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June 25, 2019

VIA EMAIL: RThompson@slco.org

Robert Thompson, Section Manager
Watershed Planning and Restoration
COUNTY OF SALT LAKE
2001 South State Street N3-120
PO Box 144575
Salt Lake City, UT 84114-4575

Re: Cloudburst Flooding Risk and Salt Lake City's Department of Public Utilities Proposed
4th Avenue Well Chemical Treatment Plant at 4th Avenue and North Canyon Road

Director Thompson:

This letter is to request if your agency has done or know of any studies that specifically model potential flow flows during cloudburst flooding events for the City Creek Drainage in Salt Lake County, Utah. The Salt Lake City Department of Public Utilities ("DPU") proposed well at 4th Avenue and Canyon Road (the "Well")¹ This chlorination treatment plant is proposed to be located in the geologic stream bed of City Creek Canyon in the Memory Grove residential pocket just south of the Memory Grove park gate;² the chemical treatment plant is proposed to be constructed in one of the City's median greenway parklands. I am participating as a citizen in land use planning hearings seeking a special use exception for the Well.³ I am seeking this information to determine whether my concern is warranted that the current design of the Well (Figure 1) is insufficiently protected against potential, rare cloud burst flooding.

Although this letter seeks information on and copies of what documents may exist, ideally, I am seeking a data cube that simulates predicted cloud burst stream flows for the following hypothetical.

¹ Salt Lake City Department of Public Utilities. 2019. Information Website on 4th Avenue Well Project (url: <https://www.slco.gov/utilities/fourth-avenue-well-project/>, accessed May 2019).

² Map location: url <https://goo.gl/maps/sjukaYA3AKY4uWwn8> .

³ Salt Lake City Historic Landmark Commission, HLC PLNHLC2018-00557 and PLNHLC2018-00558 (url: <https://www.slco.gov/boards/historic-landmark-commission-agendas-minutes/>).

1. For two points in the Salt Lake City Creek Drainage at Bonneville Drive and North Canyon Road and at 200 North Canyon Road, Salt Lake City, Utah;
2. For fires in City Creek Canyon beginning at Pleasant Valley covering the interval 1 to 5 square miles in increments of 1 square mile;
3. In such fires soil porosity declines from 10 to 90 percent in increments of 10 percent; and,
4. For rare cloudburst flood events on the interval 1 inch to 8 inches in a 5 to 30 minute duration in increments of 1 inch.

I intend to use such information in support of arguments to DPU and Salt Lake City Historic Landmark Commission that the proposed design insufficiently considers the risk of cloudburst flooding. I acknowledge and understand that it is probably impractical based on the available data to prepare a joint probability distribution for such extreme rainfall and grass and forest fire events. Here, I would like to establish the perimeters of potential flood events.

The DPU's current concept design proposes to build the facility at grade and to omit a floodwater protective barrier required by Utah Admin. Code R309-540-5(1)(a), Facility Design and Operation: Pump Stations - Pumping Facilities (effective April 1, 2019),⁴ which states in part, that:

(ii) the access to the pump station shall be six inches above the surrounding ground and the station located at an elevation which is *a minimum of three feet above the 100-year flood elevation, or three feet above the highest recorded flood elevation, which ever is higher*, or protected to such elevations . . . (emphasis added).



Figure 1 - Excerpt from DPU Architectural Rendering showing daytime view from south east. May 9, 2019.

The Salt Lake County Flood Control Office has prepared duration-based 100 year rainfall prediction maps.⁵ Of particular interest is the 30 minute duration map, which predicts a 100 year

⁴ url: <https://rules.utah.gov/publicat/code/r309/r309-540.htm>.

⁵ Flood Control Engineering, Salt Lake County. 1999. 100 Year Return Frequency Maps – 15 Minute to 24 Hour Duration. (url: <https://www.slco.org/flood-control/rainfall-maps/>).

rainfall level of 1.20 inches. The National Weather Service's AHPS service provides flood predictions based on advanced simulation models and such 100 year prediction stream flows

