Park City Municipal Corporation
Treasure Hill Open Space 2022
Forest Management

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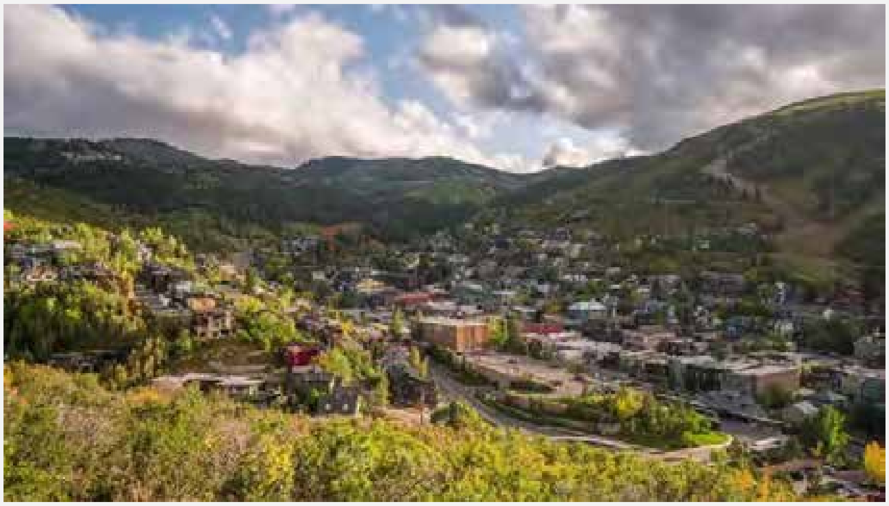

TREASURE HILL
FOREST MANAGEMENT PLAN

I have reviewed this plan, which has been prepared at my request to guide my stewardship management activities, and I will apply them on my property to the best of my ability.

Land Manager Date

Land Manager Date

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Executive Summary

In August 2021 the Park City Municipal Corporation selected Alpine Forestry to create a comprehensive plan for future forest management activities on Treasure Hill. This forest management plan is intended to be used as a basis and guide for City staff and land managers to implement projects moving forward. It also serves as an educational resource, to highlight the need for active management of forests and other resources on Treasure Hill, in a multi-phase and multi-year plan.

The tenets of the Cohesive Wildland Fire Management Strategy; developing a resilient landscape, promoting Fire Adapted Communities, and ensuring safe and effective fire suppression, provide the foundation elements for this forest management plan. As such, a thorough assessment and documentation of the current health and state of the forest was completed, along with real time mapping of vegetation. Modeling tools to analyze vegetation and landscape data were used to determine areas of high fire risk and potential resource loss. Subject matter experts were used to gather and analyze the data used to inform the decision making process. The City was consulted to establish management objectives that align with the 2014 General Plan for “Natural Setting”.

After an extensive evaluation process, the project team selected key management actions and recommendations to implement restoration work over the next several years and beyond with consideration to wildlife, recreational, aesthetic, historical, and community values. It must be noted that a commitment to forest management requires consistent monitoring of conditions and changes, and findings from this process are intended to drive and adjust future actions. Thus, we consider aspects of this report to be a living document.

General summary of findings and recommendations:

- Serious forest health concerns were found that increase the threat of wildfire and subsequent fire effects (i.e. soil erosion, avalanches) and potential to impact the Park City Wildland Urban Interface.
- Active forest management is critical on Treasure Hill to rapidly address forest health and wildfire risk.
- Priority projects were developed based on observed forest health issues and wildfire risk including;
    - Providing for defensible space adjacent to the Wildland/Urban Interface.
    - Addressing serious forest decline in the conifer stands while increasing fire resilience.
    - Restoring aspen health to maintain wildlife and aesthetic values, while providing for shaded fuel breaks.
- Ongoing monitoring and maintenance of vegetation treatments are necessary to ensure objectives and goals are being met over time.

While the residents of Park City took significant steps to preserve Treasure Hill with the 2019 purchase of the property, efforts remain in taking full responsibility for management of the land and natural resources. This forest management plan is a first step in managing the value of the forest resource while addressing fire risk, with consideration for the heavy recreational use, ski resort and historical mining infrastructure, high aesthetic value, wildlife habitat, and avalanche potential.

1 Property Overview

1.1 General Property Description

The Treasure Hill project area consists of 104 acres of land adjacent to downtown Park City in Summit County, Utah (Parcel No. PC-364-A-X and THILL-5-X). The Property is owned by Park City Municipal Corporation and it is designated as “open space.” Notable features of this property include steep forested slopes that lend an aesthetic appeal to the area, multiple ski runs, the ‘Town Lift’, 3.14 miles of trails, and service roads within its boundaries. Elevations range from 7,100 feet to over 7,700 feet. The property lies within the East Canyon Watershed which makes up a portion of the larger Weber Watershed. An overview of the Treasure Hill Parcels is shown below in Figure 1.1, and a detailed overview of the Project area including major neighboring parcel ownership is shown in **Appendix D, Exhibit 01.**

Figure 1.1 - Treasure Hill Project Area (Parcels THILL-5-X, PC-364-A-X)

Almost half of the land that makes up Summit County is forested (NRCS 2022) and nearly all the grounds that make up Treasure Hill are covered in mixed conifer, mixed hardwood, and oak forests. Although Treasure Hill makes up a small portion of acreage in the county, the management outcomes of this prominent community parcel, along with neighboring private and public lands, will help promote healthier lands and the communities they support.

1.2 Conservation-Based Planning

The Treasure Hill property was acquired by Park City Municipal Corporation in 2019 after city residents voted to buy the land; serving as one of the final remaining large parcels of open space adjacent to the historic downtown area of Park City. The acquisition of Treasure Hill showcases the shared principles of Park City residents when it comes to protecting important natural resources. As such, management strategies will strive to meet high standards for preserving the character of open space, and resource management will consider the dynamic nature of the ecological, social, and economic environments. It must be realized that not all desired goals will be met simultaneously, but care will be taken to ensure all resources are considered when planning future projects.

The majority of land in and around Park City is under private ownership, with 54.7% of Summit County in private ownership, leaving it susceptible to development choices without a conservation vision. Unlike federal, state, and other public lands set aside for conservation purposes, privatized land is readily available for the development of residential, commercial, and industrial activities. Since the end of the mining era, skiing and other forms of recreation have become a major basis for the economy in western Summit County, attracting developers to the area to provide housing and amenities. Many landowners who historically farmed or ranched the area have begun to sell their land to residential developers. This includes landowners of forested land who find a demand for residential areas built among the wooded hillsides (SWCA Environmental Consultants, 2010).

It is due to this rapid development that Park City officials and residents alike are passionate about preserving open space and maintaining the character of this area. Treasure Hill itself has been the site of many different proposals for development. One of the largest planned developments included a hotel, condominiums, commercial spaces, and conference center (Hamburger, 2016). These plans prompted residents and City officials to seriously consider the future of this parcel, which has led to conservation efforts taking place today.

It was in August of 2018 that the City Council unanimously voted in support of a $48 million dollar Treasure Hill and Armstrong/Snow Ranch Pasture open space bond. It was decided that the voters should ultimately make the final decision on these lands. Two months later, on November 6, 2018, 77% of registered voters in Park City voted to preserve these areas as open space to be protected from development. All of these efforts were finalized in 2019 when the city purchased the hillside in a $64 million dollar conservation deal (Hamburger 2019). This resulted in the preservation of Old Town's historic character and the persistence of more than 100 acres of forest (2018 Park City Municipal Corporation).

The Park City Council authorized Summit Land Conservancy to hold a conservation easement on the Treasure Hill land. A conservation easement is an important document that outlines the restrictions on ground that is protected from development. They are held and enforced by a third party land trust like Summit Land Conservancy rather than the landowner (Hamburger, 2021).

1.3 Management Objectives

Overall objectives of this 2022 Treasure Hill Forest Management Plan were developed in consultation with Park City Municipal Corporation (PCMC) Open Space staff members to align with the Natural Settings Goals and Strategies of the Park City 2014 General Plan.

2022 Treasure Hill Forest Management Plan Objectives:

1. **Prepare for probable scenarios that could threaten the health, welfare, and safety of residents through active and passive management activities.**

2. **Manage for healthy, resilient forests that respond to disturbance and climate change in such a way that ecosystem characteristics and function are not [irreparably] damaged.**
3. **Set the stage for future natural resource management planning on city owned open space to balance human use with ecosystem health.**

1.4 Land Use

Land use on Treasure Hill is “determined by the municipality through land use and zoning ordinances.’ ‘Land Use’ is not a resource in the same sense as most other resources to be considered. Land use depends heavily on the preferences and policies of the managing entity.” (2021 Utah Public Lands Policy Coordinating Office)

Management of forest and range land in Utah has relatively few limitations. Management objectives drive treatment activities using a wide range of allowable methods under federal, state, and local regulations. There are no silvicultural systems (forestry activities) that are prohibited by the Utah Forest Practice Act or guidelines provided by federal and state laws/regulations. Though there are few barriers to managing public and municipal land, it does not mean that Park City officials and residents are willing to implement any type of treatment. For example, in the case of Treasure Hill, land management objectives do not include an intensive timber harvest for economic gain, though this is an acceptable practice in the state.

Based on current land use, vegetation management would seek to maintain recreation, aesthetics, wildlife habitat, and manage wildfire risk to the wildland-urban interface. All potential management activities would follow best available science to the extent possible, realizing that not all social, ecological, and economic strategies may be met. For example, some wildfire mitigation strategies may override the strict adherence to ecologically-based management strategies. In addition, adaptive management techniques will be needed to respond to changing environmental conditions, scientific review, and public perception over time.

2 Resource Considerations

2.1 The Need for Rapid Climate Response

There is an urgent need for response to a changing climate, and many issues related to these changes have already surfaced in the state. Residents of the area have proven that they are willing to address the hard questions, find solutions, and prepare their city for the future. The area's response to climate change depends heavily on how resources are managed across all lands; however, the management outcome for a prominent community open space such as Treasure Hill has the opportunity to influence land management culture locally and across the West by setting a high standard with a long term vision in mind.

Background

It must be noted that Park City residents have long understood the potential effects of climate change to the area's natural landscapes and recreation economy. The Park City Municipal Corporation General Plan of 2014 recognized the concern for climate change. Residents approached the city council in 2016 to set ambitious goals that would preserve the natural settings, transition to a carbon-neutral future, and ensure the viability of a local economy that is susceptible to effects from climate change (2019 Park City Municipal Corporation). Due to the ambitious goals of Park City, the city became recognized as a national leader in addressing climate change through cutting carbon emissions and planning for future impacts (2020 World Wildlife Fund).

Furthermore, Park City Green completed a study in 2017 to assess how climate change will impact the city as well as the skiing industry. They reported that the ski industry employs 20,000 workers and brings in $1.3 billion into Utah. The study suggests that Utah will no longer be the world skiing destination it is now, due to decreasing winter precipitation. “As a result, total snowpack and snow coverage will be reduced, the ski season will be shorter, and less of Park City Mountain Resort will be skiable.” The immediate impact to the economy is a loss of $120 million as soon as 2030 (2019 Utah Department of Public Safety).

Regional Climate Change Impacts

The Park City area and surrounding mountains are located in a climate that is considered “mid-latitude highland…generally considered as humid regions with severely cold winters and cool to cold summers. The treeless summits of many of these mountain ranges have a tundra climate, where the temperatures are too cold to permit the growth of trees. Mean monthly summer temperatures in Utah's highland regions are usually below 72° F. Within the highland climate zone, there can be a great variety of temperature and precipitation conditions, ranging from the cool summers of the valleys on the eastern side of the Wasatch Range to the alpine tundra conditions of the higher Uinta peaks” (UCCW Directors, 2015).

Data confirms that the state has warmed about two degrees Fahrenheit in the last century (2019 Utah Department of Public Safety). Heat waves are more common and snowmelt occurs earlier in the spring. As the climate warms, it is expected that more precipitation will fall as rain rather than snow (2016 Environmental Protection Agency). One study conducted in Utah found that the proportion of precipitation falling as snow in winter decreased by 9 percent (Halofsky et al. 2018). If this trend continues, it will heavily impact the area's wintertime recreation and extend the fire season over time.

Precipitation patterns in Utah are highly variable, though there have been no observed changes to the long-term trends in precipitation. Global climate models are not in agreement, and do not give a clear projection on how precipitation will change in Utah. However, it is expected that a higher incidence of drought will occur with warming temperatures. Increases in extreme precipitation associated with monsoonal rainfall could increase the risk of flooding in much of Utah and exacerbate the problems caused by post high-intensity wildfires (2019 Utah Department of Public Safety).

Besides changes to precipitation, temperatures are estimated to increase by about 4 to 6 degrees (varies by season) by 2100 (Halofsky et al. 2018). Changes to temperature increase the probability of wildfire through lengthening the fire season and creating drier fuels, contributing to greater risk to ecosystem function, life and property (2019 Utah Department of Public Safety).

Furthermore, the combination of more fires and drier conditions may expand deserts and otherwise change parts of Utah's landscape. Forests will become drought-stressed and more susceptible to insects and disease. In fact, with higher winter temperatures, it may become more common for pests to persist year-round, with new pests and diseases taking advantage of warmer and drier conditions. Species ranges are threatened by increasing temperatures, with some of the highest elevation vegetation types at risk of extirpation (2016 Environmental Protection Agency).

In general, climate change will increase the incidence of extreme weather, whether it be drought or heavy precipitation events. Forests are becoming more susceptible to increased pressure from insects, disease, and wildfire. Much of this is a consequence of past management frameworks, but climate change is a real threat to these ecosystems that could further push species out of their ranges, greatly changing their function and pattern.

2.2 Avalanche Terrain Analysis

The Treasure Hill Parcels are situated in a subalpine environment. They receive significant winter snowfall, and contain multiple historically active avalanche paths, as well as several other Potential Release Areas (PRAs) that are either very infrequent avalanche producers, or nonexistent avalanche producers due to geography, local topography, localized weather patterns, and/or vegetation and forest structure. Planned forest health and wildfire fuels treatment warrants an investigative look at each of these identified paths and/or PRAs in order to minimize or eliminate any effect these treatments may have on the behavior, size, and frequency of potential avalanche activity in the future. Where applicable, alterations to the fuels treatments specifications are outlined both within this Report and on the corresponding map resources located in **Appendix D**.

It is worth noting that the impacts of avalanches on development were not well-understood in the early development of Park City, and buildings were subsequently impacted as a result. Continuing to modern day, zoning ordinances within Park City, as well as within Summit County continue to lack a *comprehensive* avalanche hazard zoning ordinance as it pertains to development and building location within the start zone *and / or* track / runout of avalanche slopes. Avalanches within Treasure Hill, while very infrequent, are possible among the PRAs identified within this assessment. Anomalous weather and climatic avalanche events occur on a timescale longer than Park City has been an established community. *It is important for both Alpine Forestry and the city of Park City to recognize that the scope of this assessment is not an avalanche mapping or zoning exercise, but applies solely to potential avalanche behavioral changes resulting from the silvicultural prescriptions outlined in this Plan.*

HISTORICAL CONTEXT

The Treasure Hill Parcels are located immediately west of the historical mining district of Park City. A well-documented record of avalanche activity exists within the area, as the mountains surrounding Park City have been heavily utilized for economic purposes since the mid-1800s. Based on this recorded history, it is known that historical avalanches have not occurred in recent decades within the known avalanche paths originating on the Parcel(s). Upon historical review, the frequency of avalanche events within the study area appears to have been closely associated with the removal of trees from the hillside by Park City residents for personal and commercial use around the turn of the 20th century.

A summary of notable events within the Treasure Hill Parcel(s) include:

- January 29, 1884 – *Treasure Hill;* Residence of T.A. Clark impacted on Woodside Avenue and 3rd street (now 5th St.) Residents warned about cutting timber on the Treasure Hill hillside.
- February 20, 1894 – *Treasure Hill;* a large slide impacts the homes of J.L. Weber and James Quinn, on Woodside Ave between 2nd and 3rd St (now 5th and 6th St.).
- February 21, 1917 – *Treasure Hill;* An avalanche damages homes of Frank Fleishmann, Joe Bircumshaw, while nearly missing the Shanley family home, among others. Trees on the hillside were "let grow" following this event. Possibly between modern-day 3rd and 4th St.
- January 30, 1922 – 'Big slide' off Treasure Hill, stopping short of downtown residences, exact location unknown.

Figure 2.1 - Treasure Hill circa 1917 (Park City Museum)

Beginning in 1985, the 'Town Lift' of Park City Mountain Resort was installed, and applicable avalanche hazard mitigation work was managed by Ski Area personnel. This practice continues today, however, alterations to the fuels treatment specifications in this report are made under the auspice that frequent avalanche mitigation work may be intermittently discontinued due to unforeseen circumstances, as was experienced during the shortened ski season in 2020 due to the COVID-19 pandemic.

WEATHER AND SNOWPACK HISTORY

Like much of the US Rocky Mountain Region, long-term snowfall and weather data is limited within the Treasure Hill Parcel, but short-term snowfall data can be utilized to extrapolate, and estimate avalanche release depths for the calculation of avalanche destructive size potential. Release depths of 1.5m (30-yr) and 1.8m (100-yr) can be found utilizing maximum 3-day snow depth (HS) increase data from nearby Thaynes Canyon Snotel Site (NWS); extrapolated using a Gumbel extreme-value distribution, and adjusted for elevation difference. While this statistical estimation may fall short in consideration of anomalous or climax events, the use of this distribution in the context of this report is to calculate release mass estimations for estimated destructive potential, to help better tailor treatment specifications in or around PRAs with notable destructive potential to humans or infrastructure. What is also omitted from this estimation, are the changes to snowpack depths and avalanche behavior due to anthropogenic influences of climate change which are a topic of ongoing avalanche research. As explained in Scroggins and Batatian (2008) among other publications, counties, municipalities and their planning commissions considering or evaluating existing development in areas where avalanche hazard exists, should consider an avalanche hazard zoning system; incorporating a systematic approach to avalanche risk zoning that involves work beyond the scope of this Forest Management Plan.

FIELD METHODS

POTENTIAL RELEASE AREA (PRA) IDENTIFICATION

Utilizing a photogrammetrically-derived Digital Terrain Model (DTM), as well as publicly sourced 1m Digital Elevation Models (DEMs) (USGS 3DEP), areas of the Parcel(s) were identified as Potential Release Areas

(PRAs) based on their continuity of 28 degree slope angles or greater. While other identification practices for PRAs may utilize additional terrain parameters such as slope shape, snow supply, ground roughness, among others, the most conservative (broad) approach to identifying PRAs was taken; largely due to the vulnerability of infrastructure below Treasure Hill. Utilizing historical records and photographs, some of these PRAs were initially identified as behaviorally active avalanche paths. The seven (7) PRAs were numerically categorized between TH-001 and TH-007.

FIELD DATA COLLECTION

Utilizing the ESRI ArcGIS Pro platform, ArcGIS Drone2Map, as well as the ArcGIS Field Maps mobile application, several parameters were identified and collected that pertain to forest and snowpack interactions. Much of this data involved field distance measurements (i.e. ground cover height, tree spacing), while other data is an interpretation of avalanche path behavior based on expert judgment. The pertinent data collected is summarized as follows:

1. Slope Angles

   Sighted 10-20m downslope to compliment detailed DEM slope data and better represent slope angles in a smoothed, snow-covered environment. Utilized to verify digitally identified PRAs, and adjust GIS features accordingly. Maximum slope angles taken in the field were also recorded, and average slope angles are derived from 1m DEMs, and are representative of all point-data held within the raster dataset within the identified PRAs.

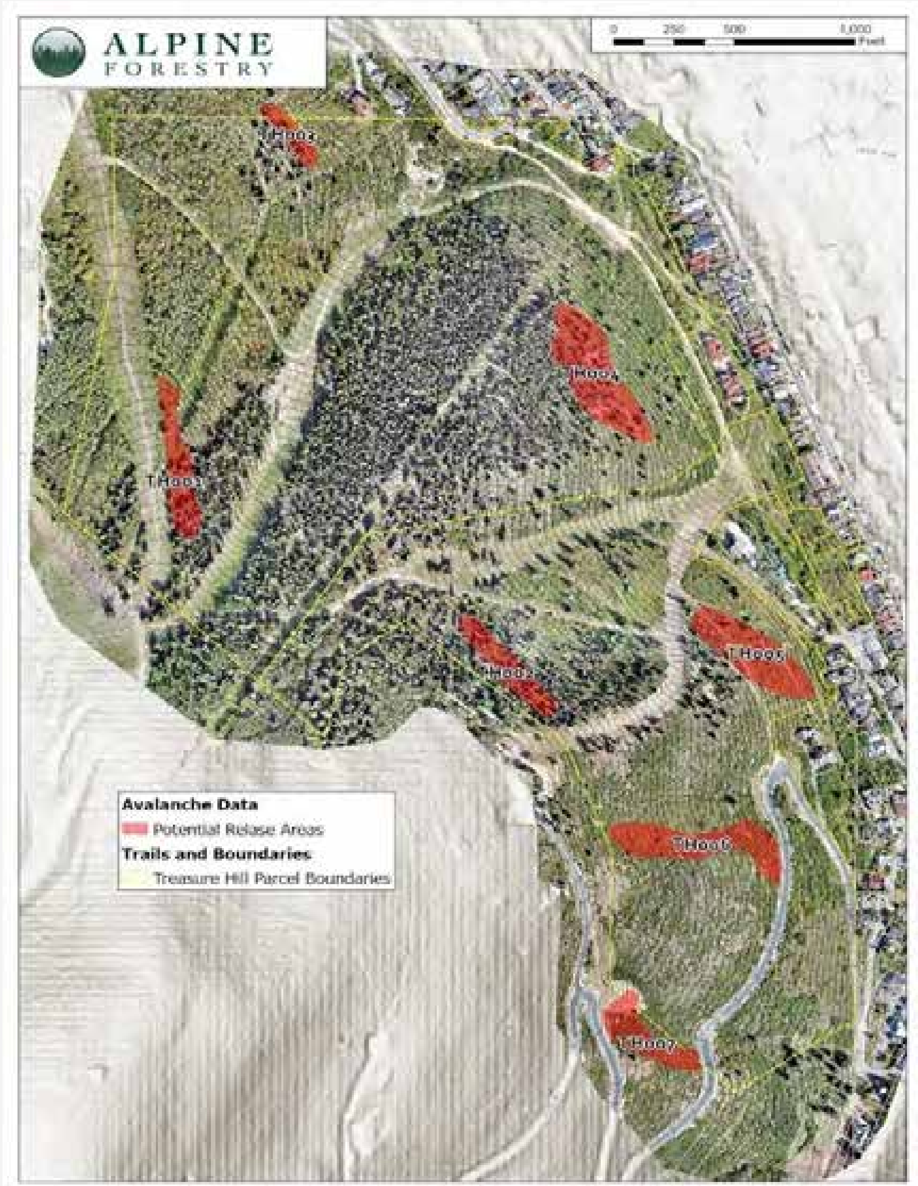


Figure 2.2 - PRA locations within the Treasure Hill Parcel(s)

2. Vegetation Data

   Primary Anchoring Vegetation:
   - Plant species within the PRA that are most relevant in providing *mechanical support* against slab avalanche release.

   Stem Density:
   - Number of anchoring stems per unit area (Stems/Ha^{-1})

   Stem Spacing:

- Average distance (m) between anchoring stems

AGL Height:

- Vegetation height (m) above ground level (AGL); if (and only if) hardwood shrubs are acting as the dominant vegetation type.

Ground / Basal Roughness:

- A qualitative assessment of ground-level sliding surfaces, most influential as it pertains to full depth, or wet slab and glide releases during anomalous warming or rain-on-snow events. Given estimated release depths, AGL height, %-coverage, and presence of durable hardwood stems or herbaceous shrubs are key observational data collected.

3. Canopy Cover

Parts of the PRA are identified by the following canopy cover description:

- FULL – Full canopy coverage (>90%)
- LOCALIZED – Localized openings between high conifer canopy (51-90% coverage)
- MIXED – Mixed canopy coverage, with areas of conifer or deciduous canopy mixed with open 'forest gaps' (20-50% coverage)
- OPEN - <2m (avg) AGL height and <20% coverage (non-forest)

Canopy Height and Coverage Modeling:

- Unmanned Aerial System (drone) technology was utilized to gather high resolution imagery, DSM, and DTM data, and derived Canopy Height Models to display canopy coverage and calculate additional ground cover height and stem densities to supplement field-observed vegetation data.

4. Loading Potential

Utilizing the Schaerer (1977) Loading Index where the higher the number, the higher the likelihood of wind-transported snow.

- 1. Start zone is completely sheltered from wind, surrounded by forest
- 2. Start zone is sheltered by open forest, or slope is facing the direction of prevailing wind
- 3. Start zone is an open slope with rolls or irregularities where local drifts can form
- 4. Start zone is on the lee side of a sharp ridge
- 5. Start zone is on the lee side of a broad rounded ridge or open area where large amounts of snow can be moved by wind

5. Avalanche Indicators

Indications of previous avalanching were documented, including 'flagging' on the uphill side of trees, scarring, tree damage, or widespread tree destruction (trim lines). *Given the extent of historical timber extraction within the Parcels, no definitive avalanche indicators were identified during our field investigations.*

6. ATES Classification

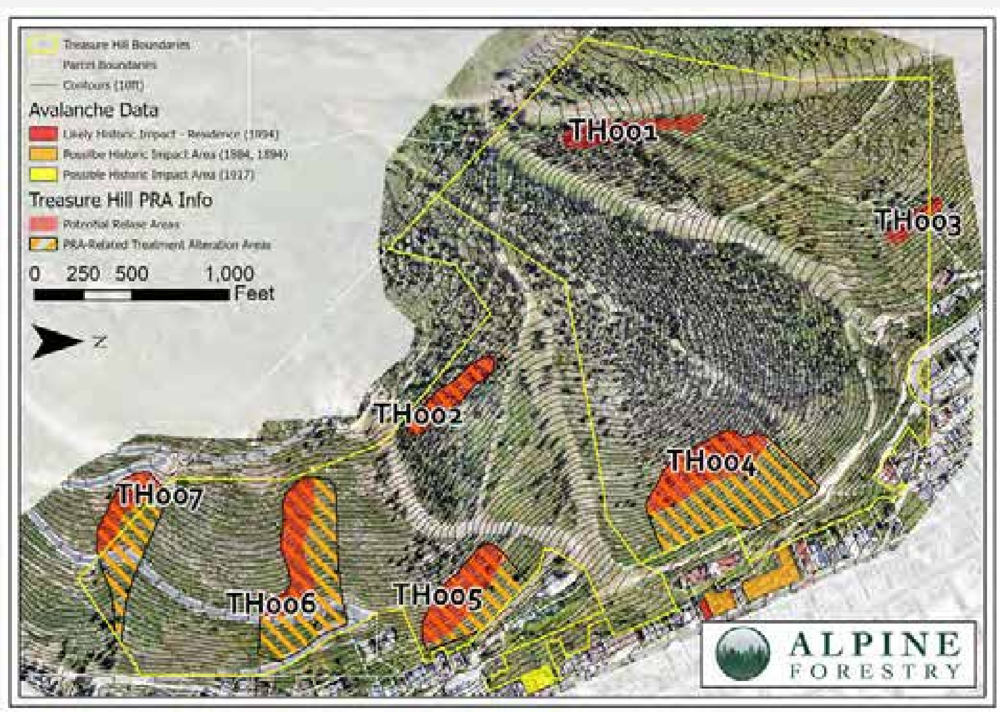
The Avalanche Terrain Exposure Scale (ATES) Zoning Model has been utilized to categorize terrain complexity and avalanche exposure to people in several applications since its inception. The parameters used to classify terrain include (in order of importance) slope angle and forest density, start zone density, interaction with avalanche paths, terrain traps, and slope shape. While this zoning model has historically been applied to larger scaled mapping (1:20,000), the key parameters (slope angle and forest density) can be evaluated prior to and following future forest treatments within the Parcel, serving as a systematic benchmark for forest structure / snowpack interactions. An ATES classification for some of the PRAs and their surrounding vicinity is utilized to help drive changes (or lack thereof) to the treatment specifications to ensure that changes to forest structure would not alter a PRAs ATES classification from one class to another (assuming terrain parameters remain constant). While this classification can be applied to large areas using digital resources, it is stated that the "*parameters and thresholds are intended to be used as general guidelines to inform expert judgment*". (Campbell, Gould, 2014)

SUMMARY OF FINDINGS

Two distinct zones of PRAs exist within the Parcels, differing in forest structure, and therefore differing in the driving mechanisms playing into forest-snowpack interactions. The PRAs throughout the entire Parcel(s) can be described as 'low to moderate angled' PRAs (28-33 degrees avg), meaning that slope angles are high enough to release, but anomalous, or atypical snowpack conditions are necessary for release. These low-moderate angled PRAs typically produce larger avalanches on a less frequent release interval as a general behavioral characteristic. Additionally, the location of these PRAs out of the alpine wind-zone, and the abundance of subalpine forests, hardwood groves, and vegetative ground cover all aid in the infrequent nature of all the PRAs within the study area.

Vegetative characteristics do vary between the northern and southern portion of the Parcel(s). The PRAs in the northern areas (TH-001 – TH-004) are largely provided mechanical support to snow slabs through the presence of conifer stands, most of which can be categorized as 'Mixed' as it pertains to stem densities (100-1000 stems/Ha) and spacing (3.2m-10m); much of which has regenerated following a near-complete harvesting of conifer in the late 19th century.

The southern PRAs (TH-005 – TH-007) lack conifer anchoring but do possess significant ground roughness through the abundance of durable hardwood shrub (gambel oak). While this type of vegetation provides minimal mechanical anchoring, it reduces the frequency of release within the basal layers of the snowpack and provides some discontinuity of snowpack stratigraphy during early season events or during below-average to average snowfall seasons.



Results from this PRA evaluation does indeed warrant alterations to treatment specifications; and given the vulnerability of life and infrastructure below Treasure Hill, some of these treatment alteration recommendations exclude live fuels treatment altogether. (Figure 2.3, Table 2.1) A detailed summary of collected PRA data and resulting treatment alteration recommendations for individual PRAs are found in **Appendix G**, Treasure Hill Avalanche Assessment.

Figure 2.3 - PRA treatment alteration areas

Table 2.1 - PRA-related Treatment Alteration Recommendation Summary

TH-002	No live conifer >6” DBH should be removed.
TH-004	No live fuels treatments should be applied within TH-004. No live hardwood shrub fuels treatments should be applied in the downslope direction (track) as depicted in Appendix D, Exhibit 05. Standing dead / down fuels treatments may still be applied.
TH-005	No live fuels treatments should be applied within or downslope of TH-005, with the exception of the proposed Defensible Space Treatment areas. (Appendix D, Exhibit 05).
TH-006	No live fuels treatments should be applied within TH-006, as well as the cross and downslope areas depicted in Appendix D, Exhibit 05.
TH-007	No live fuels treatments should be applied within TH-007, as well as the cross and downslope areas depicted in Appendix D, Exhibit 05.

2.3 Fish, Wildlife, and Threatened & Endangered Species

Sageland Collaborative analyzed local data related to fish, wildlife, and threatened and endangered species in the Treasure Hill area and compiled a stand-alone consulting report. Summarized here are a few of their findings.

Since no known aquatic or wetland habitats exist on Treasure Hill, there is not a need for a review of aquatic species. However, being part of the East Canyon Watershed, the health of aquatic species downstream of the project area is connected to the health and conservation of the forest and soils, specifically in their abilities to capture sediment and sequester excess nitrogen liberated by the effects of fire. According to Sageland Collaborative, Bonneville cutthroat trout (*Oncorhynchus clarkii utah*) are a Species of Conservation Need that would be affected by changes in water quality in this watershed.

In their assessment, they report that the threatened and endangered species likely to occur in the Treasure Hill area include the monarch butterfly (*Danaus plexippus*), western bumble bee (*bombus occidentalis*), and little brown bat (*Myotis lucifugus*). Milkweed (*Asclepias spp.*) and other nectar producing plants relied upon by monarch butterflies, flowering plants that support the western bumblebee, and forage for the little brown bat may all occur within the project area.

Sageland Collaborative’s detailed forest management recommendations provide consideration of habitat communities, vegetation, special-status species, game species, wildlife migration corridors, effects of recreation, invasives, and monitoring. See the full wildlife assessment, which includes recommendations and regulatory contexts, included in **Appendix A**.

2.4 Soils and Water

Soil is the diverse substrate of the terrestrial ecosystem in Western-montane forests. The presence of fire can alter fundamental soil processes and structure that detrimentally affect the health of the larger surrounding ecosystem and the economic thresholds of local communities. However, it is important to distinguish between high intensity (e.g., unmitigated wildfire) and low intensity fire (e.g., prescribed fire) on the landscape (Erickson et al, 2008).

Chemical changes from high intensity fires can create hydrophobic layers that prevent water from percolating into the soil. This leads to runoff and erosion that can impact watersheds by way of sediment deposition and cause material to slough off from the hillside, damaging infrastructure, homes, and public utilities. Loss of nutrients, removal of surface organic matter, and the breakdown of soil structure can lead to insufficient water storage, nutrient poor soils, and the inability to support native species for decades thereafter. Native seed mortality allows invasive species to prevent the reestablishment of biodiversity in areas of high intensity wildfire (Debano, 1990).

Low intensity fire tends to have beneficial effects on soil. Natural variation in heat intensity and consumption allow the system to repair itself by preventing runoff of material and chemically liberated nutrients, and by hosting adequate seed banks that are transported over time into burn scars (Miesel et al, 2011). Low intensity fires can also create woody biochar, which absorb and retain moisture at ground level. According to a study performed by the USFS Rocky Mountain Research Station and the Forest and Rangeland Stewardship Department in 2015, within two years of prescribed pile burn ignitions, graminoid and forb cover matched that of the unburned areas. This regeneration increasingly builds the support needed for soil structure, nutrient availability and retention, permeability, and native biota.

Research and experience have shown us that soils can withstand and recuperate from current methods used in forest management strategies such as thinning and prescribed burning, and that high intensity wildfire can have decades-long detrimental consequences on physical, chemical, and biological soil properties (Alcañiz et al, 2017). Watersheds, local flora, wildlife, infrastructure, and land users rely on the health of the soil to support these intertwined systems.

To further protect soils in the treatment area, it is important that some downed woody material and snags remain (Fargione, 2015). Woody debris catches soil material during precipitation or melt events that may otherwise erode from a slope. It retains moisture and cools the ground beneath it. Woody debris also serves as a shelter and as food for many different types of essential organisms, which may include insects, fungi, mammals, bacteria, birds, mosses, lizards, and lichens. Hence, during treatment, some down woody material and snags will be left for soils, wildfire, and tree regeneration.

There is a meaningful place for ground-truthing soil descriptions and classifications. They must usually be performed at the landscape level to be accurate. For general purposes, the Natural Resource Conservation Service and UC Davis developed a tool called Web Soil Survey to aid land managers in assessing soil, its properties and conditions.

Web Soil Survey predicted three different soil series that may dominate the Treasure Hill area, presented in order of percent of total acreage. See **Appendix H** for the full soils report of the Treasure Hill area.

Table 2.2 - Predicted soil series in the Treasure Hill Project Area (NRCS / UC Davis)

Yeates Hollow Potential Fire Damage Hazard: Low Potential Erosion Hazard: Moderate Drought Vulnerable: Yes Displacement Hazard: Not available	Dromedary (mostly north facing slopes) Potential Fire Damage Hazard: High Potential Erosion Hazard: Severe Drought Vulnerable: Yes Displacement Hazard: Slight
Park City (mostly east and west facing slopes) Potential Fire Damage Hazard: Low Potential Erosion Hazard: Severe Drought Vulnerable: Moderately Displacement Hazard: Slight	

2.5 Recreation

Treasure Hill hosts a variety of access for recreationists, with skiers, hikers, and mountain bikers being the predominant users. When residents voted to permanently designate this land as open space, it was made explicit how valuable this type of asset is to the Park City community. Though this risk assessment is not intended to increase recreational opportunities on Treasure Hill, it is intended to promote the safety of individuals who choose to recreate in the open space. The community's desire to protect access to this land for various recreational purposes has been one of the city's considerations in beginning to evaluate forest health and wildfire risk in this area. Understanding these factors is the first step in protecting this essential open space and the community it serves.

The recreational community may be asked to periodically shift or alter their activities in relation to operational strategies recommended by this assessment and the land manager, in locations where there may be temporary use restrictions in effect. For example, an area may be temporarily roped-off to support aspen regeneration on a particular part of the property. There may be short-term public safety closures of trails or other areas due to hazard tree abatement operations or other forestry activities, such as tree removal or prescribed burning. Information of the 'why, when, where, how, and who' related to these restrictions, closures, or access limitations should be readily available to site users. It is important that the public be regularly informed of land management activities affecting their recreational opportunities and that they understand why these temporary limitations will assist in protecting recreational access for the long-term.

Currently, two local recreation entities are involved in vegetation management on Treasure Hill. The Mountain Trails Foundation, a non-profit who works for the City to build and maintain trail systems on the parcels, and the resort operator for Park City Mountain, Vail Resorts. Involvement from the Mountain Trails Foundation is anticipated to be minimal over time, consisting primarily of trail clearing, routine cutting back of brush and limbs, or removing hazards. This is done independently by their own assessment, or at the direction of the City. Vail Resorts holds an easement for the ski resort related infrastructure including the town lift, ski runs, access points, and snowmaking equipment. They are responsible for the overall use, maintenance, repair, and even relocation of the infrastructure. Considering the amount of space the resort's infrastructure occupies on Treasure Hill, it is important the City encourages best practices relating to vegetation management and coordinates potential maintenance or improvement projects with the health of the forest ecosystem in mind. No long-term vegetation management plans are known to be established for Park City Mountain.

2.6 Archaeological & Cultural Resources

Park City recognizes that archaeological and cultural resources are an irreplaceable resource that tell vibrant stories of human existence over thousands of years. These fragile resources contribute to Utah's history and are in need of protection.

Alpine Forestry and the Park City Municipal Corporation are not aware of any existing cultural or historic resources on this property legally requiring protection. Alpine Forestry submitted a request to the Division of State History in March 2022 for a record review and found no records on file. However, a number of historic structures exist adjacent to and within the property boundaries that hold high value for the community in preserving its character and history; the most predominant being the Silver King Aerial Tramway towers. These towers, while not eligible for the National Register of Historic Places, are designated within the Park City Historic Site Inventory as a 'Significant' Site; and serve as one of the most visible remnants of the Mature Mining Era. Thirteen (13) of these towers reside within the Project area, and additional considerations during the application of treatments should be made, including but not limited to: the removal of encroaching vegetation around the tower foundations, and the removal of hazard trees that threaten these structures to be performed by technical fallers.

Figure 2.4 - The lower three (3) towers of the SIlver King Aerial Tramway within the Project area taken in September 2021 during UAV mapping.

The city may request a formal archaeological survey prior to implementation of management activities. Alpine Forestry and our consultants highly encourage any steps the City may take to protect archeological resources that may exist on the Treasure Hill property. If additional sites are discovered during the course of implementation or if state or federal funds are involved at any point, PCMC must notify the Division of State History as required under Utah Code Title 9-8-307. If, upon completion of a survey by the Division of State History, archaeological resources are found to be present, mitigating measures may have to be addressed for protection. The city should consider any of all viable management alternatives if such sites are discovered on or near areas designated for management. This information is provided to assist in identifying historic properties, per §36CFR800 for Section 106 consultation procedures.

3 Vegetation and Wildfire Risk Assessment

Forest and rangeland ecosystems are naturally complex. Landscape management based on the consideration of ecological, social, and economic concerns is equally complex, but necessary on Treasure Hill for the following reasons:

1. This property serves a wide range of stakeholders who value it for a variety of aspects,
2. Implementing the wrong actions now may make future restoration and maintenance more difficult, especially in an uncertain climate,
3. Managing natural landscapes for future health and resilience requires long-term goal setting that is often overlooked when the focus is solely on present-day fire safety and preparedness, and
4. This parcel is a prime educational opportunity for the community. This education should be rooted in science while integrating the social and economic values for management.

In this plan, the vegetation types are characterized by how they may have grown in the past (the “historical condition”), how they appear today (the “existing condition”), and the changes they are likely to endure in the future (the “future condition”).

For the vegetation assessment on Treasure Hill, the historical range of variation (HRV) was used to describe how these forests and rangelands may have looked in the past: which species were present, how fire, insects, and disease interacted with those species under normal disturbance regimes, and the patterns of plants and animals. This historical characterization provides a roadmap as to how forests would have appeared today had there been no mining, logging, development, or a successful fire exclusion campaign over the last century (Keane et al. 2019).

When compared to what U.S. western forests were like historically, most are very different today, even in Utah. The existing vegetation condition describes the species composition, patterns, density, and other vegetation characteristics currently found on Treasure Hill.

Forests and rangelands are facing an uncertain future due to climate change. It cannot be assumed that the historical forest structure or existing structure of these ecosystems will be sufficient to withstand the stressors under climate change and continued human disturbance. The future shifts in forest species and patterns is known as the future range of variation (FRV). The FRV is not well known due to the changing climate, insects and disease, fire, and human use, but work continues to model and estimate what the impacts may be (Millar et al., 2007). Monitoring future changes will be necessary to promote the health of vegetation on Treasure Hill and reduce fire risk over time.

3.1 Historic Forests

It is important to understand how forests and rangeland vegetation types functioned in the past in order to trend forests to a more resilient and resistant state. It is thought that by doing so, these ecosystems may also be better prepared for current and future environmental stressors. The historical range of variation (HRV) most often refers to how landscapes likely appeared and functioned prior to Euro-American settlement. This marks a period of major change to forests caused by mining, logging, development, and fire exclusion of forests throughout the western US. It is through comparisons of today’s forests to historical data that land managers can determine how much change has occurred (Keane et al. 2009).

Use of this concept stemmed from a need to manage ecosystems for the various resources rather than intensive resource extraction (Keane et al. 2009). It is thought that restoration of ecosystems works best if returned to some natural state to which it may have functioned in the past (Bailey 2010). Since the natural environment is constantly changing, the “natural state” from the past is actually a range of conditions that ecosystems exhibit (Bailey 2010).

However, it must be noted that there are limitations to the use of HRV (Millar 2014):

- It is a difficult concept due to the dynamic nature of multiple resource interactions,
- Forest composition and patterns may be vastly different depending on time periods chosen for reference conditions,
- Managing vegetation to historic conditions may not be achievable or meet land management objectives,
- It may not be the best predictor of how a forest will respond to future climate or other pressures.

Though there exists uncertainty as to whether or not the historical condition will properly set up forests and rangelands to withstand altered disturbance regimes and climate change, it is still a useful concept to define ecological objectives for treatments.

Anthropogenic Effects on Forests

Figure 3.1 - Significant deforestation adjacent to Park City, circa 1915 (Park City Museum)

Humans are a cause of profound changes to forest and range cover, from the earliest use and control of fire by the Native Americans to the intensive resource extraction by early mining and timber removal. Humans altered the vegetation of historic ecosystems, and changes continue today with increasing use, development of the area, and climate change.

The landscape around the Park City area has been influenced by both anthropogenic and natural disturbances. Park City is within the traditional and ancestral homelands of the Shoshone, Paiute, and Ute Tribes with Utah’s Indigenous peoples being the original stewards of this land. Fire, used for various purposes including cooking, lighting, heating, hunting, food gathering, forage enhancement, warfare, communications, vegetation clearing, ease of travel, ceremonies, and entertainment, was part of this stewardship (Carter et al. 2021, AGCI 2022). The Powell Expedition of 1878 and associated “Map of Utah Territory representing the extent of the Irrigable, Timber, and Pasture Lands” shows the presence of fire occurrence within Utah and the Wasatch Back from both human and natural ignitions.

It is the use of fire in this way that may have altered fire frequency and fuel availability across landscapes (Carter et al. 2021) by regularly removing the understory in addition to some of the dead and down, as well as limiting sapling survival. This use of fire affected forest species composition and structure (many forests were more open and had larger trees) had long-lasting legacies on modern montane forests (Carter et al. 2021).

The effects of Euro-Americans on fire regimes were very different from Native Americans before them. The first European settlers to the area were trappers passing through the area along with Mormons traveling nearby through the canyon on their journey to Salt Lake City. Exploration of the canyon was noted in 1848 with a toll road built in 1849 and several families settling and grazing the basin. The first known discovery of silver, gold, and lead ore in this area was by soldiers serving in the US Army in the 1860s. In 1880, a spur line was connected to the first Transcontinental Railroad and Parleys Park City was incorporated as Park City in 1884.

Many of the actions associated with mining and timber harvest during this time were highly destructive. Loggers would “high-grade” (remove only the best, most economical trees), leaving what they thought were undesirable species or smaller trees behind. Intensive cattle and sheep grazing significantly changed plant succession and saw the reduction of certain plants and animals (Alexander et al., 1987). Throughout the West, these past practices severely altered forest composition and structure, with a reduction in fine fuels to carry fire and herbivory impacts on new growth of woody vegetation, often converting forests to domination by species atypical of the area fire regime.

With European settlement, exclusion of wildland fire began to occur, along with pressure for timber to support mining. A sawmill was built and the forested areas occurring around Park City were heavily diminished. Most historic photos show the hillsides around Park City denuded of forested vegetation (Figure 3.2); thus, the views in these photos were impacted by European settlement versus what most likely occurred historically.

Figure 3.2 - A nearly treeless Treasure Hill hillside, circa early 1900’s (Park City Museum)

Furthermore, the frequency of avalanche events within the study area appears to have been closely associated with the removal of trees from the hillside by Park City residents for personal and commercial use around the turn of the 20th century (Section 2.2).

While Native Americans and the earliest Euro-Americans both suppressed fires to some degree (mainly those that threatened their village and towns), this soon changed in the early 20th century when the federal government began the highly successful campaign of suppressing wildfire (van Wagtendonk, 2007). Fire suppression had started in the late 1800s in the areas of what are now Yellowstone and Yosemite National Parks, but it really gained a foothold in fire management policy after the widespread fires of 1910 (van Wagtendonk, 2007).

Figure 3.3 - Treasure Hill hillside above Upper Norfolk Ave, circa early 1900’s (Park City Museum)

These policies affected all landowners and a major result of this policy has been the buildup of forest fuels, unnatural changes to species composition (e.g. the increase in shade-tolerant species in some areas), and a new threat: the rise of increasingly severe fires.

In general, human use and development in the western US has ultimately homogenized the spatial patterns of non-forest and forest vegetation types, reduced forest age (through the removal of large and older trees), and lowered structural diversity (more small trees now and very few large trees) (Harvey et al., 2021).

While wildland fire was being removed from the landscape, there are historical accounts of major fires in Park City that may have moved into the wildland. Park City suffered terrible fires in 1882 and 1885 with the worst disaster occurring on June 19, 1898. The 1898 fire impacted the commercial district destroying most of Main Street with $1 million in estimated losses and about 200 business and dwellings destroyed out of over 300.

With the value of silver and metal declining following World War I through the Great Depression and into World War II, by the 1950's, Park City nearly became a ghost town. With a land-redevelopment grant from the John F. Kennedy Administration, United Park City Mines was able to transform 10,000 acres into a ski area opening in 1963 as Treasure Mountain. This set the stage for what Park City has become, a world class ski destination.

There is a limited record of recent and historical wildfires occurring within the vicinity of Park City. The majority of those that occur are human caused and easily accessible to suppression resources. Under drought conditions there is opportunity for dry thunderstorms and natural ignitions, but most storms developing along the Wasatch Mountains have precipitation associated with them that effectively suppress ignitions. Some local fires of note: the Parleys Canyon Fire (2021) that was caused by a vehicle traveling on I-80 and grew to 541 acres, the Saddle Fire near Midway (2020) caused by a juvenile that reached 630 acres, the Tollgate Canyon Fire (2018) at 287 acres that was caused by a trailer traveling on I-80, the Rockport Estates Fire (2014) that reached 120 acres, the lightning caused Rockport Fire (2013) that grew to 5,000 acres, and the Fox Bay Fire (2012) near Jordanelle Reservoir in Wasatch County that ended up around 500 acres. The Utah Wildfire Risk Assessment Portal's Fire Occurrence Density map for the Treasure Hill area ranges from Low, to Low-Moderate and Moderate.

3.2 Historic Vegetation Types

Years of scientific research and vegetation modeling have reconstructed how the vegetation on Treasure Hill may have looked and functioned prior to the changes brought on by extractive uses of the land, including mining, logging, and fire suppression. Below is the detailed information for the vegetation types that historically occurred on Treasure Hill, according to modeled LANDFIRE 2016 data:

Southern Rocky Mtn Mesic Montane Mixed Conifer Forest and Woodland

This vegetation type describes what the conifer zone on Treasure Hill may have looked like in the past.

- Mixed conifer forests of the Rocky Mountains with Douglas-fir as the dominant tree species with white fir being an associated species.
- Fire acted as the primary disturbance and occurred every 6 to 60 years, on average. Many fire events were light, erratic, and infrequent due to cool moist conditions. Stand-replacing fire would occur every 100 years or so.
- Insects played a secondary role, but with an active fire regime created small openings and gaps where regeneration of aspen, Douglas-fir, and ponderosa pine could grow. White fir was limited.

Rocky Mountain Aspen Forest and Woodland

This vegetation type describes how portions of the mixed hardwood type on Treasure Hill may have looked like in the past.

- Deciduous forests were dominated by aspen, a short-lived species with an estimated lifespan of 75 to 100 years.
- Stand-replacing disturbances such as crown fire, disease, windthrow, or clearcutting by humans and beaver maintained these forests.
- Conifers such as white fir, spruce, ponderosa pine, and Douglas-fir were present at low levels.
- Important forest type for large and small mammals and birds.
- Mortality from disease and insects was limited in historical disturbance regimes, but outbreaks every 200 years occurred, on average.

Inter-mountain Basins Aspen-mixed Conifer Forest and Woodland

This vegetation type describes what the tree layer of the existing mixed hardwood and mixed vegetation types on Treasure Hill may have looked like in the past.

- Tree canopy layer was shared by aspen and conifers such as Douglas-fir, white fir, subalpine fir, spruce, and limber pine.
- The fire return interval was variable since both mixed-severity fires and stand-replacing fires occurred.
- Fire and drought were the main disturbance agents and helped maintain the aspen component.
- In areas lacking disturbance such as fire, aspen was outcompeted by conifers and disappeared from the stand.
- Insect attacks are thought to have occurred every 200 to 300 years.
- Long term and sudden aspen decline was a threat.

Rocky Mountain Gambel Oak – Mixed Montane Shrubland – patchy and continuous

This vegetation type describes the areas dominated by Gambel oak on Treasure Hill.

- Gambel oak was the only species covering extensive areas, but some patches of sagebrush, aspen, maple, and conifers occurred.
- Historical fire frequency is not well understood, but thought to have followed the fire regimes of neighboring vegetation types.
- Gambel oak is a fire-adapted species and sprouts vigorously following mixed-severity fires and maintains a stable plant community for decades to a century following fire.
- As Gambel oak ages, shoot mortality increases and adds fuel, which may lead to increased probability of ignition, fire spread, and higher burn severity. This happens at roughly 60 to 80 years of age. (Kaufman et al., 2016)

Rocky Mountain Bigtooth Maple Ravine Woodland

This vegetation type is noted, but not discussed at-length for management in this report since it is a minor forest occurrence (approximately one acre in size).

Southern Rocky Mountain Montane-Subalpine Grassland

Vegetation in this group was characterized by an open to dense perennial graminoid layer. The online database NatureServe (2018) describes this vegetation as areas where the establishment of woody species was inhibited due to a variety of factors, including: fire, wind, cold-air drainage, climatic variation, soil properties, drought, snow avalanches, and competition with graminoids. It is noted for fire risk and fuels descriptions, but not discussed at-length in this report for management.

Inter-mountain Basins Montane Sagebrush Steppe

Vegetation in this type was known for its species diversity. A brief overview of its fire regime is described here, but other attributes of this vegetation type are not discussed at-length in this report.

In many areas, wildfires maintained an open herbaceous-rich condition, though moisture may have supported unusually high shrub cover with high grasses and forbs. Pre-settlement fires tended to be patchy and formed a mosaic of shrub cover over the landscape, due to a mixed severity fire regime.

- High fire frequencies (every 2 to 5 years) favored non-native grasses at the expense of native grasses and shrubs.
- Fire-return intervals of 10 to 30 years favored short-lived sprouting shrubs.
- Fire-return intervals of 30 to 70 years favored a mixture of perennial bunch grasses and non-sprouting shrubs.
- In the absence of fire, deep-rooted shrubs become dominant and over time may have been replaced with pinyon pine and juniper, where those vegetation types met in the region.

