Mars Analog Research Station Project

Devon Island, Nunavut, Canada
American Southwest
Iceland
Australian Outback

A Program of the Mars Society

Mars Analog Research Station Project
A Program of the Mars Society

Mars is within reach. A world with a surface area the size of the combined continents of the Earth, the Red Planet contains all the elements needed to support life. As such it is the Rosetta stone for revealing whether the phenomenon of life is something unique to the Earth, or prevalent in the universe. The exploration of Mars may also tell us whether life as we find it on Earth is the model for life elsewhere, or whether we are just a small part of a much vaster and more varied tapestry. Moreover, as the nearest planet with all the required resources for technological civilization, Mars will be the decisive trial that will determine whether humanity can expand from its globe of origin to enjoy the open frontiers and unlimited prospects available to multi-planet spacefaring species. Offering profound enlightenment to our science, inspiration and purpose to our youth, and a potentially unbounded future for our posterity, the challenge of Mars is one that we must embrace.

Indeed, with so much at stake, Mars is a test for us. It asks us if we intend to continue to be a society of pioneers, people who dare great things to open untrodden paths for the future. It puts us to the question of whether we will be people whose deeds are celebrated in newspapers, or in museums; whether we will continue to open new possibilities for our descendants, or whether we will become less than those who took on the unknown to give everything we have to us. Mars is the great challenge of our time.

In order to help develop key knowledge needed to prepare for human Mars exploration, and to inspire the public by making sensuous the vision of human exploration of Mars, the Mars Society has initiated the Mars Analog Research Station (MARS) project. A global program of Mars exploration operations research, the MARS project will include four Mars base-like habitats located in deserts in the Canadian Arctic, the American southwest, the Australian outback, and Iceland. In these Mars-like environments, we will launch a program of extensive long-duration geology and biology field exploration operations conducted in the same style and under many of the same constraints as they would on the Red Planet. By doing so, we will start the process of learning how to explore on Mars.

The Flashline Mars Arctic Research Station, the first of four Mars Society research stations, sits in the far distance.

Devon Island, Nunavut Territories, Canada

Mars Analog Research Stations are laboratories for learning how to live and work on another planet. Each is a prototype of a habitat that will land humans on Mars and serve as their main base for months of exploration in the harsh Martian environment. Such a habitat represents a key element in current human Mars mission planing. Each Station’s centerpiece is a cylindrical habitat, “The Hab,” an 8-meter diameter, two-deck structure mounted on landing struts. Peripheral external structures, some inflatable, may be appended to the Hab as well.

Each station will serve as a field base to teams of four to six crew members: geologists, astrobiologists, engineers, mechanics, physicians and others, who live for weeks to months at a time in relative isolation in a Mars analog environment. Mars analogs can be defined as locations on Earth where some environmental conditions, geologic features, biological attributes or combinations thereof may approximate in some specific way those thought to be encountered on Mars, either at present or earlier in that planet's history. Studying such sites leads to new insights into the nature and evolution of Mars, the Earth, and life.

However, in addition to providing scientific insight into our neighboring world, such analog environments offer unprecedented opportunities to carry out Mars analog field research in a variety of key scientific and engineering disciplines that will help prepare humans for the exploration of that planet. Such research is vitally necessary. For example, it is one thing to walk around a factory test area in a new spacesuit prototype and show that a wearer can pick up a wrench — it is entirely another to subject that same suit to two months of real field work. Similarly, psychological studies of human factors issues, including isolation and habitat architecture are also only useful if the crew being studied is attempting to do real work.

Furthermore, when considering the effectiveness of a human mission to Mars as a whole, it is clear that there is an operations design problem of considerable complexity to be solved. Such a mission will involve diverse players with different capabilities, strengths and weaknesses. They will include the crew of the Mars habitat, pedestrian astronauts outside, astronauts on unpressurized but highly nimble light vehicles operating at moderate distances from the habitat, astronauts operating a great distances from the habitat using clumsy but long-endurance vehicles such as pressurized rovers, mission control on Earth, the terrestrial scientific community at large, robots, and others. Taking these different assets and making them work in symphony to achieve the maximum possible exploration effect will require developing an art of combined operations for Mars missions. The MARS project will begin the critical task of developing this art.

