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Canadian Consulting Engineering Awards 2017

Central at Garden City District Energy System Mini-Plant

Client: City of Richmond

Submitted by:

KERR WOOD LEIDAL
consulting engineers

Richmond

Project Information

Name:	Central at Garden City District Energy System Mini-Plant
Location:	4731 McClelland Road, Richmond BC V6X 0M5
Year Completed:	December 2016
Entering Firm:	Kerr Wood Leidal Associates Ltd.
Role of Entering Firm:	Prime Consultant
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	Mike Homenuke, PEng 604 293-3242

Project Outline

Project Summary

The City of Richmond retained Kerr Wood Leidal Associates Ltd. (KWL) to design and administer construction of the Central at Garden City District Energy System Mini-plant. The project includes a central heating and cooling plant powered by low-carbon air-source heat pumps (ASHPs) that provide heating and cooling to 284,000 sq. ft. of new retail space. This project reduces greenhouse gas (GHG) emissions by reducing natural gas use by up to 70% compared to conventional alternatives.

Project Highlights

Innovation

Central at Garden City District Energy System Mini-plant is Phase 4 expansion of the Alexandra District Energy Utility (ADEU), the largest ambient heating and cooling district energy system in North America. The overall goal of the system is to reduce the City of Richmond's carbon footprint. Phase 4 was developed to meet the unique needs of Central at Garden City shopping mall, while also integrating with the main ADEU system, which is based on geoexchange technology. Since retail buildings require significantly larger cooling and less heating capacity than surrounding residential buildings, the KWL team designed a 'mini-plant' to satisfy these load conditions while remaining within cost-of-service targets. The plant's energy source is a bank of ASHPs which were selected as the energy source due to their highly efficient operation, since they run on BC's low-carbon electricity supply and offer heating and cooling capabilities, including heat recovery.

This project is the first district energy system in Canada to provide heating and cooling to large-format retail buildings using ASHP technology and has several unique features. Buildings at Central at Garden City can share energy through the central heating and cooling mini-plant. Additionally, an energy transfer station links the mini-plant to the main ADEU system, allowing the ASHPs to back-feed the entire Alexandra neighbourhood and share excess cooling energy or heat captured from the outside air with the larger neighbourhood or recharge the geoexchange loop. Few, if any, district energy systems in Canada use multiple low-carbon heating and cooling sources, which adds to the project uniqueness.

From a process perspective, the on-site distribution system can be configured in multiple operating modes depending on site conditions. During the coldest weather conditions, where outdoor air temperature is less than -1 °C (less than 5% of hours/year for an average year), ASHPs cannot operate, hence high-efficiency boilers provide the development's heating requirements. When outside air temperature is above 5 °C, the ASHPs can provide all the development's heating requirements. From spring to fall, the heat pumps can provide simultaneous heating and cooling to the site. The cooling pipes can also be switched to a low-temperature heating mode to feed the ADEU system with the ASHPs while the boilers provide on-site heating. This extends the range of the ASHP operation and reduces gas use in the surrounding neighbourhood. A complex instrumentation and control scheme was developed to enable remote operation and monitoring of the fully automated mini-plant.

Complexity

The project delivery schedule represented a significant challenge since the project had to be completed in stages in step with the retail development, as well as be fully commissioned in time for store occupancy. Construction started in August 2015 and was completed in October 2016. KWL and the City of Richmond decided upon a staged design and tendering approach, which required significant coordination through a master preliminary design that captured all stages of the project. During this period, it was critical that KWL and the City worked with the developer's team and the general contractor to integrate the two projects. The project was eventually tendered in multiple stages under one general contract using a combination of design-bid-build process for the majority of the project components, and a design-build process for the project's structural components such as the sound barrier and pre-engineered building structure.

There were major project constraints including limitations on available space, noise control requirements, and hydraulic design limitations. The mini-plant site was located on top of the 5-level parkade (base building) to limit noise generation at the ground level, however, since the mall is surrounded by residential buildings, a sound barrier was also required to abate the noise from the AHSPs. Hydraulic design limitations existed due to the difference between the pressure rating of the system and the main ADEU system, which necessitated the installation of the energy transfer station at the ground level. Accordingly, additional piping and controls to facilitate energy transfer from the mini-plant to the energy transfer station was required.

