MARS SAMPLE RETURN VIA PHOBOS CACHE AND HUMAN RETRIEVAL. Philip J. Stooke[1], [1] Department of Geography, University of Western Ontario, Canada N6A 5C2. pjstooke@uwo.ca.

Introduction: Mars Sample Return is one of the highest priority goals for deeper understanding of Mars, but its cost and complexity have repeatedly delayed its implementation. I propose a program of sample return combining elements of robotic and human flight programs, which spreads and shares the cost and risks, while allowing ample opportunity for international cooperation. Samples are collected by robotic missions and delivered to Phobos over a period of about ten years. The first human mission to Mars, an Apollo 10-style rehearsal mission, lands on Phobos instead of Mars and collects the samples for return to Earth.

Justification: Mars Sample Return is essential for the most sophisticated analysis of Martian materials in terrestrial laboratories. Mission designs have until now proven to be prohibitively expensive and extremely challenging. Designs vary, but typically require a lander, a mechanism for collecting samples, a launch vehicle capable of placing the sample in Mars orbit, rendezvous with a return vehicle, sample transfer, and a long journey back to Earth. The complexity of orbital operations and the long travel time back to Earth add risk and expense to the mission. As a separate issue, human flights to Mars will be risky and expensive, making a rehearsal mission like Apollo 10 both necessary for system testing and hard to justify in scientific terms. Here I propose combining the two issues into a decade long program of sample collection culminating in a human flight to Phobos to collect and return the samples.

Sample Collection: The sample collection phase would be spread over about a decade and could involve missions from several space agencies. It could combine relatively simple 'ground-breaking' collection using a static lander with a sampling arm, suitable for a uniform geologic target, and sophisticated rover missions collecting samples over large areas. Each mission would deliver its sample to Mars orbit, rendezvous with Phobos and deposit its sample to the moon's surface using the simplest possible landing system, probably a small braking rocket plus airbags. Tracking or imaging would locate the landing site, and to the extent possible these sites would be reasonably close together. The advantages of this system are that (1) the long, risky journey back to Earth is eliminated at this stage; (2) international cooperation in building the cache of samples is possible but no single mission is in the critical path for overall mission success; (3) It is assumed that reaching Phobos is easier than a complex orbital rendezvous with a return spacecraft, and (4) a delay in the subsequent human mission can be accommodated by adding more sample return missions. **Nothing** precludes additional direct-to-Earth sample return missions. Deimos can substitute for Phobos as a sample cache if it is operationally preferable. If human Mars exploration is eventually deemed impossible, a flagship class robotic mission to Phobos can gather the samples instead.

International cooperation: In its simplest form this would involve parallel Mars sample collection and caching missions. Other options would include Deimos sample collection with delivery to Phobos, Mars trojan asteroid sample return with delivery to Phobos, plus Phobos rovers to gather samples and group them for easier recovery and Phobos imaging to help locate samples. A range of cooperative missions are available, all valuable if successful, but none critical to overall success if they fail.

Human mission: A human Mars mission will involve great expense and high risk. Long flight times place the crew in danger from solar flares, illness and hardware failures. The Mars entry, descent and landing will be the most challenging human operation ever undertaken in space. A test flight similar to Apollo 10 or the proposed Orion 12 mission (orbiting the Moon with a crew while testing the lander in automated mode) would be very desirable but may be hard to justify if its science return is minimal. In this proposal, the first human crew would land on Phobos, not Mars, which should be an easier operation and might use systems closely based on the lunar landing vehicle. Apart from sampling Phobos, itself a major scientific goal, it would collect all the waiting Mars samples and return them to Earth. There they would be distributed to the appropriate space agencies. The high reliability of human-rated return systems should ensure safe return of these valuable samples.

Advantages: The advantages of this system are (1) A rehearsal mission for a human Mars landing is amply justified by its science return; (2) The cost of every sample return mission is shared with the Constellation program; (3) Overall risk in the robotic missions is reduced; (4) Substantial sampling takes place before any contamination is introduced to Mars by human surface operations; (5) International cooperation is feasible, but mission success does not depend on it.

Disadvantages: The delay in retrieving samples is only an inconvenience. Possible volatile loss should not be much worse than during a normal return flight.