Feasibility Update Study Ventilation Technical Report for the Lac des Iles Mine, Ontario, Canada

Report Prepared for

North American Palladium Ltd.

Report Prepared by

SRK Consulting (Canada) Inc.
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Feasibility Study Ventilation Technical Report for the Lac des Iles Mine, Ontario, Canada

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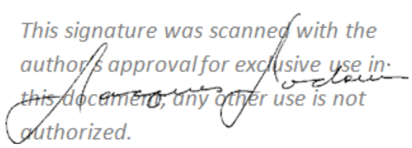

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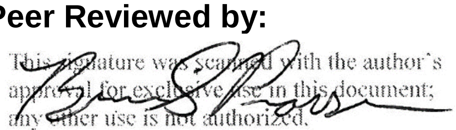

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Cover: Lac des Iles Mine

Executive Summary

SRK Consulting (Canada) Inc. (SRK) was commissioned by North American Palladium Ltd. (NAP) to complete a Feasibility Technical Update Study of the Lac des Iles Mine (LDI).

The LDI property is located approximately 140 kilometres north of the city of Thunder Bay, via Highway 527 in northwestern Ontario. Refer to Figure i.

In May 2017, NAP filed a technical report entitled, “NI 43-101 Technical Report Feasibility Study Incorporating the Life of Mine Plan for Lac des Iles Mine”. This report included a revised estimate of mineral reserves and mineral resources for LDI that are considered to be material to the NAP’s business and the associated life of mine plan (LOMP) schedules production over 9.5 years to 2026.

Figure i: Lac des Iles Mine Site Location

As a result of optimization efforts performed on the Near Surface Zones, this feasibility technical update study report includes the revisions to the associated LOMP schedules and production to 2028 as referenced in Figure ii. This work involved upgrading the previous designs to detailed feasibility level on the Near Surface Zones, inclusive of the following:

- Roby NE Extension Zone
- Roby NW Zone
- Roby FW Zone
- Roby SW Floor Zone
- Roby S Zone
- Sheriff South Zone
- B2 Zone

