185 are extremely contaminated with dissolved lead, zinc and cadmium. SF 185 is most likely located on Slaughterhouse Gulch and meets all metals criteria values. Slaughterhouse Gulch is an eastern tributary of Milo Creek that enters the creek downstream of most mining activity. There are no mills or major mine waste deposits along the gulch. The headwaters of Slaughterhouse Gulch are in the Page-Galena mineral belt. Slaughterhouse Gulch is located both north and south of the fault in the Wallace and Revett formations. Quaternary alluvium lines the creek near the mouth.

Portal Creek (SF 104)

Portal Creek is located south of the South Fork north of the Osburn Fault between Deadwood Gulch and Milo Creek. The upper headwaters of the creek may be in the Page-Galena Mineral Belt. There is a large outcropping vein north of the fault known to contain base metals, and some of the vein is in the Portal Creek drainage. The Kellogg Tunnel (Bunker Hill), Sandow, North Bunker Hill West, and the North Bunker Hill East mines are located north of the fault in the Burke formation. The lower part of Portal Gulch is a tailings impoundment, and there are four mill sites along the gulch. SF 104 was sampled three times in 1997 and 1998, and dissolved concentrations of lead, zinc, and cadmium exceed relevant chronic criterion values.

Deadwood Gulch/Bunker Creek (SF 100, 101, 102, 103)

The creek is located south of the South Fork and both north and south of the Osburn Fault. Deadwood Gulch drains the Prichard and Burke formations north of the fault and is lined with Quaternary alluvium and some terrace gravels. South of the fault, the gulch drains the St. Regis and Revett formations directly. The Fir Tunnel (Silver Bow Mine) and the Keating Mine are located north of the fault in the Prichard formation; adits from these mines are located in the drainage. The Ontario, Arizona and Viola mines are located south of the fault in the St. Regis and

Revett formations. Underground workings and veins for the west side of the Bunker Hill-Sullivan Mine are also located in the headwaters area in the Revett and St. Regis formations. There are some adits from these working in the drainage, and there are surface veins in this area as well (not marked to contain or not contain base metals). There is also an outcropping vein north of the fault that is not marked to contain or not contain base metals. The lower portions of Deadwood Gulch are impacted by mining activity and tailings, and the gulch ends in a tailing impoundment. SF 102, located near the mouth, was sampled in April 1997 and February 1998, and dissolved concentrations of cadmium, lead and zinc far exceeded relevant chronic criterion values. SF 100, 101 and 103 also exceed chronic criterion values for dissolved cadmium, lead, and zinc. SF 103 had especially high concentrations (all were quite elevated).

Government Gulch (SF 108, 110)

Government Gulch is located south of the South Fork Coeur d'Alene River at Smelterville. The Osburn Fault cuts the creek in half. The creek drains the Prichard Formation north of the fault and a combination of the St. Regis and the Revett formations south of the fault. Channel and terrace gravels (older than Quaternary alluvium) line the lower two miles of the creek. The Page-Galena Mineral Belt covers the upstream portion of the creek south of the fault. The Crown Point mine is located at the fault on the Prichard-St. Regis boundary. No other mines are located in the drainage. One extensive vein (1/4 to 1/2 mile long) known to contain base metals outcropping along the creek is known as the "OK" vein (eastern portion of vein is in the drainage). Government Gulch downstream of SF 108 is lined with tailings, and the Sweeney Mill is located approximately 1.5 km from the mouth. The water quality at the mouth (SF 110) is poor, with high concentrations of cadmium, copper, lead and zinc. Dissolved cadmium and zinc concentrations were as high as 306 and 10,500 µg/L, respectively. However, water at the upstream location (SF 108) does not violate ambient water quality criteria. This location is within the Page-Galena Mineral Belt.

III. Pine Creek and Tributaries

Pine Creek is located south of the South Fork Coeur d'Alene River just upstream of the confluence with the North Fork. The creek is located both north and south of the Osburn Fault. North of the fault, the creek drains the Prichard formation, and south of the fault it drains the Revett and Burke formations. Quaternary alluvium lines most of the creek up into the upper headwaters and tributaries. Some terrace gravels are located along the mainstem.

