

Seasonal Frost Full-Scale Accelerated Testing Facility at CREATES

Ahmed Saidi
Ian Sennstrom
Caitlin Purdy
Ayman Ali
Yusuf Mehta

Center for Research and Education in Advanced
Transportation Engineering Systems (CREATES)
Rowan University





Acknowledgment

- Danielle Kennedy
- Wade Lein
- Alexis Breigning
- Anthony Perno
- Alex Nichik





Background

- Climate change in Arctic environment presents many challenges:
 - Increase in carbon footprint → Increase in Arctic's air temperatures
 - Melting of sea
 - Permafrost thawing,
 - Coastal erosion



Yale Climate Connections



Background

Guo et al. (2023):

- The amount of near-surface permafrost could drop by 93% compared to the preindustrial period of 1850 to 1900.
- Near-surface permafrost will be nearly **gone by 2100!!!**



**Permafrost Tunnel
Research Facility**

D. Guo, H. Wang, V.E. Romanovsky, A.M. Haywood, N. Pepin, U. Salzmann, J. Sun, Q. Yan, Z. Zhang, X. Li, B.L. Otto-Bliesner, R. Feng, G. Lohmann, C. Stepanek, A. Abe-Ouchi, W. Chan, W.R. Peltier, D. Chandan, A.S. von der Heydt, C. Contoux, M.A. Chandler, N. Tan, Q. Zhang, S.J. Hunter, & Y. Kamae, Highly restricted near-surface permafrost extent during the mid-Pliocene warm period, Proc. Natl. Acad. Sci. U.S.A. 120 (36) e2301954120, (2023).



Background

- Continuous permafrost on the North Slope of Alaska has warmed **up to 3.9° C (7° F)** over the last century.

Thawing of permafrost

+

Freeze thaw cycles

=

Extensive damage to highways,
railroads, airstrips, etc.



Alaska's Thawing Permafrost





Goal & Objectives

Goal: Build a unique, state-of-the-art permafrost facility in Glassboro, New Jersey.

Objectives:

1. Develop innovative construction and building materials for the Arctic and subarctic regions.
2. Construct pavements that are resilient and more capable of sustaining seasonal frost thawing and loss of land stability; and,
3. Study the effects of pavement construction on the underlying permafrost.



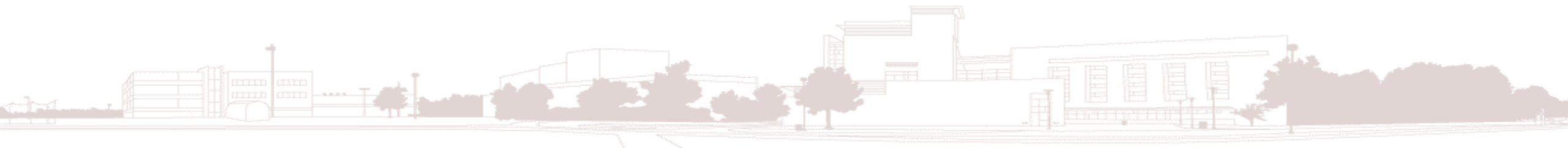


Benefits to DoD

- Test newly developed materials and technologies under more realistic Arctic conditions
 - **Cost-effective:** Validation of these materials and technologies before implementations.
- Benefit the DoD cold regions research that aims to **faster, safer** deployment of troops into the Arctic and subarctic regions.



