APPENDIX B

Little Cottonwood Canyon Alternatives and Climate Change

Memo

Date:	Friday, January 03, 2020
Project:	Little Cottonwood Canyon EIS
To:	UDOT
From:	HDR
Subject:	**Little Cottonwood Canyon Alternatives and Climate Change**

Climate variability and climate change has and will continue to have an effect on the snow and avalanche regime in Little Cottonwood Canyon. Many studies have identified widespread declines in historical snowpack amounts in western North America over the last 30 to 50 years (for example, see Mote et al. 2005; Hamlet et al. 2005; Mote 2006), and these changes have been linked to warming trends and increasing elevations at which freezing temperatures occur. About half of recent changes in the western U.S. snowpack have been attributed to anthropogenic (human-caused) effects (Pierce et al. 2008). Future projections of the snowpack, expressed in terms of snow water equivalent, point to widespread losses across the western United States (for example, see Pierce and Cayan 2012). Research that specifically considers the Wasatch Range is consistent with the findings across the western United States showing a decrease in historical and future projected snowpacks.

For the Wasatch Range specifically, there will likely be increased variability in the snowpack as a result of the jet stream moving north. In addition, although annual precipitation amounts will remain unchanged or increase slightly (depending on the model and future scenario examined), the proportion of rain to snow will increase (Strong 2013; Scalzitti et al. 2016). This reduction in the snowpack would be driven by increasing air temperatures and, on average, will result in substantially decreased snowpack depths by the middle and end of the 21st century.

These projected changes in the snowpack could affect avalanches and ski resorts in Little Cottonwood Canyon. Although there are no conclusive studies to provide specific changes, these changes in temperatures and precipitation could result in a shorter avalanche and ski seasons that start later in winter and end earlier in spring. It is also likely that the wet snow season could start earlier in the winter. This reduction in season length could reduce the frequency and potential magnitude of avalanches in Little Cottonwood Canyon. Despite this likely average reduction in avalanche frequency and magnitude, climate change has been linked to increases in extreme events and increased variability in precipitation, so infrequent larger events should still be considered possible.

A study by Lazar and Williams (2010) analyzed climate change effects for Wasatch Range ski areas. This study found that, by 2050, climate change is predicted to have a substantial effect on snow coverage and snow depth. The authors found that the snowpack could build up enough to support skiing 1 to 2 weeks later, and snow could begin to melt at the base of the resorts 1 to 2 weeks earlier. There might be little snow by Thanksgiving, and mid-winter snow depths could be 20% to 40% less than what has occurred historically.

These studies clearly point to both changes in the inter-annual variability of the snowpack and to long-term reductions of the snowpack in the Wasatch Range. These climate variability and change issues should be considered for any future structural avalanche mitigation. By 2050, skiing spring break might be difficult at lower elevations (Lazar and Williams 2010).

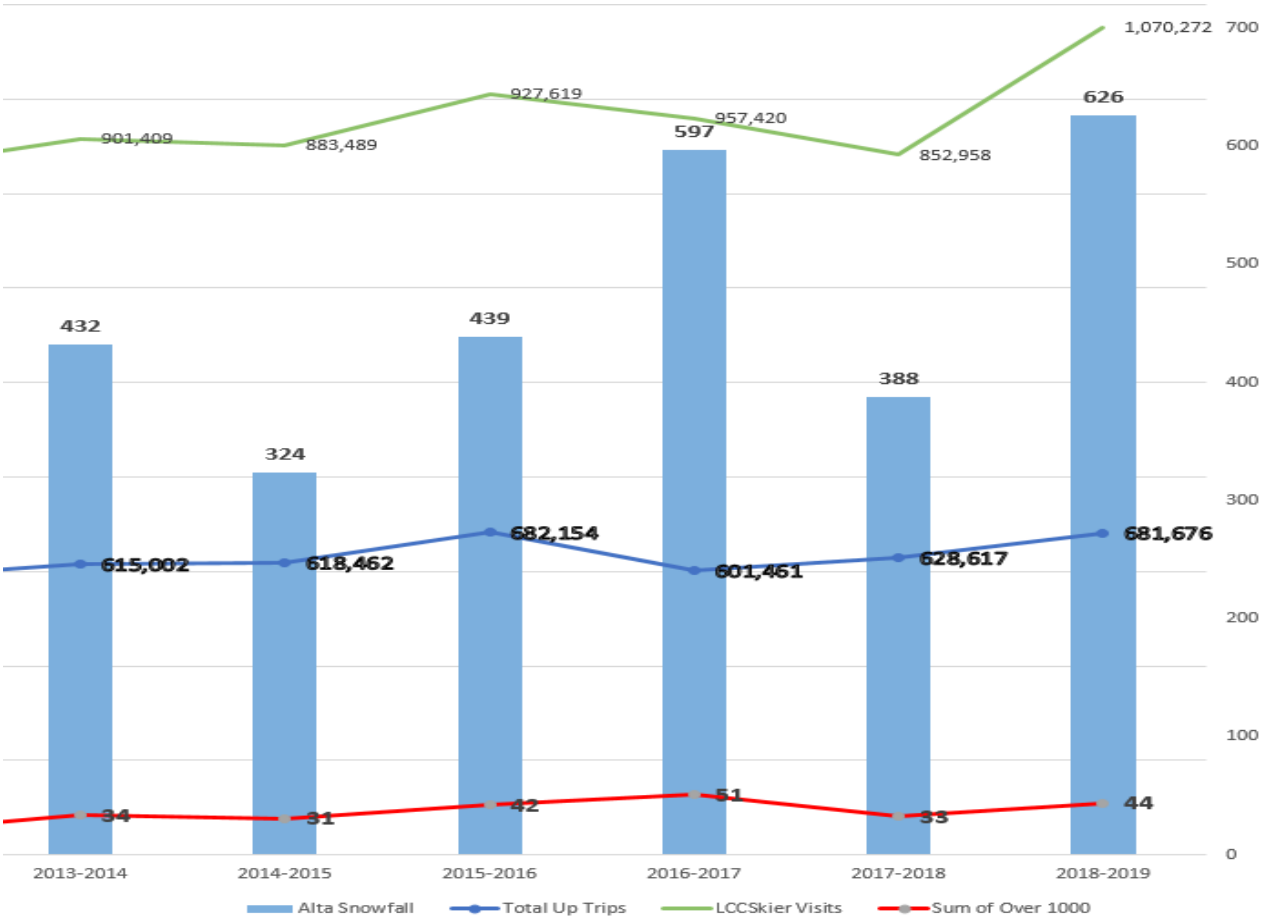
Another study (Wobus et al. 2017) found considerable variability at all levels with regard to the effects of climate change on skier days, particularly with respect to the spatial distribution of impacts. In general, sites at higher elevations (such as the Rocky Mountains and Sierras) tend to be more resilient to projected changes in temperature and precipitation. The study found that, under all scenarios of climate change that were modeled, by 2050 the number of skiing visits would be similar to current levels or would increase along with population growth.