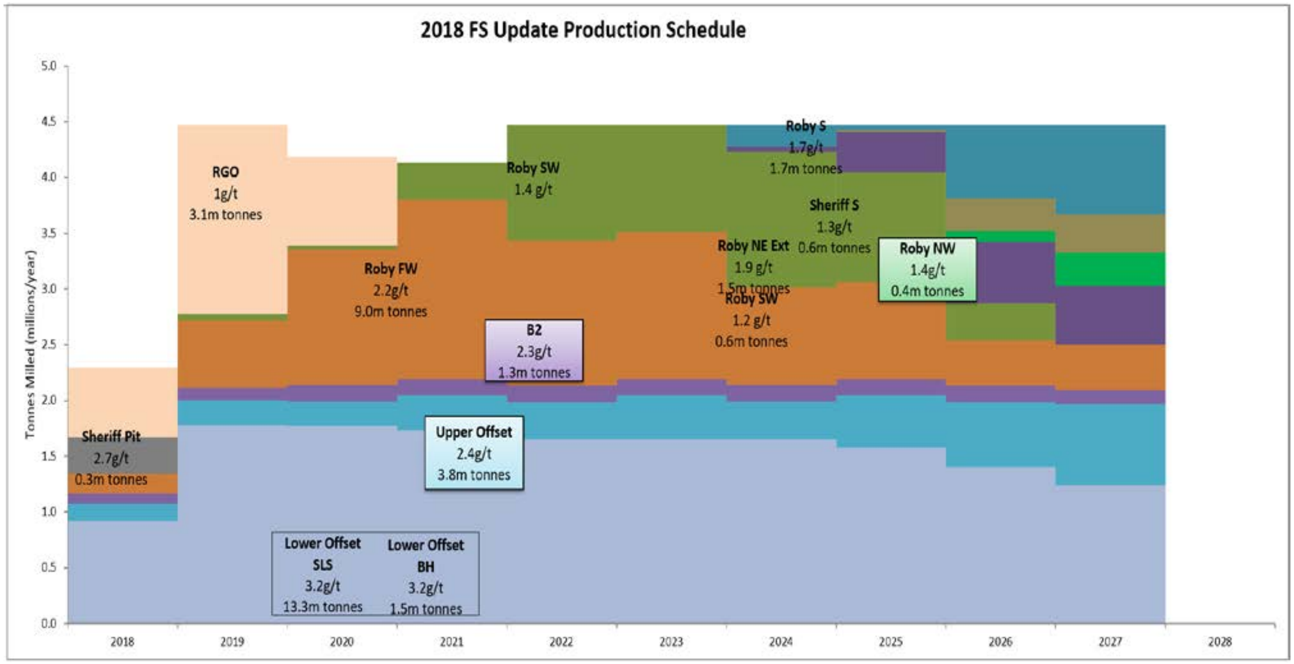


Figure ii: Production Profile – All Production Areas

Table of Contents

List of Tables

List of Figures

1 Introduction

This document provides the design basis for the ventilation facilities that will service all orebodies and operations included in the Lac des Iles Mine (LDI). This includes the Near Surface Zones, Upper and Lower Offsets.

The overall final ventilation system design is a “push / pull” system. Under normal operating conditions the shaft and main fresh air intakes are utilized to provide LDI (all mining areas) with approximately 958 cubic metres per second (m^3/s) (2,029,600 cubic feet per minute [cfm]). The return air system will consist of the main exhaust fans, 220 Level underground return air (RA) boosters and new ramp portal.

All primary fans are to be controlled by variable frequency drives (VFD) to mesh the production rate with the air volume requirements, thereby optimizing energy (power and propane) usage. Parallel fan setups are recommended for all primary installations.

2 Ventilation

The current ventilation installation consists of a push-pull system using a network of main fans on surface and booster fans underground. The main fresh air system consists of one 600 horsepower (HP) fan and propane-fired heater installed in the Roby pit. This fan supplies approximately 217 m^3/s of air to 560 Level then down to 825 Level. The shaft fresh air system consists of two 350 HP fans and propane-fired heater that deliver 203 m^3/s of air to 825 Level.

Return air exhausts from underground via the ramp, and the exhaust fans located in the open pit. The ramp exhausts approximately 96 m^3/s and the pit exhaust fans draw approximately 291 m^3/s from the mine.

As mining underground progresses at depth, the ventilation system will require upgrading. Additionally, to allow for the Near Surface Zones, additional ventilation systems will be required. These upgrades are discussed below.

2.1 Expansion Underground

NAP recently converted to a sublevel stoping (SLS) mining method in the lower portion of LDI that includes an increase in the production rate. LDI's 2018 life of mine plan (LOMP) includes mining of the SLS to 1305 Level, together with planned mining in the Upper Offset and B2 zones. This plan necessitates upgrades to the current ventilation system in order to meet the revised LOMP.

2.2 Near Surface Zones

The ventilation design for the Near Surface Zones is designed to function as a standalone system, independent of the current ventilation system at LDI.

The ventilation is configured as a push-pull system with the majority of fan duty located within the supply portion of the mine. All intake air will be heated as required, utilizing propane gas direct-fired heaters on the surface intake during the winter months.

The design of the ventilation system is based on air quantity requirements determined from the preliminary estimated diesel equipment fleet of load, haul, dump (LHD) trucks and haulage trucks.

Under normal operating conditions, the new 5.5-metre (18-foot) diameter fresh air raise (FAR) will provide 437 m^3/s (927 Kcfm) of fresh air from fans operating in parallel on surface. The fresh air delivered through the FAR is distributed in a controlled manner to the various underground working areas.

Return air (RA) for the mining zones will be via the new ramp/portal, 220 Level underground RA booster fans, and by the development of RA raises/drifts at the extents of the mining zones extending and daylighting into the pit wall.

Flow through ventilation for the mining zones will be achieved via regulators and/or auxiliary boosters to control the amount of airflow required. The amount of fresh air allocated to a level depends on the number of production/development areas on the level.