Design Plan of the Frost Facility





Location of Frost Facility



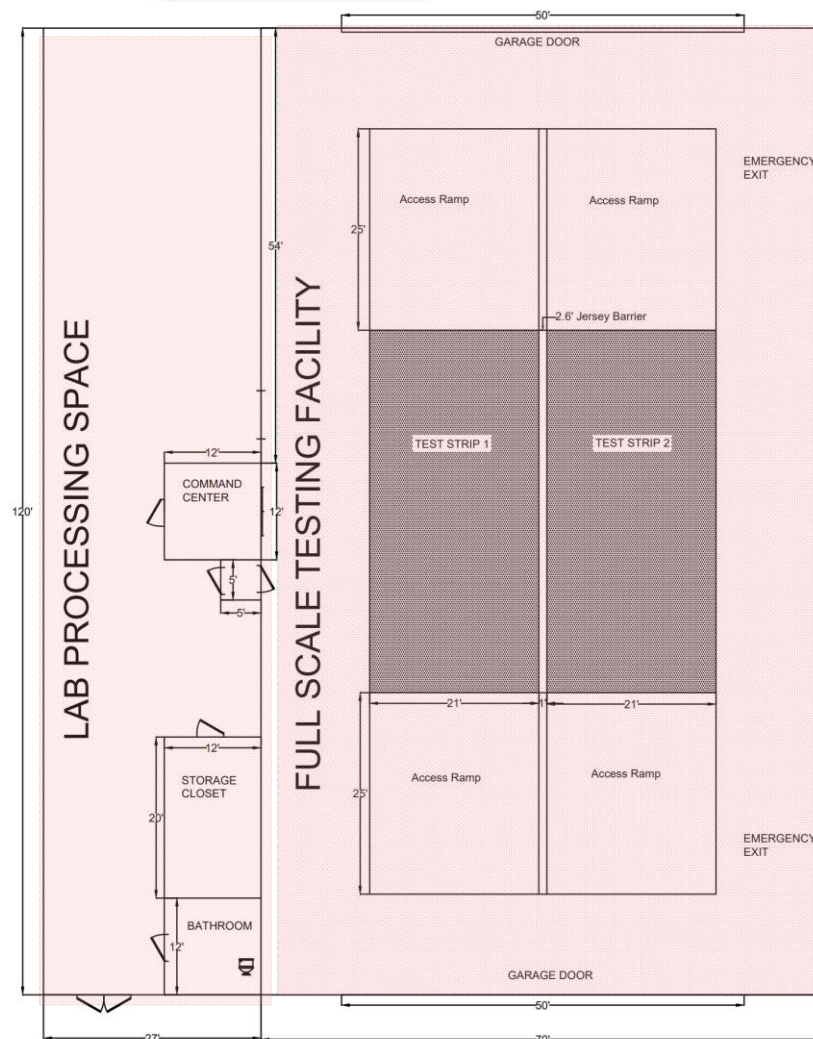
CREATES, Rowan University





Proposed Floor Plan

Lab Processing Space
27 ft x 120 ft



Full-Scale Testing Facility
70 ft x 120 ft





