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ENGINEERS

MEMORANDUM

DATE: December 17, 2018

TO: Laura Briefer, Director
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SUBJECT: Emigration Canyon Water Resources - Update

PROJECT NO.: 083.59.100

The purpose of this memorandum is to summarize an evaluation conducted to determine whether change applications filed for points of diversion in Emigration Canyon [water rights 57-7796 (a44045) and 57-10711 (a44046)] would result in decreased streamflow in Emigration Creek and possible impairments to Salt Lake City (SLC) surface water rights on Emigration Creek. SLC holds surface water rights that include water right numbers 57-8855, 57-8496, and 57-8497. When available, this water is diverted at the Jordan and Salt Lake Canal (about 1100 East) and used as part of Salt Lake City's public water supply to help meet exchange agreements. SLC's water right also includes a diversion at Hogle Zoo to benefit the zoo's operations. The Hogle Zoo diversion is based on a longstanding agreement between SLC and Hogle Zoo.

Limited water supply in Emigration Canyon is well documented and well accepted. Professional scientists, Emigration Improvement District (EID), Salt Lake County, and canyon residents have acknowledged and are planning for a 700-home limit within the canyon. After reviewing available water resource data, Hansen, Allen & Luce (HAL) has concluded that the 700-home limit is valid. Though the limit has not yet been reached, adequate streamflows have not been maintained in 10 of the last 17 years. It is unclear whether the proposed EID change application is intended to support additional development exceeding this 700-home limit. HAL recommends that additional surface and groundwater water withdrawals from the Emigration Creek watershed be limited in order to protect the canyon's water resources from overuse, and to allow for longstanding downstream uses to continue.

EMIGRATION CREEK STREAMFLOW AND CANYON DEVELOPMENT

Flow records from 1964 to 2018 describe typical flow characteristics in Emigration Creek (Salt Lake County 2018; USGS 2018). See Figure 1. Flows between September and January range from 0 to 7.5 cfs (cubic feet per second). Discharge increases beginning in February and peaks in April or May. The minimum flows typically occur between September and December.

HEARING SUBMITTAL TO
DIVISION OF WATER RIGHTS
Right No.: 57-7796(a44045) 57-10711(a44046)
Date: 19 DEC 2018
Submittee: PROTESTANT
~~Emigration Canyon Water Resources~~
BY SALT LAKE CITY
DAVID HANSEN 083.59.100 1/10

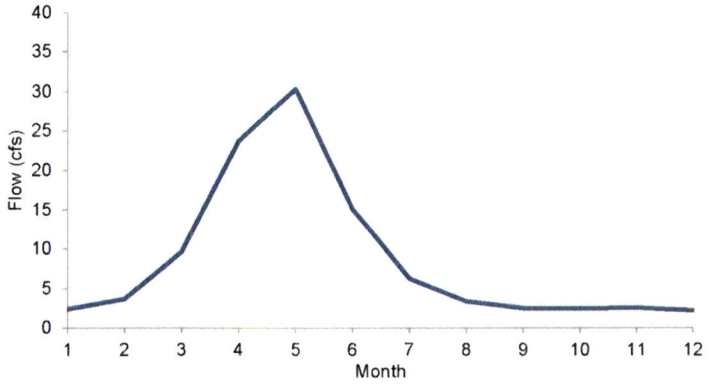

Figure 1: Mean Monthly Flow in Emigration Creek, 1964–2018 (Data: Salt Lake County 2018)

Discharge in Emigration Creek and other canyon surface waters is closely related to groundwater conditions. This interaction was documented in a 1966 report prepared by Jack Barnett (Barnett 1966, 98–99) wherein it stated "the similar quality of the water, the variation of artesian pressure in wells that corresponds to changes in streamflow, and the temperature changes in the stream in response to groundwater contribution" (Barnett 1966, 98–99). Groundwater development and other factors will continue to affect streamflow in Emigration Creek.

