NASAfacts

PROPOSED ACTION

Mars has been an object of fascination for humanity for thousands of years. A now barren planet, we know based on recent science that Mars once had an atmosphere and was abundant with water. We now ask ourselves, "What happened to Mars? Was there once life there? Can humans live on Mars?"

The most Earth-like planet in the Solar System, Mars may be able to tell us about the early evolution of water-rich terrestrial planets, and its relationship to the evolution of habitable environments. Mars has not been subjected to significant atmospheric and geological degradation, resulting in the possibility that the early geologic record of Mars has been preserved. Because of these conditions, signs of past life on Mars may have been preserved in a way that can be observed and studied. Mars, therefore, provides the opportunity to address fundamental questions about the origin and evolution of life on Earth (and elsewhere in the solar system), such as Did life arise elsewhere in the solar system, and if so, how and when? How did Mars evolve into the planet it is today and what can that tell us about Earth's evolution? and How are the biological and geological histories of a planet related?"

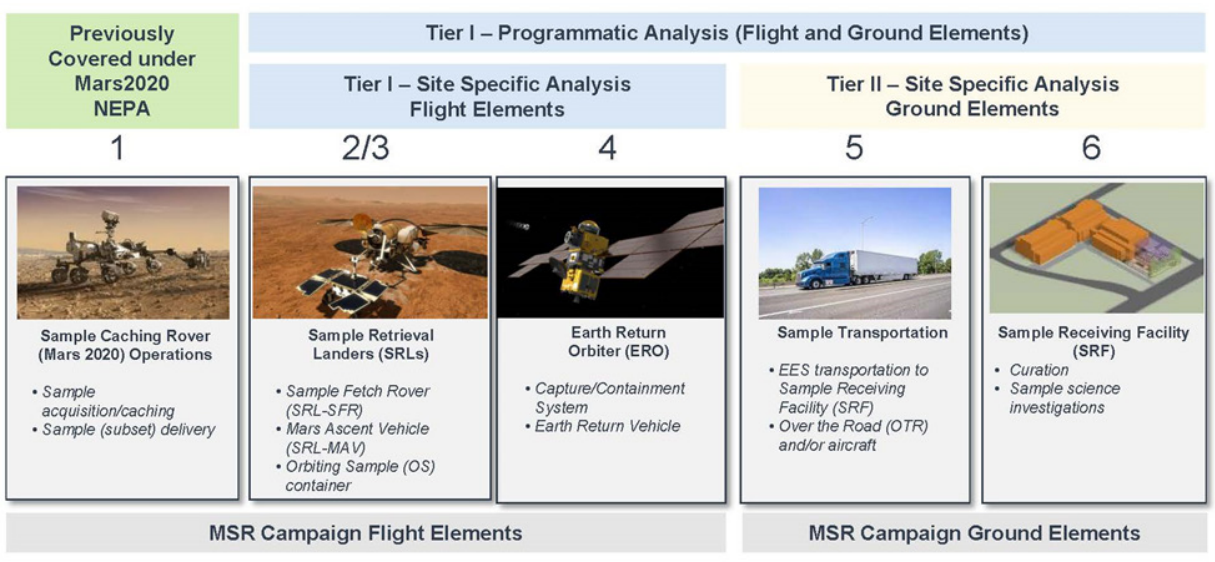
The Mars Sample Return Campaign is a high priority in the planetary science community and has long been a goal of international planetary exploration programs. By acquiring and delivering to Earth a rigorously documented set of Mars samples for investigation in terrestrial laboratories, scientists would have access to the full breadth and depth of analytical science instruments available across the world.

Under the Proposed Action, the National Aeronautics and Space Administration (NASA) in coordination with the European Space Agency (ESA) would conduct the Mars Sample Return Campaign to retrieve a scientifically selected set of Mars samples (i.e., Martian rocks, regolith[1], and atmosphere). These samples would be transported to Earth for scientific analysis and research as part of the Proposed Action. The resulting investigations of these returned samples would enable scientific advances in the following:

- the search for life on Mars;
- understanding the origin and evolution of Mars as a geological system;
- understanding the processes and history of climate on Mars; and
- closing knowledge gaps required to prepare for future human exploration

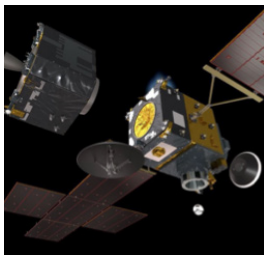
The Proposed Action, as the Mars Sample Return Campaign, includes four flight elements and two ground elements. The flight elements consist of the Perseverance rover, up to two Landers, and the Earth Return Orbiter, including its payload and recovery. The proposed landing location is the Utah Test and Training Range (see "Why Utah Test and Training Range" Factsheet). The ground elements are sample transportation and a sample receiving facility.

[1]Regolith is loose unconsolidated rock and dust that sits atop a layer of bedrock.