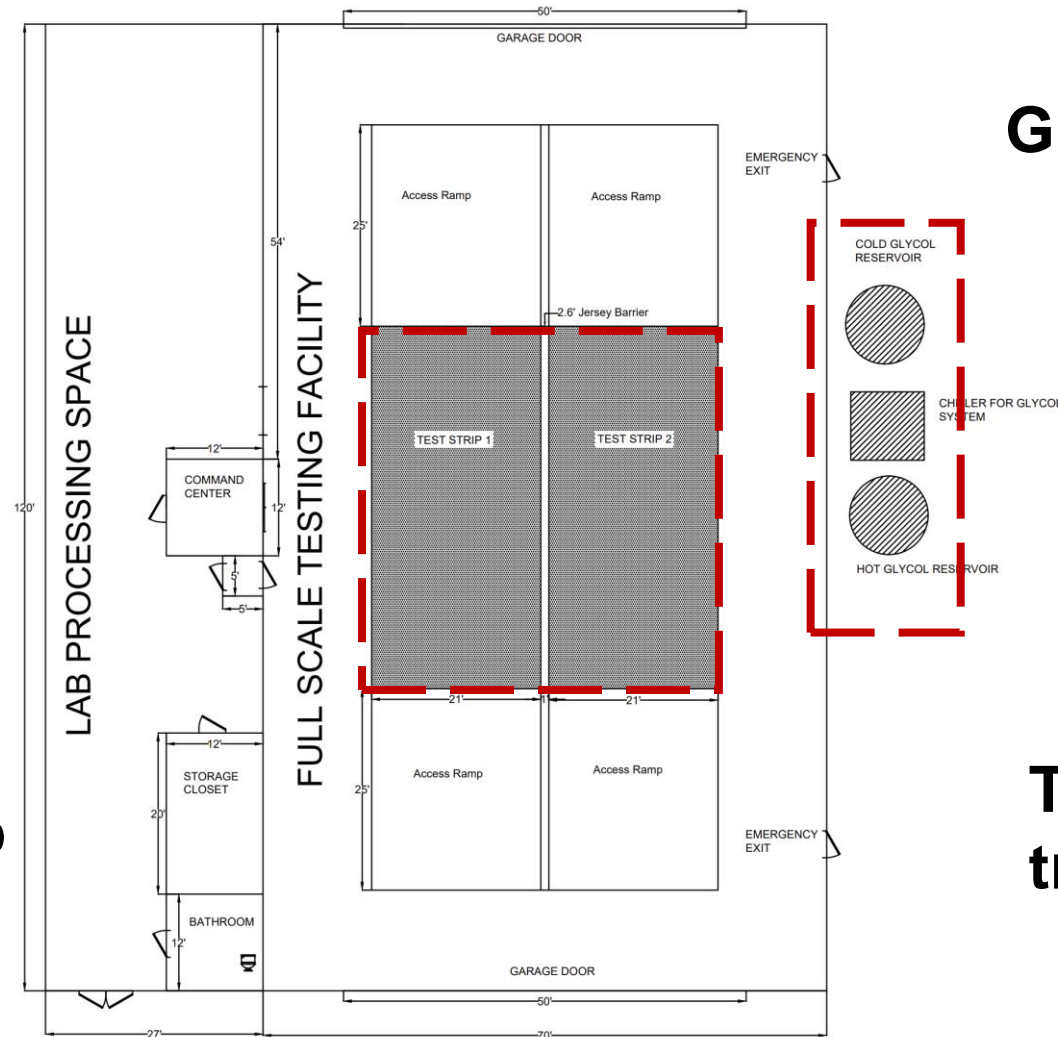
Proposed Floor Plan

Capable of housing a
Heavy Vehicle Simulator



Test Strips

45' long, 21' wide, and 15' deep



Glycol reservoirs
(-34°F to 80°F)

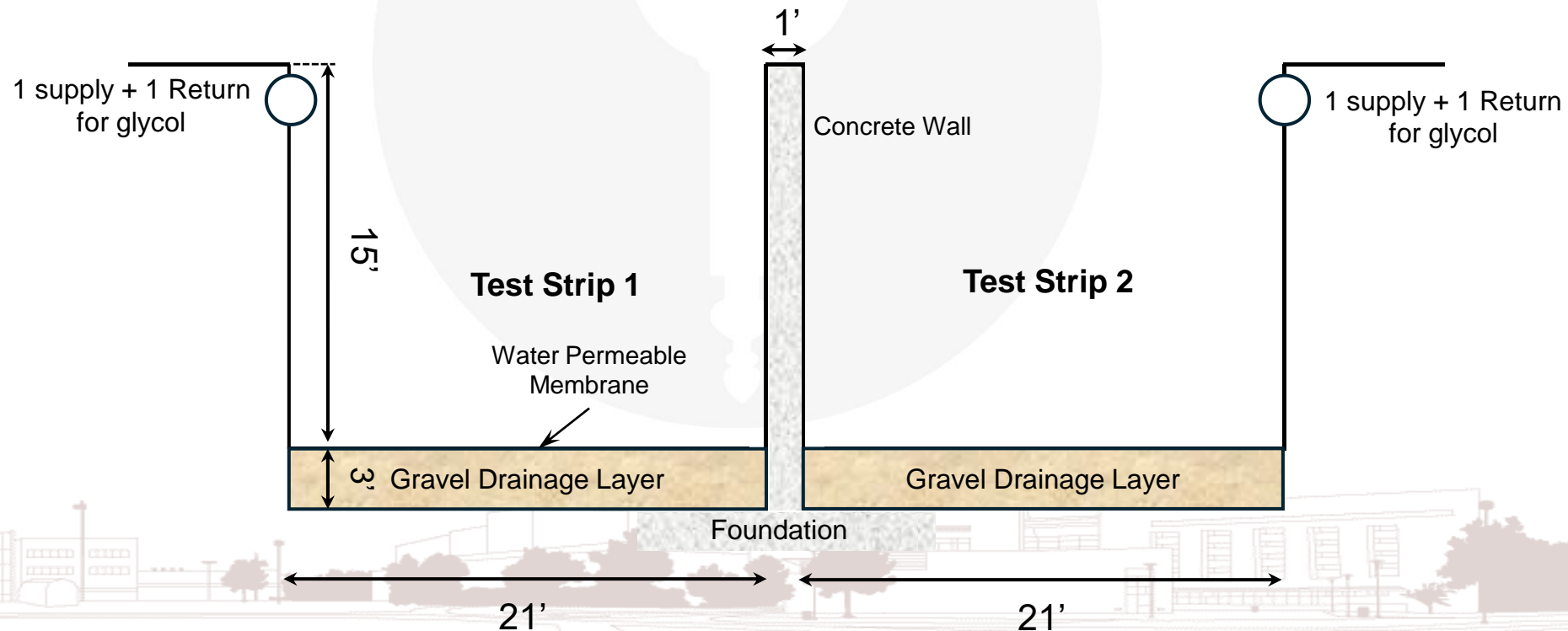
HVAC system
Air temperature
(-20°F to 75°F)

