Appendix A Review of DES

Appendix A.1 DES: A Growing Opportunity

At COP21 (the 2015 UN Climate Change Conference in Paris), the UNEP (United Nations Environmental Program) recently recognized that District Energy was a key climate solution and emphasized its importance in mitigating $C0_2$, reducing air-pollution, and paving the way for fossil-fuel free cities and countries [69].

On a global scale, the development of DE Systems is growing fast. There are currently >6,000 DE systems in North America; however, this only accounts for <1% of the total heating load and represents a significant opportunity for further development. There are already >10,000 DE systems in operation in Europe* today, and in many European countries this supplies over 40% of their heating load. The growth of the Chinese geothermal district heating and cooling sector has also grown exponentially in the past ten years [70].

* Note that the Europeans use the term GeoDH instead, which stands for “Geothermal District Heating”. The term is analogous to DES but is used instead by Europeans. Further discussion and examples provided later in this report will be highlighting Europe’s extensive present and historical use of these systems.

A number of major Canadian cities have also developed DE systems, including Toronto, Calgary, and Vancouver. The University of Toronto’s DES began in 1912 and serves most of the campus. The company Enwave operates a DES for the City of Toronto that uses Lake Ontario as a source of cooling for local buildings, including the Air Canada Center and City Hall [71]. Enmax’s DEC in downtown Calgary was brought online in 2010, and currently supplies 55MWth of energy over 5.5 kilometers of installed thermal pipeline to a number of City of Calgary buildings including City Hall [72].

Appendix A.1.1 Geothermal Energy in DE Systems

Geothermal energy (or “earth heat”) resources are a renewable source of both heat and electrical energy. Geothermal energy is a vastly untapped resource in Canada and can be a significant alternative to heating and power needs supplied by fossil fuels like natural gas, fuel, oil, and propane. The concept of using geothermal as part of a DES is nothing new, and in fact dates back thousands of years to Roman times and was used for bath houses and agriculture applications. Today, geothermal DE Systems have been developed all over the world. These systems are increasing in popularity as a viable solution for renewable energy.

European cities like Paris and Munich have already been operating DE Systems based on geothermal for decades; there are >240 GeoDH systems in Europe already [37]. Iceland provided 96% of its heating needs from their geothermal resource, and Baltic states, with similar annual temperatures to Canadian cities, provides 50-60% of its heating from geothermal DE Systems [73]. With future growth in the industry, it is estimated that by 2020 nearly all states in Europe will have DES using a geothermal energy resource [74].

A full list/map of European GeoDH projects is available at: https://map.mfgi.hu/geo_DH/

Some of the best examples of the long-term nature of geothermal DE Systems are in France. In Chaudes Aigues in Central France, the city pioneered a DES in 1330 fed by the Par hot spring at 82°C. Incredibly, it is still operating today. In those times, heated homes were charged a tax by the local landlord in exchange for maintenance duties. The Paris Basin Geothermal District Heating System is based on a dependable sedimentary resource environment (similar to the geological environment in Hinton) and has been in operation since the 1980s. The system is based on a doublet concept of heat extraction: hot waters at an average temperature of 70°C are hosted in permeable sedimentary rocks at depths of 1500 to 1800 m, and the fluids are reinjected into the reservoir to avoid premature cooling of the production well [73].

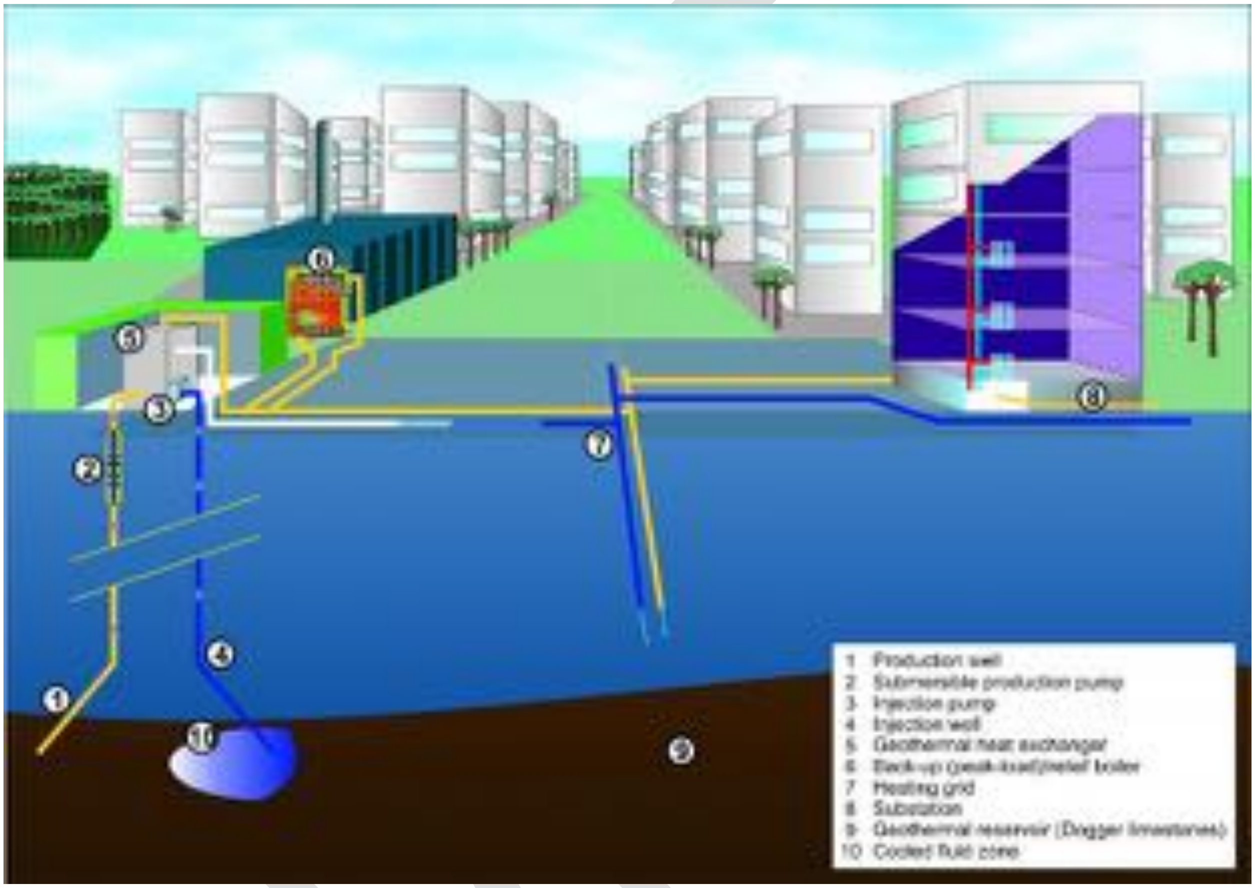


Figure 81 - Generalized diagram of a DES showing the main components and features. [74]

The geothermal aquifers in the Hinton area (further described in the Upstream section) are analogous to the geological environments in other countries that have already developed 'direct heat' projects using geothermal energy and DE systems (including Paris, France and Landau, Germany).

Appendix A.1.2 Global Examples of DES Heat Sources & Implementation

Appendix A.1.2.1 Geothermal Wells

Paris, France

The oil crisis of the 1970's created a need for affordable heating in Paris, sparking a boom of geothermal energy development within the city. Between 1970 and 1985 over 100 geothermal wells were drilled in the Paris region, and as of 2010 34 of those wells are still operating among more recent geothermal endeavours. The geothermal wells used in Paris utilize a doublet (or binary well pair) system, where each system consists of an injection and production well. The benefit of a doublet system is that formation fluids are reinjected into the aquifer, both safely disposing of the fluid and recharging the aquifer simultaneously. Geothermal district heating in Paris is powered by more than 29 production plants utilizing between one and three wells for heat.

Reykjavik, Iceland

The company Reykjavik Energy operates the largest geothermal DES in the world, providing an installed power of 750MW. The system first began operation in 1930 at a small scale, and in 1933 3% of Reykjavik's population was using the DES. Today almost every house in the city is connected to the system. The DES is split into two separate systems: the first is supplied with geothermal water from three different low temperature geothermal fields between 85°C and 130°C, and the second system is supplied with cold ground water which is heated through a heat exchanger with geothermal fluids before being distributed.

Appendix A.1.2.2 Heat Waste – Forestry

Revelstoke, British Columbia

The Revelstoke Community Energy Corporation (RCEC) is a city owned energy company that owns a biomass heating plant and DES in Revelstoke. The biomass plant is a 1.5 MW thermal biomass boiler powered with wood waste provided by the Downie Cedar Mill. The biomass boiler provides heat through an oil-water heat exchanger into the DES.

The biomass heating plant and DES has provided Revelstoke with improved air quality, reduced GHG emissions, and reduced the need for trucked in propane. The project has provided the city with a new source of revenue and has added value to a local product.

Appendix A.1.2.3 Heat Waste – Sewage

False Creek Vancouver, British Columbia

The community of False Creek within the City of Vancouver is home to the city's first renewable DES. The district heating system provided by the Neighborhood Energy Utility (NEU) is powered by North America's first waste heat recovery system utilizing heat from raw sewage. The system is credited with reducing over 60% of the GHGs involved in heating buildings. The NEU is a self-funded utility providing a return on investment to the City and affordable rates for its customers.

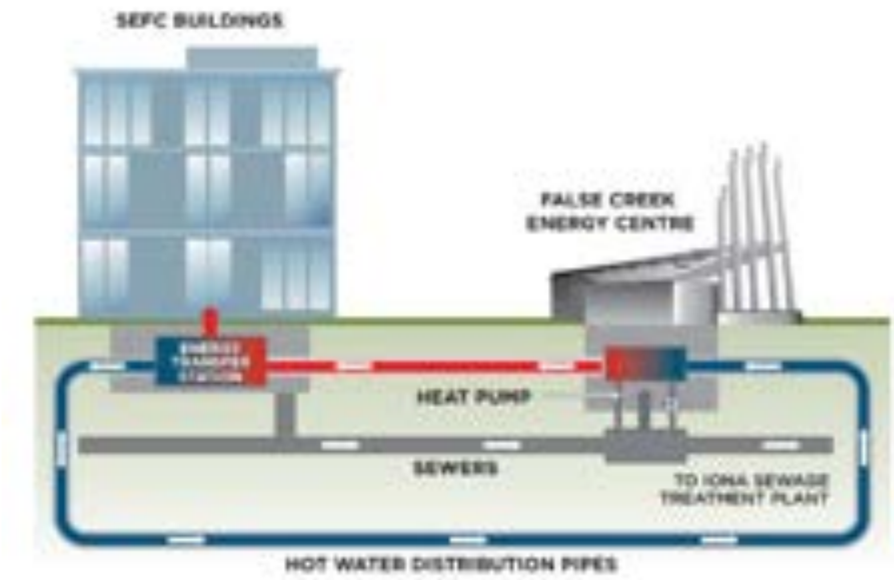


Figure 82 - False Creek Energy Centre DES diagram [75]

The system works by integrating a heat pump within a sewage pumping station. The heat pump collects and concentrates heat from the sewage and transfers the heat to the distribution system. The heat pump is backed up with a high efficiency natural gas boiler to maintain a reliable heat source even at peak demands.

Appendix B Hinton Sustainability Goals

EDUCATION AND WELLNESS

2.4.2: "Create partnerships with education providers who coordinate programming, identify potential enhancements and champion the establishment of a post-secondary institution." [76]

With examples such as the Iceland School of Energy of Reykjavik University, Hinton can establish itself as a hub for sustainable energy education, with clear cut examples located within town limits. Although the geothermal resource in Hinton is not conducive to the limited scope of this DES project, there are two things to keep in mind:

- The high geothermal potential in the Hinton area and throughout the province of Alberta abound and present many locations and opportunities for it to be utilized. Alberta is currently a leader in petroleum-based education and training programs; with such close conceptual and practical alignment with geothermal resource extraction it is no big leap for it to be a leader in the geothermal education space as well. This is a chance to further expand on sustainable energy, providing students more opportunity to learn about the industry closer to home.
- A renewable energy supplied DES can operate on heat inputs other than geothermal. A DES is a complex network of many specialized and integrated components that require maintenance and operation, and potential expansion. The upkeep of such a system, and the expansion of it to incorporate any new industries looking to start in or move to Hinton to take advantage of being part of a DES, will require very well-trained individuals. Home to the Hinton Training Centre- a facility respected for education, training and research in the Forestry industry- Hinton is well positioned as an educational hub to lead in Canadian DES training.

2.6.1: "Through partnerships, develop innovative, quality, creative and inclusive learning opportunities for K-12 students. ("Quality" is defined by parent and stakeholder input.)" [76]

By creating a control room or heat exchanger building that kids can visit for field trips, a DES can be used as a learning tool to teach others about sustainable energy.

LOCAL ECONOMY

4.13.1: "Pursue development with the natural resource industry and identify complementary businesses that diversify the local economy." [76]

4.13.2: "Foster entrepreneurship and encourage small business development and growth within the community." [76]

Both 4.13.1 and 4.13.2 fit well within the spheres of DES and geothermal.

- A DES supplied by renewable heat provides a low-cost supply of heat attractive to many industries, regardless of the source being specifically geothermal in origin or something else. There are examples around the world of unique and inspired businesses that would not exist without access to inexpensive and consistent DES heat. Nearby in Klamath Falls, Oregon there are a plethora of businesses taking advantage of their DES heat: brewery, greenhouse, aquaculture, buildings for space heating, sidewalk heating for snow and ice. Opportunities for businesses tapping into this consistent, inexpensive heat are limited only by the imagination.

- The geothermal resource in Hinton is estimated to have high enough temperatures that, if accessed, could provide consistent, baseload, reliable and long-term electricity. Beyond the advantages and attractiveness of this power supply itself, the vast “waste” heat leftover from power generation could supply heat to a DES, which as mentioned above has its own business-creating advantages.

4.13.4: “Foster industrial tourism as an opportunity to expand tourism and to showcase resource industries.” [76]

Although used globally, given that geothermal is not yet utilized and is barely known about in Canada, it would present as a fairly novel concept that would attract attention around the province, country and world. If accessed, the use of geothermal and its cascading business opportunities could be a showcase industry drawing people to Hinton to visit, and even to live.

4.13.6: “Promote and endorse commerce and trade that support people’s efforts to expand local food production operations.” [76]

Promoting other businesses to come to Hinton to capitalize on the benefits of the DES will help diversify the local economy. The use of local food production can be expanded on by using greenhouses, which, when temperature-controlled through the DES, can be used to develop new crops that are atypical in the region. Additional industries that use heat in their processes can benefit, which coincides with Hinton’s strategy to develop as a regional trading hub of the West Yellowhead.

> *“Located at the intersection of Highways 16 and 40 there are two increasingly important transportation routes where Hinton serves as a gateway to the Northern Rockies, to the west coast corridor and to global markets through Vancouver and Prince Rupert.*
>
> *The community is also connected by air, with the Jasper/Hinton Airport offering chartered flights through Edmonton and other major urban centres to the rest of the world. CN Rail, VIA Rail and Greyhound stop here.” [76]*

Inviting other industries to develop in Hinton can make it an attractive place to live and visit.

4.13.8: “Source investment capital from within or outside the community to build the local economy.” [76]

4.13.9: “Work with businesses and employers to attract and retain a balanced workforce that supports a diversified economy, employer of choice and location of choice.” [76]

Both 4.13.8 and 4.13.9 harken to the attractiveness of DES and geothermal as novel and reliable factors that attract investment and talent alike.

4.14.6: “Creatively promote Hinton as a regional hub provincially and/or nationally through identified local niche business opportunities and healthy communal living.” [76]

As previously mentioned, DES and geothermal are poised as unique and niche providing many offshoot business opportunities. As people lean more toward a desire for lifestyles that incorporate renewable and sustainable factors, communities that imbue those ideals into their fabric will become more and more attractive, drawing both businesses and people to those places.

NATURAL AND BUILT ENVIRONMENTS

5.18.1: “Develop local community gardens” and “plan for food sovereignty, in part by commercializing urban food production.” [76]

The DES is attractive because of the large optionality of connecting varied businesses and activities, which could easily include gardens and greenhouses that help strengthen community food security (uninterrupted access to safe and nutritious food, in this case grown locally).

“Strategy 19: Practise and promote energy conversation and alternate green energy development and use within all infrastructure systems to minimize our ecological footprint.

5.19.1: Identify large-scale alternative renewable energy opportunities and develop where practical…” [76]

5.19.2: “Foster site-specific applications for renewable or alternative energy, while also fitting into the neighbouring street/land scape.” [76]

5.19.3: “Establish Hinton as a leader in best “green” practices…” [76]

5.20.1: “While encouraging resource development, ensure that current “green” and scenic values are not lost.” [76]

DES and geothermal development align with this ideal as they both promote and encourage resource development and are “green” in nature.

5.20.2: “Establish well-defined business and industrial clusters and transportation corridors.” [76]

5.20.3: “Develop a Growth Management Plan…” [76]

5.20.5: “Plan and use land judicially and according to its capabilities and assets, striving for the best use of the land.” [76]

The very nature of a DES promotes this ideal. DES by design are most efficient when strong and comprehensive planning is used and- most importantly- when the buildings and businesses connected to the system are in as close proximity to each other as possible. The more clustered the users are, the more cost-effective the system becomes. Installing a DES in Hinton would drive businesses and industrial applications to cluster together.

5.20.7: “Encourage all new developments to implement environmental best practices with the intent to regulate (e.g., green buildings, development sites and subdivisions).” [76]

To elaborate further on the prior point, should a community install a DES, any future growth (new businesses, residential subdivisions, etc.) could be required to tie into the DES and greatly reduce their ecological impact. There is also potential economic benefit due to the increase of the desirability of land from the availability of access to a DES.

5.21.1: “Design and implement standards that incorporate pedestrian and cyclist routes (e.g., bicycle lanes and bicycle friendly corridors) into trails, parks and roadways.” [76]

5.21.4: “Design and implement integrated transportation strategies and systems for residents and visitors that encourage and promote walking, cycling and public transit use.” [76]

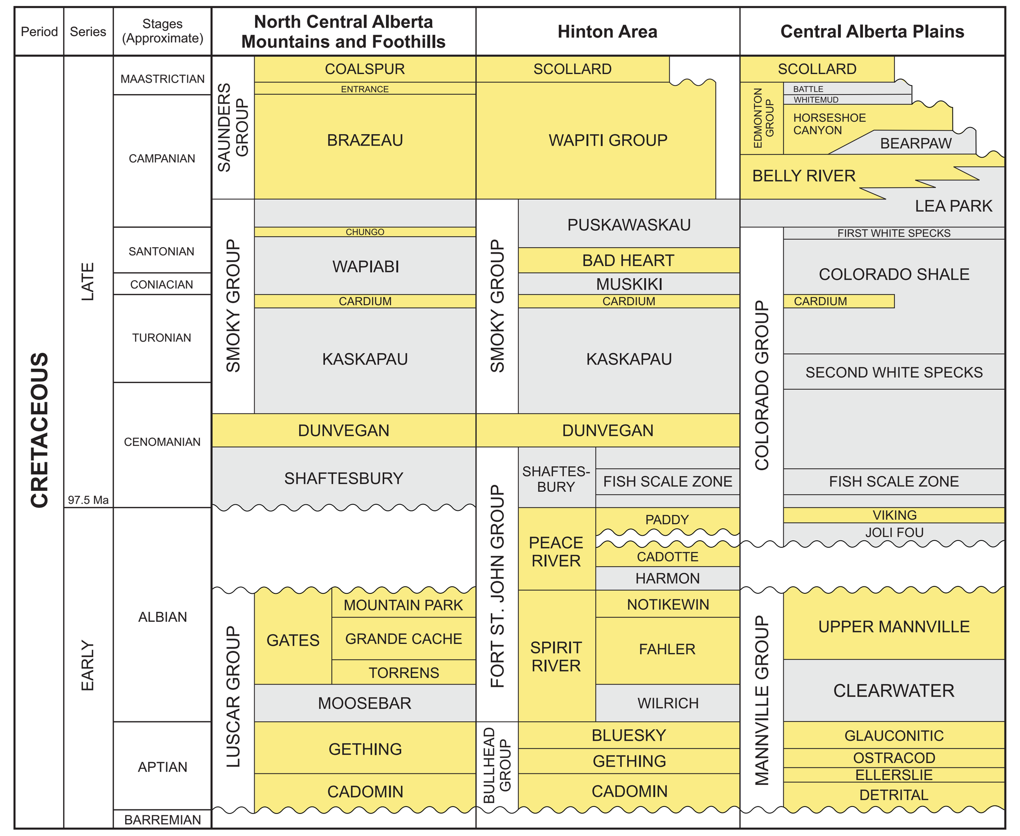
A unique benefit of a DES is that the same heat being delivered to buildings throughout town can also be used to heat sidewalks and bike lanes to keep them snow and ice free year-round. It is further advantageous that the locations of the pipes circulating the heat is usually doing so through main corridors with high foot/bike traffic, so they align well physically.

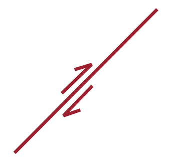
Appendix C Upstream

Appendix C.1 Geology

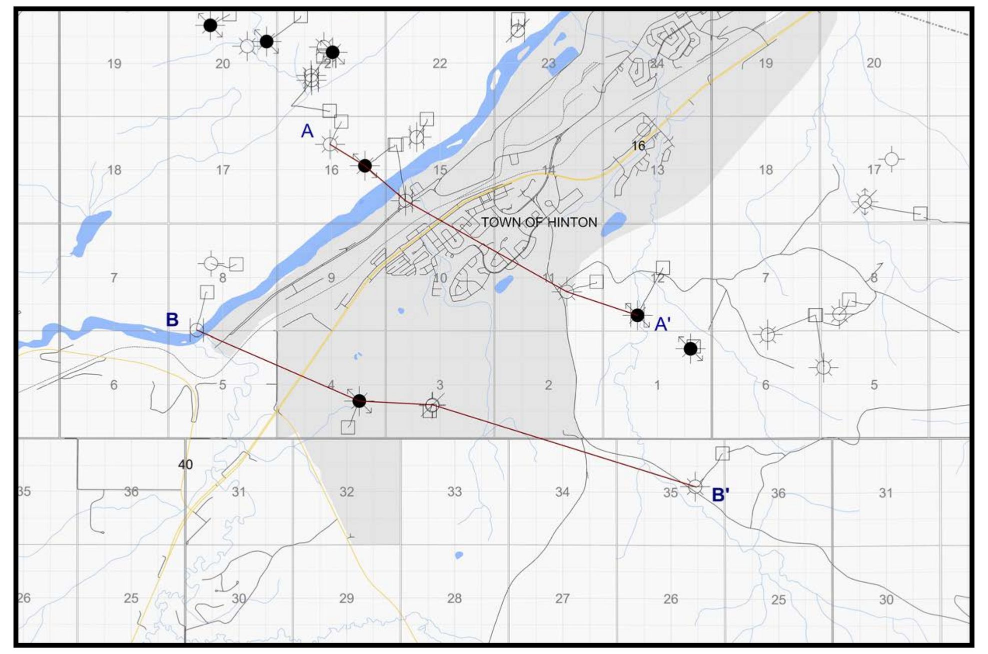
Appendix C.1.1 Full-Scale Stratigraphic Cross-Sections

Cretaceous Stratigraphy West Central Alberta





Thrust Fault
(arrows indicate
relative movement)

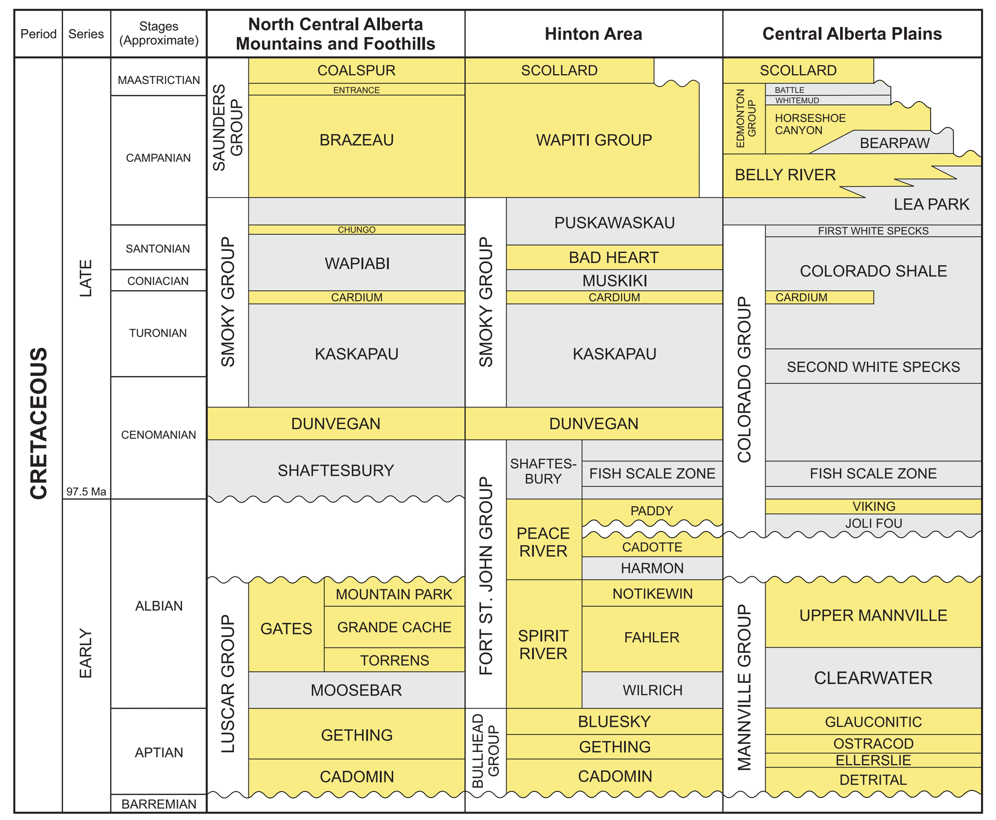


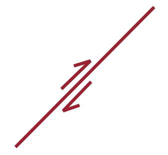
Stratigraphic Cross-Section A-A': Cardium Formation Hinton Area, West Central Alberta

Stratigraphic Datum = Top of the Cretaceous Cardium Formation

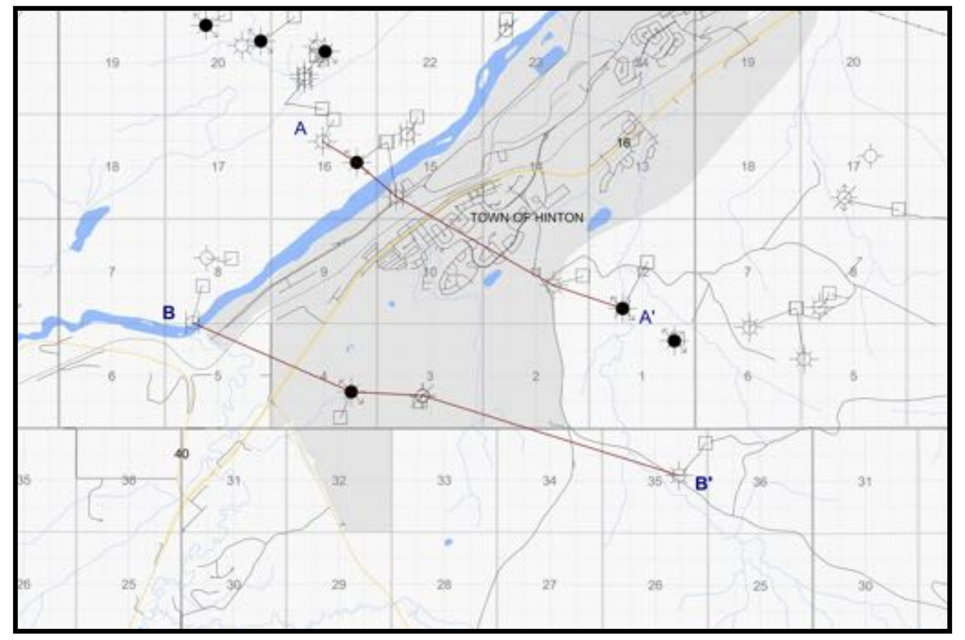
Wells displayed in Measured Depth
Horizontal Scale 1:1200
Vertical Scale 1:2400
(fault displacement not to scale)

Cretaceous Stratigraphy West Central Alberta





Thrust Fault (arrows indicate relative movement)

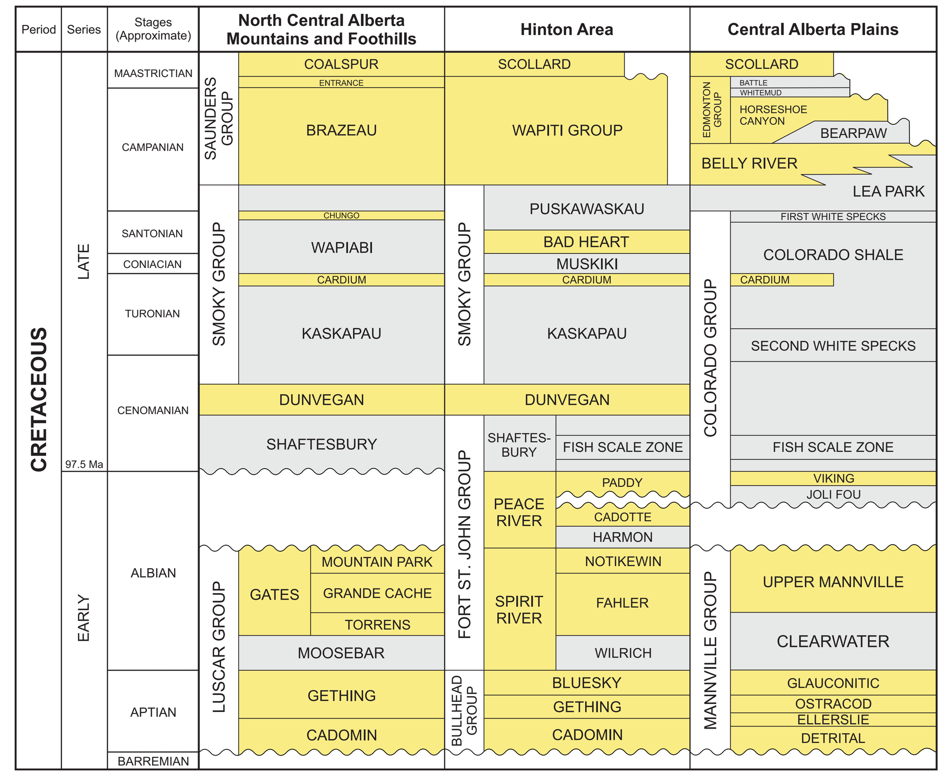


Stratigraphic Cross-Section A-A': Spirit River Formation Hinton Area, West Central Alberta

Stratigraphic Datum = Cretaceous Base of Fish Scales

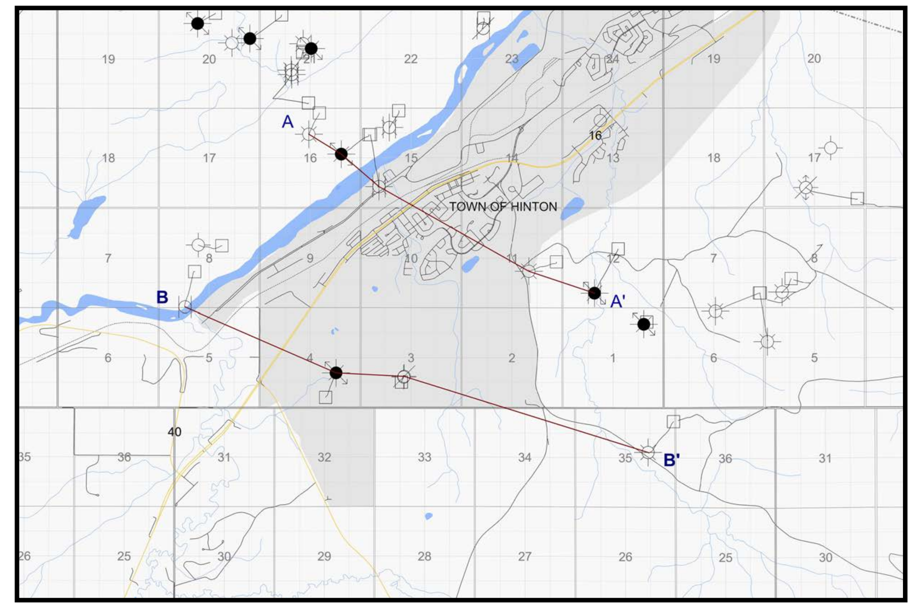
Wells displayed in Measured Depth
Horizontal Scale 1:1200
Vertical Scale 1:2400
(fault displacement not to scale)

Cretaceous Stratigraphy West Central Alberta



Thrust Fault: Confirmed from wellbore data (arrows indicate relative movement)

Thrust Fault: Inferred, occurs between wellbores (arrows indicate relative movement)

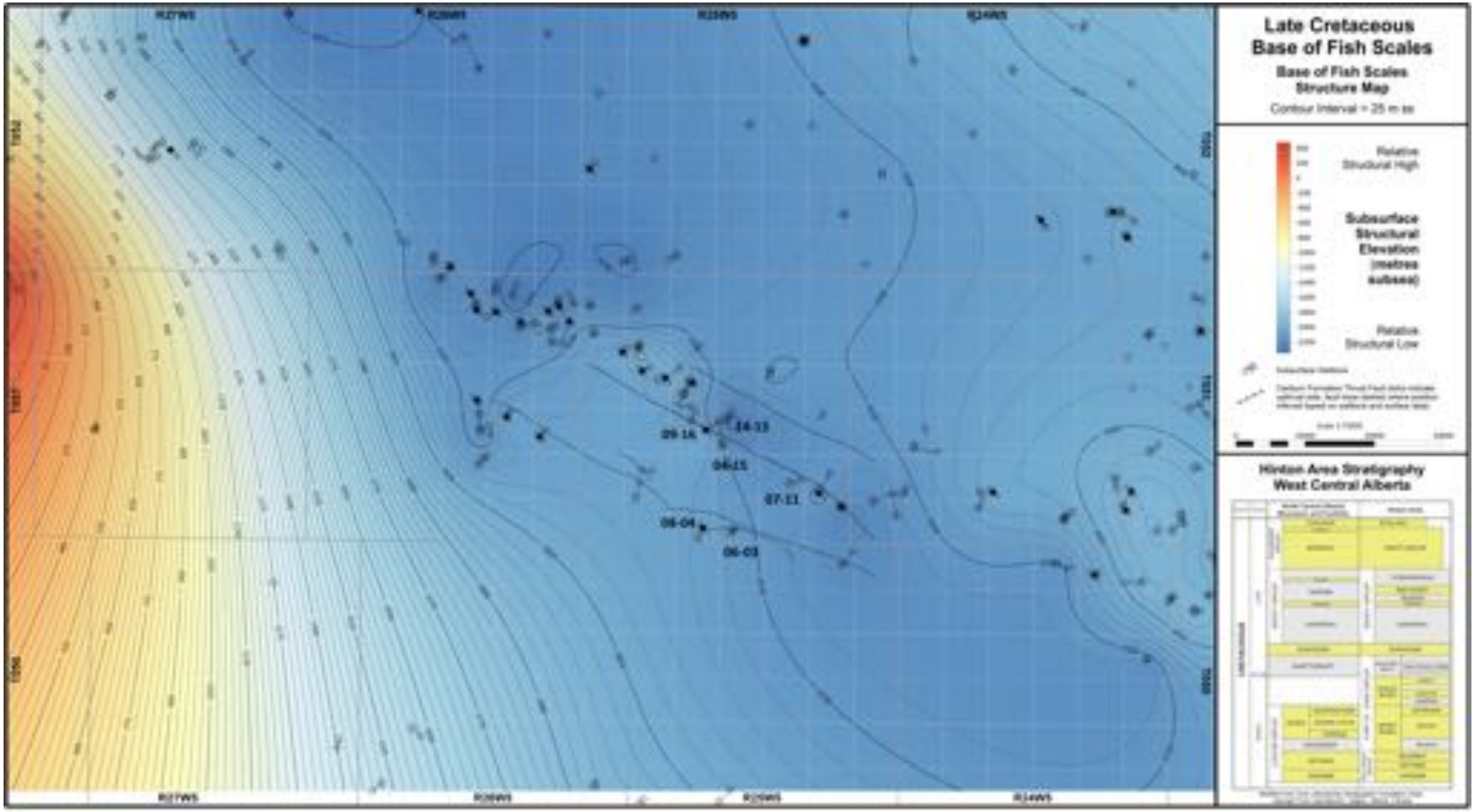


Stratigraphic Cross-Section B-B': Cardium Formation Hinton Area, West Central Alberta

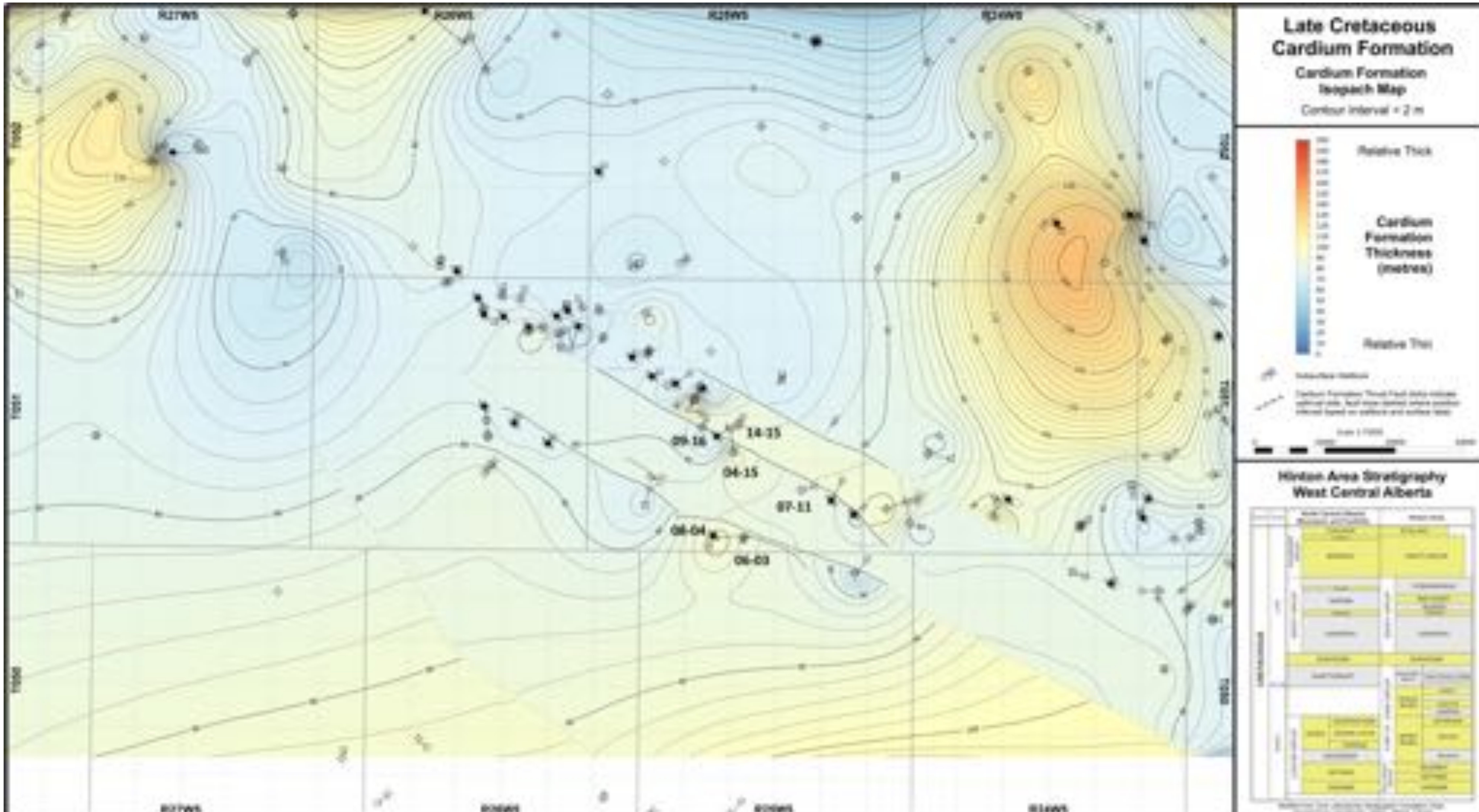
Stratigraphic Datum = Top of the Cretaceous Cardium Formation

Wells displayed in Measured Depth
Horizontal Scale 1:1200
Vertical Scale 1:2400
(fault displacement not to scale)

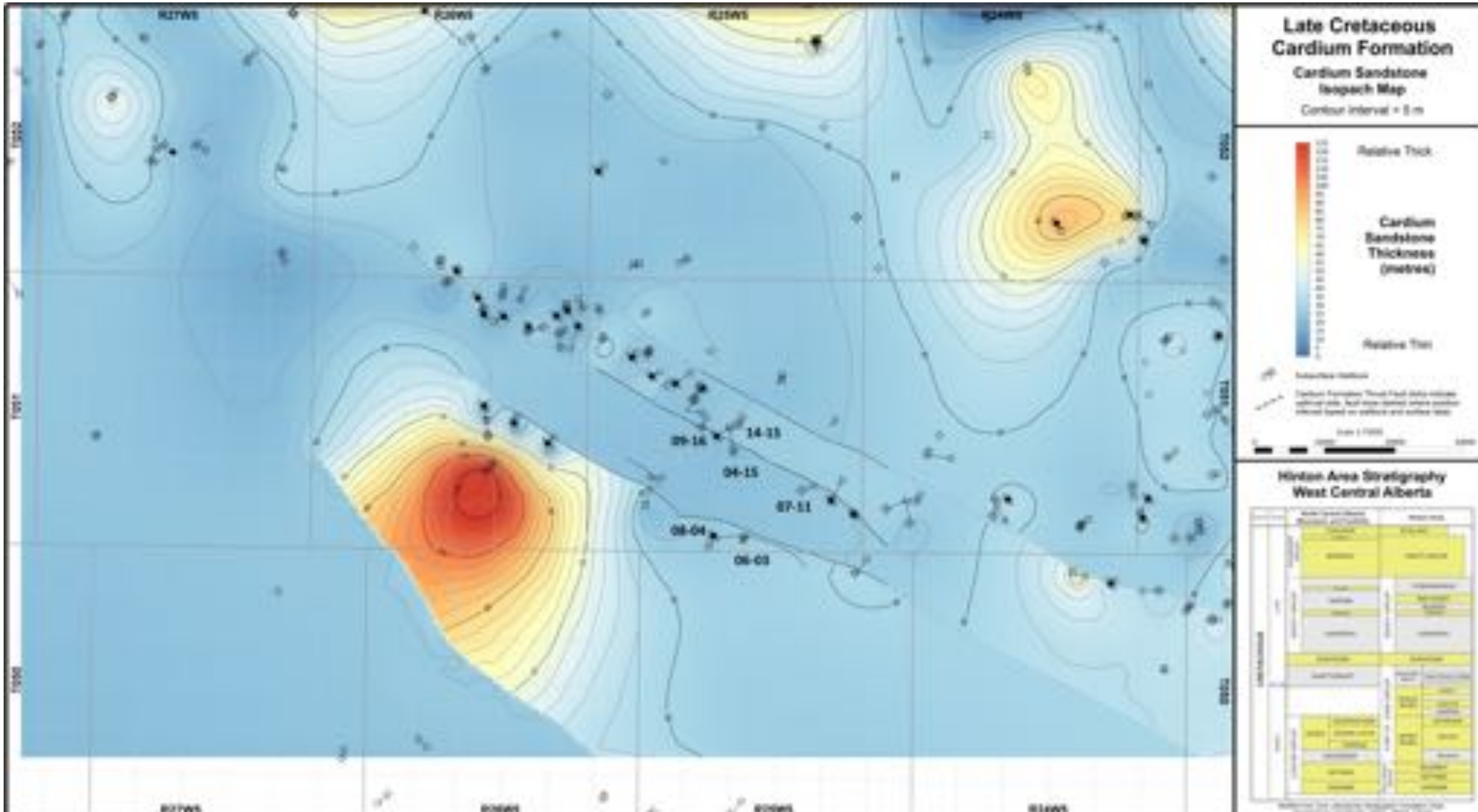
Appendix C.1.2 Full-Scale Maps



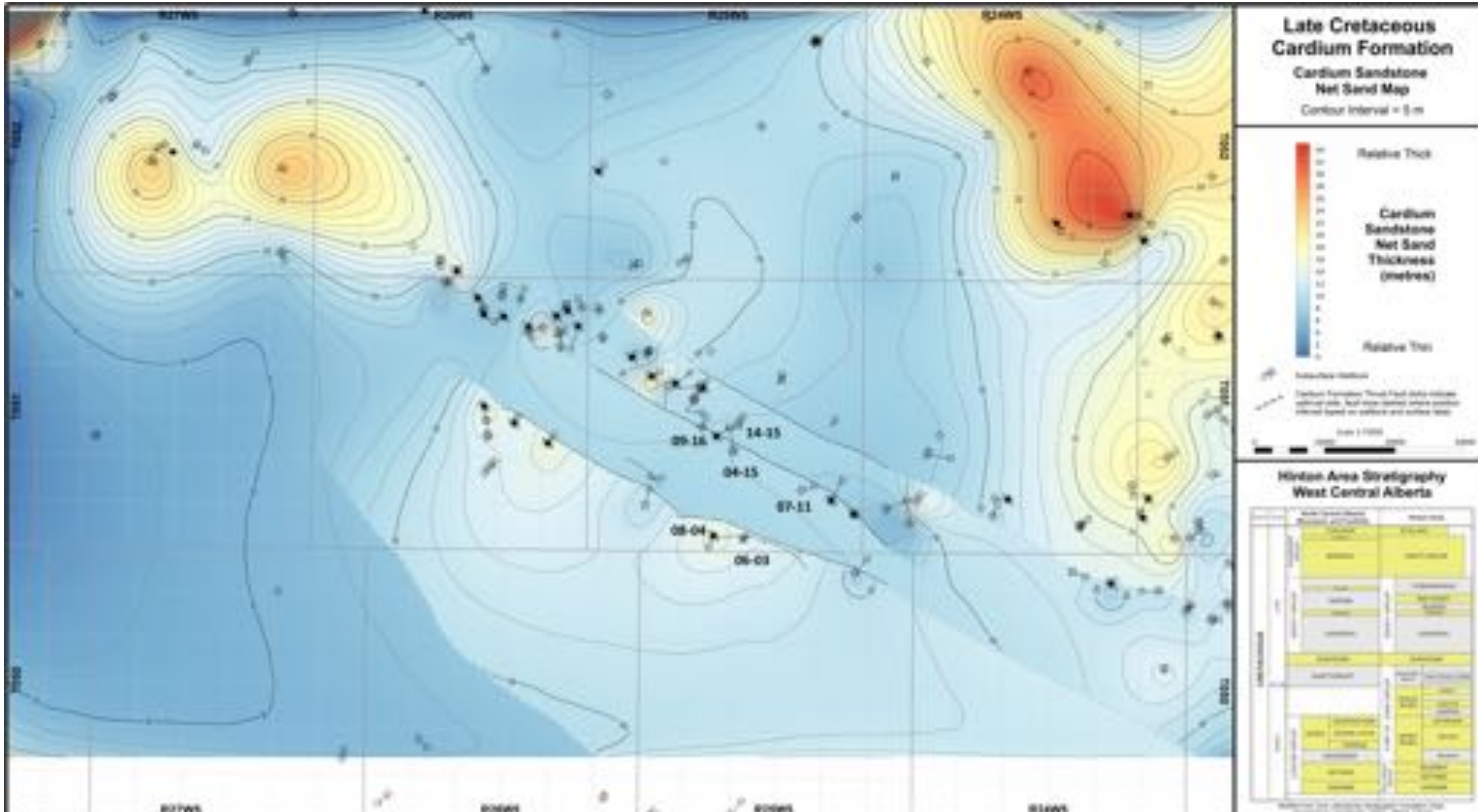
Late Cretaceous
Base of Fish Scales
Base of Fish Scales
Structure Map
Contour Interval = 25 m ss
Relative
Structural High
Subsurface
Structural
Elevation
(metres
subsea)
Relative
Structural Low
Hinton Area Stratigraphy
West Central Alberta
R27W5
R26W5
R25W5
R24W5
09-16
14-13
04-15
07-11
08-04
06-03



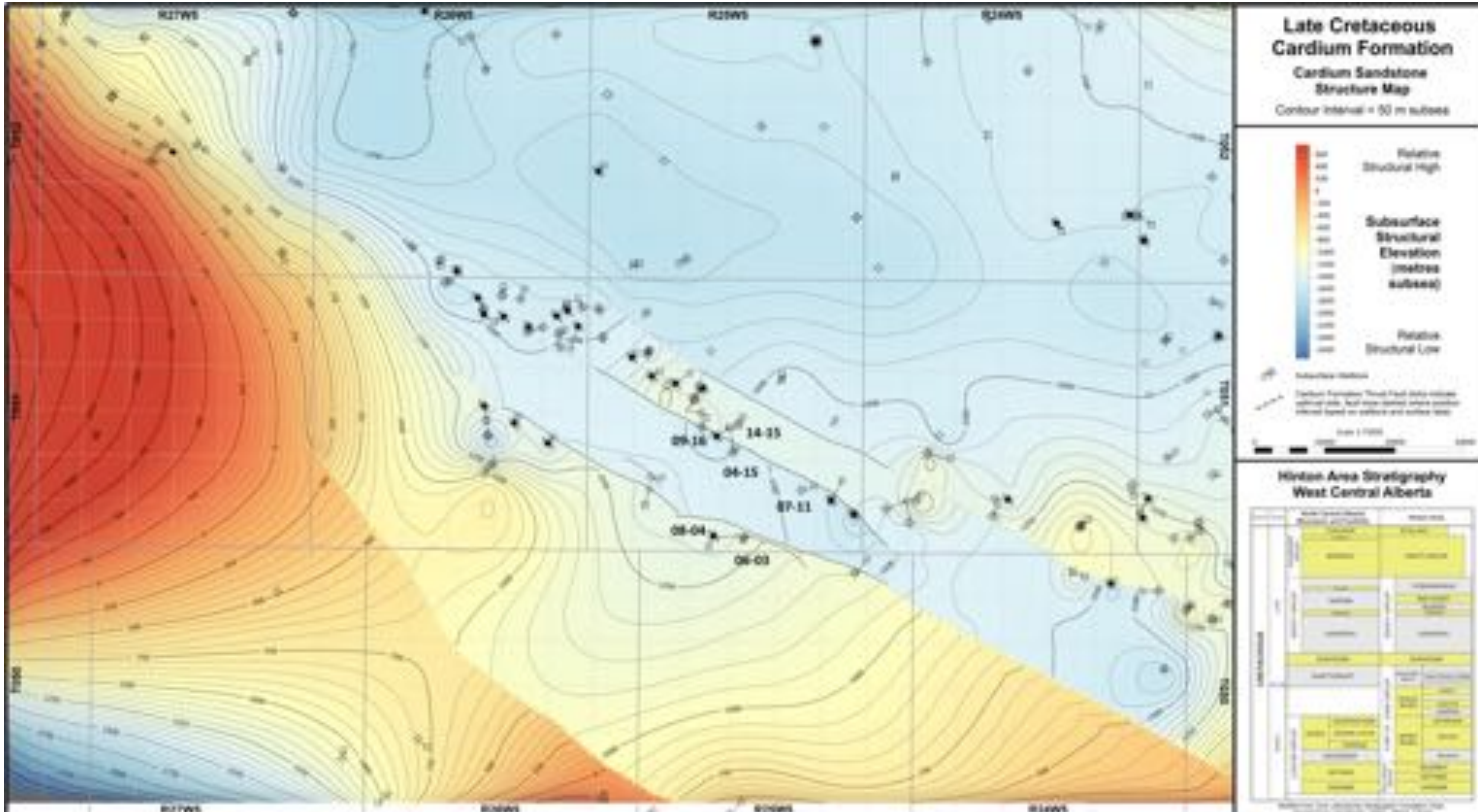
Late Cretaceous
Cardium Formation
Cardium Formation
Isopach Map
Contour interval = 2 m
Relative Thick
Cardium
Formation
Thickness
(metres)
Relative Thin
Hinton Area Stratigraphy
West Central Alberta
14-15
09-16
04-15
07-11
08-04
06-03

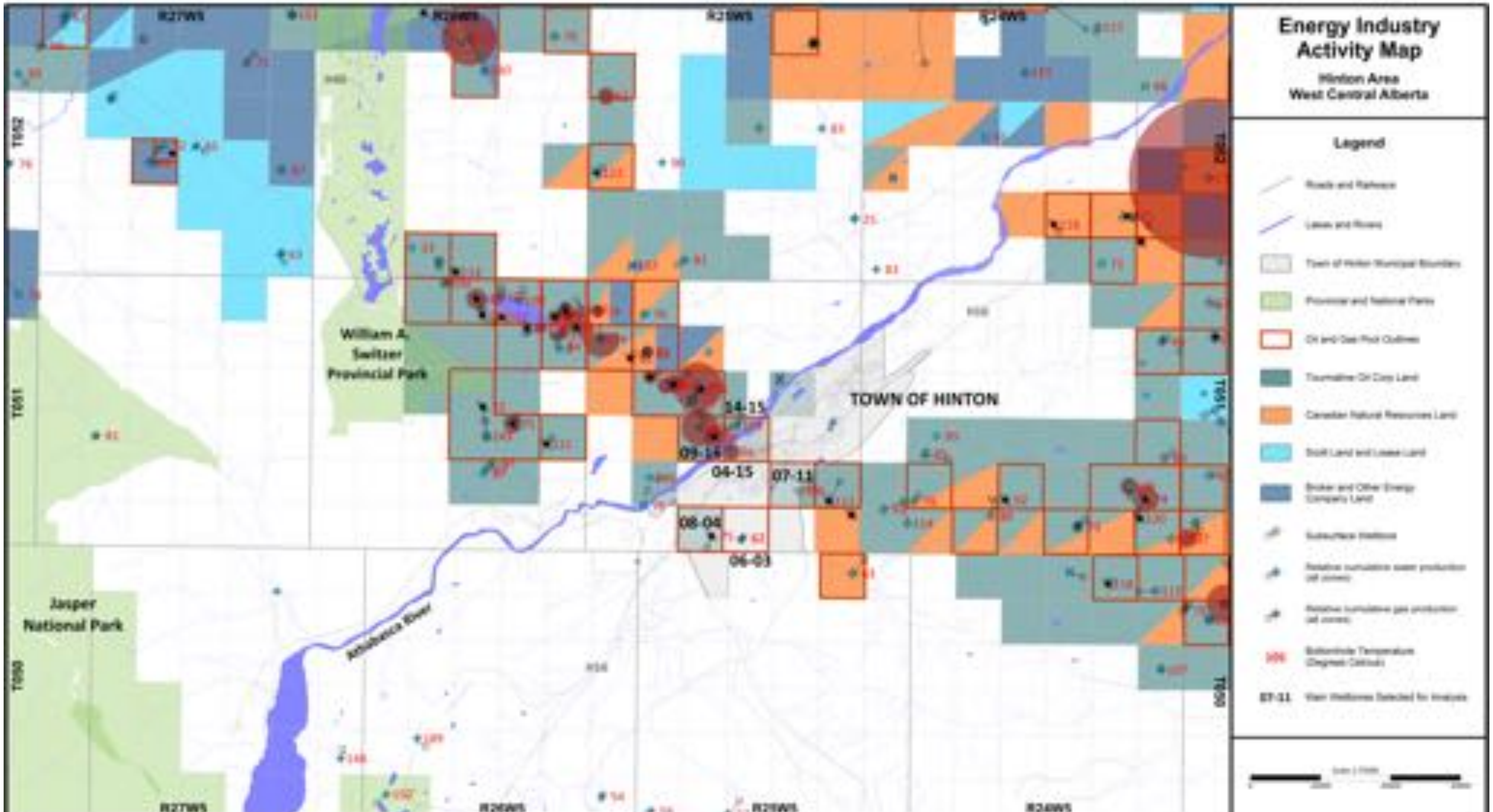


Late Cretaceous
Cardium Formation
Cardium Sandstone
Isopach Map
Contour interval = 5 m
Relative Thick
Cardium
Sandstone
Thickness
(metres)
Relative Thin
Hinton Area Stratigraphy
West Central Alberta
09-16
14-15
04-15
07-11
08-04
06-03
R27W5
R26W5
R25W5
R24W5

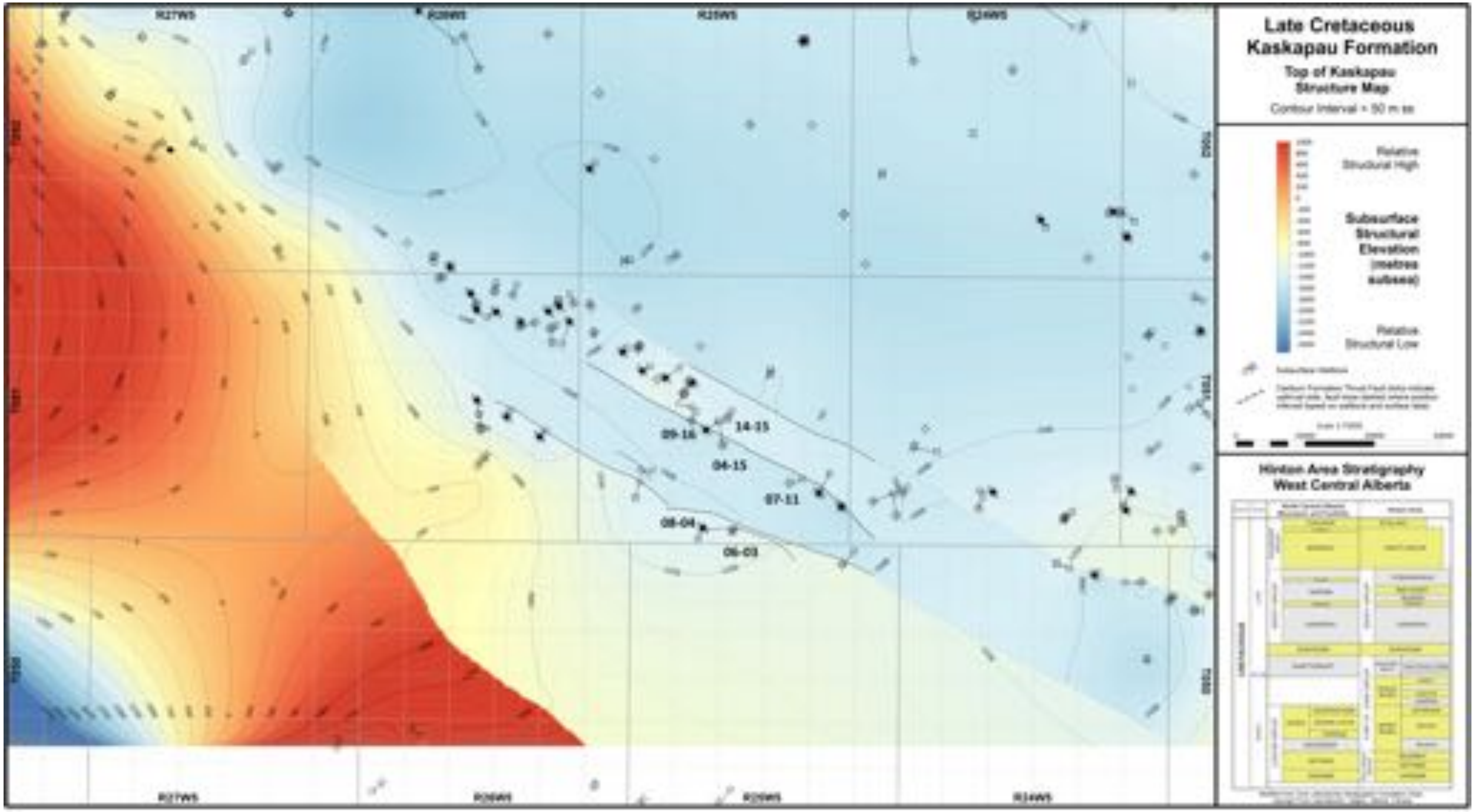


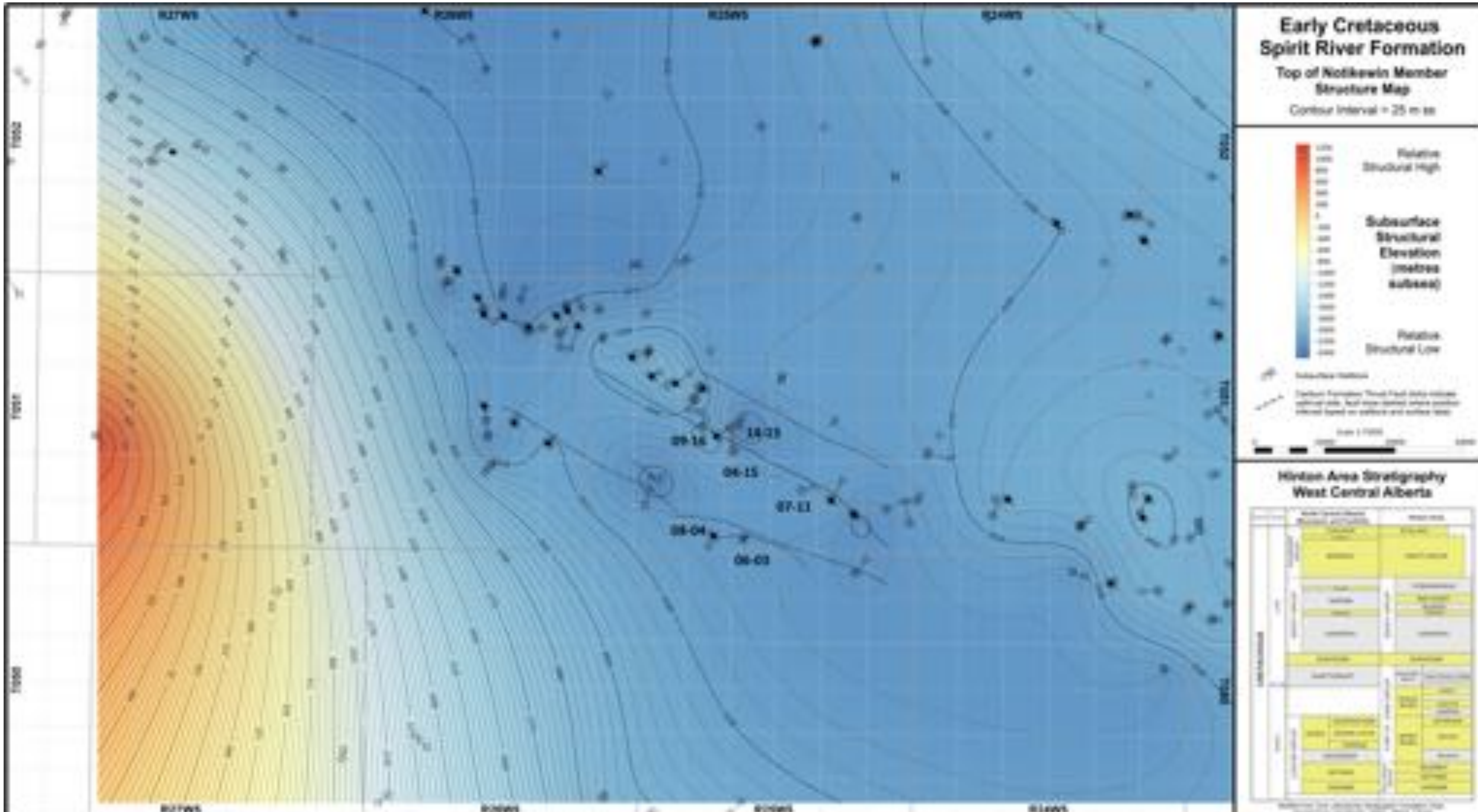
Late Cretaceous
Cardium Formation
Cardium Sandstone
Net Sand Map
Contour Interval = 5 m
Relative Thick
Cardium
Sandstone
Net Sand
Thickness
(metres)
Relative Thin
Hinton Area Stratigraphy
West Central Alberta
R27W5
R26W5
R25W5
R24W5
09-16
14-15
04-15
07-11
08-04
06-03


Late Cretaceous
Cardium Formation
Cardium Sandstone
Structure Map
Contour interval = 50 m subsea
Relative
Structural High
Subsurface
Structural
Elevation
(metres
subsea)
Relative
Structural Low
Hinton Area Stratigraphy
West Central Alberta
R27W5
R26W5
R25W5
R24W5
14-15
09-16
04-15
07-11
08-04
06-03

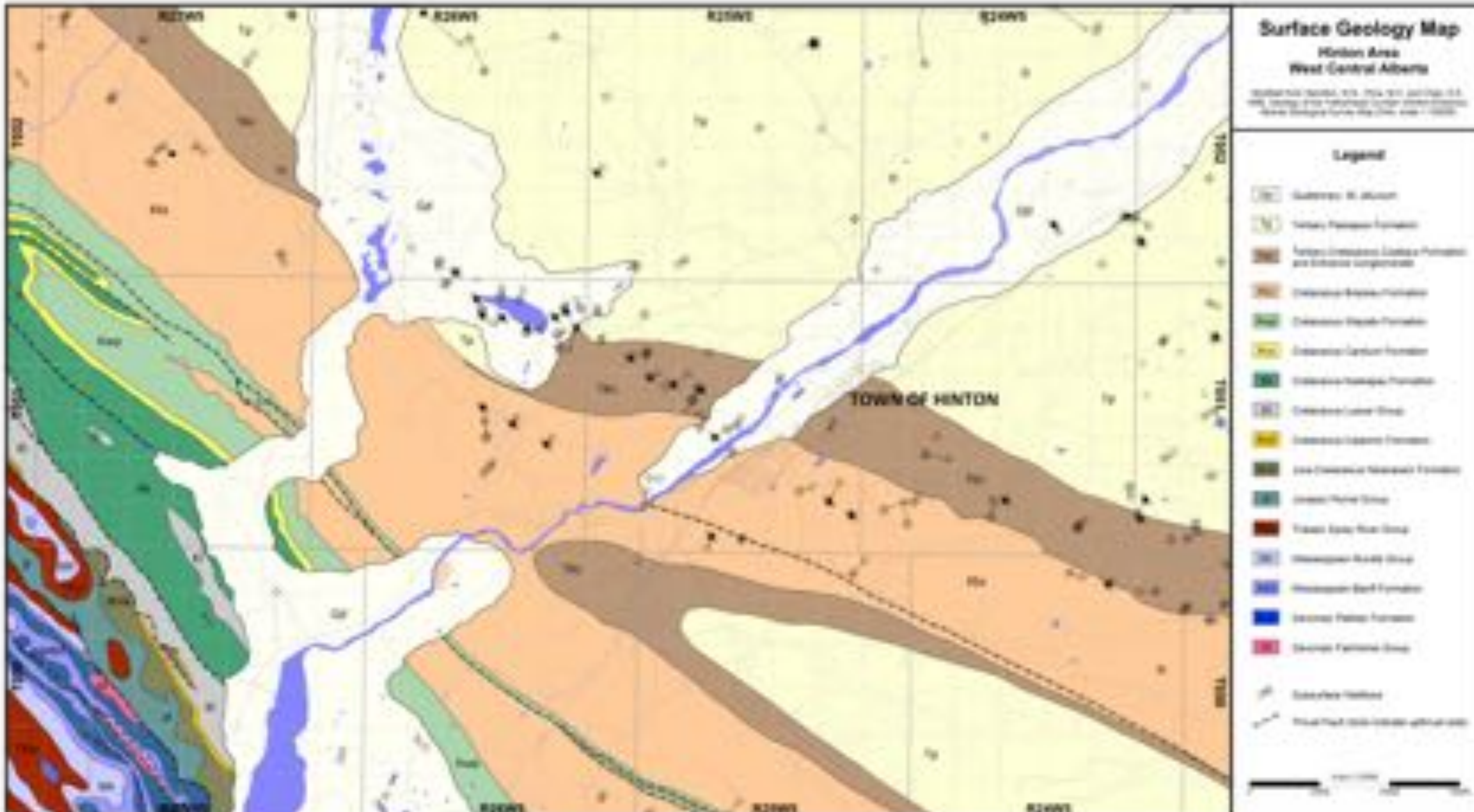


Energy Industry Activity Map
Hinton Area
West Central Alberta
Legend
Roads and Railways
Lakes and Rivers
Oil and Gas Pool Outlines
Tourmaline Oil Corp Land
Canadian Natural Resources Land
Bottomhole Temperature (Degrees Celsius)
Main Wellbores Selected for Analysis
TOWN OF HINTON
William A. Switzer Provincial Park
Jasper National Park
Athabasca River
R27W5
R26W5
R25W5
R24W5
T052
T051
T050
14-15
09-14
04-15
07-11
08-04
06-03


Late Cretaceous
Kaskapau Formation
Top of Kaskapau
Structure Map
Contour Interval = 50 m ss
Relative
Structural High
Subsurface
Structural
Elevation
(metres
subsea)
Relative
Structural Low
Hinton Area Stratigraphy
West Central Alberta
R27W5
R26W5
R25W5
R24W5
09-16
14-15
04-15
07-11
08-04
06-03



Early Cretaceous
Spirit River Formation
Top of Notikewin Member
Structure Map
Contour Interval = 25 m ss
Relative
Structural High
Subsurface
Structural
Elevation
(metres
subsea)
Relative
Structural Low
Hinton Area Stratigraphy
West Central Alberta
R27W5
R26W5
R25W5
R24W5
09-16
14-15
04-15
07-11
08-04
06-03



Surface Geology Map
Hinton Area
West Central Alberta
Legend
TOWN OF HINTON
R26W5
R25W5
R24W5

Appendix C.1.3 Well Analysis: Wireline Logs & Formation Tops

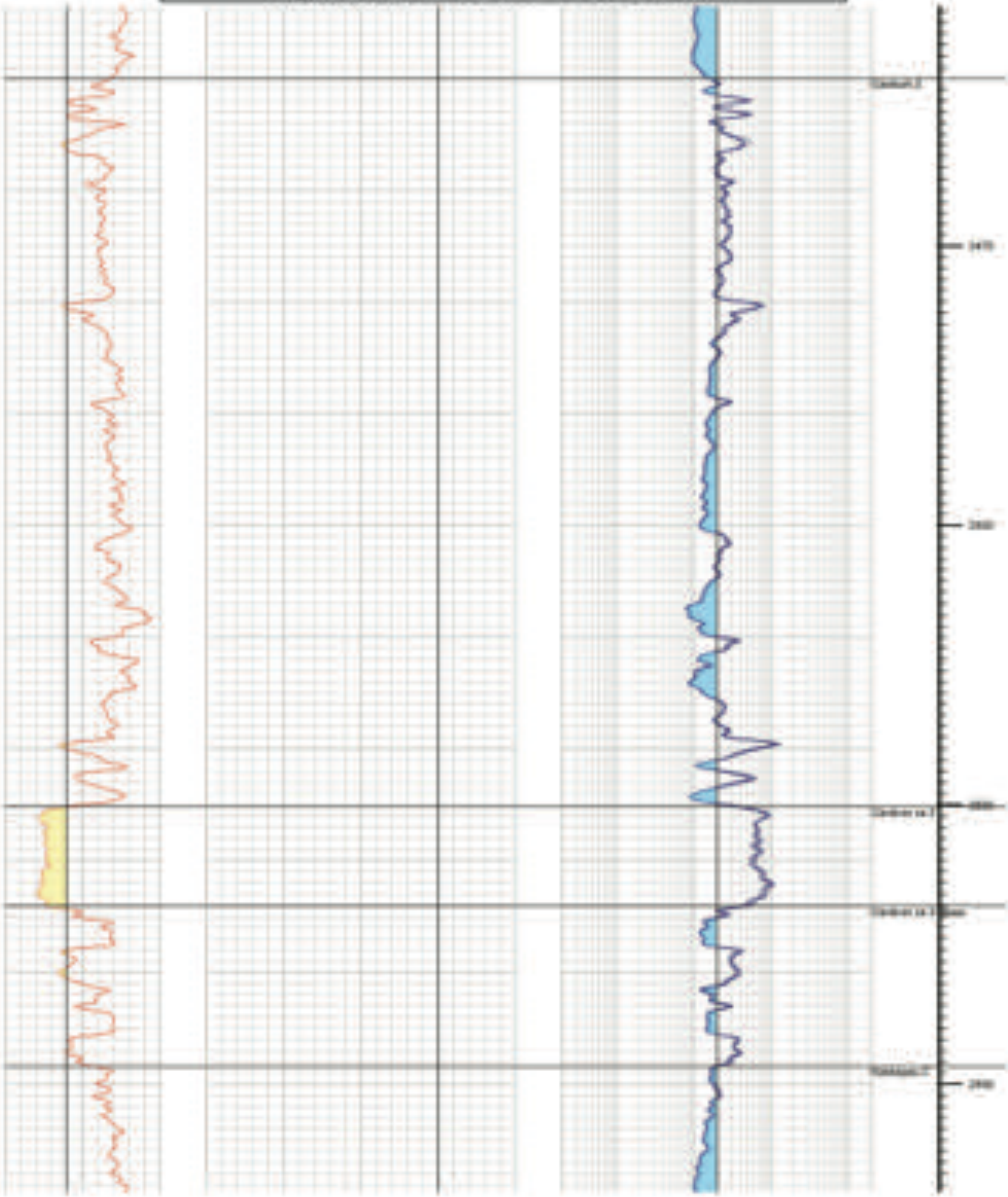
100/04-15-051-25W5/00 Formation Tops

Formation	TVD (m)	Subsea (m)	MD (m)	0% ϕ Net Sand (m)	3% ϕ Net Sand (m)	Net Pay (0% ϕ, 20 Ω)	Net Pay (3% ϕ, 20 Ω)
Wapiabi 2	1531.6	-525.1	1620.8				
Milk River 2	1610.7	-604.2	1711.9				
fault 1	1735.0	-728.5	1851.7				
Wapiabi	1735.8	-729.3	1852.7				
Badheart 2	2153.9	-1147.4	2329.0				
Muskiki 2	2190.6	-1184.1	2370.4				
Cardium 2	2273.1	-1266.6	2460.0				
Cardium ss 2	2335.6	-1329.1	2525.2	8.6	No por curve	No por curve	No por curve
Cardium ss 2 Base	2344.2	-1337.7	2534.1				
Kaskapau 2	2358.1	-1351.6	2548.4				
fault 2	2396.4	-1389.9	2587.6				
Cardium	2431.2	-1424.7	2623.0				
Cardium ss	2499.5	-1493.0	2692.1	8.9	No por curve	No por curve	No por curve
Cardium ss Base	2508.4	-1501.9	2701.1				
Kaskapau	2520.4	-1513.9	2713.2				
Dunvegan	2921.7	-1915.2	3115.6	6.4	5.2	No R-curve	No R-curve
fault 3	3032.6	-2026.1	3226.6				
Fish Scale Zone	3117.6	-2111.1	3312.0				
Base Fish Scales	3156.2	-2149.7	3350.7				
Peace River	3167.5	-2161.0	3362.0				
Notikewin	3192.7	-2186.2	3387.3	33.3	18.8	No R-curve	No R-curve
Fahler	3252.1	-2245.6	3446.7				
Fahler B	3289.4	-2282.9	3484.1				
Fahler C	3302.3	-2295.8	3497.1				
Fahler D	3321.1	-2314.6	3516.0				
Well TD	3395.8	-2389.3	3592.0				
			TOTAL	57.1	24.0		

100/04-15-051-25W5/00 Completions

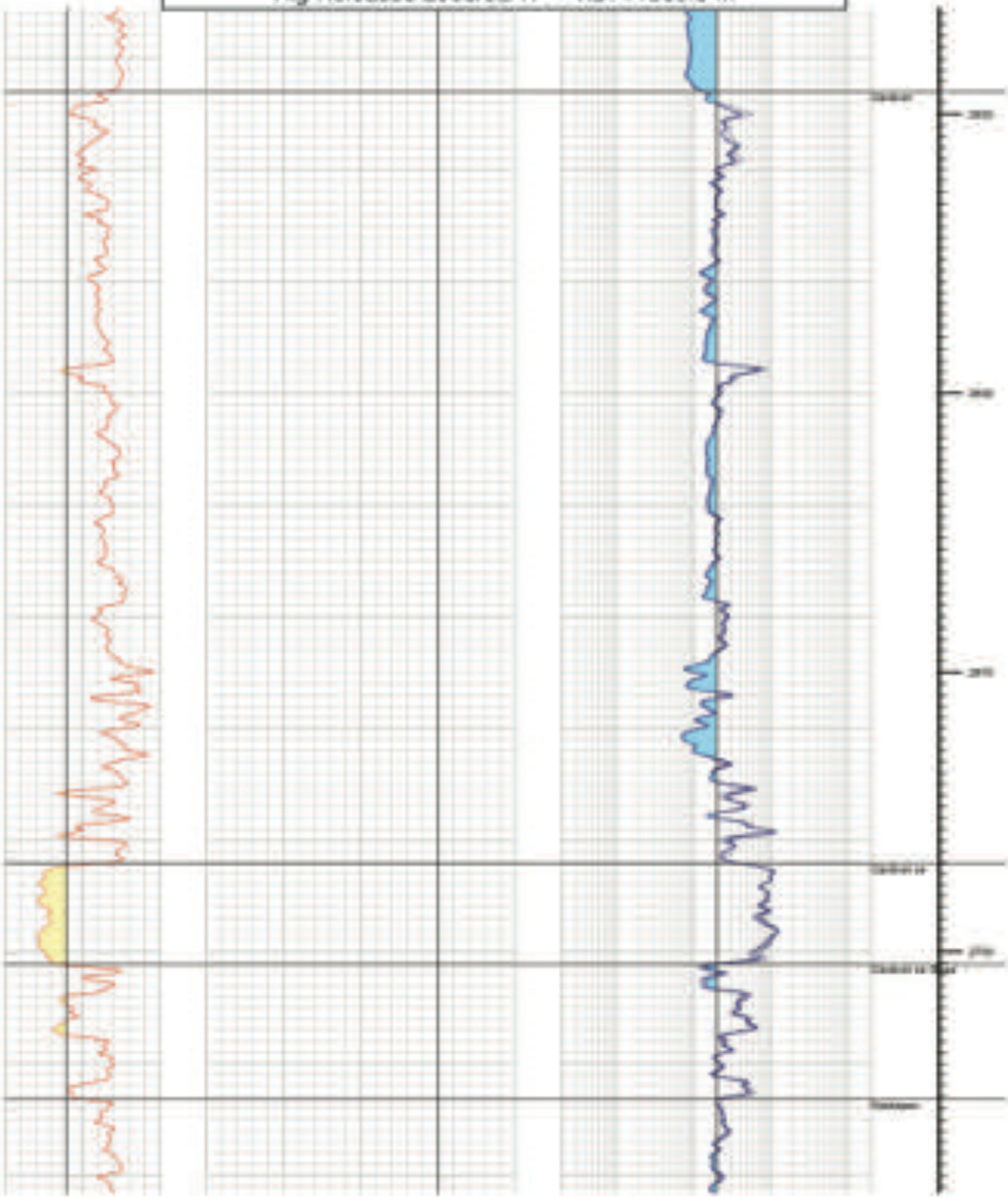
Date	Interval		Type	Subtype		Formation
2008-03-04	3432.0	3435.0	Perf	Jet	@ 17sh/m	Notikewin
2008-03-04	3404.0	3409.0	Perf	Jet	@ 17sh/m	Notikewin
2008-03-05	3393.0	3396.0	Perf	Jet	@ 17sh/m	Notikewin
2008-03-07	3432.0	3435.0	Treat	Frac		Notikewin
2008-03-07	3404.0	3409.0	Treat	Frac		Notikewin
2008-03-07	3393.0	3396.0	Treat	Frac		Notikewin
2008-07-07	3180.0		Treat	BridgePlug		Shaftesbury
2008-07-07	3142.0	3146.0	Perf	Jet	@ 17sh/m	Dunvegan
2008-07-07	3137.5	3139.0	Perf	Jet	@ 17sh/m	Dunvegan
2008-07-08	3142.0	3146.0	Treat	Frac		Dunvegan
2008-07-08	3137.5	3139.0	Treat	Frac		Dunvegan

Tourmaline Hinton 4-15-51-25
100/04-15-051-25W5/00
Rig Released 2008/02/17 KB: +1006.5 m



Cretaceous Cardium Formation: CRDM to KSKP
Upper Thrust Repeat
Cardium Sandstone: 8.6 m Net Sand
60 API sand, 0% ss porosity cutoffs

Tourmaline Hinton 4-15-51-25
100/04-15-051-25W5/00
Rig Released 2008/02/17 KB: +1006.5 m

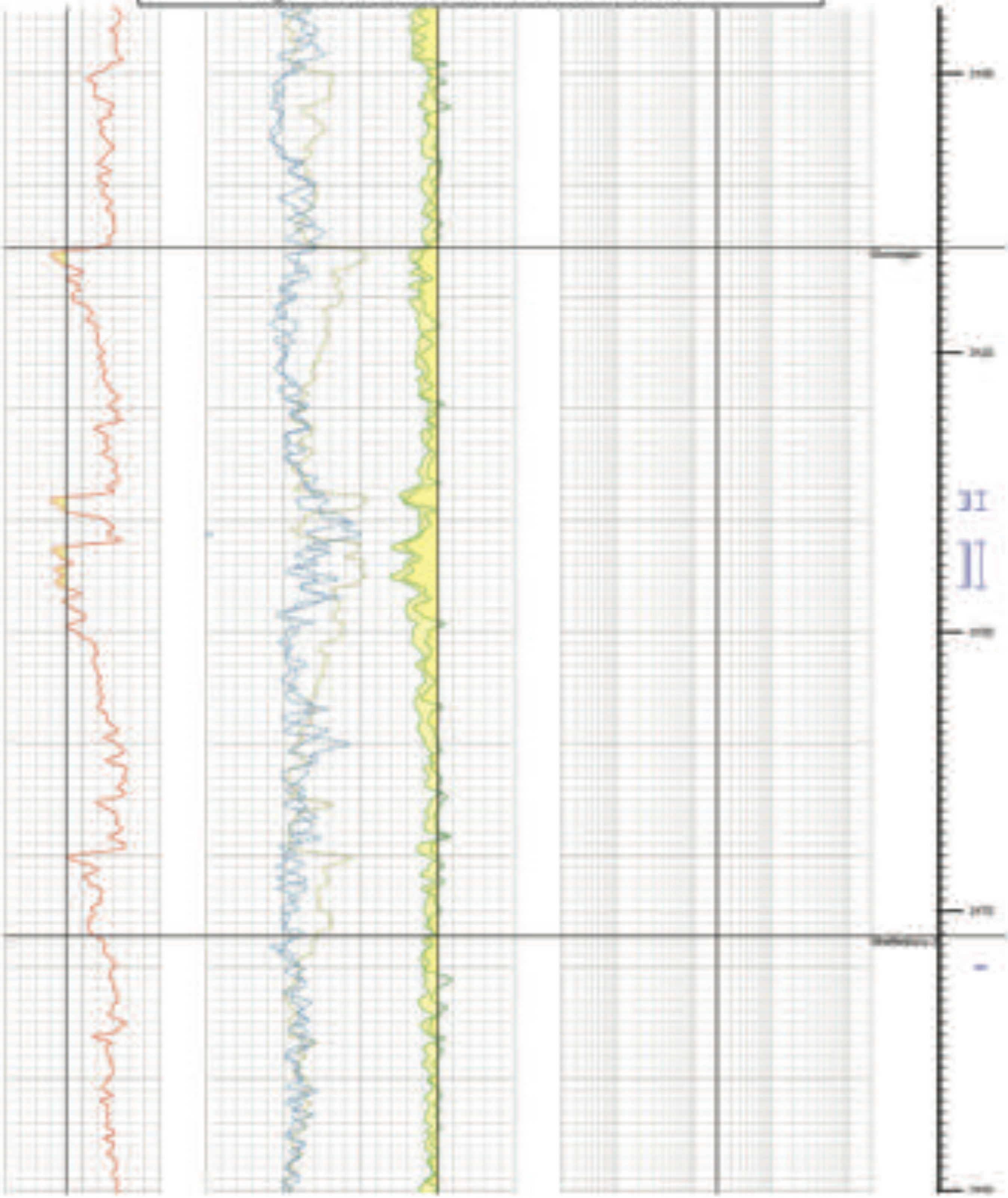


Cretaceous Cardium Formation: CRDM to KSKP
Lower Thrust Repeat
Cardium Sandstone: 8.9 m Net Sand
60 API sand, 0% ss porosity cutoffs

Tourmaline Hinton 4-15-51-25

100/04-15-051-25W5/00

Rig Released 2008/02/17   KB: +1006.5 m

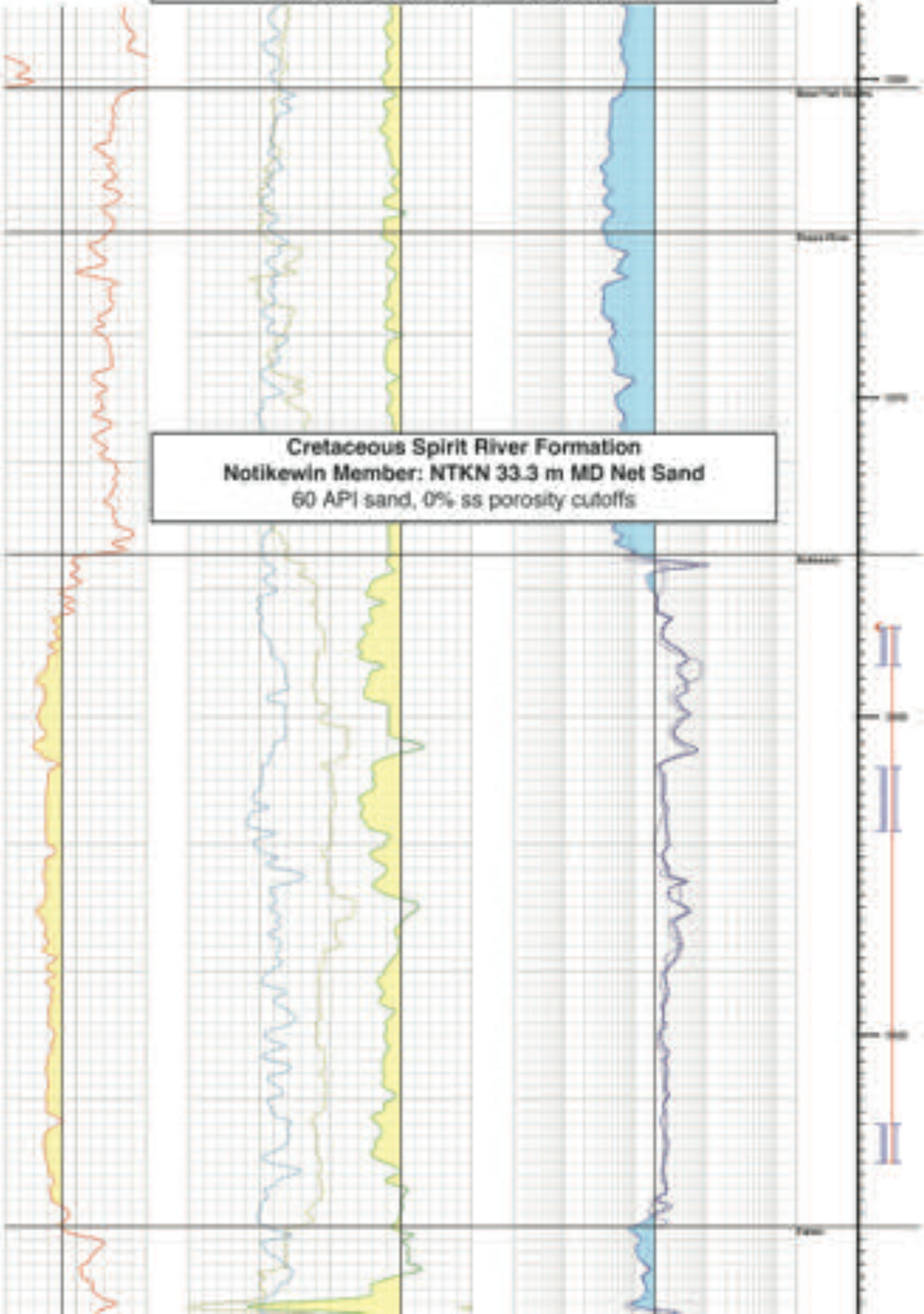


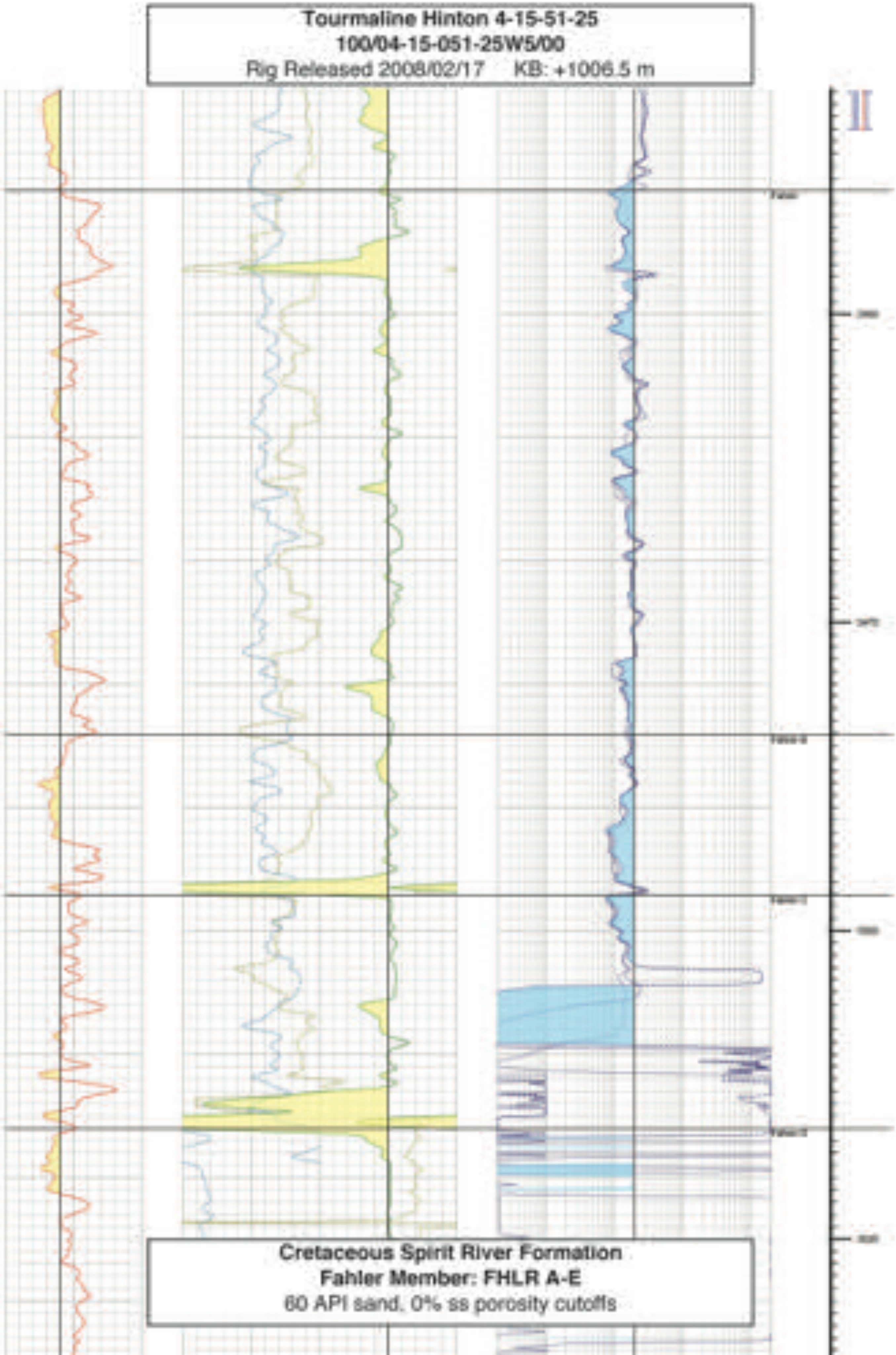
Cretaceous Dunvegan Formation: DNVG

6.4 m Net Sand

60 API sand, 0% ss porosity cutoffs

Tourmaline Hinton 4-15-51-25
100/04-15-051-25W5/00
Rig Released 2008/02/17 KB: +1006.5 m



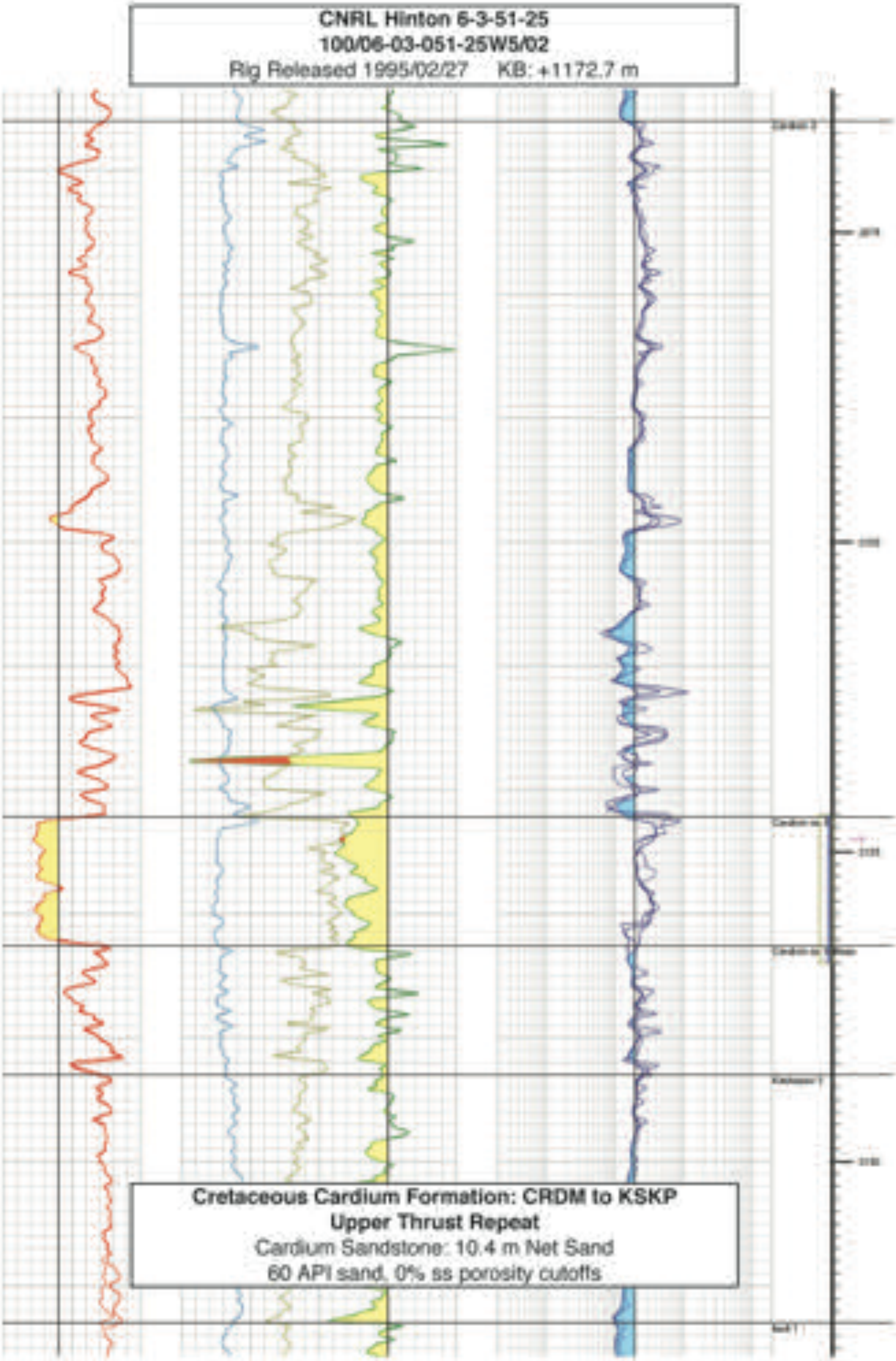

Tourmaline Hinton 4-15-51-25
100/04-15-051-25W5/00
Rig Released 2008/02/17 KB: +1006.5 m
Cretaceous Spirit River Formation
Fahler Member: FHLR A-E
60 API sand, 0% ss porosity cutoffs