Social and/or Economic Benefits

The interconnection between the Phase 4 mini-plant and the ADEU system allows the ASHPs to run for longer periods when compared to a scenario where they would only serve the Central at Garden City retail development site. This results in a more effective capital investment and helps maintain lower energy rates for both residents and the retail development. Furthermore, investment in the City of Richmond's district energy projects creates local opportunities for green jobs. This project cost approximately $5.5 million, with a significant portion of this cost supporting local employment, including consulting engineers.

The installation was designed for minimal visual impact, which was achieved through a design review with City planning staff, coordination with the base building architect, and careful colour selections to blend in with the base building. The sound wall nearly eliminates any appreciable increase in noise at sensitive interfaces in the neighbourhood and provides a visual screen of the building and equipment.

Environmental Benefits

The goals of the City of Richmond's Community Energy & Emissions Plan include reducing the community's greenhouse gas emissions by 33% by 2020, and 80% by 2050, relative to 2007 levels. The centralization of DES capitalizes on the load diversity between different developments hence enabling efficient delivery of heating and cooling services. Replacing traditional fuel-based energy sources with a low-carbon energy source further reduces the GHG emissions.

The system will gradually increase its energy output as the surrounding neighbourhood grows and additional load demand is required from the ADEU system. Due to installing the ASHPs, the City of Richmond will limit operating its back-up boiler system at the main DEU plant, except during extreme cold weather events. In the early years of operation, the plant is expected to eliminate the production of 350 tonnes per year of CO_2 equivalent (t CO_2e) that would have resulted from using natural gas boilers or furnaces. Once the ADEU reaches its full capacity, which is anticipated around 2025, the system will eliminate 800 t CO_2e per year. Over the project's estimated 25-year lifecycle, the equivalent GHG emissions from 4,000 typical passenger vehicles will have been eliminated.

Meeting the Client's Needs

The City of Richmond's main goals were to deliver a reliable supply of heating and cooling energy to the shopping centre in time for occupancy, as well as use the mini-plant as an additional low-carbon energy source for the entire ADEU to reduce carbon footprint. While the decision to install the plant on the top floor of the parkade led to unique challenges, multiple design changes, and an extremely tight construction schedule, the plant was constructed and commissioned in time to provide the required heating and cooling loads to the retail developments for the grand opening day. This was ultimately the critical target for the City to meet its contractual commitment to the developer.

The system will be monitored throughout the next few years while in operation, with ongoing system optimization to ensure that at full build-out, the energy source is used to its maximum efficiency.