3.3 Existing Conditions

Existing forest structure on Treasure Hill is characterized from data collected in formal forest inventory plots, using remote sensing methods, and through general field observations. Data collection was conducted in August-October 2021 and included information about the conifer and hardwood vegetation types pertaining to:

o Species composition

o Tree diameters and heights

o Density

o Canopy Cover

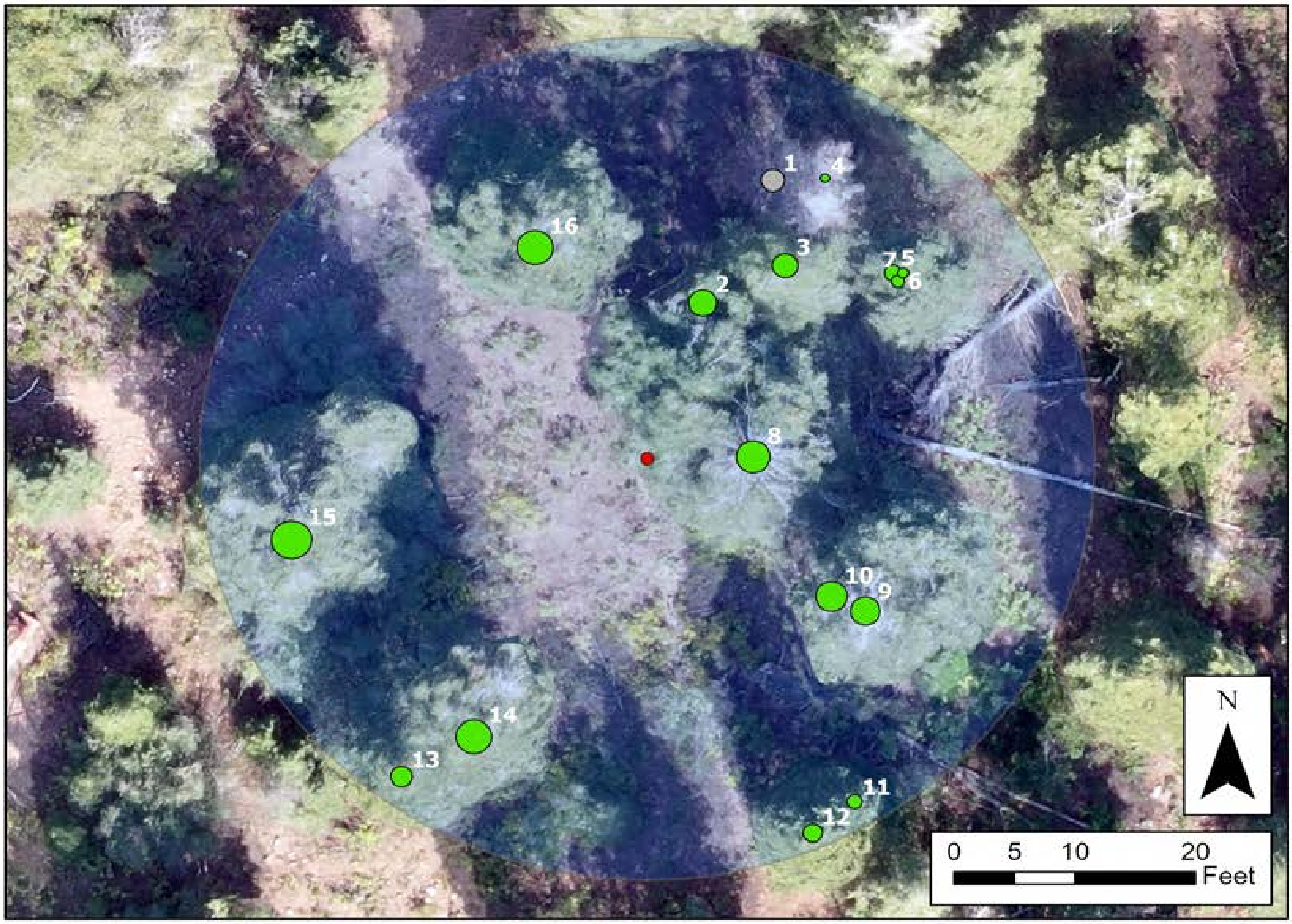
o Horizontal and vertical structure

o Associate trees and shrub species

o Disturbances that affect forest growth and structure

These forest structure metrics provide the necessary context to assess overall forest health. The more thorough our understanding of existing conditions, the better our ability to estimate and weigh disturbances caused by insects, disease, fire, and land use designations. This same data is also useful for determining the various types of wildlife habitats present, evaluating departure from desired conditions, and to identify treatment options that meet land manager objectives.

Formal inventory plots were not recorded in Gambel oak or the sagebrush and grass types. Remotely-sensed data on cover and height, along with an informal walk-through assessment of the Gambel oak, sagebrush, and grass was performed to determine their desired future management outcomes. As discussed in the recommendations (Section 4), there are no plans for active management of the maple, sagebrush and grass at this time, other than invasive weed management.



Plot 883 Tree Data
Trees per acre: 150
Snags per acre: 10
Basal area per acre, live trees: 60 ft²
Average diameter, live trees: 11.5 inches
Average diameter, snags: 9.8 inches
Tree species present: white fir

Legend

- Plot 883 Center
- Plot 883 Radius (37.5 ft)

Plot 883 Trees

Status

- Dead
- Living

ALPINE
FORESTRY

Figure 3.5 - Forest inventory plot on the Treasure Hill property, Park City, Utah (September 2021)

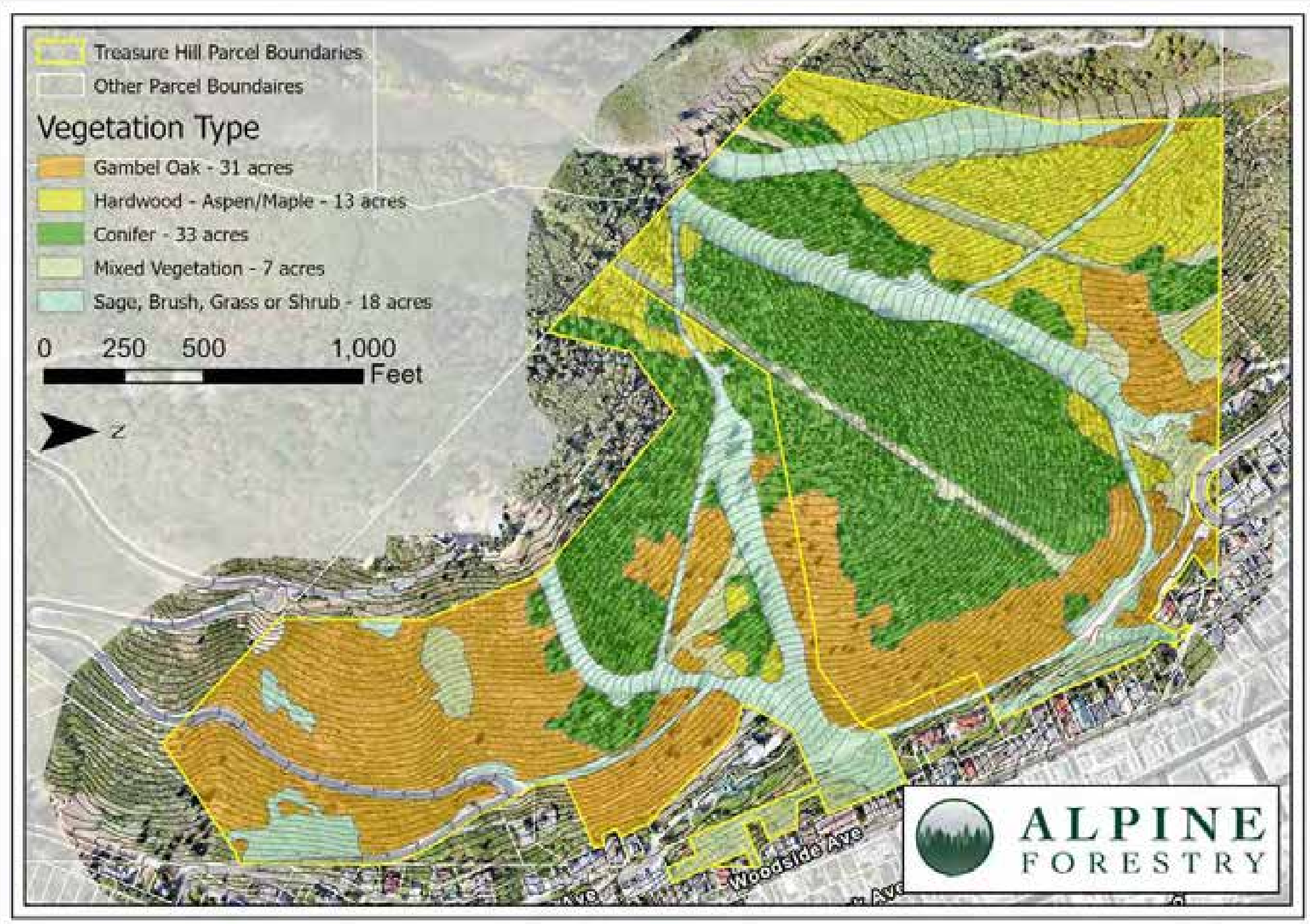


Figure 3.6 - Vegetation Distribution with the Treasure Hill Project Area

How These Vegetation Types Relate To Wildfire Risk

Based on the nature of the different vegetation types that exist on Treasure Hill, it is important to understand how they each relate to wildfire risk. Six fuel profiles were identified, listed below, and are depicted in Figure 3.6 (above). Of the six distinct types of vegetation growing on Treasure Hill, the conifer and Gambel oak types make up the largest proportion of the area, followed by sagebrush/grass/shrub and mixed hardwood. Lesser vegetation types include the mixed vegetation type (conifer and hardwood mix) and a small, pure maple stand.

Mixed Conifer (33 Acres)

Currently, the mixed conifer vegetation type on Treasure Hill is dominated by white fir (*Abies concolor*) and to a much lesser extent, Douglas-fir (*Pseudotsuga menziesii subsp glauca*), and subalpine fir (*Abies lasiocarpa*). Aspen (*Populus tremuloides*), Gambel oak (*Quercus gambelii*), and Canyon maple *(Acer grandidentatum)* are present along the edges, but do not make up a significant portion of the trees in this vegetation type.

The mixed conifer vegetation type consists of a single-storied (one canopy layer) stand structure. Many trees were established around the same time to create the existing stand structure. The average age of the conifers is between 65 and 90 years. Regeneration of coniferous species is minimal and patchy with no hardwood regeneration being recorded within this vegetation type.

Mortality in the mixed conifer vegetation type is high, with numerous down and standing dead trees (122 snags per acre, on average). The dead trees are readily viewed from town as they cover the hillsides. Balsam wooly adelgid (BWA) and fir engraver beetle (FEB) have been detected in Treasure Hill and adjacent forested stands.

The main understory shrub species recorded on plots and walk-through exams include, but are not limited to: ninebark (*Physocarpus monogynus*), pachistima (*Paxistima myrsinites*), Oregon grape (*Berberis repens*), snowbush (*Ceanothus velutinus*), serviceberry (*Amelanchier utahensis*), snowberry (*Symphoricarpos oreophilus*), elderberry (*Sambucus caerulea*), and wild strawberry *(Fragaria vesca).*

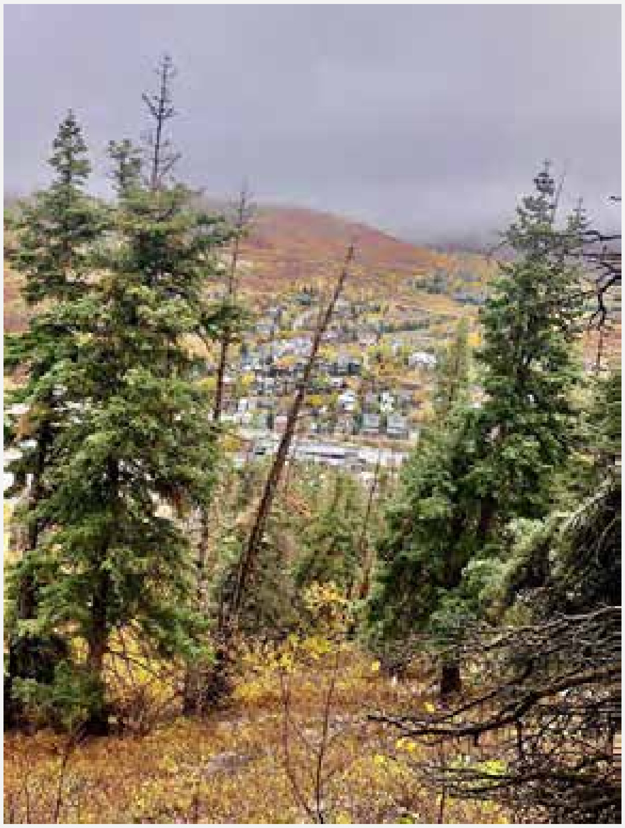


Figure 3.7 - Conifer at Treasure Hill

Mixed conifer makes up the highest percentage of land within the project area. The stand has experienced significant decline from an insect infestation (BWA and FEB) within the white fir that has contributed to high fuel loading. The primary carrier of fire is high load conifer litter coupled with light slash or mortality fuel. This fuel type has moderate spread rates and flame lengths. Fuels within the mixed conifer were adjusted to address this additional fuel loading using slash blowdown as a secondary fuel model. While this fuel model will slightly overpredict fire behavior, it helps to highlight the extent of the red needle conifer and increased levels of down and standing dead fuel that can lead to passive crown fire.

Overall, there is a lack of tree species diversity, forest structure is uniform and dense, trees are small, and widespread tree mortality is evident. This tree mortality is causing a build-up of fuels that are a concern for wildfire risk and control. Plentiful snags are found across the slope, around trails, ski runs, and access roads which present short and long-term hazards to recreationalists, infrastructure, and adjacent properties. This stand does provide habitat for wildlife; however, as a result of the widespread mortality, it is more susceptible to undesirable fire effects and continued insect activity.

Mixed Hardwood (13 Acres)

The mixed hardwood vegetation type is primarily a mixture of aspen and maple trees. Aspen is the dominant overstory tree species with lesser amounts of maple in the midstory and understory canopy layers. The aspen trees are estimated to be between 50 and 75 years of age, on average. A 1-acre pure maple stand occurs at the northwest corner of the property, surrounded by aspen and a small patch of conifers. There are no grasses, forbes, or shrubs growing under the canopy of this small area of maple.

The hardwood vegetation type consists of areas with single-storied canopy structure and other areas with two distinct canopy layers. Aspen grow in groups of genetically similar trees, called clones. Single-storied stands of aspen often result when stems sprout following a severe disturbance, whether it is a result of fire or cutting (McAvoy et al. 2012).

There is increasing mortality in this aspen stand, with a current average of 140 dead stems per acre, which is expected to continue over time. Clones are aging and the lack of disturbance is limiting the aspen from regenerating new trees for the next generation. Sudden aspen decline may also play a role in the mortality of aspen. The aspen in this area are at the lower end of their ideal elevation band where north-facing slopes are able to support their establishment and growth (Jones et al., 1985). Trees located outside of their ideal growing conditions are subjected to more stress. Aspens are intolerant to drought and their low elevation location, exposure to continued drought conditions, and lack of regeneration, suggest they are in decline (Worrall et al. 2010). These predisposing factors may be reasons why these aspen stands, which have not grown to their maximum life span, are experiencing this level of mortality. Furthermore, conifers are beginning to grow in the understory in some locations and conifer abundance is expected to increase without the influence of fire or other disturbance. This adds additional stress to available water, nutrients, and light for regenerating aspen and the mature stems.

Figure 3.8 - Mixed Hardwood at Treasure Hill

For fire behavior analysis purposes, aspen was combined with the maple and mixed hardwood as there is limited acreage of the later two vegetation types and the desired condition is similar for fire behavior outputs. The moderate load broadleaf litter consists primarily of aspen with limited maple and minimal encroachment from the mixed conifer.

The high load conifer litter represents an area that is significantly encroached with mixed conifer. The primary carrier of fire is high load conifer litter with light slash or mortality fuel with low spread rate and flame length. The last fuel model presents a very high load broadleaf litter with fluffy litter. This fuel model has moderate spread rate and flame length. Aspen and hardwood maple are desirable as a shaded fuel break with lower and more manageable fire behavior.

Gambel Oak (31 Acres)

The Gambel oak vegetation type covers approximately 30 acres along the lower slopes of the southern and eastern edges of the Treasure Hill property. Gambel oak makes up nearly 100% of the species composition with a few coniferous and other hardwood species growing mostly on the edges. Most of the oak is less than 6 feet tall in height, on average. Shrubs such as bitterbrush (*Purshia tridentata*) and pachistima (*Paxistima myrsinites*) grow beneath the Gambel oak overstory indicating that there is some biodiversity of vegetation. There are no obvious forest health issues in the Gambel oak, but that does not mean they are not present or will not be present in the future.

Gambel oak is a very dynamic fuel model capable of seeing rapid rates of spread and moderate flame lengths. Gambel oak typically becomes available as a fuel late in the summer when the live fuel moisture drops off, or earlier in the season if impacted by seasonal drought. High fire behavior can be observed when live fuel moistures reach 125% or lower with extreme fire behavior noted at 100% or lower. Under frost kill conditions Gambel oak can be a very volatile fuel.

Mixed Vegetation (7 Acres)

This vegetation type is composed of shrubs and grasses with some encroaching conifers and hardwoods. Common shrubs include, but are not limited to: Saskatoon serviceberry, chokecherry, maple, mountain snowberry, Oregon boxleaf, Woods' rose, sagebrush, and common snowberry. Trees include sparse white fir, subalpine fir, Douglas-fir, aspen, Gambel oak, and maple.

The areas of shrub/mixed vegetation are primarily along two long linear features (ski lift and power line) that transect the project area and six small pockets. The open areas with lighter and flashier fuels will burn with higher spread rate but with lower flame length once the fuels have cured out into mid-summer.

Figure 3.10 - Area of Mixed Vegetation at Treasure Hill

Sagebrush and Grasses (18 Acres)

This vegetation type covers approximately 18 acres of the Treasure Hill property. The sagebrush type occurs mainly at the southern edge of the property while the grassy slopes are mainly limited to the ski runs.

Sagebrush encompasses a very small footprint within the project area with three small sagebrush plots existing on the south end of the project area. Sagebrush is a dynamic fuel model capable of seeing rapid rates of spread and moderate flame lengths. Because of the small size of the sagebrush plots, fire behavior should be moderated over the landscape but there is potential for fire to go from a surface fire into the crowns of the adjacent Gambel oak.

Figure 3.11 - Sagebrush and Grasses at Treasure Hill (Photo credit: https://www.parkcityhikes.com/post/treasure-hill)

The areas of grass are primarily along the four ski runs that transect through the project area. The grass fuel models will burn with higher spread rate but with lower flame length then other fuel models once they have cured out into mid-summer.

Walk-through surveys of these vegetation types recorded the growth of invasive weeds. No formal vegetation plots were implemented to describe the existing vegetation condition, though modeled fuels conditions are analyzed in the fire and fuels report for this document.

3.4 Fire Behavior

Park City lies in the 93rd percentile nationally of communities and homes most at risk of severe consequences from wildfire (www.wildfirerisk.org), and on average, possess a greater wildfire likelihood than 91% of communities in the United States. Park City and Treasure Hill are included within the Wasatch National Forest's Fireshed as the number four ranked of the top 10 firesheds in Forest Service Region 4. Firesheds were identified based on the probability of wildfires igniting on forested national forest lands available for mechanical treatments (e.g., excludes wilderness), with the potential to expose buildings in adjacent communities to wildfire. This data was identified in the "Development and Application of the Fireshed Registry," USDA Forest Service RMRS GTR-425. 2021.

Figure 3.12 - Parleys Canyon Fire on Saturday, Aug. 14, 2021. (Trent Nelson | The Salt Lake Tribune)

An understanding of fire behavior is important in identifying potential wildfire activity in the event of a fire ignition, and for looking at the effects of various fuels treatments following implementation. In the absence of live fire, modeling of fire behavior can be accomplished to gain this understanding. When using such fire behavior models, one needs to understand there are various limitations and assumptions of what is being presented. Expert knowledge and experience were used to interpret the models and formulate associated findings and recommendations in this report.

The Interagency Fuels Treatment Decision Support System (IFTDSS) provides a number of fire behavior outputs including the Landscape Fire Behavior model. Landscape Fire Behavior outputs are useful in prioritizing treatment areas. Three fire behavior outputs were utilized to assess fire behavior's impact on suppression efforts and potential fire effects; flame length (FL), rate of spread (ROS), and crown fire type. The fire suppression interpretations of flame length and rate of spread in Table 3.2 provide information on the type of suppression effort that can be successful at a given FL and ROS.

A detailed Fuels and Fire Behavior Report for Treasure Hill is included in Appendix E. IFTDSS is being used to review fuel data layers from LANDFIRE, Landscape Fire and Resource Management Planning Tools, and to analyze potential fire behavior within the Treasure Hill project area. IFTDSS was designed to look at large landscapes, and because of the 30 meter resolution and the diversity within the 104 acre project area, there are some limitations with precision and in pinpointing the specific on the ground fuel model to an individual stand. Thus fire behavior outputs should be considered on a general level versus a specific point on the ground. However, field surveys were conducted by wildfire experts to compare models to real world potential fire behavior conditions. Table 3.2 demonstrates the relationships among fire suppression, interpretation of flame length, and rate of spread.

Table 3.2 - Fire Suppression, Interpretation of Flame Length, and Rate of Spread

Adjective Class	**FL (ft)**	**ROS (ch/h)**	**Interpretation**
Very Low	0-1	0-2	Fire can generally be attacked at the head or flanks by persons using hand tools. Handline should hold the fire.
Low	1-4	2-5	
Moderate	4-8	5-20	Fires are too intense for direct attack on the head by persons using hand tools. Handline cannot be relied upon to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
High	8-12	20-50	Fires may present serious control problems with torching, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
Very High	12-25	50-150	Crowning, spotting, and major fire runs are probable. Control efforts at the head of fire are ineffective. (Andrews and Rothermel 1982)
Extreme	>25	>150	

As noted in the fire suppression interpretations table, flame lengths greater than 4 feet can be problematic as hand crews are minimally effective with direct attack. This is of importance with the Treasure Hill project area as access for engines and heavy equipment is limited in many areas. Based upon the IFTDSS output at the 97th percentile, while a majority of the flame lengths are expected to be in the 1 to 4 foot range, 19% of the project area has predicted flame lengths greater than 4 feet. The mixed conifer stand and area of sagebrush in the southeast corner of the project area contain concentrations of flame lengths greater than 4 feet and are a consideration in the treatment plan.

Figure 3.13 - Crown fire in Mixed Conifer

Rates of spread greater than 5 chains (66 feet/chain) per hour (ch/hr) can cause control problems for hand crews using direct attack as identified in the fire suppression interpretation table. Based upon the IFTDSS output, while not explosive, 37% of the project area has rates of spread of 5 ch/hr or greater at the 97th percentile. The mixed conifer stand and area of Gambel oak and sagebrush in the southeast corner of the project area are where rates of spread are greater than 5 ch/hr.

Knowledge of crown fire activity is important in understanding possible control issues, spotting, and potential fire effects. Once fire becomes established within the canopy, control becomes problematic until the fire returns to the ground surface. Crown fire activity also has a higher probability of creating embers leading to spotting. While 59% of the fire should remain as a surface fire, 41% of the fire has potential in becoming passive crown fire. This is a rather high percentage and is accounted for in the treatment plan. Similar to areas of concern for flame length and rate of spread, the same areas within the mixed conifer, sagebrush, and Gambel oak have potential to experience passive crown fire.

Based upon its slope position at the bottom of Treasure Hill, a fire event affecting Park City is less likely to originate directly from a large fire front; however, concern exists for fire spotting into any area of the community adjacent to and within the wildland urban interface (WUI). In general, downhill fire movement would be a lower intensity backing fire. The exception to this would be a rare event with fire starting above the parcels and being pushed down slope with a wind event, such as a collapsing thunder cell to the west pushing winds down slope/down canyon. A more likely scenario would be a human caused fire starting lower on the slope near Park City and running upslope or parallel to the slope and into the canopy of the mixed conifer, but with existing potential for spotting back into the community.

The Suppression Difficulty Index (SDI) is a product of the Risk Management Assistance (RMA) dashboard from the Wildland Fire Management Research, Development, and Application. Areas where the SDI was run at the 97th percentile and outputs are in the 0.4 - 0.7 and 0.7 - 1.0 range are highlighted for potential control concerns (**Appendix E**). This includes areas where access is a concern and where fuels promote greater flammability. Firefighting and access issues include the areas of white fir in the center of Treasure Hill, along with the southern extent of the project area.

Areas where mixed conifer, continuous sagebrush, and Gambel oak exist are of greatest concern for higher levels of flammability. Promoting future vegetation conditions for areas that are not highlighted in the fire behavior analysis or by the SDI should be considered. This would include expanding the extent of aspen and maple hardwoods within Treasure Hill, as these areas promote lower fire intensities and can act as shaded fuel breaks.

3.5 The Future of Forests

Climate change may exacerbate environmental stresses already affecting today's forests around Park City. Drought affects forests by reducing growth and increasing vulnerability to fire, insects, and pathogens. Severe moisture stress reduces both the chemical and physical defenses of trees to insects, and often results in severe outbreaks that affect large areas of forestland. Both defoliating and boring insect attacks are higher rates during periods of drought. The long-term effects include significant timber losses (tree mortality), which in turn affects recreation, and the aesthetic quality of forests (Vose et al., 2016).

Climate shifts are also moving habitats faster than trees can keep up, meaning that many vegetation types will see a reduced range, move up in elevation, or disappear altogether. Changes in land cover and diebacks resulting from combinations of climate, disease, and human action can all contribute to expanding or contracting ranges (Man 2013). Conifer vegetation types may experience an accelerated conversion to mixed evergreen, shrub, or grasslands following fire, or multiple fire events. The extent to which vegetation ranges change is uncertain, due to uncertain climatic shifts and the limited evidence of variables that currently control range limits (Vose et al., 2016).

Fire commonly occurs in concert with drought, particularly more widespread fires. Fires that occur in moist years tend to be less widespread, whereas fires during drought years are more likely to escape control, thus affecting a wider area. Fire history evidence from diverse climate regimes and forest ecosystems suggests that North American forest fire regimes were moderately to strongly controlled by climate prior to Euro-American settlement and subsequent fire exclusion and fire suppression. Climate therefore, facilitates fire by producing fuels through vegetation growth and die-off, as well as making those fuels more flammable (Vose et al., 2016).

One potential consequence of greater area burned at high severity is an increased probability that forests will convert to alternative vegetation types. Research findings provide some guidance to managers as society struggles to better coexist with fire. For example, it may be possible to increase the prevalence of low and moderate severity fire, sometimes referred to as “good fire”, through thoughtful planning about where and when to implement prescribed fire to serve as effective “fuels treatments” (Parks and Abatzoglou 2020). This practice must be considered and included in management actions to maintain forest health and resiliency long term.

The continued development of forest and range land also poses a risk to the function of natural systems, even to Treasure Hill. The fragmentation of vegetation and wildlife habitat and introduction of invasive species present challenges for open space parcels such as Treasure Hill. It must be recognized that development will continue to occur and, in some cases, may work with the surrounding environment; especially now with increasing public awareness.

As stewards of the land and of its natural resources, the time to act is now. For decades upon decades humans have extracted and altered landscapes around Park City and on Treasure Hill. This has set up the forest and vegetation structures to respond to climate change in a way that will most likely negatively impact the local area if no deliberate restoration work is completed. Sustainability and environmental stewardship are values the City and local population hold dear, although they are rarely applied to forests. The implementation efforts recommended in this plan aim to redirect inadequate forest management practices and remediate for the sake of our land's future.

4 Implementation Recommendations

"Why here and why now?" are two important questions regarding forest management decisions. This sets the stage for determining which actions to take, when to begin treatment, and whether active or passive management strategies are used. The steps presented within this Management Plan should be taken on Treasure Hill to reduce fuel loading and fire risk to the community, increase safety for recreation, and nurture healthy forests now and into the future for Park City.

Over a century of fire exclusion, resource extraction, and lack of forest management has resulted in a number of resource issues on Treasure Hill. Current conifer forests are dense, overstocked, and contain an altered species mixture when compared to their historic condition. Diameters are smaller than what was seen on the landscape over one hundred years ago. The mixed hardwood forests rely on fire, which has been suppressed for the last century, to regenerate and maintain healthy aspen stands. Neither vegetation type is regenerating successfully, meaning there are few young trees to provide the next generation of canopy cover. On the other hand, the Gambel oak is mostly maintaining its place on the landscape, but its fire regime has been altered, resulting in forest structure change.

The presence of excessive down woody debris complicates matters for fire suppression, while also providing breeding grounds for insects. Insect infestations are also out of sync with what was thought to have occurred in historic forests. Infestations are occurring across large swaths of the landscape, taking advantage of weakened trees due to competition for water and nutrients, which are all compounded by the effects of drought. Fuels treatments are needed to restore the health and resilience of the vegetation, while reducing the fire threat to the values at risk in and around Treasure Hill.

4.1 Forest Management Objectives and Goals

Table 4.1 (below) describes the forest management objectives coupled with short and long term goals for Treasure Hill. They provide the basis for the recommended management actions and serve as a guide for planning and implementing future projects.

Table 4.1 - Forest Management Objectives and Goals

Objectives	Short-term Goals (0-5 yrs)	Long-term Goals (6+ yrs)
Increase Public Safety	Hazard trees are an immediate threat to human life. Dead trees and damaged live trees are public safety issues around trails, ski runs, and access roads.	Maintenance treatments continually remove hazard trees around trails, ski runs, and access roads.
	Create fire-resistant landscapes to aid in suppression of wildfire and protection.	Maintain fire-resistant and resilient landscapes to aid in suppression of wildfire across the entire property.
	Reduce the threat of avalanches into town by maintaining vegetation / forest structure in PRAs-related treatment alteration areas.	Avalanche hazard is minimized by retaining current vegetation / forest structure in designated areas.

Reduce Fire Risk	Removal of down and standing dead wood reduces fuel loading, continuity, and threat of high-severity fire. Fuel reduction treatments change forest structure to reduce density, remove ladder fuels, and increase crown base height where needed. Encourage shaded fuel breaks in Aspen/hardwood Maple stands. Wildfires are easier to control due to treatments. Community discussion and education about living with fire.	Scheduled maintenance treatments create fire-resistant vegetation patterns. Forest structure changes over time to include more fire-tolerant species and larger diameter trees resilient to fire effects. Scheduled understory burns used where prior treatments minimize escape. Community infrastructure and vegetation are resistant to undesirable fire effects, see an increased resiliency over time. Long term community engagement and education.
Improve Forest Health	Removal of vegetation prevents high-severity fire in most locations. Reduce concentration of down wood and slash that provide breeding grounds for insects in conifer and mixed hardwood vegetation types. Maintain desirable down woody debris for soil cover, wildlife habitat, and tree planting/regeneration. Retain desirable snags for wildlife habitat while being cognizant of public safety.	Fuel treatments maintain desirable levels of fuel loading over time. Slash and down woody debris are maintained at levels that do not promote excessive insect breeding grounds. Down woody debris provides soil cover, wildlife habitat, and vegetation cover. Snag recruitment happens naturally over time and is maintained and monitored for public safety concerns.
Protect Existing Infrastructure	Remove vegetation around infrastructure, including historic mining sites, to reduce the risk of damage from wildfire. Engage easement holders to determine responsibility for treatment and maintenance of vegetation. Ensure forest management activities do not damage infrastructure.	Maintain vegetation clearance on new and existing infrastructure. Continually engage easement holders and adjacent property owners to ensure plans are updated and being implemented..
Maintain Aesthetics (views)	Removal of excessive dead trees improves the visual character of forests across most of the property. Community discussion and education about how treatments maintain the visual appeal of the area.	Tree, shrub, and grass cover is maintained through time over the entire property area. Continued monitoring of vegetation treatments to determine efficacy of treatments for visual appeal.
Address Climate Change	Treatments trend vegetation towards climate-resilient states and prevent conversion of forest to non-forest vegetation types over the forested areas of the property.	Vegetation cover and composition are maintained or able to shift with changing climate. Forests are able to maintain productivity and resiliency in the face of changing environmental stressors.

Sustain Economics	Incur costs on treatments now to reduce potential for current and future wildfire or increased vegetation mortality across most of the property. Wildfire mitigation activities require less funding to pay for than suppression costs. Tourism is not negatively affected by wildfire occurrence, widespread mortality from insects, recreation closures, or other public safety concerns.	Budget for maintenance treatments to reduce long-term costs related to wildfire control or restoration activities following wide scale vegetation mortality. Control of wildfires is more easily accomplished. Park City remains an active and safe tourist location. Long-term economic health of the community is maintained.

As highlighted in the above table, creating resilient landscapes and forested stands is important in achieving forest management objectives and goals. The following factors (Table 4.2) increase fire resiliency and should be recognized when planning forest management activities. The positive effects of fuel treatments by removing significant standing and down, dead materials, and ladder fuels, counters the concerns and reduces the potential fire behavior and subsequent fire effects.

Table 4.2 - Factors that Increase Fire Resilience

Principle	Effect	Advantage	Concerns
Reduce surface fuels	Reduces potential flame length	Control easier; less torching	Surface disturbance less with fire than other techniques
Increase height to live crown	Requires longer flame lengths to begin torching	Less torching	Opens understory; may allow increased surface winds
Decrease crown density	Makes tree-to-tree crown fire less probable	Reduces potential for crown fire	Surface winds may increase & surface fuels may be drier
Keep big trees of resistant species	Less mortality for same fire intensity	Generally restores historic structure	Less economical; may keep trees at risk

4.2 Treatment Considerations

Community / Stakeholder Engagement

Given the location and importance of the parcel(s), notifications to the community regarding any treatments performed throughout the duration of the project is essential - all in addition to public safety related signage and closures. Coordination with neighboring stakeholders / land owners of any work planned and performed will further promote good community stewardship, and serve to engage with and inform adjacent landowners about the project and its goals.

Phased Approach

A phased approach to implementing treatments on Treasure Hill will first target fire and fuels objectives while gradually changing forest tree species and vegetation patterns. The term “entry” is used in the industry to describe specific actions taken in a vegetation type to accomplish objectives under a phased approach. The reasons for a phased approach include:

- Focus on treatments needed to meet public safety standards prior to meeting other important objectives.
- Treatments are implemented and assessed at multiple stages to ensure objectives are being met.
- Visual impacts of treatments are lessened by methodical changes to vegetation over time.
- Forest health conditions are such that multiple stages are required for treatment.

The phased approach is not without risks. Treatments will require more time, separate entries, and can add to project costs. Some areas may remain susceptible to fire and insects in the short-term (e.g. 3 to 5 years) while the highest priority treatments to protect human life and property from severe fire outcomes are implemented. However, these short-term risks will be mitigated during the long-term management (greater than 5 years) of this property. The risk of completing all vegetation treatments in one entry may be the loss of visual integrity, undesirable damages to remaining vegetation, and the inability to “go back.” The first phases are designed to reduce immediate fire risk and address public safety concerns, while structural changes to the forest (e.g. creating gaps for planting Douglas-fir, thinning live trees to reduce long-term forest health issues) will take more time to complete.

This process will include frequent monitoring to ensure objectives are met. Adaptive management should be used to the fullest extent possible to analyze treatment success and change as needed during the treatment process. This careful approach can help prevent unwanted outcomes before they are too late to mitigate.

It should be noted that approximately 3.5 acres of gambel oak were treated in 2021 as part of PCMC defensible space efforts to reduce the risk of wildfire around the homes immediately adjacent to Treasure Hill. Subsequent plans will extend and bolster existing treatments where appropriate, to further promote wildfire resilience around the community.

Treatment Methods

All treatment types should be considered to achieve objectives during treatment planning on Treasure Hill. Silvicultural activities (activities that include changes to a forest whether it is through cutting, burning, or allowing for natural succession) were discussed at-length to ensure desirable treatment outcomes over time, while not sacrificing residents’ views and use of the area. This means that manual treatments using hand tools, mechanical treatments using machines, and use of prescribed fire were analyzed. The use of best management practices would mitigate undesirable effects caused by vegetation treatments, while ensuring they are meeting objectives while preserving the resources on Treasure Hill.

Manual Treatments

Manual treatment methods primarily refer to the use of chainsaws and brushcutters to cut woody vegetation (trees and shrubs), and are typically utilized before or during other treatment types including mechanical or prescribed fire. Manual chainsaw treatments are used to thin trees and brush, limb branches, lop and scatter slash, and construct piles for later burning or removal of slash if feasible. Hand-pulling or cutting of invasive weed species would also be considered a manual treatment. These treatment methods are typically very laborious, and over large areas require entire handcrews of forest laborers to complete the work in a timely manner.

Advantages of manual methods include the ability to be very precise, which is important in areas where sensitivities exist. It is often the only viable option due to limited access or other terrain factors.

Mechanical Treatments

Mechanized equipment is often used for large-scale forestry activities or on any property that requires a significant amount of vegetation removal. Logging machinery is used to remove trees for hauling to lumber mills, while smaller machinery can be used for fuel treatments that mainly target small to medium-sized vegetation. There are many benefits to using machinery, such as covering large areas in less time than by manual methods, and the ability to move large material with ease, resulting in high production rates. There can be positive resource effects from machinery, such as scarified soil for tree seed establishment. As with any activity, mechanized operations may also produce negative outcomes, although these can often be mitigated by applying best management practices (BMPs) to prevent unwanted damage to soil, streams, and other resources.

Ground-based mechanized equipment are typically used on milder slopes where machinery can safely and effectively operate. Skyline and helicopter systems are used on steep terrain or where ground-based equipment is not allowed to operate due to soils or other resource concerns. Ground-based equipment and operators are available in Utah unlike other systems that would need to be brought into the area. This presents real challenges to managing forested steep slopes like those found on Treasure Hill with mechanical treatments.

Mechanized equipment is chosen based on terrain, available or future access roads for equipment, availability and location of the necessary equipment, and cost. In addition to logging equipment such as skidders, feller bunchers, harvesters, and forwarders, masticators and chippers would be included in mechanized equipment. One of the most probable mechanical options for Treasure Hill involves the use of existing ski runs and grooming equipment, also referred to as “snowcats”, to skid logs over snow surfaces. These machines can act as a skidder, yarder, and dozer on snow, reducing negative impacts to the ground surface. They would provide a mechanical option to get material too large to reasonably burn in piles down the hill and off site, given adequate access and a well timed operation.

Prescribed Fire

Prescribed fires, also known as prescribed burns or controlled burns, refer to the controlled application of fire by a team of fire experts under specified weather conditions to restore health to ecosystems that depend on fire. Prescribed burning can be separated out by broadcast burn, and pile burning. The purpose of prescribed burning include:

- Reduces hazardous fuels, protecting human communities from extreme fires
- Minimizes the spread of pest insects and disease
- Removes unwanted species that threaten species native to an ecosystem
- Provides forage for game
- Improves habitat for threatened and endangered species
- Recycles nutrients back to the soil
- Promotes the growth of trees, wildflowers, and other plants (USDA Forest Service 2022)

Pile burning is typically used as an initial treatment following a manual treatment where there is a heavy fuel buildup. Pile burning will many times be followed up with a broadcast burn to simulate natural wildland fire. Smoke is a byproduct of prescribed burning and can impact air quality, but is carefully regulated and requires approval through the State of Utah Department of Air Quality. Numerous sources of data show smoke from prescribed fire up to 10 times less than what could be expected from a wildfire event which does not allow for scheduling under desired burning and atmospheric conditions.

Invasive Weed Control Methods

Manual and mechanical treatments of invasive weeds are generally labor and time intensive. Pulling, cutting, and otherwise damaging plants may be used to control some invasive plants, particularly if the population is relatively small. Manual treatments are extremely specific, meaning that the risk of damage to other desirable plants and animals is low (Tu et al. 2001). Prevention measures to reduce the introduction of invasive weeds is important and one of the best ways of dealing with concern.

Herbicides can be a useful tool when managing both native and invasive vegetation. For purposes of this document, herbicide use was not considered at the request of PCMC. Manual treatments such as hand pulling invasive plants is the desired alternative, although could come at a higher cost.

Pest Control Methods

Pesticides may be used on individual, high-value trees where insect infestations occur, but are typically not used widely throughout an insect outbreak. There are many types of pesticides approved for use in forests, but these were not analyzed for use at the request of PCMC.

Insect pheromones have been used to repel insects from high value stands or trees at risk of insect attack. Although there has been some progress in the use of this technology, the application of pheromones may still lead to unintended consequences or inconsistent results. This may improve over time, and could one day be worth the investment on Treasure Hill.
https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8980.pdf

Biological control of forest pests include the predation of pest insects by other insects, birds, or animals. However, it has been found that these natural enemies are ineffective during large scale outbreaks (Bell Randall 2012, Ragenovich & Mitchell 2006). The efficacy of potential methods such as biological controls would require additional analysis by qualified specialists.

Retreatment

Forest management and wildfire risk mitigation require a long term commitment by land managers to continually reassess and often retreat areas post project completion. The timeframe and schedules will vary by vegetation type, seasonal patterns, site growing conditions, and objectives. Generally, retreatments will need to occur in faster growing and resprouting species such as gambel oak and brush first, with a more delayed retreatment in conifer and aspen. Retreatments, when applied appropriately will require considerably less cost and effort then the original treatment. Frequent monitoring is essential to ensure the correct treatment is occurring on the appropriate schedule for each project and vegetation type. The treatment methods described above, as well as the use of goats or sheep could be used to reduce the new growth of smaller herbaceous vegetation.

Biomass Management

One of the most difficult aspects of large scale fuel treatments in overgrown forests is planning for immense amounts of biomass in various forms. The team working on this report analyzed factors such as economics, feasibility, repurposing, and environmental aspects to determine best courses of action. The most cost effective method for areas with limited machinery access is removal on-site in the form of prescribed fire or broadcast chipping. Project areas with machinery access could benefit from biomass removal off-site.

It is recommended that the City work with local partners from all sectors to develop a sustainable model for biomass management. With many local entities acting on forest restoration projects for years to come, a collaborative method to process biomass is in the best interest of the community. This process would take some detailed planning, dedicated space, machinery, and personnel. Some repurposed material could have community benefits in the form of resources for private use, such as:

- Timber value
- Firewood
- Wood chips / mulch
- Special uses (BDA posts, etc)
- Biochar

Material that couldn't be repurposed can be efficiently reduced and disposed of in various ways, including high intensity burning of machine built piles, or using a tub grinder.

Monitoring

Monitoring treatment activities ensures objectives are being met and if changes to planned treatments are needed. The monitoring plan should include on-site assessments of project activities during all phases of treatment. Findings should be documented and compiled during treatment activities. The tracking of growth, survival surveys of planted trees, and aspen response to cutting or burning should be captured in written documentation and continually evaluated by Park City Municipal Corporation. It is noted that the Summit Land Conservancy conducts yearly monitoring on their conservation easements, although they do not typically capture specifics on forest health, vegetation management, or species succession. The Utah Department of Natural Resources can assist with monitoring activities as part of their business operations.

Specific Monitoring Plan:

1. Forest and rangeland inventory: On-the-ground vegetation plots were used *prior* to project planning and implementation to identify treatments that would meet landowner objectives. These plots may be revisited *following* treatments to gather post-treatment vegetation data and photos to describe changes to vegetation and assist in the development of a maintenance plan and schedule.

2. Contract inspection: An on-site assessment that occurs *during* project implementation to ensure contract specifications and resource mitigation measures are being followed. Final documentation occurs *following* treatments, once it is determined that contract specifications have been met.

3. Prescribed burning treatment, mop-up, and evaluation: Site-specific burn plans are drafted *prior* to implementation to identify proper conditions for ignition. Qualified personnel are on-site *during* burning operations to implement and observe fire behavior, ensure objectives are being met, and safety protocols are followed. Site evaluations occur *during* mop-up to ensure fire is controlled and if any further actions are needed. Additional site visits at 1, 3, and 5 years *post*-burning evaluate tree and shrub response to fire, delayed mortality of trees, and if any future actions may be needed.

4. Tree planting: On-site inspection occurs *during* tree planting to ensure seedlings are properly handled and placed in the ground.

5. Growth and survival surveys of tree seedlings: Inspections of planted areas occur 1 and 3 years *post*-planting to determine needs for replanting, release, weed control, protection from wildlife browse, and management of insect or disease problems.

Mitigation Strategies for Resource Protection

Mitigation measures should be used to ensure soil, water, wildlife, and recreation resources are not detrimentally affected by planned activities. This report addresses a multitude of resources on Treasure Hill, and should be used as a reference during future project planning and implementation. Monitoring of treatment activities will assess the use and efficacy of mitigation strategies throughout all phases of implementation.

Best Management Practices (BMPs) will be used to prevent unwanted damage to soil and water resources on the property. There are eight categories of BMPs with associated guidelines. The Utah Department of Natural Resources (DNR), Division of Forestry, Fire, and State Lands outlines the eight categories of BMPs in the "Utah Forest Water Quality Guidelines" user guide:

1. Pre-harvest planning
2. Streamside management zones
3. Roads, skid trails, landings, and stream crossings
4. Timber harvesting
5. Site preparation, regeneration, and revegetation
6. Chemical Management
7. Prescribed fire
8. Forested wetlands

Following BMPs is voluntary in Utah, but as the DNR guidelines state, its use will "assure forest management activities do not adversely impact water quality" and the proper management of forests "can be positive for watersheds and the goods and services society demands."(Storey et al., 2001)

Recreation use may be disrupted by forest management activities due to public safety concerns from equipment, tree felling, or burning activities. Proper planning and timing of activities may help limit the impacts of closures to the public. Communications regarding forest operations will be necessary to inform the public about any pending closures. Clear signage will be posted on-the-ground with detailed closure information for recreation users.

Control of invasive weed species throughout all vegetation types on the property will be on-going throughout all phases of implementation. Removal of weeds will be done manually (by hand-pulling). Equipment should be cleaned prior to working on and prior to leaving the property to limit the spread of invasives.

Avoid large scale forest management activities to protect wildlife from; February 1st to April 15th to protect owls and other raptor species' nesting periods, and May 1st to July 31st to avoid disturbance to mule deer, bats, and birds during the breeding and nesting period. Field surveys may be completed by a biologist to determine if wildlife are present during breeding and nesting seasons on Treasure Hill. This could allow for vegetation removal and other disturbance activities to proceed.

Applicable Regulations and Planning

The below documents contain applicable laws and regulations that should be adhered to in the performance of forest management on Treasure Hill.

Federal:

Clean Air Act, Clean Water Act, Endangered Species Act, Migratory Bird Treaty Act of 1918

State:

Land Use Development and Management Act (LUDMA), Utah Forest Practices Act, State Smoke Management Plan, National Historic Preservation Act of 1966 -Section 106, code 90844

City:

2014 General Plan, Park City Noxious Weed Management Plan 2015

Park City Land Management Code (LMC), Recreation and Open Space (ROS) District, Protected Open Space (POS) District

4.3 Treatment Plan

The treatment plans outlined below are derived from the Silvicultural and Fuels / Fire Prescriptions provided in **Appendix F.** Together they should be considered as the foundation for forest management on Treasure Hill, and utilized to formulate specifications for current and future projects planned on the property. All actions and prescriptions take into account the resource considerations described in the body of this Plan and its Appendices, to apply a comprehensive approach to forest management on Treasure Hill.

Table 4.3 - Overview of Management Actions by Vegetation Type

Existing Vegetation	Historical Vegetation Type	Treatment Plan	Objectives Met
Mixed Conifer	Southern Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	Active management: Phase 1 (0-2 years): Cut, pile and burn dead and down fuels and limbing of 50% of ladder fuels; remove hazardous trees; small tree thinning. Phase 2 (2-4 years): Cut, pile and burn dead standing and limbing of remaining ladder fuels. Phase 3 (3-5 years): Create gaps in tree overstory and plant Douglas-fir. All Phases: Invasive weed management.	Phases 1 and 2: Reduce fire and fuels risk, increase public safety. Phase 3: Increase biological diversity to address current and future forest health issues. All Phases: Aesthetics, Invasive weed management.
Mixed Hardwood	Rocky Mountain Aspen Forest and Woodland	Active management: Phase 1 (0-2 years): Cut, pile and burn excess fuels, remove hazardous trees. Phase 2 (1-5 years): Cut or burn in aspen to stimulate regeneration, minimize competition to aspen. All Phases: Invasive weed management.	Phase 1: Reduce fuel loading, increase public safety. Phase 2: Address forest health and create shaded fuel breaks. Phases 1 and 2: Aesthetics, Invasive weed management.

Mixed Vegetation	Mixture of vegetation communities	Active Management: Phase 1 (0-5 years): Reduce conifer encroachment to favor aspen growth and regeneration. Phase 1: Invasive weed management.	Phase 1: Reduce fire and fuels risk, forest health, Invasive weed management.
Gambel Oak	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Active Management: Phase 1 (0-2 years): Create fuel breaks around roads, property lines Phase 2 (Delayed): Treatments to increase crown base height, reduce continuity of fuels in interior sections of stand. All Phases: Invasive weed management	Phase 1: Reduce fire and fuels risk. Phase 2: Maintain desirable fuels profile over time which reduces fire and fuels risk. All Phases: Invasive weed management
Sagebrush, Grass	Inter-mountain basins montane sagebrush steppe / Southern Rocky Mountain montane-subalpine grassland	Passive Management: No immediate actions planned to change vegetation patterns or species. Invasive weed management remains a priority.	Invasive weed management

Mixed Conifer

The primary objective is to reduce the risk of undesirable fire effects to Treasure Hill and surrounding property (Phases 1 and 2 of treatment). A secondary objective is to trend the forest towards a more fire and climate-resilient structure (Phase 3 of treatment). Important design features for these treatments include the consideration of the heavy recreational use of the property, ski resort and historical mining infrastructure, high aesthetic value, wildlife habitat, and avalanche potential.

Phase 1 (0-2 years), Reduce wildfire risk:

This will be accomplished by managing fuel loading and tree mortality in the stand. The removal of dead and down material, thinning of small trees, limbing of live trees, and shrub removal will increase fire resistance. Manual and mechanical methods will remove and pile excess vegetation on- or off-site (see biomass management, sec. 4.2). Prescribed burning of the piled vegetation will occur once the material is sufficiently dried. Some down woody material and snags will be left for soils, wildlife, and tree regeneration.

Phase 2 (2-4 years), Reduce wildfire risk:

This second entry in the conifer will target remaining fuel loading and undesirable tree mortality in the stand. The removal of dead standing snags, and continued limbing of live trees will increase fire resistance. Manual and mechanical methods will remove and pile excess vegetation on- or off-site (see biomass management). Prescribed burning of the piled vegetation will occur once the material is sufficiently dried. Some down woody material and snags will be left for soils, wildlife, and tree regeneration.

Phase 3 (3-5 years), Manage forest composition and structure:

There is a need to change stand structure and composition to grow other species (Douglas-fir) and increase diversity to environmental stressors. This would happen in stages over time. The removal of smaller diameter, live white fir trees will reduce tree densities, create a variable stand structure, and will reduce the threat of undesirable disturbance. Douglas-fir will be planted in openings to increase the biodiversity of the site, but drought is a concern for regeneration since they are susceptible to desiccation. Currently, the planned openings are smaller than the recommended minimum for growing Douglas-fir, but larger openings will not meet other objectives. Created openings will follow a set of strategies to minimize effects to aesthetics (e.g. feathering edges, locating in areas away from ski lifts, existing slopes and other vegetation will cover these areas and the view from town). This phase of treatment uses concepts from the historical forest condition and potential future condition to guide treatments though fire and fuels objectives take precedent.

Mixed Hardwood

Many aspen stands rely on disturbance such as wildfire to maintain growth, health, and their reproductive cycle. Without disturbance they will eventually be replaced by conifers or die out. This is currently the case with the old, undisturbed stands on Treasure Hill. Aspen forests across Utah are a high priority for conservation and management due to the threats they face. These stands are important areas for wildlife and recreation, provide for shaded fuel breaks, and are a beautiful backdrop on the hills above Park City. The careful and methodical management of these stands is necessary to prevent their current and future loss. There are two distinct implementation phases for this prescription to meet objectives.

Phase 1 (0-2 years), Reduce fuel loading:

Reduce the surface fuel loading in the aspen stands. The removal of hazardous trees will increase public safety along trails, ski runs, and access roads. Thick understory layers of conifer, maple, and shrubs will be cut and removed as they provide fuel in the event of a wildfire, and may outcompete sprouting aspen for resources such as light, water, and nutrients. Some down woody material and snags will be left for soils, wildlife, and tree regeneration. Excess fuels will be piled and burned, once the material is sufficiently dried, or woody material will be moved off-site for disposal.

Phase 2 (1-5 years), Stimulate aspen growth:

A major concern in the Treasure Hill aspen stands is the lack of young trees to replace the aging aspen stems. A portion of mature aspen stems (an estimated 10 to 20% per acre in Phase 2) will be cut to encourage suckering. This will be accomplished by cutting groups of aspen and monitoring for the growth of new stems. Excess fuels will be piled and burned, once the material is sufficiently dried, or woody material will be moved off-site for disposal. If monitoring surveys indicate a successful suckering response, then further action may not be needed for some time. If the suckering response is not successful, then there may be a need to consider more options, such as the use of broadcast burning, further thinning of aspen, or the analysis and discussion of no further short-term treatment. Fencing or some type of barrier may be constructed if recreational or undulate activities cause damage to an aspen regeneration area. Fencing would remain in place only as long as needed for aspen to reach a size where they are no longer at risk of mortality from damage.

Mixed Vegetation

This vegetation type creates a small patchwork around Treasure Hill containing a variety of vegetation species. Some management is required to reduce the risk of wildfire and maintain species vigor and diversity.

Phase 1, Remove encroaching conifers:

The mixed vegetation type contains conifers, hardwoods, shrubs, and grasses. Remove conifers, except Douglas-fir, around aspen to reduce ladder fuels and decrease competition for resources. This will not be widespread as both the conifer and aspen concentration is overall low. Excess fuels will be piled and burned, once the material is sufficiently dried, or woody material will be moved off-site for disposal.

Gambel Oak

The Gambel oak vegetation type may either act as a “green belt” to fire (may slow or stop fire) or experience high-severity wildfire events, depending on season and local conditions. Steps are needed to create a defensible zone along roads and around private property to enable wildfire response and control, and evacuation if a wildfire were to occur. There is also a need to slowly change the homogenous, contiguous pattern of oak over time to increase fire resistance and aid in stand diversity.

Phase 1 (0-2 years), Reduce immediate risk to roads, infrastructure, and private property from wildfire:

Create defensible space around infrastructure and private property throughout the project area by removing oak within 100 feet of structures. Create shaded fuel breaks around roads by removing oak within 30 to 50 feet on either side of the road. Retain oak in patches and clumps to maintain aesthetics, shade, and ecosystem health. Complete removal of Gambel oak over large areas is not desirable nor is it necessary to reduce wildfire risk in the wildland/urban interface. Well-placed openings in oak canopies offer potential opportunities for arresting fire spread in defensible space and shaded fuel break zones. The estimated retreatment of fuel breaks is every 3 to 5 years. Excess fuels will be piled and burned, once the material is sufficiently dried, or chipped in place where feasible.