**Two cranes and
track system**



Test Strip & Drainage Layer

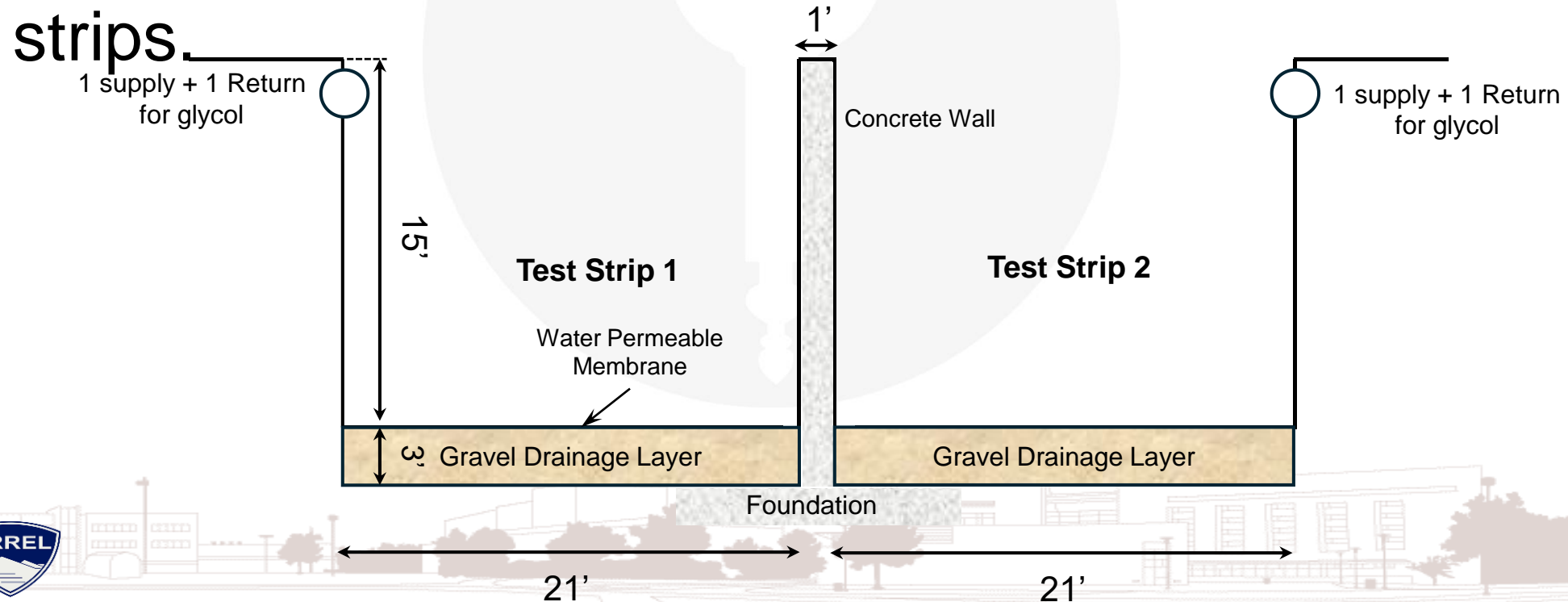
- Temperature control system in each test strip
- Cooling piping (1 supply and 1 return for glycol)