Photographs

Photo 1: Mini-plant Installed on Parkade Roof behind Sound Wall Structure

Photo 2: Mini-plant Enclosure and ASHPs Installed behind Sound Wall Structure

Photo 3: District Energy Mini-plant Interior Layout

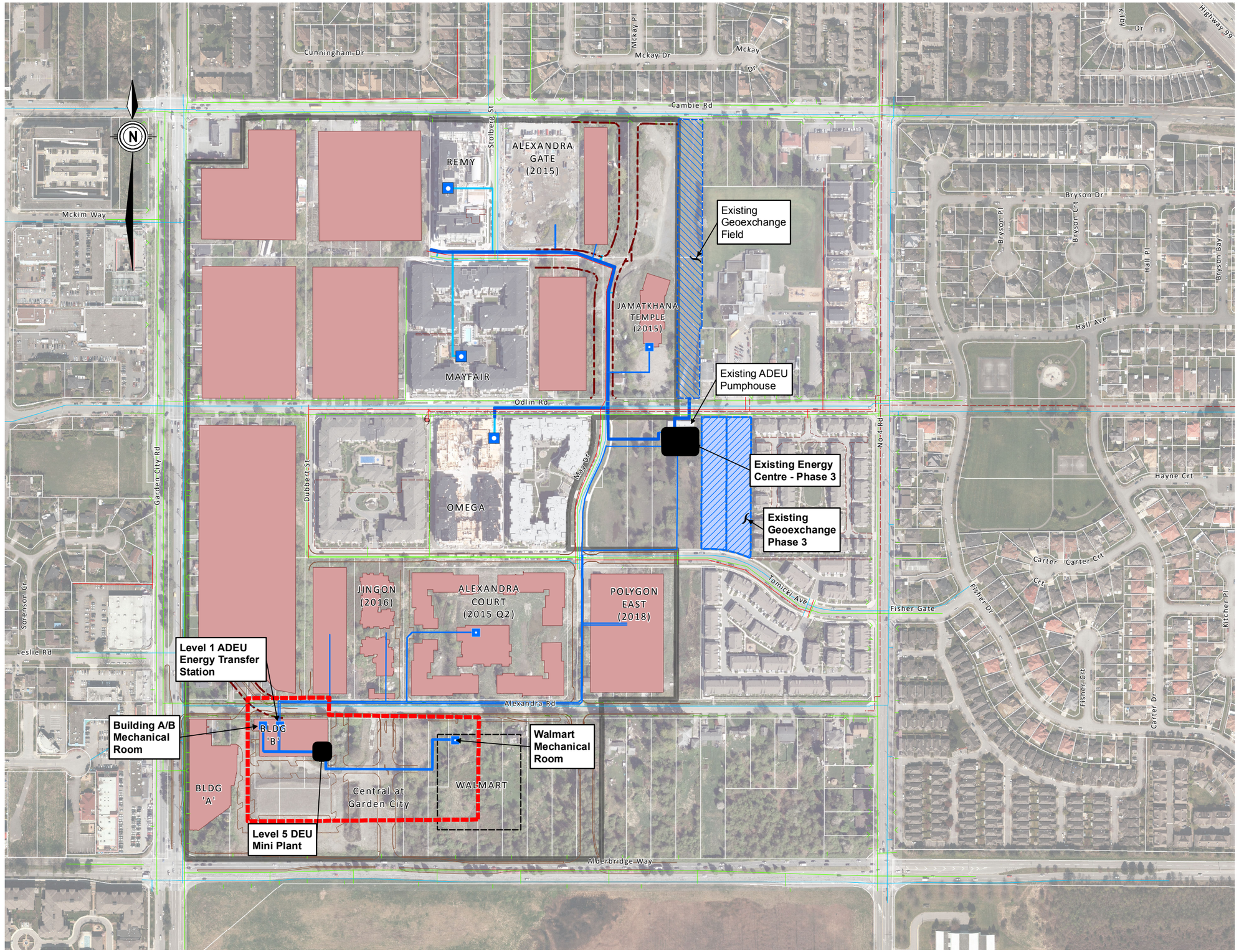
Photo 4: Air Source Heat Pumps (low carbon energy source)

Photo 5: Parkade Piping Connecting Mini-plant to Mechanical Rooms

Photo 6: Supply and Return District Energy System Piping

Photo 7: Supply and Return Piping Supplying Walmart Loads

City of Richmond
Alexandra District Energy Utility Phase 4



Legend

- Project Limits
- ADEU Service Area Boundary
- Future ROW
- Existing Watermain
- Existing Sanitary Pump Station
- Existing Sanitary Forcemain
- Existing Sewer Main
- Existing Storm Main
- Existing Culvert
- Existing Ditch
- Existing DEU Energy Transfer Station
- Existing District Energy Utility Main
- Existing District Energy Utility Service Connection

Reference: 2013 Orthophoto and GIS background data from the City of Richmond.

