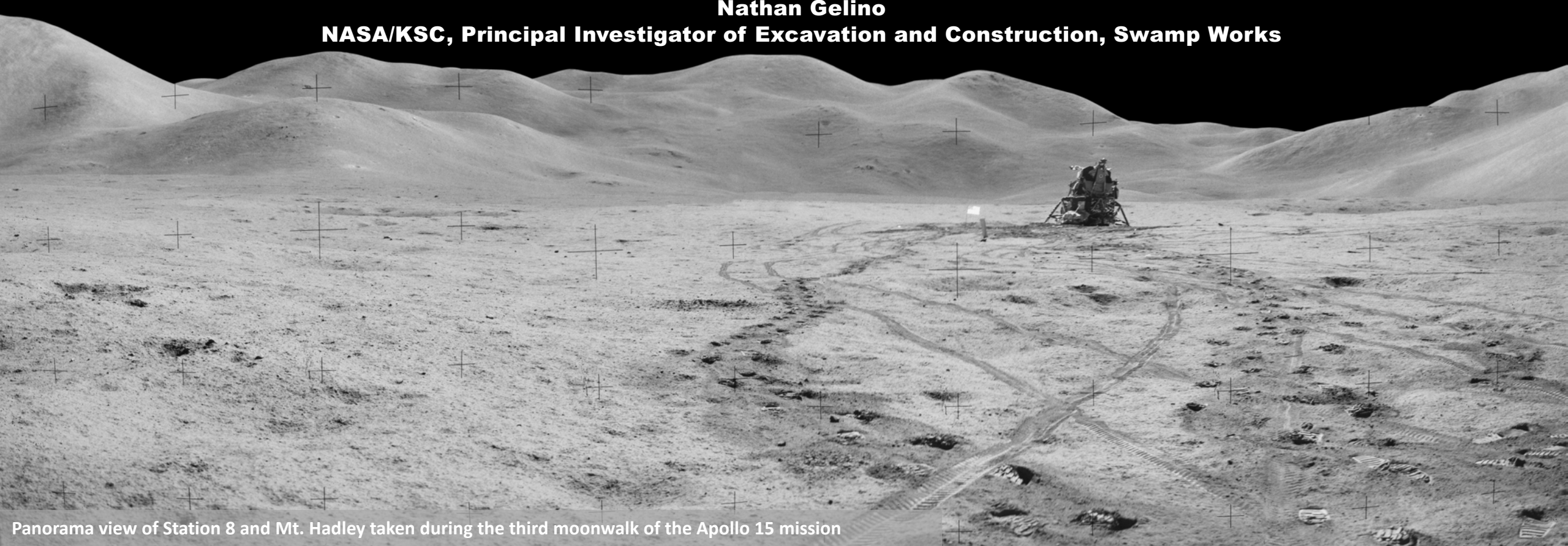
Lunar Innovation Park

Space Resources Roundtable 6/3/26

Mark Hilburger
NASA, STMD Principal Technologist Advanced Materials, Structures, and Construction

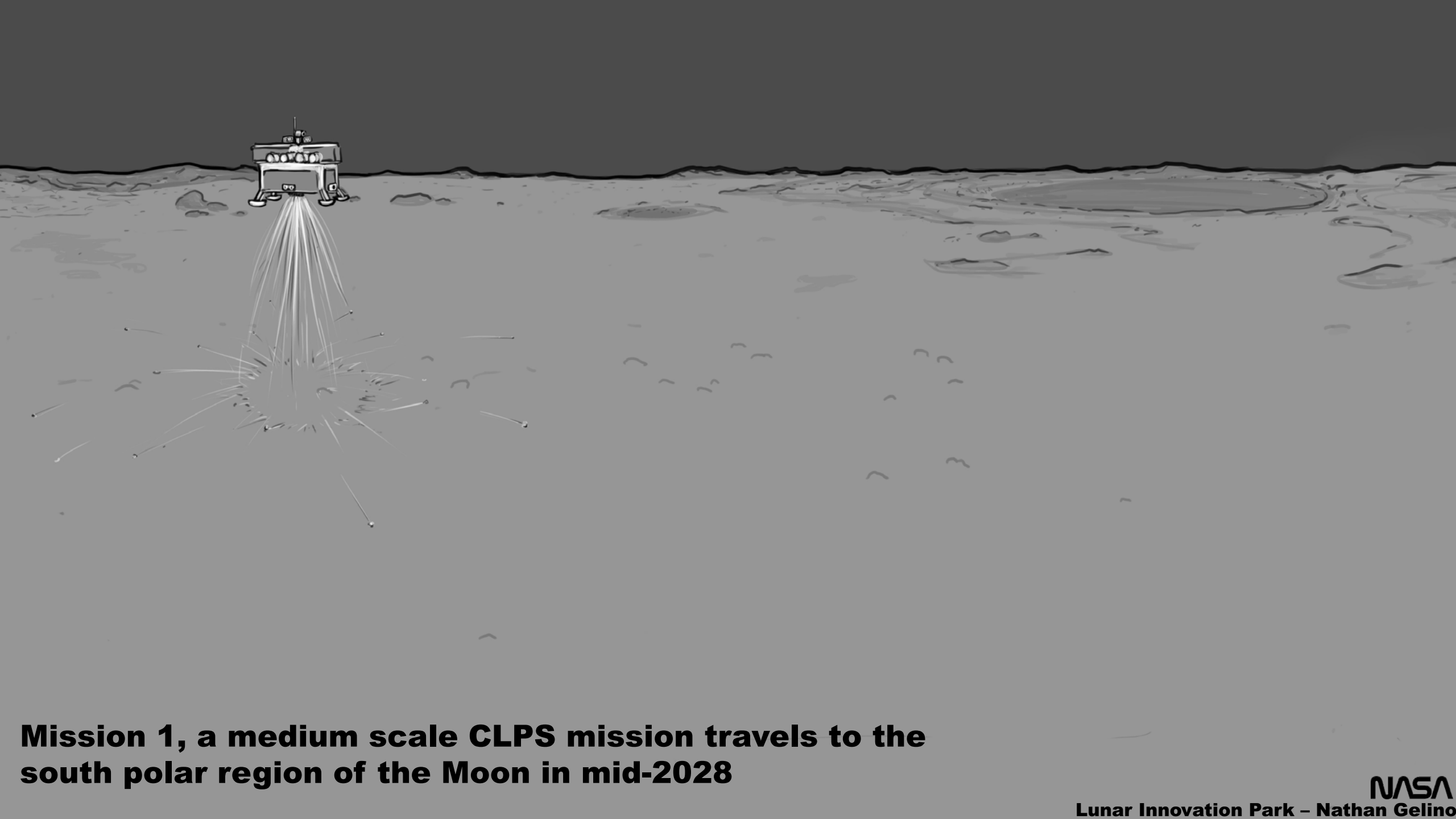
Nathan Gelino
NASA/KSC, Principal Investigator of Excavation and Construction, Swamp Works



Panorama view of Station 8 and Mt. Hadley taken during the third moonwalk of the Apollo 15 mission

Lunar Innovation Park Concept

- **Core Tenets:**
  - **Seek the fastest path to sustained lunar presence – “GO DO” philosophy**
  - **Realistically achievable, systematic build up of surface infrastructure**
  - **Kickstart a space resource-based economy**
  - **Multiple landings in extreme proximity**
  - **Replicate at locations of strategic interest to “claim” land**
  - **Applicable to Fission Surface Power missions**



Mission 1, a medium scale CLPS mission travels to the south polar region of the Moon in mid-2028

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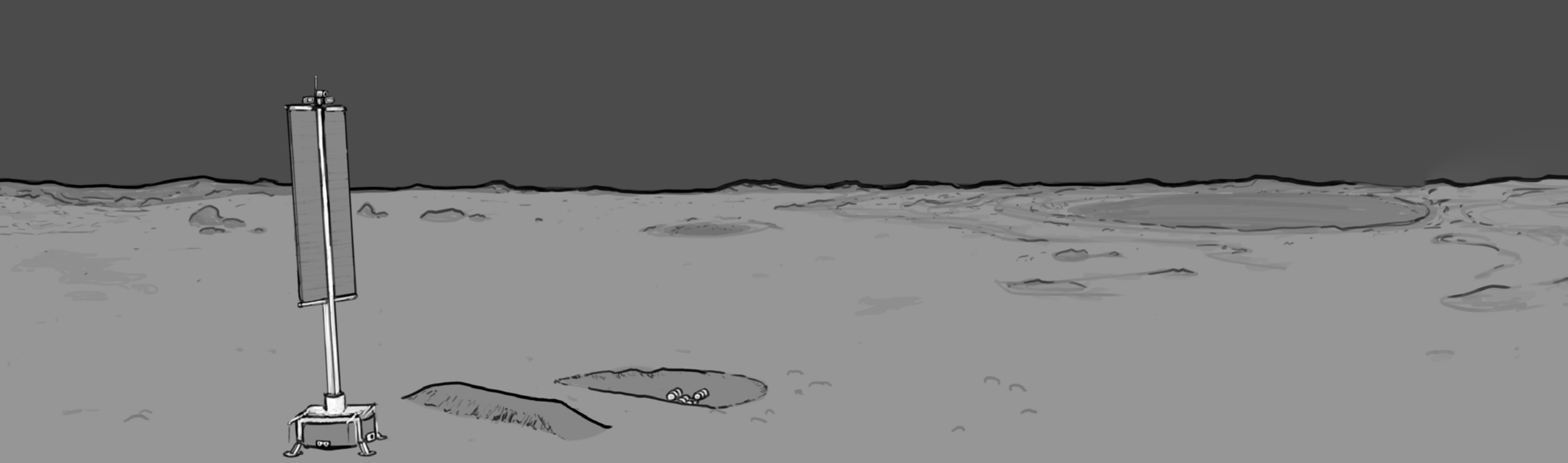
Landing occurs in location of strategic importance



- **A Vertical Solar Array (VSAT) and communications are deployed**
- **An excavation robot (IPEx) maps the region and then builds a bulk regolith berm**

Honeybee Robotics/Blue Origin tests VSAT operations in simulated lunar environments. Several industry partners are developing VSATs

Infrastructure Pilot Excavator (IPEx) completes a TRL 5 full mission simulation

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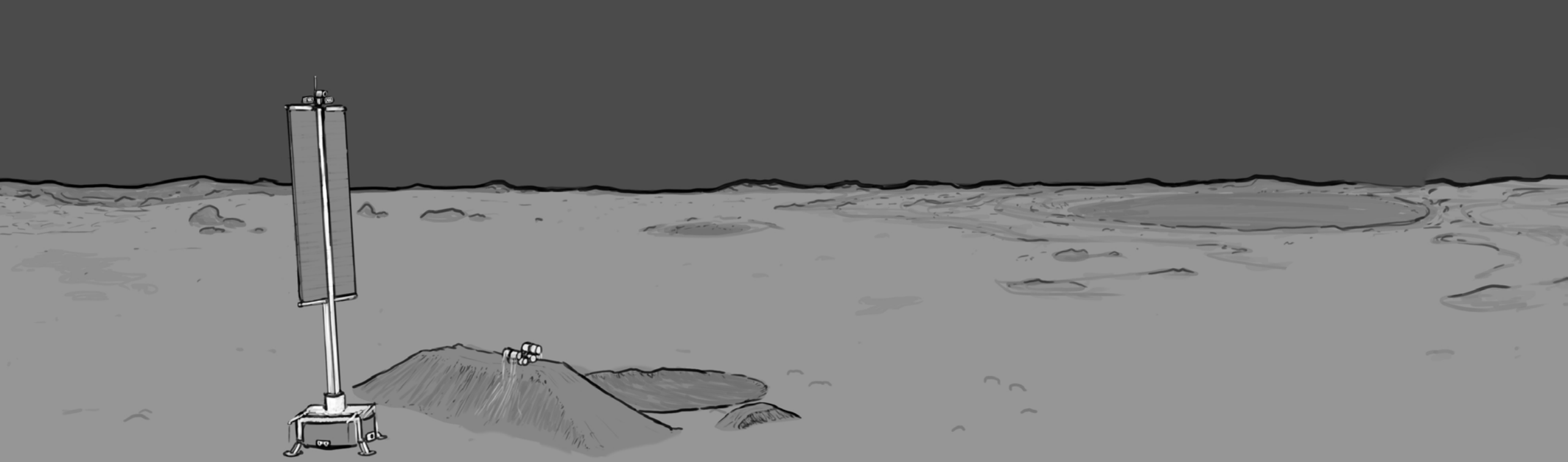
Image credits: NASA



- **The berm and an adjacent bulk regolith flat, level, rock free landing site are finished**
- **The distance between landing sites is ~20 m**