Test Strip & Drainage Layer

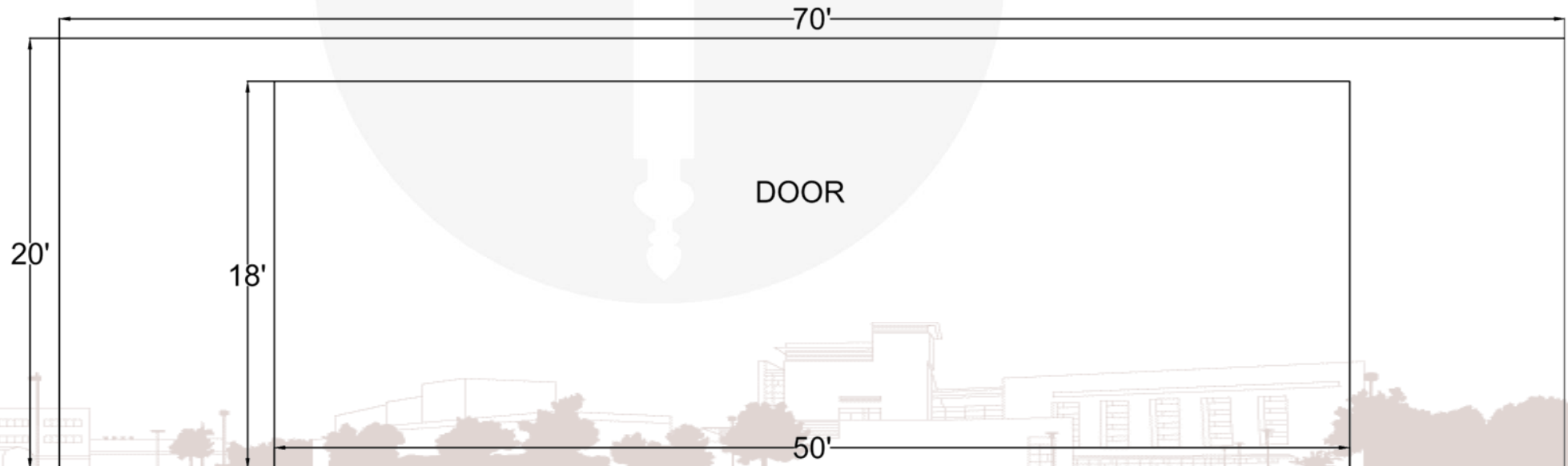
- Gravel layer will have drains in the floor to allow water to be removed and water inlets to allow water to be added.
- Moisture sensors will be installed on the walls of the test strips.





Frost Testing Facility Doors

- Two 50' wide by 18' tall, **heated** doors. One at the center of each end of the facility
- Properly **insulated** to maintain low temperatures inside the facility during testing.