KERR WOOD LEIDAL
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80 0 80 (m)

1:4,000

Project No.	Date
651-083	April 2017

DEU Layout Plan

Figure

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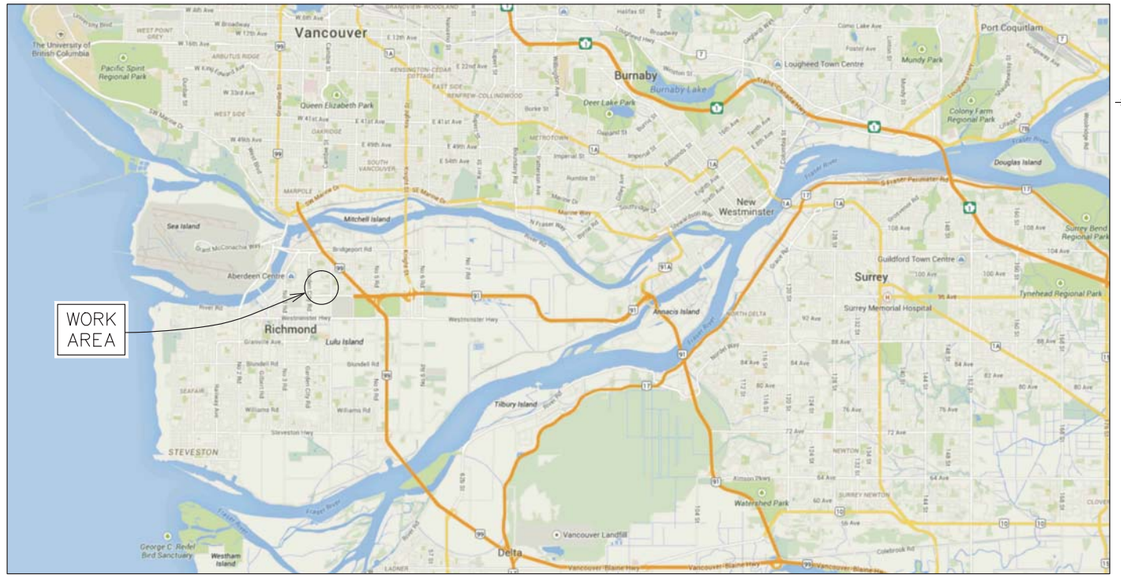
Author: GGarcIA



LOCATION MAP
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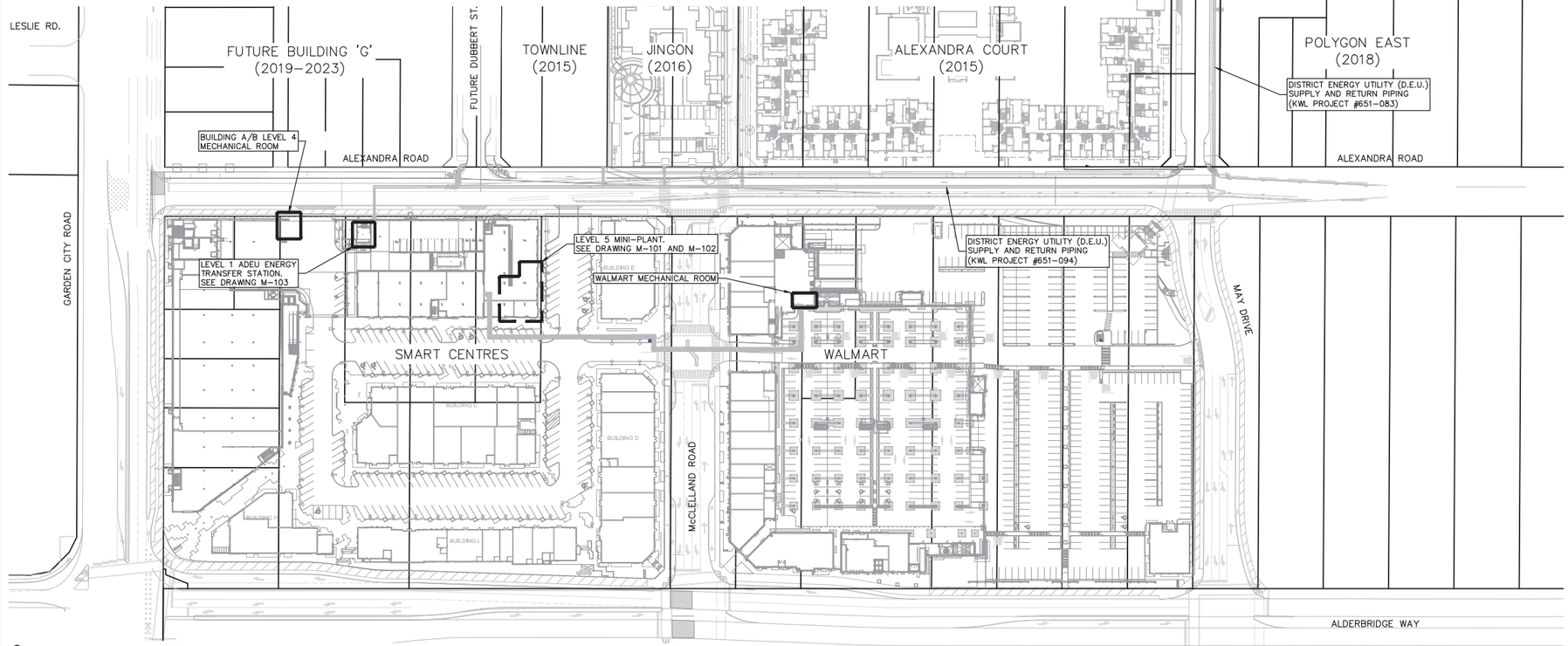