Emigration Canyon is approaching its 700-home limit. In 2013, EID noted the following: "Since there are already roughly 550 homes in the canyon and 100 more lots approved for which water has been provided for, there remain about 50 future water services" (EID 2013). These estimates are consistent with population data. Over a 12-year period from 1998 to 2010, Emigration Canyon's population grew from 1,238 to 1,567 (Salt Lake County 1999, 16; U.S. Census Bureau 2012, 13). With an average 2.9 persons per household as in 1998, the 2010 population equated to 540 homes. According to the website www.emigrationcanyon.org/about-emigration/statistics/ there are 589 households within the canyon. However, it is our understanding that there are 685 US postal mailboxes in the canyon, and that Salt Lake City serves approximately 50 connections. The balance of approximately 635 households depend upon private wells or EID for their water supply. Current development levels are rapidly approaching the 700-home limit with only 15 connections remaining.

Bill Bowen, a District trustee, "explained that the 700-home limit is predicated on maintaining a minimal flow in the stream during 80% of the years during peak use in August" (EID 2000). Based on flow records from 1964 to 2000 (the time the limit was established), HAL has determined this value to be 1.6 cfs. EID's *Water Management and Conservation Plan* explains:

> A continuing EID goal is to manage existing water resources in the canyon in such a way as to keep water flow in the creek the large majority of the time. While it is understood that in some drought years the stream may go dry, as it has historically, in most years it should be possible to maintain a flow. Recognizing that existing and future water depletions will impact the flows of Emigration Creek, EID adopted a creek protection policy to maintain our streamflow in all but the worst drought years. (EID 2013)

Even without reaching the 700-home limit, impacts to Emigration Creek have already occurred. In 2000, Bill Bowen observed that "this year they could not maintain streamflows, and if the 700-home limit is broken, he believed the stream environment would be under severe pressure in the future" (EID 2000). Average August flows in Emigration Creek since that time have been

below 1.6 cfs in 10 of 17 years, or 59% of the time. This is in contrast to the fact between 1964 and 2000 only 19%, or 3 of the total 18 years for which data is available had flows below 1.6 cfs. This shows a significant change in flow patterns within Emigration Creek post 2000.

In an email dated November 27, 2018 to SLC from a concerned resident along Emigration Creek at about 2100 East 1300 South indicated "...the creek has flowed 2 or 3 times maybe since we last emailed, but other than that it has been dry." The resident further elaborated by saying "Emigration ran dry at my house last summer as well, but not as often as this summer. There doesn't appear to be a regular pattern of stream flow (diversion) at my location." While lower discharge may be attributed to various human and environmental factors, the data show that Emigration Creek is already struggling to maintain the specified minimum flow.

GEOLOGIC SETTING

Emigration Canyon is a syncline whose axis trends along the stream and slightly plunges to the east (Barnett 1966, 15; Bryant 1990). See Figure 2. Viewed in a roughly north–south cross-section as in Figure 3, the canyon consists of many U-shaped geologic units. Units at the bottom and center of the canyon are younger; ascending either face of the canyon, the units are progressively older. Groundwater flow is toward the center of the syncline, and most streams flow perpendicular to the bedrock strike. Several known faults exist in the canyon, though none appear to be of hydrologic significance (Barnett 1966, 15–17).

AQUIFER POTENTIAL

To better assess groundwater resources Emigration Canyon, HAL has ranked each geologic unit as having high, medium, or low aquifer potential. Each unit shown on Figure 2 is discussed in order from geologically youngest to oldest.

Kelvin Formation (Kk, Kkp)—Medium Aquifer Potential

The Kelvin Formation is a limestone, sandstone, and siltstone unit 1,300–1,600 feet thick whose aquifer potential is depends on the member (Bryant 1990; Barnett 1966, 24). The lower member "is too fine grained to be a good aquifer. Siltstones and sandstones of the upper member are also fine grained, and most of the water movement in them must be confined to the secondary openings" (Barnett 1966, 24).

Preuss Sandstone (Jp)—Low Aquifer Potential

The Preuss Sandstone is about 1,000 feet thick and is a poor aquifer (Barnett 1966, 20; Bryant 1990; Granger 1953, 4). "The sandstones are not clean enough or coarse grained enough to be satisfactory as an aquifer. The shales and mudstones are too fine grained to allow free movement of water through them. The water movement in the formation is mainly limited to fractures, joints, and openings along the bedding planes." (Barnett 1966, 20).