Additional Requirements

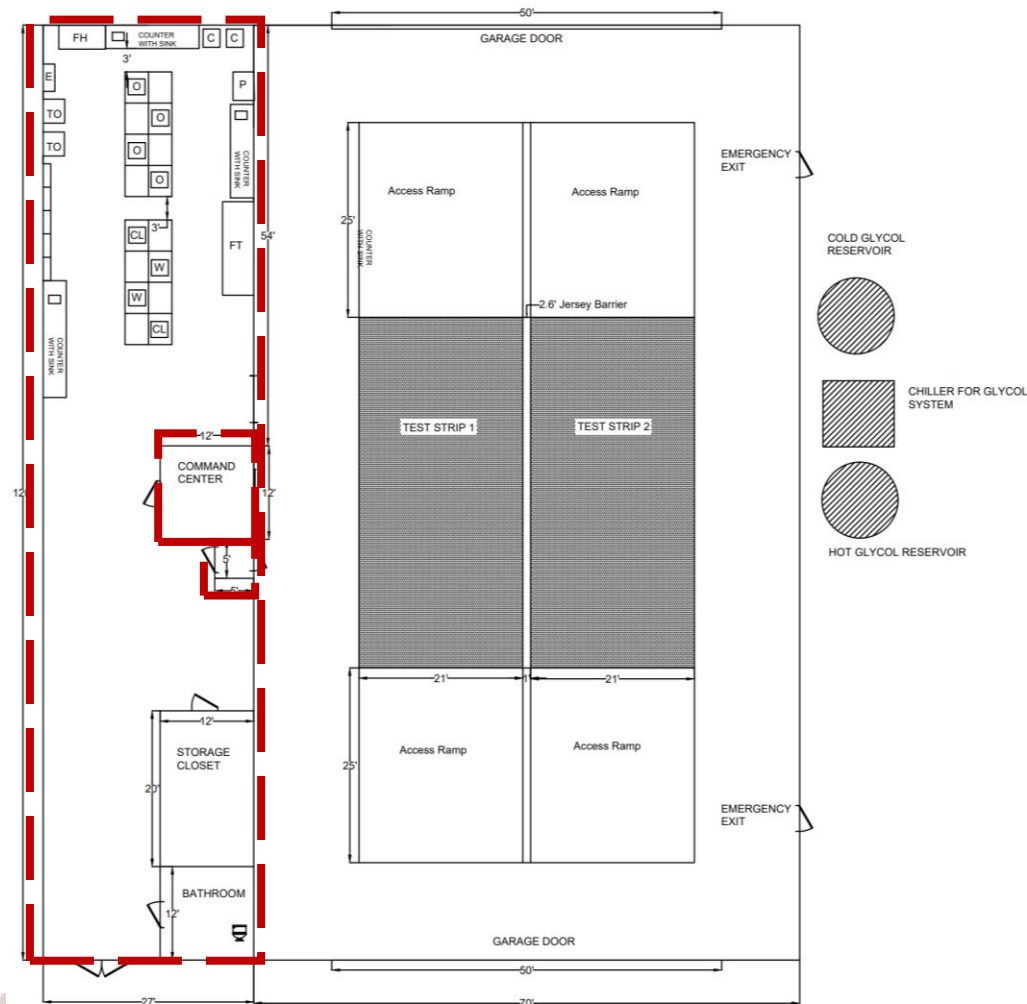
- Two cranes and track system mounted to the ceiling or wall capable of applying loads of:
 - **6,000 lbs.** (26.7 kN) for lifting small equipment and material
 - **60,000 lbs.** (267 kN) for full-scale static testing.
- 120V-20A duplex receptacles spaced regularly around the perimeter. (Each on a dedicated circuit)
- Two **exists** for emergency





Lab-Processing Space

- LEGEND**
- FH FUME HOOD
 - C COMPACTOR
 - E EYEWASH
 - P PYROCLEAN
 - CL CORELOK
 - FT FAN TABLE
 - W WATER BATH



Command Center
(with 3' wide by 2'
long glass window)

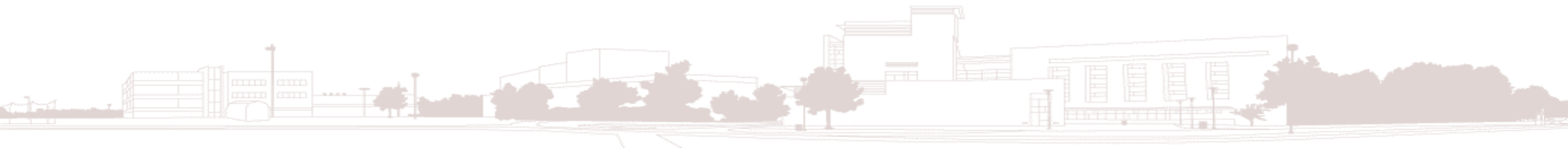
Anteroom
(5' by 5')

HVAC system
Air temperature
(70°F ± 5°F)





