3.0 RESULTS AND DISCUSSION

Results of the seep and spring inventory are contained in Table 1. Locations of these sources are shown in Figure 2.

Over 50 percent of the seeps and springs inventoried issued from the Blackhawk Formation. Flow rates at these points tend to be minimal (less than 1 gallon per minute), with seepage issuing predominantly at the interface between sandstone lenses above and less-permeable shale layers below. Usage at these points is also minimal, due to the low flow rate and often inaccessibility of the seeps.

Notable exceptions to the above generality concerning the Blackhawk Formation occur in a few springs that issue from fractured sandstone within the formation. Examples of this phenomenon were found in the western portion of the study are (SP-53 through SP-58), where flow rates of up to 15 gallons per minute were encountered. Travertine deposits are common at these springs, suggesting that the recharge area for these springs is dominated by limestone (probably the North Horn Formation on the ridges to the north and west).

Several seeps were discovered issuing from colluvium overlying sandstone of the Blackhawk Formation and the Castlegate Sandstone. These seeps normally occur in drainage bottoms where shallow subsurface water collects at topographic lows following infiltration of snowmelt. Nearly all flows from seeps of this type were insignificant, suggesting (together with the topographic position) that these seeps are intermittent in nature.

Most seeps and springs found in the Castlegate and Star Point Sandstones issue from bedding planes within these formations. Flows issuing in this manner were generally low (1 gallon per minute or less), with only occasional usage being evident (due primarily to inaccessibility and low flow rate).

Usage of seeps and springs in the study area is confined entirely to deer, elk, and other wildlife. No signs were noted of use of the springs for stockwatering or human consumption. As would be expected, wildlife usage of the springs is most abundant where flows are greatest.

Data contained in Table 1 indicate that the specific conductance of water issuing from springs in the study area generally increases with increasing stratigraphic depth. Springs issuing from the Price River Formation typically had a specific conductance varying from 150 to 450 umhos/cm at 25°C while those issuing from the Blackhawk Formation and Star Point Sandstone had a specific

Table 1. Results of seep and spring inventory in the permit and adjacent areas.

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-1	0	(b)	(b)	(b)	From base of Starpoint SS over Masuk Sh. Member of Mancos Sh.	None
SP-2	0	(b)	(b)	(b)	From base of Starpoint SS over Masuk Sh. Member of Mancos Sh.	None
SP-3	4	8.12	730	17.0	From sandstone bedding plane in Starpoint SS	None
SP-4	6	7.86	660	10.0	From colluvium at head of landslide in Blackhawk Fm.	Deer and elk
SP-5	0	(b)	(b)	(b)	From colluvium over sandstone in Starpoint SS	None
SP-6	5	7.67	590	4.5	From sandstone bedding plane in Blackhawk Fm.	Deer and elk
SP-7	10	8.36	440	10.0	From snow patch at top of Castlegate SS	Deer and elk
SP-8	20	7.95	280	3.5	From snow patch at top of Castlegate SS	Deer and elk
SP-9	0	(b)	(b)	(b)	From sandstone/shale interface Castlegate SS/Blackhawk Fm.	None
SP-10	40	7.90	220	10.0	From snow patch at base of Castlegate SS	Deer and elk