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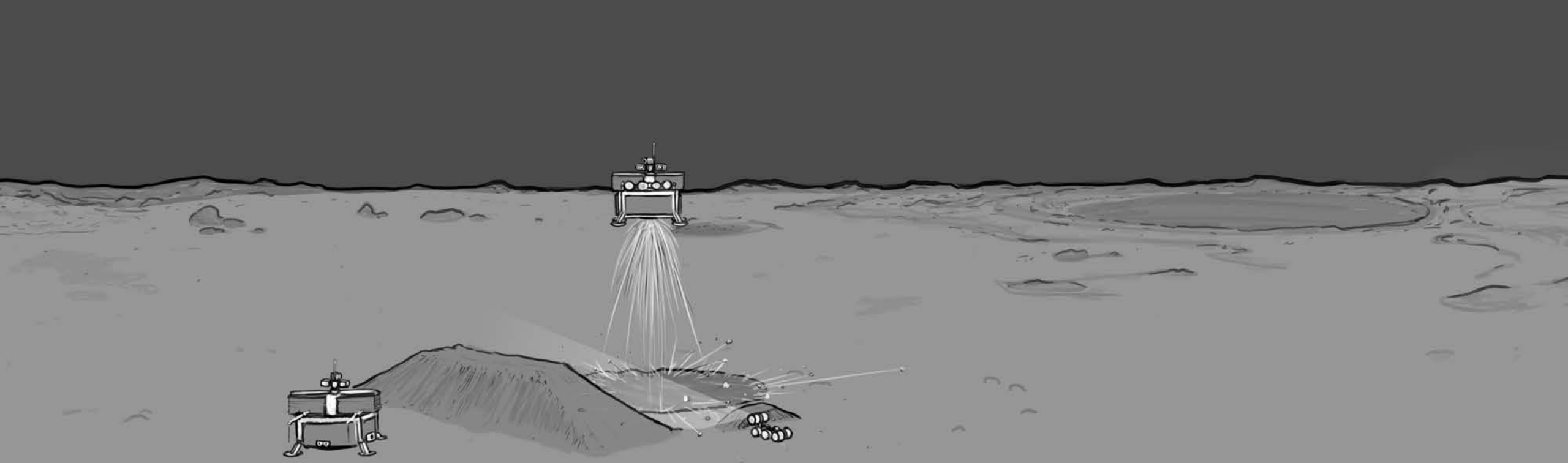
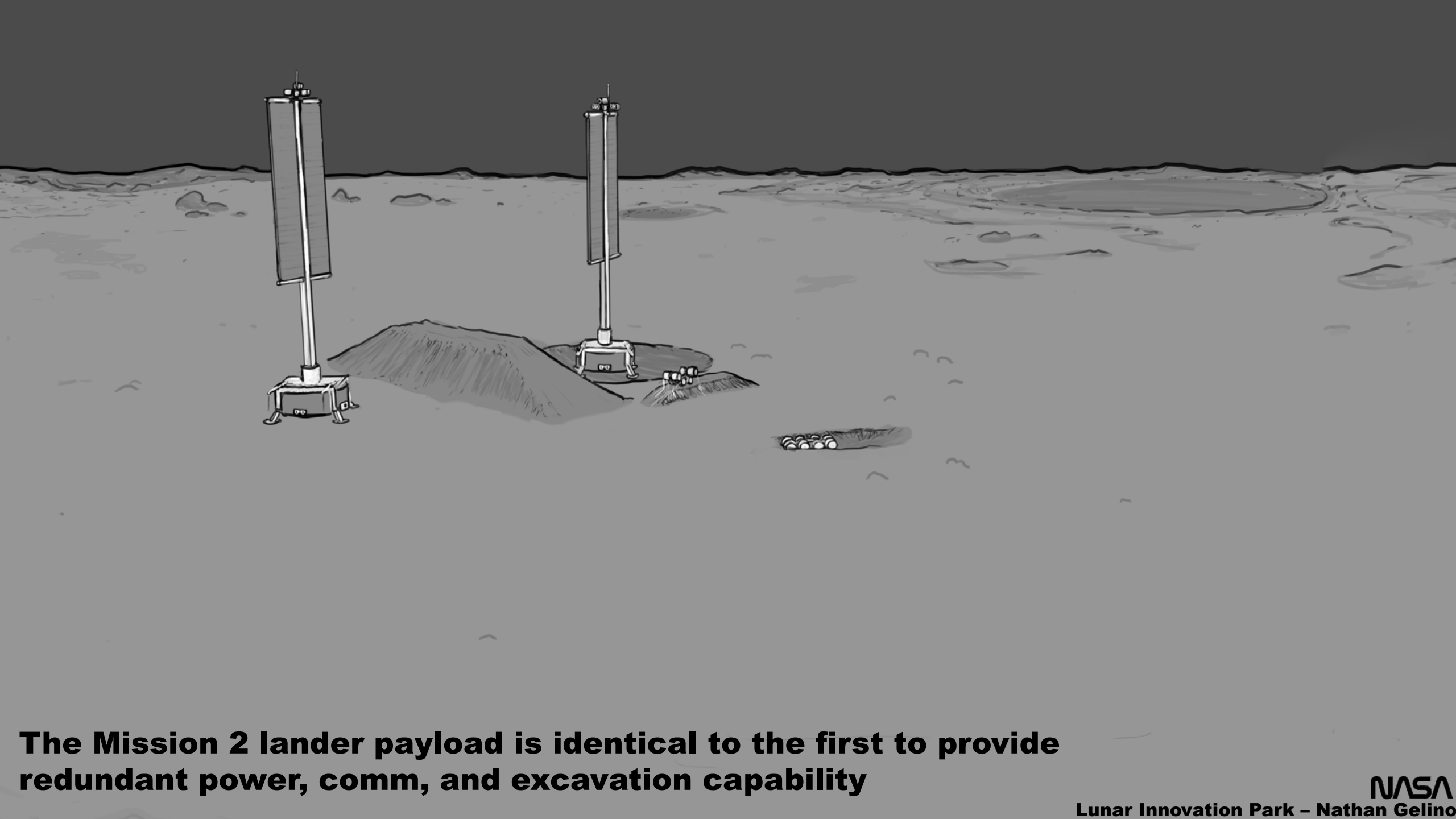


- **In late 2028, Mission 2 lands while the VSAT is stowed, and the excavation robot surveils the Plume Surface Interaction (PSI) effects**
- **Extreme landing precision is enabled by a high-res topo map and landing aids**
- **The berm protects the first lander from PSI ejecta**



The Mission 2 lander payload is identical to the first to provide redundant power, comm, and excavation capability

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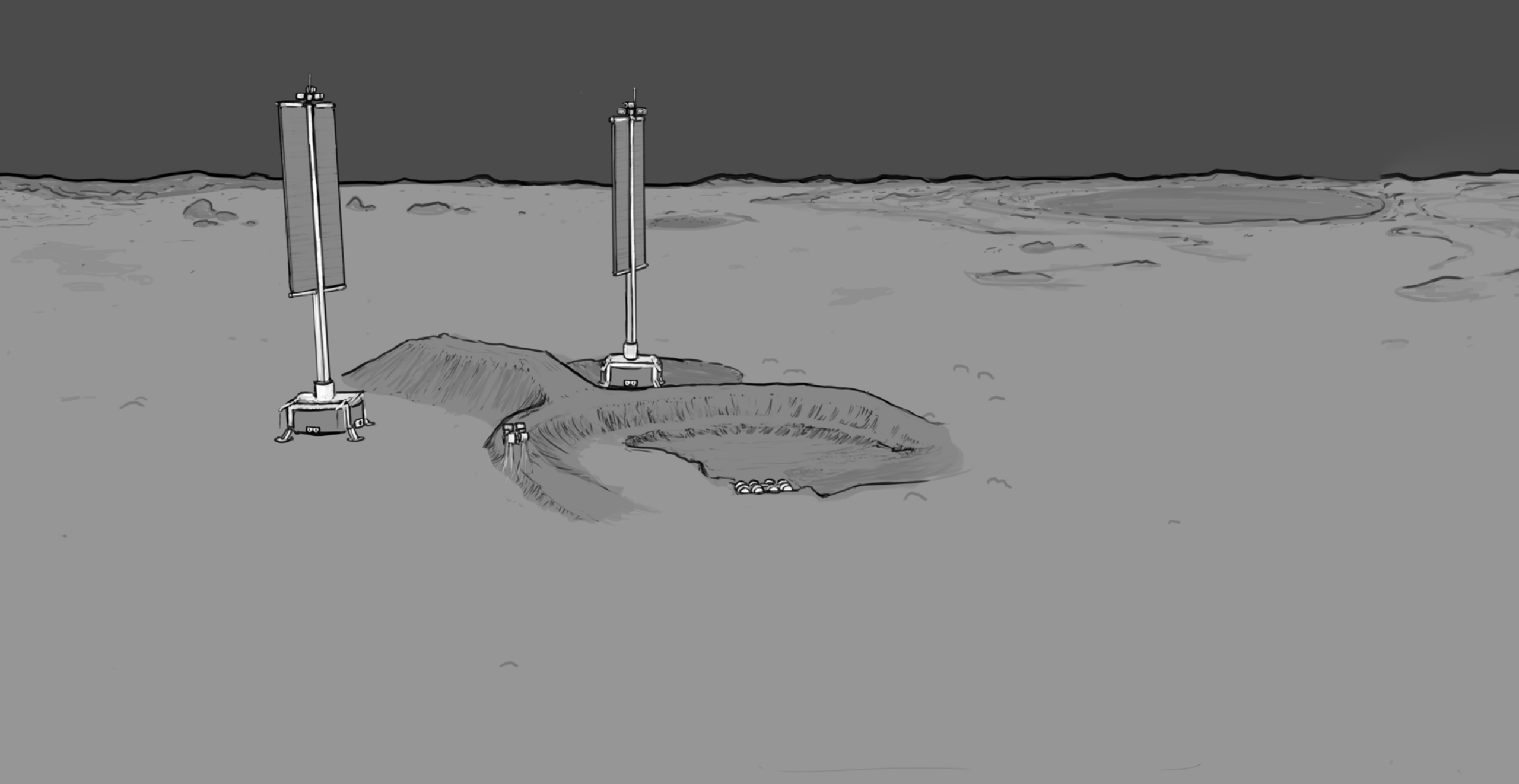

The excavators prepare the site for Mission 3 landing

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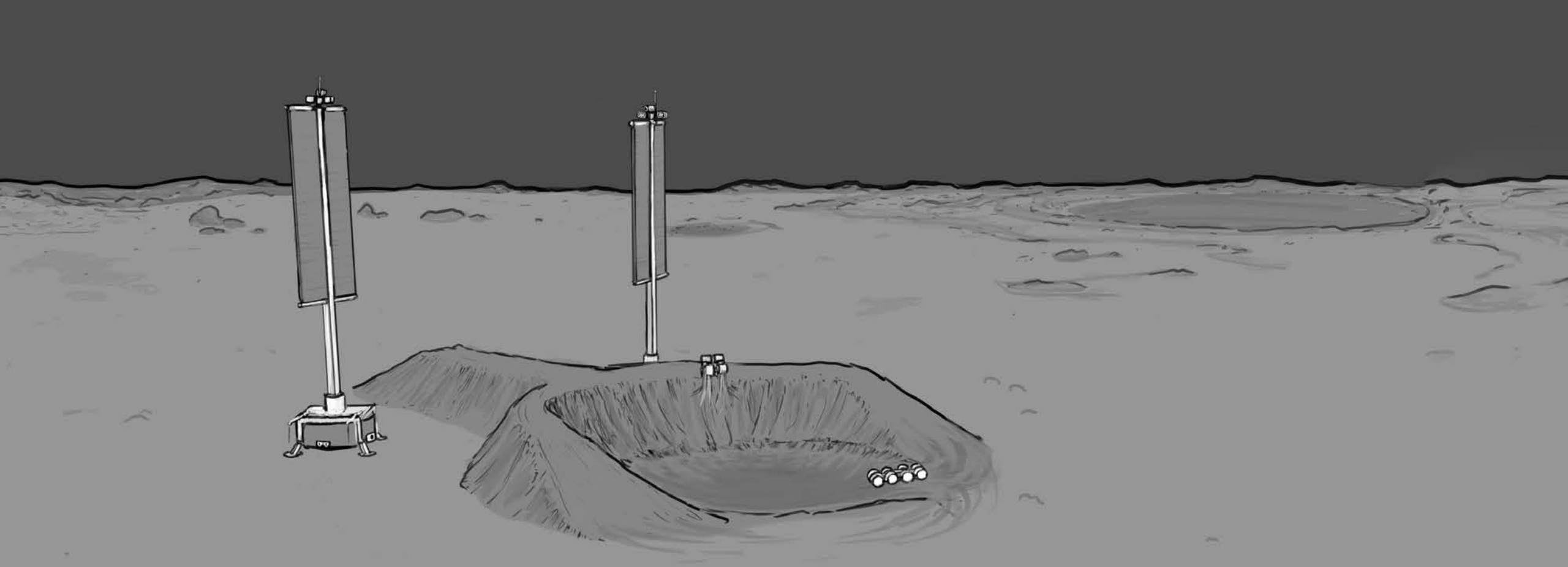