100/06-03-051-25W5/02 Formation Tops

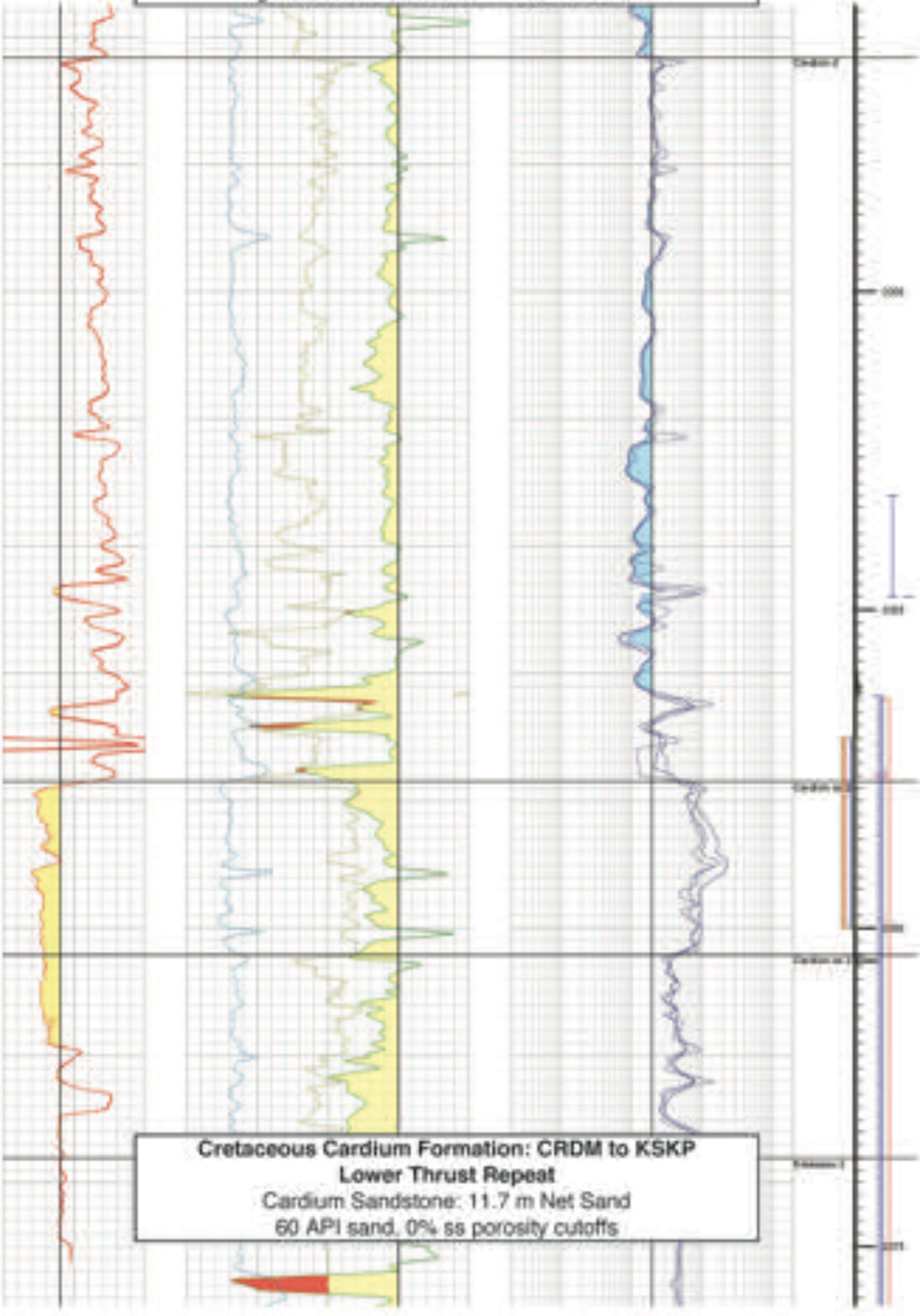
Formation	TVD (m)	Subsea (m)	MD (m)	0% ϕ Net Sand (m)	3% ϕ Net Sand (m)	Net Pay (0% ϕ, 20 Ω)	Net Pay (3% ϕ, 20 Ω)
Bad Heart 3	1957.3	-784.6	1963.9				
Muskiki 3	1987.2	-814.5	1993.9				
Cardium 3	2059.0	-886.3	2066.0				
Cardium ss 3	2115.1	-942.4	2122.2	10.4	9.3	8.8	8.7
Cardium ss 3 Base	2125.5	-952.8	2132.6				
Kaskapau 3	2135.9	-963.2	2143.0				
fault 1	2155.9	-983.2	2163.0				
Badheart 2	2166.5	-993.8	2173.6				
Muskiki 2	2201.0	-1028.3	2208.1				
Cardium 2	2274.4	-1101.7	2281.6				
Cardium ss 2	2331.0	-1158.3	2338.5	11.7	9.3	11.2	9.3
Cardium ss 2 Base	2344.5	-1171.8	2352.1				
Kaskapau 2	2360.4	-1187.7	2368.1				
Well TD	2384.1	-1211.4	2392.0				
			TOTAL	22.1	18.6	20.0	18.1

100/06-03-051-25W5/02 Completions

Date	Interval		Type	Subtype		Formation
1995-01-19	900.0	1022.0	Plug	Whipstock		
1995-03-07	2331.7	2392.0	OpenHole			CRDS 2 Base
1995-07-29	1608.0	1615.0	Perf	Jet	@ 13sh/m	CRDS 2 Base
2005-06-16	2316.0	2324.0	Treat	BridgePlug		CRDM 2
2005-06-16	2324.0		Plug	Abandoned		CRDM 2
2005-06-16	1592.0	1600.0	Treat	BridgePlug		CRDM 2
2005-06-16	1600.0		Plug	Abandoned		CRDM 2


CNRL Hinton 6-3-51-25
100/06-03-051-25W5/02
Rig Released 1995/02/27 KB: +1172.7 m
Cretaceous Cardium Formation: CRDM to KSKP
Upper Thrust Repeat
Cardium Sandstone: 10.4 m Net Sand
60 API sand, 0% ss porosity cutoffs

CNRL Hinton 6-3-51-25
100/06-03-051-25W5/02
Rig Released 1995/02/27   KB: +1172.7 m



Cretaceous Cardium Formation: CRDM to KSKP
Lower Thrust Repeat
Cardium Sandstone: 11.7 m Net Sand
60 API sand, 0% ss porosity cutoffs

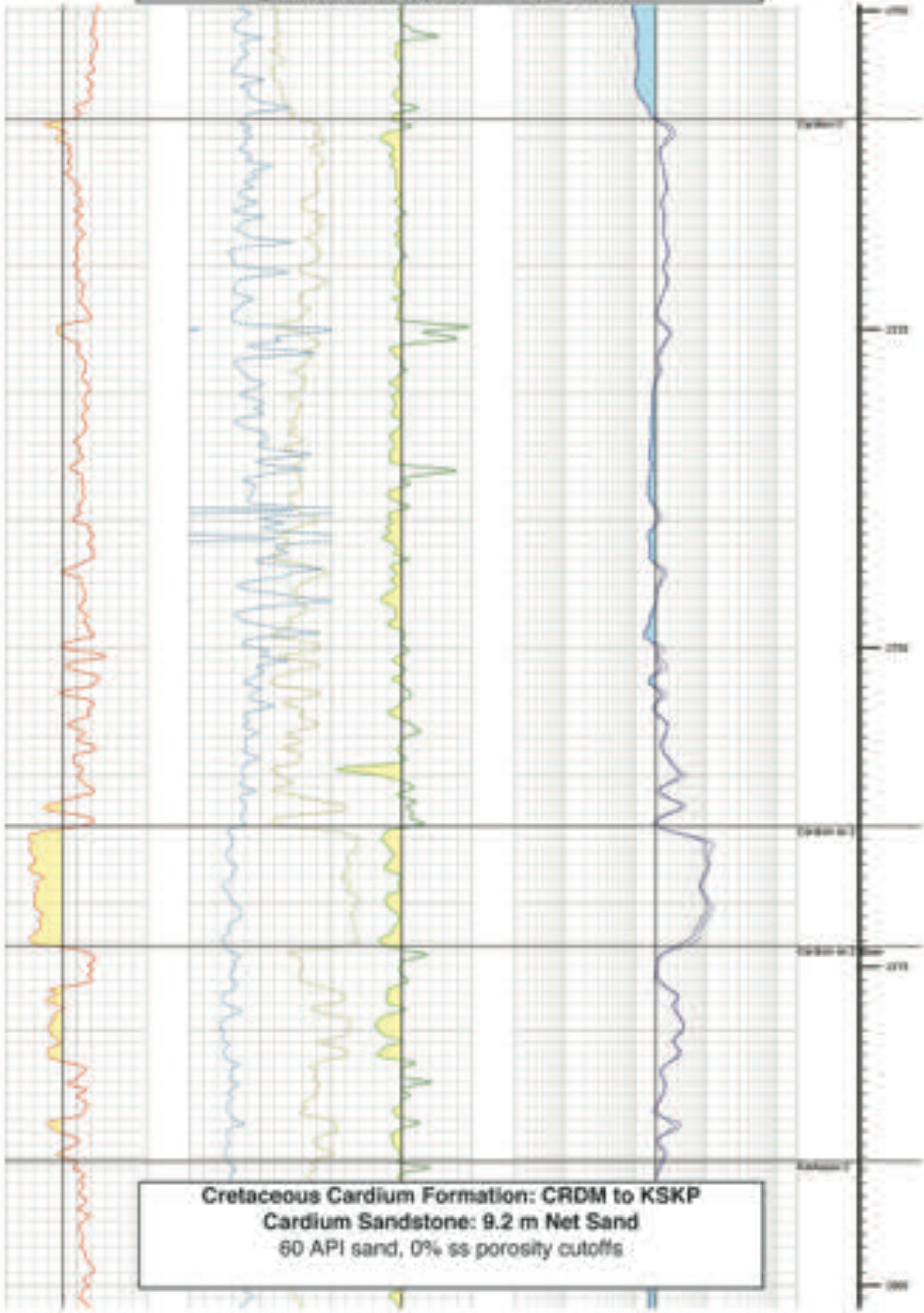
100/07-11-051-25W5/00 Formation Tops

Formation	TVD (m)	Subsea (m)	MD (m)	0% ϕ Net Sand (m)	3% ϕ Net Sand (m)	Net Pay (0% ϕ, 20 Ω)	Net Pay (3% ϕ, 20 Ω)
Wapiabi	1984.5	-845.6	2030.4				
Milk River	2040.0	-901.1	2088.0				
Bad Heart	2545.7	-1406.8	2604.7				
Muskiki 2	2578.0	-1439.1	2637.0				
Cardium 2	2649.3	-1510.4	2708.5				
Cardium ss 2	2704.7	-1565.8	2764.0	9.2	3.3	9.2	3.3
Cardium ss 2 Base	2714.1	-1575.2	2773.4				
Kaskapau 2	2731.0	-1592.1	2790.3				
Dunvegan	3167.1	-2028.2	3227.0				
Shaftesbury 2	3230.3	-2091.4	3290.4				
Fish Scale Zone	3306.7	-2167.8	3366.8				
Base Fish Scales	3320.5	-2181.6	3380.6				
Peace River	3331.3	-2192.4	3391.4				
Notikewin	3354.1	-2215.2	3414.2	27.7	18.7	23.2	15.5
Fahler	3392.4	-2253.5	3452.6				
Fahler B	3407.0	-2268.1	3467.2				
Fahler C	3413.2	-2274.3	3473.4				
Fahler D	3432.1	-2293.2	3492.3				
Fahler E	3439.3	-2300.4	3499.5				
Well TD	3469.8	-2330.9	3530.0				
			TOTAL	27.7	18.7	23.2	15.5

100/07-11-051-25W5/00 Completions

Date	**Interval**		**Type**	**Subtype**		**Formation**
Date	Interval		Type	Subtype		Formation
2010-01-27	3447.5	3448.0	Perf	Jet	@ 6sh/m	Notikewin
2010-01-27	3443.5	3444.0	Perf	Jet	@ 3sh/m	Notikewin
2010-01-27	3439.5	3440.0	Perf	Jet	@ 6sh/m	Notikewin
2010-01-27	3421.5	3422.0	Perf	Jet	@ 3sh/m	Notikewin
2010-01-28	3421.5	3448.0	Treat	Frac		Notikewin
2010-01-29	3258.0	3258.5	Perf	Jet	@ 6sh/m	Dunvegan
2010-01-29	3254.5	3255.0	Perf	Jet	@ 3sh/m	Dunvegan
2010-01-29	3241.5	3242.0	Perf	Jet	@ 3sh/m	Dunvegan
2010-01-29	3230.0	3230.5	Perf	Jet	@ 6sh/m	Dunvegan
2010-01-30	3230.0	3258.5	Treat	Frac		Dunvegan

Tourmaline Hinton 7-11-51-25
100/07-11-051-25W5/00
Rig Released 2009/12/07   KB: +1038.9 m

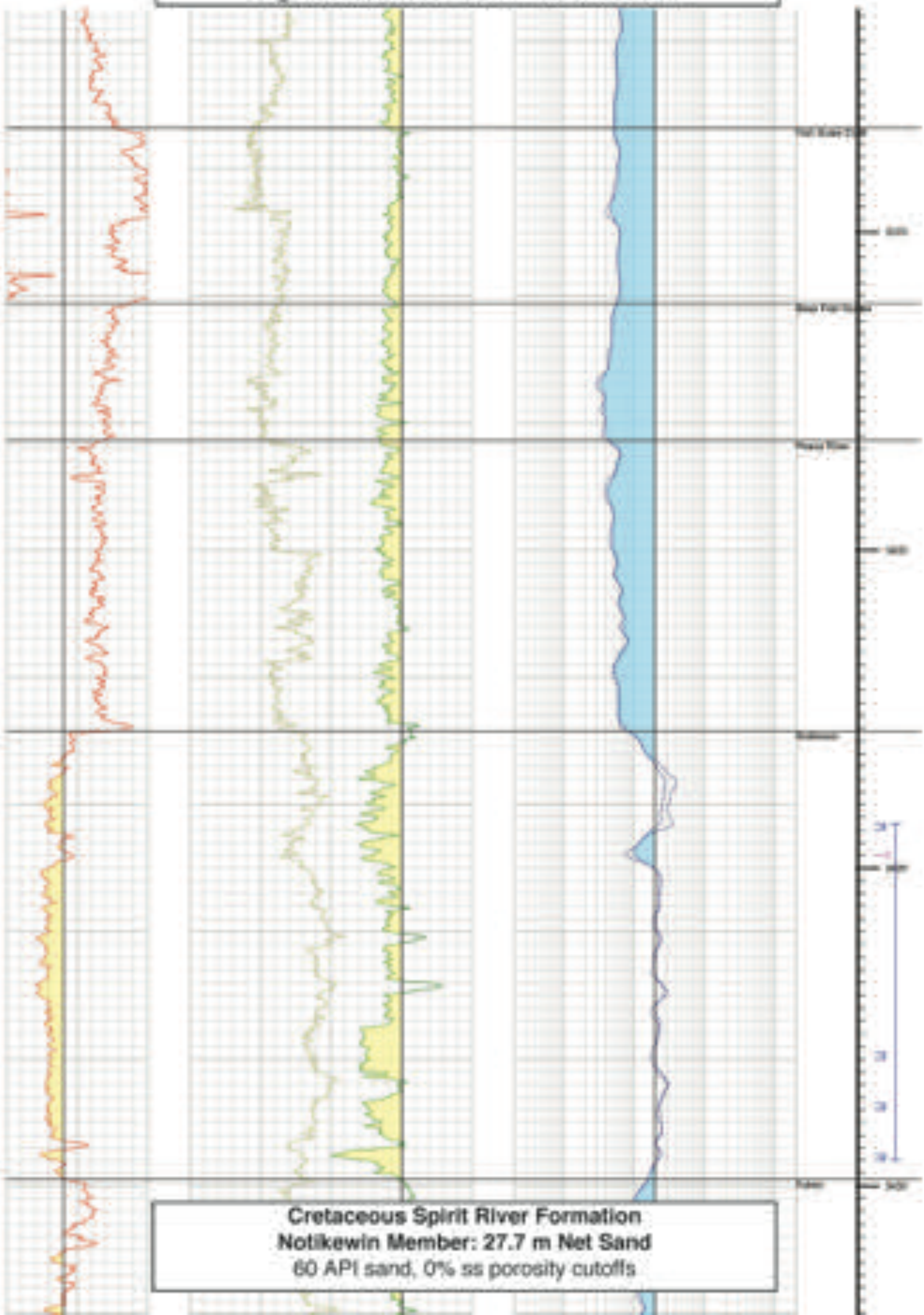


Cretaceous Cardium Formation: CRDM to KSKP
Cardium Sandstone: 9.2 m Net Sand
60 API sand, 0% ss porosity cutoffs

Tourmaline Hinton 7-11-51-25

100/07-11-051-25W5/00

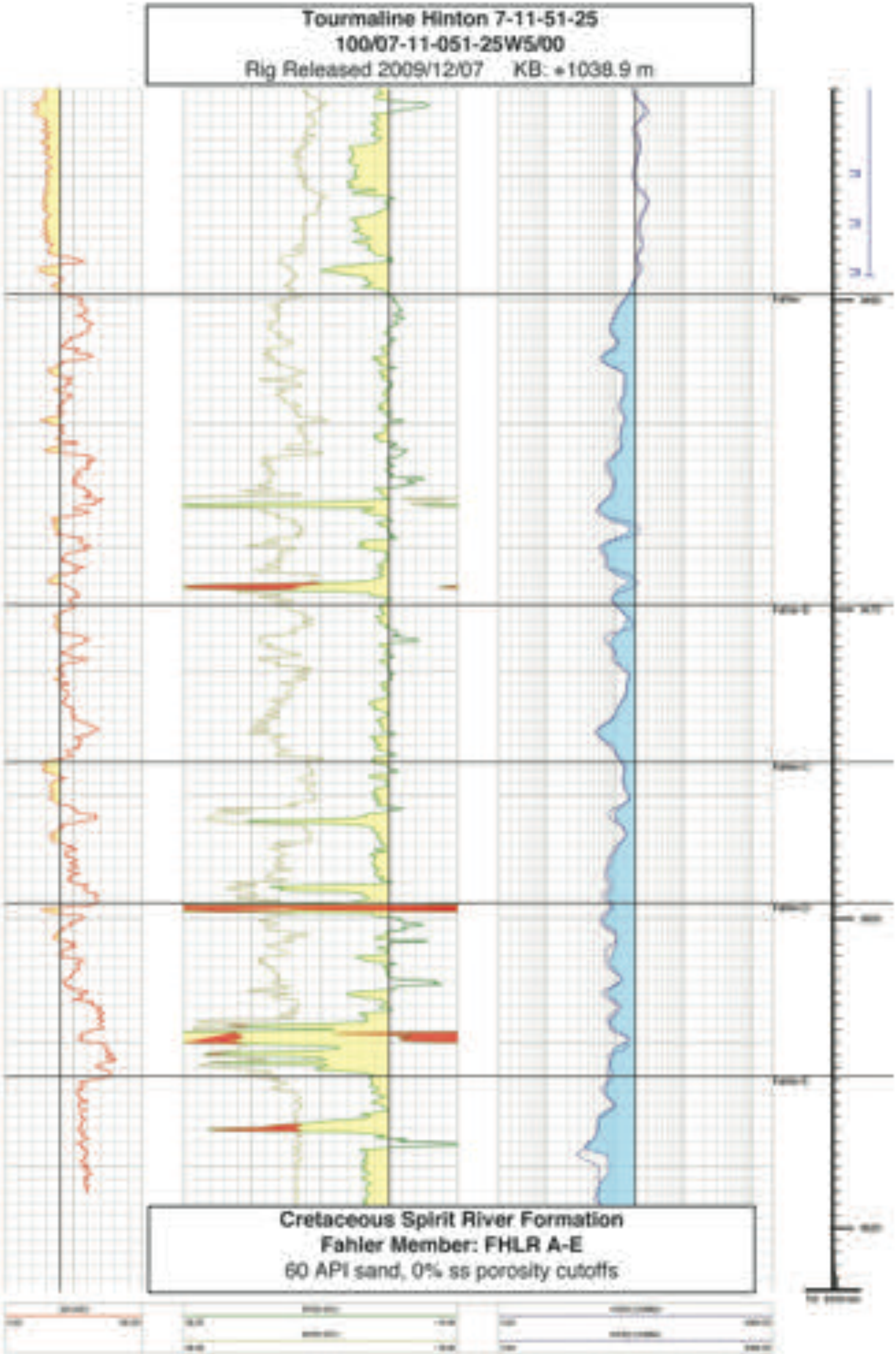
Rig Released 2009/12/07 KB: +1038.9 m



Cretaceous Spirit River Formation

Notikewin Member: 27.7 m Net Sand

60 API sand, 0% ss porosity cutoffs

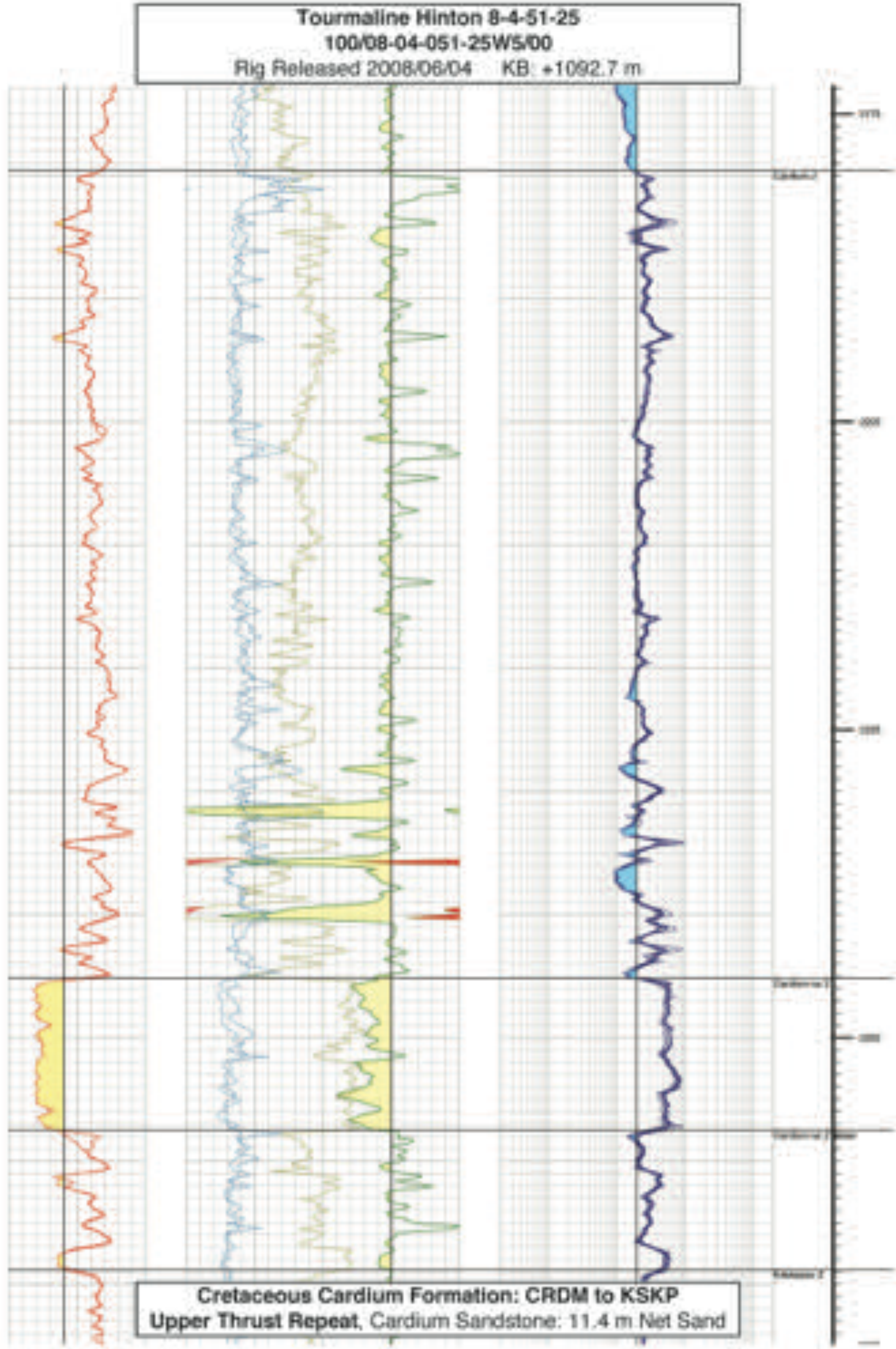

Tourmaline Hinton 7-11-51-25
100/07-11-051-25W5/00
Rig Released 2009/12/07 KB: +1038.9 m
Cretaceous Spirit River Formation
Fahler Member: FHLR A-E
60 API sand, 0% ss porosity cutoffs

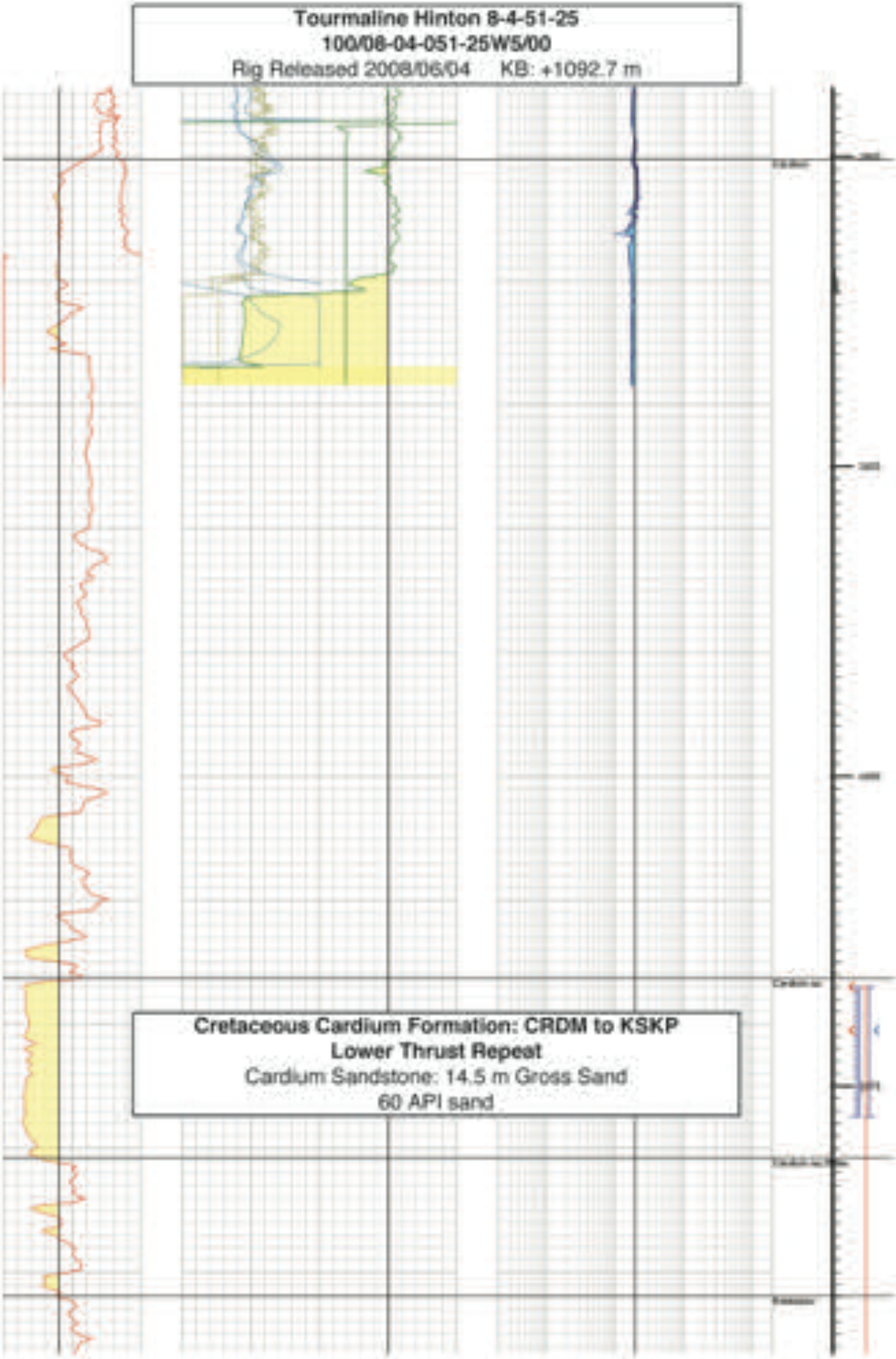
100/08-04-051-25W5/00 Formation Tops

Formation	TVD (m)	Subsea (m)	MD (m)	0% ϕ Net Sand (m)	3% ϕ Net Sand (m)	Net Pay (0% ϕ, 20 Ω)	Net Pay (3% ϕ, 20 Ω)
Wapiabi	1355.2	-262.6	1377.9				
Milk River	1422.2	-329.6	1447.0				
Bad Heart 3	1897.5	-804.9	1943.5				
Muskiki 3	1929.4	-836.8	1976.2				
fault 1	1980.2	-887.6	2028.6				
Muskiki 2	2053.0	-960.4	2102.9				
Cardium 2	2129.6	-1037.0	2179.6				
Cardium ss 2	2195.2	-1102.6	2245.2	11.4	10.5	11.4	10.5
Cardium ss 2 Base	2207.5	-1114.9	2257.5				
Kaskapau 2	2218.8	-1126.2	2268.8				
fault 2	2270.4	-1177.8	2320.4				
Cardium	2350.2	-1257.6	2400.2				
Cardium ss	2416.3	-1323.7	2466.3	GR only	GR only	GR only	GR only
Cardium ss Base	2430.8	-1338.2	2480.8				
Kaskapau	2441.9	-1349.3	2491.9				
Dunvegan	3004.7	-1912.1	3054.8				
Shafesbury	3092.1	-1999.5	3142.2				
Fish Scale Zone	3150.5	-2057.9	3200.6				
Base Fish Scales	3198.6	-2106.0	3248.7				
Peace River	3235.0	-2142.4	3285.1				
Notikewin	3304.1	-2211.5	3354.2	GR only	GR only	GR only	GR only
Fahler	3362.6	-2270.0	3412.7				
Well TD	3375.9	-2283.3	3426.0				
			TOTAL	11.4	10.5	11.4	10.5

100/08-04-051-25W5/00 Completions

Date	Interval		Type	Subtype		Formation
2008-10-16	3302.5	3397.5	Perf	Jet	@ 1sh/m	Peace River
2008-10-18	3302.5	3397.5	Treat	Frac		Peace River
2008-10-21	3048.0	3104.6	Perf	Jet	@ 1sh/m	Dunvegan
2008-10-24	3048.0	3104.6	Treat	Frac		Dunvegan
2008-11-02	2467.0	2477.5	Perf	Jet	@ 20sh/m	Cardium ss
2008-11-04	2467.0	2477.5	Treat	Frac		Cardium ss


Tourmaline Hinton 8-4-51-25
100/08-04-051-25W5/00
Rig Released 2008/06/04 KB: +1092.7 m
Cretaceous Cardium Formation: CRDM to KSKP
Upper Thrust Repeat, Cardium Sandstone: 11.4 m Net Sand


Tourmaline Hinton 8-4-51-25
100/08-04-051-25W5/00
Rig Released 2008/06/04 KB: +1092.7 m
Cretaceous Cardium Formation: CRDM to KSKP
Lower Thrust Repeat
Cardium Sandstone: 14.5 m Gross Sand
60 API sand

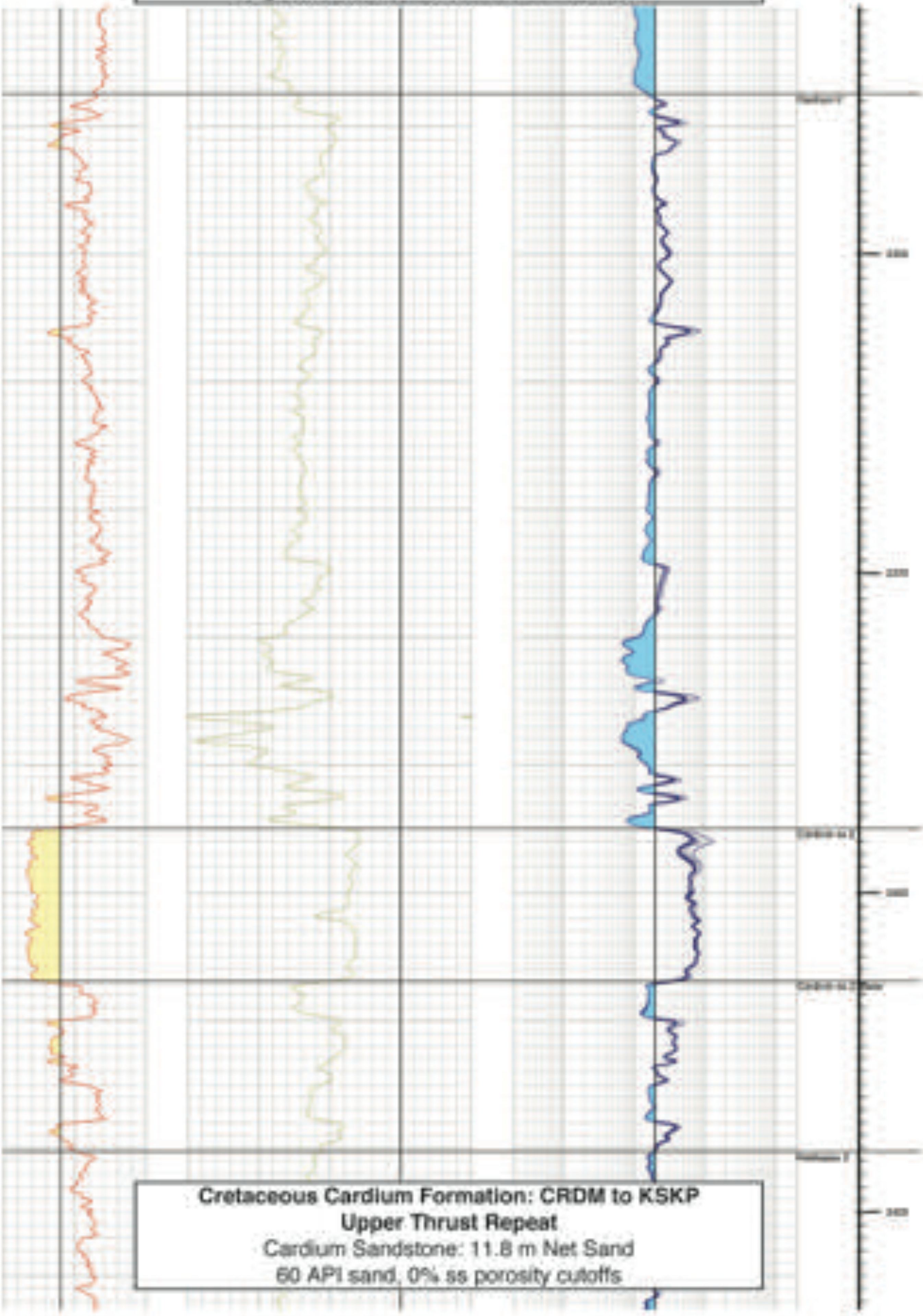
100/09-16-051-25W5/00 Formation Tops

Formation	TVD (m)	Subsea (m)	MD (m)	0% ϕ Net Sand (m)	3% ϕ Net Sand (m)	Net Pay (0% ϕ, 20 Ω)	Net Pay (3% ϕ, 20 Ω)
Wapiabi 2	1563.4	-556.6	1618.0				
Milk River 2	1604.3	-597.5	1661.9				
Badheart 2	2137.2	-1130.4	2225.8				
Muskiki 2	2170.9	-1164.1	2261.2				
Cardium 2	2245.2	-1238.4	2337.5				
Cardium ss 2	2302.4	-1295.6	2395.0				
Cardium ss 2 Base	2314.2	-1307.4	2406.9	11.8	no den curve	no den curve	no den curve
Kaskapau 2	2327.6	-1320.8	2420.3				
fault 2	2344.6	-1337.8	2437.3				
Bad Heart	2388.7	-1381.9	2481.4				
Muskiki	2419.8	-1413.0	2512.5				
Cardium	2486.0	-1479.2	2578.7				
Cardium ss	2540.3	-1533.5	2633.0	8.7	no den curve	no den curve	no den curve
Cardium ss Base	2549.0	-1542.2	2641.7				
Kaskapau	2561.3	-1554.5	2654.0				
Dunvegan	2909.4	-1902.6	3002.3				
Shaftesbury 2	2969.0	-1962.2	3061.9				
fault 3	3016.7	-2009.9	3109.6				
Fish Scale Zone	3062.0	-2055.2	3154.9				
Base Fish Scales	3089.0	-2082.2	3182.0				
Peace River	3105.3	-2098.5	3198.3				
Notikewin	3148.6	-2141.8	3241.6	7.7	1.9	3.9	1.3
Fault 4	3183.8	-2177.0	3276.8				
Notikewin 2	3195.5	-2188.7	3288.5	25.7	15.5	20.9	10.5
Fahler	3243.8	-2237.0	3336.9				
Fahler B	3278.0	-2271.2	3371.1				
Fahler C	3291.5	-2284.7	3384.6				
Fahler D	3320.5	-2313.7	3413.6				
Fahler E	3332.1	-2325.3	3425.2				
Well TD	3387.7	-2380.9	3481.0				
			TOTAL	34.6	17.4	26.0	11.9

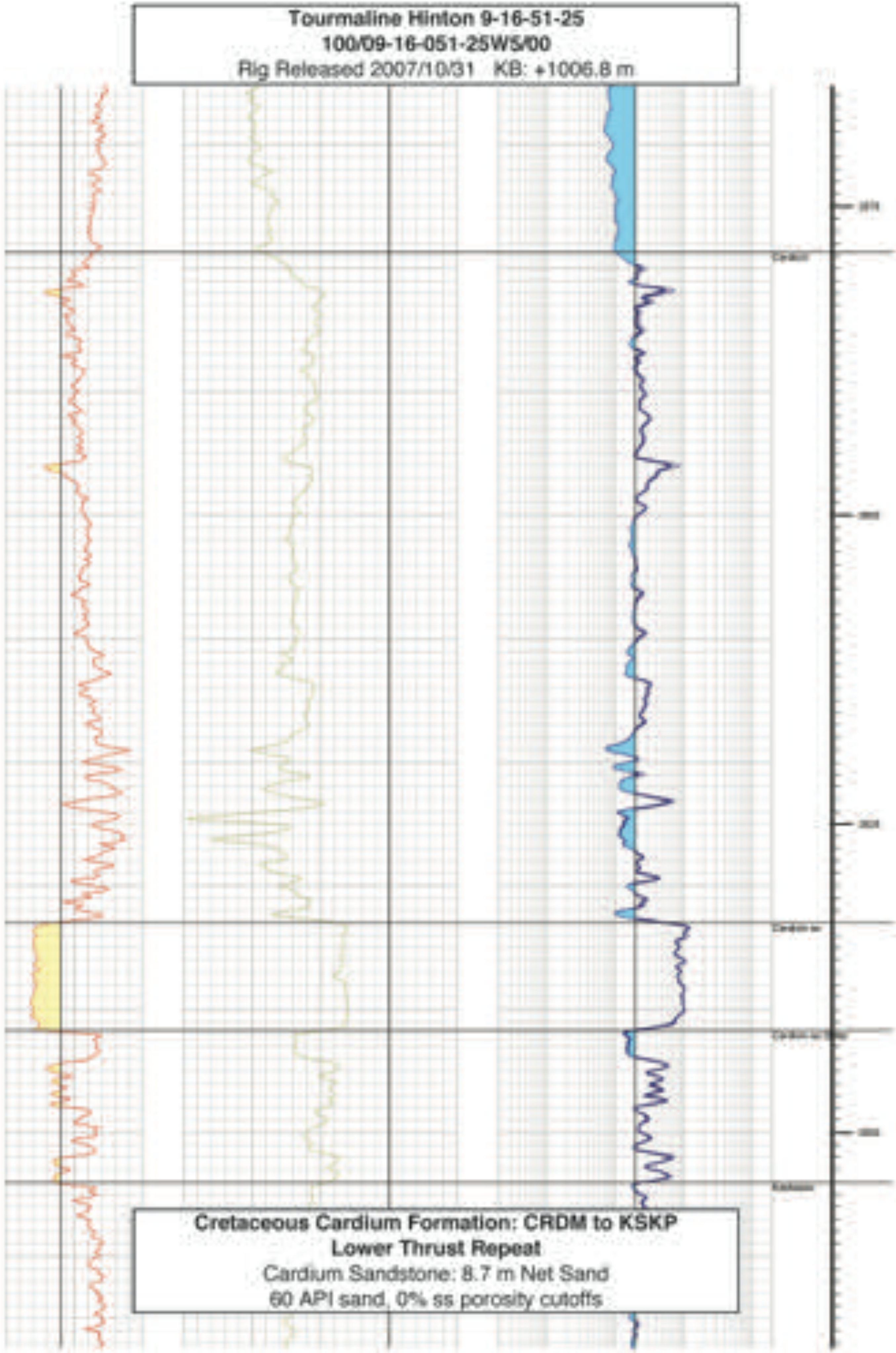
100/09-16-051-25W5/00 Completions

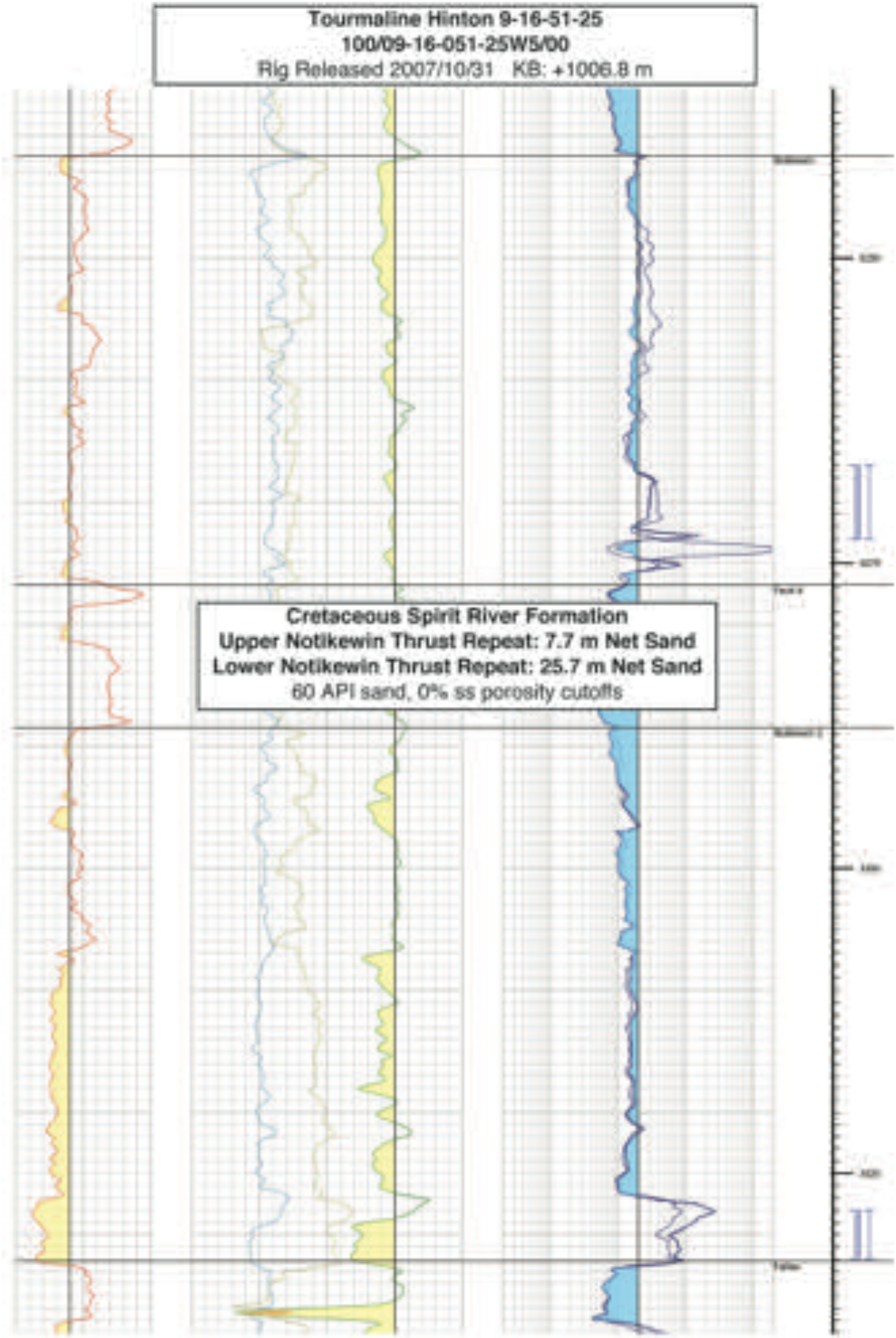
Date	Interval		Type	Subtype		Formation
2007-11-19	3328.0	3332.0	Perf	Jet	@ 17sh/m	Notikewin 2
2007-11-20	3328.0	3332.0	Treat	Frac		Notikewin 2
2007-11-27	3267.0	3273.0	Perf	Jet	@ 17sh/m	Notikewin
2007-11-28	3267.0	3273.0	Treat	Frac		Notikewin

Tourmaline Hinton 9-16-51-25
100/09-16-051-25W5/00
Rig Released 2007/10/31   KB: +1006.8 m

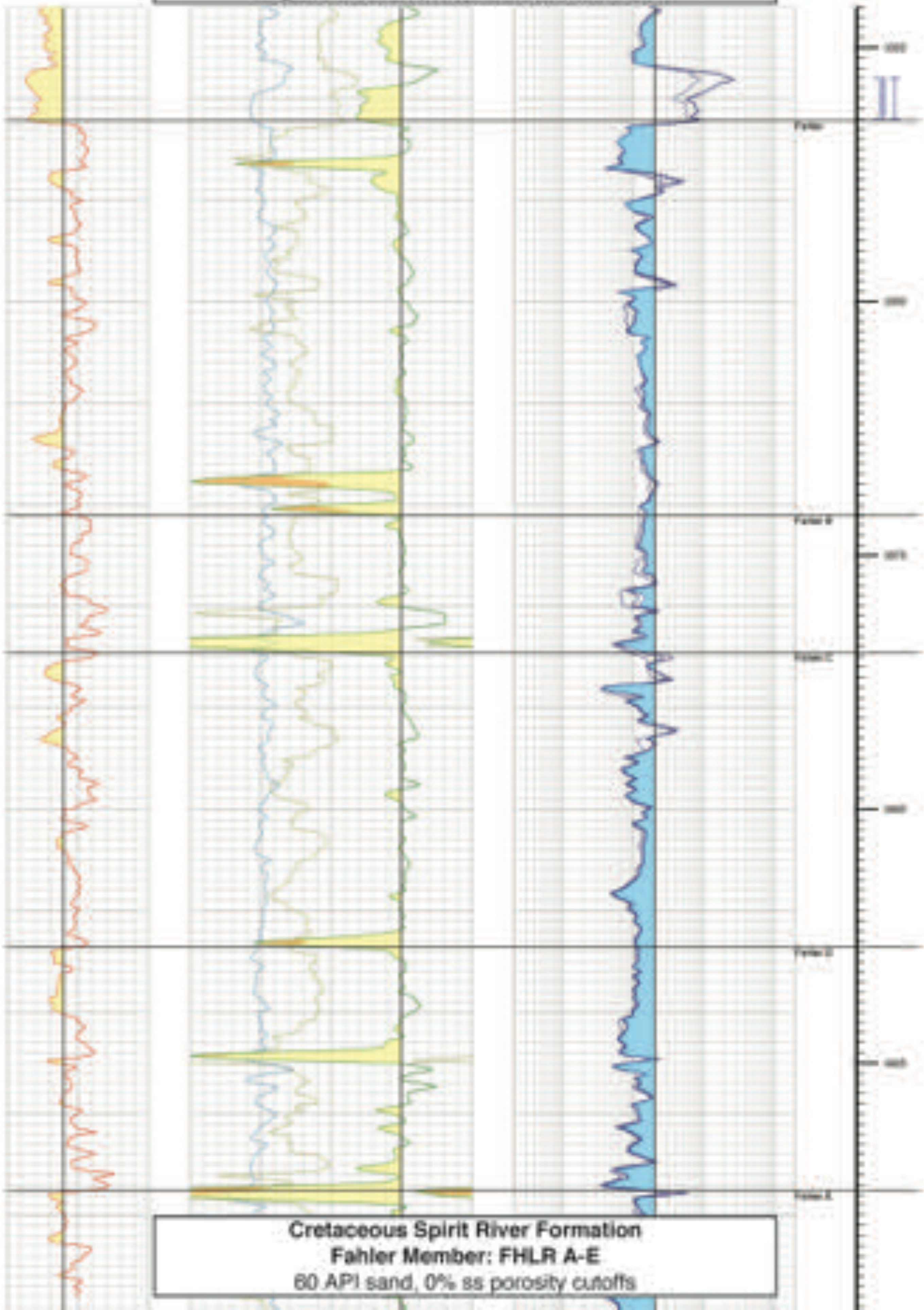


Cretaceous Cardium Formation: CRDM to KSKP
Upper Thrust Repeat
Cardium Sandstone: 11.8 m Net Sand
60 API sand, 0% ss porosity cutoffs


Tourmaline Hinton 9-16-51-25
100/09-16-051-25W5/00
Rig Released 2007/10/31 KB: +1006.8 m
Cretaceous Cardium Formation: CRDM to KSKP
Lower Thrust Repeat
Cardium Sandstone: 8.7 m Net Sand
60 API sand, 0% ss porosity cutoffs


Tourmaline Hinton 9-16-51-25
100/09-16-051-25W5/00
Rig Released 2007/10/31 KB: +1006.8 m
Cretaceous Spirit River Formation
Upper Notikewin Thrust Repeat: 7.7 m Net Sand
Lower Notikewin Thrust Repeat: 25.7 m Net Sand
60 API sand, 0% ss porosity cutoffs

Tourmaline Hinton 9-16-51-25
100/09-16-051-25W5/00
Rig Released 2007/10/31   KB: +1006.8 m



Cretaceous Spirit River Formation
Fahler Member: FHLR A-E
60 API sand, 0% ss porosity cutoffs

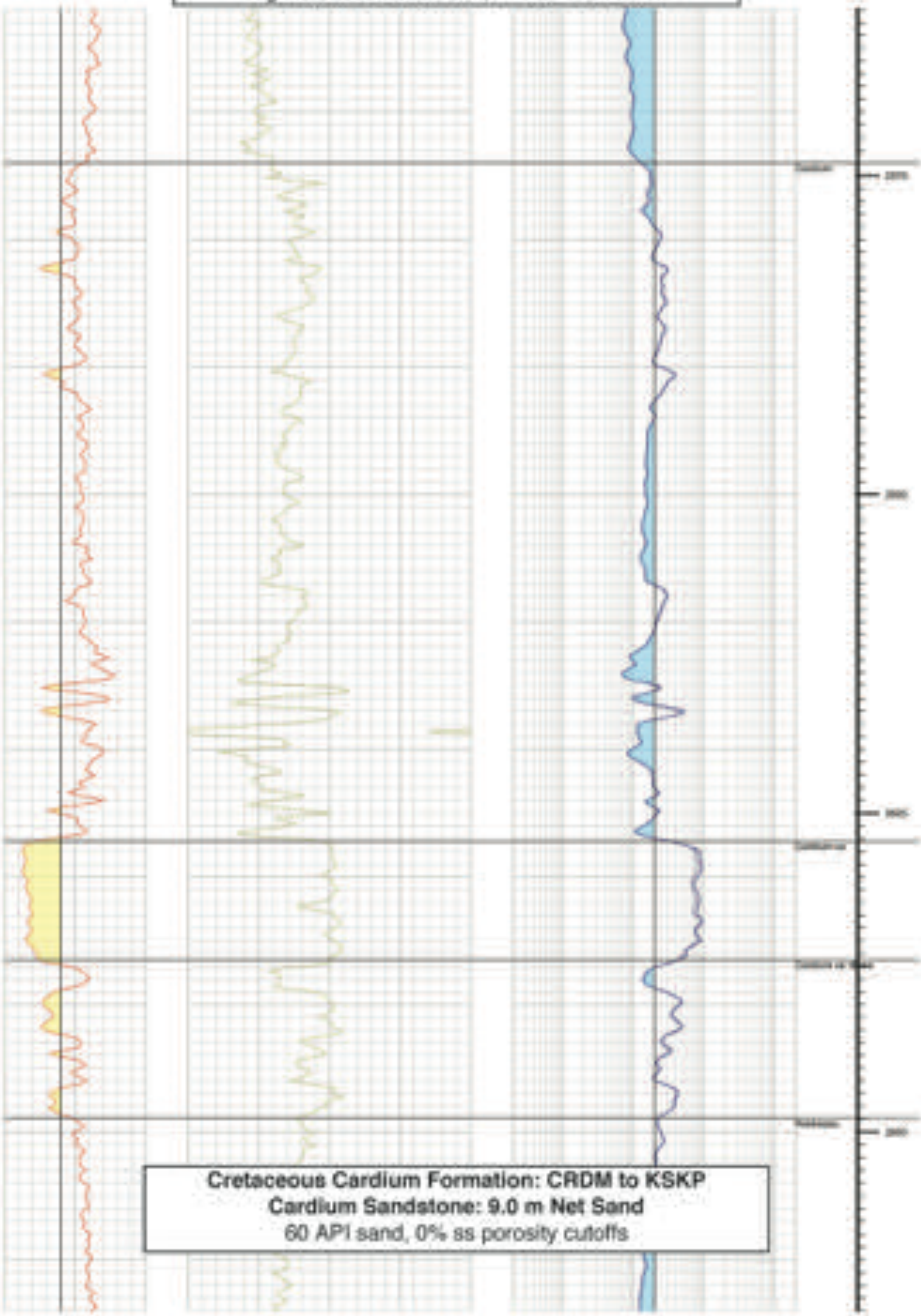
100/11-16-051-25W5/00 Formation Tops

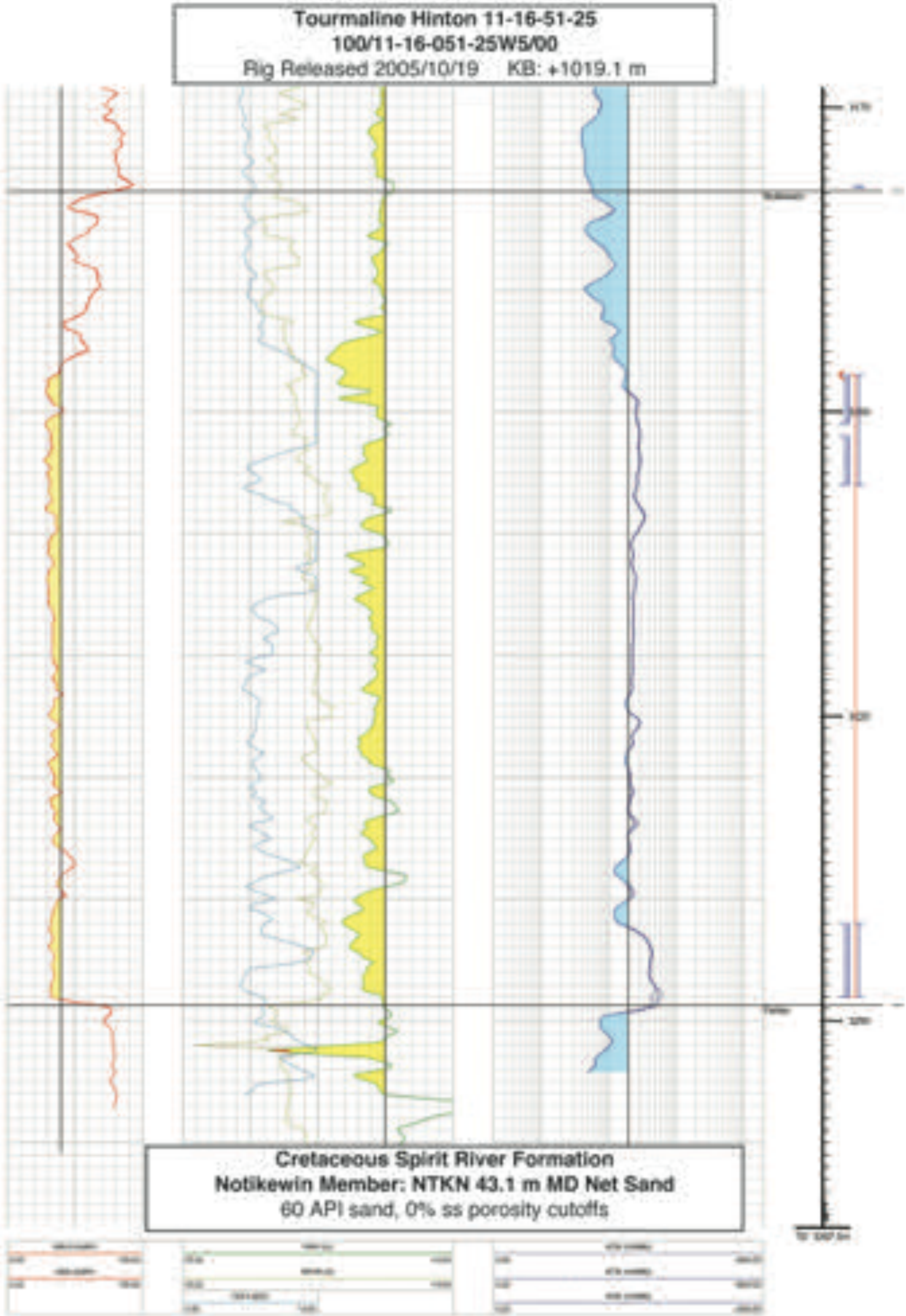
Formation	TVD (m)	Subsea (m)	MD (m)	0% ϕ Net Sand (m)	3% ϕ Net Sand (m)	Net Pay (0% ϕ, 20 Ω)	Net Pay (3% ϕ, 20 Ω)
Wapiabi 2	1589.2	-570.1	1628.2				
Milk River 2	1635.1	-616.0	1675.6				
Badheart 2	2189.0	-1169.9	2232.9				
Muskiki 2	2218.3	-1199.2	2262.4				
Cardium 2	2303.1	-1284.0	2347.6				
fault 2	2354.7	-1335.6	2399.5				
Bad Heart	2432.1	-1413.0	2477.2				
Muskiki	2462.1	-1443.0	2507.3				
Cardium	2528.5	-1509.4	2574.0				
Cardium ss	2581.5	-1562.4	2627.2	9.0	no den curve	no den curve	no den curve
Cardium ss Base	2590.8	-1571.7	2636.5				
Kaskapau	2603.1	-1584.0	2648.9				
Dunvegan	2945.0	-1925.9	2991.3				
Shaftesbury 2	3024.5	-2005.4	3070.8				
Shafesbury	3024.5	-2005.4	3070.8				
Fish Scale Zone	3085.3	-2066.2	3131.6				
Base Fish Scales	3101.1	-2082.0	3147.4				
Peace River	3111.2	-2092.1	3157.5				
Notikewin	3135.6	-2116.5	3181.9	43.1	28.5	34.7	21.8
Well TD	3220.7	-2209.5	3267.0				
			TOTAL	52.1	28.5	34.7	21.8

100/11-16-051-25W5/00 Completions

Date	Interval		Type	Subtype		Formation
2005-12-19	3242.0	3248.0	Perf	Jet	@ 25sh/m	Notikewin
2005-12-19	3202.0	3206.0	Perf	Jet	@ 8sh/m	Notikewin
2005-12-20	3197.0	3201.0	Perf	Jet	@ 8sh/m	Notikewin
2006-01-08	3242.0	3248.0	Treat	Frac		Notikewin
2006-01-08	3197.0	3206.0	Treat	Frac		Notikewin
2011-08-16	3181.5		Treat	Packer		Peace River
2011-08-16	3172.1		Treat	Packer		Peace River

Tourmaline Hinton 11-16-51-25
100/11-16-051-25W5/00
Rig Released 2005/10/19   KB: +1019.1 m




Tourmaline Hinton 11-16-51-25
100/11-16-051-25W5/00
Rig Released 2005/10/19 KB: +1019.1 m
Cretaceous Spirit River Formation
Notikewin Member: NTKN 43.1 m MD Net Sand
60 API sand, 0% ss porosity cutoffs

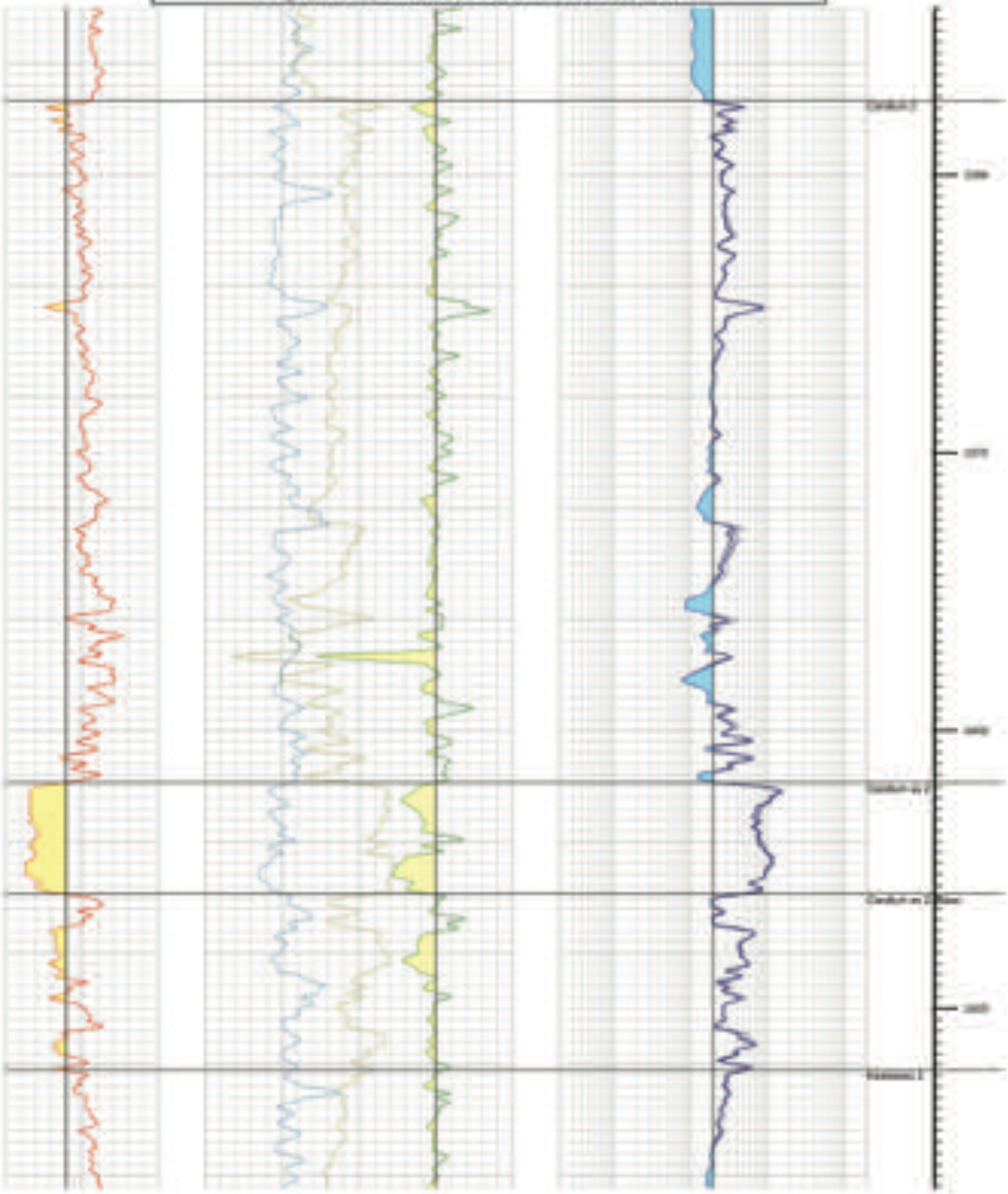
100/14-15-051-25W5/00 Formation Tops

Formation	TVD (m)	Subsea (m)	MD (m)	0% ϕ Net Sand (m)	3% ϕ Net Sand (m)	Net Pay (0% ϕ, 20 Ω)	Net Pay (3% ϕ, 20 Ω)
Wapiabi	1681.1	-678.3	1694.4				
Milk River	1721.3	-718.5	1735.1				
Badheart 2	2206.8	-1204.0	2224.8				
Muskiki 2	2236.1	-1233.3	2254.5				
Cardium 2	2323.7	-1320.9	2343.3				
Cardium ss 2	2384.4	-1381.6	2404.7	8.8	6.0	8.8	6.0
Cardium ss 2 Base	2394.3	-1391.5	2414.7				
Kaskapau 2	2410.0	-1407.2	2430.5				
Dunvegan	3159.0	-2156.2	3183.3				
Shafesbury	3237.9	-2235.1	3262.3				
Fish Scale Zone	3294.0	-2291.2	3318.5				
Base Fish Scales	3308.1	-2305.3	3332.6				
Peace River	3317.8	-2315.0	3342.3				
Notikewin	3341.8	-2339.0	3366.3	6.4	1.2	No R-curve	No R-curve
Fahler	3386.5	-2383.7	3411.0				
Fahler B	3415.8	-2413.0	3440.3				
Fahler C	3424.9	-2422.1	3449.4				
Fahler D	3435.7	-2432.9	3460.2				
Well TD	3465.5	-2462.7	3490.0				
			TOTAL	6.4	1.2	0.0	0.0

100/14-15-051-25W5/00 Completions

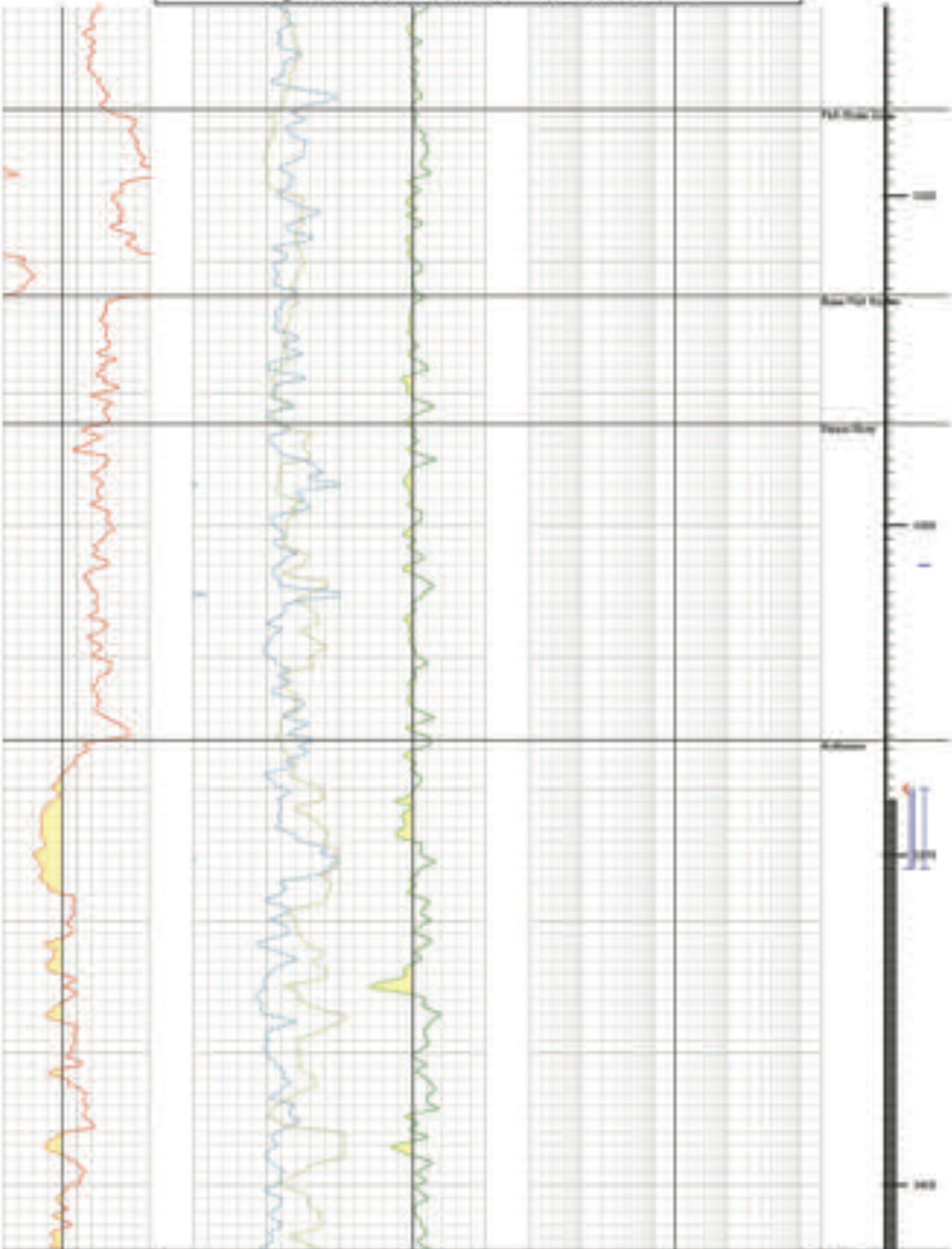
Date	Interval		Type	Subtype		Formation
2007-02-05	3426.0	3431.0	Perf	Jet	@ 10sh/m	Fahler
2007-02-05	3370.0	3376.0	Perf	Jet	@ 12sh/m	Notikewin
2007-02-06	3426.0	3431.0	Treat	Frac		Fahler
2007-02-06	3370.0	3376.0	Treat	Frac		Notikewin
2007-02-07	3353.0		Treat	Packer		Peace River
2007-02-07	3227.0	3232.0	Perf	Jet	@ 13sh/m	Dunvegan
2007-02-08	3227.0	3232.0	Treat	Frac		Dunvegan

Tourmaline Hinton 14-15-51-25
100/14-15-051-25W5/00
Rig Released 2006/12/19 KB: +1002.8 m



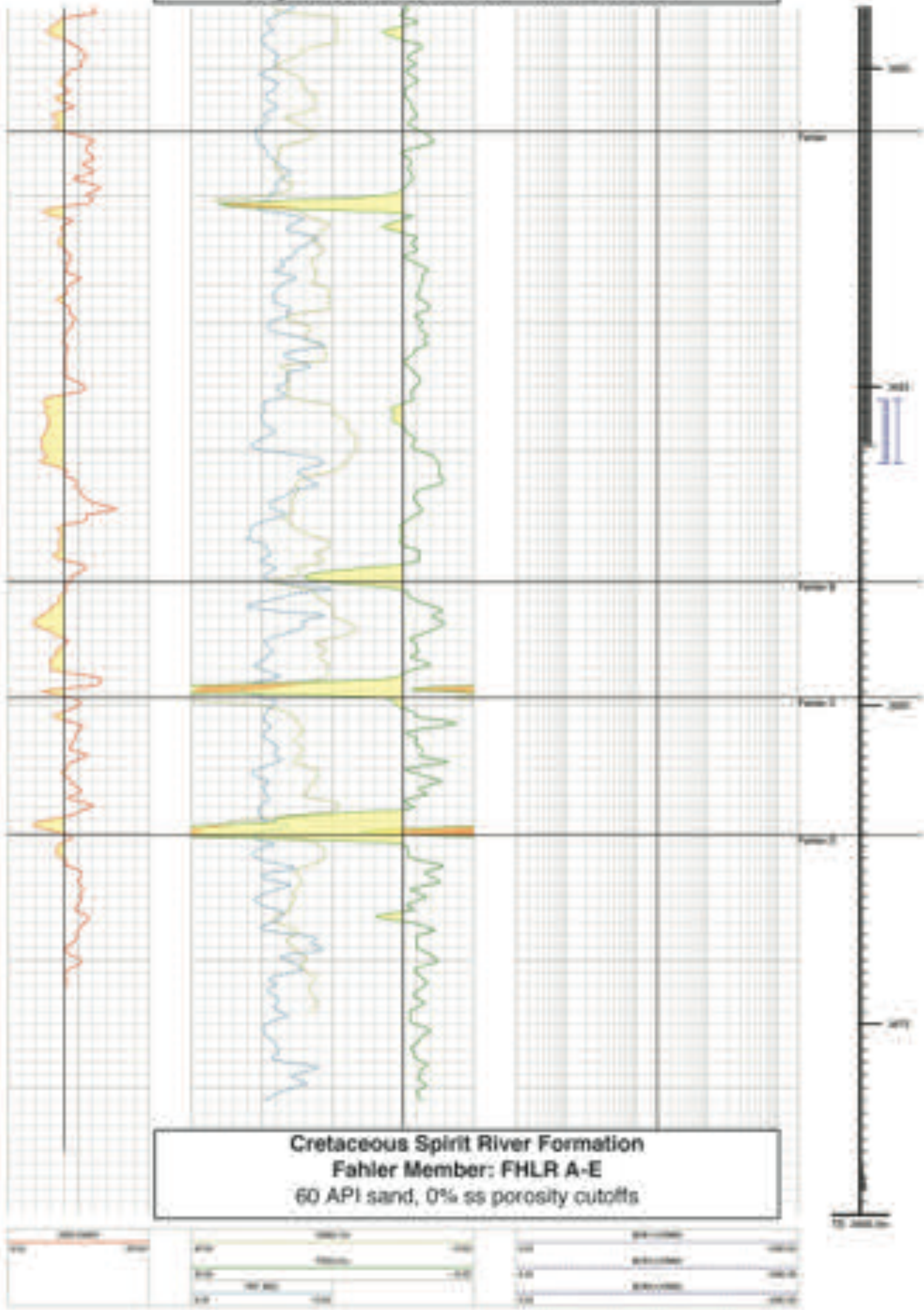
Cretaceous Cardium Formation: CRDM to KSKP
Cardium Sandstone: 8.8 m Net Sand
60 API sand, 0% ss porosity cutoffs

Tourmaline Hinton 14-15-51-25
100/14-15-051-25W5/00
Rig Released 2006/12/19 KB: +1002.8 m



Cretaceous Spirit River Formation
Notikewin Member: 6.4 m Net Sand
60 API sand, 0% ss porosity cutoffs

Tourmaline Hinton 14-15-51-25
100/14-15-051-25W5/00
Rig Released 2006/12/19 KB: +1002.8 m



Appendix C.1.4 Regional Geology

The Western Canadian Sedimentary Basin (WCSB) is a massive sedimentary basin extending from the Rocky Mountains in the West to the Canadian Shield in the east. The formation of the WCSB follows a rather simple geological model: a large depression, known as a basin, formed via tectonic activity. This basin was filled in slowly over time with sediments from various sources, including those that eroded from the surrounding features on the side of the basin that were positioned at higher altitudes, as well as from material that settled out of the water that rose because of global sea level change, forming inland seas and shorelines.

The geology of the Canadian foothills region, east of the Rocky Mountains (i.e. the Hinton area), has been shaped by both intense tectonic activity (including plate movement, compression and extension) and by the associated erosion and deposition of sediment from the upraised mountain material into foreland basins on the eastward side of the Rocky Mountains. Compressional tectonism, caused by the westward drift of the North American continent and the collision with large oceanic terranes, resulted in the accretion of this oceanic terrane onto the western margin of the North American craton. From the impact, mountain building occurred and the Canadian Cordillera was created. The weight of this material sitting on top of the North American craton caused regional north-south trending subsidence to the east of and directly adjacent to the mountain belt, forming what is known as a foreland basin, and the consequential uplift of material east of this depression, known as a fore bulge. The uplift and erosion of Cordilleran material is the source of the sediment observed to have accumulated in the foreland basin area, where present day Hinton is now situated.

With time, this material was deposited within the basin forming layer upon layer of differing types of sediments that produced the layered geological regime (stratigraphy) that is observed today. Hinton is geologically situated directly at the boundary of the western edge of the Cordilleran orogen deformation, and the Eastern limit of the undeformed deposits of the WCSB. Stratigraphically, Hinton is situated over approximately 6000m of Phanerozoic sedimentary assemblage. Marine facies Paleozoic deposits of the Cordilleran miogeocline (North American Plate passive margin) and marine to terrigenous facies Mesozoic and Cenozoic deposits are represented in the stratigraphy.

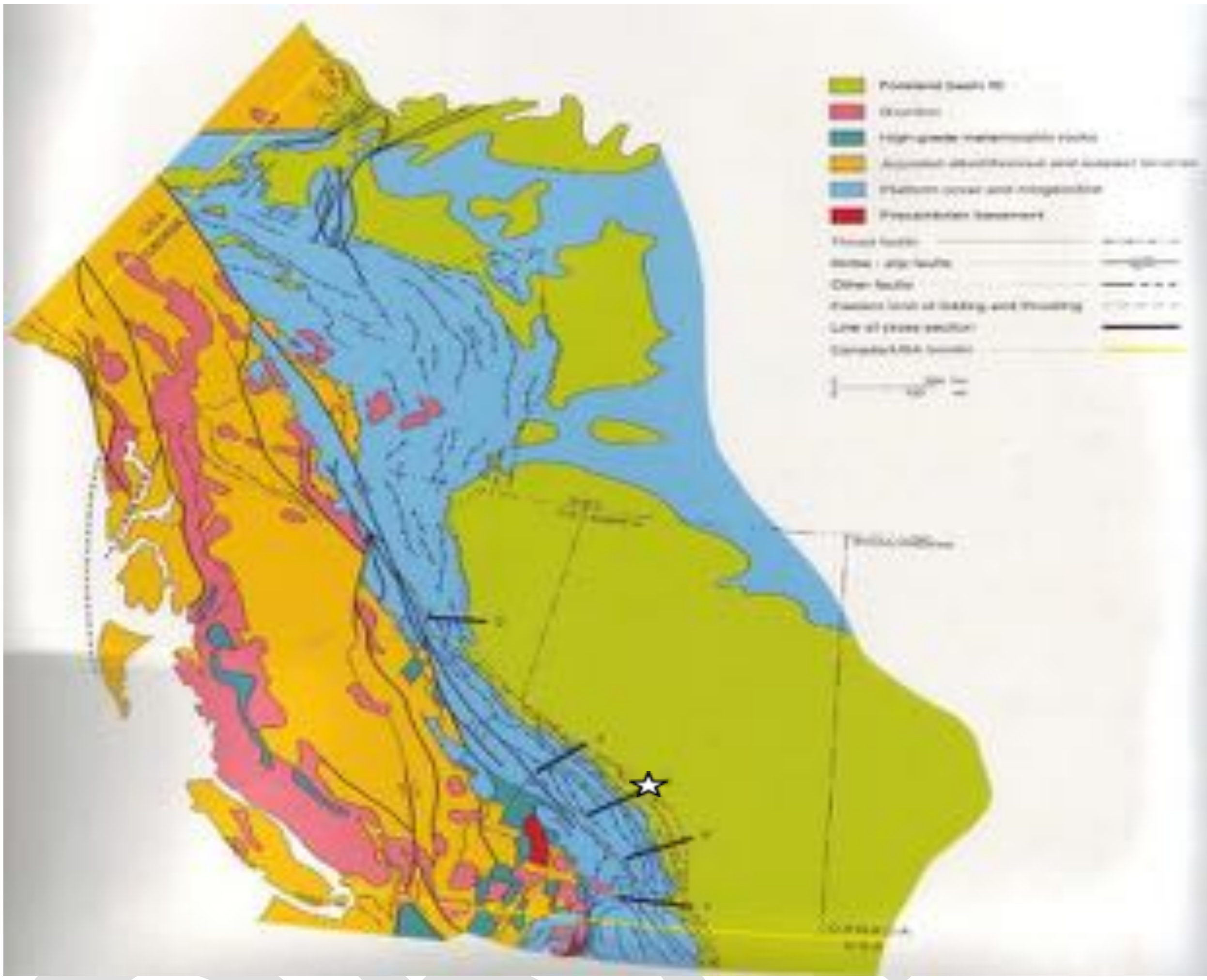


Figure 83: Regional tectonic map of the Canadian Cordillera. Hinton, AB indicated by the white star. [77]

Proterozoic to Triassic

The base of the sedimentary succession is located on top of Lower Proterozoic (2.0 to 2.4 Ga) North American Craton [78]. The paleogeograpic position of the basement rock underneath Hinton during the Late Proterozoic and Early Paleozoic lay at the passive margin of the continental rift of western Laurentia from 730Ma and 555 Ma [79]. This rifting produced accommodation space for marine sediment accumulation and reef growth, resulting in a succession grading upwards from deep marine shale facies Cambrian deposits to shallow water carbonates and marginal marine, mixed clastic-carbonate deposits during the Carboniferous and Triassic. The dominance of carbonate deposits over this period supports that Hinton was located on a shallowing carbonate ramp for an extensive length of time.

Jurassic to Tertiary

The deposition of Jurassic to Tertiary deposits underlying Hinton coincides with the main orogenic episodes of the Western Canadian Cordillera. These sediments, which are predominantly terrigenous clastic facies, are juxtaposed unconformably against subadjacent marine sediments from the previously mentioned passive margin, the Cordilleran miogeocline.

The post-Jurassic assemblage is characteristic of peripheral foreland basin deposits. When the weight of stacked wedges of thrusted rock depressed the continental crust during the Laramide orogeny, a basin emerged at the toe of this depression. The uplifted thrust slices provided a source rock for clastic sedimentation during basin infill. The foreland basin deposits below Hinton contain mostly shallow marine to terrigenous facies deposits. By virtue of its proximal paleogeographical location to an orogenic sediment source, the post-Jurassic assemblage of deposits contains an appreciable amount of sand which are concentrated most noticeably in the fluvial to deltaic facies Manville Group, the shallow shelf facies Viking Formation, and the fluvial to shoreline facies Belly River Group [80] [81].

The WCSB has been extensively explored for petroleum resources for decades. Based on hundreds of thousands of well logs across Alberta and British Columbia, our understanding of the WCSB is quite detailed. A summary of the stratigraphy of the different sedimentary formations in the Hinton area from surface to Precambrian basement is provided in the table below.

Appendix C.1.5 Resource Research to Date

There has been significant research into the vast geothermal resource in the Western Canadian Sedimentary Basin (WCSB). The porous and permeable rocks that underlie much of Alberta are a massive source of low-moderate grade geothermal energy in the form of hot water. This is especially true near the Rocky Mountain foothills, which is an area of high relief, high hydraulic head and regional water recharge. The Hinton area is situated in this deep part of the WCSB and there is a substantial increase in terrestrial heat flow with depth in the area.

The Hinton area is a well-known and extensively drilled and explored oilfield. As a reference, there are >4,000 wells drilled below 2,500m within a 70km radius of the Town of Hinton, which is suggested to be one of the best geothermal resource opportunities in Alberta. Many of these wells contain bottom hole temperatures higher than 100^{0}C - temperatures more than viable for efficient direct heat applications. With known bottom hole temperatures greater than 150^{0}C, the Hinton-Edson area has been an area that generates extensive research into the geothermal resource potential there.

Beyond the extensive dataset provided by oil and gas activities, research specifically relating to the geothermal potential in the Hinton area dates back to 1985 and continues to present day. In the last 30 years, there have been a multitude of collaborations with key researchers like Jacek Majorowicz, Simon Weides, Alan Jessop, Brian Hitchon, J.W. Jones, Stephen Grasby, and most recently Dr. Jonathan Banks and the University of Alberta, that continues to authenticate the geothermal resource mapping and reservoir identification in the western Alberta and Hinton area.

One of the very first studies on the geothermal potential of deep aquifers in the WCSB, and specifically the Hinton area, was published by Lam and Jones in 1985. In their paper the authors examined aquifer porosity, thickness, water chemistry and water recovery in the

Hinton-Edson area of western Alberta. This research concluded that the Mississippian and Upper Devonian carbonate rocks specifically had significant geothermal potential. [11]

Key researchers over the years include Dr. Alan Jessop with the Geological Survey of Canada who did extensive research on the geothermal potential throughout Canada. He specifically analyzed the thermal reservoir in the WCSB, highlighting heat flow in the Hinton -Edson area and heat contribution from the underlying basement rocks. [82] [83]

Research completed by Dr. Stefan Bachu (Alberta Geologic Survey, currently with Alberta Innovates as Principal Scientist) and collaboration with Dr. Ron Burwash (University of Alberta) in the late 1980s and early 1990s on the geothermal regime in the WCSB are some of the most frequently referenced documents on this field of study. Their initial mapping of the reservoir highlighted that the Hinton-Edson area has temperature resources >120^{0}C at the top of the Precambrian basement rock. [84] [85]

In 2008, a Queen's University group in collaboration with CanGEA (Canadian Geothermal Energy Association) completed a study of the technical challenges and feasibility of a small scale (1MWe) geothermal based power facility in the Hinton area. They were able to isolate specific wells and geologic formations viable for power generation.

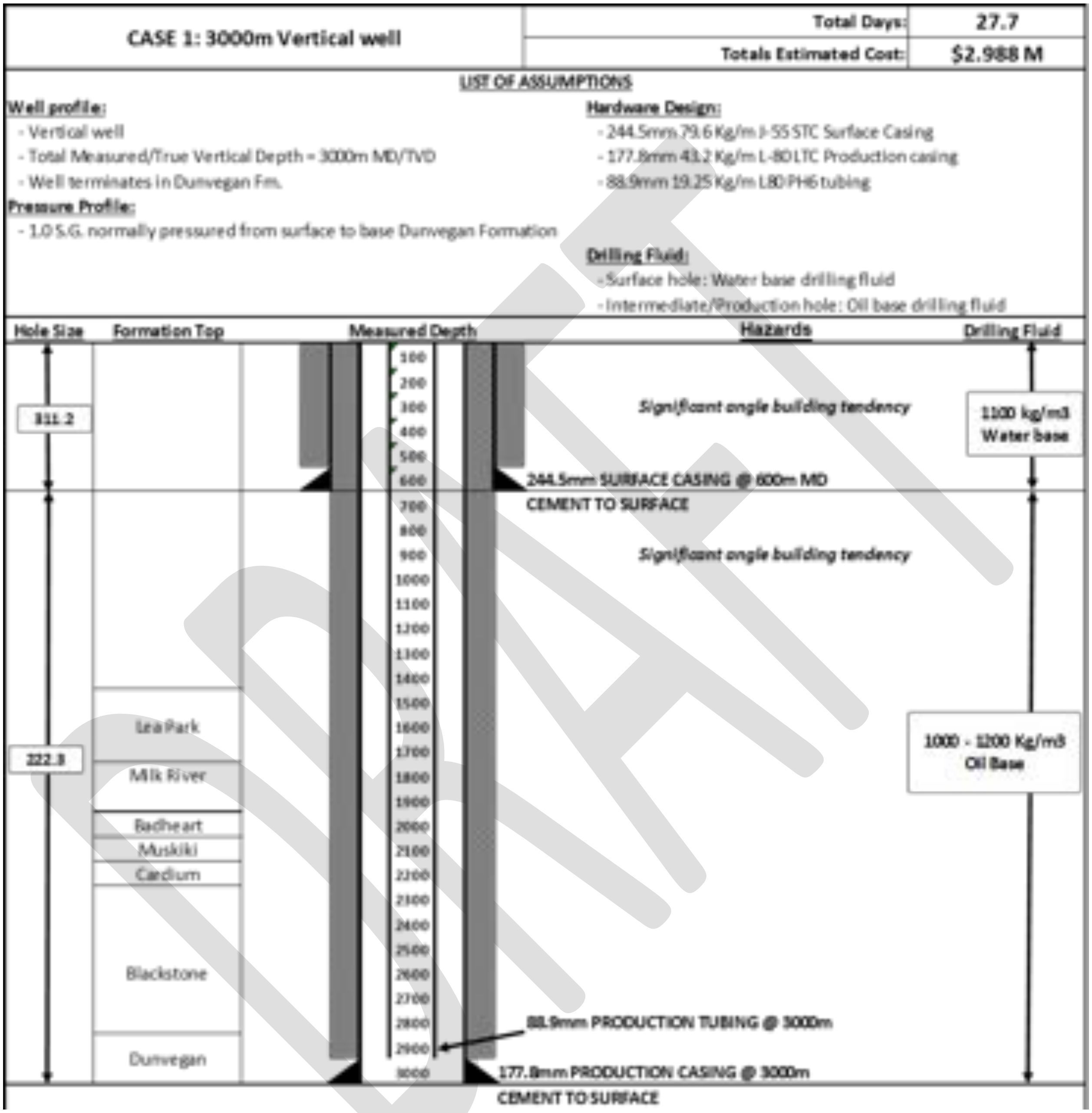
CanGEA continued research on Alberta's geothermal resource and in 2014 completed the "Alberta Geothermal Favourability Maps" [86]. This series of maps further highlights the resource potential within the Hinton area and throughout the Alberta Foothills.

More recently in 2015 Greg Nieuwenhuis and other University of Alberta researchers, with support from Alberta Geological survey and Helmholtz Center Potsdam in Germany, identified Hinton as a target for geothermal energy development in a "regional-scale geothermal exploration study using heterogeneous industrial temperature data." [87]

Most recently, Dr. Jonathan Banks, (University of Alberta, Department of Earth & Atmospheric Sciences), with support from Alberta Innovates, conducted research to determine the volume of geothermal energy available in reservoirs around Hinton and other communities in the Alberta Foothills. In May 2017 the report titled "Deep-Dive Analysis of the Best Geothermal Reservoirs for Commercial Development in Alberta: Final Report" was released. The study found that the Hinton area has sufficient temperature and depth as either electrical or thermal energy generating projects.

