ASCE | AEROSPACE
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NASA

# Lunar Innovation Park

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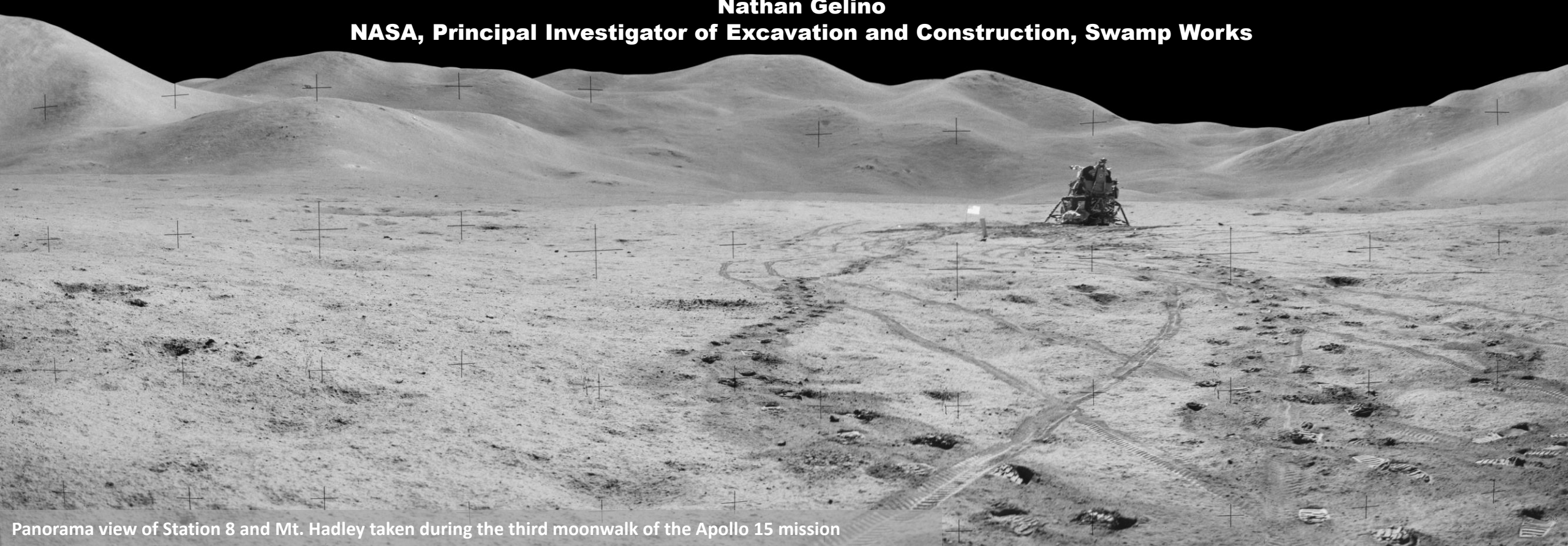


Panorama view of Station 8 and Mt. Hadley taken during the third moonwalk of the Apollo 15 mission

# Executive Order 14369 “Ensuring American Space Superiority”

## 18 December 2025

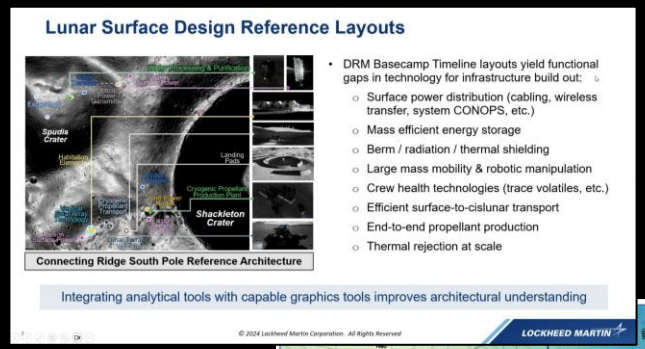
“pursue a space policy that will extend the reach of human discovery, secure the Nation’s vital economic and security interests, unleash commercial development, and lay the foundation for a new space age”.

- **Reemphasizing goals from previous US policy and strategy**
  - Establishing a sustainable/enduring presence in space
  - Lunar surface utilization and development
  - Establishing a commercial space economy
  - Industry and international partner collaboration
- **Outlines a series of specific goals and timeline**
  - Returning humans to the moon by 2028
  - Laying the foundations for lunar economic development
  - Fostering economic growth by attracting at least $50 billion of additional investments in American space markets by 2028
  - Establishing initial elements of a permanent lunar outpost by 2030 (Moon Base)

# Lunar Innovation Park – Motivation

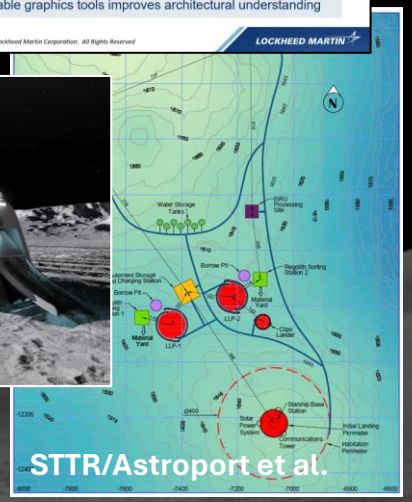
- **US Policy & Strategy**
  - A large number of NASA and US policy, and strategy documents have been released stressing the importance of space exploration and commercial activities beyond Earth's orbit with emphasis on the use of space resources.
  - **Common themes**: Sustainable/enduring presence, lunar surface utilization/development, commercial space economy, industry collaboration


- **Strong US industry interest signal**
  - US space industry and venture capitalists investing significant time/resources to develop technologies, systems, and define architectures towards the creation of a space resource-based economy
    - produce and sell lunar ISRU-based commodities such as cryogenic propellant, water, oxygen, Helium-3, and construction and manufacturing feedstocks.
    - provide services in support of a cislunar space ecosystem including power, communications, PNT, and mobility and logistics.
  - Many potential investors remain on the sidelines waiting for NASA to initiate a formal and lasting effort to capitalize on space resources





GRU Space



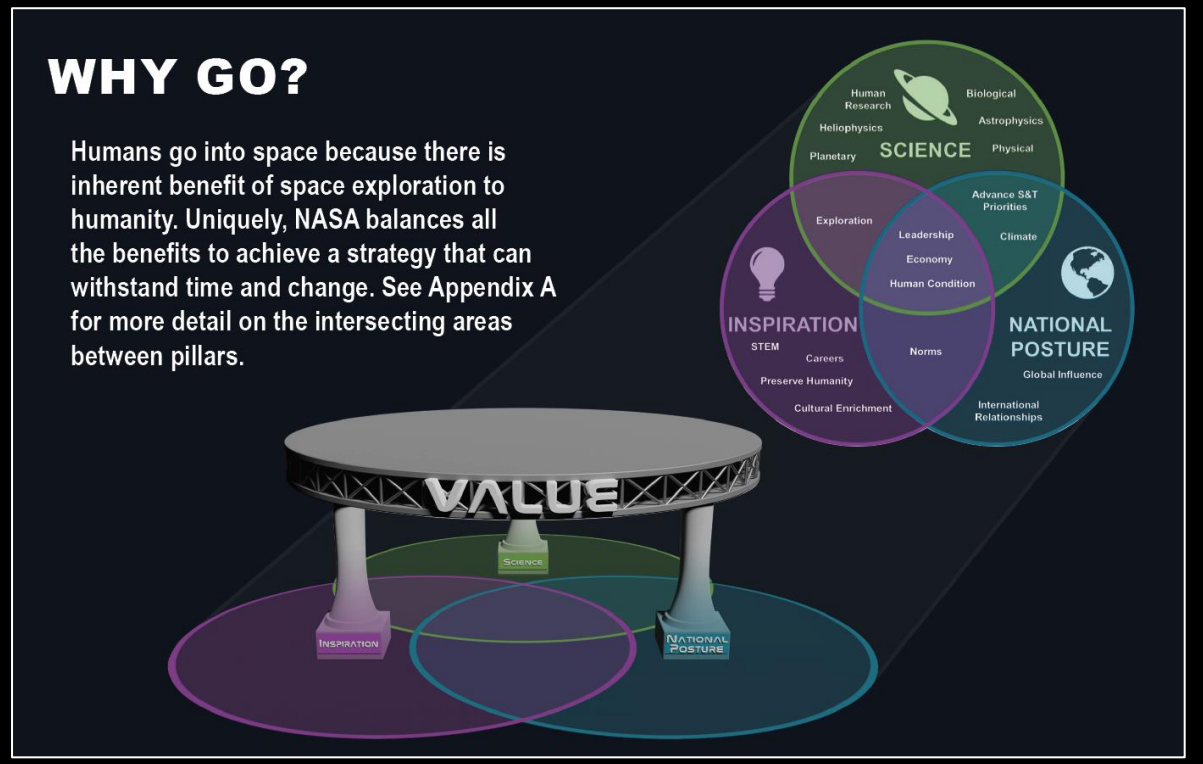
STTR/Astroport et al.

- **Accelerate technology development and demonstration to enable infusion into Artemis missions**

# NASA's Vision for Sustained Human Presence & Exploration of Space

- NASA's Moon to Mars (M2M) Value Proposition – *Science*, *Inspiration*, *National Posture*
- National Posture
  - Global Influence
  - International Relationships
  - Advance S&T Priorities
  - Climate
  - Norms
  - Leadership
  - **Economy**
  - Human Condition

  } Intersection between pillars




From *NASA's Moon to Mars Objectives and Strategy Development* document

## Thoughts and Observations:

- There is currently a heavy bias towards science and human exploration in NASA's execution of the M2M vision (Science and Inspiration pillars)
- Economy is identified as part of the M2M Value Proposition, however, the scope of the economic benefit of space and space resources appears to be underappreciated and thus underemphasized in NASA's current plans and thinking

➢ **A Lunar Innovation Park would help kickstart a space resource based economy and help meet NASA and US Exploration & Economic goals**

# Lunar Innovation Park – Consultants

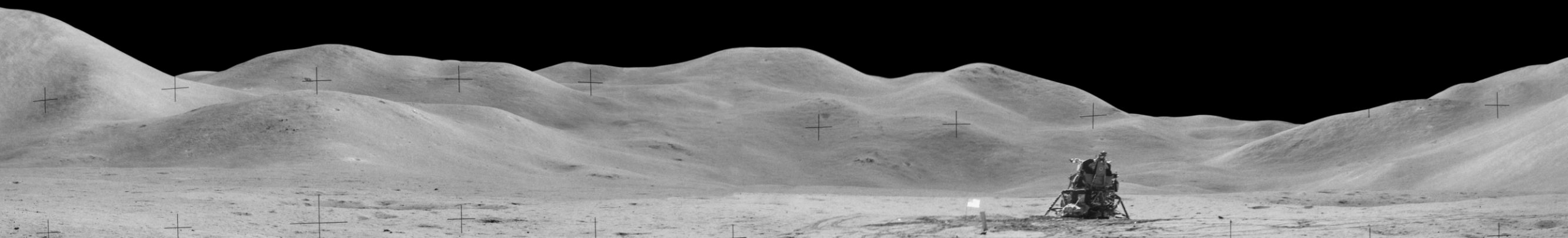
- **Jeremiah McNatt** - NASA Principal Technologist for Advanced Power
- **Bernie Edwards** – NASA System Capability Leadership Team for Advanced Communications and Navigation
- **Michelle Munk (ret.), John Carson** – NASA System Capability Leadership Team for Entry, Decent & Landing
- **Josh Mehling** – NASA Principal Technologist for Robotics
- **Jerry Sanders** (ret.), **Julie Kleinhenz -** NASA System Capability Leadership Team for In-situ Resource Utilization
- **Jason Schuler** – PI Infrastructure Pilot Excavator Project, Granular Mechanics and Regolith Operations Lab, NASA, KSC
- **Kenny Cheung, Greenfield Trinh** – ARMADAS Project PI/PM, Intelligent Systems Division, Ames Research Center
- **Glenn Research Center Compass Team** – Mission design and feasibility analysis
- **Various industry contacts** (e.g., technology developers, campaign architects, space policy experts)

# Lunar Innovation Park – Publications

- **Lunar Innovation Park – Initial Surface Infrastructure to Kickstart a Space Resource Based Economy**
- **Lunar Innovation Park – Site Plan & Bulk Regolith Feature Design**
- **Lunar Innovation Park – Site Preparation Operational Analysis (to be presented at Space Resources Roundtable)**
- **Lunar Innovation Park – Mission Campaign Analysis & Design (coming soon)**

# Core Tenets

- Seek the fastest path to sustained lunar presence – “Go Do” not “Go Study”
- Risk reduction and demonstration of the “art of the possible” for Artemis Program
- Communicate a realistically achievable plan for near term incremental build up of surface infrastructure
- Demonstrate critical technologies to kickstart a space resource-based economy
- Emplace minimum viable infrastructure and transfer to industry as soon as possible
- Land in extreme proximity to reduce mission costs and logistics complexity
- Human presence is not required
- Replicate at locations of strategic interest to “claim” land