The protective berm and landing surface are completed for Mission 3

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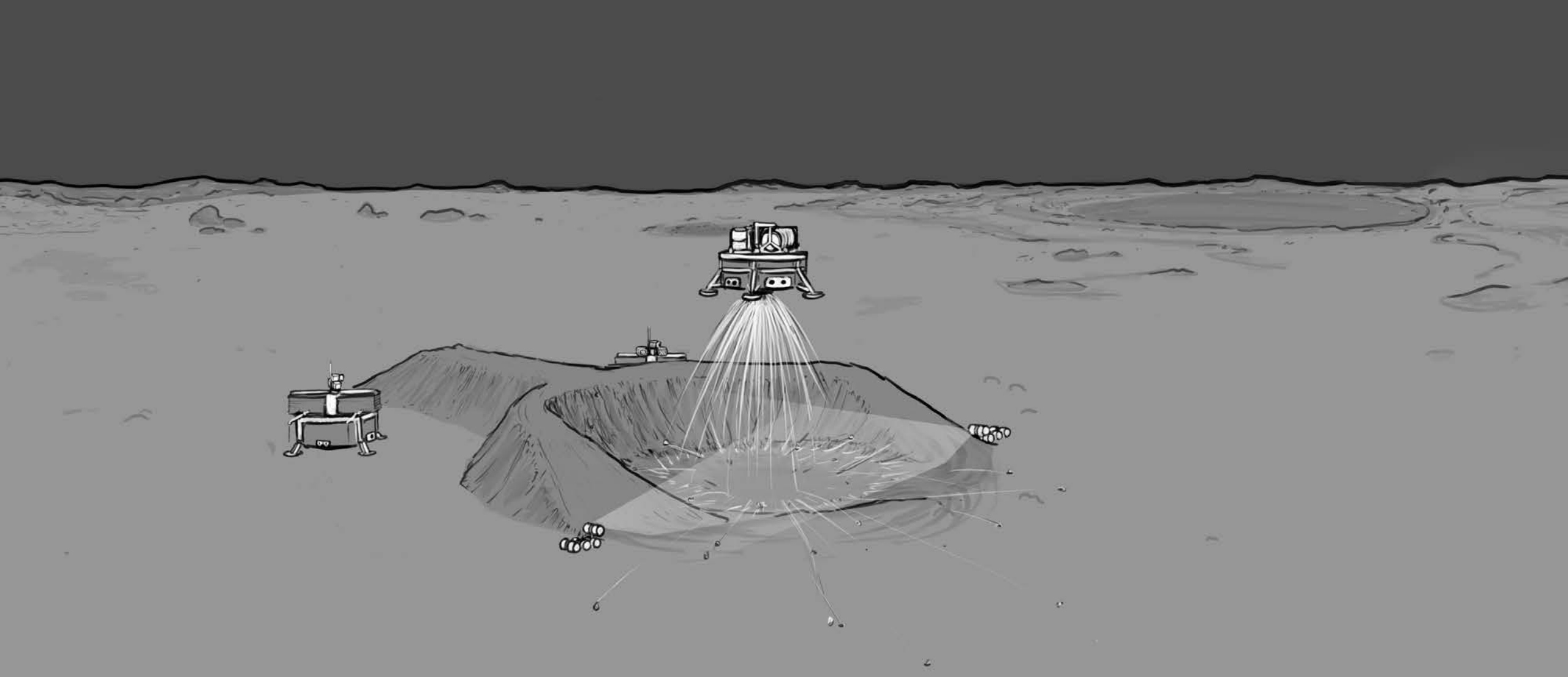

Mission 3 lands in late 2030 with surface VSATs stowed

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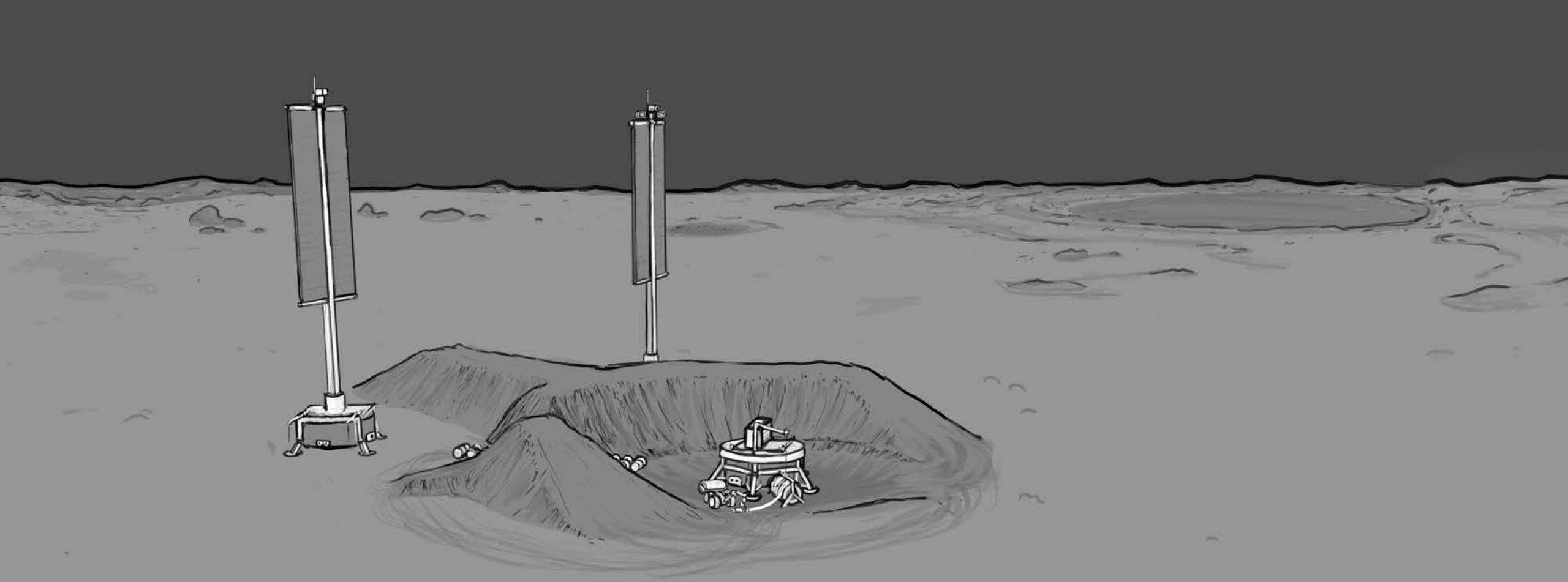
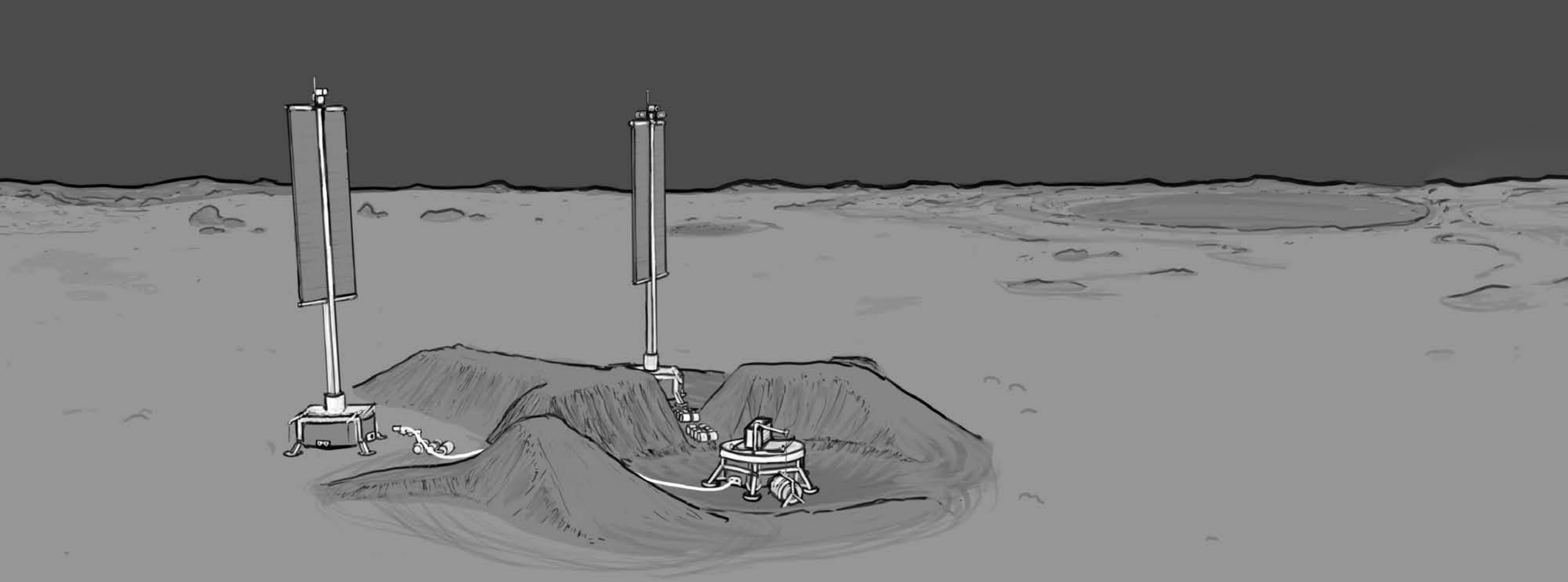
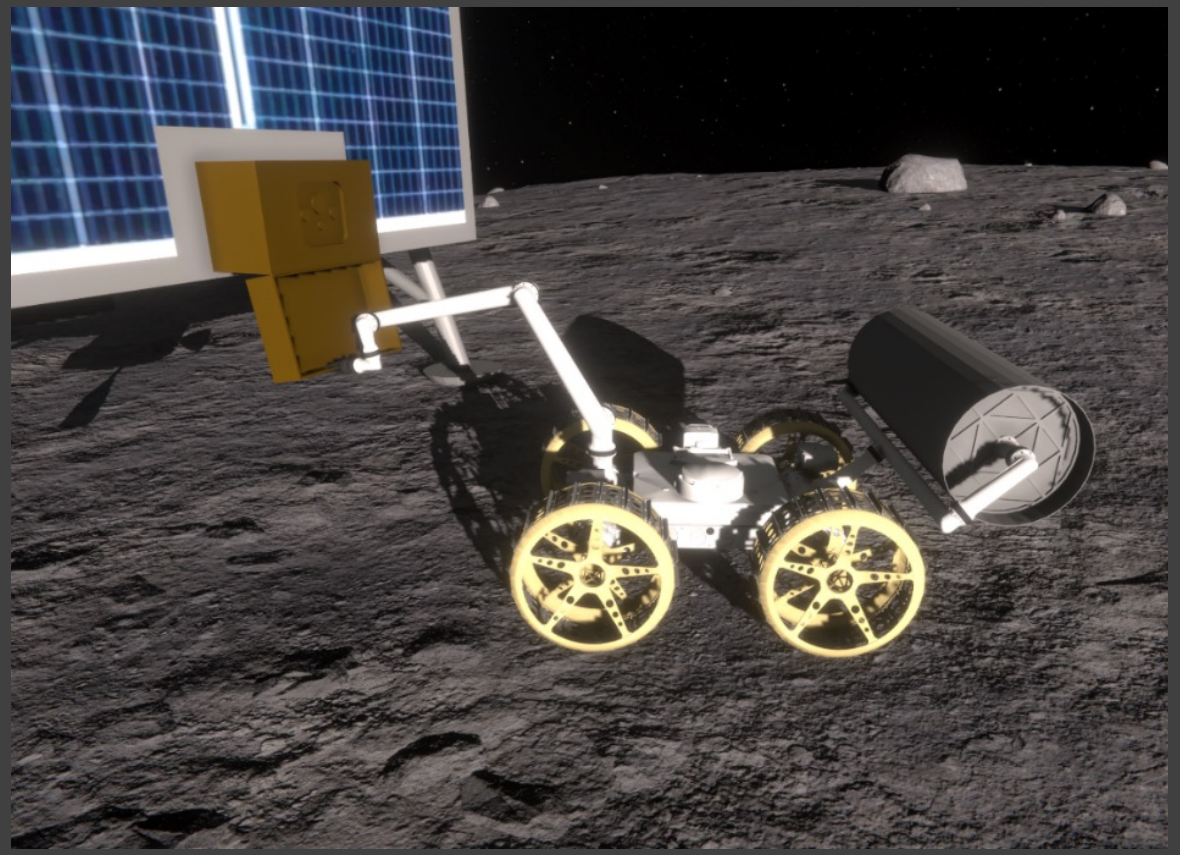


- **Mission 3 augments Park power with increased energy storage and power distribution hardware**
- **An evolved IPEx with modular interfaces for implement swapping is delivered that can do limited logistics**
- **Implements include a logistic arm, compactor, cable reel, and excavation drums**