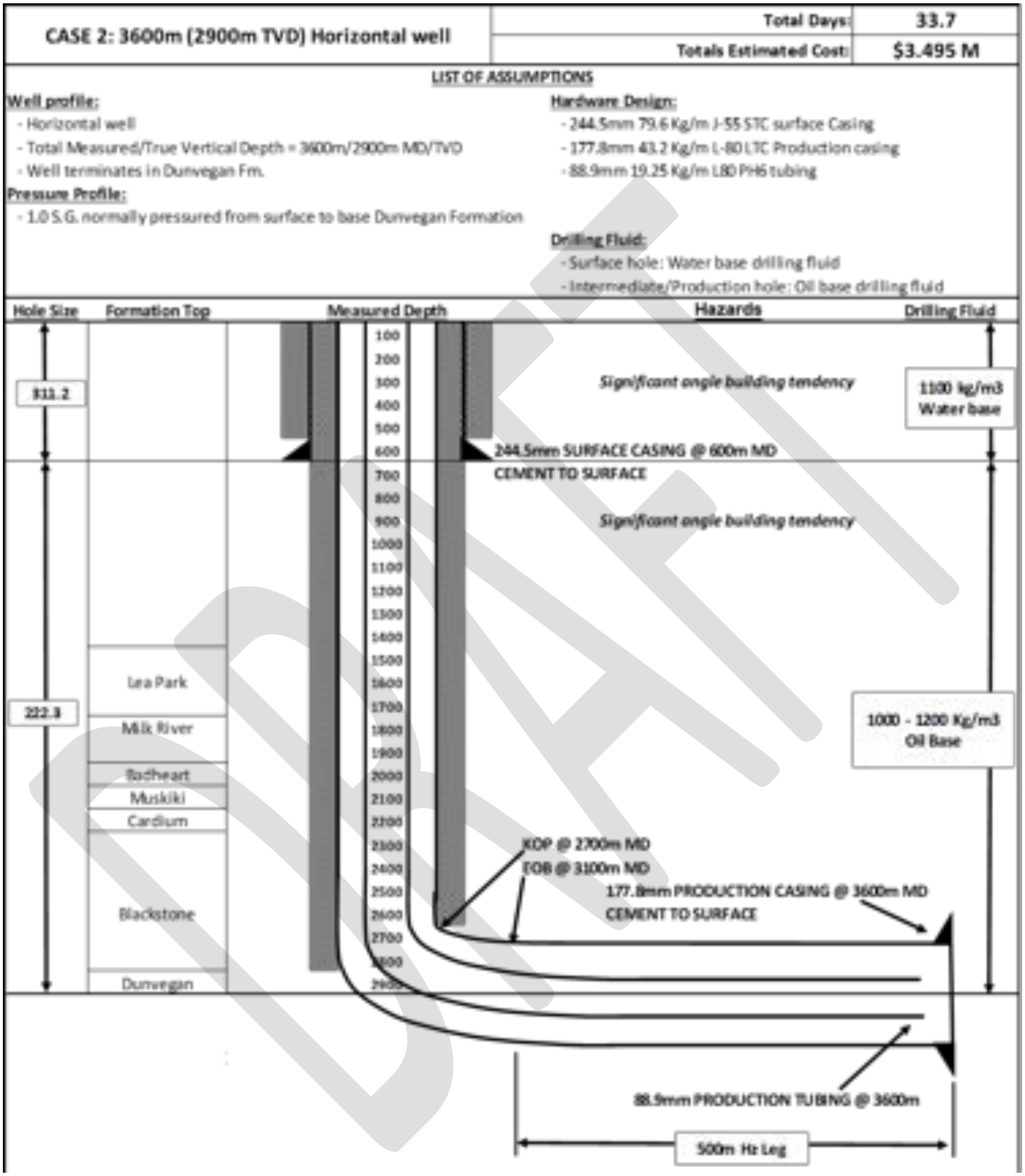
Appendix C.2 Drilling Well Schematics & Associated Cost Summary

Case 1: 3000m Vertical Well



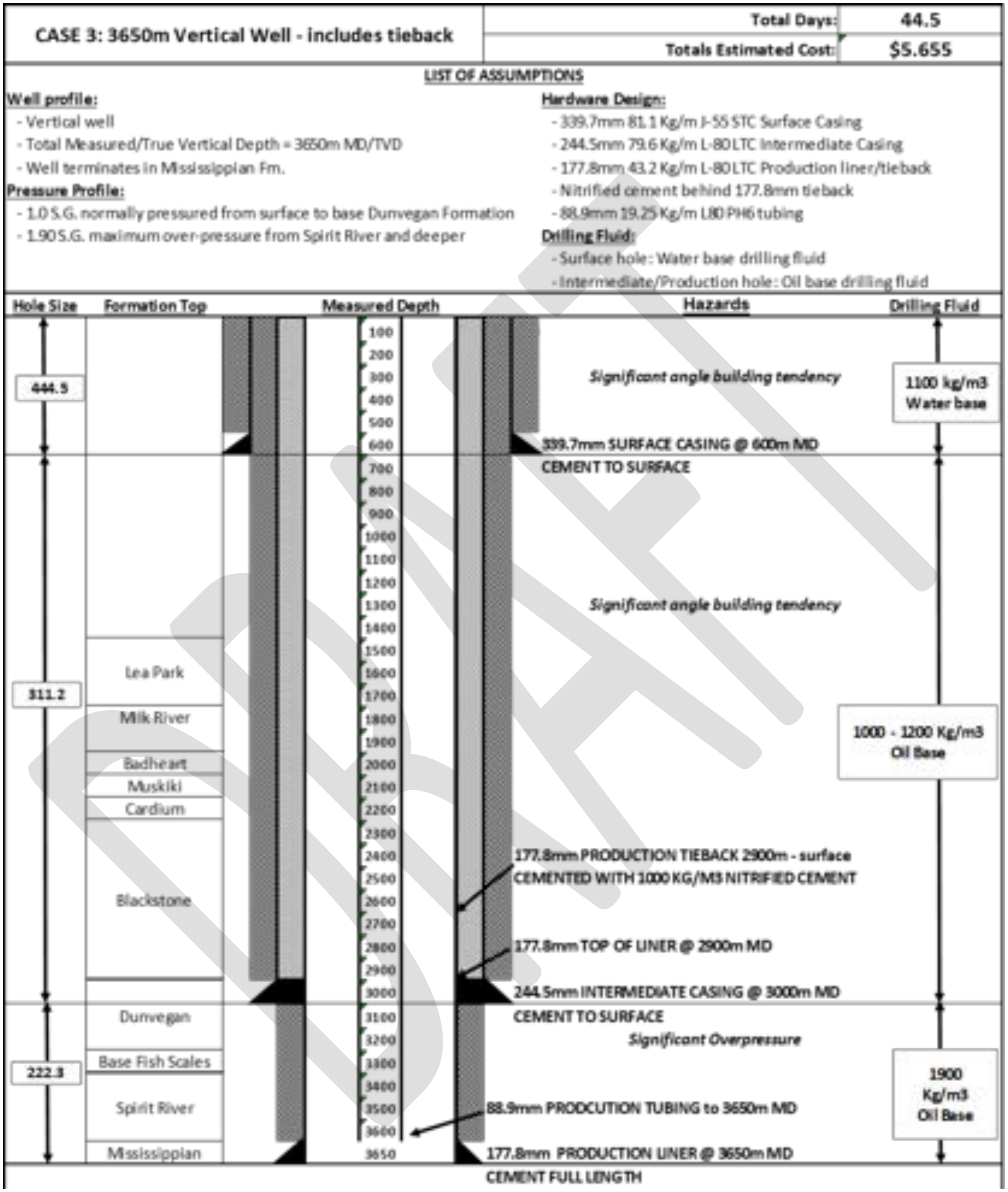
	DRILLING BUDGET CLASS COST ESTIMATE		
CASE:	CASE 1: 3000M Vertical well	Total Days	27.65
LOCATION:	Hinton Geothermal TWP 51 - RG 25 W5M	Total MD (m)	3000
TARGET ZONE:	Base Dunvegan	TVD (m)	3000
SPUD DATE:	Fall 2018	Well Profile	VERTICAL
Account Code	**Description**		**Estimate**
9300 100	SURVEYS		15,000
9300 101	ROAD AND LEASE COSTS		100,000
9300 103	ROAD AND LEASE CLEANUP		10,000
9300 105	ROAD USE FEES		10,000
9300 110	FIRST NATIONS CONSULTATION		0
9300 112	WELL LICENSE		5,000
9300 115	ABANDONMENT/PLUG BACK		0
9300 200	DRILLING RIG		672,927
9300 201	DRILLING RIG MOVE IN MOVE OUT		125,000
9300 202	RIG FUEL		152,090
9300 205	CONDUCTOR AND RATHOLE		5,000
9300 206	DRILLING MUD AND CHEMICALS		330,444
9300 207	DIRECTIONAL DRILLING		212,222
9300 250	CAMP (NON SUBSISTENCE)		85,958
9300 450	COMMUNICATION		49,892
9300 370	EQUIP RENTAL - SURFACE		104,010
9300 500	TRUCKING		52,000
9300 316	DRILL PIPE INSPECTION		2,500
9300 310	WELDING SERVICES		2,500
9300 311	PRESSURE TESTING		3,500
9300 314	LOG/PERF/ANALYSIS		0
9300 401	CONSTRUCTION/WELL SITE SUPERVISION		81,632
9300 370	MAT RENTALS		0
9300 480	SAFETY SERVICES		0
9300 309	CASING BOWL AND ATTACHMENTS		17,000
9300 304	SURFACE CASING AND ACCESSORIES		82,000
9300 300	SURFACE CASING - CEMENT		21,000
9300 306	POWER TONGS SURFACE		3,000
9300 305	INTERMEDIATE CASING & ACCESSORIES		0
9300 302	INTERMEDIATE CASING-CEMENTING		0
9300 307	POWER TONGS INTERMEDIATE		0
9300 303	PRODUCTION CASING & ACCESSORIES		280,000
9300 301	PRODUCTION CASING CEMENT		60,000
9300 308	POWER TONGS PRODUCTION		10,000
9300 303	PRODUCTION TUBING & ACCESSORIES		150,000
9300 308	POWER TONGS PRODUCTION TUBING		10,000
9300 400	ENGINEERING AND WELL PLANNING		34,383
9300 315	FISHING SERVICES		0
9300 312	CORING AND ANALYSIS		0
9300 313	MISCELLENEOUS TESTS AND ANALYSIS		0
9300 502	FLUID DISPOSAL TRUCKING		20,000
9300 510	FLUID DISPOSAL COSTS		20,000
9300 503	SOLID WASTE DISPOSAL TRUCKING		17,310
9300 511	SOLID WASTE DISPOSAL COSTS		16,257
9300 371	DOWN HOLE EQUIP RENTAL		39,854
9300 208	DRILL BITS		107,500
9300 800	CONTINGENCY COSTS		0
9300 850	INSURANCE		0
9300 610	ENVIRONMENTAL SERVICES		3,500
9300 501	WATER TRUCK		14,326
9300 402	WELL SITE GEOLOGIST		19,486
9300 700	POTABLE WATER		0
9300 996	OVERHEAD		0
9300 504	VACUUM TRUCK		42,979
	Estimated Total		2,988,272

Case 2: 3600m (2900m TVD) Horizontal Well



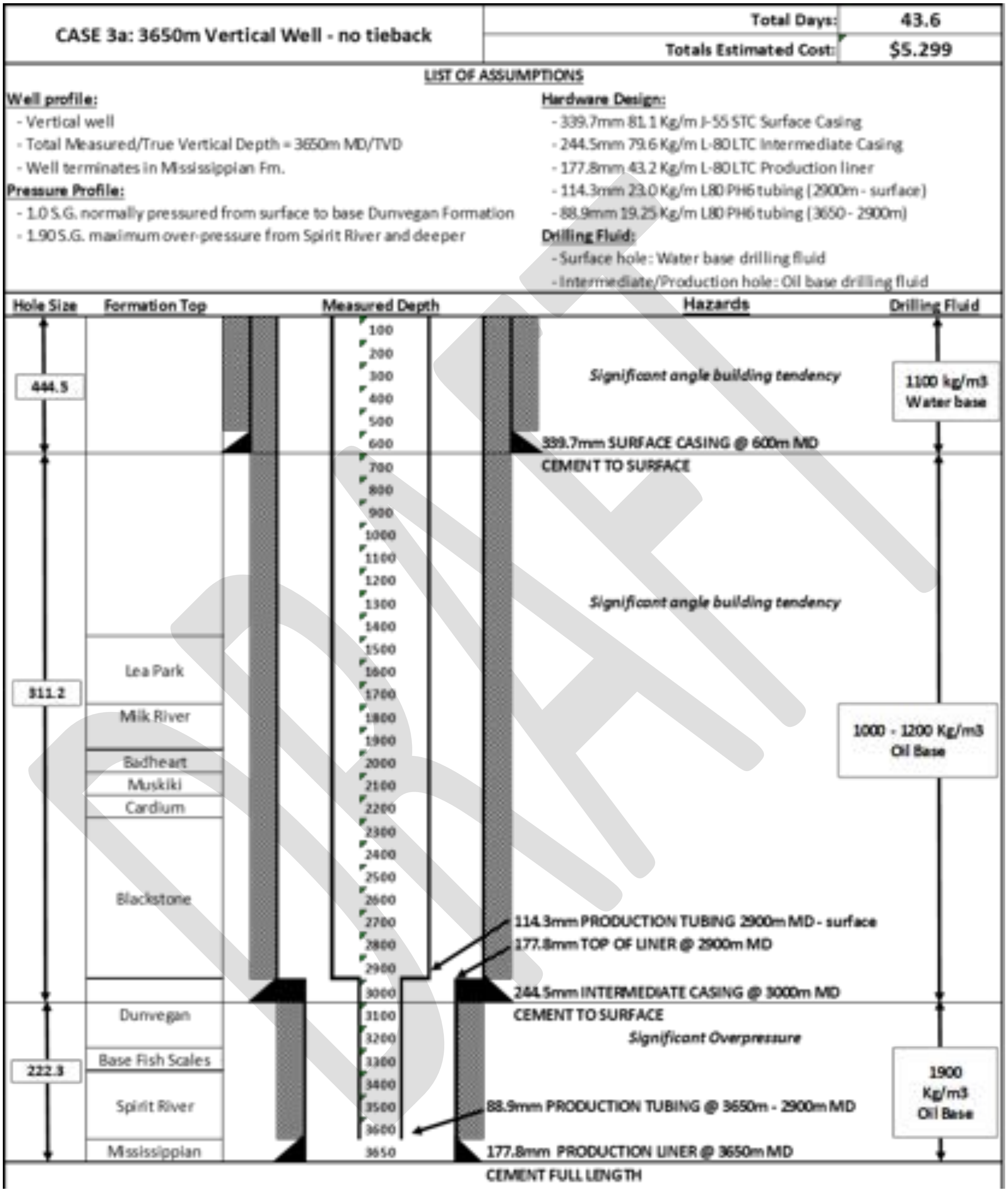
DRILLING COST ESTIMATE			
CASE:	CASE 2: 3600m (2900m TVD) Horizontal well	Total Days	33.67
LOCATION:	Hinton TWP 51 - RG 25 W5M	Total MD (m)	3600
TARGET ZONE:	Base Dunvegan	TVD (m)	2900
SPUD DATE:	Fall 2018	Well Profile	HORIZONTAL
Account Code	Description		Estimate
9300 100	SURVEYS		15,000
9300 101	ROAD AND LEASE COSTS		100,000
9300 103	ROAD AND LEASE CLEANUP		10,000
9300 105	ROAD USE FEES		10,000
9300 110	FIRST NATIONS CONSULTATION		0
9300 112	WELL LICENSE		5,000
9300 115	ABANDONMENT/PLUG BACK		0
9300 200	DRILLING RIG		812,858
9300 201	DRILLING RIG MOVE IN MOVE OUT		125,000
9300 202	RIG FUEL		185,192
9300 205	CONDUCTOR AND RATHOLE		5,000
9300 206	DRILLING MUD AND CHEMICALS		411,463
9300 207	DIRECTIONAL DRILLING		260,370
9300 250	CAMP (NON SUBSISTENCE)		104,014
9300 450	COMMUNICATION		60,425
9300 370	EQUIP RENTAL - SURFACE		125,857
9300 500	TRUCKING		54,000
9300 316	DRILL PIPE INSPECTION		2,500
9300 310	WELDING SERVICES		2,500
9300 311	PRESSURE TESTING		3,500
9300 314	LOG/PERF/ANALYSIS		0
9300 401	CONSTRUCTION/WELL SITE SUPERVISION		96,678
9300 370	MAT RENTALS		0
9300 480	SAFETY SERVICES		0
9300 309	CASING BOWL AND ATTACHMENTS		17,000
9300 304	SURFACE CASING AND ACCESSORIES		82,000
9300 300	SURFACE CASING - CEMENT		21,000
9300 306	POWER TONGS SURFACE		3,000
9300 305	INTERMEDIATE CASING & ACCESSORIES		0
9300 302	INTERMEDIATE CASING-CEMENTING		0
9300 307	POWER TONGS INTERMEDIATE		0
9300 303	PRODUCTION CASING & ACCESSORIES		334,000
9300 301	PRODUCTION CASING CEMENT		60,000
9300 308	POWER TONGS PRODUCTION		10,000
9300 303	PRODUCTION TUBING & ACCESSORIES		180,000
9300 308	POWER TONGS PRODUCTION TUBING		10,000
9300 400	ENGINEERING AND WELL PLANNING		41,606
9300 315	FISHING SERVICES		0
9300 312	CORING AND ANALYSIS		0
9300 313	MISCELLENEOUS TESTS AND ANALYSIS		0
9300 502	FLUID DISPOSAL TRUCKING		20,000
9300 510	FLUID DISPOSAL COSTS		20,000
9300 503	SOLID WASTE DISPOSAL TRUCKING		20,213
9300 511	SOLID WASTE DISPOSAL COSTS		20,321
9300 371	DOWN HOLE EQUIP RENTAL		48,882
9300 208	DRILL BITS		132,500
9300 800	CONTINGENCY COSTS		0
9300 850	INSURANCE		0
9300 610	ENVIRONMENTAL SERVICES		3,500
9300 501	WATER TRUCK		17,336
9300 402	WELL SITE GEOLOGIST		12,639
9300 700	POTABLE WATER		0
9300 996	OVERHEAD		0
9300 504	VACUUM TRUCK		52,007
	Estimated Total		3,495,360

Case 3: 3650m Vertical Well – includes Tieback



DRILLING COST ESTIMATE			
CASE:	**CASE 3: 3650m Vertical Well - includes tieback**	**Total Days**	**44.48**
LOCATION:	Hinton TWP 51 - RG 25 W5M	**Total MD (m)**	**3650**
TARGET ZONE:	Base Spirit River/Mississippian	**TVD (m)**	**3650**
SPUD DATE:	Fall 2018	**Well Profile**	**Vertical**
Account Code	**Description**		**Estimate**
9300 100	SURVEYS		15,000
9300 101	ROAD AND LEASE COSTS		100,000
9300 103	ROAD AND LEASE CLEANUP		10,000
9300 105	ROAD USE FEES		10,000
9300 110	FIRST NATIONS CONSULTATION		0
9300 112	WELL LICENSE		5,000
9300 115	ABANDONMENT/PLUG BACK		0
9300 200	DRILLING RIG		1,303,343
9300 201	DRILLING RIG MOVE IN MOVE OUT		125,000
9300 202	RIG FUEL		260,887
9300 205	CONDUCTOR AND RATHOLE		10,000
9300 206	DRILLING MUD AND CHEMICALS		544,064
9300 207	DIRECTIONAL DRILLING		338,183
9300 250	CAMP (NON SUBSISTENCE)		133,443
9300 450	COMMUNICATION		77,842
9300 370	EQUIP RENTAL - SURFACE		161,467
9300 500	TRUCKING		134,000
9300 316	DRILL PIPE INSPECTION		2,500
9300 310	WELDING SERVICES		2,500
9300 311	PRESSURE TESTING		7,000
9300 314	LOG/PERF/ANALYSIS		85,000
9300 401	CONSTRUCTION/WELL SITE SUPERVISION		121,203
9300 370	MAT RENTALS		0
9300 480	SAFETY SERVICES		0
9300 309	CASING BOWL AND ATTACHMENTS		35,000
9300 304	SURFACE CASING AND ACCESSORIES		103,600
9300 300	SURFACE CASING - CEMENT		25,000
9300 306	POWER TONGS SURFACE		5,000
9300 305	INTERMEDIATE CASING & ACCESSORIES		567,000
9300 302	INTERMEDIATE CASING-CEMENTING		100,000
9300 307	POWER TONGS INTERMEDIATE		15,000
9300 303	PRODUCTION CASING & ACCESSORIES		442,300
9300 301	PRODUCTION CASING CEMENT		100,000
9300 308	POWER TONGS PRODUCTION		15,000
9300 303	PRODUCTION TUBING & ACCESSORIES		182,500
9300 308	POWER TONGS PRODUCTION TUBING		20,000
9300 400	ENGINEERING AND WELL PLANNING		53,377
9300 315	FISHING SERVICES		0
9300 312	CORING AND ANALYSIS		0
9300 313	MISCELLENEOUS TESTS AND ANALYSIS		0
9300 502	FLUID DISPOSAL TRUCKING		40,000
9300 510	FLUID DISPOSAL COSTS		40,000
9300 503	SOLID WASTE DISPOSAL TRUCKING		48,590
9300 511	SOLID WASTE DISPOSAL COSTS		36,349
9300 371	DOWN HOLE EQUIP RENTAL		56,534
9300 208	DRILL BITS		185,000
9300 800	CONTINGENCY COSTS		0
9300 850	INSURANCE		0
9300 610	ENVIRONMENTAL SERVICES		7,000
9300 501	WATER TRUCK		33,361
9300 402	WELL SITE GEOLOGIST		27,356
9300 700	POTABLE WATER		4,448
9300 996	OVERHEAD		0
9300 504	VACUUM TRUCK		66,722
	Estimated Total		**5,655,569**

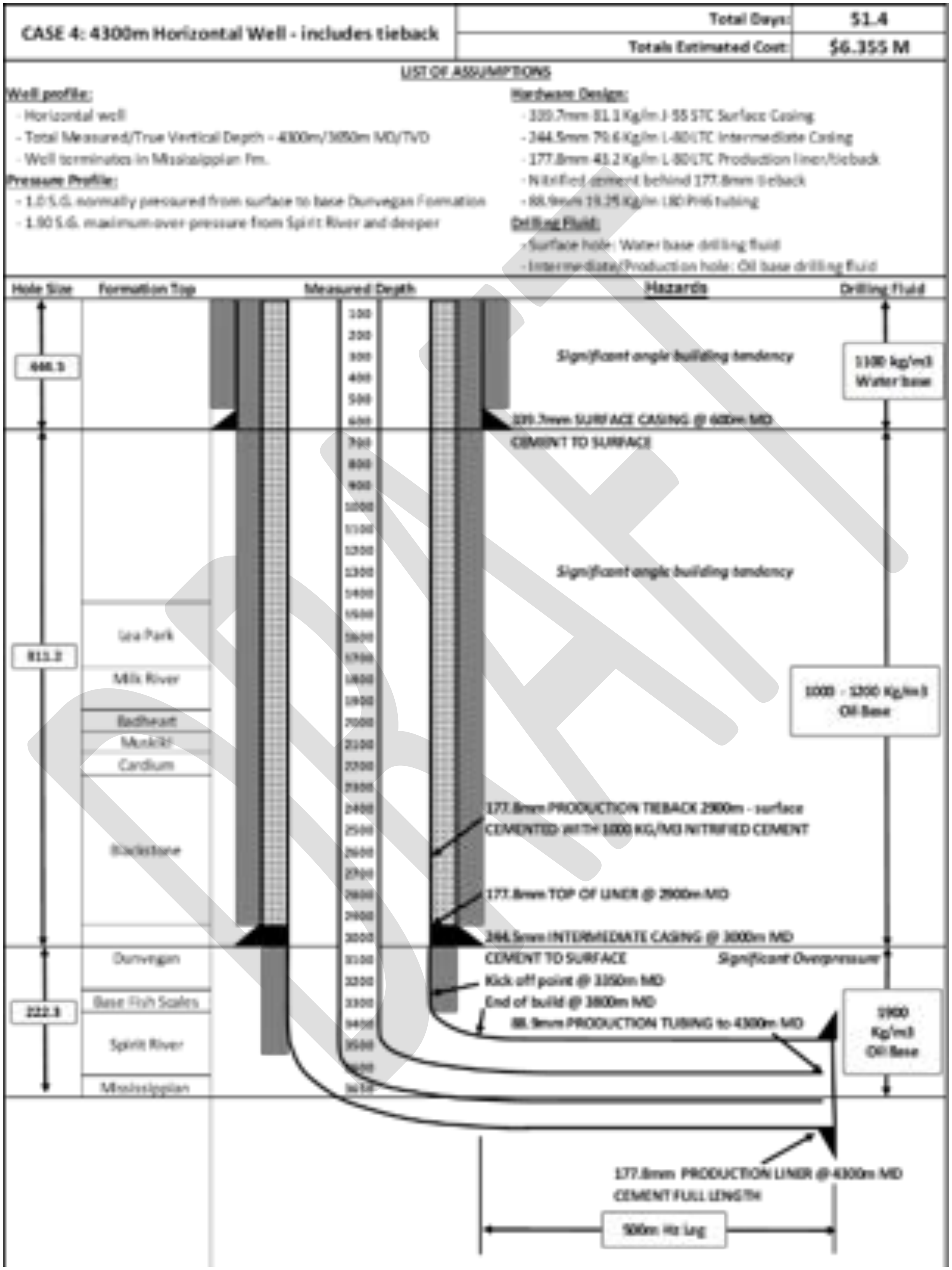
Case 3a: 3650m Vertical Well – No Tieback



DRILLING COST ESTIMATE			
CASE:	CASE 3a: 3650M Vertical well - no tieback	Total Days	43.61
LOCATION:	Hinton TWP 51 - RG 25 W5M	Total MD (m)	3650
TARGET ZONE:	Base Spirit River/Mississippian	TVD (m)	3650
SPUD DATE:	Fall 2018	Well Profile	Vertical

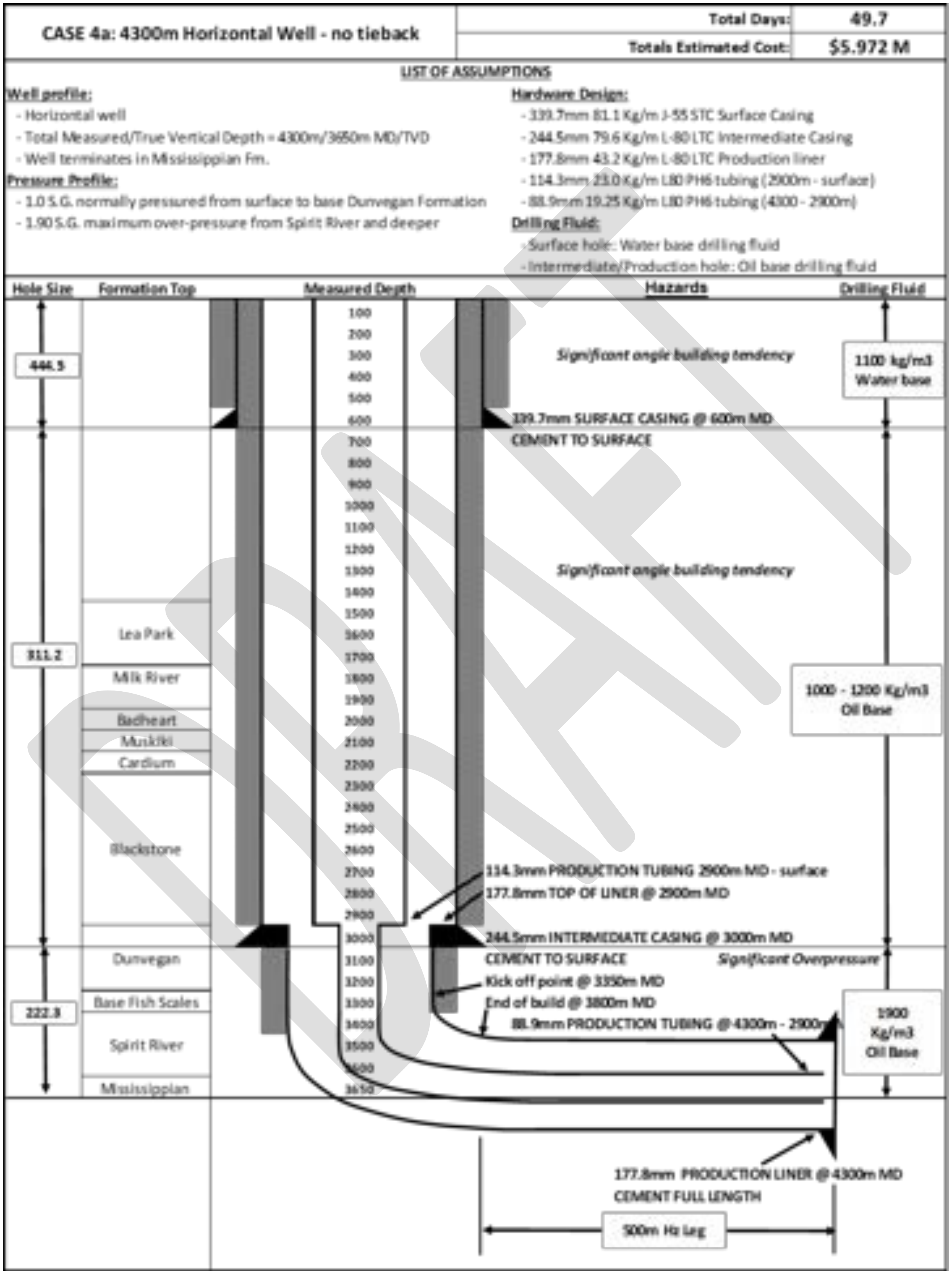
Account Code	Description		Estimate
9300 100	SURVEYS		15,000
9300 101	ROAD AND LEASE COSTS		100,000
9300 103	ROAD AND LEASE CLEANUP		10,000
9300 105	ROAD USE FEES		10,000
9300 110	FIRST NATIONS CONSULTATION		0
9300 112	WELL LICENSE		5,000
9300 115	ABANDONMENT/PLUG BACK		0
9300 200	DRILLING RIG		1,278,624
9300 201	DRILLING RIG MOVE IN MOVE OUT		125,000
9300 202	RIG FUEL		255,637
9300 205	CONDUCTOR AND RATHOLE		10,000
9300 206	DRILLING MUD AND CHEMICALS		543,189
9300 207	DIRECTIONAL DRILLING		338,183
9300 250	CAMP (NON SUBSISTENCE)		130,818
9300 450	COMMUNICATION		76,311
9300 370	EQUIP RENTAL - SURFACE		158,290
9300 500	TRUCKING		134,000
9300 316	DRILL PIPE INSPECTION		2,500
9300 310	WELDING SERVICES		2,500
9300 311	PRESSURE TESTING		7,000
9300 314	LOG/PERF/ANALYSIS		85,000
9300 401	CONSTRUCTION/WELL SITE SUPERVISION		119,015
9300 370	MAT RENTALS		0
9300 480	SAFETY SERVICES		0
9300 309	CASING BOWL AND ATTACHMENTS		30,000
9300 304	SURFACE CASING AND ACCESSORIES		103,600
9300 300	SURFACE CASING - CEMENT		25,000
9300 306	POWER TONGS SURFACE		5,000
9300 305	INTERMEDIATE CASING & ACCESSORIES		567,000
9300 302	INTERMEDIATE CASING-CEMENTING		100,000
9300 307	POWER TONGS INTERMEDIATE		15,000
9300 303	PRODUCTION CASING & ACCESSORIES		126,500
9300 301	PRODUCTION CASING CEMENT		50,000
9300 308	POWER TONGS PRODUCTION		5,000
9300 303	PRODUCTION TUBING & ACCESSORIES - 88.9mm		37,500
9300 303	PRODUCTION TUBING & ACCESSORIES - 114.3mm		217,500
9300 308	POWER TONGS PRODUCTION TUBING		15,000
9300 400	ENGINEERING AND WELL PLANNING		52,327
9300 315	FISHING SERVICES		0
9300 312	CORING AND ANALYSIS		0
9300 313	MISCELLENEOUS TESTS AND ANALYSIS		0
9300 502	FLUID DISPOSAL TRUCKING		40,000
9300 510	FLUID DISPOSAL COSTS		40,000
9300 503	SOLID WASTE DISPOSAL TRUCKING		48,590
9300 511	SOLID WASTE DISPOSAL COSTS		36,349
9300 371	DOWN HOLE EQUIP RENTAL		56,534
9300 208	DRILL BITS		185,000
9300 800	CONTINGENCY COSTS		0
9300 850	INSURANCE		0
9300 610	ENVIRONMENTAL SERVICES		7,000
9300 501	WATER TRUCK		32,705
9300 402	WELL SITE GEOLOGIST		27,356
9300 700	POTABLE WATER		4,361
9300 996	OVERHEAD		0
9300 504	VACUUM TRUCK		65,409
	Estimated Total		5,298,799

Case 4: 4300m Horizontal Well – Includes Tieback



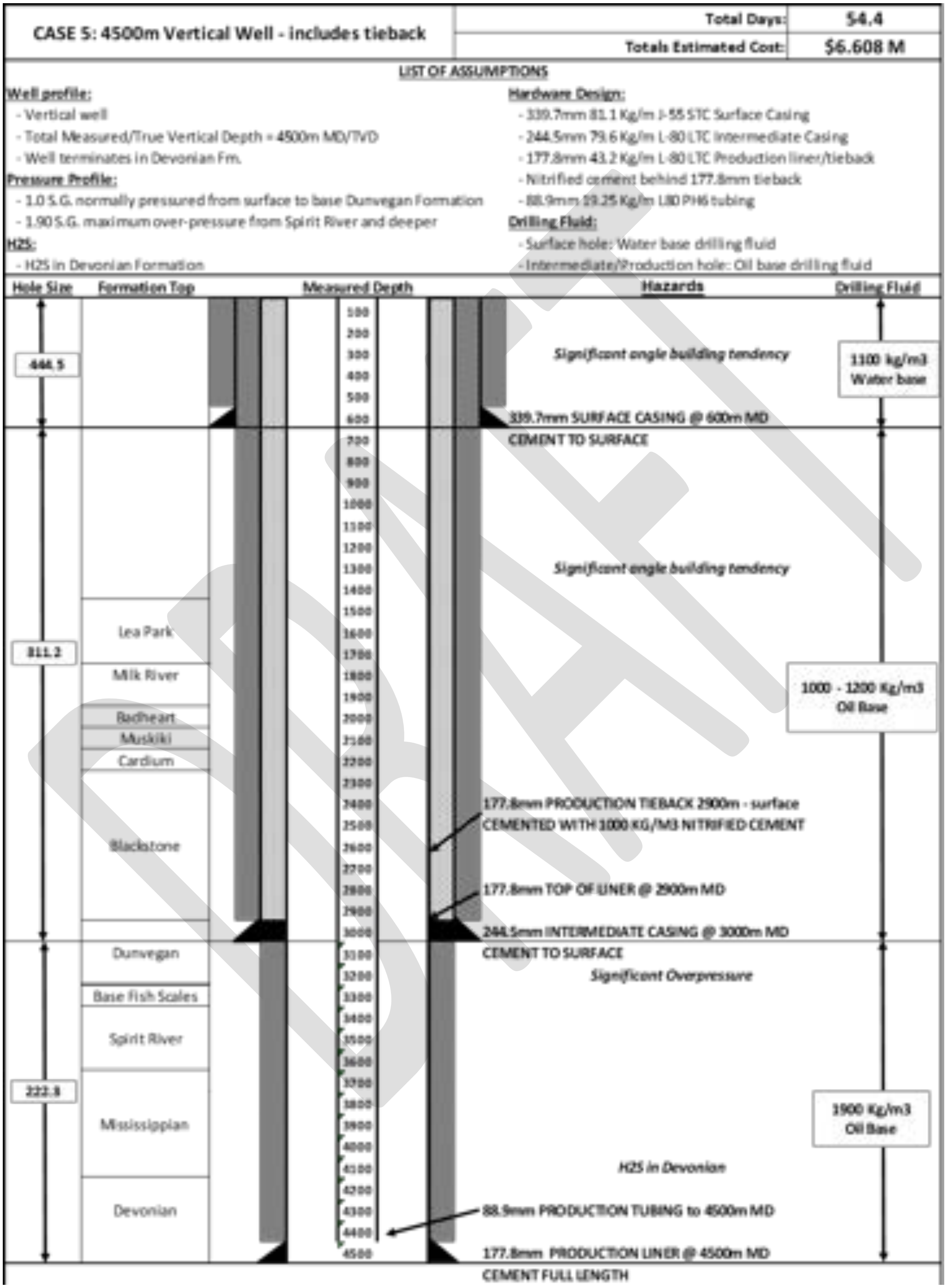
	DRILLING COST ESTIMATE		
CASE:	**CASE 4: 4300m Horizontal Well - includes tieback**	**Total Days**	**51.41**
LOCATION:	Hinton TWP 51 - RG 25 W5M	**Total MD (m)**	**4300**
TARGET ZONE:	Base Spirit River/Mississippian	**TVD (m)**	**3650**
SPUD DATE:	Fall 2018	**Well Profile**	**HORIZONTAL**
Account Code	**Description**		**Estimate**
9300 100	**SURVEYS**		**15,000**
9300 101	**ROAD AND LEASE COSTS**		**100,000**
9300 103	**ROAD AND LEASE CLEANUP**		**10,000**
9300 105	**ROAD USE FEES**		**10,000**
9300 110	**FIRST NATIONS CONSULTATION**		**0**
9300 112	**WELL LICENSE**		**5,000**
9300 115	**ABANDONMENT/PLUG BACK**		**0**
9300 200	**DRILLING RIG**		**1,499,131**
9300 201	**DRILLING RIG MOVE IN MOVE OUT**		**125,000**
9300 202	**RIG FUEL**		**302,470**
9300 205	**CONDUCTOR AND RATHOLE**		**10,000**
9300 206	**DRILLING MUD AND CHEMICALS**		**681,828**
9300 207	**DIRECTIONAL DRILLING**		**390,627**
9300 250	**CAMP (NON SUBSISTENCE)**		**154,235**
9300 450	**COMMUNICATION**		**89,970**
9300 370	**EQUIP RENTAL - SURFACE**		**186,624**
9300 500	**TRUCKING**		**136,000**
9300 316	**DRILL PIPE INSPECTION**		**2,500**
9300 310	**WELDING SERVICES**		**2,500**
9300 311	**PRESSURE TESTING**		**7,000**
9300 314	**LOG/PERF/ANALYSIS**		**85,000**
9300 401	**CONSTRUCTION/WELL SITE SUPERVISION**		**138,529**
9300 370	**MAT RENTALS**		**0**
9300 480	**SAFETY SERVICES**		**0**
9300 309	**CASING BOWL AND ATTACHMENTS**		**35,000**
9300 304	**SURFACE CASING AND ACCESSORIES**		**103,600**
9300 300	**SURFACE CASING - CEMENT**		**25,000**
9300 306	**POWER TONGS SURFACE**		**5,000**
9300 305	**INTERMEDIATE CASING & ACCESSORIES**		**567,000**
9300 302	**INTERMEDIATE CASING-CEMENTING**		**100,000**
9300 307	**POWER TONGS INTERMEDIATE**		**15,000**
9300 303	**PRODUCTION CASING & ACCESSORIES**		**508,600**
9300 301	**PRODUCTION CASING CEMENT**		**100,000**
9300 308	**POWER TONGS PRODUCTION**		**15,000**
9300 303	**PRODUCTION TUBING & ACCESSORIES - 88.9mm**		**215,000**
9300 303	**PRODUCTION TUBING & ACCESSORIES - 114.3mm**		**0**
9300 308	**POWER TONGS TUBING**		**15,000**
9300 400	**ENGINEERING AND WELL PLANNING**		**61,694**
9300 315	**FISHING SERVICES**		**0**
9300 312	**CORING AND ANALYSIS**		**0**
9300 313	**MISCELLENEOUS TESTS AND ANALYSIS**		**0**
9300 502	**FLUID DISPOSAL TRUCKING**		**40,000**
9300 510	**FLUID DISPOSAL COSTS**		**40,000**
9300 503	**SOLID WASTE DISPOSAL TRUCKING**		**53,622**
9300 511	**SOLID WASTE DISPOSAL COSTS**		**40,752**
9300 371	**DOWN HOLE EQUIP RENTAL**		**66,368**
9300 208	**DRILL BITS**		**235,000**
9300 800	**CONTINGENCY COSTS**		**0**
9300 850	**INSURANCE**		**0**
9300 610	**ENVIRONMENTAL SERVICES**		**7,000**
9300 501	**WATER TRUCK**		**38,559**
9300 402	**WELL SITE GEOLOGIST**		**33,995**
9300 700	**POTABLE WATER**		**5,141**
9300 996	**OVERHEAD**		**0**
9300 504	**VACUUM TRUCK**		**77,118**
		Estimated Total	**6,354,864**

Case 4a: 4300m Horizontal Well – No Tieback



	DRILLING COST ESTIMATE		
CASE:	**CASE 4a: 4300m Horizontal Well - no tieback**	**Total Days**	**49.66**
LOCATION:	Hinton TWP 51 - RG 25 W5M	**Total MD (m)**	**4300**
TARGET ZONE:	Base Spirit River/Mississippian	**TVD (m)**	**3650**
SPUD DATE:	Fall 2018	**Well Profile**	**HORIZONTAL**
Account Code	**Description**		**Estimate**
9300 100	SURVEYS		15,000
9300 101	ROAD AND LEASE COSTS		100,000
9300 103	ROAD AND LEASE CLEANUP		10,000
9300 105	ROAD USE FEES		10,000
9300 110	FIRST NATIONS CONSULTATION		0
9300 112	WELL LICENSE		5,000
9300 115	ABANDONMENT/PLUG BACK		0
9300 200	DRILLING RIG		1,449,693
9300 201	DRILLING RIG MOVE IN MOVE OUT		125,000
9300 202	RIG FUEL		291,970
9300 205	CONDUCTOR AND RATHOLE		10,000
9300 206	DRILLING MUD AND CHEMICALS		680,203
9300 207	DIRECTIONAL DRILLING		390,627
9300 250	CAMP (NON SUBSISTENCE)		148,985
9300 450	COMMUNICATION		86,908
9300 370	EQUIP RENTAL - SURFACE		180,272
9300 500	TRUCKING		136,000
9300 316	DRILL PIPE INSPECTION		2,500
9300 310	WELDING SERVICES		2,500
9300 311	PRESSURE TESTING		7,000
9300 314	LOG/PERF/ANALYSIS		85,000
9300 401	CONSTRUCTION/WELL SITE SUPERVISION		134,154
9300 370	MAT RENTALS		0
9300 480	SAFETY SERVICES		0
9300 309	CASING BOWL AND ATTACHMENTS		30,000
9300 304	SURFACE CASING AND ACCESSORIES		103,600
9300 300	SURFACE CASING - CEMENT		25,000
9300 306	POWER TONGS SURFACE		5,000
9300 305	INTERMEDIATE CASING & ACCESSORIES		567,000
9300 302	INTERMEDIATE CASING-CEMENTING		100,000
9300 307	POWER TONGS INTERMEDIATE		15,000
9300 303	PRODUCTION CASING & ACCESSORIES		192,800
9300 301	PRODUCTION CASING CEMENT		50,000
9300 308	POWER TONGS PRODUCTION		5,000
9300 303	PRODUCTION TUBING & ACCESSORIES - 88.9mm		82,500
9300 303	PRODUCTION TUBING & ACCESSORIES - 114.3mm		217,500
9300 308	POWER TONGS TUBING		15,000
9300 400	ENGINEERING AND WELL PLANNING		59,594
9300 315	FISHING SERVICES		0
9300 312	CORING AND ANALYSIS		0
9300 313	MISCELLENEOUS TESTS AND ANALYSIS		0
9300 502	FLUID DISPOSAL TRUCKING		40,000
9300 510	FLUID DISPOSAL COSTS		40,000
9300 503	SOLID WASTE DISPOSAL TRUCKING		53,622
9300 511	SOLID WASTE DISPOSAL COSTS		40,752
9300 371	DOWN HOLE EQUIP RENTAL		66,368
9300 208	DRILL BITS		235,000
9300 800	CONTINGENCY COSTS		0
9300 850	INSURANCE		0
9300 610	ENVIRONMENTAL SERVICES		7,000
9300 501	WATER TRUCK		37,246
9300 402	WELL SITE GEOLOGIST		33,995
9300 700	POTABLE WATER		4,966
9300 996	OVERHEAD		0
9300 504	VACUUM TRUCK		74,493
	Estimated Total		**5,972,249**

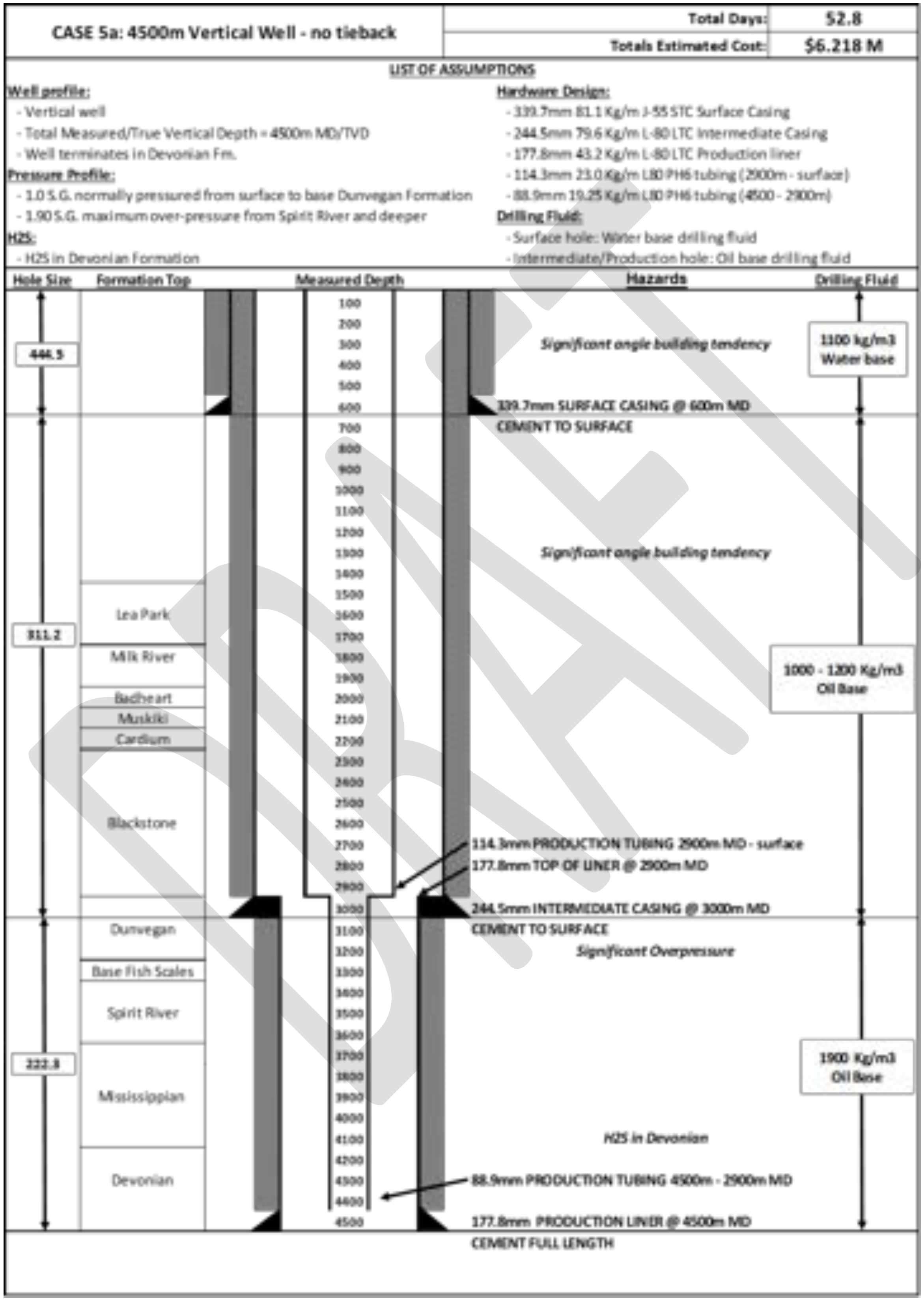
Case 5: 4500m Vertical Well – Includes Tieback



DRILLING COST ESTIMATE			
CASE:	**CASE 5: 4500m Vertical Well - includes tieback**	**Total Days**	**54.40**
LOCATION:	Hinton TWP 51 - RG 25 W5M	**Total MD (m)**	**4500**
TARGET ZONE:	Devonian	**TVD (m)**	**4500**
SPUD DATE:	Fall 2018	**Well Profile**	**Vertical**

Account Code	Description		Estimate
9300 100	SURVEYS		15,000
9300 101	ROAD AND LEASE COSTS		100,000
9300 103	ROAD AND LEASE CLEANUP		10,000
9300 105	ROAD USE FEES		10,000
9300 110	FIRST NATIONS CONSULTATION		0
9300 112	WELL LICENSE		5,000
9300 115	ABANDONMENT/PLUG BACK		0
9300 200	DRILLING RIG		1,583,488
9300 201	DRILLING RIG MOVE IN MOVE OUT		125,000
9300 202	RIG FUEL		320,387
9300 205	CONDUCTOR AND RATHOLE		10,000
9300 206	DRILLING MUD AND CHEMICALS		724,814
9300 207	DIRECTIONAL DRILLING		414,516
9300 250	CAMP (NON SUBSISTENCE)		163,193
9300 450	COMMUNICATION		95,196
9300 370	EQUIP RENTAL - SURFACE		197,464
9300 500	TRUCKING		136,000
9300 316	DRILL PIPE INSPECTION		2,500
9300 310	WELDING SERVICES		2,500
9300 311	PRESSURE TESTING		7,000
9300 314	LOG/PERF/ANALYSIS		85,000
9300 401	CONSTRUCTION/WELL SITE SUPERVISION		145,995
9300 370	MAT RENTALS		0
9300 480	SAFETY SERVICES		0
9300 309	CASING BOWL AND ATTACHMENTS		35,000
9300 304	SURFACE CASING AND ACCESSORIES		103,600
9300 300	SURFACE CASING - CEMENT		25,000
9300 306	POWER TONGS SURFACE		5,000
9300 305	INTERMEDIATE CASING & ACCESSORIES		567,000
9300 302	INTERMEDIATE CASING-CEMENTING		100,000
9300 307	POWER TONGS INTERMEDIATE		15,000
9300 303	PRODUCTION CASING & ACCESSORIES		529,000
9300 301	PRODUCTION CASING CEMENT		100,000
9300 308	POWER TONGS PRODUCTION		15,000
9300 303	PRODUCTION TUBING & ACCESSORIES - 88.9mm		225,000
9300 303	PRODUCTION TUBING & ACCESSORIES - 114.3mm		0
9300 308	POWER TONGS TUBING		15,000
9300 400	ENGINEERING AND WELL PLANNING		65,277
9300 315	FISHING SERVICES		0
9300 312	CORING AND ANALYSIS		0
9300 313	MISCELLENEOUS TESTS AND ANALYSIS		0
9300 502	FLUID DISPOSAL TRUCKING		40,000
9300 510	FLUID DISPOSAL COSTS		40,000
9300 503	SOLID WASTE DISPOSAL TRUCKING		55,171
9300 511	SOLID WASTE DISPOSAL COSTS		42,107
9300 371	DOWN HOLE EQUIP RENTAL		70,847
9300 208	DRILL BITS		235,000
9300 800	CONTINGENCY COSTS		0
9300 850	INSURANCE		0
9300 610	ENVIRONMENTAL SERVICES		7,000
9300 501	WATER TRUCK		40,798
9300 402	WELL SITE GEOLOGIST		36,981
9300 700	POTABLE WATER		5,440
9300 996	OVERHEAD		0
9300 504	VACUUM TRUCK		81,597
	Estimated Total		**6,607,872**

Case 5a: 4500m Vertical Well – No Tieback



	DRILLING COST ESTIMATE		
CASE:	CASE 5a: 4500m Vertical Well - no tieback	Total Days	52.77
LOCATION:	Hinton TWP 51 - RG 25 W5M	Total MD (m)	4500
TARGET ZONE:	Devonian	TVD (m)	3650
SPUD DATE:	Fall 2018	Well Profile	Vertical
Account Code	Description		Estimate
9300 100	SURVEYS		15,000
9300 101	ROAD AND LEASE COSTS		100,000
9300 103	ROAD AND LEASE CLEANUP		10,000
9300 105	ROAD USE FEES		10,000
9300 110	FIRST NATIONS CONSULTATION		0
9300 112	WELL LICENSE		5,000
9300 115	ABANDONMENT/PLUG BACK		0
9300 200	DRILLING RIG		1,537,582
9300 201	DRILLING RIG MOVE IN MOVE OUT		125,000
9300 202	RIG FUEL		310,637
9300 205	CONDUCTOR AND RATHOLE		10,000
9300 206	DRILLING MUD AND CHEMICALS		723,189
9300 207	DIRECTIONAL DRILLING		414,516
9300 250	CAMP (NON SUBSISTENCE)		158,318
9300 450	COMMUNICATION		92,352
9300 370	EQUIP RENTAL - SURFACE		191,565
9300 500	TRUCKING		136,000
9300 316	DRILL PIPE INSPECTION		2,500
9300 310	WELDING SERVICES		2,500
9300 311	PRESSURE TESTING		7,000
9300 314	LOG/PERF/ANALYSIS		85,000
9300 401	CONSTRUCTION/WELL SITE SUPERVISION		141,932
9300 370	MAT RENTALS		0
9300 480	SAFETY SERVICES		0
9300 309	CASING BOWL AND ATTACHMENTS		30,000
9300 304	SURFACE CASING AND ACCESSORIES		103,600
9300 300	SURFACE CASING - CEMENT		25,000
9300 306	POWER TONGS SURFACE		5,000
9300 305	INTERMEDIATE CASING & ACCESSORIES		567,000
9300 302	INTERMEDIATE CASING-CEMENTING		100,000
9300 307	POWER TONGS INTERMEDIATE		15,000
9300 303	PRODUCTION CASING & ACCESSORIES		213,200
9300 301	PRODUCTION CASING CEMENT		50,000
9300 308	POWER TONGS PRODUCTION		5,000
9300 303	PRODUCTION TUBING & ACCESSORIES - 88.9mm		80,000
9300 303	PRODUCTION TUBING & ACCESSORIES - 114.3mm		217,500
9300 308	POWER TONGS TUBING		15,000
9300 400	ENGINEERING AND WELL PLANNING		63,327
9300 315	FISHING SERVICES		0
9300 312	CORING AND ANALYSIS		0
9300 313	MISCELLENEOUS TESTS AND ANALYSIS		0
9300 502	FLUID DISPOSAL TRUCKING		40,000
9300 510	FLUID DISPOSAL COSTS		40,000
9300 503	SOLID WASTE DISPOSAL TRUCKING		55,171
9300 511	SOLID WASTE DISPOSAL COSTS		42,107
9300 371	DOWN HOLE EQUIP RENTAL		70,847
9300 208	DRILL BITS		235,000
9300 800	CONTINGENCY COSTS		0
9300 850	INSURANCE		0
9300 610	ENVIRONMENTAL SERVICES		7,000
9300 501	WATER TRUCK		39,580
9300 402	WELL SITE GEOLOGIST		36,981
9300 700	POTABLE WATER		5,277
9300 996	OVERHEAD		0
9300 504	VACUUM TRUCK		79,159
	Estimated Total		6,218,842

Appendix C.3 Well Heat Transfer Methodology & Sensitivities

Appendix C.3.1 Candidate Well Modeling

The geothermal well and the reservoir from which it operates is what makes geothermal projects viable. The ability to select and/or create wells that work at their highest efficiency helps give a good understanding of the initial capital cost and the long-term economics. Maximising the amount of energy you can pull, while keeping your construction costs for the well and operating costs such as the pump low without compromising the system.

Currently at a preliminary level of design, the ability to approximate geothermal well productivity was crucial but unable to be accurate for each specific well. To keep the comparisons on fair grounds between each candidate, assumptions were made. These assumptions include; water as the working fluid, water being kept as a saturated liquid, and negligible thermal resistance from steel pipe. These assumptions were made on the basis of properties that would be beneficial when proceeding to detailed design.

Beginning the heat transfer simulation, required a simple model of the system, this was done with a 2D model, as shown in Figure 84, that is integrated in sections over the depth of the well, since the cross sections are identical, being round.

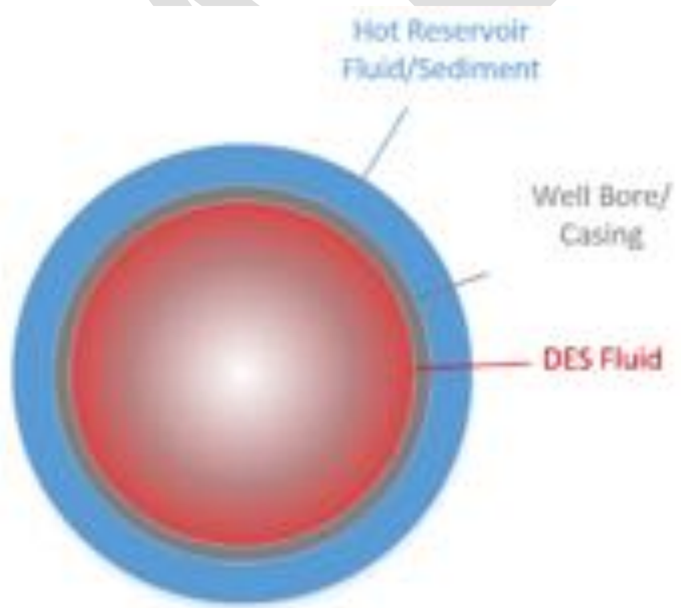


Figure 84 - 2D Cross Section view of candidate well modeling

Viewing Figure 84, the main difference is that there is no smaller core on the inside from which fluid is being brought to the service. This is excluded from the model because as mentioned, the pipe between the 2 fluids would give negligible thermal resistance, so any heat being transferred from the fluid travelling up is being transferred to the fluid being pumped down the well, making the DES fluid a closed system.

Since we are dealing with potential depths up to 6000m, segments lengths were tested, and the answers all converged at lengths of 100m, using smaller segments lengths that exponentially increase the amount of calculations, changed the answers by less than 1%, for this reason the 100m lengths were chosen. To calculate the amount of heat transfer for each 100m section, the following equation was used:

$$Q_T = \sum h * A_{s*}(T_{S,a} - T_m)$$

Where;

Q_T = The total amount of heat transfer of the well, kW

h = Convection heat transfer coefficient, W/(m²*°C)

A_S = The surface area of the inside of the bore, m²

T_s = Temperature of inner bore surface, °C

T_m = Temperature of working fluid, °C

Q is the final step of the calculation; it is the amount of heat being transferred from the well to the fluid. Obtaining Q requires four variables, the most difficult to calculate being h. Calculating h requires Prandt number (Pr), Reynold's number (Re), and Nusselt number (Nu), be determined for the fluid in every 100m length, after these values are calculated and extrapolated from existing charts, h is obtained using;

$$h = \frac{k * Nu}{D_h}$$

It is important to note, that for a circular cross section, the hydraulic diameter, D_h, is equal to the actual diameter. Calculating A_s with simple geometry of a cylinder yielded;

$$A_s = 2\pi D_h L$$

Where L is equal to the length of each segment in meters.

Then the temperature of the inner bore surface was taken from the temperature gradient from the top of the well to the bottom, then the average of each segment used, with the equation;

$$T_{s,a} = \frac{\left(\frac{T_b - T_t}{L_T} * L_{b,s} + T_t\right) - \left(\frac{T_b - T_t}{L_T} * L_{t,s} + T_t\right)}{2}$$

Where;

$T_{s,a}$ = Average temperature of the segment, °C

T_b = Temperature at the bottom of the well, °C

T_t = Temperature at the top of the well, °C

L_T = Total length/depth of the well, m

$L_{b,s}$ = Depth at the bottom of the well segment, m

$L_{t,s}$ = Depth at the top of the well segment, m

Finally, the temperature of the fluid is taken as the exit temperature from the last segment (i.e. the initial temperature for the first segment), plus the heat gained to obtain the inlet temperature of the next segment using;

$$T_m = T_{o,s} + \frac{Q_{p,s}}{\dot{m} * C_p}$$

Where;

T_m = Temperature of the fluid, °C

$T_{o,s}$ = Fluid outlet temperature of previous segment, °C

$Q_{p,s}$ = Heat transfer from previous section, kW

$\dot{m}$ = Mass flow rate of fluid, kg/s

C_p = Specific heat of the fluid, kJ/kg*k

These variables are then entered and performed for each 100m segment, the summation giving Q_T, the total heat transfer of the well to the fluid.

The next step involved optimizing the well design for choosing candidate wells. This involved running sensitivities, the sensitivities chosen for this study were; bore/casing diameter, flow rate, bottom hole temp, and well depth. Running the sensitivity, all inputs were locked except for the sensitivity being tested, and the heat output and water outlet temperature recorded for each test. The base case can be seen in Table 50.

Table 50 - Base Case Model Inputs Used for Sensitivity Study

Well Properties		
Top of Well	20	°C
Bot of well	160	°C
Fluid Temp	40	°C
Segment Lengths	100	m
Well Depth	5500	m
Diameter	12	in
Flow rate	5	kg/s
Density	1000	kg/m^3

The first sensitivity study was performed on the bore diameter. The bore diameter is important, because it affects how much fluid we can flow into the well and the velocity of said fluid. The velocity is an important factor, as you don't want the working fluid to approach the bottom hole temp, or else the amount of heat transfer decays. You also do not want the fluid moving too fast, as it reduces the residence time, and the water comes out only slightly warmer, which would mean much larger heat exchangers for the clients.

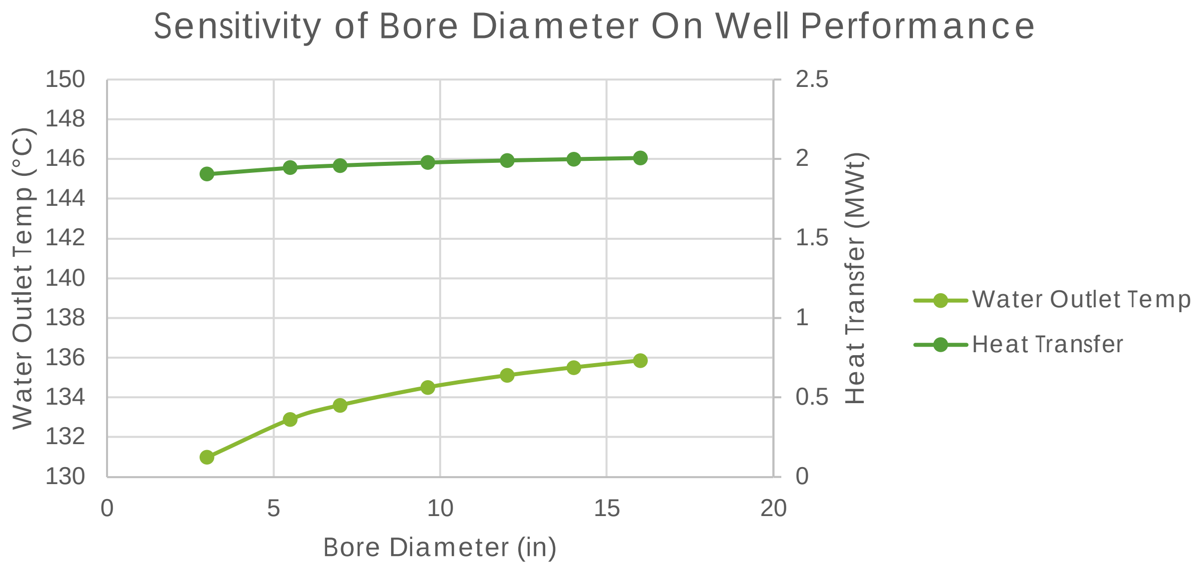


Figure 85 - Bore sensitivity results

Figure 85 shows the results of the first sensitivity, these results show that the bore hole size has very little impact on the performance, however, the changes are minor and due to the curved shape, these improvements have diminishing returns. The main benefit of the bore diameter comes into lay when selecting a pump. The larger bore diameters will create less friction, thus reducing the load on the pump, reducing operation costs, or allowing for more flow rate. Although there is no detriment to having a larger bore hole size in this range, when comparing wells, an 8 inch option can and may have other merits to be selected over a 12 inch candidate well.

The next sensitivity analysed was flow rate. Flow rate is very similar to the bore diameter, but inversed, as increasing the flow rate increases the velocity of the fluid and decreasing the flow rate decreases the velocity. However, with varying flow rates, increasing the flow rate means there is more fluid to carry heat from the well, which comes at the cost of that lower residence time and lower outlet temperature. This sensitivity was performed between reasonable flow rates of 1 to 50 kg/s.

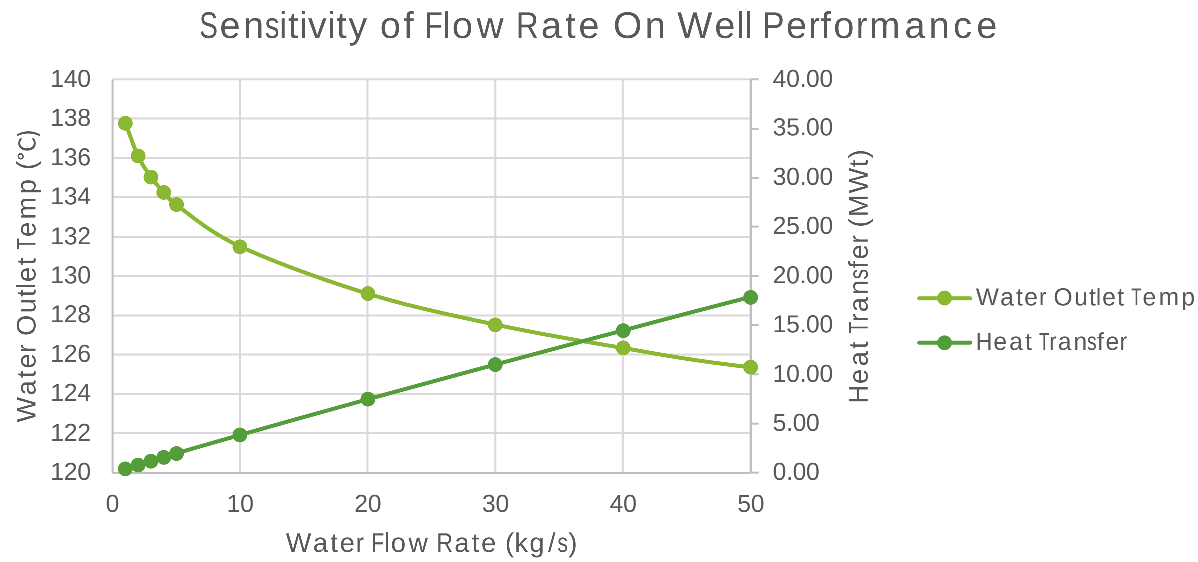


Figure 86 - Flow rate sensitivity results

Figure 86 is a great example of a sensitivity study for optimizing a well. It is a variable that the designer has control over, and greatly impacts the output of the well. Immediately when reviewing the graph, it becomes apparent that the heat transfer is linear. Doubling the flow rate will double the heat output, at the cost of a lower outlet temperature. This information could be used by setting a base flow rate or a base outlet temperature for the project and finding how much heat can be transferred. Especially important for industrial uses where the client may require high temperatures, and that cannot be compromised. Although this may seem like a well can produce an endless amount of heat, one of the assumptions does state the well walls remain a constant temperature, increasing flow rate in actuality does have the potential consequences of cooling the well and very large friction loads for the pump to overcome at these depths.

The final two sensitivities are directly related to the attributes of the well. Depth and bottom hole temperature both play a large role in selecting a well, due to their direct correlation to well performance.

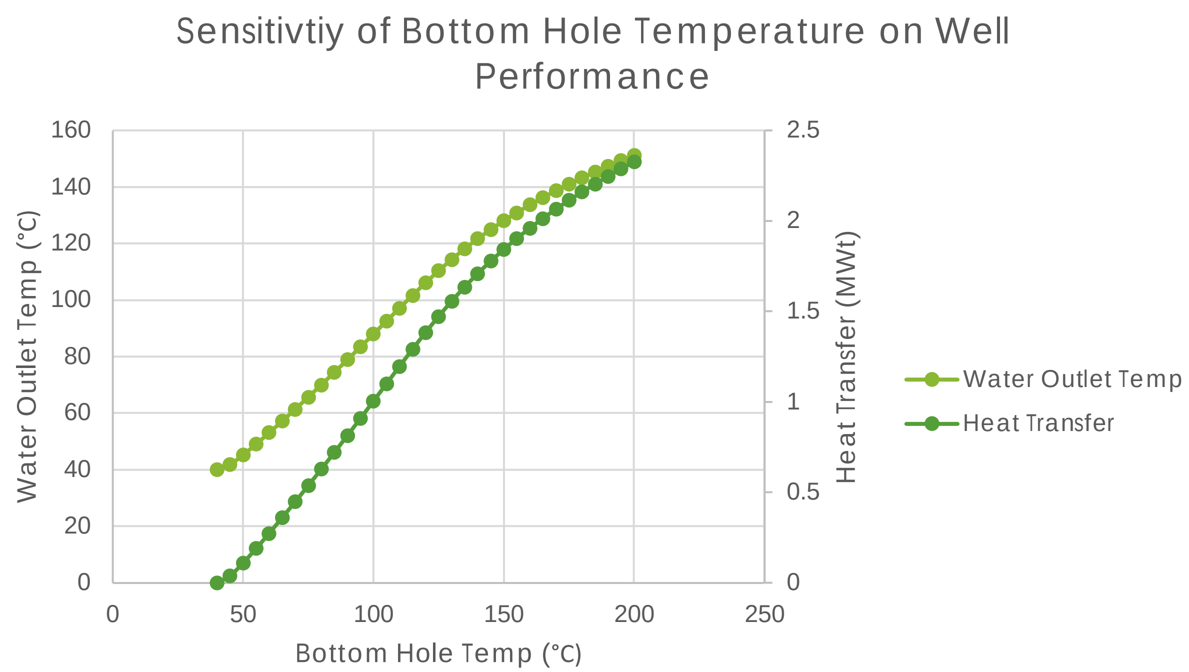


Figure 87 - Bottom hole temperature sensitivity results

The bottom hole temperature sensitivity was performed from 40°C to 200°C. All scenarios have a top of well temperature of 20°C, so the depths remaining the same, an increase in bottom hole temperature increases the gradient of heat along the well depth. A starting temperature was chosen equivalent to the fluid temperature, because that is the starting point where heat transfer will occur, if the temperature of the well were below that of working fluid, the fluid would be transferring heat to the well, while 200°C was chosen as it will encompass any well we expect to find in the area.

Most would view this sensitivity and assume a higher temperature will always result in more heat output, viewing Figure 87, that is the case. The performance of the well increases almost linearly. The temperature and heat transfer curves seem to converge, because as you increase the temperature gradient, there is more rapid heat transfer, which allows the working fluid to come to approach the bottom hole temperature more rapidly. As you approach the bottom hole temperature, heat transfer begins to diminish. As learned from the sensitivity on flow rate, the trade off between heat transfer and outlet temperature, an increased flow rate is the best way to take advantage of a higher resource temperature of a candidate well. A 150°C and 200°C well will only be able to transfer a limited amount of energy to water at 5kg/s as it will approach those temperatures.

The final sensitivity was the depth of the well, although our model has a heat gradient, depth will affect this gradient in the simulation. A deeper well having more sections for heat transfer to occur at lower average section temperatures, while a shallow well will only have a few sections of hotter average section temperatures. The advantage to well depth, is that the average temperature of well will always be the same, meaning depth is simply creating more surface area for heat transfer to occur.

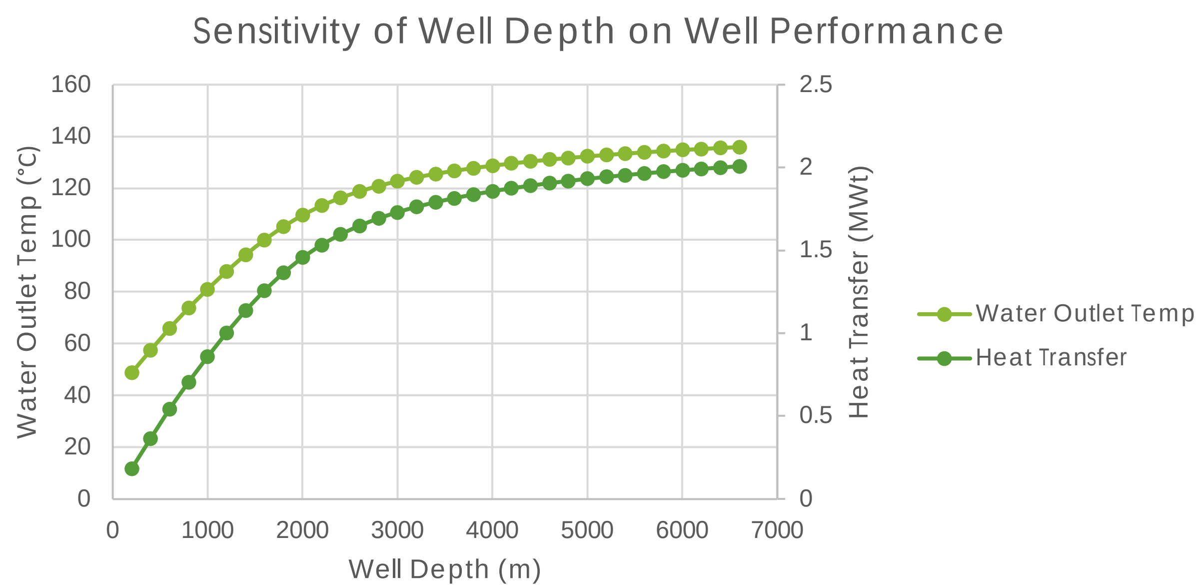


Figure 88 - Well depth sensitivity results

Viewing Figure 88, the amount of heat transfer seems to reach a maximum at 2MWt, with the outlet temperature following a similar trend and reaching a maximum of 140°C. The shape of the graph shows that well depth has the great benefits, but quickly displays diminishing returns. Although the hardest to explain, the heat transfer and water outlet temperature curves matching is an indicator that the flow rate is the bottle neck for well depth. Increasing the well depth at a fixed flow rate is consistently increasing the amount of time for heat transfer to occur while maintaining the same velocity in the well. The fluid having more time to come to temperature, decreases the temperature differential between the working fluid and the well, making the deeper segments, although the hottest, transfer very little heat to the fluid as it has also been heated to a relatively high temperature.

In this particular model, the important not only comes for well selection, but pumping once again. Although a candidate well may be discovered with a depth of 5 or 6km depth, the benefit to the extra pumping may not be viable. Once again referring to Figure 88, the benefits after 3000m are minimal, and even doubling the depths of this well only increases the heat transfer by ~10%.

With a constant bottom hole temperature, the gradient for all the wells in Figure 88 decreases as the depth increases. This prompted a look at comparing well depth, with a fixed gradient. To obtain a gradient, existing well data with depths and bottom hole temperatures as was used. Using 12 data points within the area, after visually inspecting and removing outliers, the following graph, Figure 89 is produced.

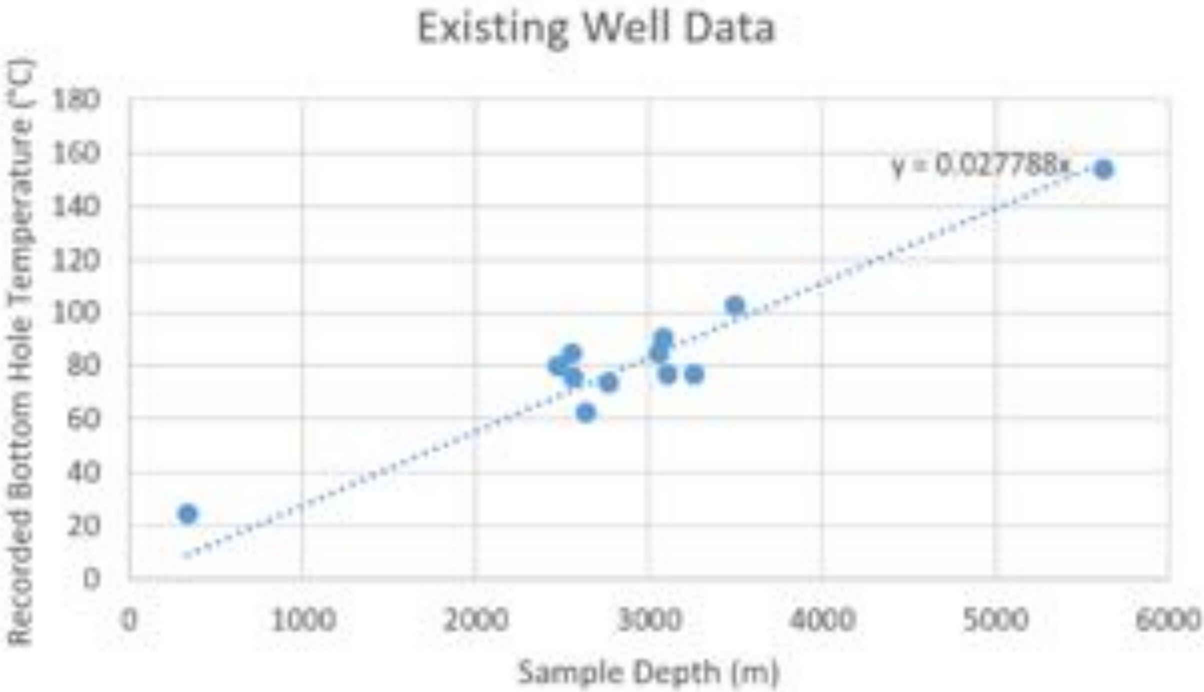


Figure 89 - Existing well data

Using a linear trend line with an intercept at zero, the average gradient is revealed to be 0.027788°C/m or 27.78°C/km. This gradient was then used for a depth range of 2000 to 7000m, producing Figure 90.

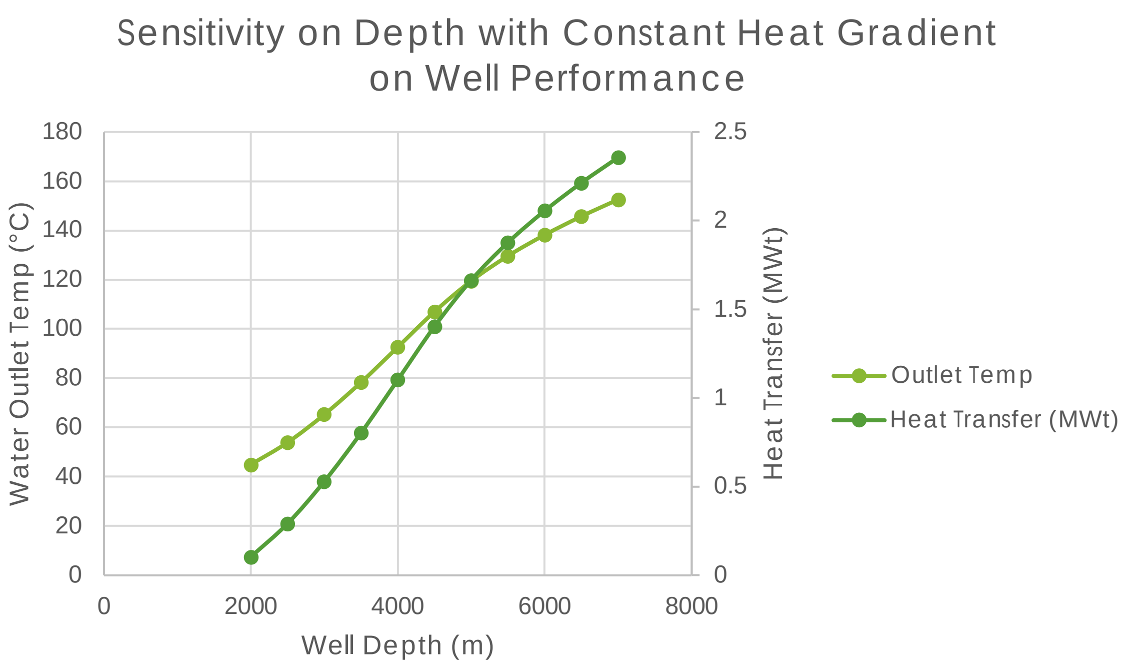


Figure 90 - Gradient and depth sensitivity results

The results in Figure 90 are expected, showing improved performance at deeper depths, for reasons being both a higher bottom hole temperature and more area for heat transfer. The relationship is almost linear, showing no disadvantage in well depth at a constant gradient. This is to say, a deeper well at a constant gradient will always perform better and produce a higher outlet temperature of the working fluid. The main constraint here again being the frictional load of the fluid for pumping from greater depths.

Appendix C.4 Regulatory Environment

Appendix C.4.1 Introduction to the Regulatory Environment

Accessing an existing oilfield wellbore for the development of a geothermal energy resource is a new concept in the province of Alberta. There is currently no regulatory framework in Alberta specific to high-temperature geothermal energy development, and any deep-geothermal project would need to operate and abide by the current regulatory requirements for oil and gas field environments.

As an abundance of oilfield wells involve production of water in conjunction with fossil fuel exploitation, there is an opportunity to align geothermal project operations with the current oil field regulatory environment. There has been precedence set by the 'Living Energy project', which uses a former oil well in Leduc (Leduc #1) to heat the Energy Discovery Centre with geothermal energy.

To help facilitate the navigation of the appropriate regulatory environment, Epoch Energy has already begun dialogue with the Alberta Energy Regulator ('AER'). "The Alberta Energy Regulator is a regulatory body with a mandate to provide for the efficient, safe, orderly, and environmentally responsible development of Alberta's energy resources. The AER is responsible for regulating the life cycle of oil, oil sands, natural gas, and coal projects in Alberta from application and construction to production, abandonment, and reclamation." [1]

There is an extensive set of regulatory processes for the access and operation of oilfield wells, which includes the requirements for 'produced water' and the liability for well owners and operators. This study completed an initial review of the regulatory directives (i.e. Directive 001) that are likely applicable for this 'well repurposing', and key requirements and rules that are specific to the project activities. This is not intended to be a complete analysis of the regulatory process as there is considerable regulatory uncertainty for deep geothermal energy development in the province of Alberta, but an overview of the relevant AER directives. A basic description of these key directives are provided below; the complete set of points for each directive is provided in the following section (Appendix C.4.2).

Directive 001 - Requirements for Site-Specific Liability Assessments in Support of the AER's Liability Management Programs: Directive 001 addresses one of the primary attributes in the suspension and abandonment of existing oilfield wells: the issue of estimating the cost of environmental cleanup and liability. This directive focuses on the identification and the costs associated with remediation and reclamation of oilfield wells and scoping of the environmental liability. Quantifying the 'cost of cleanup' is crucial to determining the overall liability that an owner/operator is responsible for on a well. This issue of liability is discussed further in Directive 006 below.

Directive 006 - Licencee Liability Rating Program (LLR) And Licence Transfer Process: Directive 006 addresses the concern that oilfield producers are required to maintain the necessary assets to offset their ongoing environmental liabilities associated with their oilfield operations.

"The purpose of the Alberta Energy Regulator (AER) LLR Program and licence transfer process as set out in this directive is to:

- *Prevent the costs to suspend, abandon, remediate, and reclaim a well, facility, or pipeline in the LLR Program from being borne by the public of Alberta should a licencee become defunct, and*
- *Minimize the risk to the Orphan Fund posed by the unfunded liability of licences in the program."* [1]

Of note: This regulatory environment recently changed in June of 2016 from an asset to liability ratio (LMR: Liability Management Ratio) of 1:1 to 2:1 ratio, thus requiring oilfield operators/producers to have twice the necessary assets to ensure that they have the necessary financial fortitude to be able to cover reclamation and remediation costs. The transfer or purchase of AER-licenced wells requires approval from the AER to ensure that licencee's eligible deemed assets have a LMR ratio of at least 2.0.

Directive 011- LLR Program: Updated Industry Parameters and Liability Costs: Directive 011 determines the calculation of the LLR rating based on industry netback and estimated well abandonment costs. The industry netback is a calculation of earnings minus the direct operating and general expenses (i.e. midstream revenue less cost of goods sold). The estimated well abandonment cost incorporates a number of variables including location (regional cost map), depth and downhole completion scenario.

Directive 013 - Suspension Requirements for Wells: Directive 013 addresses the change of status from 'active' to 'suspended wells'. Wells that have not reported any 'volumetric activity for 12 consecutive months' are termed 'inactive' and require that the AER status be updated to 'suspended'. This directive also deals with the reactivation of suspended wells, which may be relevant for the repurposing of wells for geothermal applications.

Directive 020 – Well Abandonment: Directive 020 documents the process and AER requirements for moving well status for complete well abandonment. The documentation shows that extensive work is needed to finalize a well abandonment, including well testing, cementing, ground water protection, and cut & cap process. As discussed earlier, this creates a more complex regulatory environment to re-enter an abandoned well (addressed by Directive 056, the content of which can be found at https://www.aer.ca/rules-and-regulations/directives/directive-056). It should be stated that it is not the intention of this project to re-enter an abandoned well and as such this possibility is not covered. This directive also clarifies that if the licence for an abandoned well is transferred, the new licencee assumes all responsibility for the control or further abandonment of the well and the cost of doing that work, which relates back to the previous LMR discussion in Directive 006 & Directive 011.

Appendix C.4.2 Applicable AER Regulatory Directives

Directive 001 – Requirements for Site-Specific Liability Assessments in Support of the AER's Liability Management Programs

2.2.1 – Identifying a Potential Problem Site

3 – Scope of Liability Assessment

4.1 - Assessment of Suspension or Abandonment costs

- Guide 20 – Well abandonment guide

4.2 – Reclamation Assessment

- Phase 1 environmental assessment – meet or exceed standards in ESRD T/573: Phase 1 Environmental Site Assessment Guideline for Upstream Oil & Gas
- Phase 2 environmental assessment – environmental issues ID'd in phase 1 – meet or exceed CSA Z769-00: Phase 2 Environmental Site Assessment

5 – Cost estimate

- Address currently outstanding suspension, abandonment or reclamation obligations must be site-specific

5.1 – Suspension costs

- 3 years of care, custody, security

5.2 – Abandonment costs

- Provide for downhole and surface abandonment of a well, decommission and dismantling of a facility, or abandonment of a pipeline

5.3 – Reclamation costs

- Remediation and surface reclamation of all land directly affected by the development

5.3.1 – Remediation Costs

- Remediation cost estimate must be based on plan that:
    - Excavates
    - Treats or disposes of oilfield waste
    - Treats affected water, groundwater, bedrock and inaccessible soil contamination

5.3.2 – Surface Reclamation Costs

- Costs based on approach that returns ability of land to support land uses similar to that which existed before development

6 – Other reporting requirements

7 – Previously conducted liability assessment must be less than 3 years old

8 – Current licencee or approval hold is responsible for ensuring liability assessment provided to AER is updated according to the schedule specified by AER

9 – AER may require more frequent updates of site-specific liability assessment costs estimates

- At time of licence transfer request
- Upon audit of a licence
- If site conditions warrant update
- If AER requirement specifies an earlier submission deadline
- AER determines circumstance warrant an update

Appendix 1 – Tasks for Estimating Site-Specific Costs

- A1.3 – Well Suspension Costs
- A1.6.2 – Well Abandonment
- A1.7.1 – Remediation
- A1.7.2 – Surface Reclamation

Directive 006: Licensee Liability Rating Program (LLR) And Licence Transfer Process

Appendix 1 – Licence Types Included in the LLR Program and Protected by Orphan Fund

- Wells – oil, gas Bitumen; injection; disposal; gas storage; oilfield source water wells; observation wells; brine well; LPG wells

Appendix 2 – Licence Transfer Process and LMR Assessments

- Agreements for the purchase and sale of AER-licenced wells do not affect a transfer of associated licences unless and until the AER approves the related transfer application
- Licence transfer application submitted electronically through Licence Transfer System (LTS) accessed through DDS
- Licence transfer application submitted by one party must be accepted by the other party with 90 days
- 6 – Transfer of Abandoned wells and Facilities
    - AER permits licence for abandoned wells and facilities and discontinued pipelines to be transferred only in the following cases:
        - Licence for a well that has been abandoned in compliance with AER Requirements and is shown in AER records as surface abandoned (cute, capped, prospered reported) and that require but is not in receipt of a reclamation certificate or its equivalent
    - AER does NOT permit licences transfers for abandoned Well to be transferred in the following cases:
        - Licence for a well or facility that is abandoned and in receipt of reclamation certificate or equivalent
        - Abandoned and classified as “reclamation exempt”
        - Abandoned and in receipt of overlapping reclamation certificate exemption for its surface location
    - AER approval of a transfer of an abandoned well does NOT permit the new licencee to re-enter the well. An application must be submitted in accordance with D056 to re-enter or reactivate.
- 8 – LMR assessments – Security Deposit Requirements
    - If both transferor and transferee have post-transfer LMR >= 1.0, security deposit not required
    - If LMR, 1.0, AER requires security deposit in amount representing the difference between its deemed liabilities and deemed assets plus any existing liability management security deposits.

Appendix 4 – LMR and LLR Assessment formulas

Appendix 5 – Deemed Assets

- Deemed assets of a producer licencee is the cash flow derived from oil and gas production reported to Petrinex from wells for which it is the licencee.
- Calculated by multiplying a licencee's reported production of O&G from the preceding 12 calendar months in cubic meters oil equivalent by the 3-year average industry netback by 3 years.
- Current shrinkage factor, m3 OE conversion factor, and industry netback factors are in Directive 011
- Deemed asset of an eligible producer licencee is the sum of its cash flow derived from O&G production reported to Petrinex from wells (calculated in accordance with section 1) and the cash flow derived from midstream activity from wells or facilities for which is I the licencee (calculated in accordance with section 3)

Appendix 6 – Deemed Liabilities

- Deemed liability is the sum of the costs to suspend, abandon, remediate, reclaim all wells for which it is the licencee, adjust for status (active, inactive, abandoned, problem site designation)
- 1 – Definitions
- 2 – Calculation of Deemed Liability
  - Deemed liability of a well
    - Sum of abandonment and reclamation liability. Liability for abandoned but uncertified or unreclaimed is solely its reclamation cost

Appendix 7 – Variation of LLR Formula Parameters

- 1 – Licencee-initiated Request for Variation of an LLR Parameter
  - LLR program is based on the use of provincial and regional averages, and their use may not accurately reflect the deemed assets or deemed liabilities of a particular licencee
- 1.1 – Licencee Netback
- 1.2 Well Abandonment Liability
- 1.3 Well Reclamation Liability

Directive 011: LLR Program: Updated Industry Parameters and Liability Costs

Industry parameters and regional abandonment costs used in LLR Calculations as required

- Industry netback
- Shrinkage factor
- m^3 OE conversion factor
- regional well abandonment costs used in LLR are based on information provided to the AER through an annual well abandonment cost review conducted by 3rd party
- abandonment liability for a well considers its geographic location based on the Regional Abandonment Cost Map, depth, downhole completion scenario, and where applicable, the number of events requiring abandonment, the costs to address groundwater protection, surface casing vent flows, and gas migration
- 6 – Regional Well Abandonment Cost Tables

Directive 013: Suspension Requirements for Wells

- Suspension deadline is 12 months from the date the well becomes inactive
  - Inactive status date listed in this Directive calculated based on definition of the inactive well. If no volumetric activity is reported in Petrinex, a final drill date is used as a last volumetric activity date
- For a well to attain active status and be reactivated on DDS, it must report volumetric activity for at least 1hr/month for 3 consecutive months
- Pressure testing casing or tubing for reactivation is NOT required if initial well suspension was completed <12 months prior to reactivations
- DEFINITION: Inactive well – Critical sour wells (perforated or not) that have not reported any type of volumetric activity (production, injection, disposal) for 6 consecutive months; all other wells that have not reported any type of volumetric activity for 12 consecutive months
- For wells to remain in compliance with this Directive, licencee must complete the ongoing well inspection requirements and report to AER by the end of each calendar year in which the inspection date is calculated.

2.3 – Surface and Wellhead Requirements

2.3.3 – associated infrastructure

2.4 – Repair Requirements

2.5 – Reporting requirements

- Well Status update in Petrinix
  - *Directve 007: Volumetric Infrastructure Requirements*; *Directive 059: Well Drilling and Completion Data Filing Requirements* – submitting amendments to the well status in Petrinix
- Well licence status updated in AER DDS
  - Following must be reported to AER

Suspension Date	H2S Content (%)	Inspection Reason	Casing Failure detected
Suspension Class (risk)	CO2 content (%)	Packer/Plug Failure detected	Wellhead Failure detected
Well Operational Data	Inhibitor Program	Gas migration detected	Inspection outcome
Downhole Operation	Inspection Date	Vent Flow Detected	Remedial work completed

3 – Risk-Based Suspension Requirements

- All inactive wells are divided into 3 categories – low, medium, high
- Table 1 – Suspension requirements for all inactive wells

- 3.1 – Low Risk Well requirements – downhole, wellbore fluid, initial suspension, wellhead; 3.1.2 ongoing inspection requirements
- 3.2 – Medium Risk Well requirements – Cavern Wells; downhole, wellbore fluid, initial suspension, well head; 3.2.2 ongoing inspection requirements
- 3.3 – High Risk Well requirements – downhole, wellbore fluid, initial suspensions, wellhead; 3.3.2 ongoing inspection requirements

4 – Reactivating suspended wells

- All Wells:
    - Inspect, service, pressure test wellhead
    - Inspect, service, control systems and lease facilities
    - Report reactivations of well on DDS within 30 days after attained active status and retain records
- Medium – and High-Risk wells
    - Pressure test casing to 7MPa for 10 minutes
    - If tubing is present, pressure test tubing to 7MPa for 10 minutes
- Pressure test results valid for 12 months

5 – Long-Term Suspension Requirements

- All low-risk wells must meet suspension requirements for medium-risk wells after being inactive for 10 consecutive years after the first year of inactivity

Appendix 1 – Classifying Suspended Gas Wells

Directive 020: Well Abandonment

Routine vs. non routine

- Routine – planned abandonment that meets all the requirements that apply to the well based on:
    - Type of well being abandoned
    - Well's geographic location
    - Impact of the well on any oil sands zones
    - Absence of a wellbore problem
- Routine abandonment operations do NOT require AER approval before work is started
- Nonroutine abandonment operations DO require AER approval before work
    - 1.4 – Overview for examples of nonroutine

2 – Requirements for Nonroutine Abandonment Requests and for Notification Reporting

- 2.1 – obtaining approval
- 2.2 – AER notification
- 2.3 – AER Reporting requirements
    - Well abandonment submission cannot be made if there is a casing failure or surface casing/vent flow report that is open and/or outstanding for the well licence

3 – Previously Abandoned Wells/Zones

- 3.1 – Previously Abandoned Wells (cut and capped
  - Wells abandoned to the standards in place PRIOR to this edition of D-20 are not required to be re-abandoned to current standards. Exceptions – leaking wells and wells being reentered
- 3.2 – Zonal Abandonments
- 3.3 – Leaking Wells/Lowering Casing Stubs
  - Current Licencee of well must submit nonroutine abandonment request to the Well Operations Group for approval
  - Licencee must also notify mineral rights owners and have an active surface agreement – approval from Alberta Energy is required if the mineral rights have reverted back to the Crown
  - Follow Directive 056 when reentering an abandoned well for the purpose of production or if it is not the current licencee
- 3.4 – Reentry Wells

4 – Open-Hole Abandonment Requirements

- Set cement plugs of sufficient length and number
- 4.1 – Open-Hole abandonment of non-oil sands wells
  - Figure 1 – Oil Sands boundaries
  - For well's not in the oil sands area, fillers and/or additives in the cement used for plugs is acceptable for open-hole abandonments
- 4.2 – 4.4 – Wells in Oil Sands area's

5 – Cased-Hole Abandonment Requirements

- Each completed pool must be abandoned separately and cover all nonsaline groundwater with cement
- 5.1 – cement evaluation
- 5.2 – Use of Inhibitor
  - Casing must be filled with nonsaline water from uppermost abandoned zone to surface
- 5.3 – Wells not Penetrating Oil Sands Zones
- 5.4 – Wells penetration oil sands zones
- 5.5 – Groundwater Protection
  - All nonsaline groundwater must be covered by cement
  - Groundwater protection must include the identification and isolation of the BGWP from hydrocarbon formations below, as well as ID and isolation of all protected intervals that are above BGWP
    - To determine BGWP depth refer to the query tool available on AER DDS – elevations are subsea and must be converted to Kelly bushing (KB)
  - Protected intervals are above BGWP and defined as any lithology with >3% porosity or any coal seam
    - Protected intervals may be grouped tether (i.e. not isolated), provided that the lithologies with >3% porosity are not separated from each other by more than 10m and the coal seams are not separated by >30m of non-coal-bearing strata, or a sandstone with >3% porosity.

- 5.5.2 Requesting a Groundwater Protection Waiver
  - AER requires all protected intervals be covered by cement
  - In specific situations, AER may consider industry requests to waive the requirement to cover protected intervals
  - Abandonment operations for which a groundwater waiver is requests are nonroutine

7 – Testing and Inspection Requirements

- o Gas Migration Testing
- o Surface Casing Vent Flow testing

8 – Surface Abandonment

- o Cutting off of casing string(s) and the capping of a well
- o Required testing must be performed (section 7)
- o 8.1 – Cutting and capping

9 – Compliance Assurance

- o AER's enforcement process is specified in *Manual 013: AER Compliance Assurance – Enforcement*
- o Keep all test results and abandonment details
- o If the licence for an abandoned well is transferred, the new licencee assumes all responsibility for the control or further abandonment of the well and the cost of doing that work

Appendix C.4.3 Regulatory Opportunities & Challenges

The recent AER changes to the Liability Management Ratio and the increase in inactive wells in Alberta creates both an opportunity and a challenge for the repurposing of oilfield wells into geothermal applications for operators.

The opportunity for repurposing oilfield wells results from offsetting 'deemed liabilities', which is also 'adjusted for status'. A well that is currently operating with a revenue steam (i.e. 'active') continues to qualify as an asset to the well owner. However, many wells that were cost effective at higher oil or gas prices may now by sub-economic with the price change, and the prevention of a well moving to 'inactive' (i.e. not currently producing, suspended or abandoned) can present an opportunity for oilfield operators with the goal of extending the life of a well in conjunction with geothermal applications.

The challenge for repurposing oilfield wells is that the acquisition of wells (licensing, permits) requires any new owner/developer (geothermal or oilfield) to operate in the current regulatory environment and have the necessary assets to offset the environmental liability for the required LMR rating. The 'deemed assets', however, are calculated based on oil and gas production and a 3-year average of 'calculated netback'. It is uncertain that any geothermal energy-based revenue stream would qualify as assets in the LMR calculation, which would therefore prevent a positive LMR rating for active geothermal wells and require a significant security deposit to the AER to compensate for the environmental liability. The number of wells that have moved to 'inactive' has also steadily climbed in the last 20 years, furthering the environmental risk profile from defunct oilfield operators (discussed further in the Orphan Well section below).

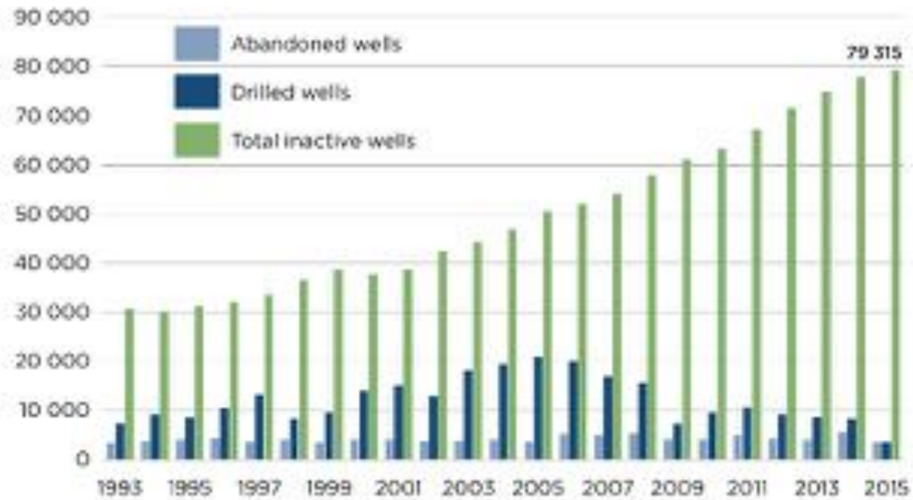


Figure 91 - Inactive wells in Alberta [66]

The topic of well liability is very relevant to geothermal repurposing projects as oilfield operators are highly incented to pass the liability of inactive wells onto the next developer (oilfield or geothermal). Under the current regulatory environment, a geothermal energy producer would be treated as a standard oilfield operator and would thus be expected to incur that liability, even though they may not be producing oil/gas at the well. The topic of environmental liability and its legal implications is further analyzed by Grant Van Hal in his 2013 paper titled “Legal Obstacle to the development of Geothermal Energy in Alberta” [67].

Appendix C.4.4 Orphan Wells

There is a potential opportunity for the AER to assist with the repurposing of oilfield wells. The AER currently manages the ‘Orphan Program and Fund’ with the LLR regulations:

The Orphan Fund will pay the costs to suspend, abandon, remediate, and reclaim a well, facility, or pipeline included in the LLR Program if a licencee or working interest participant (WIP) becomes defunct.

During the recent downturn in oil pricing and the increase in LMR, there have been a significant increase in the number of wells that are now part of the orphan program.

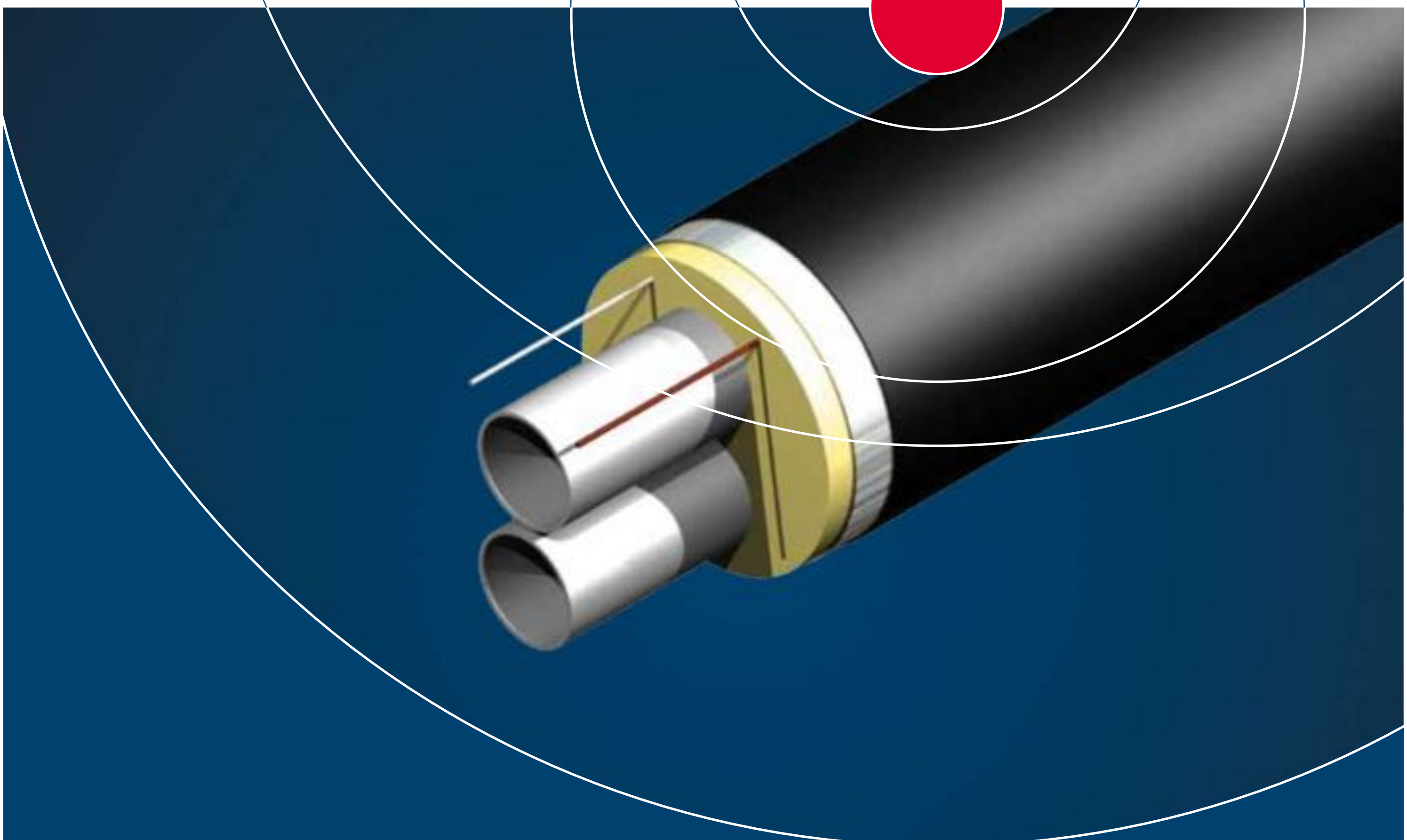
Orphan Well exclusion has no reference to deep geothermal wells, but does reference ‘municipal water wells’, ‘test holes’ and ‘industrial waste disposal wells’.

Any alternative to acquiring future environmental liability associated with a specific well would require quantification of the costs for remediation and reclamation, agreements with current oilfield owner & operator, and agreement with AER to comply with Directives.

Appendix D Midstream

Appendix D.1 Logstor Pipe Data Sheets & Technical Documentation

LOGSTOR *TwinPipe* system



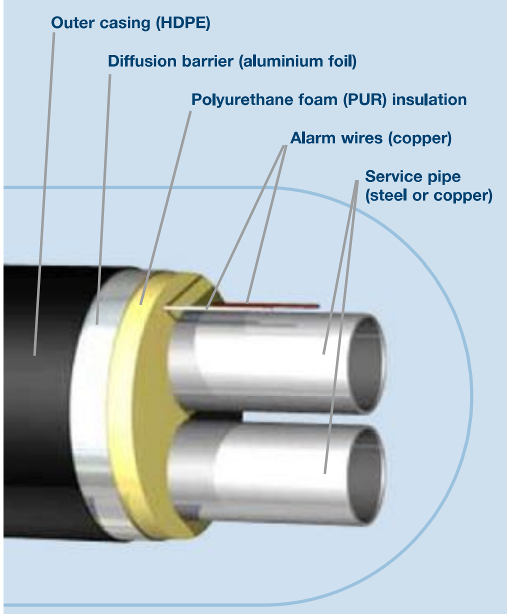
Reduces operating costs and CO_2 emissions by as much as 50%

distributing energy efficiency

LOGSTOR

LOGSTOR *Twin*Pipe system
– when energy efficiency is in focus

- **Absolute minimum of heat loss**
- **ROI increases as world energy prices rise**
- **Lowest possible environmental impact**
- **Significant savings on operating costs**
- **Significant savings on civil works costs**
- **Easier planning and installation**
- **Lower costs for post-installation civil engineering**
- **Insulation that ensures consistently high heat retention throughout the service life of the pipe**
- **Fewer components and joints needed**
- **All fittings and joints included as an integral part of the system**
- **Diffusion barrier on pipes with outer casings up to Ø 315 mm, for extra efficiency**



TwinPipe district heating systems provide you with significant reductions in CO_2 emissions as well as big savings on purchase costs, civil works and operating costs compared to single pipe systems. It is possible to reduce both operating costs and CO_2 emissions by as much as 50%.