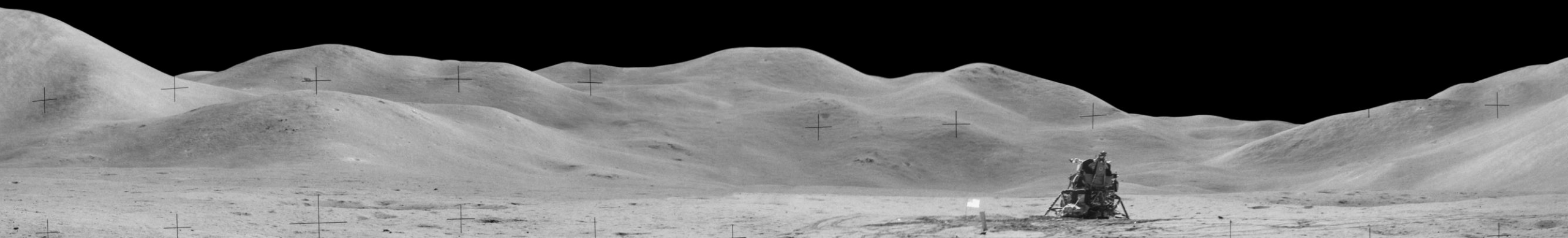


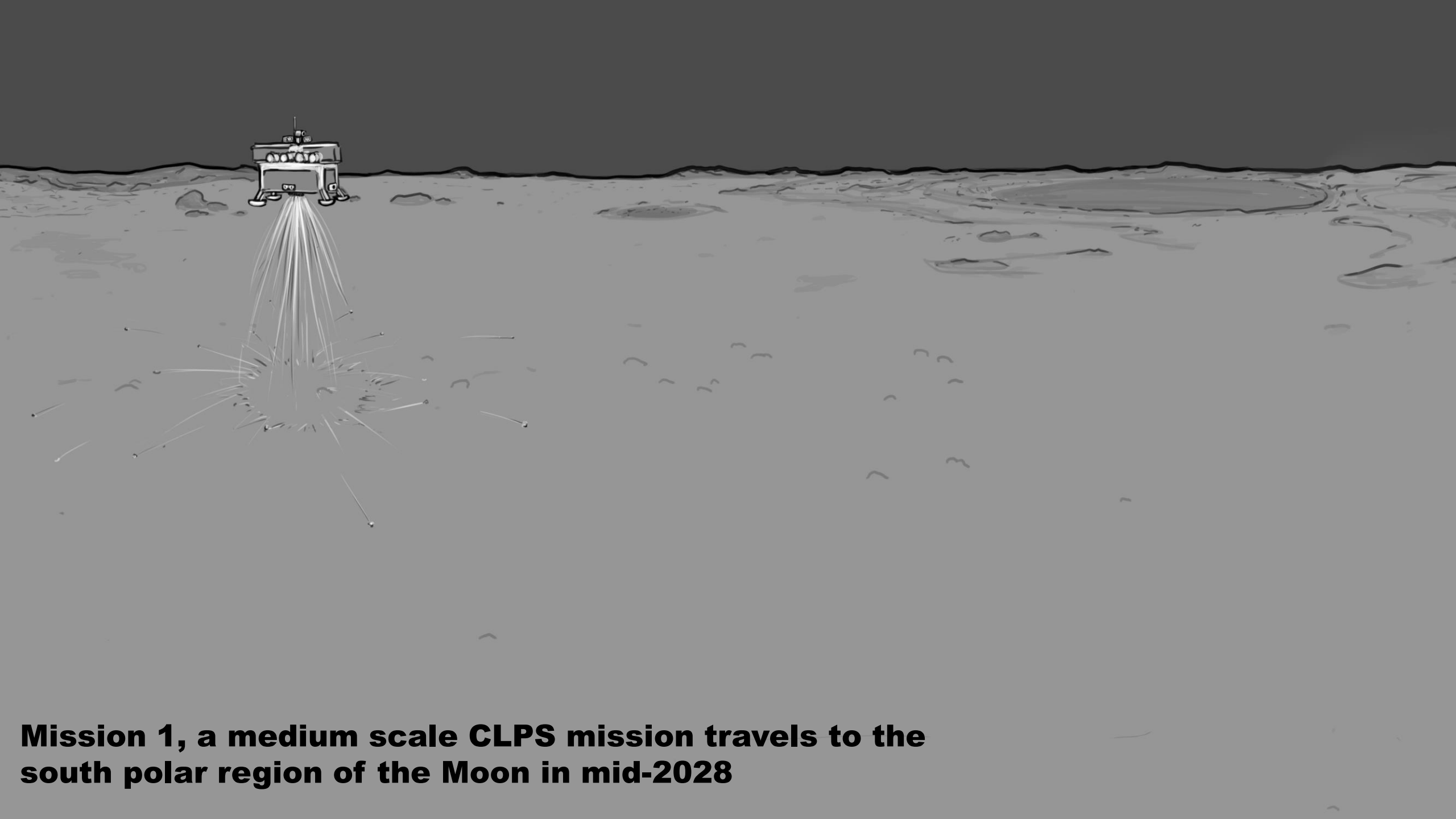
# Ground Rules and Schedule

- Medium scale CLPS landers (~625 kg)
  - Future work will investigate larger landers
- Power from VSATs
  - Future work will investigate FSP application
  - Site preparation for FSP foundations and berms for radiation mitigation
- Non-interference with Artemis

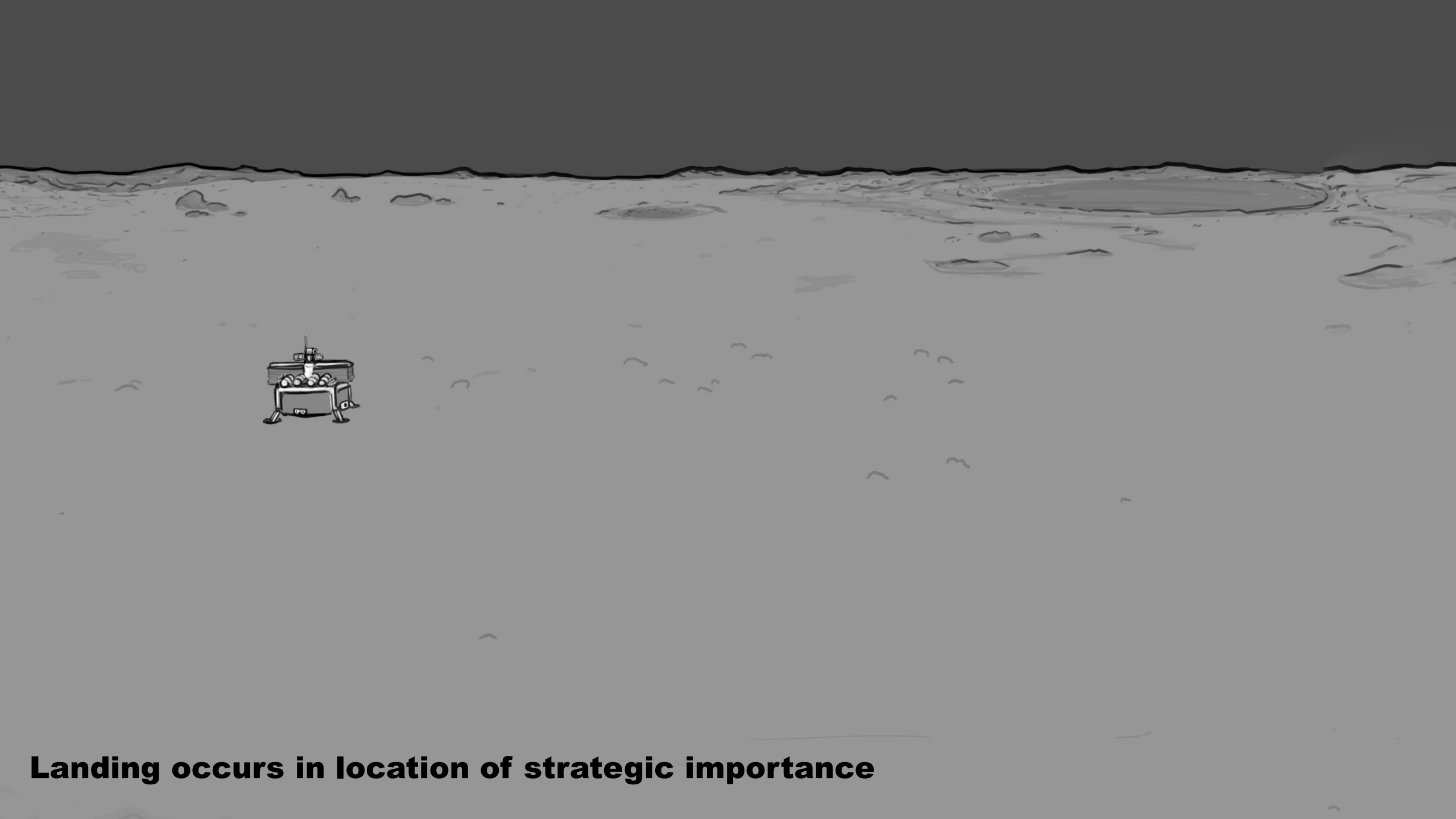
**With urgency of action and appropriate funding, it is possible to:**

- **Land first two missions in 2028 to survive the night, build a berm, and demonstrate PSI ejecta mitigation for proximity landings (before current Administration ends)**
- **Land first three missions in 2030 to commission a lunar power grid (before Space Superiority EO target date for "initial elements of a permanent lunar outpost")**

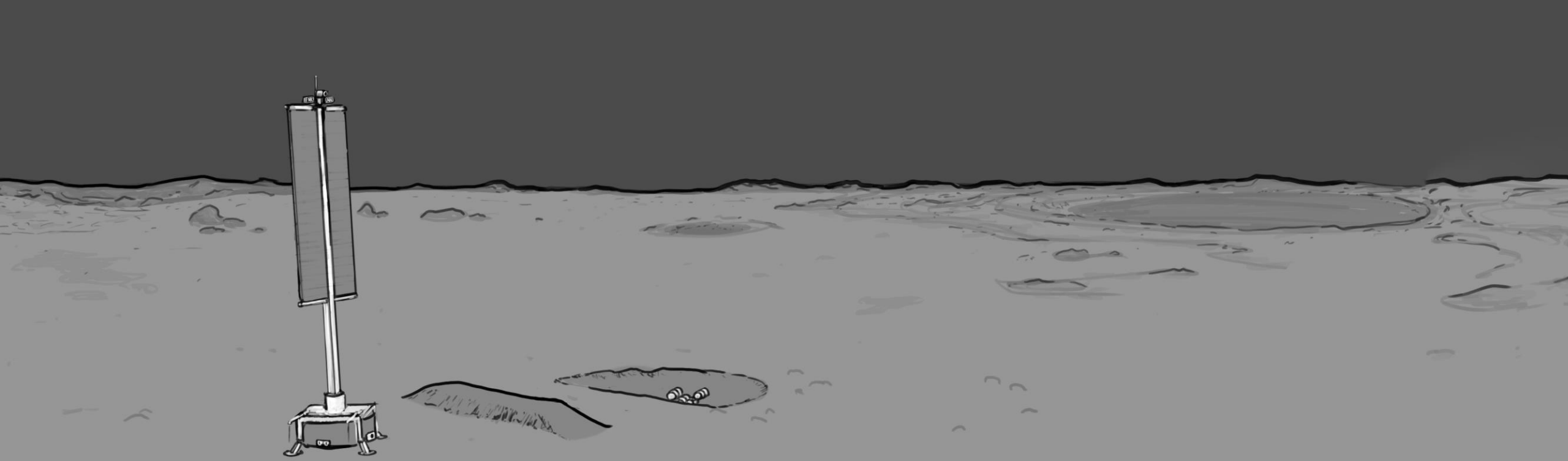




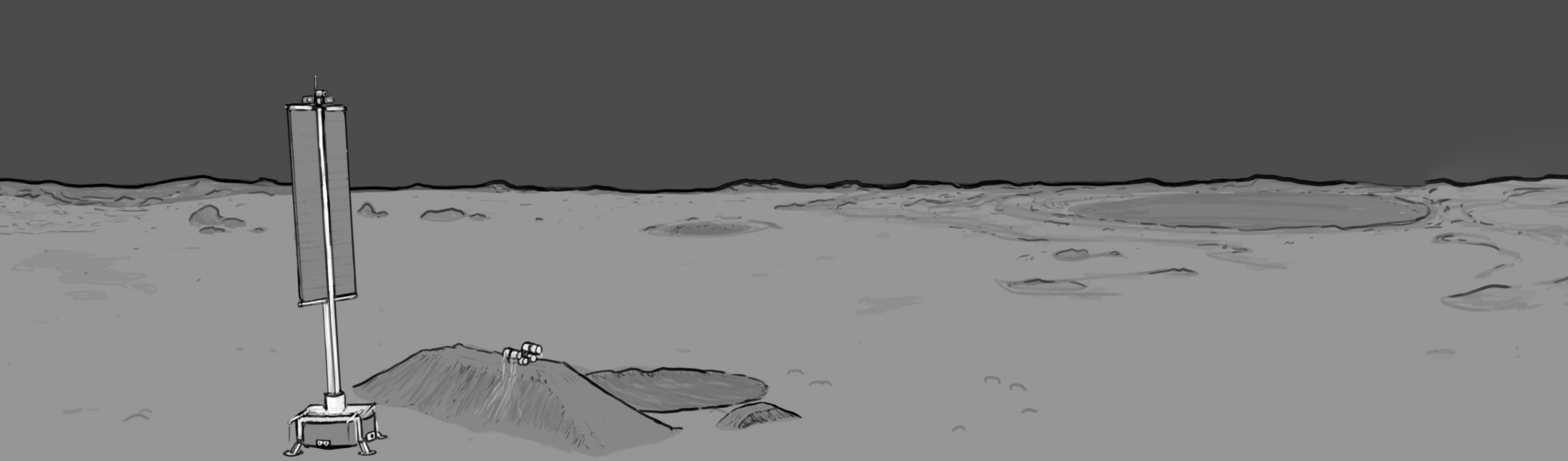
**Mission 1, a medium scale CLPS mission travels to the south polar region of the Moon in mid-2028**