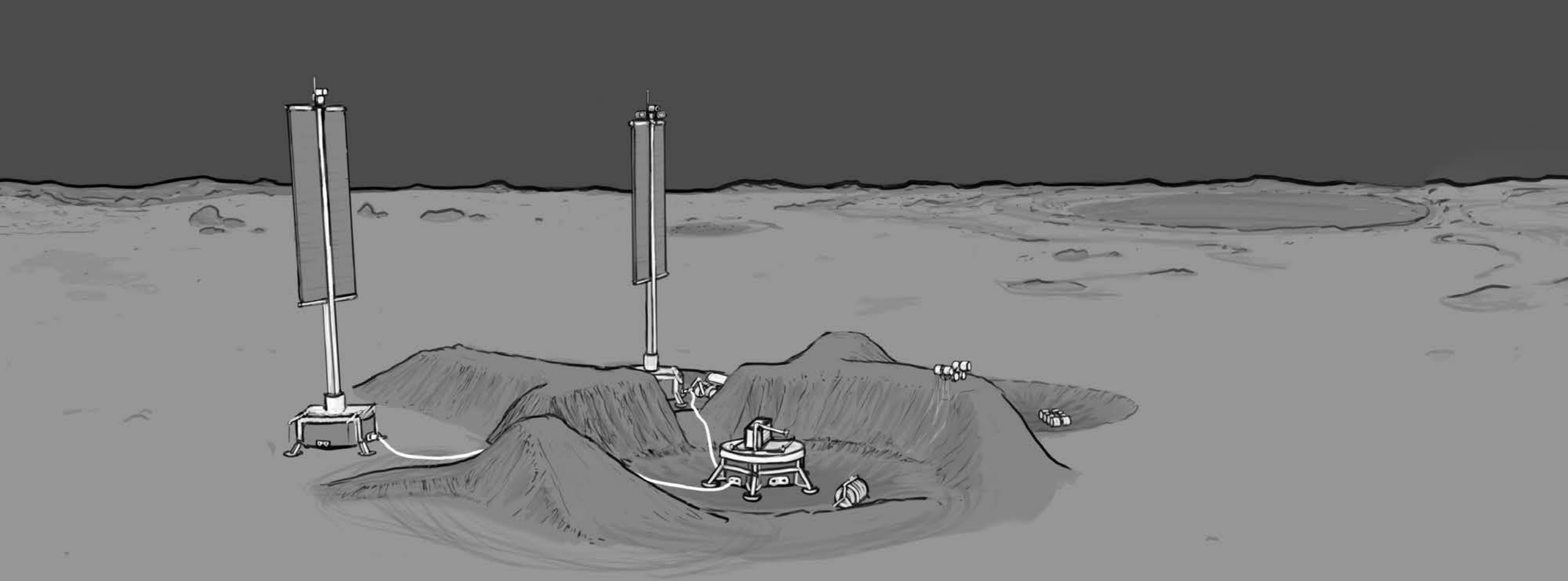
- **The excavators cut through the berms between landers**
- **The logistics robot pulls cables and mates dust tolerant connections between the power assets creating the first lunar power grid**

A dust tolerant umbilical is tested in extreme dusty conditions



A rendering of Construction Pilot Excavator (CPEx) accessing power interface with a logistics arm. CPEx has a roller compactor implement installed.

Image credits: NASA



The landing site for Mission 4 is prepared

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A landing site is prepared for Park services Customer 1

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Mission 4 lands in 2031

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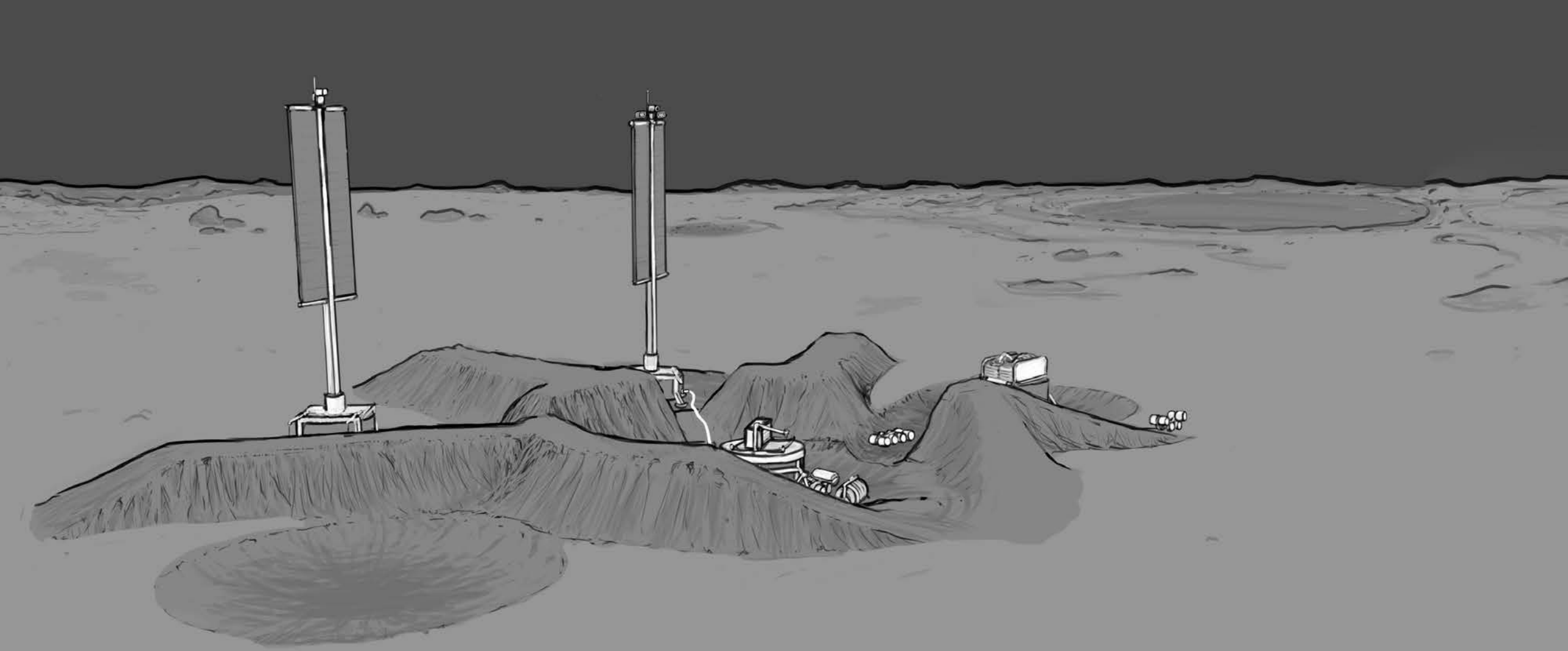

- **Mission 4 brings ARMADAS assembly robots and structural elements to build an unpressurized protective shelter**
- **The excavators clear an area through the berm**

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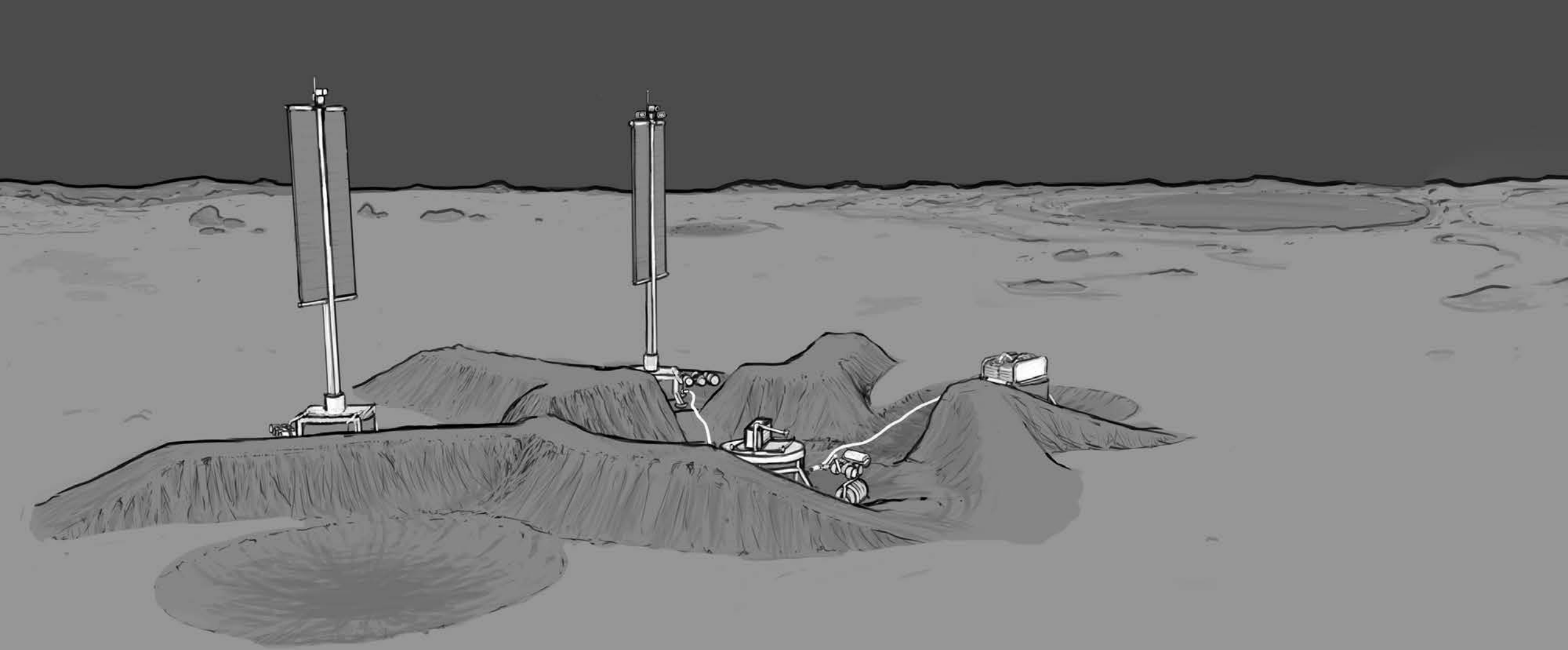

- **Power is connected to the fourth lander**
- **The foundation is prepared for the unpressurized shelter**

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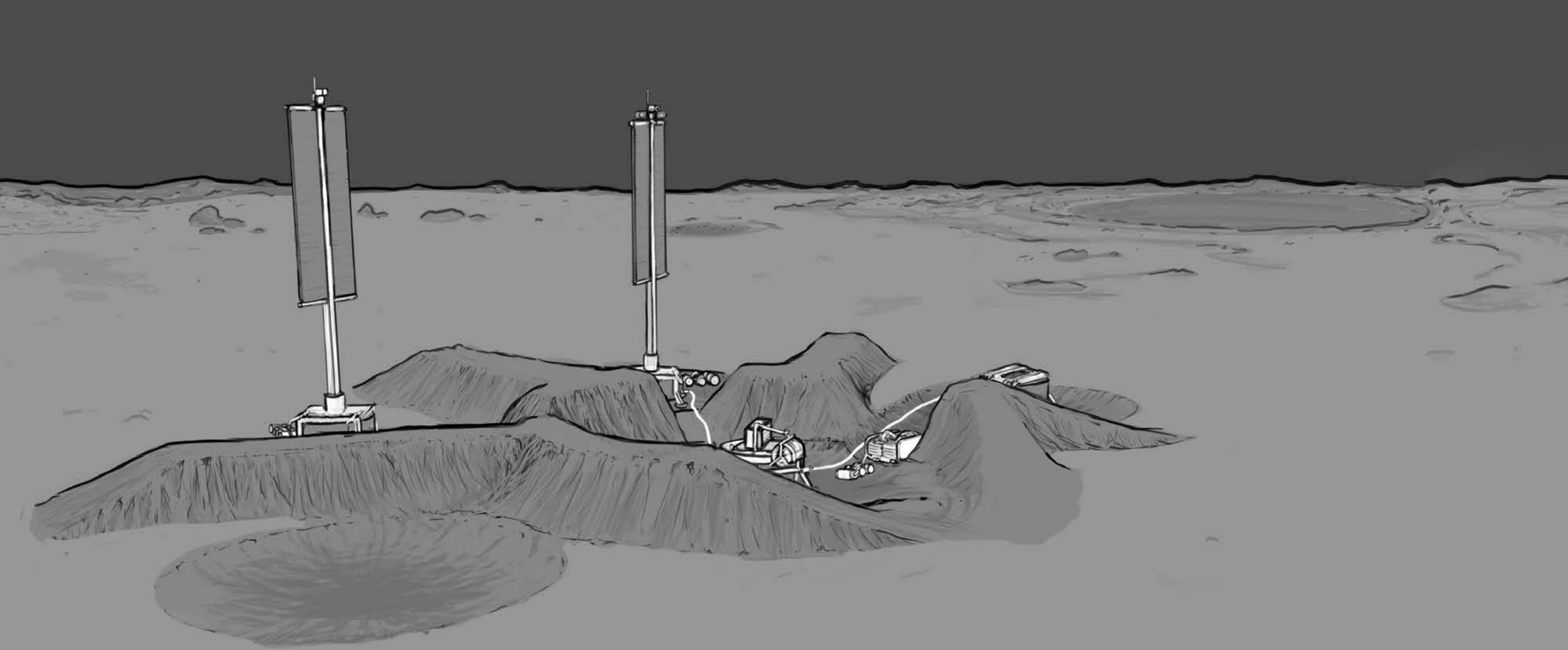

The ARMADAS elements are delivered to the shelter site, and the “cornerstone” of the shelter is placed