And TwinPipes fitted with a diffusion barrier provide even greater savings.

The LOGSTOR TwinPipe system places both forward and return flow pipes within one single outer casing, encapsulated in the same kind of highly effective polyurethane foam insulation as used in LOGSTOR pre-insulated single pipes. And to maintain its insulation properties unchanged, TwinPipe is available with a diffusion barrier on all sizes up to outer casing Ø 315 mm.

Minimise heat loss

The special TwinPipe design means the heat loss from a TwinPipe system is less than when using a single pipe solution. When also fitted with a diffusion barrier, heat loss is kept consistently low throughout the entire service life of the pipe.

Figure 1 below provides an example of the heat loss over a 30-year period, for lengths of single pipe and TwinPipe of comparable dimensions. The distance between the performance curves clearly shows that use of TwinPipe – with or without a diffusion barrier – significantly reduces heat loss.

The diffusion barrier advantage

LOGSTOR TwinPipe fitted with a diffusion barrier has thermal conductivity levels of lambda 24 or better. The diffusion barrier keeps the foam propellant gases inside the insulation, and prevents any nitrogen or oxygen from the soil or air penetrating into it. This means the pipe retains the same low lambda value throughout its entire service life.

The diffusion barrier provides greatest benefits for district heating pipes with smaller diameters, where the relative heat loss is greatest. This is why TwinPipe is available with a diffusion barrier on pipes with the smallest diameters.

Figure 2 below shows the total heat loss for single pipe and TwinPipe of different dimensions, with and without diffusion barrier. The calculations are based on average insulation performance over the duration of a 30-year service life.

Figure 1 : Example of annual heat loss, with and without diffusion barrier

Parameters: Single pipe Ø 40/110 mm • TwinPipe Ø 40/160 mm • Service pipe: steel • Insulation: Series 1 • Pipe length: 1 m trench • Temperature, flow/return pipe: 120/70°C • Temperature, ambient: 8°C • Operating period: 30 years

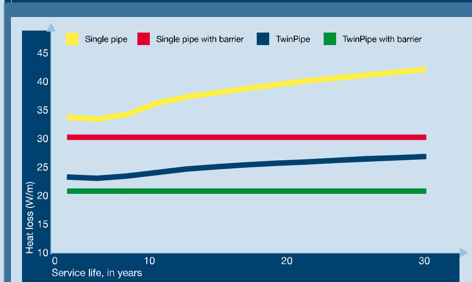
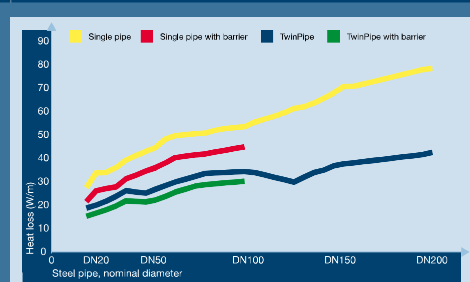


Figure 2 : Heat loss from single pipe and TwinPipe of different dimensions

Parameters: Service pipe: steel • Insulation: Series 1 • Pipe length: 1 m trench • Soil cover: 0.6 m • Thermal conductivity: soil 1.6 W/mK, service pipe 60 W/mK • Distance between single pipe: 0.15 m • Temperature, flow/return pipe: 120/70°C • Temperature, ambient: 8°C • Operating period: 30 years



The advantages of a TwinPipe system differ from one project to the next, and individual assessments are crucial.

For example, the two-in-one TwinPipe configuration results in special requirements when laying the pipe, and is best suited to relatively flat terrain.

For some projects, the initial investment is higher than for single pipe systems. However, this is soon outweighed by the savings on subsequent operating costs.

Any decision about installing a TwinPipe system should therefore be based on careful consideration of all the parameters involved. One way of doing this is via the calculation feature available at www.logstor.com

Greater reliability
– and savings on civil works

Save on civil works

TwinPipe systems are particularly advantageous in projects where only limited space is available. Trenches can be kept narrower and don't have to be as deep as for single pipe systems. This is because the branch pipes are installed at the same level as the main TwinPipe run. The benefits include substantial savings on installation costs.

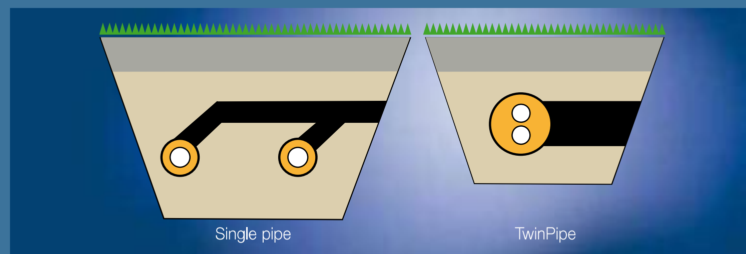
This is particularly important in locations that are paved over.

Fewer joints, greater dependability and lower installation costs

A TwinPipe system involves only half as many joints as a comparable single pipe system. This means fewer components and results in lower installation costs as well as significantly cutting down on any likelihood of operating interruptions during the service life of the system.

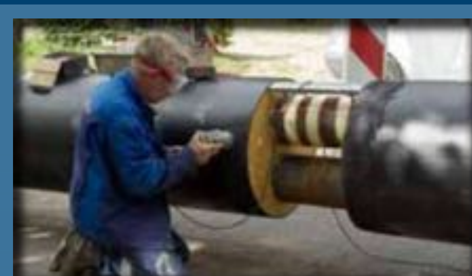
This, combined with the benefits of the well-known LOGSTOR joint systems, which eliminate the use of pre-insulated branch joints, results in further savings and greater operational reliability throughout the system.

Trench



Single pipe system

TwinPipe system



LOGSTOR TwinPipe is the most efficient solution available for small and medium-scale transmission and distribution piping. The system includes components that ensure cost-effective installation, including standard joints, bends and transitions between lengths of single pipe and TwinPipe.

To ensure the necessary stability, the two service pipes are locked together using special fixing bars placed at the end of all straight sections. This limits any expansion that might take place where the laid pipe changes direction, and helps do away with any need for special sections to absorb expansion and reduce stress and tension in the pipe.

More detailed information is available in the LOGSTOR manual at www.logstor.com.

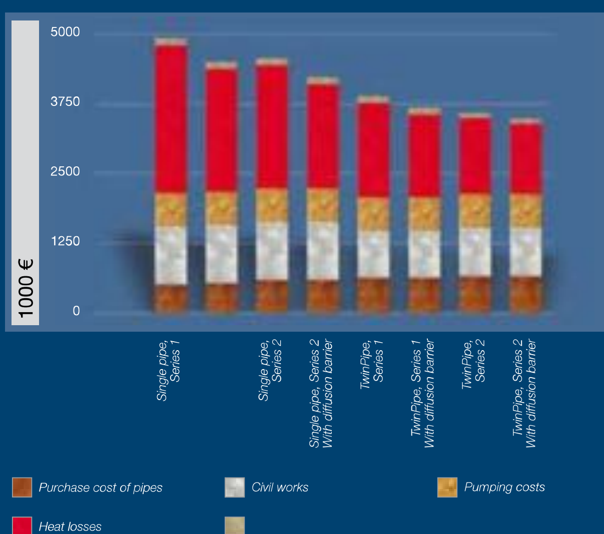
Service life costs and CO_2 emissions both reduced

LOGSTOR has more than 20 years of experience in the development, manufacture and installation of pre-insulated twin pipes. The sum total of all this practical experience has been integrated into the LOGSTOR TwinPipe system of today. The results add up to significant advantages and benefits – both financial and environmental.

Lowest possible service life costs

Calculations of the service life costs for district heating systems clearly show that the largest single cost stems from heat loss. This makes it a good investment to prevent this expensive heat loss from occurring.

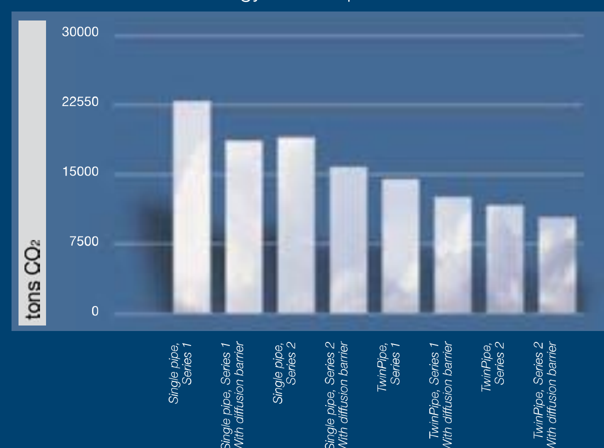
As the example shown here indicates, a TwinPipe system – whether fitted with a diffusion barrier or not – is an exceptionally good investment, provided the installation parameters are appropriate.



Lower energy loss, less environmental impact

The fundamental advantages of using district heating systems – responsible use of energy and low environmental impact – are now high on many political agendas.

LOGSTOR TwinPipe systems provide exceptional levels of energy efficiency, enabling you to cut the CO_2 emissions from your district heating system to the absolute minimum and make a visible contribution to reducing the climate problems that stem from our energy consumption.



Assumptions for calculations:
Heat effect of the system: 4 MW • Temperature, flow/return: 120/70°C • Pump energy: 1% of heat supply • Energy source: natural gas • Energy price: EUR 0.05/kW • Price of electricity: EUR 0.10/kWh • Effective interest rate: 4% • Service life: 30 years • Calculation method: EN 13941

The pipe system includes:
2 x 1000 m DN 150 • 2 x 1000 m DN 100 • 2 x 2000 m DN 80 • 2 x 500 m DN 40, straight pipes (5 consumers, 250 kW each) • 2 x 5000 m Ø 20 mm SteelFlex (200 consumers, 10 kW each)

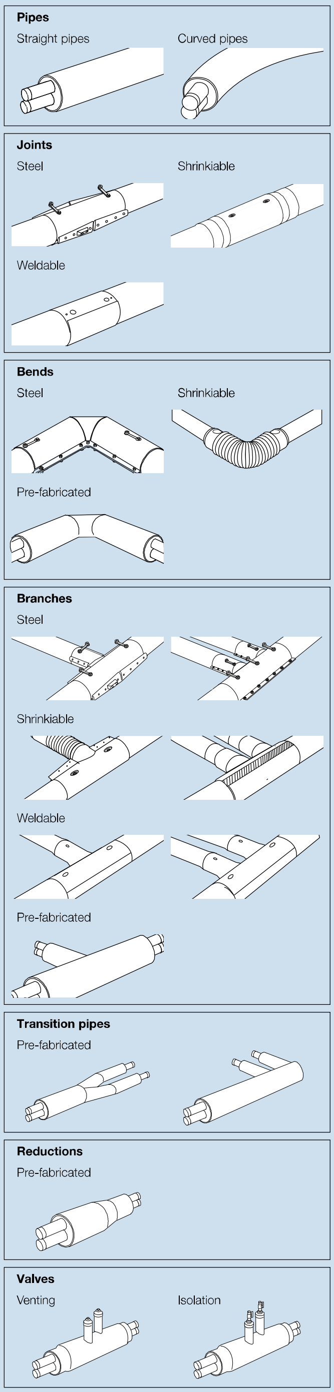
	Type of pipe	Series 1 (dimensions)	Heat retention (W/mK)	Heat loss (W/m)	CO_2 emissions with natural gas (kg/metre/year)
A.	TwinPipe with diffusion barrier	DN 40/160	0.024	20.56	43
B.	TwinPipe without diffusion barrier	DN 40/160	0.027	24.70	52
C.	Single pipe with diffusion barrier	DN 40/110	0.024	29.62	62
D.	Single pipe without diffusion barrier	DN 40/110	0.027	37.48	79

This table shows calculations of the annual heat loss and CO_2 emissions for a 1-metre length of LOGSTOR pipe with Series 1 insulation, at operating temperatures of 120°C and 70°C on the flow/return pipes, respectively.

Calculation method used is EN 13941.

A comparison between the values in installation types A and D represents a saving of more than 45%.

Components



Technical data – TwinPipe

Service pipe *	Longitudinal welded steel pipe, P235TR1, P235TR2 according to EN10217-1, or P235GH according to EN 10217-2
Insulation	Polyurethane foam (PUR), using cyclopentane as blowing agent
Diffusion barrier	Aluminium foil Optional up to Ø 114.3-114.3/315 mm
Outer casing	High-density polyethylene (HDPE)
Alarm wires	Copper
Guaranteed insulation performance with diffusion barrier	λ 0.024 W/mK
Guaranteed insulation performance without diffusion barrier	λ 0.027 W/mK
Continuous operating parameters	30 years at 140°C and 25 bar
Jointing method	Gas or TIG welding
Hot tapping possible	Yes

Steel pipe			Outer casing			
Nominal diameter mm	Outer diameter mm	Wall thickness mm	Outer diameter, Series 1 mm	Outer diameter, Series 2 mm	Wall thickness mm	Lengths available m
20	26.9	2.6	125		3.0	12
20	26.9	2.6		140	3.0	12
25	33.7	2.6	140		3.0	12
25	33.7	2.6		160	3.0	12
32	42.4	2.6	160		3.0	12
32	42.4	2.6		180	3.0	12
40	48.3	2.6	160		3.0	12
40	48.3	2.6		180	3.0	12
50	60.3	2.9	200		3.2	12
50	60.3	2.9		225	3.4	12
65	76.1	2.9	225		3.5	12
65	76.1	2.9		250	3.6	12
80	88.9	3.2	250		3.6	12
80	88.9	3.2		280	3.9	12
100	114.3	3.6	315		4.1	12 & 16
100	114.3	3.6		355	4.5	12 & 16
125	139.7	3.6	400		4.8	12 & 16
125	139.7	3.6		450	5.2	12 & 16
150	168.3	4.0	450		5.2	12 & 16
150	168.3	4.0		500	5.6	12 & 16
200	219.1	4.5	560		6.0	12 & 16
200	219.1	4.5		630	6.6	12 & 16

* TwinPipes are also available with service pipes made of hard copper.
The LOGSTOR FlexPipe range also includes TwinPipes in which the service pipes are made of soft copper, alu/PEX or PEX.
LOGSTOR TwinPipes meet or exceed the requirements prescribed in EN 15698-1.

pindpromotor.dk 18614

distributing energy efficiency

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logstor@logstor.com · **www.logstor.com**

LOGSTOR

PRE-INSUALTED FLEXIBLE SYSTEMS
PRODUCT: PEX-FLEX
PRODUCT GUIDE & TECHNICAL MANUAL

CONTENTS:

PRODUCT DESCRIPTION - PIPING

General:

PexFlex pipe are flexible, pre insulated pipe systems with a complete range of fittings and joints in all available pipe dimensions. The semi-flexible polyurethane foam with its closed cells has a high insulation value, is Freon free and environmentally friendly. The foam is moulded directly around the carrier pipe, followed by extrusion of the jacket; no spacers are required, therefore thermal bridges are eliminated.

A proprietary Polymer membrane is incorporated between the PUR foam and PE outer jacket to avoid the migration of cell gases through the jacket over the long term. This foil material is made up of a special polymer with PEL adhesive on both sides, bonding the foam to the casing.

The smooth polyethylene (LDPE) jacket is strong and is able to resist any impacts or blows incurred during transport or installation. The jacket pipe is resistant to both high and low temperatures and is UV treated.

In the solid-foamed flexible system, the carrier pipe, polyurethane foam and LDPE jacket pipe are bonded together, eliminating the risk of water penetration along the carrier pipe. In operation, the system is held in place by the soil friction. The plastic properties of the Pex carrier pipe is utilized to absorb thermal expansion, consequently these Pex pipes are self-compensating and expansion need not be considered.

PexFlex has a cross-linked polyethylene (PEX) carrier pipe intended for maximum temperatures of 203^{0}F (95^{0}C) and a pressure of 87 psi (6 bar), a detailed specification is available at www.pexflex.net . The PEX carrier pipe also features an EVOH external oxygen diffusion barrier, which prevents oxygen from diffusing into the water.

Material Properties

Thermal Conductivity of PEX Pipe @ 0.38 W/(m•K) (0.219 BTU/h• ft•°F)
Thermal Conductivity of PUR Insulation 0.022 W/(m•K) (0.012 BTU/h• ft•°F)

Dimensions and Coil Lengths:

PexFlex, Single

Nominal pipe size in	Carrier pipe O.D. mm *(in)*	Carrier pipe wall mm *(in)*	Jacket pipe O.D. mm *(in)*	Standard/ Maximum coil length m *(ft)*	Weight kg/m (lb/ft)
¾	25 *(0.98)*	2.5 *(0.098)*	77 *(3.0)*	100/300 *(328/984)*	1.0 (0.7)
1	32 *(1.26)*	2.9 *(0.114)*	77 *(3.0)*	100/300 *(328/984)*	1.0 (0.7)
1 ¼	40 *(1.57)*	3.7 *(0.145)*	90 *(3.5)*	100/300 *(328/984)*	1.3 (0.9)
1 ½	50 *(1.97)*	4.6 *(0.181)*	110 *(4.3)*	100/200 *(328/656)*	1.9 (1.3)
2	63 *(2.48)*	5.8 *(0.228)*	125 *(5.0)*	100/200 *(328/656)*	2.4 (1.6)
2 ½	75 *(2.95)*	6.9 *(0.272)*	140 *(5.5)*	100 *(328)*	3.3 (2.2)
3	90 *(3.54)*	8.2 *(0.323)*	160 *(6.3)*	100 *(328)*	4.2 (2.8)
4	110 *(4.33)*	10.0 *(0.393)*	160 *(6.3)*	100 *(328)*	5.5 (3.7)

PexFlex, Dual

Nominal pipe size in	Carrier pipe O.D. mm (in)	Carrier pipe wall mm (in)	Jacket pipe O.D. mm (in)	Standard/ Maximum coil length m (ft)	Weight kg/m (lb/ft)
2 x ¾	2 x 25 *(2 x 0.98)*	2.5 *(0.098)*	110 *(4.3)*	100/200 *(328/800)*	2.1 (1.4)
2 x 1	2 x 32 *(2 x 1.57)*	2.9 *(0.114)*	110 *(4.3)*	173/246 *(567/1,134*	2.2 (1.5)
2 x 1¼	2 x 40 *(2 x 1.26)*	3.7 *(0.145)*	125 *(5.0)*	100/200 *(328/656)*	2.7 (1.8)
2 x 1 ½	2 x 50 *(2 x 1.97)*	4.6 *(0.181)*	160 (6.3)	100 *(328)*	4.1 (2.8)
2 x 2	2 x 63 (2 x 2.48)	5.8 *(0.228)*	180 (7.0)	100 (328)	4.8 (3.5)

- All sizes are metric, neither IPS nor CTS sizes; imperial adapters are supplied as required.

Temperature and Pressure:
PexFlex is intended for a maximum temperature of 203^{0}F (95^{0}C) and a pressure of 87 (6 bar). Continuous operating temperature of 85°C *(185°F)* will ensure an extended service life of more than 30 years. More details pertaining to temperature and pressure are available in the PexFlex Specification.

Quality:
Logstor was the worlds' first producer of pre-insulted PEX and has been producing PexFlex since 1974. LOGSTOR continues to be Europe's leading manufacturer of insulated piping systems. (copper or steel carrier pipes also available). Both Logstor and Urecon's quality management system is certified in accordance with ISO-9001: 2000. The product is sold in more than 30 countries, with manufacturing facilities in Denmark and Poland.

Urecon is Logstor's agent for Canada, the Americas, the Bahamas and the Caribbean.

The company staff of engineers and technicians is ready to assist in all aspects on project planning, selection of materials and systems, as well as system layout.

COMPRESSION FITINGS

TERMINATION ADAPTERS
(PEX TO MALE THREAD NPT)
3/4" – 4" (25 – 110mm)

PEX TO PEX COUPLING (UNION) – Reduction Available
3/4" – 4" (25 – 110mm)

ELBOW – (90 or 45 degrees)

3/4" – 4" (25 – 110mm)

BRANCH TEE (PEX x PEX x PEX)
Unequal Branches available.

3/4" – 4" (25 – 110mm)

ACCESSORIES

INSULATION KITS FOR FITTINGS

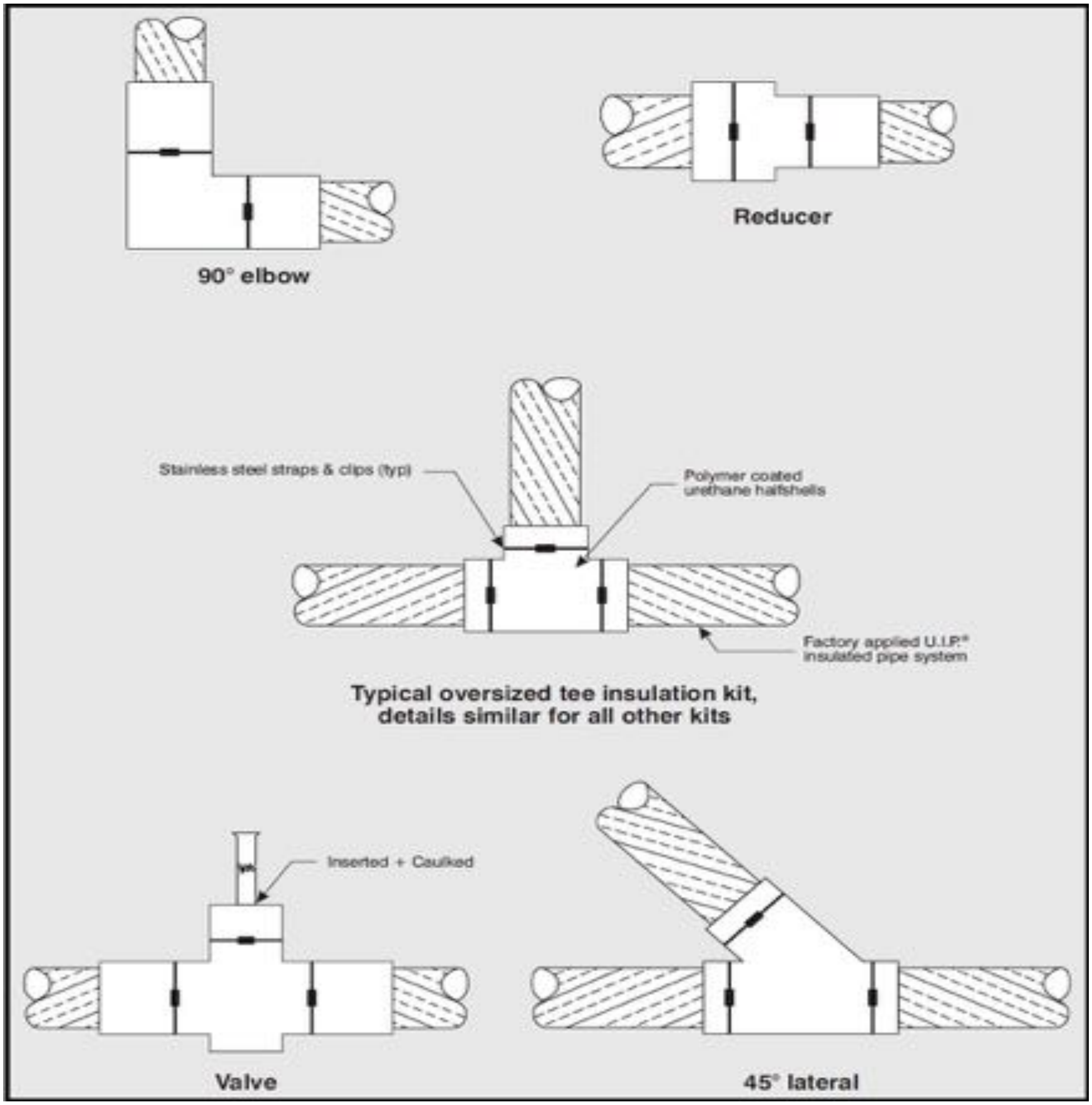
- TEES *AND* REDUCING TEES
- ELBOW *(45 OR 90 degree)*
- COUPLING (UNION) *AND* REDUCING COUPLING

KITS INCLUDE:

Kits include:

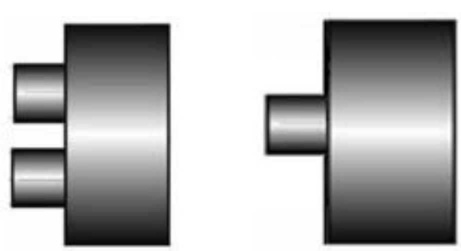
- Polymer coated Polyurethane half shells
- Caulking
- Stainless Steel bands
- Some configuration include Heat Shrink Wrap

EXAMPLES OF INSULATION KIT CONFIGURATIONS



PROTECTION END CAPS

-Due to Hydrophobic nature of PUR foam watertight shrink seals are not necessary for pipe ends unless in wet surroundings. Inquire for availability of Heat Shrink End Caps.



Additional Services and Expertise

- Advice on Pipe layout
- Advice on pipe dimensioning
- Installation advice and assistance*
- Heat Loss/Time to Freeze Calculations and comparisons
- Transportation & Logistics
- Material Handling

*May incur time and travel costs

PEX FLEX

SUBMITTALS

URECON PRE-INSULATED PIPE

Submittal Data

LOGSTOR PexFlex

General:
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Thermal Conductivity of PUR Insulation 0.022 W/(m•K) (0.012 BTU/h• ft•˚F)

Dimensions and Coil Lengths:

PexFlex, Single

Nominal pipe size in	Carrier pipe O.D. mm *(in)*	Carrier pipe wall mm *(in)*	Jacket pipe O.D. mm *(in)*	Standard/ Maximum coil length m *(ft)*	Weight kg/m (lb/ft)
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1 ¼	40 *(1.57)*	3.7 *(0.145)*	90 *(3.5)*	100/300 *(328/984)*	1.3 (0.9)
1 ½	50 *(1.97)*	4.6 *(0.181)*	110 *(4.3)*	100/200 *(328/656)*	1.9 (1.3)
2	63 *(2.48)*	5.8 *(0.228)*	125 *(5.0)*	100/200 *(328/656)*	2.4 (1.6)
2 ½	75 *(2.95)*	6.9 *(0.272)*	140 *(5.5)*	100 *(328)*	3.3 (2.2)
3	90 *(3.54)*	8.2 *(0.323)*	160 *(6.3)*	100 *(328)*	4.2 (2.8)
4	110 *(4.33)*	10.0 *(0.393)*	160 *(6.3)*	100 *(328)*	5.5 (3.7)

PexFlex, Dual

Nominal pipe size in	Carrier pipe O.D. mm (in)	Carrier pipe wall mm (in)	Jacket pipe O.D. mm (in)	Standard/ Maximum coil length m (ft)	Weight kg/m (lb/ft)
2 x ¾	2 x 25 *(2 x 0.98)*	2.5 *(0.098)*	110 *(4.3)*	100/200 *(328/800)*	2.1 (1.4)
2 x 1	2 x 32 *(2 x 1.57)*	2.9 *(0.114)*	110 *(4.3)*	173/246 *(567/1,134*	2.2 (1.5)
2 x 1¼	2 x 40 *(2 x 1.26)*	3.7 *(0.145)*	125 *(5.0)*	100/200 *(328/656)*	2.7 (1.8)
2 x 1 ½	2 x 50 *(2 x 1.97)*	4.6 *(0.181)*	160 (6.3)	100 *(328)*	4.1 (2.8)

- All sizes are metric, neither IPS nor CTS sizes; imperial adapters are supplied as required.

Minimum Bending Radius:
Wherever a change of direction is required PexFlex can be curved on site to reach a minimum radius depending on the dimension.

Jacket Pipe O.D. mm (in.)	Minimum radius of curvature m (ft.)
77 (3.0)	0.8 (2.6)
90 (3.5)	0.9 (3.0)
110 (4.3)	1.1 (3.5)
125 (4.9)	1.2 (4.0)
140 (5.5)	1.4 (4.5)
160 (6.3)	1.6 (5.2)

Temperature and Pressure:
PexFlex is intended for a maximum temperature of 203^{0}F (95^{0}C) and a pressure of 87 (6 bar). Continuous operating temperature of 85°C *(185°F)* will ensure an extended service life of more than 30 years. More details pertaining to temperature and pressure are available in the PexFlex Specification.

PexFlex Pipe Connections:

Logstor offers top quality brass compression or PRESSFIT fittings in a wide variety, such as:
T-couplings, reducers, PEX to PEX couplings and PEX to thread-end couplings.
When connecting to NPT thread, metric to NPT thread adapters are also offered.

Joints and Fittings Insulation:
Preformed polyurethane insulation foam covers are available to accommodate the Compression or PRESSFIT couplers and T-fittings. A waterproof seal is accomplished by field applying the supplied heat shrink material.

Quality:
Logstor was the worlds' first producer of pre-insulted PEX and has been producing PexFlex since 1974. LOGSTOR continues to be Europe's leading manufacturer of insulated piping systems. (copper or steel carrier pipes also available). Both Logstor and Urecon's quality management system is certified in accordance with ISO-9001: 2000. The product is sold in more than 30 countries, with manufacturing facilities in Denmark and Poland.

Urecon is Logstor's agent for Canada, the Americas, the Bahamas and the Caribbean.

The company staff of engineers and technicians is ready to assist in all aspects on project planning, selection of materials and systems, as well as system layout.

For further information and technical assistance on Urecon or Logstor's pre-insulated piping systems, please contact any of the following offices, or your local Agent/Distributor.

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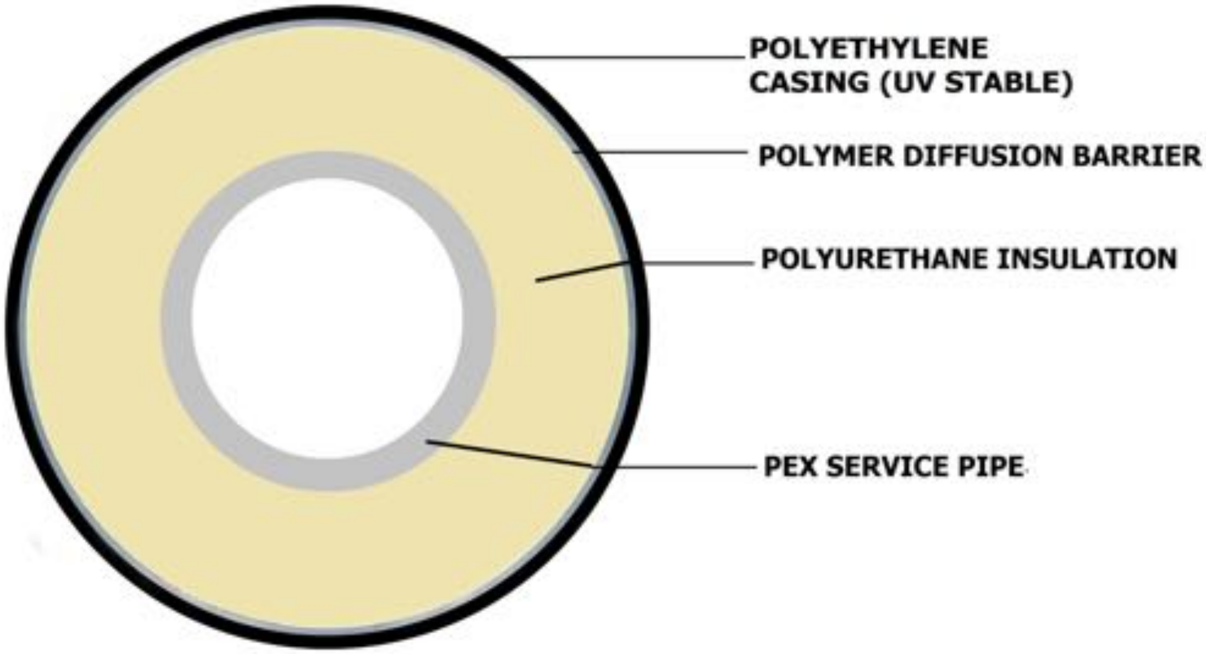
MANUFACTURING AND WAREHOUSE

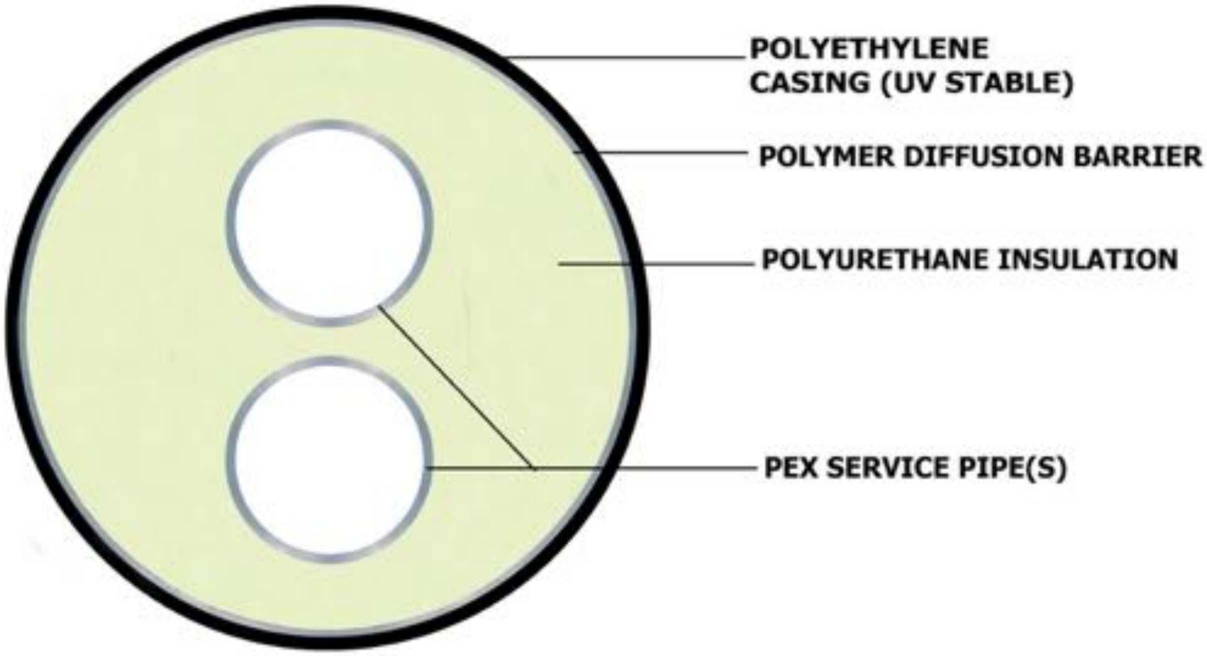
WEB SITES: www.pexflex.net / www.urecon.com

Local Representative



PEX-FLEX CROSS SECTION

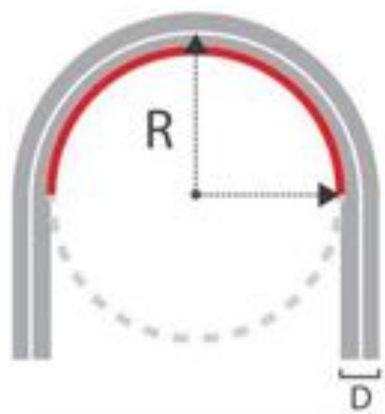
Nominal pipe size inches	Carrier pipe O.D. mm *(in)*	Carrier pipe wall thickness mm *(in)*	Jacket pipe O.D. mm *(in)*	Standard/Maximum coil length m *(ft)*	Minimum Bending Radius m (ft)	Weight kg/m(lb/ft)
¾	25 *(0.98)*	2.5 *(0.098)*	77 *(3.0)*	100/300 *(328/984)*	0.8 (2.6)	1.0 (0.7)
1	32 *(1.26)*	2.9 *(0.114)*	77 *(3.0)*	100/300 *(328/984)*	0.8 (2.6)	1.0 (0.7)
1 ¼	40 *(1.57)*	3.7 *(0.145)*	90 *(3.5)*	100/300 *(328/984))*	0.9 (3.0)	1.3 (0.9)
1 ½	50 *(1.97)*	4.6 *(0.181)*	110 *(4.3)*	100/200 *(328/656)*	1.1 (3.5)	1.9 (1.3)
2	63 *(2.48)*	5.8 *(0.228)*	125 *(5.0)*	100/200 *(328/656)*	1.2(4.0)	2.4 (1.6)
2 ½	75 *(2.95)*	6.9 *(0.272)*	140 *(5.5)*	100/200 *(328/656)*	1.4 (4.5)	3.3 (2.2)
3	90 *(3.54)*	8.2 *(0.323)*	160 *(6.3)*	100/200 *(328/656)*	1.6 (5.2)	4.2 (2.8)
4	110 *(4.33)*	10.0 *(0.393)*	160 *(6.3)*	100/200 *(328/656)*	1.6 (5.2)	5.5 (3.7)



PEX-FLEX CROSS SECTION

Nominal pipe size in	Carrier pipe O.D. mm (in)	Carrier pipe wall mm (in)	Jacket pipe O.D. mm (in)	Standard/ Maximum coil length m (ft)	Minimum bending radius m(ft)	Weight kg/m (lb/ft)
2 x ¾	2 x 25 *(2 x 0.98)*	2.5 *(0.098)*	110 *(4.3)*	100/200 *(328/800)*	1.1 (3.5)	2.1 (1.4)
2 x 1	2 x 32 *(2 x 1.57)*	2.9 *(0.114)*	110 *(4.3)*	173/246 *(567/1,134)*	1.1 (3.5)	2.2 (1.5)
2 x 1¼	2 x 40 *(2 x 1.26)*	3.7 *(0.145)*	125 *(5.0)*	100/200 *(328/656)*	1.2 (4.0)	2.7 (1.8)
2 x 1 ½	2 x 50 *(2 x 1.97)*	4.6 *(0.181)*	160 (6.3)	100 *(328)*	1.6 (5.2)	4.1 (2.8)
2 x 2	2 x 63 (2 x 2.48)	5.8 (0.228)	180 (7.0)	100 (328)	1.8 (5.9)	3.7 (5.5)

Pex-Flex Minimum Bending Radius Table



D Jacket Pipe O.D. mm (in.)	**R** Minimum radius of curvature m (ft.)
77 (3.0)	0.8 (2.6)
90 (3.5)	0.9 (3.0)
110 (4.3)	1.1 (3.5)
125 (4.9)	1.2 (4.0)
140 (5.5)	1.4 (4.5)
160 (6.3)	1.6 (5.2)
180 (7.0)	1.8 (5.9)

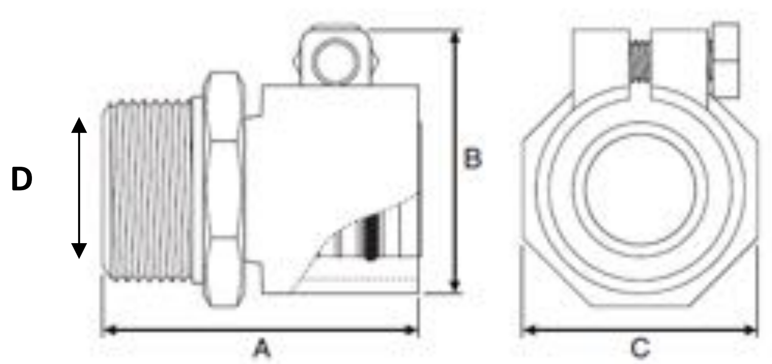
Description

Solid brass fitting complete with EPDM O-ring to convert PEX pipe to male NPT thread. To be installed on PEX-Flex piping system.

Technical Data

Material..................................DZR Brass
Operating Temperature...........203 °F / 95 °C
Operating Pressure...................87 psi / 6 bar

			Dimension				
PEX Size	NPT Size	Part #	A	B	C	D	Weight
3/4" I.D. *(25mm)*	3/4"	LOGP505850	1-7/8" *(48mm)*	1-1/2" *(38mm)*	1-1/8" *(29mm)*	0.78" *(20mm)*	0.5 lb *(225 g)*
1" I.D. *(32mm)*	1.0"	LOGP505851	2-3/8" *(60mm)*	1-7/8" *(48mm)*	1-5/8" *(42mm)*	0.98" *(25mm)*	0.77 lb *(350 g)*
1-1/4" ID *(40mm)*	1 1/4"	LOGP505852	2-7/8" *(72mm)*	2-1/2" *(63mm)*	2-1/8" *(54mm)*	1.25 *(32mm)*	1.5 lb *(680g)*
1-1/2" I.D. *(50mm)*	1 1/2"	LOGP505853	3-1/8" *(79mm)*	3-1/8" *(79mm)*	2-7/16" *(61mm)*	1.57 *(40mm)*	2.1lb *(950g)*
2" I.D. *(63mm)*	2"	LOGP505854	3-13/16" *(97mm)*	3-13/16" *(97mm)*	2 -3/16" *(71mm)*	1.96 *(50mm)*	3.5 lb *(1.57 kg)*
2-1/2" I.D. *(75mm)*	2 1/2"	LOGP505855	4" *(102mm)*	4-1/4" *(107mm)*	3-3/8" *(86mm)*	2.36 *(60mm)*	4.1 lb *(1.85 kg)*
3" *(90mm)*	3"	LOGP505856	5-3/8" *(137mm)*	5-13/16" *(148mm)*	5-1/8" *(130mm)*	2.95 *(75mm)*	7.14 lb *(3.24 kg)*
4" *(110mm)*	4"	LOGP505857	5-7/8" *(147mm)*	6-7/8" *(175mm)*	5-7/8" *(147mm)*	3.54 *(90mm)*	9.0 lb *(4.08 kg)*



Installation

Installation must follow all guidelines provided by URECON

URECON Pre-Insulated Pipe
1800 Av. Bedard
Saint Lazare, QC Canada J7T 2G4
www.pexflex.net / www.urecon.com
Toll Free: (866) 739-2645

Description

Solid brass fitting made up of 2 threaded brass compression adapters and one threaded brass union configured as required. Adapters are complete with EPDM O-ring to convert PEX pipe to male NPT thread for use in straight and reducing couplers or unions. To be installed on PEX-Flex piping system.

Technical Data

Material..................................DZR Brass
Operating Temperature...........203 °F / 95 °C
Operating Pressure...................87 psi / 6 bar

Diameter Main Pipe mm (in)	25 (0.75)	32(1)	40 (1.25)	50(1.5)	63 (2)	75 (2.5)	90 (3)	110 (4)
Diameter Branch Pipe mm(in)								
25 (0.75)	X	X						
32(1)		X	X					
40 (1.25)			X	X				
50(1.5)				X	X			
63 (2)					X	X		
75 (2.5)						X	X	
90 (3)							X	X
110 (4)							X	X

Installation

Installation must follow all guidelines provided by URECON

URECON Pre-Insulated Pipe
1800 Av. Bedard
Saint Lazare, QC Canada J7T 2G4
www.pexflex.net / www.urecon.com
Toll Free: (866) 739-2645

Description

Solid brass fitting made up of 3 threaded brass compression adapters and one threaded brass tee configured as required. Adapters are complete with EPDM O-ring to convert PEX pipe to male NPT thread for use in straight and reducing brass tees. To be installed on PEX-Flex piping system.

Technical Data

Material..................................DZR Brass
Operating Temperature...........203 °F / 95 °C
Operating Pressure...................87 psi / 6 bar

Diameter Main Pipe mm (in)	25 (0.75)	32(1)	40 (1.25)	50(1.5)	63 (2)	75 (2.5)	90 (3)	110 (4)
Diameter Branch Pipe mm(in)								
25 (0.75)	X	X						
32(1)		X	X					
40 (1.25)			X	X				
50(1.5)				X	X			
63 (2)					X	X		
75 (2.5)					X	X	X	X
90 (3)					X	X	X	X
110 (4)						X	X	X

Installation

Installation must follow all guidelines provided by URECON

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1800 Av. Bedard
Saint Lazare, QC Canada J7T 2G4
www.pexflex.net / www.urecon.com
Toll Free: (866) 739-2645

URECON
PRE-INSULATED PIPE

Description

Solid brass fitting made up of 2 threaded brass compression adapters and one threaded brass ELBOW (90^{O} or 45^{O}) configured as required. Adapters are complete with EPDM O-ring to convert PEX pipe to male NPT thread for use in straight and reducing ELBOWS. To be installed on PEX-Flex piping system. Rate for direct burial if thread is sealed properly, brass is insulated or mastic applied and pressure tested.

Technical Data

Material..................................DZR Brass
Operating Temperature...........203 °F / 95 °C
Operating Pressure...................87 psi / 6 bar

Diameter Main Pipe mm (in)	25 (0.75)	32(1)	40 (1.25)	50(1.5)	63 (2)	75 (2.5)	90 (3)	110 (4)
Diameter Branch Pipe mm(in)								
25 (0.75)	X	X						
32(1)		X	X					
40 (1.25)			X	X				
50(1.5)				X	X			
63 (2)					X	X		
75 (2.5)						X	X	
90 (3)							X	X
110 (4)							X	X

Installation

Installation must follow all guidelines provided by URECON.
Approved for DIRECT BURIAL thread is sealed properly, brass is insulated or mastic applied and pressure tested.

Thread Seal Methods – Installers choice

REFER TO:
TECHNICAL BULLETIN 04/02/2012
"MALE THREAD ADAPTERS – COMMON METHODS TO SEAL THE THREAD WHEN TYING INTO HYDRONIC HEATING AND COOLING SYSTEMS."

Pressure testing

When required by the authorities or the owner, pressure testing must be carried out on pipe-sections as long as possible with cold water at **1.5X design pressure**. Testing should be made on the finished and buried pipe-sections, using the adequate measuring instruments (pressure gauges) installed, preferably in the lowest points.

In case the leakage test is performed with water then pressure testing can easily be made by increasing the water pressure and inspecting the FITTINGS.

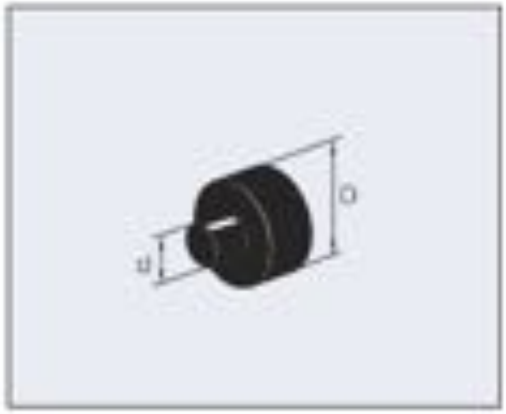
In case a defect is found during leakage and pressure testing then the defect in question must be repaired, the repair approved and the test repeated.

If not leak found FITTING can then be insulated or mastic applied for protection.

Description

POLYETHYLENE CAP WITH THE DIMENSION OF THE CASING AND SERVICE PIPE USED TO PROTECT THE CUT END FROM EXPOSURE TO SUNLIGHT AND MOISTURE. MASTIC STRIP INCLUDED FOR ADHESION TO CASING. To be installed on PEX-Flex piping system.

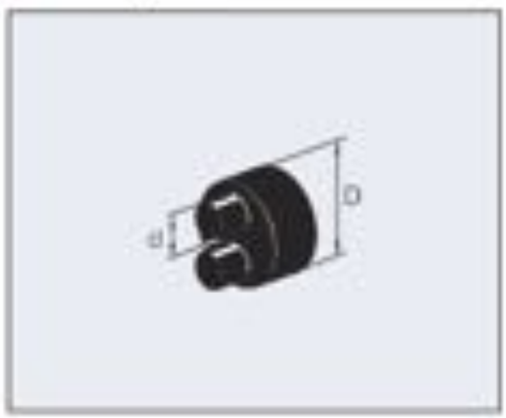
Protection cap is applied for protection of the foamed ends against moisture penetration. Protection cap has no shrinking properties.



Component no. 1230

d, mm	20	22	25	28	32	40	50	63	75	90	110
D, mm	77	77	77	77	77	90	110	125	140	160	180

Protection cap double



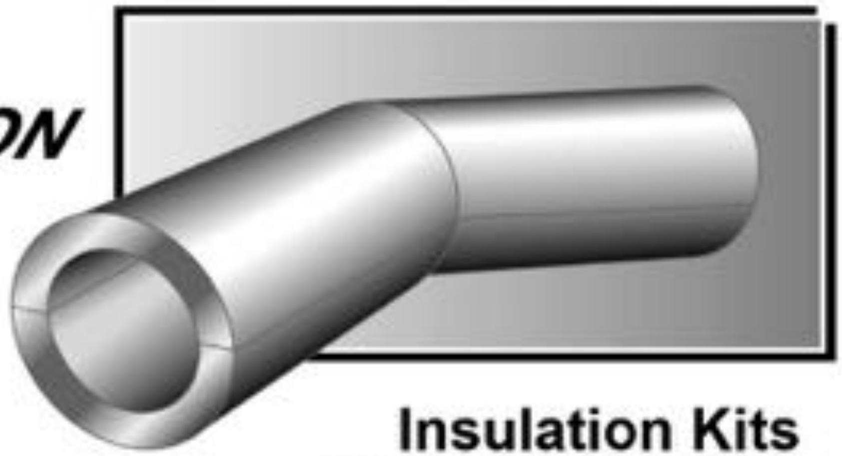
Component no. 1230

d, mm	20/20	25/25	32/32	40/40	50/50
D, mm	90	110	110	125	160

Installation

Installation must follow all guidelines provided by URECON

Submittal Data



Insulation Kits
with polymer coating

Urecon factory fabricated insulation kits are easy to field install and provide equivalent insulation value as that of the pre-insulated pipe. Kits are fabricated for standard dimensional steel, PVC, CPVC, copper, and HDPE fittings. Non standard kits are also available if required. Specify the type of fittings being insulated when ordering. (Urecon can supply bare pipe fittings in addition to insulation if desired).
Our superior quality kits are manufactured from closed cell polyurethane or polyisocyanurate foam and are coated with a polymer outer jacket. They are a wise choice for applications where moisture resistance is essential.

Application:
Urecon form fitting insulation kits are ideally suited for the above or below ground insulation of chilled, domestic hot and process water piping up to a maximum service temperature of 86°C *(185°F)*.

- 100mm or 150mm *(4 in or 6 in)* wide polyethylene adhesive backed butyl mastic tape shall be provided to provide a waterproof seal between the insulated pipe and kit.
- For above ground with metal Spiwrap jacket: kit includes a metal cover consistent with the pipe jacket*.

Insulation:

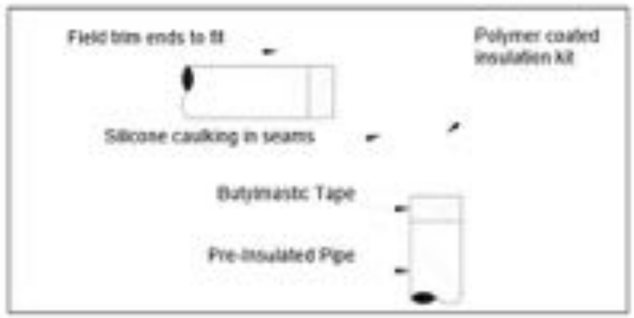
- Rigid polyisocyanurate or polyurethane foam.
- Density: (ASTM D 1622) 27 to 32 kg/m^3 *(1.7 to 2 lbs/ft^3)*.
- Compressive Strength: (ASTM D 1621) 131 to 158 kPa *(19 to 23 lbs/in^2)*.
- Closed Cell Content: 90% minimum.
- Water Absorption: 4% by volume.
- K factor: (ASTM C 518) 0,027 W/m°C *(0.19 Btu. In/ft^2.hr.0F)*.
- Thickness: shall match pipe insulation.

Polymer coating:

- Two component high density polyurethane

Butyl mastic tape:

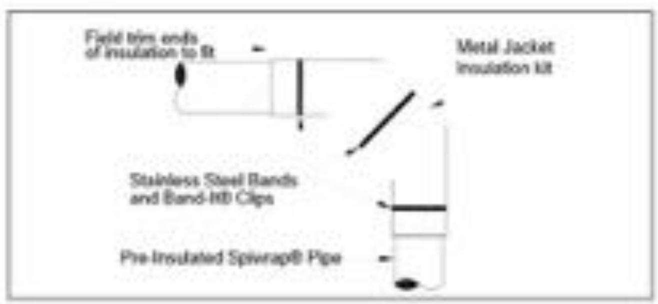
- To seal seams between pre-insulated pipe and kit.
- Width: 100mm *(4 in)*.or 150mm *(6 in)*.
- Backing: Low density Polyethylene.
- Adhesive: Butyl rubber and resin.
- Thickness: 0,90 mm *(35 mils)*.
- Meets AWWA C-209 Standard.
- Note: Butyl mastic tape not required for above ground application with metal covers.



Fitting kit configurations:

Urecon insulation kits are manufactured to suit the fitting and accommodate the factory insulation cut-back on the adjacent pipes.
These are:

- Butt-welded steel @ 150mm *(6 in.)*
- All solvent weld or Bell x Spigot jointed pipe @ spigot insertion depth.
- Butt-fused HDPE @ 225mm *(9 in.)*
- Soldered copper @ 75mm *(3 in.)* for up to 37mm *(1½ in.)*, and 150 mm *(6 in.)* for 50 mm *(2 in.)* and larger.



Metal Cover:

- Two piece pre-formed metal with extension legs to suit.
- All metal overlaps shall be 50mm *(2 in.)* minimum and shall be field installed in such a way as to shed water.
- Stainless steel straps and Band-it® clips.
- Note: Butyl mastic tape not required for above

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ISO 9001: 2000
Registered Company

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E-mail: sales.usa@urecon.com

Local Representative

PEX FLEX

Logstor PEX-Flex Pre-Insulated Hydronic Heating pipe

Handling & Installation Guidelines

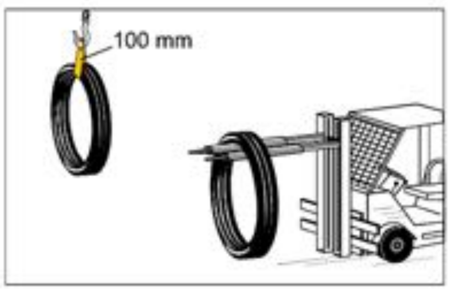
Receiving LOGSTOR PEX-Flex

LOGSTOR pipe, although flexible enough to bend on a radius in any direction and strong enough to withstand some compression of the protective jacket, insulation and pipe, it can be damaged with extreme handling. Therefore, care should be taken to prevent crushing when handling the pipe. Please inspect all LOGSTOR pipe when received, to ensure that the pipe is in operational condition. It is normal for LOGSTOR PEX-Flex to have some small indentations on the inside radius of the pipe while it is rolled tight. These small indentations will smooth out when uncoiled and will not hinder the overall performance of the pipe. If you find that there are any significant damages to the pipe, such as a forklift fork puncture, have the freight carrier make a notation regarding the damaged pipe on the bill of lading and call Urecon immediately to receive instructions on what action is to be taken. If you cannot contact Urecon and damage to the pipe seems to be unfixable, please refuse shipment and have LOGSTOR PEX-Flex shipped back to Urecon.

Unloading LOGSTOR PEX-Flex

When unloading LOGSTOR PEX-Flex from the freight carrier, do not remove any packing materials, banding or the pipe from the skid. If a forklift is being used to unload the pipe, fork extensions 7 feet in length help keep the load balanced.

Take care in unloading the pipe as to not puncture the pipe. Punctured pipe, as a result of handling by the customer, although fixable, is not returnable and all materials provided to fix the pipe are at the cost of the purchaser. Do not drop the pipe from any height; it could result in damages to the pipe.



Storage of LOGSTOR PEX-Flex

End caps should come on the ends of the pipe when shipped and should remain on the pipe when stored. Avoid storing the pipe on any sharp or narrow surfaces. When using Logstor pipe in cold weather, try to store the pipe in a warm storage area prior to installation to assist in keeping the pipe flexible. Keep all other accessories and installation parts in a dry clean area.

Repair of LOGSTOR PEX-Flex

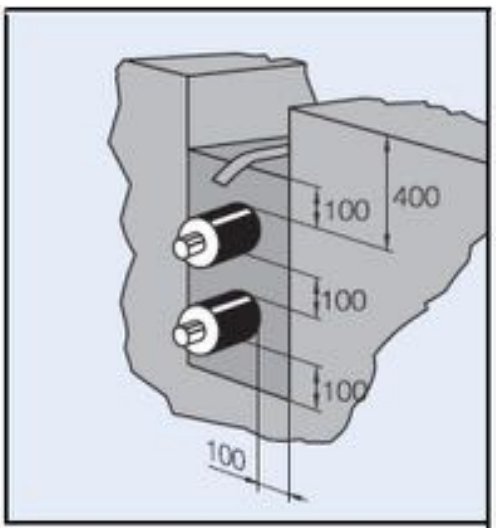
If the pipe becomes damaged, a heat shrink material can be used to fix a small puncture. It is extremely important to ensure a tight seam and water tight outer jacket so that no water can enter into the insulation. If you do not repair the damaged section of pipe before use, it could result in increased heat-loss, resulting in a greater consumption of fuel. Make sure the damaged surface is clean, dry and without debris before applying the heat shrink material. If the surface is dirty or wet, it could result in a poor seal. Refer to the manufacturer's installation instruction for the application of the heat shrink.

Trench Layout

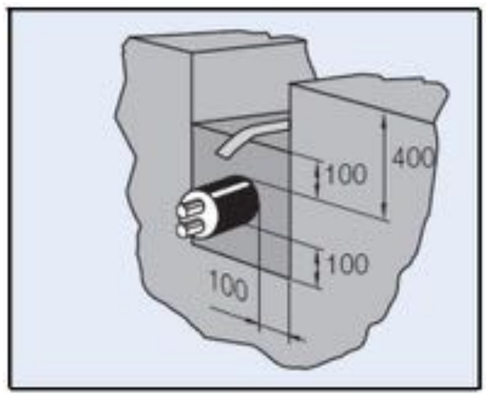
Before you begin installing LOGSTOR PEX-Flex, you should take the time to plan your layout. Take into consideration all trees, gardens, flowerbeds, and call your local utility to have all underground utilities marked. A well planned layout could save a lot of time and expense in the future.

Digging the Trench

When digging your trench plan on where all the excess soil will be piled. It is easier to install the pipe from one side of the trench, therefore you should attempt to pile the soil on the opposite side. Using a standard trenching machine provides a sufficient cavity for the pipe to lay into approximately 16" - 24" deep. LOGSTOR PEX-Flex pipe will bend in any direction, so be sure to dig your trench clearly around any trees or shrubs that may pose a potential concern.



400mm = 16” / 100mm =4”



High Traffic or Weight Areas

PEX-FLEX is suitable for H-20 Loading at depth of >24”. If you are installing your LOGSTOR pipe under a high traffic or Weight load area, it is recommended that you prepare and excavate your trench to a depth of 24" below the deepest point of the traffic road bed. It would also be a good idea to surround LOGSTOR PEX-Flex in a 6" cushion of sand to add a secondary precaution in preventing any large stones from the road bed puncturing the outer jacket of LOGSTOR PEX-Flex.

Backfilling the Trench

When backfilling the trench be sure to fill the trench in layers with the same material excavated. This will allow for even distribution of the soil, allowing for less soil settling. Do not mechanically compact the soil directly on the pipe until there is a sufficient amount of soil directly above the pipe. It is recommended to have a 4" – 6" bed of sand around the pipe in high stone concentration areas. Take extra care in ensuring that there are no sharp objects such as tree roots, rocks, frozen lumps of soil, or manmade objects in the trench around the pipe which could puncture the pipe, resulting in an exposed area allowing moisture to enter the insulation.

Above Ground Installations

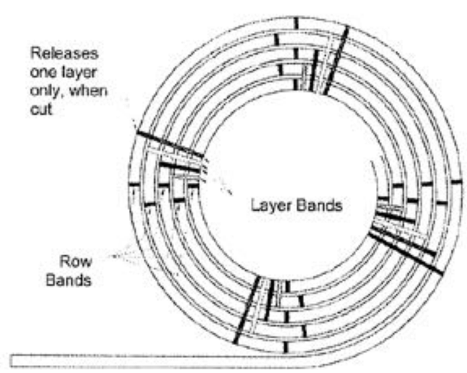
The casing of PEX-FLEX is UV stable so above ground installations are possible. They must be properly supported with either fixed or sliding supports. Local code may define the maximum distances between supporting devices, otherwise, horizontal and vertical runs should be supported every 40 inches (1m).

Fixed Supports – Fixed supports are typically applied at fitting locations place the fixed support on the body of the fitting, nut on the PEX-FLEX outer casing or on a compression nut.

Sliding Supports – to allow for expansion and contraction that occurs in non-buried PEX-FLEX support devices should allow for movement with slide fittings accommodating for the outside diameter of the casing and not squeeze the pipe unnecessarily. Make sure the material in contact with the PEX-FLEX is not abrasive and does not allow sharp edges to protrude into the casing.

Laying of LOGSTOR PEX-Flex

Before laying the pipe in trench, please take note of how the roll of LOGSTOR is banded together. Each layer of pipe is banded to assist you by maintaining a tight roll while you roll out the pipe. As well, each row of pipe on a full roll is banded together to ensure that each layer does not release when a band is cut.



Before you begin cutting the bands on the roll to unroll LOGSTOR PEX-Flex, make sure the yellow end caps are in place then securely fasten the outer end of the pipe to a stable object at the beginning of the roll, so it does not roll back when unrolled. Because the pipe is shipped in a coil, the pipe will have a certain degree of memory and will want to bend back. Once the end is secure, begin unrolling LOGSTOR PEX-Flex pipe adjacent to the open trench, systematically cutting each band during each revolution of the pipe. Once you have enough pipe unrolled to fulfill your installation you need to measure and cut LOGSTOR PEX-Flex to length. Once the pipe is cut, it IS up to the installer whether he wants to install the pipe in the trench before or after cutting and stripping the ends of the pipe.

Measuring the Length of LOGSTOR PEX-Flex

LOGSTOR PEX-Flex pipe comes pre marked every meter. Full rolls of 328 ft are 100m in length. Most rolls either start with a 100m mark and decrease in count or begin with 0 m and increase in count. Therefore, if you want to measure how much pipe you need to cut off the roll, you can measure by each meter mark.

Cutting LOGSTOR PEX-Flex to Length

When cutting the pipe be sure to secure the pipe at the point where you will be cutting to stop the pipe from moving back to its pre-rolled form. If 100 ft of pipe is required for your installation, you are therefore cutting the pipe at the 69.5m position marked on the pipe if the roll started at 100m. Taking a carpenters saw, cut through LOGSTOR PEX-Flex pipe at your desired position from one side through to the other. Do not cut from both sides as this could give you an uneven cut. Once you have cut the pipe, wipe the end and then cover to make sure that no debris can enter each water line.

Stripping the Protective Outer Jacket

To expose the insulation in order to remove it from the carrier pipes, you must first remove the outer extruded low-density polyethylene jacket. In order to remove the protective jacket, take a sharp utility knife, or equivalent, and cut lengthwise down the pipe to your desired length to strip. Cut around the diameter of the pipe through the outer jacket. Use extreme care in cutting the outer jacket so you do not penetrate down to the pex carrier pipes. You can now peel the outer jacket from the polyurethane foam insulation. A straight edged screwdriver may have to be used to lift the end edge of the outer jacket before you can remove it.

Removal of the Foam Insulation

Before removing the polyurethane foam insulation, it may be easier to remove the insulation if the supply and return carrier pipes are separated. Score the insulation on the end of the pipe between the supply and return carrier pipes. With a straight edged screwdriver, pry the two carrier pipes apart creating two separate pieces. Now with a knife, scraper or equivalent, you can remove the excess foam insulation from the pipe if it does not break off by itself using your hand.

Cleaning of LOGSTOR PEX-Flex

Before you can attach the carrier pipes to the adapters, you must make sure that the pipe outer diameter surface is clean and any burrs are removed before attaching any fitting. Take a de-burring reamer and scrape the I.D. of the pipe. Take a utility knife of equivalent and scrape clean the O.D. of the pipe. You may have to use some sand cloth to buff the insulation residue from the pipe before an adapter can be attached. A clean pipe will help promote a dry, tight seal to prevent any potential leaks.

Bending the Pipe

When bending the pipe, make sure that the two ends of the pipe are secure from potential moving. At this point in the installation, you can place each end in position and the middle of the pipe outside of the trench, which will hold the pipe in position. When trying to bend LOGSTOR PEX-Flex up under an object, such as an Outdoor Wood Furnace, place the end of the pipe under the furnace and pull up on the end while having someone push the middle of the pipe into the trench. To assist you in bending LOGSTOR PEX-Flex under an object, you may increase the depth of the trench at the point of radius in the pipe to allow more space for maneuvering the insulated pipe.

Wall Penetration

Pipe laying

Service line inlets

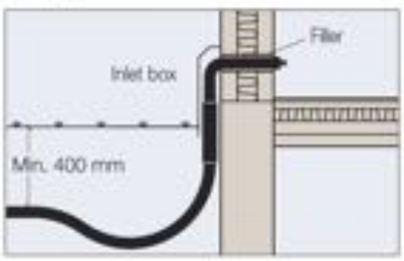
LR-Pex - Design **6.1.4**

When seal rings are used to prevent water penetration, the opening for the inlet must be big enough to ensure good, tight casting.

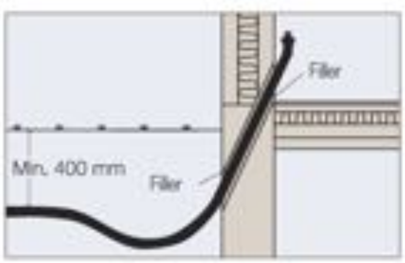
If the service line inlet is made by drilling with a core drill, a rubber filler must be used to protect against water penetration.

The figures below are schematic diagrams of service line inlets.

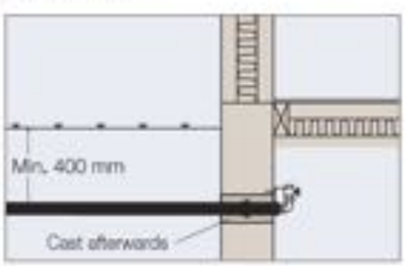
Above ground inlet



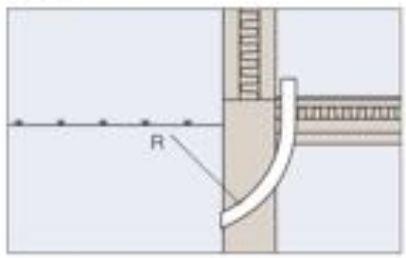
Oblique drilling in wall



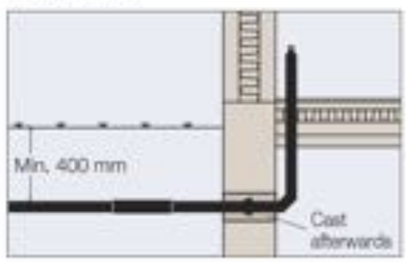
Basement inlet



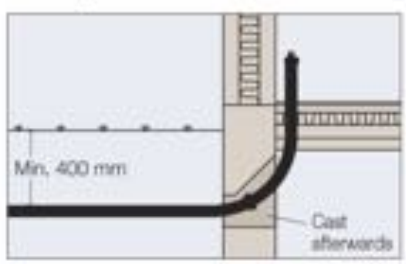
Inlet pipe



Inlet with bend



Pex bend upwards



Link Seals or Rubber Pipe rings can be used in the core holes. There a number of brands on

Connecting the Fittings

Make sure the pipe is clean from any debris on the O.D. and I.D. of the carrier pipe. Refer to the adapter fitting manufacturer's installation instructions for further details on installing the connection fittings. The supply carrier pipe of LOGSTOR PEX-Flex is marked with a red stripe. This red stripe marking has been provided for easy identification of the supply pipe. Connect the supply adapter to this pipe so your supply and return carrier pipes are not crossed during the installation.

See separate document on installing compression fittings.

Flushing the Lines

Before attaching the waterlines to any system, it may be a good idea to flush the supply and return carrier lines to remove any loose debris from the pipes to avoid any damage to the heating system.

Pressure Testing

A pressure test must always be performed prior to and during filling of the trench to ensure the PEX-FLEX connections are leak-free. Air or water can be used to perform the test.

-Perform an initial pressure test to either 1.5 times the system operating pressure or 100psi, whichever is greater, for 30 minutes.

-As the piing expands restore pressure at 10 minutes and then again at 20 minutes if necessary.

-At the end of 30 minutes the pressure should not have fallen more than 5 psi. If so – it is leak-free.

Estimating Labour

One of the greatest benefits of using PEX-Flex products is the savings in installation time. A long coil length means fewer connections in a properly designed system. The flexibility of PEX-Flex allows you to avoid obstacles such as boulders and landscaping – not to mention hidden objects below the surface that might otherwise require extensive cost and time. Use the tables below to estimate the time required to install PEX-flex products. The quick learning curve associated with PEX-Flex will enhance this estimate dramatically.

Estimated Installation Time - PEX-Flex Single Service Pipe		
Pipe Size	Number of Mechanics	Time in HOURS / 100m
¾" (25mm)	2	1 hour
1" (32mm)	2	1 hour
1 ¼" (40mm)	2	1 hour
1 ½" (50mm)	2	1 hour
2" (63mm)	2	1.25 hours
2 ½" (75mm)	2	1.25 hours
3" (90mm)	3	1.5 hours
4" (110mm)	3	1.5 hours

Estimated Installation Time - PEX-Flex DUAL Service Pipes		
Pipe Size	Number of Mechanics	Time in HOURS / 100m
¾" (25mm)	2	1 hour
1" (32mm)	2	1 hour
1 ¼" (40mm)	2	1.25 hours
1 ½" (50mm)	3	1.5 hours

Estimated Installation Time - PEX-Flex Accessories		
Part	Number of Mechanics	Working Time /Connection
Terminal Connections (Male Thread Adapter) upto 1 ½"	1	15 min.
Terminal Connections (Male Thread Adapter) 2" to 4"	1	20 min.
PEX Coupling up to 1 ½"	2	20 min.
PEX Coupling 2" to 4"	2	20 min.
PEX Tee up to 1 ½"	2	30 min.
PEX Tee 2" to 4"	2	40 min.
Insulation kit for couplings	1	20 min.
Insulation Kit for Tees	1	30 min.

Tools Required for Installation of Fittings.
To cut the casing, remove insulation, cut and clean the PEX tubing



For Installation of Adapters, Couplers, Elbows and Tees



Small and Large Format

Note: Tools depicted are for example only. URECON does not endorse a particular brand of tool.

HEAT LOSS

PEX-FLEX

Conditions:

Flow Temperature:	175^{O}F (80^{O}C)
Return Temperature:	104^{O}F (40^{O}C)
Soil Temperature:	50^{O}F (10^{O}C)
Soil Cover:	2 ft. (600mm)
Lambda Value of the soil:	2.78 Btu/hr-ft^2-F (1.6 W/mK)

If exact calculations with other considerations are required please refer to LOGSTOR Calculator at calc.logstor.com or contact your URECON representative.

Single Pipe					
Service Pipe		Outer casing		Heat Loss	
in	mm	in	mm	BTU/hr-ft	W/m
3/4	25	3	77	8.95	8.58
1	32	3	77	11.45	10.98
1 1/4	40	3.5	90	12.02	11.53
1 1/2	50	4.3	110	12.47	11.96
2	63	4.9	125	14.13	13.55
2 1/2	75	5.5	140	15.11	14.49
3	90	6.3	160	16.72	16.04
4	110	6.3	160	25.08	24.05

Twin Pipes					
				Heat Loss	
in	mm	in	mm	BTU/hr-ft	W/m
2 x 3/4	2 x 25	110	4.3	8.77	8.41
2 x 1	2 x 32	110	4.3	12.14	11.64
2 x 1 1/4	2 x 40	125	4.9	13.87	13.3
2 x 1 1/2	2 x 50	160	6.3	12.65	12.13
2 x 2	2 x 63	180	7	15.93	15.28

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Flow vs velocity for Logstor Pex-Flex pipes

Nominal pipe size		Carrier pipe OD		Carrier pipe ID		Flow if velocity is 1.22 m/s (4 ft/s)		Pressure loss	Flow if velocity is 1.52 m/s (5 ft/s)		Pressure loss	Flow if velocity is 2 m/s (6.6 ft/s)		Pressure loss
mm	inches	mm	inches	mm	inches	l/s	USGPM	psi/100ft	l/s	USGPM	psi/100ft	l/s	USGPM	psi/100ft
20	0.5	20	0.79	16	0.63	0.25	3.89	4.9	0.31	4.84	5.40	0.40	6.37	11.70
25	0.75	25	0.98	20	0.79	0.38	6.08	3.7	0.48	7.57	5.20	0.63	9.96	8.90
32	1	32	1.26	26.2	1.03	0.66	10.43	2.5	0.82	12.99	3.80	1.08	17.09	6.20
40	1.25	40	1.57	32.6	1.28	1.02	16.14	2.0	1.27	20.11	3.20	1.67	26.46	4.50
50	1.5	50	1.97	40.8	1.61	1.60	25.28	1.5	1.99	31.50	2.20	2.61	41.45	3.80
63	2	63	2.48	51.4	2.02	2.53	40.13	1.1	3.15	49.99	1.70	4.15	65.78	2.80
75	2.5	75	2.95	61.2	2.41	3.59	56.89	0.9	4.47	70.88	1.40	5.88	93.26	2.20
90	3	90	3.54	73.6	2.90	5.19	82.27	0.7	6.47	102.51	1.10	8.51	134.88	1.80
110	4	110	4.33	90	3.54	7.76	123.02	0.6	9.67	153.28	0.90	12.72	201.68	1.40

Maximum recommended velocity to avoid couplings erosion = 2 m/s (6.6 ft/s)

Pressure Correction Factors

100% WATER	30% GLYCOL	40% GLYCOL	50% GLYCOL
1	1.24	1.33	1.4

DIMENSIONAL DATA – PEX-FLEX

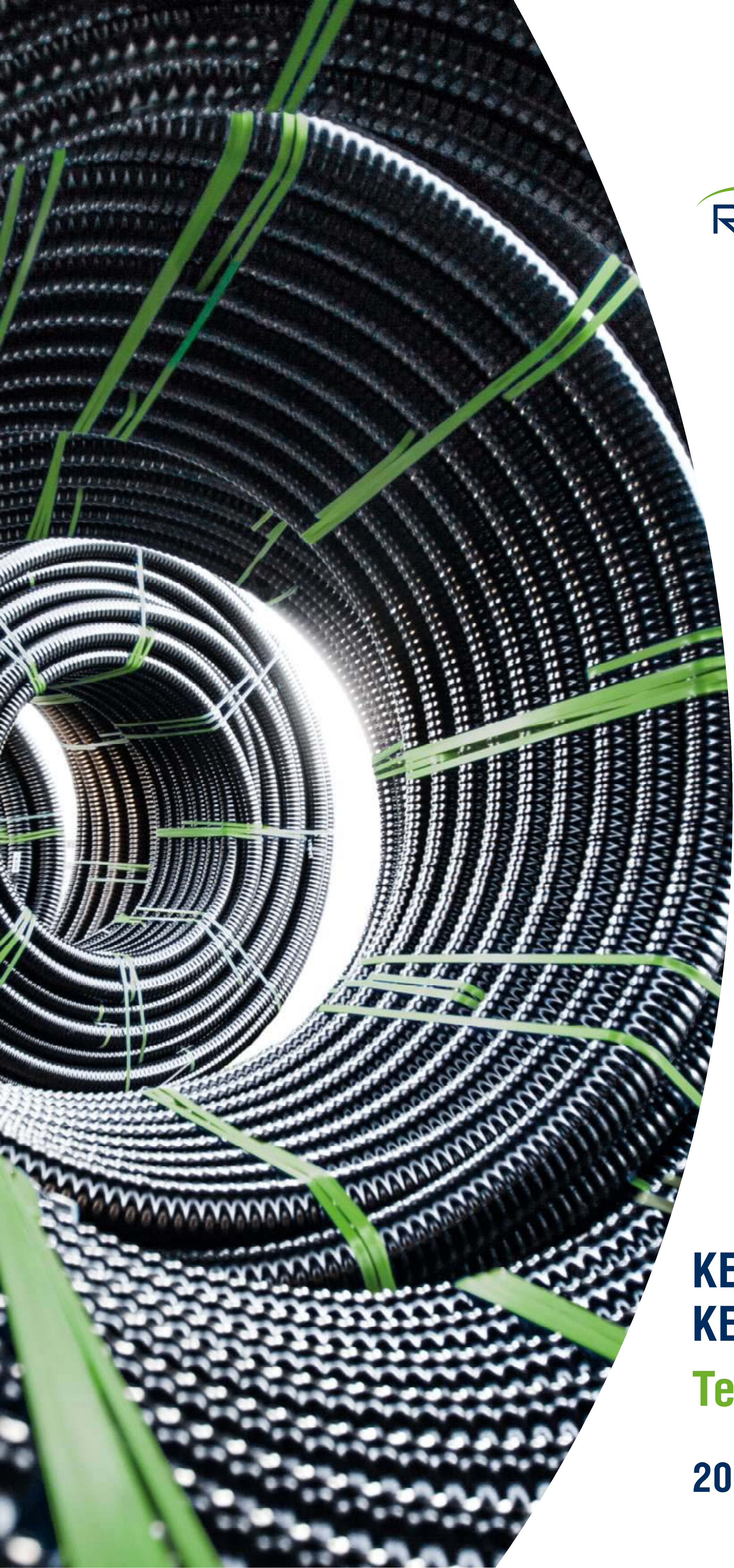
Nominal pipe size in	Carrier pipe O.D. mm *(in)*	Carrier pipe wall thickness mm *(in)*	Carrier pipe I.D. mm *(in)*	Jacket pipe O.D. mm *(in)*	Minimum/Maximum coil length m *(ft)*	Weight kg/m (lb/ft)	Coil Total Weight kg (lbs)	Coil Height ** (ft)
¾	25 *(0.98)*	2.5 *(0.098)*	20 (0.79)	77 *(3.0)*	50/300 *(164/984)*	1.0 (0.7)	50/300 (110/661)	4' / 8'
1	32 *(1.26)*	2.9 *(0.114)*	26.2 (1.03)	77 *(3.0)*	50/300 *(164/984)*	1.0 (0.7)	50/300 (110/661)	4' / 8'
1 ¼	40 *(1.57)*	3.7 *(0.145)*	32.6 (1.28)	90 *(3.5)*	50/300 *(164/984)*	1.3 (0.9)	65/390 (143/859)	4' / 8'
1 ½	50 *(1.97)*	4.6 *(0.181)*	40.8 (1.61)	110 *(4.3)*	50/200 *(164/656)*	1.9 (1.3)	95/380 (209/837)	4' / 8'
2	63 *(2.48)*	5.8 *(0.228)*	51.4 (2.02)	125 *(5.0)*	50/200 *(164/656)*	2.4 (1.6)	120/480 (264/1058)	4' / 8'
2 ½	75 *(2.95)*	6.9 *(0.272)*	61.2 (2.41)	140 *(5.5)*	50/100 *(164/328)*	3.3 (2.2)	165/330 (363/727)	4' / 8'
3	90 *(3.54)*	8.2 *(0.323)*	73.6 (2.9)	160 *(6.3)*	50/100 *(164/328)*	4.2 (2.8)	210/420 (462/925)	4' / 8'
4	110 *(4.33)*	10.0 *(0.393)*	90 (3.54)	160 *(6.3)*	50/100 *(164/328)*	5.5 (3.7)	275/550 (1018/1212)	4' / 8'
2 x ½	2 x 20 *(2 x 0.79)*	2 *(0.079)*	16 (0.63)	90 *(3.5)*	50/300 *(164/984)*	1.7 (1.1)	85/510 (187/1124)	4' / 8'
2 x ¾	2 x 25 *(2 x 0.98)*	2.5 *(0.098)*	20 (0.79)	110 *(4.3)*	50/200 *(164/656)*	2.1 (1.4)	105/420 (231/925)	4' / 8'
2 x 1	2 x 32 *(2 x 1.26)*	2.9 *(0.114)*	26.2 (1.03)	110 *(4.3)*	50/200 *(164/656)*	2.2 (1.5)	110/440 (242/970)	4' / 8'
2 x 1¼	2 x 40 *(2 x 1.26)*	3.7 *(0.145)*	32.6 (1.28)	125 *(5.0)*	50/200 *(164/656)*	2.7 (1.8)	135/540 (297/1190)	4' / 8'
2 x 1 ½	2 x 50 (2 x 1.97)	4.6 (0.181)	40.8 (1.61)	160 (6.3)	50/100 (164/328)	4.1 (2.8)	205/410 (451/903)	4' / 8'
2 x 2	2 x 63 *(2 x 2.95)*	5.8 (0.228)	51.4 (2.02)	180 (7.0)	50/100 *(164/328)*	5.5 (3.7)	275/550 (1018/1212)	4' / 8'

**** Diameter for <u>ALL</u> coils is 7'8" - consistent with internal dimension of Hi-Cube Ocean Container**

Footprint is a nominal 8' x 8' pallet

	77mm(1/2",3/4"/1")	**90mm** (1/2" dual, 1 1/4")	**110mm** (1 1/2", 3/4"dual, 1" Dual)	**125mm** (2" pex)	**140mm**(2 1/2" pex)	**160mm** (3 & 4" pex)
Inside Diameter	5.24'	5.24'	5.9'	5.9'	6.6'	6.6'
Outside diameter	7.54'	7.54'	7.54'	7.54'	7.54'	7.54'
Height of 100m	1.55'	1.55'	2.62'	3.7'	7.38'	7.87'

High cube 40' container =	39'6" L	7'9"H	7'8"W



Radius - Kelit
Infrastructure

KELIT PEX 95R-10
KELIT PEX 115R-16
Technical catalogue

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KELIT PEX 95R-10
KELIT PEX 115R-16

Technical catalogue

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System description

KELIT PEXR is a new class of bonded flexible pre–insulated pipe systems for district heating networks, which include a range of pre–insulated Thermoplastic Reinforced Service (TRS) pipes, specifically designed for use within district heating networks operating at elevated temperature and pressures.

The multilayer structure of KELIT PEXR pipes incorporates a high modulus Aramid fibre mesh reinforcement enabling the pipe to operate at high internal pressure and temperature without the requirement to increase the pipe wall thickness. These thinner wall Thermoplastic Reinforced Service pipes, which are more flexible than conventional monolayer pipes, significantly increase the range of application of flexible pre–insulated plastic pipes for district heating systems.

KELIT PEXR service pipes have a multilayer pipe wall construction, comprising of a cross linked polyethylene PEX–a inner layer (cross linked using the peroxide method), a high modulus Aramid fibre mesh reinforcement layer, an oxygen barrier, and additional high temperature thermoplastic adhesive layers needed to bond the individual major layers into a composite pipe structure.

The main purpose of TRS inner layer is to provide a leak–tight pipeline. The cross–linked PEX–a polyethylene material has been chosen for the inner layer due to its outstanding thermal and mechanical properties that are a requirement for district heating applications. Additionally PEX–a material offers excellent corrosion and chemical resistance.

The high modulus Aramid fibre mesh reinforcement layer resists the applied stress resulting from the internal pressure within the pipe.

Thermal insulation

KELIT PEXR pipes are insulated using CFC–free Polyurethane foam with an outstanding thermal conductivity value of ≤ 0.021W/mK.

To accommodate the varying heat loss requirements of a pipe network, KELIT PEXR pipes are available with a range of insulation thickness to suit the required insulation class.

Applications

KELIT PEX 95R–10 is a flexible pre–insulated TRS pipe system with a maximum continuous operating temperature of +80°C (maximum fluctuating temperature limit +95°C) and 10 bar design pressure. A range of service pipe diameters from 25 mm to 160 mm are available.

KELIT PEX 95R–10 is an ideal solution for:

- Local district heating networks
- Low temperature City Heat networks
- Elevated pressure heating networks in hilly areas
- Drinking water applications
- Agriculture applications
- Private domestic heating applications
- Other heated media transportation applications with operating temperatures and pressure limited by +95°C and 10 Bar .

KELIT PEX 115R–16 is a flexible pre–insulated TRS pipe system with a maximum continuous operating temperature of +100°C (maximum fluctuating temperature limit +115°C) and 16 bar design pressure. A range of service pipe diameters from 25 mm to 160 mm are available.

KELIT PEX 115R–16 is an ideal solution for:

- Medium and large scale City Heat networks with an operating temperature limitation of +115°C, supplied by CHP, gas, biomass wood pallet, waste–burning, surplus, and other types of Power Plants.
- Other heated media transportation applications with operating temperatures and pressure limited by +115°C and 16 Bar.

An optional leak detection cable, specifically designed and implemented for KELIT PEX 115R–16 pipe systems, allows existing pre–insulated steel district heating networks to be extended with flexible pre–insulated plastic pipes without interruption of the leak detection system.

Difference in design

To achieve the high operating temperature and pressure limits for KELIT PEX 115R–16, an improved polyethylene PEX–a stabilization package is used in conjunction with a reinforced and optimised structure Aramid fibre mesh. Modern high temperature thermoplastic materials have been used as adhesive layers to provide required thermal stabilization properties for TRS pipe as a complete system.

System advantages

KELIT PEXR pipe systems offer increased pipeline flexibility, both simplifying the design and installation of district heating networks especially where the pipe is to be installed in trenches with existing service pipes or where the pipe has to be routed around existing trees or buildings.

KELIT PEXR pipes are suitable for installation without the need to design for complex thermal expansion; resulting in a much simplified system design as thermal compensators are not required for correct system operation.

KELIT PEXR flexible pre–insulated pipes are delivered to the installation site in long continuous lengths either as a coil or on a drum. Pipes can be supplied cut to the required length, significantly reducing both the on–site installation time and number of joints required to complete the system.

The KELIT PEXR compression jointing system overcomes the need for fully qualified on–site welding techniques normally associated with rigid district heating systems. Less joint insulation work on–site is needed due to minimized number of connections.

Overall, the long continuous flexible pipe lengths, combined with an easy to install non–welded fittings solution, enables long pipe lengths to be installed using narrow trenching techniques, offering significant on–site installation time and cost savings.

KELIT PEX 95R–10 and KELIT PEX 115R–16 pipe systems are manufactured in accordance with Technical Specification OFI CERT ZG 200–2.

Service life

KELIT PEX 95R–10 pipe system is designed for a minimum 30 year service life with a continuous operating temperature of +80°C at a maximum operating pressure of 10 Bar (+95°C maximum fluctuating temperature).

KELIT PEX 115R–16 pipe system is designed for a minimum 30 year service life with a continuous operating temperature of +100°C at a maximum operating pressure of 16 Bar (+115°C maximum fluctuating temperature).

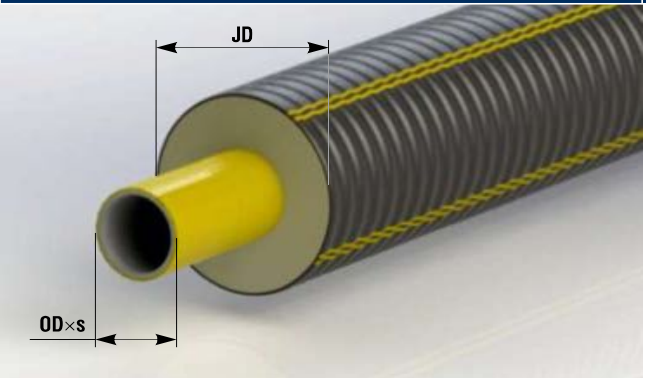
Where KELIT PEX 95R–10 and KELIT PEX 115R–16 pipelines are operated at temperatures and pressures lower than their design maximum, then the service life of these pipe systems can be extended.

1. Pipe products

Table 1.1. Flexible pipe systems

	KELIT PEX 95R-10	KELIT PEX 115R-16
Technical Specifications		
Max. continuous operating temperature	+80°C	+100°C
Max. operating temperature (fluctuating)	+95°C	+115°C
Max. operating pressure	10 bar at +80°C	16 bar at +100°C
Design		
Service pipe	cross–linked polyethylene (PEXa), reinforced with aramid fibers	cross–linked polyethylene (PEXa), reinforced with aramid high temperature composite
Insulation	CFC free, cyclopentane–blown polyurethane foam (PUR), (CO_2–blown PUR on request)	CFC free, cyclopentane–blown polyurethane foam (PUR)
Casing jacket	Low density polyethylene LDPE	Low density polyethylene LDPE
Leak Detection system	Optional	Optional
Single–pipe system	Table 1.2	Table 1.3

Table 1.2. Flexible pipe KELIT PEX 95R–10

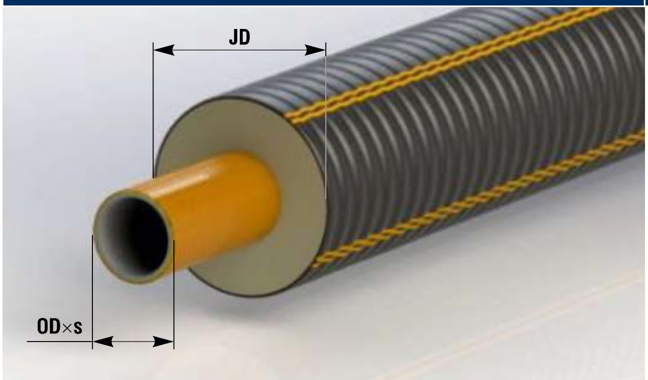
Design	General
	**Max. continuous operating temperature:** +80°C **Max. operating temperature (fluctuating):** +95°C **Max. operating pressure:** 10 bar at +80°C **Thermal conductivity of PUR insulation:** ≤ 0.021 W/mK at +50°C (cyclopentane–blown PUR) ≤ 0.032 W/mK at +50°C (CO_2–blown PUR) KELIT DUO PEXR pipes with 2 service pipes insulated in one casing jacket will be available soon.

Pos	Item	Service pipe, OD×s, mm	Jacket pipe, JD, mm	Weight, kg/m	Min bending radius, m	Max length in coil, m	Max length on drum, m
Insulation series 1							
1	25/76	25.0×2.2	76	0.812	0.7	807	1500
2	25/91	25.0×2.2	91	1.021	0.9	590	1170
3	32/76	32.0×2.5	76	0.860	0.7	807	1500
4	32/91	32.0×2.5	91	1.070	0.9	590	1170
5	40/91	40.0×2.8	91	1.129	0.9	590	1170
6	50/111	49.4×3.6	111	1.803	0.9	430	750
7	63/126	58.5×4.0	126	2.079	1.0	305	650
8	75/142	69.5×4.6	142	2.677	1.1	230	440
9	90/162	84.0×6.0	162	3.601	1.2	150	330
10	110/162	101.0×6.5	162	3.867	1.2	150	330
11	110/182	101.0×6.5	182	4.424	1.3	86	200
12	125/182	116.0×6.8	182	4.633	1.3	86	200
13	125/202	116.0×6.8	202	5.241	1.4	80	135
14	140/202	127.0×7.1	202	5.422	1.4	80	135
15	160/225	144.0×7.5	225	6.446	1.6	40*	130*
Insulation series 2							
1	25/111	25.0×2.2	111	1.452	0.9	430	750
2	32/111	32.0×2.5	111	1.500	0.9	430	750
3	40/111	40.0×2.8	111	1.560	0.9	430	750
4	50/126	49.4×3.6	126	2,082	1.0	305	650
5	63/142	58.5×4.0	142	2.514	1.1	230	440
6	75/162	69.5×4.6	162	3.219	1.2	150	330
7	90/182	84.0×6.0	182	4.157	1.3	86	200
8	110/202	101.0×6.5	202	5.033	1.4	80	135
9	125/225	116.0×6.8	225	5.996	1.6	40*	130*
10	140/225	127.0×7.1	225	6.177	1.6	40*	130*

Note: * will be available soon

Table 1.3. Flexible pipe KELIT PEX 115R–16

Design	General



Max. continuous operating temperature: +100°C
Max. operating temperature (fluctuating): +115°C
Max. operating pressure: 16 bar at +100°C
Thermal conductivity of PUR insulation: ≤ 0.0210W/mK at +50°C

KELIT DUO PEXR pipes with 2 service pipes insulated in one casing jacket will be available soon.

Pos	Item	Service pipe, OD×s, mm	Jacket pipe, JD, mm	Weight, kg/m	Min bending radius, m	Max length in coil, m	Max length on drum, m
Insulation series 1							
1	25/91	25.0×2.2	91	1.021	0.9	590	1170
2	32/91	32.0×2.5	91	1.070	0.9	590	1170
3	40/91	40.0×2.8	91	1.129	0.9	590	1170
4	50/111	47.6×3.6	111	1.684	0.9	430	750
5	63/126	58.5×4.0	126	2.079	1.0	305	650
6	75/142	69.5×4.6	142	2.677	1.1	230	440
7	90/162	84.0×6.0	162	3.601	1.2	150	330
8	110/162	101.0×6.5	162	3.867	1.2	150	330
9	110/182	101.0×6.5	182	4.424	1.3	86	200
10	125/182	116.0×6.8	182	4.633	1.3	86	200
11	125/202	116.0×6.8	202	5.241	1.4	80	135
12	140/202	127.0×7.1	202	5.422	1.4	80	135
13	160/225	144.0×7.5	225	6.446	1.6	40*	130*
Insulation series 2							
1	25/111	25.0×2.2	111	1.452	0.9	430	750
2	32/111	32.0×2.5	111	1.500	0.9	430	750
3	40/111	40.0×2.8	111	1.560	0.9	430	750
4	50/126	47.6×3.6	126	1.964	1.0	305	650
5	63/142	58.5×4.0	142	2.514	1.1	230	440
6	75/162	69.5×4.6	162	3.219	1.2	150	330
7	90/182	84.0×6.0	182	4.157	1.3	86	200
8	110/202	101.0×6.5	202	5.033	1.4	80	135
9	125/225	116.0×6.8	225	5.996	1.6	40*	130*
10	140/225	127.0×7.1	225	6.177	1.6	40*	130*

Note: * will be available soon

2. Coupling connections

Table 2.1. Coupling connections

Name		KELIT PEX 95R-10	KELIT PEX 115R-16
PEXR–Steel Compression Connector	Type I	Table 2.2	—
	Type II	Table 2.3	Table 2.3
PEXR–PEXR Compression I–connector	Type I	Table 2.4	—
	Type II	Table 2.5	Table 2.5
Compression T–connector	Type I	Table 2.6	—
	Type II	Table 2.7	Table 2.7

KELIT PEX 95R–10 and KELIT PEX 115R–16 pipes are connected using compression couplings. A Radius–Kelit hydraulic press tool is used for the installation of the compression coupling, once installed (compressed) these couplings cannot be removed and reinstalled on the pipeline. Standard press tools for the installation of PEX pipe compression couplings may be used for pipe diameters upto and including 90mm.

- PEXR–Steel compression connectors are used to join PEXR pipes with steel pipes.
- PEXR–PEXR Compression connectors are used to join two PEXR pipes together.
- Both equal and reducing PEXR–Steel and PEXR–PEXR connectors are available.
- PEXR Compression T–connectors are used for PEXR T–branch connection.
- A range of PEXR Compression T–connectors are available with either equal or reduced outlet.

Two types of PEXR compression couplings are available, namely Type 1 and Type 2.

Type 1 Compression couplings are suitable only for connections to KELIT PEX 95R–10 pipes.

The coupling consists of 2 parts:

- Inner steel coupler and
- Outer steel sleeve

The installation of the compression coupling Type 1 requires the pipe end to be expanded before placing the insert into the pipe and compression of the steel outer sleeve onto the pipes outer surface.

Type 2 Compression couplings are suitable for connections to both KELIT PEX 95R–10 and KELIT PEX 115R–16 pipes.

The coupling consists of 3 parts:

- Inner steel coupler
- High temperature polymer sleeve and
- Outer steel sleeve.

When installing the Type 2 compression coupling there is no requirement for the pipe end to be expanded. A high temperature polymer sleeve is placed between the pipe and outer steel sleeve, this provides the necessary compressive force to ensure a reliable connection.