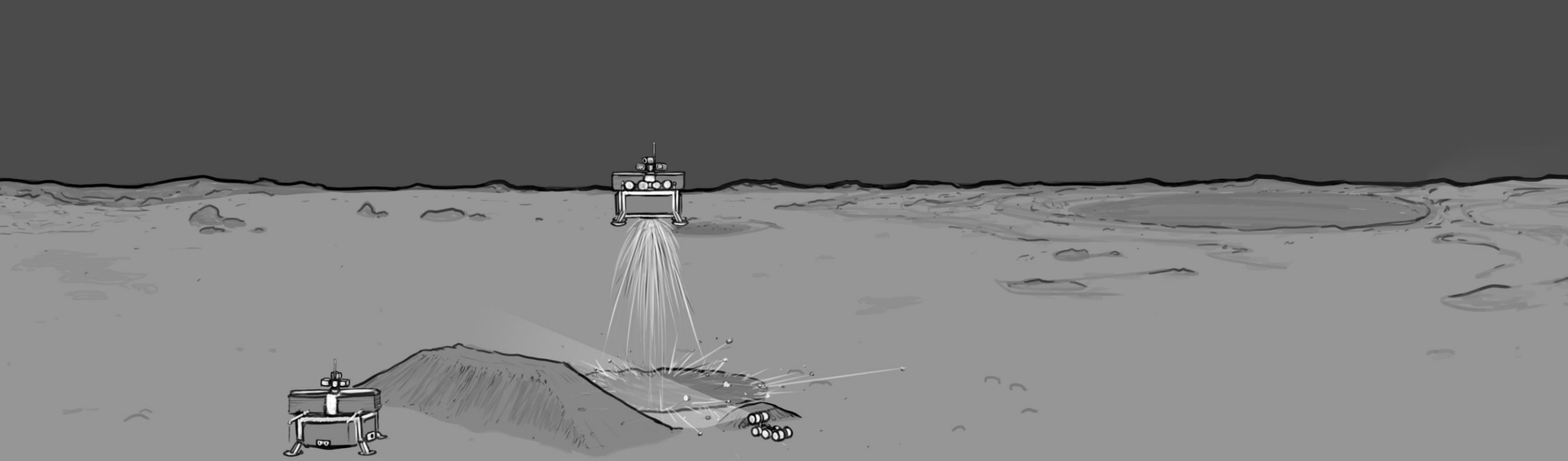
**Landing occurs in location of strategic importance**



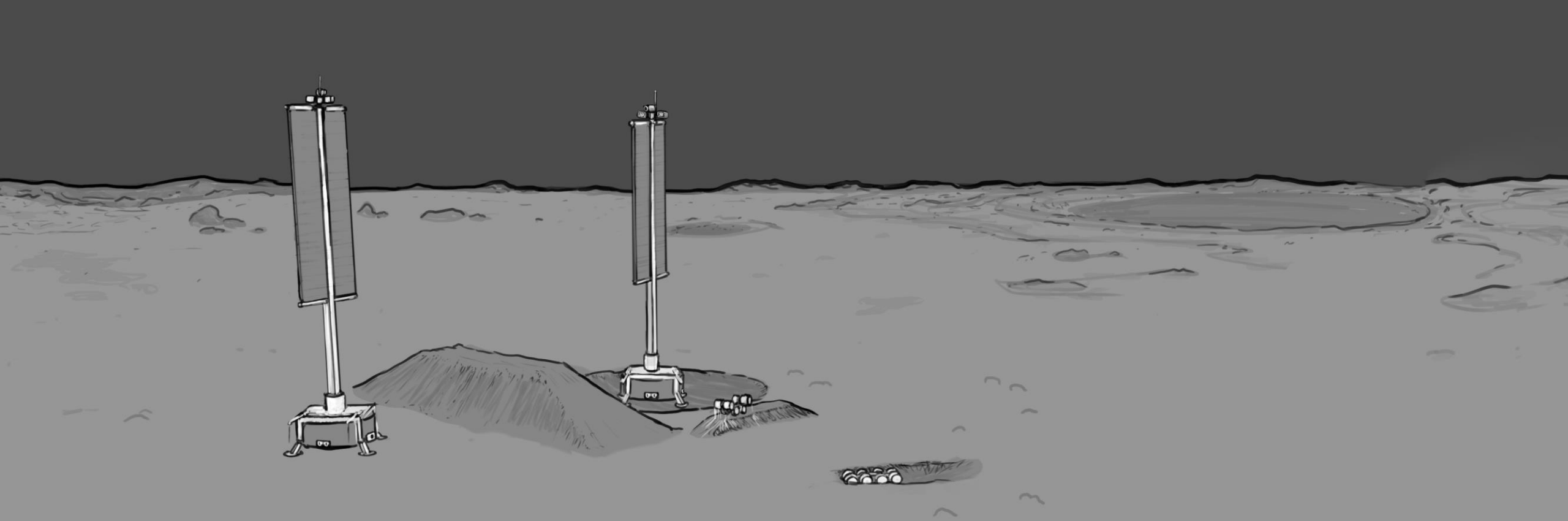
- **A Vertical Solar Array (VSAT) and communications are deployed**
- **An excavation robot (IPEx) maps the region and then builds a bulk regolith berm**



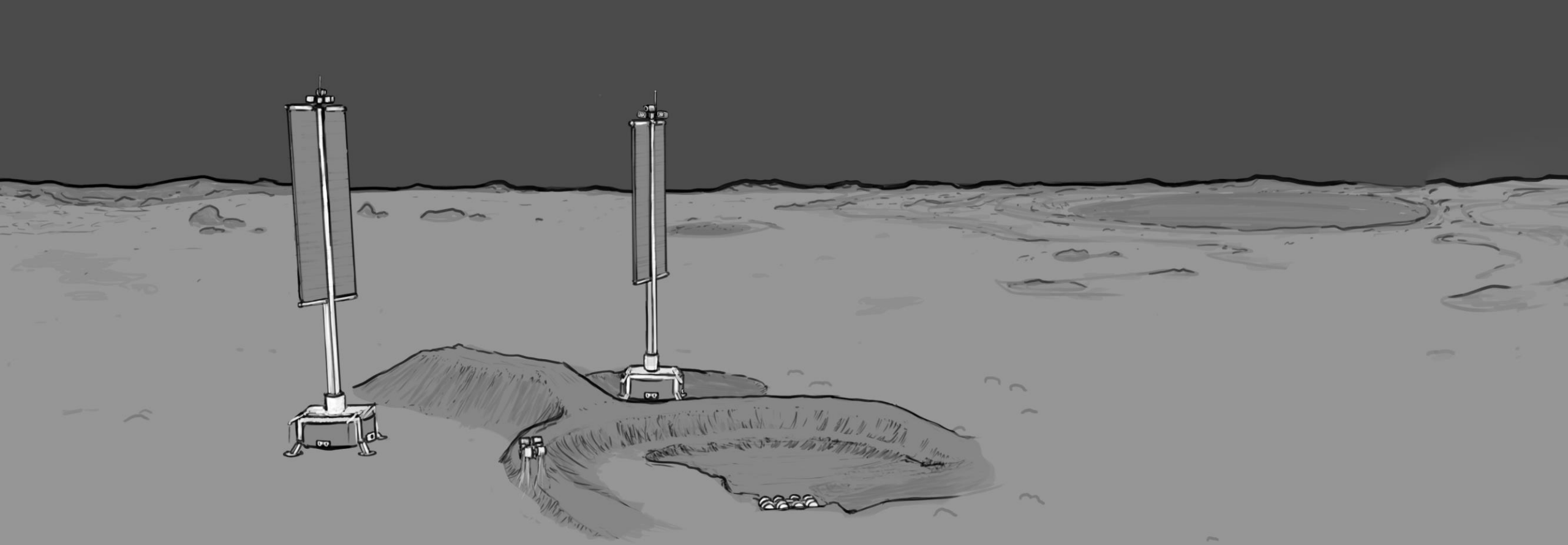
- **The berm and an adjacent bulk regolith flat, level, rock free landing site are finished**
- **The distance between landing sites is ~20 m**



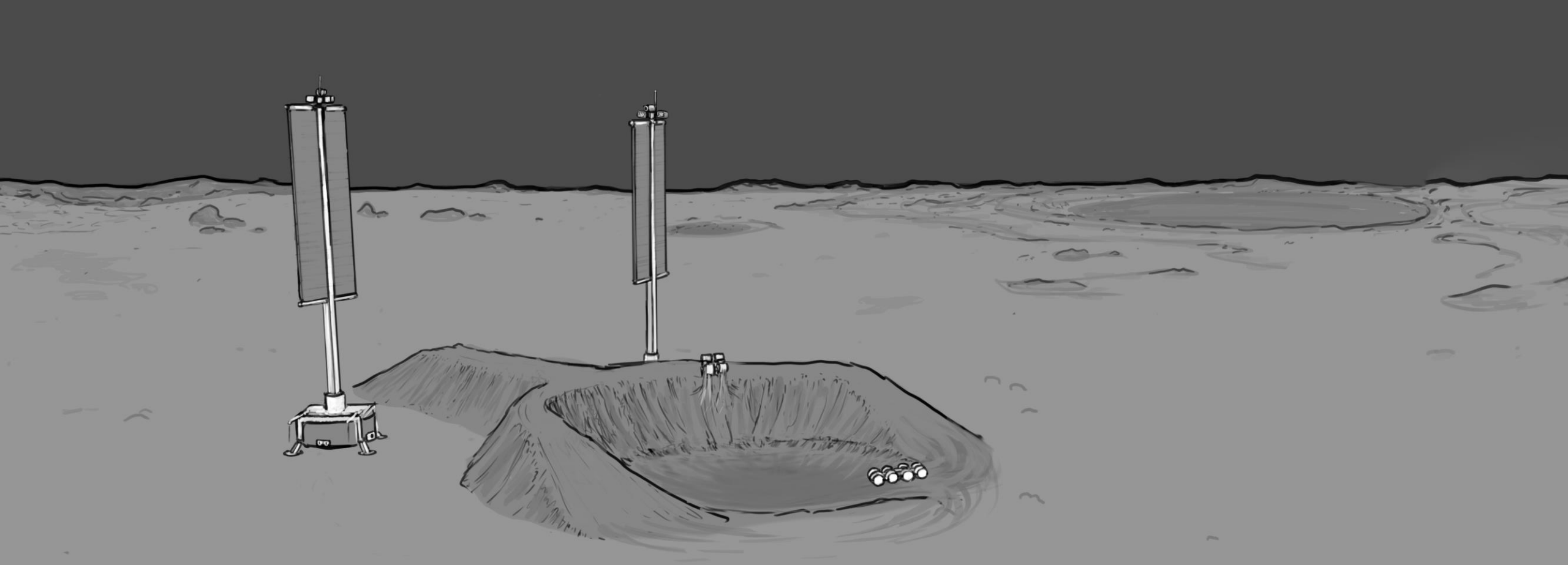
- **In late 2028, Mission 2 lands while the VSAT is stowed, and the excavation robot surveils the Plume Surface Interaction (PSI) effects**
- **Extreme landing precision is enabled by a high-res topo map and landing aids**
- **The berm protects the first lander from PSI ejecta**



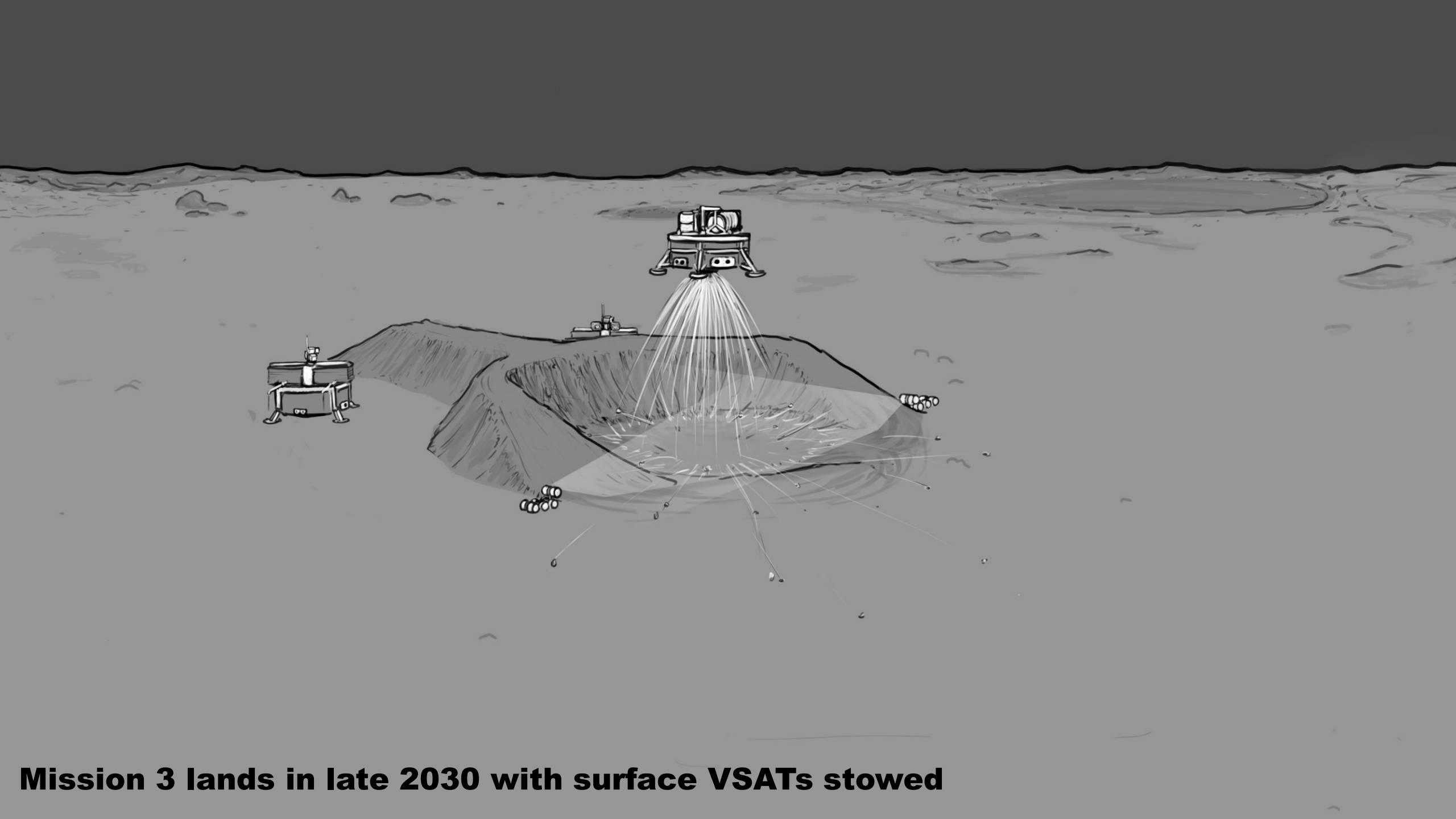
**The Mission 2 lander payload is identical to the first to provide redundant power, comm, and excavation capability**