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-11	0	(b)	(b)	(b)	From colluvium over sandstone of Castlegate SS	None
SP-12	15	7.66	250	3.0	From base of sandstone (Price River Fm.) in channel bottom	Deer and elk
SP-13	3	8.57	100	7.0	From sandstone at head of slide in Price River Fm.	Deer and elk
SP-14	25	8.10	150	5.5	From fractured sandstone and soil in Price River Fm.	Deer and elk
SP-15	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-16	1	8.34	560	14.5	From sandstone at head of slide in Blackhawk Fm.	Deer
SP-17	2	7.71	460	10.0	From sandstone/shale interface in Blackhawk Fm.	Deer and elk
SP-18	10	7.42	500	7.0	From sandstone bedding plane in Star Point SS	Deer and elk
SP-19	5	7.60	620	6.5	From sandstone at head of slide in Blackhawk Fm.	None
SP-20	0	(b)	(b)	(b)	From sandstone bedding plane in Star Point SS	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-21	2	8.53	820	13.5	From sandstone bedding plane in Star Point SS	Deer
SP-22	4	8.05	230	3.5	From fractured sandstone over shale in Blackhawk Fm.	None
SP-23	5	8.02	550	6.0	From sandstone/shale interface in Blackhawk Fm.	None
SP-24	2	7.35	790	6.0	From sandstone/shale interface in Blackhawk Fm.	Deer and elk
SP-25	<1	6.80	820	10.0	From sandstone bedding plane in Star Point SS	None
SP-26	0	(b)	(b)	(b)	From road cut, sandstone bedding plane in Star Point SS	None
SP-27	0	(b)	(b)	(b)	From colluvium over sandstone in Star Point SS	None
SP-28	<<1	(b)	(b)	(b)	From road cut, sandstone bedding plane in Star Point SS	None
SP-29	0	(b)	(b)	(b)	From road cut, sandstone bedding plane in Star Point SS	None
SP-30	1	8.10	1060	16.5	From sandstone/shale interface in Blackhawk Fm.	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-31	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-32	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-33	<<1	(b)	(b)	(b)	From alluvium over sandstone in Blackhawk Fm.	None
SP-34	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-35	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-36	2	8.39	890	16.0	From sandstone/shale interface in Blackhawk Fm.	Deer and elk
SP-37	0	(b)	(b)	(b)	From sandstone bedding plane in Blackhawk Fm.	None
SP-38	<1	8.22	1180	9.0	From sandstone/shale interface in Blackhawk Fm.	Deer and elk
SP-39	0	(b)	(b)	(b)	From sandstone bedding plane in Blackhawk Fm.	None
SP-40	0	(b)	(b)	(b)	From sandstone bedding plane in Blackhawk Fm.	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-41	<<1	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-42	<<1	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	Deer and elk
SP-43	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-44	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-45	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-46	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-47	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-48	0	(b)	(b)	(b)	From colluvium over sandstone in Blackhawk Fm.	None
SP-49	0	(b)	(b)	(b)	From sandstone bedding plane in road cut in Blackhawk Fm.	None
SP-50	0	(b)	(b)	(b)	From sandstone/shale interface in slump in Blackhawk Fm.	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-51	0	(b)	(b)	(b)	From sandstone/shale interface in slump in Blackhawk Fm.	None
SP-52	1	7.99	600	12.0	From colluvium over sandstone in Blackhawk Fm., w/ travertine	Deer
SP-53	8	7.31	490	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-54	15	7.35	500	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-55	10	7.36	480	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-56	15	7.61	490	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-57	6	7.35	480	5.5	From fractured sandstone with travertine in Blackhawk Fm.	Deer
SP-58	10	7.40	500	5.0	From fractured sandstone in Blackhawk Fm.	Deer
SP-59	1	7.43	690	7.0	From colluvium over sandstone in Blackhawk Fm.	Deer
SP-60	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-61	15	7.36	450	2.0	From fractured sandstone in Price River Fm.	Deer and elk
SP-62	0	(b)	(b)	(b)	From sandstone/shale interface in Price River Fm.	None
SP-63	0	(b)	(b)	(b)	From sandstone/shale interface in Price River Fm.	None
SP-64	10	7.33	440	3.0	From fractured sandstone in Price River Fm.	Deer
SP-65	15	7.43	430	5.0	From colluvium over sandstone in Price River Fm.	Deer and elk
SP-66	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-67	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-68	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-69	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-70	15	7.17	550	3.5	From fractured sandstone in in Price River Fm.	Deer

Table 1. (Continued).

Field Number	Flow (gpm)	pH (Units)	Specific Cond.[a]	Temp (°C)	Geology	Use
SP-71	0	(b)	(b)	(b)	From sandstone bedding plane in Castlegate SS	None
SP-72	<<1	(b)	(b)	(b)	From sandstone/shale interface in Price River Fm.	None
SP-73	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-74	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-75	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-76	1	7.48	960	10.0	From sandstone/shale interface in Blackhawk Fm.	Deer
SP-77	0	(b)	(b)	(b)	From sandstone/shale interface in Blackhawk Fm.	None
SP-78	0	(b)	(b)	(b)	From sandstone bedding plane in Star Point SS	None
SP-79	0	(b)	(b)	(b)	From sandstone bedding plane in Star Point SS	None
SP-80	0	(b)	(b)	(b)	From sandstone bedding plane in Star Point SS	None