Recently, a team of researchers led by MARS project scientist Dr. Pascal Lee of NASA Ames Research Center identified a new Mars analog site of high promise: The 15-mile diameter Haughton meteorite impact crater and its surroundings, Devon Island, Nunavut, in the Canadian High Arctic. Set in a rocky polar desert, Haughton is an intriguing site because it appears to present not just one or a few potential Mars analog features, but a wide variety.

Because of its unique Mars-like characteristics, Devon Island was chosen by the Mars Society as the location for its first field research station, the Flashline Mars Arctic Research Station. This unit was successfully constructed during the summer of 2000. However, because of its remote high-Arctic location, this unit can only be used to support field research during the northern hemisphere's central summer months. The establishment of additional stations in other Mars analog environments, including the American southwest, Iceland, and the Australian outback, will allow the MARS project to operate year-round, offering Mars Society members and invited researchers an unprecedented opportunity to carry out Mars analog field research in a variety of key scientific and engineering disciplines that will help prepare humans for the exploration of Mars.

The Flashline Station will begin simulation operations in June, 2001. Followed by construction of additional stations at the other identified locations, it is anticipated that the global MARS project will generate tremendous public interest and support and will receive worldwide recognition.

Haughton Crater, Devon Island

Mars Analog Research Station Project • Goals

The Mars Society has identified three prime goals to be met by the Mars Analog Research Station Project:

- The Stations will serve as an effective testbed for field operations studies in preparation for human missions to Mars specifically. They will help develop and allow tests of key habitat design features, field exploration strategies, tools, technologies, and crew selection protocols, that will enable and help optimize the productive exploration of Mars by humans. In order to achieve this, each Station must be a realistic and adaptable habitat.

- The Stations will serve as useful field research facilities at selected Mars analog sites on Earth, ones that will help further our understanding of the geology, biology, and environmental conditions on the Earth and on Mars. In order to achieve this, each Station must provide safe shelter and be an effective field laboratory.

- The Stations will generate public support for sending humans to Mars. They will inform and inspire audiences around the world. As the Mars Society's flagship program, the MARS project that will serve as the foundation of a series of bold steps that will pave the way to the eventual human exploration of Mars.

Mars Analog Research Stations will be operated by Mars Society researchers and will be made available to NASA and selected scientists, engineers and other professionals from a variety of institutions worldwide to support science investigations and exploration research at Mars analog sites. As an operational testbed, the stations will serve as a central element in support of parallel studies of the technologies, strategies, architectural design, and human factors involved in human missions to Mars. The facilities will also bring to the field compact laboratories in which in-depth data analysis can begin before scientists leave the field site and return to their home institutions. The Stations will help develop the capabilities needed on Mars to allow productive field research during the long months of a human sojourn. The facilities will evolve through time to achieve increasing levels of realism and fidelity with the ultimate goal of supporting the actual training of Mars-bound astronauts.

Mars Analog Research Station Project •
The Building of Flashline Station

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The MARS Project took its first giant step forward during the summer of 2001 with the successful construction of the Flashline Mars Arctic Research Station on Devon Island.

Devon Island is located circa 75 degrees north in Canada's Nunavut Territory. Consisting largely of polar desert and home to the 15-mile diameter Haughton impact crater, the completely uninhabited island is one of the most Mars-like environments on Earth. Since 1997, NASA Haughton Mars Project scientists led by Dr. Pascal Lee have been exploring the area's geology and biology in order to explore Mars by comparison. At its Founding Convention in 1998, at the suggestion of Lee, the Mars Society decided to make the construction of a simulated human Mars exploration station on Devon Island its first major project. The purpose of the station would be to continue the scientific exploration of Devon, but do it in the same style and under many of the same constraints as would be involved in conducting such activities on Mars. By doing so, researchers would be forced to confront some of the problems of human Mars exploration and begin the process of developing appropriate field tactics for exploring the Red Planet. The establishment of a Mars arctic research station would also be a highly visible step forward that would help inspire public support for the human exploration of Mars.

