
IDEA2021
Powering the Future: District Energy/CHP/Microgrids
Sept. 27-29 | Austin Convention Center | Austin, Texas

Associated Engineering

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Utility-Scale Geoexchange Fields

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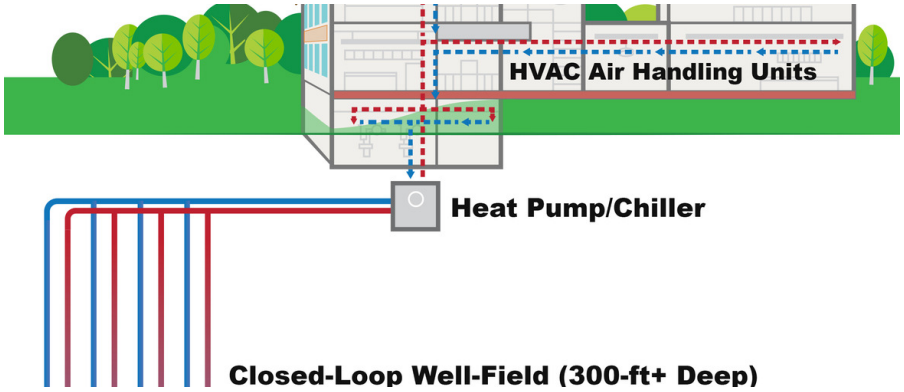
September 29, 2021

Agenda

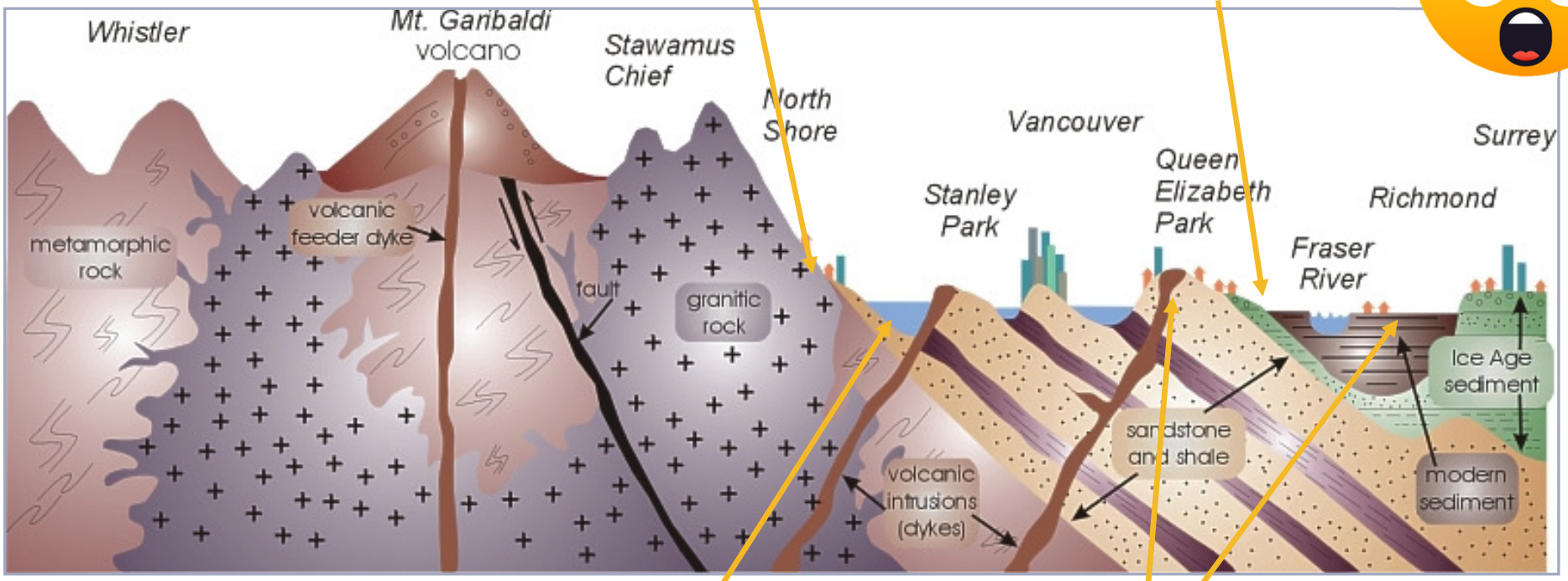
- ✓ Challenges of Geoexchange installations in Western Canada (and USA)
- ✓ Case Studies:
  - Marine Gateway Development, Vancouver, BC
  - Surrey City Centre, Surrey, BC
  - YVR CORE, Vancouver, BC
  - Blatchford, Edmonton, AB
- ✓ Lessons learned and focus points related to:
  - Borehole design and piping layout / coordination
  - Construction (Quality Control and Documentation)