**The excavators prepare the site for Mission 3 landing**

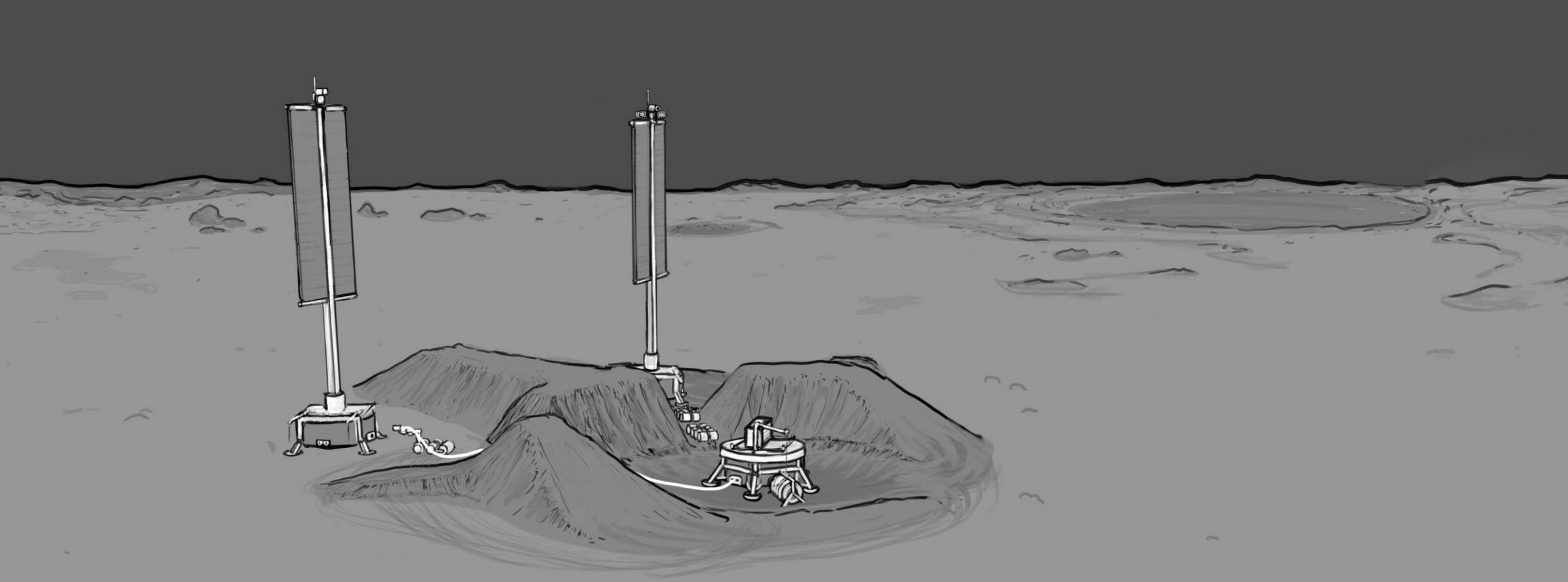


**The protective berm and landing surface are completed for Mission 3**

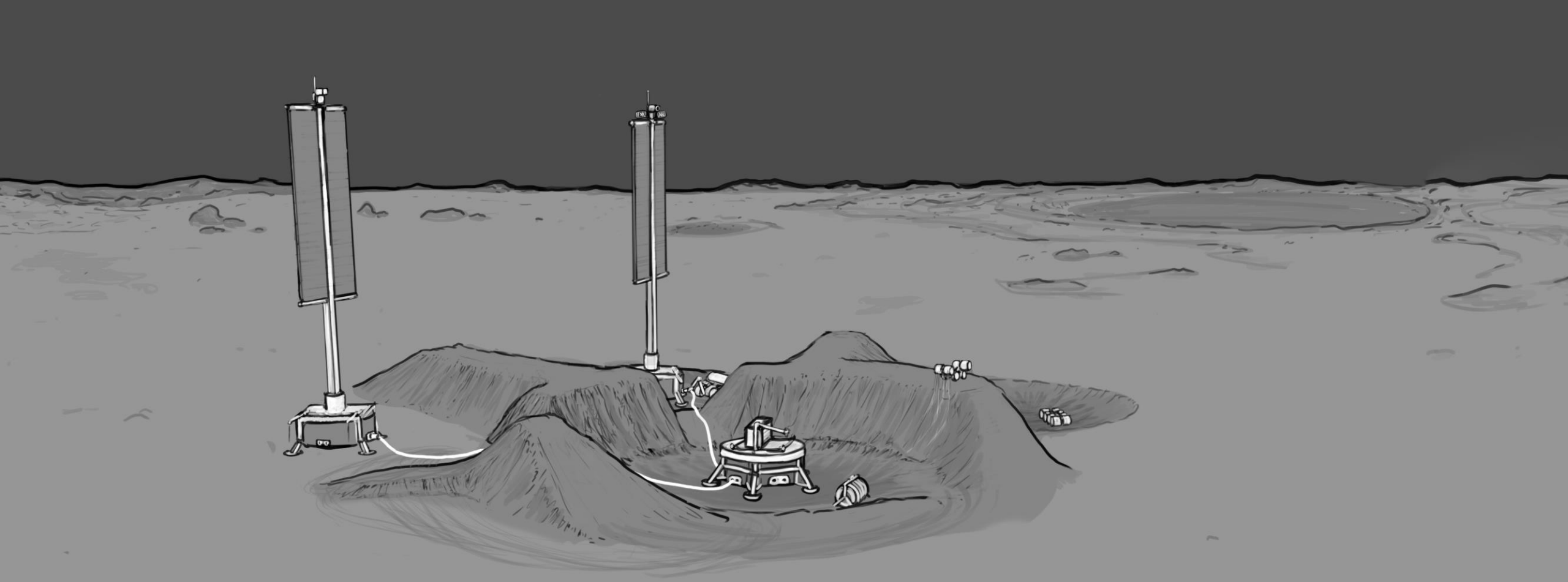


**Mission 3 lands in late 2030 with surface VSATs stowed**

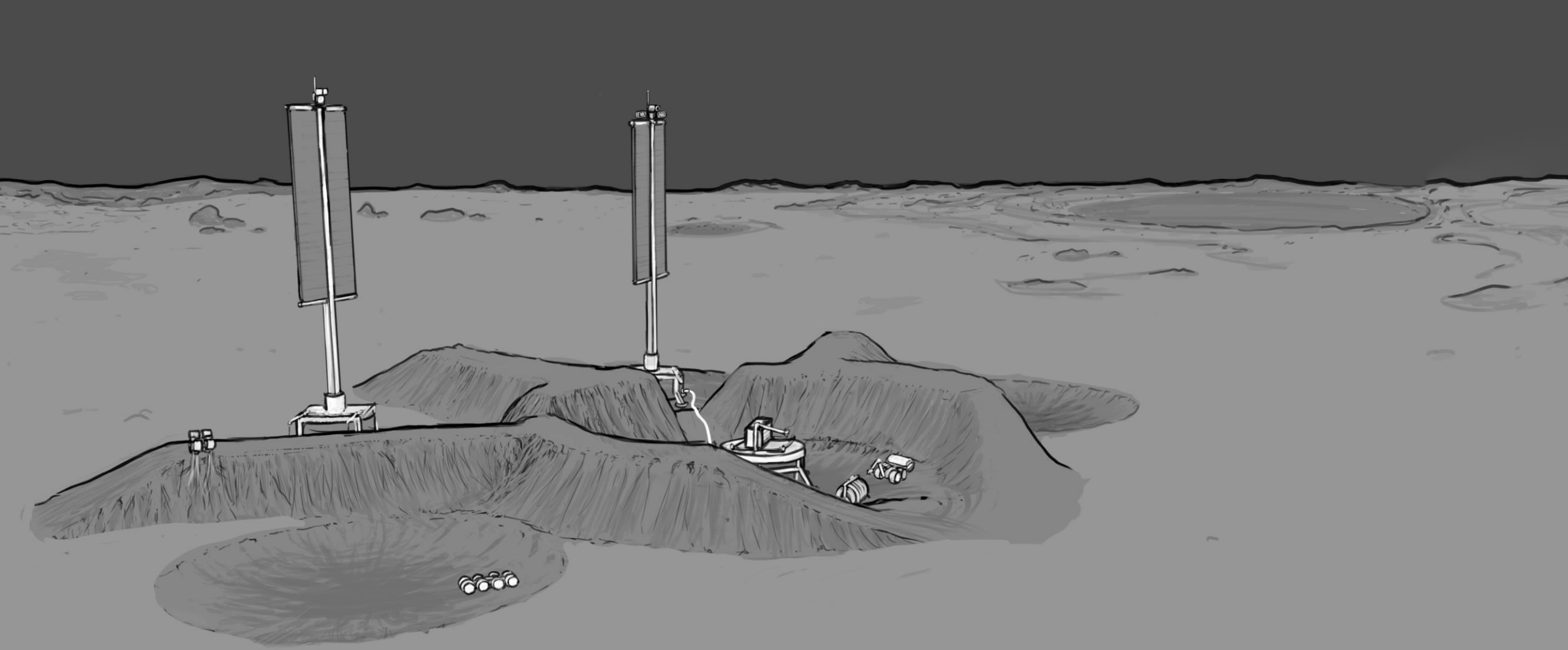
- **Mission 3 augments Park power with increased energy storage and power distribution hardware**
- **An evolved IPEx with modular interfaces for implement swapping is delivered that can do limited logistics**
- **Implements include a logistic arm, compactor, cable reel, and excavation drums**



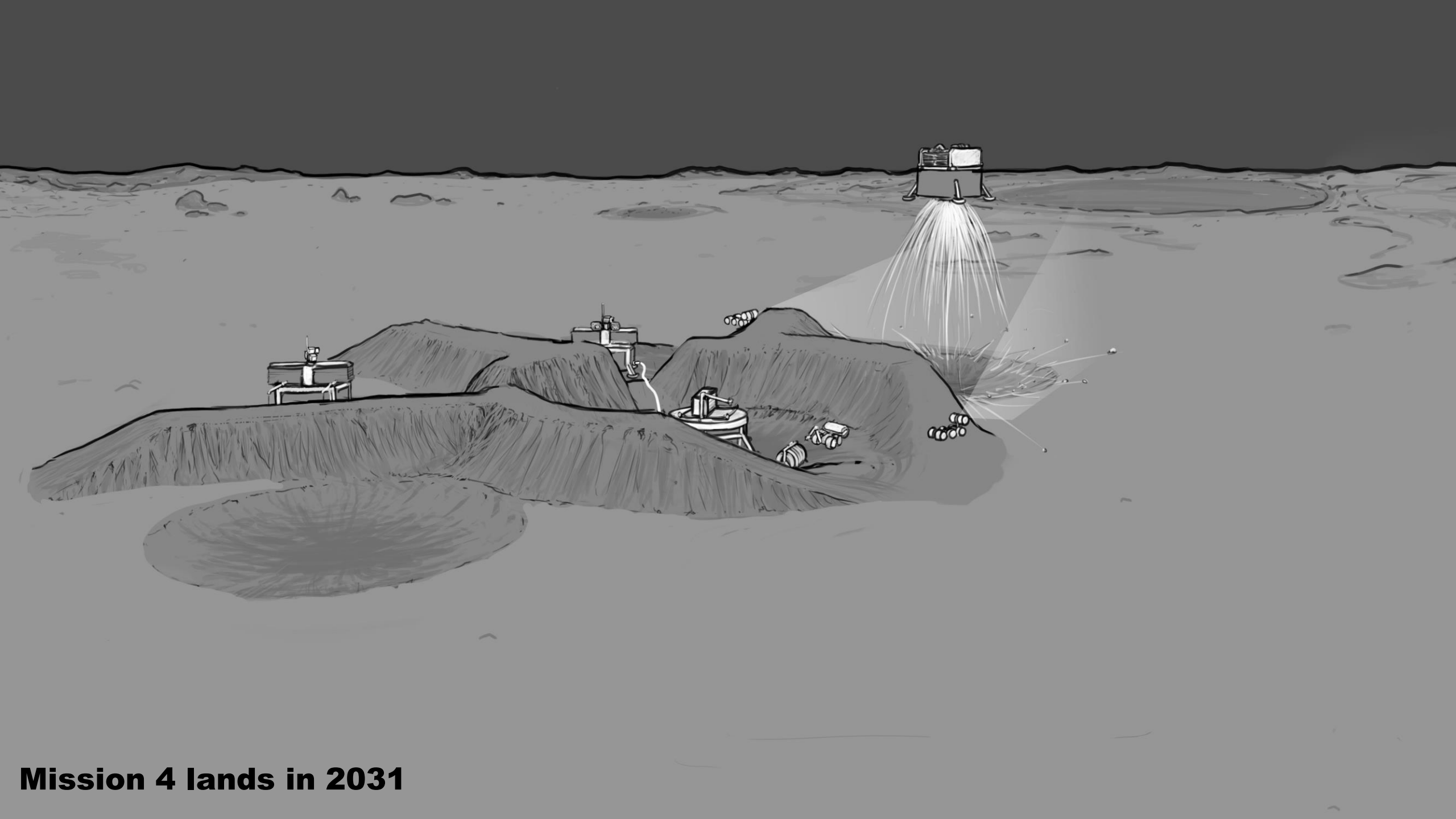
- **The excavators cut through the berms between landers**
- **The logistics robot pulls cables and mates dust tolerant connections between the power assets creating the first lunar power grid**