Table 2.2. PEXR–Steel Compression Connector (Type I)

Design	General
	**Pipe system:** KELIT PEX 95R–10 **Purpose:** for weld connection with steel pipes and system elements **Material:** steel* * can be made of stainless steel on special order

Service pipe, OD	Steel pipe, DN									
	20	25	32	40	50	65	80	100	125	150
25	Pos.1									
32		Pos.2								
40			Pos.3							
50				Pos.4						
63					Pos.5					
75					Pos.6	Pos.7				
90						Pos.8	Pos.9			
110							Pos.10	Pos.11		
125								Pos.12	Pos.13	
140								Pos.14	Pos.15	
160									Pos.16	Pos.17

Pos	Item	Steel pipe d×s, mm	Diameter D, mm	Length L, mm	Weight, kg	Pos	Item	Steel pipe d×s, mm	Diameter D, mm	Length L, mm	Weight, kg
1	25/DN20	26.9×2.3	30	50 (51)*	0.08 (0.11)**	10	110/DN80	88.9×3.2	130	130 (185)	1.70 (5.57)
2	32/DN25	33.7×2.6	40	60 (64)	0.14 (0.26)	11	110/DN100	114.3×3.6	130	130 (185)	1.70 (5.57)
3	40/DN32	42.4×2.6	50	70 (71)	0.28 (0.44)	12	125/DN100	114.3×3.6	152	117 (212)	3.38 (8.20)
4	50/DN40	48.3×3.2	60	85 (155)	0.49 (1.05)	13	125/DN125	139.7×3.6	152	117 (212)	3.38 (8.20)
5	63/DN50	60.3×3.2	74	90 (160)	0.68 (1.50)	14	140/DN100	114.3×3.6	160	125 (222)	3.65 (8.28)
6	75/DN50	60.3×3.2	90	95 (170)	1.02 (1.43)	15	140/DN125	139.7×3.6	160	125 (222)	3.65 (8.28)
7	75/DN65	76.1×3.2	90	95 (170)	1.02 (1.43)	16	160/DN125	139.7×3.6	180	125 (227)	4.69 (10.94)
8	90/DN65	76.1×3.2	108	95 (180)	1.23 (4.05)	17	160/DN150	168.3×4.0	180	125 (227)	4.69 (10.94)
9	90/DN80	88.9×3.2	108	95 (180)	1.23 (4.05)						

Note: * in brackets: size with couplings
** in brackets: weight with couplings

Table 2.3. PEXR–Steel Compression Connector (Type II)

Design	General

Pipe system: KELIT PEX 115R–16
KELIT PEX 95R–10

Purpose: for weld connection with steel pipes and system elements

Material: steel*, high temperature polymer
* can be made of stainless steel on special order

Service pipe, OD	Steel pipe, DN									
	20	25	32	40	50	65	80	100	125	150
25	Pos.1									
32		Pos.2								
40			Pos.3							
50				Pos.4						
63					Pos.5					
75					Pos.6	Pos.7				
90						Pos.8	Pos.9			
110							Pos.10	Pos.11		
125								Pos.12	Pos.13	
140								Pos.14	Pos.15	
160									Pos.16	Pos.17

Pos	Item	Steel pipe d×s, mm	Diameter D, mm	Length L, mm	Weight, kg	Pos	Item	Steel pipe d×s, mm	Diameter D, mm	Length L, mm	Weight, kg
1	25/DN20	26.9×2.3	30	64 (84)*	0.11 (0.19)**	10	110/DN80	88.9×3.2	130	188 (211)	3.40 (7.29)
2	32/DN25	33.7×2.6	40	79 (104)	0.19 (0.45)	11	110/DN100	114.3×3.6	130	188 (211)	3.40 (7.29)
3	40/DN32	42.4×2.6	50	90 (116)	0.36 (0.71)	12	125/DN100	114.3×3.6	148	195 (219)	4.10 (8.35)
4	50/DN40	48.3×3.2	74	115 (145)	0.92 (1.70)	13	125/DN125	139.7×3.6	148	195 (219)	4.10 (8.35)
5	63/DN50	60.3×3.2	74	130 (156)	0.93 (1.75)	14	140/DN100	114.3×3.6	157	218 (243)	5.60 (10.69)
6	75/DN50	60.3×3.2	90	153 (178)	1.47 (2.81)	15	140/DN125	139.7×3.6	157	218 (243)	5.60 (10.69)
7	75/DN65	76.1×3.2	90	153 (178)	1.47 (2.81)	16	160/DN125	139.7×3.6	177	232 (257)	7.54 (12.82)
8	90/DN65	76.1×3.2	108	168 (195)	2.33 (4.79)	17	160/DN150	168.3×4.0	177	232 (257)	7.54 (12.82)
9	90/DN80	88.9×3.2	108	168 (195)	2.33 (4.79)						

Note: * in brackets: size with couplings
** in brackets: weight with couplings

Table 2.4. PEXR–PEXR Compression I–connector (Type I)

Design	General
	**Pipe system:** KELIT PEX 95R–10 **Purpose:** for connection of two service KELIT PEXR pipes **Material:** steel* * can be made of stainless steel on special order

Inlet service pipe, OD1	Outlet service pipe, OD2										
	25	32	40	50	63	75	90	110	125	140	160
25	Pos.1										
32	Pos.2	Pos.3									
40		Pos.4	Pos.5								
50			Pos.6	Pos.7							
63				Pos.8	Pos.9						
75					Pos.10	Pos.11					
90						Pos.12	Pos.13				
110							Pos.14	Pos.15			
125								Pos.16	Pos.17		
140								Pos.14	Pos.18	Pos.19	
160										Pos.20	Pos.21

Pos	Item	Diameter D, mm	Length L, mm	Weight, kg	Pos	Item	Diameter D, mm	Length L, mm	Weight, kg
1	25/25	30	74 (76)*	0.12 (0.17)**	12	90/75	108	135 (295)	2.25 (6.18)
2	32/25	40	79 (84)	0.16 (0.30)	13	90/90	108	135 (305)	2.46 (7.46)
3	32/32	40	84 (92)	0.21 (0.43)	14	110/90	130	135 (310)	2.93 (8.89)
4	40/32	50	88 (95)	0.31 (0.57)	15	110/110	130	135 (315)	3.40 (10.32)
5	40/40	50	92 (94)	0.56 (0.84)	16	125/110	152	150 (335)	5.08 (13.52)
6	50/40	60	95 (172)	0.77 (1.47)	17	125/125	152	164 (354)	6.76 (16.72)
7	50/50	60	106 (246)	0.98 (2.10)	18	140/125	159	172 (364)	7.03 (16.64)
8	63/50	74	117 (257)	1.17 (2.55)	19	140/140	159	180 (374)	7.30 (16.56)
9	63/63	74	128 (268)	1.36 (3.00)	20	160/140	180	180 (379)	8.34 (19.22)
10	75/63	90	133 (278)	1.70 (3.95)	21	160/160	180	180 (384)	9.38 (21.88)
11	75/75	90	135 (285)	2.04 (4.90)					

Note: * in brackets: size with couplings
** in brackets: weight with couplings

Table 2.5. PEXR–PEXR Compression I–connector (Type II)

Design	General
	**Pipe system:** KELIT PEX 115R–16 KELIT PEX 95R–10 **Purpose:** for connection of two service KELIT PEXR pipes **Material:** steel*, high temperature polymer * can be made of stainless steel on special order

Inlet service pipe, OD1	Outlet service pipe, OD2										
	25	32	40	50	63	75	90	110	125	140	160
25	Pos.1										
32	Pos.2	Pos.3									
40		Pos.4	Pos.5								
50			Pos.6	Pos.7							
63				Pos.8	Pos.9						
75					Pos.10	Pos.11					
90						Pos.12	Pos.13				
110							Pos.14	Pos.15			
125								Pos.16	Pos.17		
140								Pos.14	Pos.18	Pos.19	
160										Pos.20	Pos.21

Pos	Item	Diameter D, mm	Length L, mm	Weight, kg	Pos	Item	Diameter D, mm	Length L, mm	Weight, kg
1	25/25	30	88 (128)*	0.22 (0.34)**	12	90/75	108	246 (274)	2.84 (6.65)
2	32/25	40	100 (145)	0.28 (0.58)	13	90/90	108	251 (279)	3.49 (8.43)
3	32/32	40	110 (160)	0.34 (0.81)	14	110/90	130	265 (290)	4.29 (10.55)
4	40/32	50	118 (170)	0.52 (1.08)	15	110/110	130	279 (304)	5.10 (12.68)
5	40/40	50	126 (178)	0.69 (1.35)	16	125/110	148	306 (353)	5.62 (13.66)
6	50/40	74	144 (200)	1.04 (2.15)	17	125/125	148	318 (366)	6.15 (14.65)
7	50/50	74	162 (222)	1.38 (2.94)	18	140/125	157	356 (405)	7.25 (16.59)
8	63/50	74	184 (240)	1.38 (2.98)	19	140/140	157	360 (410)	8.40 (18.58)
9	63/63	74	206 (258)	1.39 (3.03)	20	160/140	177	360 (410)	9.85 (20.22)
10	75/63	90	227 (278)	1.79 (3.95)	21	160/160	177	360 (410)	11.31 (21.87)
11	75/75	90	241 (291)	2.20 (4.88)					

Note: * in brackets: size with couplings
** in brackets: weight with couplings

Table 2.6. Compression T–connector (Type I)

Design	General
	**Pipe system:** KELIT PEX 95R–10 **Purpose:** for branch pipeline connection **Material:** steel* * can be made of stainless steel on special order

Inlet service pipe, OD1	Outlet service pipe, OD3	Branch service pipe, OD2										
		25	32	40	50	63	75	90	110	125	140	160
25	25	Pos.1										
32	25	Pos.2										
32	32	Pos.3	Pos.4									
40	32	Pos.5	Pos.6									
40	40	Pos.7	Pos.8	Pos.9								
50	40	Pos.10	Pos.11	Pos.12								
50	50	Pos.13	Pos.14	Pos.15	Pos.16							
63	50	Pos.17	Pos.18	Pos.19	Pos.20							
63	63	Pos.21	Pos.22	Pos.23	Pos.24	Pos.25						
75	63	Pos.26	Pos.27	Pos.28	Pos.29	Pos.30						
75	75	Pos.31	Pos.32	Pos.33	Pos.34	Pos.35	Pos.36					
90	75	Pos.37	Pos.38	Pos.39	Pos.40	Pos.41	Pos.42					
90	90	Pos.43	Pos.44	Pos.45	Pos.46	Pos.47	Pos.48	Pos.49				
110	90	Pos.50	Pos.51	Pos.52	Pos.53	Pos.54	Pos.55	Pos.56				
110	110	Pos.57	Pos.58	Pos.59	Pos.60	Pos.61	Pos.62	Pos.63	Pos.64			
125	110	Pos.65	Pos.66	Pos.67	Pos.68	Pos.69	Pos.70	Pos.71	Pos.72			
125	125	Pos.73	Pos.74	Pos.75	Pos.76	Pos.77	Pos.78	Pos.79	Pos.80	Pos.81		
140	125	Pos.82	Pos.83	Pos.84	Pos.85	Pos.86	Pos.87	Pos.88	Pos.89	Pos.90		
140	140	Pos.91	Pos.92	Pos.93	Pos.94	Pos.95	Pos.96	Pos.97	Pos.98	Pos.99	Pos.100	
160	140	Pos.101	Pos.102	Pos.103	Pos.104	Pos.105	Pos.106	Pos.107	Pos.108	Pos.109	Pos.110	
160	160	Pos.111	Pos.112	Pos.113	Pos.114	Pos.115	Pos.116	Pos.117	Pos.118	Pos.119	Pos.120	Pos.121

Pos	Item	Length L, mm	Height H, mm	Weight, kg	Pos	Item	Length L, mm	Height H, mm	Weight, kg
1	25/25/25	180 (182)*	103 (104)*	0.46 (0.55)**	13	50/25/50	250 (390)	115 (116)	1.45 (2.60)
2	32/25/25	190 (195)	106 (107)	0.57 (0.75)	14	50/32/50	250 (390)	125 (129)	1.56 (2.80)
3	32/25/32	200 (208)	106 (111)	0.63 (0.90)	15	50/40/50	250 (390)	135 (136)	1.74 (3.02)
4	32/32/32	200 (208)	116 (120)	0.74 (1.10)	16	50/50/50	250 (390)	150 (220)	2.03 (3.71)
5	40/25/32	210 (215)	110 (111)	0.81 (1.12)	17	63/25/50	285 (425)	122 (123)	1.86 (3.27)
6	40/32/32	210 (215)	120 (124)	0.92 (1.32)	18	63/32/50	285 (425)	132 (136)	1.97 (3.47)
7	40/25/40	220 (222)	110 (111)	0.95 (1.30)	19	63/40/50	285 (425)	142 (143)	2.15 (3.69)
8	40/32/40	220 (222)	120 (124)	1.06 (1.50)	20	63/50/50	285 (425)	157 (227)	2.44 (4.38)
9	40/40/40	220 (222)	130 (131)	1.24 (1.72)	21	63/25/63	290 (430)	122 (123)	2.05 (3.72)
10	50/25/40	235 (306)	115 (116)	1.24 (1.99)	22	63/32/63	290 (430)	132 (136)	2.16 (3.92)
11	50/32/40	235 (306)	125 (129)	1.35 (2.19)	23	63/40/63	290 (430)	142 (143)	2.34 (4.14)
12	50/40/40	235 (306)	135 (136)	1.53 (2.41)	24	63/50/63	290 (430)	157 (227)	2.63 (4.83)

Pos	Item	Length L, mm	Height H, mm	Weight, kg	Pos	Item	Length L, mm	Height H, mm	Weight, kg
25	63/63/63	290 (430)	177 (247)	3.04 (5.50)	74	125/32/125	394 (584)	163 (167)	8.99 (18.75)
26	75/25/63	295 (440)	128 (129)	2.25 (3.51)	75	125/40/125	394 (584)	173 (174)	9.17 (18.97)
27	75/32/63	295 (440)	138 (142)	2.36 (3.71)	76	125/50/125	394 (584)	188 (258)	9.46 (19.66)
28	75/40/63	295 (440)	148 (149)	2.54 (3.93)	77	125/63/125	394 (584)	208 (278)	9.87 (20.33)
29	75/50/63	295 (440)	163 (233)	2.83 (4.62)	78	125/75/125	394 (584)	213 (288)	10.34 (20.39)
30	75/63/63	295 (440)	183 (253)	3.24 (5.29)	79	125/90/125	394 (584)	218 (303)	10.73 (23.19)
31	75/25/75	300 (450)	128 (129)	2.86 (3.71)	80	125/110/125	394 (584)	263 (318)	11.76 (25.27)
32	75/32/75	300 (450)	138 (142)	2.97 (3.91)	81	125/125/125	394 (584)	260 (355)	14.00 (28.46)
33	75/40/75	300 (450)	148 (149)	3.15 (4.13)	82	140/25/125	432 (624)	160 (161)	9.51 (18.99)
34	75/50/75	300 (450)	163 (233)	3.44 (4.82)	83	140/32/125	432 (624)	170 (174)	9.62 (19.19)
35	75/63/75	300 (450)	183 (253)	3.85 (5.49)	84	140/40/125	432 (624)	180 (181)	9.80 (19.41)
36	75/75/75	300 (450)	188 (263)	4.32 (5.55)	85	140/50/125	432 (624)	195 (265)	10.09 (20.10)
37	90/25/75	310 (470)	135 (136)	3.25 (6.51)	86	140/63/125	432 (624)	215 (285)	10.50 (20.77)
38	90/32/75	310 (470)	145 (149)	3.36 (6.71)	87	140/75/125	432 (624)	220 (295)	10.97 (20.83)
39	90/40/75	310 (470)	155 (156)	3.54 (6.93)	88	140/90/125	432 (624)	225 (310)	11.36 (23.63)
40	90/50/75	310 (470)	170 (240)	3.83 (7.62)	89	140/110/125	432 (624)	270 (325)	12.39 (25.71)
41	90/63/75	310 (470)	190 (260)	4.24 (8.29)	90	140/125/125	432 (624)	267 (362)	14.63 (28.90)
42	90/75/75	310 (470)	195 (270)	4.71 (8.35)	91	140/25/140	440 (634)	160 (161)	9.78 (19.07)
43	90/25/90	310 (480)	135 (136)	3.46 (9.13)	92	140/32/140	440 (634)	170 (174)	9.89 (19.27)
44	90/32/90	310 (480)	145 (149)	3.57 (9.33)	93	140/40/140	440 (634)	180 (181)	10.07 (19.49)
45	90/40/90	310 (480)	155 (156)	3.75 (9.55)	94	140/50/140	440 (634)	195 (265)	10.36 (20.18)
46	90/50/90	310 (480)	170 (240)	4.04 (10.24)	95	140/63/140	440 (634)	215 (285)	10.77 (20.85)
47	90/63/90	310 (480)	190 (260)	4.45 (10.91)	96	140/75/140	440 (634)	220 (295)	11.24 (20.91)
48	90/75/90	310 (480)	195 (270)	4.92 (10.97)	97	140/90/140	440 (634)	225 (310)	11.63 (23.71)
49	90/90/90	310 (480)	200 (285)	5.31 (13.77)	98	140/110/140	440 (634)	270 (325)	12.66 (25.79)
50	110/25/90	365 (505)	145 (146)	4.49 (11.21)	99	140/125/140	440 (634)	267 (362)	14.90 (28.98)
51	110/32/90	365 (505)	155 (159)	4.60 (11.41)	100	140/140/140	440 (634)	290 (387)	15.53 (29.42)
52	110/40/90	365 (505)	165 (166)	4.78 (11.63)	101	160/25/140	470 (669)	170 (171)	12.09 (23.00)
53	110/50/90	365 (505)	180 (250)	5.07 (12.32)	102	160/32/140	470 (669)	180 (184)	12.20 (23.20)
54	110/63/90	365 (505)	200 (270)	5.48 (12.99)	103	160/40/140	470 (669)	190 (191)	12.38 (23.42)
55	110/75/90	365 (505)	205 (280)	5.95 (13.05)	104	160/50/140	470 (669)	205 (275)	12.67 (24.11)
56	110/90/90	365 (505)	210 (295)	6.34 (15.85)	105	160/63/140	470 (669)	225 (295)	13.08 (24.78)
57	110/25/110	400 (510)	145 (146)	4.96 (12.73)	106	160/75/140	470 (669)	230 (305)	13.55 (24.84)
58	110/32/110	400 (510)	155 (159)	5.07 (12.93)	107	160/90/140	470 (669)	235 (320)	13.94 (27.64)
59	110/40/110	400 (510)	165 (166)	5.25 (13.15)	108	160/110/140	470 (669)	280 (335)	14.97 (29.72)
60	110/50/110	400 (510)	180 (250)	5.54 (13.84)	109	160/125/140	470 (669)	277 (372)	17.21 (32.91)
61	110/63/110	400 (510)	200 (270)	5.95 (14.51)	110	160/140/140	470 (669)	300 (397)	17.84 (33.35)
62	110/75/110	400 (510)	205 (280)	6.42 (14.57)	111	160/25/160	470 (674)	170 (171)	13.13 (25.66)
63	110/90/110	400 (510)	210 (295)	6.81 (17.37)	112	160/32/160	470 (674)	180 (184)	13.24 (25.86)
64	110/110/110	400 (510)	255 (310)	7.84 (19.45)	113	160/40/160	470 (674)	190 (191)	13.42 (26.08)
65	125/25/110	407 (557)	153 (154)	7.20 (15.92)	114	160/50/160	470 (674)	205 (275)	13.71 (26.77)
66	125/32/110	407 (557)	163 (167)	7.31 (16.12)	115	160/63/160	470 (674)	225 (295)	14.12 (27.44)
67	125/40/110	407 (557)	173 (174)	7.49 (16.34)	116	160/75/160	470 (674)	230 (305)	14.59 (27.50)
68	125/50/110	407 (557)	188 (258)	7.78 (17.03)	117	160/90/160	470 (674)	235 (320)	14.98 (30.30)
69	125/63/110	407 (557)	208 (278)	8.19 (17.70)	118	160/110/160	470 (674)	280 (335)	16.01 (32.38)
70	125/75/110	407 (557)	213 (288)	8.66 (17.76)	119	160/125/160	470 (674)	277 (372)	18.25 (35.57)
71	125/90/110	407 (557)	218 (303)	9.05 (20.56)	120	160/140/160	470 (674)	300 (397)	18.88 (36.01)
72	125/110/110	407 (557)	263 (318)	10.08 (22.64)	121	160/160/160	470 (674)	315 (417)	21.19 (39.94)
73	125/25/125	394 (584)	153 (154)	8.88 (18.55)					

Note: * in brackets: size with couplings
** in brackets: weight with couplings

Table 2.7. Compression T–connector (Type II)

Design	General	
	**Pipe system:**	KELIT PEX 115R–16 KELIT PEX 95R–10
	Purpose:	for branch pipeline connection
	Material:	steel*, high temperature polymer * can be made of stainless steel on special order

Inlet service pipe, OD1	Outlet service pipe, OD3	Branch service pipe, OD2										
		25	32	40	50	63	75	90	110	125	140	160
25	25	Pos.1										
32	25	Pos.2										
32	32	Pos.3	Pos.4									
40	32	Pos.5	Pos.6									
40	40	Pos.7	Pos.8	Pos.9								
50	40	Pos.10	Pos.11	Pos.12								
50	50	Pos.13	Pos.14	Pos.15	Pos.16							
63	50	Pos.17	Pos.18	Pos.19	Pos.20							
63	63	Pos.21	Pos.22	Pos.23	Pos.24	Pos.25						
75	63	Pos.26	Pos.27	Pos.28	Pos.29	Pos.30						
75	75	Pos.31	Pos.32	Pos.33	Pos.34	Pos.35	Pos.36					
90	75	Pos.37	Pos.38	Pos.39	Pos.40	Pos.41	Pos.42					
90	90	Pos.43	Pos.44	Pos.45	Pos.46	Pos.47	Pos.48	Pos.49				
110	90	Pos.50	Pos.51	Pos.52	Pos.53	Pos.54	Pos.55	Pos.56				
110	110	Pos.57	Pos.58	Pos.59	Pos.60	Pos.61	Pos.62	Pos.63	Pos.64			
125	110	Pos.65	Pos.66	Pos.67	Pos.68	Pos.69	Pos.70	Pos.71	Pos.72			
125	125	Pos.73	Pos.74	Pos.75	Pos.76	Pos.77	Pos.78	Pos.79	Pos.80	Pos.81		
140	125	Pos.82	Pos.83	Pos.84	Pos.85	Pos.86	Pos.87	Pos.88	Pos.89	Pos.90		
140	140	Pos.91	Pos.92	Pos.93	Pos.94	Pos.95	Pos.96	Pos.97	Pos.98	Pos.99	Pos.100	
160	140	Pos.101	Pos.102	Pos.103	Pos.104	Pos.105	Pos.106	Pos.107	Pos.108	Pos.109	Pos.110	
160	160	Pos.111	Pos.112	Pos.113	Pos.114	Pos.115	Pos.116	Pos.117	Pos.118	Pos.119	Pos.120	Pos.121

Pos	Item	Length L, mm	Height H, mm	Weight, kg	Pos	Item	Length L, mm	Height H, mm	Weight, kg
1	25/25/25	208 (248)	117 (137)	0.55 (0.79)	13	50/25/50	310 (370)	129 (149)	2.34 (3.98)
2	32/25/25	223 (268)	120 (140)	0.68 (1.10)	14	50/32/50	310 (370)	144 (169)	2.47 (4.29)
3	32/25/32	238 (288)	120 (160)	0.76 (1.36)	15	50/40/50	310 (370)	155 (181)	2.68 (4.59)
4	32/32/32	238 (288)	135 (140)	0.89 (1.67)	16	50/50/50	310 (370)	180 (210)	3.32 (5.66)
5	40/25/32	249 (300)	124 (144)	0.97 (1.66)	17	63/25/50	355 (411)	136 (156)	2.57 (4.25)
6	40/32/32	249 (300)	139 (164)	1.10 (1.97)	18	63/32/50	355 (411)	151 (176)	2.70 (4.56)
7	40/25/40	260 (312)	124 (144)	1.14 (1.92)	19	63/40/50	355 (411)	162 (188)	2.91 (4.86)
8	40/32/40	260 (312)	139 (164)	1.27 (2.23)	20	63/50/50	355 (411)	187 (217)	3.5 (5.93)
9	40/40/40	260 (312)	150 (176)	1.48 (2.53)	21	63/25/63	370 (422)	136 (156)	2.58 (4.30)
10	50/25/40	285 (341)	129 (149)	1.78 (2.99)	22	63/32/63	370 (422)	151 (176)	2.71 (4.61)
11	50/32/40	285 (341)	144 (169)	1.91 (3.30)	23	63/40/63	370 (422)	162 (188)	2.92 (4.91)
12	50/40/40	285 (341)	155 (181)	2.12 (3.60)	24	63/50/63	370 (422)	187 (217)	3.56 (5.98)

Pos	Item	Length L, mm	Height H, mm	Weight, kg	Pos	Item	Length L, mm	Height H, mm	Weight, kg
25	63/63/63	370 (422)	217 (243)	3.79 (6.25)	74	125/32/125	550 (598)	182 (207)	10.48 (19.24)
26	75/25/63	393 (444)	142 (162)	2.98 (5.22)	75	125/40/125	550 (598)	193 (219)	10.69 (19.54)
27	75/32/63	393 (444)	157 (182)	3.11 (5.53)	76	125/50/125	550 (598)	218 (248)	11.33 (20.61)
28	75/40/63	393 (444)	168 (194)	3.32 (5.83)	77	125/63/125	550 (598)	248 (274)	11.56 (20.88)
29	75/50/63	393 (444)	193 (223)	3.96 (6.90)	78	125/75/125	550 (598)	271 (296)	12.23 (22.07)
30	75/63/63	393 (444)	223 (249)	4.19 (7.17)	79	125/90/125	550 (598)	291 (318)	13.27 (24.23)
31	75/25/75	416 (466)	142 (162)	3.79 (6.55)	80	125/110/125	550 (598)	321 (344)	14.90 (27.29)
32	75/32/75	416 (466)	157 (182)	3.92 (6.86)	81	125/125/125	550 (598)	338 (362)	16.16 (28.91)
33	75/40/75	416 (466)	168 (194)	4.13 (7.16)	82	140/25/125	603 (652)	174 (194)	12.21 (21.63)
34	75/50/75	416 (466)	193 (223)	4.77 (8.23)	83	140/32/125	603 (652)	189 (214)	12.34 (21.94)
35	75/63/75	416 (466)	223 (249)	5.00 (8.50)	84	140/40/125	603 (652)	200 (226)	12.55 (22.24)
36	75/75/75	416 (466)	246 (271)	5.67 (9.69)	85	140/50/125	603 (652)	225 (255)	13.19 (23.31)
37	90/25/75	441 (493)	149 (169)	4.83 (8.71)	86	140/63/125	603 (652)	255 (281)	13.42 (23.58)
38	90/32/75	441 (493)	164 (189)	4.96 (9.02)	87	140/75/125	603 (652)	278 (303)	14.09 (24.77)
39	90/40/75	441 (493)	175 (201)	5.17 (9.32)	88	140/90/125	603 (652)	298 (325)	15.13 (26.93)
40	90/50/75	441 (493)	200 (230)	5.81 (10.39)	89	140/110/125	603 (652)	328 (351)	16.76 (29.99)
41	90/63/75	441 (493)	230 (256)	6.04 (10.66)	90	140/125/125	603 (652)	345 (369)	18.02 (31.61)
42	90/75/75	441 (493)	253 (278)	6.71 (11.85)	91	140/25/140	626 (676)	174 (194)	13.71 (23.97)
43	90/25/90	456 (510)	149 (169)	5.69 (10.69)	92	140/32/140	626 (676)	189 (214)	13.84 (24.28)
44	90/32/90	456 (510)	164 (189)	5.82 (11.00)	93	140/40/140	626 (676)	200 (226)	14.05 (24.58)
45	90/40/90	456 (510)	175 (201)	6.03 (11.30)	94	140/50/140	626 (676)	225 (255)	14.69 (25.65)
46	90/50/90	456 (510)	200 (230)	6.67 (12.37)	95	140/63/140	626 (676)	255 (281)	14.92 (25.92)
47	90/63/90	456 (510)	230 (256)	6.90 (12.64)	96	140/75/140	626 (676)	278 (303)	15.59 (27.11)
48	90/75/90	456 (510)	253 (278)	7.57 (13.83)	97	140/90/140	626 (676)	298 (325)	16.63 (29.27)
49	90/90/90	456 (510)	273 (300)	8.61 (15.99)	98	140/110/140	626 (676)	328 (351)	18.26 (32.33)
50	110/25/90	496 (546)	159 (179)	7.32 (13.75)	99	140/125/140	626 (676)	345 (369)	19.52 (33.95)
51	110/32/90	496 (546)	174 (199)	7.45 (14.06)	100	140/140/140	626 (676)	383 (408)	21.38 (36.65)
52	110/40/90	496 (546)	185 (211)	7.66 (14.36)	101	160/25/140	670 (720)	184 (204)	16.92 (27.37)
53	110/50/90	496 (546)	210 (240)	8.30 (15.43)	102	160/32/140	670 (720)	199 (224)	17.05 (27.68)
54	110/63/90	496 (546)	240 (266)	8.53 (15.70)	103	160/40/140	670 (720)	210 (236)	17.26 (27.98)
55	110/75/90	496 (546)	263 (288)	9.20 (16.89)	104	160/50/140	670 (720)	235 (265)	17.90 (29.05)
56	110/90/90	496 (546)	283 (310)	10.24 (19.05)	105	160/63/140	670 (720)	265 (291)	18.13 (29.32)
57	110/25/110	516 (562)	159 (179)	8.39 (16.25)	106	160/75/140	670 (720)	288 (313)	18.80 (30.51)
58	110/32/110	516 (562)	174 (199)	8.52 (16.56)	107	160/90/140	670 (720)	308 (335)	19.84 (32.67)
59	110/40/110	516 (562)	185 (211)	8.73 (16.86)	108	160/110/140	670 (720)	338 (361)	21.47 (35.73)
60	110/50/110	516 (562)	210 (240)	9.37 (17.93)	109	160/125/140	670 (720)	355 (379)	22.73 (37.35)
61	110/63/110	516 (562)	240 (266)	9.60 (18.20)	110	160/140/140	670 (720)	393 (418)	24.59 (40.05)
62	110/75/110	516 (562)	263 (288)	10.27 (19.39)	111	160/25/160	684 (734)	184 (204)	18.86 (29.50)
63	110/90/110	516 (562)	283 (310)	11.31 (21.55)	112	160/32/160	684 (734)	199 (224)	18.99 (29.81)
64	110/110/110	516 (562)	313 (336)	12.94 (24.61)	113	160/40/160	684 (734)	210 (236)	19.20 (30.11)
65	125/25/110	543 (590)	167 (187)	9.65 (17.87)	114	160/50/160	684 (734)	235 (265)	19.84 (31.18)
66	125/32/110	543 (590)	182 (207)	9.78 (18.18)	115	160/63/160	684 (734)	265 (291)	20.07 (31.45)
67	125/40/110	543 (590)	193 (219)	9.99 (18.48)	116	160/75/160	684 (734)	288 (313)	20.74 (32.64)
68	125/50/110	543 (590)	218 (248)	10.63 (19.55)	117	160/90/160	684 (734)	308 (335)	21.78 (34.80)
69	125/63/110	543 (590)	248 (274)	10.86 (19.82)	118	160/110/160	684 (734)	338 (361)	23.41 (37.86)
70	125/75/110	543 (590)	271 (296)	11.53 (21.01)	119	160/125/160	684 (734)	355 (379)	24.67 (39.48)
71	125/90/110	543 (590)	291 (318)	12.57 (23.17)	120	160/140/160	684 (734)	393 (418)	24.59 (40.05)
72	125/110/110	543 (590)	321 (344)	14.20 (26.23)	121	160/160/160	684 (734)	422 (447)	29.74 (45.58)
73	125/25/125	550 (598)	167 (187)	10.35 (18.93)					

Note: * in brackets: size with couplings
** in brackets: weight with couplings

3. Pre-insulated coupling connections

Table 3.1. Pre–insulated coupling connections

Name	KELIT PEX 95R-10	KELIT PEX 115R-16
Pre–insulated T–connector	Table 3.2	Table 3.2
Parallel pre–insulated T–connector	Table 3.3	Table 3.3
Angled pre–insulated T–connector	Table 3.4	Table 3.4
Pre–insulated L–connector 90°	Table 3.5	Table 3.5

Steel pre–insulated couplings can be used in KELIT PEX 95R–10 and KELIT PEX 115R–16 pipe systems.

A range of pre–insulated T–connectors are available for branch pipeline connections, both equal and reducing outlets are available.

Where it is not possible to bend the KELIT PEXR pipe to the required radius, then fabricated pre–insulated 90° bends (L–connectors) are available.

Pre–insulated connectors are available with Type 1 and Type 2 coupling connection for KELIT PEXR service pipes.

Table 3.2. Pre–insulated T–connector (Type I & Type II)

Design	General
	**Pipe system:** KELIT PEX 95R–10 KELIT PEX 115R–16 **Purpose:** for branch pipeline connection **Size:** 1000×500 mm

Inlet service pipe, OD1	Outlet service pipe, OD3	Branch service pipe, OD2										
		25	32	40	50	63	75	90	110	125	140	160
25	25	Pos.1										
32	25	Pos.2										
32	32	Pos.3	Pos.4									
40	32	Pos.5	Pos.6									
40	40	Pos.7	Pos.8	Pos.9								
50	40	Pos.10	Pos.11	Pos.12								
50	50	Pos.13	Pos.14	Pos.15	Pos.16							
63	50	Pos.17	Pos.18	Pos.19	Pos.20							
63	63	Pos.21	Pos.22	Pos.23	Pos.24	Pos.25						
75	63	Pos.26	Pos.27	Pos.28	Pos.29	Pos.30						
75	75	Pos.31	Pos.32	Pos.33	Pos.34	Pos.35	Pos.36					
90	75	Pos.37	Pos.38	Pos.39	Pos.40	Pos.41	Pos.42					
90	90	Pos.43	Pos.44	Pos.45	Pos.46	Pos.47	Pos.48	Pos.49				
110	90	Pos.50	Pos.51	Pos.52	Pos.53	Pos.54	Pos.55	Pos.56				
110	110	Pos.57	Pos.58	Pos.59	Pos.60	Pos.61	Pos.62	Pos.63	Pos.64			
125	110	Pos.65	Pos.66	Pos.67	Pos.68	Pos.69	Pos.70	Pos.71	Pos.72			
125	125	Pos.73	Pos.74	Pos.75	Pos.76	Pos.77	Pos.78	Pos.79	Pos.80	Pos.81		
140	125	Pos.82	Pos.83	Pos.84	Pos.85	Pos.86	Pos.87	Pos.88	Pos.89	Pos.90		
140	140	Pos.91	Pos.92	Pos.93	Pos.94	Pos.95	Pos.96	Pos.97	Pos.98	Pos.99	Pos.100	
160	140	Pos.101	Pos.102	Pos.103	Pos.104	Pos.105	Pos.106	Pos.107	Pos.108	Pos.109	Pos.110	
160	160	Pos.111	Pos.112	Pos.113	Pos.114	Pos.115	Pos.116	Pos.117	Pos.118	Pos.119	Pos.120	Pos.121

Pos	Item	Jacket size, mm		Pos	Item	Jacket size, mm	
		Series 1	Series 2			Series 1	Series 2
1	25/25/25	91/91/91	111/111/111	13	50/25/50	111/91/111	126/111/126
2	32/25/25	91/91/91	111/111/111	14	50/32/50	111/91/111	126/111/126
3	32/25/32	91/91/91	111/111/111	15	50/40/50	111/91/111	126/111/126
4	32/32/32	91/91/91	111/111/111	16	50/50/50	111/111/111	126/126/126
5	40/25/32	91/91/91	111/111/111	17	63/25/50	126/91/126	142/111/142
6	40/32/32	91/91/91	111/111/111	18	63/32/50	126/91/126	142/111/142
7	40/25/40	91/91/91	111/111/111	19	63/40/50	126/91/126	142/111/142
8	40/32/40	91/91/91	111/111/111	20	63/50/50	126/111/126	142/126/142
9	40/40/40	91/91/91	111/111/111	21	63/25/63	126/91/126	142/111/142
10	50/25/40	111/91/111	126/111/126	22	63/32/63	126/91/126	142/111/142
11	50/32/40	111/91/111	126/111/126	23	63/40/63	126/91/126	142/111/142
12	50/40/40	111/91/111	126/111/126	24	63/50/63	126/91/126	142/126/142

Radius - Kelit Infrastructure

Pos	Item	Jacket size, mm		Pos	Item	Jacket size, mm	
		Series 1	Series 2			Series 1	Series 2
25	63/63/63	126/126/126	142/142/142	74	125/32/125	202/91/202	225/111/225
26	75/25/63	142/91/142	162/111/162	75	125/40/125	202/91/202	225/111/225
27	75/32/63	142/91/142	162/111/162	76	125/50/125	202/111/202	225/126/225
28	75/40/63	142/91/142	162/111/162	77	125/63/125	202/126/202	225/142/225
29	75/50/63	142/111/142	162/126/162	78	125/75/125	202/142/202	225/162/225
30	75/63/63	142/126/142	162/142/162	79	125/90/125	202/162/202	225/182/225
31	75/25/75	142/91/142	162/111/162	80	125/110/125	202/162/202	225/202/225
32	75/32/75	142/91/142	162/111/162	81	125/125/125	202/202/202	225/225/225
33	75/40/75	142/91/142	162/111/162	82	140/25/125	202/91/202	225/111/225
34	75/50/75	142/111/142	162/126/162	83	140/32/125	202/91/202	225/111/225
35	75/63/75	142/126/142	162/142/162	84	140/40/125	202/91/202	225/111/225
36	75/75/75	142/142/142	162/162/162	85	140/50/125	202/111/202	225/126/225
37	90/25/75	162/91/162	182/111/182	86	140/63/125	202/126/202	225/142/225
38	90/32/75	162/91/162	182/111/182	87	140/75/125	202/142/202	225/162/225
39	90/40/75	162/91/162	182/111/182	88	140/90/125	202/162/202	225/182/225
40	90/50/75	162/111/162	182/126/182	89	140/110/125	202/162/202	225/202/225
41	90/63/75	162/126/162	182/142/182	90	140/125/125	202/182/202	225/225/225
42	90/75/75	162/142/162	182/162/182	91	140/25/140	202/91/202	225/111/225
43	90/25/90	162/91/162	182/111/182	92	140/32/140	202/91/202	225/111/225
44	90/32/90	162/91/162	182/111/182	93	140/40/140	202/91/202	225/111/225
45	90/40/90	162/91/162	182/111/182	94	140/50/140	202/111/202	225/126/225
46	90/50/90	162/111/162	182/126/182	95	140/63/140	202/126/202	225/142/225
47	90/63/90	162/126/162	182/142/182	96	140/75/140	202/142/202	225/162/225
48	90/75/90	162/142/162	182/162/182	97	140/90/140	202/162/202	225/182/225
49	90/90/90	162/162/162	182/182/182	98	140/110/140	202/182/202	225/202/225
50	110/25/90	182/91/182	202/111/202	99	140/125/140	202/202/202	225/225/225
51	110/32/90	182/91/182	202/111/202	100	140/140/140	202/202/202	225/225/225
52	110/40/90	182/91/182	202/111/202	101	160/25/140	225/91/225	
53	110/50/90	182/111/182	202/126/202	102	160/32/140	225/91/225	
54	110/63/90	182/126/182	202/142/202	103	160/40/140	225/91/225	
55	110/75/90	182/142/182	202/162/202	104	160/50/140	225/111/225	
56	110/90/90	182/162/182	202/182/202	105	160/63/140	225/126/225	
57	110/25/110	182/91/182	202/111/202	106	160/75/140	225/142/225	
58	110/32/110	182/91/182	202/111/202	107	160/90/140	225/162/225	
59	110/40/110	182/91/182	202/111/202	108	160/110/140	225/162/225	
60	110/50/110	182/111/182	202/126/202	109	160/125/140	225/182/225	
61	110/63/110	182/126/182	202/142/202	110	160/140/140	225/202/225	
62	110/75/110	182/142/182	202/162/202	111	160/25/160	225/91/225	
63	110/90/110	182/162/182	202/182/202	112	160/32/160	225/91/225	
64	110/110/110	182/182/182	202/202/202	113	160/40/160	225/91/225	
65	125/25/110	202/91/202	225/111/225	114	160/50/160	225/111/225	
66	125/32/110	202/91/202	225/111/225	115	160/63/160	225/126/225	
67	125/40/110	202/91/202	225/111/225	116	160/75/160	225/142/225	
68	125/50/110	202/111/202	225/126/225	117	160/90/160	225/162/225	
69	125/63/110	202/126/202	225/142/225	118	160/110/160	225/182/225	
70	125/75/110	202/142/202	225/162/225	119	160/125/160	225/202/225	
71	125/90/110	202/162/202	225/182/225	120	160/140/160	225/202/225	
72	125/110/110	202/162/202	225/202/225	121	160/160/160	225/225/225	
73	125/25/125	202/91/202	225/111/225				

Table 3.3. Angled pre–insulated T–connector

Design	General
	**Pipe system:** KELIT PEX 115R–16 KELIT PEX 95R–10 **Purpose:** for branch pipeline connection with higher level of branch pipe

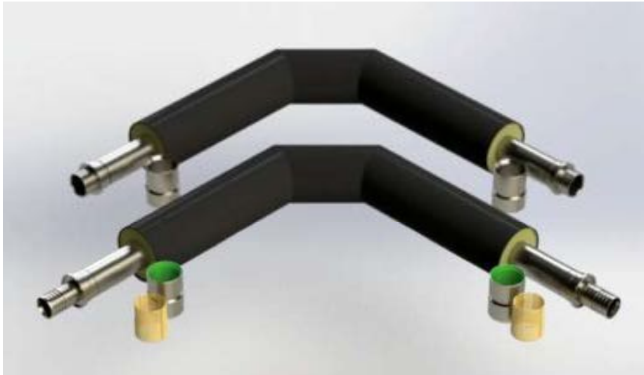
Note
Production and delivery on special order

Table 3.4. Parallel pre–insulated T–connector

Design	General
	**Pipe system:** KELIT PEX 115R–16 KELIT PEX 95R–10 **Purpose:** for parallel branch pipeline connection

Note
Production and delivery on special order

Table 3.5. Pre–insulated L–connector 90° (Type I & Type II)

Design	General
	**Pipe system:** KELIT PEX 95R–10 KELIT PEX 115R–16 **Назначение:** for pipeline sharp bending

Pos	Item	Jacket size, mm	
		Series 1	Series 2
1	25	91	111
2	32	91	111
3	40	91	111
4	50	111	126
5	63	126	142
6	75	142	162
7	90	162	182
8	110	182	202
9	125	202	225
10	140	202	225
11	160	225	

4. Products and materials for water and heat insulation

Table 4.1. Products and materials for water and heat insulation

Name	KELIT PEX 95R-10	KELIT PEX 115R-16
Wall entry sleeve	Table 4.1	
Endcap	Table 4.2	
I–shell	Table 4.3	
T–shell	Table 4.4	
Two–component PUR foam	Table 4.3	

Table 4.1. Wall sleeve

Design	General
	**Pipe system:** KELIT PEX 115R–16 KELIT PEX 95R–10 **Purpose:** for hydro insulation KELIT PEXR pipes passage through walls **Material:** rubber

Pos	Inner diameter, ID, mm	Outside diameter, OD, mm	Thickness, mm
1	90	124	50
2	110	145	
3	125	159	
4	140	175	
5	160	194	
6	180	214	
7	200	233	
8	225	270	

Table 4.2. Endcap

Design	General
	**Pipe system:** KELIT PEX 115R–16 KELIT PEX 95R–10 **Purpose:** for hydro insulation KELIT PEXR pipe ends **Material:** polyethylene

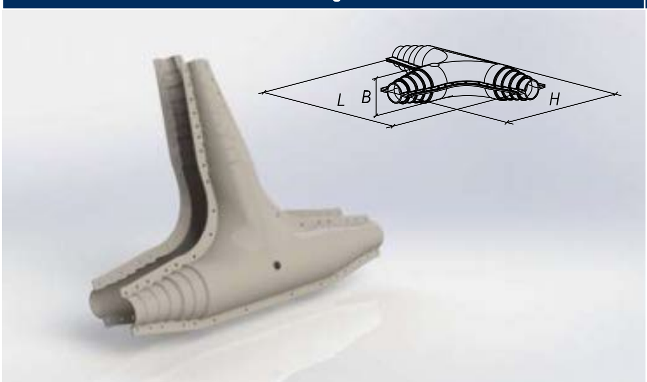
Service pipe, OD	Jacket pipe, JD								
	76	91	111	126	142	162	182	202	225
25	×	×	×						
32	×	×	×						
40		×	×						
50			×	×					
63				×	×				
75					×	×			
90						×	×		
110						×	×	×	
125							×	×	×
140								×	×
160									×

Table 4.3. I–shell

Design	General
	**Pipe system:** KELIT PEX 95R–10 KELIT PEX 115R–16 **Purpose:** for hydro insulation KELIT PEXR pipe connection places **Length:** 700 mm

Jacket pipe, JD1	Jacket pipe, JD2								
	76	91	111	126	142	162	182	202	225
76	×								
91	×	×							
111		×	×						
126			×	×					
142				×	×				
162					×	×			
182						×	×		
202							×	×	
225								×	×

Table 4.4. T–shell

Design	General
	**Pipe system:** KELIT PEX 95R–10 KELIT PEX 115R–16 **Purpose:** for hydro insulation KELIT PEXR pipe branch connection places

Pos	Item	L, mm	H, mm	B, mm	Weight, kg
1	110/63 × 110/63 × 110/63	1105	680	130	5.86
2	160/90 × 160/63 × 160/90	1190	860	160	6.31
3	160/125 × 160/125 × 160/125	810	565	160	5.38
4	225/160 × 225/160 × 225/160	1330	855	240	10.96

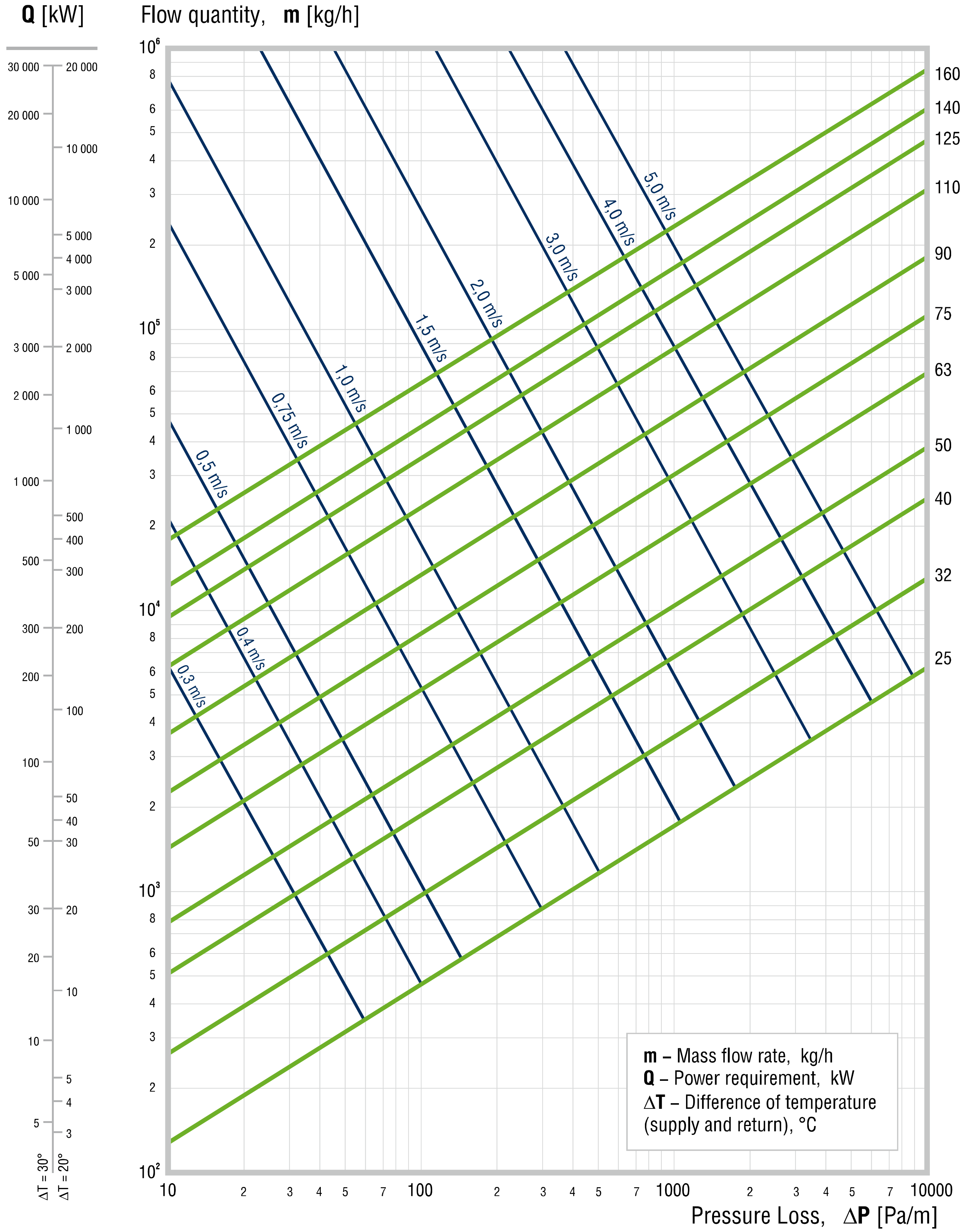
Table 4.5. Two–component PUR foam

Design	General
	**Pipe system:** KELIT PEX 95R–10 KELIT PEX 115R–16 **Purpose:** for insulation of KELIT PEXR pipes connection places.

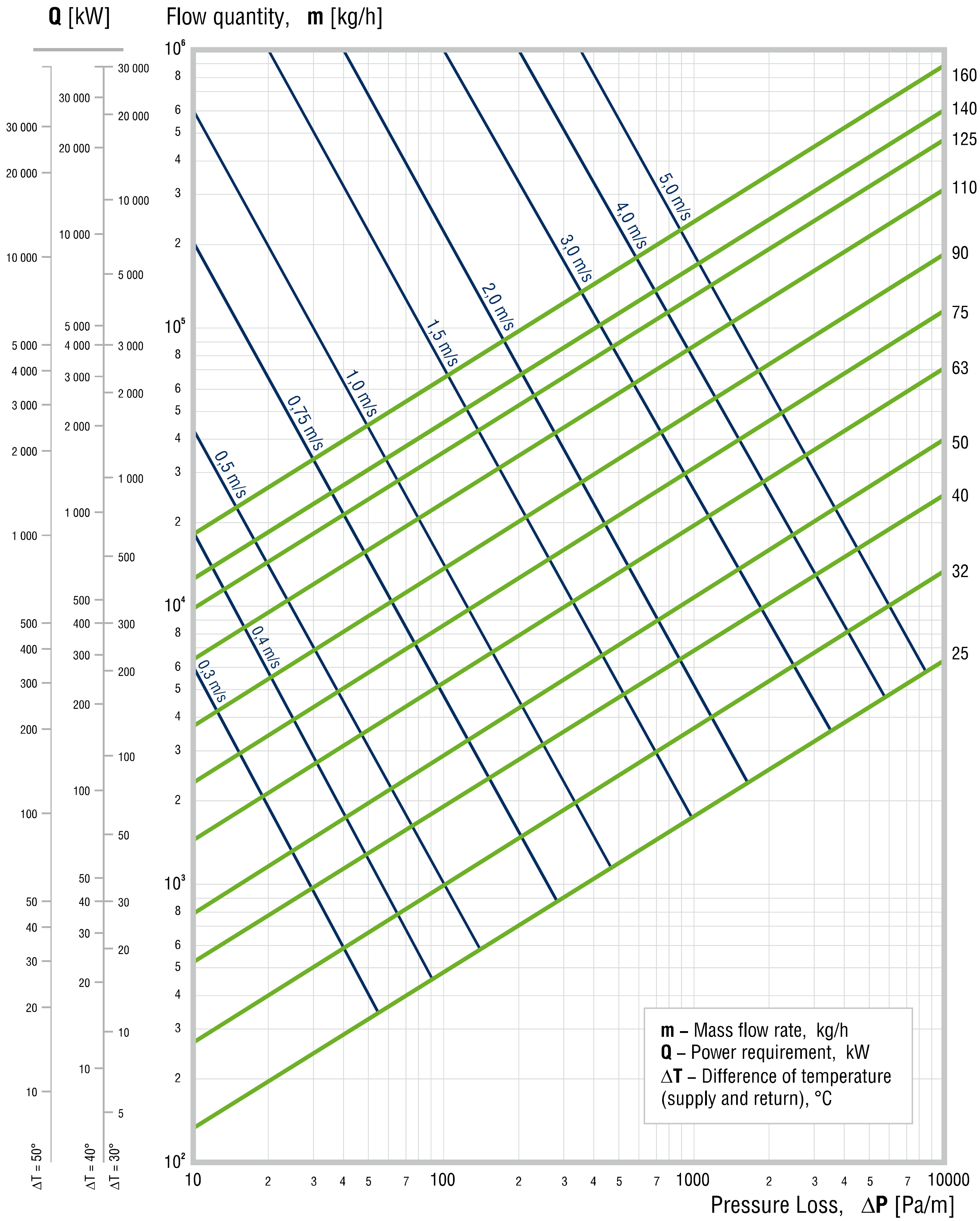
Pos	Service pipe, OD	Series 1				Series 2		
		Jacket pipe, mm		Volume	Packing size	Jacket pipe, mm	Volume	Packing size
1	25	76	91	0.31	1	111	0.31	1
2	32	76	91	0.31	1	111	0.31	1
3	40	91		0.31	1	111	0.31	1
4	50	111		0.31	1	126	0.35	2
5	63	126		0.35	2	142	0.40	3
6	75	142		0.40	3	162	0.53	4
7	90	162		0.53	4	182	0.53	4
8	110	162	182	0.53	4	202	0.53	4
9	125	182	202	0.53	4	225	0.62	5
10	140	202		0.53	4	225	0.62	5
11	160	225		0.62	5			

5. Pressure Loss

Water temperature **80°C**



Water temperature **100°C**



6. Heat Loss

Conditions:

Cover above pipe	0.8 m
Ground temperature	+ 10°C
Soil thermal conductivity	1.0 W/mK
PUR insulation thermal conductivity	0.0210 W/mK
Service pipe thermal conductivity	0.38 W/mK

Heat loss calculation for 1 meter network with supply and return pipelines (with a 100 mm distance between).

$$q = K(\bar{t} - t_s),$$

$$\bar{t} = \frac{t_f + t_r}{2}$$ – Average operating temperature,

K – Heat transfer coefficient,

t_f – Supply operating temperature,

t_r – Return operating temperature.

Table 6.1. Heat Loss

Pipe	K, W/mK	q, W/m						
		Average operating temperature t, °C						
		40	50	60	70	80	90	100
Insulation series 1								
25/76	0.215	6.5	8.6	10.8	12.9	15.1	17.2	19.4
25/91	0.188	5.7	7.5	9.4	11.3	13.2	15.1	17.0
32/76	0.270	8.1	10.8	13.5	16.2	18.9	21.6	24.3
32/91	0.229	6.9	9.2	11.5	13.7	16.0	18.3	20.6
40/91	0.284	8.5	11.4	14.2	17.1	19.9	22.7	25.6
50/111	0.286	8.6	11.4	14.3	17.2	20.0	22.9	25.8
63/126	0.303	9.1	12.1	15.1	18.2	21.2	24.2	27.2
75/142	0.326	9.8	13.0	16.3	19.6	22.8	26.1	29.3
90/162	0.356	10.7	14.2	17.8	21.4	24.9	28.5	32.1
110/162	0.475	14.2	19.0	23.7	28.5	33.2	38.0	42.7
110/182	0.394	11.8	15.7	19.7	23.6	27.6	31.5	35.4
125/182	0.497	14.9	19.9	24.8	29.8	34.8	39.7	44.7
125/202	0.430	12.9	17.2	21.5	25.8	30.1	34.4	38.7
140/202	0.505	15.1	20.2	25.2	30.3	35.3	40.4	45.4
160/225	0.514	15.4	20.6	25.7	30.8	36.0	41.1	46.3
Insulation series 2								
25/111	0.165	4.9	6.6	8.2	9.9	11.5	13.2	14.8
32/111	0.195	5.8	7.8	9.7	11.7	13.6	15.6	17.5
40/111	0.233	7.0	9.3	11.7	14.0	16.3	18.7	21.0
50/126	0.253	7.6	10.1	12.6	15.2	17.7	20.2	22.8
63/142	0.269	8.1	10.7	13.4	16.1	18.8	21.5	24.2
75/162	0.284	8.5	11.4	14.2	17.0	19.9	22.7	25.5
90/182	0.308	9.3	12.3	15.4	18.5	21.6	24.7	27.8
110/202	0.351	10.5	14.0	17.5	21.0	24.5	28.0	31.5
125/225	0.361	10.8	14.5	18.1	21.7	25.3	28.9	32.5
140/225	0.413	12.4	16.5	20.6	24.8	28.9	33.0	37.1

Radius - Kelit
Infrastructure

Radius - Kelit
Infrastructure

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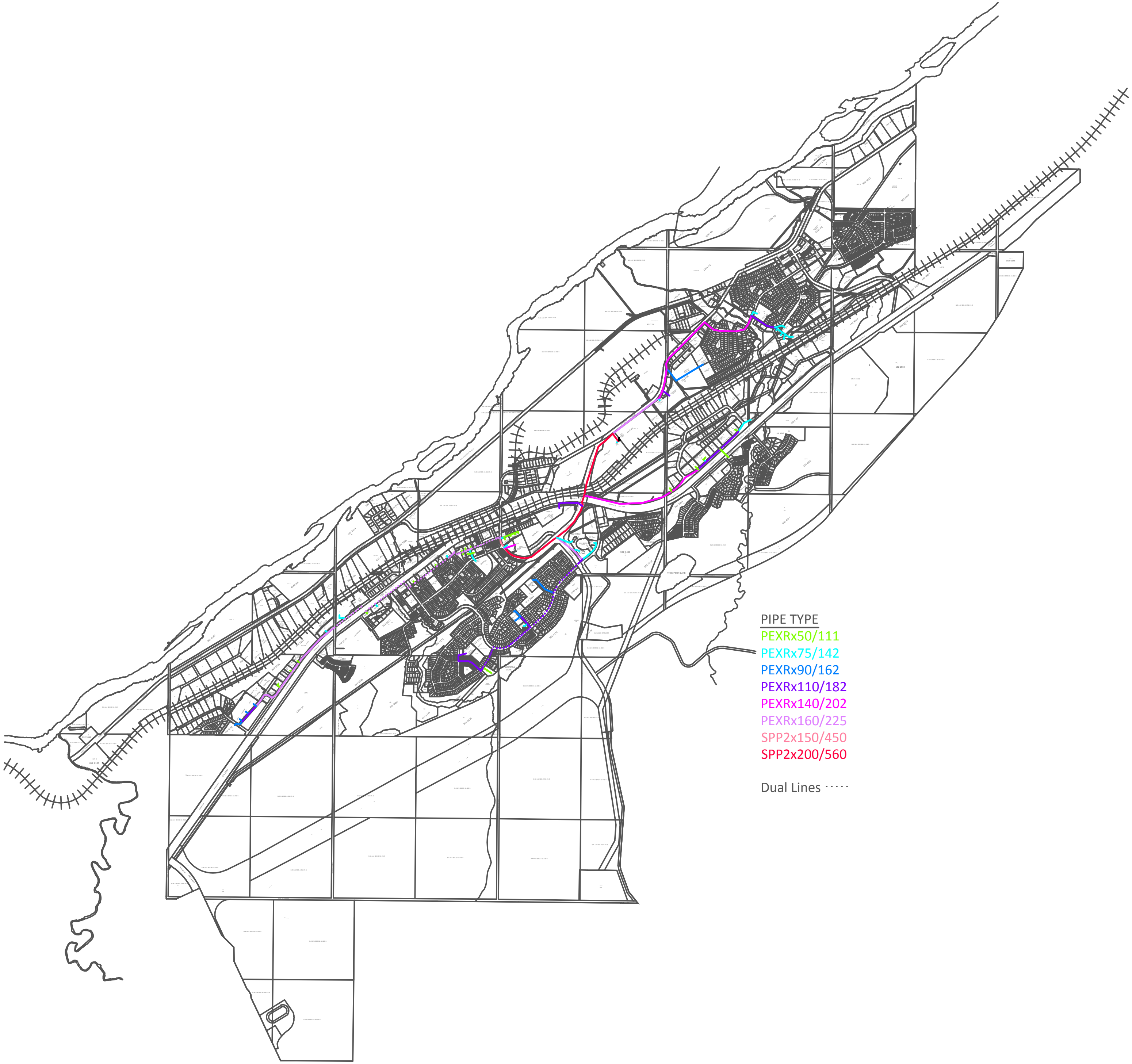
Appendix D.2 Proposed Hinton Distribution Network


PIPE TYPE
PEXRx50/111
PEXRx75/142
PEXRx90/162
PEXRx110/182
PEXRx140/202
PEXRx160/225
SPP2x150/450
SPP2x200/560
Dual Lines

Appendix D.3 Pipeline Comparison Table

PIPELINE MATERIAL COMPARISON TABLE

Type	Vendor	Model	Pros	Cons
PEX	Shawcor	PEX-B	• Using the pipe at a higher temperature is possible, but it will shorten the life span of the pipe. • Easy installation	• Max temp 90°C • Potential thermal expansion • Low pressure rating • Requires insulation (added costs and logistical step)
FRP	Fibrex	IntegraLine and IntegraLine AR (abrasion barrier)	• High Corrosion Resistance : The corrosion barrier of IntegraLine pipe is nominally 100 mils thick and is comprised of 70% to 80% resin. • Abrasion Resistance: IntegraLine AR includes 10-40% granular ceramic added to the resin. •Fittings are manufactured utilizing a highly efficient contact-molded laminate consisting of alternating layers of glass fiber strand mat and bi-directional woven glass roving.	• At 180F (82°C), thermal expansion is 2.5 inches per 100 ft (Installation costs increase with mitigation measures) • Low Pressure Rating • Thermal expansion
	FRP Systems		• De-ionized and soft water has a lower max temp than hard water (see guide saved in the procurement folder)	• No distributors available locally - they manufacture everything in Thunder Bay, Ontario • Max temperature is 100C for hard water and 80C for soft water
	Hanwei Energy		• Up to 3,600 PSI continued operating pressure • Deep hole capability to 1,500 meters • Cathodic protection not required • Lightweight and easy to handle. Fewer personnel and equipment needed for installation. At ¼ the weight of steel, reducing handling and installation costs •Smooth internal wall: low friction; low scale and low paraffin formation • Service Lifecycle 30-50 years	• Up to 93°C continued operating temperatures. They may be able to tweak the manufacturing to get it up to 110 °C • No uses for DES • 9m spools, installation increases
SteelFlex PEXR	LOGSTOR KELIT (PEXR)	KELIT 115R-16	• EN 253 Certified • Steel and Pex System • Pre-Insulated • Proven product used in DES systems in Revelstoke, Vancouver – False Creek, North Vancouver, Surry, Burnaby, Richmond BC, Calgary, Markham, Edmonton (future) •High Pressure Ratings •No thermal expansion found in PEX and PEXR	• High Material Cost • Availability • Pex pipe rated to 85°C for 30 year life (other pex brands are rated to 95°C , but no life span given) • Potential thermal expansion and corrosion for Steel
PEX	Tricon	one pipe	• Min OD 25mm, Max OD 90mm • Max Temperature 94 C	• Potential thermal expansion • Low Pressure Rating
	Tricon	two pipe	• Min OD 25mm, Max OD 50 mm • Max Temperature 94 C • Dual pipe reduces installation	• Potential thermal expansion • Low Pressure Rating
	Uponor	ecoflex thermal single	• Min OD 25mm, Max OD 100 mm • Max Temperature 95 C	• Potential thermal expansion • Low Pressure Rating
	Uponor	ecoflex thermal twin	• Min OD 25mm, Max OD 73 mm • Max Temperature 95 C • Dual pipe reduces installation	• Potential thermal expansion • Low Pressure Rating
	Rovanco	Single Line Rhinoflex	• Min OD 20mm, Max OD 140mm • Max Temperature 95 C	• Potential thermal expansion • Low Pressure Rating
	Rovanco	Dual Line Rhinoflex	• Min OD 25mm, Max OD 63 mm • Max Temperature 95 C • Dual pipe provides easier installation	• Potential thermal expansion • Low Pressure Rating
	Logstor	PEX-Flex Single	• Min OD 25mm, Max OD 100 mm • Max Temperature 95 C • No thermal expansion	•High Material Cost • Low Pressure Rating
	Logstor	PEX-Flex Dual	•Min OD 20mm, Max OD 50 mm • Max Temperature 95 C • Dual pipe provides easier installation • No thermal expansion	•High Material Cost • Low Pressure Rating
PE-RT	ISCO Pipe	Insulated PE-RT	• Polyurethane foam results in the most uniform cell structure and therefore the lowest possible insulating value	•Pressure Rating nearing Operating Pressures • Potential thermal expansion • High Material Cost
	ISCO Pipe	Bare HDPE 4710	• 434.9 Btu/hr*ft heat loss (for 85C)	•Requires additional steps to insulate piping prior to receiving.
HDPE	Aquatherm	SDR 9 Blue Pipe	• Insulation of hot, cold, concealed and exposed piping operating at temperatures from 0°F (-18°C) to 1,000°F (538°C) • No corrosion due to materials • High strength, low coefficient of expansion	• Allowable pressure is 88 psi • Field bends not recommended. Most bends to be completed using low angle elbows. • Installation similar to steel piping, specialized training required from pipeliners to install • Additional installation of thrust blocks required to minimize expansion and contraction • SDR 9 Blue pipe is a relatively new product, availability may be limited but TBD.
Polypropylene	Corix		• Thermal Expansion is 0.18 mm/(m * °C) • Sold in lengths of 5m or 16.4ft	•We do have stub ends, For 6" and up, they're either SDR11 or SDR17 we use our standard flange backing rings. •5m lengths require extensive installation •Thermal Expansion requires mitigation measures
Concrete	Lafarge	N/A	• High Strength and Durability • Long life cycle, leads to reduction in costs	• No sizes available below NPS 12 • High anticipated installation costs
Steel	Permapipe (INSULATION)		• Insulation of steel pipe to provide minimal heat loss • Void free compared to injection (maintains density) • Centered installation within the jacket, even heat conservation around piping	• Use of steel invites corrosion • Fittings that are insulated are unavailable, site installation of insulation is required. •Welding and installation costs are high relative to spool/reel PE piping

Appendix D.4 Town of Hinton – Municipal Development Plan

Figure 6
Existing Development Map

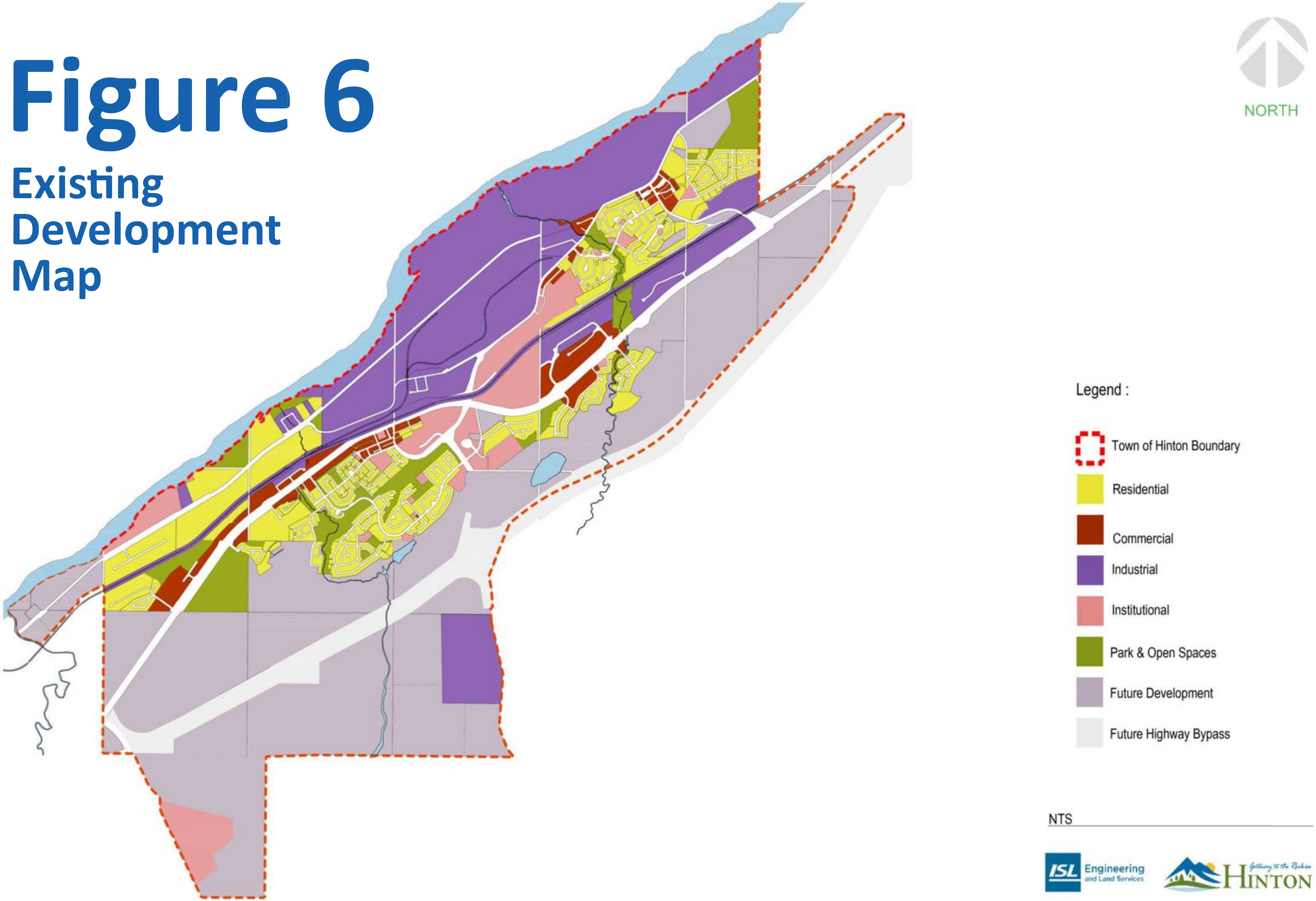
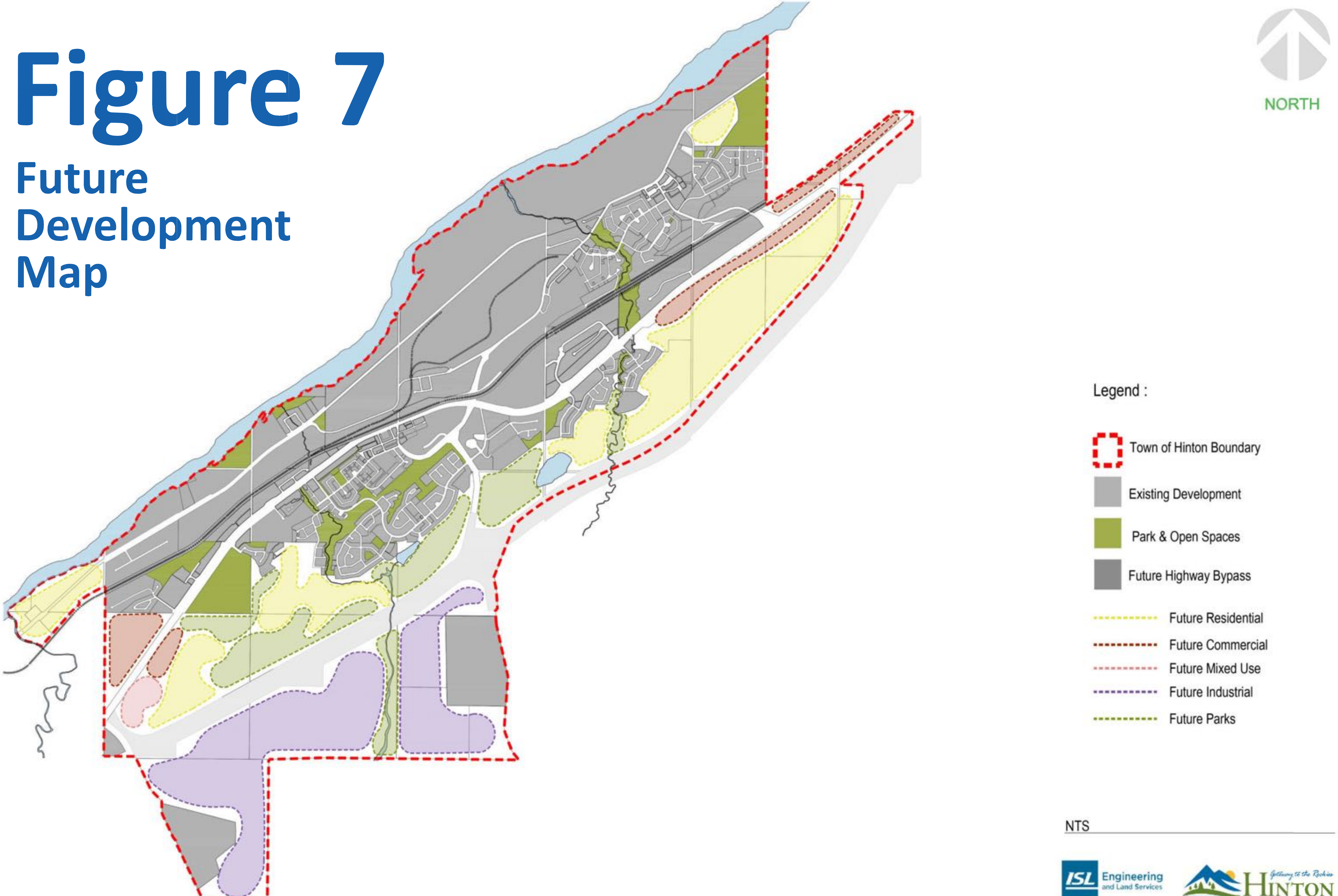


Figure 7
Future Development Map



Appendix D.5 Snow Melting Calculations

ASHRAE Handbook - HVAC Applications 51.1 Calculations

Input Data

Snowfall rate water equivalent, s (in/h)	0.07
Ambient temperature during snowfall, t_a (°F)	14
Ambient temperature during snowfall, T_a (°R)	473.67
Snow free area ratio, Ar	0.5
Characterisitc slab length, L (ft)	20
Design wind speed, V (mph)	15
Relative humidity of air at elevation for which typical weather measurments are made, ϕ	0.8
Fraction of radiation exchange that occurs between slab and clouds, Fsc	0.5

Constants

Specific heat of ice, Cp,ice (Btu/lb °F)	0.490
Specific heat of water, Cp,water (Btu/lb °F)	1.008
Melting temperature, Ts (°F)	32.000
Liquid film temperature, Tf (°F)	33.000
Density of water, pwater (lb/ft^3)	62.420
Heat of fusion of snow, hif (Btu/lb)	144.000
Thermal conductivity of air at ta, kair (Btu*ft/h*ft^2*°F)	0.014
Prandtl number, Pr	0.700
Kinematic viscosity of air, vair (ft^2/h)	0.000
Stefan-Boltzmann constant, σ (Btu/h*ft^2*°R^4)	0.000
Emittance of surface, ε	0.930
Density of dry air, pdryair (lb/ft^3)	0.084
Specific heat of air (Btu/lb*°F)	0.240
Atmospheric pressure, p (psi)	14.368
Dew point temperature, Tdp (°F)	32.000
Heat of vaporization of water, hfg (Btu/lb)	970.400

ASHRAE Handbook - HVAC Applications 51.1 Calculations

Calculated values

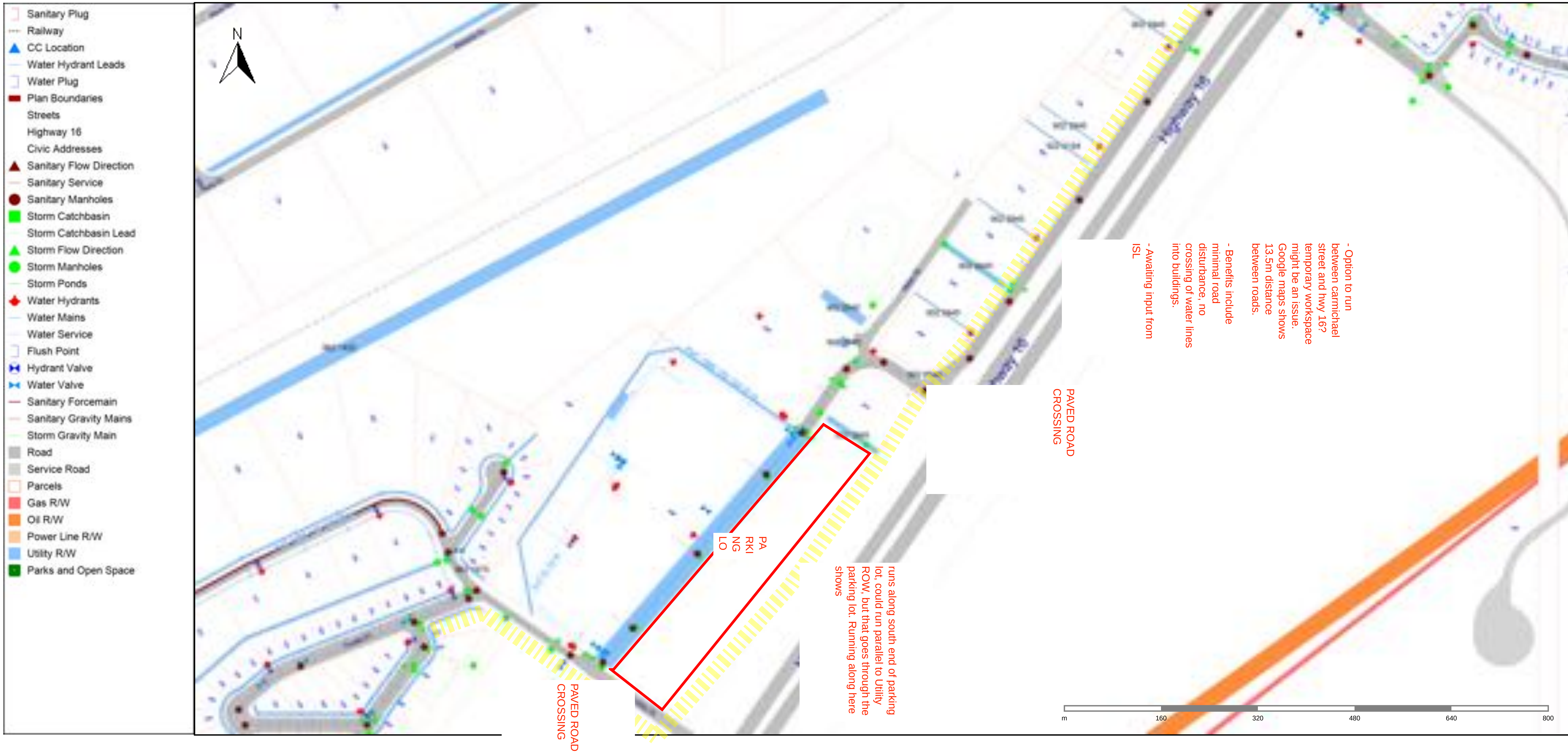
Reynolds number based on L, Rel	1.16E+08
Convection heat transfer for turbulent flow, hc (Btu/h ft^2 °F)	6.34E+01
Mean radiant temperature during snowfall, Tmr (°R)	4.74E+02
Fraction of radiation, Fsc	5.00E-01
Temperature of clouds, Tcloud (°R)	4.39E+02
Temperature of clear sky, Tskyclear (°R)	4.32E+02
Mean radiant temperature after snowfall, Tmr (°R)	4.35E+02
Mass transfer coefficient, hm (ft/h)	3.50E+03
Humidity ratio of ambient air, Wa (lbvapour/lbair)	3.85E-03
Humidity ratio of saturated air at film surface temperature, Wf (lbvapour/lbair)	4.02E-03
Saturation pressure of water vapor at dew point, psa (psi)	8.85E-02
Saturation pressure of water vapor at film temperature, psf (psi)	9.23E-02

Outputs

Sensible Heat Flux, qs (Btu/h ft^2)	3.58
Melting Heat Flux, qm (Btu/h ft^2)	52.43
Convective and Radiative Heat Flux from a Snow-Free Surface during snowfall, qh (Btu/h*ft^2)	27.49
Convective and Radiative Heat Flux from a Snow-Free Surface after snowfall, qh (Btu/h*ft^2)	214.80
Evaporation Heat Flux, qe (Btu/h*ft^2)	46.87

Heat Flux required at snow-melting surface during snowfall, qo (Btu/h*ft^2)	93.19
Heat Flux required at snow-melting surface after snowfall, qo (Btu/h*ft^2)	186.85
Heat Flux required at snow-melting surface after snowfall, qo (kW/m^2)	0.59

Appendix D.6 Distribution Network Construction Proposal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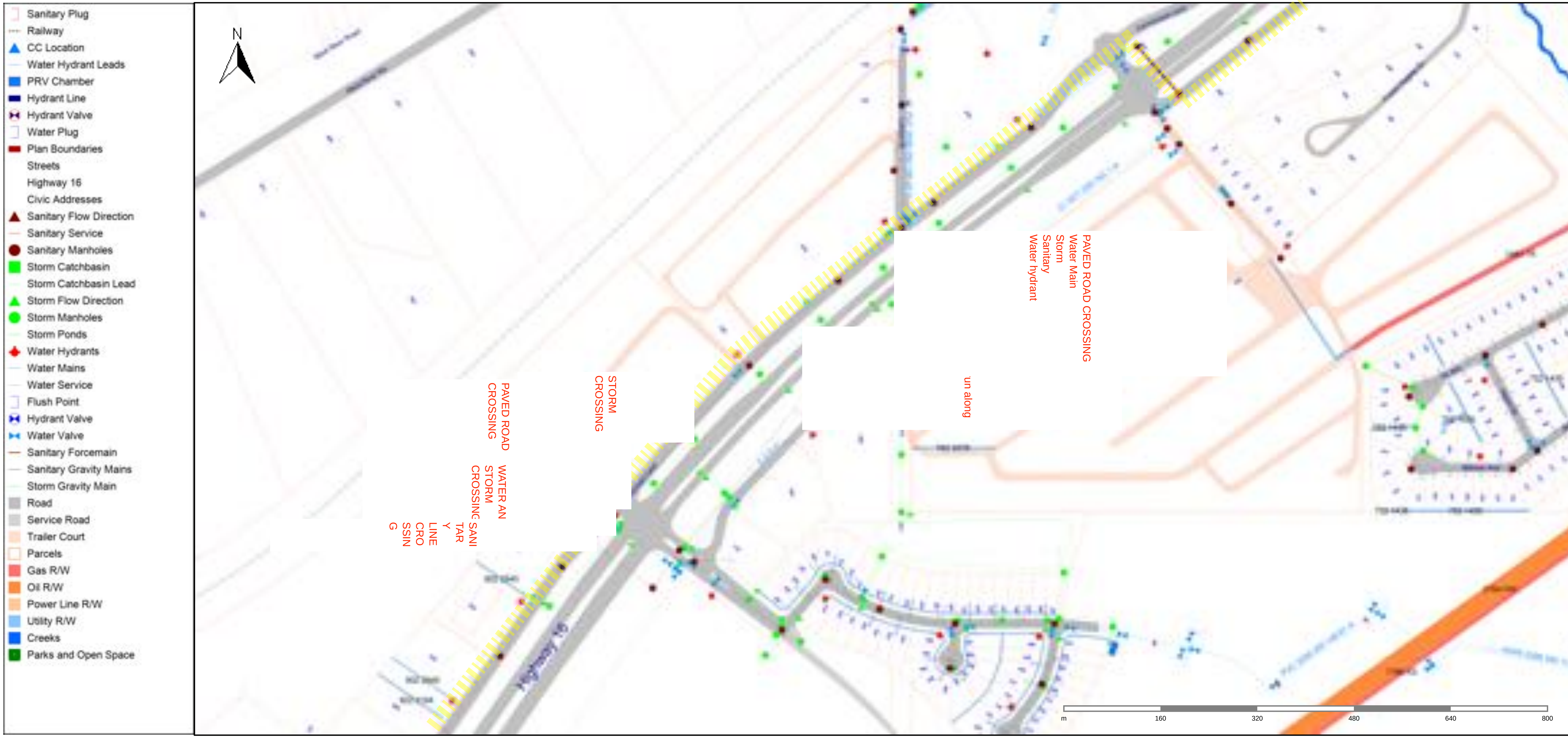
Railway
CC Location
Water Hydrant Leads
Water Plug
Plan Boundaries
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Storm Ponds
Water Hydrants
Water Mains
Water Service
Flush Point
Hydrant Valve
Water Valve
Sanitary Forcemain
Sanitary Gravity Mains
Storm Gravity Main
Road
Service Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Parks and Open Space
N
- Option to run between carmichael street and hwy 16? temporary workspace might be an issue. Google maps shows 13.5m distance between roads.
- Benefits include minimal road disturbance, no crossing of water lines into buildings.
- Awaiting input from ISL
PAVED ROAD CROSSING
PA RKI NG LO
runs along south end of parking lot, could run parallel to Utility ROW, but that goes through the parking lot. Running along here shows
PAVED ROAD CROSSING
m 160 320 480 640 800


Sanitary Plug
Railway
CC Location
Water Hydrant Leads
PRV Chamber
Hydrant Line
Hydrant Valve
Water Plug
Plan Boundaries
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Storm Ponds
Water Hydrants
Water Mains
Water Service
Flush Point
Hydrant Valve
Water Valve
Sanitary Forcemain
Sanitary Gravity Mains
Storm Gravity Main
Road
Service Road
Trailer Court
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Creeks
Parks and Open Space
N
PAVED ROAD CROSSING
Water Main
Storm
Sanitary
Water hydrant
un along
STORM CROSSING
PAVED ROAD CROSSING
WATER AN STORM CROSSING SANI TAR Y LINE CRO SSIN G
Highway 16
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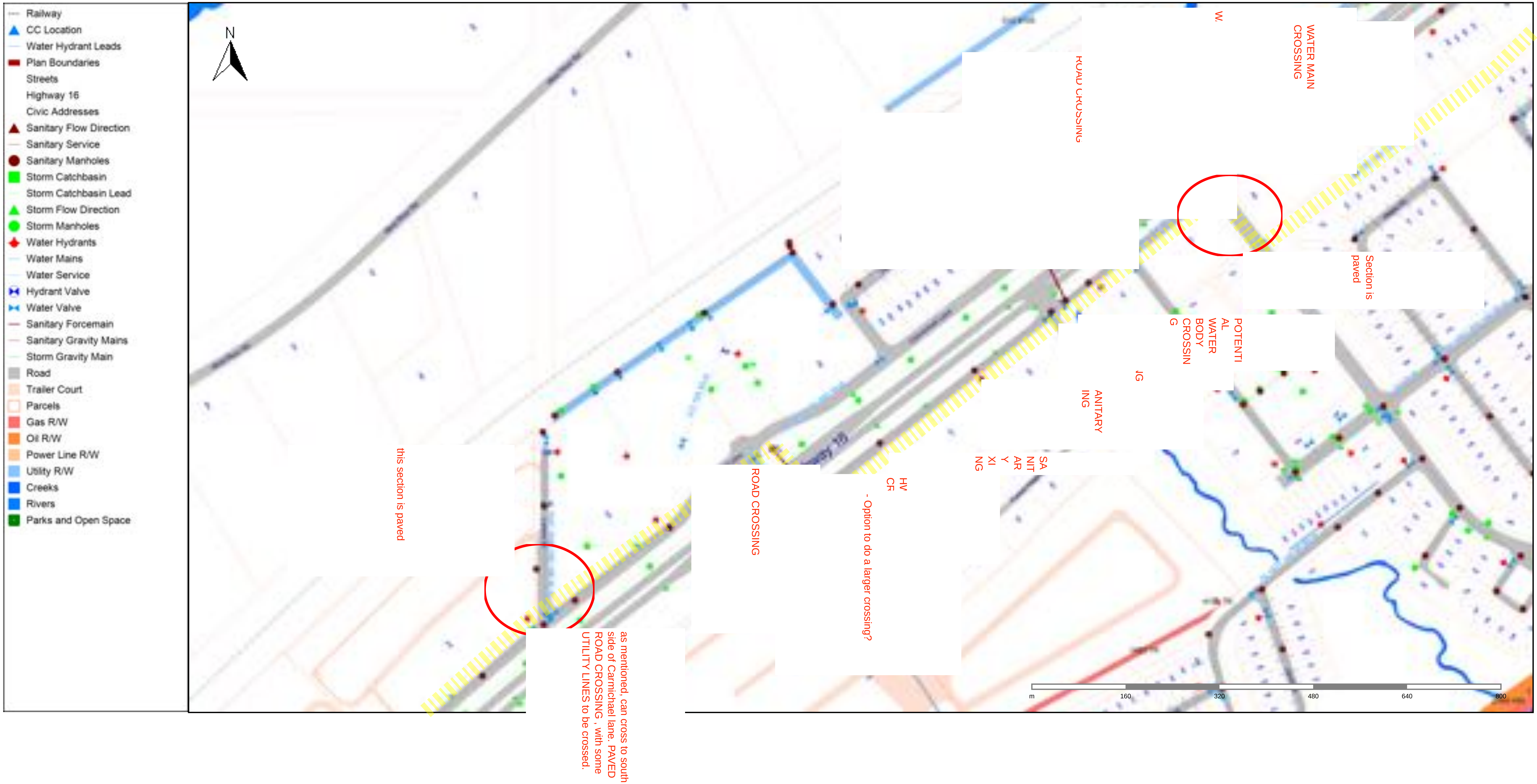
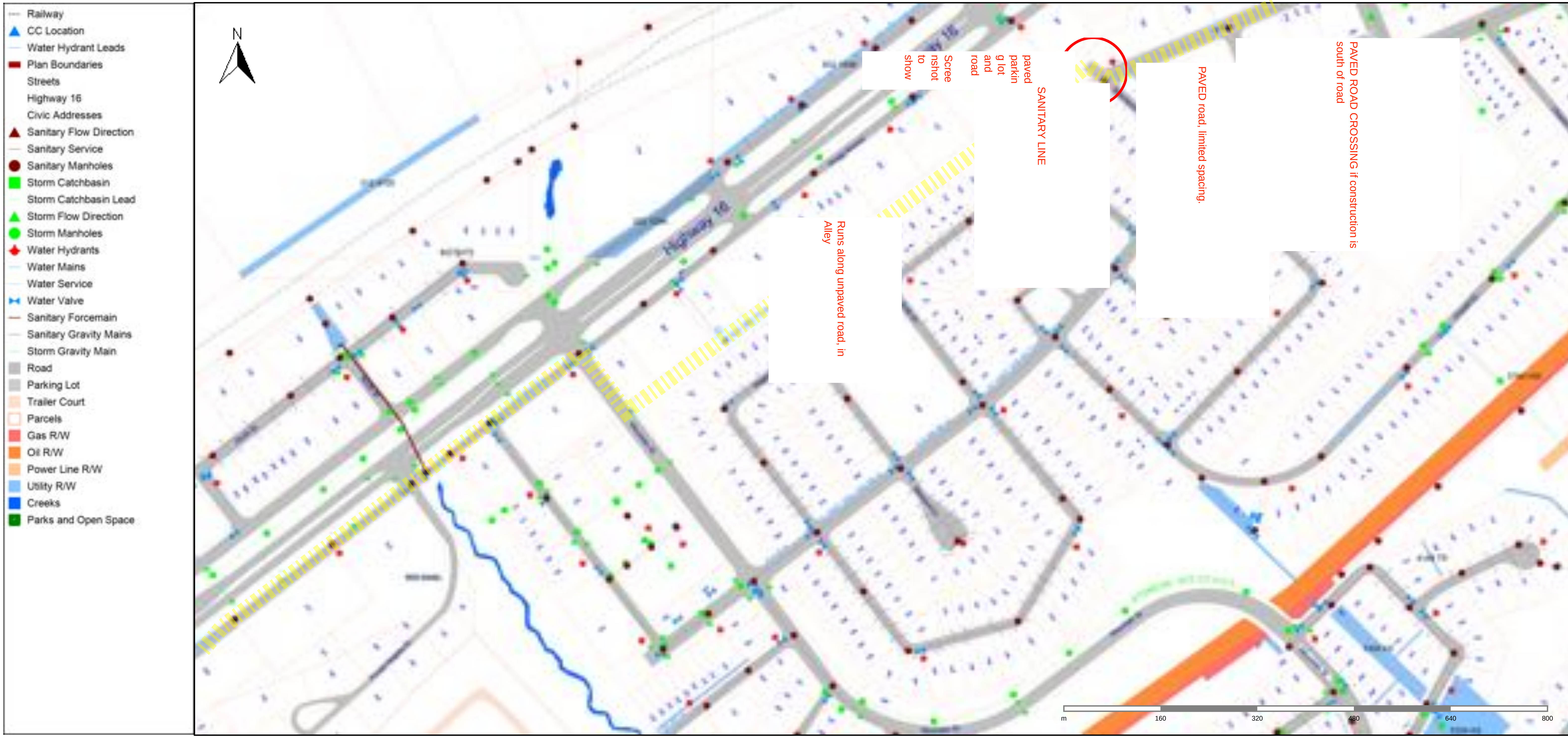
160
320
480
640
800


Railway
CC Location
Water Hydrant Leads
Plan Boundaries
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Hydrant Valve
Water Valve
Sanitary Forcemain
Sanitary Gravity Mains
Storm Gravity Main
Road
Trailer Court
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Creeks
Rivers
Parks and Open Space
N
WATER MAIN CROSSING
ROAD CROSSING
Section is paved
POTENTIAL WATER BODY CROSSING
SANITARY CROSSING
this section is paved
ROAD CROSSING
- Option to do a larger crossing?
as mentioned, can cross to south side of Carmichael lane. PAVED ROAD CROSSING , with some UTILITY LINES to be crossed.
m
160
320
480
640
800


Railway
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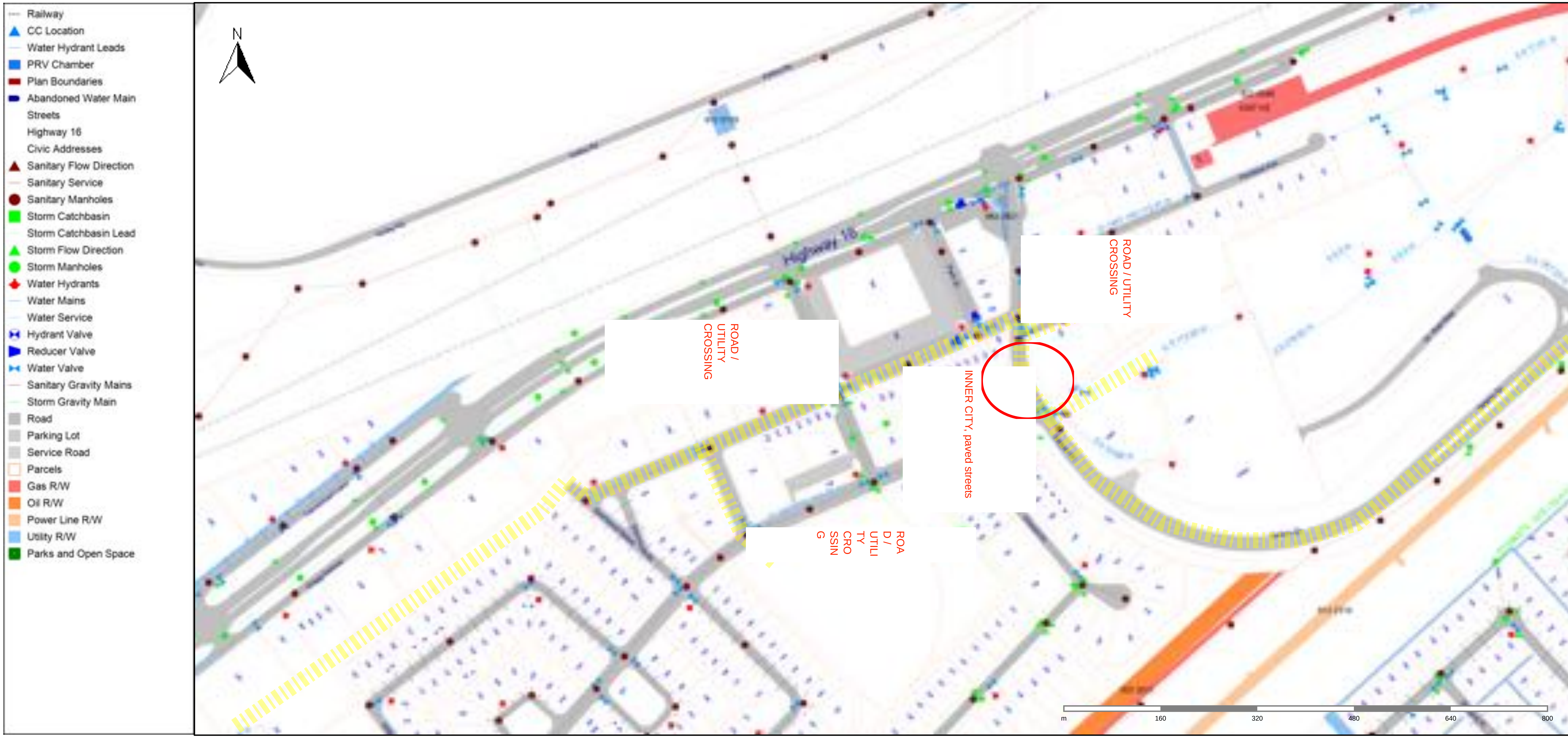
Water Hydrant Leads
Plan Boundaries
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Water Valve
Sanitary Forcemain
Sanitary Gravity Mains
Storm Gravity Main
Road
Parking Lot
Trailer Court
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Creeks
Parks and Open Space
N
Highway 16
Screenshot to show paved parking lot and road
SANITARY LINE
PAVED road, limited spacing.
PAVED ROAD CROSSING if construction is south of road
Runs along unpaved road, in Alley
m 160 320 480 640 800