Geoexchange (Geothermal heat pumps) 101

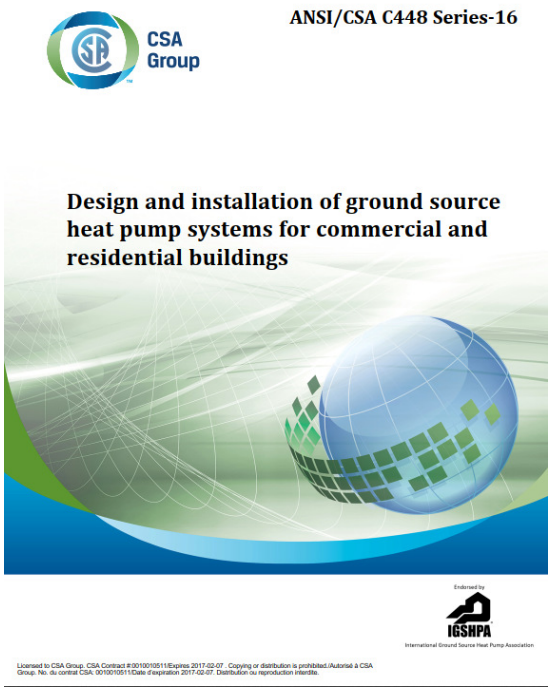


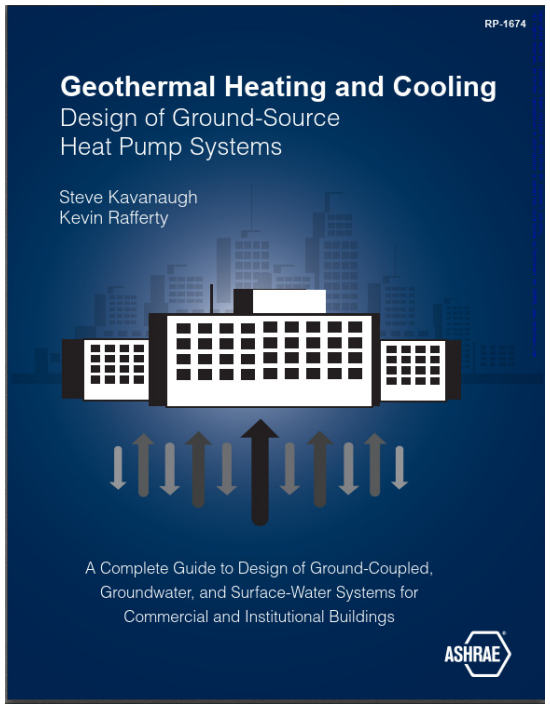
- Heating and cooling air or water using heat pumps.
- Uses the shallow earth or waterbody as a stable, low-grade heat source or sink (~ 10 °C).
- Simply “moving” energy, with help of the heat pump “vapour-refrigeration” cycle.
- Thermal energy provided is 3 to 5 times the electric energy that you put in (conventional fuel is 0.7 to 1.0 times). i.e., 300-500% efficient.
- “Balanced” heating and cooling not absolute requirement (but preferable for CAPEX and OPEX)

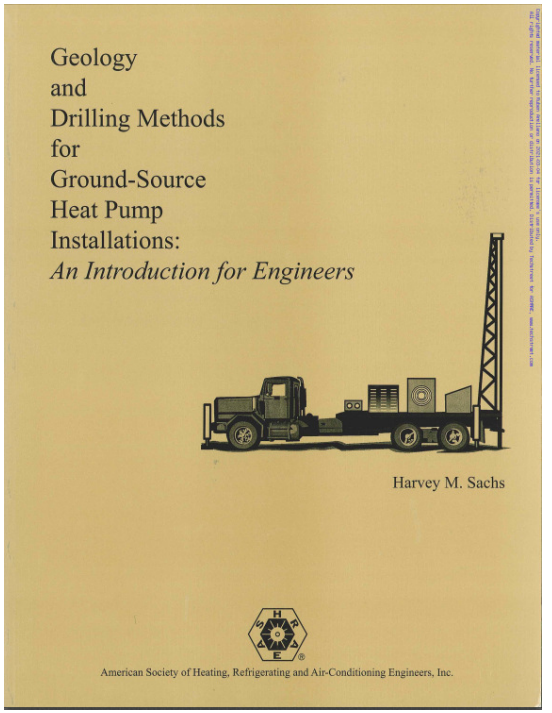
Diverse Conditions in Western Canada



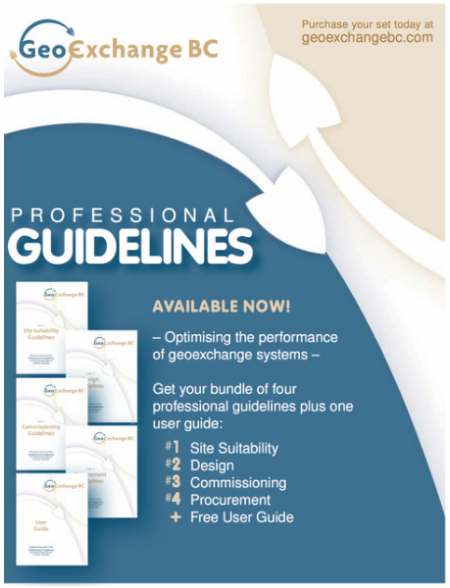
Design and Implementation References

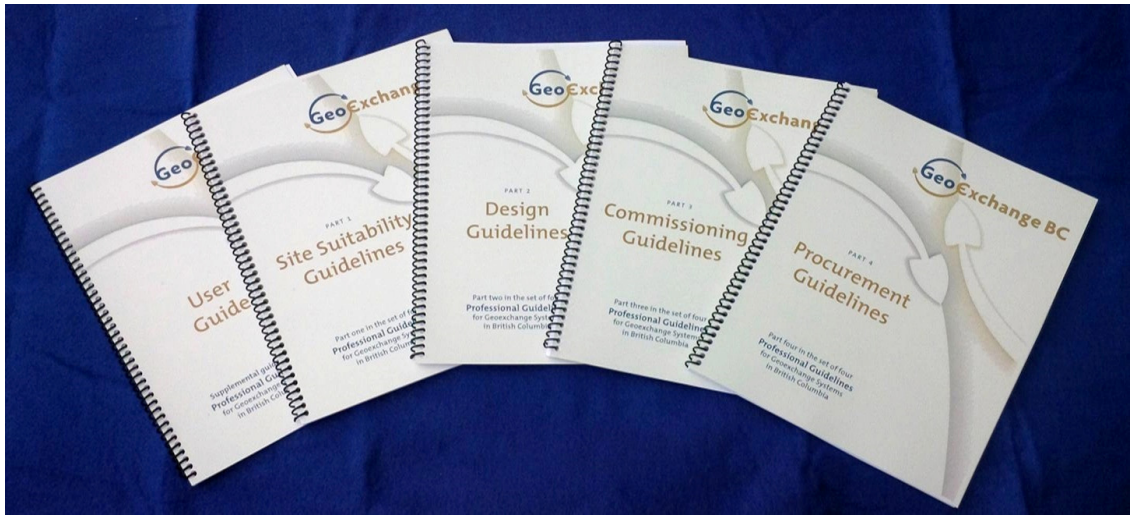






→Recognize and advocate that geoexchange is its own design and engineering discipline – like Geotechnical, Structural, or Environmental





→ Intersection of geotechnical, civil, structural, mechanical, and environmental considerations is unique.

→Look for local or regional literature and training resources like these GeoExchange BC Guides.

GHX Thermal and Piping Design Fundamentals

- Must consider site-specific ground and site conditions
- Utilize high-quality building energy model (hour-by-hour)
- “Rules-of-thumb” are *rules-of-dumb*
- High quality thermal modelling of GHX size requirements
- Reduce peak loads and consider annual balance to reduce size and maintain sustainable fluid temps (or other mitigating factors)
- Efficient and constructible piping / hydraulic design
- Detailed construction specifics and quality control / review

Integrating GHX Into Your Project

A staged approach, with thoughtful attention to all options and design details yields the best results.