As you are aware, the northern Utah Wasatch Front canyons and valleys are also subject to rare cloudburst flooding events that can greatly exceed the 100 year prediction levels. Craddock (1945) notes previous maximum recorded rainfalls of 4.80 and 5 inches in a five minute period during 1931 and 1936, and he estimated for the 1945 Salt Lake Perry's Hollow cloudburst flood, a maximum rainfall of 5 to 8 inches in a five minute period (with a longer duration average of 1.25 to 1.75 inches).⁶ He estimated flows during the resulting cloudburst flood at 2,400 cubic feet per second. A recent example was the July 2019 cloudburst in Salt Lake City's Millcreek neighborhood that resulted in the City's Mayor declaring an emergency.⁷ It is also well known for northern Utah that when such random high-rainfall events are coupled with the denuding of ground cover from grazing practices or grass and forest fires that extreme cloudburst floods events – similar to the infamous 1907 Heppner, Oregon cloudburst flood - occur.⁸

Historically, there have been three, possibly four, cloudburst floods from the nearby Salt Lake Salient that has sent waves of water into the city causing severe damage: the 1945 Perry's Hollow flood (2,400 c.f.s. down M and N Streets to South Temple and moving 500 lb. boulders); the 1916 Dry Canyon flood (a 4 to 10 foot wall of water went down Virginia Street and Second and Third Avenue west to 200 South and 900 East moving cattle and 1,000 to 1,500 lb. boulders); and the 1918 West Capitol cloudburst flood (burying properties at 200 West in up to 1 foot of mud).⁹ A possible

⁶ Craddock, G. W. (1945). The Salt Lake City Flood, 1945. Proceedings of the Utah Academy of Sciences, Arts and Letters, 23, 51–61 (copy attached, *id* at 58).

⁷ Biskupski, J. Mayor. July 28, 2019. Press Conference: Mayor Biskupski Declares Local Emergency in SLC. Video. YouTube.com. (url: <https://www.youtube.com/watch?v=aE86VK43tII>), DPU Director Laura Briefer appears to the Mayor's left); Fox News (Channel 13, SLC). July 28th, 2019. Mayor Biskupski declares local emergency after SLC flooding. Fox News. (url: <https://fox13now.com/2017/07/28/mayor-biskupski-declares-local-emergency-after-slc-flooding/>).

⁸ Utah Flood Commission. (1931). Torrential floods in Northern Utah, 1930. Logan: Agricultural Experiment Station, Utah State Agricultural College (url: <http://www.lib.utah.edu>); Salt Lake Telegram, August 20 and 27, 1945; Salt Lake Tribune, August 19, 1945; Craddock 1945, *supra*; Woolley, R. R. (1946). Cloudburst Floods in Utah: 1850-1938. Washington, D.C. at 96-120 (url: <http://pubs.er.usgs.gov/publication/wsp994>); Honker, A. M. (1999). "Been Grazed Almost to Extinction": The Environment, Human Action, and Utah Flooding, 1900-1940. Utah Historical Quarterly, 76(1), 23–47 (url: <http://heritage.utah.gov/history/quarterly>); Boyce, R. R. (1958). A historical geography of Salt Lake City, Utah. Thesis. Masters. Department of Geography, University of Utah at 41 re 1876).

⁹ See Addendum for historical references. Floods from both of the Perry's Hollow and Dry Fork salient side canyons are now controlled by combined road-flood structures. Perry's Hollow at Chandler Drive (url <https://goo.gl/maps/5DU9NJDxphwWWbXUA>) and 1691 E. Federal Heights Drive (url <https://goo.gl/maps/gYZvJyBUJMmH2Vtn8>). Two much smaller flood control structures exist in the City Creek Canyon drainage (n. 16, *infra*).

fourth flood occurred along the highway north of the City and completely buried cars under tons of gravel (*id*).

The proposed 4th Avenue and North Canyon Road site in the geologic stream bed also has been repeatedly flooded by the high-snow pack runoff waters of City Creek Canyon.¹⁰ As a result of the 1983 state-wide floods from high-snowpack melting, the DPU's predecessor spent about \$1,000,000 repairing flood damage to roads from North Temple and State Street north to Memory Grove.¹¹ The City replaced 1,040 feet of 6" inch pipeline excavated and damaged by flood waters between 4th Avenue and Memory Grove, 18 subsurface sewer and water connections in the area were destroyed, and the foundations of the old Brick Tank house north of Memory Grove were undermined (*id*).



Figure 2 – Flood waters passing Ottinger Hall 300 feet north of proposed Well in June 1983. Source: KUTV News. Remembering the Floods of 1983. Web. Accessed May 2019 (url: <https://kutv.com/news/local/gallery/photo-gallery-remembering-the-floods-of-1983#photo-28>).