Railway
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Water Hydrant Leads
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Plan Boundaries
Abandoned Water Main
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Hydrant Valve
Reducer Valve
Water Valve
Sanitary Gravity Mains
Storm Gravity Main
Road
Parking Lot
Service Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Parks and Open Space
N
Highway 16
ROAD / UTILITY CROSSING
ROAD / UTILITY CROSSING
INNER CITY, paved streets
ROAD / UTILITY CROSSING
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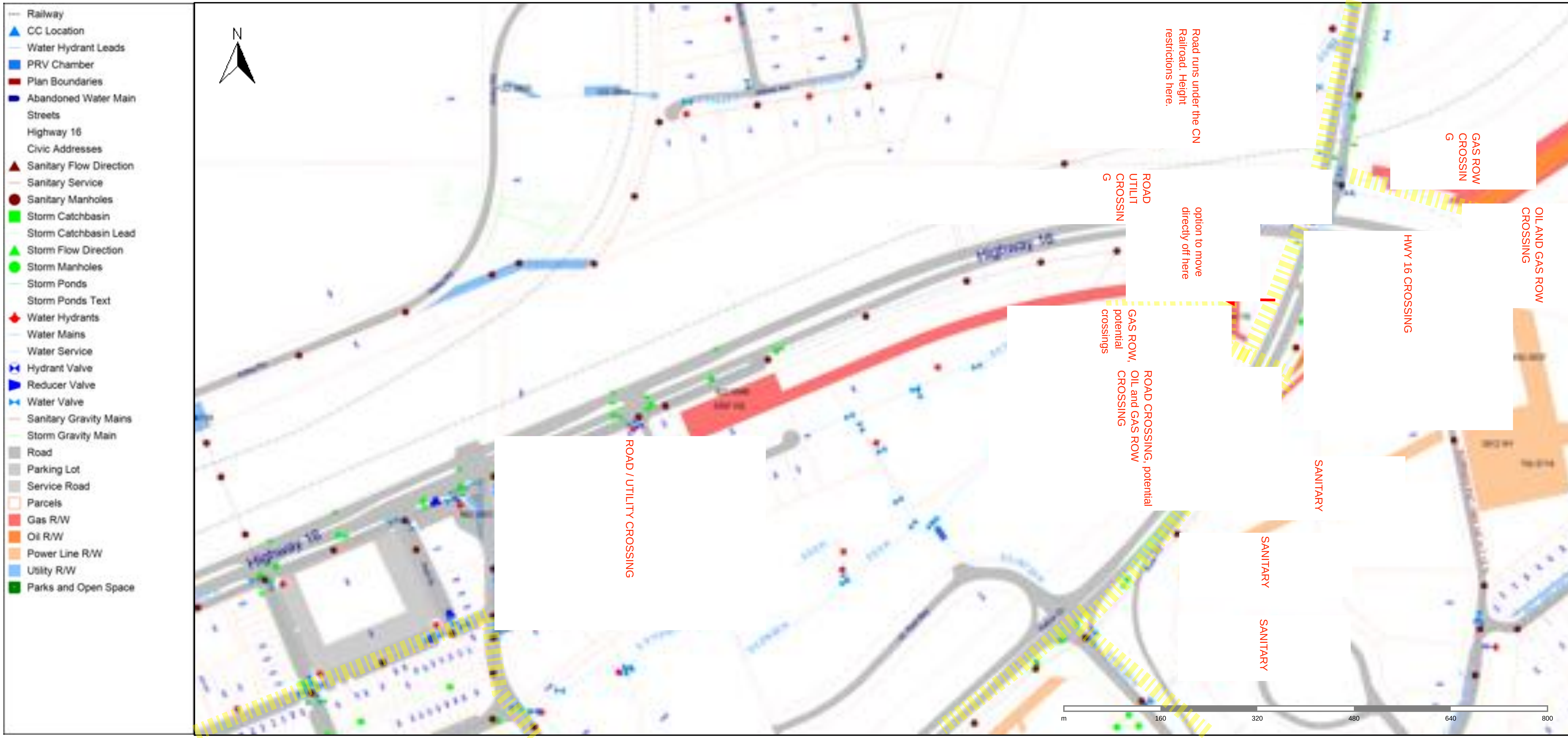
800



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Highway 16
Civic Addresses
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Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Storm Ponds
Storm Ponds Text
Water Hydrants
Water Mains
Water Service
Hydrant Valve
Reducer Valve
Water Valve
Sanitary Gravity Mains
Storm Gravity Main
Road
Parking Lot
Service Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Parks and Open Space
N
Highway 16
Highway 16
Road runs under the CN
Railroad. Height
restrictions here.
GAS ROW
CROSSIN
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ROAD
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CROSSIN
G
option to move
directly off here
OIL AND GAS ROW
CROSSING
HWY 16 CROSSING
GAS ROW,
potential
crossings
ROAD CROSSING, potential
OIL and GAS ROW
CROSSING
ROAD / UTILITY CROSSING
SANITARY
SANITARY
SANITARY
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Railway
CC Location
Water Hydrant Leads
Plan Boundaries
Abandoned Water Main
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Air Release
Hydrant Valve
Reducer Valve
Water Valve
Sanitary Gravity Mains
Storm Gravity Main
Road
Parking Lot
Service Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Parks and Open Space
N
UTILITY CROSSING
FRIENDSHIP CENTER, PROPOSED DEC LOCATION
ROAD CROSSING, OR MOVE AROUND THIS EXIT RAMP
ROAD/ UTILITY CROSSING
Highway 16
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320
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800


Railway
CC Location
Water Hydrant Leads
Plan Boundaries
Streets
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Hydrant Valve
Water Valve
Sanitary Gravity Mains
Storm Gravity Main
Road
Parking Lot
Service Road
Parcels
Environmental Reserve
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Parks and Open Space
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SANITARY. WATER. STORM CROSSING
ROAD CROSSING
GAS ROW CROSSING. ROAD CROSSING
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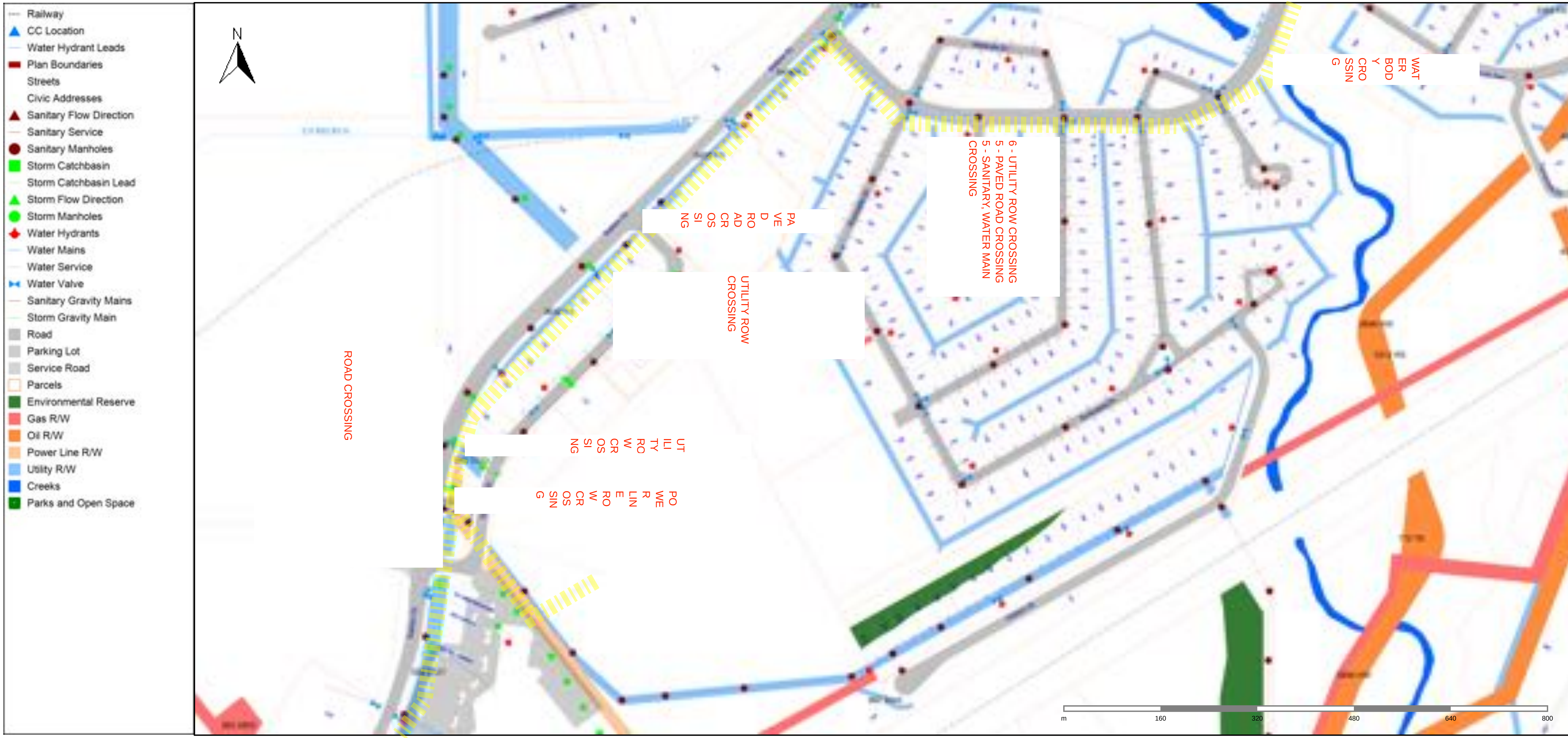
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Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Water Valve
Sanitary Gravity Mains
Storm Gravity Main
Road
Parking Lot
Service Road
Parcels
Environmental Reserve
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Creeks
Parks and Open Space
N
PAVED ROAD CROSSING
UTILITY ROW CROSSING
6 - UTILITY ROW CROSSING
5 - PAVED ROAD CROSSING
5 - SANITARY, WATER MAIN CROSSING
WATER BODY CROSSING
ROAD CROSSING
UTILITY ROW CROSSING
POWER LINE ROW CROSSING
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Railway
CC Location
Water Hydrant Leads
Hydrant Line
Water Service Line
Hydrant Valve
Water Plug
Water Valve
Plan Boundaries
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
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Storm Ponds Text
Water Hydrants
Water Mains
Water Service
Hydrant Valve
Reducer Valve
Water Valve
Sanitary Forcemain
Sanitary Gravity Mains
Storm Gravity Main
Road
Service Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Creeks
Parks and Open Space
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WATER BODY CROSSING
ROAD / UTILITY CROSSING
GAS ROW CROSS
ROAD CROSSING
UTILITY AND SANITARY CROSSING
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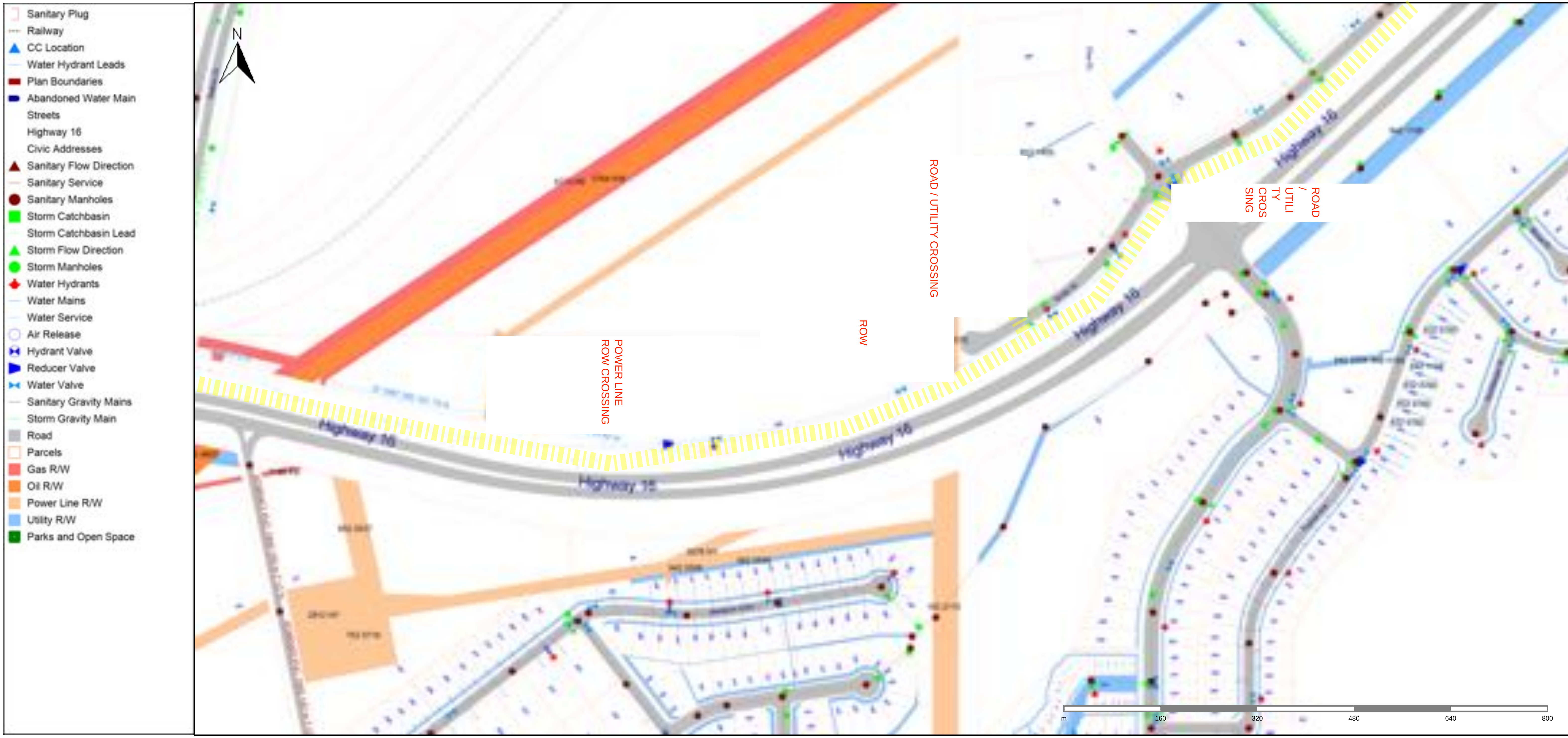
Sanitary Plug
Railway
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Water Hydrant Leads
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Streets
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Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Air Release
Hydrant Valve
Reducer Valve
Water Valve
Sanitary Gravity Mains
Storm Gravity Main
Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Parks and Open Space
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POWER LINE ROW CROSSING
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ROAD / UTILITY CROSSING
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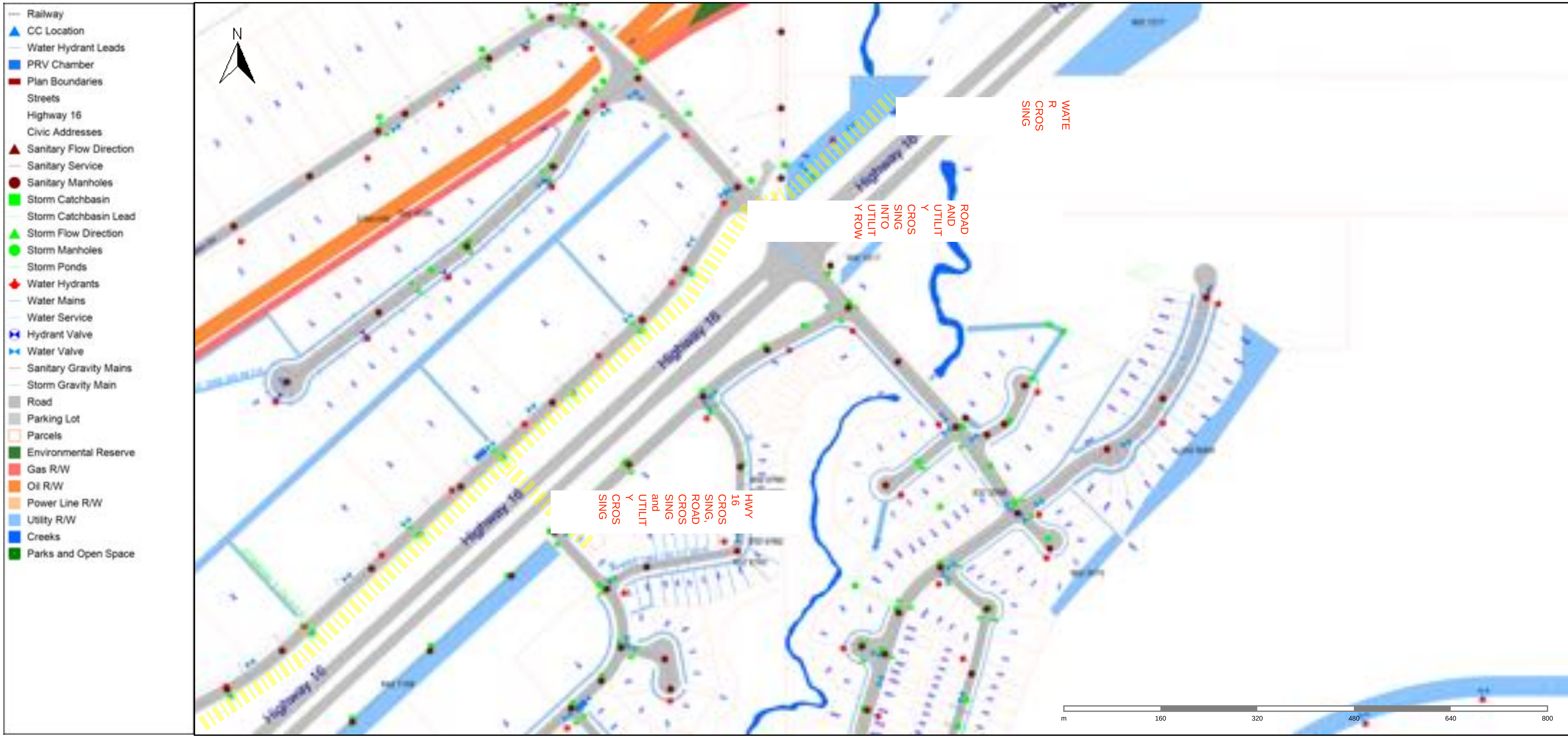


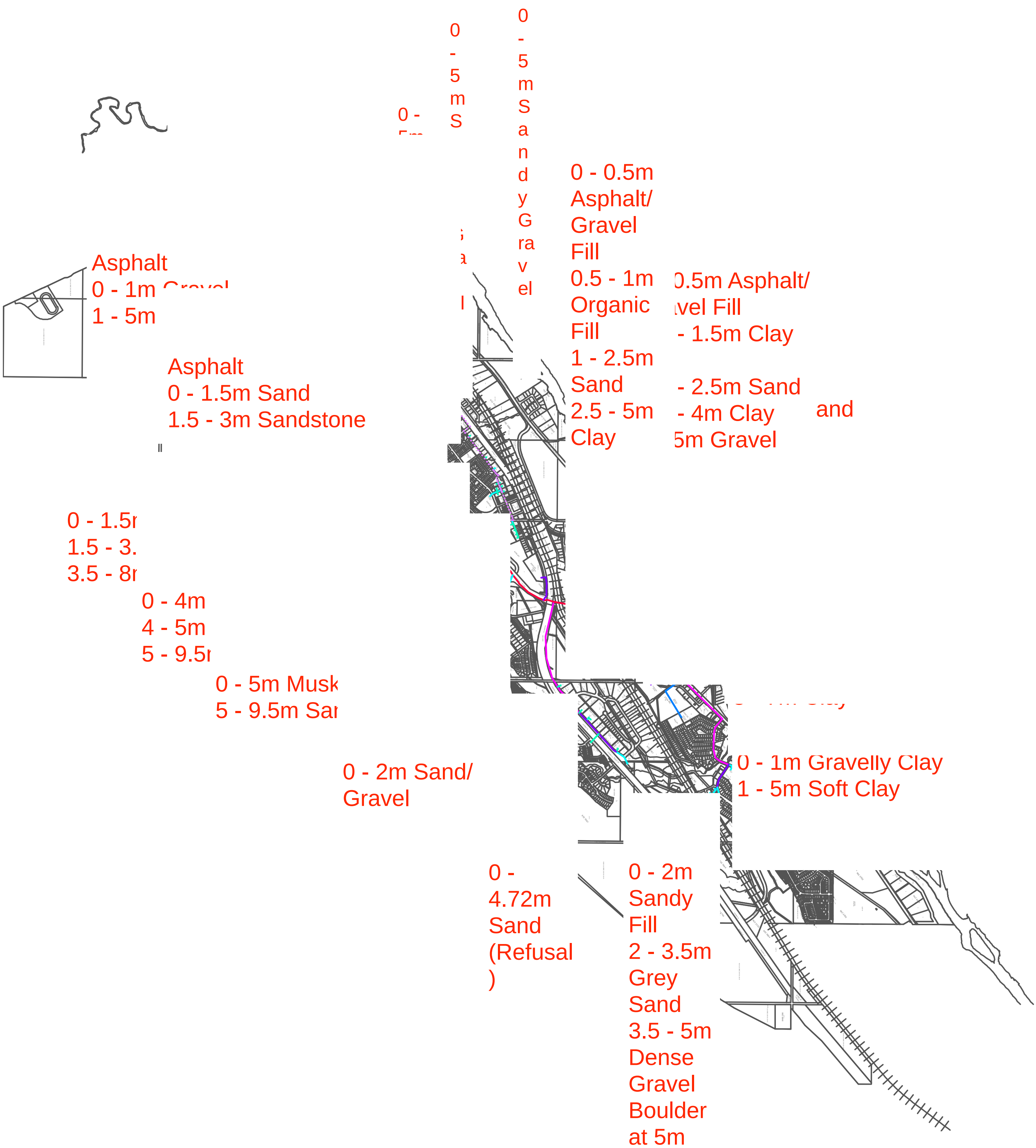
Railway
CC Location
Water Hydrant Leads
PRV Chamber
Plan Boundaries
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Storm Ponds
Water Hydrants
Water Mains
Water Service
Hydrant Valve
Water Valve
Sanitary Gravity Mains
Storm Gravity Main
Road
Parking Lot
Parcels
Environmental Reserve
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Creeks
Parks and Open Space
N
WATER CROSSING
ROAD AND UTILITY CROSSING INTO UTILITY ROW
HWY 16 CROSSING, ROAD CROSSING and UTILITY CROSSING
Highway 16
Highway 16
Highway 16
Highway 16
m
160
320
480
640
800

CC Location
Water Hydrant Leads
PRV Chamber
Water Plug
Plan Boundaries
Streets
Highway 16
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Hydrant Valve
Reducer Valve
Water Valve
Sanitary Gravity Mains
Storm Gravity Main
Road
Parking Lot
Service Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Parks and Open Space
N
ROAD, UTILITY, ROW CROSSING
ROAD, UTILITY CROSSING
ROAD, UTILITY CROSSING
ROAD, UTILITY CROSSING
SANITARY, ROAD CROSSING
160
320
480
640
800


CC Location
Water Hydrant Leads
Plan Boundaries
Streets
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Reducer Valve
Water Valve
Sanitary Forcemain
Sanitary Gravity Mains
Storm Gravity Main
Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Lakes
Parks and Open Space
N
Note: if it matters, sanitary lines run along south of this road, but there less road crossings.
SING
ROAD / UTILITY
ROAD / UTILITY CROSSING
ROAD / UTILITY CROSSING
ROAD / UTILITY CROSSING
UTILITY CROSSING
ROAD / UTILITY CROSSING
ROAD / UTILITY CROSSING
Proximity to maxwell lake ~200 m
m
160
320
480
640
800


CC Location
Water Hydrant Leads
Hydrant Line
Hydrant Valve
Water Plug
Plan Boundaries
Streets
Civic Addresses
Sanitary Flow Direction
Sanitary Service
Sanitary Manholes
Storm Catchbasin
Storm Catchbasin Lead
Storm Flow Direction
Storm Manholes
Water Hydrants
Water Mains
Water Service
Air Release
Flush Point
Hydrant Valve
Reducer Valve
Water Valve
Sanitary Forcemain
Sanitary Gravity Mains
Storm Gravity Main
Road
Parcels
Gas R/W
Oil R/W
Power Line R/W
Utility R/W
Creeks
Lakes
Parks and Open Space
N
alternative route through the school field
Runs along multiple water main lines to residential areas.
ROAD / UTILITY CROSSING
m
160
320
480
640
800

Appendix D.7 Geotechnical Summary Using Previous Reports



0 - 5m Sandy Gravel
0 - 5m S
0 - 0.5m Asphalt/ Gravel Fill
0.5 - 1m Organic Fill
1 - 2.5m Sand
2.5 - 5m Clay
0.5m Asphalt/
vel Fill
- 1.5m Clay
- 2.5m Sand
- 4m Clay
5m Gravel
and
Asphalt
0 - 1m Gravel
1 - 5m
Asphalt
0 - 1.5m Sand
1.5 - 3m Sandstone
0 - 1.5r
1.5 - 3.
3.5 - 8r
0 - 4m
4 - 5m
5 - 9.5r
0 - 5m Musk
5 - 9.5m Sar
0 - 2m Sand/ Gravel
0 - 1m Gravelly Clay
1 - 5m Soft Clay
0 - 4.72m Sand (Refusal)
0 - 2m Sandy Fill
2 - 3.5m Grey Sand
3.5 - 5m Dense Gravel Boulder at 5m

Appendix D.8 Summarized Construction Execution Plan

Dunwald & Fleming
ENTERPRISES LTD
PIPELINE AND UTILITY CONSTRUCTION
EST 1978

Hinton DES Installation

CONSTRUCTION EXECUTION PLAN AND SCHEDULE

Rev No.	Prepared by/ Date	Reviewed by/ Date	Approved by/ Date	Pages Revised	Remarks
A	Kevin Ainsworth 07/09/18	Matt Maclellan 07/10/18	Marvin Dunwald 07/10/18		Issued for Use
B	Kevin Ainsworth 08/01/18	Marvin Dunwald 08/03/18	Marvin Dunwald 08/03/18		Issued for Use

Table of Contents

Rev No.	Prepared by/ Date	Reviewed by/ Date	Approved by/ Date	Pages Revised	Remarks
A	Kevin Ainsworth 07/09/18	Matt Maclellan 07/10/18	Marvin Dunwald 07/10/18		Issued for Use
B	Kevin Ainsworth 08/01/18	Marvin Dunwald 08/03/18	Marvin Dunwald 08/03/18		Issued for Use

1.0 PURPOSE

The purpose of this document is to outline the estimated schedule and execution plan that Dunwald and Fleming Enterprises Ltd. would utilize to complete the construction of the Hinton DES scope of work. This document is intended to reflect the overarching execution strategy taking into consideration the status of the FEED stage of engineering and provide a general summary of the methodologies planned for completion of the work.

2.0 ORGANIZATION

2.1 Project Management Team

It is recognized that utility construction does have inherent hazards. A key objective of the Project Management Team is to maintain a culture of safety and mitigate those hazards to ensure a safe and efficient workplace. The establishment of HSE policies and procedures and the communication and adherence to those policies STOPS injuries from occurring. This mandate is embedded within each member of our team.

All projects completed by Dunwald and Fleming Enterprises Ltd. follow a clear set of organizational reporting and responsibility lines. The Hinton DES scope will be managed by a single project Superintendent. He is responsible for coordinating all activities and information related to the project. In addition, he is responsible for ensuring all activities are executed in full compliance with HSE and quality standards, contract terms and within the agreed upon schedule.

The Superintendent is supported by a team including safety, quality control, office administration and the multiple crew foreman who may be assigned to the project.

2.2 Facilities and Infrastructure

Dunwald and Fleming Enterprises Ltd. head office and yard location is based in North East Calgary. Mobilization will take place from this location. Administration functions and general project oversight will take place from that location.

Field office trailers will be maintained at site. It is expected that Dunwald and Fleming would rent existing public or private lands within proximity to the site for equipment storage and setup of field office.

3.0 GENERIC CONSTRUCTION METHODOLOGY

3.1 Open Cut Trench

Depth is a primary driver to cost on any open cut work being completed. Deeper depth results in increased cost. Trench that reaches sufficient depth is required to be stepped or V to ensure sluffing does not pose risk to workers or other individuals.

Shallow ditch less than 1.0 meter will generally be above gas lines, deep infrastructure and all other utilities except for communications. This will limit number of crossings and allow for greater productivity.

Ditch from 1.0 to 2.0 meters will be under communications, gas lines and interfere with electrical but still remain above deep utilities.

Ditch deeper than 2.0 meters will likely interfere with all municipal utilities and will result in the highest cost for completion.

In addition to interference with other utilities, ground and soil conditions will create differing cost profiles depending on those conditions encountered. While we understand very well those conditions in various locations around the city of Calgary, Hinton is different, and conversation related to ground conditions with the town foreman is likely one of the most important pieces of information that can be obtained to understand the cost associated with the terrain in the area.

Dunwald and Fleming conducted a site visit on July 5th and 6th to review the scope of work and meet with representatives from the Town of Hinton. During this meeting, several important pieces of information related to ground conditions were observed:

- Hinton is comprised of rocky material near the surface. During installation of other shallow utilities by HDD, boulders prevented completion of those HDD's
- Anecdotally, Hinton didn't seem to provide line assignments for utilities in the same way that other municipalities would provide line assignments. The result was noticeable when reviewing the infrastructure that may interfere with the installation of the DES. There appeared to be locations with utilities in street and along each side of the boulevard through the residential areas.

Occupational Health and Safety requires the following trench profile for any open excavation:

> If the walls of an excavation are cut back, an employer must ensure that
>
> (a) if the soil is classified as "hard and compact soil", the walls are sloped to within 1.5 metres of the bottom of the excavation at an angle of not less than 30 degrees measured from the vertical,
>
> (b) if the soil is classified as "likely to crack or crumble soil" the walls are sloped to within 1.5 metres of the bottom of the excavation at an angle of not less than 45 degrees measured from the vertical, and
>
> (c) if the soil is classified as "soft, sandy or loose soil" the walls are sloped from the bottom of the excavation at an angle of not less than 45 degrees measured from the vertical.

Based on the likely soil type, Dunwald and Fleming believes that "b" would likely be applicable in the Town of Hinton, but would assess as work is completed.

3.2 Utility Crossings

Implications are different on utilities that are crossed under or over. Utilities which we cross under will require Hydrovac excavation, may potentially require shoring or support to stabilize the other infrastructure and may result in a tie-in within the ditch requiring a bell hole to complete. Utilities which we cross over top will require Hydrovac excavation, may require us to expose their lines but will not generate a separate tie-in or bell hole.

Estimates are based on normal ground disturbance policies in Alberta. Until such time as crossing agreements are received, it may be difficult to estimate the cost of restrictions applied by third parties for crossing their infrastructure.

Some infrastructure will impact the construction regardless of whether we cross or not. This includes infrastructure within close enough proximity where ground disturbance policies require us to hand excavate or hydrovac if we parallel that utility. High pressure lines require any excavation within 5 meters to be hand excavated or hydrovac. Other utilities generally require hydrovac within 1 meter unless crossing agreements dictate additional restrictions. Depending on the crossing agreement, daylighting of other infrastructure every 5-10 meters may be allowable.

We did not see significant numbers of high pressure utilities or those utilities included within their own right of way which may have specific restrictions requiring hydrovac trench or bell holes. Individual utility crossings would require hydrovac excavation when crossing to daylight those lines, however, this is included in the pricing for utility crossings.

3.3 Services

Runs for services should be not completed after installation of the mains. Typically, this causes disruption on landowners and stakeholders, may increase business interruption payouts and requires the contractor to re-excavate bell holes for tie-in on the services. This will increase the cost of installation of the services. Typical execution includes a subset of the main crew working towards installation of the services from the mainline to the appropriate location. This will allow for completion of work in a specific area with minimum interference to stakeholders. We have priced the unit rate line items to include only the cap and tie-off points for the services without inclusion of the length of line installed. Installation of the service lines are included in the general unit rates for pipe installation.

The scope of work for services should be defined within this initial phase of construction to determine the level of effort required for each. For purposes of this estimate, it is assumed that lines would be run from the main to edge of building with no additional work other stubs at the end of each service. Additional work to tie in would not be completed in this phase or scope. This may allow for all services to be estimated on a per meter unit price basis without a base amount per service.

3.4 Certain Ancillary Charges

There are certain requirements that could cause incremental cost which are significant to the overall estimate. We have attempted to outline many of these considerations for your FEED phase, but providing certainty on cost cannot be achieved without known assumptions.

3.4.1 Fillcrete

Calgary and Edmonton road building standards prefer the use fillcrete after open excavation within city streets. Fillcrete limits issues with compaction in the roadway and the rework experienced in the City of Calgary and Edmonton. It is assumed that fillcrete will not be used on this project. Pricing for fillcrete is highly dependent on the location of the plant which it is delivered and overall travel times.

Based on minimum design standards from the Town of Hinton soil compaction tests were required within the municipality. It is recommended that all work within the streets require soil compaction tests to be completed as part of the quality program to ensure that road bases are restored to Town standards and limit future issues that may arise as a result.

3.4.2 Traffic and Access Control

Based on the site visit, there are a number of roadways with reasonable levels of traffic. Most roadways are build with large shoulders and sufficient room that access and traffic control should not be an issue on this project.

3.4.3 Clearing and Grubbing on Geothermal Supply Pipeline

Majority of work is to be completed within Hinton with limited clearing or grubbing required except in a number of specific areas. At this time, it is unclear what the line assignment may look like from the supply well and as a result an estimate of the clearing required has been included, but may differ depending on specific conditions for this line. Environmental sweeps and migratory bird windows may require this activity to be completed in advance of general construction to ensure no limitations are placed on the execution of the work.

3.4.4 HDD and water course crossings

Costs associated with HDD or various classes of watercourse crossings have not been estimated. Based on ground conditions it is assumed that all work is to be completed by conventional open cut. If drilling is required due to certain water course crossings, additional premium may be required due to ground conditions previously discussed that could be encountered.

4.0 SCOPE OF WORK

4.1 1.0 – SPP 2 x 200mm/560mm

This installation runs from the east side of the intersection between Kelley Road and Switzer Drive. Switzer Drive includes wide boulevards and good access for the majority of 1.0. Elevation changes are not significant and a good line assignment in this area would limit any constructability issues.

As the route progresses to the west end of Switzer Drive, the boulevards become narrow and it is likely that the route would be pushed into the roadway. This begins the construction in the area of the project with the highest expected level of congestion and traffic control requirements as the line turns down Pembina Avenue. Traffic control plans and

4.2 1.1 – SPP 2 x 150mm/450mm and 1.2 – PEXR 4 single lines x 160mm/225mm

Pembina Avenue may require special measures from the Town of Hinton to minimize impacts on businesses and manage flow of traffic. Workspace provided in this area would ideally be as much room as possible. It is likely that one lane would be provided and access to parking for some businesses would be interrupted for a period of time. Efforts would be made to minimize the duration on the impacted area by either limiting the distance that could be taken for the line installation, ensuring all accesses and egresses remain open during peak hours and sufficient manpower are assigned to this area to efficiently execute the installation. Traffic management plan should limit flow of traffic to one-way and crossings of parking and roadways should take place during off-peak hours.

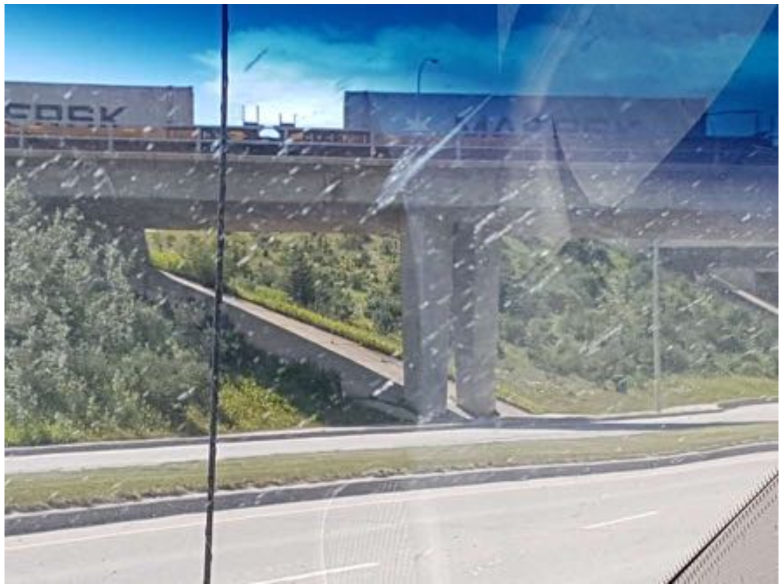
It is assumed that the crossing of highway 16 would be completed by open cut trench and not HDD. If provincial approvals require HDD for the completion of the crossing in this area, additional costs may be incurred. With proper traffic controls, disruption to highway traffic should be minimal considering the crossing takes place near set of traffic lights in the area.

4.3 1.3 – PEXR 160mm/225mm, 1.4 – PPP 2 x 63mm/180mm and 1.5 – PPP 2 x 50mm/180mm

The area along the northside of Highway 16 has wide boulevards and open access. A combination of construction in the boulevard and asphalt may be required in this area due to potential utility line assignment conflicts, however, execution in this area is not problematic and could be efficiently executed. We see no issues with the execution of the work in this area.

4.4 3.0 – PEXR 140mm/202mm, 3.1 – PEXR 110mm/182mm and 3.2 – PEXR 63mm/142mm

It is assumed that the 1.0 will run along the east side of Switzer Dr and 3.0 will move up the hill between the Highway 16 overpass and CN overpass as show in the photo below:



Other than the traffic control required at Switzer Dr and installation up the side slope between the overpasses, installation is fairly straight forward. Some clearing is required between the overpass and the service road beside highway 16, however, these small shrubs are not significant.

Within HP 2.0A clearing between the Environmental Training Centre along highway 16 likely required. Distance from overpass to Environmental Training Centre appears greater than 38 meters. Confirmation should be made of the total distance for this leg.

Open access and wide boulevard for construction should allow this work to progress quickly. Other than traffic mitigations while crossing the asphalt for businesses, there appears to be no restrictions for efficiently executing this work.

It is assumed that the HDD would be drilled from the north side of highway 16 towards the south. This would allow for room on the pullback to setup the pipe string in advance with road closures required only during the brief pullback of the drill.

4.5 4.0 – PEXR 160mm/225mm, 4.1 – 4 x PEXR 110mm/182mm and 4.2 – PPP 4 x 110mm/160mm

The construction along Mountain St. offers some challenges through the residential areas. Through conversations with representatives with the Town of Hinton, the line assignments for other infrastructure in the area appears fragmented. In addition, it is our understanding that the water and sewer mains in this area are likely to be replaced within the next 5 to 10 years. The line assignment given to utilities has filled the areas in the boulevard on each side of the road and center. The picture below provides a clear example of the congestion of infrastructure in the area.

It is likely that that the line assignment will get pushed in to the asphalt along the road. We have completed our pricing as if this were the case. Besides the unknown line assignment, the road is fairly wide, with good access, some garages with frontage to the street and limited traffic at the time we viewed this location.

Four individual lines running in a single trench creates a significant excavation required to maintain the designed separation between the lines. With 200mm from edge of trench and 200mm between each of the four 160mm outside diameter lines, the overall trench width totals 1,640mm and likely would excavated to a total of 2,000 mm or 2 meters. The line assignment should either be entirely within asphalt, or entirely within boulevard. Replacement of curbs and storm drains should be minimized wherever possible to limit cost in this area.

5.0 EXECUTION

5.1 Execution Start and Productivity

Further details and IFC packages will be required to finalize mobilization and execution plans for this scope of work. The intent of this document is to outline the proposed construction methodologies outlining the benefits and weaknesses of those methodologies for further IFC design. We have made certain assumptions on start and end dates for planning purposes, however, schedule constraints may require alteration of these plans.

5.2 Crew Composition

The small diameter PEX vs. large diameter steel or extra wide trench require different sets of equipment for installation. Small diameter pipe and congested areas require 75-100 series excavators and equipment that limits the overall working space and inconvenience on residents. Large diameter pipe or small diameter pipe with multiple lines in a single trench require larger equipment. This would typically include 200 series excavators and small sidebooms for installation.

The typical crew composition for installation of the small diameter PEX will be:

Description	**Quantity**
Foreman	1
Second	1
Fuser/Joiner	3
Operator	3
Saw cutter	1
Labourer	5
Total	14

Many municipalities restrict the number of blocks that can be opened up at any given time. The result is that construction can only take place in a limited area. We have found that traditional pipeline execution with multiple crews dedicated to individual tasks does not work in urban environments due to this constraint. These smaller crews complete the excavation, installation and backfill activities as a single unit.

We generally operate crews with total personnel of 12-14 when working in urban environments. We believe that increasing the size of the crew above this number decreases overall efficiency relative to the additional personnel and equipment added. If schedule is a constraint, it would maintain efficiency to add an additional crew for the installation of the PEX pipe in a different area of the project.

The crew for installation of large diameter pipe would be made up of the following resources:

Description	Quantity
Foreman	1
Second	1
Welder/Fuser	3
Welder's Helper	3
Operator	6
Saw cutter/labourer	2
Labourer	8
Total	24

This crew of 24 would be broken into three sub-categories within the crew

- Front end for grading, hauling, stringing, asphalt cutting
- Mechanical for joining, welding, bending, ditch
- Back end for lower in, sand-padding, backfill and cleanup

The majority of the larger diameter pipe appears to be installation in boulevard. The restriction on the amount of space is less in this instance than installation within streets or asphalt. As a result additional efficiency can be gained by breaking the crew into three sub-categories described above. Once the installation within the boulevard is completed, this single crew would likely split into two individual crews to begin installation in asphalt. The crew make-up would change where welders and welders helpers would be replaced with additional labourers and saw cutters as the need arose.

Stringing and lowering-in pipe on reels requires significantly less effort that larger diameter pipe that requires welding and higher volume of joints. Multiple lines within a trench is not a constraint and cutting of asphalt/trenching, sand-padding and backfill would be main factor driving productivity.

5.3 Schedule

The following schedule constraints likely apply to the project. These constraints would be typical to pipeline projects in Alberta, but confirmation would be required prior to commencement of construction:

Constraint	Start of Constraint	End of Constraint
Migratory Bird Window	March 15	August 15
Species at Risk	To be determined	To be determined
Winter Construction	November 1	March 31
Road Bans*	N/A	N/A
Installation of facility infrastructure	Unknown	Unknown

*Assumed that road bans would not significantly impact cost or schedule. Most equipment would be mobilized to site and is not of sufficient size to trigger road bans. Hauling of materials may be impacted but mitigations to be considered.

This pipeline installation work is ideally suited towards a summer construction season. Winter construction within the Hinton area poses challenges due to proximity to mountains, frost in urban areas and likelihood that snowfall does not melt for the majority of the season. This, combined with the limited space available on the right of way creates problems for removal and clearing of excess snow.

It is assumed that the migratory bird window is the key constraint for clearing activities which would not take place within this window. This would necessitate clearing in winter months as the first activity undertaken to open the right of way for construction. Clearing in winter when timber is frozen is ideal if there is limited salvageable timber. Based on what we viewed, most timber is not salvageable. Based on this information, we see the following schedule applicable for the work:

Activity	Start Date	End Date	Work Days
Clearing	January 15	Feb 28	
Grubbing and Stump Removal	April 1	April 15	
Installation of steel – Crew 2	April 1	June 30	51
Installation of PEX main and service lines – Crew 1	April 1	September 30	151
Installation of PEX main and services lines – Crew 2a and 2b	July 1	September 30	100
Final clean up	Following Season	Following season	

5.4 Productivity

The following key installation quantities drive the overall execution of the project

Activity	Quantity	Work Days	Productivity
Install Steel pipe	4,952	51	97m/day
Install PEX pipe	19,455	151	129m/day

5.5 Pricing

The following installation prices are expected for the project.

Activity	Cost ($000)
0.0	1,822
1.0 – 1.5	5,135
2.0 – 2.3	1,707
3.0 – 3.2	1,095
4.0 – 4.3	2,640
5.0 – 7.0	542
Total	**12,943**

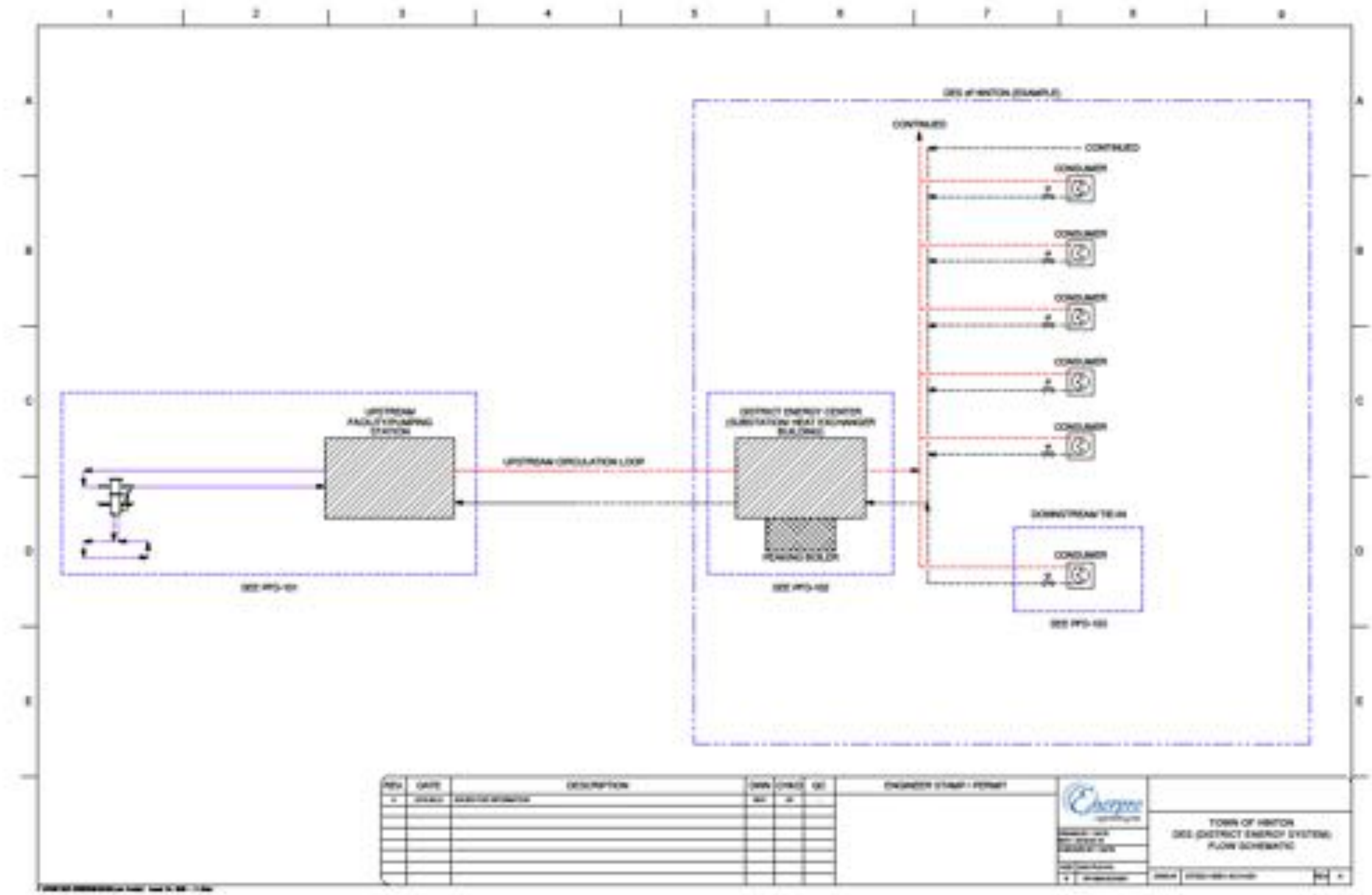
6.0 CONCLUSION

Operating in urban environments is substantially different than traditional pipeline construction. Mainline crews and the assembly line approach works well in open country where space is not limited and stakeholders infrequently travel the area. In urban areas, it is impossible to close down large areas where business operate on a daily basis, traffic is continuous and residents live in close proximity. We have found that over the past 40 years the method of installation we employ limits disruption of the municipality, limits effects of down-time and creates the most efficient execution for our customers.

We would like to thank you for the opportunity to participate in the FEED stage of this project and look forward to maintaining our relationship as the next phase of the project continues.

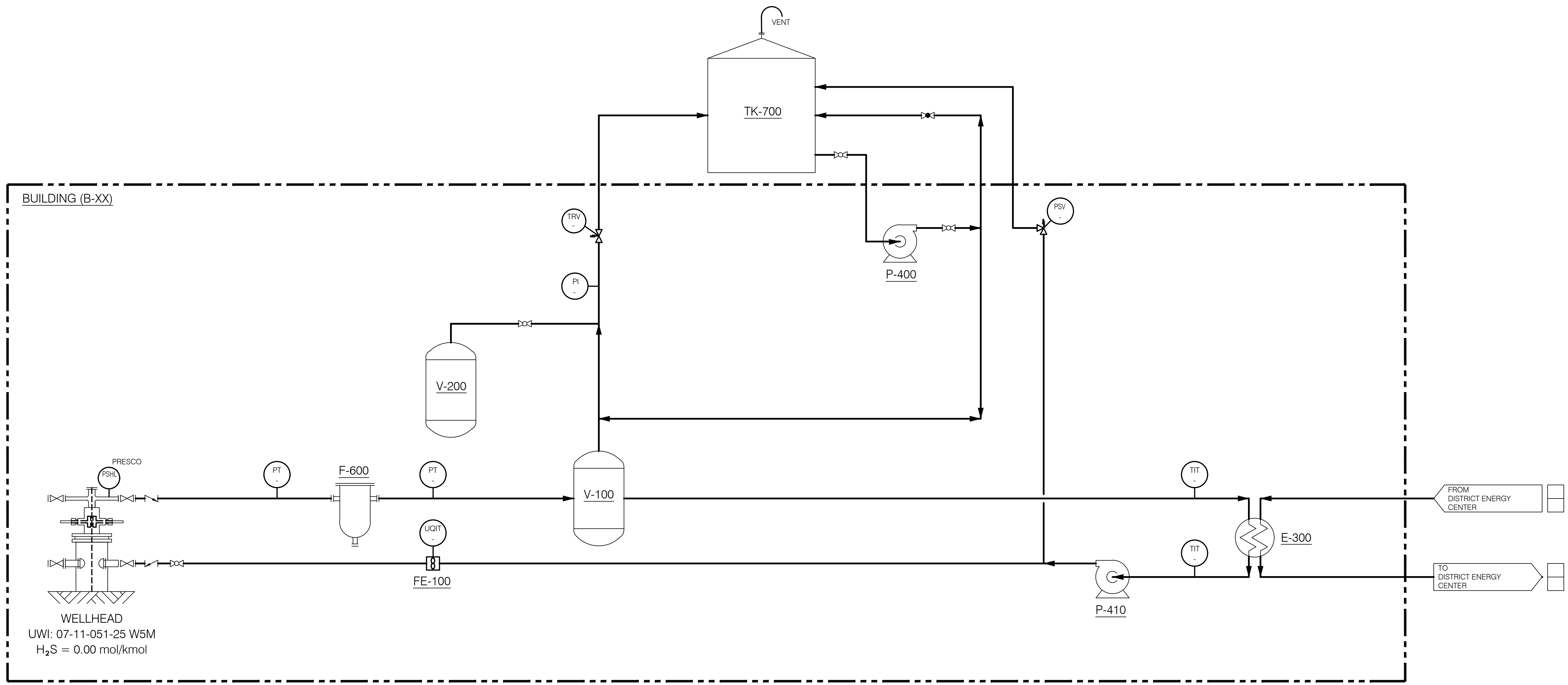
Appendix D.9 Process Flow Diagrams

Appendix D.9.1 Hinton District Energy Centre Schematic (SCH-001)



Appendix D.9.2 Upstream Facility (PFD-101)

F-600 BASKET STRAINER	V-200 EXPANSION TANK	FE-100 HEAT METER	V-100 AIR SEPARATOR	TK-700 RELIEF TANK	P-400 MAKE-UP PUMP	P-410 DOWNHOLE CIRCULATION PUMP	E-300 HEAT EXCHANGER
MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:
MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:



REV.	DATE	DESCRIPTION	DWN	CHKD	QC
A	2018.08.24	ISSUED FOR INFORMATION	MVV	UK	-

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Enerpro Engineering Inc.

DRAWN BY / DATE
MVV / 2018.08.09

CHECKED BY / DATE
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SIZE	CAD FILE NO.
B	EP20218001PFD101

TOWN OF HINTON
UPSTREAM
PUMPING STATION
PROCESS FLOW DIAGRAM

DWG #	EP202-18001-PFD-101	REV	A

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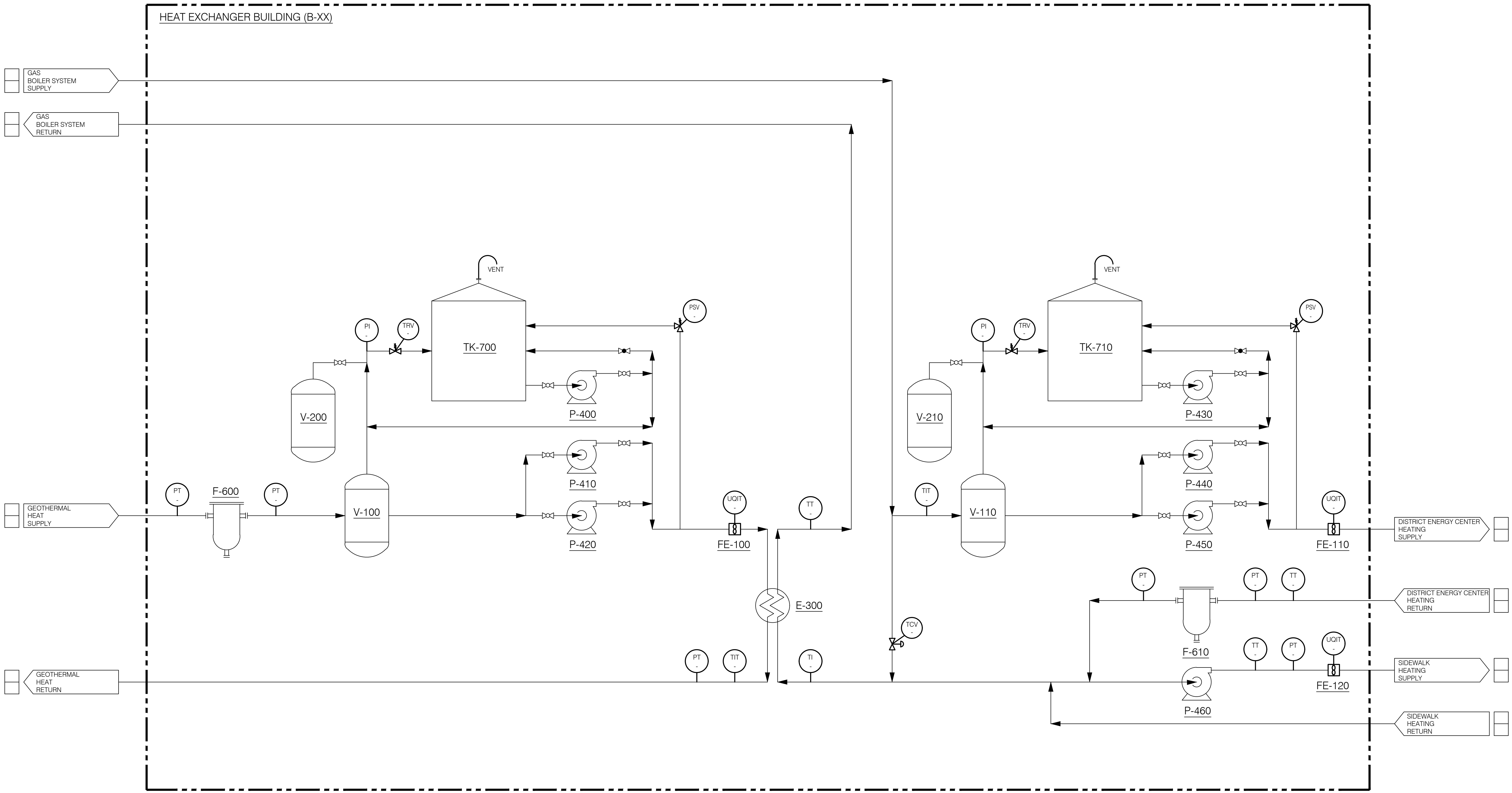
Appendix D.9.3 District Energy Centre (PFD-102)

F-600	V-100	V-200	TK-700	P-400	P-410/P-420	FE-110	V-110	V-210	TK-710	P-430	P-440/P-450	P-460	F-610	FE-120	FE-130
BASKET STRAINER	AIR SEPARATOR	EXPANSION TANK	RELIEF TANK	MAKE-UP PUMP	CIRCULATING PUMP	HEAT METER	AIR SEPARATOR	EXPANSION TANK	RELIEF TANK	MAKE-UP PUMP	CIRCULATING PUMP	CIRCULATING PUMP	BASKET STRAINER	HEAT METER	HEAT METER
MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:	MAKE:
MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:	MODEL:



REV.	DATE	DESCRIPTION	DWN	CHKD	QC
A	2018.08.24	ISSUED FOR INFORMATION	MVV	UK	-

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DRAWN BY / DATE	MVV / 2018.02.13
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SIZE	B
CAD FILE NO.	EP20218001PFD102

TOWN OF HINTON
FEED STUDY
HEAT EXCHANGER BUILDING
PROCESS FLOW DIAGRAM

DWG #	EP202-18001-PFD-102	REV	A

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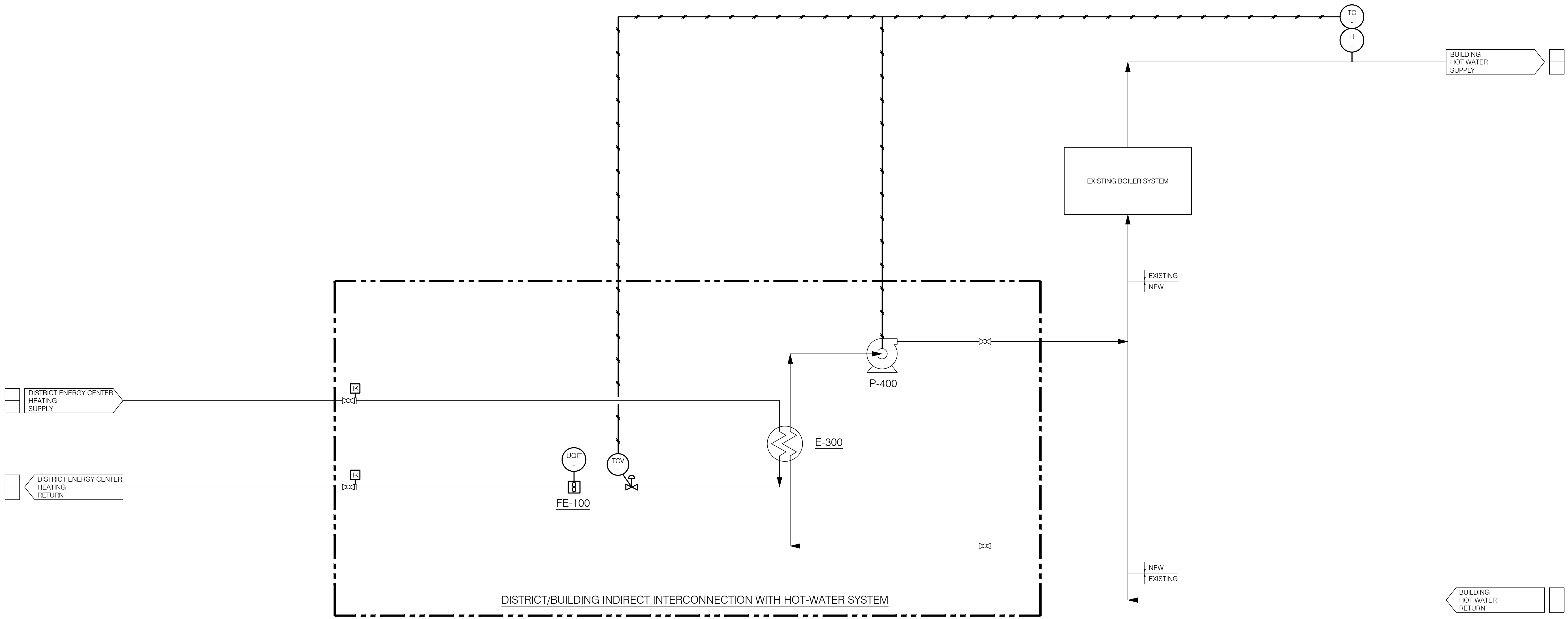
Appendix D.9.4 Downstream Tie-in Example (PDF-103)

FE-100
FLOW METER
MAKE:
MODEL:

E-300
HEAT EXCHANGER
MAKE:
MODEL:

P-400
HYDRONIC SYSTEM PUMP
MAKE:
MODEL:



REV.	DATE	DESCRIPTION	DWN	CHKD	QC
A	2018.08.24	ISSUED FOR INFORMATION	TS	UK	-

ENGINEER STAMP / PERMIT

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TS / 2018.08.01
CHECKED BY / DATE
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SIZE	CAD FILE NO.
B	EP20218001PFD103

TOWN OF HINTON
FEED STUDY
BUILDING INDIRECT INTERCONNECTION
PROCESS FLOW DIAGRAM

DWG # EP202-18001-PFD-103 REV A

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Appendix D.10 Novatherm Safety Sheet

Safety Data Sheet

NovaTherm IPG 100%

SECTION 1 – IDENTIFICATION

Supplier:

Novamen Inc.
111A, 4818 - 50th Avenue
Red Deer, AB T4N 4A3
Phone Number: 403-348-5956

Product Name: **NovaTherm IPG 100%**
Product Description: *Heat Transfer Fluid*
UN Number: Non-regulated under TDG and WHIMIS

Emergency Contacts:
CANUTEC 24-hour Emergency Phone Number: 1-613-996-6666
Chemtrec 24-hour Emergency Phone Number: 1-800-424-9300

SECTION 2 – HAZARD IDENTIFICATION

Potential Health Effects:

Eyes:
This substance is slightly irritating to the eyes and could cause temporary irritation.

Skin Contact:
This substance is not expected to cause prolonged or significant skin irritation.

Ingestion:
Considered to be non-toxic in normal quantities expected to be consumed by accident.

Inhalation:
Considered to be non-hazardous.

Occupational Exposure Limits:
None Identified.

Notes:
Exposure may occur via inhalation, ingestion, skin absorption, skin or eye contact, and accidental ingestion. No specific hazards under normal use conditions. Not classified as flammable but will burn.

SECTION 3 – COMPOSITION/INFORMATION ON INGREDIENTS

Component	Percent	CAS number
Propylene Glycol	90-99	57-55-6
Proprietary Corrosion Inhibitor	Min 1.0	Blend

All components of this product are listed on the Canadian Domestic Substances List.
THIS PRODUCT IS NOT A WHMIS CONTROLLED SUBSTANCE.
Refer to Chapter 8 for Occupational Exposure Guidelines.

SECTION 4 – FIRST AID MEASURES

Skin Contact:

No first aid procedures are required. As a precaution, wash skin thoroughly with soap and water. Remove and wash contaminated clothing. Do not reuse contaminated clothing without laundering.

Eye Contact:

Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. Remove contact lenses if worn. No additional first aid should be necessary, however if irritation persists, see a doctor.

Ingestion:

Product is not considered to be toxic in small amounts.

Inhalation:

Since this material is not expected to be an immediate inhalation problem, no first aid procedures are required. Move to fresh air if feeling ill.

Notes to Physician:

The decision whether to induce vomiting or not should be made by an attending physician. If lavage is performed, suggest endotracheal and/or esophageal control. No specific antidote. If burn is present, treat as any thermal burn. Specific treatment must be based on judgment of the physician in response to reactions of the patient.

SECTION 5 – FIRE-FIGHTING MEASURES

Suitable Extinguishing Media:

Large fires should only be fought by properly trained fire fighters; alcohol-resistant foam, water sprays or fog. Dry chemical powder, carbon dioxide, sand or earth may be used for small fires only.

Unsuitable Extinguishing Media:

Do not use water in a jet.

Specific Hazards Arising from the Chemical:

Carbon Dioxide and Carbon Monoxide.

Special Protective Equipment and Precautions for Firefighters:

Wear full protective clothing and self-contained breathing Firefighters apparatus.

Additional Advice:

All storage areas should be provided with adequate firefighting facilities. Keep adjacent containers cool by spraying with water.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Methods and Materials for Containment and Cleaning Up:

Do not wash to sanitary sewer. All spills – confine spill, soak up with approved absorbent, shovel product into approved container for disposal. Flush area with water, recover flush for proper disposal.

Small Spills:

Take up with sand or other non-combustible absorbent material and place in closed containers for later disposal.

Large Spills:

Build dikes far ahead of spill to contain for later reclamation or disposal.

SECTION 7 – HANDLING AND STORAGE

Precautions for Safe Handling:

Keep container closed when not in use; protect from abuse; protect from extreme temperatures, and store in covered containment out of direct sun exposure. Keep this and other chemicals out of reach of children. Avoid contact with skin and eyes. Avoid breathing mist when spraying.

Conditions for Safe Storage, Including any Incompatibilities:

Store in clean vessels and containers away from direct heat and strong oxidizing agents.

SECTION 8 – EXPOSURE CONTROLS/PERSONAL PROTECTION

Eye/Face Protection:

Do not get this material in your eyes. Eye contact can be avoided by wearing well fitted chemical goggles or glasses.

Skin and Body Protection:

No special skin protection is usually necessary. Avoid prolonged or frequently repeated skin contact with this material. Skin contact can be minimized by wearing rubberized or neoprene gloves and protective clothing.

Respiratory Protection:

No special respiratory protection is normally required.

Ventilation:

No special ventilation is necessary.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid
Colour:	Colourless, clear
Odour:	Mild to no odour
Specific Gravity:	1.045 @ 20°C
Boiling Point Range:	186°C
Freezing Point Range:	-47°C
pH:	9.0
Flashpoint:	99°C
Evaporation Rate:	Not available
Lower Explosion Limit:	2.6% (V)
Upper Explosion Limit:	12.6% (V)
Vapour Pressure:	10 mm Hg @ 20°C
Relative Vapour Density:	1.6 @ 15°C
Solubility:	Completely soluble
Auto-Ignition Temperature:	446°C

SECTION 10 – STABILITY AND REACTIVITY

Chemical Stability:

Stable.

Incompatible Materials:

May react with strong acids or strong oxidizing agents such as chlorates, nitrates, peroxides, etc.

Hazardous Decomposition Products:

None known.

Possibility of Hazardous Reactions:
Polymerization will not occur.
Special Precautions:
Read and observe all precautions on product label. Store away from strong oxidizing materials.

SECTION 11 – TOXICOLOGICAL INFORMATION

Eye Irritation:
No product toxicology data available. The hazard evaluation was based on data from similar products.
Skin Irritation:
No product toxicology data available. The hazard evaluation was based on data from similar products.
Acute Dermal Toxicity:
No product toxicology data available. The hazard evaluation was based on data from similar products.
Respiratory/Inhalation:
No product toxicology data available. The hazard evaluation was based on data from similar products.
Ingestion:
The oral LD_{50} in rats is greater than 10.0g/kg.

SECTION 12 – ECOLOGICAL INFORMATION

Acute Toxicity:

Species	Test	Test Results
Fish	$LC/EC/IC_{50}$	> 100mg/l Low toxicity
Aquatic Invertebrates	$LC/EC/IC_{50}$	> 100mg/l Low toxicity
Algae	$LC/EC/IC_{50}$	> 100mg/l Low toxicity
Microorganisms	$LC/EC/IC_{50}$	> 100mg/l Expected to have low toxicity

Mobility in Soil:
If product enters soil, it will be highly mobile and may contaminate groundwater. Dissolves in water.
Persistence and Degradability:
Readily biodegradable. Does not bio-accumulate significantly.

SECTION 13 – DISPOSAL CONSIDERATIONS

Based on information available to Novamen, Inc., this material is neither listed as a hazardous waste nor does it exhibit any of the characteristics that would cause it to be classified or disposed of as hazardous waste.
Disposal Instructions:
Dispose of in accordance with all applicable federal, provincial, and local environmental regulations and laws.

SECTION 14 – TRANSPORT INFORMATION

Special Shipping Information:

Not a regulated product according to the Transportation of Dangerous Goods Act of Canada

Note:

Transportation information provided is for reference only. Client is urged to consult CFR 49 parts 100-177, IMDGA, IATA, EC, United Nations TDG, and WHMIS Canada TDG information manuals for detailed regulations and exceptions covering specific container sizes, packaging materials and methods for shipping.

SECTION 15 – REGULATORY INFORMATION

CPR (Canadian Controlled Products Regulations)

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulation and the SDS contains all the information required by the Controlled Products Regulations.

IDL (Canadian Ingredient Disclosure List)

Components of the product identified by CAS number and listed on the Canadian Ingredient Disclosure List are shown in Section 2.

DSL / NDSL (Canadian Domestic Substances List / Non-Domestic Substances List)

Components of this product identified by CAS number are listed on the DSL and NDSL or are otherwise in compliance with the New Substances Notification (NSN) regulations. Only ingredients classified as "hazardous" are listed in Section 2 unless otherwise indicated.

TSCA (Toxic Substance Control Act)

All components of this product are listed on the U.S. Substance Control Act Chemical Inventory (TSCA Inventory).

CERCLA (Comprehensive Response Compensation and Liability Act)

None

SECTION 16 – OTHER INFORMATION

SDS Prepared by:	Novamen HSE Department
Original Preparation Date:	January 22, 2017
Revision Date:	June 5, 2018
Revision Number:	2
Reason for Revision:	Formatting and review

The information provided on this SDS is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

PROPYLENE GLYCOL

Typical Physical Properties of Aqueous Solutions

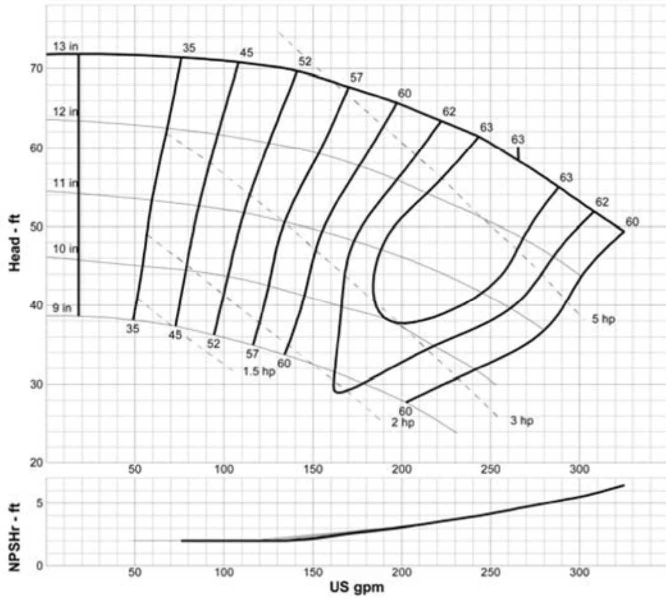
Volume %	Weight %	Freeze Point F	Freeze Point C
0	0.0	32.0	0.0
10	10.4	28.4	-2.0
16	16.5	22.3	-5.4
20	20.6	20.0	-6.6
21	21.6	19.0	-7.2
22	22.6	18.0	-7.7
23	23.6	17.0	-8.3
24	24.5	16.0	-8.8
25	25.5	15.0	-9.4
26	26.5	14.0	-9.9
27	27.4	13.0	-10.5
28	28.4	12.0	-11.0
29	29.4	11.0	-11.6
30	30.3	9.0	-12.7
31	31.3	8.0	-13.2
32	32.3	7.0	-13.8
33	33.3	5.0	-14.9
34	34.3	4.0	-15.4
35	35.3	2.0	-16.5
36	36.2	1.0	-17.1
37	37.2	-1.0	-18.2
38	38.2	-3.0	-19.3
39	39.2	-4.0	-19.8
40	40.2	-6.0	-20.9
41	41.2	-8.0	-22.0
42	42.2	-10.0	-23.1
43	43.2	-12.0	-24.2
44	44.1	-14.0	-25.3
45	45.1	-16.0	-26.4
46	46.1	-18.0	-27.5
47	47.1	-20.0	-28.6
48	48.0	-22.0	-29.7
49	49.0	-25.0	-31.4
50	50.0	-27	-32.5
51	51.0	-29	-33.6
52	52.0	-32	-35.2
53	53.0	-34	-36.3
54	54.0	-36	-37.4
55	55.0	-39	-39.1
56	56.0	-41	-40.2
57	57.0	-44	-41.8
58	58.0	-47	-43.5
59	59.0	-50	-45.1
60	60.0	-53	-46.8
100	100	-60	-51

Appendix D.11 Griswold Example Pump Curves

PERFORMANCE CURVES

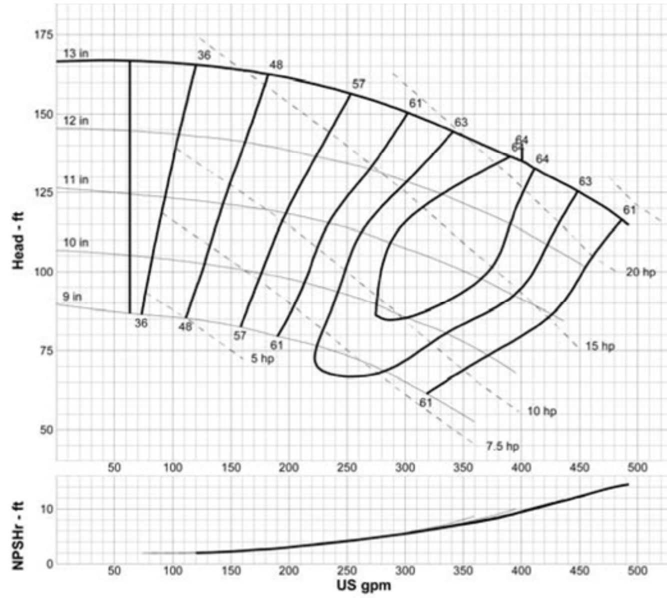
3 x 2 - 13 A30 1200 RPM

Curve: G-1218



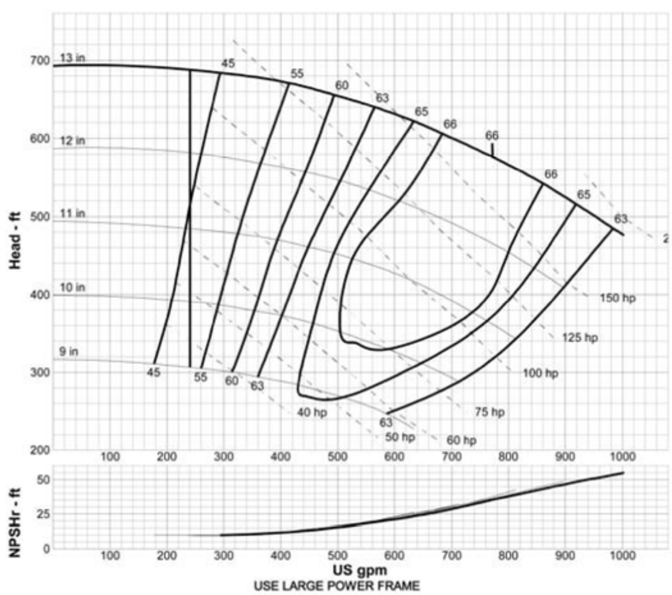
3 x 2 - 13 A30 1800 RPM

Curve: G-1818



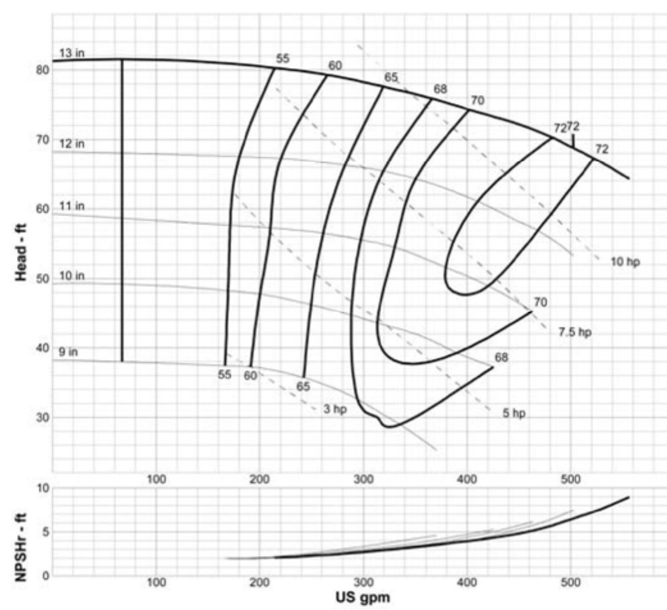
3 x 2 - 13 A30 3600 RPM

Curve: G-3618



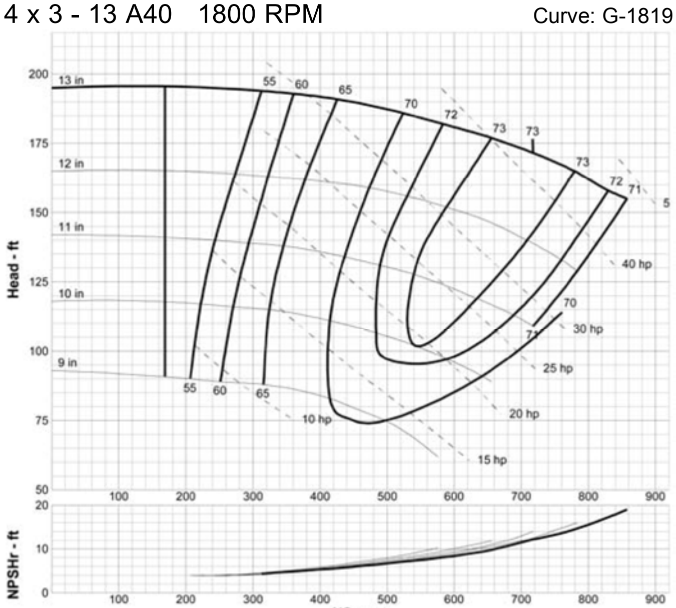
4 x 3 - 13 A40 1200 RPM

Curve: G-1219



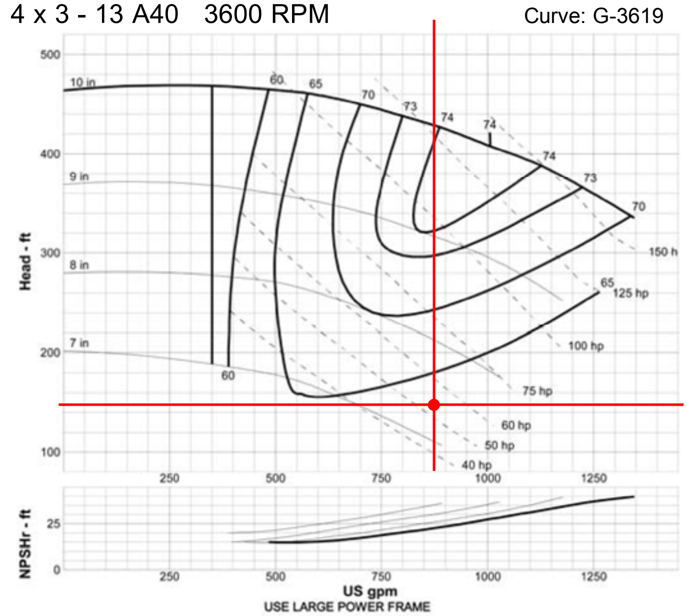
4 x 3 - 13 A40 1800 RPM

Curve: G-1819



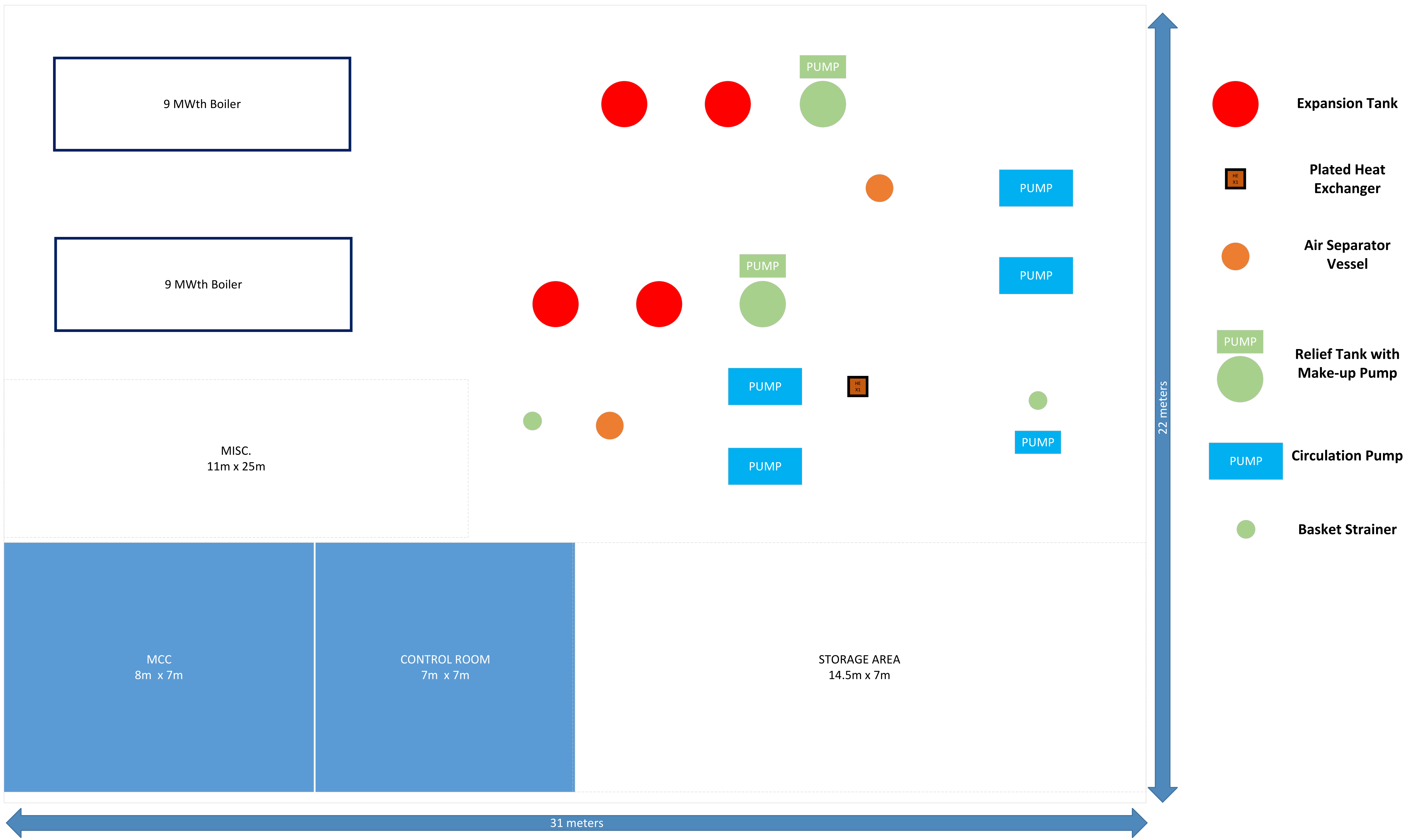
4 x 3 - 13 A40 3600 RPM

Curve: G-3619



Appendix D.12 DEC General Arrangement Layout Drawing

General Arrangement Drawing of the Hinton District Energy Center



Appendix D.13 TCV Fisher Sizing Document

FISHER

Valve/Regulator Sizing Calculation

EMERSON

Customer:
Contact:
Customer Reference:
Item: **1** Rev: Qty: **1**
Tags:
Description: **NPS 2 D4**
Service Description:

Spartans Controls Ltd
Contact: **Mark Fukuda**
Sales Office Reference:
Date Last Modified: **06/07/2018**

Lead Time:
Rev: **A**

Sizing Type: Liquid | Flow is Turbulent | Solving for: Cv | Noise is None | Flow is Volumetric

Variable Name	Units	Minimum	Maximum
SERVICE & SIZING			
Liquid			
Specific Gravity (SG)		**1.000**	**1.000**
Inlet Pressure (P1)	**kPa(g)**	**521.800**	**597.300**
Pressure Change (dP)	**kPa**	**73.200**	**41.800**
Inlet Temperature (T1)	**deg C**	**84.1000**	**64.3000**
Volumetric Flow Rate Liquid (Ql)	**m3/h**	**13.7000**	**2.1000**
Pressure Recovery Factor (Fl)		**0.940**	**0.940**
Valve style modifier (Fd)		**0.400**	**0.400**
Cavitation coefficient (Kc)		**0.600**	**0.600**
Kinematic Viscosity (Nu)	**SSU**	**4.536**	**4.536**
Vapor Pressure (Pv)	**kPa(g)**	**1.000**	**1.000**
Critical Pressure (Pc)	**kPa(g)**	**22000.000**	**22000.000**
Atmospheric Pressure	**kPa**	**91**	**91**
Pipe Size Up	**in**	**2**	**2**
Pipe Schedule Up		**STD**	**STD**
Pipe Size Down	**in**	**2**	**2**
Pipe Schedule Down		**STD**	**STD**
Nominal Valve Diameter (dv)	**in**	**2.000**	**2.000**
Sizing Coefficient (Cv)		**18.512**	**3.755**
Application Ratio (Ar)		**0.141**	**0.070**
dP Cavitation	**kPa**	**312.480**	**357.780**
dP Choked	**kPa**	**464.899**	**531.611**
Fp		**1.00**	**1.00**
VELOCITY OUTPUTS			
V1 Pipe	**m/s**	**1.7571**	**0.2693**
V2 Pipe	**m/s**	**1.7571**	**0.2693**

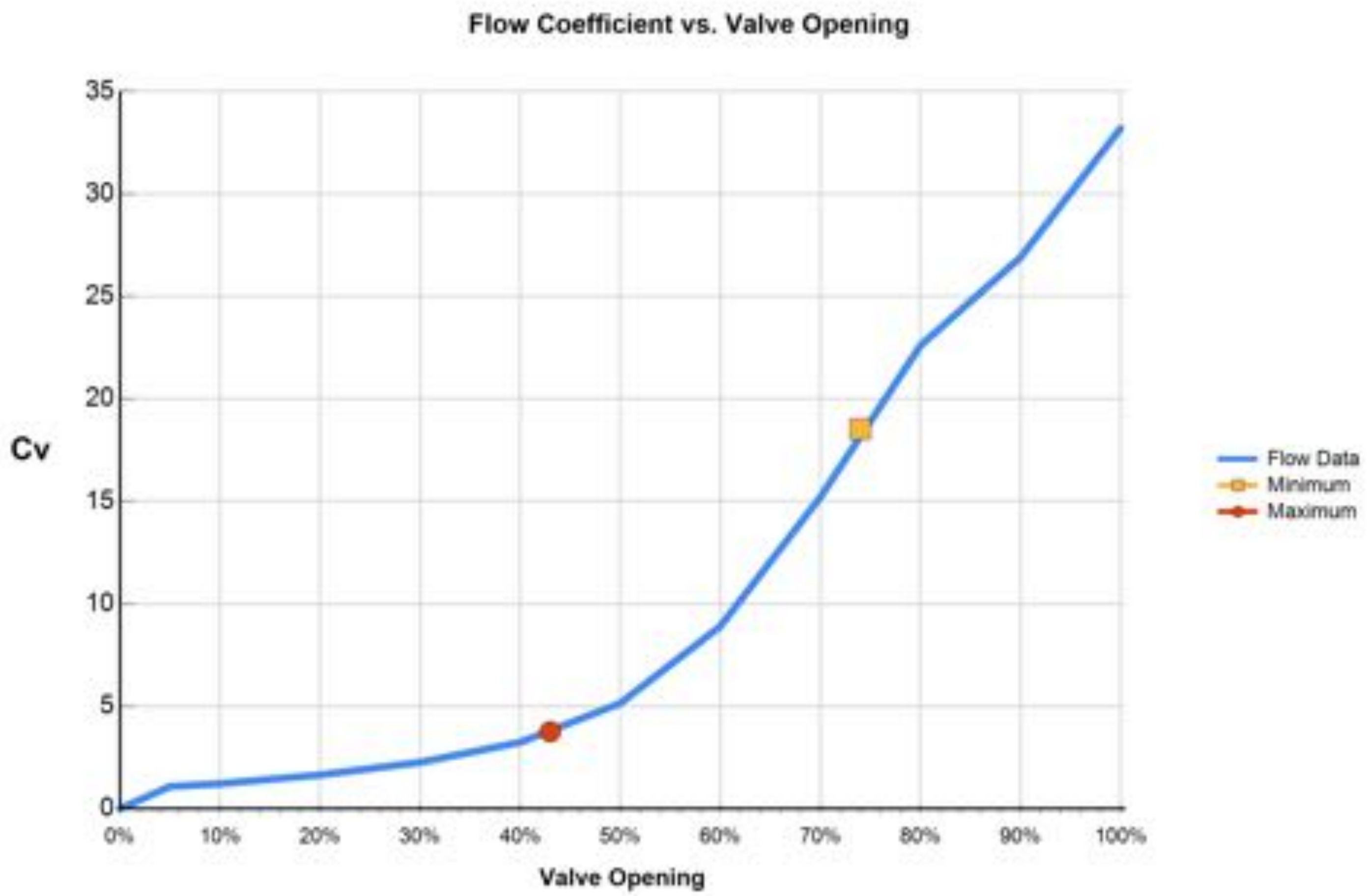
Item Notes:

FISHER

Flow Coefficient Graph

EMERSON

Customer:	Spartans Controls Ltd	
Contact:	Contact: **Mark Fukuda**	
Customer Reference:	Sales Office Reference:	Lead Time:
Item: **1** Rev: Qty: **1**		
Tags:	Date Last Modified: **06/07/2018**	
Description: **NPS 2 D4**		
Service Description:		



Product: D4 easy-Drive *Valve Size=NPS 2* *Trim Style/Characteristic=Micro-Form (Eq Pct)* *Port Diameter=1 1/4 Inch* *Travel=3/4 Inch*

FISHER

Valve/Regulator Sizing Calculation

EMERSON

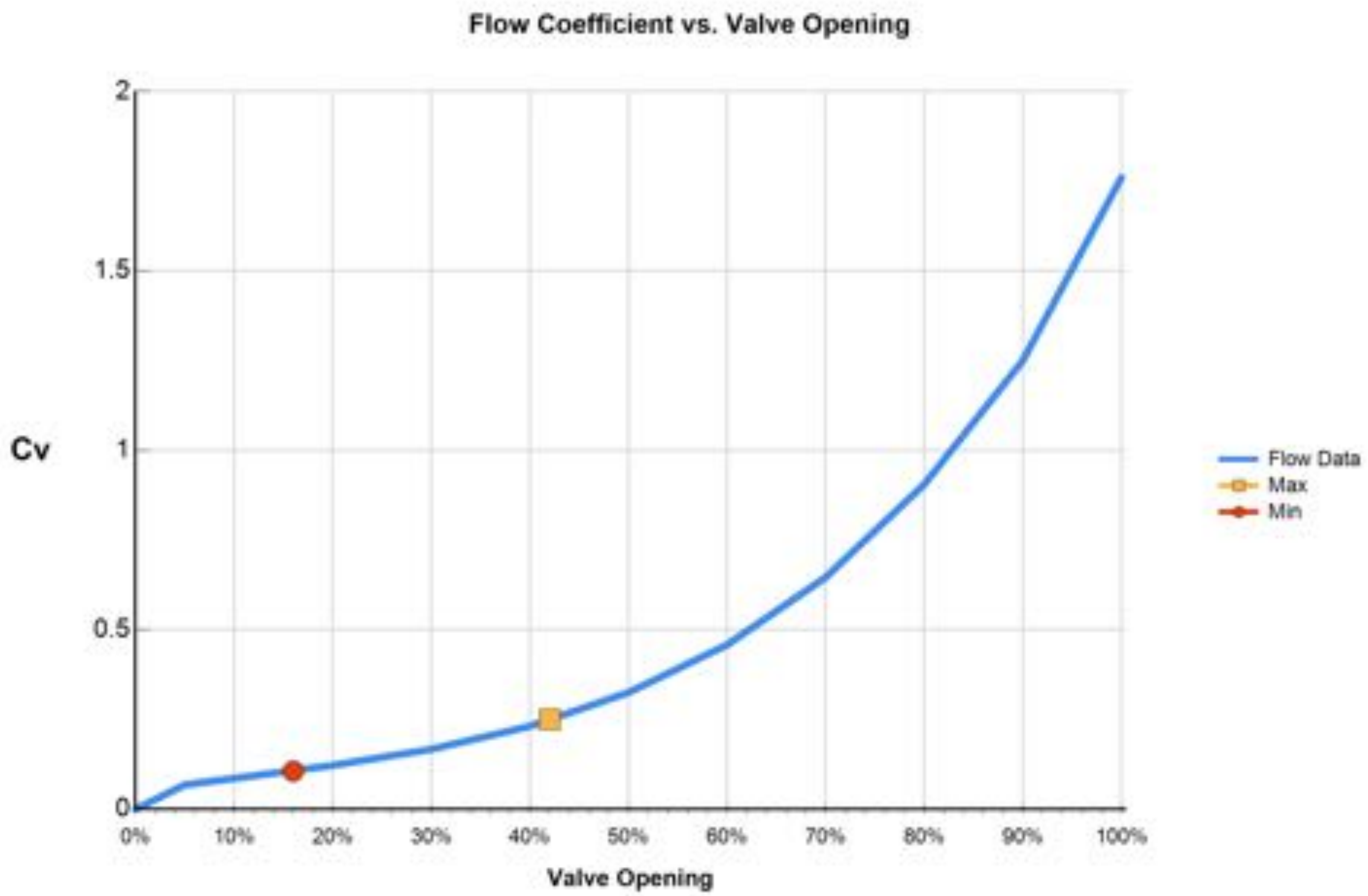
Customer:		Spartans Controls Ltd	
Contact:		Contact: **Mark Fukuda**	
Customer Reference:		Sales Office Reference:	Lead Time:
Item: **2**	Rev:	Qty: **1**	Rev: **A**
Tags:		Date Last Modified: **06/07/2018**	
Description: **NPS 2 D4**			
Service Description:			

Sizing Type: Liquid	Flow is Turbulent	Solving for: Cv	Noise is None	Flow is Volumetric

Variable Name	Units	Max	Min
SERVICE & SIZING			
Liquid			
Specific Gravity (SG)		**1.000**	**1.000**
Inlet Pressure (P1)	**kPa(g)**	**535.400**	**549.400**
Pressure Change (dP)	**kPa**	**193.500**	**119.900**
Inlet Temperature (T1)	**deg C**	**82.2000**	**79.8000**
Volumetric Flow Rate Liquid (Ql)	**m3/h**	**0.3000**	**0.1000**
Pressure Recovery Factor (Fl)		**0.960**	**0.960**
Valve style modifier (Fd)		**0.400**	**0.400**
Cavitation coefficient (Kc)		**0.600**	**0.600**
Kinematic Viscosity (Nu)	**SSU**	**4.536**	**4.536**
Vapor Pressure (Pv)	**kPa(g)**	**1.000**	**1.000**
Critical Pressure (Pc)	**kPa(g)**	**22000.000**	**22000.000**
Atmospheric Pressure	**kPa**	**91**	**91**
Pipe Size Up	**in**	**2**	**2**
Pipe Schedule Up		**STD**	**STD**
Pipe Size Down	**in**	**2**	**2**
Pipe Schedule Down		**STD**	**STD**
Nominal Valve Diameter (dv)	**in**	**2.000**	**2.000**
Sizing Coefficient (Cv)		**0.249**	**0.106**
Application Ratio (Ar)		**0.362**	**0.219**
dP Cavitation	**kPa**	**320.640**	**329.040**
dP Choked	**kPa**	**497.427**	**510.329**
Fp		**1.00**	**1.00**
VELOCITY OUTPUTS			
V1 Pipe	**m/s**	**0.0385**	**0.0128**
V2 Pipe	**m/s**	**0.0385**	**0.0128**
Item Notes:			

Flow Coefficient Graph

Customer:	Spartans Controls Ltd	
Contact:	Contact: **Mark Fukuda**	
Customer Reference:	Sales Office Reference:	Lead Time:
Item: **2** Rev: Qty: **1**		
Tags:	Date Last Modified: **06/07/2018**	
Description: **NPS 2 D4**		
Service Description:		



Product: D4 easy-Drive *Valve Size=NPS 2* *Trim Style/Characteristic=Micro-Form (Eq Pct)* *Port Diameter=1/4 Inch*
Travel=3/4 Inch

Appendix D.14 Load List sent to Fortis

UPSTREAM FACILITY LOAD LIST

480VAC Loads	Qty	Volts	Phase	kW ea	kW total	PF	Conn'd FLA	Conn'd kVA	Utilization	Expected kVA	Notes
300 HP Circulation Pump	1	460	3	223.8	223.8	80%	351.1	279.8	100%	279.8	confirm size; confirm voltage
2 HP Makeup Pump	1	460	3	1.5	1.5	80%	2.3	1.9	10%	0.2	
240/120VAC Loads											
HVAC system	1	230	1	2.0	2.0	75%	11.6	2.7	100%	4.0	for control room; assume 1000 sqft
UPS (115VAC - 24VDC)	1	115	1	2.0	2.0	70%	24.8	2.9	100%	2.9	
Building lighting	3	115	1	1.0	3.0	70%	37.3	4.3	75%	3.2	assume LED; assume 3 ccts
Yard lighting	3	115	1	1.0	3.0	70%	37.3	4.3	75%	3.2	assumed LED; assume 3 ccts
Receptacles	2	115	1	1.0	2.0	70%	24.8	2.9	75%	2.1	assume 2 ccts
Totals					237.3		489.3	298.6		295.4	for transformer sizing

24 VDC Loads (From UPS)											
Instruments	30	24	1	0.001	0.030	60%	2.1				assume 50 instruments @ 1W each
PLC	1	24	1	0.010	0.010	60%	0.7				assume 10W
RTU/SCADA	1	24	1	0.010	0.010	60%	0.7				assume 10W
Radios	1	24	1	0.010	0.010	60%	0.7				assume 10W

DISTRICT ENERGY CENTER LOAD LIST

480VAC Loads	Qty	Volts	Phase	kW ea	kW total	PF	Conn'd FLA	Conn'd kVA	Utilization	Expected kVA	Notes
40 HP Upstream Circulation Pump	1	460	3	29.8	29.8	80%	46.8	37.3	100%	37.3	
40 HP Upstream Circulation Pump	1	460	3	29.8	29.8	80%	46.8	37.3	0%	0.0	
60 HP Downstream Circulation Pump	1	460	3	44.8	44.8	80%	70.2	56.0	100%	56.0	
60 HP Downstream Circulation Pump	1	460	3	44.8	44.8	80%	70.2	56.0	0%	0.0	
2 HP Makeup Pump	1	460	3	1.5	1.5	80%	2.3	1.9	5%	0.1	
2 HP Makeup Pump	1	460	3	1.5	1.5	80%	2.3	1.9	5%	0.1	
2 HP Sidewalk Pump	1	460	3	1.5	1.5	80%	2.3	1.9	100%	1.9	
2 HP Sidewalk Pump (backup)	1	460	3	1.5	1.5	80%	2.3	1.9	0%	0.0	
20 HP Boiler Blower	1	460	3	14.9	14.9	80%	23.4	18.7	50%	9.3	
20 HP Boiler Blower (backup)	1	460	3	14.9	14.9	80%	23.4	18.7	0%	0.0	
TCV	1	460	3	1.0	1.0	80%	1.6	1.3	10%	0.1	assume electrically actuated
240/120VAC Loads											
HVAC system	1	230	1	3.0	3.0	75%	17.4	4.0	100%	4.0	for control room; assume 2500 sqft
UPS (115VAC - 24VDC)	1	115	1	2.0	2.0	70%	24.8	2.9	100%	2.9	
Building lighting	3	115	1	1.0	3.0	70%	37.3	4.3	75%	3.2	assume LED; assume 3 ccts
Yard lighting	3	115	1	1.0	3.0	70%	37.3	4.3	75%	3.2	assumed LED; assume 3 ccts
Receptacles	2	115	1	1.0	2.0	70%	24.8	2.9	75%	2.1	assume 2 ccts
Totals					199.0		43344%	25080%		12018%	for transformer sizing

24 VDC Loads (From UPS)											
Instruments	50	24	1	0.001	0.050	60%	3.5				assume 50 instruments @ 1W each
PLC	1	24	1	0.010	0.010	60%	0.7				assume 10W
Burner PLC	1	24	1	0.010	0.010	60%	0.7				assume 10W
RTU/SCADA	1	24	1	0.010	0.010	60%	0.7				assume 10W
Radios	1	24	1	0.010	0.010	60%	0.7				assume 10W

Appendix D.15 Fortis Budgetary Quote

June 21, 2018

Enerpro Engineering Inc.
Attn: Michael Skaf
2710, 700 - 9th Avenue SW
Calgary, Alberta
T2P 3V4

Billing Customer:	Michael Skaf
Service Location:	11-14-51-25-5, 550 Kelley Road Hinton, Alberta
Request Number:	500068394-01

Dear Michael Skaf,

Subject: Commercial - New Service

FortisAlberta delivers electricity in Alberta communities and maintains local electrical lines and poles. Our customers are central to everything we do. That's why we consistently invest in our communities and why we are always working on ways to improve our service.