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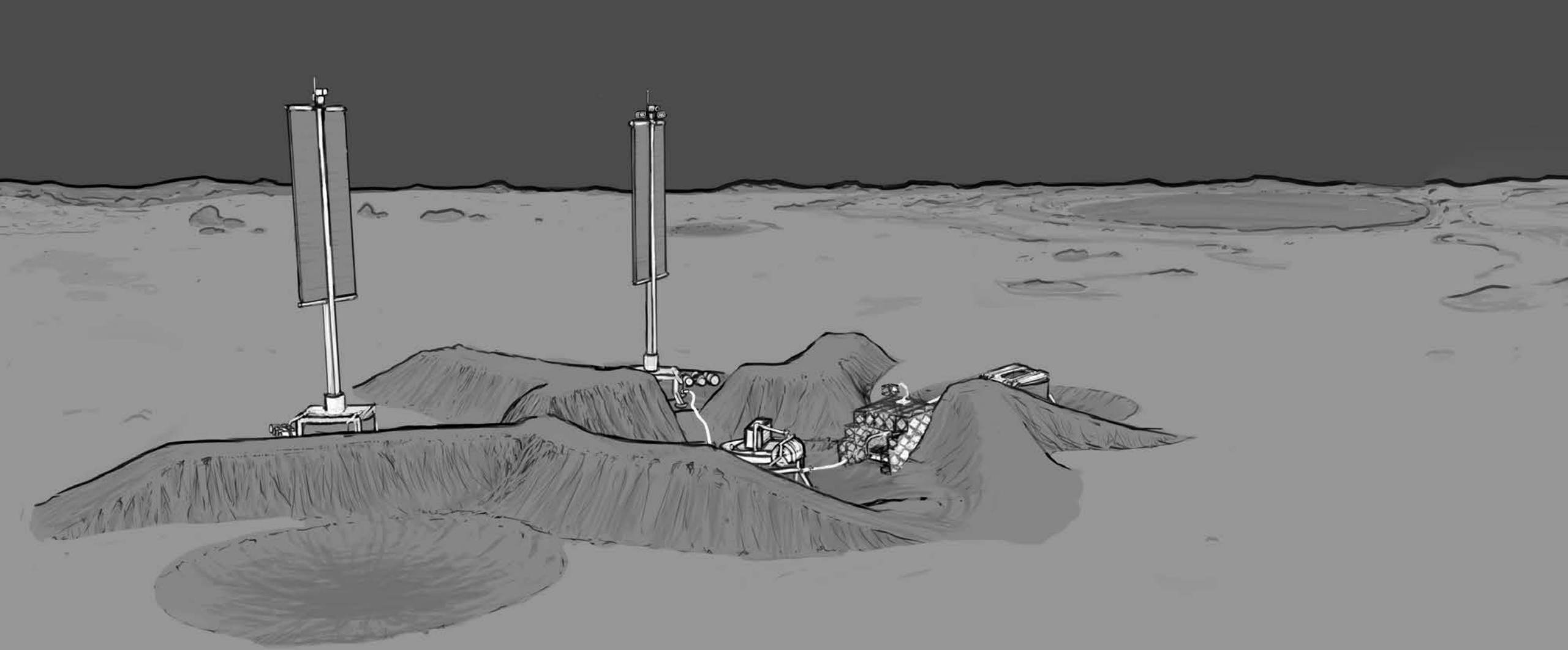

The ARMADAS robots assemble the protective shelter structure with support from the logistics robot

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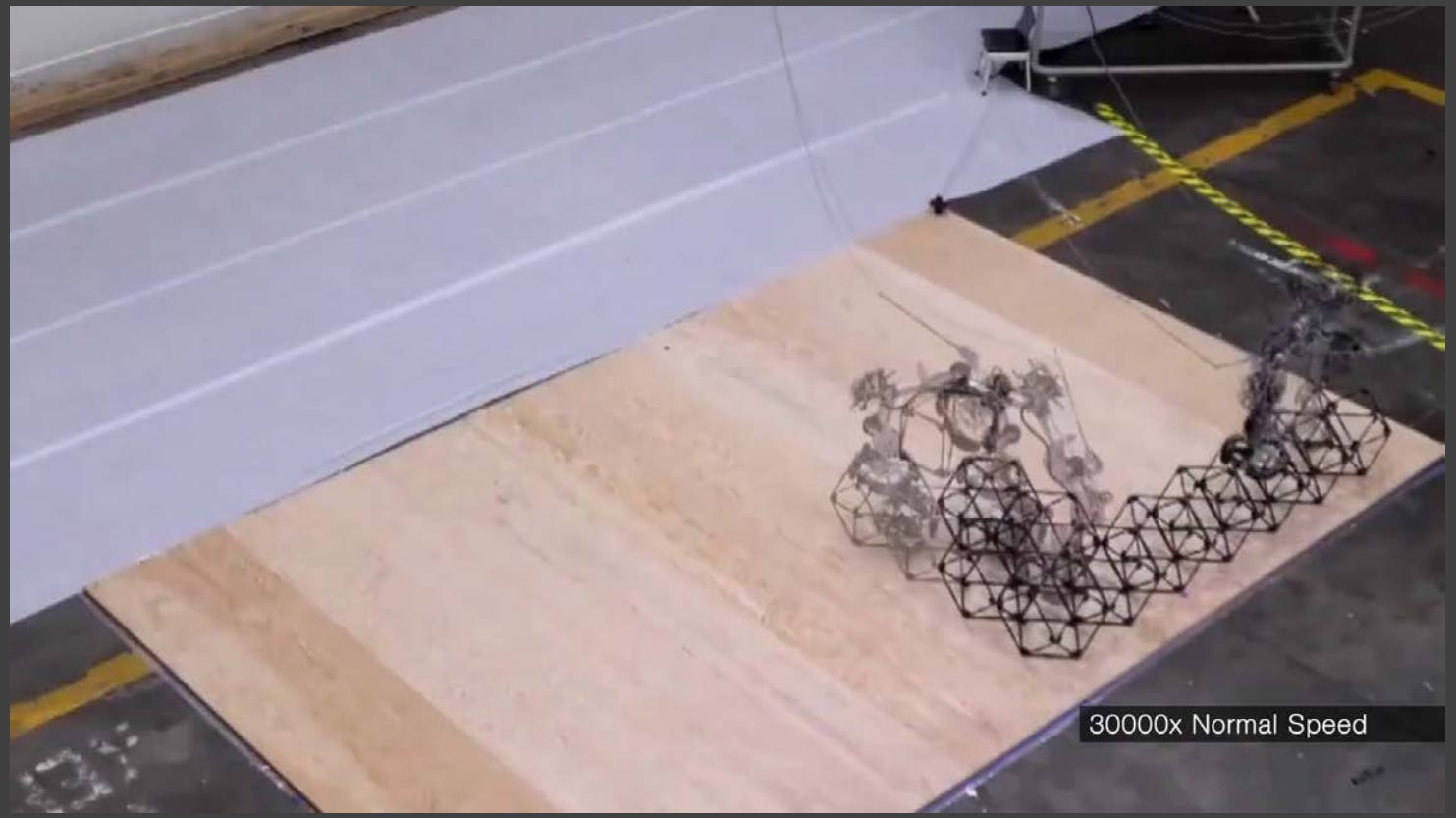
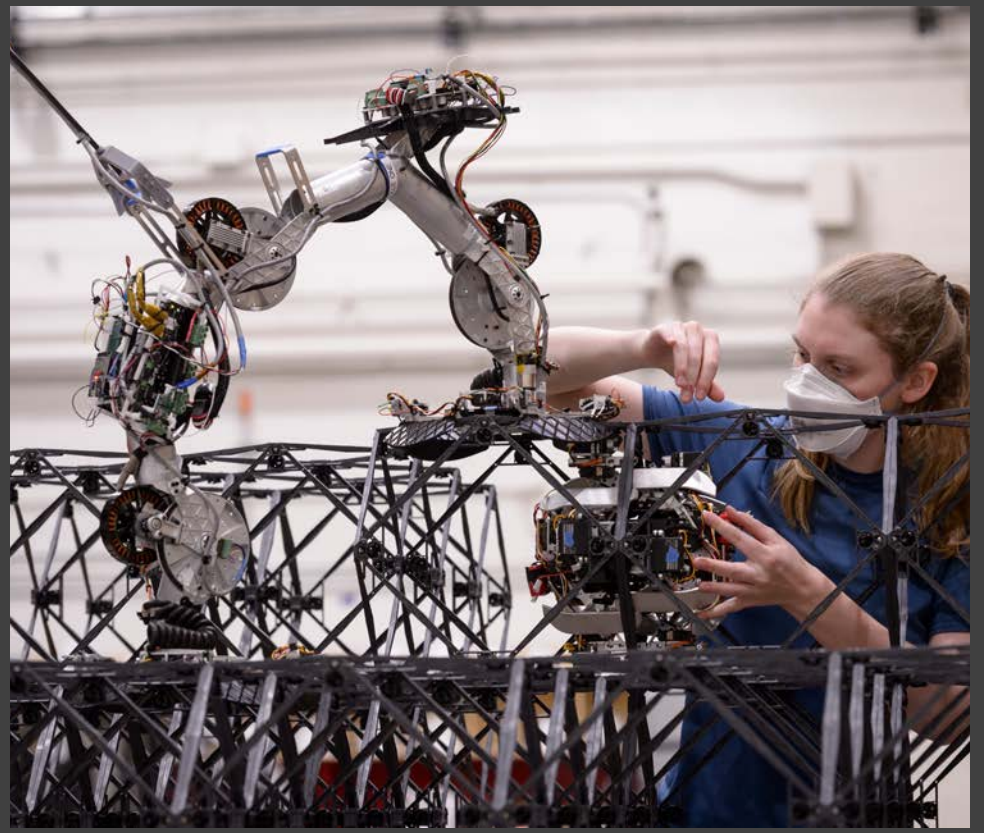
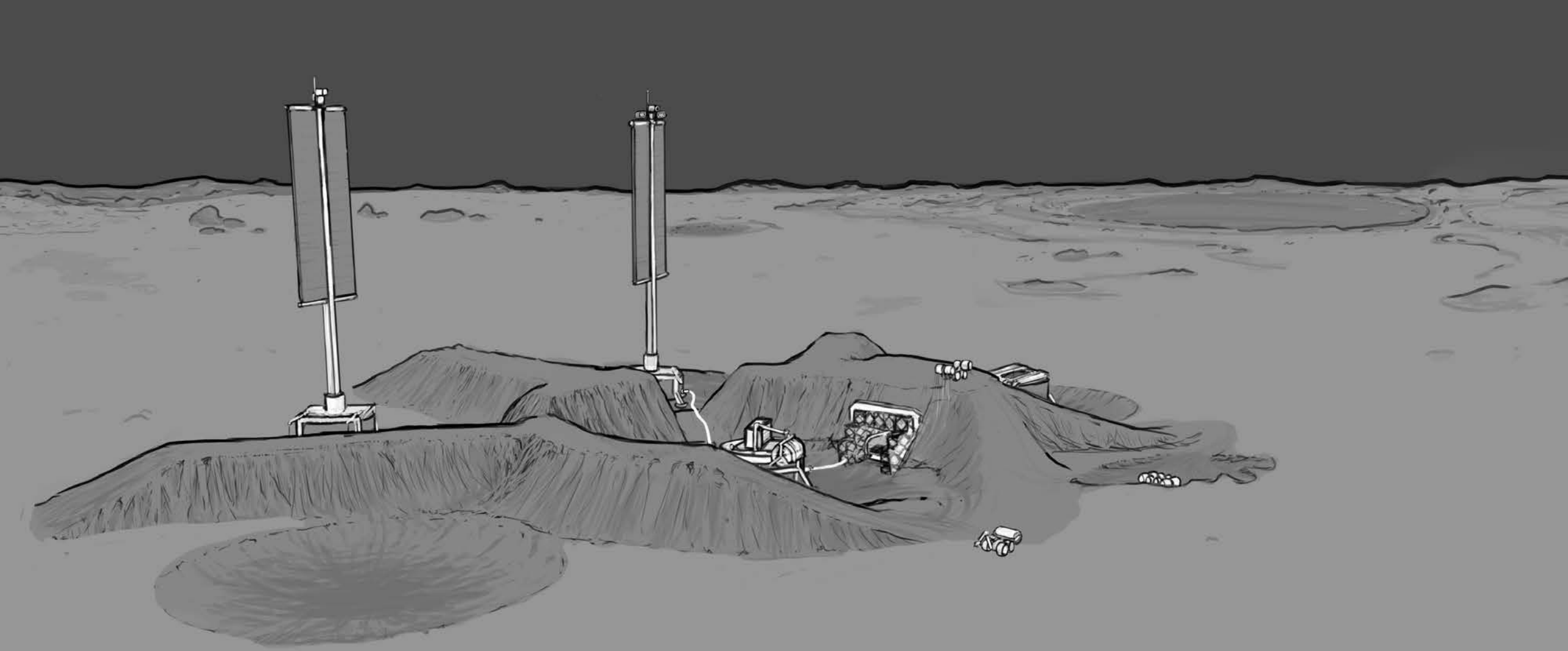


A structure is robotically built using the ARMADA voxel structural elements and assembly robots