In response to the 1983 high-snowpack melt flood, the City has also built two small flood control basins – each about 15 feet deep with a triangular shape of about 100 feet by 200 feet – at the intersection of Bonneville Drive and North Canyon Road.¹² Based on the oblique pyramid formula, I roughly estimate volume of these basins at 100,000 cubic feet each.¹³ These basin are principally

¹⁰ See discussion and supporting academic references in Letter by K. Fisher to SLC DPU dated May 25, 2019 (url: <http://fisherka.csolutionshosting.net/misc/FourthAveWell/20190525WellCommentFloodingFinal.pdf>). For easy reference, the key documents and academic and research articles regarding historical flooding from high-snow packs and cloudburst floods are listed with retrieval urls where available in the Addendum. Copies of documents not available by internet download are available from this writer on request.

¹¹ Excerpts from SLC DPU GRAMA production to K. Fisher, June 13, 2019 (url: <http://fisherka.csolutionshosting.net/misc/FourthAveWell/20190617ExcerptsfromDPUProductionre4thAveWell.pdf>).

¹² Map location: url <https://goo.gl/maps/ez7uk97yt98Jpz6U8> .

¹³ $V = 1/3Bh = 1/3 * 200 * 15 * 100$.

designed as strainers and not to retain flood waters.¹⁴ An analogous strainer grate also exists at the south end of the dog wading pond at Memory Grove.¹⁵

Part of the damage in the City's 1983 flood was caused by administrative policies. Since the late 1800s, the City had a program of removing fallen trees from the City Creek Canyon streambed from Pleasant Valley¹⁶ to Memory Grove, but this was discontinued during the 1910s. Currently, the DPU only removes trees that have fallen on or endanger traffic along City Creek Canyon Road; there is no systematic program to remove fallen trees from the stream bed. The 1983 high-snow pack flood waters swept fallen trees that had accumulated in the 12 miles of City Creek stream bed above Memory Grove Park and down into the lower canyon, about 600 feet north of the proposed Well site:



Figure 3 – Tree debris in Memory Grove Park after flood waters receded. Salt Lake City Tribune, July 22, 1983. “Restoration of Memory Grove will be a joint project.”

The first nearby ground failure associated with the 1983 flood was at the clogged culvert about 800 feet south of the proposed Well site. The underground culvert carrying City Creek burst, and a city worker had to be lowered into the pipe full of swirling flood waters to set dynamite charges and to free the blockage.¹⁷ Nevertheless, flood waters were so great that the creek also flooded above its entry point into the underground culvert within Memory Grove Park (Figure 2 and Figure 3). In 1983, maximum flows were estimated at about 330 cubic feet per second, far above the 90 foot per second capacity of City Creek's 1908 entombment conduit.

¹⁴ Over the last two spring seasons (2018 and 2019), I have observed that even with moderate snowpack run-off, the north basin fills to about three feet below overtopping.

¹⁵ Map location: <https://goo.gl/maps/sLptGo6ezYGptBEq6> .

¹⁶ Map location: url <https://goo.gl/maps/CojrGNv2BPiMkev18> .

¹⁷ Salt Lake Tribune, June 3, 1983.

A second ground failure associated with the 1983 flood was a 12 foot deep sinkhole that formed north of the proposed Well site, shown in Figure 4:



Figure 4 – Twelve Foot Deep Surface Failure North of Ottinger Hall and 400 feet north of proposed Well site, looking south, June 9, 1983. Salt Tribune. 1983. Spirit of Survival: Utah Floods of 1983.

In response to the 1983 floods, the City also increased subsurface conduit carrying capacity from the intersection of North Temple and State Street by adding a second underground conduit west to the Jordan River. The flood carrying capacity of the underground pipe from Memory Grove through North Temple remains at the 90 c.f.s. of the original 1908 subsurface conduit. In conclusion, the 4th Avenue and North Canyon Road site remains vulnerable to both high-snow pack runoff and rare extreme cloudburst events and notwithstanding the two small flood basins at the intersection of Bonneville Drive and North Canyon Road.

My impression from reviewing DPU concept drawings and other available memoranda are that the DPU and the City planning staff either considers the risk of cloudburst flooding at the site to be remote or that such risk would be fully controlled by the two basins at Bonneville Drive and North Canyon Road. My requests stated above¹⁸ are intended to a) locate studies or reports that have already analyzed the perimeters of potential cubic feet per second floodwaters during a cloudburst and/or cloudburst after fire event or b) that your office conduct a floodwater simulation of such an event so the perimeters of the risk can be quantified. Again, the joint probability distribution of such rare events probably cannot be quantified. In the interest of full disclosure, my participation the City land use matter seeks to have the 4th Avenue chemical treatment plant moved to a City owned park about 800 feet to the south and elevated three to six feet above the geological City Creek floodplain.