Phase 2 (10 years), Interior stand management of oak:

It is recommended that the Phase 2 prescription for interior Gambel oak be delayed until a future date (estimated 10 years) when treatments will be much more effective. At this time, the Gambel oak stems are too small and thinning these stems will not result in any meaningful change in existing or near-term fire behavior.

Reduce canopy density and horizontal and vertical continuity to reduce fire intensity and rates of spread by removing a portion of the oak in patches. Mechanical and/or manual treatments will be scheduled to remove oak and maintain stand structure where needed. Excess fuels will be piled and burned, once the material is sufficiently dried, or chipped in place where feasible. Decadent woody material in taller Gambel oak will be removed to reduce fuel loadings and create shaded fuel breaks. In addition to reducing fire intensity and severity, desirable side effects of these types of treatments in Gambel oak communities are increased access and movement corridors for animals. Treatments will need to be reapplied every 5 to 7 years in order to maintain openings.

Sagebrush and Grass

These vegetation types do not have any planned active management at this time other than invasive weed management. This does not preclude these areas from active vegetation management in the future and treatments may be developed when necessary.

5 Conclusion

The Park City Municipal Corporation - Treasure Hill Open Space - 2022 Forest Management Plan is intended to meet the objectives set within this plan and focuses on the tenet of creating and maintaining resilient and resistant landscapes as part of the National Cohesive Wildland Fire Management Strategy. In carrying out the recommendations of this plan, creating Fire Adapted Communities to help protect the adjacent Park City Wildland/Urban Interface and infrastructure, along with providing for safe and effective wildfire response can be achieved, while managing for all the natural resources on Treasure Hill.

While implementation of this plan and the associated prescriptions are a significant investment by PCMC, these costs are relatively low when compared to the consequences if a wildfire or other natural disaster were to occur. When looking at the recent Parleys Canyon Fire, suppression costs alone were ~$6,000 per acre, and similar cost per acre would be expected for a similar sized wildfire occurring adjacent to Park City. Fire suppression and rehabilitation, vegetation loss, post fire landslides and avalanches, potential recreation and tourism industry detriment, and aesthetic value loss all come with huge economical and social implications. Data within this plan shows how fire behavior and the potential negative fire effects to the landscape can be reduced and provide for a positive return to the community.

This document utilized a mix of subject matter experts, latest available science, and industry best practices to lay the foundation for future management actions. While the prescriptions are written for Treasure Hill, it is recommended that project specifications be developed for new projects based upon the ongoing monitoring and adaptive management of the open space, type of treatment, number and type of acres to be treated, any changes to short- or long-term objectives, and any changes to the landscape that may have occurred after the release of this management plan. In an “all hands, all lands” approach, the Treasure Hill Forest Management Plan can be the model and set the stage for future and expanded work around Park City including outcomes derived from the PCMC Wildfire Risk Assessment Project.

6 Warranty and Liability

Alpine Forestry LLC does not warrant, either expressed or implied, the accuracy, completeness, reliability, or suitability of the information in this document. Property boundaries included in any product do not represent an on-the-ground survey suitable for legal, engineering, or surveying purposes. They represent only the approximate relative locations. By accessing this document and/or data contained within the aforementioned databases, PCMC agrees to use all information at your own risk, and you hereby release the providers and their employees, agents, contractors, and suppliers from any and all responsibility and liability associated with this document.

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Appendix A

Wildlife Assessment by Sageland Collaborative

A Report to
Alpine Forestry, LLC

Treasure Hill Wildlife Assessment

April 2022

Compiled by
Janice Gardner

SAGELAND
COLLABORATIVE

1 Purpose

The Treasure Hill parcel (the Project area) is under ownership of Park City. The Project area is anticipated to be managed as open space under a conservation easement, held by Summit Land Conservancy. The Project area is highly valued within the community for its many resources, including as open space, recreation, and wildlife habitat. The purpose of this section is to assess the wildlife resources within the Project area.

2 Regulatory Context

2.1 Local and Municipal

Park City Municipal Code

Under the Park City Land Management Code, the entire Project area is zoned as Recreation Open Space. The purpose of the Recreational Open Space Zones is to:

- Establish and preserve districts for land uses requiring substantial areas of open land covered with vegetation and substantially free from structures, streets and parking lots;
- Permit recreational uses and preserve recreational Open Space land;
- Encourage parks, golf courses, trails and other compatible public or private recreational uses;
- Preserve and enhance environmentally sensitive lands, such as wetlands, steep slopes, ridge lines, meadows, stream corridors, and forests; and
- Encourage sustainability, conservation, and renewable energy.

Park City General Plan

In Park City's General Plan, designated natural settings are one of the four core community values. Goals and objectives related to wildlife resources are summarized below.

Open Space Goal - Conserve a connected, healthy network of open space for continued access to and respect for the natural setting. Relevant Objective(s):

- Protect natural areas critical to biodiversity and healthy ecological function.

- Buffer entry corridors from development and protect mountain vistas to enhance the natural setting, quality of life, and visitor experience.
- Prevent fragmentation of open space to support ecosystem health, wildlife corridors, and recreation opportunities.
- Minimize further land disturbance and conversion of remaining undisturbed land areas to development in order to minimize the effects on neighborhoods.
- Collaborate with neighborhoods to create small parks or passive open space areas.

Climate Adaptation Goal - Park City will implement climate adaptation strategies to enhance the City's resilience to the future impacts of climate change. Relevant Objective(s):

- Support ecosystem health, biodiversity, and natural buffers between development and sensitive lands.

Park City Sensitive Land Overlap Zone Regulations

While no development is being proposed in the Project area, the Park City Sensitive Land Overlap Zone regulations provide a list of resources important to Park City. Relevant to this wildlife assessment are vegetative cover (i.e., deciduous, conifer, oak and shrub, sage, grassland, and agricultural crops) wetlands; stream corridors, canals, and irrigation ditches; and wildlife habitat areas (ecological characterization, critical wildlife movement corridors, special habitat features, habitat for species with special status).

In terms of development, this code describes setbacks of 50 feet from wetlands and stream corridors. Setbacks of 20 feet must be maintained from other federally jurisdictional water features (e.g., irrigation canals, if requirements are met).

Summit County – 2015 Snyderville Basin General Plan

In the 2015 Snyderville Basin General Plan, wildlife was identified as highly valued by the public. Goals and objectives related to wildlife resources are summarized below.

The County recognizes the importance of the natural resources within the Basin and the surrounding areas and desires to preserve and maintain access to these scenic areas. To the extent possible, the County will preserve open space in the Basin that contains Critical Lands and spaces that are recreational, cultural, and scenic. Preservation of these lands and connections between them is necessary in order to support a healthy environment and retain the sense of place, quality of life, and the economic success of the resort economy.

Ensure the preservation of open space.

- Work with landowners and nonprofit agencies to protect open lands for the purposes of preserving scenic viewsheds, preventing the fragmentation of open lands, preserving important wildlife habitat, protecting watersheds, providing significant buffers between developed areas, and protecting Critical Lands.
- Review the potential of creating open-space zoning districts for conservation, wildlife, and/or public recreation purposes.
- Review new development for potential environmental impacts and to demonstrate sensitivity to the natural environment including preservation of viewsheds, trees and native vegetation, water quality, and wildlife corridors.

Minimize the impacts of local and/or regional utility systems and related facilities on the environment and community character.

- Review all proposed transmission lines, pipelines, communication towers, landfills, and truck hauling routes to minimize the potential impacts on local neighborhoods, the environment, open space, and wildlife corridors.

Winter recreational opportunities, such as Nordic skiing, snow shoeing, dog sledding, and the like should be encouraged. Care should be taken to ensure that these activities are located sensitively, avoiding sensitive wildlife habitat.

Jurisdictional Wetlands are declared to be critical since development in wetland areas has a significant adverse effect on water quality, the rate and volume of storm water discharge, and wildlife.

2.2 State

Utah's Wildlife Action Plan

Utah's Wildlife Action Plan identifies both habitats and species that are of high conservation value. Habitats and species identified as Species of Conservation Need in Utah's Wildlife Action Plan do not receive any legal protections, but they are a priority for conservation (Utah Division of Wildlife Resources 2015, 2021a). Habitats of conservation value are Aquatic-Forested, Aquatic-Scrub/Shrub, Riverine, Open Water, Emergent (wetland), Aspen-Conifer, Desert Grassland, Gambel Oak, Lowland Sagebrush, Mojave Desert Shrub, Mountain Sagebrush, and Mountain Shrub. Habitat types that occur in the Project area are outlined in the Vegetation Communities section, below and in Table 1. Utah Species of Conservation Need that have the potential to occur in the Project area are included in Table 2.

Clean Water Act Section 401 and 404

The Utah Division of Water Quality's 401 Water Quality Certification program is to ensure that Section 404 of the Clean Water Act (permits issued by the U.S. Army Corps of Engineers) comply with Utah discharge and water quality requirements. This is related to any activity that may result in a discharge into Waters of the United States, which include jurisdictional wetlands. The purpose is to maintain the chemical, physical, and biological integrity of waters.

Stream Alteration

Section 73-3-29 of the Utah Code requires that any alteration of the bed or banks of a natural stream to obtain written authorization from the Utah State Engineer through the Stream Alteration Program. This program protects the natural resource value of the state's streams, water rights, and recreational opportunities. The U.S. Army Corps of Engineers allows both state and federal authorization under Section 404 of the Clean Water Act though a Programmatic General Permit 10.

Utah Noxious Weed Act

The Utah Noxious Weed Act allows the creation of the Summit County Weed Department and the authority to designate and control noxious weeds. Property owners are responsible for controlling noxious weeds. Many noxious weeds are agricultural pests, but also have negative impact on native plants and wildlife.

2.3 Federal

Endangered Species Act

The federal Endangered Species Act protects plant and animal species from extinction, recover populations, and protect the ecosystems on which the species depend. Species listed as Threatened are likely to become endangered in the foreseeable future and species listed as Endangered are in danger of extinction. When species are listed as Threatened or Endangered, the U.S. Fish and Wildlife Service is required to designate Critical Habitat, areas of habitat that are essential to the species' survival. However, it is important to note that for some species, Critical Habitat has not yet been designed.

Under the Endangered Species Act, Candidate species have sufficient information to propose them as Endangered or Threatened, but their listing proposals are precluded by other higher priority listings. These species do not receive any protections under the Endangered Species Act. However, these species may warrant protections in the future. As of March 2022, the U.S. Fish and Wildlife Service's Environmental Conservation Online System lists four Threatened, Endangered, and Candidate species in Summit County: Ute ladies'-tresses (*Spiranthes diluvialis*), monarch butterfly

(*Danaus plexippus*), yellow-billed cuckoo (*Coccyzus americanus*), and Canada lynx (*Lynx canadensis*). The western bumble bee (*Bombus occidentalis occidentalis*), little brown bat (*Myotis lucifugus*), and gray wolf (*Canis lupus*) are under review. Of these species, the monarch butterfly, western bumble bee, and little brown bat are the only species that may occur in the Project area. It is of importance to note that the greater sage-grouse (*Centrocercus urophasianus*) was determined to be "not warranted" for listing. Species profiles for each of the aforementioned species, regardless of the potential to occur in the Project area, are included below to support future land management actions.

Monarch Butterfly

The monarch butterfly relies on habitats that contain their host plant, milkweed (*Asclepias* spp.), and other nectar plants on which they forage. The Project area contains plants that are of value to the monarch butterfly and this species has the potential to occur in the Project area.

Western Bumble Bee

The western bumble bee was once common in the region but has declined across its western range by over 90 percent (Graves et al. 2020). Reasons for decline include loss of habitat, pathogens and disease, pesticide use, and introduced species. This species may occur in the Project area where it is known to feed on a variety of flowering plants.

Ute Ladies'-Tresses

Habitat for the Ute ladies'-tresses is characterized as wetland meadows associated with perennial streams and floodplains, spring-fed streams, or lakeshores (Fertig et al. 2005). The Project area does not contain any suitable habitat, and Ute ladies'-tresses does not occur.

Yellow-Billed Cuckoo

Yellow-billed cuckoo use large cottonwoods and willow stands as foraging or breeding habitat. The Project area does not contain these habitats. The yellow-billed cuckoo could occur in the region during migration, but this would be considered extremely rare.

Greater Sage-Grouse

Greater sage-grouse were classified as "not warranted" for listing under the Endangered Species Act in 2015. This species uses sagebrush dominated habitat which was historically dominant in the region of Park City. However, development in the region has created poor habitat conditions for greater sage-grouse. Due to the small patch sizes of sagebrush in the Project area, coupled with development in the vicinity, the Project area is not suitable for greater sage-grouse, and they are not expected to occur (State of Utah 2019). The Project area is outside of Utah's Sage-grouse Management Areas and the nearest suitable habitat is located approximately 3 miles to the north and east.

Little Brown Bat

Little brown bat may be found across Utah in a variety of habitats, including those found in the Project area (Utah Division of Wildlife Resources 2015, 2021a). They forage in many forest types and are known to roost in buildings. This species is under review for listing under the Endangered Species Act because the disease white-nose syndrome has decimated populations of this species, particularly in eastern and central portions of North America. As of 2022, white-nose syndrome has not reached Utah and little brown bat populations appear to be stable in Utah. Little brown bat may occur in the Project area.

Canada Lynx

Canada lynx use large, expansive forests with high densities of their preferred prey, snowshoe hare (*Lepus americanus*) (Aubry 1999, Ulev 2007). The U.S. Fish and Wildlife Service has designated Critical Habitat for Canada lynx, however it does not overlap with Utah. Within the Project area, there is no suitable habitat for Canada.

Gray Wolf

As of March 2022, any gray wolf that is located outside of northern Utah (defined as the portion of the state bounded by Interstate 80 and 84 and the boundaries of Wyoming and Idaho) is considered Endangered. However, there are no known wolf packs in Utah and reports of individual wolves remain rare in Utah. The habitat in the Project area and region would not be considered suitable habitat for gray wolf and their occurrence would be unlikely.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act protects all non-game, native bird species in the United States by making it illegal to take, possess, import, export, transport, sell, purchase, barter or offer for sale, purchase or barter, any bird, nest, or egg, without a permit. At this time, the current administration considers incidental take of birds during an otherwise legal activities such as forest or recreation management to be illegal. Every species of bird (excluding game species such as dusky grouse [*Dendragapus obscurus*]) that occurs in the Project area is protected by the Migratory Bird Protection Act. Game species are protected by the Utah Division of Wildlife Resources.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act prohibits take of bald eagles (*Haliaeetus leucocephalus*) or golden eagles (*Aquila chrysaetos*), including their parts, nests, or eggs. Some levels of disturbance are considered "take" under this Act.

Fish and Wildlife Conservation Act

The Fish and Wildlife Conservation Act requires the U.S. Fish and Wildlife Service to identify bird species that, without action, are likely to become listed under the Endangered Species Act. This list, the Birds of Conservation Concern, is intended to promote conservation efforts in collaboration with other agencies and partners. The Project area overlaps with Bird Conservation Region 16, Southern Rockies/Colorado Plateau. Species of Birds of Conservation Concern that have the potential to occur in the Project area are included in Table 2.

3 Existing Uses

The Project area is situated on the eastern facing slopes of Treasure Hill in Park City, Utah. The Project area has been managed as ski runs for winter skiing since the 1960s. In recent decades, an array of mountain biking and hiking trails have been managed for use outside of ski season. The Project area and surrounding lands are dispersed with open space, recreational trails, residences, ski resort infrastructure, and roads (Figure 1).

The eastern boundary of the Project area is adjacent to the downtown Park City and its historic Main Street. The entire Project area is within approximately 0.25 mile of this urban corridor. The juxtaposition of human development with open space is often referred to the wildland urban interface. This distinction is important in terms of wildfire risk, but also has major implications for wildlife. Wildlife living near to urban areas are significantly influenced by human activities (Fehrig 2003, others). Noise disturbance, increased predation from mesopredators (e.g., raccoons [*Procyon lotor*]), habitat degradation by invasive species, and increased exposure to disease and toxins impact the suitability of wildlife habitat within the Project area. The influence of recreation on the Project area is also significant. The presence of humans, bicycles, and dogs on trails disturbs wildlife and can cause wildlife to avoid otherwise suitable habitat (Dertienet al. 2021, Miller et al. 2020). For example, rodents avoided habitat within 160 feet to 330 feet of trails and people. Songbirds avoided habitat within 330 feet or less from trails and people. To illustrate the probable influence of trails, dirt and paved roads, and other infrastructure (e.g., ski lifts) on wildlife, Figure 2 shows illustrative buffers of 30 feet and 100 feet around these disturbances.

Despite the level of human disturbance within and around the Project area, Treasure Hill still holds great value to many wildlife species and the humans that enjoy them. The Project area will also likely become increasingly important for wildlife as adjacent lands continue to be developed and fragmented by residences and recreational use.

4 Habitat & Wildlife Associations

4.1 Aquatic Habitats

Within the Project area, there are no aquatic or wetland habitats. Field investigations, the National Wetlands Inventory, and National Hydrography Dataset do not show any water resources (i.e., streams, lakes, springs, wetlands) within the Project area. As such, the opportunity is limited for some species of plants and wildlife to occur in the Project area.

While no aquatic habitats exist on site, it is important to note that the Project area remains part of the East Canyon Creek watershed. This watershed contains valuable aquatic habitats for species like Bonneville cutthroat trout (*Oncorhynchus clarkii utah*), which is listed as a Species of Conservation Need. Healthy watersheds rely on important ecosystem services like sediment capture that are found in upland areas. The health of the land in the Project area remains valuable to the function of the region's water resources and the wildlife that rely on them.

4.2 Upland Habitats

Vegetation communities were mapped in the field, and these vegetation communities correspond to the major habitat types found in the Project area (Figure 3, Table 1). For comparison between wildlife habitat planning documents like the Utah Wildlife Action Plan, Table 1 also provides corresponding ecological land cover classes (Lowry et al. 2005). This section provides descriptions of the major vegetation communities and outlines some wildlife species that would be uniquely expected to occur in those habitat types.

The Project area provides a variety of upland habitats for species like mule deer. © Janice Gardner

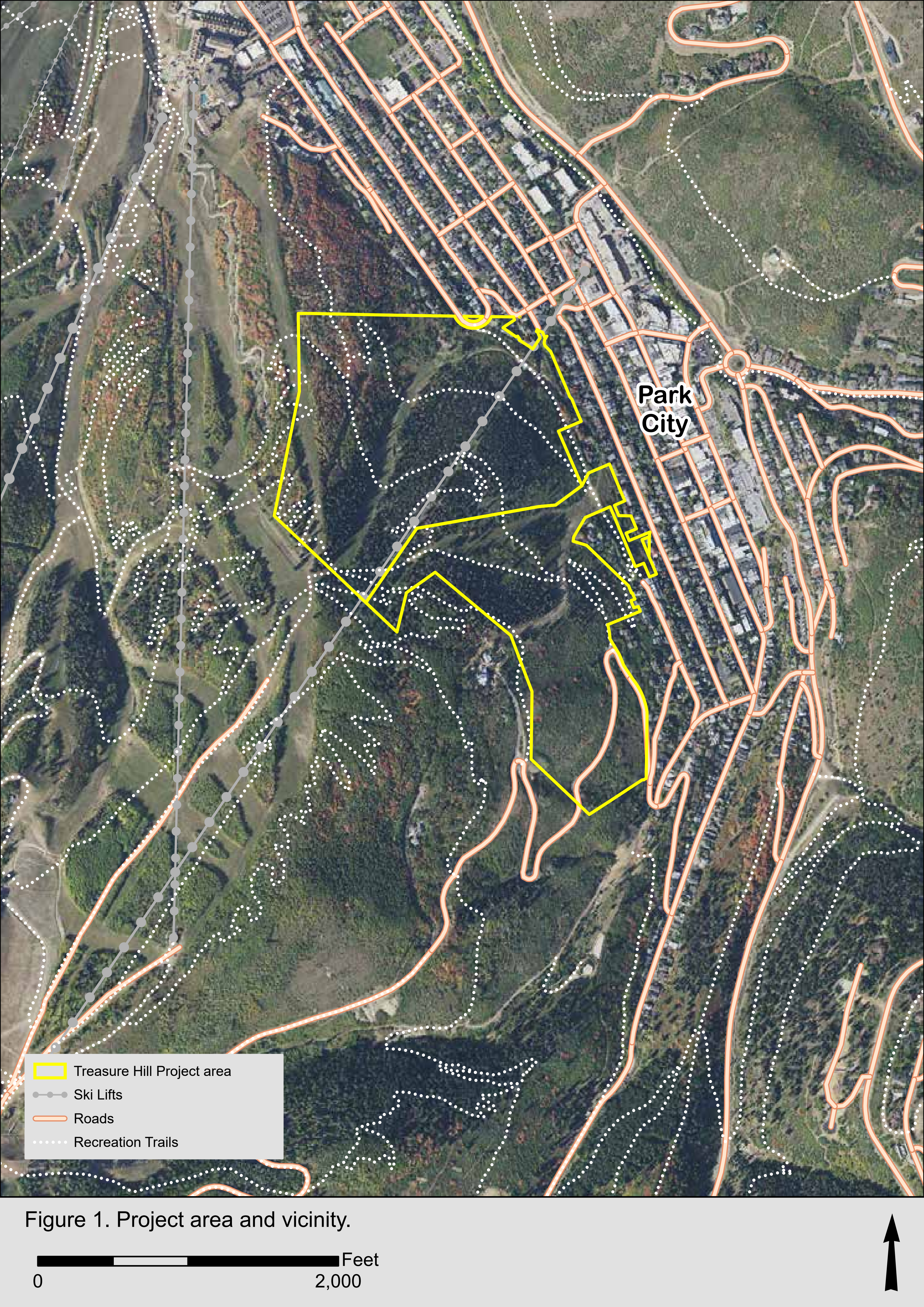

Figure 1. Project area and vicinity.

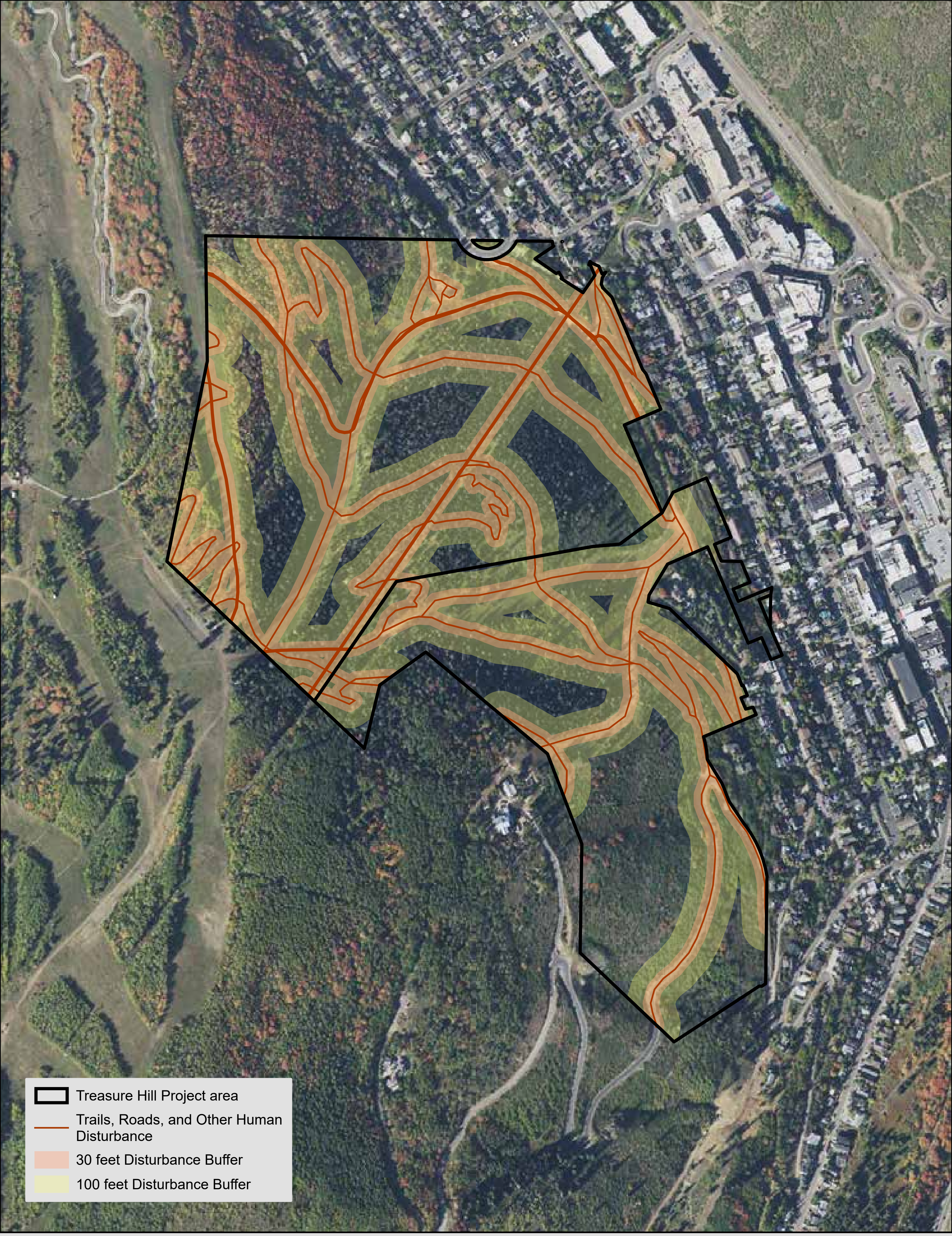

Figure 2. Disturbance features in Project area

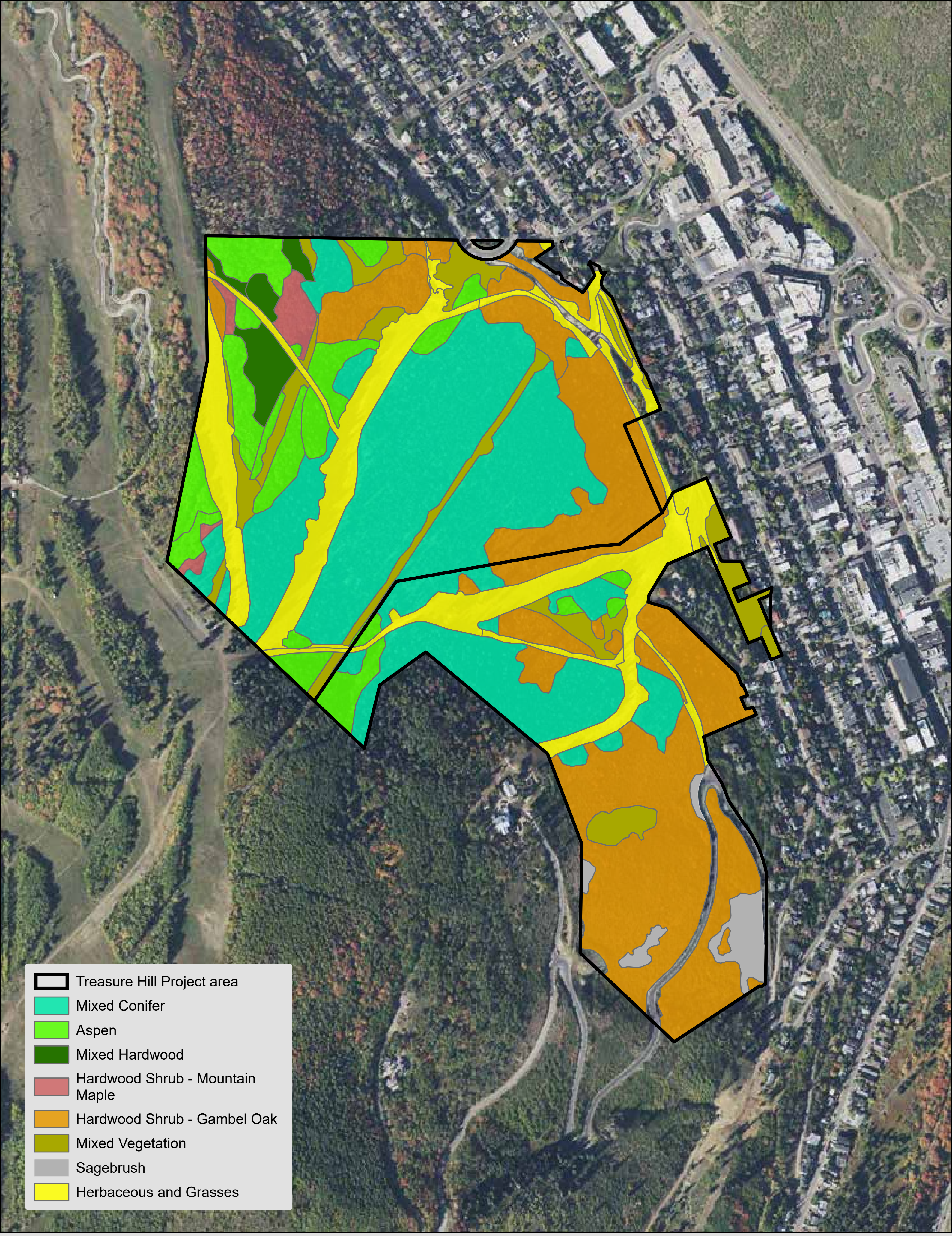

Figure 3. Vegetation Types in Project area.

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Table 1. Vegetation and habitat communities that occur in the Treasure Hill Project area.

Vegetation Community (Figure 3)	General Description	Land Cover Descriptions (Lowry et al. 2005)	Acres	Notes
Aspen	Dominated by aspen trees with varied understory	Rocky Mountain Aspen Forest and Woodland	9.83	High Value in Utah
Hardwood Shrub – Rocky Mountain Maple	Dominated by mountain maple	Rocky Mountain Bigtooth Maple Ravine Woodland	1.30	High value in Utah ("Mountain Shrub")
Hardwood Shrub – Gambel Oak	Dominated by Gambel oak	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	30.51	High Value in Utah
Herbaceous and Grasses	Dominated by grasses and other herbaceous (non woody species	Southern Rocky Mountain Montane-Subalpine Grassland	15.80	
Mixed Conifer	Mixture of conifer species, dominated by white fir	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	33.10	
Mixed Hardwood	Mixture of aspen and Rocky Mountain maple	Mix of other communities	2.09	
Mixed Vegetation	Transition zones between other communities, includes hardwoods and conifer species	Mix of other communities	7.39	
Sagebrush	Dominated by sagebrush species	Inter-Mountain Basins Montane Sagebrush Steppe	1.30	High Value in Utah
		Total	**101.33**	

Aspen

Aspen (*Populus tremuloides*) is of high aesthetic value to humans and is important wildlife habitat. Aspen are referred to as a "keystone species," meaning this species is depended upon by several other plants and animals (Rogers 2017, Utah Forest Restoration Working Group 2010). In the West, aspen forests can contain some of the highest biodiversity of plants and animals.

Aspen leaves and twigs provide important forage and cover for large-bodied wildlife like mule deer and moose (DeByle and Winokur 1985). Northern pocket gopher (*Thomomys talpoides*), a small rodent, is frequently associated with aspen forests and is an important food for predator species like coyotes (*Canis latrans*). Aspen habitat in the Project area is likely of highest value to migratory songbirds during the nesting season. Birds like warbling vireo (*Vireo gilveus*), Cassin's finch (*Haemorhous cassinii*), broad-tailed hummingbird (*Selasphorus platycercus*) will nest in the tree canopy. Dying aspens provide breeding sites for cavity-nesting birds like northern flicker (*Colaptes auratus*), hairy woodpecker (*Picoides villosus*), and mountain chickadees (*Poecile gambeli*) (Witt 2010).

Aspen forests have been decreasing across Utah, and this vegetation community has been identified priority for conservation (Utah Division of Wildlife Resources 2015). There are many reasons for the decline of aspens. In in general, a loss of aspen in Utah is attributed to alteration of the natural fire regime and heavy browsing by domestic livestock, deer, and elk. This creates conditions that allow conifer trees to outcompete aspens. Conifers can become dominate in the stands, causing aspen to decline (Utah Division of Wildlife Resources 2015, Rogers et al. 2021).

Cavities created by woodpeckers in aspens provide nesting sites for other species like house wrens (*Troglodytes aedon*). © Janice Gardner

Hardwood Shrub – Rocky Mountain Maple

Rocky Mountain maple (*Acer glabrum*) is a common species in the region and found in many soil types. This species often thrives after disturbance like fire (U.S. Forest Service 2021a). The leaves and twigs of Rocky Mountain maple are of high value to mule deer, moose, and elk throughout the year (Nesom 2006). The seeds are also consumed by ruffed grouse (*Bonasa umbellus*), dusky grouse, and evening grosbeak (*Coccothraustes vespertinus*).

Mountain shrub vegetation communities are identified as a key habitat because they are suspectable to degradation from invasive plant species (Utah Division of Wildlife Resources 2015).

Hardwood Shrub – Gambel Oak

Gambel oak (*Quercus gambelii*) is a widespread shrub in the region. This habitat type is valued by wildlife throughout the year, especially for crops of acorns in the fall (Kaufman et al. 2016). This food is important to many species including mule deer, rock squirrels (*Otospermophilus variegatus*), and ruffed grouse. Gambel oak habitats are often used by large mammals during the winter. However, disturbance from winter recreation may impact suitability within the Project area. A number of bird species will nest in Gambel oak, including mourning dove (*Zenaida macroura*) and lazuli bunting (*Passerina amoena*) (Leidolf et al. 2000).

Gambel oak is adapted to fire and readily re-sprouts after fires (Kaufman et al. 2016). Gambel oak was identified as a key habitat by the Utah's Wildlife Action Plan because it is threatened by development and invasion by the invasive plant cheatgrass (*Bromus tectorum*) (Utah Division of Wildlife 2015). In the Project area, future pressure from development is mitigated. Due to the higher elevation of the Project area, cheatgrass is not as major of a concern, compared to other regions of Utah.

Herbaceous and Grasses

In the Project area, the herbaceous and grasses vegetation community largely corresponds with ski trails. The herbaceous and grassland vegetation community are important for leafy, non-woody plants like paintbrush (*Castilleja* sp.), balsamroot (*Balsamorhiza sagittata*), and Lewis flax (*Linum lewisii*). The vegetation in these open habitats provide forage for species like Uinta ground squirrel (*Urocitellus armatus*) and Brewer's sparrow (*Spizella breweri*). Bats such as little brown myotis (*Myotis lucifugus*) and silver-haired bat (*Lasionycteris noctivagans*) forage for insects over and along the edges of open habitats (Oliver 2000). This habitat will provide some of the greatest abundance of flowering plants. The nectar resources these plants provide are important for pollinators like bumblebees (*Bombus* sp.), broad-tailed hummingbird, and Monarch butterfly.

In the Project area and region, herbaceous and grass habitats are most susceptible to invasion by invasive species like Canada thistle (*Cirsium arvense*). These sites are also at higher risk from being disturbed by recreation (i.e., social trails).

Mixed Conifer

In the Project area, the mixed conifer vegetation type is largely dominated by white fir (*Abies concolor*). White fir is considered a seral species, meaning there are different communities formed as the ecosystem develops, also referred to as forest succession (U.S. Forest Service 2021b). In the Project area, conifer trees in this habitat type are mature or dead. Cover and conifer seeds are important for northern flying squirrel (*Glaucomys sabrinus*), western tanager (*Piranga ludoviciana*), and least chipmunk (*Neotamias minimus*).

Sagebrush

The sagebrush vegetation community is of high value to wildlife. Sagebrush shrubs provide important food for big game like mule deer, but also space for other herbaceous plants that are valuable forage. The small patches of sagebrush in the Project area are not suitable to support sagebrush-obligate species like greater sage grouse (*Centrocercus urophasianus*) and sagebrush sparrow (*Artemisiospiza nevadensis*). Wildlife that would be expected to occur in sagebrush habitat in the Project area is similar to the Herbaceous and Grasses habitat and include gopher snake (*Pituophis calenifer*) and red-tailed hawk (*Buteo jamaicensis*).

Sagebrush vegetation communities are a key habitat in the Utah's Wildlife Action Plan because they have experienced loss due to encroachment of tree species and invasion of non-native grasses, like cheatgrass.

Noxious Weeds and Other Invasive Species

Invasive species is a term to describe species that are undesirable and cause harm to the native environment. These species are often transplants from other regions to the local area. In Utah, many of the most serious invasive species are aquatic (e.g., Quagga mussels [*Dreissena bugensis*]) and do not occur in the Project area. Several upland invasive species include European Starling (*Sturnus vulgaris*). European starlings thrive near urban areas like Park City and can out compete native birds for nest sites (Linz et al. 2007).

The most common invasive species in the Project area are plants. A number of noxious weed species have been reported in the Project area, including yellow toadflax (*Linaria vulgaris*), spotted knapweed (*Centaurea stoebe*), musk thistle (*Carduus nutans*), Canada thistle (*Cirsium arvense*), myrtle spurge (*Euphorbia myrsinites*), houndstounge (*Cynoglossum officianale*), garlic mustard (*Alliaria petiolate*), and Dyers woad (*Isatis tinctoria*). Recreational activity and ground disturbance provide many opportunities for noxious weed species to be spread to or within the Project area. In the Project area, the herbaceous and grasses and sagebrush vegetation communities are most at risk of being degraded by invasive species.

5 Special-Status Species & Habitats

Due to lack of aquatic habitat in the Project area, there is no potential for fish to occur in the Project area. Some aquatic species that have upland life stages do have the potential to occur in the Project area and will be highlighted. For the purpose of this assessment, special status species are those listed by the Endangered Species Act, U.S. Fish and Wildlife Service's Birds of Conservation Concern, the Bald and Golden Eagle Protection Act, and Utah's Wildlife Action Plan, Table 2. The northern goshawk (*Accipter gentilis*) is designated as a Sensitive Species by the Wasatch Cache National Forest Plan. While the Project area is not on U.S. Forest Service administered lands, this species was identified as special status for this Project area and is included.

Broad-tailed hummingbirds are a Bird of Conservation Concern and the Project area provides suitable breeding and migratory habitat. © Janice Gardner

Table 2. Special-status plant and wildlife species that have the potential to occur in the Treasure Hill Project area.

Common Name	Scientific Name	Endangered Species Act	Bird of Conservation Concern	Bald and Golden Eagle Protection Act	Utah Species of Conservation Concern	Notes on Presence in the Project area
Mollusks						
Deseret Mountain snail	*Oreohelix peripherica*				X	Often highly endemic to certain areas and are often under studied. There is little available information about the presence of Utah's special status mollusk species (Utah Division of Wildlife Resources 2019). While not likely, there is some potential for these species to occur.
Mitered Vertigo	*Vertigo concinnula*				X	
Insects						
Monarch Butterfly	*Danaus plexippus plexippus*	C[1]			X	Relies on plants that provide foraging opportunities and milkweed plants (e.g., showy milkweed [*Asclepias speciose*]) that provide breeding habitat. The Project area is suitable for milkweed species and as such, Monarch butterfly could occur in the Project area.
Western Bumble Bee	*Bombus occidentalis occidentalis*	Under Review			X	Once common across the West and in montane habitats but is now largely absent (Graves et al. 2020). Flowering plants in the Project area are suitable habitats.
Amphibians & Reptiles						
Boreal Toad	*Anaxyrus boreas boreas*				X	While breeding sites are not know in immediately area, boreal toads may use upland sites in the Project area but would be rare (Utah Division of Wildlife Resources 2015).

Common Name	Scientific Name	Endangered Species Act	Bird of Conservation Concern	Bald and Golden Eagle Protection Act	Utah Species of Conservation Concern	Notes on Presence in the Project area
Birds						
Bald Eagle	*Haliaeetus leucocephalus*				X	Bald eagle may forage or travel over the Project area, the upland habitat provided in the Project area is not preferred habitat. Bald eagle would not be expected to nest in the Project area.
Band-tailed Pigeon	*Patagioenas fasciata*				X	Presence of band-tailed pigeon in the Project area is considered rare or uncommon. However, suitable habitat for this species can be found in the conifer or mixed conifer vegetation communities (Seamans 2018).
Black Rosy-Finch	*Leucosticte atrata*		X			Nests in high alpine habitats that do not occur within the Project area, however during the non-breeding season these birds are nomadic can use a variety of habitat types, including those that are found in the Project area (Johnson 2002).
Broad-tailed Hummingbird	*Selasphorus platycercus*		X			The Project area contains suitable nesting and foraging habitats for broad-tailed hummingbirds (Calder and Calder 1992). Nectar plants found in open habitats are of high value to this species.
Cassin's Finch	*Haemorhous cassinii*		X			The Project area contains suitable year-round habitat that Cassin's finches may use for nesting and foraging (Marks et al. 2016).

Common Name	Scientific Name	Endangered Species Act	Bird of Conservation Concern	Bald and Golden Eagle Protection Act	Utah Species of Conservation Concern	Notes on Presence in the Project area
Clark's Nutcracker	*Nucifraga columbiana*		X			Mixed conifer forest in Project area provides suitable foraging sites, preferred breeding sites are at higher elevations (McMurray 2008).
Evening Grosbeak	*Coccothraustes vespertinus*		X			One of the steepest population declines of all land birds in United States (Roseberg et al. 2016). Breeds in mixed-conifer and aspen forests. Likely prefer nesting at higher elevation sites but can be found in the Project area in the winter for foraging opportunities (eBird 2022).
Flammulated Owl	*Psiloscops flammeolus*		X		X	Known to breed in the region of the Project area, but at higher elevation sites with less human disturbance (eBird 2021). Aspen and conifer habitat may still provide foraging or migratory habitat.
Golden Eagle	*Aquila chrysaetos*				X	Golden eagle may forage for pray (e.g., rabbits) in the Project area, however, preferred nesting sites like cliffs do not occur in the Project area.
Lewis's Woodpecker	*Melanerpes lewis*		X		X	Occurrences are uncommon and patchy in region (eBird 2021). Breed in pine forests and riparian areas that are above 6,500 feet in elevation (Utah Division of Wildlife Resources 2015). Occasionally breeds in aspen patches, which occur in the Project area (Vande Voort 2011). May also occur in the Project area during the non-breeding season.

Common Name	Scientific Name	Endangered Species Act	Bird of Conservation Concern	Bald and Golden Eagle Protection Act	Utah Species of Conservation Concern	Notes on Presence in the Project area
Long-eared Owl	*Asio otus*		X			Uses a wide variety of habitat, including those found in the Project area. Species is uncommon across its range (eBird 2021).
Northern goshawk	*Accipter gentilis*					Nests and forages in conifer and aspen forests, including those in the Project area. Uncommon, but records occur in area (eBird 2021).
Northern Pygmy-owl	*Glaucidium gnoma*				X	Uses forested habitat and may occur in the Project area, especially during the winter. Likely prefers breeding at higher elevation sites (Utah Division of Wildlife Resources 2015, eBird 2021).
Olive-sided Flycatcher	*Contopus cooperi*		X		X	Experiencing significant population declines. Associated with mixed forests, forest edges, openings, and sites burned by wildfires (Kotliar 2007).
Peregrine Falcon	*Falco peregrinus*				X	Peregrine falcon may forage in open habitats in the Project area, but suitable cliff nesting sites are not available.
Short-eared Owl	*Asio flammeus*		X			Species prefers large, open habitats (Booms et al. 2014). The small size of available habitat is not preferred, and species is not likely to occur.
Virginia's Warbler	*Leiothlypis virginiae*		X			May occur in shrubland habitats in the Project area, however considered uncommon (eBird 2021). Project area may provide suitable foraging habitat during migration.

Common Name	Scientific Name	Endangered Species Act	Bird of Conservation Concern	Bald and Golden Eagle Protection Act	Utah Species of Conservation Concern	Notes on Presence in the Project area
Mammals						
Allen's Big-eared Bat	*Idionycteris phyllotis*				X	Bats are largely understudied, and little is known about their distribution in Utah or the Project area. The Project area likely provides suitable foraging habitat and tree roosting sites for many species of bats (Oliver 2000).
Fringed Myotis	*Myotis thysanodes*				X	
Little Brown Myotis (Bat)	*Myotis lucifugus*	Under Review			X	
Long-eared Myotis	*Myotis evotis*				X	
Long-legged Myotis	*Myotis volans*				X	
Spotted Bat	*Euderma maculatum*				X	
Townsend's Big-eared Bat	*Corynorhinus townsendii*				X	
Western Red Bat	*Lasiurus blossevillii*				X	
Yuma Myotis	*Myotis yumanensis*				X	

[1] C = Candidate Species

5.2 Game Species

Game species are wildlife species that may be hunted with permits from the Utah Division of Wildlife Resources. The Project area does not allow hunting within its boundaries without written permission. In addition to hunting opportunities, many game species are highly valued by the community and are some of the most charismatic species that can be found in the Project area. A summary of the game species that may occur in the Project area along with Utah Division of Wildlife Resource's habitat descriptions are provided in Table 3.

Table 3. Wildlife "game" species that may occur in the project area, along with habitat designations from the Utah Division of Wildlife Resources (2021b).

Common Name	Scientific Name	Habitat Type (if designated)
Moose	*Alces alces*	Entire Project area is mapped as crucial year-round moose habitat, specifically as calving habitat.
Elk	*Cervus canadensis*	None but within 1 mile of the Project area, there are crucial winter and crucial spring and fall habitat for elk.
Mule Deer	*Odocoileus hemionus*	Entire Project area is mapped as crucial summer habitat.
Dusky Grouse	*Dendragapus obscurus*	The Project area is year-long crucial habitat.
Ruffed Grouse	*Bonasa umbellus*	The Project area year-round substantial habitat.

5.3 Wildlife Migration Corridors

The Project area is bounded to the northeast by Park City's Main Street or "Old Town", a high-density urban corridor. As such, there are limited opportunities for wildlife to move beyond the Project area to the east. Wildlife can use the Project area to move in north-south directions, but roads and other human infrastructure likely limit the suitability of the Project area as a major wildlife migration or movement corridor for large terrestrial wildlife like moose, deer, and elk. The 2011 Park City General Plan (Figure 4) and the Snyderville Basin General Plan (Figure 5) did not identify the Project area as a priority or secondary wildlife crossing area.

While the Project area may be limited as a movement corridor for some species of wildlife, there are many species that use this site for travel between seasonal habitats. Wildlife species like montane vole (*Microtus montanus*) and porcupine (*Erethizon dorsatu*m) with smaller home ranges likely rely on the Project area to move between seasonal habitats. Small, but highly mobile wildlife like migratory birds and insects likely find the Project area suitable during seasonal migrations. For example, during fall migration, raptors follow mountain ranges like the Wasatch Mountains when traveling south (Hoffman et al. 2002). Areas like the Project area can provide suitable habitat for raptors to hunting rodent and bird prey and sustain their migrations. In Utah, Monarch butterflies travel between California to winter and Utah to breed (Tilley et al. 2019). Monarch butterflies need stopover sites where they can find nectar plants to sustain their travels.

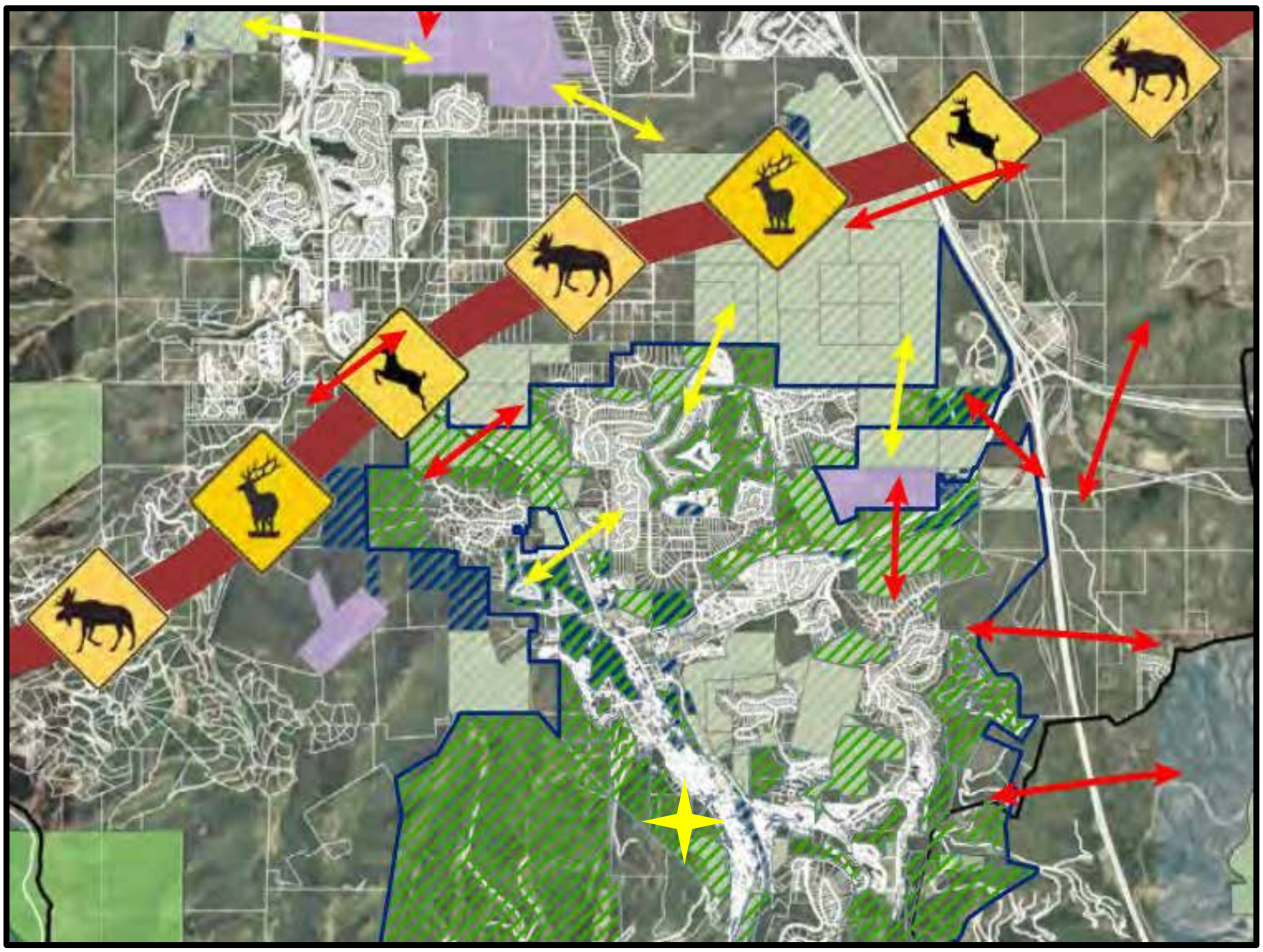

Figure 4. An excerpt of the Park City General Plan showing priority proposed wildlife crossings (red arrows) and secondary proposed wildlife crossings (yellow arrows). The Treasure Hill Project area is noted as a yellow star.

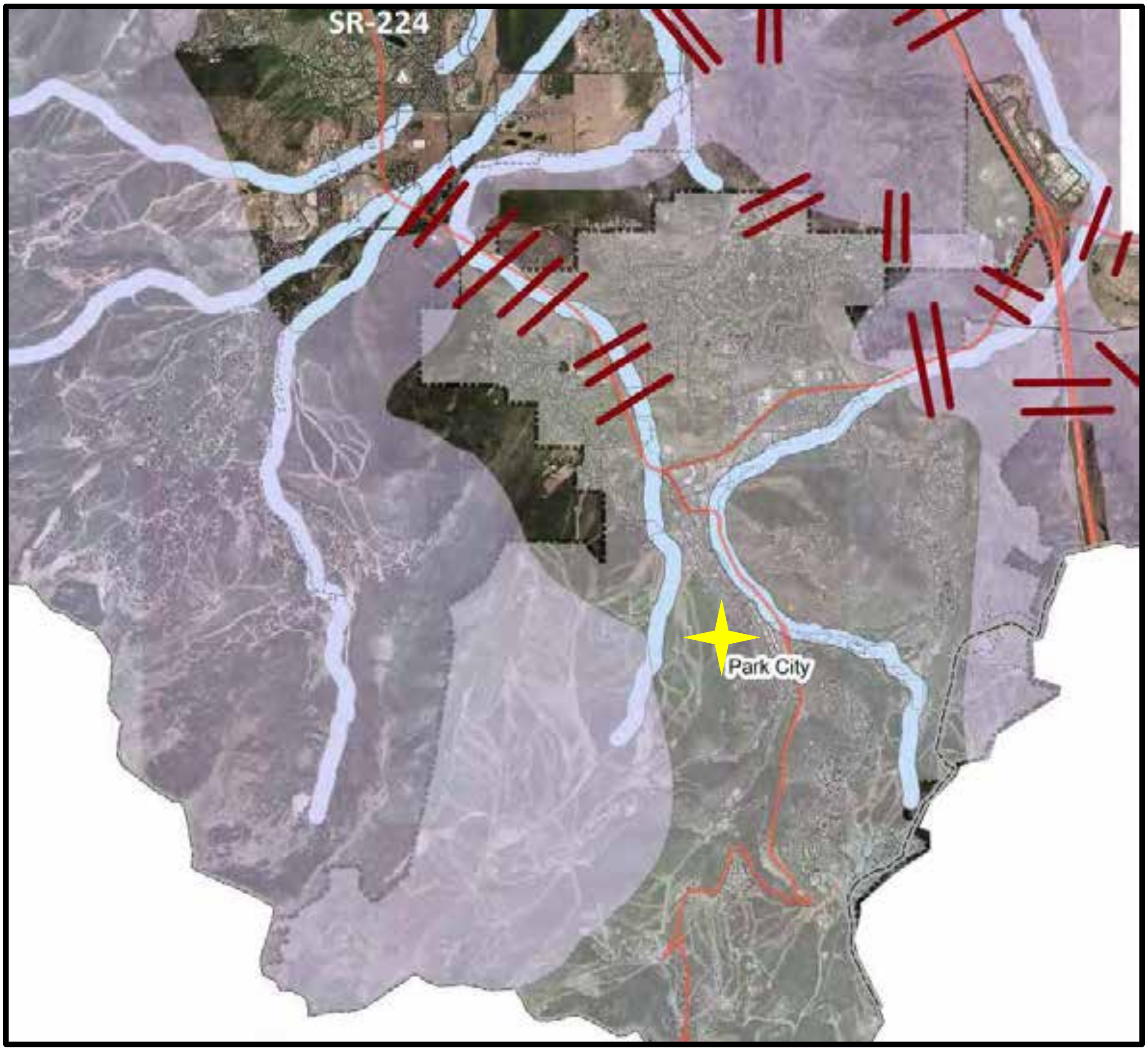

Figure 5. An excerpt of the Snyderville Basin General Plan showing riparian corridors (blue), wildlife habitat (purple), and the location of wildlife migration routes (red lines). The Treasure Hill Project area is noted as a yellow star.