Twin Creek Limestone (Jt)—High Aquifer Potential

The Twin Creek Limestone is about 2,800–3,000 feet thick (Barnett 1966, 20; Bryant 1990; Granger 1953, 4). Aquifer potential is high, though it depends on the bed. "Wells that encounter the massive, strongly jointed limestone are able to develop water because the limestone acts as an aquifer. Wells are unable to develop water from the incompetent [shale] beds because they act as partial aquicludes" (Barnett 1966, 20).

All three existing EID wells have been completed in the Twin Creek Limestone. Their surface locations fall within the formation and their depths are within the 2,800-foot formation depth described. Though the formation is part of a syncline, the wells are near the inside edge and therefore overlie the formation's greater depth. A technical memorandum confirms that Freeze Creek Wells No. 1 and No. 2 were completed in the Twin Creek Limestone and that the then-proposed Brigham Fork Well should be also be completed there (BIWC 2001, 2–4). Wells completed in the Twin Creek Limestone elsewhere in the state have also been productive (Hurlow 2012, 53).

Nugget Sandstone (JTRn)—High Aquifer Potential

The fine-grained Nugget Sandstone is 830–1,300 feet thick (Bryant 1990; Granger 1953, 4). The formation has high potential for groundwater development and is used for public supply elsewhere in the state (Hurlow 2002).

Ankareh Formation (TRau, TRag, Tram)—Low Aquifer Potential

The Ankareh formation is 1,300–1,800 feet thick and consists of three members (Bryant 1990; Granger 1953, 4). It "is an aquitard that separates Nugget Sandstone aquifer from Thaynes Formation" and therefore is a poor aquifer (Wallace et al. 2012, 114).

Thaynes Limestone (TRt)—High Aquifer Potential

The Thanyes Limestone, which is exposed higher in the canyon, is about 2,000 feet thick and consists of a thick series of limestone beds interbedded with shale and sandstone (Bryant 1990; Granger 1953, 4). "Some members are aquifers and others are aquitards, with the lower Thaynes limestone member and upper tongue of the Dinwoody Formation being the best aquifers" (Wallace et al. 2012, 114). A few private wells in the Pinecrest area have been developed in the Thaynes Limestone. Wells completed in this formation elsewhere in the state have been productive (Hurlow 2012, 53).

Woodside Formation (TRw)—Low Aquifer Potential

The Woodside Formation is a low-permeability unit of fine-grained sandstone, siltstone, and mudstone and therefore a poor aquifer (Bryant 1990; Hurlow 2002, 23).

Park City Formation—Medium Aquifer Potential

The Park City Formation consists of interlayered cherty limestone and sandstone and is 600–2,000 feet thick (Hurlow 2002, 6; Bryant 1990). Its hydrogeologic properties are not well documented, but its thickness and media suggest a somewhat productive aquifer.

EMIGRATION IMPROVEMENT DISTRICT WATER SOURCES

EID supplies water to about 275 homes in Emigration Canyon (EID 2014). The rest are served by private, individual wells.

EID currently operates three wells for its water supply (EID 2013). Freeze Creek Well No. 1 is 500 feet deep and can reliably supply 80 gallons per minute (gpm). Freeze Creek Well No. 2 is 800 feet deep and can reliably supply 200 gpm. The Brigham Fork Well, completed in about

2003, is 1,200 feet deep and can reliably supply 150 gpm. A fourth well, presumably the so-called Nugget Well, is proposed (BIWC 2001).

With change applications, EID's water rights total 740 acre-feet (EID 2013).

DOCUMENTATION OF LIMITED WATER SUPPLY

Limited Water Supply. EID provides water services to about half of canyon residents and the limited water supply in the Wasatch canyons in general, and Emigration Canyon in particular, has been a concern since the 1960s. EID has acknowledged the canyon's limited water resources in its *Water Management and Conservation Plan*: "After substantial professional investigation as discussed in various details below, it was determined that the Canyon hydrology could not support more than approximately 700 homes without meaningful impacts to the flows in Emigration Creek" (EID 2013).