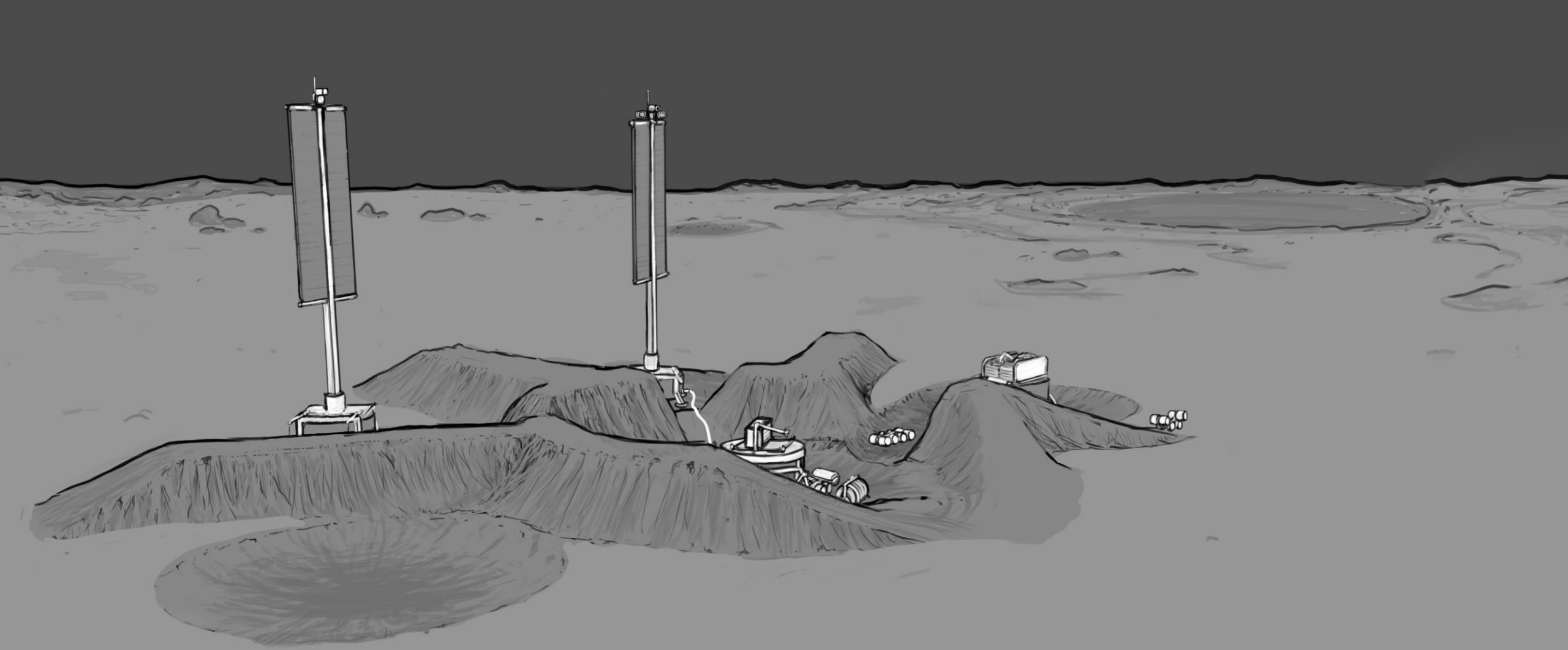
**The landing site for Mission 4 is prepared**



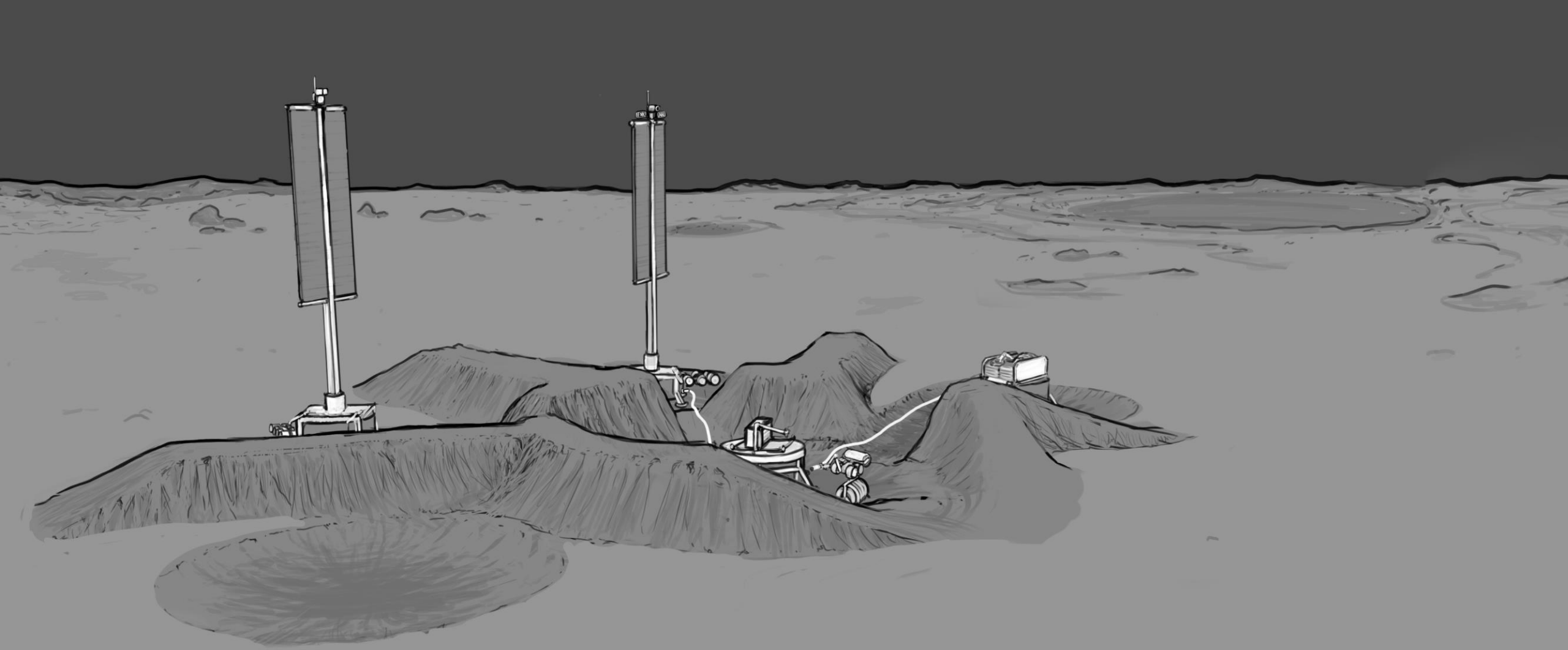
A landing site is prepared for Park services Customer 1



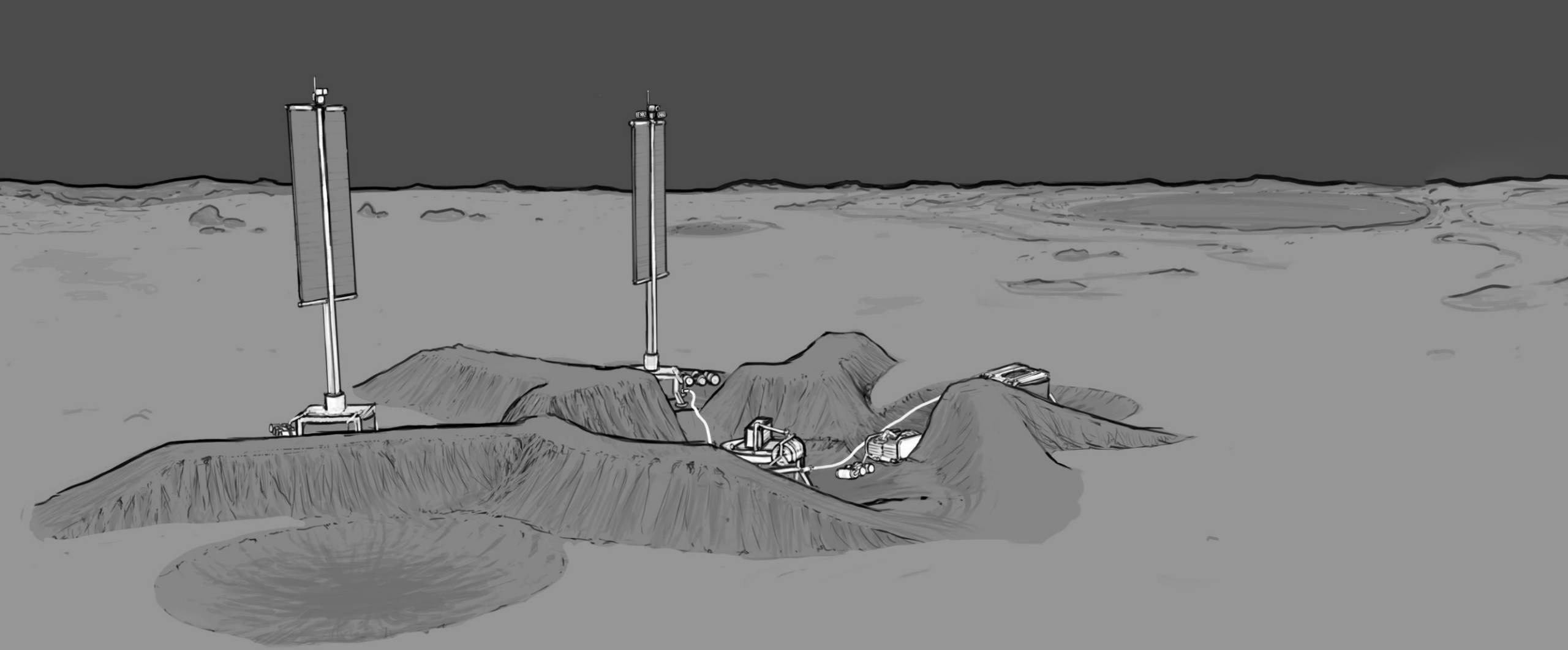
**Mission 4 lands in 2031**



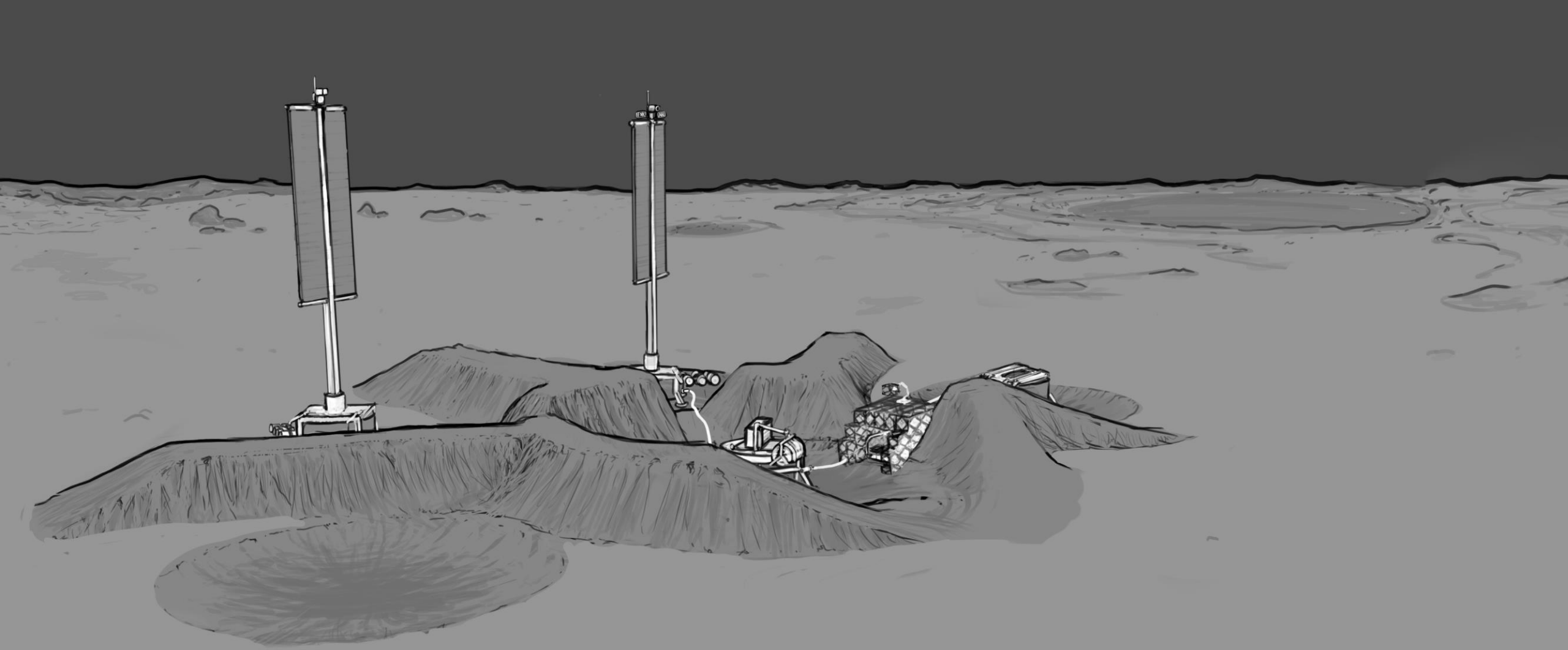
- **Mission 4 brings ARMADAS assembly robots and structural elements to build an unpressurized protective shelter**
- **The excavators clear an area through the berm**