Flight Elements

- Perseverance Rover (Sample Caching Rover): Provided by NASA and launched in July 2020, the mission currently underway is responsible for sample selection, acquisition, and caching. The total sample amount would be approximately 525 grams (about 1 pound). This flight element was previously analyzed under NEPA in the NASA Final EIS for the Mars 2020 Mission and the Final Supplemental EIS for the Mars 2020 Mission.
- Landers (Landers): Anticipated for launch in 2028 from Cape Canaveral Space Force Station or Kennedy Space Center in Brevard County, Florida, the Landers would include lander platforms delivered from launch through entry, descent, and landing on Mars. NASA anticipates that payload mass and volume may predicate the need for the equipment to be divided into two Lander payloads, one for the Sample Fetch Rover and one for the Mars Ascent Vehicle. At this time, NASA has not confirmed if the use of nuclear power will be necessary to ensure that mission needs are met. If nuclear power will be necessary, a payload of up to 20 Radioisotope Heater Units (RHUs) may be utilized; any Lander launches involving the use of RHUs and routine payloads would fall within the scope of previous NEPA analysis conducted for RHUs Final Programmatic Environmental Assessment for Launches Involving RHUs and NASA Routine Payload Environmental Assessment. The Sample Fetch Rover would transit to deposited sample tubes, collect the sample tubes using a robotic Sample Transfer Arm, and deliver the tubes to the Lander carrying the Mars Ascent Vehicle. The tubes would then be transferred, using a Sample Transfer Arm on the Lander, into the Orbiting Sample container inside the upper stage of the Mars Ascent Vehicle. If still operational, Perseverance rover could also deliver sample tubes directly to the Landers or Sample Fetch Rover. The retrieved samples for return to Earth would consist of approximately 30 tubes weighing about 15 grams (0.03 pounds) each, for a total sample amount of approximately 450 grams (about 1 pound).
- Earth Return Orbiter (Orbiter): Provided by the ESA and launched from French Guiana in 2027 (prior to the Lander launches), the Orbiter would rendezvous with the Orbiting Sample container in space, and return it for a safe entry and landing on Earth. The Orbiter would be capable of (1) providing communications relay for all Mars Sample Return flight elements on the surface of Mars (Landers, Perseverance Rover, Sample Fetch Rover, and Mars Ascent System), (2) locating the Orbiting Sample container in Mars orbit, and (3) supplying power, propulsion, and navigation needed for the National Aeronautics and Space Administration-provided Capture/Containment and Return System payload to function. More information regarding ESA's role in the Mars Sample Return Campaign can be found at the ESA website: https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/Mars_sample_return. The Capture/Containment and Return System payload would provide the ability to capture and contain the Orbiting Sample container, transfer the Orbiting Sample container into the Earth Entry Vehicle (creating the Earth Entry System [EES]), and protect it during the return flight to Earth (see http://www.jpl.nasa.gov/missions/mars-sample-return-msr for additional information). After departing orbit around Mars on an Earth-bound trajectory, the Orbiter would release the EES above the Earth's atmosphere, continue past Earth and would navigate to a trajectory that would avoid Earth for over 100 years, ensuring that residual Mars material, if any, associated with the Orbiter is not returned to Earth. After all critical spacecraft systems can be verified to be healthy and reliable, the Orbiter would be maneuvered onto a path that would allow the EES to land precisely in the target area.



Ground Elements – while specific transportation protocols and sample return facility (SRF) design and operational requirements are still in development, this fact sheet describes the reasonably foreseeable transportation, safety, security, and storage/curation for the Mars Sample Return Campaign.

- Earth Entry System and Mars Sample Transportation: After containment of the EES (which contains the samples) at the landing site and transfer to the vault (see Recovery Operations Factsheet), the EES would be transported to an SRF. Transport methods have yet to be determined; however, the vault would be transported either over the road entirely or using a combination of over the road and aircraft. Exact transportation methods and routes would depend on the type of vault utilized and the location of an SRF. Thus, potential impacts associated with possible transportation methods are analyzed from a programmatic perspective (see Programmatic Approach Factsheet) based on either over the road and/or aircraft use. There is no site-specific analysis of EES transportation from the landing site to an SRF in the Programmatic Environmental Impact Statement; future NEPA analysis will address the specific impacts once the requirements have been further defined.
- SRF: Currently, National Aeronautics and Space Administration does not have a facility that can support the biosafety level required for a mission such as the Mars Sample Return Campaign; consequently, an SRF would need to be established or added to an existing facility. An SRF within the context of this Programmatic Environmental Impact Statement includes temporary or permanent facilities used to isolate unsterilized Mars material from the Earth's environment. Activities anticipated at this type of facility are removal of the Mars samples from the EES, sample safety assessment, curation, including the preservation, conservation, management, preliminary examination, cataloging, allocation, and distribution, and physical security of sterilized Mars materials, and analysis, which may include scientific or planetary protection activities.

MSR Campaign Architecture