For the past several years, EID and the canyon community have repeatedly acknowledged a 700-home limit. "Don Barnett, hydrologist, and Adolph Yonkee, geologist, feel that the canyon has enough water resources to support up to 700 homes and still retain water in the creek. All District trustees are committed to meeting the objective of staying within the 700 canyon water user numbers" (EID 2002, 7–8). The topic drew considerable attention during a September 2000 trustee meeting:

> Mr. [Bill] Bowen explained that the District's best scientific information is that water resources will support only 700 homes. . . . Given that there is a finite resource sufficient to supply 700 homes using 0.75 acre feet of water per year while sustaining the resource, the Board has developed water management policies within that context. (EID 2000c)

Similar commentary is found in other meeting minutes (EID 2000a, 2000b).

Additional historic comments and findings related to canyon hydrology since the mid-1960's follows.

August, 1966 Jack Barnett Study. Significant statements made in this report related to canyon hydrology and development limitations are summarized below.

> "If larger wells were constructed in areas where domestic well development has already taken place, and these wells produced large amounts of water, influence on the water levels in the domestic wells would be almost a certainty, It is probable that this influence could be measured directly, and it could be of significance to the domestic well owners. The very low specific capacities of the domestic wells indicate that the aquifers are not able to yield water readily to the wells. The drawdown of the water levels was several feet in some of the domestic wells when they were pumped at only a few gallons per minute."

It is our position and belief that this has occurred, especially as it relates to surface stream recharge by canyon aquifers.

> "It is doubtful that present well development has had the effect of interfering with surface water rights, at least in quantity. The total production of the wells in the canyon is less than one fortieth the annual average stream flow."

One fortieth of the 1901 – 1965 annual average stream flow is 0.15 cfs or 110 ac-ft/yr. Significant development has continued to occur within the canyon since that time with noted negative impacts on canyon low flows. The proposed permanent change application would allow up to 600 ac-ft/yr to be withdrawn, 5.5 times the 1965 annual average stream flow.

> "It is doubtful that the ground water exists in sufficient quantities to allow the development of large volumes of water by wells, except on a limited basis in areas of the canyon other than near the stream channel. The Twin Creek sub-district, Preuss sub-district, and Kelvin sub-district below Burr Fork appear to have the best supply of ground water both from a quantity and quality standpoint. Development in these areas should be limited to small-diameter, domestic wells if influence on existing rights is to be avoided."

The proposed change application would allow continued development of large volumes of water from existing and new wells.

> "The return flow of water diverted from the wells for domestic purposes will be greatly reduced if the Salt Lake County Board of Health requires all homes to use sealed vaults as a pollution control measure in place of septic tanks."

Sealed vaults capture 100% of the diverted culinary water, contrary to the typical 80% returns through typical culinary or municipal systems.

> "The surface water and the ground water are closely related".

We agree with this statement.

> "A seepage run during the summer of I965 established the fact that some reaches of the stream channel were gaining water from ground-water contributions and other reaches were losing water to the ground water."

Upper reaches of the canyon generally loose water to the ground water system. These waters typically then move down canyon and re-enter the stream in the lower reaches, contributing to critical surface supplies within Salt Lake Valley.

> "Future development of large-diameter wells to produce supplies of water much greater than is required for the domestic needs of one family could significantly influence already established surface-water and ground-water rights."

We agree with this statement.

1989 Wasatch Canyons Master Plan. The 1989 *Wasatch Canyons Master Plan* acknowledged a limited water supply:

> Available water within the canyons is a constraining factor in development. . . . There are about 1,100 single family dwelling units in the Canyons with over 850 of them in Emigration and Big Cottonwood Canyons. There are nearly 2,000 unoccupied, previously recorded residential lots, 1,200 in Emigration Canyon, 680 in Big Cottonwood, and the remainder in Parleys and Little Cottonwood. All of these lots of record may not qualify for a building permit because of an inadequate water supply or for other reasons. (Salt Lake County 1989, 41)

1996 EID Change Application a17521. EID acknowledged the hydraulic limitations within Emigration Canyon per the following change application explanatory submitted on December 31, 1996.

> "This permanent change application is to replace a6538 previously filed by EID. It is filed so as to receive authorization to develop an adequate water supply for canyon residents. The water will be used for the municipal purposes with-in the Emigration Improvement District's service area. The maximum development of the water resources is the subject of a current engineering study and the future growth of the canyon."