COMPREHENSIVE PLAN
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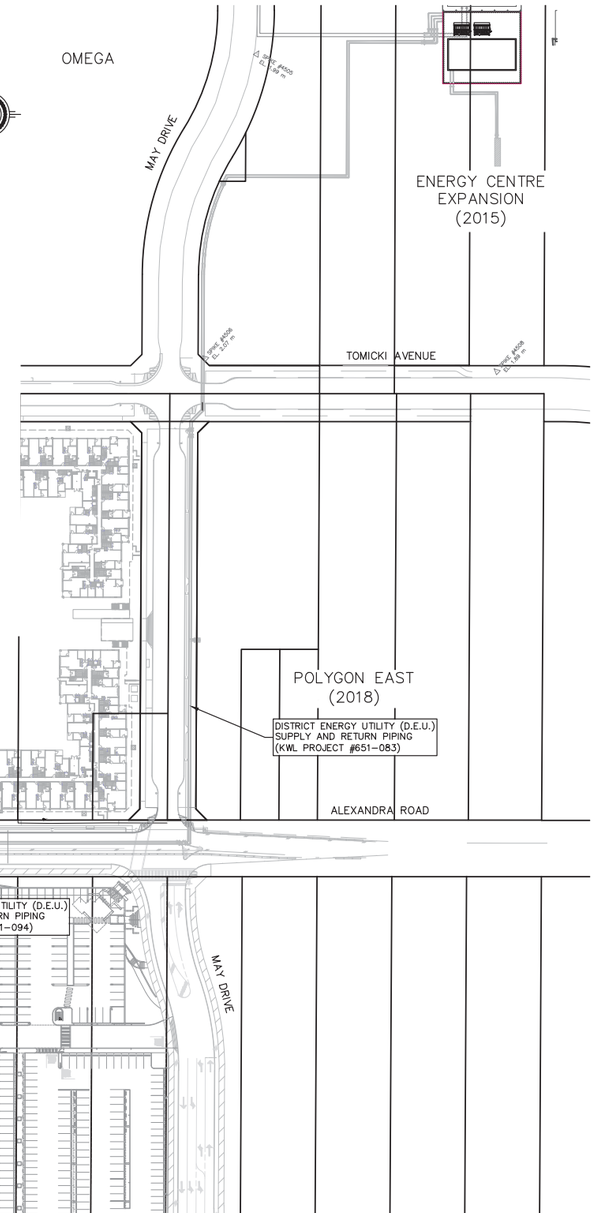