Starting in the fall of 1998, a volunteer Mars Society task force was formed to define the project further, and during 1999 private funds were raised allowing the project to be initiated in earnest. Among those donating to support the project were FINDS, the Kirsch Foundation, Flashline.com, and the Discovery Channel. In January 2000, a contract for fabrication was let to Infrastructure Composites International (Infracomp) of Commerce City, Colorado, whose unique ultrastrong, comparatively lightweight, and weatherproof fiberglass honeycomb technology provided an attractive option for the Devon Island Station.

While Infracomp's craftsmanship proved to be excellent, the fabrication effort fell seriously behind schedule, resulting in a crisis in early June, when it became clear that unless something was done, the structure would not be ready in time for a scheduled June 28 ship date. However, the mobilization of additional labor from Mesa Fiberglass, Pioneer Astronautics, and volunteers from the Rocky Mountain Mars Society — some of who worked up to two weeks in the fiberglass factory with no compensation — ensured that the structure was ready to ship on time. Meanwhile, the Mars Society finalized plans with the NASA-led Haughton Mars Project (HMP) to secure, on a cost-sharing basis, the needed cargo flight support from the US Marine Corps. Accordingly, on June 28, three trucks carrying the components of the Station left Colorado for Moffett Field, CA, where, together with gear for the NASA HMP, they were loaded on Marine Corp C-130 aircraft for flight to Resolute Bay in the high Arctic.

The plan was to deliver the station components to Devon Island via C-130 paradrop, as the fiberglass panels comprising the station were much too large to be brought in by the small Twin-Otter aircraft used for general transportation between Resolute Bay and Devon Island. Five paradrop sorties from Resolute to Devon were needed, with a total of seven drops to be carried out. The first five paradrops carrying the walls, legs and some of the dome sections of the habitat occurred on July 5. Despite adverse gusty winds, these drops were largely successful, in that the payloads were delivered safely to the ground, but fell wide of the Haynes Ridge target construction site. The sixth drop, on July 8, carrying the remaining domes and other equipment, went well. However, that day's seventh and final drop, was a disaster. The payload separated from the parachute at an altitude of 1,000 ft, causing the complete destruction of the habitat fiberglass floors, a trailer that had been shipped to the Arctic to help move the 800 lb. fiberglass wall panels in the event they did drop wide of the target site, and a crane required to construct the station.

With the loss of the trailer, the floors, and the crane, the on-site construction crew that the Mars Society had contracted to assemble the station declared that building it this year was impossible, and left the island. It seemed to most observers that the project was doomed. Indeed, one journalist covering the events went so far as to ask Mars Society President Robert Zubrin if he saw a parallel between the "failure of your mission" and that of the Mars Polar Lander. Zubrin’s reply: “There’s a parallel in that we both hit a rock. But the difference is that we have a human crew here, and we are going to find a way out of this.

Refusing to give up, Zubrin and Lee assembled a makeshift construction team consisting of Mars Society scientist-volunteers, Inuit youth hired from Resolute Bay, and journalists, who, having come to cover the construction of the station, were strongly encouraged to participate in the effort. Frank Schubert, a design/build expert from Denver and a Founding Member of the Mars Society, was brought in to direct the construction effort, with the assistance of his foreman Matt Smola, and Infracomp president John Kunz. A new trailer, “the Kunzmobile,” was constructed out of wood and parts of a wrecked baggage cart from Resolute Bay airport. Using the Kunzmobile, the team managed in three days of heavy sledding in freezing rain to move all the dispersed habitat components to the construction site.