3 Ventilation Airflows, Fans, and Raises

3.1 Ventilation System Design Parameters

The best practice in ventilation design considers the following elements:

- Ramp systems maintained in fresh air
- Maintain optimum velocity within raises, travelways and workplaces. Maximum velocities enforced in the designs are presented in Table 1

Table 1: Airway Velocity Criteria

Area/Airway	**Maximum Velocity (m/s)**
Ramp or other primary travelway	6
Ventilation drift (no regular personnel access)	10
Raise (not used for escapeway)	20
Upcasting shaft range to avoid (for water suspension)	(7 to 12)

- One pass ventilation is employed for primary ventilation systems
- Limited use of recycled air

3.2 Airflow Requirements

The estimated underground air volume requirements are based on the Ontario Occupational Health and Safety Act, Regulations 854 Section 183.1 (3).

The regulation states:

> *"The flow of air must be at least 0.06 cubic metres per second for each kilowatt of the diesel-powered equipment operating in the workplace"*.

The airflow requirement is commonly expressed in cfm and the conversion is 100 cfm per HP.

The maximum ventilation demand would occur if all mobile equipment in the mine was operating simultaneously. Although this is possible, in practice it is very unlikely to occur. To estimate a more likely peak ventilation demand, utilization factors were applied to the mobile equipment.

The utilization factors reflect the likely combination of equipment that will be running during the busiest periods of any working shift (i.e. during the work periods with high diesel activity). Refer to Table 2. Fractional Equipment factors refer to transient equipment location within areas.

Ventilation utilization should not be confused with operator utilization (or "seat time"). For example, a haul truck may only operate for 6 hours during a 10-hour shift (60% utilized), but the 6 hours are primarily during the nominal 8 hours of high diesel activity. It is the period of high diesel activity for which the ventilation system must be designed to support. During the periods of low activity, ventilation on demand (VOD) settings can be used to reduce the ventilation flows accordingly.

Utilization factors vary with the type of equipment and reasonable judgement was used. Equipment such as drill jumbos, which operate on diesel power only while moving from one workplace to the next, are utilized much less than LHDs or haul trucks.

Table 2: Utlization Cycle

Shift Start	Work Period	Lunch	Work Period	Shift End
Low activity	High diesel activity	Low activity	High diesel activity	Low activity

Ventilation simulation modelling and associated facility designs were prepared based on these airflows. Details of the airflow requirement calculations are provided in Appendix A.

The peak fresh airflow capacity for the mining of LDI's 2018 LOMP includes mining of the SLS to 1305 Level, together with planned mining in the Upper Offset and B2 zones has been presented in Table 3.

Table 3: Underground Expansion Peak Fresh Air Ventilation System Capacities

Milestone	Stage	FA Capacity m^3/s (Kcfm)
U/G Expansion	LOMP 2018	558 (1,181)

Mining of the Near Surface Zones over the LOMP by milestone will be as follows:

- Milestone 1
  - Roby FW Zone with one production front and one development front.
  - Roby SW Floor Zone with one development front.
- Milestone 2
  - Roby FW Zone with one production front and one development front.
  - Roby SW Floor Zone with one production front and one development front.
  - Roby NE Extension Zone with one development front.
- Milestone 3
  - Roby FW Zone with one production front.
  - Roby SW Floor Zone with one production front and one development front.
  - Roby NE Extension Zone with one production front.
  - Roby NW Zone with one production front.
  - Sheriff Zone with one development front.
- Milestone 4
  - Roby FW Zone with one production front.
  - South Zone with one production front and one development front.
  - Sheriff Zone with one production front.

The peak fresh airflow capacity for mining the underground expansion and Near Surface Zones is presented in Table 4.

Table 4: Near Surface Zones Peak Fresh Air Ventilation System Capacities

Milestone	Stage	FA Capacity m^3/s (Kcfm)
Milestone 1	Year 2020	234 (497)
Milestone 2	Year 2024	407 (861)
Milestone 3	Year 2026	437 (927)
Milestone 4	Year 2028	367 (778)

4 Ventilation Modelling

The ventilation simulation modelling and associated facility designs were prepared based on the following:

- Ventsim ventilation numerical model software
- Mine development and production plans, including access and production level 3D designs.
- Mine production schedules.
- Underground mobile equipment list and engine power estimates.
- Airflow requirements as calculated under the initial design criteria.
- Creation of numerical model for steady state ventilation milestone to determine infrastructure requirements and schedule.