The engineering study referenced is entitled "Ground-Water Hydrology of Emigration Canyon, Salt Lake County, Utah" completed by Jack Barnett in August, 1966 as discussed above.

1999 Emigration Canyon General Plan. The 1999 *Emigration Canyon General Plan* describes a similar limit: "Hydrologists have studied volumes of surface water and estimates of underground water sources in the canyon and have come to the conclusion that if a moderate amount of water is allowed to flow in Emigration Creek in the dry seasons of the year, there is sufficient water flow within the canyon to provide for approximately 725 dwelling units" (Salt Lake County 1999, 6). The difference of 725 homes versus 700 homes is trivial and may be attributed to a slightly different water consumption.

Many objectives of the *Emigration Canyon General Plan* involve protecting the canyon's water resources from overuse. "Everyone should be conscious of the limited supply and participate in assuring prevention of overburdening the Canyon's natural ability to recharge its water supply. Any decline in the service level or quality of the public water supply that would result from new growth should not be allowed" (Salt Lake County 1999, 24). Some of the plan's objectives are to "ensure that the public water supply remains at its current service level and is not adversely affected by new development," to "protect the community's groundwater supply from significant depletion or hazardous contamination," and to "balance the availability of water and its use to ensure that water resources are not depleted" (Salt Lake County 1999, 24, 31, 32). It also urges that "to protect the water supply, new development should not deplete existing groundwater supply beyond the ability of the local area to recharge itself" (Salt Lake County 1999, 88).

2000 Don Barnett and Adolph Yonkee Report. Though the original report was not available for review, its findings are mentioned in other documentation reviewed. The basic finding of the report appears to have concluded that Emigration Canyon's water resources can support 700 homes without threatening flows in Emigration Creek. The figure is based on 525 acre-feet of sustainable water supply and a use of 0.75 acre-feet per dwelling unit.

CONCLUSIONS

After reviewing and analyzing available information, HAL has reached the following conclusions.

- Limited water supply in Emigration Canyon is well established and well accepted. The Emigration Improvement District, Salt Lake County, and canyon residents have acknowledged and planned for a 700-home limit.
- In the absence of evidence to the contrary, Barnett and Yonkee's professional investigations and resultant 700-home limit, although accepted by many, may be excessive based on stream flow data reviewed since the year 2000.
- Though the 700-home limit has not yet been reached, impacts to Emigration Creek have already been observed as a minimum flow of 1.6 cfs has not been maintained in 10 of the last 17 years, or 59% of the time. In contrast, between 1964 and 2000 only 19%, or

3 of the total 18 years for which data is available had flows below 1.6 cfs. Whether this change is due to human or environmental factors, the lower flows indicate that the creek is struggling to maintain the specified minimum flow required at the identified maximum housing density or 700.

- Canyon development should be limited as planned in order to protect the canyon's water resources from overuse.
- Additional permanent water withdrawals within Emigration Canyon will negatively impact streamflow in Emigration Creek, as well as the ability for SLC to use its water resources further downstream.

REFERENCES

BIWC (Barnett Intermountain Water Consulting). 2001. Technical memorandum on Emigration Canyon Hydrogeology and Potential Impact to Stream Flows from Proposed Well Drilling. http://www.emigrationcanyon.org/docs/app_a_7.pdf.

Barnett, Jack A. 1966. "Ground-Water Hydrology of Emigration Canyon, Salt Lake County, Utah." Master's thesis, University of Utah.

Bryant, Bruce. 1990. "Geologic Map of the Salt Lake City 30′ × 60′ Quadrangle, North-Central Utah, and Uinta County, Wyoming." Map I-1944. U.S. Dept. of the Interior, U.S. Geological Survey. http://ngmdb.usgs.gov/Prodesc/proddesc_10018.htm.

Daly, Chris, and George Taylor. 2000. "Average Annual Precipitation (PRISM model) 1961–1990." GIS dataset. U.S. Dept. of the Interior, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center. https://www.sciencebase.gov/catalog/item/543d4dece4b0fd76af69cbb5.

DWR (Utah Division of Water Rights). 2015. Public Water Supplier Information for Emigration Improvement District. Accessed Apr. 27, 2015. http://www.waterrights.utah.gov/cgi-bin/wuseview.exe?Modinfo=Pwsview&SYSTEM_ID=10999.