This Quotation Package for a new electrical service (project) includes important information about your quote and the construction of your service.
This package contains an Estimate Print specific to your project along with, a Schedule for Services which details FortisAlberta's terms and conditions and construction process. It is important that you the customer or your assigned representative thoroughly read all information in this Quotation Package.

This proposal is a **budgetary estimate** only and will be updated to a firm quote upon confirmation of details of your electrical service.

Please note: There are no Customer Contribution Costs ($0.00) (payable amount) associated with this project.

DESIGN DETAILS

As the Estimate Print indicates, design of this project includes the following:

- Primary line built: 150 meters, 25 kV, Three Phase, Overhead
- Transformers installed: 1 - 150 kVA, 277/480 V, Overhead
- Meter to be installed: Self-Contained

This budgetary estimate is based on information provided by the customer for standard ground conditions and does not provide for any costs associated with brushing, alignment or access. Also, this estimate is contingent on the availability of right-of-way for the proposed line and permission to clear brush along the line route if necessary.

FOR MORE INFORMATION

For more information about your electrical service, electrical upgrade and/or your quotation package, please view our website at www.fortisalberta.com. You can also check the status of your Application online at Project Status Portal.

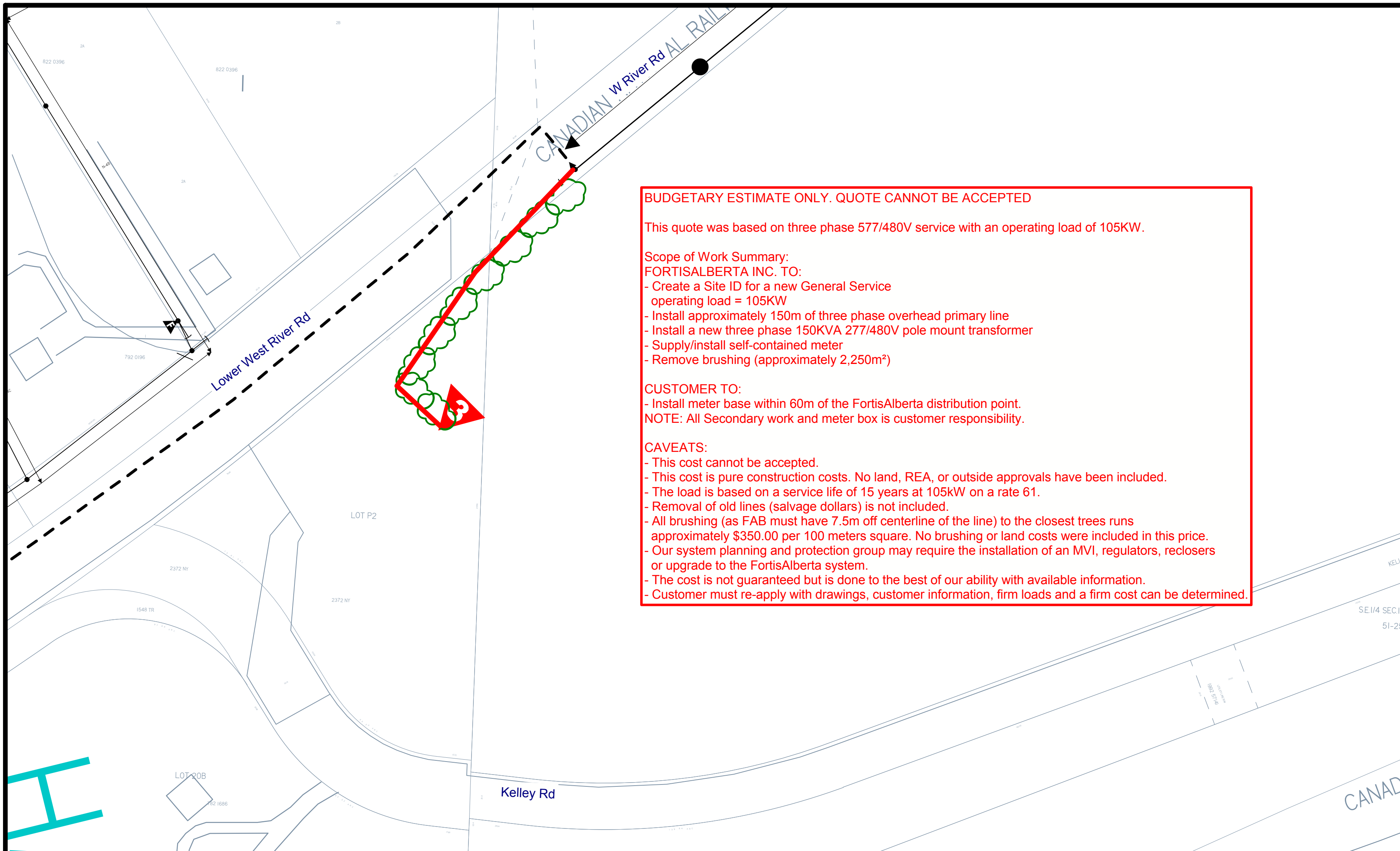
If you have further questions, please call me at: 403-901-2601 or Toll Free at: 1-855-901-2601. If you wish to proceed with a firm quote, please call 310-WIRE (9473) and provide our agent with this request number 500068394-01.

Yours truly,

(for) Landon Wegener
Quotation Analyst

Attachments:

- Schedule “A”
- Estimate Print



BUDGETARY ESTIMATE ONLY. QUOTE CANNOT BE ACCEPTED

This quote was based on three phase 577/480V service with an operating load of 105KW.

Scope of Work Summary:
FORTISALBERTA INC. TO:
- Create a Site ID for a new General Service operating load = 105KW
- Install approximately 150m of three phase overhead primary line
- Install a new three phase 150KVA 277/480V pole mount transformer
- Supply/install self-contained meter
- Remove brushing (approximately 2,250m²)

CUSTOMER TO:
- Install meter base within 60m of the FortisAlberta distribution point.
NOTE: All Secondary work and meter box is customer responsibility.

CAVEATS:
- This cost cannot be accepted.
- This cost is pure construction costs. No land, REA, or outside approvals have been included.
- The load is based on a service life of 15 years at 105kW on a rate 61.
- Removal of old lines (salvage dollars) is not included.
- All brushing (as FAB must have 7.5m off centerline of the line) to the closest trees runs approximately $350.00 per 100 meters square. No brushing or land costs were included in this price.
- Our system planning and protection group may require the installation of an MVI, regulators, reclosers or upgrade to the FortisAlberta system.
- The cost is not guaranteed but is done to the best of our ability with available information.
- Customer must re-apply with drawings, customer information, firm loads and a firm cost can be determined.

NOTES:

LAND ONLY TO SCALE 1:2,500
Print

FORTIS ALBERTA

LEGEND:

RED	NEW PRIMARY
PURPLE	NEW SECONDARY
BLUE	SALVAGE
GREEN	BRUSHING
BLACK	EXISTING FACILITIES
MAGENTA	POSTED PROPOSED

Designer: Wegener, Landon
Customer: Enerpro Engineering Inc.
Location: 11-14-51-25-W5
Date: 6/20/2018
WO#/OI#: 500068394

Power line contacts are hazardous

You cannot tell if a power line is energized just by looking at it. Even if the line is not live one moment, automatic switching equipment may restore power to the line without warning. The protective covering on some power lines is not insulation; it only protects the line from the weather. It won't protect you from electrical contact.

The electricity in a power line always seeks a path to the ground. This path might include a tree, a vehicle, or a fence. These objects then become energized. If you touch the energized line or object, the electricity can flow through your body. Keep away from any object that is in contact with a power line (minimum 10m).

Once electricity comes into contact with the ground or object, such as a vehicle or tree, they can become energized. The electricity then flows through the ground over a wide area, spreading out like ripples in a pool of water. The voltage in the ground is very high at the point of electrical contact. Farther away, the voltage drops off. With power lines of up to 25,000 volts, the voltage drops to zero at about 10 metres. However, if the ground is wet, it will be more than 10 metres from the point of contact to the point where the voltage drops to zero.

To stay safe inside equipment or a vehicle that is in contact with a power line (overhead and underground) – follow these steps:

- If possible, move the equipment or vehicle away to break contact with the power line (min. 10m away).
- If the equipment or vehicle cannot be moved, call 911 and the power company. STAY INSIDE the equipment or vehicle until the power company and emergency crews arrive onsite and let you know the power line has been de-energized. If anyone approaches while you are waiting, open the window and tell them to keep away (min. 10m).
- If you must get out of the equipment or vehicle (in the case of fire) jump out with your feet together. Never touch the ground and the vehicle/ equipment at the same time. Move away slowly by shuffling and keeping both feet close together, or by bunny hopping away slowly. Do this until you are at least 10 metres away from the vehicle/equipment.

B-010 - Last updated Nov. 2012

When to be extra careful…

Our research also reveals that most of these incidents occurred at the beginning of the week either just before or after lunch, between Monday and Wednesday from 10 a.m. to 2 p.m.

Make sure you'll get home safely…

- Take responsibility for your own safety
- Always make a safe work plan, and ask yourself, "**Where's the Line**?"
- Know your proximity to overhead power lines when parked or operating equipment: remember to keep a minimum distance of 7 metres away . If you have to get closer, call FortisAlberta 310–WIRE (9473) or 1-855-333-9473 before you encroach on the power lines so we can assist you.

Most incidents occur at work…

Most of the incidents occur in Alberta's busiest industries – oil and gas, construction, transportation and agriculture. Below is a list of the types of equipment that most often contact overhead and underground power lines:

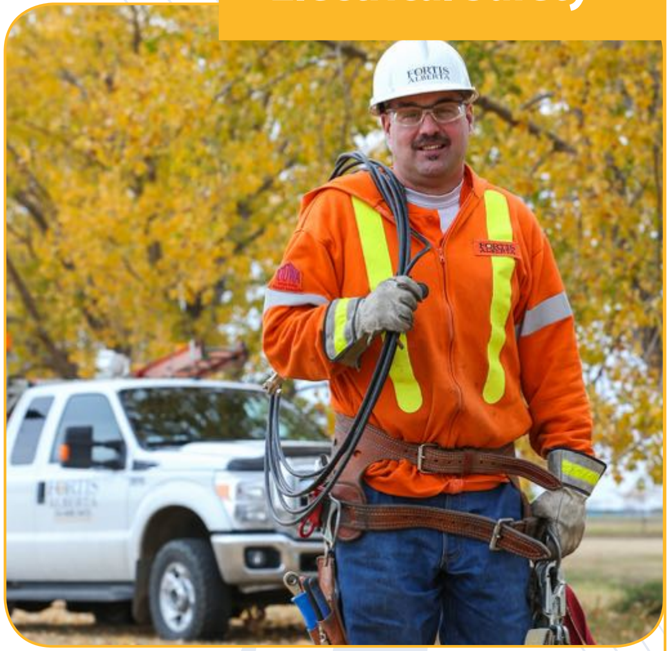
- Trackhoes
- Gravel trucks
- Backhoes
- Crane trucks
- Delivery trucks and high load moves
- Farm equipment (tractors, combines, air seeders, sprayers, grain augers)

FORTIS ALBERTA
our promise is your power

For electrical emergencies call us at 310-WIRE (9473) or 1-855-333-9473

FORTIS ALBERTA
our promise is your power

Electrical Safety



What you need to know to stay safe

MISSION ZERO
Preventable Injuries

FORTIS ALBERTA
our promise is your power

FortisAlberta brings electricity to homes, businesses and oilfields across Alberta

We work with this dangerous product every day so we follow strict guidelines and never compromise safety.

We also urge the public to keep safety top-of-mind. Every day someone comes in contact with a power line, risking serious injury or death. While most incidents occur at work, you still need to keep safety in mind at home.

Seven is more than a lucky number…

It's also the number of metres that you must stay away from any power line when parked and operating equipment. If you think you have to get closer, call us first at 310-WIRE (9473) or 1-855-333-9473.

If you come upon a downed power line…

Stay at least 10 metres away and phone us right away at 310-WIRE (9473) or 1-855-333-9473. Make sure nobody else comes near. If the power line has come down on your equipment or vehicle, stay inside and call for help. If you must get out of the equipment or vehicle (in the case of fire) jump out with your feet together. Never touch the ground and the vehicle/equipment at the same time. Move away slowly by shuffling and keeping both feet close together, or by bunny hopping away slowly. Do this until you are at least 10 metres away from the vehicle/equipment.

WHERE'S THE LINE?
POWER LINE SAFETY
wherestheline.ca

Power lines are constructed according to Alberta Electric Utility Code Standards. The overhead power lines and communication lines are installed and maintained to permit the safe movement of equipment, buildings, or objects. There are two different approach distances to power lines that must be understood and maintained by workers and the general public:

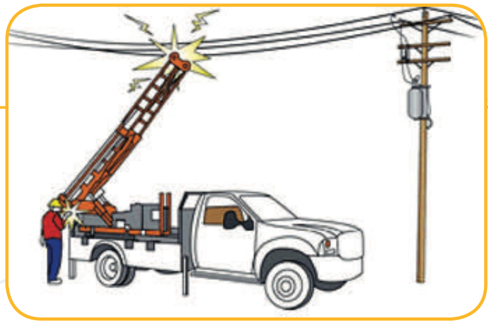
1. distances while equipment is moving
2. distances while equipment is parked and operating near a power line.

The following chart highlights safe distances while passing under power and communication lines. The heights shown reflect the maximum height equipment, buildings or objects can be.

Safe distances while passing under power lines

3.6 metres (11.8 feet)	areas normally accessible to pedestrians only
4.1 metres (13.5 feet)	driveways to residences or residential garages
4.2 metres (13.7 feet)	areas where agricultural equipment is normally used
4.2 metres (13.7 feet)	farm or yard entrances or farm field access roads
4.3 metres (14.1 feet)	right of way of underground pipelines
4.8 metres (15.7 feet)	lanes, alleys or entrances to commercial or industrial premises
5.3 metres (17.3 feet)	roads and highways
5.3 metres (17.3 feet)	crossing oilfield lease roads

If your equipment, buildings or objects exceed these heights in the above chart, you must contact your electrical service provider before proceeding.



Do not approach or touch anything, such as a vehicle, tree or fence that is in contact with a power line.

Equipment and machinery is getting bigger all the time. Busy operators often have long days with tight timelines.

- **Be aware of the size of your equipment** – our power lines are designed and maintained to Alberta Electrical Utility Code standards. Depending on the location, power lines (includes guy wires) - can be as low as 3.7 metres from the ground.
- **Pile safely** – locate piles (dirt, gravel, etc) away from power lines and where kids can't climb too near. Remember the 7 metre rule!
- **Watch tree branches** – overgrown vegetation may be too close to overhead wires and make pruning dangerous. Don't take chances!
- **Call before you dig** – before doing any ground disturbance, contact Alberta One-Call at 1-800-242-3774 to locate any underground facilities. Underground excavation accounts for more than 20 per cent of power line contacts.
- **Plan your recreation – away from power lines.** FortisAlberta is aware of situations where a parachute and sailboat have each contacted a power line.

Call us at 310-WIRE (9473) or 1-855-333-9473 with your electrical safety concerns or visit www.fortisalberta.com

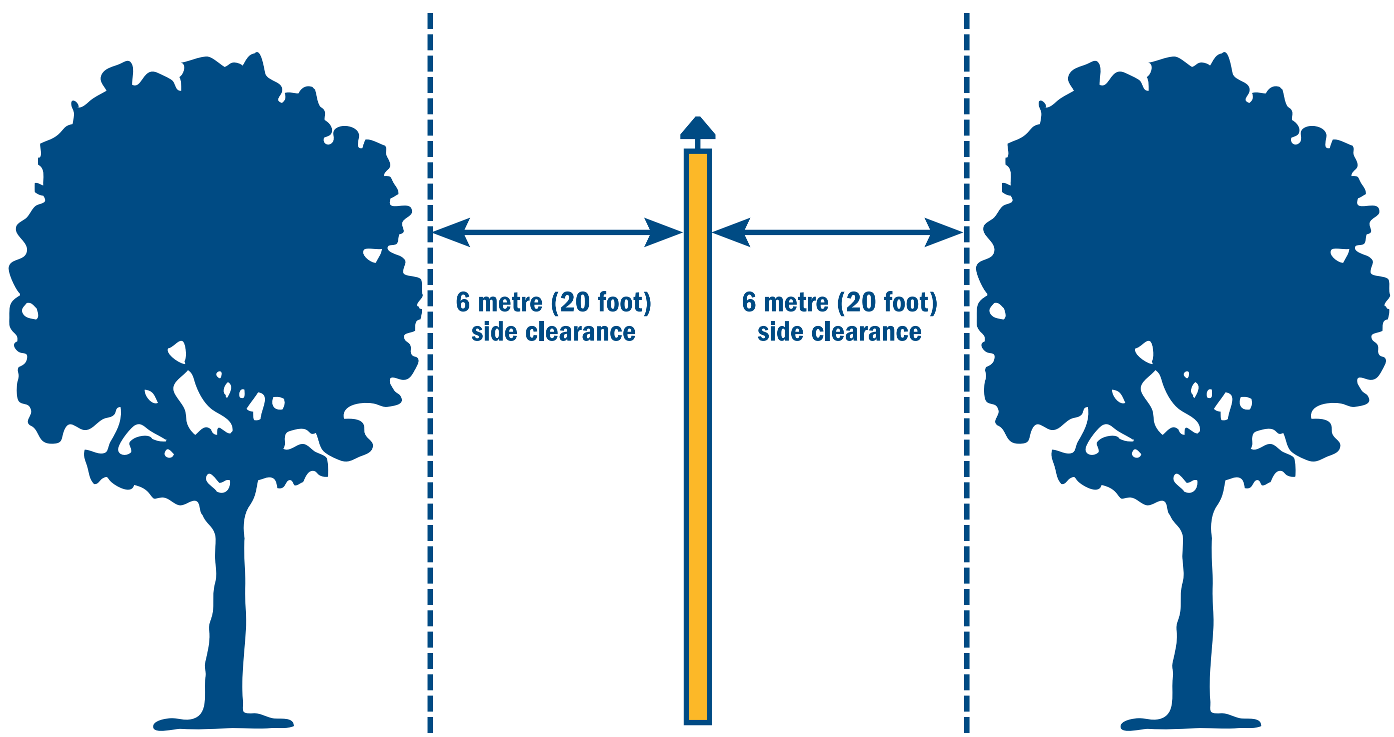
Nip future problems in the bud And keep your investment *growing*

Tall-growing trees that come in contact with power lines can present a safety risk to people and animals. Most of the time, it will interrupt your power. Every year trees that grow into power lines cause more than 70,000 hours of outage time – an inconvenience that can be avoided.

FortisAlberta has an extensive tree and brush clearing program which helps to avoid safety hazards associated with contacts to power lines. However, it is important that customers realize the importance of planting tall-growing trees a safe distance from electrical equipment.

It is very important that customers plant new tall-growing trees at least eight metres from power lines. Trees planted near higher voltage transmission lines require even greater clearances.

Trees are an investment and it is important that trees are safe, now and in the future. Nip tomorrow's problems in the bud by planting trees in safe locations today – and keep your investment growing.



For a standard 8 kV or 14.4 kV power line

HEDGE MATERIAL SUITABLE FOR PLANTING NEAR A POWER LINE:

Tree Name		*Height at Maturity*
Caragana**	Common	3 m (10 ft)
	Globe	1 m (3 ft)
	Pygmy	1 m (3 ft)
Cherry**	Nanking	2 m (7 ft)
Cotoneaster**	Hedge	2 m (7 ft)
Cranberry**	Nannyberry	5 m (16 ft)
	Wayfaring Tree	3 m (10 ft)
Dogwood**	Red Osier	2 m (7 ft)
Honeysuckle**	Clavey's Dwarf	1 m (3 ft)
	Tartarian	3 m (10 ft)
	Zabel's	2 m (7 ft)
Lilac**	Common	3 m (10 ft)
	Late	3 m (10 ft)
Pricepia**		3 m (10 ft)
Potentilla		1 m (3 ft)

***suitable for planting in Chinook Region.*

For information on tree planting and pruning, contact your local nursery or garden centre.

CAUTION:

May plant near a power line*

Tree Name	*Height at Maturity*
Pincherry *(Prunus pensylvanica)*	5 m (16 ft)
Western Chokecherry *(Prunus virginiana Melanocarpa)***	5 m (16 ft)
Black cherry *(Prunus serotina)*	6 m (20 ft)
Tartarian maple *(Acer tataricum)***	6 m (20 ft)
Amur maple *(Acer ginnala)***	4 m (13 ft)
Flowering crabapples *(Malus baccata)***	5 m (16 ft)
Hawthorns *(Crataegus sp.)***	5 m (16 ft)
Showy mountain ash *(Sorbus decora)***	5 m (16 ft)
Green's mountain ash *(Sorbus scopulina)*	5 m (16 ft)
French pussy-willow *(Salix caprea)***	5 m (16 ft)
Mugo pine *(Pinus Mugo rostrata)***	6 m (20 ft)
Pyramidal white cedar *(Thuja o "Pyramidalis)*	5 m (16 ft)
Montgomery blue spruce *(Picea pungens "Montgomery")*	3 m (10 ft)
Caragana *(Caragana arborescens)***	3 m (10 ft)
Hedge cotoneaster *(Cotoneaster lucidus)***	2 m (7 ft)
Highbush cranberry *(Viburnum trilobum)***	3 m (10 ft)
Nannyberry *(Viburnum Lentago)***	5 m (16 ft)
Dogwood *(Cornus sp.)***	3 m (10 ft)
Elder *(Sambucus sp.)***	4 m (13 ft)
Honeysuckle *(Lonicera sp.)***	3 m (10 ft)
Lilac *(Syringa sp.)***	5 m (16 ft)
Saskatoon *(Amerlanchier alnifola)*	4 m (13 ft)

**May require trimming under most favourable soil and climatic conditions.*
***Suitable for planting in Chinook region.*

DO NOT PLANT WITHIN EIGHT METRES OF A POWER LINE:

Tree Name	*Height at Maturity*
Trembling aspen *(Populus tremuloides)*	18 m (60 ft)
Balsam poplar *(Populus balsamifera)*	20 m (65 ft)
Northwest poplar *(Populus x. "Northwest")*	20 m (65 ft)
Plains cottonwood *(Populous deltoids)*	30 m (90 ft)
White spruce *(Picea glauca)*	15 m (50 ft)
Blue spruce *(Picea p. "Glauca")*	15 m (50 ft)
Manitoba maple *(Acer Negundo)*	14 m (45 ft)
Laurel leaved willow *(Salix pentandra)*	15 m (50 ft)
Golden leaved willow *(Salix alba vitellina)*	15 m (50 ft)
Sharp leaf willow *(Salix acutifolia)*	10 m (35 ft)
Green ash *(Fraxinus pensylvanica "lanceolata")*	15 m (50 ft)
Patmore green ash *(Fraxinum pensylvanica "Patmore")*	15 m (50 ft)
American elm *(Ulmus americana)*	20 m (65 ft)
Brandon elm *(Ulmus Americana "Brandon")*	15 m (50 ft)
Siberian elm *(Ulmus pumila)*	12 m (40 ft)
Paper birch *(Betula papyrifa)*	12 m (40 ft)
European white birch *(Betula pendula)*	12 m (40 ft)
Cut-leaved weeping birch *(Betula pendula "Gracilis")*	20 m (65 ft)
Slender weeping birch *(Betula pendula "Tristis")*	12 m (40 ft)

For more information on tree-to-tree power line clearances call FortisAlberta at 310-WIRE.

FORTIS ALBERTA

SCHEDULE "A" FOR SERVICES < 75kW

As part of the quotation package, this document includes key information about your quote and construction for your new electrical service or electrical service upgrade. Items within this document may not apply to everyone. It is important that you, the customer, or as the representative of someone who has requested a quote, read thoroughly.

Upon receiving your signed acceptance letter included with this quotation package, a FortisAlberta employee will contact you to discuss details of your upcoming construction and installation dates.

ABOUT YOUR QUOTATION

1) The terms in this quotation package will be effect for 60 days from the date of this letter. If the signed acceptance from the customer is not received within 60 days, FortisAlberta reserves the right to re-quote these costs and terms of your new electrical service.

2) By signing your quotation package you are officially authorizing FortisAlberta to proceed with construction.

3) The quotation is conditional upon FortisAlberta obtaining necessary outside approvals and easements, if required. This may mean accessing approvals from municipal or provincial governments.

4) The Customer Terms and Conditions of Electric Distribution Service govern the relationship between FortisAlberta and the customer as filed and are approved by the Alberta Utilities Commission. When you have signed and returned the quotation package to FortisAlberta, it is deemed that you have also accepted these Terms and Conditions. The Customer Terms and Conditions can be viewed on our website at www.fortisalberta.com.

ABOUT CONSTRUCTION

1) The construction of your new electric service or service upgrade does not include any costs associated with brushing, alignment or access.

2) This also means FortisAlberta does not assume the availability of the proposed right of way for the line route or permission to brush along this line route if necessary.

3) A FortisAlberta representative will confirm the project scope upon your acceptance. Should project parameters change or the scope of the project differ from the quote letter, it may be necessary to review the overall costs and submit an updated proposal for your consideration. This includes if the project scope changes due to external influences and/or the customer.

HOW TO ENERGIZE THE SITE

When this quotation package has been signed and returned to FortisAlberta, the customer will receive a site identification number (site ID).

1) You will then use the site ID to enroll your site and create an account with your chosen retailer. You must also have a valid electrical permit is on site or authorization issued by the inspection authority having jurisdiction.

2) The Retailer will then submit an energize order through FortisAlberta to allow the physical connection of the site. They will advise you about anticipated timelines.

IMPORTANT TO KNOW

1) All energy negotiations must be completed with your Retailer for the energy portion of your rate.

2) Alberta's Deregulated electrical industry allows you to choose a Retailer that suits your electrical energy needs. A list of Retailers can be found at ucahelps.gov.ab.ca or call 310-4822.

3) You must enroll their site within 30 days after the construction is complete.

4) If you do not enroll with a Retailer within 30 days, FortisAlberta will enroll you with the Regulated Rate Option Retailer (EPCOR). The billing of the rate minimums will commence regardless if electric consumption is used.

DISTRIBUTION TARIFF

As a regulated utility, FortisAlberta is required to flow through charges and refunds related to services provided by the Alberta Electric System Operator (AESO) and include taxes set by municipal councils and the provincial government. Distribution is only one component of a customer's electricity bill. In addition, the total bundled bill includes transmission, retail energy charges and riders. These charges are included in the bill from your Retailer.

Distribution Access Tariff charges will commence 30 days after installation date or upon service connection, whichever comes first.

The Rate Minimums can be found on FortisAlberta's website www.fortisalberta.com in the Rates, Options and Riders Schedule.

REGISTERED OWNER

If you are not the registered owner of the property, by signing the Quotation Acceptance/Notification to Proceed page, you are authorizing FortisAlberta to notify the registered owner of the property regarding the nature of the proposed service and this may include any information that you are providing to FortisAlberta.

CANCELLATION FEES

Once you have signed and accepted the terms of this quotation package, FortisAlberta will initiate construction. If you cancel the project after this time, you may be responsible for direct and indirect costs incurred by FortisAlberta.

TO PERMANENTLY DISCONNECT SERVICE

You or the registered landowner of the property may be responsible for costs to permanently disconnect an existing service. These charges may include any costs associated to initially build the service and costs to salvage.

PRIVACY ACT

FortisAlberta collects and uses personal information about customers to establish and manage the relationship necessary to provide electricity distribution services to customers.

FortisAlberta is committed to complying with the privacy legislation that governs how personal information must be managed and protected and therefore requires your signature on this quote as consent to collect and use the information necessary to establish a business relationship.

FortisAlberta complete privacy statement is on the web site at www.fortisalberta.com.

Appendix D.16 Heat Meter Data Sheets

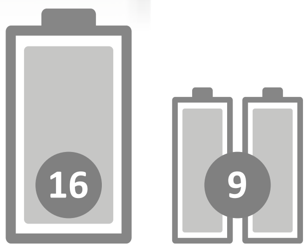
kamstrup

Data sheet

MULTICAL® 603

The future-proof heat and cooling meter with full flexibility

- Fully programmable data logger with minute loggers
- 2 second integration interval
- 16 years battery lifetime at a reading interval down to 10 seconds
- Possibility of built-in M-Bus
- 2 communication modules
- 7 or 8 digit display resolution
- User-friendly interface with 3 push buttons
- Possibility of backlit display
- Auto Detect of ULTRAFLOW®



MID

CE M17 0200

EN 1434

DK-BEK 1178 – 06/11/2014

DK 268 17

EN 1434

Contents

Description

MULTICAL® 603 is an all-round calculator, suitable as heat meter, cooling meter or combined heat/cooling meter together with 1 or 2 flow sensors and 2 or 3 temperature sensors. The meter is intended for energy measurement in almost all types of thermal installations where water is used as the energy-conveying medium.

MULTICAL® 603 can, in addition to heat and cooling measurement, be used for leakage monitoring, permanent performance monitoring, as power and flow limiter with valve control as well as for energy measurement in both open and closed systems.

According to EN 1434 and MID, MULTICAL® 603 can be designated as a "calculator" with separate type approval and verification, and it can be delivered either as a separate calculator or as a complete meter, with mounted temperature sensors and flow sensor according to customer requirements.

MULTICAL® 603 has 2 flow sensor inputs that can be used for both electronic and mechanical flow sensors. The pulse figure can be programmed from 0.001 to 300 pulses/liter, and the calculator can be programmed to all nominal flow sensor sizes from 0.6 to 15,000 m^3/h. The calculator can be delivered with both galvanically connected and separated flow sensor inputs.

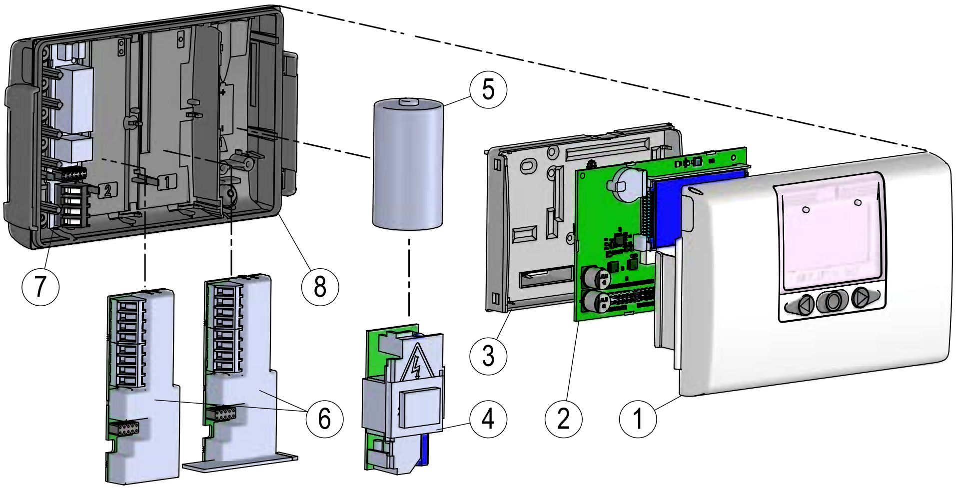
The accumulated heat energy and/or cooling energy can be displayed in kWh, MWh, GJ or Gcal, all in the form of seven or eight significant digits plus measuring unit. The display has been specially designed with a view to obtaining long lifetime and sharp contrast in a wide temperature range. Furthermore, MULTICAL® 603 can be delivered in a variant with backlit display (type 603-F).

MULTICAL® 603 is powered by an internal D-cell lithium battery with a lifespan of up to 16 years or a 2xAA lithium packet with a lifespan of up to 9 years. Alternatively, the meter can be mains supplied, either by 24 VAC or 230 VAC.

In designing MULTICAL® 603, great importance has been attached to flexibility through programmable functions and plug-in modules in order to secure optimum use in a wide range of applications. The meter has been configured from the factory and is ready for use. It can, however, be changed/reconfigured after installation via the front keys of the meter, READy or METERTOOL HCW.

Auto Detect enables the exchange of ULTRAFLOW® X4 on MULTICAL® 603 without the need for reconfiguration (change of the CCC code). MULTICAL® 603 can automatically adjust the pulse figure and q_p to match the connected ULTRAFLOW® X4 via Auto Detect. Auto Detect is active with CCC code 8xx and is initiated when the calculator top and base are separated and reassembled.

Mechanical construction



1	Calculator top with front keys and laser engraving
2	PCB with microcontroller, display, etc.
3	Verification cover (may only be opened at an authorised laboratory)
4	Either a power supply module can be mounted…
5	… or a battery can be mounted
6	1 or 2 communication modules
7	Connection of temperature sensors and flow sensors
8	Calculator base

Mechanical data

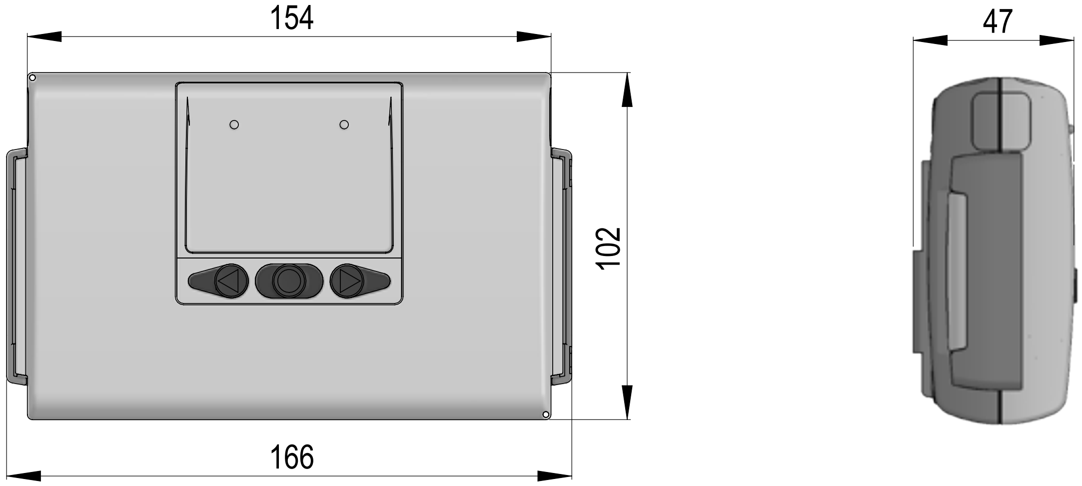
Environmental class	Complies with EN 1434 class A and C (MID class E1 and E2)
Ambient temperature	5…55 °C non-condensing, closed location (installation indoors)
Protection class	Calculator: IP65 according to EN/IEC 60529
Medium temperatures ULTRAFLOW®	2…130 °C At medium temperatures below ambient temperature or above 90 °C in the flow sensor, we recommend that the calculator is wall-mounted.
Medium in ULTRAFLOW®	Water (district heating water as described in CEN TR 16911 and AGFW FW510)
Storage temperature	-25…60 °C (drained flow sensor)
Connection cable	ø3.5…6 mm
Supply cable	ø5…8 mm

Materials

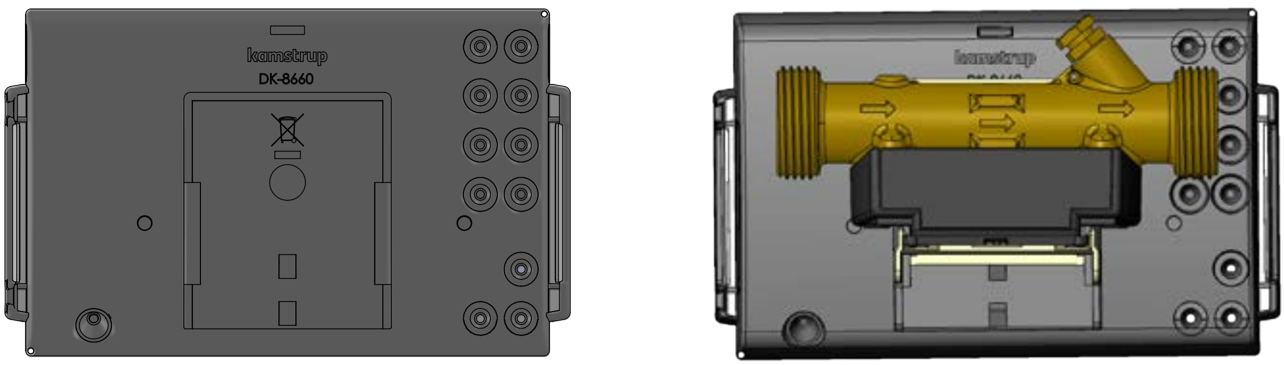
Calculator case	
– Top and base	Thermoplastic, PC 10 % GF with TPE (thermoplastic elastomer)
– Verification cover	ABS
Cables	Silicone cable with inner Teflon insulation

Dimensioned sketches

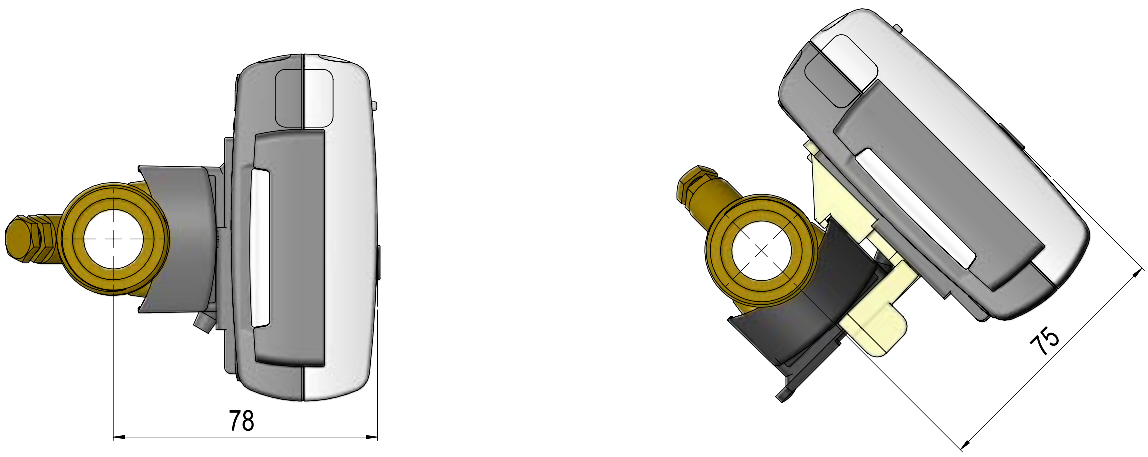
All measurements in [mm].



Mechanical measurements for MULTICAL® 603 calculator



Calculator base separate and mounted on ULTRAFLOW®



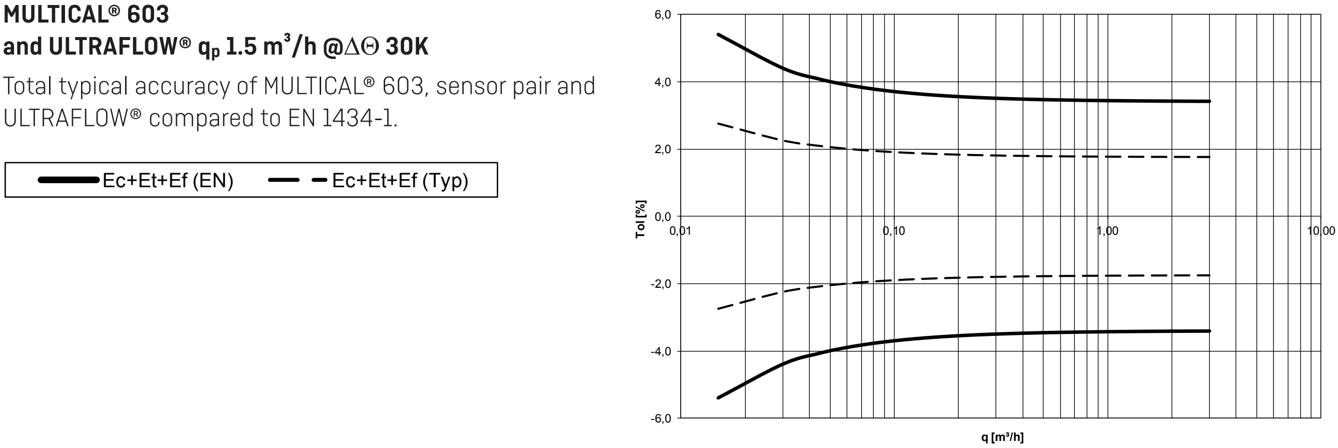
MULTICAL® 603 mounted on ULTRAFLOW® with G¾ threaded connection

Measurement accuracy

Heat meter components	MPE according to EN 1434-1	Typical accuracy
MULTICAL® 603	$E_c = \pm (0.5 + \Delta\Theta\ min/\Delta\Theta)$ %	$E_c = \pm (0.15 + 2/\Delta\Theta)$ %
Sensor pair	$E_t = \pm (0.5 + 3\ \Delta\Theta\ min/\Delta\Theta)$ %	$E_t = \pm (0.4 + 4/\Delta\Theta)$ %
ULTRAFLOW®	$E_f = \pm (2 + 0.02\ q_p/q)$, but not above ± 5 %	$E_f = \pm (1 + 0.01\ q_p/q)$ %

MULTICAL® 603
and ULTRAFLOW® q_p 1.5 m^3/h @$\Delta\Theta$ 30K

Total typical accuracy of MULTICAL® 603, sensor pair and ULTRAFLOW® compared to EN 1434-1.



Approved meter data

Approvals	DK-0200-MI004-040, heat meter according to MID 2014/32/EU and EN 1434:2015 TS 27.02 012, cooling meter according to DK-BEK 1178 and EN 1434:2015
EU directives	Measuring Instrument Directive, Low Voltage Directive, Electromagnetic Compatibility Directive, Radio Equipment Directive, RoHS directive
Heat meter approval – Temperature range – Differential area	DK-0200-MI004-040 θ: 2 °C…180 °C ΔΘ: 3 K…178 K
Cooling meter and cooling/heat meter – Temperature range – Differential area	TS 27.02 012 θ: 2 °C…180 °C ΔΘ: 3 K…178 K
Medium temperature, ULTRAFLOW®	θq: 2 °C…130 °C
Temperature sensor connection	Type 603-A Pt100 – EN 60751, 2-wire connection Type 603-B Pt100 – EN 60751, 4-wire connection Type 603-C/E/F Pt500 – EN 60751, 2-wire connection Type 603-D/G Pt500 – EN 60751, 4-wire connection
EN 1434 designation	Environmental class A and C
MID designation	Mechanical environment: Class M1 and M2 Electromagnetic environment: Class E1 and E2 Non-condensing environment, closed location (indoors), 5…55 °C

Electrical data

Calculator data	
Typical accuracy	Calculator: E_c ± (0.15 + 2/ΔΘ) % Sensor pair: E_t ± (0.4 + 4/ΔΘ) %
Display	LCD – 7 or 8 digits, digit height 8.2 mm
Resolutions	999,9999 - 9999,999 – 99999,99 – 999999,9 – 9999999 9999,9999 - 99999,999 – 999999,99 – 9999999,9 – 99999999
Energy units	MWh – kWh – GJ – Gcal
Data logger (EEPROM)	
– Logger contents	Programmable – all registers can be selected
– Logging interval	Programmable – from 1 minute to 1 year
– Logging depth	Programmable – standard: 20 years, 36 months, 460 days, 1400 hours (RR code = 10)
Info logger (EEPROM)	250 info codes (last 50 are shown in the display)
Clock/calender (with backup battery)	Clock, calendar, leap year compensation, target date
Daylight saving time/wintertime (DST)	Programmable This function can be disabled so that "technical normal time" is used
Time accuracy	Without external adjustment: Less than 15 min./year With external adjustment every 48 hours: Less than 7 s from legal time
Data communication	KMP protocol with CRC16 used for optical communication as well as for modules
Power in temperature sensors	< 10 μW RMS
Power supply	3.6 VDC ± 0.1 VDC
Battery	

	3.65 VDC, D-cell lithium	**3.65 VDC, 2xA cell lithium**
Wall-mounted	16 years @ t_{BAT} < 30 °C	9 years @ t_{BAT} < 30 °C
Mounted on flow sensor	14 years @ t_{BAT} < 40 °C	7 years @ t_{BAT} < 40 °C

Note: Depends on the meter and module configuration

Mains supply	230 VAC +15/-30 %, 50/60 Hz 24 VAC ±50 %, 50/60 Hz
Insulation voltage	3.75 kV
Power consumption	< 1 W
Backup supply	Integrated supercap eliminates interruptions due to short-term power failures (only supply modules type 7 and 8)
EMC data	Complies with EN 1434:2015, class A and C (MID class E1 and E2)

Electrical data

Temperature measurement	t1 Inlet	t2 Outlet	t3 Inlet	t4 Outlet	ΔΘ (t1-t2) Heat measure-ment	ΔΘ (t2-t1) Cooling measure-ment	t5 Preset for A1 and A2
Measuring range 603-A, 2-wire, Pt100 603-B, 4-wire, Pt100 603-C/E/F, 2-wire, Pt500 603-D/G, 4-wire, Pt500	0.00…185.00 °C (t1 and t2: Approved for 2.00…180.00°C)						
Offset adjustment	± 0.99 K joint zero point adjustment for t1, t2 and t3 **Note:** The offset adjustment is only active on measured temperatures. If, for example, t3 has been selected for a preset value, the offset adjustment will not influence the preset value.						

Max cable lengths (max ø6 mm cable)	Pt100, 2-wire	Pt100, 4-wire	Pt500, 2-wire	Pt500, 4-wire
	2 x 0.25 mm²: 2.5 m 2 x 0.50 mm²: 5 m 2 x 1.00 mm²: 10 m	4 x 0.25 mm²: 100 m	2 x 0.25 mm²: 10 m	4 x 0.25 mm²: 100 m

Flow measurement V1/V2	ULTRAFLOW® V1: 9-10-11 V2: 9-69-11	Reed contacts V1: 10-11 V2: 69-11	FET contacts V1: 10-11 V2: 69-11	24 V active pulses V1: 10B-11B
CCC-code	1xx-2xx-4xx-5xx-8xx	0xx	9xx	2xx and 9xx
EN 1434 pulse class	IC	IB	IB	(IA)
Pulse input	680 kΩ pull-up to 3.6 V	680 kΩ pull-up to 3.6 V	680 kΩ pull-up to 3.6 V	12 mA at 24 V
Pulse ON	< 0.4 V in > 0,5 ms	< 0.4 V in > 300 ms	< 0.4 V in > 30 ms	< 4 V in > 3 ms
Pulse OFF	> 2.5 V in > 10 ms	> 2.5 V in > 100 ms	> 2.5 V in > 100 ms	> 12 V in > 10 ms
Pulse frequency	< 128 Hz	< 1 Hz	< 8 Hz	< 128 Hz
Integration frequency	< 1 Hz	< 1 Hz	< 1 Hz	< 1 Hz
Electrical isolation	No	No	No	2 kV
Max cable length	10 m	10 m	10 m	100 m
Max cable length with Cable Extender Box, Type 66-99-036	30 m	30 m	30 m	-

Pulse inputs In-A/In-B	Electronic switch	Reed-switch
Pulse input	680 kΩ pull-up to 3.6 V	680 kΩ pull-up to 3.6 V
Pulse ON	< 0.4 V in > 30 ms	< 0.4 V in > 500 ms
Pulse OFF	> 2.5 V in > 30 ms	> 2.5 V in > 500 ms
Pulse frequency	< 3 Hz	< 1 Hz
Electrical isolation	No	No
Max cable length	25 m	25 m
Requirements to external contact	Leakage current at function open < 1 μA	

Pulse outputs Out-C/Out-D	Type HC-003-21	Type HC-003-11	Type HC-003-11
Pulse output type		Before 2017-05-01	After 2017-05-01
Type	Open collector (OB)	Open collector (OB)	Opto FET
External voltage	5…30 VDC	5…30 VDC	5…48 VDC/AC
Current	1…10 mA	1…10 mA	1…50 mA
Residual stress	U_{CE} ≈ 1 V at 10 mA	U_{CE} ≈ 1 V at 10 mA	R_{ON} ≤ 40 Ω
Electrical isolation	2 kV	2 kV	2 kV
Max cable length	25 m	25 m	25 m

Product variants

The required product variant is selected via the meter's type number, whereas the meter configuration is selected via the meter's configuration number. Further configuration parameters can be selected at submission of order. The meter has been configured from the factory and is ready for use. It can, however, be changed/reconfigured after installation via the front keys of the meter, READy or METERTOOL HCW.

MULTICAL® 603 type number

Statistical data Written on the meter's front | Dynamic data Appearing from display

Type 603- □ □ □□ – □ □□ □ □□ □□

Calculator type				
Pt100 2-wire	t1-t2	V1	M-Bus	A
Pt100 4-wire	t1-t2	V1	M-Bus	B
Pt500 2-wire	t1-t2	V1	M-Bus	C
Pt500 4-wire	t1-t2	V1	M-Bus	D
Pt500 2-wire	t1-t2-t3	V1-V2		E
Pt500 2-wire	t1-t2-t3	V1-V2	Backlit display	F
Pt500 4-wire	t1-t2	V1 (24 V active pulses)	M-Bus	G

Meter type			
Heat meter	MID module B		1
Heat meter	MID module B+D		2
Heat/cooling meter	MID module B+D & TS 27.02	θ_{HC} = OFF	3
Heat meter	National approval		4
Cooling meter	TS 27.02+BEK1178		5
Heat/cooling meter	MID module B+D & TS 27.02	θ_{HC} = ON	6
Volume meter			7
Energy meter			9

Country code	
Determined by Kamstrup upon receipt of order	XX

Flow sensor connection type	
Delivered with one ULTRAFLOW®	1
Delivered with two identical ULTRAFLOW®	2
Prepared for one ULTRAFLOW®	7
Prepared for two identical ULTRAFLOW®	8
Prepared for flow sensor with fast and bounce-free electronic pulses	C
Prepared for flow sensor with slow and bounce-free electronic pulses	J
Prepared for flow sensor with slow pulses with bounce	L
Prepared for flow sensor with 24 V active pulses	P

Product variants

MULTICAL® 603 type number

				Dynamic data Appearing from display			
			Type 603- □ □ □□ – □	□□	□	□□	□□
Temperature sensor set							
No temperature sensors				00			
PT500 temparature sensor pair							
Short direct sensor pair	27.5 mm	1.5 m		11			
Short direct sensor pair	27.5 mm	3.0 m		12			
Short direct pair (3 pairs)	27.5 mm	1.5 m		15			
Short direct pair (3 pairs)	27.5 mm	3.0 m		16			
Short direct sensor pair	38.0 mm	1.5 m		21			
Short direct sensor pair	38.0 mm	3.0 m		22			
Pocket sensor pair	ø5.8 mm	1.5 m		31			
Pocket sensor pair	ø5.8 mm	3.0 m		32			
Pocket sensor pair	ø5.8 mm	5.0 m		33			
Pocket sensor pair	ø5.8 mm	10.0 m		34			
Pocket sensor pair (3 pairs)	ø5.8 mm	1.5 m		35			
Pocket sensor pair (3 pairs)	ø5.8 mm	3.0 m		36			
Pocket sensor pair (3 pairs)	ø5.8 mm	5.0 m		37			
Pocket sensor pair (3 pairs)	ø5.8 mm	10.0 m		38			
Pt100 temperature sensor pair							
Short direct sensor pair	27.5 mm	2.0 m		J1			
Short direct sensor pair	38.0 mm	2.0 m		J2			
Supply							
No supply					0		
Battery, 1 x D-cell					2		
230 VAC high-power SMPS					3		
24 VAC/VDC high-power SMPS					4		
230 VAC power supply					7		
24 VAC power supply					8		
Battery, 2 x A-cells					9		
Communication module (2 module slots)							
No module						00	00
Data + 2 pulse inputs (In-A, In-B)						10	10
Data + 2 pulse outputs (Out-C, Out-D) + pulse transmitter (V1+V2)						11	11
M-Bus, configurable + 2 pulse inputs (In-A, In-B)						20	20
M-Bus, configurable + 2 pulse outputs (Out-C, Out-D)						21	21
M-Bus, configurable with Thermal Disconnect						22	22
Wireless M-Bus, EU, configurable, 868 MHz + 2 pulse inputs (In-A, In-B)						30	30
Wireless M-Bus, EU, configurable, 868 MHz + 2 pulse outputs (Out-C, Out-D)						31	31
Analog output module 2x 0/4…20 mA						40	40
LON FT-X3 + 2 pulse inputs (In-A, In-B)						60	60
BACnet MS/TP (RS-485) + 2 pulse inputs (In-A, In-B)						66	66
Modbus RTU (RS-485) + 2 pulse inputs (In-A, In-B)						67	67

Meter configuration

The required product variant is selected via the meter's type number, whereas the meter configuration is selected via the meter's configuration number (shown below). The below overview shows the standard configurations. Contact Kamstrup A/S for information about further configuration posasibilities.

		A	B	CCC	DDD	EE	FF	GG	L	M	N	PP	RR	T	VVVV
Flow sensor position															
Inlet		3													
Outlet		4													
Measuring unit															
GJ			2												
kWh			3												
MWh			4												
Gcal			5												
Auto Detect CCC codes (UF x4)															
Normal resolution (7 digits)				807											
High resolution (8 digits)				818											
Static CCC codes															
Reed contact (7 digits)				0xx											
Electronic, fast pulses (7 digits)				1xx											
Electronic, fast pulses (8 digits)				2xx											
Kamstrup, UF X4 (7 digits)				4xx											
Kamstrup, UF X4 (8 digits)				5xx											
Electronic, slow pulses (7 digits)				9xx											
Display															
Heat meter (standard)					210										
Heat/cooling meter (standard)					310										
Cooling meter (standard)					510										
Tariffs															
No active tariff						00									
Power tariff						11									
Flow tariff						12									
t1-t2 tariff						13									
Inlet tariff						14									
Outlet tariff						15									
Time-controlled tariff						19									
Heat/cooling volume tariff						20									
PQ tariff						21									
Pulse inputs In-A/In-B															
10 m^3/h, 10 l/imp, pre-counter 1 (standard)							24	24							
Integration mode															
Adaptive mode (2-64 s)	Display on								1						
Normal mode (32 s)	Display on								2						
Fast mode (8 s)	Display on								3						
Mains mode (2 s)	Display on								4						
Adaptive mode (2-64 s)	Display off								5						
Normal mode (32 s)	Display off								6						
Fast mode (8 s)	Display off								7						
Mains mode (2 s)	Display & backlight on								9						
Leakage limits (V1/V2)															
OFF										0					
1.0 % of q_p + 20 % of q										1					
1.0 % of q_p + 10 % of q										2					
0.5 % of q_p + 20 % of q										3					
0.5 % of q_p + 10 % of q										4					
Cold water leakage limits (In-A/In-B)															
OFF											0				
30 min. without pulses											1				
One hour without pulses											2				
Two hours without pulses											3				

Meter configuration

A - B - CCC - DDD - EE - FF - GG - L - M - N - PP - RR - T - VVVV

		PP	RR	T	VVVV
Pulse outputs Out-C/Out-D					
Out-C: V1/1, Out-D: V2/1	3.9 ms	80			
Out-C: V1/1	3.9 ms	82			
Out-C: V1/4	22 ms	83			
E1 and V1 or E3 and V1	10 ms	94			
E1 and V1 or E3 and V1	32 ms	95			
E1 and V1 or E3 and V1	100 ms (0.1 s)	96			
Controlled output based on data commands		99			
Data logger profile					
Standard data logger profile			10		
Encryption level					
Common key				2	
Individual key				3	
Customer label					
Serial number					0000

Information code types in display

Display digit								
1	2	3	4	5	6	7	8	
Info	t1	t2	t3	V1	V2	In-A	In-B	Description
1								No voltage supply *
2								Low battery level
9								External alarm (e.g. via KMP)
	1							t1 Above measuring range or switched off
		1						t2 Above measuring range or switched off
			1					t3 Above measuring range or switched off
	2							t1 Below measuring range or short-circuited
		2						t2 Below measuring range or short-circuited
			2					t3 Below measuring range or short-circuited
	9	9						t1-t2 Invalid temperature difference
				1				V1 Communication error
					1			V2 Communication error
				2				V1 Wrong pulse figure
					2			V2 Wrong pulse figure
				3				V1 Air
					3			V2 Air
				4				V1 Wrong flow direction
					4			V2 Wrong flow direction
				6				V1 Increased flow (flow1 > q_s, for more than 1 hour)
					6			V2 Increased flow (flow2 > q_s, for more than 1 hour)
				7				V1/V2 Burst, water loss (flow1 > flow2)
					7			V1/V2 Burst, water penetration (flow1 < flow2)
				8				V1/V2 Leakage, water loss (M1 > M2)
					8			V1/V2 Leakage, water penetration (M1 < M2)
						7		In-A2 Leakage in the system
						8		In-A1 Leakage in the system
						9		In-A1/A2 External alarm
							7	In-B2 Leakage in the system **
							8	In-B1 Leakage in the system **
							9	In-B1/B2 External alarm

Note: Info codes are configurable. Therefore, it is not certain that all the parameters are available in a given MULTICAL® 603.

* This parameter of the info code does not appear from the current info code as it is only active when the meter is without supply.

** The info code for leakage at pulse input B must be actively selected.

Accessories

Article number	Description
HC-993-02	Battery module with one D-cell
HC-993-03	230 VAC high-power supply module
HC-993-04	24 VAC/VDC high-power supply module
HC-993-07	230 VAC supply module
HC-993-08	24 VAC supply module
HC-993-09	Battery module with 2 A-cells
3026-207	Wall bracket
3026-858	Angle fitting ULTRAFLOW® (q_p 0.6...2.5)
3026-909	Holder for optical readout head for MULTICAL® 302/403/603
6699-035	USB module configuration cable
6699-099	Infrared optical reading head w/USB plug
6699-724	METERTOOL HCW
6699-725	LogView HCW

Calibration units

Article number	Description
6699-363	2-wire Pt500, Heat/Cooling (used with METERTOOL HCW)
6699-364	4-wire Pt500, Heat/Cooling (used with METERTOOL HCW)
6699-365	2/4-wire Pt100, Heat/Cooling (used with METERTOOL HCW)

Sensor nipples and pockets

Article number	Description
6556-491	R½ nipple for Pt500 short direct sensor
6556-492	R¾ nipple for Pt500 short direct sensor
6557-324	R½ x 65 mm sensor pocket, ø5.8 mm
6557-327	R½ x 90 mm sensor pocket, ø5.8 mm
6557-314	R½ x 140 mm sensor pocket, ø5.8 mm
6561-330	11 mm adapter for 38 mm short direct sensor

Ball valves

Article number	Description
6556-474	½" ball valve with M10 connection for short direct temperature sensor with flat gasket
6556-475	¾" ball valve with M10 connection for short direct temperature sensor with flat gasket
6556-476	1" ball valve with M10 connection for short direct temperature sensor with flat gasket
6556-526	1¼" ball valve with M10 connection for short direct temperature sensor with flat gasket
6556-527	1½" ball valve with M10 connection for short direct temperature sensor with flat gasket

Contact Kamstrup A/S for information about further accessories.

Kamstrup A/S • 58101516_C1_GB_10.2017

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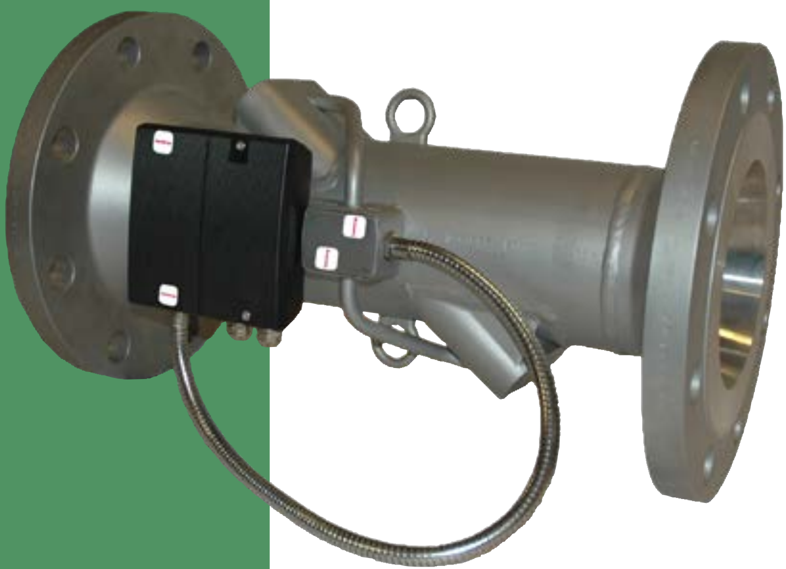
Data sheet

ULTRAFLOW® 54 DN150-300

- For flow from 150 m^3/h up to 1000 m^3/h
- Ultrasonic flow sensor
- Compact design
- Static meter, no moving parts
- Large dynamic range
- No wear
- High accuracy
- Longevity



MID 2014/32/EU

CE M18 0200

EN 1434

DK-BEK 1178 – 06/11/2014

DK 268 18

EN 1434

Contents

Application

ULTRAFLOW® 54 is a static flow sensor based on the ultrasonic measuring principle. It is primarily used as a volume flow sensor for energy meters such as MULTICAL®.

ULTRAFLOW® 54 has been designed for use in heating and cooling installations where water is the heat-bearing medium.

ULTRAFLOW® 54 employs ultrasonic measuring techniques and microprocessor technology. All calculating and flow measuring circuits are collected on one single board, thus providing a compact and rational design and, in addition, exceptionally high measuring accuracy and reliability is obtained.

The volume is measured using bidirectional ultrasonic technique based on the transit time method, with proven long-term stability and accuracy. Four ultrasonic transducers are used to send sound signals both against and with the flow. The ultrasonic signal travelling with the flow reaches the opposite transducer first. The time difference between the two signals can be converted into flow velocity and thereby also volume.

A three-wire signal cable is used to connect ULTRAFLOW® 54 to the Kamstrup MULTICAL® calculator. The cable supplies the flow sensor and also transfers the signal from sensor to calculator. A signal corresponding to the flow – or more correctly, a number of pulses proportional to the water volume flowing through – is transmitted.

ULTRAFLOW® 54 is available with internal supply, e.g. if the distance between MULTICAL® and ULTRAFLOW® 54 is 10 m or more.

If ULTRAFLOW® 54 is used for other equipment (e.g. other brands of calculators), the meter must be fitted with a galvanically separated output module and a supply of its own.

Approvals

Type approval

ULTRAFLOW® 54 is approved as a heat meter in accordance with MID 2014/32/EU:

EC-Type Examination certificate	DK-0200-MI004-008
MID-certificate acc. to module D	DK-0200-MID-D-001

ULTRAFLOW® 54 is approved as a cooling meter in accordance with DK-BEK 1178 – 06/11/2014:

System designation	TS 27.02 002
Verification	DANAK accreditation 268

Please contact Kamstrup A/S for further information relating to type approval and verification.

Standard

EN 1434:2015

CE-marking

ULTRAFLOW® 54 is marked in accordance with:

– EMC-directive	2014/30/EU
– LV-directive	2014/35/EU (when fitted with 230 VAC power supply)
– PE-directive	2014/68/EU (category II)

MID designation

– Mechanical environment	Class M1 and M2
– Electromagnetic environment	Class E1 and E2
– Ambient temperature	5...55 °C, closed location (indoor installation)

Technical data

Electrical data

Supply voltage	3.6 VDC ± 0.1 VDC
Supply, galvanically coupled output module (Y=1)	Powered by MULTICAL®
Supply, galvanically separated output module (Y=2) *	
– Mains supply	230 VAC +15/-30 %, 50 Hz 24 VAC ±50 %, 50 Hz
- Power consumption	< 1 W
- Backup	Integral SuperCap eliminates interruptions due to short-term power failures
Supply, galvanically separated output module (Y=3)	
– Battery	3.65 VDC, D-cell lithium
- Replacement interval	6-years @ t_{BAT} < 30 °C
– Mains supply	230 VAC +15/-30 %, 50 Hz 24 VAC ±50 %, 50 Hz
- Power consumption	< 1 W
- Backup	Integral SuperCap eliminates interruptions due to short-term power failures
Length of signal cable, flow sensor electronics box	
– Galvanically coupled output module (Y=1)	Max. 10 m (powered by MULTICAL® calculator) Max. 30 m via Cable Extender Box (powered by MULTICAL® calculator)
– Galvanically separated output module (Y=2 and Y=3)	Depending on the calculator.
EMC data	Fulfils EN 1434:2015 class C, MID E1 and E2

* It is possible to use battery supply in combination with output module (Y=2), e.g. for temporary supply of flow sensors installed at construction sites.

Technical data

Mechanical data

Metrological class	2 or 3
Environmental class	Fulfils EN 1434 class C
Ambient temperature	5…55 °C (indoors)
Protection class	IP67
Humidity	< 93 % RH non-condensing
Medium in flow sensor	Water (recommended water quality as in CEN TR 16911 and AGFW FW510)
Medium temperature	2…150 °C (Heat and heat/cooling meters) 2…130 °C (Heat/cooling meters) 2…50 °C (Cooling meters)

At medium temperatures above 90 °C or below ambient temperature the electronics box must be wall-mounted or mounted via the enclosed distance piece.

Storage temperature (empty sensor)	-25…60 °C
Pressure stage	PN16, PS16 PN25, PS25

Flow data

Nom. flow q_p [m³/h]	Nom. diameter [mm]	Meter factor * [imp./l]	Dynamic range q_p:q_i	q_s:q_p	Flow @125 Hz ** [m³/h]	$\Delta p@q_p$ [bar]	Min. cut off [l/h]
150	DN150	1	100:1	2:1	450	0.02	300
250	DN150	0.6	100:1	2:1	750	0.055	500
400	DN150	0.4	100:1	2:1	1125	0.04	800
400	DN200	0.4	100:1	2:1	1125	0.01	800
400	DN250	0.4	100:1	2:1	1125	0.01	800
600	DN200	0.25	100:1	2:1	1800	0.022	1200
600	DN250	0.25	100:1	2:1	1800	0.022	1200
1000	DN250	0.15	100:1	2:1	3000	0.015	2000
1000	DN300	0.15	100:1	2:1	3000	0.015	2000

* Default value. The meter factor appears from the ULTRAFLOW® label.

** Saturation flow. Max. pulse frequency is maintained at higher flow rates.

Materials

Wetted parts

Housing	Stainless steel, W.no. 1.4307
Transducer holder	Stainless steel, W.no. 1.4308
Transducer	Titanium
Gaskets	Fibre

Electronics box

Base	Thermoplastic, PC 10 % GF
Cover	Thermoplastic, PC 10 % GF
Fitting hardware and distance piece for the electronic box	Thermoplastic, PPS 40 % GF

Signal cable

Silicone cable (3 x 0.5 mm^2)

Power supply cable 24/230 VAC (optional)

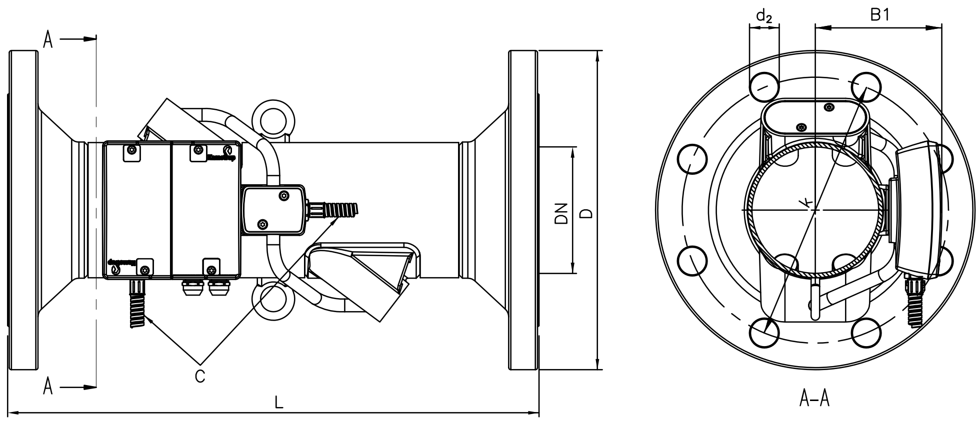
Cable with PVC mantle (2 x 0.75 mm^2)

Type summary

Nom. flow q_p [m^3/h]	Sizes		
150	DN150 x 500 mm		
250	DN150 x 500 mm		
400	DN150 x 500 mm	DN200 x 500 mm	DN250 x 600 mm
600	DN200 x 500 mm	DN250 x 600 mm	
1000	DN250 x 600 mm	DN300 x 500 mm	

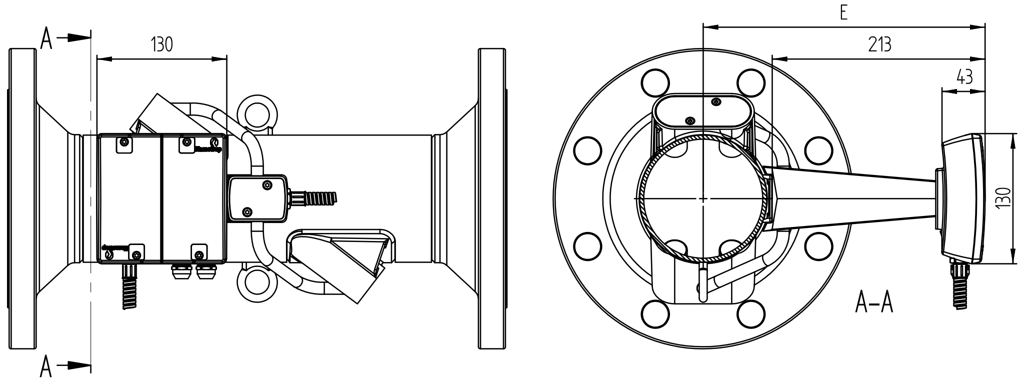
Flange EN 1092-1. Flange facing type B, raised face.

Dimensional sketches



Flange EN 1092-1. Flange facing type B, raised face.

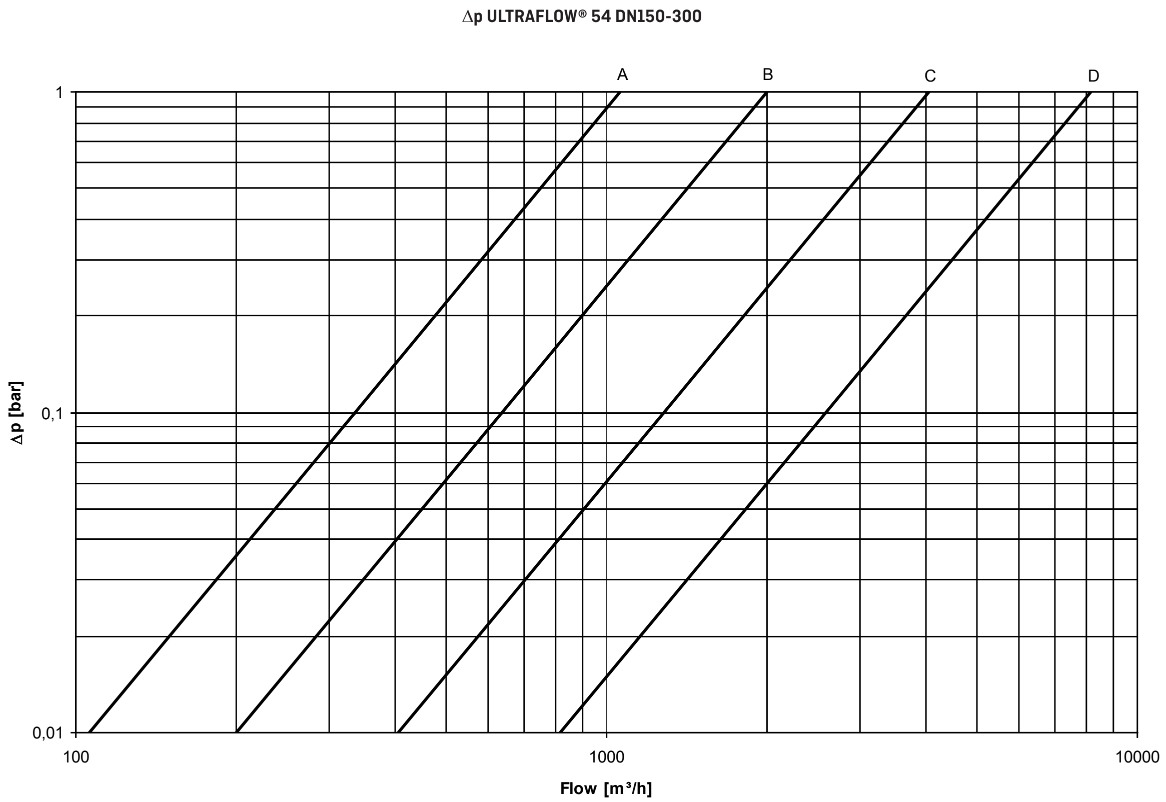
Nom. diameter [mm]	PN [bar]	Nom. flow q_p [m^3/h]	L [mm]	D [mm]	k [mm]	Bolts Quantity	Bolts Thread [mm]	Bolts d_2 [mm]	B1 [mm]	E [mm]	Steel tube length C [mm]	Approx. weight [kg]
DN150	25	150 & 250	500	300	250	8	M24	26	119	282	650	37
DN150	25	400	500	300	250	8	M24	26	140	303	625	36
DN200	25	400 & 600	500	360	310	12	M24	26	166	329	570	49
DN250	25	400 & 600	600	425	370	12	M27	30	166	329	570	79
DN250	25	1000	600	425	370	12	M27	30	194	357	500	75
DN300	16	1000	500	460	410	12	M24	26	194	357	500	76



Pressure loss

Graph	Nominal flow q_p [m³/h]	Nominal diameter [mm]	k_v *	q@0.25 bar [m³/h]
A	150 & 250	DN150	1060	530
B	400	DN150	2000	1000
C	400 & 600	DN200 & DN250	4040	2020
D	1000	DN250 & DN300	8160	4080

* $q = k_v \times \sqrt{\Delta p}$



Installation

Prior to installation of the flow sensor, the system should be flushed.

Correct flow sensor position (inlet or outlet) appears from the front label of MULTICAL®. The flow direction is indicated by an arrow on the flow sensor.

Please note: ULTRAFLOW® 54 may be lifted in the lifting rings only.

Pressure stage ULTRAFLOW® 54: PN16, PS16/PN25, PS25. See marking on label.

Temperature of medium, ULTRAFLOW® 54: 2…150 °C/ 2…130 °C/2…50 °C. See marking on label.

Mechanical environment: M1 and M2 (fixed installation with minimum vibration and fixed installation with considerable or high vibration level respectively). See marking on label.

Electromagnetic environment: E1 and E2 (housing/light industry and industry respectively). See marking on label.

The meter's signal cables must be drawn at min. 25 cm distance to other installations.

Climatic environment: Must be installed in environments with non-condensing humidity as well as in closed locations (indoors).

The ambient temperature must be within 5…55 °C.

Maintenance and repair: The flow sensor is verified separately and can, therefore, be separated from the calculator.

It is permitted to replace the supply and change the supply type. For battery supply a lithium battery with connector from Kamstrup A/S must be used. Lithium batteries must be correctly handled and disposed of (see Kamstrup document 5510-408, "Lithium batteries - Handling and disposal"). Other repairs require subsequent reverification in an accredited laboratory.

If ULTRAFLOW® 54 is connected via a galvanically coupled output module, the flow sensor may be connected to a Kamstrup MULTICAL® calculator only.

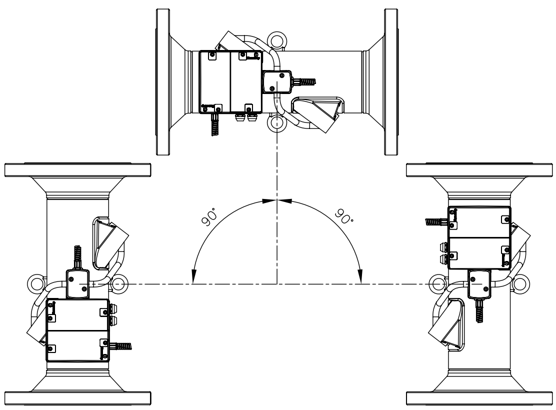
If other calculator types are connected, ULTRAFLOW® 54 must be fitted with a galvanically separated output module and a power supply of its own.

Please note: Make sure that meter factor of flow sensor and calculator are identical.

The steel tube between flow sensor housing and electronics box must not be disassembled.

At medium temperatures above 90 °C or below ambient temperature the flow sensor's electronics box must be mounted via the enclosed distance piece. Alternatively, the electronics box can be wall-mounted at a distance of minimum 170 mm from the sensor.

When the installation has been completed, water flow can be turned on. The valve on the inlet side must be opened first.



Installation angle of ULTRAFLOW® 54

ULTRAFLOW® 54 can be installed horizontally, vertically, or at an angle.

ULTRAFLOW® 54 is normally installed horizontally, with the lifting rings oriented vertically. The ultrasound paths in the flow sensor tube will thus be vertical, which is optimal in connection with possible stratification of the medium.

Straight inlet ULTRAFLOW® 54

ULTRAFLOW® 54 requires neither straight inlet nor outlet in order to fulfil the Measuring Instruments Directive (MID) 2014/32/EU and EN 1434:2015. Only in case of heavy flow disturbances before the meter will a straight inlet section be necessary.

We recommend following the guidelines in CEN CR 13582.

Operating pressure

In order to prevent cavitation, the back pressure at ULTRAFLOW® 54 (the pressure at the flow sensor outlet) must be min. 1.5 bar at q_p and min. 2.5 bar at q_s. This applies to temperatures up to approx. 80 °C.

Connection to calculator

ULTRAFLOW® 54 and MULTICAL®, galvanically coupled

If ULTRAFLOW® 54 and MULTICAL® are connected via output module (Y=1), ULTRAFLOW® 54 is galvanically coupled with MULTICAL® and is powered via the three-wire signal cable (cable length up to 10 m).

If ULTRAFLOW® must be connected to MULTICAL® with a cable length between 10 m and 30 m and galvanic separation is not necessary, a Cable Extender Box can be utilized. See document no. 5512-2008 (DK-GB-DE-RO) for further information.

Battery life time in e.g. MULTICAL® 602 is approximately 10 years depending on data communication to the calculator.

Note: It is not permitted to mount a supply module or battery in ULTRAFLOW® 54.

ULTRAFLOW® 54	→	MULTICAL®		
11	→	11	GND	(Blue)
9	→	9	+ 3.6 V	(Red)
10	→	10		(Yellow)

Connection to calculator

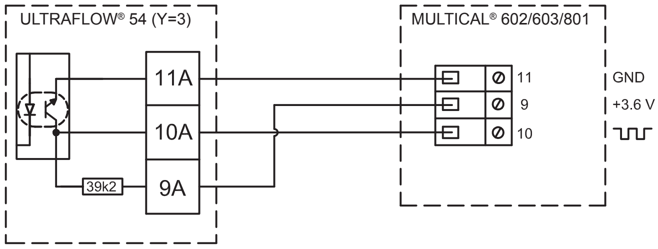
ULTRAFLOW® 54 and MULTICAL®, galvanically separated

If ULTRAFLOW® 54 and MULTICAL® are connected via output module (Y=2 or 3), ULTRAFLOW® 54 is galvanically separated from MULTICAL®.

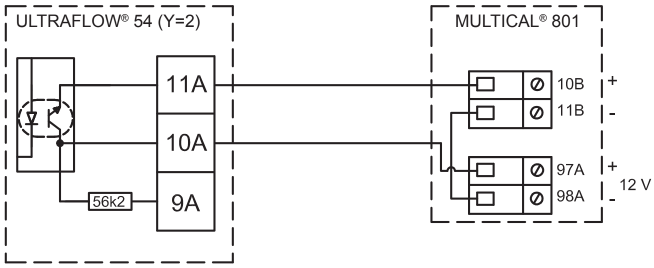
Maximum cable length depends on calculator.

Note: Flow info cannot be read.

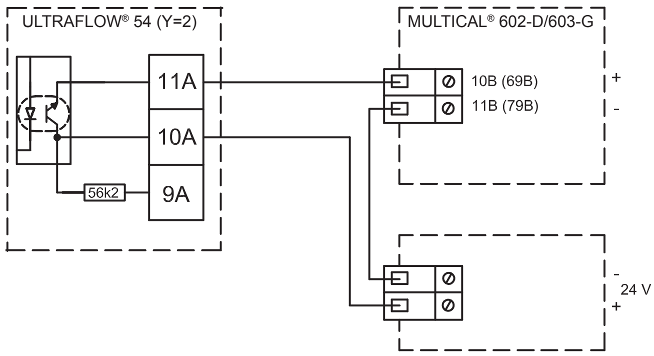
Three-wire connection,
MULTICAL® 602/603/801 via output module (Y=2 or 3).



Two-wire connection,
MULTICAL® 801 via output module (Y=2).



Two-wire connection,
MULTICAL® 602-D/603-G via output module (Y=2) and external 24 VDC supply.



When using long signal cables, careful consideration is required in connection with installation. Due to EMC there must be a distance of min. 25 cm between signal cables and all other cables.

Type numbers of ULTRAFLOW® 54 for MULTICAL®

Type number *	Nom. flow q_p [m³/h]	Min. flow q_i [m³/h]	Max. flow q_s [m³/h]	Connection [mm]	PN [bar]	Length [mm]	Meter factor [imp./l]	Material flow sensor housing
65-5-FCCN-XXX	150	1.5	300	DN150	25	500	1	Stainless steel
65-5-FDCN-XXX	250	2.5	500	DN150	25	500	0.6	Stainless steel
65-5-FECN-XXX	400	4.0	800	DN150	25	500	0.4	Stainless steel
65-5-FECP-XXX	400	4.0	800	DN200	25	500	0.4	Stainless steel
65-5-FECR-XXX	400	4.0	800	DN250	25	600	0.4	Stainless steel
65-5-FFCP-XXX	600	6.0	1200	DN200	25	500	0.25	Stainless steel
65-5-FFCR-XXX	600	6.0	1200	DN250	25	600	0.25	Stainless steel
65-5-FGCR-XXX	1000	10.0	2000	DN250	25	600	0.15	Stainless steel
65-5-FGDS-XXX	1000	10.0	2000	DN300	16	500	0.15	Stainless steel

* XXX-code pertaining to final assembly, approvals etc. – determined by Kamstrup A/S. Some variants may not be available in national approvals.

Type numbers for separate ULTRAFLOW® 54

Type number *	Nom. flow q_p [m³/h]	Min. flow q_i [m³/h]	Max. flow q_s [m³/h]	Connection [mm]	PN [bar]	Length [mm]	Material flow sensor housing
65-5-FCCN-YZ-XXX	150	1.5	300	DN150	25	500	Stainless steel
65-5-FDCN-YZ-XXX	250	2.5	500	DN150	25	500	Stainless steel
65-5-FECN-YZ-XXX	400	4.0	800	DN150	25	500	Stainless steel
65-5-FECP-YZ-XXX	400	4.0	800	DN200	25	500	Stainless steel
65-5-FECR-YZ-XXX	400	4.0	800	DN250	25	600	Stainless steel
65-5-FFCP-YZ-XXX	600	6.0	1200	DN200	25	500	Stainless steel
65-5-FFCR-YZ-XXX	600	6.0	1200	DN250	25	600	Stainless steel
65-5-FGCR-YZ-XXX	1000	10.0	2000	DN250	25	600	Stainless steel
65-5-FGDS-YZ-XXX	1000	10.0	2000	DN300	16	500	Stainless steel

* XXX-code pertaining to final assembly, approvals etc. –determined by Kamstrup A/S. Some variants may not be available in national approvals.

Type number composition of separate ULTRAFLOW® 54

In addition to the basic variants output module (Y), supply module (Z) as well as meter factor (CC) and pulse duration (E) must be selected.

The variant with galvanically coupled output module (Y=1) is solely for use together with MULTICAL®.

The variant with galvanically separated output module (Y=2 or 3) is used in the following situations:

A More than 10 m cable length between MULTICAL® and ULTRAFLOW® 54 is required (Y=2).

B As flow sensor no. 2 in connection with MULTICAL®.
If two flow sensors are used together with MULTICAL®, one must include a galvanically separated output module (Y=2 or 3).

C Together with other equipment/foreign calculators (Y=2 or 3).

Please note: Flow info cannot be read if output module with galvanic separation is used.

ULTRAFLOW® 54 **Type 65-5-** □□ □□ - Y Z - □□□

Dynamic range and flow

Connection and overall length

Output module

Supply module

Final assembly and marking

Type numbers of output and supply modules

Type number overview of output modules (Y) as well as supply modules (Z) for separate ULTRAFLOW® 54

Y	Output module	Corresponding supply module
1	Galvanically coupled module	0 (powered by MULTICAL®)
2	Galvanically separated module	0, 7, 8
3	Galvanically separated module, "Low power"	0, 2, 7, 8

Z	Supply module	Corresponding output module
0	No supply	1, 2, 3
2	Battery, D-cell	3
7	230 VAC supply module	2, 3
8	24 VAC supply module	2, 3

Programming variants of meter factor and pulse duration

Overview of programming variants of meter factor (CC) and pulse durations (E) for separate ULTRAFLOW® 54.

q_p	Meter factor			Pulse duration				
[m³/h]	[imp./l]	[l/imp.]	CC	[ms] (E=1)	[ms] (E=4)	[ms] (E=5)	[ms] (E=6)	
150	1		33	3.9	-	-	-	Default
150		10	34	-	20	-	-	
150		25	64	-	20	-	-	
150		100	35	-	20	50	100	
150		250	65	-	20	50	100	
150		1000	36	-	20	50	100	
150		2500	66	-	20	50	100	
250	0.6		43	3.9	-	-	-	Default
250		10	34	-	20	-	-	
250		25	64	-	20	-	-	
250		100	35	-	20	50	100	
250		250	65	-	20	50	100	
250		1000	36	-	20	50	100	
250		2500	66	-	20	50	100	
400	0.4		63	3.9	-	-	-	Default
400		100	35	-	20	50	-	
400		250	65	-	20	50	100	
400		1000	36	-	20	50	100	
400		2500	66	-	20	50	100	
600	0.25		14	3.9	-	-	-	Default
600		100	35	-	20	50	-	
600		250	65	-	20	50	-	
600		1000	36	-	20	50	100	
600		2500	66	-	20	50	100	
1000	0.15		24	3.9	-	-	-	Default
1000	(0.25)	4	14	3.9	-	-	-	*)
1000		100	35	-	20	50	-	
1000		250	65	-	20	50	-	
1000		1000	36	-	20	50	100	
1000		2500	66	-	20	50	100	

* Spare part for ULTRAFLOW® type 65-S/R/T q_p 1000. Configured 65-5-FGCR. No flow info.

Accessories

Description	Type number
Flange gaskets	
DN150, PN25 (1 pc.)	1150-140
DN200, PN25 (1 pc.)	1150-139
DN250, PN25 (1 pc.)	1150-141
DN300, PN16 (1 pc.)	1150-164
Supply	
D-cell lithium battery with two-pole connector	65000000-2000
230 VAC supply module	65000000-7000
24 VAC supply module	65000000-8000
Miscellaneous	
Short distance piece	6561-332
Cable Extender Box	6699-036

Cables

ULTRAFLOW® 54 DN150-300, when ordered with MULTICAL®, is delivered with 2.5 m signal cable, optionally 5 or 10 m. The cable is mounted in the ULTRAFLOW® 54 electronics box and in MULTICAL® 6xx.

When ULTRAFLOW® 54 is ordered with MULTICAL® 8xx, the calculator is delivered separately. Hence the cable is only mounted in the ULTRAFLOW® 54 electronics box.

ULTRAFLOW® 54 DN150-300, when ordered as a separate flow sensor, is optionally available with signal cable in lengths of 2.5, 5 or 10 m.
The cable is mounted in the ULTRAFLOW® 54 electronics box.

If 24/230 VAC supply module is selected, the sensor is optionally available with power cable. The cable is mounted in the sensor's electronics box from the factory.

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Data sheet

MULTICAL® 801

- Precise measuring of heat and cooling up to 30,000 m^3/h
- Remote reading with four communication channels
- 4 analogue outputs
- Two plug-in modules simultanously: GSM, M-Bus, RadioRouter, LonWorks pulse inputs for electricity and water meters
- Data logger with latest 460 days, 36 months and 15 years as well as programmable data logger
- Complies with EN 1434:2007 Class C and MID M1, E1 and E2

MID

CE M16 0200

DK-0200-MI004-009

IP67

Contents

Application

MULTICAL ® 801 is a robust and rugged calculator. It is ideal for buildings and industries using extra communication possibilities, programmable functions and a wide range of other modules.

MULTICAL® 801 is used for measurement of both heat and cooling in all water based plants with flow temperatures from 2 °C to 180 °C and with all flow meter sizes between qp 0.6 m^3/h and qp 30,000 m^3/h.

The meter is simple to install, read and verify. Furthermore,

MULTICAL® 801 contributes to keeping the annual operating costs at a minimum with its unique combination of high measuring accuracy and long lifetime.

If MULTICAL® 801 is connected to flow meters installed in both inlet and outlet pipes, the meter can monitor leaks and burst in the heating/cooling system. Furthermore, leakages in the tap water system can be monitored by means of pulses if a water meter is connected.

MULTICAL® 801 receives volume pulses from the connected flow meters and calculates the energy for every predetermined water volume. The energy calculation includes temperature measurements in inlet and outlet as well as correction for density and heat content according to EN 1434.

MULTICAL® 801 can be supplied by 230 VAC or 24 VAC.

MULTICAL® 801 can be extended by two independent modules in the form of GSM/GPRS, M-Bus, RadioRouter and LonWorks. The modules also include two extra pulse inputs for connection of water and electricity meters. The modules make remote reading of the meter possible.

MULTICAL® 801 fulfils the IP67 requirements to very rugged design and robust functionality. The IP67 seal guarantees that the meter is resistant to dust, humidity and water.

Pulse outputs, valve control, battery backup and many other features are standard functions in MULTICAL® 801.

Calculator functions

Energy calculation

MULTICAL® 801 calculates energy based on the formula in EN 1434-1:2007, in which the international temperature scale from 1990 (ITS-90) and the pressure definition of 16 bar is used.

The energy calculation can in a simplified way be expressed as:
Energy = V x ΔΘ x k.

V   is the supplied water volume

ΔΘ   is the temperature difference measured

k   is the thermal coefficient of water

The calculator always calculates energy in [Wh], and then it is converted into the selected measuring unit.

E [Wh] =	V x ΔΘ x k x 1000
E [kWh] =	E [Wh] / 1.000
E [MWh] =	E [Wh] / 1.000.000
E [GJ] =	E [Wh] / 277.780
E [Gcal] =	E [Wh] / 1.163.100

Application types

MULTICAL® 801 operates with 9 different energy formulas, E1…E9, that are all calculated in parallel in connection with each integration no matter how the meter is configured.

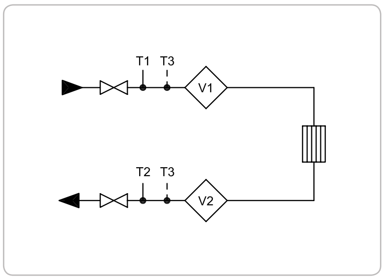
The energy types E1 to E9 are calculated as follows:

E1=V1(T1-T2)k	Heat energy	(V1 in inlet or outlet)
E2=V2(T1-T2)k	Heat energy	(V2 in outlet)
E3=V1(T2-T1)k	Cooling energy	(V1 in inlet or outlet)
E4=V1(T1-T3)k	Inlet energy	
E5=V2(T2-T3)k	Outlet energy or tapping from outlet	
E6=V2(T3-T4)k	Tap water energy, separate	
E7=V2(T1-T3)k	Tap water energy, inlet pipe	
E8=m^3xT1	(Inlet pipe)	
E9=m^3xT2	(Outlet pipe)	

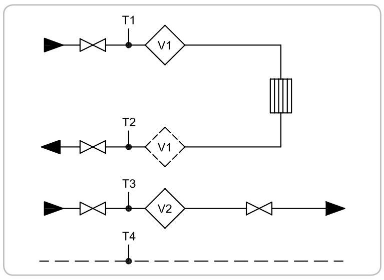
This renders MULTICAL® 801 capable of calculating the heat and cooling energy of most applications, both closed and open systems.

All energy types are data logged and can be displayed independent of configuration.

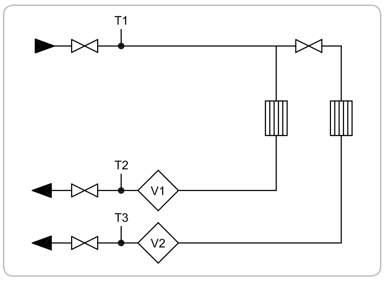
Calculator functions



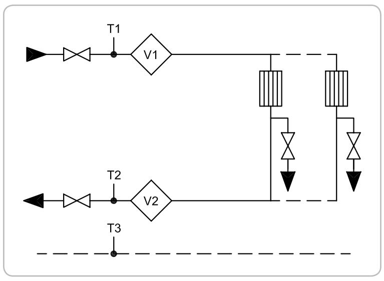
Example 1:
Closed thermal system with 1 or 2 flow meters



Example 2:
Closed thermal system with 2 flow meters



Example 3:
2 heat circuits with joint flow

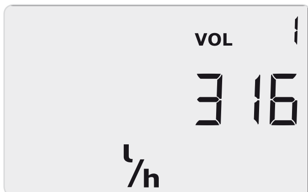


Example 4:
Open system with 2 flow meters

Flow measurement

MULTICAL® 801 calculates current water flow according to two different principles depending on the connected flow meter type:

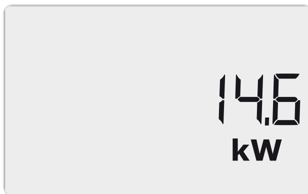
- The flow indication of electronic flow meters is updated every 10 seconds.
- The flow indication of mechanical flow meters, typically with reed contact, is calculated on the basis of periodic time measurement and is updated with each volume pulse.



Power measurement

MULTICAL® 801 calculates current power on the basis of current water flow and the temperature difference measured in connection with the latest integration.

Current power is updated in the display simultaneously with the flow update.



Calculator functions

Min. and max. flow and power

MULTICAL® 801 registers minimum and maximum flow and power on a monthly as well as on a yearly basis. The registrations which appear from the display or can be read via data communication include max. and min. flow and power values, all with date indication.