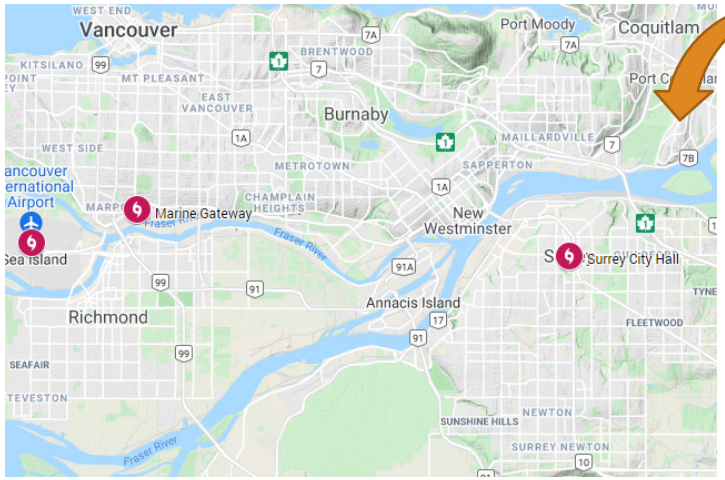
1. Preliminary Desktop-level Assessment (background, options, concept design)
2. Intrusive Investigation and Testing (assess ground conditions, document for tender)
3. Detailed Design
4. Construction Services / Inspection
5. Commissioning and documentation
6. Performance Monitoring and Preventative Maintenance

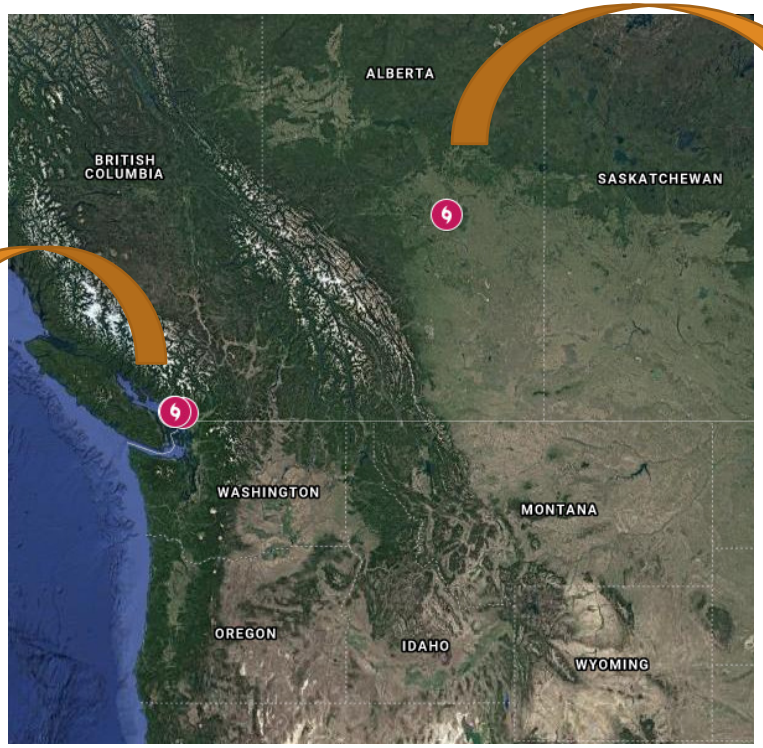
Project Spotlights

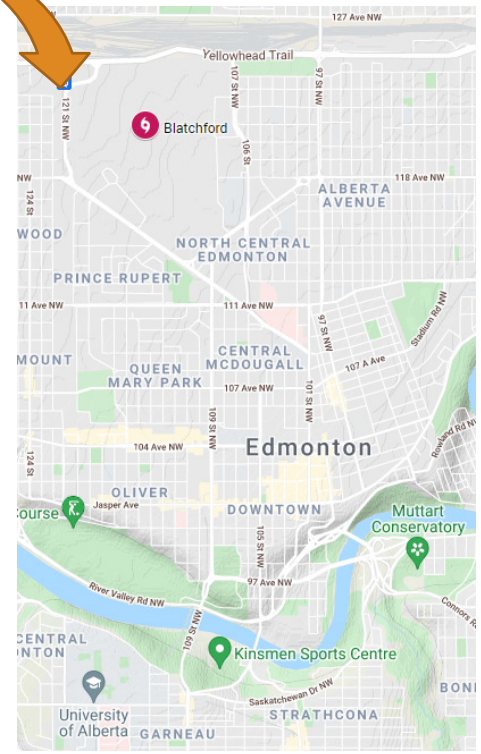
- Marine Gateway Development, Vancouver
- City of Surrey Geoexchange and DES
- YVR CORE Project (largest GHX in Canada)
- Blatchford Redevelopment, Edmonton

- **Marine Gateway Development**: 322 GHX field under multi-tower high density development, plant designed for district energy, Fortis Utility ownership.
- **City of Surrey**: 389 borehole GHX field below underground parking and plaza, serving new City Hall and residential tower. City owned utility.
- **YVR CORE Project**: over 841 borehole GHX field under two new buildings, with 6 pipe district energy piping serving the existing and future Airport Terminals and future buildings, replacing current DE plant.
- **Blatchford District Energy System:** 570 borehole GHX @ 585' deep, installed under storm water retention pond. Serves Phase 1 staged district energy system for 500 acre / 30,000 resident development area. City owned utility.

Site Locations







Marine Gateway

- 322 boreholes @ 150 ft. depth, 5 manifolds
- Depth limited by lithology (artesian aquifer)