EID (Emigration Improvement District). 2000a. "Emigration Canyon Community Council Newsletter, August 2000." Accessed Apr. 27, 2015. http://www.emigrationcanyon.org/newsletters.asp?newsid=4&org=ECC&ind=y.

———. 2000b. "Trustee Meeting Notice and Agenda." Excerpts from meeting minutes of Sept. 15. Accessed Apr. 27, 2015. http://www.emigrationcanyon.org/meetings.asp?meetingid=20&org=EID&ind=y.

———. 2000c. "Emigration Canyon Community Council Newsletter, November 2000." Accessed Apr. 27, 2015. http://www.emigrationcanyon.org/newsletters.asp?newsid=3&org=ECC&ind=y.

———. 2002. "Emigration Canyon Community Council Newsletter, Fall 2002." Accessed Apr. 27, 2015. http://www.emigrationcanyon.org/docs%5Cecc_newsletter_fall2002.doc.

———. 2013. *Water Management and Conservation Plan.* Mar. 13. Accessed Apr. 17, 2015. http://www.emigrationcanyon.org/documents.asp?documentid=127&org=EID&ind=y.

———. 2014. "June 2014 Fact Sheet." Accessed Apr. 27, 2015. http://www.emigrationcanyon.org/documents.asp?documentid=149&org=EID&ind=y.

Granger, Arthur E. 1953. *Stratigraphy of the Wasatch Range near Salt Lake City, Utah.* Geological Survey Circular 296. Washington, D.C.: U.S. Dept. of the Interior, U.S. Geological Survey. http://pubs.usgs.gov/circ/1953/0296/report.pdf.

Hurlow, Hugh A. 2002. *The Geology of the Kamas-Coalville Region, Summit County, Utah, and Its Relation to Ground-Water Conditions.* Water Resource Bulletin 29. Salt Lake City: Utah Department of Natural Resources, Utah Geological Survey. http://files.geology.utah.gov/online_html/wrb/wrb-29/wrb-29txt.pdf.

Salt Lake County. 1989. *Wasatch Canyons Master Plan.* Salt Lake City: Salt Lake County Public Works Department, Planning Division. http://slco.org/pwpds/zoning/pdf/1989WasatchCanyonsPl.pdf.

———. 1999. *Emigration Canyon General Plan.* Salt Lake City: Salt Lake County Planning and Development Services Division. http://slco.org/watershed/pdfwlibr/emigrationgplan.pdf.

———. 2011. *TMDL for Escherichia coli (*E. coli*) in the Upper Emigration Creek Watershed*. Salt Lake City: Salt Lake County Watershed Planning and Restoration Program. http://www.deq.utah.gov/ProgramsServices/programs/water/watersheds/docs/2011/11Nov/Emigration_Creek_TMDL_FINAL.pdf.

———. 2015. "Streamflow Historical Data." Flood Control & Engineering Division. http://slco.org/pweng/flood/streamFlow/history/index21.cfm.

U.S. Census Bureau. 2012. *2010 Census of Population and Housing, Population and Housing Unit Counts, CPH-2-46, Utah*. Washington, D.C.: U.S. Government Printing Office. https://www.census.gov/prod/cen2010/cph-2-46.pdf.

USGS (U.S. Geological Survey). 2015. Monthly Mean Discharge in Cubic Feet per Second, USGS 10172000 Emigration Creek near Salt Lake City, Utah. National Water Information System. U.S. Dept. of the Interior, U.S. Geological Survey. Accessed Apr. 28. http://waterdata.usgs.gov/nwis/monthly?referred_module=sw&site_no=10172000&por_10172000_1=449126,00060,1,1963-10,1986-06&format=html_table&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list.

Wallace, Janae, Mike Lowe, Jon K. King, Walid Sabbah, and Kevin Thomas. 2012. *Hydrogeology of Morgan Valley, Morgan County, Utah.* Special Study 139. Salt Lake City: Utah Dept. of Natural Resources, Utah Geological Survey. http://files.geology.utah.gov/online/ss/ss-139/ss-139txt.pdf.