6 Best Management & Opportunities

6.1 Recreation

The Project area is of high value for year-round recreation opportunities. For many of Treasure Hill's visitors, connecting with nature and viewing wildlife is central to their recreation experience. Preserving both the recreation and wildlife habitat is important. While by no means exhaustive, Miller et al. (2020), Leung et al. (2018) and Hennings (2017) provide best management practices for summer and winter recreation:

- Provide opportunities to learn about the Project area's wildlife resources through informational outreach and programming.
- The suppression and restoration of social trails (i.e., non-designated informal trails) can help maintain suitable habitat for wildlife.
- Suppress or limit additional recreation in the more important wildlife habitat. In the Project area, stands of aspen in the northern portion are of highest value to wildlife.
- Enforcement of trail rules and etiquette (e.g., dog leashing and dog clean up) can mitigate negative impacts on wildlife in the Project area. Recreation with dogs can create high levels of disturbance for wildlife.
- Recreation that is loud, of longer duration, and of fasters speeds causes greater disturbance to wildlife.
- To avoid disturbing wildlife during seasons when they are most sensitive (i.e., breeding in spring, early summer) special events (e.g., running or biking races) should be carefully considered.
- Control of trash can mitigate increased activity of predator species, like common raven (*Corvus corvax*) and rodents, that also prey on wildlife like nesting birds.
- Non-motorized recreation has less disturbance to wildlife than motorized recreation.
- If special status species are discovered, consider restricting recreational activity during sensitive seasons like nesting or breeding.
- Minimize artificial lighting within the Project area, as it can alter behavior and movement of wildlife.
- Limit recreation to day-time hours to increase wildlife use of the Project area.

6.2 Forestry Management

Forests in the region have adapted to regular intervals of disturbance, such as wildfire. In absence of these natural disturbances, vegetation communities have changed and sometimes to the detriment of wildlife. To sustain desired wildlife habitat, there are a variety of management actions that can be implemented. These actions can also support means to mitigate catastrophic wildfires that would be devastating to the Park City community. Due to the high recreation activity in the Project area, careful considerations must be made for safety (e.g., skiers and low snow conditions).

Patches of hardwoods (i.e., aspen) represent the highest value for wildlife in the Project area and region. Managing this forest type to ensure health and sustainability should be a priority in the Project area. Key structural aspects of forests can be retained, in order to support a range of wildlife species (Bunnell et al. 2002a, Bagne et al. 2008).

- The most sensitive season for wildlife that occur in the Project area is during the breeding season when young animals such as mule deer, bats, and birds are less mobile. For most species, breeding seasons occur May through July. In the case of birds protected by the Migratory Bird Protection Act, "take" of nests can be avoided by doing land-disturbing activities outside of these breeding seasons. For some raptors and owl species, they may begin nesting as early as January and February. The resource "Protecting Nesting Birds Best Management Practices for Vegetation and Construction Projects" provides helpful, detailed information (City of Portland 2017).
- Creating "feathered edges" of different age class trees adjacent to ski runs and other patches can promote wildlife habitat.
- Dead and dying standing trees or "snags" are important habitat for wildlife, including songbirds, owls, northern flying squirrels, and bats.
- Retain snags that are a range of size and age classes. Retaining two to three larger snags (greater than 11 inches diameter at breast height) and 10 to 20 smaller snags per hectare. Tress that are 11 inches diameter at breast height will accommodate most bird species.
- Where snags are retained, disperse randomly to create varied habitat and "don't do the same thing everywhere." A variety of live trees and snags will benefit a larger range of wildlife.
- Strive to retain snags of both hardwoods and conifer species.
- Retain declining live trees intended to become snags.
- If salvage logging is conducted after prescribed fire, retain some standing snags, where safety allows.
- Dead, downed wood and slash ("Coarse woody debris") on the forest floor provides important habitat for wildlife and supports soil

stabilization. Even small diameter (2.5 inches at breast height) coarse woody debris supports ecosystem function.

- Management of vegetation in the summer can create conditions that support winter wildlife. For example, mast or seed production in conifers like Douglas fir (*Pseudotsuga menziesii*) should be promoted to provide important food sources for wintering birds such as evening grosbeak and Cassin's finch (Setinberg 2002). Douglas fir begins to seed at 12 to 15 years of age. Seeds crops are produced nearly every year, but abundant crops are only expected every 2 to 11 years. Insect infestation can reduce the number of seeds produced each year.
- If disturbed soils are reseeded, consider addition of pollinator friendly species.

6.3 Invasive Species

Management and control of invasive plant species is important to ensure the Project area continues to provide suitable habitat for wildlife. Control of invasive species is also valuable to limit the threat of catastrophic wildfires. The Project area's location near Park City and trailheads means there is a higher risk for invasive species to be introduced into the Project area and into adjacent lands. Park City's Noxious Weed Management Plan (2015) can be referenced for best management practices, which includes mechanical and chemical removal of existing infestations. Soil disturbance from project actions, such as implementing forestry treatments, are opportunities for noxious weeds to spread. Plans and strategies should be in place before any activities occur in the Project area, in line with Park City's Noxious Weed Management Plan.

The Noxious Weed Plan (Park City 2015) outlines benefits and challenges in reaching outreach goals for noxious weed management. At minimum, the adjacent landowners should be made aware of their legal requirements to control noxious weeds in order to minimize impacts to the Project area.

Late spring and summer are sensitive seasons for breeding wildlife. © Janice Gardner

6.4 Monitoring

Monitoring the Project area will allow managers the ability to evaluate the outcomes of their efforts. However, robust monitoring programs are often difficult to implement because of staff capacity and funding. Managers may wish to participate in existing monitoring programs with established methods to maximize staff capacity and to put the Project area in context of other sites across the region. Citizen or community science programs are increasingly popular to collect information that land managers can use. There are several existing community science programs in the region that may be appropriate for monitoring wildlife resources in the Project area.

Vegetation

Forest treatments should be monitored to ensure outcomes are being achieved. Aspen stands can be effectively monitoring using the recommendations in Rogers 2017. The presence of noxious weed species should be priority for monitoring due to the elevated risk from recreation and any proposed land disturbing management activities. Noxious weeds can often best be controlled while their populations are small and isolated. Efforts to identify and monitor of noxious weeds in the Project area are on-going (Park City's Noxious Weed Management Plan 2015). Park City uses a modified version of the North American Invasive Species Management Association to inventory and monitor noxious weeds. Based on the results of these surveys, management techniques can be prescribed based on the location and type of species.

Insects and Pollinators

The Utah Pollinator Pursuit is a statewide data collection, monitoring, and database for the monarch butterfly and western bumble bee. Data collected include a GPS location, photo of the plant or live stage of the insect, and habitat information. In the Project area, this program can be used to document the presence of milkweed or monarch butterflies. It can also monitor the effectiveness of restoration efforts if they occur.

Birds

Christmas Bird Count is a long-standing community-led bird census that occurs each winter. While it is not specific to the Project area, the Park City Bird Count provides a census of birds in the Park City region. eBird (2021) is now one of the largest community-science projects in the world and compiles millions of bird observations from bird watchers. eBird is managed by the Cornell Lab of Ornithology and has revolutionized how bird populations can be studied. In the Project area, eBird's use can be promoted in order to understand the species of birds present throughout the year.

The Integrated Monitoring in Bird Conservation Regions program administered by the Bird Conservancy of the Rockies is one of North

America's largest and most rigorous avian monitoring programs. While participation requires trained, expert biologists, this program can provide land managers with population density and occupancy estimates for breeding birds and is comparable at different geographic extents.

General

iNaturalist is an online system that supports identification and recording of any living organism. The program's goal is to connect people with nature, and it also provides valuable information for scientists and managers about where species occur and in what habitats. iNaturalist can be utilized for a variety of census needs in the Project area, including for noxious weeds.

Programs like iNaturalist can be used by community scientists to inventory and monitor species like milkweed. © Janice Gardner

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Appendix B

Vegetation and Forest Health Assessment

Existing Forest Condition Summary

Description of site:

The Treasure Hill property consists of 104 acres of land adjacent to downtown Park City. Approximately 80% of the Treasure Hill property is covered by distinct types of forests, described in this document as “vegetation types.” The primary vegetation types include conifer, hardwood (a mixture of aspen and maple), hardwood oak and shrub, grass, and sagebrush. Table B-1 describes the area of each vegetation type on these properties. This tract consists of large, continuous openings in the canopy that are mainly a result of the removal of trees for ski runs, ski lifts, and access roads. The ski runs are typed as “grass” in maps of Treasure Hill.

The elevation of the property is from 7,100 feet to over 7,700 feet. Slopes range from 20 to 70 percent. The main aspects are east and northeast.

Table B-1. Vegetation types found on the Treasure Hill property, Park City, Utah.

Vegetation Type	Area (ac)
Conifer	33
Mixed Vegetation	7
Mixed Hardwood – Aspen/Maple	13
Gambel Oak	30
Sagebrush, Grass, or Shrub	18
other – Maple, road, misc.	3
Total	104

The headwaters of the East Canyon Watershed, host to the Treasure Hill parcel, begin in the mountains above Park City and drain 145 square miles. Agriculture, development, and recreation currently affect water quality in this area (Utah State University, 2012). There are no known springs or seeps within the parcel’s boundaries.

Forest Structure:
The forest structure is interpreted from data collected in field plots, by remote sensing software, and through forest inventory plots. Data collection includes information pertaining to:

- Species composition
- Tree diameters and heights
- Density
- Canopy Cover
- Horizontal and vertical structure
- Associate trees and shrub species
- Disturbances that affect forest growth and structure

These metrics provide the necessary context to assess overall health. The more thorough our understanding of existing conditions, the better our ability to estimate and weigh disturbances caused by insects, disease, fire, and land use designations. This same data is also useful for determining the various types of wildlife habitats present, evaluating departure from desired conditions, and to identify treatment options that meet landowner objectives.

Conifer:

The conifer vegetation type is dominated by the presence and growth of one tree species with a very small number of other species intermixed. 100% of the live and dead trees recorded in plot data are white fir (*Abies concolor*), though Douglas-fir (*Pseudotsuga menziesii subsp glauca*) and subalpine fir (*Abies lasiocarpa*) also grow within this vegetation type. The sample plots are representative of the larger area where woody biomass and the stems per acre are heavily dominated by white fir. Douglas-fir is a nominal portion of the species composition and grows in scattered individuals across the slope, whereas subalpine fir was mainly noted in a few, small groups of 2 to 4 individuals. A few hardwood individuals also grow among the conifers, but this mainly occurs within a small transition zone that contains a mixture of vegetation communities ("mixed vegetation" type, Table B-1).

Figures B-1 and B-2: Forest vegetation in the conifer type is dominated by white fir.

The conifer vegetation type consists of a single-storied (one canopy layer) stand structure. 86% of sampled trees make up the dominant/codominant tree overstory layer coupled with trees growing in open conditions. The remaining 14% of trees are growing where little to no sunlight reaches trees because of the shade from the overstory. Canopy cover is approximately 56% which considers an average between forest openings and clumps of trees. Large openings in the canopy are caused by human infrastructure (ski runs, roads) and are not included in the canopy cover calculations. Natural openings in this forest are best characterized as small gaps less than 0.05 acres in size (Figure B-3).

Figure B-3. Oblique photo of plot 1098 showing uniformity of horizontal stand structure and small gap sizes

Many trees established around the same time to create the existing stand structure. The youngest tree recorded is 53 years, but the majority of trees range between 68 to 84 years of age. Regeneration of coniferous species is minimal and patchy and no hardwood regeneration was recorded within this vegetation type.

The average diameter of all live trees is approximately 9.5 inches. Diameters of the overstory plots ranged from a minimum of 5 inches to the largest recorded tree at 19.3 inches. There may be some trees greater than 19.3 inches that did not fall within inventory plots across the vegetation type, but those would be uncommon across the entire area. There is a known patch of larger coniferous trees covering approximately 4 acres; 2.5 acres of which is wedged between two ski runs (King's Crown and Creole) and the remaining area of large trees grows in a thin strip along the eastern side of the ski run.

Figure B-4. A standing dead tree with little decomposition that still has many of its fine branches.

Currently, the average number of living trees per acre is 222. The estimated number of trees calculated from the plots ranges from a low of 140 to a high of 370 trees per acre.

Mortality in the mixed conifer vegetation type is high. Standing dead trees (snags) are plentiful throughout the mixed conifer zone with an average of 122 snags per acre. The number of snags ranges from 10 to 210 snags per acre. The average diameter of snags is 9.5 inches and various stages of decomposition were recorded, many of which are newly dead (Figure 4). Snags make up approximately 35% of all sampled stems per acre, of the live and dead trees. Figure 5 shows the average number of trees per acre by 2-inch diameter classes for both living and dead trees. Fir engraver is a major disturbance agent and has caused considerable damage in the white fir. The tops of trees are often killed, though trees can be killed if enough beetles attack the tree (Hagle et al. 2003). Root disease and other disturbance agents were not evident on any of the plots or field observations, but that does not mean they are not present. White fir, subalpine fir, and Douglas-fir are all susceptible to various root diseases, stem decays, defoliating insects, bark beetles, and wood boring beetles (Keyes et al. 2019).

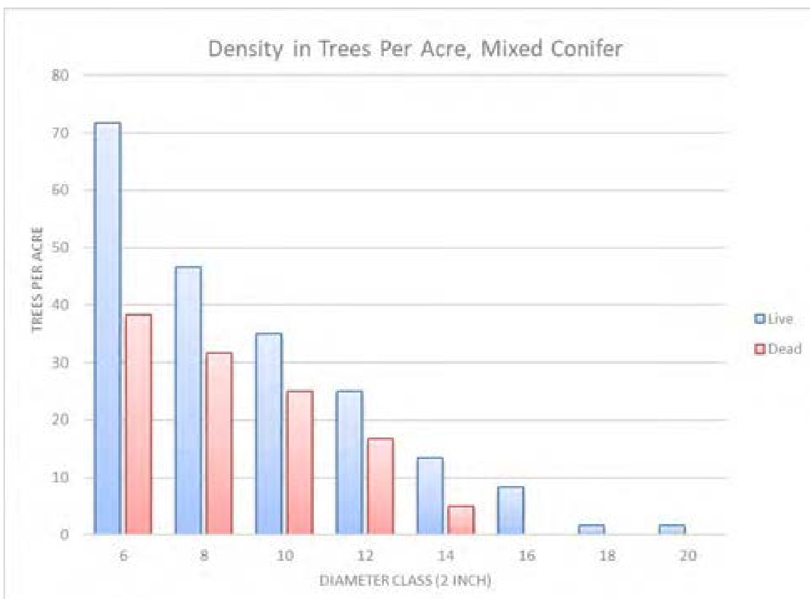

Figure B-5. Live and dead tree diameter distribution, shown in 2-inch diameter classes.

Trees smaller than 5 inches were recorded on a separate seedling plot. Four out of the five inventory plots did not have any established seedlings. This indicates that the forest is not regenerating a new cohort of seedlings that would become future overstory trees.

The main shrub species recorded on plots and walk-through exams include, but are not limited to: ninebark (*Physocarpus monogynus*), pachistima (*Paxistima myrsinites*), Oregon grape (*Berberis repens*), snowbush (*Ceanothus velutinus*), serviceberry (*Amelanchier utahensis*), snowberry (*Symphoricarpos oreophilus*), elderberry (*Sambucas caerulea*), and wild strawberry *(Fragaria vesca).*

Mixed Hardwood:

The mixed hardwood vegetation type is primarily a mixture of aspen and maple trees (Figure B-6). Aspen is the dominant overstory tree species with lesser amounts of maple in the midstory and understory canopy layers. Informal observations (outside of inventory plots) recorded few, scattered individuals of subalpine fir growing in the midstory outside of the formal inventory plots. Aspen accounts for approximately 56% to 94% of the live trees per acre whereas maple accounted for about 6% to 44% of the trees per acre. Species composition includes white fir, which accounted for 13% of the trees per acre. When species composition is computed using basal area, aspen accounted for greater than 75% of the woody biomass volume within plots and far outweighs the number of other species.

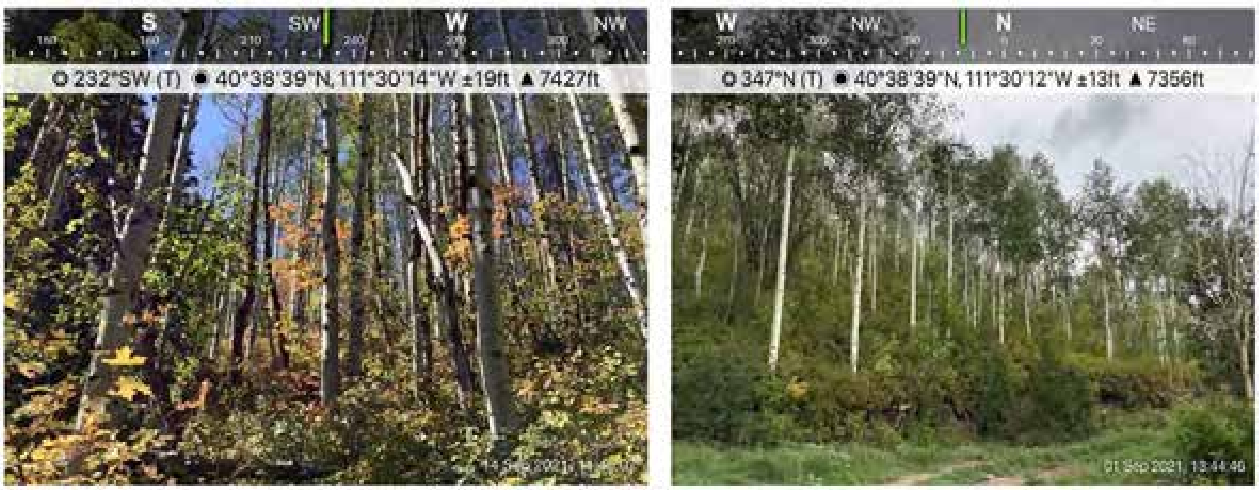

Figure B-6. Current condition of the mixed hardwood type, showing the dominance of aspen in species composition.

The hardwood vegetation type consists of areas with single-storied canopy structure and other areas with two distinct canopy layers. However, 80% of trees make up the overstory layer. The remaining 20% consists of stems in the intermediate (trees receive very little sunlight from above) and suppressed (tree receives no direct light on its leaves) crown positions in the different canopy layers. Aspen grow in groups of genetically similar trees, called clones. Single-storied stands of aspen often result when stems sprout following a severe disturbance, whether it is a result of fire or cutting (McAvoy et al. 2012). The boundaries of clones are not mapped on the Treasure Hill property. The aspen trees are estimated to be between 50 and 75 years of age, on average.

Average canopy cover in the mixed hardwood vegetation is approximately 60%. This average considers natural openings with tree cover while excluding openings created by human infrastructure. Natural openings in this vegetation type are very small gaps, estimated at less than 0.02 acres on average.

The average diameter of all live trees within the hardwood plots is approximately 8.1 inches. Diameters of trees ranged from a minimum of 5 inches to the largest recorded tree at 14.7 inches (Figure B-7). There may be some trees greater than 14.7 inches that did not fall within inventory plots and if so, they are uncommon. Trees smaller than 5 inches were recorded on a separate seedling plot. Two of the four inventory plots did not have any established seedlings. This means that hardwood trees are regenerating, but it is occurring in dense patches rather than uniformly spread throughout the property.

Currently, the average number of living trees per acre is 173. The estimated number of trees calculated from the plots ranges from a low of 110 to a high of 230 trees per acre. Snags are also plentiful throughout the mixed hardwood type with an average of 131 snags per acre. The number of snags ranges from 30 to 280 per acre. Figure B-7 (below) shows the size class distribution of live and dead trees in the mixed hardwood vegetation type.

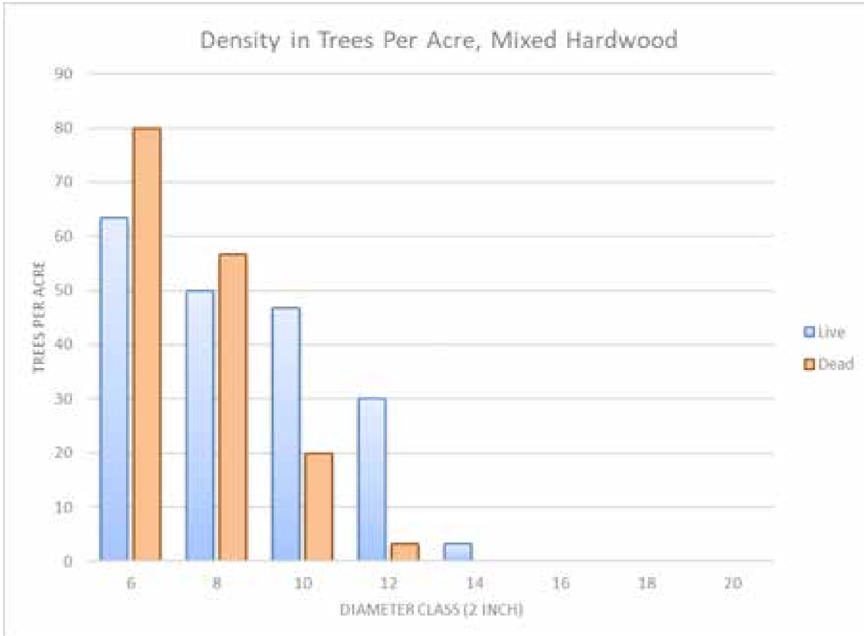

Figure B-7. Diameter distribution of the mixed hardwood vegetation type, classified into 2-inch diameter classes.

Elderberry, pachistima, Oregon grape, wild rose (*Rosa woodsii*), box elder (Acer negundo), Douglas hawthorn (*Crataegus douglasii*), and ash (*Sorbus scopulina*) are present within this vegetation type.

Gambel Oak:

The Gambel oak vegetation type covers approximately 30 acres (Table B-1) of the Treasure Hill property. Oak is by far the dominant species, but some conifers grow in and around this vegetation type (Figure B-8). It is estimated that Gambel oak makes up nearly 100% of the species composition with a few coniferous and other hardwood species growing mostly on the edges. Most of the oak is less than 6 feet tall in height, on average.

Shrubs such as bitterbrush (Purshia tridentata) and pachistima grow beneath the Gambel oak overstory.

Figure B-8. A uniform cover of Gambel oak growing in an easterly slope with few conifers in the background.

Figure B-9. A small patch of pure, small diameter maple trees

Pure Maple

A 1-acre, pure maple stand occurs at the northwest corner of the property, surrounded by aspen and a small patch of conifers. It is a single-storied stand structure and canopy cover is estimated to be greater than 80%. Nearly 2,000 stems per acre averaging 3.5 inches grow in this small, nominal vegetation type (Figure B-9). The understory is largely depauperate, meaning that the shrub, forb, and grass cover is nonexistent or minimal in this area.

Sagebrush, grass, and shrub mix:

This vegetation type covers approximately 18 acres of the Treasure Hill property (Table B-1). The sagebrush type occurs mainly at the southern edge of the property while the grassy slopes are mainly limited to the ski runs.

Figure B-10. Sagebrush and grass cover the slopes of Treasure Hill towards the south end of the property.

Mixed vegetation:

The vegetation types on this property have distinct edges between transitioning to other vegetation types, as a whole. There are areas where aspen, conifers, shrubs, and grasses grow intermixed with one another (Figure 11). In other places, a mixture of Gambel oak and conifers (Figure 12) create a small transition zone between vegetation types.

Figure B-11. Conifers growing beneath an overstory of aspen.

Figure B-12. Transition zone from Gambel oak to conifer.

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Treasure Hill Forest Health Conditions Report

Background

The forests around Park City have always had insect and disease activity throughout time, but in recent years, these forests have suffered recent and significant forest health issues. Insects and disease are not the cause of forest health issues but are influenced by poor forest health. Several factors have contributed to this decline in forest health on Treasure Hill and surrounding areas, including historic logging, grazing patterns, and fire exclusion. Climate change and prolonged drought conditions can also detrimentally affect forest health causing significant changes in vegetative conditions, particularly in combination with these other human-caused practices (Keyes et al., 2019).

Forest conditions throughout much of Utah are composed of dense stands that are relatively uniform in age. These thick, overgrown forests include expansive areas of single tree species, changes in sizes and types of species, stressed large trees, and other characteristics which make these forests very susceptible to insect outbreaks. As species or age class composition changes due to large-scale insect outbreaks, large amounts of woody debris accumulate. Because of these alterations, many lower elevation forested landscapes are now susceptible to more severe wildfire. In many ways, human intervention has led to changes in forest structure and composition that, coupled with environmental stressors, has led to the forest health issues seen today.

Within the Treasure Hill project area both conifer and aspen stands are suffering from forest decline as determined from formal inventory plots and aerial surveys conducted by the United States Department of Agriculture. This decline is adding both dead standing and down material to the fuel profile along with red needled fuels that could contribute to increased fire behavior. This tree mortality is readily visible from town and from the many trails and ski lifts in the area. Some of these dead trees are a hazard to people using the area for recreation.

Forest health may be defined in many ways, but commonly-used definitions provided by Edmonds et al. (2011) include:

1. A fully functioning community of plants and animals and their physical environment,
2. Resilient to change and associated effects,
3. The ability of a forest to recover from natural and human stressors, and
4. Forest ecosystems that maintain complexity while providing for human needs, among others.

It must be acknowledged that some level of disturbance is both a natural and necessary part of forest ecosystems; it is what drives the stages of forest succession and allows trees to grow and recycle or die (Campbell and Leigel 1996). There are several disturbance agents that can change the structure and composition of forests such as fire, weather, insects, pathogens, and humans. Bark beetles and native tree defoliating insects were generally endemic (meaning they persisted at low levels) to the landscape because of historic disturbance regimes such as fire (Hessburg et al. 2015). Fire, insect, and disease regimes are currently driven by a warming climate, past management, and patterns of fuels and host trees, fostering increased numbers of larger and more severe disturbances than occurred historically (Hessburg et al. 2015).

Methods

The USDA Forest Service's Forest Health Protection Group conducts annual Aerial Insect and Disease Surveys (USDA Forest Health and Protection 2022) throughout the nation. With Park City's proximity to the Uinta-Wasatch-Cache National Forest, lands within the Treasure Hill project area were included in aerial surveys. Aerial detection flight data from 2016, 2019, and 2021 were analyzed to identify insect and disease concerns. The insect and disease reporting conducted by the Forest Service and Utah Department of Natural Resources is also used to analyze forest health trends.

In addition, a formal forest inventory to gather tree data and forest health information was conducted on Treasure Hill in October 2022. This inventory confirmed the presence of FEB. The high mortality in the aspen is assumed to be related to Sudden Aspen Decline.

Disturbance Agents Detected

Fir Engraver Beetle

While fir engraver beetles (*Scolytus ventralis*), usually found in white fir, decreased substantially throughout the state from 2018 (USDA Forest Health and Protection 2018), the impacts from this beetle are seen within the project area. White fir is the main host for fir engraver beetles, but Douglas-fir may be attacked as well. This insect will attack trees of all sizes. The effects of the fir engraver beetle are easily seen as they have resulted in the top kill (dead upper stem and branches of trees), dead branches, and outright tree death across Treasure Hill. This contributes to the increased standing and down fuel loadings.

Management of this insect includes reducing stand densities (overstocked fir stands like those on Treasure Hill are at greatest risk), removal of dead and dying trees (especially hazardous trees to human use of the area), increasing the composition of more tolerant species such as Douglas-fir, and the removal of fresh slash that provides breeding habitat. Reliance on natural control (use of predatory insects or birds or animals) of this insect has shown to be impractical. (Bell Randall, 2012).

Insecticides may be used to protect high-value trees through a spray applied to the stems of trees, but this is impractical over larger areas. (Garrison et al., 2016)

Figure B-13 - Fir engraver galleries

Figure B-14 - Mortality caused by fir engraver

Balsam Woolly Adelgid

Balsam woolly adelgid (*Adelges piceae*), a defoliator, is a tiny sucking insect identified as an invasive species introduced to North America from Europe. It is a damaging insect of true fir species. In Utah, subalpine fir (*Abies lasiocarpa*) is a highly susceptible host tree with white fir (*Abies concolor*) also a host, but identified as being more tolerant (Ragenovich & Mitchell, 2006). In September 2017 BWA was first confirmed in Utah including Summit County (*Utah Forest Health Highlights* 2019). The USDA Forest Service's 2019 aerial insect and disease survey detected balsam woolly adelgid (BWA) within the project area.

Figure B-15 - Balsam Woolly Adegid (Photo credit: https://forestry.usu.edu/news/utah-forest-facts/a-new-utah-forest-insect-pest-balsam-woolly-adelgid)

All sizes of trees are attacked by this insect. Trees that experience crown loss over time die more slowly than those with severe stem infections. Mortality of host trees may be sudden at first during an outbreak, but the insect continues causing damage in susceptible forests for years to come. (Ragenovich & Mitchell, 2006)

There are no known parasites, but there exist predaceous insects that will feed on the BWA. However, these natural control methods are unreliable in controlling BWA populations. Cold winters may decrease insect populations, but the potential rise of temperature with climate change may limit winter's effect on BWA and other pests. True firs seem to be more susceptible at the lower ends of their elevational ranges.

There is some evidence that reducing stand densities may help increase individual tree resistance (potentially through better growing conditions and tree vigor to help defenses), but a main management goal is to increase species diversity of trees that are not susceptible to this insect. The spraying of pesticides is only effective in high-value trees, otherwise it is infeasible across large areas. (Ragenovich & Mitchell, 2006)

Sudden Aspen Decline

Figure B-16 - Photo credit: **Researchers find cause of 'sudden aspen decline' - Deseret News**

Short-term aspen decline, sometimes called sudden aspen decline (SAD), presumes a relatively rapid die-off of overstory trees, as well as supporting root systems. Worrall et al. (2008, 2013) have provided documentation of this phenomenon for southern Colorado and across wider areas. However, in many instances, root system die-off has not followed drought-induced aspen mortality and may simply be a common mode of stable aspen regeneration (Rogers 2017, Rogers observation of Ashley National Forest, Utah). There appears to be more common instances of combined effects of drought and browsing decreasing aspen resilience, sometimes leading to system collapse (Rogers and Mittanck 2014).

Long-term decline of western aspen related to conifer “encroachment” deserve consideration. There has been recent documentation of both aspen cover loss (Di Orio et al. 2005) and gain (Kulakowski et al. 2004) in different areas, as well as expansion and contraction within the same landscape (Sankey 2009; Elliot and Baker 2004). Climate fluctuations, fire suppression, and other human manipulations affect aspen and specific landscapes in varying ways (Rogers et al. 2011).

Poplar borers, cankers, and aspen bark beetles are often associated with the decline of aspen. Incidence of drought increases insect populations and incidence of pathogens and associated mortality of aspen has increased over the last decade. (Keyes et al., 2019)

There are some management options to reduce the effects of SAD. Singer et al. 2019 discuss the use of clear-fell coppice and prescribed fire:

1) The clear-fell coppice method encourages a wide range of tree size classes. This method requires intensive variable thinning with opening sizes large enough to allow direct sunlight and encourage sprouting. It may also be done in conjunction with prescribed fire to limite conifer encroachment.

2) The authors also mention that while the reintroduction of fire may be a useful tool, managers should first consider the structure of aspen stands: 1) fire-independent, stable aspen, 2) fire-influenced, stable aspen, 3) fire-dependent, seral conifer-aspen, 4) fire-dependent seral montane conifer-aspen, and 5) fire-dependent seral subalpine conifer-aspen. Fire severity plays a role in the suckering of aspen where regeneration has been found to be higher in high severity burns versus low-severity.

Other disturbance agents in the region, but not detected within Treasure Hill:

While not detected within the Treasure Hill project area, outbreaks of other insects have occurred along the Wasatch Back and Front within the Salt Lake City Quad aerial survey area. These include Douglas-fir Beetle, Western Spruce Budworm, and Subalpine Fir Decline. As seen with the rapid occurrence of BWA, these insects can expand into new areas within a short period of time under the right conditions (USDA).

Root diseases were not detected on Treasure Hill during forest inventory data collection. This does not mean they are not present, but in general, root diseases are less damaging than other forests located in wetter climates or have been impacted by exotic pathogens. Root diseases are known as “diseases of the site” and expand through the roots of adjoining trees. Bark beetles are often associated with root disease centers and evidence of these areas can be easily detected by aerial surveys (Keyes et al., 2019).

More information:

Table B-2 - Most common forest health issues for associated tree species*:*

Species	Associated insects	Associated pathogens	Other	Reference(s)
Douglas-fir	Douglas-fir beetle, wood borers, western spruce budworm, Douglas-fir needle midge	Armillaria root disease, Annosus root disease, Schweinitzii root and butt rot, Laminated root rot, Pini rot	Needle casts, mistletoe, fir canker	Hagle et al. 2003
White fir	Fir engraver, western spruce budworm	Armillaria root disease, Indian paint fungus,	White fir dwarf mistletoe, fir canker, rust, needle cast	Hagle et al. 2003
Subalpine fir	Western balsam bark beetle, wood borers, fir engraver, Balsam woolly adelgid	Armillaria root disease, Annosus root disease, Indian paint fungus, Red belt fungus	Needle casts, fir canker	Hagle et al. 2003
Aspen	Aphids, leaf miners, sawflies, western tent caterpillar, poplar twiggall fly, epidermal bark mining fly, borer, oystershell scale	Ink spot disease, trunk rot,	Black canker, sooty bark canker, blight	Colorado State Forest Service 2022
Maple	Aphids, borers, cicadas,	Leaf anthracnose, Phytophthora root rot	None	Richards 2010
Gambel oak	Galls, leaf galls, stem galls, leafrollers, canker worms, cicadas	Anthracnose, perennial canker, leaf blister, powdery mildew, root rot, heart rot	None	(Utah State University 2022)

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Appendix C

Forest Inventory Data

PLOT DATA SUMMARY

PLOT	VEG TYPE	SAMPLE SIZE	DBH, ALL TREES (AVERAGE)	STD DEV (N-1) OF DBH	DBH MAX (ALL)	DBH MIN (ALL)	DBH, LIVE TREES (AVERAGE)	DBH, DEAD TREES (AVERAGE)	TOTAL BA	TOTAL TPA
1243	C	31	10.3	2.3	16.4	6.6	10.7	9.9	110	310
1098	C	58	7.4	1.9	13.9	5.0	7.7	7.0	110	580
647	C	27	9.6	3.0	15.2	5.4	9.0	12.3	80	270
883	C	16	11.4	4.5	19.3	5.3	11.5	9.8	60	160
1093	C	40	8.7	2.7	16.7	5.3	8.7	8.7	160	400
1238	MH	20	7.3	1.4	10.2	5.0	7.4	7.2	35	200
1235	MH	35	7.5	2.4	14.7	5.0	7.6	7.3	90	350
1117	MH	45	8.1	2.0	12.5	5.1	9.7	7.2	140	450
639	MH	26	7.6	2.4	12.2	5.0	7.8	6.0	50	260

CONIFER AVERAGES:	9.5			9.5	9.5	104	344
MIXED HARDWOOD AVERAGES:	7.6			8.1	6.9	79	315

C: Conifer

MH: Mixed Hardwood

SAMPLE SIZE (n): Number of trees recorded within plot diameter

DBH: Diameter at Breast Height of trees ≥5 inches diameter, expressed in inches to the nearest tenth.

STD DEV: Standard deviation

DBH LIVE: Diameter of living trees

DBH DEAD: Diameter of dead standing trees (snags)

BA: Basal Area (ft²per acre)

TPA: Trees Per Acre

DENSITY – TREES PER ACRE

PLOT	VEG TYPE	TPA (ALL)	TPA (LIVE)	TPA (DEAD)	SPECIES COMPOSITION (TOTAL TPA)			SPECIES COMPOSITION (LIVE TPA)			SPECIES COMPOSITION (DEAD TPA)		
					ABCO	POTR	ACER	ABCO	POTR	ACER	ABCO	POTR	ACER
1243	C	310	140	170	310	0	0	140	0	0	170	0	0
1098	C	580	370	210	580	0	0	370	0	0	210	0	0
647	C	270	220	50	270	0	0	220	0	0	50	0	0
883	C	160	150	10	160	0	0	150	0	0	10	0	0
1093	C	400	230	170	400	0	0	230	0	0	170	0	0
1238	MH	200	110	90	0	160	40	0	70	40	0	90	0
1235	MH	350	180	170	0	260	90	0	100	80	0	160	10
1117	MH	450	170	280	0	440	10	0	160	10	0	280	0
639	MH	260	230	30	30	210	20	30	180	20	0	30	0
	C (avg TPA)	344	222	122	344	0	0	222	0	0	122	0	0
	MH (avg TPA)	315	173	143	8	268	40	8	128	38	0	140	3

C: Conifer

MH: Mixed Hardwood

ABCO: Abies concolor (white fir)

POTR: Populus tremuloides (aspen)

ACER: Acer grandidentatum (Bigtooth maple)

TPA: Trees Per Acre

SPECIES COMPOSITION, TREES PER ACRE

PLOT	VEG TYPE	SPECIES COMPOSITION (PERCENT LIVE, TPA)			SPECIES COMPOSITION (PERCENT DEAD, TPA)			SPECIES COMPOSITION (TOTAL LIVE AND DEAD, TPA)		
		ABCO	POTR	ACER	ABCO	POTR	ACER	ABCO	POTR	ACER
1243	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
1098	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
647	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
883	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
1093	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
1238	MH	0%	64%	36%	0%	100%	0%	0%	80%	20%
1235	MH	0%	56%	44%	0%	94%	6%	0%	74%	26%
1117	MH	0%	94%	6%	0%	100%	0%	0%	98%	2%
639	MH	13%	78%	9%	0%	100%	0%	100%	81%	8%

C: Conifer

MH: Mixed Hardwood

ABCO: Abies concolor (white fir)

POTR: Populus tremuloides (aspen)

ACER: Acer grandidentatum (Bigtooth maple)

TPA: Trees Per Acre

DENSITY – BASAL AREA PER ACRE

PLOT	VEG TYPE	PLOT BA	SPECIES COMPOSITION (TOTAL BA)			SPECIES COMPOSITION (LIVE BA)			SPECIES COMPOSITION (DEAD BA)		
			ABCO	POTR	ACER	ABCO	POTR	ACER	ABCO	POTR	ACER
1243	C	110	110	0	0	60	0	0	50	0	0
1098	C	110	110	0	0	70	0	0	40	0	0
647	C	80	80	0	0	70	0	0	10	0	0
883	C	60	60	0	0	60	0	0	0	0	0
1093	C	160	160	0	0	100	0	0	60	0	0
1238	MH	35	0	30	5	0	15	5	0	15	0
1235	MH	90	0	90	0	0	45	0	0	45	0
1117	MH	140	0	120	20	0	100	20	0	20	0
639	MH	50	0	50	0	0	50	0	0	0	0
	C (avg BA)	104	104	0	0	72	0	0	32	0	0
	MH (avg BA)	79	0	73	6	0	53	6	0	20	0

C: Conifer

MH: Mixed Hardwood

ABCO: Abies concolor (white fir)

POTR: Populus tremuloides (aspen)

ACER: Acer grandidentatum (Bigtooth maple)

BA: Basal Area (ft² per acre)

SPECIES COMPOSITION, BASAL AREA PER ACRE

PLOT	VEG TYPE	SPECIES COMPOSITION (PERCENT LIVE BA)			SPECIES COMPOSITION (PERCENT DEAD BA)			SPECIES COMPOSITION (PERCENT TOTAL LIVE AND DEAD BA)		
		ABCO	POTR	ACER	ABCO	POTR	ACER	ABCO	POTR	ACER
1243	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
1098	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
647	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
883	C	100%	0%	0%	0%	0%	0%	100%	0%	0%
1093	C	100%	0%	0%	100%	0%	0%	100%	0%	0%
1238	MH	0%	75%	25%	0%	100%	0%	0%	86%	14%
1235	MH	0%	100%	0%	0%	100%	0%	0%	100%	0%
1117	MH	0%	83%	17%	0%	100%	0%	0%	86%	14%
639	MH	0%	100%	0%	0%	0%	0%	0%	100%	0%

C: Conifer

MH: Mixed Hardwood

ABCO: Abies concolor (white fir)

POTR: Populus tremuloides (aspen)

ACER: Acer grandidentatum (Bigtooth maple)

BA: Basal Area (ft^2 per acre)

TREE CANOPY DATA

PLOT	VEG TYPE	AVERAGE CROWN RATIO (PERCENT)	AVERAGE HEIGHT (FEET)	MINIMUM HEIGHT (FEET)	MAXIMUM HEIGHT (FEET)	CROWN BASE HEIGHT, RANGE (FEET)
1243	C	61	48	15	70	0-10
1098	C	54	29	13	45	0-20
647	C	42	35	16	46	0-18
883	C	52	38	15	60	0-7
1093	C	50	31	20	60	0-15
1238	MH	29	36	12	45	12-30
1235	MH	28	51	25	75	20-50
1117	MH	20	67	35	75	15-60
639	MH	40	54	9	80	0-4

Canopy cover:

Derived from remotely-sensed data, Conifer canopy cover is approximately 56%, on average. Mixed hardwood is approximately 60%, on average. There are areas within these stands that contain dense clumps of trees and other areas where openings contribute no canopy cover.

C: Conifer

MH: Mixed Hardwood

ABCO: Abies concolor (white fir)

POTR: Populus tremuloides (aspen)

ACER: Acer grandidentatum (Bigtooth maple)

REGENERATION – SEEDLINGS PER ACRE

PLOT	VEG TYPE	ABCO	POTR	ACER	TOTAL TPA
1243	C	0	0	0	0
1098	C	0	0	0	0
647	C	0	0	0	0
883	C	1	0	0	100
1093	C	0	0	0	0
1238	MH	0	0	10	1000
1235	MH	0	0	0	0
1117	MH	0	0	0	0
639	MH	11	0	0	1100

Conifer, avg. seedlings/acre:	20
Mixed Hardwood, avg. seedlings/acre:	525

Seedlings: Trees ≤4.9 inches diameter

C: Conifer

MH: Mixed Hardwood

ABCO: Abies concolor (white fir)

POTR: Populus tremuloides (aspen)

ACER: Acer grandidentatum (Bigtooth maple)

GROWTH AND AGE OF SELECT SAMPLE TREES

PLOT	TREE NUMBER	SPECIES	DBH (INCHES)	HEIGHT (FEET)	CROWN CLASS	CROWN RATIO (PERCENT	GROWTH (20THS)		TREE AGE (YEARS)	SITE INDEX
							10-year	20-year		
1243	15	ABCO	16.4	70	D	70	10	23	84	80
1098	5	ABCO	8.7	38	D	80	8	17	68	60
883	14	ABCO	17.3	60	D	70	10	22	80	70
1093	30	ABCO	11.1	40	D	50	5	12	101	40
1117	12	POTR	11.1	72	CD	20	10	22	75	80
647	6	ABCO	8.4	35	CD	40	10	32	53	60
1235	21	POTR	8.5	60	CD	20	15	30	53	80

Summary on growth:

Conifer sample trees grew between 0.25 and 0.5 inches in the past ten years, and between 0.5 inches to over 1 inch in the past twenty years. Mixed hardwood sample trees grew between 0.5 to 0.75 inches in the past ten years, and between 1.0 to 1.5 inches in the past twenty years.

ABCO: Abies concolor (white fir)

POTR: Populus tremuloides (aspen)

DBH: Diameter at Breast Height, 4.5-foot mark on stem of tree

Crown Class D: Dominant tree position in canopy

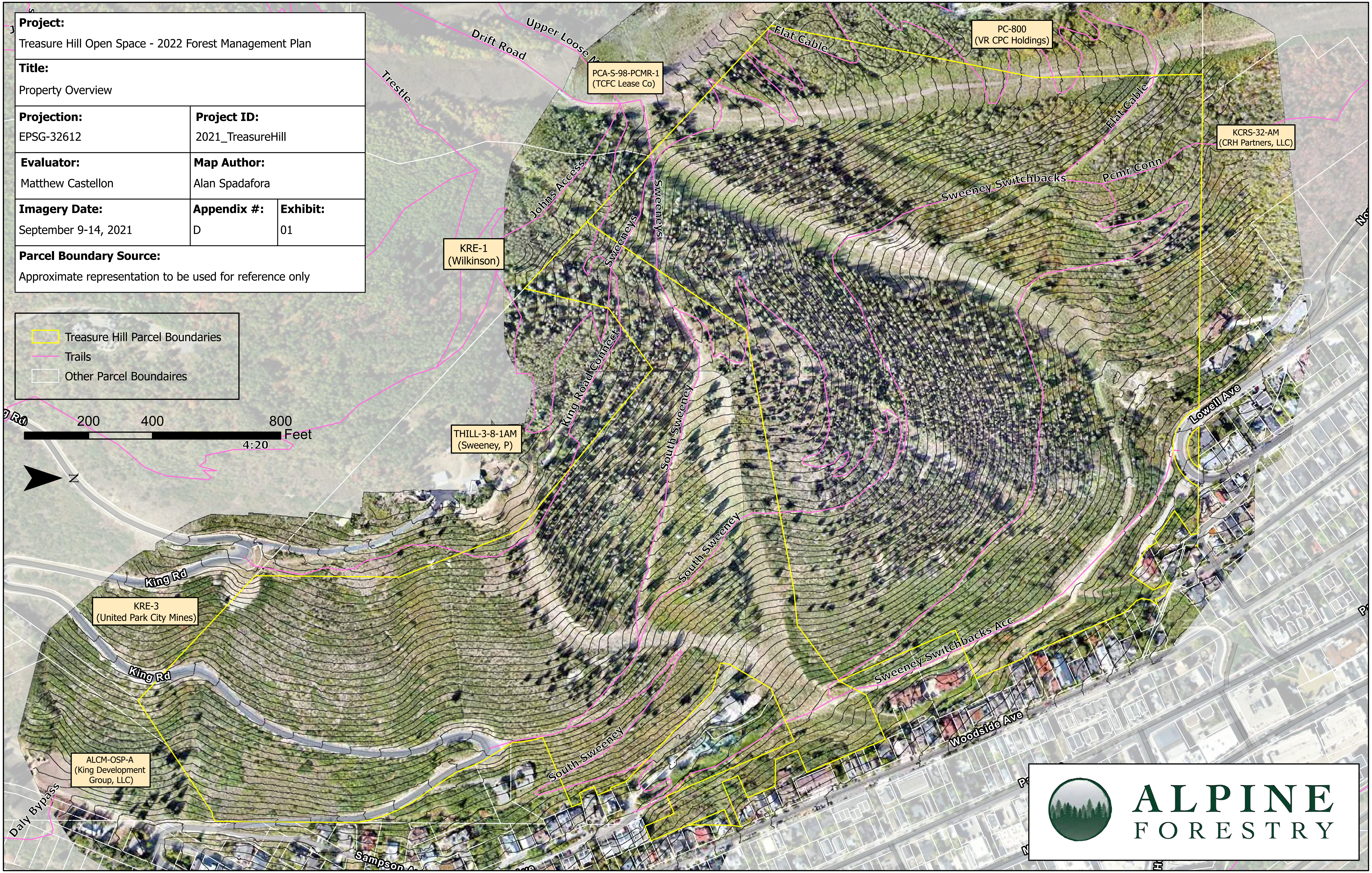
Crown Class CD: Codominant tree position in canopy

Growth 10-year: diameter growth gained in last ten years

Growth 20-year: diameter growth gained in last twenty years

Appendix D

Map Packet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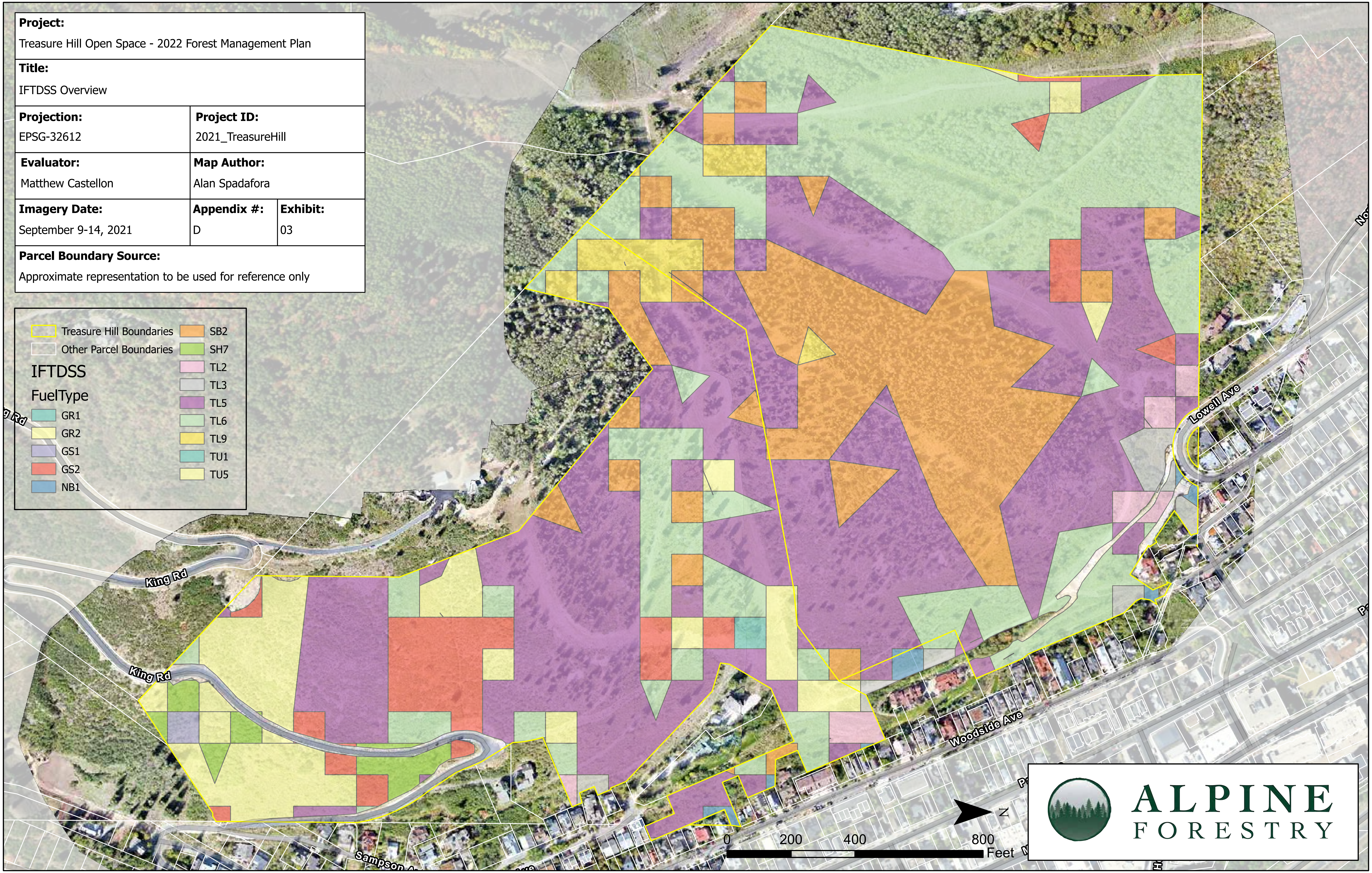
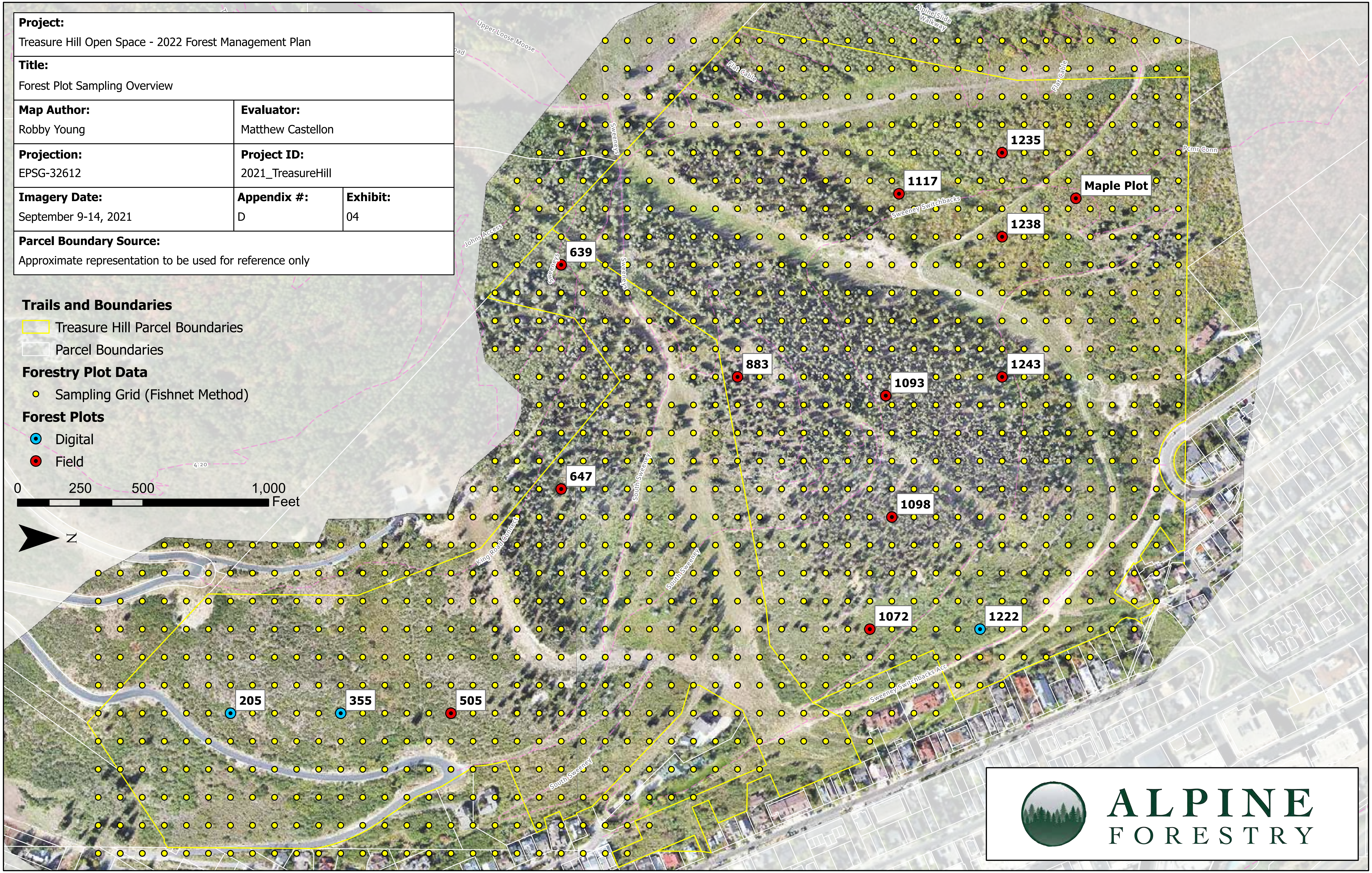
Treasure Hill Open Space - 2022 Forest Management Plan
Title:
Property Overview
Projection:
EPSG-32612
Project ID:
2021_TreasureHill
Evaluator:
Matthew Castellon
Map Author:
Alan Spadafora
Imagery Date:
September 9-14, 2021
Appendix #:
D
Exhibit:
01
Parcel Boundary Source:
Approximate representation to be used for reference only
Treasure Hill Parcel Boundaries
Trails
Other Parcel Boundaires
200
400
800
Feet
4:20
N
PC-800
(VR CPC Holdings)
PCA-S-98-PCMR-1
(TCFC Lease Co)
KCRS-32-AM
(CRH Partners, LLC)
KRE-1
(Wilkinson)
THILL-3-8-1AM
(Sweeney, P)
KRE-3
(United Park City Mines)
ALCM-OSP-A
(King Development
Group, LLC)
Drift Road
Upper Loose
Trestle
Flat Cable
Flat Cable
Johns Access
Sweeneys
Sweeneys
Sweeney Switchbacks
Pcmr Conn
King Road Connect
South Sweeney
South Sweeney
South Sweeney
Sweeney Switchbacks Acc
King Rd
King Rd
Lowell Ave
Woodside Ave
Daly Bypass
ALPINE
FORESTRY