(a) In µmhos/cm at 25°C
(b) Insufficient water to sample

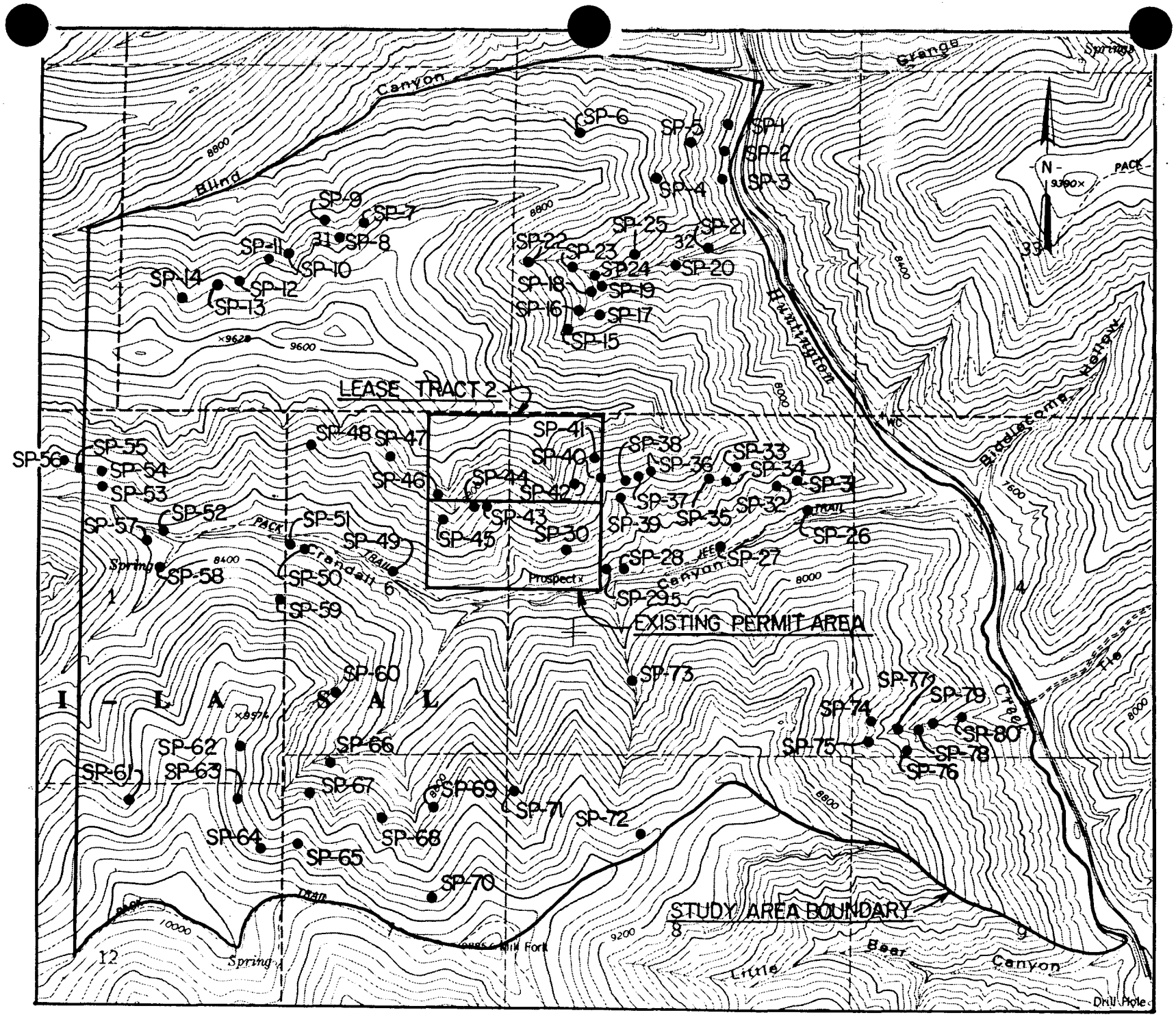

Figure 2. Location of seeps and springs found in the inventory.

conductance varying from 500 to 1000 umhos/cm at 25°C. This increase in specific conductance is indicative of leaching of minerals by the groundwater as it flows through increasing lengths of bedrock to the lower stratigraphic positions.

The hydrogen ion activity (pH) of water issuing from springs in the study area showed no trends within or between formations. Values varied from 6.80 to 8.57, averaging 7.74. Hence, spring water in the study area is slightly alkaline.

Water temperature varied widely at the site. In general, temperatures were lowest in springs issuing from fractures and highest in springs issuing from shallow colluvium over bedrock.

Based on the seep and spring inventory, two general conclusions can be drawn concerning the occurrence of groundwater in the vicinity of the Crandall Canyon Mine. Most of the seeps and some of the lower-flowing springs in the area issue along sandstone bedding planes or at the interface between overlying sandstones and underlying less-permeable shales. In simple terms, groundwater under these conditions flows vertically from the recharge area to the underlying confining bed (shale) or more permeable zone (bedding plane), whereupon the flow becomes horizontal and flows to the surface. Flow under these conditions is low, since most of the flow occurs in unfractured bedrock.

The other general condition occurs where springs issue from fractured bedrock. The temperature and specific conductance of water discharged from these springs tends to be lower and flows tend to be higher than that of other seeps and springs in the area, suggesting a topographically higher source of recharge and a shorter flow time. This is consistent with the higher hydraulic conductivity of the fractures relative to the unfractured bedrock.