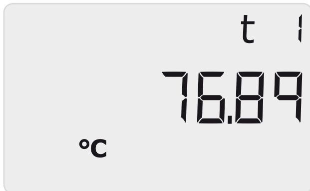
All max. and min. values are calculated as largest and smallest average respectively of a number of current flow or power measurements. The average period used for all calculations is selected in the interval 1…1440 min.

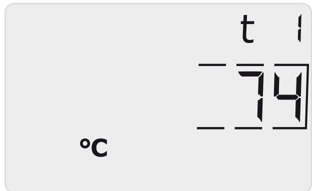
Temperature measurement

MULTICAL® 801 is available in different versions for either Pt100 or Pt500 sensors as well as in 2-wire and 4-wire versions.

The measuring circuit includes a high resolution analog/digital converter with a temperature range of 0.00…185.00 °C.

In addition to current temperatures used for the energy calculation, average temperatures on a yearly and monthly basis can also be displayed.

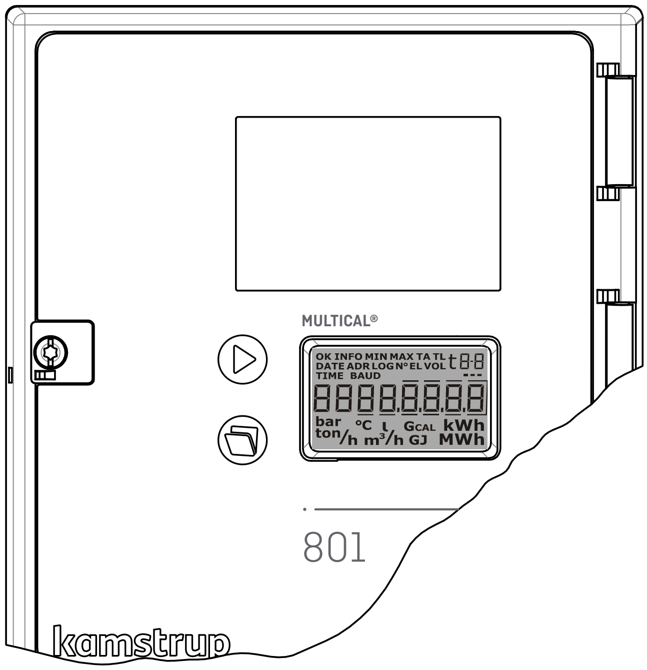




Display functions

MULTICAL® 801 is equipped with a clear LC display including 8 digits, units of measurement and information panel. In connection with energy and volume readings, 7 digits are used, together with the relevant unit, whereas 8 digits are used when e.g. the meter number is displayed.

As a starting point the display shows accumulated energy. When the push buttons are activated the display reacts immediately by calling other readings. The display automatically returns to accumulated energy reading 4 minutes after the latest activation of the push buttons..



The upper push button is used to switch between the primary readings. The consumers typically use the first primary readings in connection with self-reading for billing purposes.
The lower push button is used to show secondary information on the selected primary reading.

Calculator functions

Info codes

MULTICAL® 801 constantly monitors a number of important functions, e.g. power supply, temperature sensors and leakage alarms. Should a serious error occur in the measuring system or in the installation, a flashing 'info' will appear in the display whilst the error exists. The 'info' panel will automatically disappear when the error has been corrected.

An info event logger indicates how many times the info code has been changed.

The info logger stores the latest 50 changes, of which 36 can be displayed.

Standard

Info code	Description	Response time
0	No irregularities	-
1	The supply voltage has been interrupted	-
8	Temperature sensor T1 outside measuring range	1...10 min.
4	Temperature sensor T2 outside measuring range	1...10 min.
32	Temperature sensor T3 outside measuring range	1...10 min.
64	Leak in cold water system	24 hours
256	Leak in heating system	24 hours
512	Burst in heating system	120 sec.

ULTRAFLOW® X4 info (enabled when CCC=4XX)

Info code	Description	Response time
16	Flow meter V1 communication error	After reset and 24 hours (at 00:00)
1024	Flow meter V2 communication error	After reset and 24 hours (at 00:00)
2048	Flow meter V1 wrong pulse value	After reset and 24 hours (at 00:00)
128	Flow meter V2 wrong pulse value	After reset and 24 hours (at 00:00)
4096	Flow meter V1, signal too weak (air)	After reset and 24 hours (at 00:00)
8192	Flow meter V2, signal too weak (air)	After reset and 24 hours (at 00:00)
16384	Flow meter V1 wrong flow direction	After reset and 24 hours (at 00:00)
32768	Flow meter V2 wrong flow direction	After reset and 24 hours (at 00:00)

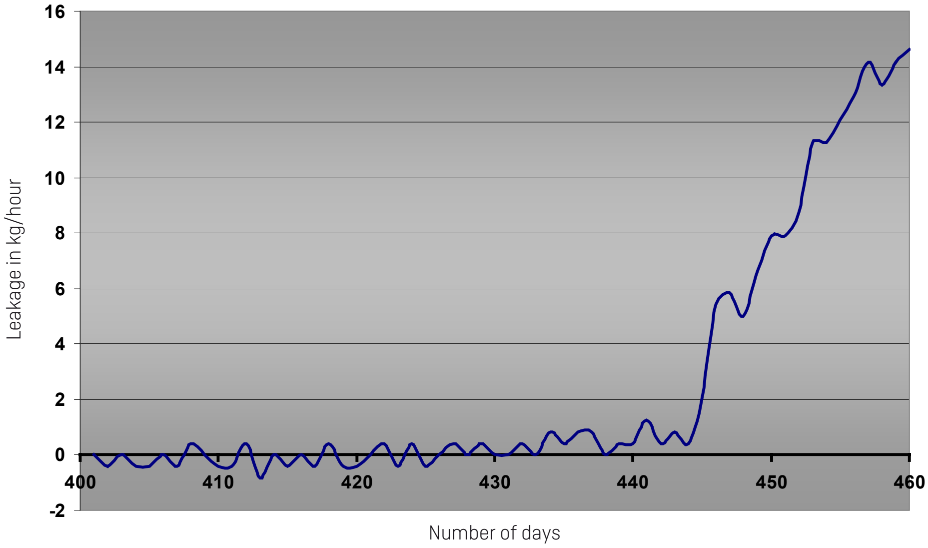
Data loggers

MULTICAL® 801 contains a permanent memory (EEPROM), where the results of a number of various data loggers are stored. The meter contains the following data loggers which can be read on the display or via serial data:

Data logging interval	Data logging depth	Logged value
Yearly logger	15 years	Counter register
Monthly logger	36 months	Counter register
Daily logger	460 days	Consumption (increase)/day
Programmable data logger	1080 loggings (e.g. 45 days' hour loggings or 11 days' 15 min. loggings)	30 registers and values
Info logger	50 events	Info code and date

Calculator functions

Leak surveillance



District heating systems

The leak surveillance system is primarily intended for direct connected district heating installations. The surveillance system consists of two flow meters based on the ultrasonic principle, placed in the inlet and outlet pipes respectively, and of temperature sensors in both pipes. MULTICAL® 801 monitors the mass difference that may appear between inlet and outlet pipes.

Tap water systems

The pulse signal from a tap water meter can be connected to MULTICAL® 801. In this way it is possible to monitor the tap water consumption. A running toilet cistern, leaky heating coils in the water tanks or other leaks can be monitored. If pulses from the tap water meter are received continuously for 24 hours, this indicates leakage.

Pulse outputs CE and CV

MULTICAL® 801 has pulse outputs for energy and volume pulses respectively. CE on terminals 16-17 releases one pulse per least significant digit of the energy count in the display and CV on terminals 18-19 releases one pulse per least significant digit of the volume count in the display.

If a higher resolution of pulse outputs is required, a CCC code with high resolution must be selected.

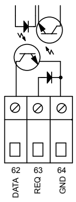
Calculator functions

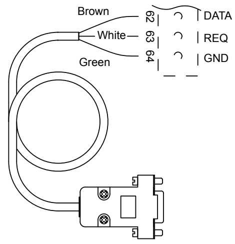
Pulse inputs VA and VB

MULTICAL® 801 has two pulse inputs, VA and VB, to collect and accumulate pulses remotely, e.g from tap water meters and electricity meters. The pulse inputs are physically placed on 'Module 1'.

The pulse inputs VA and VB function independently of the other inputs/outputs.

Data connection [62-64]





MULTICAL® 801 has data connection on terminals 62-63-64. The data connection is passive and optoisolated, as shown in the block diagram to the right. Adaption to RS232 level is possible via data cable type 6699-106. Adaption to USB is possible via data cable 6699-098.

The data connection uses the KMP protocol. Please contact Kamstrup for further details on the KMP protocol.

Voltage supply

MULTICAL® 801 is available with 230 VAC or 24 VAC supply voltage. Both types have battery backup that ensures the operation of the RTC and the energy calculation during power failure.

Plug-in modules

Two plug-in modules, Module 1 and 2, can be added to MULTICAL® 801, in order for the meter to adapt to various applications and data reading methods.

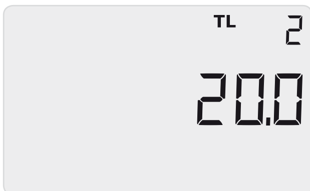
Programming and verification

METERTOOL HCW is a Windows® -based software which includes all facilities for calculator programming. If the software is used together with VERIFICATION EQUIPMENT for MULTICAL® 801, the calculator can be tested and verified.

Tariff functions

MULTICAL® 801 has 2 extra registers, TA2 and TA3, to accumulate energy in parrallel to the main register based on a programmed tariff condition. Regardless of the tariff type selected, the tariff registers will be displayed as TA2 and TA3.

The main register is always accumulated, irrespective of the selected tariff function, since it is considered to be the legal billing register. Tariff conditions TL2 and TL3 are monitored before each integration. If the tariff conditions are fulfilled, the consumed heat energy is accumulated in either TA2 or TA3, as well as in the main register.



Cabinet design

Approved meter data

Approval	DK-0200-MI004-009
Standard	EN 1434:2007 and OIML R75:2002
EU-directives	
– MID (Measuring Instruments Directive)	
– LVD (Low Voltage Directive)	
– EMC (Electromagnetic Compatibility Directive)	
Temperature range	θ: 2...180 °C
Differential range	$\Delta\Theta$: 3...170 K
Accuracy	E_C ±(0,5 + $\Delta\Theta_{min}/\Delta\Theta$)%
Temperature sensors	
– Type 67-F and 67-K	Pt100 – EN 60 751, 4-wire connection
– Type 67-G and 67-L	Pt500 – EN 60 751, 4-wire connection
Flow meter types	
– ULTRAFLOW®	
– Electronic meters with active and passive pulse output	
– Mechanical meters with electronic pick-up	
– Mechanical meters with reed switch	
Flow meter sizes	
– [kWh]	q_p 0,6 m³/h...q_p 15 m³/h
– [MWh]	q_p 0,6 m³/h...q_p 15000 m³/h
– [GJ]	q_p 0,6 m³/h...q_p 30000 m³/h
EN 1434 designation	Environmental class A and C
MID designation	
– Mechanical environment	Class M1
– Electromagnetic environment	Class E1 and E2
– Non condensing, closed location (indoor installation), 5...55 °C	

Electrical data

Calculator data

Typical accurac	
– Calculator	E_C ±(0,15 + 2/ΔΘ)%
– Sensor set	E_T ±(0,4 + 4/ΔΘ)%
Display	LCD – 7 (8) digits with a digit heigth of 7.6 mm with back illumination
Resolution	9999,999 – 99999,99– 999999,9 – 9999999– 99999999
Energy units	MWh – kWh – GJ – Gcal
Data logger (EEPROM)	
– Standard	460 days, 36 months, 15 years, 50 info codes
– Standard	Programmable data logger with a logging depth of 1080 registers
Clock/calendar	
– Standard	Clock, calendar, leap-year compensation, target date
– Standard	Real time clock with battery backup
– Standard	Battery backup of energy measurement incl. ULTRAFLOW®
Data communication	
– Standard	KMP protocol with CRC16 used for optical communication and for base modules
Power in temperature sensors	< 10 μW RMS
Mains supply	
– 230 VAC	+15/-30%, 50/60 Hz (all types)
– 24 VAC	±50%, 50/60 Hz (Type 67-F/G without analogue outputs)
– 24 VAC	±25%, 50/60 Hz (Type 67-K/L with analogue outputs)
Insulation voltage	4 kV
Power consumption	< 3 W without analogue outputs < 9 W with analogue outputs
Current	Maks. 50 mA/230 VAC Maks. 450 mA/24 VAC
Battery backup	3.65 VDC, 2 pcs A-cell lithium (Type No. 6699-619)
Replacement interval	10 years at normal operation (with supply)
Backup period	1 year (without supply) The replacement interval is reduced at high ambient temperature
EMC-data	Meets EN 1434 Class A and C (MID Class E1 and E2)
Analogue outputs	
– Output type	0…20 mA or 4…20 mA
– Loop voltage	0…12.5 VDC
– Output load	0…500 Ohm
– Current limitation	24 mA
– Accuracy	0.15 %

Electrical data

Temperature measurement	T1	T2	T3	T4	T4
67-F and 67-K	Measuring range	0.00…185.00 °C	0.00…185.00 °C	0.00…185.00 °C	N/A
4-W Pt100	Preset range	0.01…180.00 °C	0.01…180.00 °C	0.01…180.00 °C	0.01…180.00 °C
67-G and 67-L	Measuring range	0.00…185.00 °C	0.00…185.00 °C	0.00…185.00 °C	N/A
4-W Pt500	Preset range	0.01…180.00 °C	0.01…180.00 °C	0.01…180.00 °C	0.01…180.00 °C

Max. cable length	Pt100, 2-wire	Pt500, 2-wire	Pt500, 4-wire
	2 x 0.25 mm^2: 2.5 m	2 x 0.25 mm^2: 10 m	4 x 0.25 mm^2: 100 m
	2 x 0.50 mm^2: 5 m	2 x 0.50 mm^2: 20 m	-

Flow measuring V1 and V2	ULTRAFLOW® V1: 9-10-11 and V2: 9-69-11	Reed switches V1: 10-11 and V2: 69-11	24 V active pulses V1: 10B-11B and V2: 69B-79B
EN 1434 pulse class	IC	IB	(IA)
Pulse input	220 kΩ pull-up to 3.6 V	220 kΩ pull-up to 3.6 V	12 mA at 24 V
Pulse ON	< 0.4 V for > 0.5 msec.	< 0.4 V for > 50 msec.	< 4 V for > 0.3 msec.
Pulse OFF	> 2.5 V for > 10 msec.	> 2.5 V for > 50 msec.	> 12 V for > 10 msec.
Pulse frequency	< 128 Hz	< 1 Hz	< 128 Hz
Integration frequency	< 1 Hz	< 1 Hz	< 1 Hz
Electrical isolation	No	No	2 kV
Max. cable length	10 m	25 m	100 m

Pulse inputs VA and VB VA: 65-66 and VB: 67-68	Water meter connection FF(VA) and GG(VB) = 01…40	Electricity meter connection FF(VA) and GG(VB) = 50…60
Pulse input	680 kΩ pull-up to 3.6 V	680 kΩ pull-up to 3.6 V
Pulse ON	< 0.4 V for > 30 msec.	< 0.4 V for > 30 msec.
Pulse OFF	> 2.5 V for > 30 msec.	> 2.5 V for > 30 msec.
Pulse frequency	< 1 Hz	< 3 Hz
Electrical isolation	No	No
Max. cable length	25 m	25 m
Requirements to external contact	Leakage current at function open < 1 μA	

Pulse outputs CE and CV Energy (16-17) Volume (18-19)	
Type	Open collector (OB)
Pulse length	Programmable 32 msec., 100 msec. or 247 msec. via METERTOOL HCW
External voltage	5…30 VDC
Current	1…10 mA
Residual voltage	UCE ≈ 1 V at 10 mA
Electrical isolation	2 kV
Max. cable length	25 m

Mechanical data

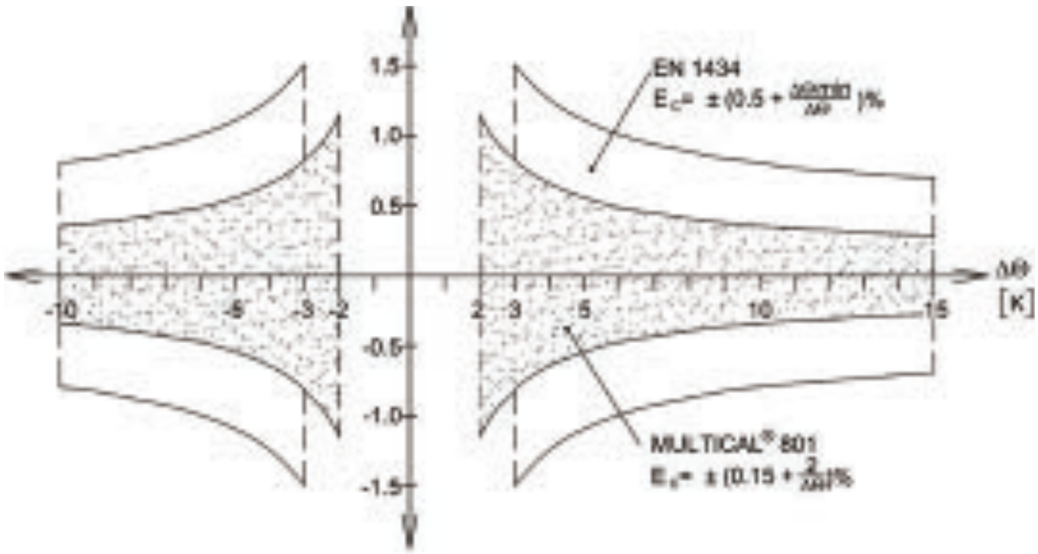
Environmental class	Meets EN 1434 Class A and C
Ambient temperature	5…55 °C non condensing, closed location (indoor installation)
Protection class	IP67
Storage temperature	-20…60 °C (drained flow meter)
Weight	1.4 kg excluding sensors and flow meter
Connection cables	6 pcs ø3…6 mm and 3 pcs ø4…8 mm

Materials

Top cover	PC
Base unit	PC + 10 % GF
Sealing cover, top	ABS
Sealing cover, bottom	PC
Prism behind display	PMMA

Tolerance band

Max. permitted error [%]



The above diagram shows the typical tolerance band of MULTICAL® 801 compared to the tolerance requirements of EN 1434.

Order specifications

MULTICAL® 801	□	□	□□	□	□	□	□	□□
Sensor connection								
Pt100 4-wire (T1-T2-T3) no analogue outputs	**F**							
Pt500 4-wire (T1-T2-T3) no analogue outputs	**G**							
Pt100 4-wire (T1-T2-T3) 4 analogue outputs	**K**							
Pt500 4-wire (T1-T2-T3) 4 analogue outputs	**L**							
Module 2 (VA and VB are not available at module place 2)								
None		**0**						
SIOX module (Auto detect baud rate)		**M**						
M-Bus (Alternative registers)		**P**						
M-Bus module with MC-III data package		**Q**						
Ethernet/IP (IP201)		**T**						
3G GSM/GPRS (GSM8H)		**U**						
M-Bus		**V**						
RadioRouter *		**W**						
LonWorks, FTT-10A		**Y**						
GSM/GPRS *		**Z**						
Module 1 (VA and VB are available at module place 1)								
None			**00**					
M-Bus + pulse inputs			**20**					
RadioRouter + pulse inputs *			**21**					
Data logger + 4-20 mA inputs + pulse inputs			**22**					
LonWorks, FTT-10A + pulse inputs			**24**					
M-Bus with alternative registers + pulse inputs			**27**					
M-Bus with MULTICAL® III data package + pulse inputs			**29**					
Wireless M-Bus Mode C1 + pulse inputs			**30**					
Wireless M-Bus Mode T1 OMS 15 Min. (Incl. Key)			**31**					
Wireless M-Bus Mode C1 with alternative registers + pulse inputs			**35**					
ZigBee 2.4 GHz int.ant. + pulse inputs			**60**					
Metasys N2 (RS485) + pulse inputs			**62**					
SIOX module (Auto detect baud rate)			**64**					
BACnet MS/TP + pulse input			**66**					
Modbus RTU + pulse inputs			**67**					
High Power Radio Router + pulse inputs			**84**					
Supply								
230 VAC				**7**				
24 VAC				**8**				
Pt500 sensor set (2-wire sensors)								
No sensor set					**0**			
Pocket sensor set w/1.5 m cable					**A**			
Pocket sensor set w/3.0 m cable					**B**			
Pocket sensor set w/5 m cable					**C**			
Pocket sensor set w/10 m cable					**D**			
Short direct sensor set w/1.5 m cable					**F**			
Short direct sensor set w/3.0 m cable					**G**			
3 pocket sensors in sets w/1.5 m cable					**L**			
3 short direct sensors in sets w/1.5 m cable					**Q3**			
Flow meter/pick-up unit								
Supplied w/1 ULTRAFLOW® ** (specify type)						**1**		
Supplied w/2 (identical) ULTRAFLOW® ** (specify type)						**2**		
Prepared for 1 ULTRAFLOW® (specify type) (specify type)						**7**		
Prepared for 2 (identical) ULTRAFLOW® (specify type)						**8**		
Prepared for meters w/reed switch output (both V1 and V2)						**L**		
Prepared for foreign flowpart with passive/active pulses						**N**		
Meter type								
Heat meter, delivered with MID marking							**2**	
Heat meter, closed systems							**4**	
Cooling meter							**5**	
Heat/cooling meter							**6**	
Volume meter, hot water							**7**	
Volume meter, cold water							**8**	
Energy meter, open systems							**9**	
Country code (language on label etc.)								**XX**

* GSM and RF modules must not be combined in the same meter.

** ULTRAFLOW® is delivered in a separate box which is strapped together with the MULTICAL® 801 carton. The cable between MULTICAL® 801 and ULTRAFLOW® is not connected on delivery.

Accessories

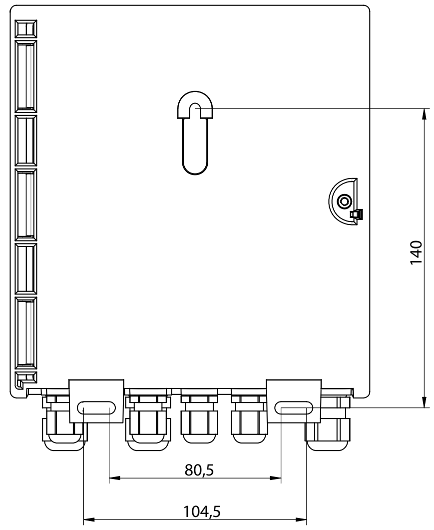
Description	Type No.
Data cable w/USB plug	6699-098
Infrared optical reading head w/USB plug	6699-099
Infrared optical reading head RS232 w/D-sub 9F	6699-102
Q144 dummy cover (144 mm x 144 mm) for blinding in panels/racks	6699-103
Data cable RS232, D-sub 9F	6699-106
Infrared optical reading head for Kamstrup/EVL w/RS232 w/D-sub 9F	6699-136
Infrared optical reading head for Kamstrup/EVL w/USB plug	6699-144
Verification unit, Pt100 (used with METERTOOL HCW)	6699-370
Verification unit, Pt500 (used with METERTOOL HCW)	6699-371
Battery backup (2xA cell lithium battery)	6699-619
Short circuit pen (for total reset and total programming)	6699-278
Short circuit jumper (for use with 2-wire temperature sensors)	6699-209
230 VAC High Power SMPS module	6699-622
24 VAC High Power SMPS module	6699-634
Jumper for modules	1640-080
Temperature sensor set with connecting head (2/4 wired)	6556-4x-xxx
External communication box	679x-xxxxx-2xx
Cable gland wrench 15 mm	5920-177
Cable gland wrench 19 mm	5920-178
METERTOOL HCW	6699-724
LogView HCW	6699-725

Please contact Kamstrup for questions concerning further accessories.

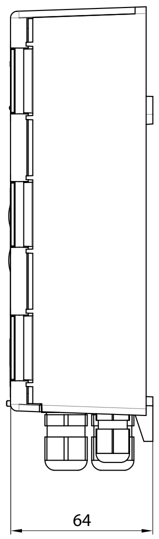
Dimensional sketches

Front dimensions of MULTICAL® 801

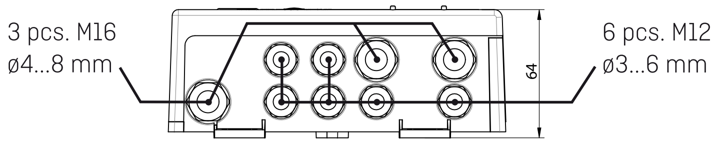
Mounting dimensions of MULTICAL® 801



Wall-mounted MULTICAL® 801 seen from the side



MULTICAL® 801 cable connections



All dimensions in [mm]

Kamstrup A/S • 5810625_K1_GB_05.2016

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ULTRAFLOW® 54
DN15-125
DATA SHEET

- Ultrasonic flow sensor
- For flow from 0.6 m³/h up to 100 m³/h
- Compact design
- Static meter with no moving parts
- Large dynamic range
- No wear
- Exceptionally accurate
- Longevity

MID-2004/22/EC

CE M12 0200

Application

ULTRAFLOW® 54 is a static flow sensor based on the ultrasonic measuring principle. The prime area of application is as a volume flow sensor for use with thermal heat meters such as MULTICAL®. ULTRAFLOW® 54 has been designed for use in heating installations where water is used as the heat-bearing medium.

ULTRAFLOW® 54 employs microprocessor technology and ultrasonic measuring techniques. All circuits for calculating and measuring are collected on a single board, providing compact and rational design in addition to an exceptionally high level of measuring accuracy and reliability.

The flow is measured using bidirectional ultrasonic technique based on the transit time method, with proven long-term stability and accuracy. Two ultrasonic transducers are used to send the sound signal both against and with the flow direction.

The ultrasonic signal travelling with the flow direction reaches the opposite transducer first. The time difference between the two signals can be converted to a flow velocity and thus a volume.

A three-wire pulse cable is used to connect ULTRAFLOW® 54 to MULTICAL®. This cable is used to supply the flow sensor from the calculator and also to send the signal to the calculator. The signal corresponds to the flow, or more correctly, a number of pulses proportional to the water volume flowing through the meter is transmitted.

If required a Pulse Transmitter can be used to supply ULTRAFLOW® 54, e.g. if the distance between MULTICAL® and ULTRAFLOW® 54 is 10 m or more. If ULTRAFLOW® 54 is used as pulse generator for other equipment, it must be connected through a Pulse Transmitter.

The Pulse Transmitter has a built-in supply and a galvanically separated pulse outlet.

Kamstrup

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Table of contents

ULTRAFLOW® 54 DN15-125
DATA SHEET

Approvals

Type approval

ULTRAFLOW® 54 approved in accordance with MID-2004/22/EC.
EC-Type Examination certificate: DK-0200-MI004-008.

Please contact Kamstrup A/S for further information relating to type approval and verification.

CE-marking

ULTRAFLOW® 54 is marked in accordance with:

– MID-directive	2004/22/EC
– LV-directive	2006/95/EC (together with the Pulse Transmitter or the Pulse Divider)
– PE-directive	97/23/EC (DN50...DN125 category I)

MID-2004/22/EC

CE M12 0200

MID designation

– Mechanical environment	Class M1
– Electromagnetic environment	Class E1 and E2
– Ambient temperature	5...55°C, non condensing closed location (indoor installation)

Technical data

Mechanical data

Metrological class	2 and 3
Environmental class	Complies with DS/EN 1434 class C
Ambient temperature	5...55°C
Protection class	
– Flow sensor	IP65
– Pulse Transmitter	IP54
Temperature* of medium	15...130°C
Storage temperature (empty sensor)	
– Meter without battery	-25...70°C
– Meter with battery	-25...60°C
Pressure stage	PN16, PN25 flange

** If the temperature of the medium exceeds 90°C a flange meter should be used. Additionally, MULTICAL® calculator or the Pulse Transmitter should be wall-mounted.*

ULTRAFLOW® 54 DN15-125
DATA SHEET

Technical data

Electrical data

Supply voltage	3.6 V ± 0.1 V
Battery (Pulse Transmitter)	3.65 VDC, D-Cell lithium
Replacement interval	6 years @ t_{BAT} <30°C
Power supply (Pulse Transmitter)	230 VAC +15/-30%, 48...52 Hz 24 VAC ±30%
Back-up supply	Integral super-cap eliminates operational disturbances due to short-term power-cuts
Cable length, flow sensor	Max. 10 m
Cable length (Pulse Transmitter)	Depends on calculator
EMC data	Complies with DS/EN 1434 class C

Flowdata

Nom. flow q_p [m³/h]	Nom. diameter [mm]	Meter factor [1] [imp./l]	Dynamic range q_i:q_p	q_s :q_p	Flow @125 Hz [2] [m³/h]	Δp@q_p [bar]	Min. cut off [l/h]
0.6	DN15 & DN20	300	1:50 & 1:100	2:1	1.5	0.04	2
1.5	DN15 & DN20	100	1:50 & 1:100	2:1	4.5	0.22	3
2.5	DN20	60	1:50 & 1:100	2:1	7.5	0.03	5
3.5	DN25	50	1:50 & 1:100	2:1	9	0.07	7
6	DN25	25	1:50 & 1:100	2:1	18	0.2	12
10	DN40	15	1:50 & 1:100	2:1	30	0.06	20
15	DN50	10	1:50 & 1:100	2:1	45	0.14	30
25	DN65	6	1:50 & 1:100	2:1	75	0.06	50
40	DN80	5	1:50 & 1:100	2:1	90	0.05	80
60	DN100	2.5	1:50 & 1:100	2:1	180	0.03	120
100	DN100	1.5	1:50 & 1:100	2:1	300	0.07	200
100	DN125	1.5	1:50 & 1:100	2:1	300	0.1	200

[1] The meter factor can be seen on the ULTRAFLOW® label on the meter.
[2] Saturation flow. Max. pulse frequency 128 Hz is maintained at higher flow rates.

Materials

Wetted parts

ULTRAFLOW® 54, q_p 0.6 og 1.5 m³/h

Housing, gland	DZR brass (Dezincification resistant brass)
Housing, flange	Stainless steel, W.no. 1.4308
Transducers	Stainless steel, W.no. 1.4401
Gaskets	EPDM
Reflectors	Thermoplastic, PES 30% GF and stainless steel, W.no. 1.4301
Measuring pipe	Thermoplastic, PES 30% GF

ULTRAFLOW® 54, q_p 2.5 til 100 m³/h

Housing, gland	DZR brass (Dezincification resistant brass)
Housing, flange	Stainless steel, W.no. 1.4308
Transducers	Stainless steel, W.no. 1.4401
Gaskets	EPDM
Reflectors	Stainless steel, W.no. 1.4301
Measuring pipe	Thermoplastic, PES 30% GF

Electronic housing

Base	Thermoplastic, PBT 30% GF
Lid	Thermoplastic, PC 20% GF

Connection cable

Silicone cable (3 x 0.5 mm²)

ULTRAFLOW® 54 DN15-125

DATA SHEET

Type summary

Nom.flow q_p [m³/h]	Size				
0.6	G¾B x 110 mm	G1B x 130 mm			
1.5	G¾B x 110 mm	G¾B x 165 mm	G1B x 130 mm	G1B x 190 mm	(G1B x 165 mm)
2.5	G1B x 190 mm	DN20 x 190 mm			
3.5	G5/4B x 260 mm	DN25 x 260 mm			
6	G5/4B x 260 mm	DN25 x 260 mm			
10	G2B x 300 mm	DN40 x 300 mm			
15	DN50 x 270 mm				
25	DN65 x 300 mm				
40	DN80 x 300 mm				
60	DN100 x 360 mm				
100	DN100 x 360 mm	DN125 x 350 mm			

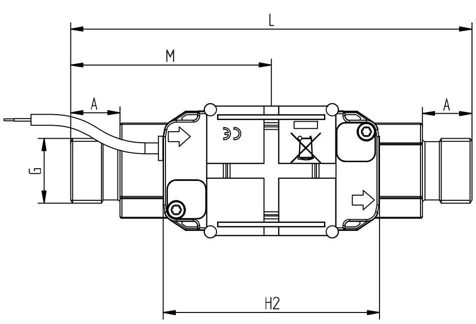
(...) Country specific variants

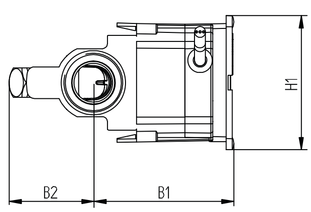
Thread ISO 228-1
Flange EN 1092, PN25

Dimension sketches

ULTRAFLOW® 54, G¾B and G1B

All measurements are in mm, unless otherwise stated.



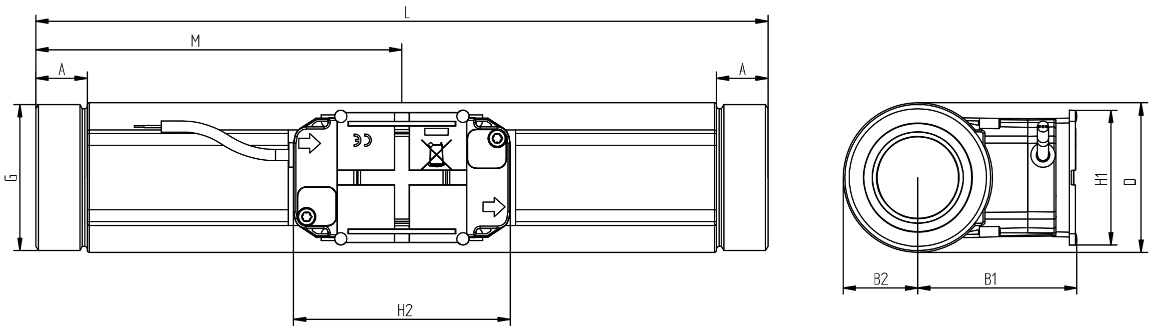


Thread ISO 228-1

Thread	L	M	H2	A	B1	B2	H1	App. weight [kg]
G¾B	110	L/2	89	10.5	58	35	55	0.8
G1B	130	L/2	89	20.5	58	35	55	1.1
G¾B	165	L/2	89	20.5	58	35	55	1.2
G1B	165	L/2	89	20.5	58	35	55	1.2
G1B (q_p 1.5)	190	L/2	89	20.5	58	35	55	1.5
G1B (q_p 2.5)	190	L/2	89	20.5	58	36	55	1.3

Dimension sketches

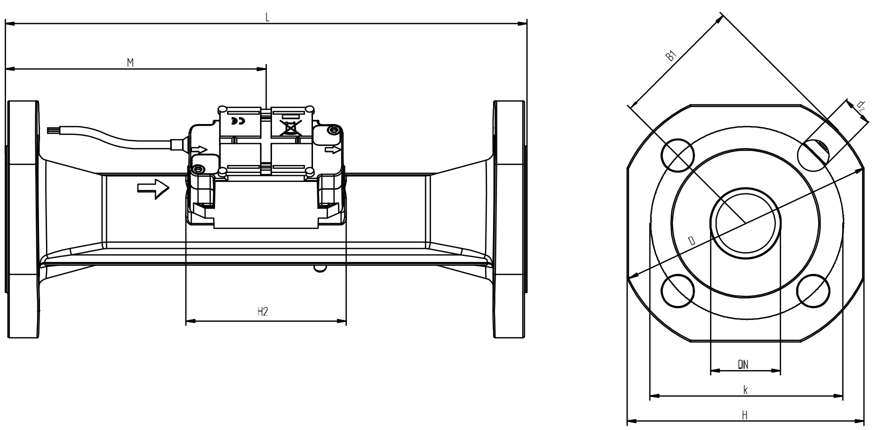
ULTRAFLOW® 54, G5/4B and G2B



Thread ISO 228-1

Thread	L	M	H2	A	B1	B2	H1	App. weight [kg]
G5/4B	260	L/2	89	17	58	22	55	2.3
G2B	300	L/2	89	21	65	31	55	4.5

ULTRAFLOW® 54, DN20 to DN50



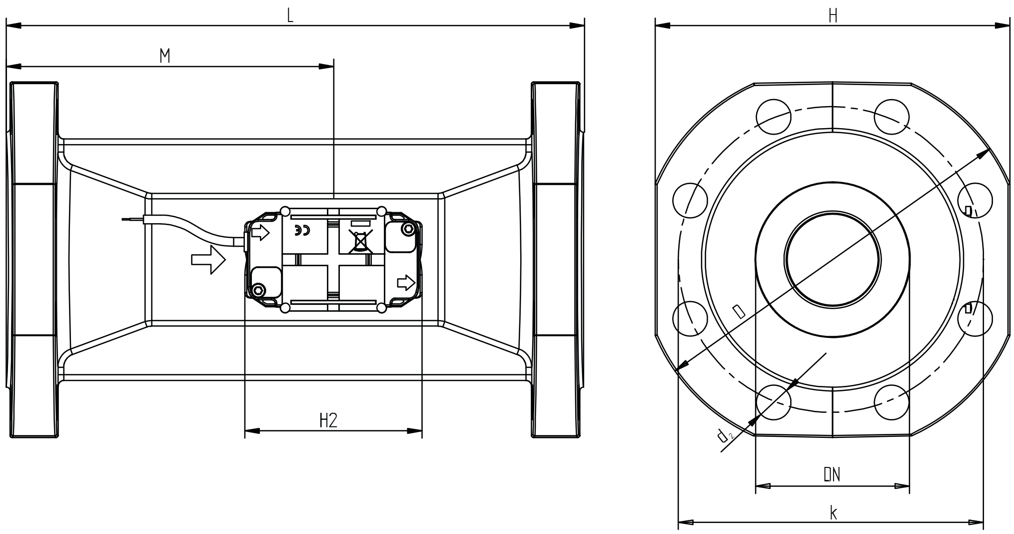
Flange EN 1092, PN25

Nom. diameter	L	M	H2	B1	D	H	k	Bolts No.	Bolts Thread	Bolts d_2	App. weight [kg]
DN20	190	L/2	89	58	105	95	75	4	M12	14	2.9
DN25	260	L/2	89	58	115	106	85	4	M12	14	5.0
DN40	300	L/2	89	<D/2	150	136	110	4	M16	18	8.3
DN50	270	155	89	<D/2	165	145	125	4	M16	18	10.1

ULTRAFLOW® 54 DN15-125
DATA SHEET

Dimension sketches

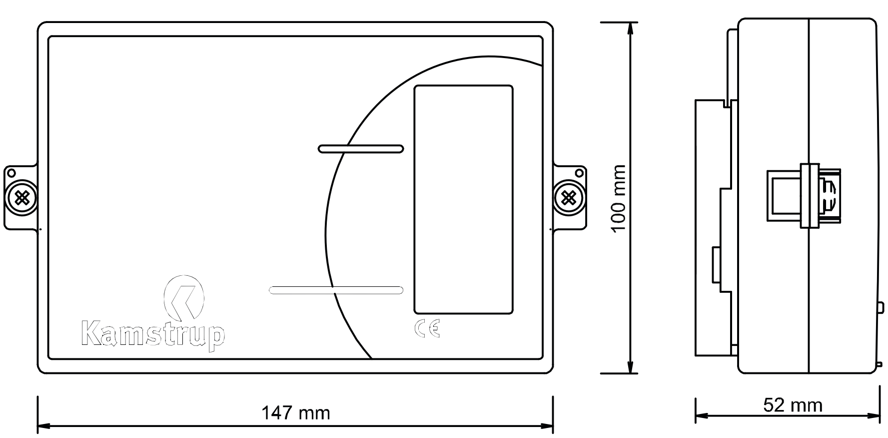
ULTRAFLOW® 54, DN65 to DN125



Flange EN 1092, PN25

Nom. diameter								Bolts			App. weight
	L	M	H2	B1	D	H	k	No.	Thread	d_2	[kg]
DN65	300	170	89	<H/2	185	168	145	8	M16	18	13.2
DN80	300	170	89	<H/2	200	184	160	8	M16	18	16.8
DN100	360	210	89	<H/2	235	220	190	8	M20	22	21.7
DN125	350	212	89	<H/2	270	260	220	8	M24	28	28.2

Pulse Transmitter

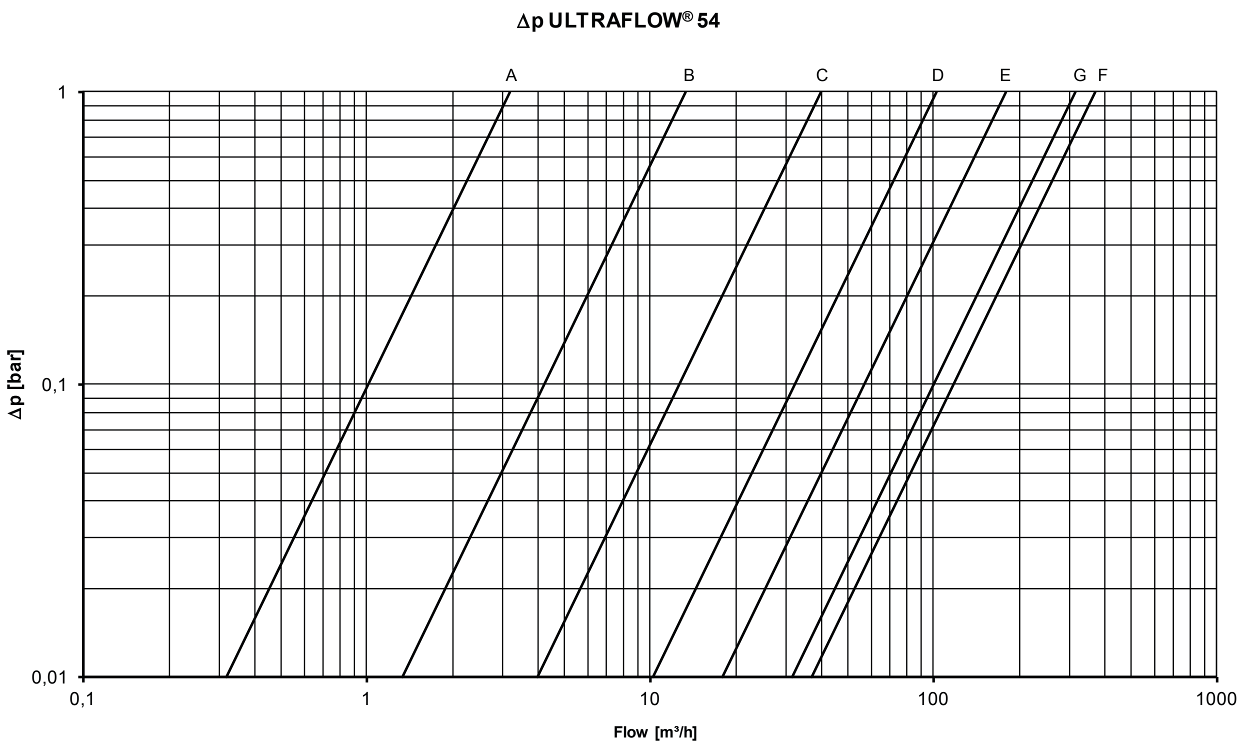


Pressure loss

Graph	q_p [m³/h]	Nom. diameter	k_v [3)]	Q@0.25 bar [m³/h]
A	0.6 & 1.5	DN15 & DN20	3.2	1.6
B	2.5 & 3.5 & 6	DN20 & DN25	13.4	6.7
C	10 & 15	DN40 & DN50	40	20
D	25	DN65	102	51
E	40	DN80	179	90
F	60 & 100	DN100	373	187
G	100	DN125	316	158

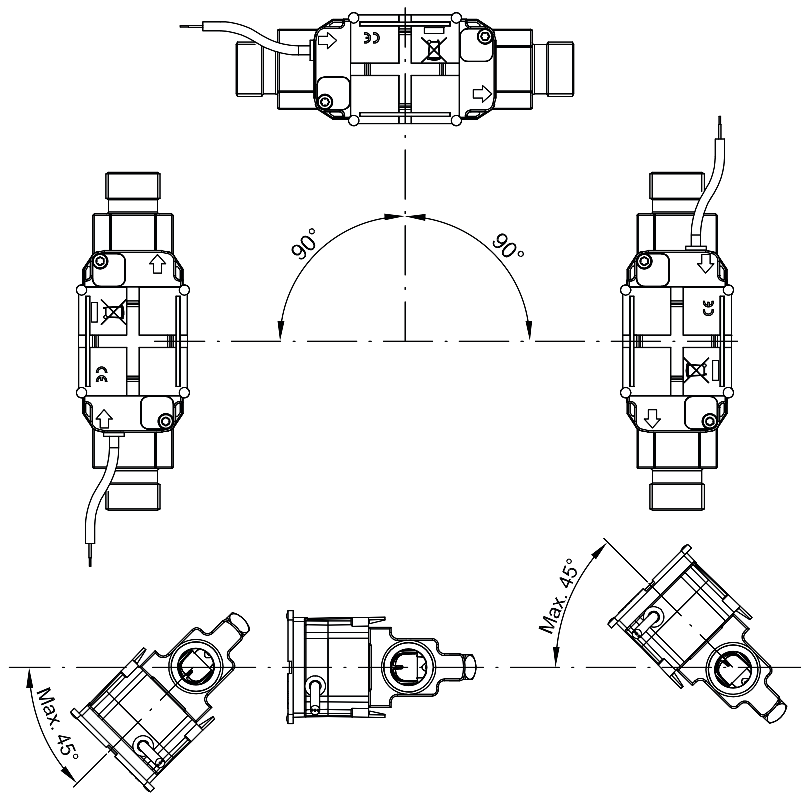
3) $q=k_v \times \sqrt{\Delta p}$

Pressure loss graphs



Installation

Installation angle for ULTRAFLOW® 54



ULTRAFLOW® 54 may be installed horizontally, vertically or at an angle.

IMPORTANT!

With ULTRAFLOW® 54, the electronics/plastic case must be placed to the side (with horizontal installation).

ULTRAFLOW® 54 may be turned up to ±45° in relation to the pipe axis.

Straight inlet

ULTRAFLOW® requires neither straight inlet nor outlet to meet the Measuring Instruments Directive (MID) 2004/22/EC, OIML R75:2002 and EN 1434:2007. Only in case of heavy flow disturbances before the meter will a straight inlet section be necessary. We recommend to follow the guidelines in CEN CR 13582.

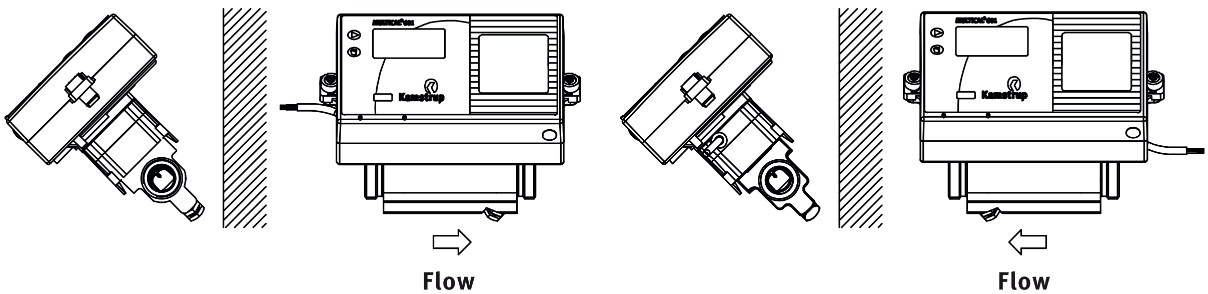
Working Pressure

In order to prevent cavitation the back pressure at ULTRAFLOW® 54 must be min. 1.5 bar at q_p and min. 2.5 bar at q_s. This applies to temperatures up to approx. 80°C.

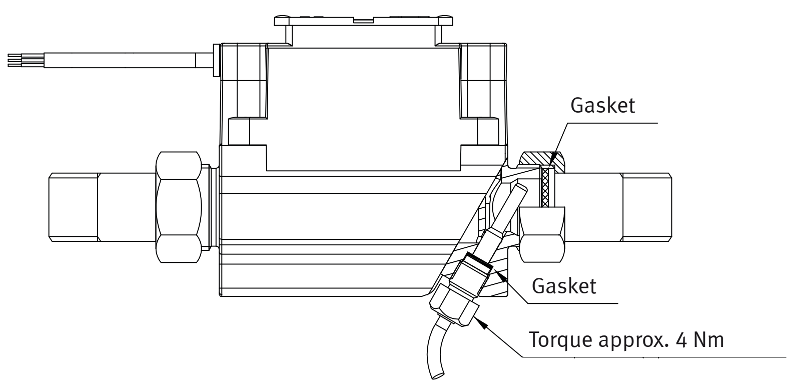
ULTRAFLOW® 54 must not be exposed to lower pressure than the ambient pressure (vacuum).

Examples of installation

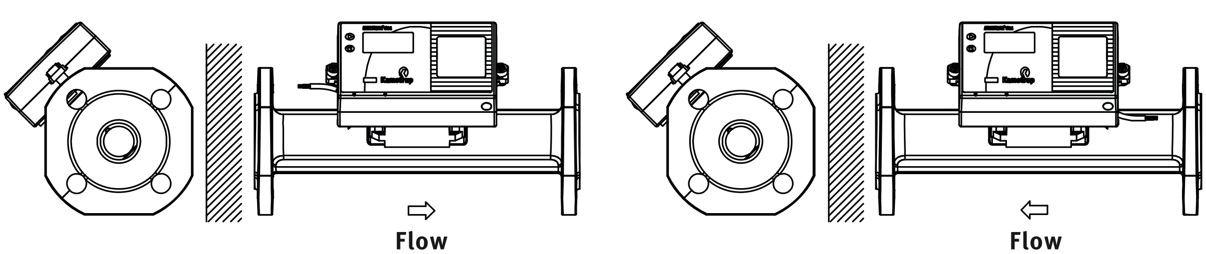
Gland meter with MULTICAL®/Pulse Transmitter fitted directly on ULTRAFLOW® 54.



Glands and short direct sensor fitted in ULTRAFLOW® 54 (G¾B (R½) and G1B (R¾) only).



Flange meter with MULTICAL®/Pulse Transmitter fitted directly on ULTRAFLOW® 54.



Electrical connection

Connecting MULTICAL® & ULTRAFLOW® 54

ULTRAFLOW® 54	->	MULTICAL®
Blue (GND)/11A	->	11
Red (supply)/9A	->	9
Yellow (signal)/10A	->	10

Connecting via Pulse Transmitter

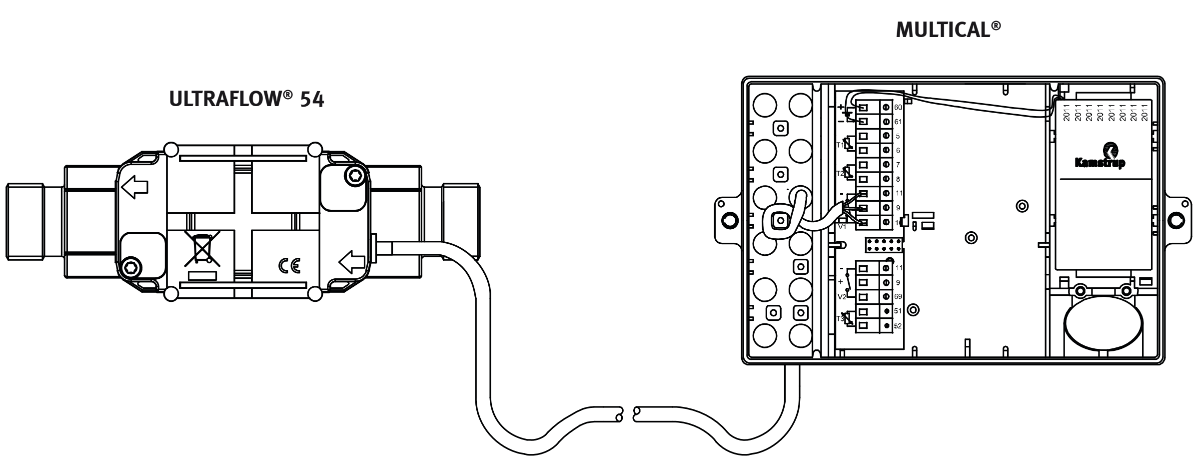
3.65 VDC supply [4]	->	Pulse Transmitter
Red (+)	->	60
Black (-)	->	61

[4] *from battery or supply module.*

ULTRAFLOW® 54	->	Pulse Transmitter		->	MULTICAL®
		In	Out		
Blue (GND)/11A	->	11	11A	->	11
Red (supply)/9A	->	9	9A	->	9
Yellow (signal)/10A	->	10	10A	->	10

If long signal cables are used, please consider the installation carefully. There must be **at least 25 cm** between the signal cable and all other cables due to EMC.

Example of connecting ULTRAFLOW® 54 and MULTICAL®



ULTRAFLOW® 54 DN15-125
DATA SHEET

Order specification

The list below shows type numbers for ULTRAFLOW® 54

Type number [5]			q_p [m³/h]	q_i [m³/h]	q_s [m³/h]	Connection	Length [mm]	Meter factor [imp./l]	CCC (high res.)	Material
65-5-	CAAA	-XXX	0.6	0.006	1.2	G¾B (R½)	110	300	416 (484)	Brass
65-5-	CAAD	-XXX	0.6	0.006	1.2	G1B (R¾)	130	300	416 (484)	Brass
65-5-	CDAA	-XXX	1.5	0.015	3	G¾B (R½)	110	100	419 (407)	Brass
65-5-	CDAC	-XXX	1.5	0.015	3	G¾B (R½)	165	100	419 (407)	Brass
65-5-	CDAD	-XXX	1.5	0.015	3	G1B (R¾)	130	100	419 (407)	Brass
(65-5-	CDAE	-XXX)	1.5	0.015	3	G1B (R¾)	165	100	419 (407)	Brass
65-5-	CDAF	-XXX	1.5	0.015	3	G1B (R¾)	190	100	419 (407)	Brass
65-5-	CEAF	-XXX	2.5	0.025	5	G1B (R¾)	190	60	498 (-)	Brass
65-5-	CECA	-XXX	2.5	0.025	5	DN20	190	60	498 (-)	Stainless steel
65-5-	CGAG	-XXX	3.5	0.035	7	G5/4B (R1)	260	50	451 (436)	Brass
65-5-	CGCB	-XXX	3.5	0.035	7	DN25	260	50	451 (436)	Stainless steel
65-5-	CHAG	-XXX	6	0.06	12	G5/4B (R1)	260	25	437 (438)	Brass
65-5-	CHCB	-XXX	6	0.06	12	DN25	260	25	437 (438)	Stainless steel
65-5-	CJAJ	-XXX	10	0.1	20	G2B (R1½)	300	15	478 (483)	Brass
65-5-	CJCD	-XXX	10	0.1	20	DN40	300	15	478 (483)	Stainless steel
65-5-	CKCE	-XXX	15	0.15	30	DN50	270	10	420 (485)	Stainless steel
65-5-	CLCG	-XXX	25	0.25	50	DN65	300	6	479 (-)	Stainless steel
65-5-	CMCH	-XXX	40	0.4	80	DN80	300	5	458 (486)	Stainless steel
65-5-	FACL	-XXX	60	0.6	120	DN100	360	2.5	470 (487)	Stainless steel
65-5-	FBCL	-XXX	100	1	200	DN100	360	1.5	480 (488)	Stainless steel
65-5-	FBCM	-XXX	100	1	200	DN125	350	1.5	480 (488)	Stainless steel

[5] XXX-code pertaining to final assembly, approvals etc. is determined by Kamstrup A/S. Some variants may not be included in national approvals.
(...) Country specific variants

ULTRAFLOW® 54 is as standard supplied with 2.5 m cable, but can also be supplied with 5 or 10 m cable.

Pulse Transmitter – type No. 66-99-603
The Pulse Transmitter is supplied with built-in supply for ULTRAFLOW® 54. Battery, 24 VAC and 230 VAC supply are available. Please state the required supply type when ordering.

Accessories

Glands including gaskets (PN16)

Size	Nipple	Union	Type No.	2 pcs.
DN15	R½	G¾	-	6561-323
DN20	R¾	G1	-	6561-324
DN25	R1	G5/4	6561-325	-
DN40	R1½	G2	6561-315	-

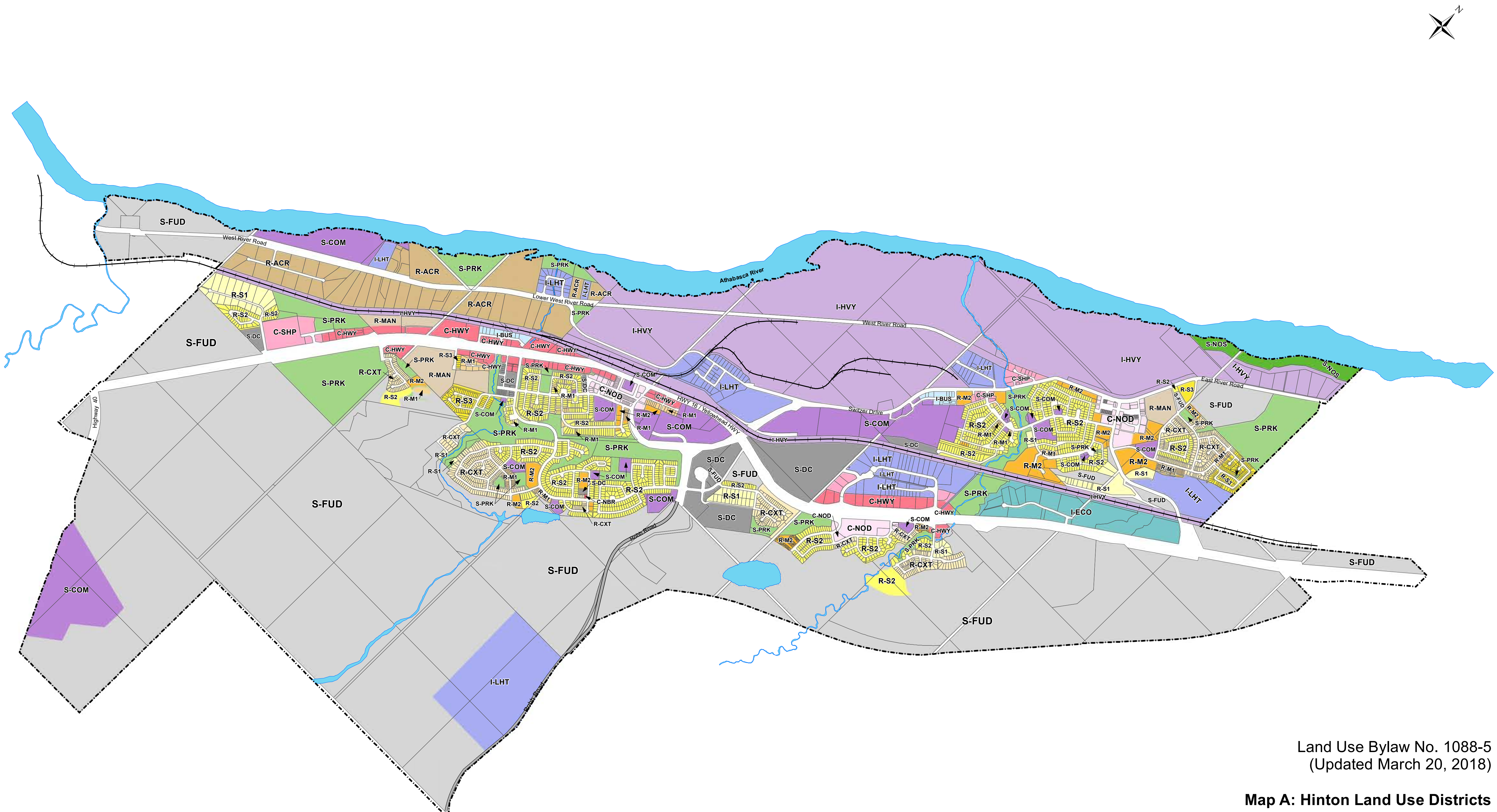
Gaskets for flange meters (PN25)

Size	Type No.
DN20	2210-147
DN25	2210-133
DN40	2210-132
DN50	2210-099
DN65	2210-141
DN80	2210-140
DN100	1150-142
DN125	1150-153

Gaskets for glands

Size (union)	Type No.
G¾	2210-061
G1	2210-062
G5/4	2210-063
G1½	2210-064
G2	2210-065

Appendix D.17 Town of Hinton Land Use Bylaw Map



Land Use Bylaw No. 1088-5
(Updated March 20, 2018)

Map A: Hinton Land Use Districts

Legend

- RailWay
- Town Boundary
- Water

Land Use Districts

- R-S1: Single Detached Residential Large Lot District
- R-S2: Single Detached Residential Standard Lot District
- R-S3: Residential Narrow Lot District
- R-CXT: Contextual Residential District
- R-M1: Low Density Multiple Dwelling Residential District
- R-M2: Medium to High Density Multiple Dwelling Residential District
- R-MAN: Manufactured Housing District
- R-ACR: Acreage Residential District
- C-NOD: Urban Node Commercial District
- C-SHP: Shopping Centre Commercial District
- C-HWY: Highway Commercial District
- C-NBR: Neighbourhood Commercial District
- I-BUS: Business Industrial District
- I-ECO: Eco-Industrial District
- I-LHT: Light Industrial District
- I-HVY: Heavy Industrial District
- S-PRK: Parks and Recreation District
- S-COM: Community Services District
- S-DC: Direct Control District
- S-FUD: Future Urban Development District
- S-NOS: Natural Open Space District

0 0.1 0.2 0.4 0.6 0.8 Kilometers

ISL Engineering and Land Services

Gateway to the Rockies HINTON

I-BUS BUSINESS INDUSTRIAL DISTRICT

General Purpose

This District is intended to accommodate a range of small to medium scale commercial and industrial uses appropriate for a transition between other more intense land uses. Uses in this District shall not cause any objectionable or dangerous conditions beyond the confines of the Building/Parcel upon which they are located. Storage areas must be screened from view of public roadways.

Permitted Uses

Accessory Building/Structure
Animal Service Centre
Service Station (Minor)Bulk Fuel Facility
Gas Station
Car Wash
General Office
Greenhouse & Plant Nursery
Warehouse & Warehouse Sales
Equipment/Vehicle Sales & Repair
Commercial School
Park
Public Utility
Oilfield Support Services
Manufacturing & Operations Facility

Discretionary Uses

Drive-through
Eating or Drinking Establishment (Minor)
Indoor Recreation
Surveillance Suite
Self-Storage
Crematorium
Funeral Home

Those uses which in the opinion of the Development Authority are similar to the Permitted or Discretionary Uses, and which conform to the general purpose and intent of the District

Minimum Parcel Dimensions

At the discretion of the Development Authority

Minimum Setback Requirements

Front Yard	6.0 m*
Side Yard (Adjacent to Residential Use)	6.0 m
Side Yard (Adjacent to Non-Residential Use)	0.0 m
Side Yard (Corner Lot Adjacent to Public Roadway)	3.0 m
Side Yard (vehicular access from the front public roadway only)	6.0 m
Rear Yard	6.0 m

*The front yard setback shall not preclude the use of a portion of the front yard for walks, driveways or freestanding signs

Massing & Coverage

Maximum Building Height	10.6 m
Maximum Coverage	60%

1088-5

I-ECO ECO-INDUSTRIAL DISTRICT

General Purpose

This District is intended to establish an area that will allow for the development of an industrial park that will demonstrate innovation and high levels of environmental and economic performance. Uses in this District shall not cause any objectionable or dangerous conditions beyond the confines of the Building/Parcel upon which they are located.

Permitted Uses

Accessory Building/Structure	Equipment/Vehicle Sales & Repair
Animal Service Centre	Commercial School
Service Station (Minor)	Care Facility (Child)
Bulk Fuel Facility	Funeral Home
Gas Station	Recycling Facility
Car Wash	Shipping/Receiving Facility
General Office	Truck Wash
Greenhouse & Plant Nursery	Park
Warehouse & Warehouse Sales	Public Utility

Discretionary Uses

Drive-through	Self-Storage
Eating or Drinking Establishment (Minor)	Auction Facility
Indoor Recreation	Service Station (Major)
Surveillance Suite	Crematorium

Those uses which in the opinion of the Development Authority are similar to the Permitted or Discretionary Uses, and which conform to the general purpose and intent of the District

Minimum Parcel Dimensions

Parcel Type	Width	Area
Standard	20.0 m	2000.0 m^2

Minimum Setback Requirements

Front Yard	7.5 m
Side Yard	0.0 m
Rear Yard	2.0 m

Massing & Coverage

Maximum Building Height	10.6 m
Maximum Coverage	60%*

*Coverage greater than 60% may be allowed at the discretion of the Development Authority where other innovative design elements and strategies are applied

Additional Regulations

a) All proposed uses within this District shall be subject to and comply with the *Innovista Eco-Industrial Park Development Guidelines;*

b) Up to 50% of the required permeable area of the site (20% of site area) may be provided on the roof of a Building as a rooftop garden;

c) Each business shall provide one (1) Preferential Parking Stall in a convenient location for every twenty (20) required parking stalls for use by: car pool vehicles, electric vehicles, or small cars;

d) A minimum depth of 3.0 metres of landscaping shall be provided to buffer parking, loading and outdoor storage areas from a public right-of-way;

e) The Development Authority may in its discretion require Developers to connect Buildings to a 'district energy system' or to make provision for future connection to this system.

1088-5

I-LHT LIGHT INDUSTRIAL DISTRICT

General Purpose

This District is generally intended to provide for a variety of industrial activities that carry out a portion of their operation outdoors or require outdoor storage areas. Uses in this District shall not cause any adverse effects beyond the boundaries of the District.

Permitted Uses

Accessory Building/Structure	Laboratory Facility
Animal Service Centre	Oilfield Support Services
Auction Facility	Warehouse & Warehouse Sales
Service Station (Major/Minor)	Manufacturing & Operations Facility
Bulk Fuel Facility	Shipping/Receiving Facility
Gas Station	Equipment/Vehicle Sales & Repair
Car Wash	Outdoor Storage
Truck Wash	Park
Heavy Truck & Equipment Storage	Public Utility

Discretionary Uses

Commercial School	Recycling Facility
Drive-through	Surveillance Suite
Eating or Drinking Establishment (Minor)	Crematorium
Self-Storage	

Those uses which in the opinion of the Development Authority are similar to the Permitted or Discretionary Uses, and which conform to the general purpose and intent of the District

Minimum Parcel Dimensions

At the discretion of the Development Authority

Minimum Setback Requirements

Front Yard	6.0 m*
Side Yard (Adjacent to Residential Use)	6.0 m
Side Yard (Adjacent to Non-Residential Use)	0.0 m
Side Yard (Corner Lot Adjacent to Public Roadway)	3.0 m
Side Yard (vehicular access from the front public roadway only)	6.0 m
Rear Yard	6.0 m

*The front yard setback shall not preclude the use of a portion of the front yard for walks, driveways or freestanding signs.

Massing & Coverage

Maximum Building Height	10.6 m
Maximum Coverage	60%

1088-5

I-HVY HEAVY INDUSTRIAL DISTRICT

General Purpose

This District is generally intended to provide for a variety of industrial activities that may handle dangerous goods or produce noise and odours, which do not cause adverse effects beyond the boundary of the District.

Permitted Uses

Accessory Building/Structure
Bulk Fuel Facility
Warehouse
Oilfield Support Services
Manufacturing & Operations Facility
Public Utility

Discretionary Uses

Salvage/Wrecking Yard
Shipping/Receiving Facility
Surveillance Suite

Those uses which in the opinion of the Development Authority are similar to the Permitted or Discretionary Uses, and which conform to the general purpose and intent of the District

Minimum Parcel Dimensions

Parcel Type	Width	Area
Standard	40.0 m	2600.0 m^2

Minimum Setback Requirements

Front Yard	9.0 m*
Side Yard	6.0 m
Side Yard (vehicular access from the front public roadway only)	9.0 m
Rear Yard	9.0 m

*The front yard setback shall not preclude the use of a portion of the front yard for walks, driveways or freestanding signs

Massing & Coverage

Maximum Building Height	Discretion of the Development Authority
Maximum Coverage	60%

Additional Regulations

a) Parking may be permitted 3.0 metres back from the front property line at the discretion of the Development Authority, as long as on-site screening and landscaping are provided.

S-FUD FUTURE URBAN DEVELOPMENT DISTRICT

General Purpose

This District is intended to protect lands for future forms of development and provide for a limited range of temporary uses.

Permitted Uses

Park
Public Utility

Discretionary Uses

Single Detached Dwelling
Accessory Building/Structure
Agricultural Operation
Gravel Pit
Temporary Storage
Home Based Business

Any strictly temporary use or Building which, in the opinion of the Development Authority, will not prejudice the possibility of conveniently and economically developing the area in the future.

Additional Regulations

a) All siting, Parcel coverage, densities, yard setbacks and height of Buildings shall be at the discretion of the Development Authority;
b) The Development Authority may specify the length of time a use is permitted, having regard to the future servicing and development of the subject land.

S-COM COMMUNITY SERVICES DISTRICT

General Purpose

This District is intended to establish an area for the development of publicly or privately owned institutions or community services.

Permitted Uses

School
Cemetery
Community Garden
Place of Worship
Public Building
Hospital
Assisted Living (AL/DAL/EDAL)
Outdoor Recreation
Park
Public Utility

Discretionary Uses

Accessory Building/Structure
Care Facility (Child)
Surveillance Suite
Landfill

Those uses which in the opinion of the Development Authority are similar to the Permitted or Discretionary Uses, and which conform to the general purpose and intent of the District

Additional Regulations

a) All Parcel and development regulations shall be at the discretion of the Development Authority.

LUB 1088-1

Appendix D.18 Template Permit Applications

Alberta Safety Codes Authority

A Division of the Safety Codes Council

[date received stamp]

the inspections group inc.

[agency file no.]

[eSITE permit no.]

BUILDING PERMIT APPLICATION FORM

Development Permit No.: ____________________ Other Permits Required (under separate application): ☐ Electrical ☐ Plumbing ☐ Gas ☐ PSDS

New Home Warranty No.(if applicable): ____________________

Application Date (mmm/dd/yyyy): ____________________ Estimated Project Completion Date (mmm/dd/yyyy): ____________________

Permit Applicant: ☐ Owner ☐ Contractor Value of Installation (labour and material): $ ____________________

Owner Name: ____________________ Mailing Address: ____________________

City: ____________________ Province: ______ Postal Code: __________ Phone: __________

Cell: ____________________ Email: ____________________ Fax: __________

Contractor Name: ____________________ Mailing Address: ____________________

City: ____________________ Province: ______ Postal Code: __________ Phone: __________

Contact Name: ____________________ Cell: __________ Email: ____________________ Fax: __________

Project Location: Municipality: ____________________ Subdivision Name: __________ Tax Roll No.: __________

Street/Rural Address: ____________________ Postal Code: __________

Lot: ______ Block: ______ Plan: ______ LSD: ______ Quarter: ______ Section: ____ Township: ______ Range: ____ West of: ___

Directions: ____________________

Description of Work: ☐ Work has not started ☐ Work is in progress ☐ Work is complete

____

____

TYPE OF OCCUPANCY	TYPE OF WORK		BUILDING AREA
☐ Single Residential	☐ New	☐ Garage ☐ Detached ☐ Attached	☐ ft² ☐ m²
☐ Multi-family	☐ Addition	☐ Temporary Structure	Main Area: ______
☐ Farm/Ranch	☐ Renovation	Removal Date: ______	2nd Floor Area: ______
☐ Commercial	☐ Relocation/Ready to Move	☐ Foundation Type: ______	Basement Area: ______
☐ Industrial	☐ Change of Occupancy/Use		Developed: ☐ Yes ☐ No
☐ Institutional	☐ Accessory Building	☐ Manufactured/Mobile Home	
☐ Manufactured/Mobile Home	☐ Shed	CSA No.: ______	Total Developed Area: ______
☐ Oil and Gas	☐ Deck	AMA No.: ______	
☐ Other: ______	☐ Secondary Suite	☐ Wood Burning/Pellet Stove/Fireplace	No. of Storeys: ______
______	☐ Nanny Suite	Certification No.: ______	Garage: ______
	☐ Basement Development	☐ Other: ______	Deck: ______
	☐ Demolition	______	Shed: ______
	☐ Swimming Pool/Hot Tub		

____________________ Permit Applicant's Name (print)

____________________ Permit Applicant's Signature

____________________ Homeowner 's Signature (homeowner permit only) Homeowner Declaration: By signing this I hereby certify that I own/will own and occupy this dwelling.

Office Use Only

Permit Fee: $ __________ SCC Levy: __________ Issuing Officer's Name: ____________________

Total Cost: $ __________ ($4.50 or 4% of the permit fee maximum $560.00) Issuing Officer's Signature: ____________________

Receipt No.: __________ Designation No.: ____________________

☐ Cash ☐ Debit ☐ Cheque ____________________ Permit Issue Date (mmm/dd/yyyy): ____________________

☐ Credit Card (attach signed credit card authorization form)

Alberta Safety Codes Authority

A Division of the Safety Codes Council

[date received stamp]

the inspections group inc.

[agency file no.]

[eSITE permit no.]

ELECTRICAL PERMIT APPLICATION FORM

Development Permit No.: ________________ Other Permits Required (under separate application): ☐ Building ☐ Plumbing ☐ Gas ☐ PSDS

Application Date (mmm/dd/yyyy): ________________ Estimated Project Completion Date (mmm/dd/yyyy): ________________

Permit Applicant: ☐ Owner ☐ Contractor Value of Installation (labour and material): $ ________________

Owner Name: ________________ Mailing Address: ________________

City: ________________ Province: ______ Postal Code: ________ Phone: ________________

Cell: ________________ Email: ________________ Fax: ________________

Contractor Name: ________________ Mailing Address: ________________

City: ________________ Province: ______ Postal Code: ________ Phone: ________________

Contact Name: ________________ Cell: ________________ Email: ________________ Fax: ________________

Project Location: Municipality: ________________ Subdivision Name: ________________ Tax Roll No.: ________________

Street/Rural Address: ________________ Postal Code: ________

Lot: ______ Block: ______ Plan: ______ LSD: ______ Quarter: ______ Section: ______ Township: ______ Range: ______ West of: ______

Directions: ________________

Description of Work: ☐ Work has not started ☐ Work is in progress ☐ Work is complete

____

____

____

____

TYPE OF OCCUPANCY	TYPE OF WORK	SERVICE AND DEVELOPED AREA
☐ Single Residential ☐ Multi-family ☐ Farm/Ranch ☐ Commercial ☐ Industrial ☐ Institutional ☐ Manufactured/Mobile Home ☐ Oil and Gas ☐ Skid Units ☐ Other: ________	☐ New ☐ Renovation ☐ Connection Only ☐ Service ☐ Temporary Service ☐ Annual Permit ☐ Other: ________	☐ Overhead ☐ Underground ☐ ft² ☐ m² Amps: ______ Main Floor: ______ Volts: ______ 2nd Floor: ______ Phase: ______ Developed Basement: ______ Garage: ______ Other: ______ Total Developed Area: ______

FOIPP Notification: Personal information collected on this form is collected under the authority of section 33(c) of the Alberta Freedom of Information and Protection of Privacy Act. It is used for processing permit applications, issuing permits, safety codes compliance monitoring, verification and program evaluation. The name of the permit holder and nature of the permit may be included on reports provided to a municipality or made available to the public as required or allowed by legislation. Questions about this collection may be directed to ASCA Coordinators at 1-888-413-0099 or at Suite 500, 10405 Jasper Avenue, Edmonton, AB T5J 3N4.

________________ Master Electrician's Name (print)

________________ Master Electrician's Signature

________________ Homeowner 's Signature (homeowner permit only)

Homeowner Declaration: By signing this application I hereby certify that I own/will own and occupy this dwelling.

Master Electrician's Certification No.: ________________

Office Use Only

Permit Fee: $ ________ SCC Levy: ________ Issuing Officer's Name: ________________

Total Cost: $ ________ ($4.50 or 4% of the permit fee maximum $560.00) Issuing Officer's Signature: ________________

Receipt No.: ________ Designation No.: ________________

☐ Cash ☐ Debit ☐ Cheque ________ Permit Issue Date (mmm/dd/yyyy): ________________

☐ Credit Card (attach signed credit card authorization form)

Alberta Safety Codes Authority

A Division of the Safety Codes Council

[date received stamp]

the inspections group inc.

[agency file no.]
[eSITE permit no.]

GAS PERMIT APPLICATION FORM

Development Permit No.: ______________________ Other Permits Required (under separate application): ☐ Building ☐ Electrical ☐ Plumbing ☐ PSDS

Application Date (mmm/dd/yyyy): ______________________ Estimated Project Completion Date (mmm/dd/yyyy): ______________________

Permit Applicant: ☐ Owner ☐ Contractor Value of Installation (labour and material): $ ______________________

Owner Name: ______________________ Mailing Address: ______________________

City: ______________ Province: ______ Postal Code: ______________ Phone: ______________

Cell: ______________ Email: ______________________ Fax: ______________

Contractor Name: ______________________ Mailing Address: ______________________

City: ______________ Province: ______ Postal Code: ______________ Phone: ______________

Contact Name: ______________ Cell: ______________ Email: ______________ Fax: ______________

Project Location: Municipality: ______________ Subdivision Name: ______________ Tax Roll No.: ______________

Street/Rural Address: ______________________ Postal Code: __________

Lot: ______ Block: ______ Plan: ______ LSD: ______ Quarter: ______ Section: ____ Township: ______ Range: ____ West of: ___

Directions: ______________________

Description of Work: ☐ Work has not started ☐ Work is in progress ☐ Work is complete

____

____

____

____

TYPE OF OCCUPANCY	TYPE OF WORK	NUMBER OF OUTLETS	INSTALLATION
☐ Single Residential ☐ Multi-family ☐ Farm/Ranch ☐ Commercial ☐ Industrial ☐ Institutional ☐ Oil and Gas ☐ Other: ______________ ______________	☐ New ☐ Renovation ☐ Addition ☐ Appliance Replacement ☐ Refill Centre ☐ Manufactured/Mobile Home ☐ Service Reconnection ☐ Grain Dryer ☐ Accessory Building ☐ Other: ______________ Temporary Heat: ______________units Project Total BTU (excluding residential and farm): ______________	Furnaces: ______ Water Heaters: ______ Boilers: ______ Fireplaces: ______ Dryers: ______ Unit Heaters: ______ BBQs: ______ Ranges: ______ Secondary Gas Line: ______ Other: ______ Total: ______	☐ Natural Gas ☐ Propane Tank Size: ______________ Serial No.: ______________ ______________

______________________ Journeyman's Name (print)

______________________ Journeyman's Signature

______________________ Homeowner 's Signature (homeowner permit only)

Homeowner Declaration: By signing this application I hereby certify that I own/will own and occupy this dwelling.

Journeyman's Certification No.: ______________________

Office Use Only

Permit Fee: $ ______________ SCC Levy: ______________ Issuing Officer's Name: ______________________

Total Cost: $ ______________ ($4.50 or 4% of the permit fee maximum $560.00) Issuing Officer's Signature: ______________________

Receipt No.: ______________ Designation No.: ______________________

☐ Cash ☐ Debit ☐ Cheque ______________ Permit Issue Date (mmm/dd/yyyy): ______________________

☐ Credit Card (attach signed credit card authorization form)

Alberta Safety Codes Authority
A Division of the Safety Codes Council

[date received stamp]

the inspections group inc.

[agency file no.]

[eSITE permit no.]

PLUMBING PERMIT APPLICATION FORM

Development Permit No.: ______ Other Permits Required (under separate application): ☐ Building ☐ Electrical ☐ Gas ☐ PSDS

Application Date (mmm/dd/yyyy): ______ Estimated Project Completion Date (mmm/dd/yyyy): ______

Permit Applicant: ☐ Owner ☐ Contractor Value of Installation (labour and material): $ ______

Owner Name: ______ Mailing Address: ______

City: ______ Province: ______ Postal Code: ______ Phone: ______

Cell: ______ Email: ______ Fax: ______

Contractor Name: ______ Mailing Address: ______

City: ______ Province: ______ Postal Code: ______ Phone: ______

Contact Name: ______ Cell: ______ Email: ______ Fax: ______

Project Location: Municipality: ______ Subdivision Name: ______ Tax Roll No.: ______

Street/Rural Address: ______ Postal Code: ______

Lot: ______ Block: ______ Plan: ______ LSD: ______ Quarter: ______ Section: ______ Township: ______ Range: ______ West of: ______

Directions: ______

Description of Work: ☐ Work has not started ☐ Work is in progress ☐ Work is complete

TYPE OF OCCUPANCY	TYPE OF WORK	NUMBER OF FIXTURES	
☐ Single Residential	☐ New	Kitchen Sinks: ______	Bathtubs: ______
☐ Multi-family	☐ Addition	Basins: ______	Floor Drains: ______
☐ Farm/Ranch	☐ Renovation	Showers: ______	Grease Traps: ______
☐ Commercial	☐ Accessory Building	Laundry Tubs: ______	Bidets/Water Fountains: ______
☐ Industrial	☐ Ready to Move	Toilets: ______	Urinals: ______
☐ Institutional	☐ Basement Development	Washing Machine: ______	Other Fixtures: ______
☐ Manufactured/Mobile Home	☐ Service Connection		Total: ______
☐ Oil and Gas	☐ Other: ______		
☐ Skid Units			
☐ Other: ______		Total Footprint: ______	☐ ft² ☐ m²

FOIPP Notification: Personal information collected on this form is collected under the authority of section 33(c) of the Alberta Freedom of Information and Protection of Privacy Act. It is used for processing permit applications, issuing permits, safety codes compliance monitoring, verification and program evaluation. The name of the permit holder and nature of the permit may be included on reports provided to a municipality or made available to the public as required or allowed by legislation. Questions about this collection may be directed to ASCA Coordinators at 1-888-413-0099 or at Suite 500, 10405 Jasper Avenue, Edmonton, AB T5J 3N4.

Journeyman's Name (print) ______ Journeyman's Signature ______ Homeowner 's Signature (homeowner permit only) ______

Journeyman's Certification No.: ______

Homeowner Declaration: By signing this application I hereby certify that I own/will own and occupy this dwelling.

Office Use Only

Permit Fee: $ ______ SCC Levy: ______ Issuing Officer's Name: ______

Total Cost: $ ______ ($4.50 or 4% of the permit fee maximum $560.00) Issuing Officer's Signature: ______

Receipt No.: ______ Designation No.: ______

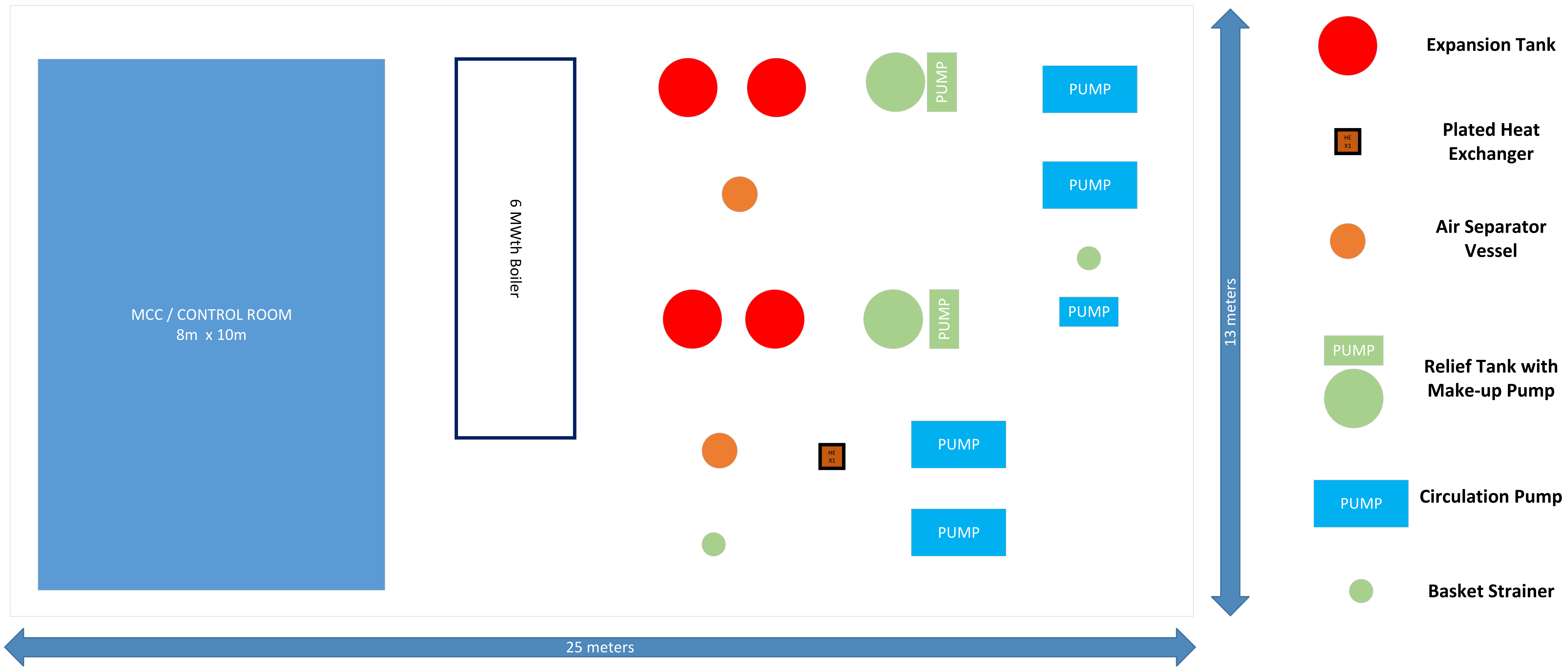
☐ Cash ☐ Debit ☐ Cheque ______ Permit Issue Date (mmm/dd/yyyy): ______

☐ Credit Card (attach signed credit card authorization form)

The Inspections Group Inc.,12010 111 Avenue, Edmonton, Alberta T5G 0E6 Phone: 780-454-5048 or 1-866-554-5048 Fax: 780-454-5222 or 1-866-454-5222 Email: questions@inspectionsgroup.com

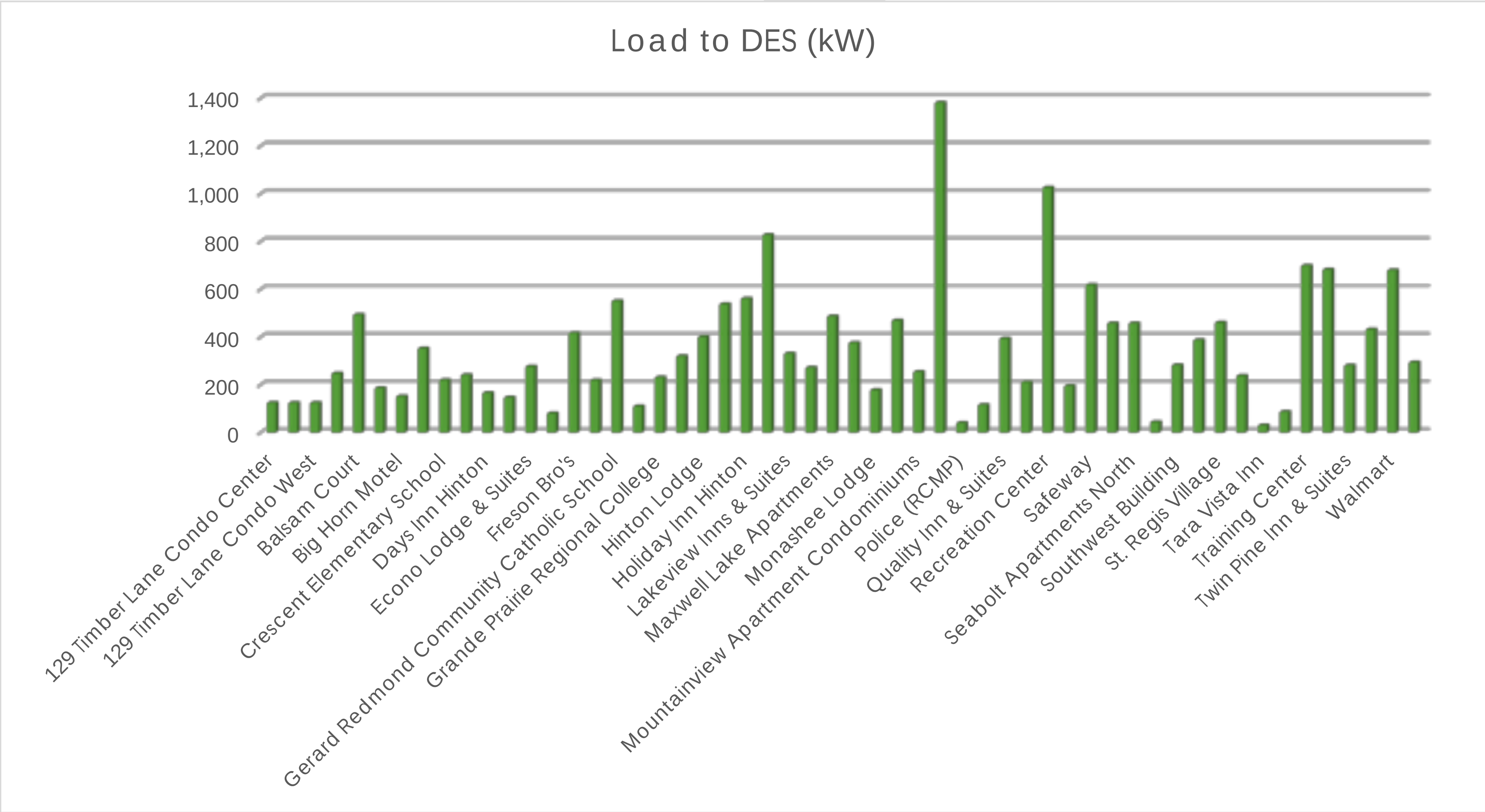
Appendix D.19 DEC General Layout Drawing – Minimized Design

General Arrangement Drawing of the Hinton District Energy Center (Minimum Design)

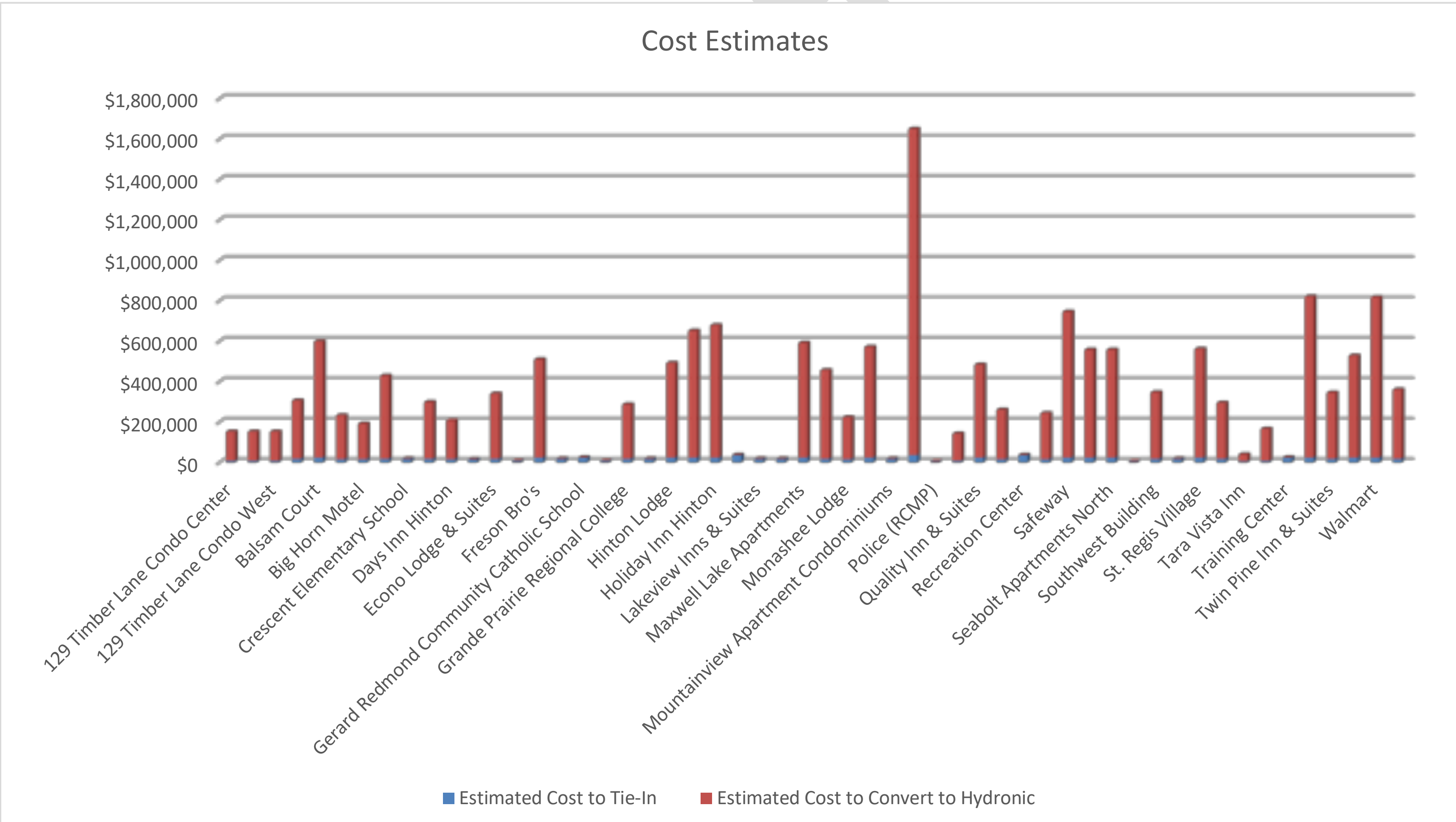


Appendix E Downstream

Appendix E.1 Load to DES (kW)



Appendix E.2 Cost Estimates



Appendix F Potential CRA Opportunities

Below is an excerpt from the Tax Measures: Supplementary Information of the Government of Canada's Budget 2017 Budget Plan. The section quoted is from "Clean Energy Generation Equipment: Geothermal Energy".

"Under the capital cost allowance (CCA) regime, Classes 43.1 and 43.2 of Schedule II to the *Income Tax Regulations* provide accelerated CCA rates (30 per cent and 50 per cent, respectively, on a declining-balance basis) for investment in specified clean energy generation and conservation equipment. Both classes include eligible equipment that generates or conserves energy by:

- using a renewable energy source (e.g., wind, solar or small hydro);
- using a fuel from waste (e.g., landfill gas, wood waste or manure); or
- making efficient use of fossil fuels (e.g., high efficiency cogeneration systems, which simultaneously produce electricity and useful heat).

Providing accelerated CCA is an exception to the general practice of setting CCA rates based on the useful life of assets. Accelerated CCA provides a financial benefit by deferring taxation. Class 43.2 is available in respect of property acquired before 2020.

In addition, if the majority of the tangible property in a project is eligible for inclusion in Class 43.1 or 43.2, certain intangible project start-up expenses (for example, engineering and design work and feasibility studies) are treated as Canadian renewable and conservation expenses. These expenses may be deducted in full in the year incurred, carried forward indefinitely for use in future years or transferred to investors using flow-through shares.

Geothermal heating is the extraction and direct use of thermal energy generated in the earth's interior. Equipment that uses geothermal energy is currently eligible for inclusion in Class 43.2 (50-per-cent rate) if it is primarily used for the purpose of generating electricity, while equipment used primarily for heating purposes is generally included in Class 1 (4-per-cent rate).

The costs of drilling and completing exploratory wells are fully deductible in the year they are incurred as Canadian renewable and conservation expenses when it is reasonable to expect that at least 50 per cent of the capital cost of the depreciable property will be used in an electricity generation project included in Class 43.1 or 43.2. The costs of drilling and completing geothermal production wells for an electricity generation project that qualifies for Class 43.2 are included in Class 43.2. In contrast, the costs of drilling and completing geothermal wells for projects that do not meet this electricity generation threshold (e.g., projects focussed on supplying heat) could be included in Class 1 (4-per-cent rate), Class 17 (8-per-cent rate), Class 14.1 (5-per-cent rate) or treated as a current expense, depending on the circumstances.

District energy systems transfer thermal energy between a central generation plant and one or more buildings by circulating (through a system of pipes) an energy transfer medium that is heated or cooled using thermal energy. Thermal energy distributed by a district energy system can be used for heating, cooling or in an industrial process. Certain equipment that is part of a district energy system is currently included in Class 43.1 or 43.2. Geothermal heat is not currently eligible as a thermal energy source for use in a district energy system.

Budget 2017 proposes three changes in this area. First, it proposes that eligible geothermal energy equipment under Classes 43.1 and 43.2 be expanded to include geothermal equipment that is used primarily for the purpose of generating heat or a combination of heat and electricity. Eligible costs will include the cost of completing a geothermal well (e.g., installing the wellhead and production string) and, for systems that produce electricity, the cost of related electricity transmission equipment. As with active solar heating and ground source heat pump systems, equipment used for the purpose of heating a swimming pool will not be eligible. Secondly, geothermal heating will be made an eligible thermal energy source for use in a district energy system. Lastly, expenses incurred for the purpose of determining the extent and quality of a geothermal resource and the cost of all geothermal drilling (e.g., including geothermal production wells), for both electricity and heating projects, will qualify as a Canadian renewable and conservation expense.

These measures will encourage investment in technologies that can contribute to a reduction in emissions of greenhouse gases and air pollutants, in support of targets set out in the Federal Sustainable Development Strategy. Accelerated CCA will be available in respect of eligible property only if, at the time the property first becomes available for use, the requirements of all environmental laws, by-laws and regulations applicable in respect of the property have been met. Similarly, Canadian renewable and conservation expense treatment will be available for expenses in geothermal projects only if, in the year incurred, such expenses meet the requirements of all applicable environmental laws, by-laws and regulations.

The measures will apply in respect of property acquired for use on or after Budget Day that has not been used or acquired for use before Budget Day." [88]