Upper Pine Creek (PC 100, 305, 306, 311, 312, 313, 314, 315, 327, 338, 339)

PC 306 is located in the headwaters, also known as the South Fork, and does not exceed any water quality criteria values. This location is off the geologic map, so no information is available on geology or mineralogy of the area, but it is assumed to be in an unmineralized area. There is no evidence of mining activity or mine waste deposits near this location. This location is approximately 1 km upstream of the Constitution Mine and mill and 3 km upstream of the

Douglas Mine and mill. PC 311 is located on the West Fork Pine Creek in no known mineral belt and does not exceed any water quality criteria values. The threshold value for lead in soil was exceeded in portions of the drainage (Gott and Cathrall, 1980). The Sherman Mine and the International Mine are located in the drainage. The Sherman Mine has an adit but no underground workings, and the International Mine has an adit, underground workings in the Prichard formation and underground veins. However, there are no mills and no major mine waste deposits in the West Fork drainage. PC 338, 327, 312, 100, 339, 313, 314, 315, and 305 are all downstream of the mining activities and mills. PC 305, at the mouth, exceeded at nearly all times for dissolved lead and zinc and also had occasional cadmium exceedences. PC 313, 314, 315, and 339, located more upstream, exceeded for zinc in all samples using a hardness of 25 mg/L as CaCO3, but there were few exceedences for lead and none for cadmium. Samples PC 312, 327, and 338, located even more upstream, exceeded for zinc and lead at all times but only once for cadmium, using a hardness of 25 mg/L a CaCO3 (hardness not measured).

Highland Creek (PC 323, 322, 307)

Highland Creek is a tributary of East Fork Pine Creek and drains the Douglas Mineral Subbelt and the Pine Creek Mineral Belt. The Sidney (Red Cloud adit), Nevada-Stewart and Highland Surprise (700 level) mines are located in the headwaters in the Pine Creek Mineral Belt in the Prichard formation. The Sidney (Red Cloud) mine and mill are located on Red Cloud Creek, a headwaters tributary of Highland Creek. The Highland Surprise mine and mill are located upstream of the Nevada-Stewart Mine on the mainstem. There are extensive surface veins known to contain base metals and many underground veins. The Star Antimony Mine is located at the mouth of Highland Creek. This mine is small, has no underground workings and only one adit. Most of Highland Creek, except for the upper headwaters areas, is lined with tailings deposits. All three surface water sampling locations are located downstream of mining activity and waste deposits and exceeded relevant water quality criteria for cadmium, lead, and zinc.

Denver Creek (PC 325)

Denver Creek is also a tributary of East Fork Pine Creek and also drains both the Douglas Mineral Subbelt and the Pine Creek Mineral Belt. The Denver (Nabob adit), the Sidney (500 Level), and the Little Pittsburg mines are located in the headwaters in the Prichard Formation. The Sidney Mill is located in the headwaters area, and the Little Pittsburgh Mill is located approximately 2 km from the mouth. There are many underground veins and many extensive (1/2 to 3/4 mile long) outcropping veins known to contain base metals in the headwaters area (Pine Creek Mineral Belt). The New Hilarity mine is located near the mouth in the Prichard formation. Adits from these mines are located in the drainage. Most of Denver Creek drainage is impacted by tailings and mining activity. The most upstream sampling location, PC 325, does not exceed for any water quality criterion value; the hardness at this location is 17 mg/L as $CaCO_3$. This sample point appears to be located upstream of the Sidney mine and mill and other mines and mine waste deposits in the drainage. PC 324, also in the upstream area but downstream of some mining activity, did exceed for dissolved lead, zinc, and cadmium; the hardness at this location was also very low (21 mg/L as $CaCO_3$). PC 308, located

at the mouth, exceeded for dissolved cadmium, lead, and zinc; hardness values were 53 mg/L as $CaCO_3$ in the fall and 26 mg/L in the spring.