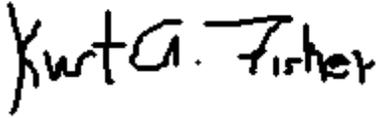
¹⁸ At page 2.

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Please feel free to contact me with any questions that you may have by the means listed above.

Very Truly Yours

A handwritten signature in black ink that reads "Kurt A. Fisher". The signature is written in a cursive, slightly slanted style.

Kurt A. Fisher

cc: Holly Mullen, Communications and Engagement Manager (holly.mullen@slcgov.com)

Kelsey Lindquist, Senior Planner, Salt Lake City Historic Landmark Commission
(Kelsey.lindquist@slcgov.com)

Kirk P. Bagley, P.E., Bowen Collins and Associates, Inc (info@bowencollins.com) (Well consulting designers) .

John Ewanowski, P.E., CRSA (jewanowski@crsa-us.com) (Well consulting designers)

Addendum

Key Historical Salt Lake City Creek Floods and Northern Utah Cloudburst Flooding Documents, Research and Academic Articles¹⁹

Excerpts from SLC DPU GRAMA production to K. Fisher, June 13, 2019 (url: <http://fisherka.csolutionshosting.net/misc/FourthAveWell/20190617ExcerptsfromDPUProduction4thAveWell.pdf>).

As a result of the 1983 state-wide floods, the DPU's predecessor spent about \$1,000,000 repairing flood damage to roads from North Temple and State Street north to Memory Grove. The City replaced 1,040 feet of 6" inch pipeline excavated and damaged by flood waters between 4th Avenue and Memory Grove, 18 subsurface sewer and water connections in the area were destroyed, and the foundations of the old Brick Tank house north of Memory Grove were undermined.

Nicoli, K. and Lundeen, Z. J., University of Utah. (2016). A case study: geomorphic effects of the 2009 Big Pole fire, Skull Valley, Utah (Vignettes: Key Concepts in Geomorphology). Northfield, Minnesota. (url: <http://serc.carleton.edu/47063>).

Recent example of the effects of cloudburst flooding in northern Utah. In a large Skull Valley canyon fire covering about 41,000 acres. Such fires decrease soil permeability by 9 to 100 times. *See also* Craddock, below. During subsequent heavy rains in Skull Valley, large sheet flows occurred and craved 1 meter deep rills in the alluvium. Historically, a similar incident occurred a Dry Creek Canyon. In 1915, there was a large 4 square mile fire in the Canyon that spread over the Salt Lake City Salient southern city-facing hillside. *See* Salt Lake Telegram and Tribune, 1915, below. Woolley records that on July 25, 1916, a Dry Creek Canyon cloudburst sent a 4 to 10 foot wall of water down City Creek and into city, along with mud, boulders and cattle (below, Salt Lake Tribune July 25, 1916).

Wirth, Craig (KUTV News). May 12, 2014. Remembering the flood of '83. KUTV News. At min. 1:35. (url: <https://www.abc4.com/wirth/wirth-watching-remembering-the-salt-lake-city-flood-of-83/204262974>)

Salt Lake Tribune, and Smart, C. (2011, Apr 29). River on State Street unlikely in 2011, official says. Salt Lake City Tribune. Salt Lake City, Utah. ProQuest No. 864039697. (Retrospective

¹⁹ In reverse chronological order.

article in which Salt Lake Councilperson describes sandbagging efforts to control 1952 flood; available through Proquest (<https://www.proquest.com/>) or copy on file with this author).

Honker, A. M. (1999). "Been Grazed Almost to Extinction": The Environment, Human Action, and Utah Flooding, 1900-1940. *Utah Historical Quarterly*, 76(1), 23–47 (url: <http://heritage.utah.gov/history/quarterly>) (Includes review and photographs of Salt Lake City Creek flooding, in particular, in 1909. Overviews high-snow melt verses cloudburst flooding in northern Utah).

Salt Lake Tribune, June 3, 1983 and July 22, 1983. Reproduced in Salt Tribune. 1983. *Spirit of Survival: Utah Floods of 1983* (Available at Reference Desk, Main Branch, Salt Lake City Public Library and Special Collections, Marriott Library, University of Utah, Call No. F830 .S657).