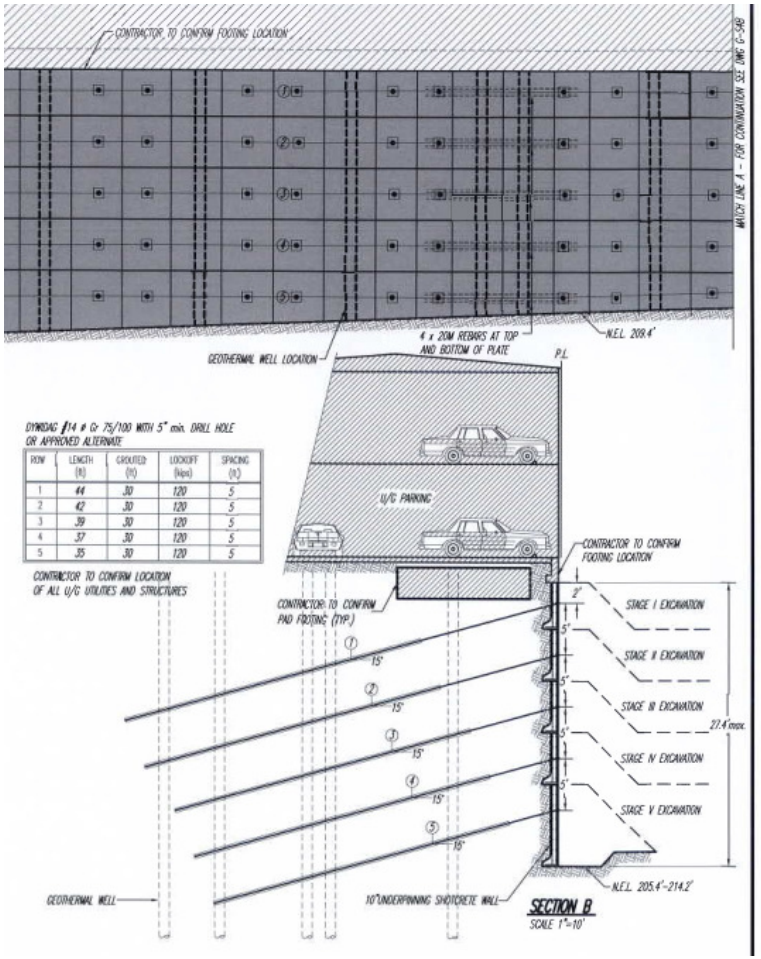
- System Status:
- Operating above expectations
- Excess capacity likely available due to more building heat recovery than anticipated

Surrey Civic Centre DES

- Serving City Hall and adjacent residential tower
- Owned and operated by City of Surrey
- Operational 2013
- 389 boreholes (@ 193 ft. deep)
- 5 vaults w up to 12 headers up to 8 boreholes each
- Provides 45% of peak heating and 93% of annual energy plus all cooling requirements
- In-parkade “low-height” drilling technique
- System status from owner:
- Exceeding expectations, but need more monitoring points and concerted plan to track performance

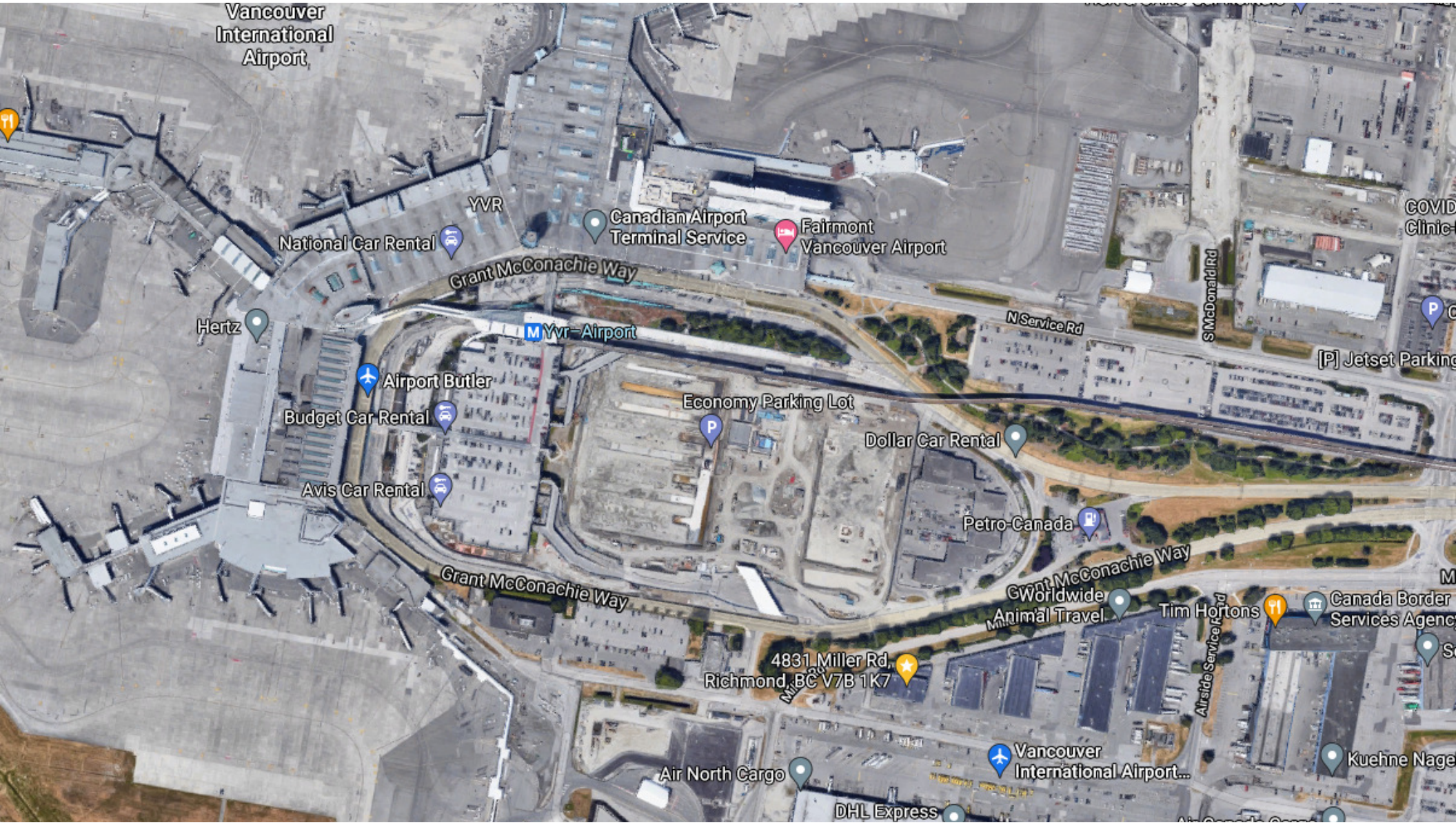
You want to do what?!?