Nabob Creek (PC 326, 310)

Nabob Creek is another tributary of the East Fork of Pine Creek; its headwaters are in the Pine Creek Mineral Belt. The Lynch-Pine Creek and Nabob (600 and 1300 Levels) mines are located in the drainage. The Nabob Mine and Mill are located in the headwaters area. There are two surface veins known to contain base metals in the drainage. Both surface water locations are located near the mouth and exceeded for dissolved cadmium, lead, and zinc. The hardness in upstream Nabob Creek (PC 326) was 25 mg/L as $CaCO_3$, while the hardness at the mouth (PC 310) was 233 mg/L, most likely influenced by leaching of mine waste deposits near the mouth.

Trapper Creek (PC 309)

Trapper Creek is a western tributary of East Fork Pine Creek and is not in any known mineral belt. However, the Big It Mine is located in the drainage in the Prichard Formation, has an underground vein and workings and an adit. In addition, the threshold value for lead in soil (60 mg/kg; Gott and Cathrall, 1980) was exceeded in samples collected near the mouth. No mine waste deposits are located in the drainage. Water samples from this drainage did not exceed any relevant water quality criterion values.

IV. North Fork Coeur d'Alene Basin

Upper Beaver Creek drains the Sunset Mineral Belt and the Carlisle-Hercules Mineral Belt (Figure 10-8a), which extend southeastward to the headwaters regions of Ninemile Creek. In addition, there are likely northwestern extensions of the Rex-Snowstorm Mineral Belt near the Dago Peak Stocks (Figure 10-8a), based on soil and rock concentration data in Gott and Cathrall (1980). Prior to faulting along the Osburn Fault, the Gem-Gold Hunter and the Rex-Snowstorm Mineral Belts may have extended to the northwest into the Beaver Creek drainage in the vicinity of the Dago Peak Stocks (Gott and Cathrall, 1980). It is therefore likely that drainages such as Dudley Creek and Moore Gulch in the Beaver Creek basin may have similar mineralization to that of the Ninemile and Canyon creek drainages. Dudley Creek may be similar in flow to the East Fork of Ninemile Creek. Because the area in vicinity of Dudley Creek and Moore Gulch is similar geologically and mineralogically to Ninemile and Canyon creeks, Dudley Creek and Moore Gulch samples was included in the Upper South Fork area for baseline surface water determination.

Dudley Creek

Dudley Creek, a tributary of Beaver Creek west of upper Ninemile Creek, may serve as an unmined analogue of the East Fork Ninemile Creek and possibly Canyon Creek. Like the East Fork Ninemile Creek, upper Dudley Creek cuts predominantly through the Dago Peak stocks, which are monzonitic intrusions of Cretaceous age. The Dago Peak stocks are believed to be the severed tops of the Gem stocks located to the east of the Dobson Pass fault along Ninemile Creek (Hobbs et al., 1965). Pieces of the Revett and St. Regis formations underlie less than half of upper Dudley Creek. The unnamed west fork of Dudley Creek also drains a Dago Peak Stock and the St. Regis Formation. From just upstream of the confluence of the west fork to its mouth, Dudley Creek cuts through the calcareous Wallace Formation, just as Ninemile Creek and Canyon creeks do downstream of the Osburn Fault. Quaternary alluvium lines the mainstem of Dudley Creek from the mouth to approximately one mile upstream of the west fork. Upper Dudley Creek and the west fork lie directly on bedrock, as does upper Ninemile Creek and Gorge Gulch on Canyon Creek. Water quality samples recently collected (August 1999) from Dudley Creek (51032 and 51033 (duplicate)) demonstrate that concentrations of total cadmium, lead, and zinc were all below chronic aquatic life criteria values. The low concentrations indicate that streams draining mineralized areas with unmined potential ore deposits have low concentrations of cadmium, lead, and zinc.

Moore Gulch

Moore Gulch is located to the west of Dudley Creek and empties into Beaver Creek downstream of Dudley Creek. The very upper reaches of Moore Gulch drain the Revett Quartzite. The more downstream areas drain the St. Regis formation, and most likely the Wallace formation, although the lower part of the drainage is off the Hobbs et al. (1965) maps. The portion of the drainage that is shown lies directly on the Belt Supergroup rocks with no Quaternary alluvium. (Both Dudley and Moore are on Plate 3, Hobbs et al.). Samples were collected from Moore Gulch (51034) in August 1999, and concentrations of total cadmium, lead, and zinc were all below chronic aquatic life criteria values.