

**Pikes Peak Observatory** is an initiative of the *National Space & Technology Institute (NSSTI)* to place a research-grade observatory on the summit of Pikes Peak. *Pikes Peak Observatory* will be used to support informal and formal science, technology, engineering, and math (STEM) education and research. Our purpose is to inspire the next generation of Earth and space scientists while creating a more environmentally aware, scientifically-literate general public.

*NSSTI* proposes incorporating into the observatory design a one-meter primary mirror research-grade observatory telescope, equipped with atmospheric and space science instrumentation to:

- support research and environmental education, engaging students in STEM disciplines,
- increase environmental, atmospheric and space science literacy of summit visitors, and
- provide awareness of the important role of astronomical/meteorological observations and science to the history of Pikes Peak and contributions to U.S. western expansion.

The observatory will employ an optical telescope, hydrogen-alpha solar telescopes, atmospheric monitoring instrumentation, and interpretive display(s). Its purpose is to inform, educate, and support research into our environment, the Earth-Sun connection, and the search for other planets capable of sustaining life. It will be used by those who visit the summit of Pikes Peak from across our nation and throughout the world and those who operate the observatory telescopes remotely, including students across Colorado and the US. In fast-track mode, *Pikes Peak Observatory* will support orbital/trajjectory analysis of satellites and asteroids.

Figure 1: Architect rendering of Pikes Peak Observatory



*Pikes Peak Observatory* will provide visitors to the summit an opportunity to connect with science, interact with scientist-educators, and experience the astronomical and atmospheric

instrumentation used to collect data for research that impacts our understanding of the Earth and space. *Pikes Peak Observatory* will advance environmental and space science research, and help the public better understand how science conducted on the summit of Pikes Peak, past, present, and future, is being used to improve the human condition. First-hand exposure to this research will inspire youth to pursue additional science and technology education leading some to careers in STEM disciplines.

Because of the prominence of Pikes Peak in the culture of Native Americans (48 tribes claim a connection to Pikes Peak, which is considered the origin of the Ute Indian tribes in their culture), NSSTI is willing to work with interested tribes and other ethnic or racial groups to include relevant science they provide in our educational programs and/or interpretive displays.

A local director of observatories will be hired to oversee the operation and maintenance of the observatory and related equipment. NSSTI will train local astronomy enthusiasts to serve as scientist-educators/docents to interact with the public at the observatory, providing informal education regarding the use of the observatory to support atmospheric and space science.

The focus of this informal education, which will be introduced on the summit and expanded upon in Colorado Springs will encompass:

- How Pikes Peak serves as a water source for multiple Colorado watersheds, how climate and climate change impact water availability, and how water is essential for life.
- How the sun impacts life on Earth, including the impact of the sun on Earth's weather and climate, water supplies, and the effects of solar events on telecommunications.
- How astronomers use telescopes and other instruments which are part of *Pikes Peak Observatory* in the search for other planets capable of sustaining life.