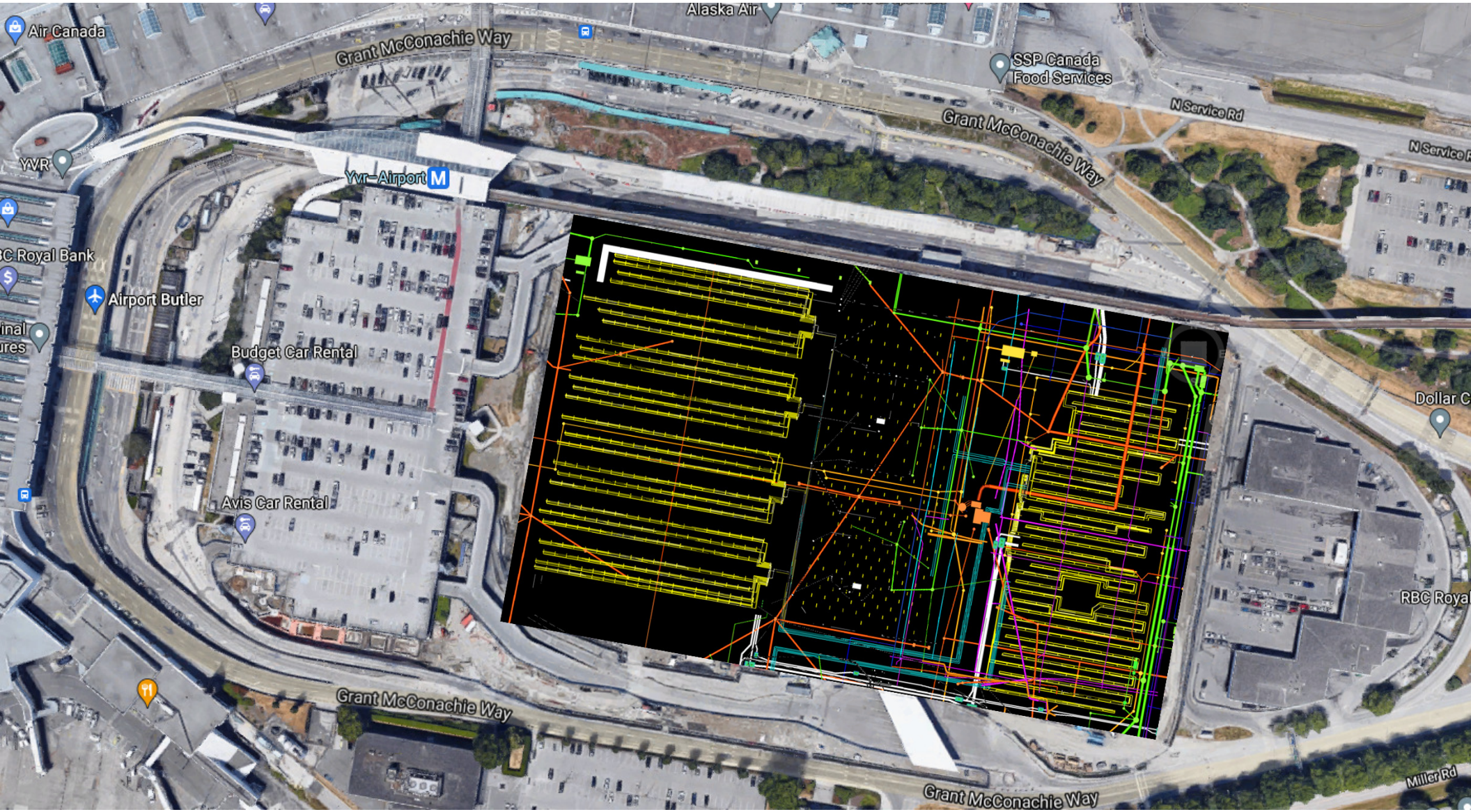
- Adjacent development required underpinning shotcrete wall.
- City bound to cooperate…
- ~150 anchors @ 5’ spacing drilled through 57 boreholes (3 vaults)
- Very careful survey, as-built, and continual monitoring required
- →One borehole damage and removed from circuit
- → Some shallow grout ejected and later replaced



YVR CORE GeoExchange

- Major redevelopment including new central utility building, hot and chilled district energy, and Parkade Building
- 841 Boreholes, 500 ft. deep, under two buildings
- CUB Building: Raft slab (1.5m thick)
- GTF Building: Strip spread footings
- Stone-column geotechnical densification and anchors between all GHX
- High water table, foundation mechanical, congested site utilities for mains and headering
- Staged construction requiring careful non-linear sequencing of elements


Vancouver International Airport
YVR
National Car Rental
Canadian Airport Terminal Service
Fairmont Vancouver Airport
Grant McConachie Way
Hertz
M Yvr—Airport
N Service Rd
S McDonald Rd
[P] Jetset Parking
Airport Butler
Budget Car Rental
Economy Parking Lot
Dollar Car Rental
Avis Car Rental
Petro-Canada
Grant McConachie Way
Worldwide Animal Travel
Tim Hortons
Canada Border Services Agency
4831 Miller Rd, Richmond, BC V7B 1K7
Airside Service Rd
Vancouver International Airport...
Air North Cargo
Kuehne Nage
DHL Express