Wooden floors to replace the ruined fiberglass decks were designed and construction materials secured in Resolute Bay. To replace the crane, an alternative ancient-Roman style construction technique was devised, utilizing large labor teams with bracing timbers and guy ropes operating in coordination with a scaffold and a winch to lift the 20-foot by 7-foot wall panels into place. Shortly before the construction effort began, the weather cleared, and the team seized the opportunity to get the job done fast in good weather by instituting 14-hour work-days. The first wall section of the Flashline Station was raised on July 20, coincidentally but fittingly the anniversary of both the Apollo 11 Moon landing and the Viking 1 landing on Mars. In three days all the walls were up. The decks were then partly built out, and block and tackle gear was used to haul the 350 lb. dome sections up onto the upper deck. Once there, a scaffold was constructed, and two dome sections plus the central core were erected to create an arch. The dome sections were then added in, with the last one being brought into place around 7 P.M. July 26. Interior buildout then commenced rapidly.


The first wall is raised.


More wall sections are lifted.


The dome arch is built.


The dome is up!

On the evening of July 27, Zubrin sent a message to Mars Society Mission Control in Denver to establish contact in preparation for the commencement of simulation operations the next day.

“Mission Control, this is Flashline Station. Are you there? Please Respond.”

After a delay of several minutes, Mission Control replied, “Flashline Station, this is Mission Control. It’s good to hear from you. Clearly, failure was not an option.”

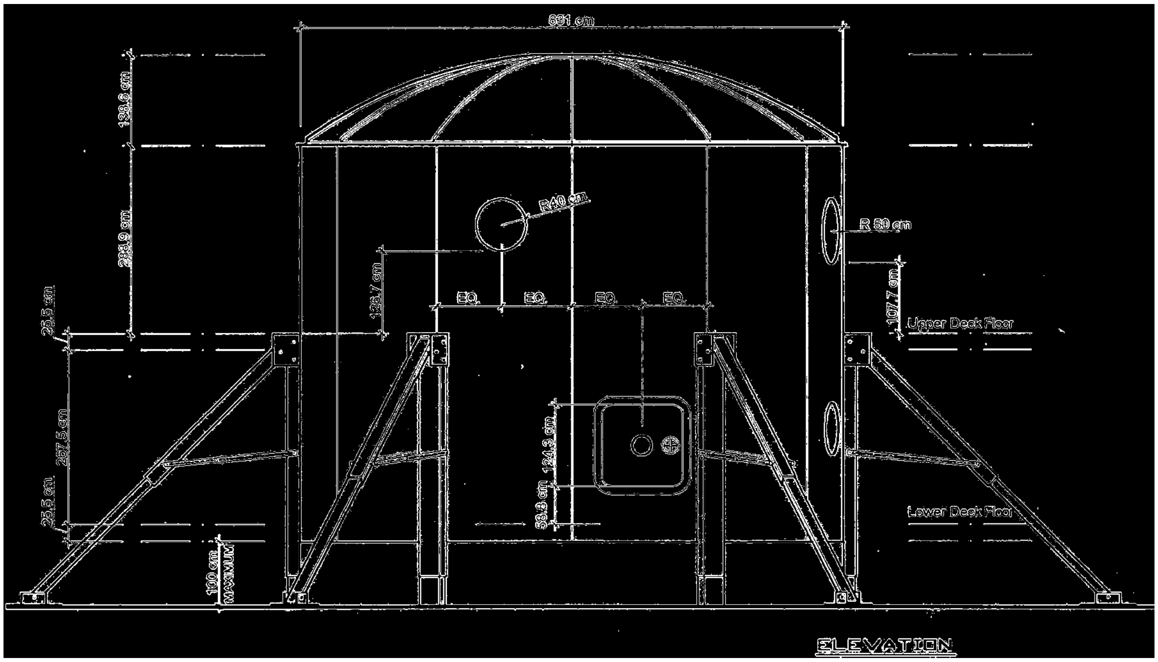
In a ceremony attended by about 50 scientists, Inuits and journalists on the evening of July 28, the station was formally commissioned. Speeches were given by NASA Ames scientist Carol Stoker, British Antarctic Survey scientist Charles Cockell, Lee, and Zubrin. At the conclusion of the speeches, a shotgun was fired in salute to a red, green and blue Mars Society Martian tricolor flag flying atop the station. Zubrin then christened the habitat, smashing a bottle of champagne against the Flashline Mars Arctic Research Station. This provoked a sigh from the crowd. Lee, however, immediately reassured them; “It’s all right folks. It’s just Canadian champagne.”