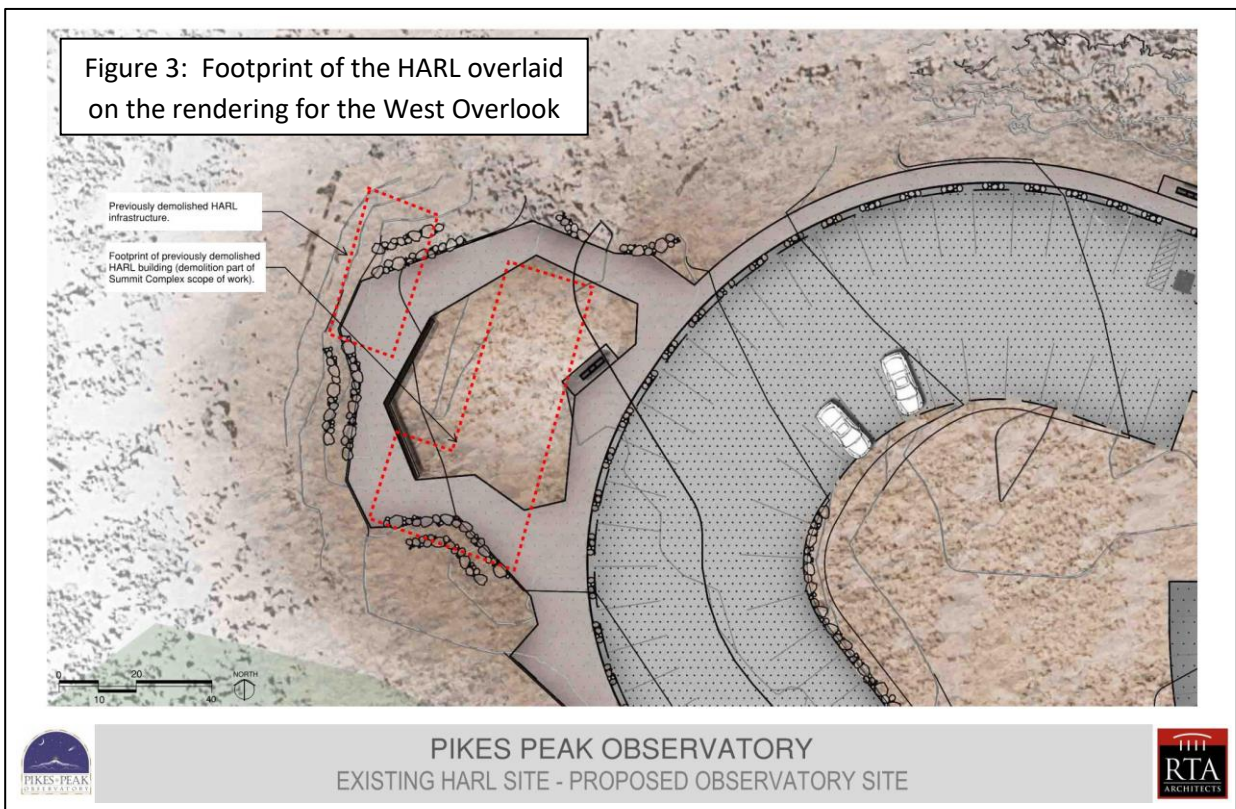
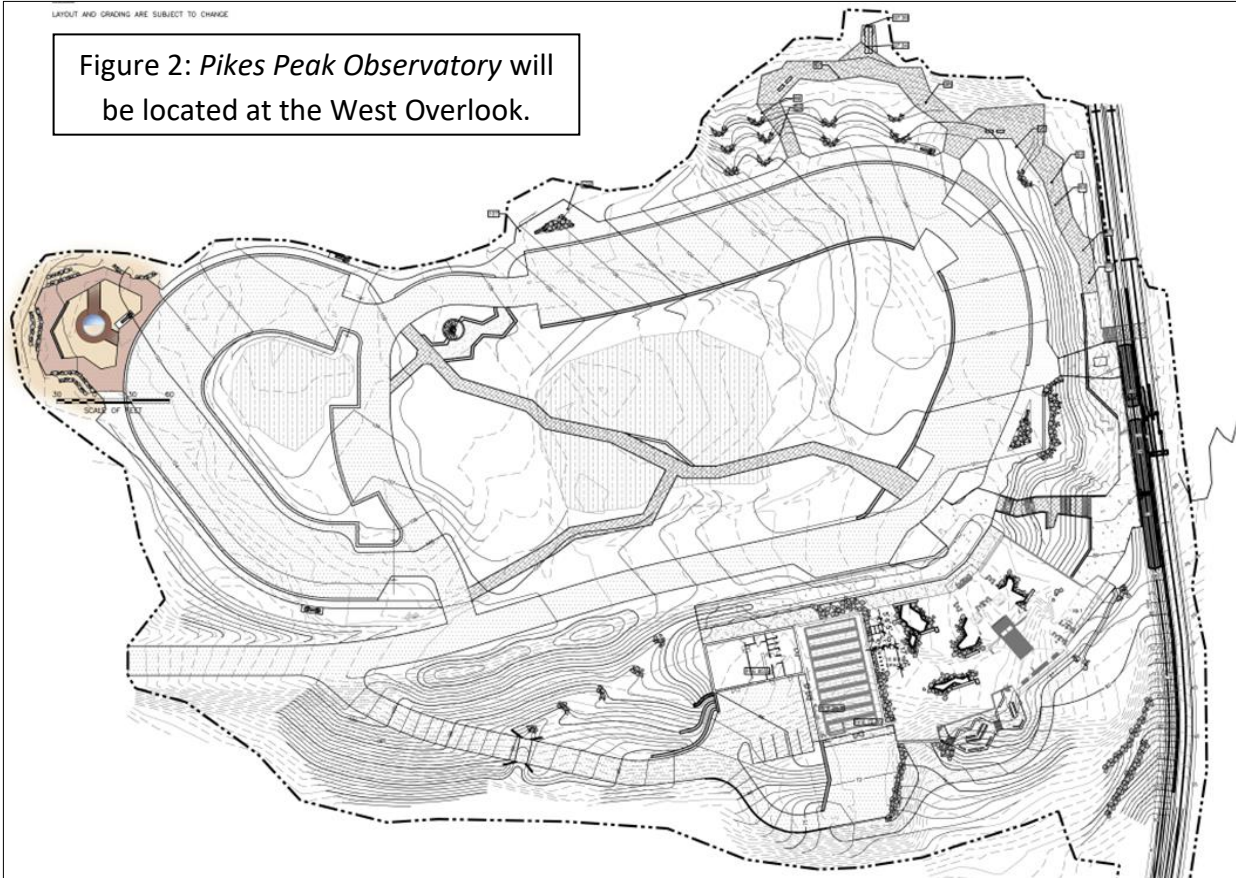
The observatory will have a footprint of 250 square feet, plus viewing platform, to be situated on the disturbed site where the U.S. Army *High Altitude Research Laboratory (HARL)* previously stood, which will become the West Overlook. The observatory will be placed at the West Overlook of the new Summit Complex, with installation scheduled for the summer of 2021, after the new summit facilities have been completed and the current HARL is removed.