Air Canada
Alaska Air
Grant McConachie Way
SSP Canada Food Services
N Service Rd
Grant McConachie Way
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Yvr—Airport
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Budget Car Rental
Avis Car Rental
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RBC Royal
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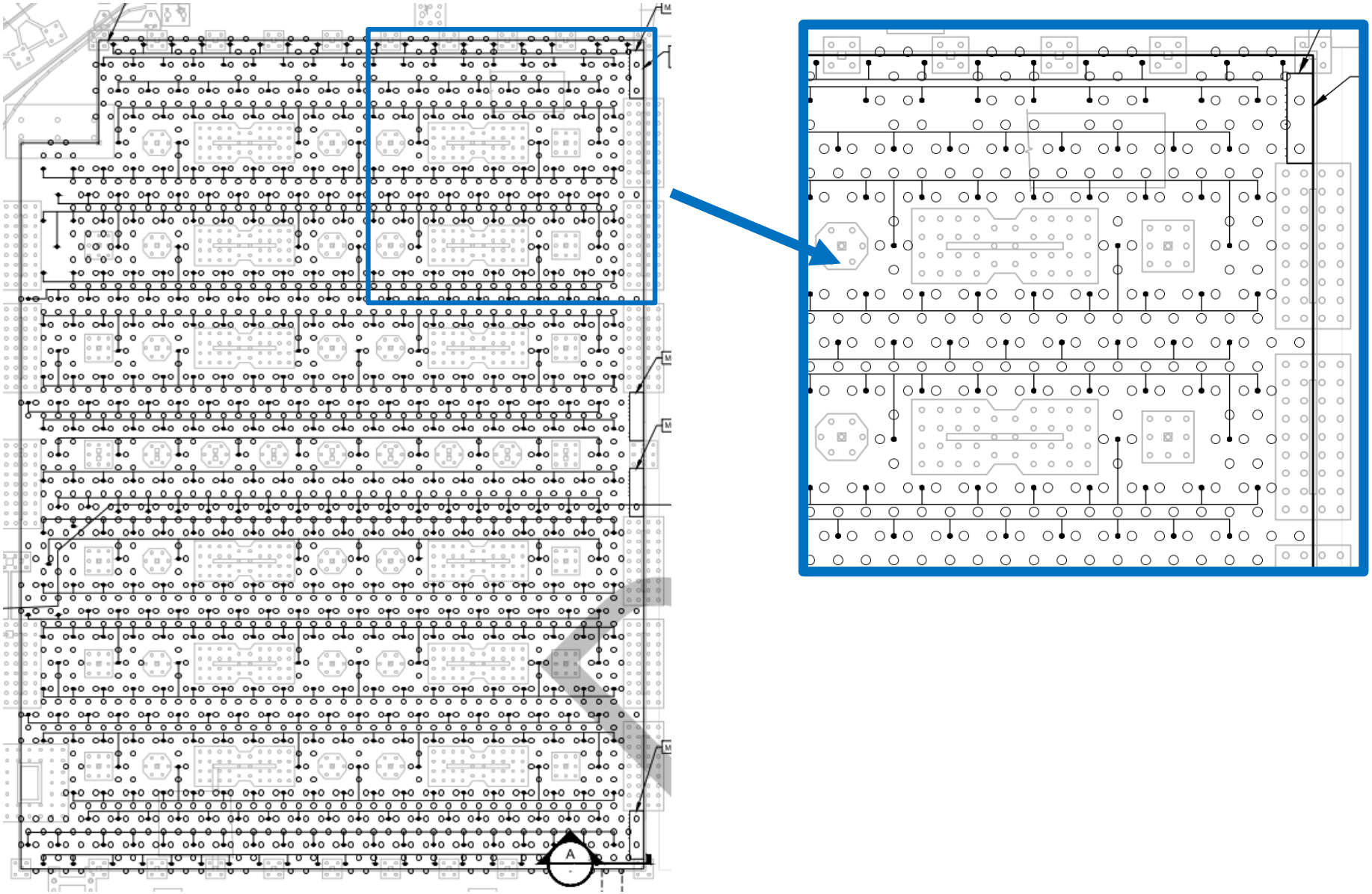
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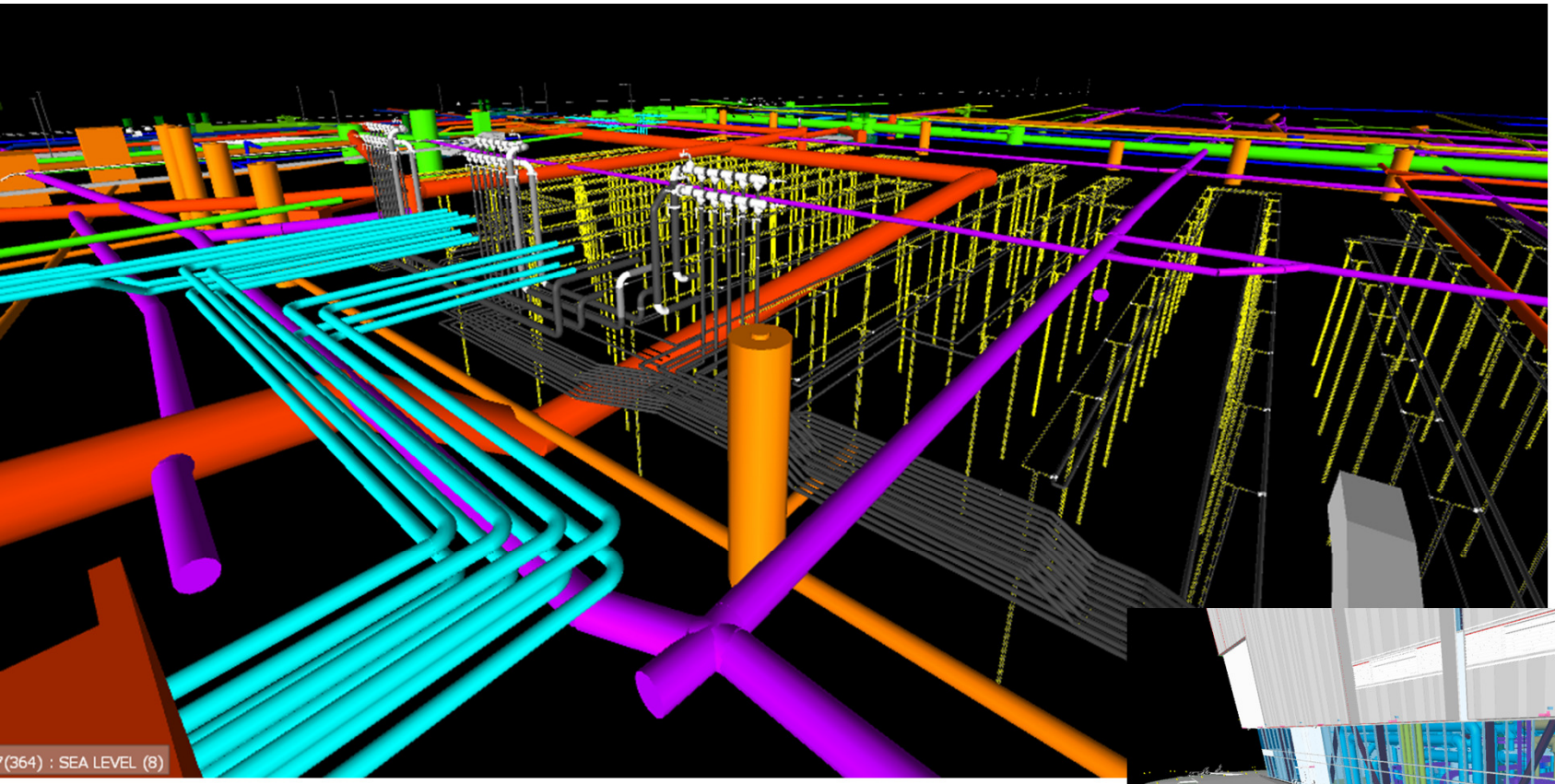
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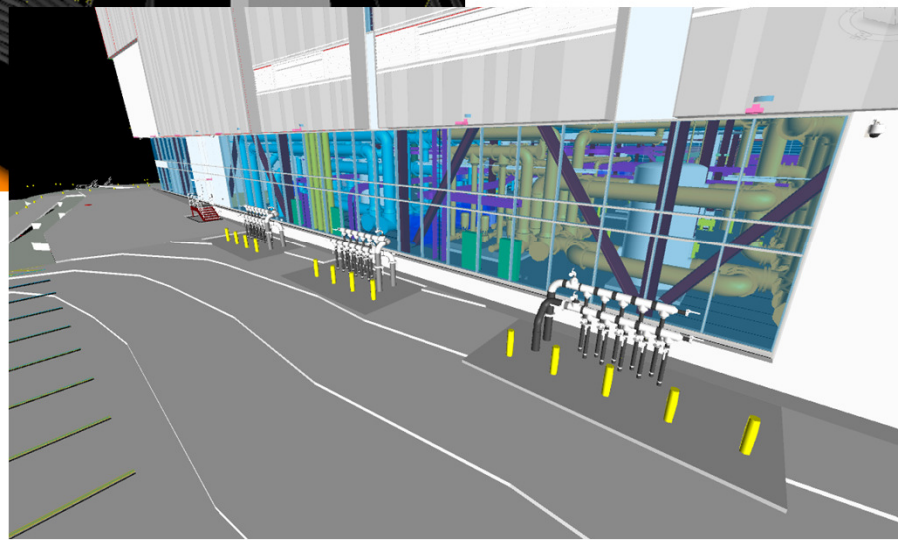