DRAWING LIST	
DWG. #	DRAWING TITLE
	GENERAL
G–001	COMPREHENSIVE PLAN, LOCATION MAP AND INDEX TO DRAWINGS
	PIPING AND INSTRUMENTATION DIAGRAM
P–001	STANDARD INSTRUMENTATION SYMBOLS
P–002	STANDARD PIPING SYMBOLS
P–101	SYSTEM OVERVIEW
P–102	LEVEL 1 ADEU ENERGY TRANSFER STATION
P–103	BUILDING A/B LEVEL 4 MECHANICAL ROOM
P–104	WALMART MECHANICAL ROOM
P–105	LEVEL 5 MINI PLANT
P–501	COMMON ASSEMBLIES AND EQUIPMENT SCHEDULES
	ARCHITECTURAL
A–101	LEVEL 5 MINI–PLANT GENERAL ARRANGEMENT
A–102	LEVEL 5 MINI–PLANT BUILDING CURB AND SUPPORT PLAN, DETAILS
A–103	LEVEL 5 SLAB MODIFICATIONS AND DRAINAGE PLAN, DETAILS
A–301	LEVEL 5 MINI–PLANT ELEVATIONS
A–302	LEVEL 5 MINI–PLANT ELEVATIONS AND DETAIL – STEEL BUILDING ONLY
A–501	DETAILS
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M–101	LEVEL 5 MINI–PLANT MECHANICAL PLAN
M–102	LEVEL 5 MINI–PLANT PIPING PLANS
M–103	LEVEL 5 MINI–PLANT VENTILATION PLAN, SECTIONS AND DETAILS
M–104	LEVEL 1 ADEU ENERGY TRANSFER STATION PLAN AND SECTIONS
M–301	LEVEL 5 MINI–PLANT PIPING SECTIONS
M–302	LEVEL 5 MINI–PLANT PIPING SECTIONS
M–501	DETAILS – SHEET 1 OF 2
M–502	DETAILS – SHEET 2 OF 2
	ELECTRICAL
E–001	SITE PLAN AND SYMBOL LEGEND
E–002	SINGLE LINE DIAGRAM
E–003	UNDERGROUND SERVICE DETAILS
E–004	CONDUIT RISER ROUTING DETAILS
E–102	POWER LAYOUT
E–201	MCC LAYOUT

NOTES

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2. THE CONTRACTOR TO NOTIFY THE ENGINEERING INSPECTION DEPARTMENT AT LEAST 48 HOURS PRIOR TO START OF WORK. PHONE 604–276–4014 / 604–276–4189.
3. ALL WORKS SHALL BE DONE IN ACCORDANCE WITH THE CITY OF RICHMOND ADOPTED MMCD AND SUPPLEMENTAL SPECIFICATIONS AND THE CITY BYLAWS.

TENDER ISSUE
DO NOT USE FOR CONSTRUCTION

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City of Richmond
6911 No. 3 ROAD RICHMOND B.C. V6Y 2C1

B.C. GAS SERVICES

THE DEVELOPER OR CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING EXISTING LOCATION OF GAS SERVICE LINES, AND WHERE NECESSARY ARRANGE FOR THEIR RELOCATION IN ORDER TO FACILITATE INSTALLATION OF THE WORKS SHOWN ON THESE PLANS. A LIST OF SERVICE LINE LOCATIONS MAY BE OBTAINED FROM:

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TELEPHONE 1–800–474–6886
CELLULAR: *6886

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BENCHMARK

ALL ELEVATIONS ARE TO GEODETIC DATUM AND REFER TO RICHMOND BENCHMARK NUMBER:

MON. 77H4970

LOCATED: BROWN ROAD AT BROWN GATE

ELEVATION 1.793 METRES FIELD BOOK Nº

CITY WORK ORDER Nº TENDER / PROJECT Nº

CONTRACTOR WORK ORDER Nº ACCOUNT Nº

REFERENCE DRAWINGS

PROPERTY ACQUISITION	Aq
SURVEY PLAN & PROFILE	PP
ROAD CONSTRUCTION	Oc
STORM SEWER INSTALLATION	Lc
WATERMAIN INSTALLATION	Wc
ORNAMENTAL STREET LIGHTING	Tc
TRAFFIC SIGNALS	Ec
SANITARY SEWER INSTALLATION	
OTHER	