The first crew prepares to enter the hab.

The first crew, consisting of Lee, Mars Society webmaster Marc Boucher, Zubrin, Schubert, Cockell and the Discovery Channel’s Bob Nesson then entered the habitat for a largely symbolic one night and one day occupation and simulation. A more thorough three-day shakedown simulation began on July 30. Commanded by Carol Stoker, the crew of the shakedown consisted of Stoker, Boucher, NASA Ames’ Bill Clancey and Larry Lemke, the University of Toronto’s Darlene Lim, and Nesson. In the course of the next several days, this group lived and worked in the hab, supporting a series of exploration traverses on Devon Island in collaboration with the NASA HMP, including the field testing of a Hamilton Sundstrand Mars spacesuit prototype. To report on their activities, the crew engaged in Mars-Earth simulated time-delayed dialogue with Mission Control in Denver.

On August 4th, shakedown simulation operations were discontinued. The hab was then sealed for the winter. Based on experience gathered to date, plans are now being developed for the summer of 2001, when the station will be used to support up to eight weeks of Mars operations field research in the high arctic.

Mars Analog Research Station Project •
Flashline Mars Arctic Research Station Exterior Layout



Shown above is the exterior layout of the Flashline Mars Arctic Research Station. The Station is 8.3 m in diameter and 8.45 m tall. The primary components of the station are twelve wall panels, each 6.1 m long and 2.17 m wide, and 12 dome sections converging on a 1 m diameter central node at the top. The Walls and domes are made of a unique weatherproof and superstrong fiberglass honeycomb that is 15 cm thick, but only weighs as much as 2.5 cm thick pine. The structure is supported by 6 vertical steel legs, augmented against horizontal loads by 6 oblique steel legs. The structure has two decks, separated by 2.7 meters. The lower deck features two airlock ports, two windows, and a sample hatch. The upper deck features 4 windows. The living quarters and cooking area are upstairs, the laboratory, workshop, storages areas, EVA prep areas, bathroom, and airlocks are downstairs.

The station is similar in overall architecture to the habitat designed at Martin Marietta for the “Mars Direct” mission plan in 1990, and to that designed for the NASA Johnson Space Center Design Reference Mission in 1993. It is thus “flight like” in the sense that it would be compatible with the fairing limitations of the kind of heavy lift launch vehicles generally proposed for human Mars missions.

Mars Analog Research Station Project •
Flashline Mars Arctic Research Station Interior Layout

The following drawings depict interior arrangement plans for the habitat’s decks.

A Ladder

B Sample port

C Lab/work area

D Simulated airlock

E Primary EVA hatch

F EVA prep area

G General hygiene area

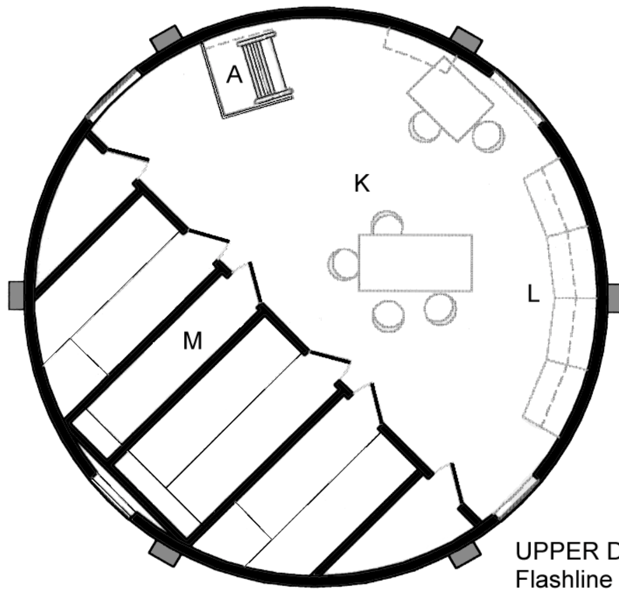
H Mechanical Stack – Contains plumbing and electrical systems