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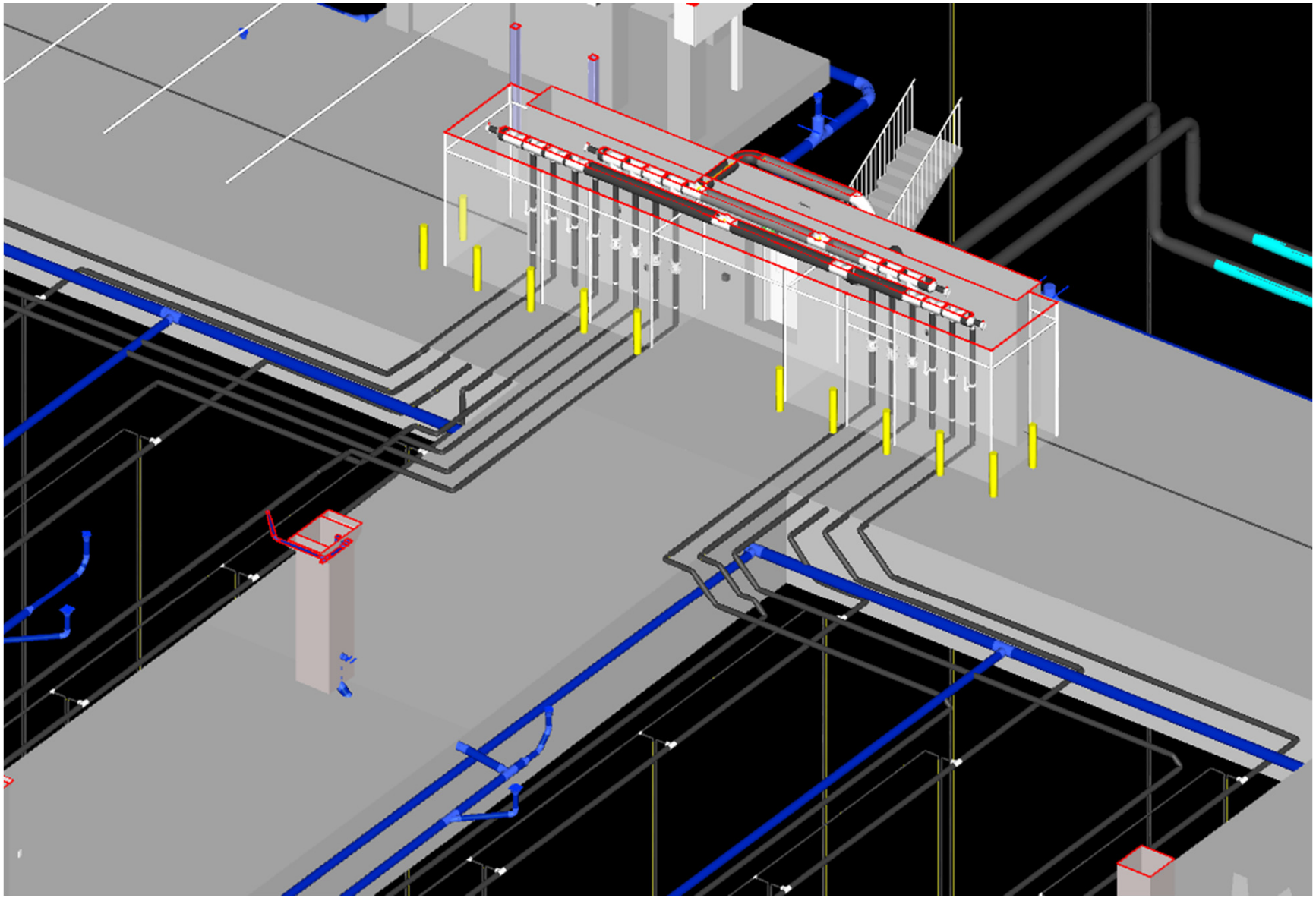
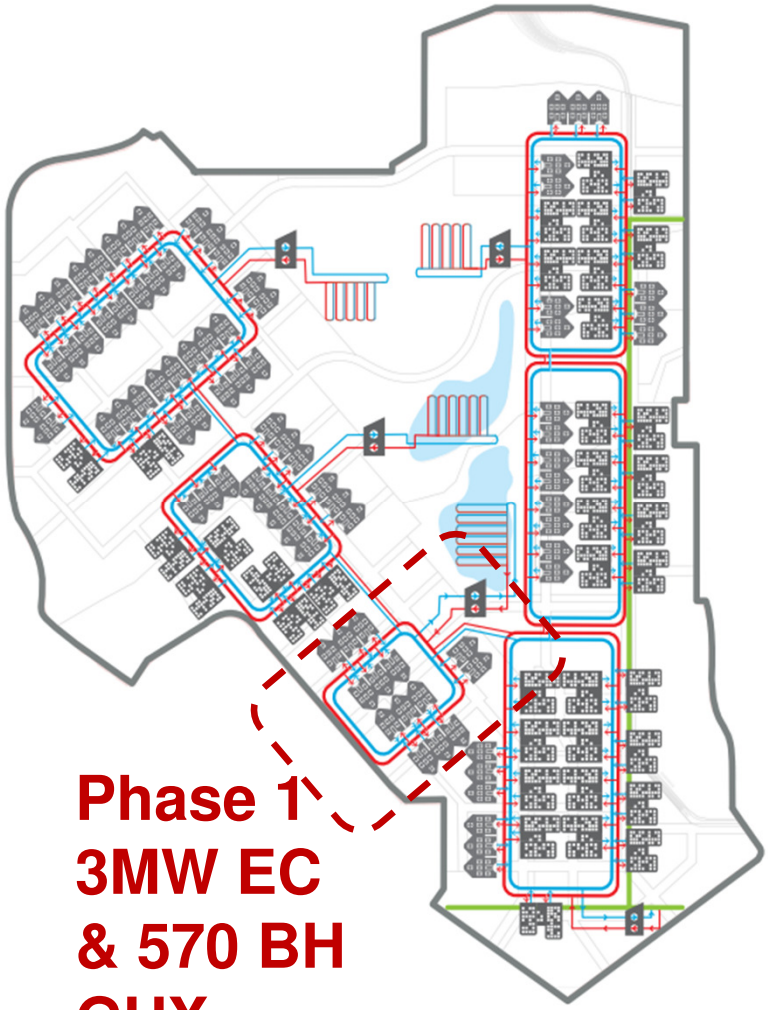