An engineer inspects the voxel hauling and internal fastening robots

Image credits: NASA



- **The excavators bury the shelter with regolith**
- **The regolith provides protection from radiation and meteoroids and provides insulation to keep the shelter warm**
- **Sheltered space is available for Park assets and customers**
- **The site is prepared for the Mission 5 lander**

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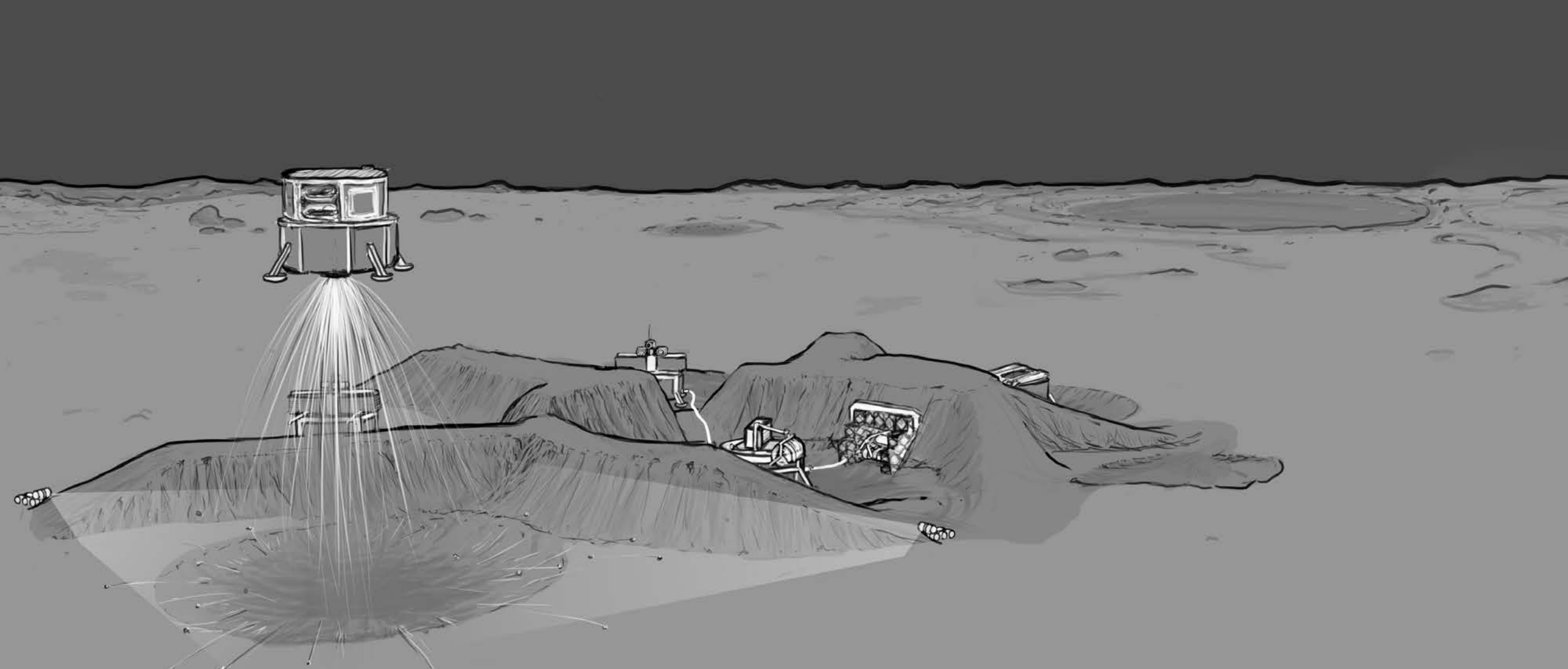
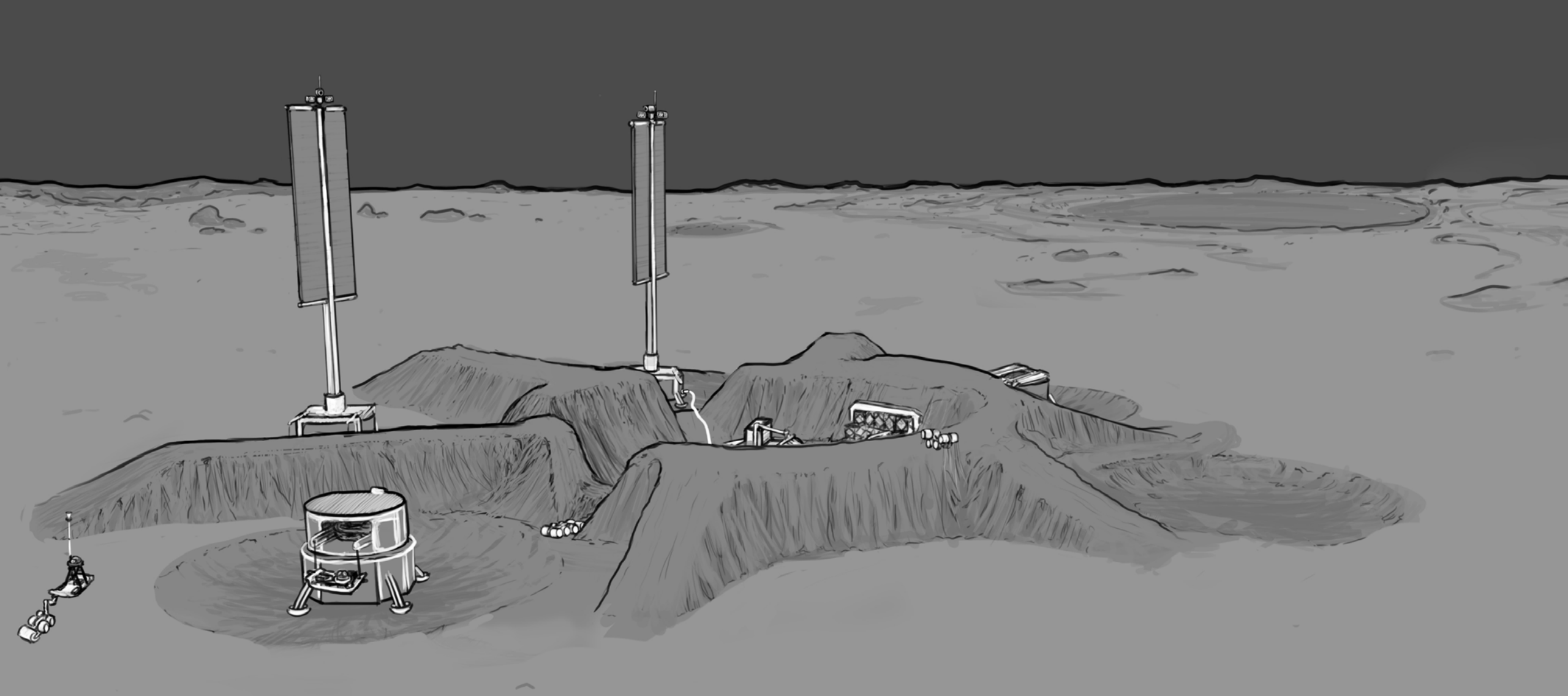
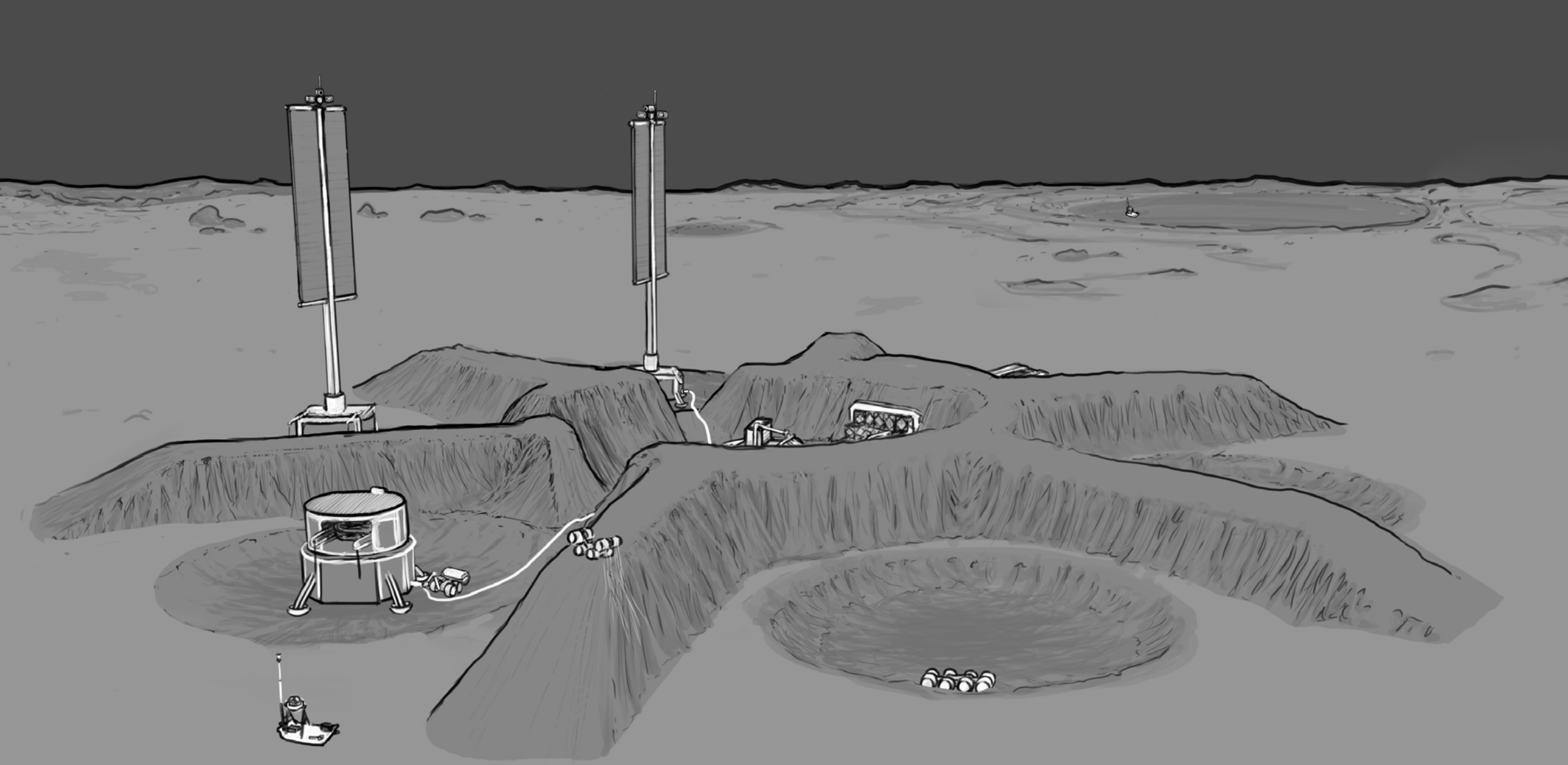


- **Customer 1 lander arrives with technology development or scientific payloads who pay for park services (power, comm, transportation, regolith delivery, shelter, etc.)**
- **Customers with ISRU commodity production and/or reusable launch pad construction technologies are preferred for small scale demos**



- **A cut-through is made in the berm**
- **Customer operations are supported by Park services**



- **Power is connected to the Customer 1 lander**
- **Customer 2 landing site is prepared**