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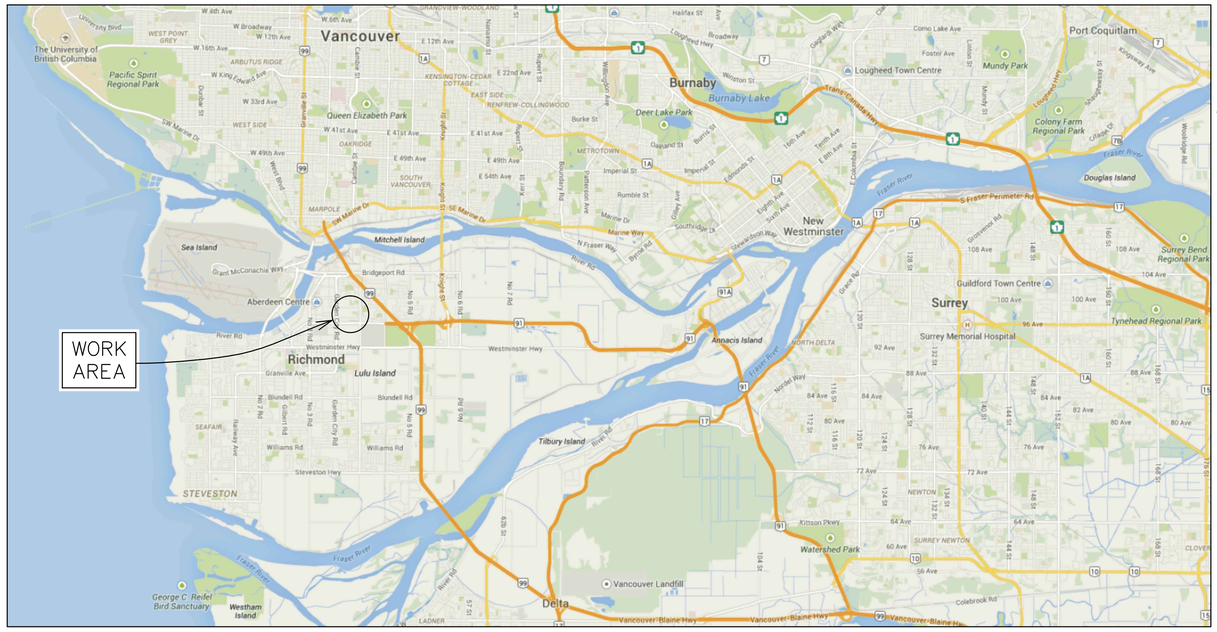
Nº	DATE	BY	CH.	DESCRIPTION
A	09/28/15	AU	MEH	ISSUED FOR TENDER

REVISIONS

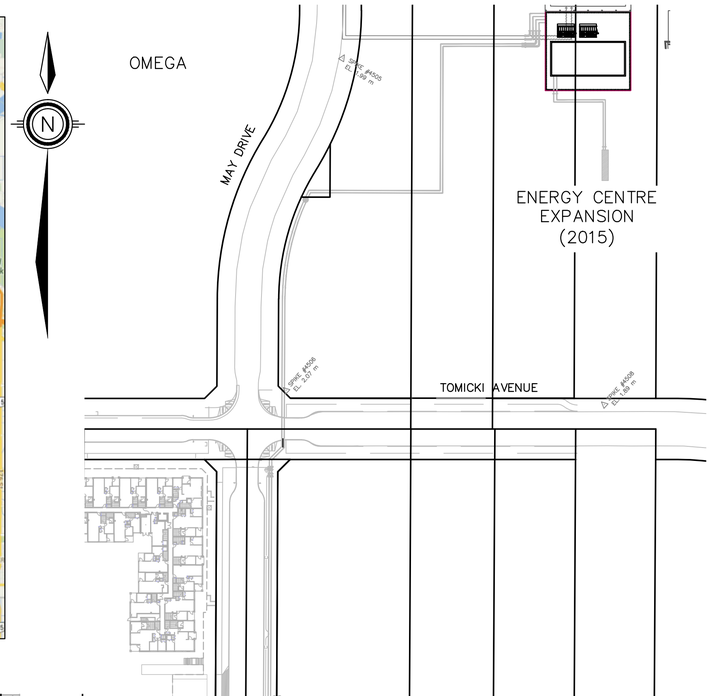
TITLE: **CENTRAL GARDEN CITY DEU PKG B MINI-PLANT AND ENERGY TRANSFER STATION COMPREHENSIVE PLAN, LOCATION MAP AND INDEX TO DRAWINGS**