Link-Belt
Link-Belt

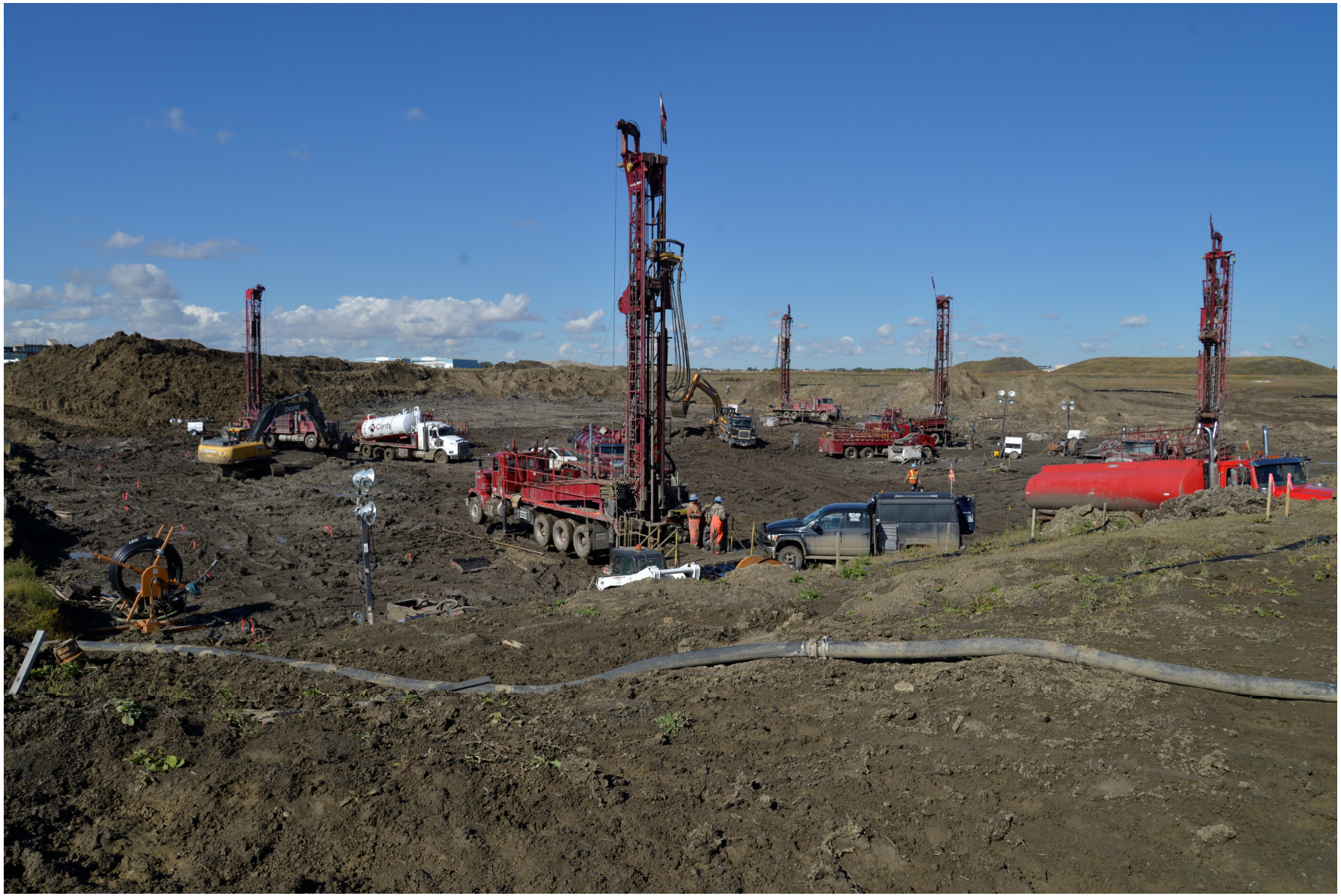
Blatchford District Energy, Edmonton, AB

“Blatchford will be home to up to **30,000 Edmontonians** living, working and learning in a sustainable community that uses **100 percent renewable energy, is carbon neutral,** significantly reduces its ecological footprint, and empowers residents to pursue a range of sustainable lifestyle choices.”

Phased Build Out



Phase 1
3MW EC
& 570 BH
GHX



Energy Centre #1

Lessons Learned: Design Process

- Constantly evolving design constraints as GHX is often “first in” while other discipline designs evolve
  - Allow for communication process, tracking, schedule, and budget
- “Are these really the loads?”
- Limit ‘field fit’ assumption, especially in constrained areas
- Use the Design-Build approach with caution. If this must be done consider:
  - Tight specifications around any design-build scope
  - Retain independent review consultant

Lessons Learned: Construction

- Large-scale GHX in urban settings will inevitably clash with other disciplines. Early and ongoing communication and coordination is critical!
- Consider scale and availability of drilling / construction equipment
- Caution on limitations of test drilling and types of equipment used vs in construction
- Caution on design, access requirements and waterproofing of vaults and chambers
- Ensure construction specifications and submittal requirements are *thorough, current and relevant*. *Complete as-built records!*
- Full-time resident engineering / inspection is often warranted and worthwhile
- Changes during construction are common (The Earth is fickle!).
  - Have a documentation and approval process
  - Update thermal capacity and hydraulic design

Questions?

Submit in chat Q&A now!

or contact me at

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