Once the observatory is operational, docents will ride the public shuttle operated by the City of Colorado Springs (as long as this transportation is available) or carpool to minimize impact on parking spaces available to the public.

Figure 2 depicts the location of *Pikes Peak Observatory* on the new Summit Complex site plan.

Figure 3 shows the location of the footprint of the current *High Altitude Research Laboratory*.

*Pikes Peak Observatory* will use an 18'-diameter clamshell-type observatory dome designed to withstand 200 mph winds. In addition, the observatory will meet a design criterion to be able



to conduct telescopic observations during sustained winds as high as 30 knots (35 mph) and permit automated remote operations. The dome will be manufactured in a color compatible with the natural terrain and other facilities on the summit. Because telescopes are operated at ambient temperature, the observatory will not need heating, ventilation or air conditioning.

Figure 4: Architect Rendering of Pikes Peak Observatory serving visitors to the Summit



Four telescopes will be incorporated into *Pikes Peak Observatory*. The main telescope will have a 40" mirror, and will extend 10'10" high when aligned vertically. A solar telescope with a 6" mirror will be affixed to the side of the main telescope, sharing the computer-controlled mount which will permit remote operation from Colorado Springs or other locations. Flat screen displays at the observatory and within the Summit House will allow visitors to see what is being viewed by the main telescope and affixed solar telescope.

Two 4" solar telescopes on carts will be kept within the observatory dome when not in use, and rolled out onto a viewing platform permitting summit guests to view solar activity with exceptional clarity, guided by observatory docents.

The viewing platform, built with the same materials used for Summit Complex walkways, will permit summit visitors to see into the observatory dome without walking on fragile permafrost.

Shown behind the observatory dome, a tower will support weather and atmospheric monitoring instrumentation, with associated electronics contained in a weatherproof enclosure at its base. This tower will be 16' tall, the height of the closed observatory dome.

The interpretive sign for the West Overlook will be located adjacent to the observatory by the Summit Complex developers. *Pikes Peak Observatory* will provide interpretive information for use within the Summit House describing the scientific data collected at the summit and scientific contributions associated with Pikes Peak, past, present and future.

Historical science interpretive information will include content relating to such things as: Native American scientific understanding, discovery of the state flower on Pikes Peak by botanist Dr. Edwin James in 1820; the weather station operated by the US Army Signal Corps from 1874-1888; an observatory assembled on the Summit by Samuel Pierpont Langley for the total solar eclipse on July 29, 1878; the impact of the 1878 solar eclipse on the migration of scientists to the Pikes Peak region; the weather station operated on the summit by the Weather Bureau from 1892-1894; the international distribution of weather information from the summit of Pikes Peak by professor of meteorology Frank Loud, PhD, at Colorado College and its impact locally and abroad; solar observations from the summit in 1893 by Dr. George Ellery Hale (founder of Wilson Observatory); altitude testing by Dr. Sanford Alexander Moss in 1918 of the Liberty aircraft engine with turbocharger (the first turbocharged US aircraft engine) leading to the award of the Collier Trophy in 1940; and the discovery on Pikes Peak of atomic particles called "mu mesons" in 1935 by Dr. Carl David Anderson, whose work in cosmic radiation included discovery of the positron, advancing particle physics leading to a 1936 Nobel Prize.