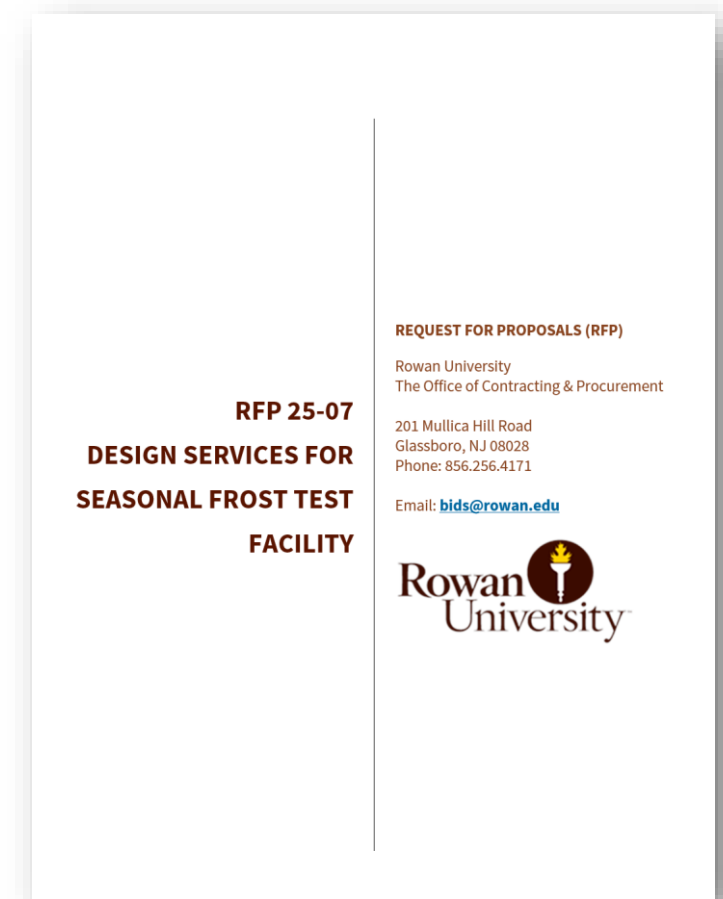
Public Bidding through Rowan Procurement





RFP– Frost Facility’s Public Bidding

- ❖ CREATES team worked with the Rowan University’s Facilities, Planning, & Operations to prepare an RFP.
- ❖ Rowan opened the construction effort for competitive bidding
- ❖ Several bid proposals were received.



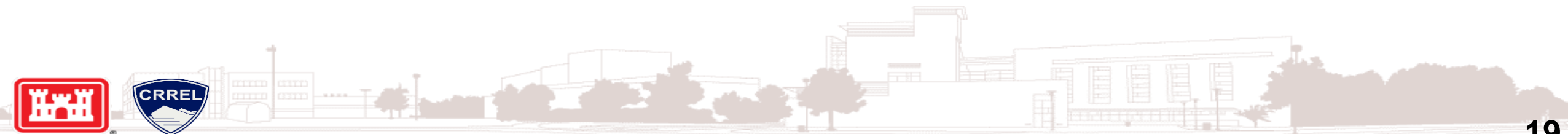
→ Several requirements have been added to the RFP





RFP Addendum

- ❖ 100% Design Completion **by April 2026.**
- ❖ Include **geotechnical** and **environmental engineers** on the project team
- ❖ All these engineers shall have **completed**, at a minimum, two facilities of equal complexity & scope in the last 10 years.
- ❖ These facilities must demonstrate a proven example of process engineering and building function dealing with **HVAC systems** and **temperatures below 10°F.**





Important Dates

- ❖ February 13th : **Site Visit.**
- ❖ February 18th: **Questions from contractors**
- ❖ February 20th: **Answers due**
- ❖ February 27th: **Proposal Submission due**



Thank You!

Center for Research & Education in Advanced
Transportation Engineering Systems (CREATEs)

109 Gilbreth Pkwy,

Mullica Hill, NJ 08062

Phone: (856) 256-5395

Email: creates@rowan.edu

Web.: www.rowan.edu/creates