With regard to the Little Cottonwood Canyon EIS, the Utah Department of Transportation (UDOT) considered how climate change might affect its development of alternatives for the EIS. UDOT reviewed traffic data from Little Cottonwood Canyon during the winter season (November to April) of 2018. According to the traffic data, during the winter season of 2018, there were 72 1-hour periods with more than 800 vehicles in the canyon. Nearly all (68) of the 1-hour periods with more than 800 vehicles occurred from December through the end of March. November had no 1-hour periods with more than 800 vehicles, and April had 4.

Based on the climate change literature, in 2050, the buildup of the snowpack at the canyon resorts could be delayed by 1 to 2 weeks, with little snow at Thanksgiving, and the ski season might end 1 to 2 weeks earlier. Historically, high-traffic days in the canyon have occurred from late December (typically around the Christmas holiday) through March, when the snowpack should be deep enough based on climate studies for skiing. Since most high traffic days don't occur until December and likely around the late December holiday period and end in March when snow pack should be enough to ski based on literature, climate change should not result in a need to modify alternatives that address mobility during high travel periods. In addition, sites at higher elevations (such as Snowbird and Alta ski resorts -7,800 feet and above) tend to be more resilient to projected changes in temperature and precipitation.

UDOT also reviewed traffic data for eastbound traffic in the canyon from the 2013 through 2018 ski seasons. These ski seasons had different yearly snow totals. During this 6-year period, there were an average of 39 travel periods per ski season with more than 1,000 vehicles in the canyon. As shown in the graph below, the highest number of travel periods on S.R. 210 in Little Cottonwood Canyon with more than 1,000 vehicles (51) occurred during the 2016–2017 ski season, and the lowest number of travel periods with more than 1,000 vehicles (31) occurred during the 2014–2015 ski season. The 2014–2015 ski season had the lowest snow total of any year from the 2006–2007 ski season to the 2018–2019 ski season. Overall, the data show that, even during years with low snow totals, there are more than 30 travel periods per ski season in which the number of vehicles in the canyon exceeds 1,000 vehicles. This number (30) is only 9 below the average number for the 6-year period (39). Therefore, even with the potential for less snowfall at the resorts in the future, UDOT still expects that there would be enough heavy traffic days to justify developing alternatives that address mobility during high-travel periods.

Graph 1. Number of Eastbound Travel Periods over 1,000 from 2013–2014 to 2018–2019



Graph notes:

- Total snowfall in inches for Alta Ski resort.
- Total up trips are up canyon trips (eastbound) for winter season in Little Cottonwood Canyon.
- LCC skier visits is the total number of skiers (Snowbird and Alta ski resorts) on S.R. 210 in Little Cottonwood Canyon for the winter season.
- Sum of over 1,000 is the number of up canyon (eastbound) hours that exceed 1,000 vehicles in the hour on S.R 210 in Little Cottonwood Canyon.

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