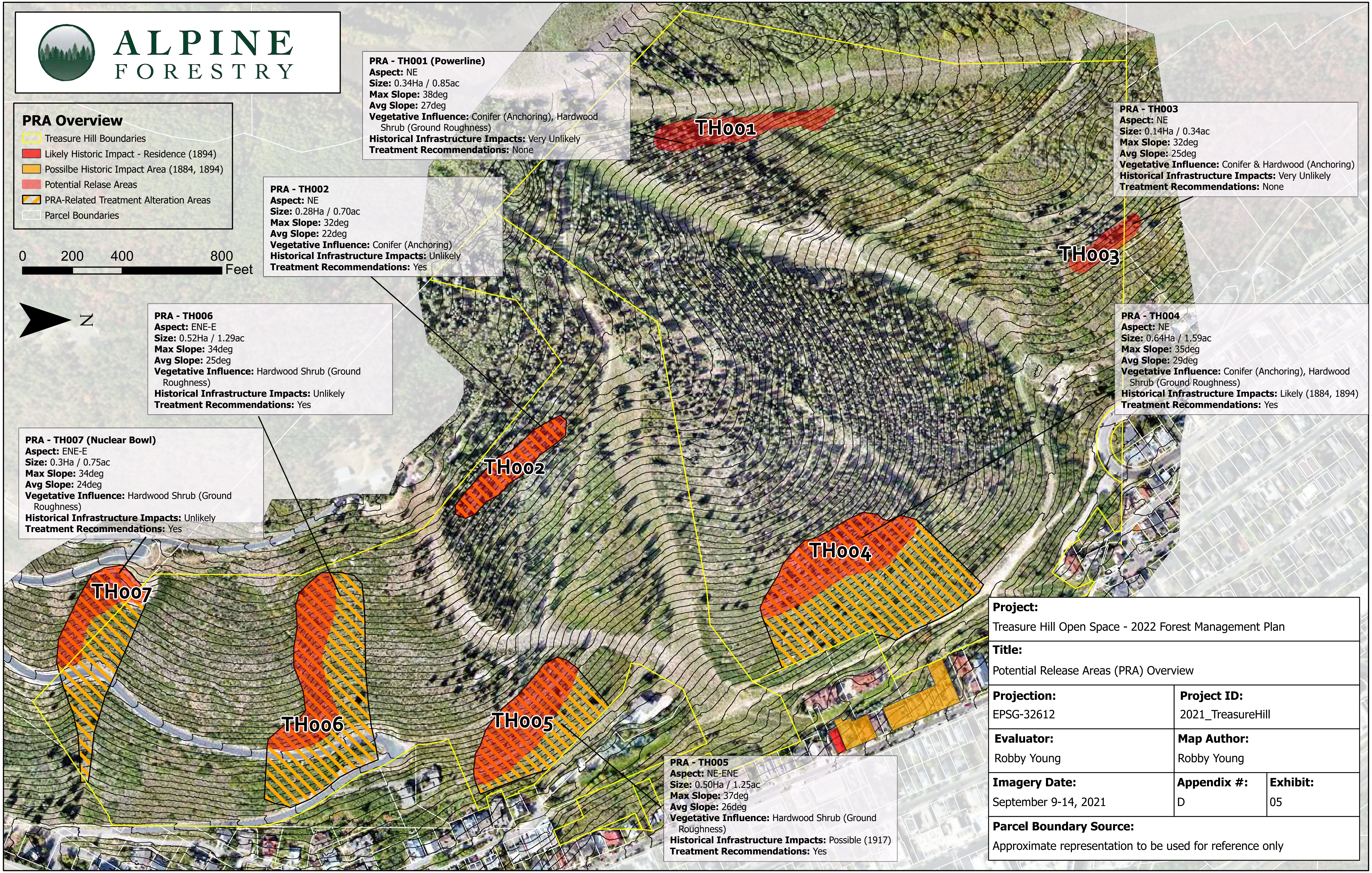

Project:
Treasure Hill Open Space - 2022 Forest Management Plan
Title:
Vegetation Overview
Projection:
EPSG-32612
Project ID:
2021_TreasureHill
Evaluator:
Matthew Castellon
Map Author:
Robby Young
Imagery Date:
September 9-14, 2021
Appendix #:
D
Exhibit:
02
Parcel Boundary Source:
Approximate representation to be used for reference only
Treasure Hill Boundaries
Other Parcel Boundaries
Vegetation Type
Gambel Oak - 31 acres
Hardwood - Aspen/Maple - 13 acres
Conifer - 33 acres
Mixed Vegetation - 7 acres
Sage, Brush, Grass or Shrub - 18 acres
N
King Rd
King Rd
Lowell Ave
Woodside Ave
0
200
400
800
Feet
ALPINE
FORESTRY

Project: Treasure Hill Open Space - 2022 Forest Management Plan	
Title: IFTDSS Overview	
Projection: EPSG-32612	**Project ID:** 2021_TreasureHill
Evaluator: Matthew Castellon	**Map Author:** Alan Spadafora
Imagery Date: September 9-14, 2021	**Appendix #:** D — **Exhibit:** 03
Parcel Boundary Source: Approximate representation to be used for reference only	

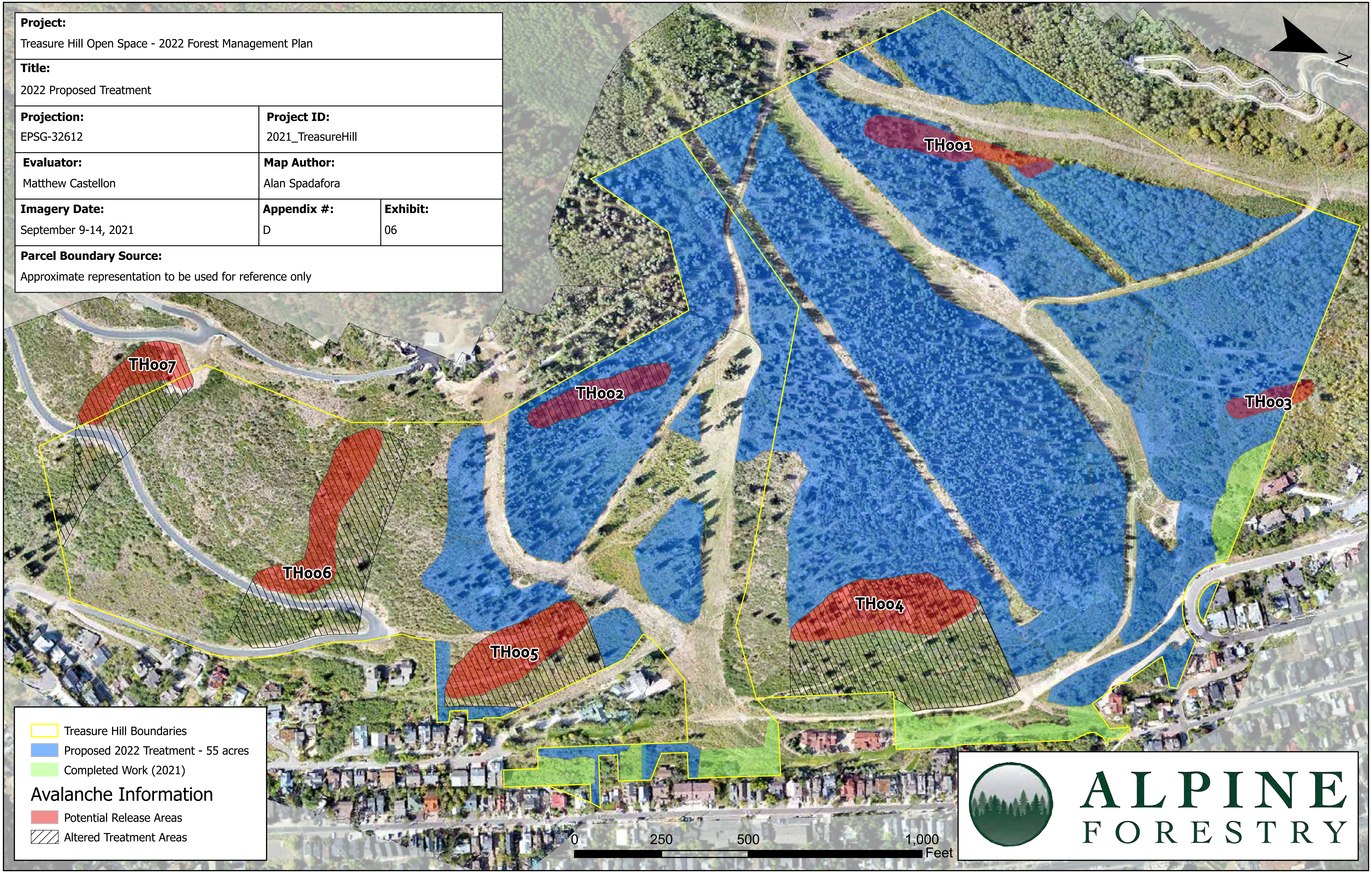


Project: Treasure Hill Open Space - 2022 Forest Management Plan	
Title: Forest Plot Sampling Overview	
Map Author: Robby Young	**Evaluator:** Matthew Castellon
Projection: EPSG-32612	**Project ID:** 2021_TreasureHill
Imagery Date: September 9-14, 2021	**Appendix #:** D · **Exhibit:** 04
Parcel Boundary Source: Approximate representation to be used for reference only	





Project:	
Treasure Hill Open Space - 2022 Forest Management Plan	
Title:	
Potential Release Areas (PRA) Overview	
Projection: EPSG-32612	**Project ID:** 2021_TreasureHill
Evaluator: Robby Young	**Map Author:** Robby Young
Imagery Date: September 9-14, 2021	**Appendix #:** D / **Exhibit:** 05
Parcel Boundary Source:	
Approximate representation to be used for reference only	


Project:
Treasure Hill Open Space - 2022 Forest Management Plan
Title:
2022 Proposed Treatment
Projection:
EPSG-32612
Project ID:
2021_TreasureHill
Evaluator:
Matthew Castellon
Map Author:
Alan Spadafora
Imagery Date:
September 9-14, 2021
Appendix #:
D
Exhibit:
06
Parcel Boundary Source:
Approximate representation to be used for reference only
N
TH001
TH002
TH003
TH004
TH005
TH006
TH007
Treasure Hill Boundaries
Proposed 2022 Treatment - 55 acres
Completed Work (2021)
Avalanche Information
Potential Release Areas
Altered Treatment Areas
0
250
500
1,000
Feet
ALPINE
FORESTRY

Appendix E

Fuels and Fire Behavior Report

Appendix E: Fuels and Fire Behavior Report

Park City - Treasure Hill Fuels & Fire Behavior

The Interagency Fuels Treatment Decision Support System (IFTDSS) is being used to analyze potential fire behavior within the Treasure Hill project area. IFTDSS is a web-based application designed to make fuels treatment planning and analysis more efficient and effective. IFTDSS provides access to data and models through one simple user interface. It is available to all interested users, regardless of agency or organizational affiliation. As with all models, there are various limitations and assumptions that go into the analysis, and these must be considered when interpreting the data.

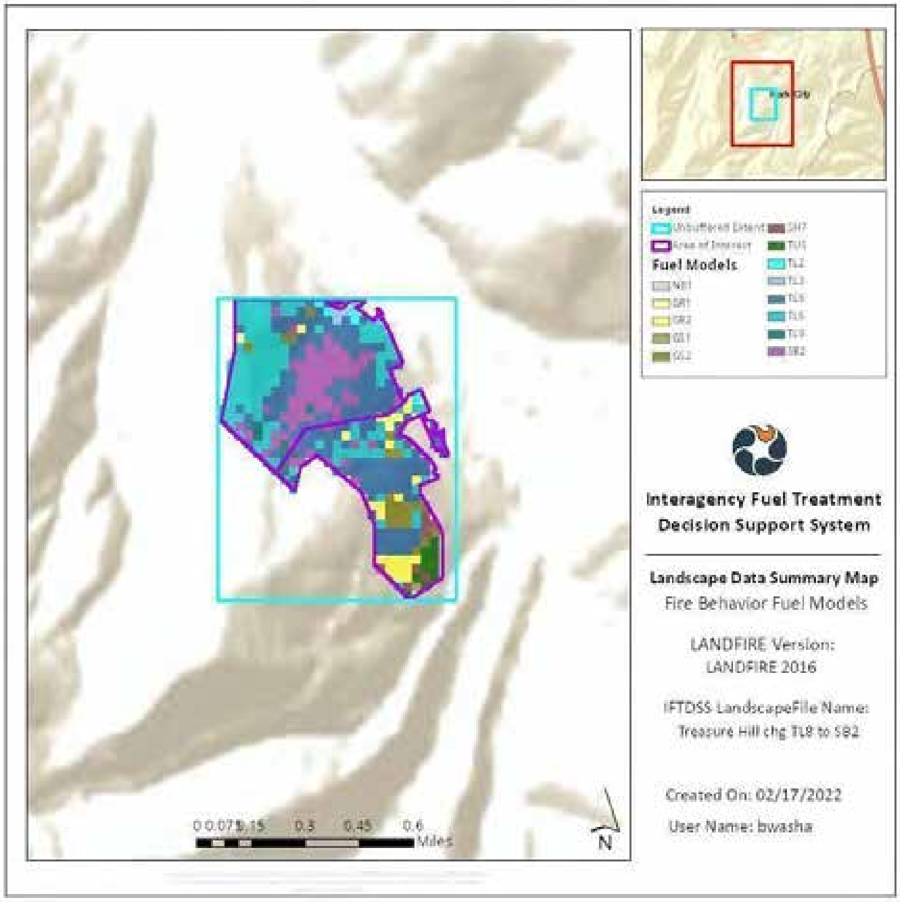
LANDFIRE (LF), Landscape Fire and Resource Management Planning Tools (2016 Refresh) is the fuels data layer being used. LANDFIRE is a shared program between wildland fire management programs providing landscape scale geo-spatial products to support cross-boundary planning, management, and operations. LANDFIRE Landscape (.LCP) file downloaded in IFTDSS are a multi-band raster format used by wildland fire behavior and fire effect simulation models. The bands of an .LCP file store data describing terrain, tree canopy, and surface fuel at a 30-meter resolution.

The forests around Park City have suffered recent and significant forest health decline since the last refresh of LANDFIRE in 2016. Both fir engraver beetle (*Scolytus ventralis*) and balsam woolly adelgid (*Adelges piceae*), a defoliator first confirmed in Summit County in 2017, have impacted the stands of white fir. Short and long-term aspen decline is also occurring within the treatment area. The death of white fir and aspen has changed the fuel profile with an increase in both dead standing and down fuels and will need to be adjusted within the LANDFIRE fuels layer.

Fuels

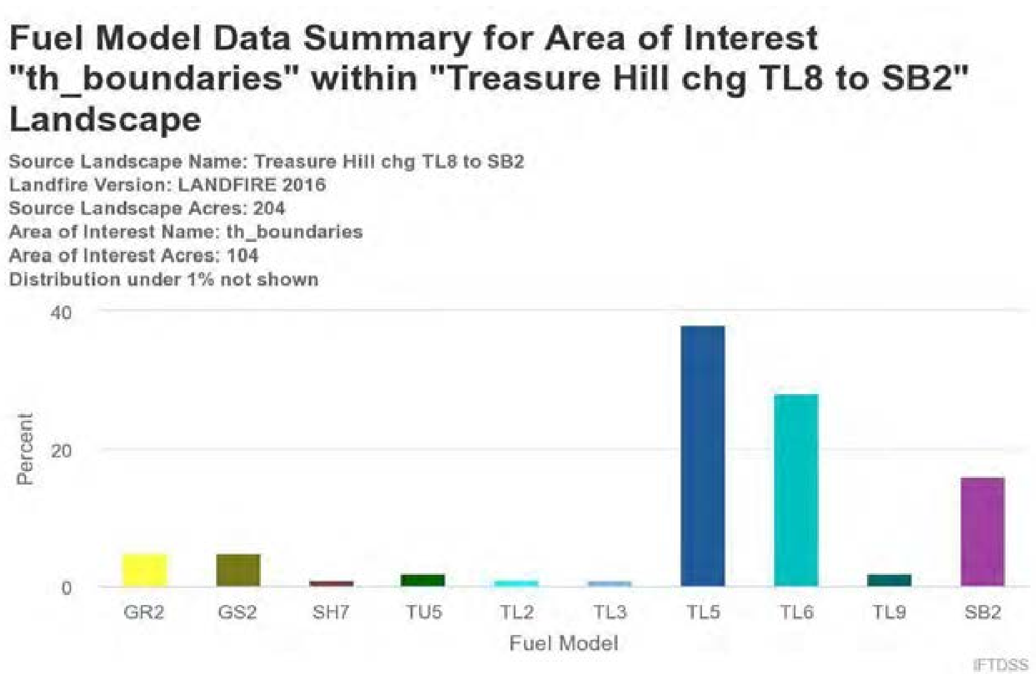
The IFTDSS analysis used the 40 Fire Behavior Fuel Models to better define the fuels on a 30-meter resolution. In reviewing the unedited landscape (LANDFIRE) created by IFTDSS there was one fuel model of suspect that could impact the fire behavior outputs at the extreme end of the spectrum for analysis purposes. Sixteen acres of TL8 were identified by LANDFIRE primarily within the interior of the mixed conifer stand experiencing a significant level of forest decline. TL8 is timber litter with a moderate load long-needle pine litter with a moderate spread rate and low flame length. There are no known long-needle pines within the project area.

Existing condition (EC) landscape represents, as closely as possible, the current condition of the landscape. The TL8 – long-needle pine litter fuel model was globally changed within the project area to SB2 – slash-blowdown to represent the significant insect-caused dead standing and down component in the mixed conifer and the EC. The primary carrier of fire in SB2 is moderate dead and down light blowdown. Fine fuel load is 7 to 12 t/ac, evenly distributed across all diameter classes up to 3” in diameter with a depth of about 1 foot. Blowdown is scattered, with many trees still standing exhibiting moderate spread rate and flame length.



The breakdown of fuel models across the treatment area within the EC from highest composition to lowest is found on the below table. Included within the table are Fuel model code (used for oral and written communication and input to fire modeling systems) and fuel model number (for use in computer code and mapping applications), description or fuel model name (used for description and communication), percent or area covered and total acres of the fuel model over the project area. Fuels analyzed as burnable were 101.82 acres.

Fuel Model	Description	Percent	Acres
TL5 (185)	Timber Litter - High Load Conifer Litter	38%	39.5
TL6 (186)	Timber Litter - Moderate Load Broadleaf Litter	26%	27.0
SB2 (202)	Slash-Blowdown - Moderate Load Low Load Blowdown	16%	16.6
GR2 (102)	Grass - Low Load, Dry Climate Grass (Dynamic)	5%	5.2
GS2 (122)	Grass-Shrub - Moderate Load, Dry Climate Grass-Shrub (Dynamic)	5%	5.2
TU5 (165)	Timber-Understory - Very High Load, Dry Climate Timber-Shrub	2%	2.08
TL9 (189)	Timber Litter - Very High Load Broadleaf Litter	2%	2.08
SH7 (147)	Shrub - Very High Load, Dry Climate Shrub	1%	1.04
TL2 (182)	Timber Litter - Low Load Broadleaf Litter	1%	1.04
TL3 (183)	Timber Litter - Moderate Load Conifer Litter	1%	1.04
Other		1%	1.04
Non-Burn	Roads and parking areas	2%	2.2
Total			104



Weather

Weather streams are required when running IFTDSS and typically taken from the nearest Fire Remote Automated Weather Station (RAWS). Park City is basically in a void for nearby Fire RAWS with data required as inputs into IFTDSS. The below table identifies nearby Fire RAWS closest to Park City.

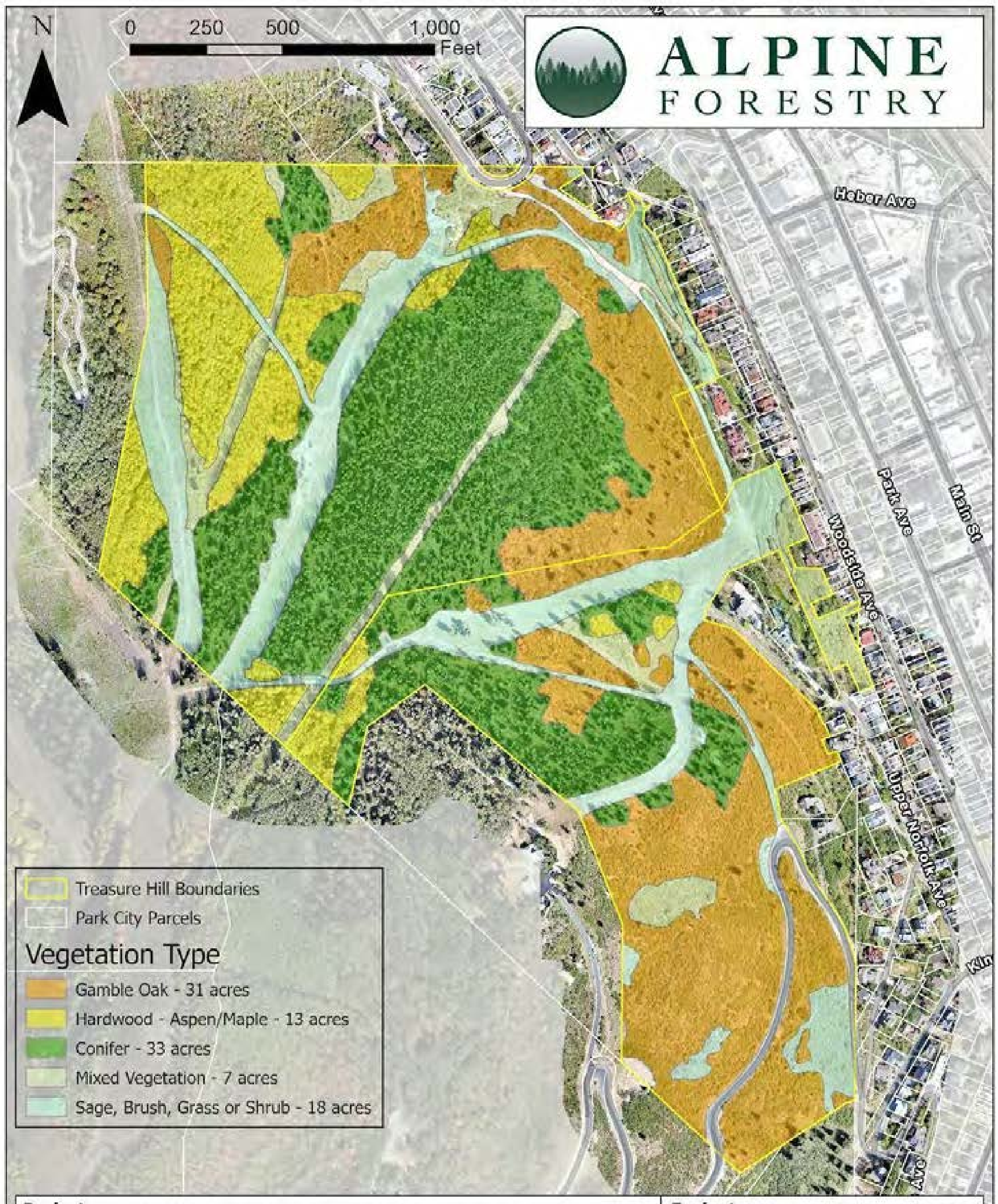
Fire RAWS	Elevation	Distance	Direction
PLEASANT GROVE	5200 ft	20 mi	SW
NORWAY	8280 ft	22 mi	E
RAY'S VALLEY	7300 ft	39 mi	SSE

With the Treasure Hill project area at 7,073-7,782 ft, a significant level of elevational difference exists between the project area and nearby RAWS. The Pleasant Grove RAWS is a drier and warmer site at 1,900 ft below Park City. The Norway Flat RAWS is a wetter and cooler site at 1,000 ft higher. Ray's Valley RAWS is a similar elevation but 39 miles SSE of Park City.

Weather data was analyzed in Fire Family Plus 5.0. A Significant Interest Group (SIG) of the three RAWS was created to determine extreme fuel and weather conditions at the 97^{th} percentile as an input into IFTDSS. Comparisons were made with local live and dead fuel moisture sampling conducted by the Uinta-Wasatch-Cache National Forest as reported in the National Fuel Moisture Database.

Fuel Summary

The Treasure Hill project area has eight stands identified that have been compressed to six fuel profiles. With the maple and mixed hardwood composed of less than two acres each and with similar fuel models, these have been combined with aspen and identified as hardwoods. IFTDSS was designed to look at large landscapes and because of the 30-meter resolution and the diversity within the 104 acre (101.82 acres of burnable) project area, there are some limitations with precision and in pinpointing the specific on the ground fuel model to a specific stand. Thus fire behavior outputs should be considered on a general level vs a specific point on the ground. The below highlights the six fuel profiles (in order of highest concern/interest for treatment).



Project: 2021 Treasure Hill Forest Health and Wildfire Assessment		**Evaluator:** Matthew Castellon	
Title: Vegetation Overview		**Map Author:** Alan Spadafora	
Projection: EPSG-32612	**Project ID:** 2021_TreasureHill	**Appendix #:** D	**Exhibit:** 02
Parcel Boundary Source: Approximate representation to be used for reference only		**Imagery Date:** September 9-14, 2021	

Mixed Conifer – White and Douglas fir – 33.1 acres (32.5%) - TL5 – 14 ac (45%), SB2 – 12.9 ac (39%), TL6 – 4 ac (12%) and other 1.2 ac (4%). Mixed conifer makes up the highest percentage of land within the project area. The TL5 - high load conifer litter represents an area that has mixed conifer with some dead and down material, but not to the degree of the slash blowdown. The primary carrier of fire is high load conifer litter with light slash or mortality fuel with low spread rate and flame length. Landfire originally identified a TL8 – timber litter fuel layer that represents long needled conifers such as Ponderosa or Lodgepole Pine. Neither of these species exist within the project area. The stand has also experienced significant decline from an insect infestation within the white fir that was probably not present in Landfire 2016 data. The TL8 was present within the core of the mixed conifer stand and was globally converted to SB2 – Slash Blowdown. While this fuel model will slightly overpredict fire behavior, it helps to highlight the extent of the red needle conifer and increased levels of down and standing dead fuel. The TL5 high load conifer litter represents an area that has mixed conifer with some dead and down material, but not to the degree of the slash blowdown. The primary carrier of fire is high load conifer litter with light slash or mortality fuel with low spread rate and flame length.
The TL6 is classified as moderate load broadleaf litter and consists primarily of aspen experiencing encroachment from the mixed conifer.

Aspen/Hardwood Maple – 13.2 acres (13%) - TL6 – 10.5 acres 79.4%, TL5 – 1.0 acres (7.6%), SB2 – 0.5 acres (3.9%), TL9 – 0.5 acres (3.8%), and other 0.7 acres (5.3%). For fire behavior analysis purposes, aspen was combined with the maple and mixed hardwood as there is limited acreage of the later two vegetation types and the desired condition is similar for fire behavior outputs. The TL6 is classified as moderate load broadleaf litter and consists primarily of aspen with limited maple and minimal encroachment from the mixed conifer. TL5 is high load conifer litter and represents an area that is significantly encroached with mixed conifer. The primary carrier of fire in TL5 is high load conifer litter with light slash or mortality fuel with low spread rate and flame length. TL9 presents a very high load broadleaf litter with fluffy litter. This fuel model has moderate spread rate and flame length. Aspen and hardwood maple is desirable as a shaded fuel break with lower and more manageable fire behavior.

Gambel Oak – 30.5 acres (30%) – TL5 – 14.4 acres (47.3%), TL6 – 4.3 acres (14.1%), GR2 – 3.5 acres (11.4%), GS2 – 3.1 acres (10.1%) and other 5.2 acres (xx%). Gambel oak is a very dynamic fuel model capable of seeing rapid rates of spread and moderate flame lengths. Gambel oak typically becomes available as a fuel late in the summer when the live fuel moisture drops off or earlier if impacted by early growing season frost kill or seasonal drought. Located in the south end of the project area, under frost kill conditions Gambel oak can be a very volatile fuel.

Sagebrush – 1.8 acres (1.8%) - TU5 – 1.1 acre (61.9%) and other 0.7 acres (38.0%). Sagebrush encompasses a very small footprint within the project area with three small sagebrush plots existing on the south end of the project area. Sagebrush is a dynamic fuel model capable of seeing rapid rates of spread and moderate flame lengths. Gambel oak typically becomes available as a fuel late in the summer when the live fuel moisture drops off or earlier if impacted by seasonal drought. High fire behavior can be observed when live fuel moistures reach 125% or lower with extreme fire behavior noted at 100% or lower. Because of the small size of the sagebrush plots, fire behavior should be moderated over the landscape but there is potential for fire to go from a surface fire into the crowns of the adjacent Gambel oak.

Grass – 15.8 acres (15.5%) – TL5 – 6.9 acres (43.5%), TL6 – 5.5 acres (34.9%), GR2 – 1.4 acres (8.8%), and others 2.0 acres (xx%). The areas of grass are primarily along the four ski runs that transect through the project area. Because the resolution is at 30 meters, the grass fuel models are not well represented with the relatively long and narrow runs. The grass fuel models of GR1 and GR2 will burn with higher spread rate but with lower flame length once the fuels have cured out into mid-summer.

Mixed Vegetation – 7.4 acres (7.3%) – TL6 – 2.8 acres (38.2%), TL5 – 1.9 acres (25.2%), SB2 – 1.1 acres (14.3%), GS2 – 0.6 acres (8.2%), and others 2.0 acres (xx%). The areas of shrub/mixed vegetation are primarily along two long linear features (ski lift and power line) that transect through the project area and six small pockets. Because the resolution is at 30 meters, the shrub/mixed vegetation fuel models are not well represented with the relative linear features. The open areas with lighter and flashier fuels will burn with higher spread rate but with lower flame length once the fuels have cured out into mid-summer.

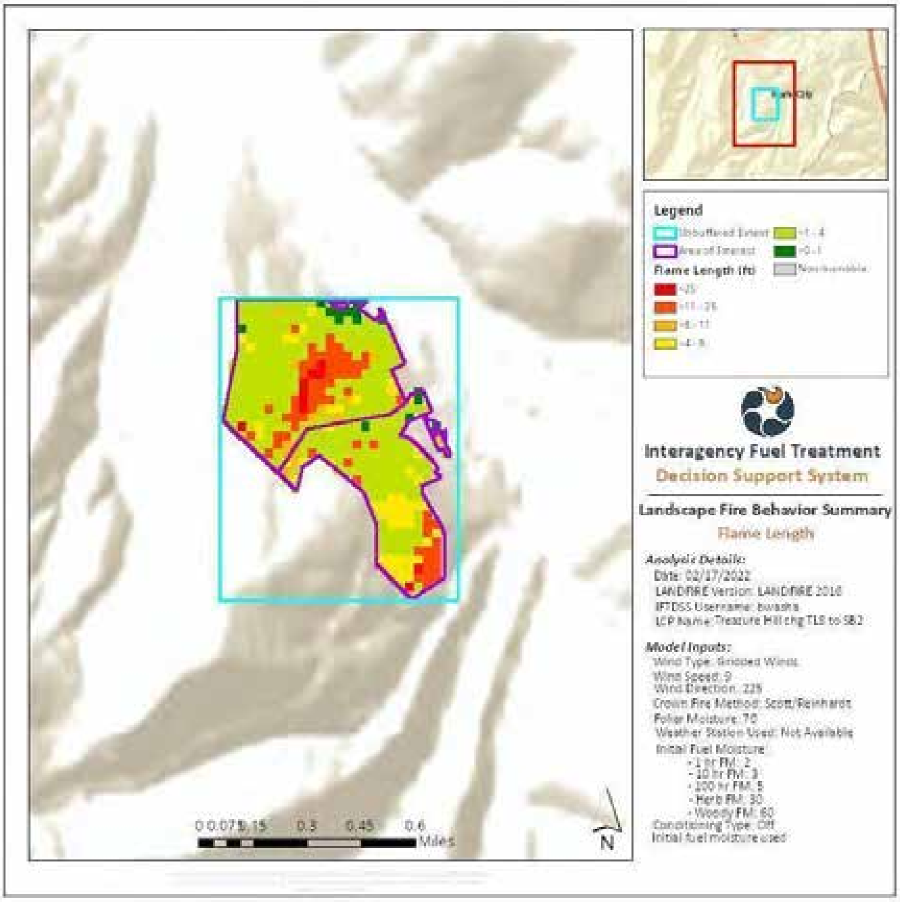
Fire Behavior

IFTDSS provides a number of fire behavior outputs including the Landscape Fire Behavior model. One of the first steps in the evaluation stage of landscape planning includes running a basic fire behavior model for the area. The Landscape Fire Behavior (LFB) model will create spatial outputs as well as summary reports. Landscape Fire Behavior outputs can be useful in prioritizing treatment areas. Three of the fire behavior outputs that are most helpful and easy to understand in assessing fire behavior's impact on fire suppression efforts and potential fire effects including flame length (FL), rate of spread (ROS) and crown fire type. The fire suppression interpretations of flame length and rate of spread table below provides information on type of suppression efforts that can be successful at a given FL and ROS.

Fire suppression interpretation of flame length and rate of spread

Adjective Class	**FL (ft)**	**ROS (ch/h)**	**Interpretation**
Very Low	0-1	0-2	Fire can generally be attacked at the head or flanks by persons using hand tools. Handline should hold the fire.
Low	1-4	2-5	
Moderate	4-8	5-20	Fires are too intense for direct attack on the head by persons using hand tools. Handline cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
High	8-12	20-50	Fires may present serious control problems with torching, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
Very High	12-25	50-150	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.
Extreme	>25	>150	

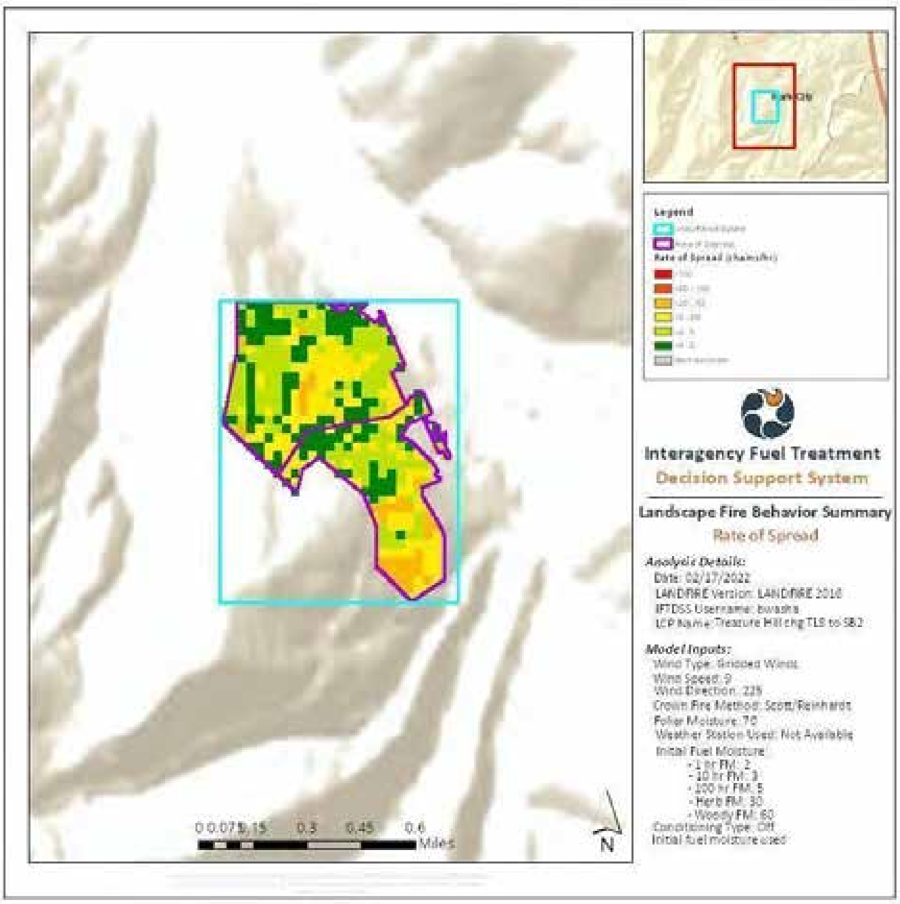
As noted in the Fire suppression interpretations table, flame lengths greater than 4 feet can be problematic as hand crews are minimally effective with direct attack. This is of importance with the Treasure Hill project area as access for engines and heavy equipment is limited in many areas. Based upon the IFTDSS output at the 97th percentile, while a majority of the flame lengths are in the 1 to 4 foot range, 19% of the project area has flame lengths greater than 4 feet. The mixed conifer stand and area of sagebrush in the southeast corner of the project area is where concentrations of flame lengths greater than 4 feet occur and should be a consideration in developing a treatment plan.

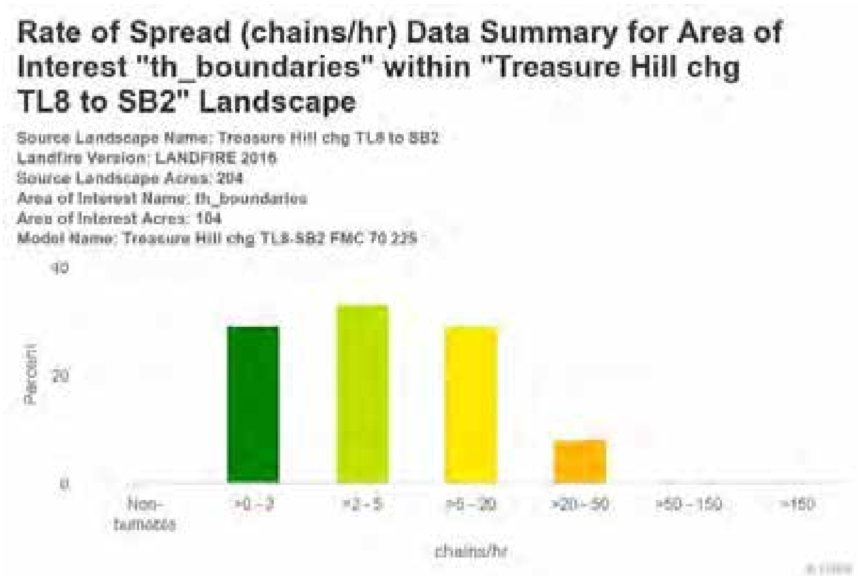


Flame Length (feet) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

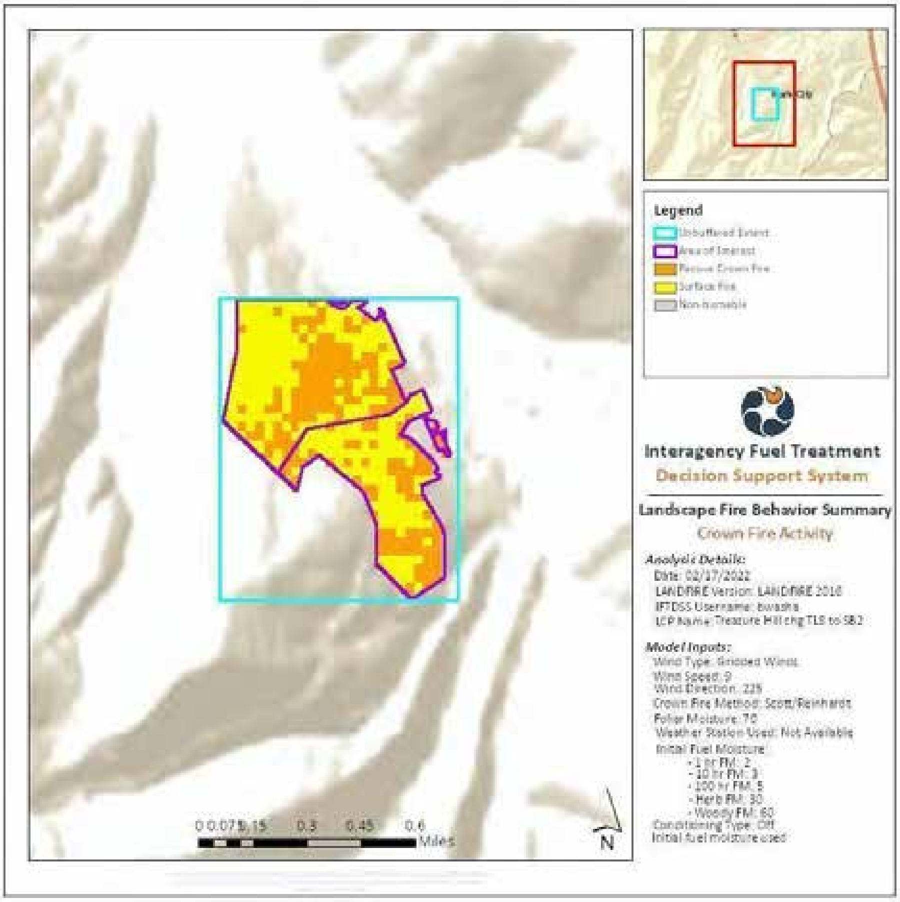
Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104
Model Name: Treasure Hill chg TL8-SB2 FMC 70 225

Rates of spread greater than 5 chains (66 feet/chain) per hour (ch/hr) can cause control problems by hand crews using direct attack as identified in the fire suppression interpretation table. Based upon the IFTDSS output, while not explosive, 37% of the project area has rates of spread of 5 ch/hr or greater at the 97th percentile. The mixed conifer stand and area of Gambel oak and sagebrush in the southeast corner of the project area are where rates of spread are greater than 5 ch/hr.



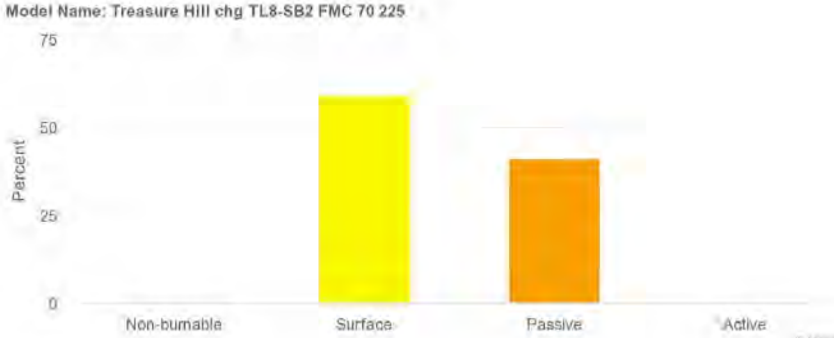


Knowledge of crown fire activity is important in understanding possible control issues, spotting, and potential fire effects. Several types of crown fire activity are identified including passive and active. Passive crown fire (intermittent or persistent torching) occurs where surface fire intensity is sufficient to ignite tree crowns, individually or in groups, but winds are not sufficient to support propagation from tree to tree. Ladder fuels are present to take the fire from the surface into the tree canopies. Active crown fire is not identified within the project area. Once fire becomes established within the canopy, control becomes problematic until the fire returns to the surface. Crown fire activity also has a higher probability of creating embers leading to spotting. While 59% of the fire will remain as a surface fire, 41% of the fire has potential in becoming passive fire. This is a rather high percentage and should be addressed when developing a treatment plan. Similar to areas of concern for flame length and rate of spread, the same areas within the mixed conifer, sagebrush, and Gambel oak have potential to experience passive crown fire.



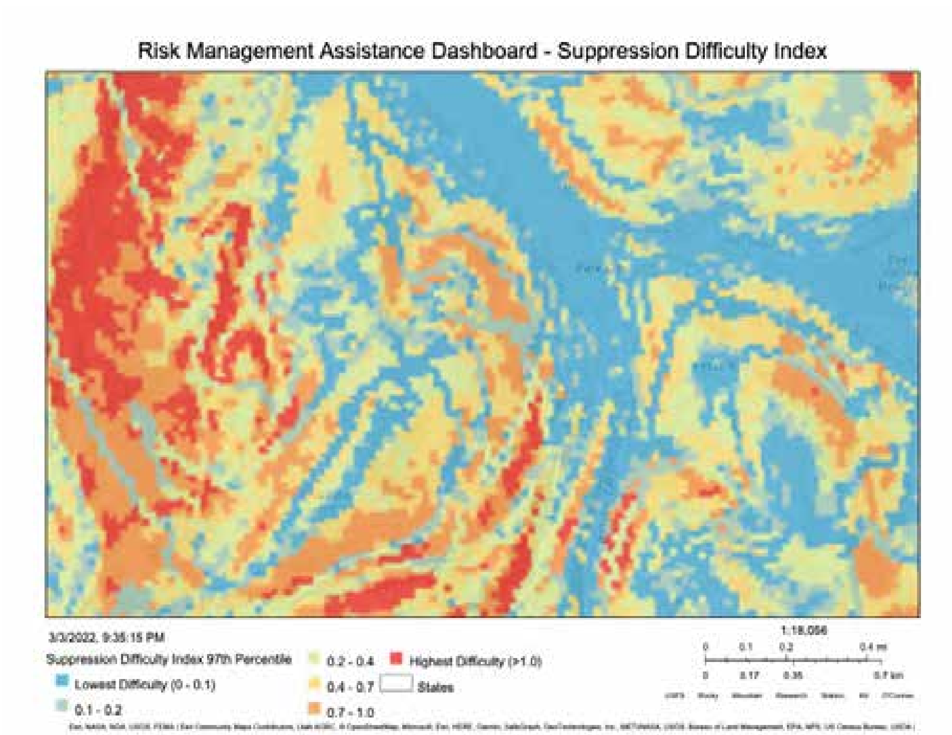
Crown Fire Activity Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104
Model Name: Treasure Hill chg TL8-SB2 FMC 70 225



While it is not believed a large fire front would directly impact Park City based upon the slope position at the bottom of the hill, concern exists for fire spotting into any area of the community adjacent and within the WUI. In general downhill fire movement would be a lower intensity backing fire. The exception to this would be a rare event with fire starting above the project area and being pushed down slope with a wind event such as a collapsing thunder cell to the west and pushing winds down slope/down canyon. A more likely scenario would be a human caused fire starting lower on the slope near Park City and running upslope or parallel to the slope and into the canopy of the mixed conifer, but with potential for spotting back into the community still existing.

The Suppression Difficulty Index (SDI) is a product of the Risk Management Assistance (RMA) dashboard from the Wildland Fire Management Research, Development, and Application. The SDI provides a spatial summary of “watch out” situations as well as areas with reduced risk to fire fighters that can be used to facilitate strategic and tactical fire management decisions. While much of this information is intuitive to firefighters on the ground, the spatial overlay can also be used to help with strategic decision making and fuels management planning. The current generation of SDI does not directly address snag hazards. With the forest health decline, snags are a concern for firefighter safety in both the mixed conifer and aspen stands.



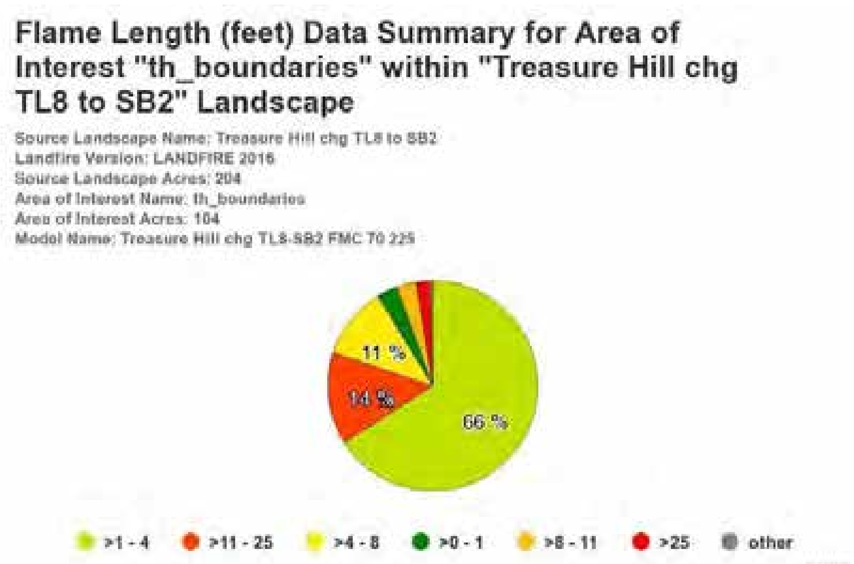
Areas where the SDI was run at the 97th percentile and outputs are at the 0.4 - 0.7 and 0.7 - 1.0 should be highlighted for potential control concerns. This includes areas where access is a concern and where fuels promote greater flammability. Firefighting and access concerns include the areas of white fir in the center along with the southern extent of the project area.

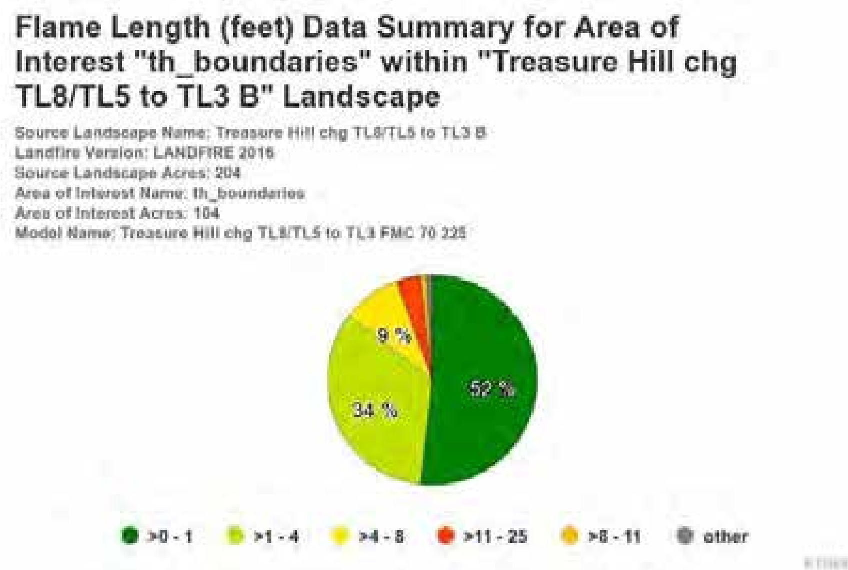
Areas where mixed conifer and continuous sagebrush along with Gambel oak exist are of greatest concern for higher levels of flammability. Looking to promote future vegetation conditions for areas that are not highlighted in the fire behavior analysis or by the SDI should be considered. This would include expanding the extent of aspen and maple hardwoods where such is being encroached upon within the Treasure Hill project area as these areas promote lower fire intensities.