J Pressure port for future attachment to greenhouse or other additional structures

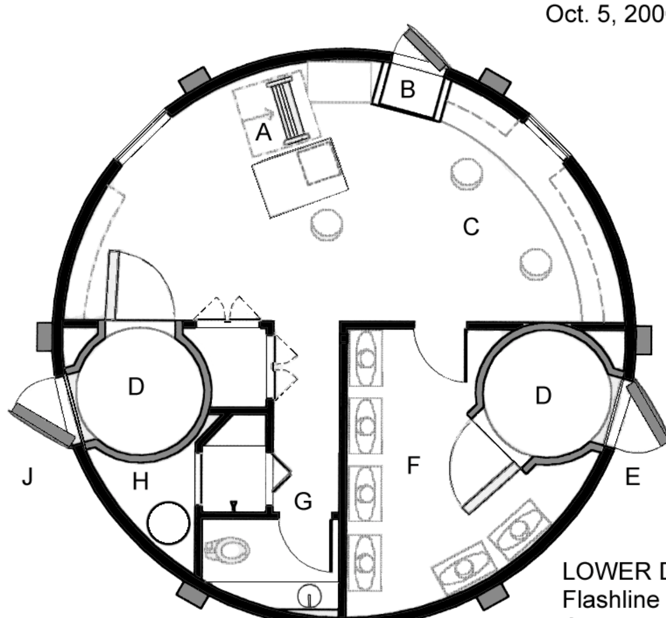
K Wardroom

L Galley and food storage compartments

M Crew staterooms



UPPER DECK PLAN
Flashline Station
Oct. 5, 2000



LOWER DECK PLAN
Flashline Station
Oct. 5, 2000

The Mars Analog Research Station (MARS) project is conceived as a multi-year, phased project to enable distribution of the required budget over a period of time. In addition, phasing the project provides us the flexibility to incorporate design changes and new technologies in response to knowledge gained each field season.

The first step in this plan was accomplished in 2000 with the construction on Devon Island of the Flashline Mars Arctic Research Station. In the summer of 2001, Flashline will be operated for two months in Mars operations simulation mode. Also, in 2001, we will be developing an analog pressurized rover that can be used either independently or in combination with Flashline or other MARS project field stations. Work on the first of these other units, in the American southwest, will also begin in 2001, with the commencement of associated simulation operations planned for January 2002. Then in 2002 and 2003, two more stations will be established; one in the basaltic and geothermally active deserts of Iceland, and the other in the Austrian outback, whose ancient deserts contain fossils which date from the same period when Mars' surface ran with liquid water.

Each of these additional stations offers unique new advantages to the MARS program. Because of its ease of access, the American station is the ideal place to serve as a test bed for equipment that will later be sent to more remote and unforgiving locations. For the same reason, the American station is the best place to begin long-duration isolation experiments. With its geothermally active areas, Iceland best simulates areas on Mars where life might be found today, and thus it is the optimum location to practice Mars exobiology field work. In addition, with its European location, Iceland is well situated to act as a place from which the MARS project can act to inspire the European public with the challenge of the modern age's New World. Finally, Australia's ancient fossils are among the oldest records of life on Earth, and as such may mirror the kind of traces that life may have left on Mars. In learning how to look for such remnants within the constraints faced by Mars explorers, we will be teaching ourselves how to search for the record of the origin of life on our neighboring world.

The budget for the MARS project for the years 2000-2003 follows.