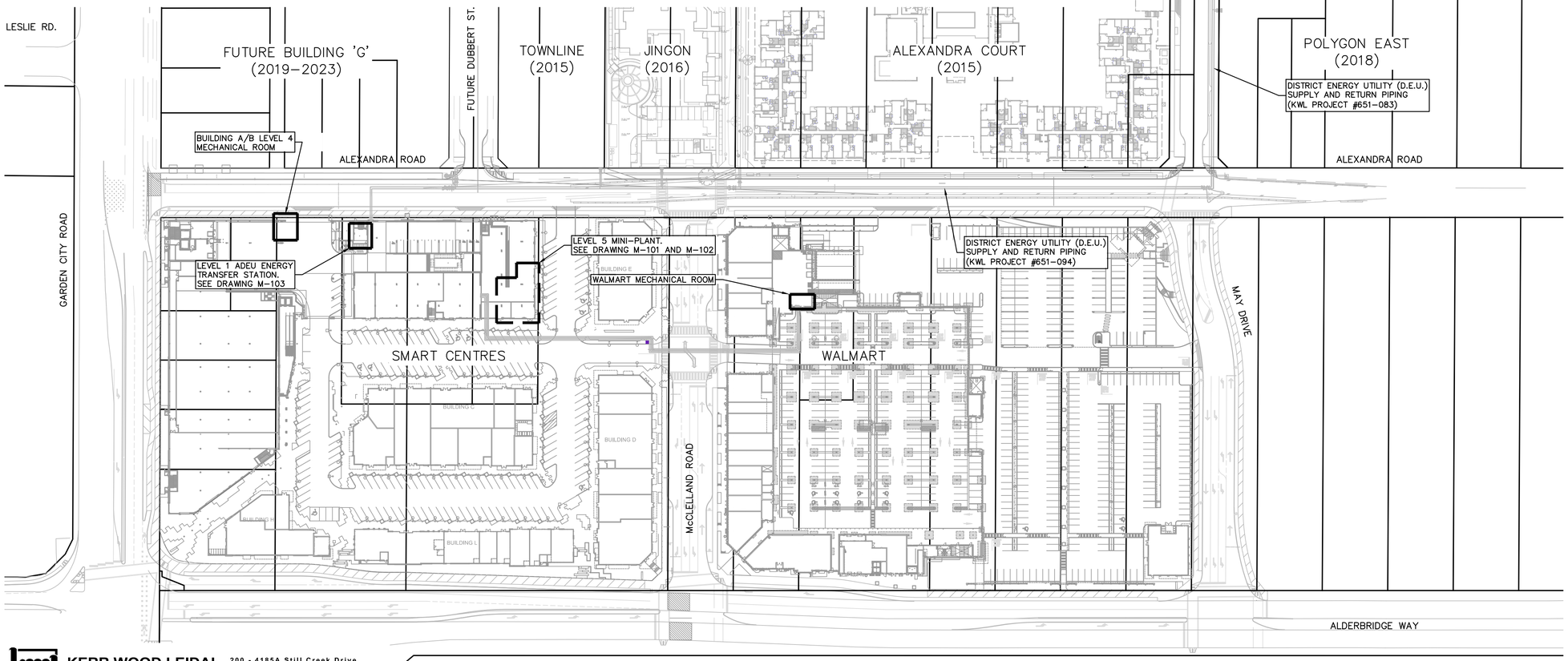
DESIGN: TMAH			
DRAWN: SB/AU	DWG. Nº: G-001		
CHECKED: MEH	SCALE: AS SHOWN	DATE: SEPTEMBER 2015	
ENGINEER: RDP	SEC. Nº:	SHT. Nº:	



LOCATION MAP

SCALE N.T.S.





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