Treatment Effects

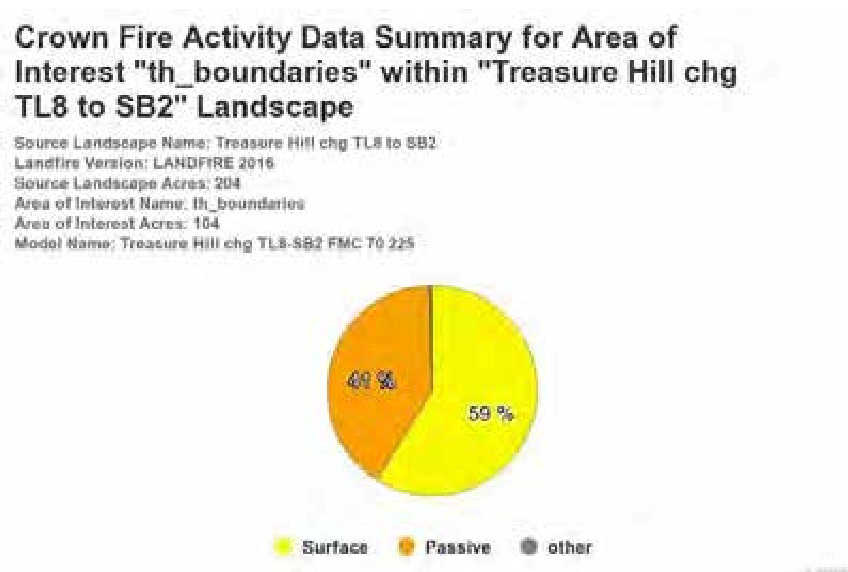
To see the effects of fuel treatments to fire behavior within the Treasure Hill project area, the area of mixed conifer was modeled as a TL3 (183) Moderate Load Conifer Litter. Thus the SB2 – slash-blowdown and TL5 – timber litter – high load conifer litter were globally changed over the entire project area to TL3. In TL3 the primary carrier of fire is moderate load conifer litter and light load of coarse fuels. The TL3 considers that most of the dead standing and down fuels are removed and ladder fuels reduced with limbing of the conifers. This results in a spread rate of very low and flame length of low.

When looking at the fire behavior outputs, the flame length of 0-4 feet changes from occurring within 69% of the project area to 86%. This is a significant change and impacts the ability to use direct attack with hand crews as a suppression strategy. Specifically in the 0-1 foot range, an increase following treatment occurred from 3% to 52%.





Another fire behavior output of concern in the Existing Condition (EC) within the project area is the high percentage of passive crown fire at 41%. Once fire becomes established as a crown fire, suppression opportunities are limited and potential for spotting increases. With the reduction of ladder fuels and dead fuels, passive crown fire is reduced to 7%. Areas of passive crown fire remain primarily within the southeast corner within the sagebrush and Gambel Oak along with pockets on top of the unit in the northwest corner within the mixed conifer stand.



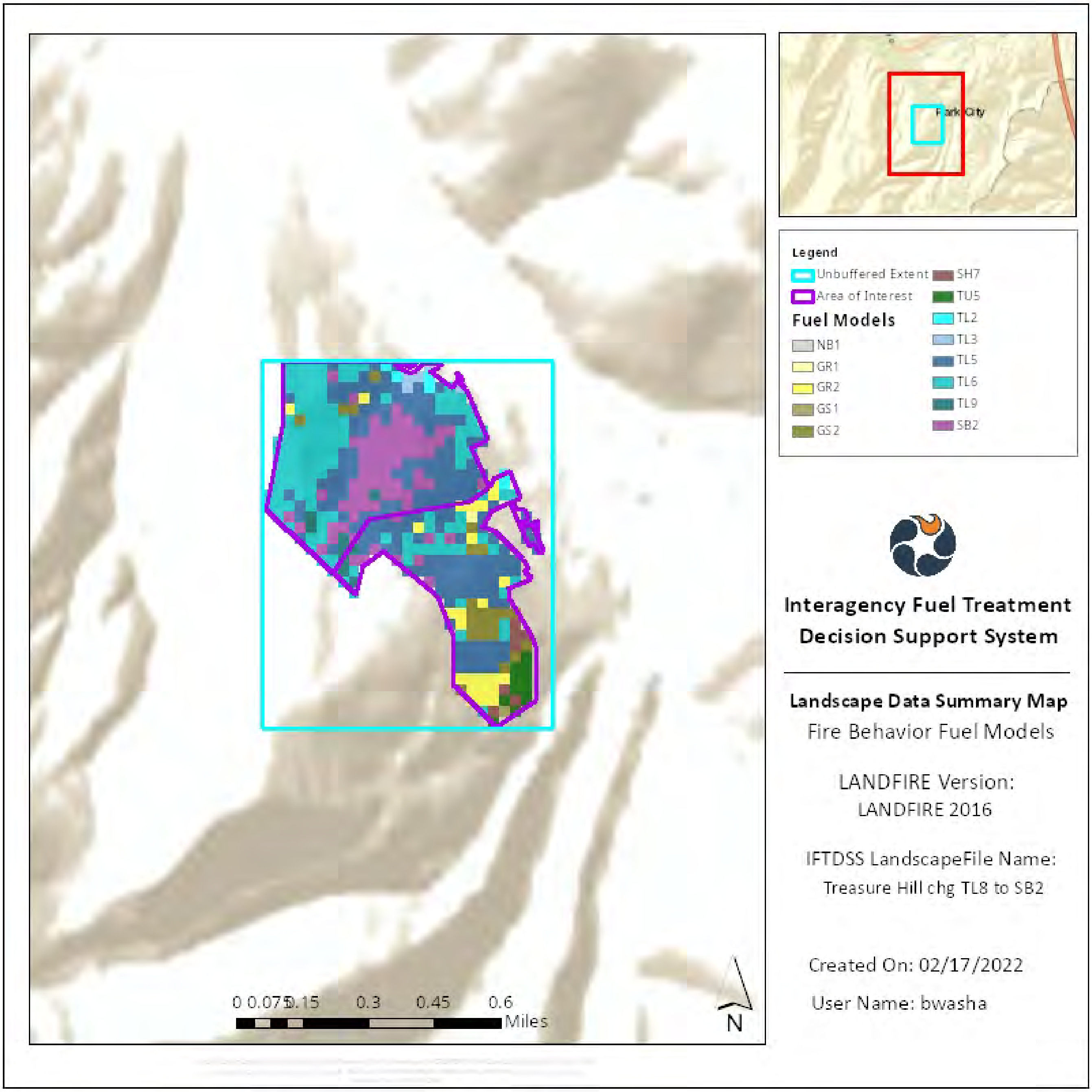
Crown Fire Activity Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8/TL5 to TL3 B" Landscape

Source Landscape Name: Treasure Hill chg TL8/TL5 to TL3 B
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104
Model Name: Treasure Hill chg TL8/TL5 to TL3 FMC 70 225

Report: Landscape Summary
Landfire Version: LANDFIRE 2016
Landscape Name: Treasure Hill chg TL8 to SB2
Landscape Acres: 204
Area of Interest: th_boundaries

Prepared for: Bradley Washa
2/17/2022, 7:30:57 PM

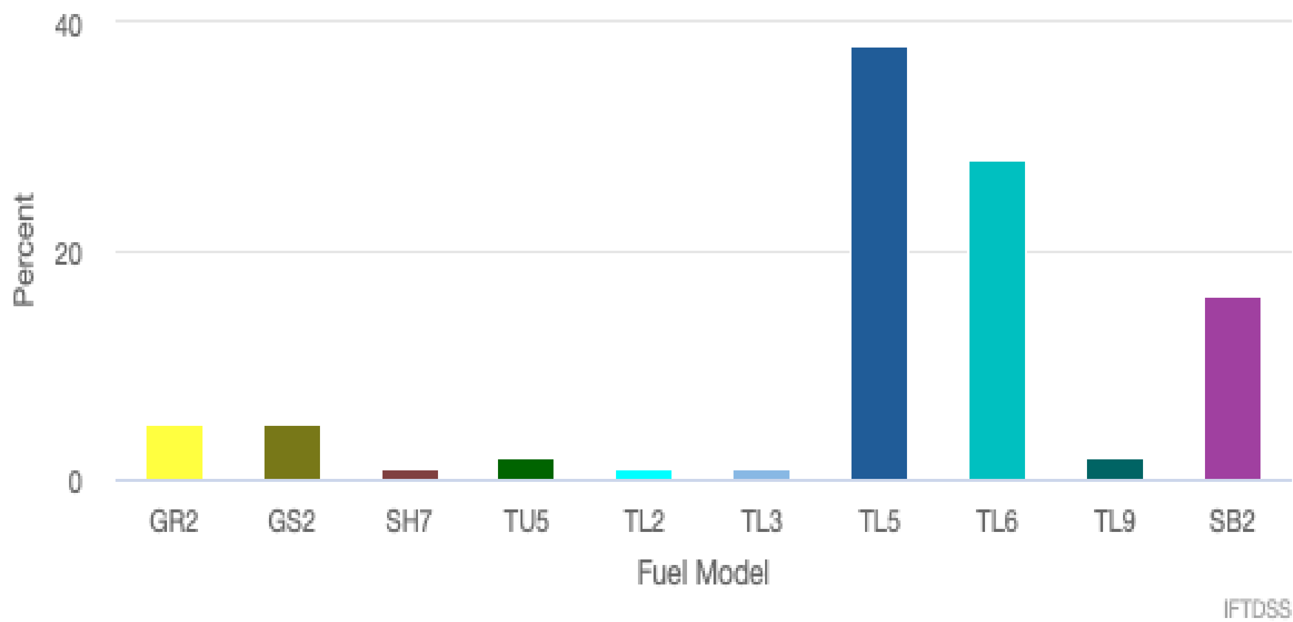
Fuel Model (FBFM)



Fuel Model (FBFM)

Fuel Model Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

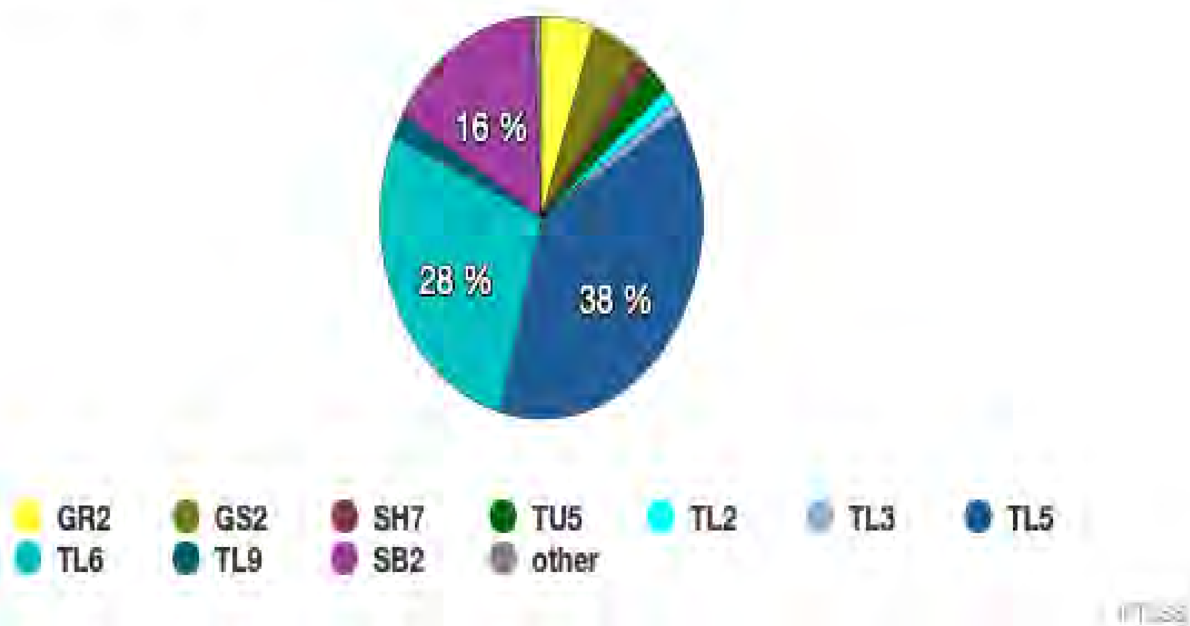
Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104
Distribution under 1% not shown



Fuel Model (FBFM)

Fuel Model Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104



IFTDSS

Fuel Model (FBFM)

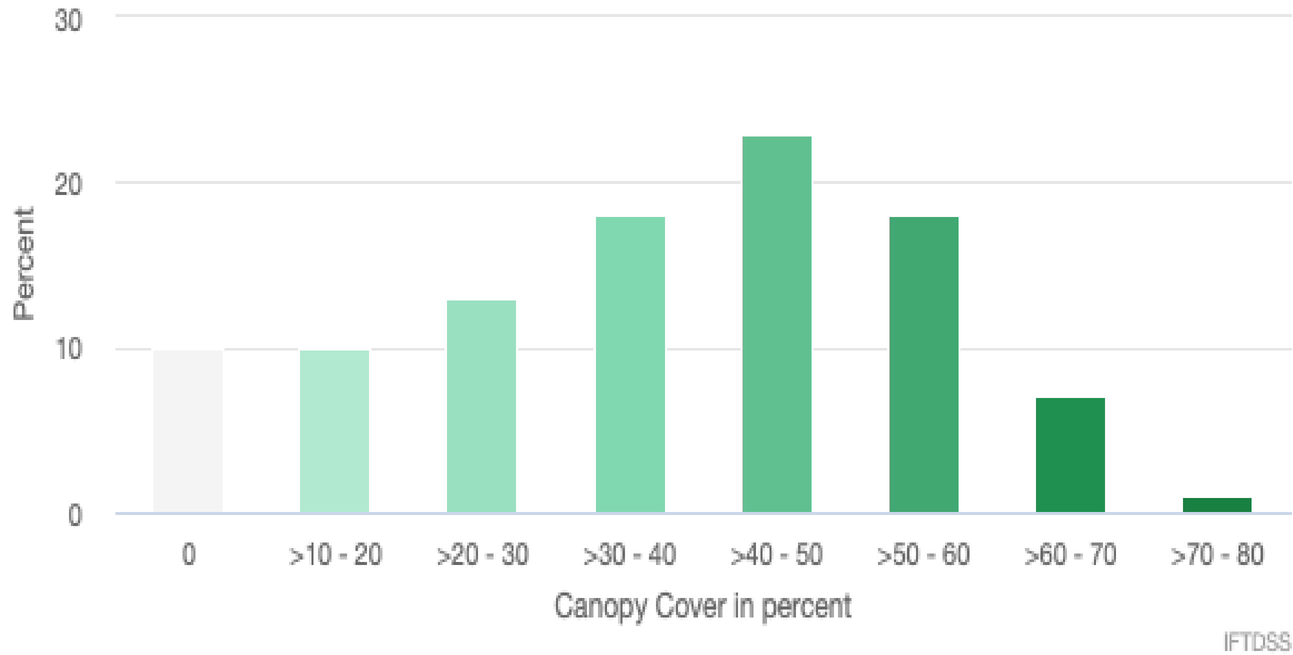
Fuel Model	Pixel Count (freq)	Acres In AOI	Percent In AOI
NB1 (91)	2	0	0
GR1 (101)	1	0	0
GR2 (102)	25	6	5
GS1 (121)	1	0	0
GS2 (122)	23	5	5
SH7 (147)	7	2	1
TU5 (165)	11	2	2
TL2 (182)	6	1	1
TL3 (183)	5	1	1
TL5 (185)	177	39	38
TL6 (186)	129	29	28
TL9 (189)	9	2	2
SB2 (202)	73	16	16

Canopy Cover

Canopy Cover

Canopy Cover (percent) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104



Canopy Cover

Canopy Cover (percent) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

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Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
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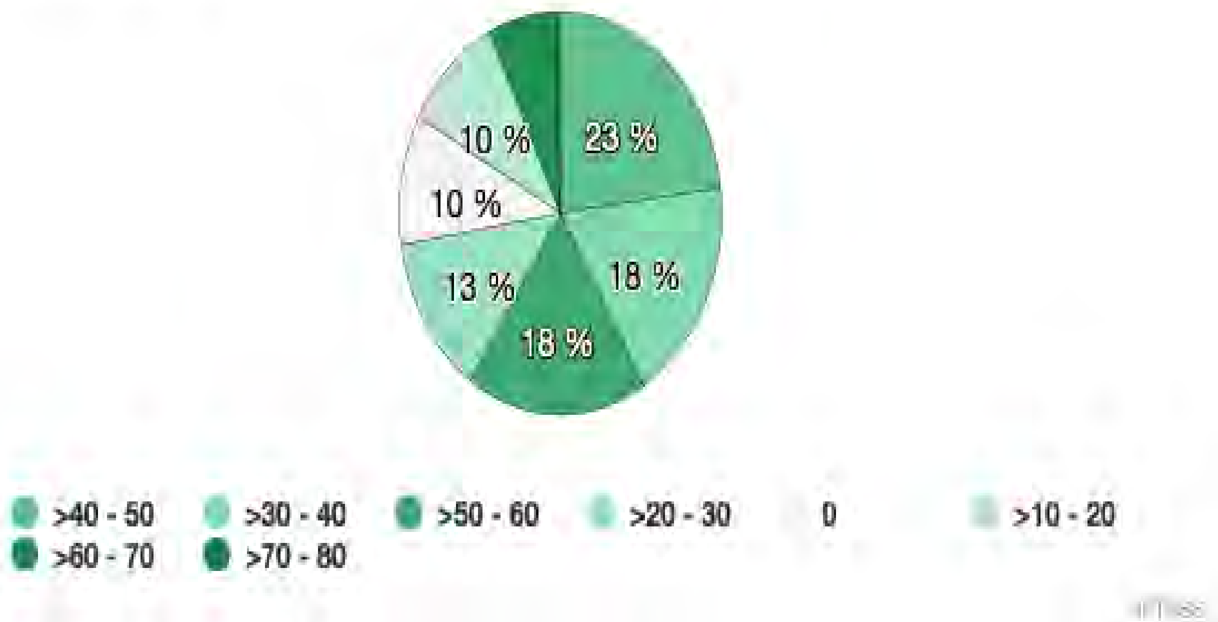
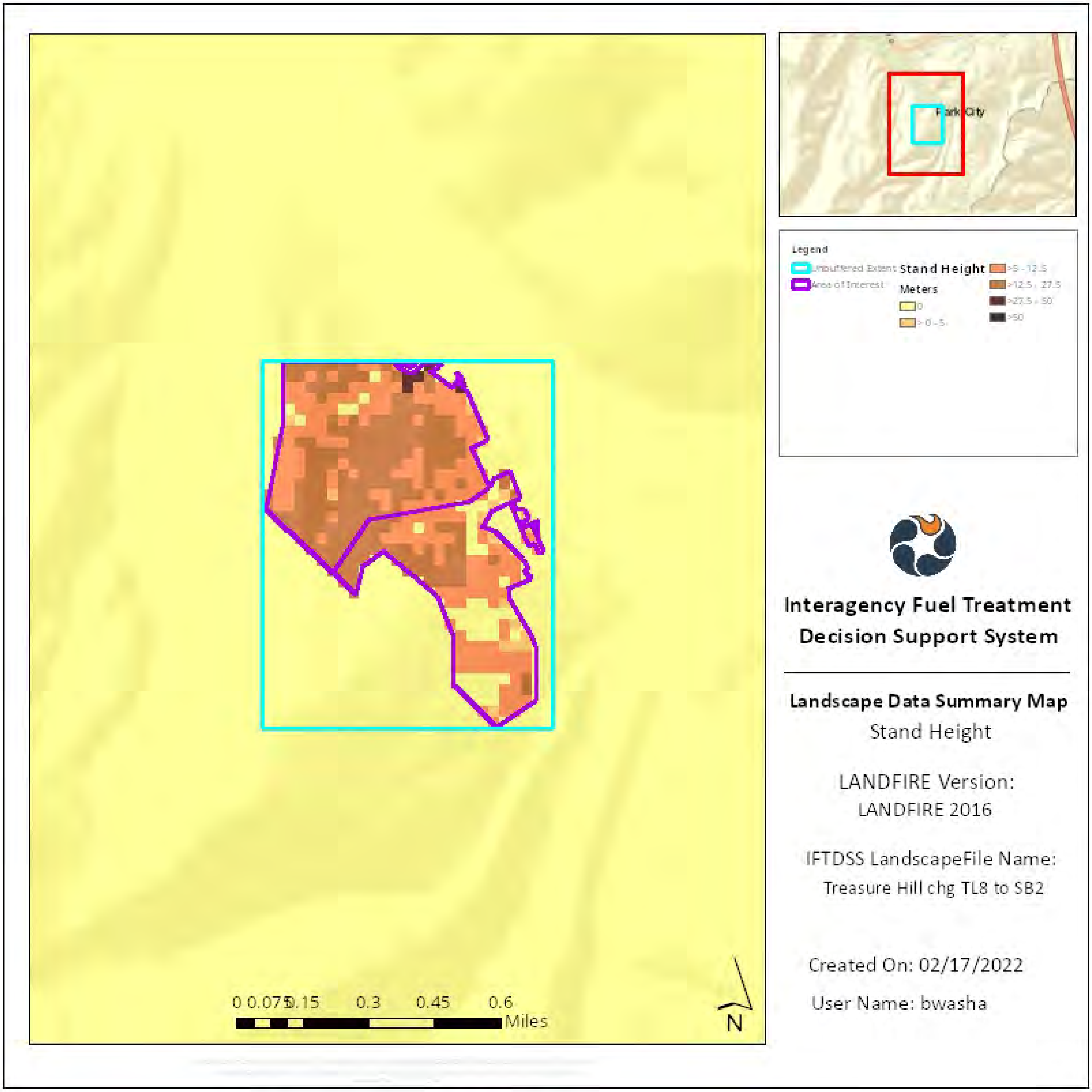


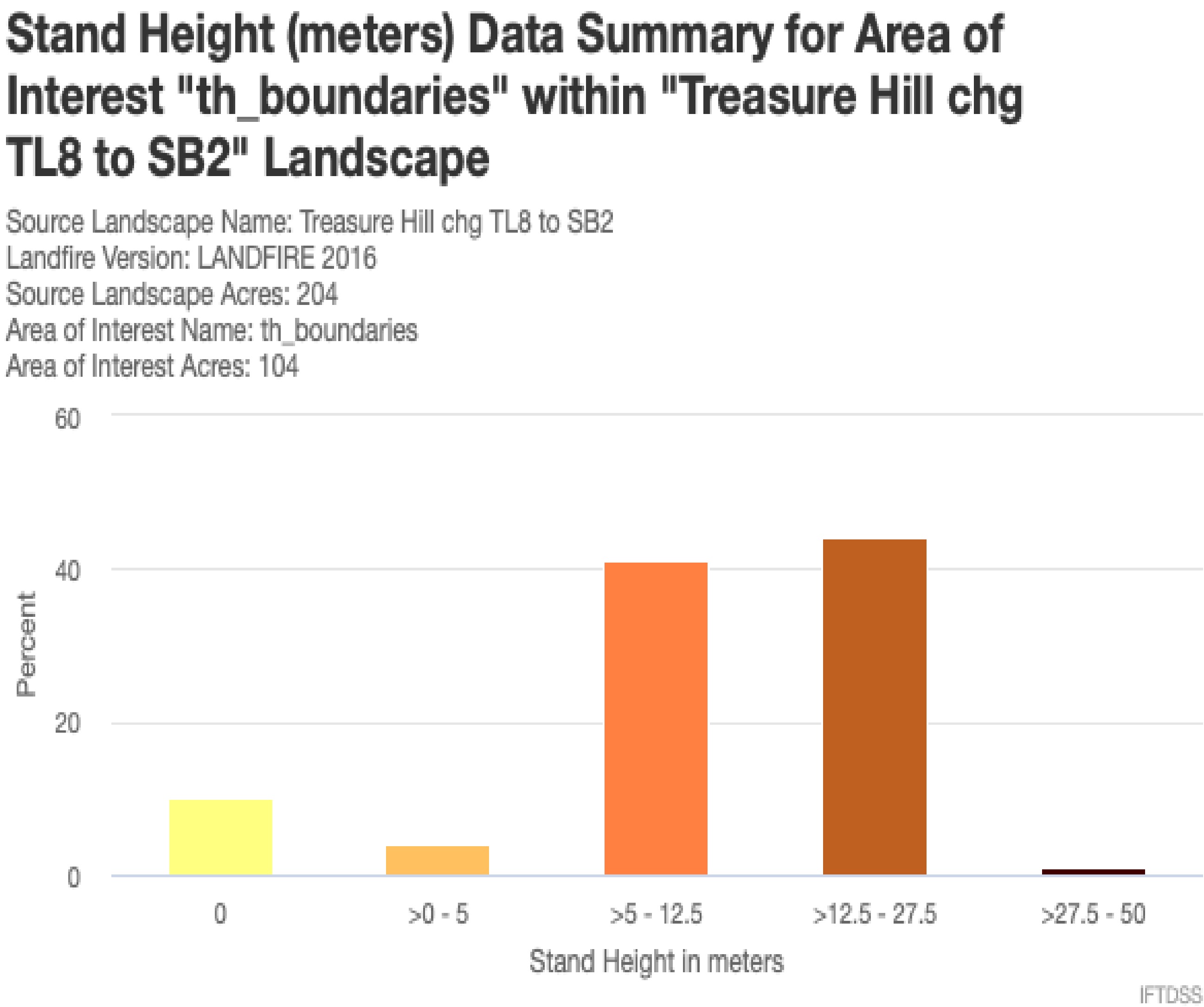
Canopy Cover

Canopy Cover (percent)	Pixel Count (freq)	Acres In AOI	Percent In AOI
0 (non-forested)	49	11	10
>10 - 20	46	10	10
>20 - 30	61	14	13
>30 - 40	86	19	18
>40 - 50	108	24	23
>50 - 60	85	19	18
>60 - 70	31	7	7
>70 - 80	3	1	1

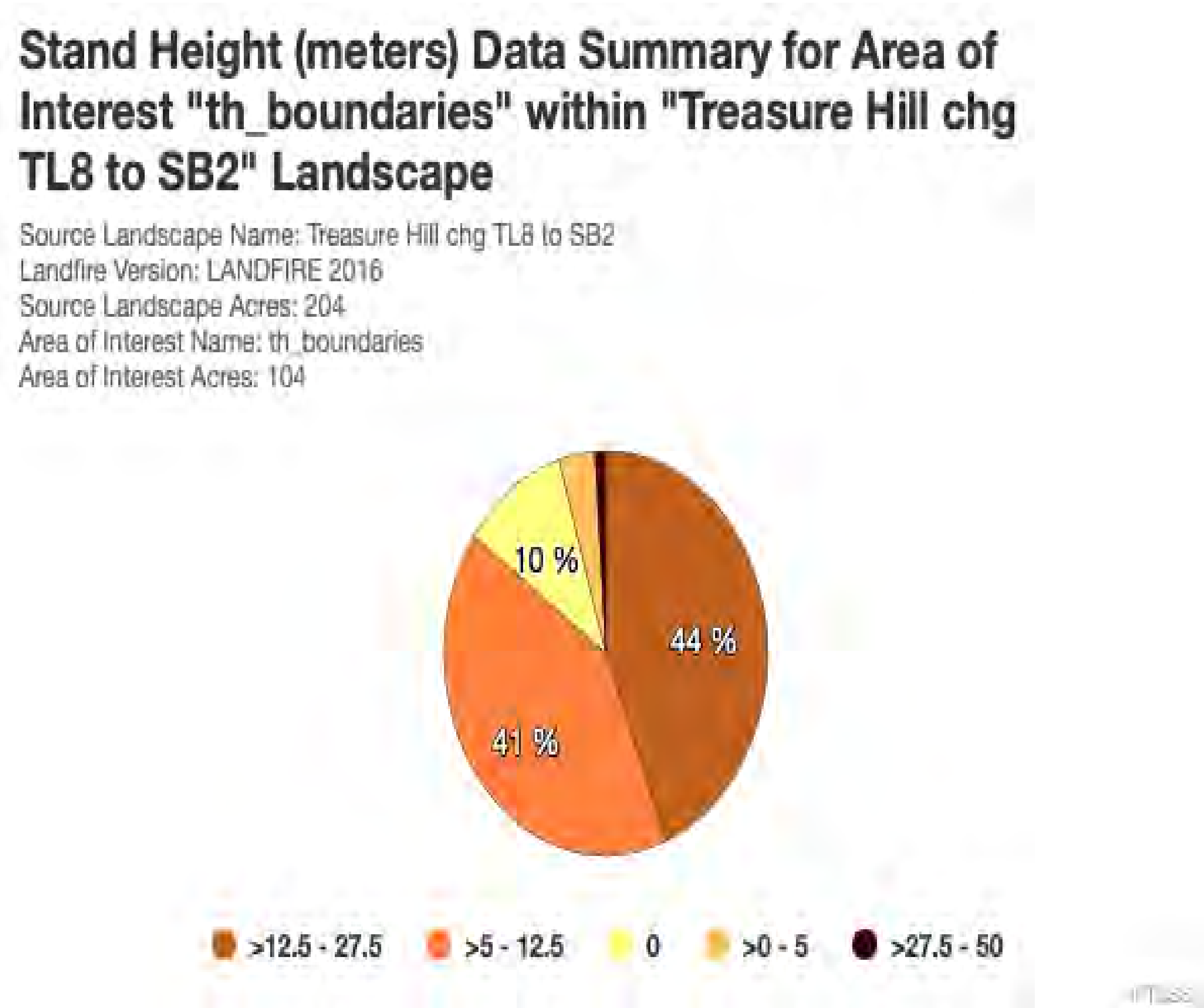
Stand Height



Stand Height



Stand Height

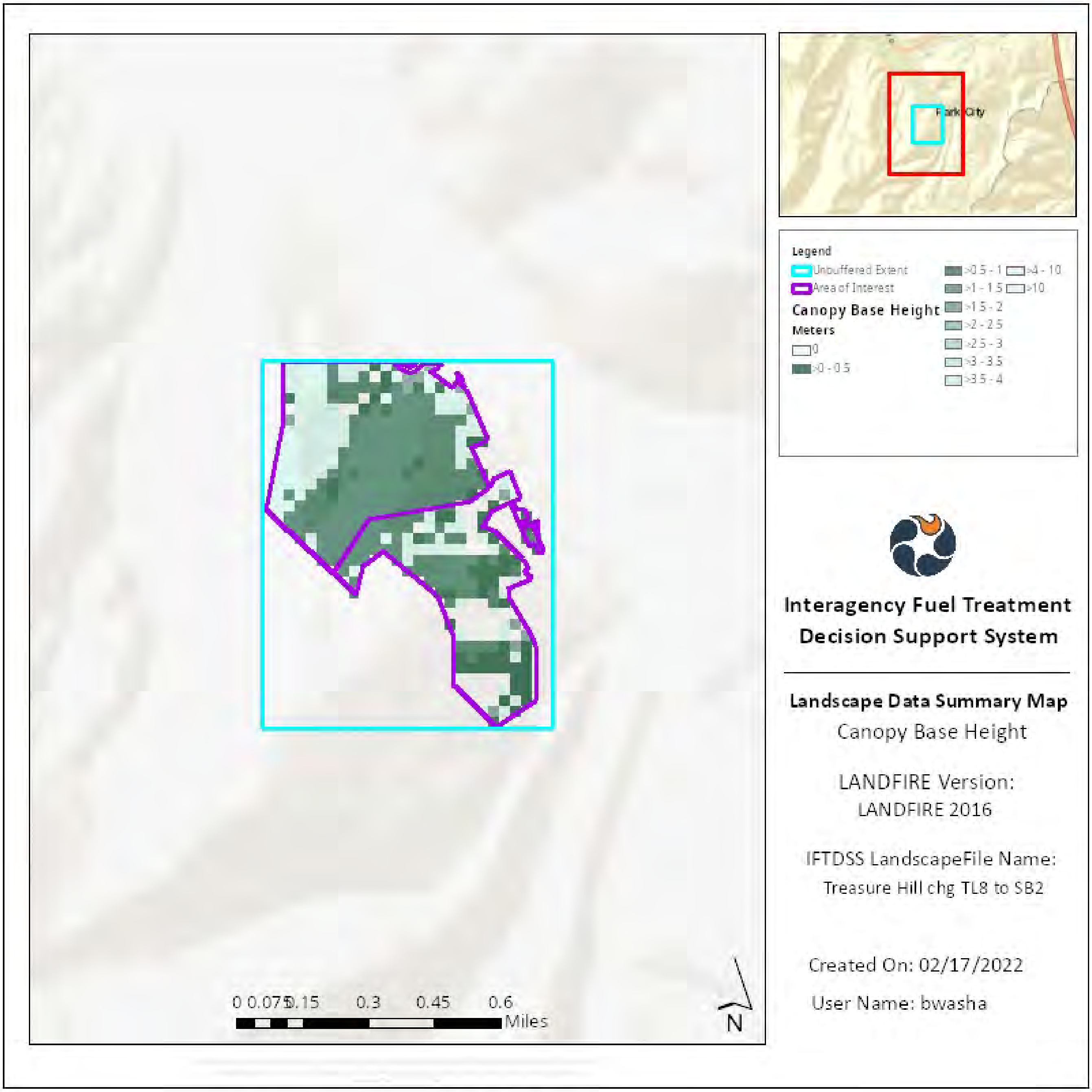


IFTDSS

Stand Height

Stand Height (meters)	Pixel Count (freq)	Acres In AOI	Percent In AOI
0 (non-forested)	49	11	10
>0 - 5	17	4	4
>5 - 12.5	192	43	41
>12.5 - 27.5	206	46	44
>27.5 - 50	5	1	1

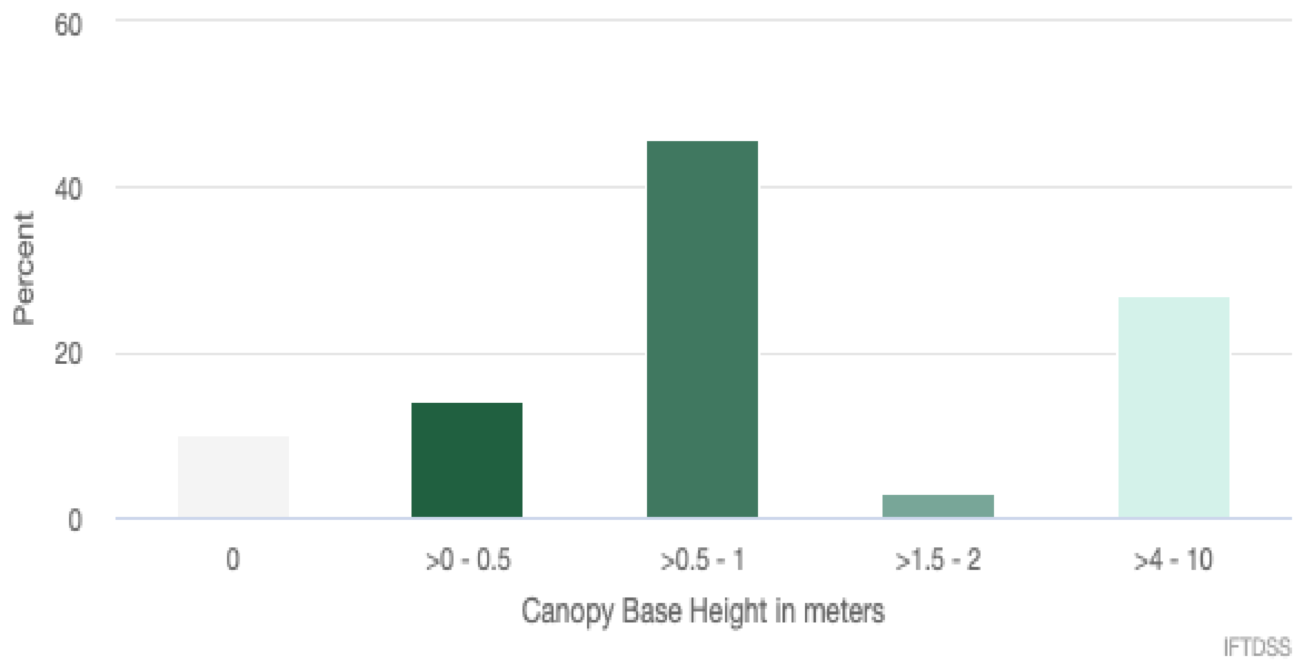
Canopy Base Height



Canopy Base Height

Canopy Base Height (meters) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104



Canopy Base Height

Canopy Base Height (meters) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

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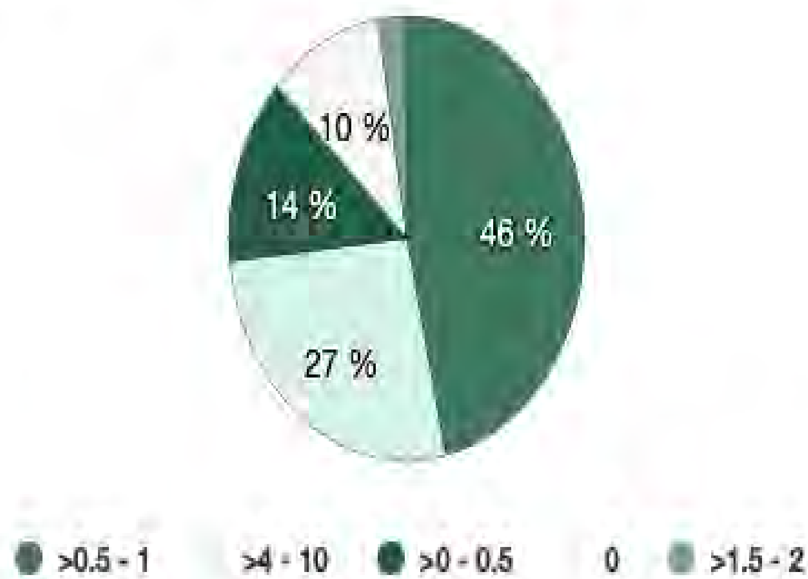


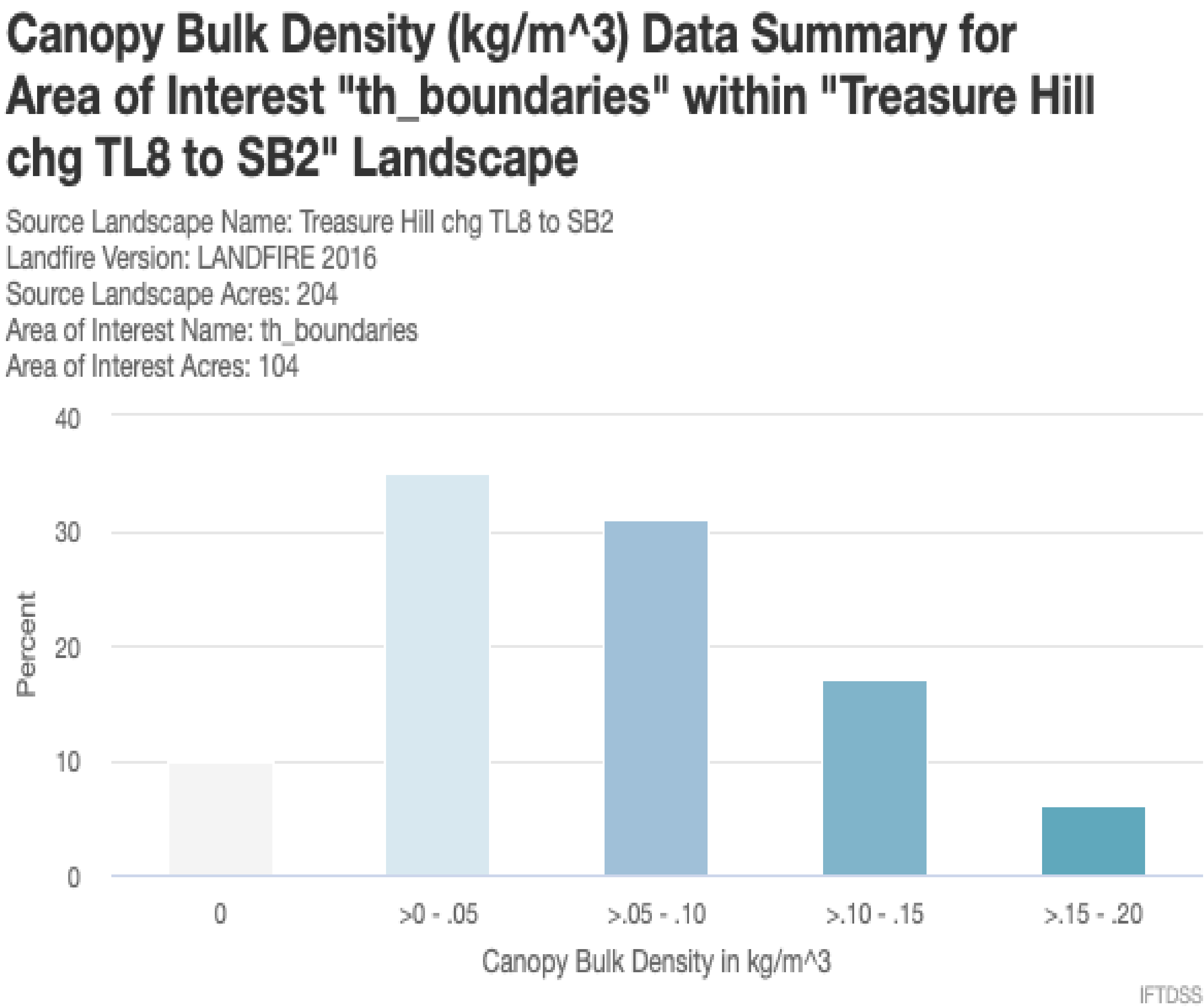
IFTDSS

Canopy Base Height

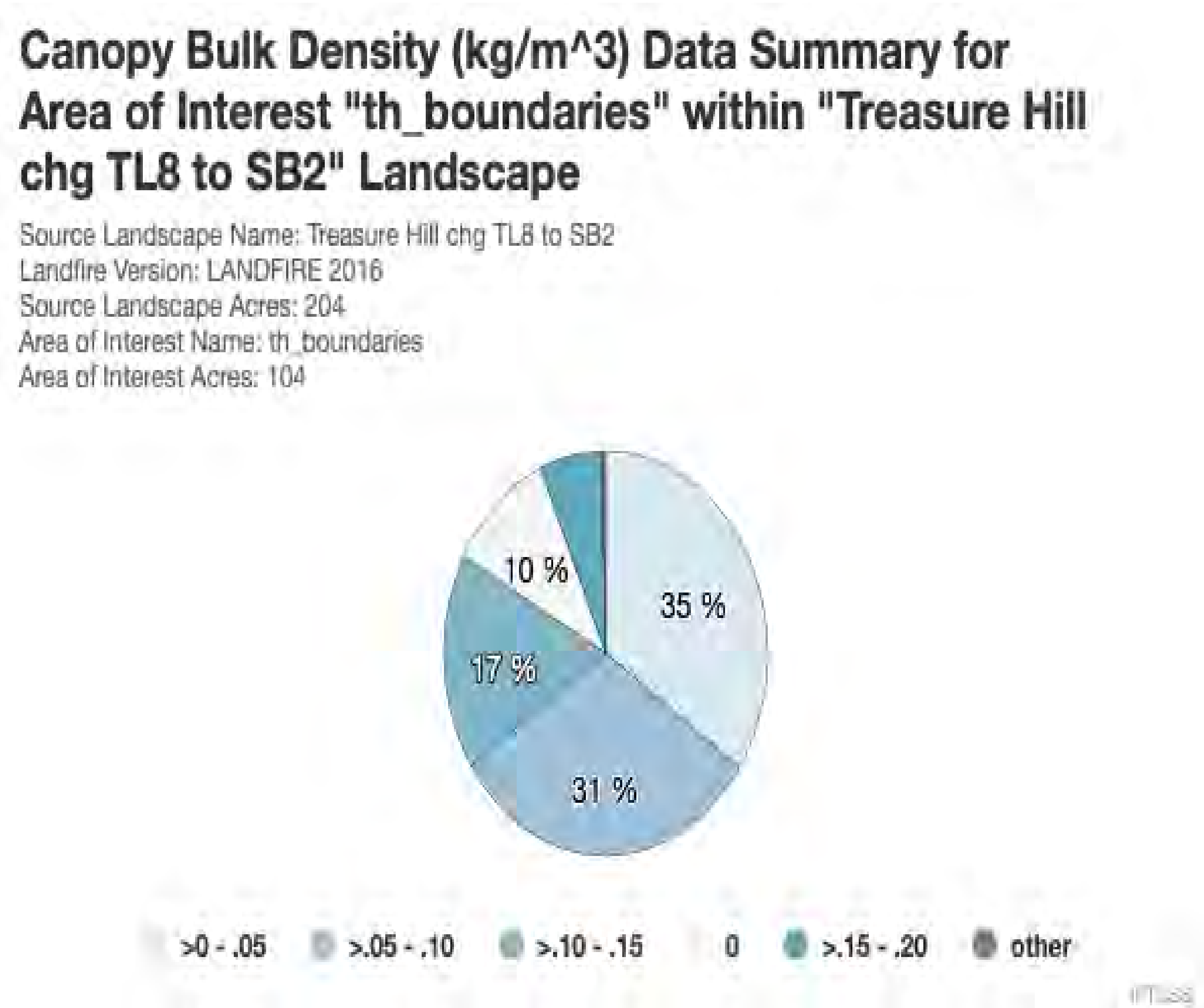
Canopy Base Height (meters)	Pixel Count (freq)	Acres In AOI	Percent In AOI
0 (non-forested)	49	11	10
>0 - 0.5	64	14	14
>0.5 - 1	218	48	46
>1.5 - 2	12	3	3
>4 - 10	126	28	27

Canopy Bulk Density

Canopy Bulk Density



Canopy Bulk Density

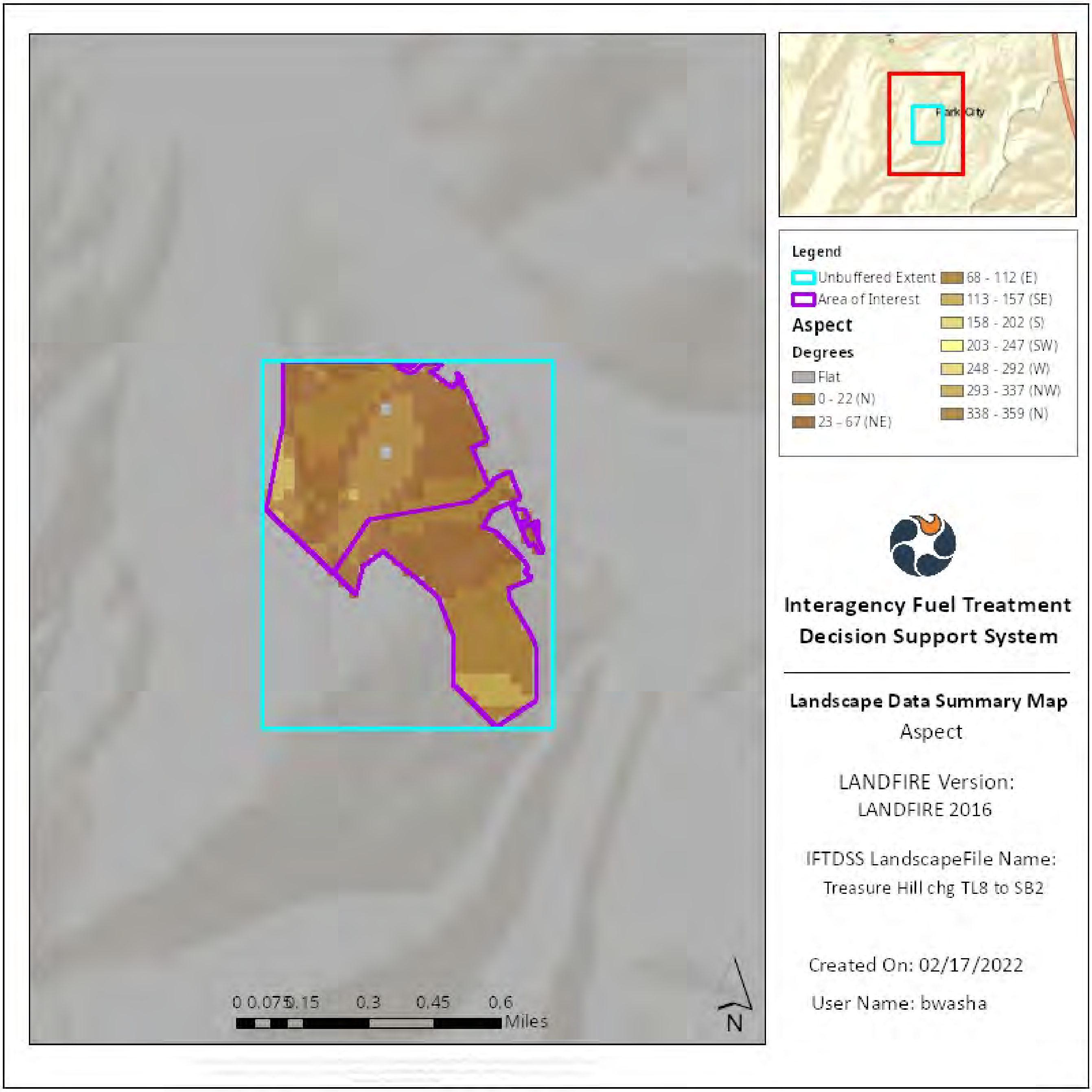


IFTDSS

Canopy Bulk Density

Canopy Bulk Density (kg/m^3)	Pixel Count (freq)	Acres In AOI	Percent In AOI
0 (non-forested)	49	11	10
>0 - .05	162	36	35
>.05 - .10	146	32	31
>.10 - .15	81	18	17
>.15 - .20	29	6	6
>.20 - .25	2	0	0

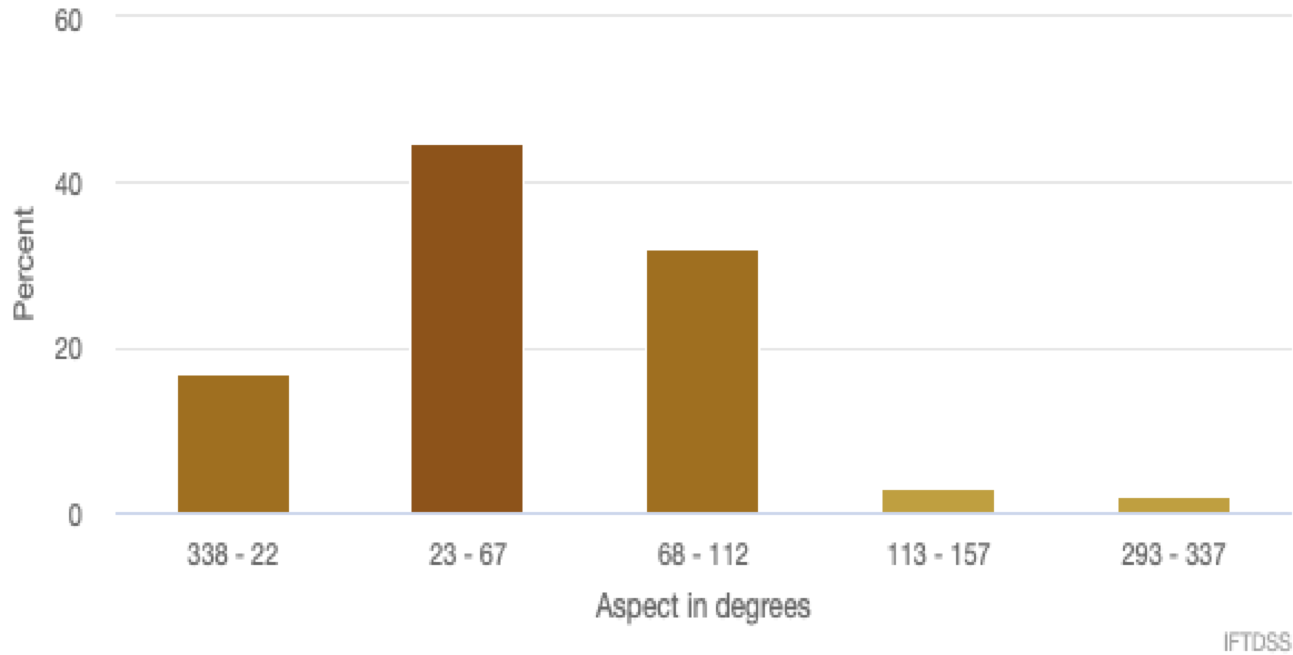
Aspect


Park City
Legend
Unbuffered Extent
Area of Interest
Aspect
Degrees
Flat
0 - 22 (N)
23 - 67 (NE)
68 - 112 (E)
113 - 157 (SE)
158 - 202 (S)
203 - 247 (SW)
248 - 292 (W)
293 - 337 (NW)
338 - 359 (N)
Interagency Fuel Treatment Decision Support System
Landscape Data Summary Map
Aspect
LANDFIRE Version:
LANDFIRE 2016
IFTDSS LandscapeFile Name:
Treasure Hill chg TL8 to SB2
Created On: 02/17/2022
User Name: bwasha
0 0.075 0.15 0.3 0.45 0.6
Miles
N