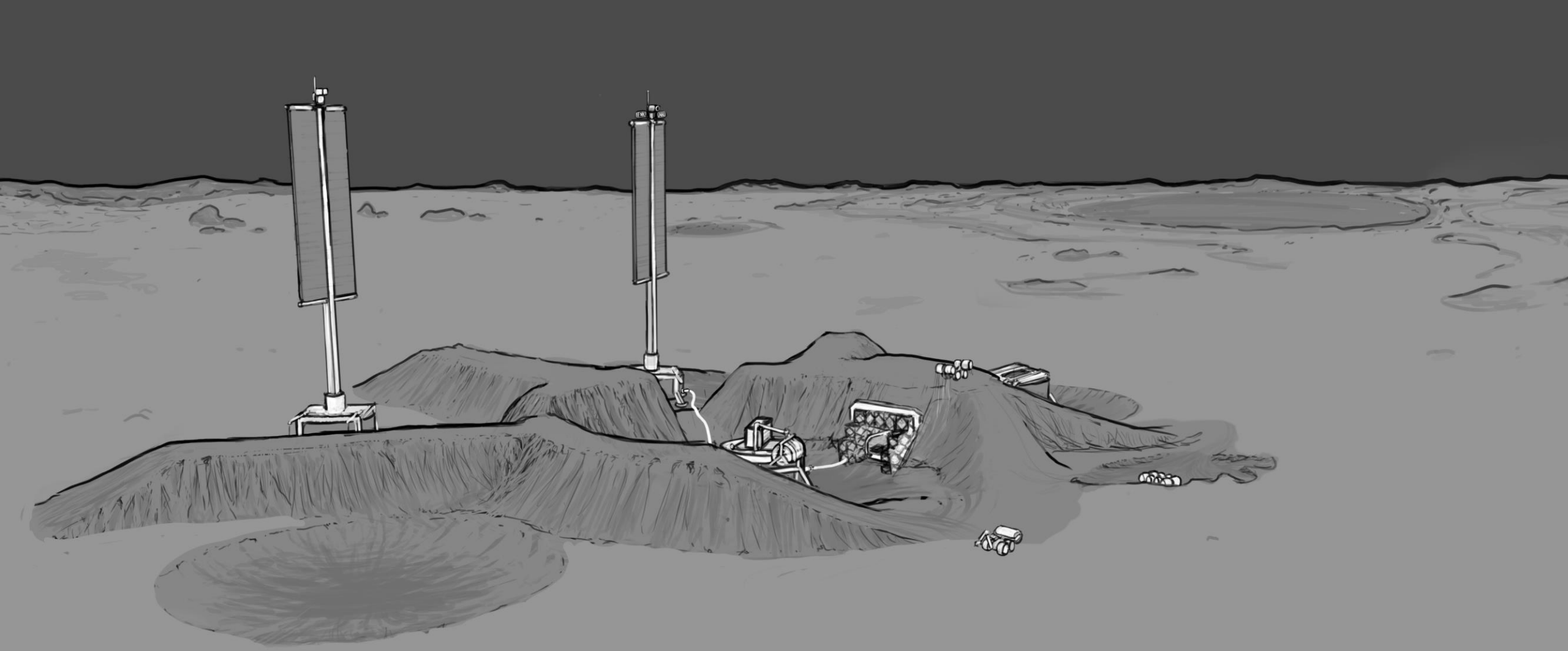
- **Power is connected to the fourth lander**
- **The foundation is prepared for the unpressurized shelter**



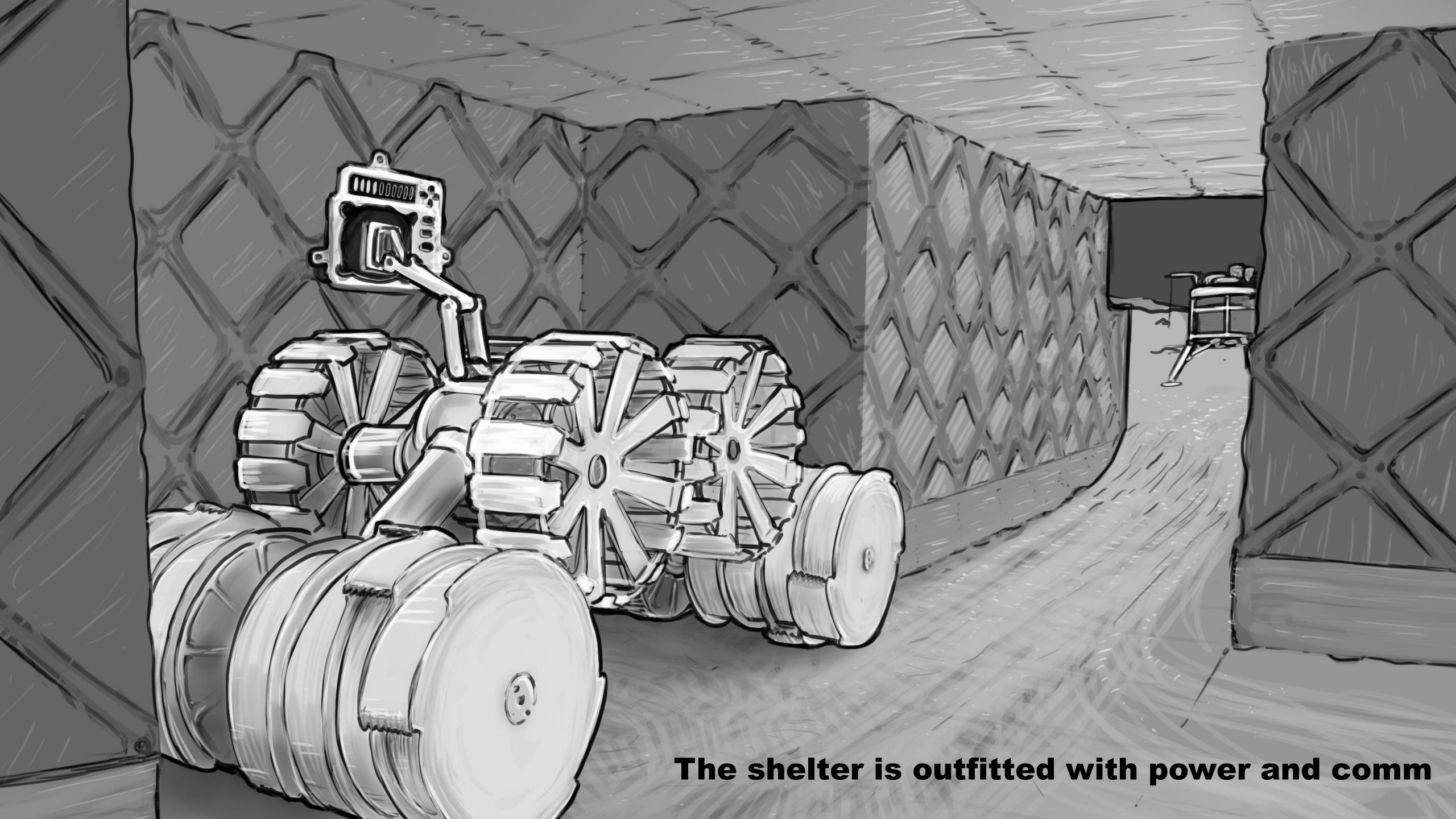
**The ARMADAS elements are delivered to the shelter site, and the “cornerstone” of the shelter is placed**



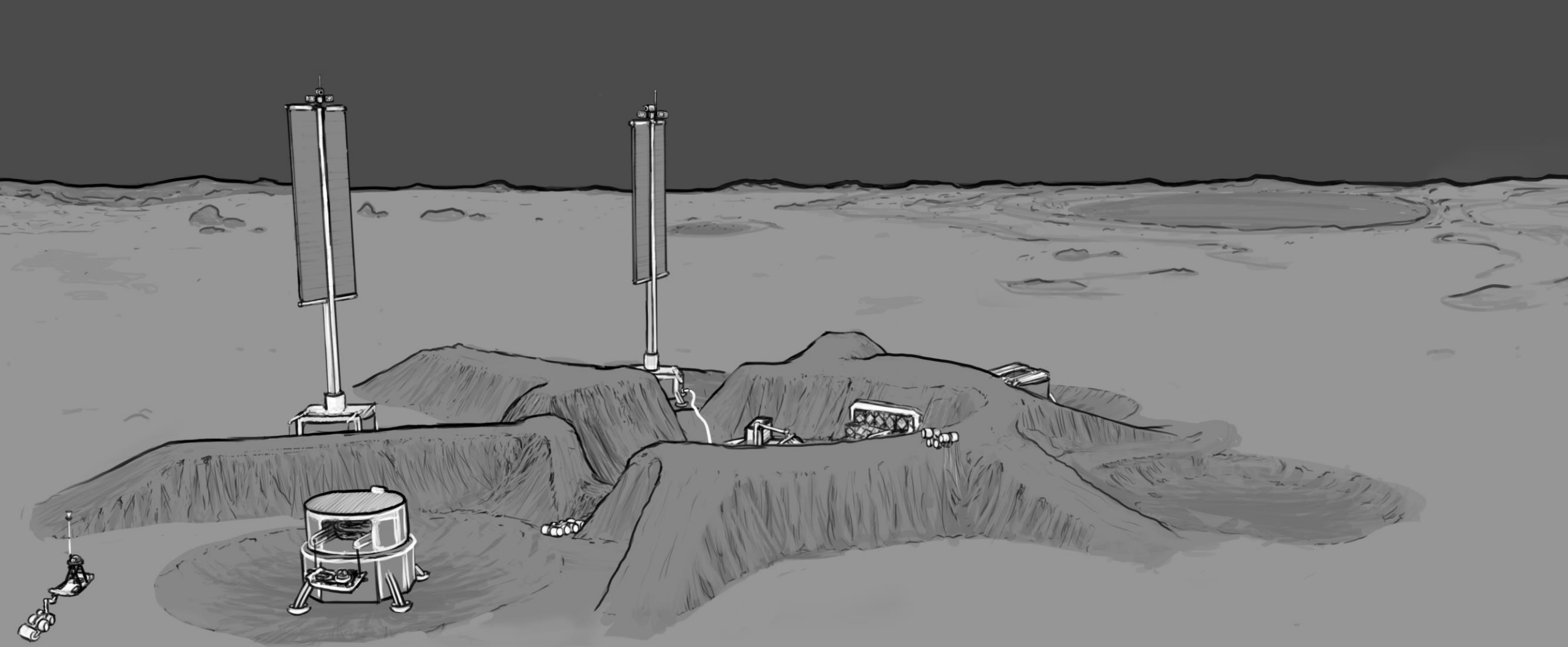
**The ARMADAS robots assemble the protective shelter structure with support from the logistics robot**



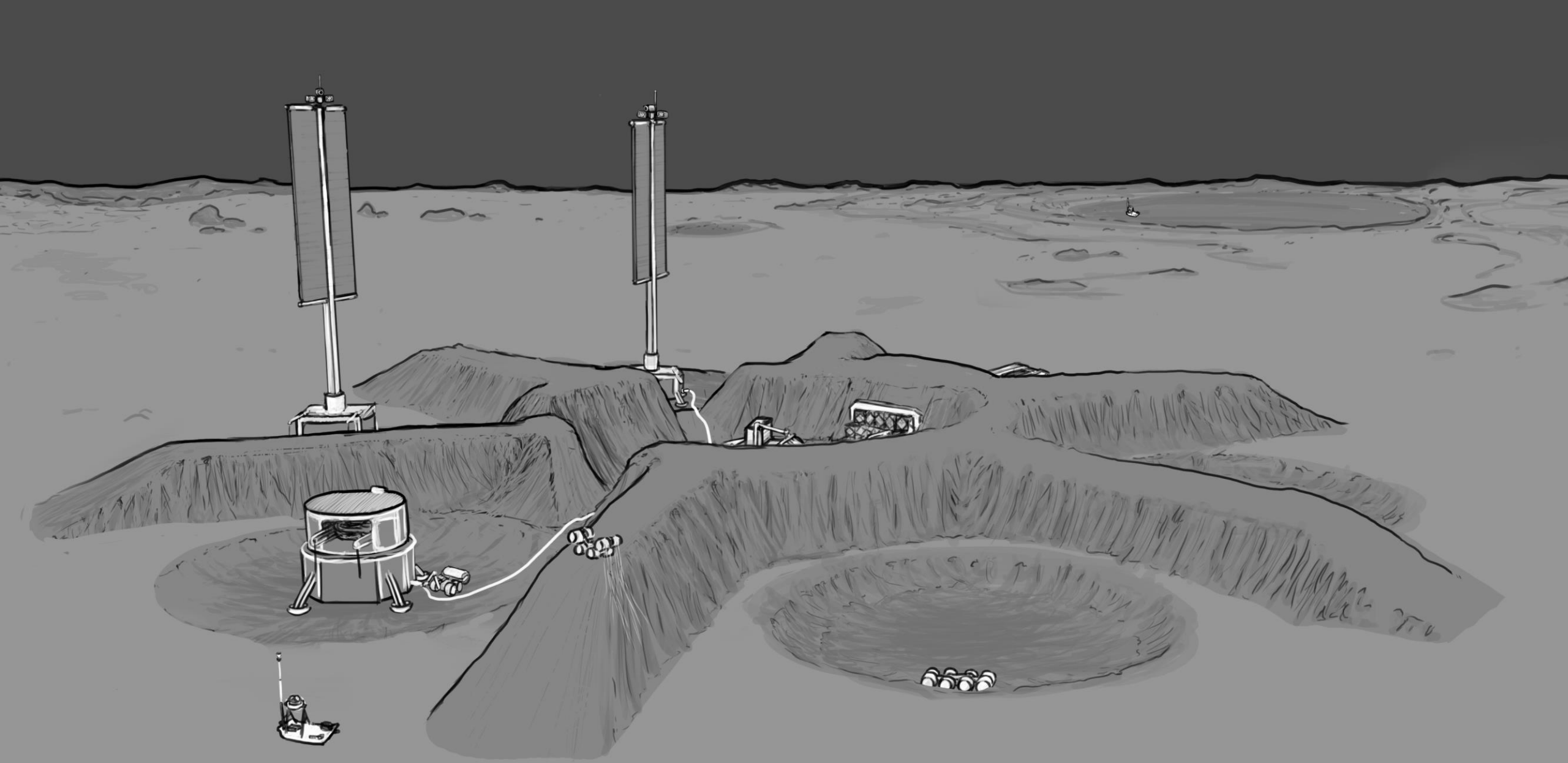
- **The excavators bury the shelter with regolith**
- **The regolith provides protection from radiation and meteoroids and provides insulation to keep the shelter warm**
- **Sheltered space is available for Park assets and customers**
- **The site is prepared for the Mission 5 lander**