It is noteworthy that the research conducted from Pikes Peak during the total solar eclipse of 1878 demonstrated the benefits of high altitude observing, leading many astrophysicists to come to Colorado, which is now home to the *National Center for Atmospheric Research (NCAR) High Altitude Observatory (HAO)*. In April 1971, the NCAR/HAO operated far infrared and meteorological equipment on the summit of Pikes Peak as part of an infrared site survey.

"Present" and "Future" scientific observations and discoveries will relate to environmental/atmospheric, solar and astronomical science.

In May of 1998, the *Colorado Springs Utilities Water Resources Department* installed and began operating an automated weather station on the Pikes Peak summit. Since wind is a critical weather element in telescope siting, wind data was reviewed for the 42,651 observations collected on the summit of Pikes Peak for the period from May 1998 through September 1999. Analysis of these observations indicated that verified winds were within telescope operating limits 79.42% of the time. [The highest wind recorded during this period was 93 knots (107 mph) at 9:31 am on February 19, 1999; *Pikes Peak Observatory* will withstand 200 mph winds.]

In 2000, a study conducted by D. Andre Erasmus, PhD, a certified consulting meteorologist, substantiated the suitability of Pikes Peak to support celestial observations using an infrared telescope. Pikes Peak ranked #1 based on the fraction of the time sky conditions were clear (useable 77% of the time) and #1 (tied with Mt. Evans) for dryness- precipitable water vapor.

*Pikes Peak Observatory* will be accessible to visitors to the summit during the hours that the Summit House is open, and will be remotely operated by off-site users at other times. Public accessibility will improve public scientific literacy, enhancing their decision-making around issues involving water, climate change, and space exploration. Off-site users will include college and university students, staff and research assistants. No permanent staff is needed on the Pikes Peak summit; remote operations will be coordinated from Colorado Springs.

Key to the educational and research missions of *Pikes Peak Observatory* is the ability for students and researchers to connect remotely from local or distant locations. Because of international visitors to the summit and international students as part of *Falcon Telescope Network* through the US Air Force Academy, *Pikes Peak Observatory* will have a global reach.

Informal and formal science educational programs about the importance of water to life and human well-being; the impact of the sun on the Earth and its inhabitants; and space exploration of potentially habitable planets, including Mars, drawing from observations and measurements taken at *Pikes Peak Observatory*, will be incorporated in environmental education programs delivered at Colorado schools. Students of all ages will be able to remotely task *Pikes Peak Observatory* telescopes, download what is being observed to their classrooms or labs, and access atmospheric data collected by sensors on the summit. This will enhance appreciation for environmental science, space science, and the STEM disciplines at play.

Many organizations assisted in the development of the plans and operating concept for *Pikes Peak Observatory* and its educational programs. Here are key players and their contributions.

- The *National Space Science & Technology Institute* is overseeing *Pikes Peak Observatory* design and development and prepared the special use permit application (SF 299) to the *US Forest Service* (USFS) for its construction, operation, and maintenance.
- The *City of Colorado Springs*, *Pikes Peak – America’s Mountain*, and *RTA Architects* provided information for ensuring the compatibility of *Pikes Peak Observatory* with the design, operating concept, and intent of the new Pikes Peak Summit Complex. The City of Colorado Springs has annually endorsed this concept since 2015.
- The *Colorado College* and the *US Air Force Academy* provided technical advice regarding observatory capabilities and remote operation, especially as they relate to research applications by students and faculty at local institutions of higher education.

- The *Colorado Springs Astronomical Society* offered support to the development and operation of the proposed docent program.
- *BSCS* (formerly the *Biological Sciences Curriculum Study*), the *Colorado Consortium for Earth & Space Science Education (Challenger Learning Center of Colorado)*, the *National Center for Atmospheric Research*, the *National Renewable Energy Laboratory*, and the *American Association of Variable Star Observers* provided subject matter expertise on *Pikes Peak Observatory* educational content to be developed for schools and the public.

*Pikes Peak Observatory* will be unique in that more than 90% of the time it sits above the boundary layer and within the free troposphere, which makes it extremely valuable in making atmospheric measurements. No other Colorado peak has the elevation coupled with the relative isolation and lack of high terrain to the immediate west that keeps Pikes Peak in the free troposphere and isolated from ground effects.