Aspect

Aspect (degrees) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104



IFTDSS

Aspect

Aspect (degrees) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

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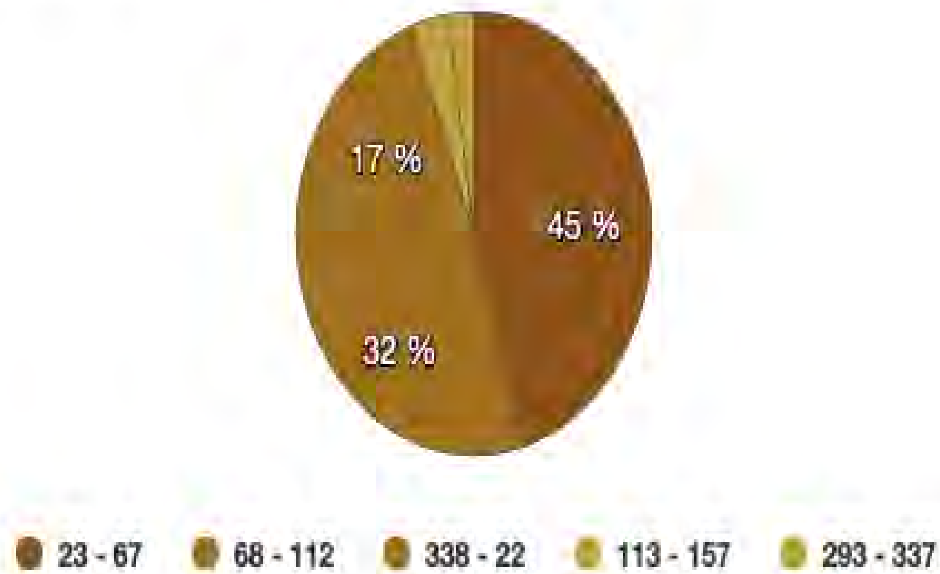
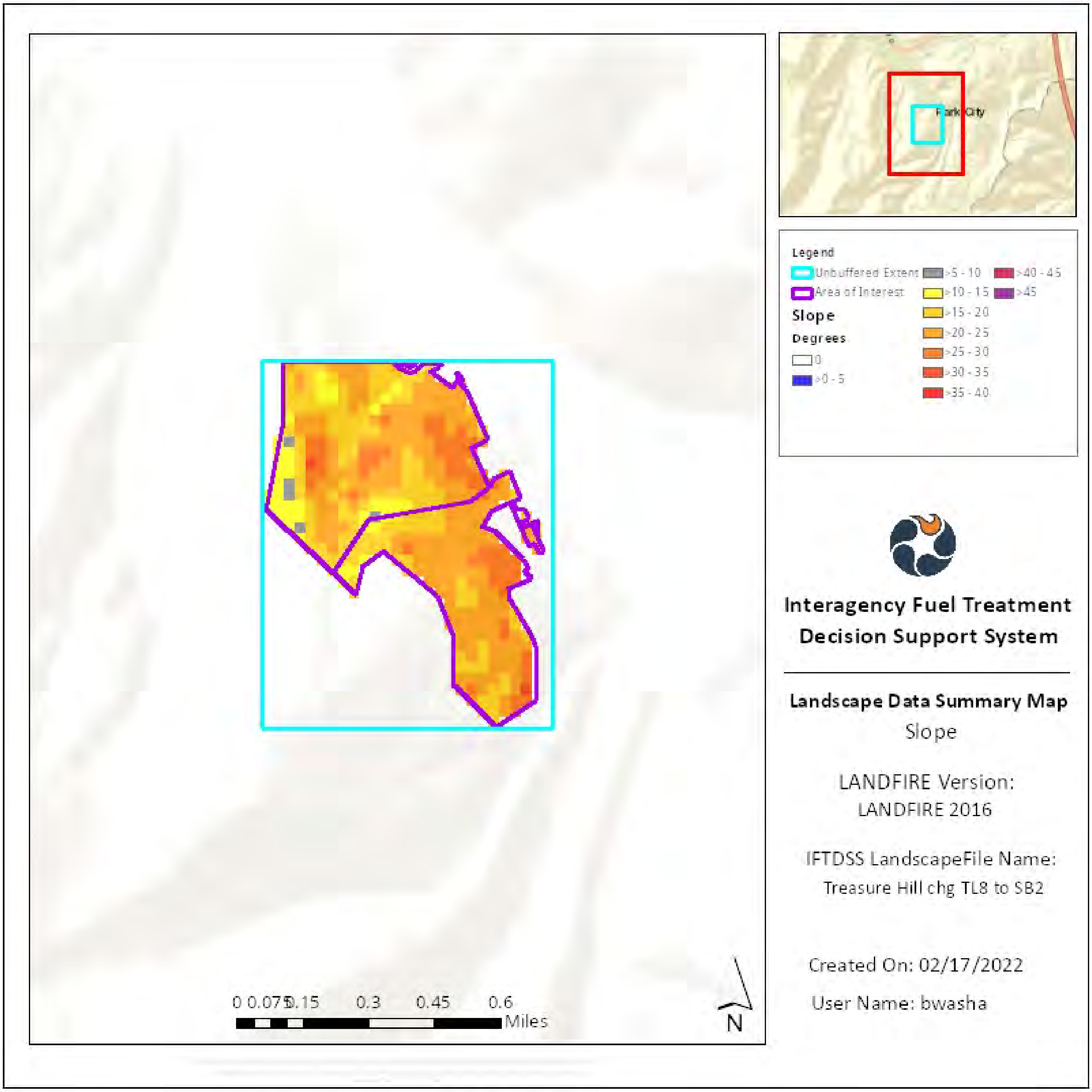


IFTDSS

Aspect

Aspect (degrees)	Pixel Count (freq)	Acres In AOI	Percent In AOI
338 - 22 (N)	79	18	17
23 - 67 (NE)	213	47	45
68 - 112 (E)	150	33	32
113 - 157 (SE)	16	4	3
293 - 337 (NW)	11	2	2

Slope

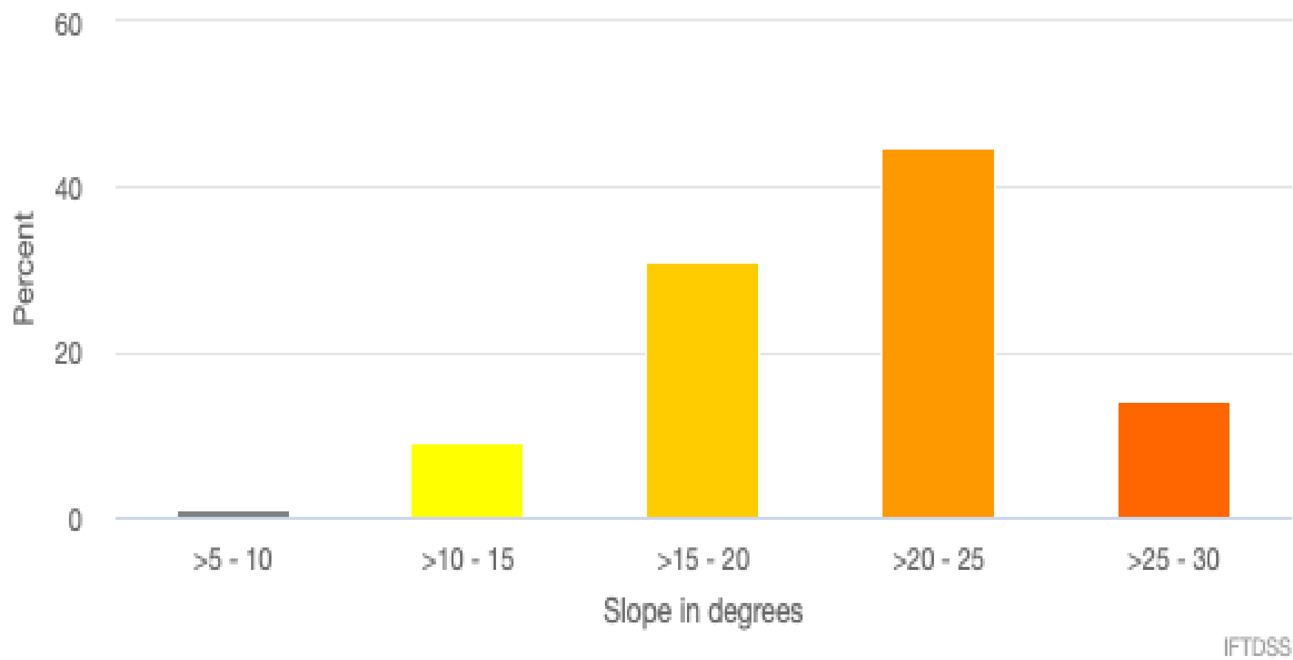


IFTDSS

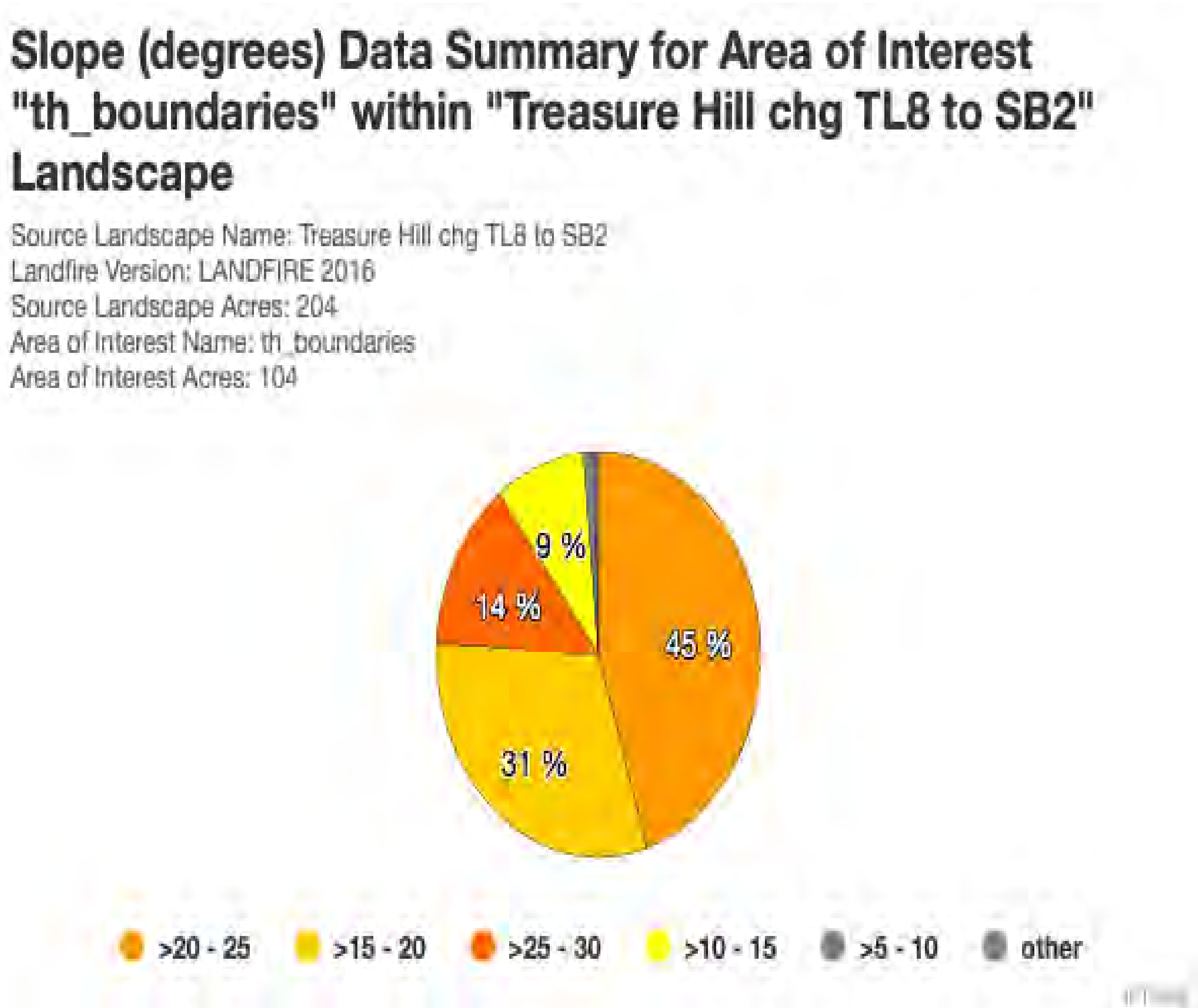
Slope

Slope (degrees) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104



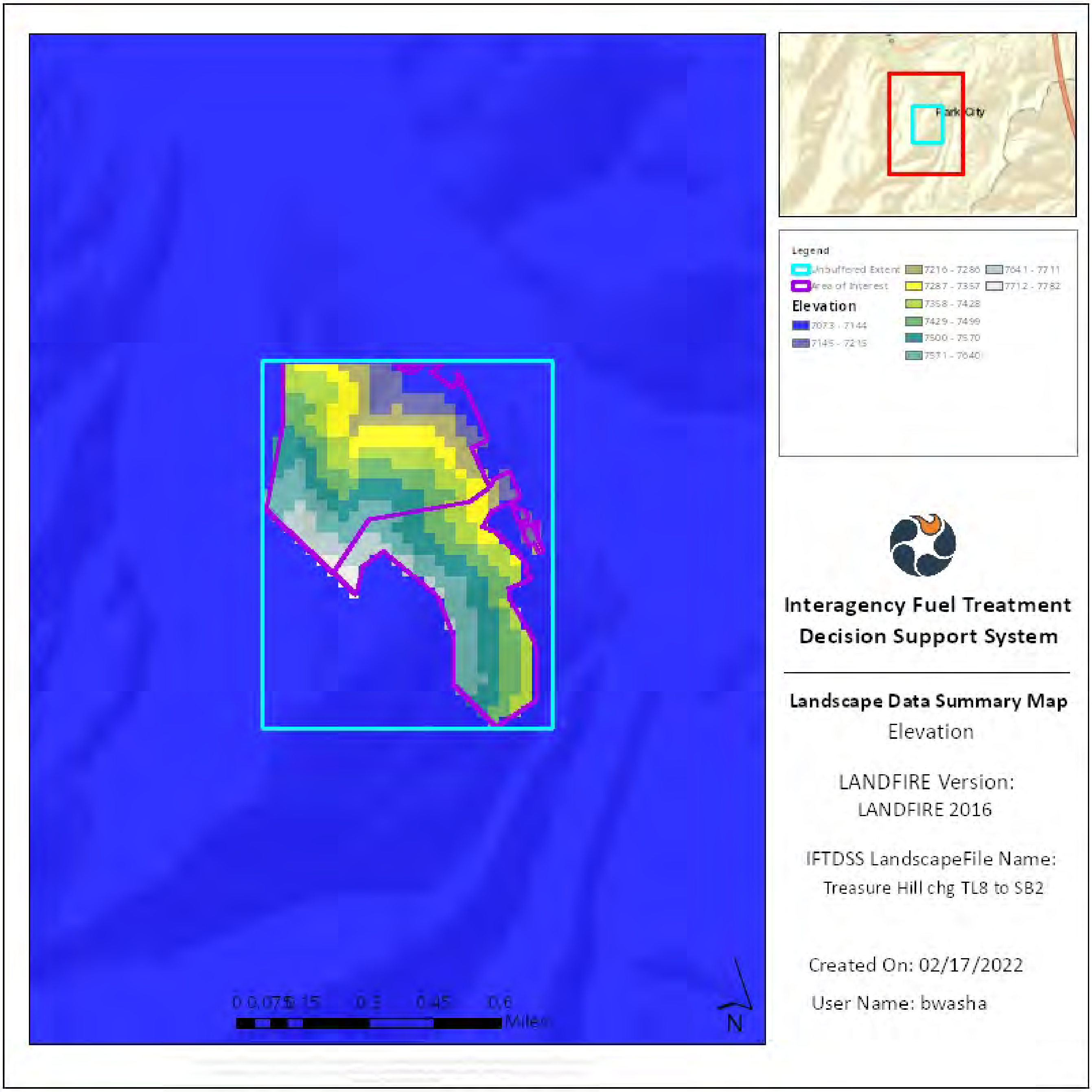
Slope


Slope (degrees) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape
Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104
9 %
14 %
45 %
31 %
>20 - 25
>15 - 20
>25 - 30
>10 - 15
>5 - 10
other

Slope

Slope (degrees)	Pixel Count (freq)	Acres In AOI	Percent In AOI
>5 - 10	5	1	1
>10 - 15	42	9	9
>15 - 20	144	32	31
>20 - 25	212	47	45
>25 - 30	64	14	14
>30 - 35	2	0	0

Elevation

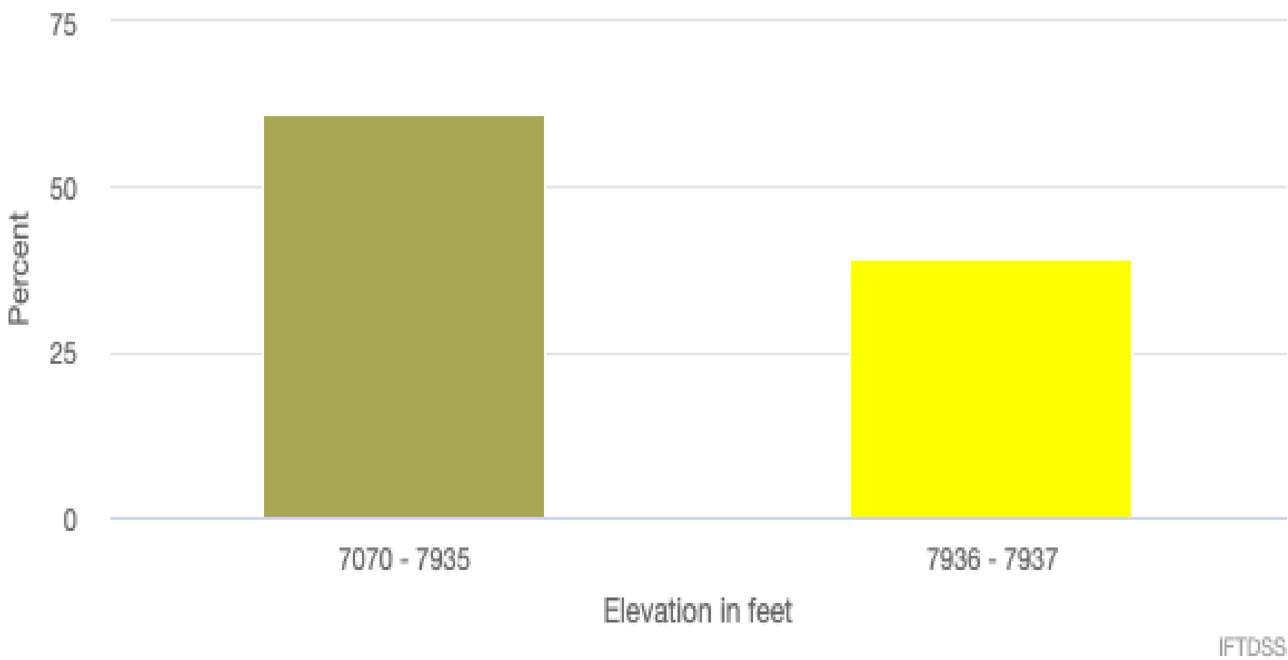


IFTDSS

Elevation

Elevation (feet) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

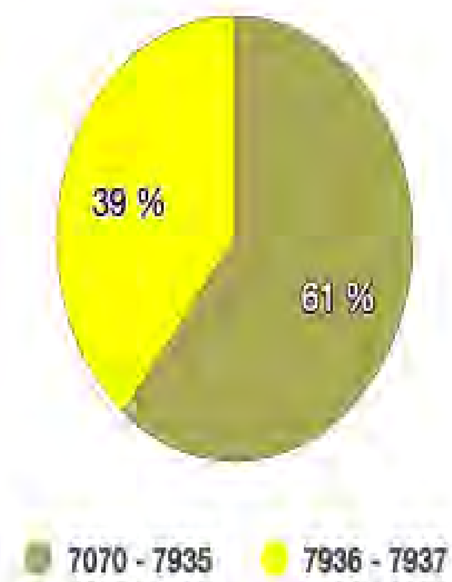
Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104



Elevation

Elevation (feet) Data Summary for Area of Interest "th_boundaries" within "Treasure Hill chg TL8 to SB2" Landscape

Source Landscape Name: Treasure Hill chg TL8 to SB2
Landfire Version: LANDFIRE 2016
Source Landscape Acres: 204
Area of Interest Name: th_boundaries
Area of Interest Acres: 104



IFTDSS

Elevation

Elevation (feet)	Pixel Count (freq)	Acres In AOI	Percent In AOI
7070 - 7935	285	63	61
7936 - 7937	184	41	39

Appendix F

Silviculture and Fuels/Fire Prescriptions

SILVICULTURAL and FUELS/FIRE PRESCRIPTION
Treasure Hill Conifer Stand: Description and Treatment Plan

LANDOWNER: Park City PARCEL: Treasure Hill STAND(s): Mixed Conifer

LEGAL: T2S R4E Sec 16 SIZE: 33 ac ELEVATION: 7,200 – 7,800 SLOPE: avg. 40% ASPECT: NE

HISTORIC: S. Rocky Mtn Mesic Montane Mixed Conifer STRUCTURE STAGE: Mid & Late Development - Closed

FUEL MDL: TL5 – 14 ac (45%), SB2 – 12.9 ac (39%), TL6 – 4 ac (12%) and other 1.2 ac (4%)

DATA COLLECTION: Formal stand exam plots 10/2021 by Alpine Forestry.

EXISTING STAND CONDITION:

This is a mixed conifer stand dominated by white fir (WF) with very few Douglas-fir (DF) scattered throughout the stand. Average tree size is small: approximately 9 inches diameter, on average. High stand densities prevail throughout the stand with an average of 222 trees per acre and 100 square feet of basal area per acre. Extensive mortality has occurred throughout the stand with 122 snags per acre (approximately 35% of all trees per acre), on average. Regeneration is minimal.

SILVICULTURAL SYSTEM: Uneven-aged management – This unit will receive a combination of variable density thinning and gap creation.

PRIMARY CONSIDERATIONS: High aesthetic value, ski lift runs through unit, multiple trails, avalanche potential release areas TH001, TH002, TH003, and TH004 **(prescription alteration required TH002, TH004),** invasive weeds.

OVERVIEW: SILVICULTURE AND FUELS TREATMENT PLAN (All current and planned activities):

TIME (YR)	TREATMENT DETAIL
0-1	Phase 1, reduce fire risk: Pile and burn excess down woody material or remove off-site, limb live trees, remove hazardous trees and snags around high-use areas.
1	Phase 2, continued fuel reduction activities: piling of excess down woody material and burn or off-site removal, limb live trees, remove snags throughout stand to meet fuels objectives.
2-3	Phase 3: Create openings in overstory through removal of white fir on 5 to 10 acres across the property. Thin trees. Pile and burn activity slash.
3	Phase 3: Prepare site for artificial planting through weeding and shrub removal.
4	Plant/interplant with Douglas-fir (DF) in created openings at 12' x 12' spacing, space off desirable leave trees and from edges of opening. Expect some natural WF to naturally establish. Shrub competition may be a concern if planting is delayed after site prep. Estimated 5 to 7 acres and up to 1,000 DF seedlings planted.
5, 7	Survival and Growth Surveys at 1 and 3 years following planting; monitor shrub/grass competition
0-10	Remove invasive weed species by manual methods.
5	Reassessment of needed snag or hazard tree removal for public safety reasons.
15	Examine stand to determine thinning needs and growth response.
15-20	Precommercial thinning of regeneration. Favor aspen and DF over WF.
40-50	Commercial thinning, prescribed burning, or other activities to maintain healthy forest conditions.

Prescriptions are based on current vegetative conditions to determine objectives and treatment specifications. These conditions may change over time due to growth and mortality of vegetation, disturbance to the stand, wildlife considerations, or changing landowner objectives. A reassessment of prescription elements may be needed prior to implementation of specific phases or other forestry activities.

PREPARED BY: Alpine Forestry DATE: 03.15.22

OBJECTIVES (Desired End Results):

The primary objective is to immediately reduce the risk of undesirable fire effects to Treasure Hill and surrounding property (Phases 1 and 2 of treatment). A secondary objective is to trend the forest towards a more fire and climate-resilient structure (Phase 3 of treatment). Important design features for these treatments include the consideration of the heavy recreational use of the property, high aesthetic (scenic) value, wildlife, and avalanche potential.

Phase 1, reduce fire risk:

The focus of this phase is to begin management of fuel loading and tree mortality in the stand. The removal of dead and down material, thinning of small trees, limbing of live trees, and shrub removal would increase fire resistance in the short-term. The removal of hazardous trees and snags around high-use areas will decrease the threat to public safety. Manual and mechanical methods will remove and pile excess down woody material and snags on- or off-site. Prescribed burning will be used to burn piles on-site if removal off-site is not feasible. Some down woody material and snags will be left for soils, wildlife, and tree regeneration.

Phase 2, continued reduction of fire risk:

The second entry targets remaining excess fuel loading and tree mortality while also beginning to address stand density of live trees. Removal of snags will address on-going tree mortality and will help limit fire behavior and spread across the stand. Thinning and limbing of live green trees will take place through the entire stand, and will begin to create smaller openings that phase 3 can capitalize on. Excess down woody debris will be piled and burned or removed to an off-site location. Some down woody material and snags will be left for soils, wildlife, and tree regeneration.

Phase 3, manage forest composition and structure:

The removal of some green, live trees to create openings in the canopy would occur to reduce stand density and successfully regenerate more fire-tolerant species of Douglas-fir trees and aspen. There is a need to change stand composition to grow other species (Douglas-fir and potentially aspen) and increase diversity to environmental stressors. The removal of smaller diameter, live white fir trees will reduce tree densities, create a variable stand structure, and will create openings for growing other species. Douglas-fir will be planted in openings to increase the biodiversity of the site. Drought is a concern for regeneration since they are susceptible to desiccation, so some down woody debris will be left in openings to aid in moisture retention. Currently, the planned created openings are smaller than the recommended minimum for growing Douglas-fir, but larger openings will not meet other objectives. Created openings will follow a set of strategies to minimize effects to aesthetics (e.g. feathering edges, locating in areas away from lifts, and where slopes and other vegetation will minimize a view from town).

Prescribed burning, if used, will cause some direct tree mortality, stimulate grasses and shrubs, and maintain a more open stand structure. Prescribed burning will be completed prior to planting openings.

DETAILED TREATMENT PLAN (Specifications):

Phase 1:

- In all areas, remove down woody debris to minimize fuel loading:
  - Remove 80% of downed woody material 3-10 inches diameter.
  - Downed woody material >10 inches diameter will be left in place, bucked in lengths necessary to lay flat on the ground.
- Cut snags and other identified hazard trees within 1.5 times the snag/tree height targeting areas protecting infrastructure, trails, ski runs, and roads.
  - Hazard tree cleanup would follow specifications for downed woody debris.
  - Retain 1 to 2 snags >11 inches diameter per acre and 6 to 15 snags <11 inches diameter per acre where feasible (away from trails, roads, and other infrastructure to meet public safety objectives).
- Thin conifer regeneration <5 inches dbh to approximately 15 foot spacing between stems.
  - Leave species priority (most to least desirable): healthy aspen, DF, WF. As a rule, leave the healthiest trees first as exact spacing is not the desired outcome.
  - Spacing will not be met where existing densities are lower than target, or where trees do not meet the definition of "healthy."
- Remove conifer regeneration <5 inches dbh under drip lines of larger trees adding to ladder fuels.
- Limb 6 feet (leave a minimum of 30% of live crown ratio) of lower bole of live trees, targeting areas within 50 feet of infrastructure.
- Reduce understory hardwood shrubs by 60%, clearing around conifer drip lines and targeting ladder fuels.
- All material will be eliminated by piling and burning, lightly broadcast chipping, or hauling offsite.
- Burn piles when sufficiently cured to achieve at least 80% consumption of materials, and under conditions that minimize residual fire effects and risk of fire spreading beyond the piles.
- **No live conifer >6" DBH should be removed from PRA TH002 (Appendix D, Ex. 5).**
- **No fuels reduction activities involving live trees and shrubs will occur within PRA TH004, and no hardwood shrub fuels reduction should occur in the downslope area of TH004 (Appendix D, Ex. 5).**

Phase 2:

- Remove down woody debris that has accumulated after phase 1 completion.
  - Remove 80% of downed woody material 3-10 inches diameter.
  - Downed woody material >10 inches diameter will be left in place, bucked in lengths necessary to lay flat on the ground.
- Remove snags throughout the stand that are concerns for fuels/fire mitigation or points of ignition.
  - Retain 1 to 2 snags >11 inches diameter per acre and 6 to 15 snags <11 inches diameter per acre where feasible (to meet public and operational safety objectives).
- Thin from below white fir (WF) <12 inches dbh within 150 feet of ski lift and powerline corridor to 60-70 BA/ac, retaining the healthiest trees.
  - Select the healthiest trees for retention.
  - A healthy tree consists of at least 50% crown ratio, full crowns with green foliage that is not fading, no signs of root rot or active insect infestation.
  - To meet BA requirements, some undesirable trees may be left.
  - Limb trees to 6 feet (retain a minimum of 30% live crown ratio).
- Limb 6 feet (leave a minimum of 30% live crown ratio) of lower bole of live trees throughout the stand.
- All material will be eliminated by piling and burning, lightly broadcast chipping, or hauling offsite.

- Burn piles when sufficiently cured to achieve at least 80% consumption of materials, and under conditions that minimize residual fire effects and risk of fire spreading beyond the piles.
- **No live conifer >6" DBH should be removed from PRA TH002 (Appendix D, Ex. 5).**
- **No fuels reduction activities involving live trees and shrubs will occur within PRA TH004, and no hardwood shrub fuels reduction should occur in the downslope area of TH004 (Appendix D, Ex. 5).**

Phase 3:

- Create openings in the overstory canopy layer. Target: 10 to 14 openings between ½ to ¾ acres in size.
    - Locate openings near areas of lower tree density to maximize light availability, to the extent feasible.
    - Openings should be irregular in shape and not less than 100 feet from another created opening (excludes smaller, natural canopy gaps).
    - Remove all WF within created openings.
    - Retain all healthy DF within created openings.
    - Retain 2 to 4 pieces of down woody debris > 10 inches diameter to promote moisture retention for planted seedlings.
- All material will be eliminated by piling and burning, lightly broadcast chipping, or hauling offsite.
- Burn piles when sufficiently cured to achieve at least 80% consumption of materials, and under conditions that minimize residual fire effects and risk of fire spreading beyond the piles.
- Site preparation and planting:
    - Plant created openings with DF on 12 x 12 foot spacing. Space off larger retention trees.
    - Locate planting spots around down woody debris or stumps that may retain more moisture, where feasible.
    - Scalp or grub on a 3 x 3 foot area around the planting spot to reduce competition from shrubs and grasses.
    - Determine potential for future interplanting of DF outside of created openings within the stand.
- **Do not locate created openings in PRA TH004 (Appendix D, Ex. 5).**
- **Do not locate created openings in PRA TH002. No live vegetation ≥ 6 inches dbh shall be removed in this location to meet avalanche mitigation objectives (Appendix D, Ex. 5).**

ADDITIONAL INFORMATION:

Consult with Wasatch High School as they operate a nursery for native seeds. They may be able to fill an order of 1,000 trees and could be a local partnership opportunity.

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SILVICULTURAL and FUELS/FIRE PRESCRIPTION
Treasure Hill Mixed Hardwood Stand: Description and Treatment Plan

LANDOWNER: Park City PARCEL: Treasure Hill STAND(s): Aspen

LEGAL: T2S R4E Sec 16 SIZE: 13 ac ELEVATION: 7,200 – 7,700

SLOPE: avg. 40% ASPECT: NE HISTORIC: R. Mtn Aspen-Woodland Forest / Intermountain aspen-mixed conifer

STRUCTURE STAGE: Mid and Late Development - Closed

FUEL MODEL: TL6 – 7.4 acres 75.6%, TL5 – 0.8 acres (8.6%), TL9 – 0.5 acres (5.1%), and other 1.058 acres

DATA COLLECTION: Formal stand exam plots established 10/2021 by Alpine Forestry.

EXISTING STAND CONDITION:

The overstory layer is dominated by mature aspen that average approximately 8 inches in diameter. Aspen is continuing to decline and high mortality is evident in stand exams. Maple and nominal subalpine fir occur in the understory layer of the aspen-dominated stands while white fir is encroaching on the edges in many locations. Aspen regeneration is minimal in some areas and nonexistent in others.

SILVICULTURAL SYSTEM: – Coppice selection, conifer removal, and/or burn clones to stimulate a sprouting of aspen. The primary goal is to reinvigorate aspen by activities that stimulate a new cohort, or group, of seedlings. This will result in an uneven-aged stand with different size classes of aspen over time.

PRIMARY CONSIDERATIONS: High aesthetic value, fire protection, ski runs, multiple trails, portion of avalanche potential release area **(PRA TH001 – no modification to fuels treatments)** within aspen stand, wildlife use, invasive weeds.

OVERVIEW: SILVICULTURE AND FUELS TREATMENT PLAN (All current and planned activities):

TIME (YR)	TREATMENT DETAIL
0-1	Remove aspen using the coppice selection with reserves method (1 to 2 acres), remove conifers growing under aspen overstory and encroaching conifers, snags and hazardous tree removal.
1	Pile limbs and tops for burning on-site or removal to off-site disposal area
1, 3, 5	Monitor sprouting response, determine if release is needed from competing maple, fencing or other measures need to be taken to prevent damage to aspen regeneration from skiing damage or herbivory.
0-10	Remove invasive weed species by manual methods.
5-50	Schedule regular cuttings of mature aspen on 1 to 2 acres over time and remove encroaching conifers if regeneration is successful.

Prescriptions are based on current vegetative conditions to determine objectives and treatment specifications. These conditions may change over time due to growth and mortality of vegetation, disturbance to the stand, wildlife considerations, or changing landowner objectives. A reassessment of prescription elements may be needed prior to implementation of specific phases or other forestry activities.

SILVICULTURAL AND FUELS/FIRE PRESCRIPTION

Treasure Hill Mixed Hardwood Stand: Objectives and Treatment Plan

OBJECTIVES (Desired End Results):

The objective of these treatments is to restore aspen health and regeneration. Many aspen stands rely on disturbance such as wildfire to maintain growth, health, and their reproductive cycle. Without disturbance they will eventually be replaced by conifers or die out. This is currently the case with the old, undisturbed stands on Treasure Hill. Aspen forests across Utah are a high priority for conservation and management due to the threats they face.

Phase 1, reduce fuel loading:

The removal of snags and other hazardous trees will increase public safety along trails, ski runs, and access roads. Encroachment of conifer will be addressed to improve fire resilience and reduce competition in the aspen. Thick understory layers of maple and shrubs will be cut and removed as they may outcompete sprouting aspen for resources such as light, water, and nutrients. Excess fuels will be piled and burned, or woody material will be moved off-site.

Phase 2, stimulate aspen growth:

A major concern in the Treasure Hill aspen stands is the lack of young trees to replace the aging aspen stems. A portion of mature aspen stems (an estimated 10 to 20% per acre in Phase 2) will be cut to encourage suckering. This will be accomplished by cutting groups of aspen and monitoring for the growth of new stems. If monitoring surveys indicate a successful suckering response, then further action may not be needed for some time. If the suckering response is not successful, then there may be a need to consider more options, such as the use of prescribed fire, thinning aspen, or the analysis and discussion of no further short-term treatment if the stand is at high risk of regeneration failure. Fencing or some type of barrier may be constructed if recreational or undulate activities cause damage to an aspen regeneration area. Fencing would remain in place only as long as needed for aspen to reach a size where they are no longer at risk of mortality from damage, typically 6 to 8 years..

There is the potential for reduced sprouting potential and future loss of these stands (to conifer dominance) if no action is taken to simulate disturbance. A high-severity fire event would likely encourage successful aspen regeneration, but that is an unwanted scenario due to loss of other objectives previously mentioned.

Monitoring will also indicate whether or not release from understory shrubs or maple is necessary.

DETAILED TREATMENT PLAN (Specifications):

Phase 1:

- Cut snags and other identified hazard trees within 1.5 times the tree height around trails, lifts, or other infrastructure.
- Remove all conifers (subalpine fir, white fir, and Douglas-fir) growing in the understory and midstory layers of aspen stands (under the drip lines).
- Remove 90% of the understory consisting of maple and shrubs, preserving any aspen regeneration.
- Remove 90% of slash to increase the suckering potential of aspen.
    - o 10% of dead and down aspen shall be left for moisture retention and soil stability.
- Burn piles when sufficiently cured to achieve at least 80% consumption of materials, and under conditions that minimize residual fire effects and risk of fire spreading beyond the piles.

Phase 2:

- Cut and remove aspen stems ≥4 inches dbh on 15% of the stand area during each cutting cycle (1-2 acres).

- Locate first cuttings on the south and west-facing portions of the aspen stand to capture best sunlight for resprouting aspen.
    - Cuttings should be irregular in shape so managed areas appear more natural.
- Burn piles when sufficiently cured to achieve at least 80% consumption of materials, and under conditions that minimize residual fire effects and risk of fire spreading beyond the piles.

Resources:

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Silvicultural terms as defined by the Dictionary of Forestry (Helms 1998):
Coppice with reserves is a regeneration method that relies on the sprouting of trees following the removal of all or most trees in a stand.

SILVICULTURAL and FUELS/FIRE PRESCRIPTION
Treasure Hill: Description and Treatment Plan

LANDOWNER: Park City PARCEL: Treasure Hill STAND(s): Gambel Oak

LEGAL: T2S R4E Sec 16 SIZE: 31 ac ELEVATION: 7,200 – 7,600

SLOPE: avg. 40% ASPECT: E HISTORIC: Rocky Mountain Gambel Oak - Mixed Montane Shrubland

STRUCTURE STAGE: Mid closed

FUEL MODEL: TL5 - 14.4 ac, TL6 - 4.3 ac, GR2 - 3.5 ac, GS2 - 3.1 ac, other - 5.2 ac

DATA COLLECTION: No formal field inventory plots.

EXISTING STAND CONDITION:

The Gambel oak vegetation type covers approximately 30 acres along the lower slopes of the southern and eastern edges of the Treasure Hill property. It is estimated that Gambel oak makes up nearly 100% of the overstory species composition with a few coniferous and other hardwood species growing mostly on the edges. Most of the oak is less than 6 feet tall in height, on average. Shrubs such as bitterbrush (*Purshia tridentata*) and pachistima (*Paxistima myrsinites*) grow beneath the Gambel oak overstory indicating that there is some biodiversity of vegetation. There are no obvious forest health issues in the Gambel oak, but that does not mean it is not present or will not be present in the future.

SILVICULTURAL SYSTEM: – Fuel management activities to control flammability of vegetation and increase success of wildland fire suppression through mechanical and/or manual means.

PRIMARY CONSIDERATIONS: Adjacency to private property/structures, fire protection, wildlife use, invasive weeds. **PRA TH004, 005, 006, 007 all require treatment alterations.**

OVERVIEW: SILVICULTURE AND FUELS TREATMENT PLAN (All current and planned activities):

TIME (YR)	TREATMENT DETAIL
0-2	Phase 1: Create shaded fuel breaks around roads and other high value resources.
0-2	Phase 1: Pile limbs and tops for burning on-site, chip, or removal to off-site disposal area. Burn piles
10	Phase 2: Mechanical and/or manual treatments to create variable density, reduce canopy bulk density
10	Phase 2: Pile limbs and tops for burning on-site, chipping, or removal to off-site disposal area. Burn piles
5-50	Schedule maintenance fuel treatments every 10 years to maintain defensible space, provide for fire control.

Prescriptions are based on current vegetative conditions to determine objectives and treatment specifications. These conditions may change over time due to growth and mortality of vegetation, disturbance to the stand, wildlife considerations, or changing landowner objectives. A reassessment of prescription elements may be needed prior to implementation of specific phases or other forestry activities.

PREPARED BY: Alpine Forestry DATE: 03/09/22

SILVICULTURAL AND FUELS/FIRE PRESCRIPTION
Treasure Hill: Objectives and Treatment Plan

OBJECTIVES (Desired End Results):

Create a defensible space zone along roads and around private property to enable wildfire response and control, and evacuation if a wildfire were to occur. Slowly change the homogenous, contiguous pattern of oak over time to increase fire resistance and aid in stand diversity.

Phase 1 (0-2 years), Reduce immediate risk to roads, infrastructure, and private property from wildfire:

Create defensible space around infrastructure and private property throughout the project area by removing oak within 100 feet of structures. Reduce oak density where possible and create shaded fuel breaks around roads by removing oak within 30 to 50 feet on either side of the road with the higher distances on the downhill side. Retain oak in patches and clumps to maintain aesthetics, shade, and ecosystem health. Complete removal of Gambel oak over large areas is not desirable nor is it necessary to reduce wildfire risk in the wildland/urban interface. Well-placed openings in oak canopies offer potential opportunities for arresting fire spread in defensible space and shaded fuel break zones. The estimated retreatment of fuel breaks is every 3 to 5 years. Younger stands of Gambel oak have lower flammability as there is higher live fuel moisture content and less decadence.

Gambel oak is a prolific resprouter and herbicide use to control Gambel oak growth in suitably placed patches is considered an effective urban interface protection strategy. However, the Park City Municipal Corporation has stated they are moving away from the use of herbicides for various reasons and all management will be done mechanically or manually.

Phase 2 (Delayed), Interior stand management of oak:

It is recommended that the Phase 2 prescription for interior Gambel oak be delayed until a future date (estimated 10 years) when treatments will be much more effective. At this time, the Gambel oak stems are too small and thinning these stems will not result in any meaningful change in existing or near-term fire behavior.

Reduce canopy density and horizontal and vertical continuity to reduce fire intensity and rates of spread by removing a portion of the oak in patches in the area not treated in Phase 1. Mechanical and/or manual treatments will be scheduled to remove oak and maintain stand structure where needed. Decadent woody material in taller Gambel oak will be removed to reduce fuel loadings and create shaded fuel breaks. In addition to reducing fire intensity and severity, desirable side effects of these types of treatments in Gambel oak communities are increased access and movement corridors for animals. Treatments will need to be reapplied every 5 to 7 years in order to maintain openings.

DETAILED TREATMENT PLAN (Specifications):

Phase 1: Reduce immediate risk to roads, infrastructure, and private property from wildfire:

- The focus of these treatments provide for public and firefighter safety providing for ingress and egress along roads within Treasure Hill and adjacency to structures at risk in the Wildland/Urban Interface.
- Along the roadways focus will be 50 feet below the edge of the road with 30 feet above the edge of the road.
- Adjacent to structures, Firewise Home Ignition Zone concepts should be used with limited Gambel oak within 30 feet and small pockets allowed from 30-100 feet from the structure.
- In the majority of these areas Gambel oak should be thinned allowing for a few older growth clumps of 5-10 trees to remain serving as a shaded fuel break. Place small clumps where they may act as privacy screens along private property in areas where clumps will not impede fire suppression or create unwanted fuels profile.
- Decadent and dead material and branches serving as ladder fuels should be removed to minimize opportunity of surface fire to transition into a crown fire. Limb oak clumps to a height of 3 feet to raise canopy base height.

- Maintenance treatments will need to be applied every 3 to 5 years at a minimum to address sprouting response.
- **No fuels reduction activities involving live trees and shrubs will occur within PRA TH004, and no hardwood shrub fuels reduction should occur in the downslope area of TH004 (Appendix D, Ex. 5).**
- **No fuels reduction activities should be performed within or downslope of TH005, with the exception of defensible space treatment (Appendix D, Ex. 5).**
- **No fuels reduction activities should be performed within or downslope of TH006 and TH007 (Appendix D, Ex. 5).**

Phase 2: Interior stand management of oak:

- Remove decadent and dead Gambel oak stems throughout the stand.
- Locate a minimum of 25 small clumps per acre of Gambel oak throughout the stand.
    - Small clumps are groups of oak 16 feet in diameter or less, measured from the edges of crowns.
    - Retain 10 to 16 healthy, desirable oak stems within these small clumps.
    - Limb oak clumps to a height of 3 feet to raise canopy base height.
- Retain 3 to 6 large patches of oak where it would not impede wildfire suppression. A large patch of oak is defined as ¼ to ½ acre in size, measured from edges of crowns.
    - Placement of Gambel oak retention patches in PRAs 004, 005, 006, and 007 and the associated downslope tracks meets two objectives - reduces the threat of avalanche from active treatments and retains large patches of undisturbed Gambel oak for wildlife, aesthetics, etc.
    - PRA 005 - defensible space treatments allowed. Live shrub material may be removed as needed to meet fuels objectives
- Remove Gambel oak stems within 25 to 30 feet between small and large clumps to reduce the continuity of fuels across the stand.
- Maintenance treatments will need to be applied every 5 to 7 years at a minimum to address sprouting response.
- **No fuels reduction activities involving live trees and shrubs will occur within PRA TH004, and no hardwood shrub fuels reduction should occur in the downslope area of TH004 (Appendix D, Ex. 5).**
- **No fuels reduction activities should be performed within or downslope of TH005, with the exception of defensible space treatment (Appendix D, Ex. 5).**
- **No fuels reduction activities should be performed within or downslope of TH006 and TH007 (Appendix D, Ex. 5).**

Resources:

https://extension.colostate.edu/topic-areas/natural-resources/gambel-oak-management-6-311/

https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Preparing-homes-for-wildfire

https://journals.uair.arizona.edu/index.php/rangelands/article/viewFile/10738/10011

SILVICULTURAL and FUELS/FIRE PRESCRIPTION
Treasure Hill: Description and Treatment Plan

LANDOWNER: Park City PARCEL: Treasure Hill STAND(s): Mixed Vegetation

LEGAL: T2S R4E Sec 16 SIZE: 7 ac ELEVATION: 7,200 – 7,700

SLOPE: avg. 40% ASPECT: NE/E HISTORIC: Mixed Communities

STRUCTURE STAGE: Variable

FUEL MODEL: TL6 - 2.8 ac (38.2%), TL5 - 1.9 ac (25.2%), SB2 - 1 ac (14.3%), GS2 - 0.6 ac (8.2%), other - 2 ac (28%)

DATA COLLECTION: No formal field inventory plots.

EXISTING STAND CONDITION:

This vegetation type is composed of shrubs and grasses with some encroaching conifers and hardwoods. Common shrubs include, but are not limited to: Saskatoon serviceberry, chokecherry, maple, mountain snowberry, Oregon boxleaf, Woods' rose, sagebrush, and common snowberry. Trees include sparse white fir (WF), subalpine fir (SF), Douglas-fir (DF), aspen, Gambel oak, and maple. The areas of shrub/mixed vegetation are primarily along two long linear features (ski lift and power line) that transect the project area and six small pockets. The open areas with lighter and flashier fuels will burn with higher spread rate but with lower flame length once the fuels have cured out into mid-summer.

SILVICULTURAL SYSTEM: Remove all competing conifers within 25 feet of an aspen tree.

PRIMARY CONSIDERATIONS: Decrease conifer competition with aspen, invasive weed management.

OVERVIEW: SILVICULTURE AND FUELS TREATMENT PLAN (All current and planned activities):

TIME (YR)	TREATMENT DETAIL
0-1	Remove competing conifers around aspen, lop and scatter.
0-10	Remove invasive weed species by manual methods.

Prescriptions are based on current vegetative conditions to determine objectives and treatment specifications. These conditions may change over time due to growth and mortality of vegetation, disturbance to the stand, wildlife considerations, or changing landowner objectives. A reassessment of prescription elements may be needed prior to implementation of specific phases or other forestry activities.

PREPARED BY: Alpine Forestry DATE: 03/09/22

SILVICULTURAL AND FUELS/FIRE PRESCRIPTION
Objectives and Treatment Plan

OBJECTIVES (Desired End Results):

The mixed vegetation type covers 7 acres of Treasure Hill. The main objectives for this vegetation type are the removal of encroaching white fir on existing aspen trees and invasive weed management. Tree cover is already sparse within this vegetation type, so it is likely that very little will take place. Therefore, any slash created by treatments will be lopped and scattered according to fuels specifications. Pile and burn material if lop and scatter produces too much slash to effectively meet fuels objectives.

DETAILED TREATMENT PLAN (Specifications):

Phase 1:

- Cut all WF trees <16 inches dbh within 25 feet of an aspen tree.
- Thin patches of dense conifer regeneration ("doghair thickets") <5 inches dbh to about 200-220 trees/ac. This is approximately 14-15 foot spacing.
    - Leave species priority (most to least desirable): healthy aspen, DF, WF. As a rule, leave the healthiest trees first as exact spacing is not the desired outcome.
    - Spacing will not be met where existing densities are lower than target, or where trees do not meet the definition of "healthy."
- Lop and scatter or pile and burn cut material < 10".
- Buck tree boles > 10" into 6-foot lengths as required by fuels specifications.
- Manual removal of invasive weeds where they occur.

SILVICULTURAL and FUELS/FIRE PRESCRIPTION
Treasure Hill: Description and Treatment Plan

LANDOWNER: Park City PARCEL: Treasure Hill STAND(s): Sagebrush and Grass

LEGAL: T2S R4E Sec 16 SIZE: 18 ac ELEVATION: 7,200 – 7,700

SLOPE: avg. 40% ASPECT: NE/E HISTORIC: Mixed Communities

STRUCTURE STAGE: Variable

FUEL MODEL: TL6 - 2.8 ac (38.2%), TL5 - 1.9 ac (25.2%), SB2 - 1 ac (14.3%), GS2 - 0.6 ac (8.2%), other - 2 ac (28%)

DATA COLLECTION: No formal field inventory plots.

EXISTING STAND CONDITION:

Vegetation in this type is known for its species diversity. The sagebrush type occurs mainly at the southern edge of the property while the grassy slopes are mainly limited to the ski runs. Sagebrush encompasses a fairly small footprint within the property area. Walk-through surveys of these vegetation types confirmed the presence of invasive weeds.

SILVICULTURAL SYSTEM: – None

PRIMARY CONSIDERATIONS: Invasive weed management

OVERVIEW: SILVICULTURE AND FUELS TREATMENT PLAN (All current and planned activities):

TIME (YR)	TREATMENT DETAIL
0-10	Remove invasive weed species by manual methods.

Prescriptions are based on current vegetative conditions to determine objectives and treatment specifications. These conditions may change over time due to growth and mortality of vegetation, disturbance to the stand, wildlife considerations, or changing landowner objectives. A reassessment of prescription elements may be needed prior to implementation of specific phases or other forestry activities.

OBJECTIVES (Desired End Results):

The sagebrush and grass vegetation type covers 18 acres on Treasure Hill. The only treatments planned for this vegetation type are invasive weed management. The primary objective is to identify and treat invasive weeds to reduce competition with the native species and allow them to prosper on the site.

DETAILED TREATMENT PLAN (Specifications):

Phase 1:
- A comprehensive invasive weed survey and analysis is recommended to identify existing invasive species and to develop an action plan for eradication.
- Manual removal of invasive weeds where they occur.
- Targeted grazing is a potential viable option depending on the type and extent of invasives found on the property.

PREPARED BY: Alpine Forestry DATE: 03/09/22

Appendix G

Avalanche Assessment

TH-001

Aspect: ENE
Elevation: 7503-7696’
Maximum Slope Angle: 38°
Average Slope Angle: 27°
Size: 0.34 Ha / 0.85 Acres
Destructive Potential: D2
Loading Potential: 3
Cross-Slope Shape: Planar
Primary Vegetative Anchor: Conifer
Ground Cover Height: 0.3-2m
Ground Cover Type: Mixed (Herbaceous and Hardwood Shrub)
Conifer Stem Density: 388 Stems / Ha
Average Conifer Anchor Spacing: 7m
Canopy Cover: Mixed Conifer Forest with localized openings in canopy (ie Forest Gaps)
ATES Forest Parameter: Mixed (100-1000 stems/Ha, 3.2-10m spacing)

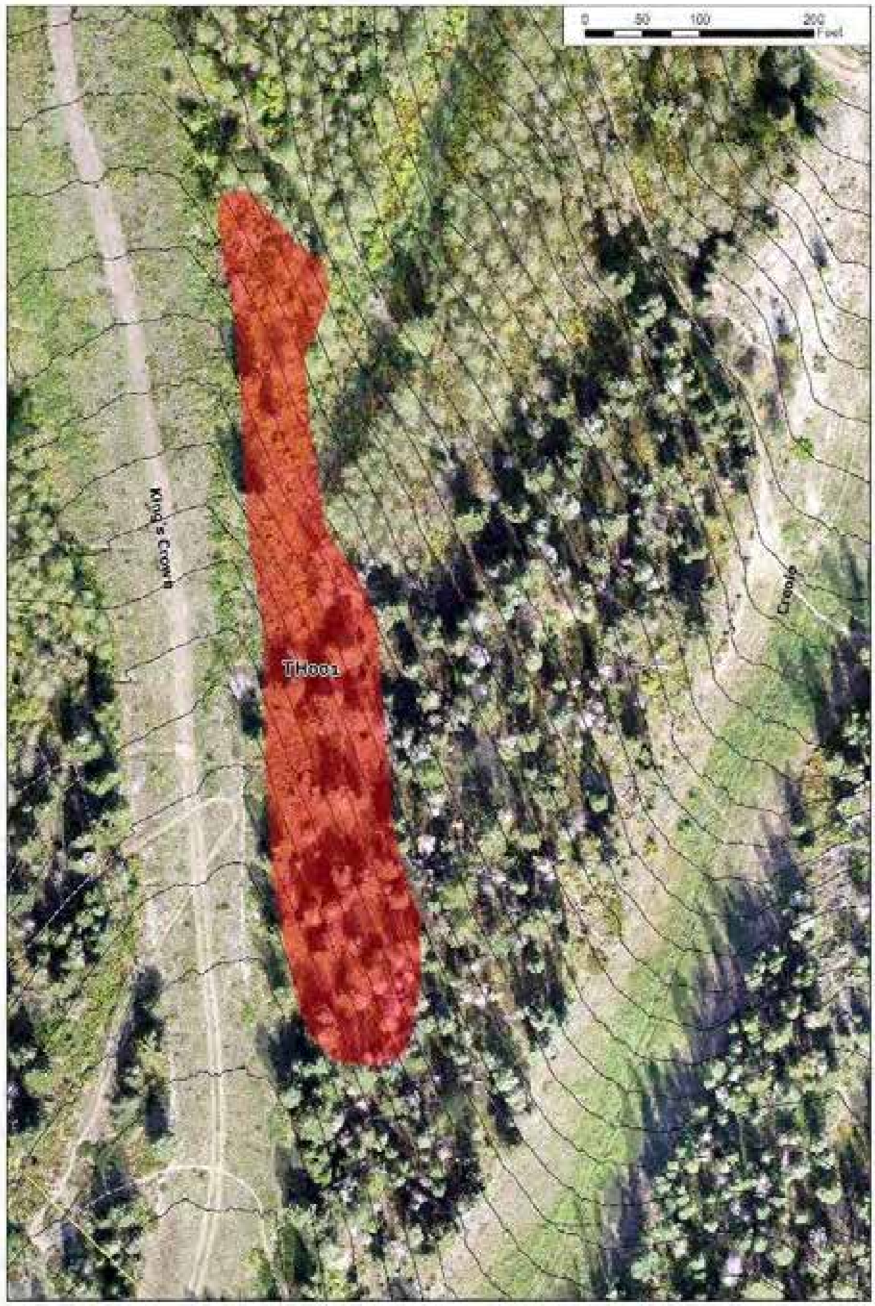


Figure G-1 – TH-001 Orthomosaic and PRA highlighted in red

Description: TH-001 is a relatively steep, but vertically limited PRA adjacent to the King’s Crown ski trail at Park City Mountain Resort. This active path does not threaten roads or other infrastructure. The open ski trail on the windward side of the PRA allows for localized fetch and snow supply, aiding in occasional wind loading and small avalanches are an annual occurrence in this frequently mitigated path. Deterrence to avalanching is topographic limitation, moderately dense hardwood ground cover, and mixed conifer forest that provide discontinuity through variable canopy cover and “Mixed” forest stem densities (100-1000 stems/Ha). Mature conifer dominate, and fuels treatments will leave this PRA’s avalanche behavior and frequency relatively unchanged. **No treatment alterations are recommended**. This area is actively managed by the Park City Mountain Ski Patrol and should be advised of the application of silvicultural treatments following completion.