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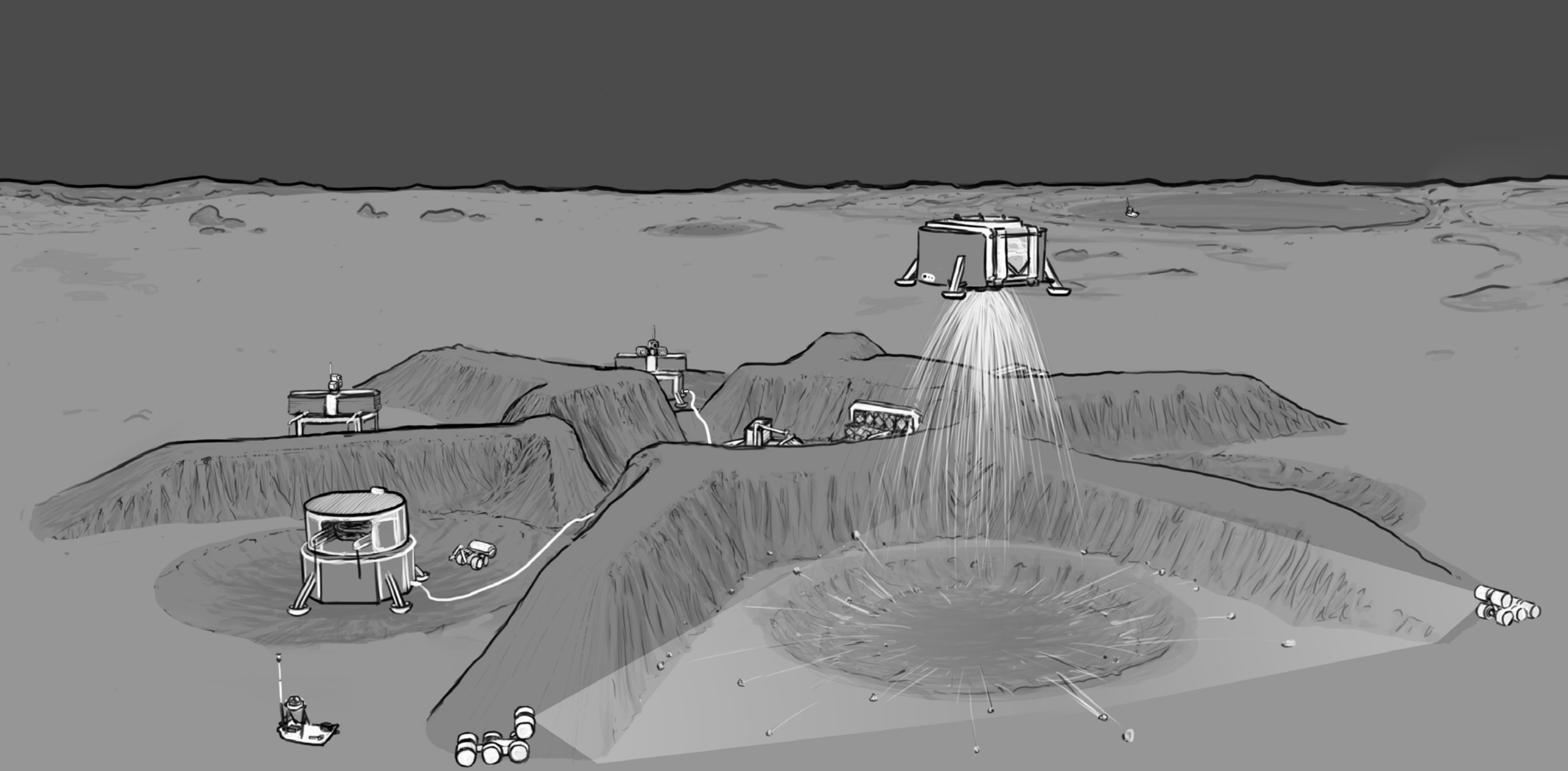

Customer 2 lander arrives

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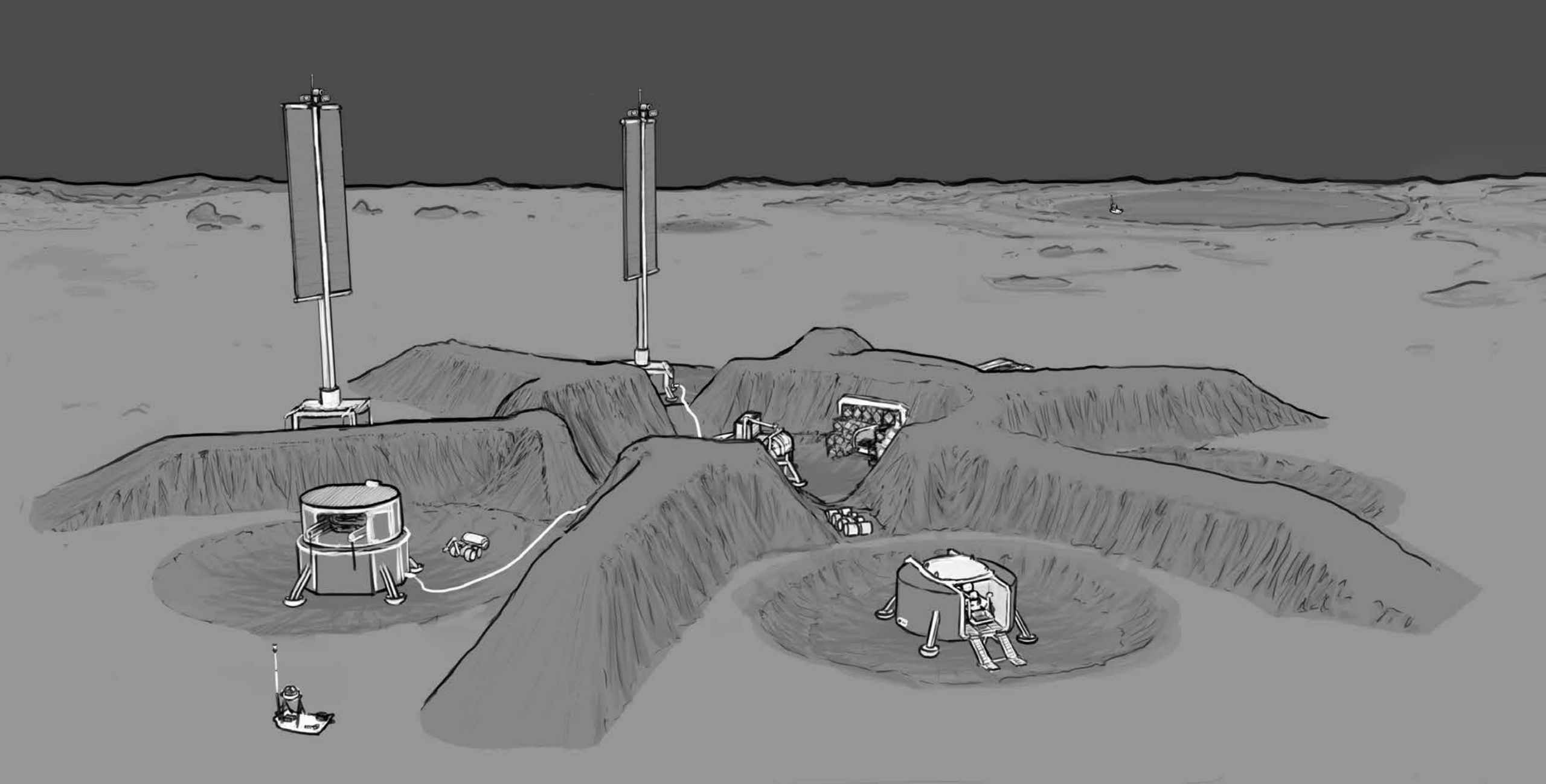

A cut-through is made to the Customer 2 lander

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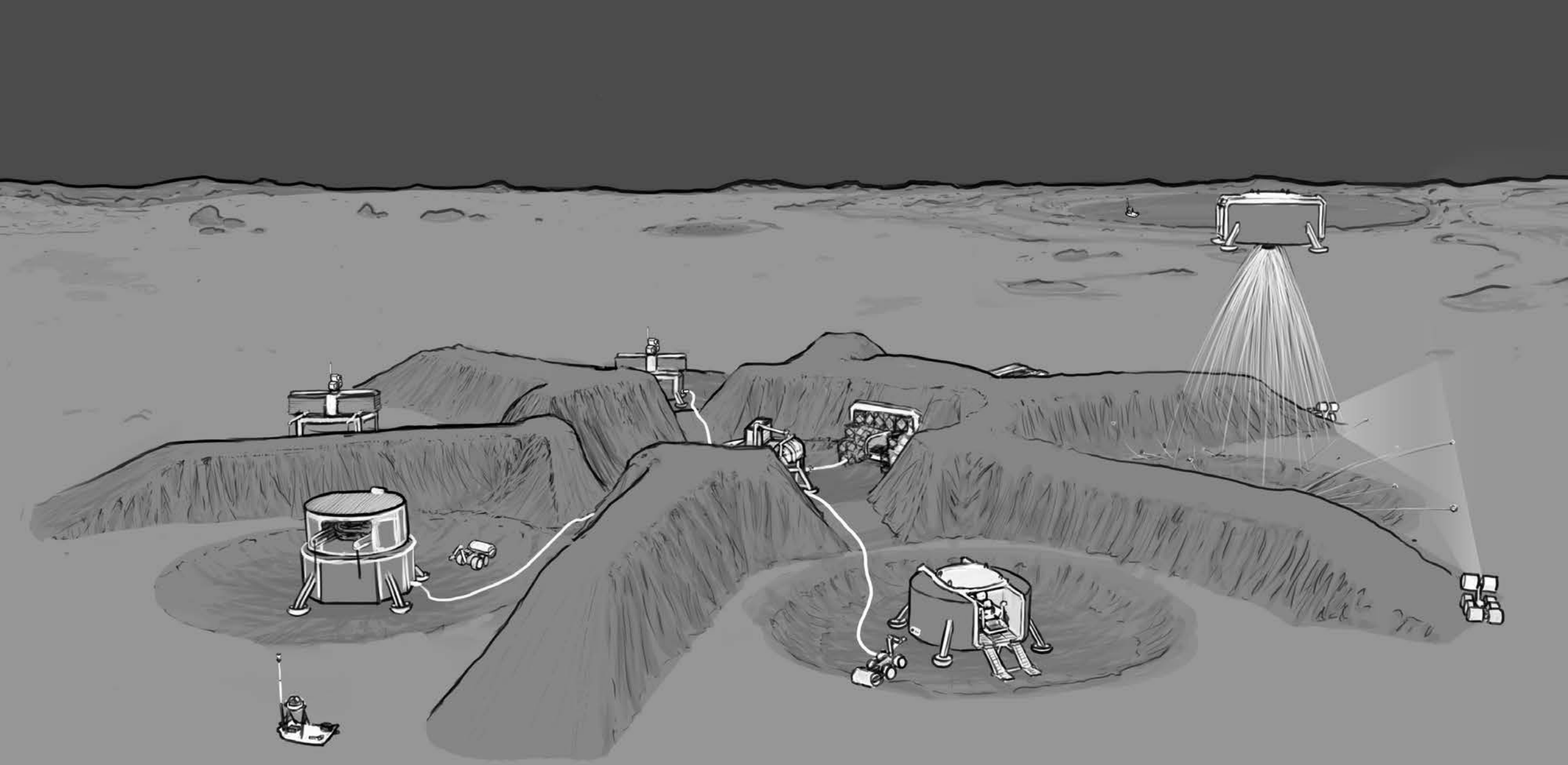

- **Power is connected to the Customer 2 lander**
- **Park construction Mission 5 lander arrives in 2032**

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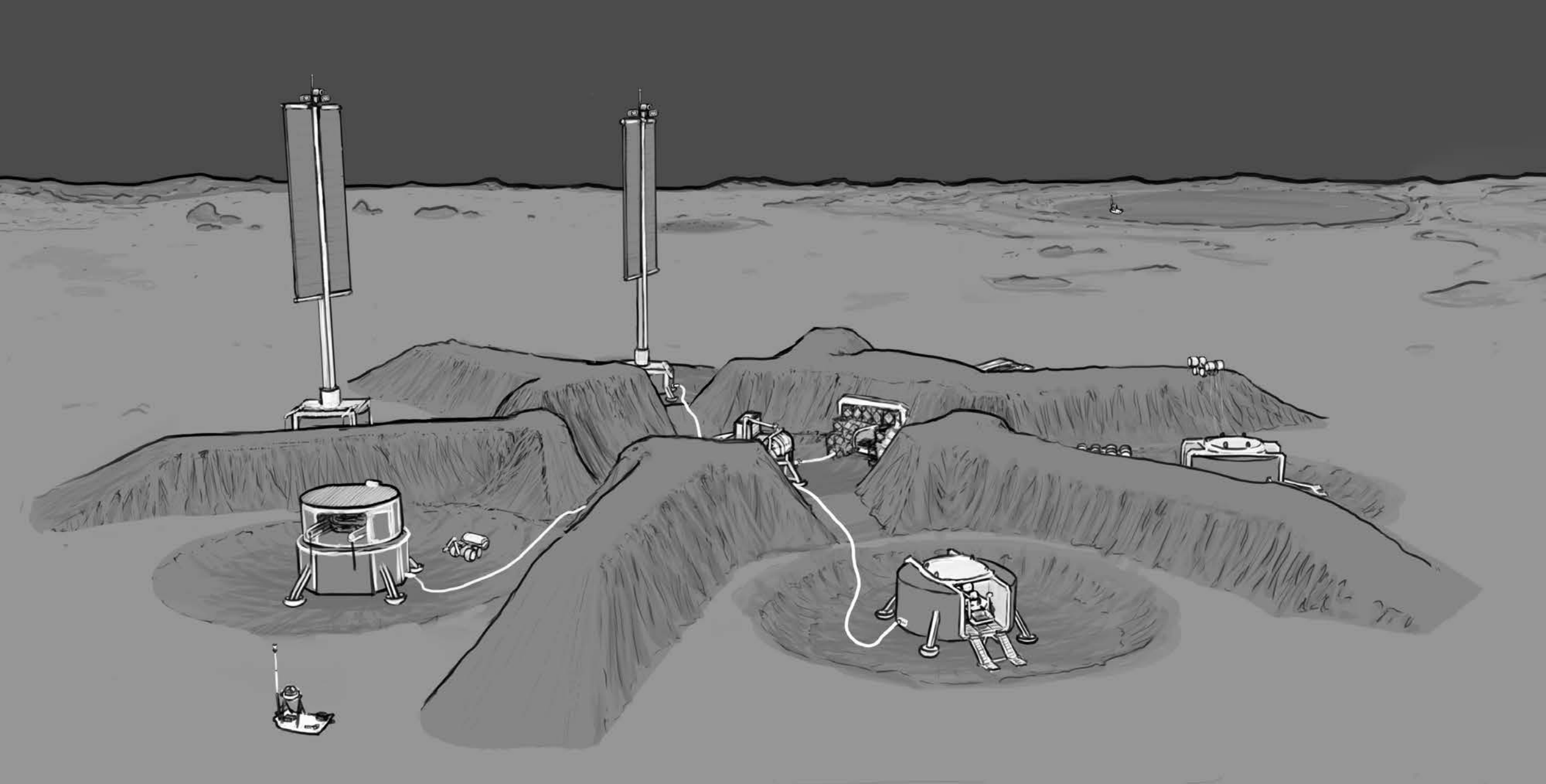