Boyce, R. R. (1958). A historical geography of Salt Lake City, Utah. Thesis. Masters. Department of Geography, University of Utah at 41 re 1876). (On file at Special Collections, Marriott Library, University of Utah; copy in author's possession).

Salt Lake Tribune. April 30, 1952 (Available through <https://go.newspapers.com/>, re: floods of 1952).

Woolley, R. R. (1946). Cloudburst Floods in Utah: 1850-1938. Washington, D.C. at 96-120 (url: <http://pubs.er.usgs.gov/publication/wsp994>)

Woolley listed numerous cloudbursts floods that have come across the Avenues District and from City Creek and across the proposed Well site and into the downtown: (Woolley 1946). Summer cloudburst floods included: June 13th, 1854 (city streets flooded), September 11th, 1864 (heavy flooding of North Temple from City Creek), August 25th, 1872 (downtown flooded), July 23rd, 1874 (downtown flooded from City Creek), August 1st, 1874 (Lindsey Gardens areas flooded as in 1945), August 8th, 1884 (North Temple flooded from City Creek), July 26th, 1893 (cloudburst flooded basements in city), July 19th, 1912 (1 inch fell in 1 hour filled South Temple with sand and mud from above), July 25th, 1916 (cloudburst sent a 10 foot wall of water into city along with mud, boulders and cattle), July 30th, 1930 (cloudburst over Emigration, Red Butte, and Parley's Canyons washed out highway north of Salt Lake and washed away three homes with damages of 500,000 USD), and August 13th, 1931 (four to 12 inches of water swept through streets and 12 feet of debris washed over road near Beck Hot Springs).

Craddock, G. W. (1945). The Salt Lake City Flood, 1945. Proceedings of the Utah Academy of Sciences, Arts and Letters, 23, 51–61. (On file with the Special Collections, Marriott Library, University of Utah; copy attached).

Salt Lake Telegram, August 20 and 27, 1945 (Available through <https://go.newspapers.com/>; copy in author's possession).

Utah Flood Commission. (1931). Torrential floods in Northern Utah, 1930. Logan: Agricultural Experiment Station, Utah State Agricultural College. On file at Special Collections, Marriott Library, University of Utah. ([url:http://www.lib.utah.edu](http://www.lib.utah.edu)).

Salt Lake Telegram. August 14, 1931. Flood Traps Car on Highway. (A cloudburst flood buried cars on highway to the north of Salt Lake City). ([url:https://newspapers.lib.utah.edu/ark:/87278/s6cr728k](https://newspapers.lib.utah.edu/ark:/87278/s6cr728k)).

Salt Lake Telegram. Sept. 24, 1918. Property Damaged by Big Cloudburst. (A cloudburst flood swept down West Capitol Hill and buried properties at 200 West in up to 1 foot of mud). ([url:https://newspapers.lib.utah.edu/ark:/87278/s6d80jz5](https://newspapers.lib.utah.edu/ark:/87278/s6d80jz5)).

Salt Lake Tribune. July 25, 1916. Cloudburst Kills Cattle in Canyon. ([url:https://newspapers.lib.utah.edu/ark:/87278/s6j10wfd](https://newspapers.lib.utah.edu/ark:/87278/s6j10wfd))

“A cloudburst breaking in Dry canyon during the electrical storm of yesterday emerged from the ravine a solid ten-foot wall of rushing water, carrying with it eight head of cattle and rocks weighing from 1000 to 1500 pounds, swirling them along as lightly as feathers. Following the course of the old waterway, the waters rushed through Popperton place, down Second and Third Avenues, turning on Ninth East to the Second South conduit before the force of the flood was spent. In the residence district of Popperton place and the avenues the telephone poles showed that the water mark to have been four feet.”

Salt Lake Tribune. August 6, 1915. City's Watershed Suffers from Fire. ([url:https://newspapers.lib.utah.edu/ark:/87278/s6tf17rk/14627562](https://newspapers.lib.utah.edu/ark:/87278/s6tf17rk/14627562))

Salt Lake Telegram. August 5, 1915. Big Damage Caused by Brush Fire in City Creek. ([url:https://newspapers.lib.utah.edu/ark:/87278/s6km0kdd/19586313](https://newspapers.lib.utah.edu/ark:/87278/s6km0kdd/19586313) , re: 4 square mile brush fire in City Creek Canyon that crossed city-side ridgeline).

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Salt Lake Telegram, June 19th, 1903. Salt Lake City in Path of Cloudburst, Should It Break in City Creek. (url: <https://newspapers.lib.utah.edu/ar/87278/s6ck2gdq>)