An additional feature of the Pikes Peak summit which greatly enhances its suitability for an observatory is its accessibility. Year-round accessibility to the telescope is important, in the event there is a problem with the telescope, drive mechanism, or dome operation requiring maintenance by an on-call observatory staff member. The existence of both a highway and a railway to the top of Pikes Peak provides needed accessibility.

VANDA GRUBISIC, Ph.D., Director of the *National Center for Atmospheric Research (NCAR) Earth Orbiting Laboratory (EOL)*, is one of many scientists who endorse the placement of a research-quality observatory on the summit of Pikes Peak: *"I am expressing support for the proposed effort to create the Pikes Peak Observatory by incorporating a research grade observatory telescope equipped with atmospheric and space science instrumentation. Hereby, I would like to emphasize the high potential of the proposed Pikes Peak Summit Complex as a site for unique atmospheric measurements. The number of mountain top observatories in the world is relatively small, especially in the western United States. Yet, it is the atmospheric measurements at those unique high mountain top locations that are extremely valuable for climate and climate change research given that they provide long-term measurements in extreme alpine environments where impacts of climate change first become evident. Furthermore, given its high elevation (14,116') and relative isolation from the rest of the Colorado Rockies massif, Pikes Peak is an ideal location for measurements of long-range transport of pollutants and many other free tropospheric measurements that are typically only possible with the use of an instrumented research aircraft."*

*Pikes Peak Observatory* is looking forward to working with the USFS Pikes Peak Ranger District; the City of Colorado Springs; current USFS Special Use Permit holders (Pikes Peak Cog Railway, Colorado Springs Utilities, US Army High Altitude Research Laboratory); other constituent groups and stakeholders connected with Pikes Peak (individually and/or through the non-profit

group *Advocates for Pikes Peak Summit House*); and with government entities and agencies with an interest in serving those who visit Pikes Peak.

Our concept, and intent, is to enrich the experience of visitors to the Summit through informal environmental education focused on Earth and space science relevant to Pikes Peak past, present and future. By educating students and the public through both direct and remote operation of telescopes and weather/atmospheric monitoring instrumentation, *Pikes Peak Observatory* will motivate students to seek additional STEM education leading to science careers and improve environmental literacy of the public on issues such as water rights and conservation, global warming, and uses of space. *Pikes Peak Observatory* will contribute to a better understanding of the interactions among solar activity and changing land uses, weather patterns, pollution levels, watersheds, water quantity and quality, and climate change.

Chief Thomas L. Tidwell, Chief of the US Forest Service, said “*America’s national forests and grasslands are there for the benefit not of the few, but of all Americans. Our commitment at the Forest Service is to work with partners to achieve ‘the greatest good of the greatest number,’ both now and for generations to come.*”<sup>1</sup> *Pikes Peak Observatory* supports this vision, and will provide research data and environmental education directly relevant to USFS strategic objectives listed in the Forest Service’s Strategic Plan<sup>1</sup>, such as: fostering resilient, adaptive ecosystems to mitigate climate change; mitigating wildfire risk; providing abundant clean water; strengthening communities; and connecting people to the outdoors.

Working with national agencies, educating summit visitors from across the US, and providing remote access to telescopes and scientific data, *Pikes Peak Observatory* is designed to serve the nation. The work of Pikes Peak Observatory is especially pertinent to the USFS research and development mission “to develop and deliver knowledge and innovative technology to improve the health and use of the Nation’s forests and grasslands—both public and private.” As stated in their Research and Development 2015 Overview, “Upon the founding of the Forest Service, one of the new agency’s missions was to protect our Nation’s headwaters. Today, the provisioning of water of sufficient quality and quantity remains integral to our work.”

Our education programs recognize that Colorado is a headwaters state. Water from mountain rain and snowmelt impacts not only state citizens but those in neighboring states on both sides of the continental divide. Beginning with the story of water, which is essential for all life, we then address the impact of energy from the sun, also essential for life, and the search for other habitable planets to expand understanding of the universe. Pikes Peak Observatory can fulfill its promise in serving the nation only by operating from the summit of America’s Mountain.

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1. USDA Forest Service Strategic Plan: 2015-2020. <https://www.fs.fed.us/strategicplan>.
  2. USDA Forest Service Publication *Forest Service Research and Development: 2015 Overview*. <https://www.fs.fed.us/research/publications/2015overview.pdf>.