TH-002

Aspect: NE
Elevation: 7539'-7735'
Maximum Slope Angle: 32°
Average Slope Angle: 22°
Size: 0.28 Ha / 0.7 Acres
Destructive Potential: D2
Cross-Slope Shape: Planar
Loading Potential: 2
Primary Vegetative Anchor: Conifer
Ground Cover Height: 0.3-1m
Ground Cover Type: Herbaceous
Stem Density: 517 stems/Ha
Conifer Stem Density (<3" DBH excluded): 431 stems/Ha
Conifer Stem Density (<6" DBH excluded): 270 stems/Ha / 229 stems/Ha (digitally-derived)
Canopy Cover: Mixed (20-50%) with the presence of small 'forest gaps' with minimal canopy
ATES Forest Parameter: Mixed (100-1000 stems/Ha, 3.2-10m spacing)
Description: A low-angled PRA, comprised of mixed conifer with varying stem densities and small 'forest gaps' up to 20m in downslope length. The topography of TH-002, and specifically its track and runout, has been altered upon the development of the ski trails in the 1980s. Historical photos show that TH-002 had seen complete deforestation around the early 20th century. Under its current forest condition, excluding conifer with a DBH less than 6", stem densities were measured to be 229 stems/Ha. In order to maintain adequate stem densities, as well as maintain current arrangement (and isolation) of 'forest gaps', **no live conifer >6" DBH should be removed from within the TH-002 PRA.**

TH-003

Aspect: NE
Elevation: 7211'-7343'
Maximum Slope Angle: 32°
Average Slope Angle: 25°
Size: 0.14 Ha / 0.34 Acres
Destructive Potential: <D2
Cross-Slope Shape: Planar
Loading Potential: 1
Primary Vegetative Anchor: Conifer
Ground Cover Height: 1m
Ground Cover Type: Mixed (Herbaceous and Hardwood)
Stem Density: 357 stems/Ha
Average Conifer Anchor Spacing: 3.2-10m
Canopy Cover: Mixed (20-50%) with 'Forest Gaps'
ATES Forest Parameter: Mixed (100-1000 stems/Ha, 3.2-10m spacing)
Description: A vertically limited PRA that is both statistically and qualitatively insufficient to produce size 2 avalanches. The topographic limitations and uneven distribution of slopes >30deg confine this PRA to small releases, minimal vertical runout, and are unlikely to occur regardless of applied forest treatments. **No treatment alterations are recommended.**

TH-004

Aspect: NE-ENE
Elevation: 7191'-7474'
Maximum Slope Angle: 35°
Average Slope Angle: 29°
Size: 0.64 Ha / 1.59 Acres
Destructive Potential: D3
Cross-Slope Shape: Planar
Primary Vegetative Anchor: Conifer
Ground Cover Height: 0-1m
Ground Cover Type: Mixed Hardwood and Herbaceous Shrub where Conifer is not present
Conifer Stem Density: 368 stems/Ha (digitally-derived)
Conifer Stem Density (<3" DBH excluded): 215 stems/Ha
Conifer Stem Density (<6" DBH excluded): 172 stems/Ha
Average Conifer Anchor Spacing: 3.2-10m
Canopy Cover: Mixed (20-50%) – Mixed canopy with the presence of 'forest gaps' up to 25m in downslope length
ATES Forest Parameter: Mixed (100-1000 stems/Ha, 3.2-10m spacing)
Description: TH-004 is a likely historic producer of avalanches, as several historical records indicate infrastructure (residence) impacts in 1884 and 1894 between modern-day 5th and 6th streets on Woodside Ave. The PRA is moderate angled and sheltered by conifer forest to the west and has likely seen an even further decrease in frequency in modern history due to the reestablishment of conifer forest following complete harvesting of the hillside in the late 19th century. Conifer trees are consistent in age (60-80 years).

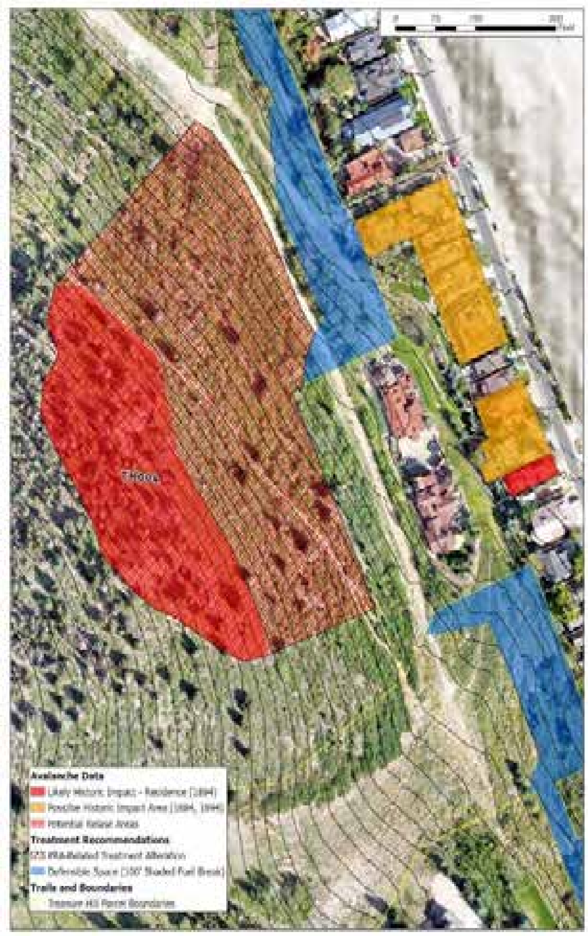


Figure G-2 – TH-004 PRA and altered treatment area.

The current forest structure contributes to avalanche abatement through 'mixed' stem densities providing mechanical slab support (anchoring) as well as canopy coverage which provides discontinuity in snowpack stratigraphic development. In its current state, the PRA receives minimal downslope slab support as the conifer forest ends in the lower portion of the PRA, giving way to hardwood shrub dominated hillside, with durability and height that provides minimal amounts of ground roughness, but insignificant mechanical support. Conifer stem densities are 'mixed', however, when excluding stems <6" in diameter, stem densities decrease significantly compared to neighboring PRAs. Due to the current forest structure, and the potential risk to infrastructure, **no live fuels treatments should be applied within PRA TH-004.** Additionally, within the track (downslope) of this PRA, **no live hardwood shrub fuels treatments should be performed** within the area outlined in Figure G-2. Standing dead / down fuels treatments may still be performed within the TH-004 treatment alteration area.

TH-005

Aspect: NE-ENE
Elevation: 7260'-7517'
Maximum Slope Angle: 37°
Average Slope Angle: 26°
Size: 0.50 Ha / 1.25 Acres
Destructive Potential: D2
Cross-Slope Shape: Planar
Primary Vegetative Anchor: Gambel Oak
Ground Cover Height: 0.5-3m
Ground Cover Type: Hardwood Shrub (Oak)
Canopy Cover: OPEN – No conifer canopy present. Average ground cover height of 1.5m.
ATES Forest Parameter: Open
Description: While evidence of past avalanche occurrences within this PRA are less definitive than TH-004, it is possible that a 1917 event originated from TH-005 (or TH-002). Regardless, avalanche abatement is aided by significant ground roughness provided by a continuous and durable gambel oak grove, ranging in AGL height from 0.5-3m, with locally higher heights. Runout angles to infrastructure are approximately 30 degrees, and while other terrain parameters indicative of avalanche slopes are absent (downslope convexities, cross-slope concavity, loading potential), its adjacence to homesites warrants conservative treatment specification alteration. **No live fuels treatments should be applied within TH-005, or in the track (downslope direction),** with the exception of an area of Defensible Space Treatment (Figure G-3).

Figure G-3 – TH-005 and altered treatment area.

TH-006

Aspect: ENE-E
Elevation: 7565’-7686’
Maximum Slope Angle: 34°
Average Slope Angle: 25°
Size: 0.52 Ha / 1.29 Acres
Destructive Potential: D2
Cross-Slope Shape: Concave / Bowl
Primary Vegetative Anchor: None
Ground Cover Height: 1-2m
Ground Cover Type: Hardwood Shrub (Oak)
Canopy Cover: Open
ATES Classification: Open
Description: TH-006 is a low-angled, bowl-shaped PRA and historical records reveal no significant events where infrastructure was impacted. Infrequency or absence of notable events is likely due to continuous and robust gambel oak coverage, low elevation, and low slope angles. However, due to its bowl shape and extruding terrain on its southern flank, southwest to southerly winds can load this area (Loading Potential - 3), leading to artificially higher slope angles during above-average snowpack conditions. Evidence of this loading pattern can be seen in historic imagery (Figure G-5). Runout angles to infrastructure are 26° and 24° to the King Road and residences, respectively, and while impacts to the residences from powder-snow avalanches are unlikely, high dense-flow or wet releases with significant entrainment may pose a risk to residences in climactic or anomalous events. As a result, current vegetative ground cover / ground roughness conditions should be maintained, and **no live fuels treatments should be applied within TH-006 as well as the cross and downslope areas depicted in Figure G-4.**

Figure G-4 – TH006 and TH007 and corresponding altered treatment areas.

TH-007

Aspect: ENE-E
Elevation: 7506’-7666’
Maximum Slope Angle: 34°
Average Slope Angle: 24°
Size: 0.3 Ha / 0.75 Acres
Destructive Potential: D2
Cross-Slope Shape: Concave / Bowl
Primary Vegetative Anchor: None
Ground Cover Height: 1-1.5m
Ground Cover Type: Hardwood Shrub (Oak)
Canopy Cover: Open
ATES Classification: Open
Description: Like TH-006, TH-007 is a low-angled, bowl-shaped PRA, where historical records reveal no significant events where infrastructure was impacted. Park City Ski Patrol has periodically performed avalanche mitigation work within this PRA, known locally as “Nucelar Bowl”, with recorded avalanche results up to size 2 and no recorded impacts to infrastructure. Like TH-006, this PRAs bowl shape combined with southwest to southerly winds can load this area (Loading Potential - 3), leading to artificially higher slope angles during above-average snowpack conditions. Evidence of this loading pattern can be seen in historic imagery (Figure G-5). Runout angles to infrastructure are 26° and 23° to the upper and lower King Rd, respectively, and while impacts to the lower King Rd or adjacent residences from powder-snow avalanches are unlikely, high dense-flow or wet releases with significant entrainment may pose a risk to residences in climactic or anomalous events. As a result, current vegetative ground cover / ground roughness conditions should be maintained, and **no fuels treatments should be applied within TH-007 as well as the cross and downslope areas depicted in Figure G-4.**

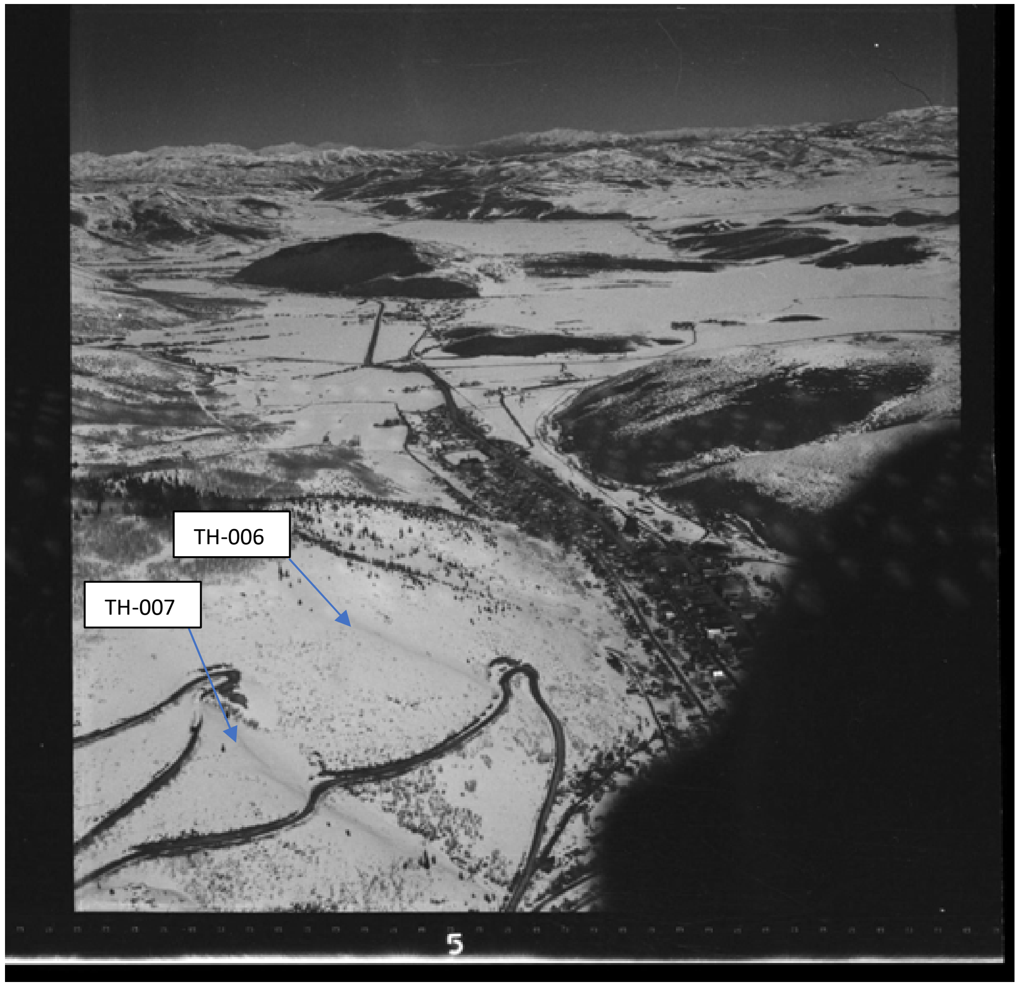


Figure G-5 – TH-006 and TH-007 during deep snowpack conditions, highlighting cross-loading deposits within both PRAs. Historic snowsheds visible above TH-007. (JW Marriott Digital Library)

Appendix H

Custom Soils Report for the Treasure Hill Area

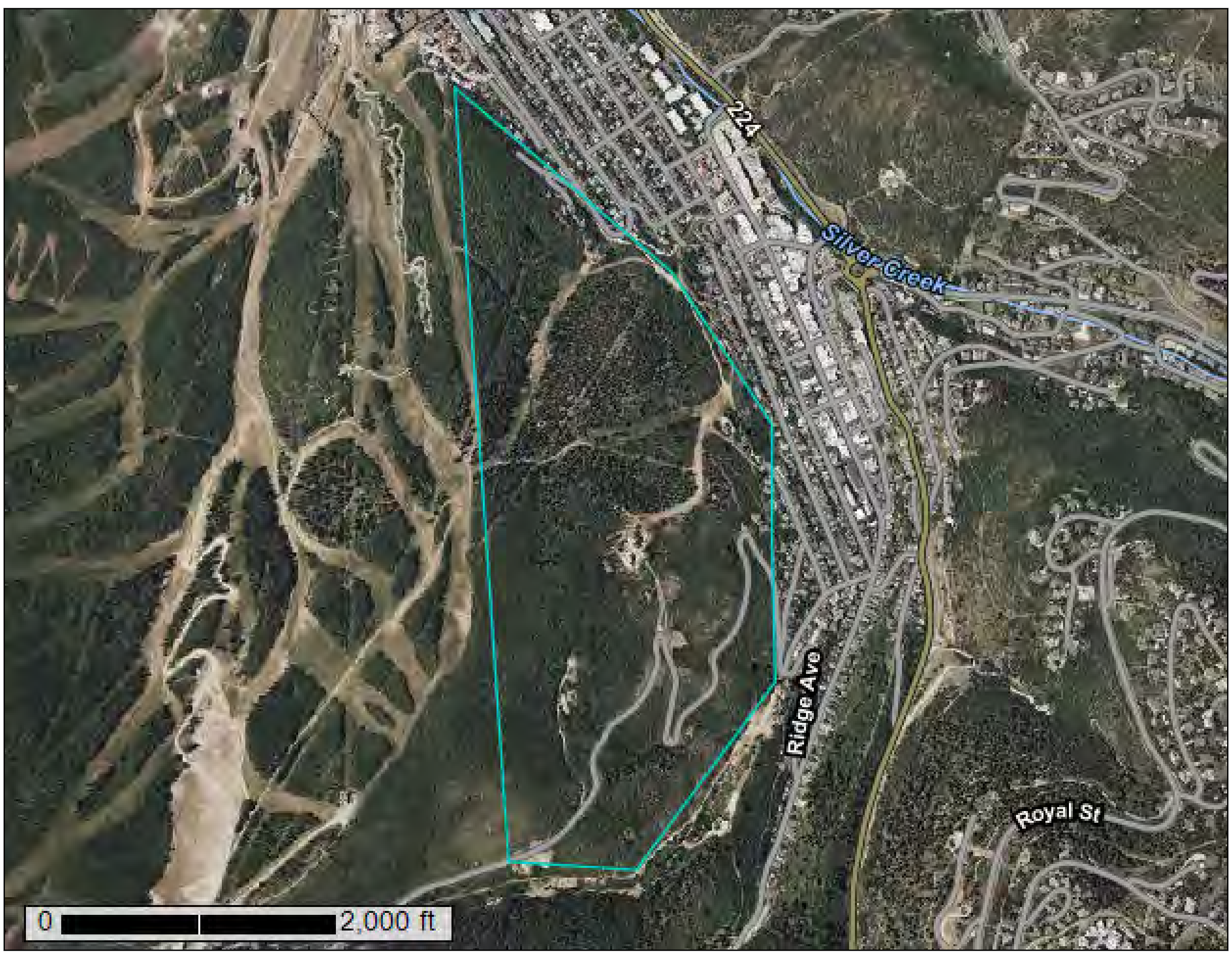
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Summit Area, Utah, Parts of Summit, Salt Lake and Wasatch Counties



April 20, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

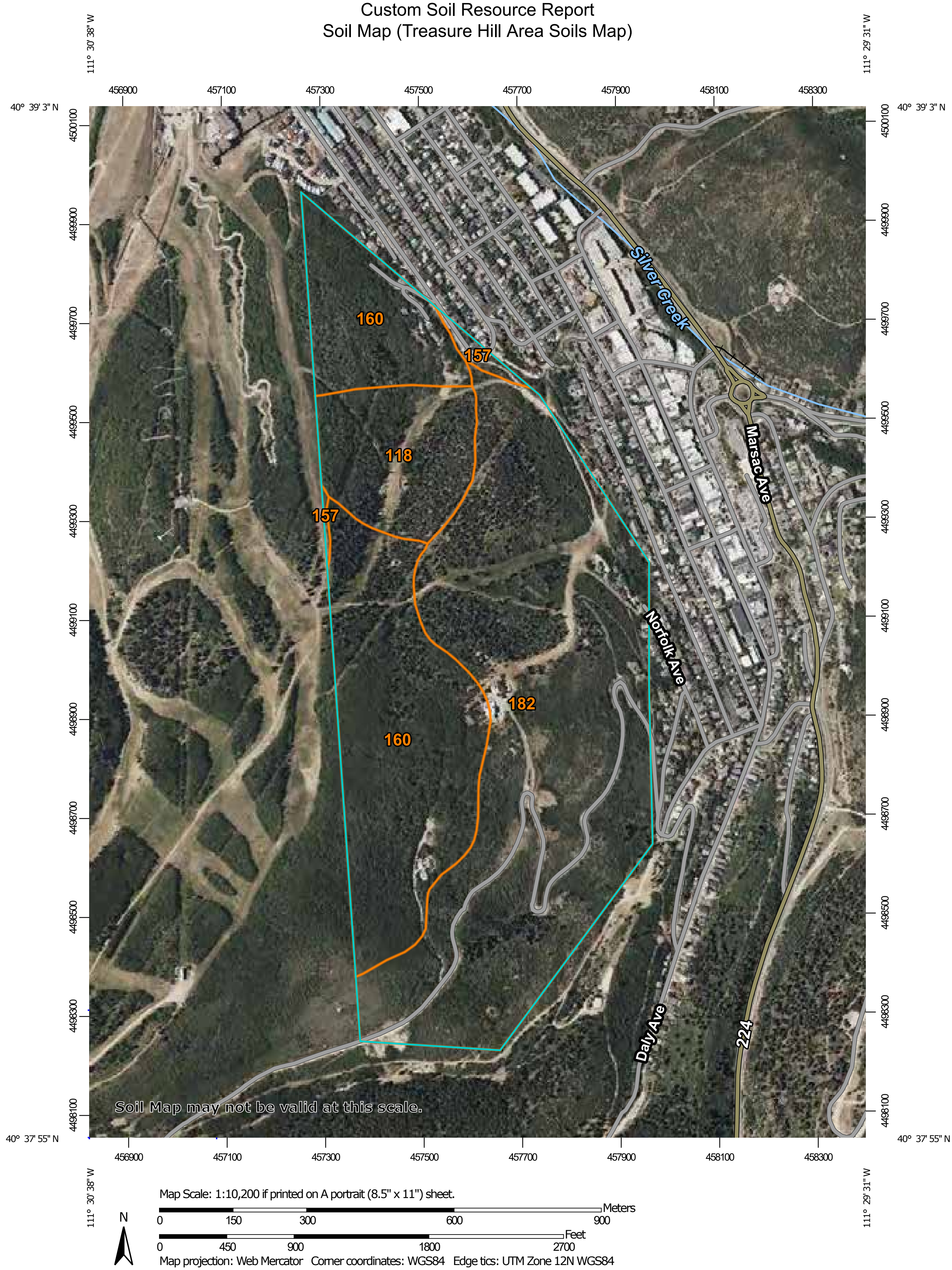
Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map (Treasure Hill Area Soils Map)



MAP LEGEND

Area of Interest (AOI)
Area of Interest (AOI)

Soils
Soil Map Unit Polygons
Soil Map Unit Lines
Soil Map Unit Points

Special Point Features
Blowout
Borrow Pit
Clay Spot
Closed Depression
Gravel Pit
Gravelly Spot
Landfill
Lava Flow
Marsh or swamp
Mine or Quarry
Miscellaneous Water
Perennial Water
Rock Outcrop
Saline Spot
Sandy Spot
Severely Eroded Spot
Sinkhole
Slide or Slip
Sodic Spot
Spoil Area
Stony Spot
Very Stony Spot
Wet Spot
Other
Special Line Features

Water Features
Streams and Canals

Transportation
Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background
Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Summit Area, Utah, Parts of Summit, Salt Lake and Wasatch Counties
Survey Area Data: Version 13, Sep 7, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 20, 2021—Jun 21, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

Map Unit Legend (Treasure Hill Area Soils Map)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
118	Dromedary-Rock outcrop complex, 30 to 70 percent slopes	21.1	10.3%
157	Manila-Henefer complex, 8 to 15 percent slopes	1.9	0.9%
160	Parkcity-Dromedary gravelly loams, 30 to 70 percent slopes	68.4	33.2%
182	Yeates Hollow-Henefer complex, 30 to 60 percent slopes	114.3	55.6%
Totals for Area of Interest		**205.7**	**100.0%**

Map Unit Descriptions (Treasure Hill Area Soils Map)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Summit Area, Utah, Parts of Summit, Salt Lake and Wasatch Counties

118—Dromedary-Rock outcrop complex, 30 to 70 percent slopes

Map Unit Setting

National map unit symbol: k1s9
Elevation: 5,800 to 10,200 feet
Mean annual precipitation: 22 to 35 inches
Mean annual air temperature: 35 to 40 degrees F
Frost-free period: 20 to 60 days
Farmland classification: Not prime farmland

Map Unit Composition

Dromedary and similar soils: 70 percent
Rock outcrop: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dromedary

Setting

Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium and till derived from sandstone, shale and conglomerate

Typical profile

A - 0 to 6 inches: gravelly loam
E - 6 to 22 inches: very cobbly sandy loam
Bt/E - 22 to 44 inches: very cobbly sandy clay loam
Bt1 - 44 to 51 inches: very cobbly sandy clay loam
Bt2 - 51 to 60 inches: very cobbly sandy clay loam

Properties and qualities

Slope: 30 to 70 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F047XA532UT - High Mountain Stony Loam (Douglas Fir)
Other vegetative classification: High Mountain Stony Loam (Douglas-fir) (047XA532UT_2)
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Ridges, escarpments
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Parkcity

Percent of map unit: 6 percent
Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: F047XA531UT - High Mountain Stony Loam (Aspen)
Hydric soil rating: No

Starley family

Percent of map unit: 5 percent
Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R047XA516UT - High Mountain Loam (Mountain Big Sagebrush)
Hydric soil rating: No

Crandall

Percent of map unit: 4 percent
Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R047XA560UT - High Mountain Gravelly Loam (Mountain Big Sagebrush)
Hydric soil rating: No

157—Manila-Henefer complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: k1th
Elevation: 6,000 to 7,900 feet
Mean annual precipitation: 16 to 22 inches
Mean annual air temperature: 40 to 45 degrees F
Frost-free period: 60 to 90 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Manila and similar soils: 60 percent
Henefer and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manila

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Slope alluvium derived from conglomerate, sandstone and shale

Typical profile

A1 - 0 to 4 inches: loam
A2 - 4 to 15 inches: loam
Bt1 - 15 to 22 inches: clay loam
Bt2 - 22 to 40 inches: clay
Bt3 - 40 to 46 inches: gravelly clay
Bt4 - 46 to 60 inches: clay

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R047XA430UT - Mountain Loam (Mountain Big Sagebrush)
Hydric soil rating: No

Description of Henefer

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from quartzite, sandstone and shale

Typical profile

A1 - 0 to 7 inches: gravelly loam
A2 - 7 to 12 inches: gravelly loam
Bt1 - 12 to 21 inches: cobbly clay
Bt2 - 21 to 30 inches: cobbly clay
Bt3 - 30 to 37 inches: very gravelly clay loam
Bt3 - 37 to 43 inches: very gravelly clay loam

Bt5 - 43 to 50 inches: very cobbly sandy clay loam
Bt5 - 50 to 60 inches: very cobbly sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R047XA432UT - Mountain Loam (Oak)
Hydric soil rating: No

Minor Components

Horrocks

Percent of map unit: 10 percent
Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R047XA461UT - Mountain Stony Loam (Mountain Big Sagebrush)
Hydric soil rating: No

Yeates hollow

Percent of map unit: 5 percent
Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R047XA461UT - Mountain Stony Loam (Mountain Big Sagebrush)
Hydric soil rating: No

160—Parkcity-Dromedary gravelly loams, 30 to 70 percent slopes

Map Unit Setting

National map unit symbol: k1sd
Elevation: 5,600 to 9,600 feet
Mean annual precipitation: 22 to 35 inches
Mean annual air temperature: 35 to 40 degrees F
Frost-free period: 20 to 60 days
Farmland classification: Not prime farmland

Map Unit Composition

Parkcity and similar soils: 70 percent
Dromedary and similar soils: 20 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Parkcity

Setting

Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium derived from sandstone, limestone and quartzite

Typical profile

A1 - 0 to 5 inches: gravelly loam
A2 - 5 to 19 inches: gravelly loam
Bw - 19 to 36 inches: very cobbly loam
C - 36 to 60 inches: very cobbly loam

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F047XA531UT - High Mountain Stony Loam (Aspen)
Hydric soil rating: No

Description of Dromedary

Setting

Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium and till derived from conglomerate, sandstone and shale

Typical profile

A - 0 to 6 inches: gravelly loam
E - 6 to 22 inches: very cobbly sandy loam
Bt/E - 22 to 44 inches: very cobbly sandy clay loam
Bt1 - 44 to 51 inches: very cobbly sandy clay loam
Bt2 - 51 to 60 inches: very cobbly sandy clay loam

Properties and qualities

Slope: 30 to 70 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F047XA532UT - High Mountain Stony Loam (Douglas Fir)
Other vegetative classification: High Mountain Stony Loam (Douglas-fir) (047XA532UT_2)
Hydric soil rating: No

Minor Components

Crandall

Percent of map unit: 5 percent
Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R047XA560UT - High Mountain Gravelly Loam (Mountain Big Sagebrush)
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent
Landform: Escarpments on mountain slopes, ridges on mountain slopes
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

182—Yeates Hollow-Henefer complex, 30 to 60 percent slopes

Map Unit Setting

National map unit symbol: k1v9
Elevation: 5,600 to 8,400 feet
Mean annual precipitation: 16 to 22 inches
Mean annual air temperature: 40 to 45 degrees F
Frost-free period: 60 to 90 days
Farmland classification: Not prime farmland

Map Unit Composition

Yeates hollow and similar soils: 55 percent

Henefer and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Yeates Hollow

Setting

Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium derived from conglomerate, sandstone and quartzite

Typical profile

A - 0 to 12 inches: very stony loam
Bt1 - 12 to 25 inches: very cobbly clay
Bt2 - 25 to 37 inches: very cobbly clay
Bt3 - 37 to 43 inches: extremely cobbly clay loam
R - 43 to 53 inches: bedrock

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: R047XA461UT - Mountain Stony Loam (Mountain Big Sagebrush)
Hydric soil rating: No

Description of Henefer

Setting

Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from quartzite, sandstone and shale

Typical profile

A1 - 0 to 7 inches: gravelly loam
A2 - 7 to 12 inches: gravelly loam
Bt1 - 12 to 21 inches: cobbly clay
Bt2 - 21 to 30 inches: cobbly clay
Bt3 - 30 to 37 inches: very gravelly clay loam
Bt3 - 37 to 43 inches: very gravelly clay loam
Bt5 - 43 to 50 inches: very cobbly sandy clay loam
Bt5 - 50 to 60 inches: very cobbly sandy clay loam

Properties and qualities

Slope: 30 to 60 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: R047XA432UT - Mountain Loam (Oak)
Hydric soil rating: No

Minor Components

Fewkes

Percent of map unit: 6 percent
Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R047XA430UT - Mountain Loam (Mountain Big Sagebrush)
Hydric soil rating: No

Heiners

Percent of map unit: 5 percent
Landform: Ridges on mountain slopes
Down-slope shape: Linear, convex
Across-slope shape: Convex
Ecological site: R047XA320UT - Upland Shallow Loam (Wyoming Big Sagebrush)
Other vegetative classification: Upland Shallow Loam (Mountain Big Sagebrush) (047XA320UT_1)
Hydric soil rating: No

Rock outcrop

Percent of map unit: 4 percent
Landform: Escarpments on mountain slopes, ridges on mountain slopes
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Soil Information for All Uses

Suitabilities and Limitations for Use

The Suitabilities and Limitations for Use section includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

Land Classifications

Land Classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Soil Taxonomy Classification (Treasure Hill Area - Soils Taxonomy Classification)

This rating presents the taxonomic classification based on Soil Taxonomy.

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff, 1999 and 2003). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. This table shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in sol. An example is Alfisols.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalfs (Ud, meaning humid, plus alfs, from Alfisols).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludalfs (Hapl, meaning minimal horizonation, plus udalfs, the suborder of the Alfisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective Typic identifies the subgroup that typifies the great group. An example is Typic Hapludalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, active, mesic Typic Hapludalfs.

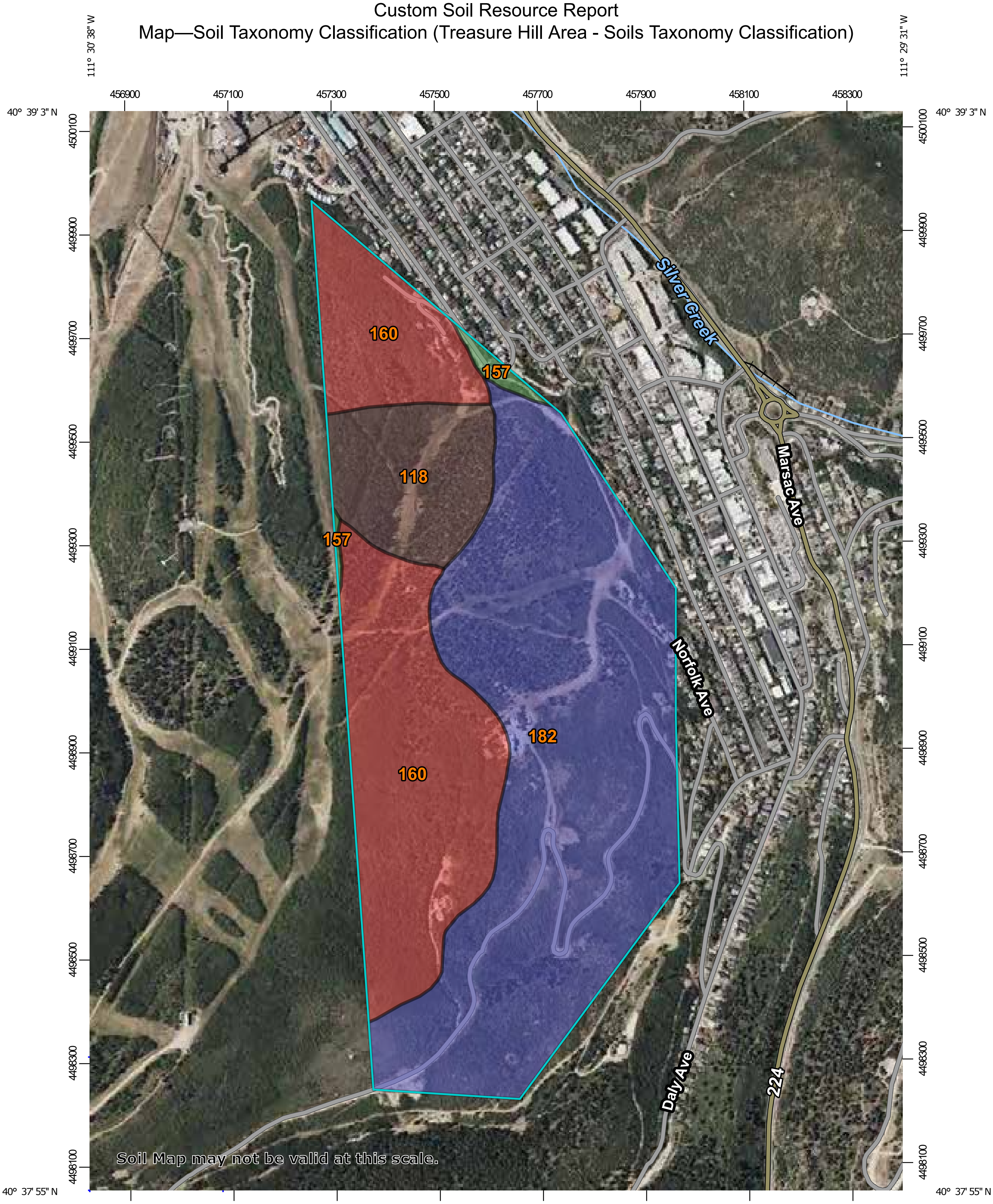
SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

References:

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. (The soils in a given survey area may have been classified according to earlier editions of this publication.)

Map—Soil Taxonomy Classification (Treasure Hill Area - Soils Taxonomy Classification)



Map Scale: 1:10,200 if printed on A portrait (8.5" x 11") sheet.

0 150 300 600 900 Meters

0 450 900 1800 2700 Feet

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Clayey-skeletal, smectitic, frigid Typic Argixerolls
- Fine, smectitic, frigid Typic Argixerolls
- Loamy-skeletal, mixed, superactive Mollic Haplocryalfs
- Loamy-skeletal, mixed, superactive Pachic Haplocryolls
- Not rated or not available

Soil Rating Lines

- Clayey-skeletal, smectitic, frigid Typic Argixerolls
- Fine, smectitic, frigid Typic Argixerolls
- Loamy-skeletal, mixed, superactive Mollic Haplocryalfs
- Loamy-skeletal, mixed, superactive Pachic Haplocryolls
- Not rated or not available

Soil Rating Points

- Clayey-skeletal, smectitic, frigid Typic Argixerolls
- Fine, smectitic, frigid Typic Argixerolls
- Loamy-skeletal, mixed, superactive Mollic Haplocryalfs
- Loamy-skeletal, mixed, superactive Pachic Haplocryolls
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Summit Area, Utah, Parts of Summit, Salt Lake and Wasatch Counties
Survey Area Data: Version 13, Sep 7, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 20, 2021—Jun 21, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

Table—Soil Taxonomy Classification (Treasure Hill Area - Soils Taxonomy Classification)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
118	Dromedary-Rock outcrop complex, 30 to 70 percent slopes	Loamy-skeletal, mixed, superactive Mollic Haplocryalfs	21.1	10.3%
157	Manila-Henefer complex, 8 to 15 percent slopes	Fine, smectitic, frigid Typic Argixerolls	1.9	0.9%
160	Parkcity-Dromedary gravelly loams, 30 to 70 percent slopes	Loamy-skeletal, mixed, superactive Pachic Haplocryolls	68.4	33.2%
182	Yeates Hollow-Henefer complex, 30 to 60 percent slopes	Clayey-skeletal, smectitic, frigid Typic Argixerolls	114.3	55.6%
Totals for Area of Interest			**205.7**	**100.0%**

Rating Options—Soil Taxonomy Classification (Treasure Hill Area - Soils Taxonomy Classification)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Physical Properties

Soil Physical Properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

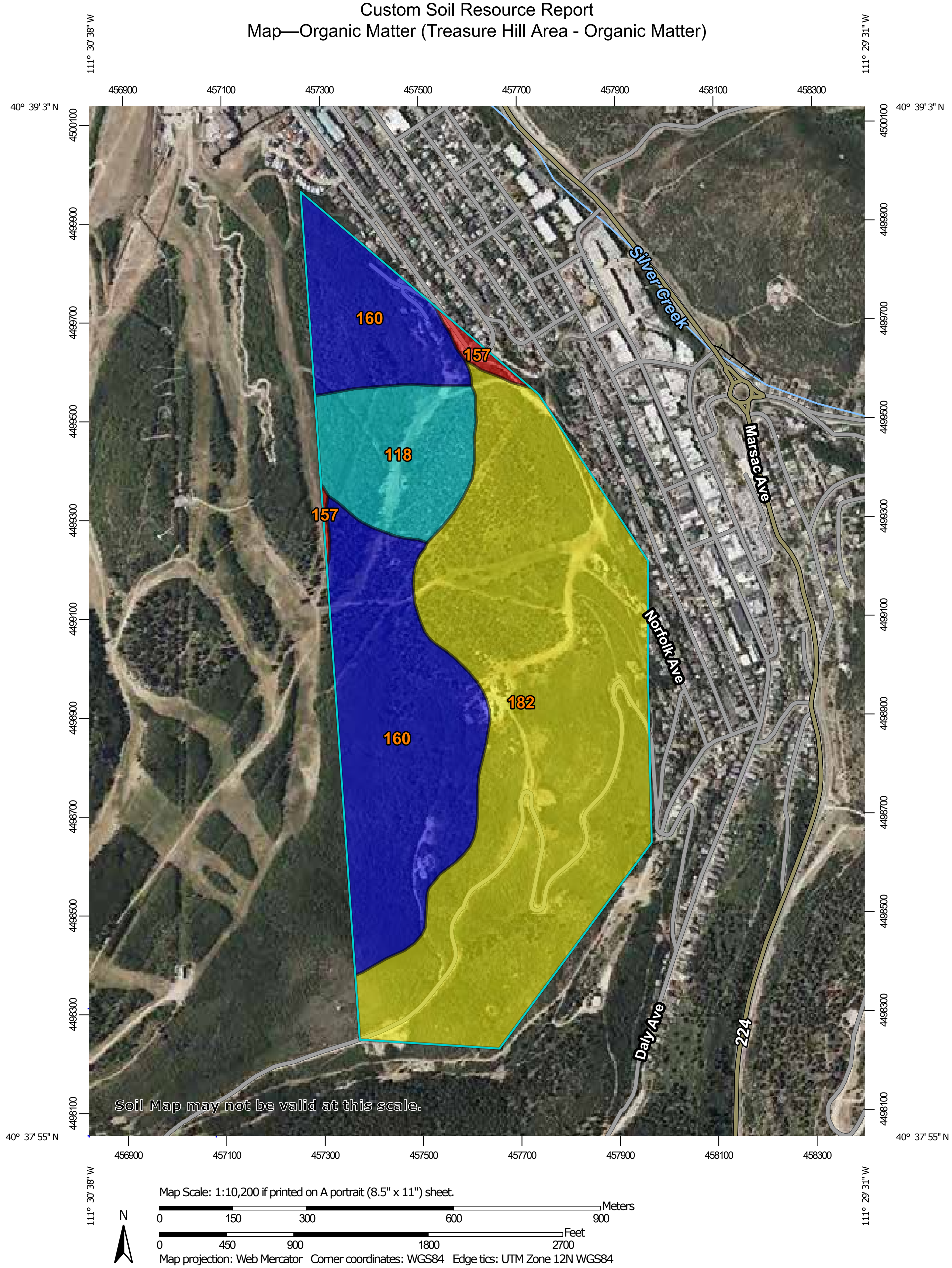
Organic Matter (Treasure Hill Area - Organic Matter)

Organic matter is the plant and animal residue in the soil at various stages of decomposition. The estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained by returning crop residue to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms. An irregular distribution of organic carbon with depth may indicate different episodes of soil deposition or soil formation. Soils that are very high in organic matter have poor engineering properties and subside upon drying.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Map—Organic Matter (Treasure Hill Area - Organic Matter)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

<= 3.00

> 3.00 and <= 3.50

> 3.50 and <= 4.00

> 4.00 and <= 4.80

Not rated or not available

Soil Rating Lines

<= 3.00

> 3.00 and <= 3.50

> 3.50 and <= 4.00

> 4.00 and <= 4.80

Not rated or not available

Soil Rating Points

<= 3.00

> 3.00 and <= 3.50

> 3.50 and <= 4.00

> 4.00 and <= 4.80

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Summit Area, Utah, Parts of Summit, Salt Lake and Wasatch Counties
Survey Area Data: Version 13, Sep 7, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 20, 2021—Jun 21, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

Table—Organic Matter (Treasure Hill Area - Organic Matter)

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
118	Dromedary-Rock outcrop complex, 30 to 70 percent slopes	4.00	21.1	10.3%
157	Manila-Henefer complex, 8 to 15 percent slopes	3.00	1.9	0.9%
160	Parkcity-Dromedary gravelly loams, 30 to 70 percent slopes	4.80	68.4	33.2%
182	Yeates Hollow-Henefer complex, 30 to 60 percent slopes	3.50	114.3	55.6%
Totals for Area of Interest			**205.7**	**100.0%**

Rating Options—Organic Matter (Treasure Hill Area - Organic Matter)

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 6

Units of Measure: Inches

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

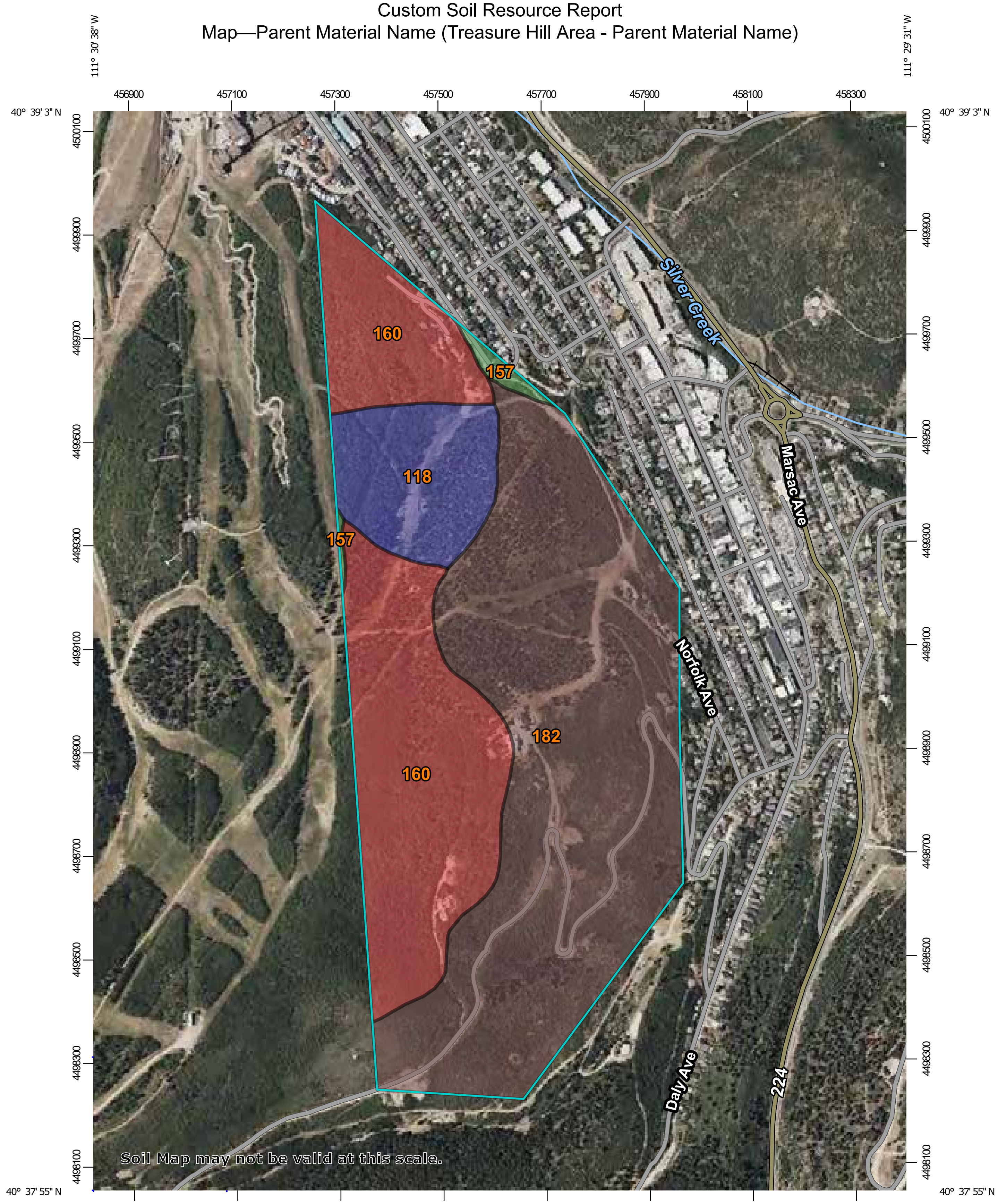
Parent Material Name (Treasure Hill Area - Parent Material Name)

Parent material name is a term for the general physical, chemical, and mineralogical composition of the unconsolidated material, mineral or organic, in which the soil forms. Mode of deposition and/or weathering may be implied by the name.

The soil surveyor uses parent material to develop a model used for soil mapping. Soil scientists and specialists in other disciplines use parent material to help interpret soil boundaries and project performance of the material below the soil. Many soil properties relate to parent material. Among these properties are proportions of sand, silt, and clay; chemical content; bulk density; structure; and the kinds and amounts of rock fragments. These properties affect interpretations and may be criteria used to separate soil series. Soil properties and landscape information may imply the kind of parent material.

For each soil in the database, one or more parent materials may be identified. One is marked as the representative or most commonly occurring. The representative parent material name is presented here.

Custom Soil Resource Report
Map—Parent Material Name (Treasure Hill Area - Parent Material Name)



Map Scale: 1:10,200 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 150, 300, 600, 900

Feet: 0, 450, 900, 1800, 2700

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- colluvium and till derived from sandstone, shale and conglomerate
- colluvium derived from conglomerate, sandstone and quartzite
- colluvium derived from sandstone, limestone and quartzite
- slope alluvium derived from conglomerate, sandstone and shale
- Not rated or not available

Soil Rating Lines

- colluvium and till derived from sandstone, shale and conglomerate
- colluvium derived from conglomerate, sandstone and quartzite
- colluvium derived from sandstone, limestone and quartzite
- slope alluvium derived from conglomerate, sandstone and shale
- Not rated or not available

Soil Rating Points

- colluvium and till derived from sandstone, shale and conglomerate
- colluvium derived from conglomerate, sandstone and quartzite
- colluvium derived from sandstone, limestone and quartzite
- slope alluvium derived from conglomerate, sandstone and shale
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Summit Area, Utah, Parts of Summit, Salt Lake and Wasatch Counties
Survey Area Data: Version 13, Sep 7, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 20, 2021—Jun 21, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

Table—Parent Material Name (Treasure Hill Area - Parent Material Name)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
118	Dromedary-Rock outcrop complex, 30 to 70 percent slopes	colluvium and till derived from sandstone, shale and conglomerate	21.1	10.3%
157	Manila-Henefer complex, 8 to 15 percent slopes	slope alluvium derived from conglomerate, sandstone and shale	1.9	0.9%
160	Parkcity-Dromedary gravelly loams, 30 to 70 percent slopes	colluvium derived from sandstone, limestone and quartzite	68.4	33.2%
182	Yeates Hollow-Henefer complex, 30 to 60 percent slopes	colluvium derived from conglomerate, sandstone and quartzite	114.3	55.6%
Totals for Area of Interest			**205.7**	**100.0%**

Rating Options—Parent Material Name (Treasure Hill Area - Parent Material Name)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

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Appendix I

Climate Vulnerability of Vegetation Types

Climate Vulnerability of Vegetation Types (LANDFIRE 2019)

Southern Rocky Mtn Mesic Montane Mixed Conifer forest and woodland

This vegetation type currently scores in the moderate range of vulnerability due to sensitivity from fire regime departure. It is projected to be high in 20 years.

Fire exclusion and suppression practices have led to increased tree densities and understory fuels. There is a higher likelihood of stand-replacing fire in these ecosystems. Furthermore, there exists a higher risk for insect and disease mortality exacerbated by drought which may also add to the fuel loading and increasing fire risk.

These stands have the potential for upslope migration of dominant species in its range, unlike some high elevation forests that are limited in upslope movement.

Inter-mountain basins aspen-mixed conifer forest and woodland

The climate vulnerability index for this ecosystem is currently moderate. It is projected to be high in 20 years.

This system represents a stable mixed aspen-conifer woodland maintained by periodic disturbance that naturally limited conifers from dominating and shading out the aspen. Increased fire frequency in the future may convert these forests to a Rocky Mountain aspen forest and woodland type. It is also possible that this type may expand if frequent droughts limit conifer canopy closure. However, there are restrictions to the potential movement of aspen as stated in Rocky Mountain aspen forest and woodland type, especially those growing at the extent of its range and elevation.

Rocky Mountain aspen forest and woodland

This vegetation currently scores in the moderate range of vulnerability to climate change due to higher temperatures and increased moisture stress. It is projected to be moderate in 20 years.

Aspen is a water-limited, drought-intolerant species that may experience higher mortality and decreased regeneration. Incidence of Sudden Aspen Decline may increase under a changing climate, more so than it already has in recent years. Predisposing factors for Sudden Aspen Decline include open stands at lower elevations on exposed slope locations that are sensitive to drought.

There is a moderate departure from the historical fire regime, which reflects fire suppression and exclusion practices across its range. This has led to increasing conifer abundance and the loss of aspen.

Opportunities for aspen to migrate and reestablish are limited in a warming climate. Aspen on marginal sites (drier, lower end of elevation, south-facing) will see the highest impacts. The aspen occurring on Treasure Hill fits this description of marginal site (though it is north-facing), and maintaining the stands could become a problem if a high severity event occurred.

Rocky Mountain Gambel Oak – Mixed Montane Shrubland – patchy and continuous

The climate vulnerability index for this ecosystem is currently moderate. It is projected to be high in 20 years.

Mining, fragmentation from road networks, and livestock grazing increase sensitivity of these ecosystems to climate change.

Fire regime departure is moderate to high across this type. The fire regime has been altered by increased fire frequency in areas due to invasive grasses at lower elevations and fire suppression at higher elevations. An increase in fire frequency may cause declines for Gambel oak and increase the area occupied by invasive grasses.

In the case of Treasure Hill, there is the potential that Gambel oak may move upslope to where the conifer vegetation type currently exists.

Landscape fragmentation and fire regime departure have resulted in changes to the structure of these shrublands, leading to an increased sensitivity of the system to the effects of changes in temperature or precipitation patterns.

Rocky Mountain Bigtooth Maple Ravine Woodland

No information available on the climate vulnerability of bigtooth maple ravine woodlands.

Southern Rocky Mountain Montane-Subalpine Grassland

Current climate vulnerability is moderate. It is expected to be high in 20 years.

This system is expected to increase its range at the expense of adjacent forests and woodland stands. This is especially true following fires that reduce forests’ abilities to regenerate and woodlands already on the edge of their climate tolerance. Departure from the fire regime (and intensive grazing elsewhere) ranks this vegetation type as low in its regional adaptive capacity for future topoclimate variability.

Inter-mountain Basins Montane Sagebrush Steppe

Current climate vulnerability is moderate. It is expected to be moderate in 20 years.

It is expected that a warming climate with more frequent droughts may weaken big sagebrush and eliminate recruitment of this species.

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