The shelter is outfitted with power and comm

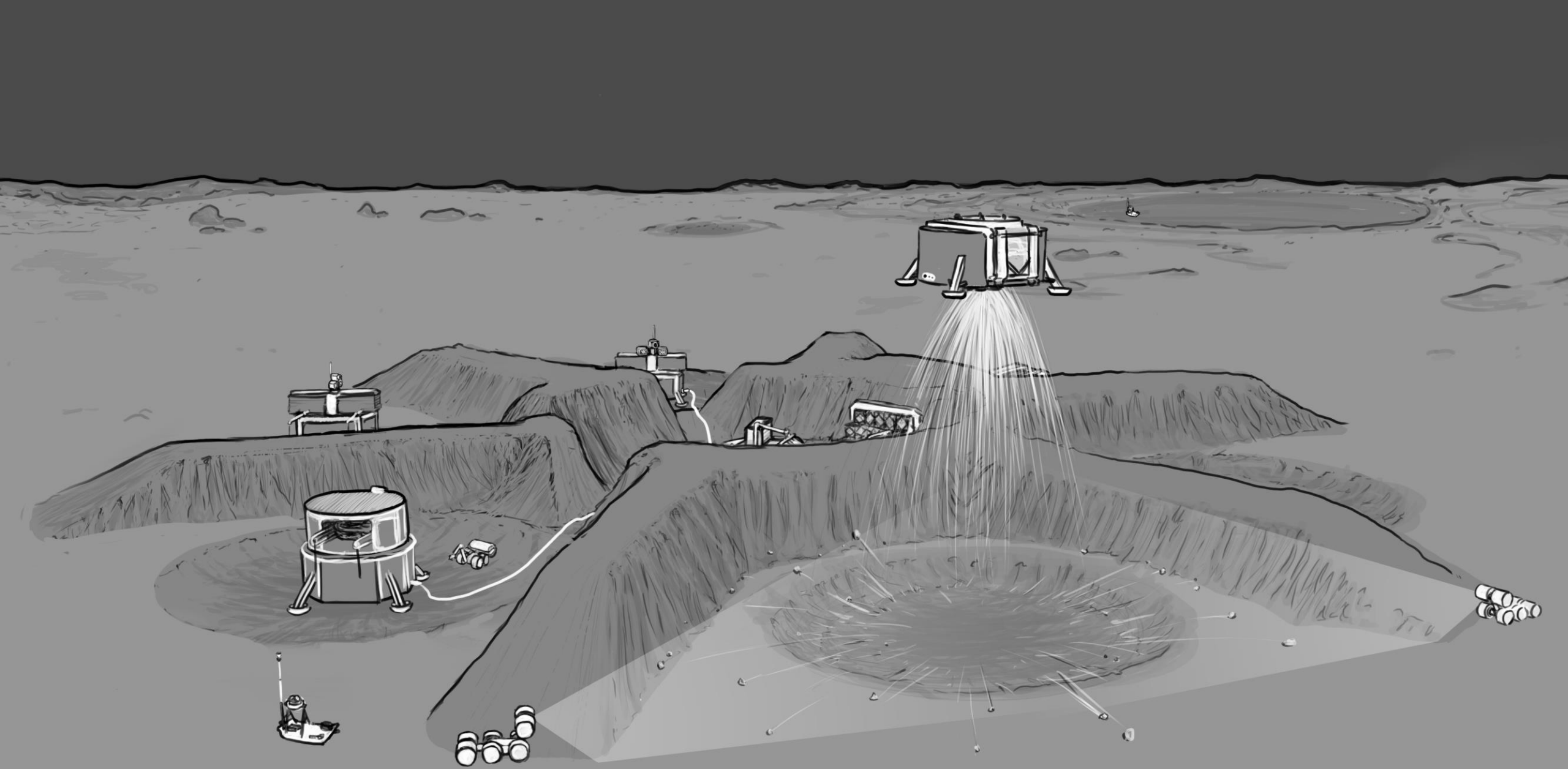
- **Customer 1 lander arrives with technology development or scientific payloads who pay for park services (power, comm, transportation, regolith delivery, shelter, etc.)**
- **Customers with ISRU commodity production and/or reusable launch pad construction technologies are preferred for small scale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



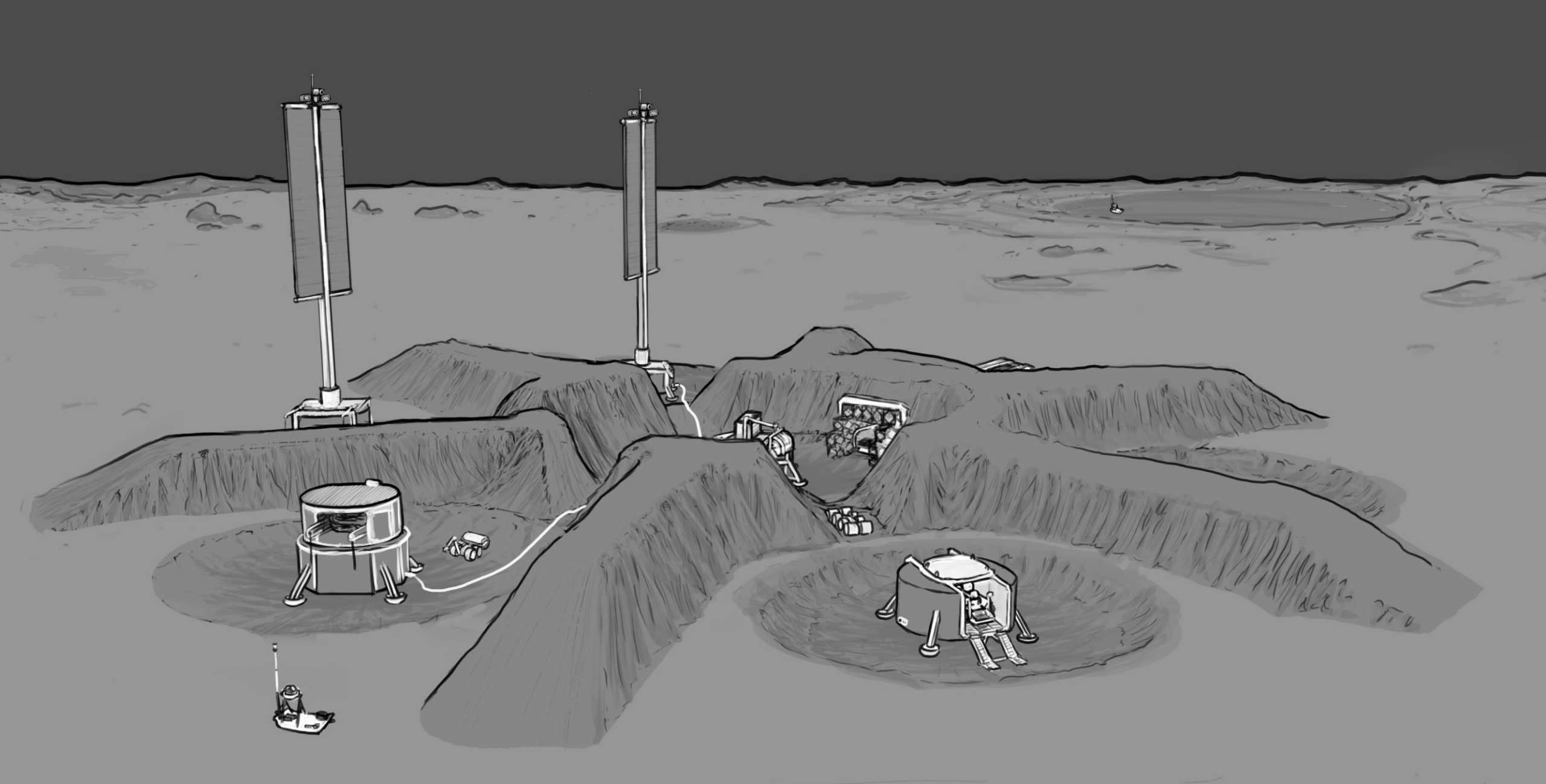
- **A cut-through is made in the berm**
- **Customer operations are supported by Park services**



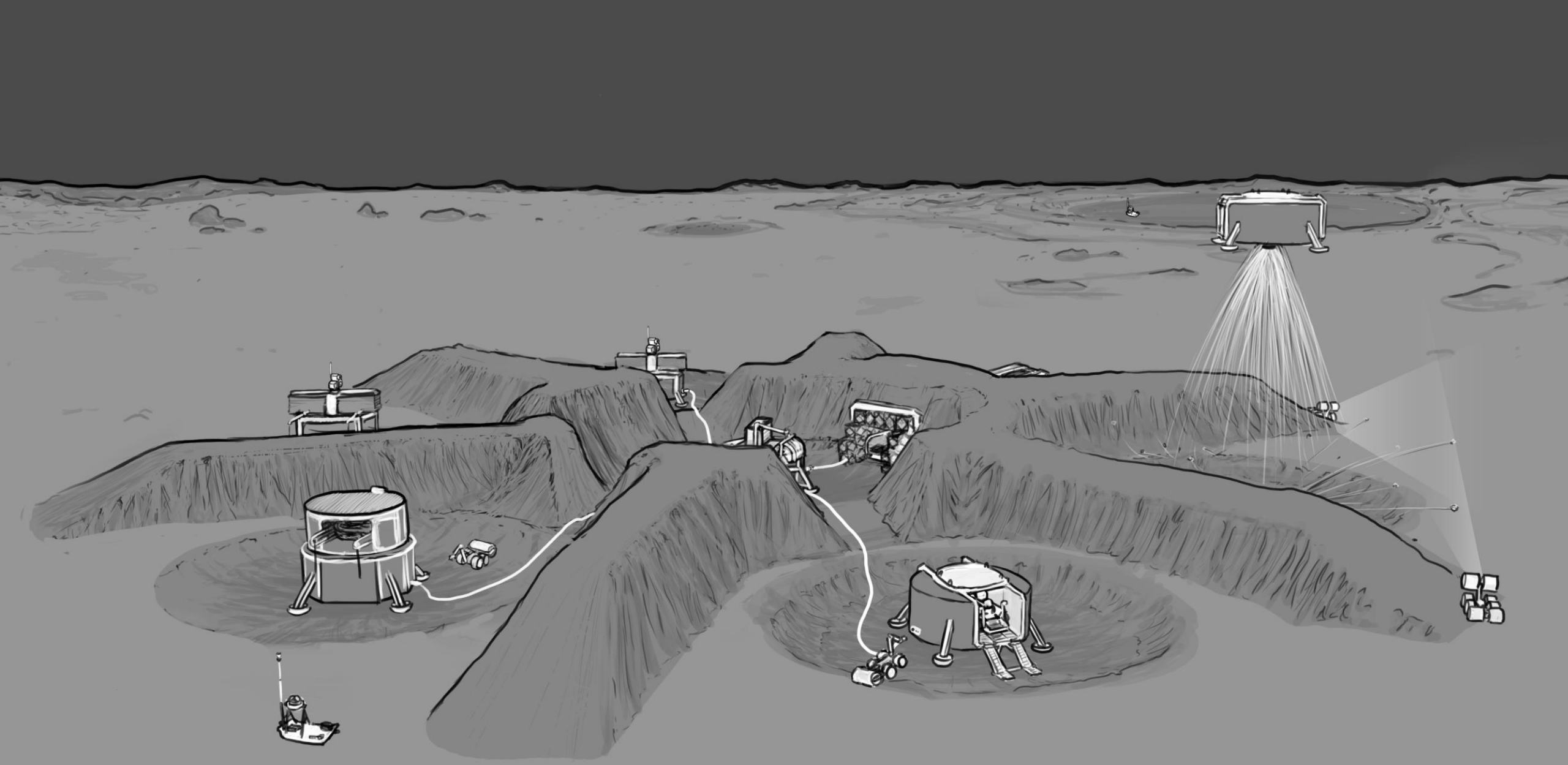
- **Power is connected to the Customer 1 lander**
- **Customer 2 landing site is prepared**