A cut-through is made to the Mission 5 lander

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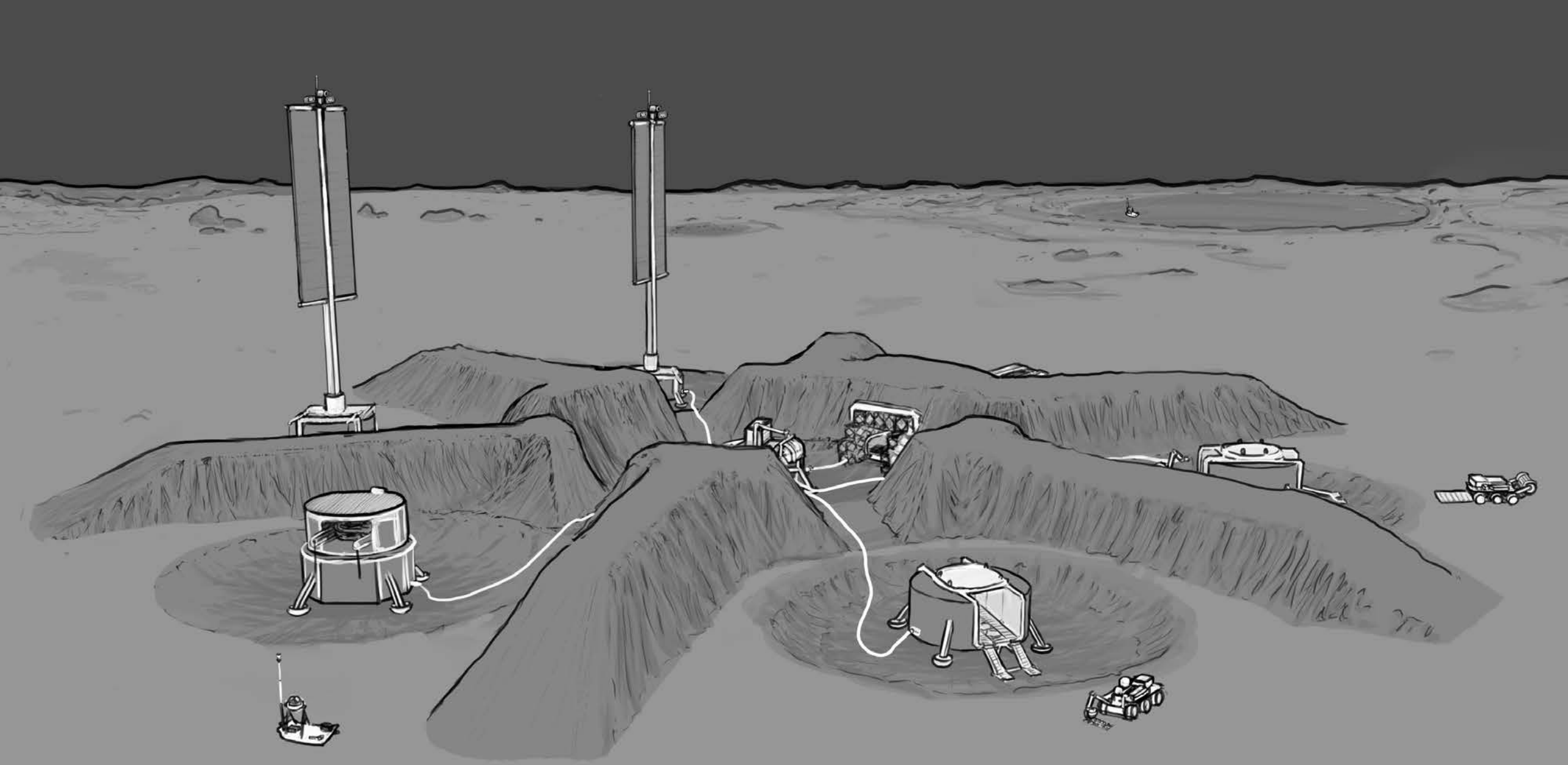

Power is connected to the Mission 5 lander

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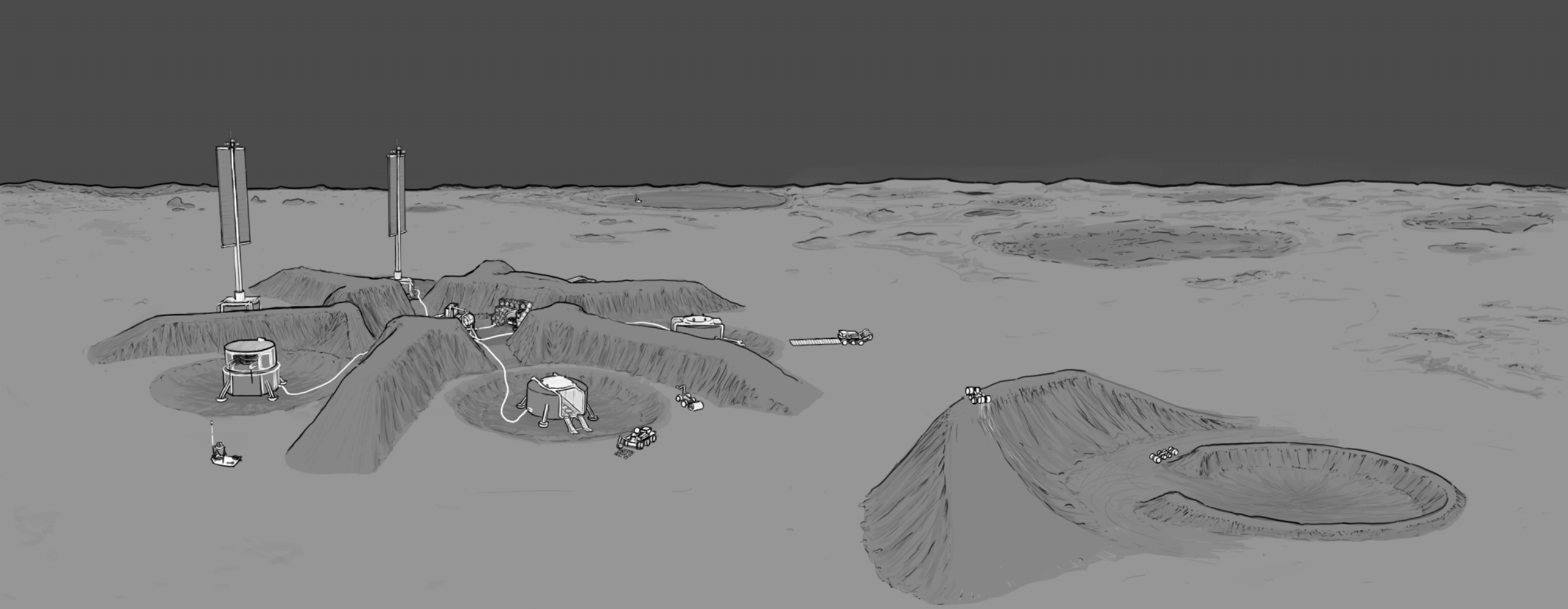
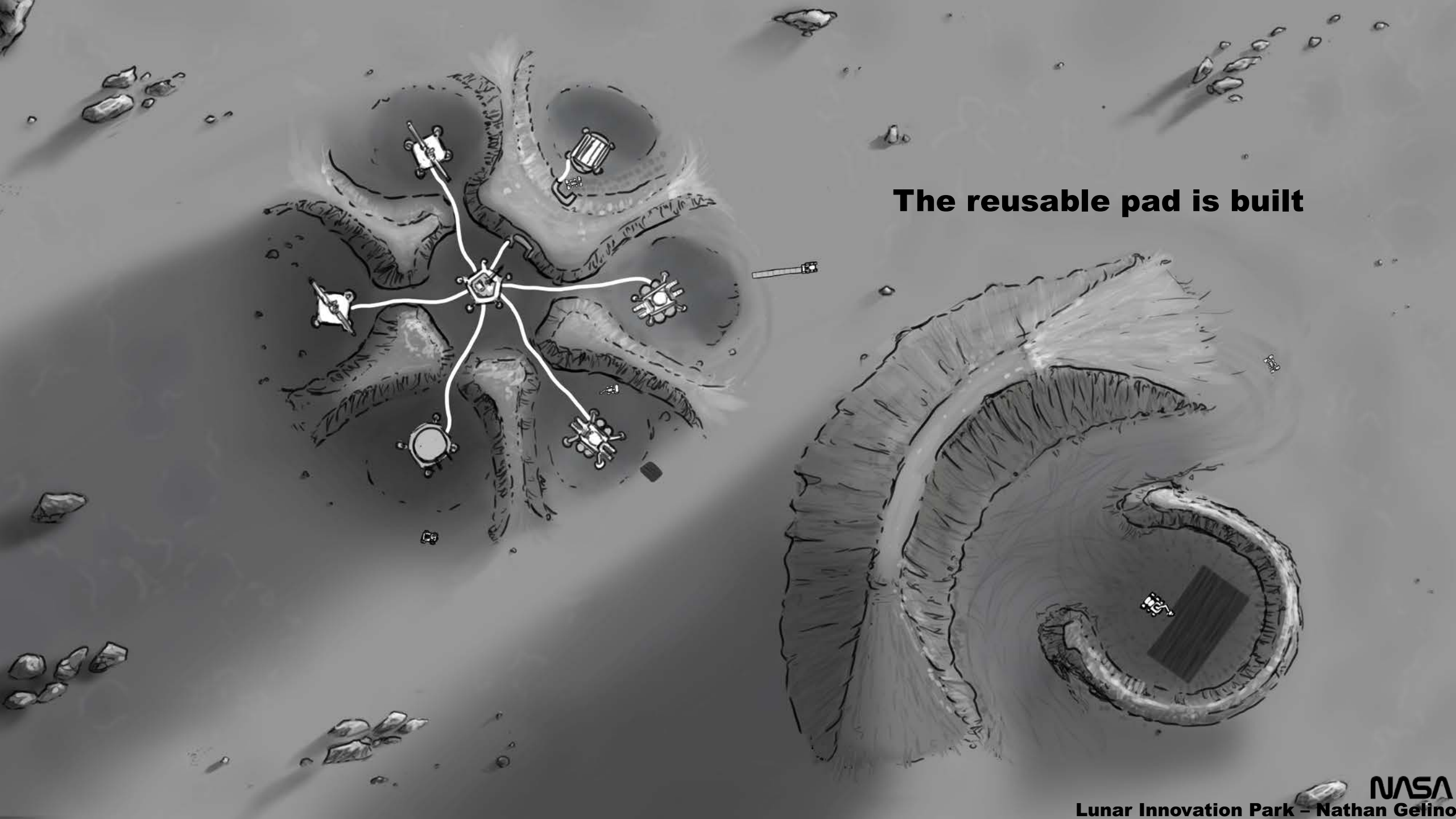


- **The reusable launch/landing pad regolith foundation and berms are for hardened pad construction operations**
- **The large berm protects all Park assets including VSATs in extended condition**
- **The smaller berm protects the entire region from PSI ejecta**



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Lunar Innovation Park Publications

Hilburger, Mark W., Gelino, N. J., and Mueller, R. P. (2026). “Lunar innovation park – initial surface infrastructure to kickstart a space resource-based economy.” In Proc., *ASCE Earth & Space 2026 Conference*, April 13-16, 2026.

Gelino, N. J., Burdess, B.H., Hilburger, M.W., Mueller, R. P., M W. Pradhananga, N., Miletić, M., Abel, P.B., Sibille, L., Gertsch, L.S., Schuler, J.M., Smith, J.D., Nick, A.J., Cloud, J.M., (2026). “Lunar Innovation Park – Site Plan and Bulk Regolith Feature Design” In Proc., *ASCE Earth and Space 2026. American Society of Civil Engineers*.

Gelino, N. J., Burdess, B. H., Mueller, R. P., Schuler, J. M., Nick, A. J., Smith, J. D., Buckles, B. C., and Cloud, J. M. (2026) (manuscript in preparation). “Lunar Innovation Park – Site Preparation Operational Analysis.”

Gelino, N. J., Abel, P.B., M W. Pradhananga, N., Miletić, M., Sibille, L., Gertsch, L.S., Burdess, B. H., Mueller, R. P., Schuler, J. M., (2026) (manuscript in preparation). “Lunar Innovation Park – Mission Design and Feasibility Analysis.”

Coming soon:

- AIAA Space Resources Webinar with Jared Long-Fox
- Space Policy Podcast with Peter Garretson