Mars Analog Research Station Project • Four Year Budget

FY 2000	*Devon*	*SW*	*site 3*	*site 4*	***Total item***
Item					
Construction					
Hab fabrication	$153,000	$0	$0	$0	$153,000
Hab construction	40,000	0	0	0	40,000
Interior buildout	0	0	0	0	0
Equipment	13,000	0	0	0	13,000
Travel	20,000	0	0	0	20,000
Labor	0	0	0	0	0
Transport	90,000	0	0	0	90,000
Field operations	0	0	0	0	0
Management	54,000	0	0	0	54,000
Fees	0		0	0	0
Subtotal	$370,000	$0	$0	$0	$370,000
15% contingency	$55,500	$0	$0	$0	$55,500
Total	$425,500	$0	$0	$0	$425,500

FY 2001	*Devon*	*SW*	*site 3*	*site 4*	***Total item***
Item					
Construction					
Hab fabrication	$0	$150,000	$0	$0	$150,000
Hab construction	0	30,000	0	0	30,000
Interior buildout	20,000	20,000	0	0	40,000
Equipment	4,000	0	0	0	4,000
Travel	6,000	10,000	0	0	16,000
Labor	12,000	14,000	0	0	26,000
Transport	4,000	10,000	0	0	14,000
Field operations	100,000	0	0	0	100,000
Management	15,000	15,000	0	0	30,000
Fees	0	0	0	0	0
Subtotal	$161,000	$249,000	$0	$0	$410,000
15% contingency	$24,150	$37,350	$0	$0	$61,500
Total	$185,150	$286,350	$0	$0	$471,500

Mars Analog Research Station Project • Four Year Budget

FY 2002	*Devon*	*SW*	*site 3*	*site 4*	***Item total***
Item					
Construction					
Hab fabrication	$0	$0	$150,000	$0	$150,000
Hab construction	0	0	30,000	0	30,000
Interior buildout	0	10,000	25,000	0	35,000
Equipment	0	0	3,000	0	3,000
Travel	20,000	10,000	20,000	0	50,000
Labor	0	0	20,000	0	20,000
Transport	0	0	20,000	0	20,000
Field operations	80,000	50,000	0	0	130,000
Management	10,000	10,000	10,000	0	30,000
Fees	0	0	0	0	0
Subtotal	$110,000	$80,000	$278,000	$0	$468,000
15% contingency	$16,500	$12,000	$41,700	$0	$70,200
Total	$126,500	$92,000	$319,700	$0	$538,200

FY 2003	*Devon*	*SW*	*site 3*	*site 4*	***Item total***
Item					
Construction					
Hab fabrication	$0	$0	$0	$150,000	$150,000
Hab construction	0	0	0	30,000	30,000
Interior buildout	0	0	10,000	25,000	35,000
Equipment	0	0	0	3,000	3,000
Travel	20,000	10,000	10,000	20,000	60,000
Labor	0	0	0	20,000	20,000
Transport	0	0	0	20,000	20,000
Field operations	80,000	50,000	50,000	0	180,000
Management	10,000	10,000	10,000	10,000	40,000
Fees	0	0	0	0	0
Subtotal	$110,000	$70,000	$80,000	$278,000	$538,000
15% contingency	$16,500	$10,500	$12,000	$41,700	$80,700
Total	$126,500	$80,500	$92,000	$319,700	$618,700

Mars Analog Research Station Project • Principals

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Dr. Robert Zubrin
President, Pioneer Astronautics
Author of *The Case for Mars* and *Entering Space*.
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Dr, Chris McKay
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Planetary Scientist, NASA Ames Research Center
Principal Investigator, NASA Haughton-Mars Project

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Webmaster, Mars Society

Mars Analog Research Station Project • Information

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The Mars Analog Research Station Project is a privately funded project. Your donations and support will enable it to realize its full potential. All donations are tax deductible. For donations of stock, the Mars Society has set up a charitable lead trust with Prudential Securities, and custom arrangements can be created for those wishing to make major donations to the trust. The Mars Society's federal tax ID number is 31-1585646.

Should you have any questions regarding Mars Analog Research Station Project or wish to make a donation, please contact:

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