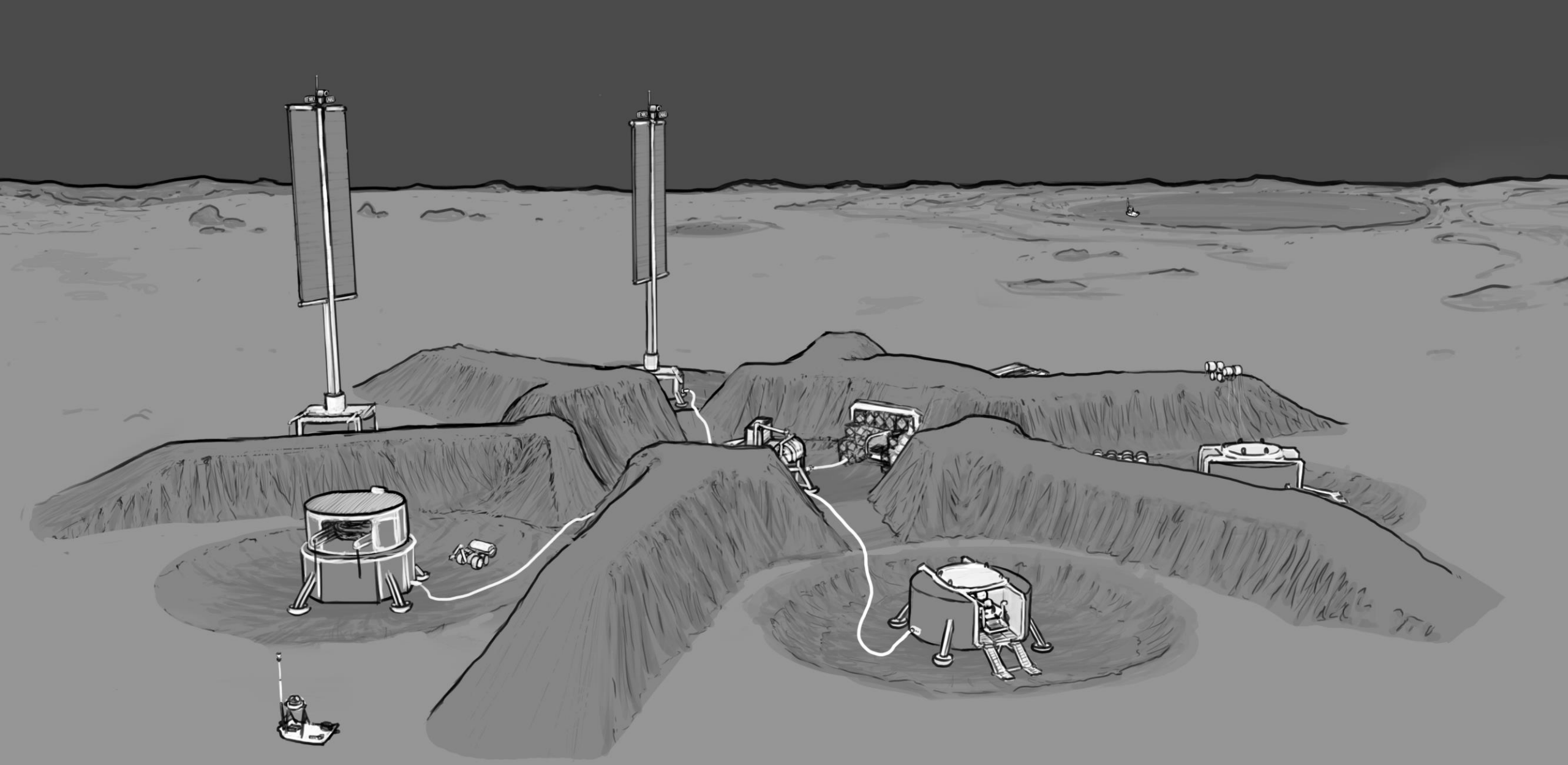
**Customer 2 lander arrives**



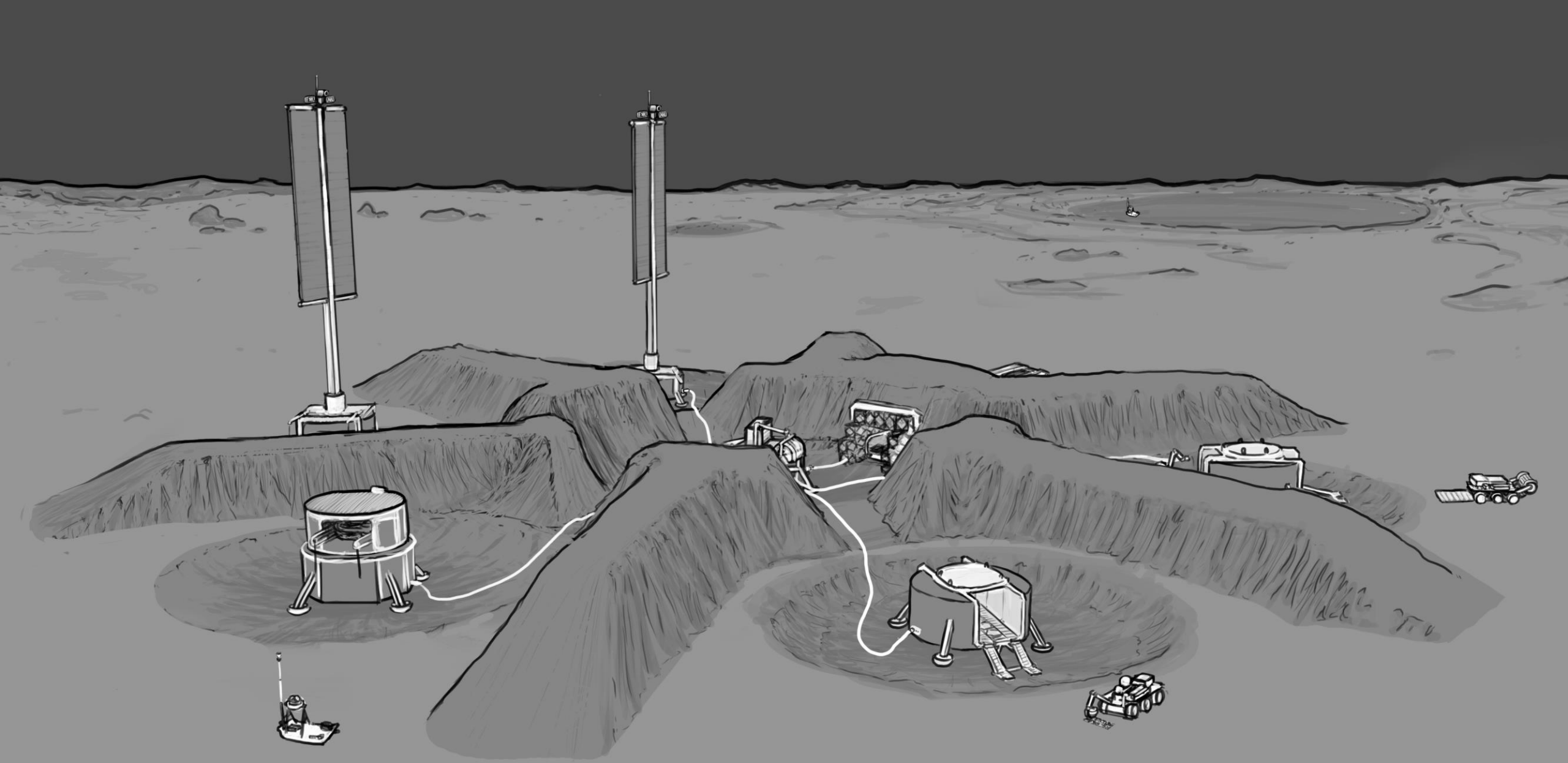
**A cut-through is made to the Customer 2 lander**



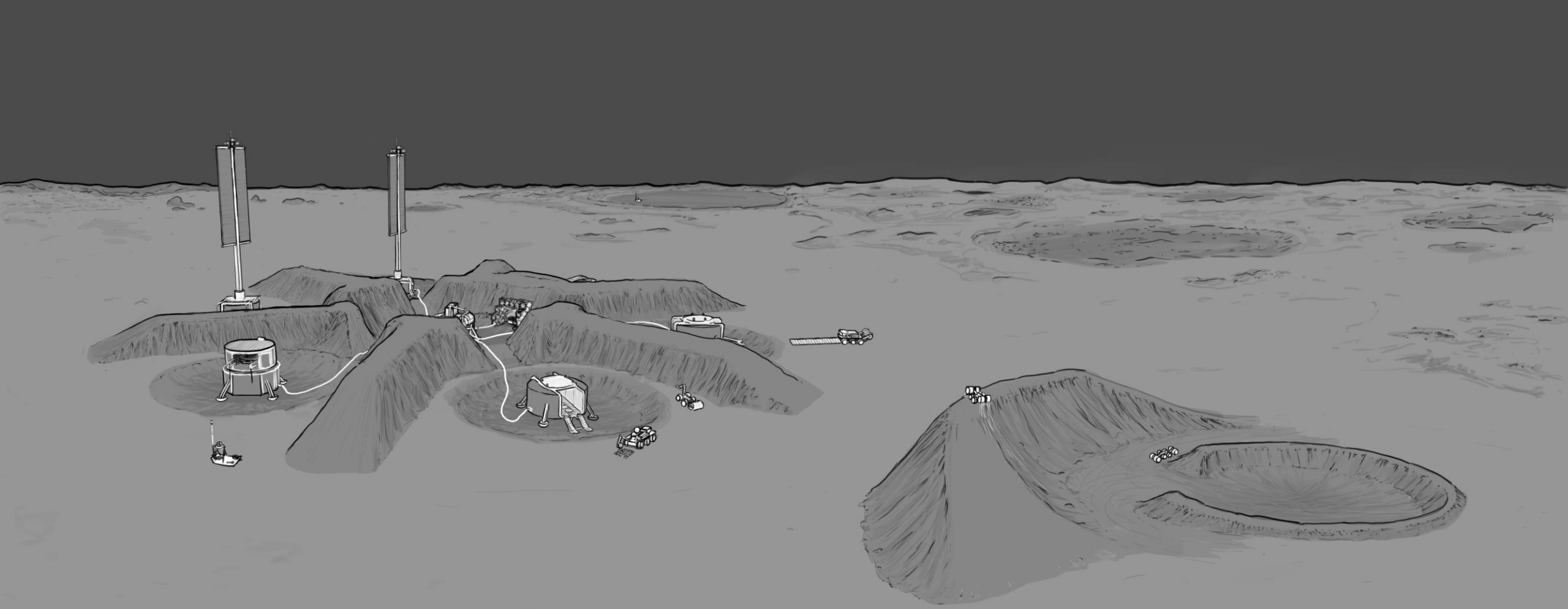
- **Power is connected to the Customer 2 lander**
- **Park construction Mission 5 lander arrives in 2032**



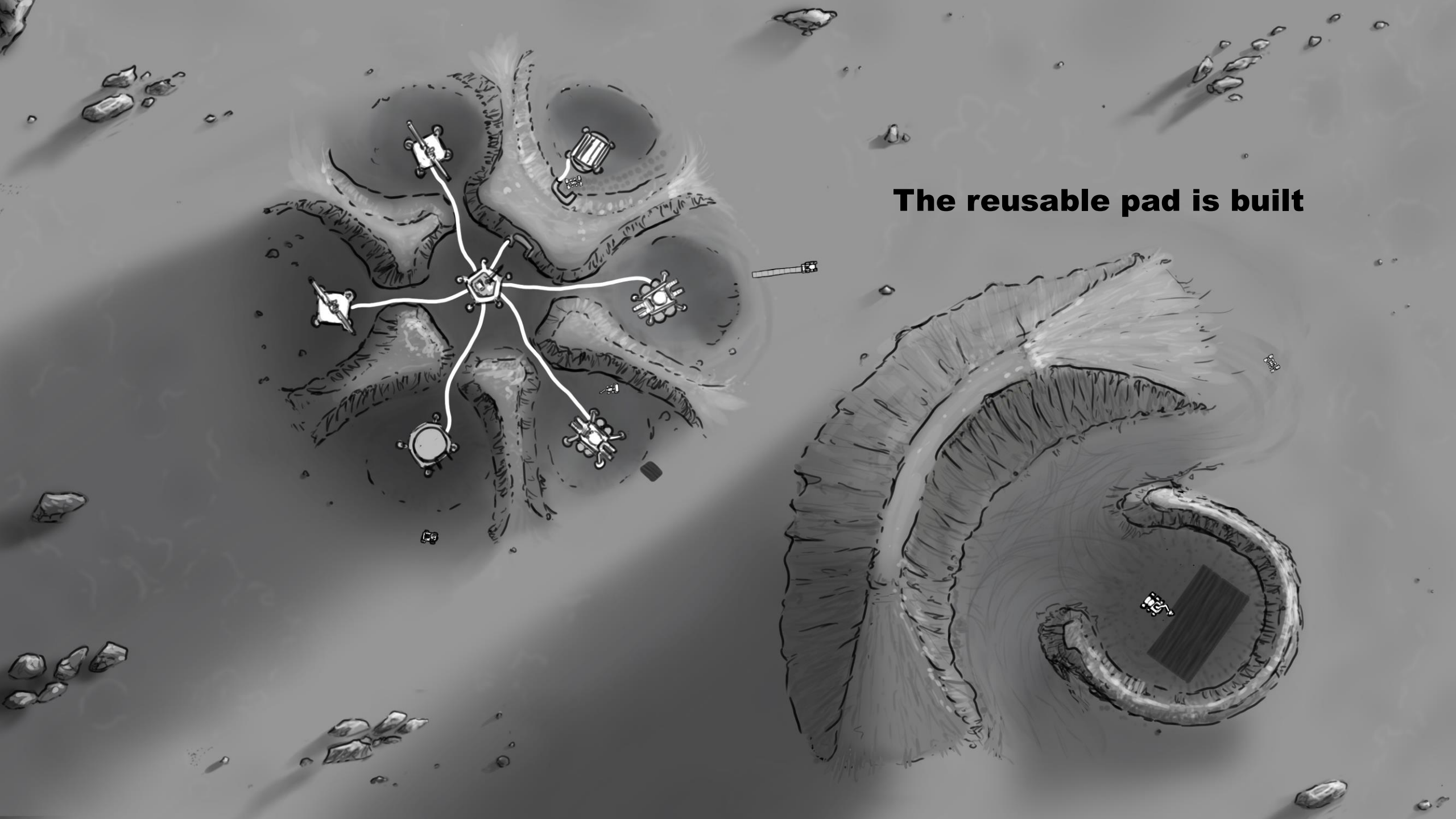
**A cut-through is made to the Mission 5 lander**



**Power is connected to the Mission 5 lander**



- **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**


The reusable pad is built

# Relationship to Moon Base

- Work was completed prior to Moon Base announcement
- Engaged with Moon Base team
- Expect similar themes to emerge from Moon Base planning

**Ignition RFI**