The ventilation models were prepared to simulate the airflows during each of the determined stages and the selected peak production year. During this year, mining is active in most areas and the ventilation demand is at its highest. The ventilation numerical models for the 2018 LOMP and underground expansion are presented for illustration purposes in Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, and Figure 7. The long sections are provided in Appendix B.

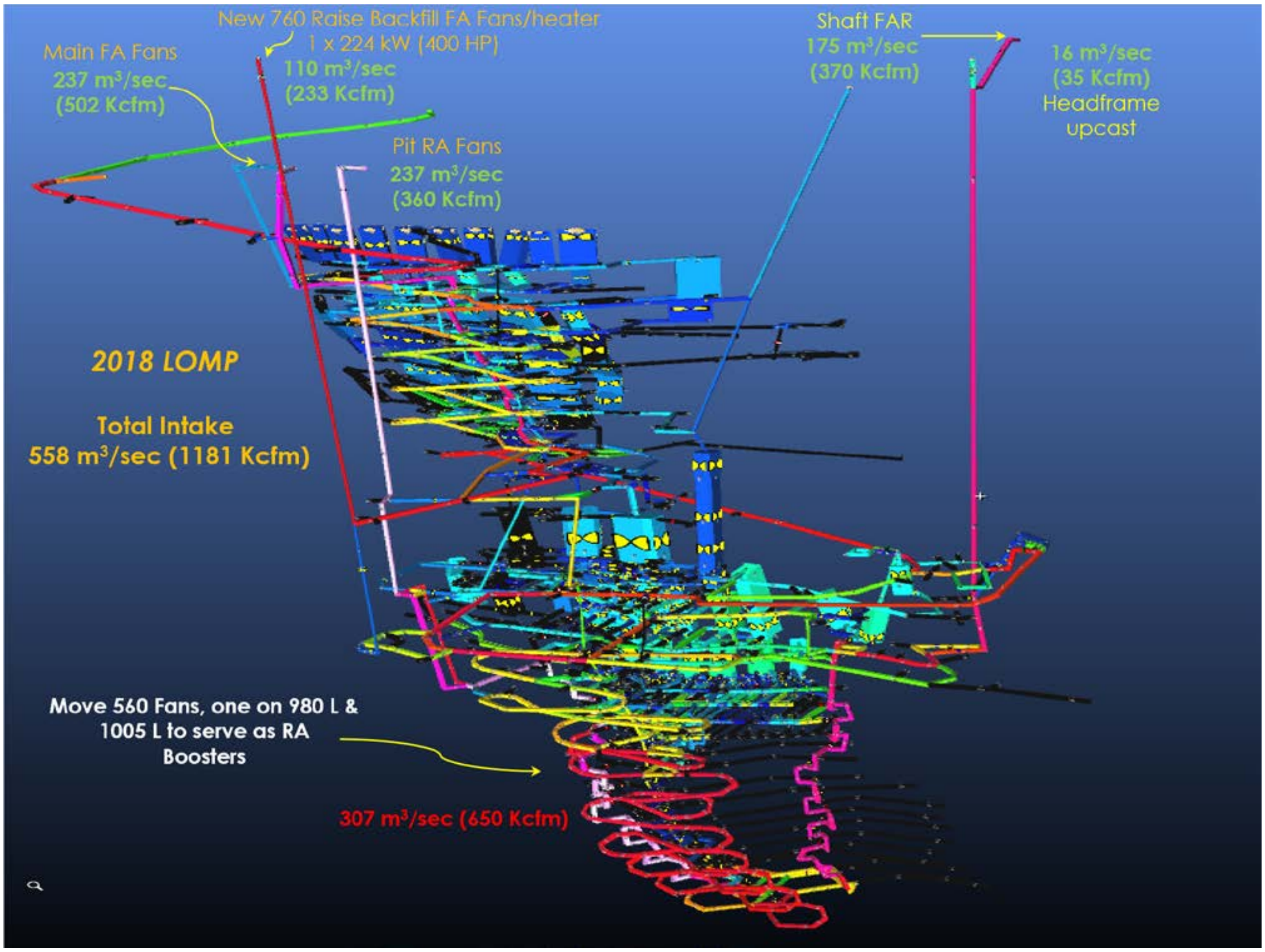


Figure 1: Underground Expansion 2018 LOMP

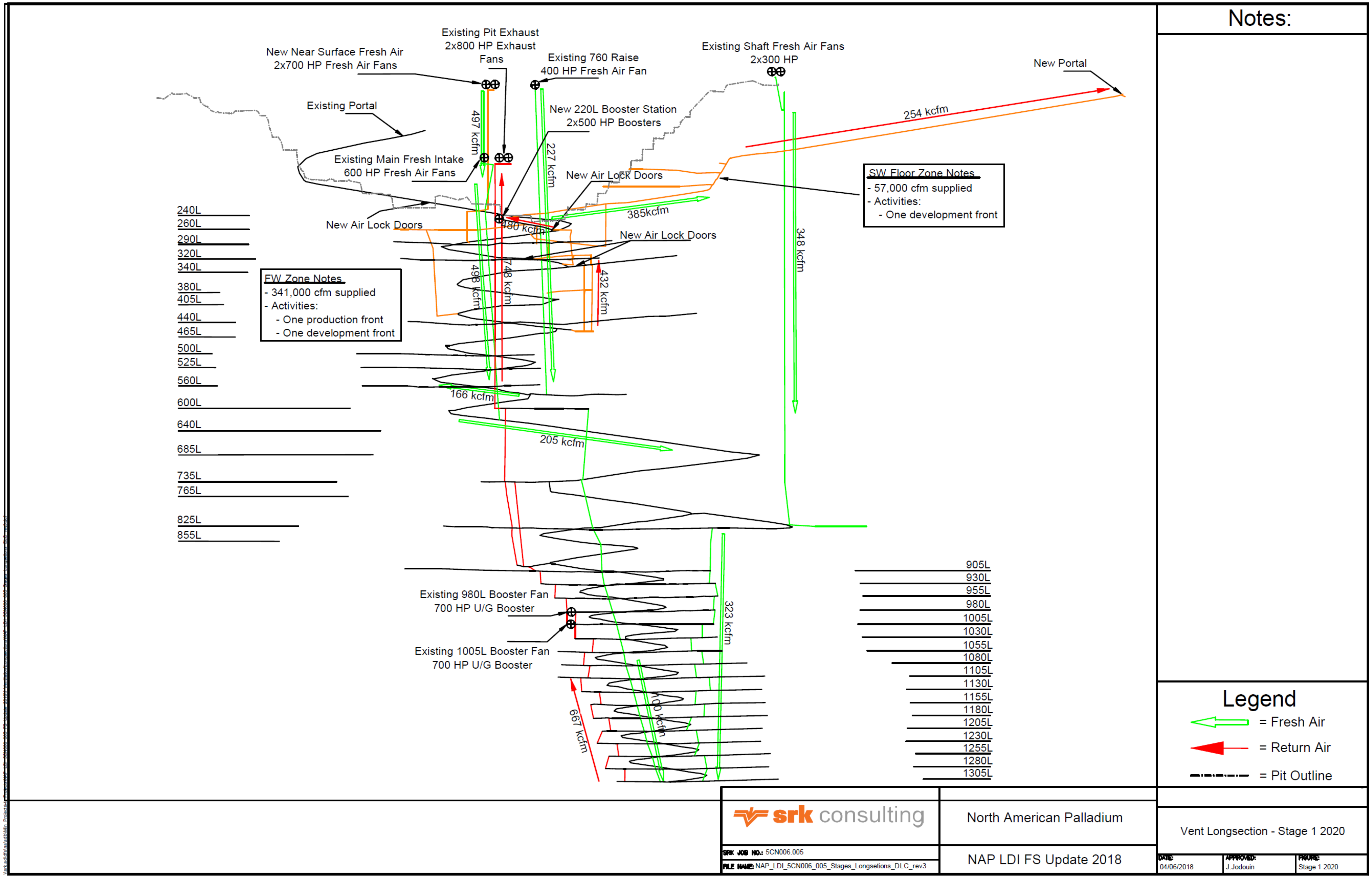


Figure 2: Near Surface Zones Milestone 1 2020

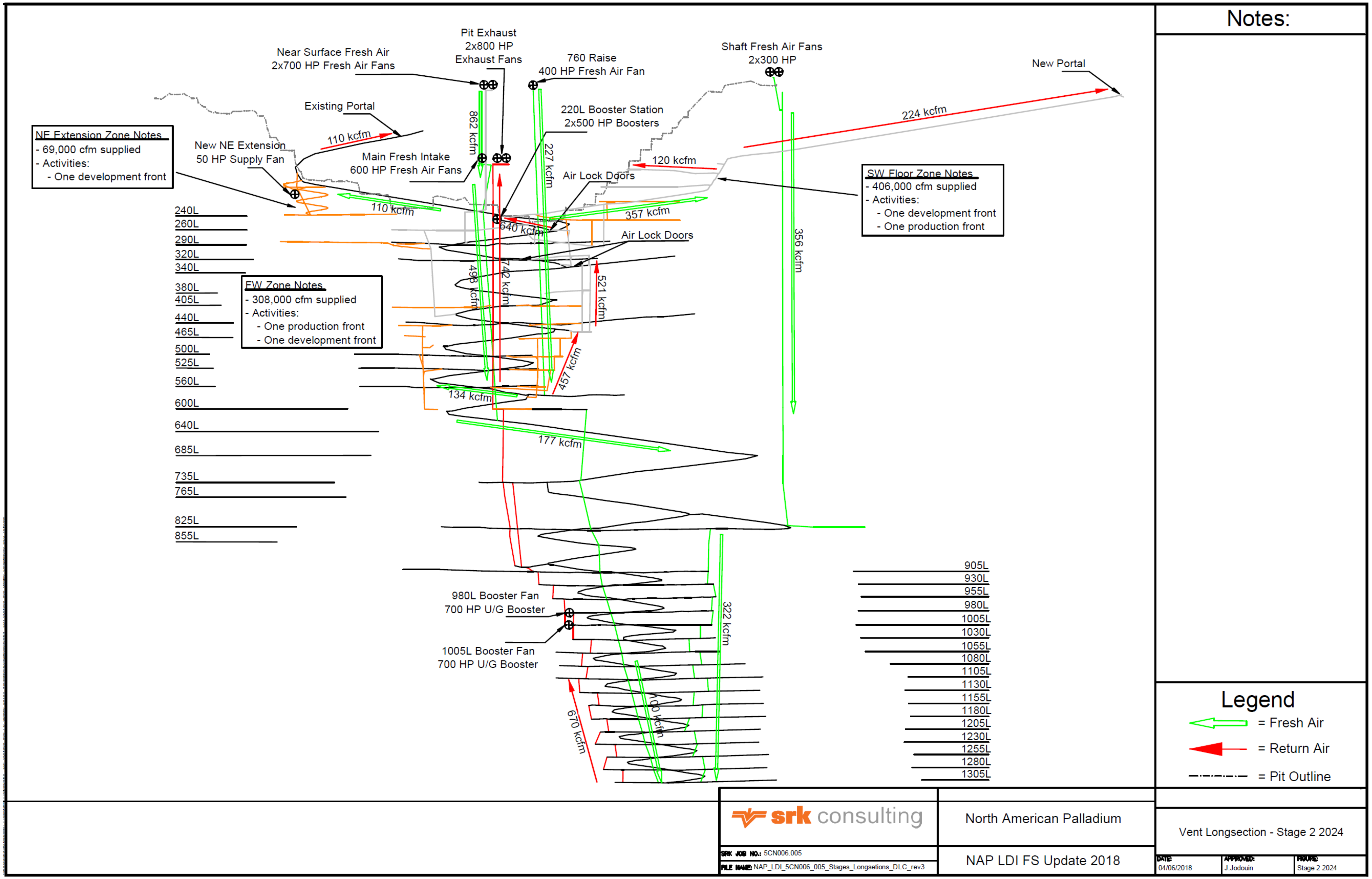


Figure 3: Near Surface Zones Milestone 2 2024

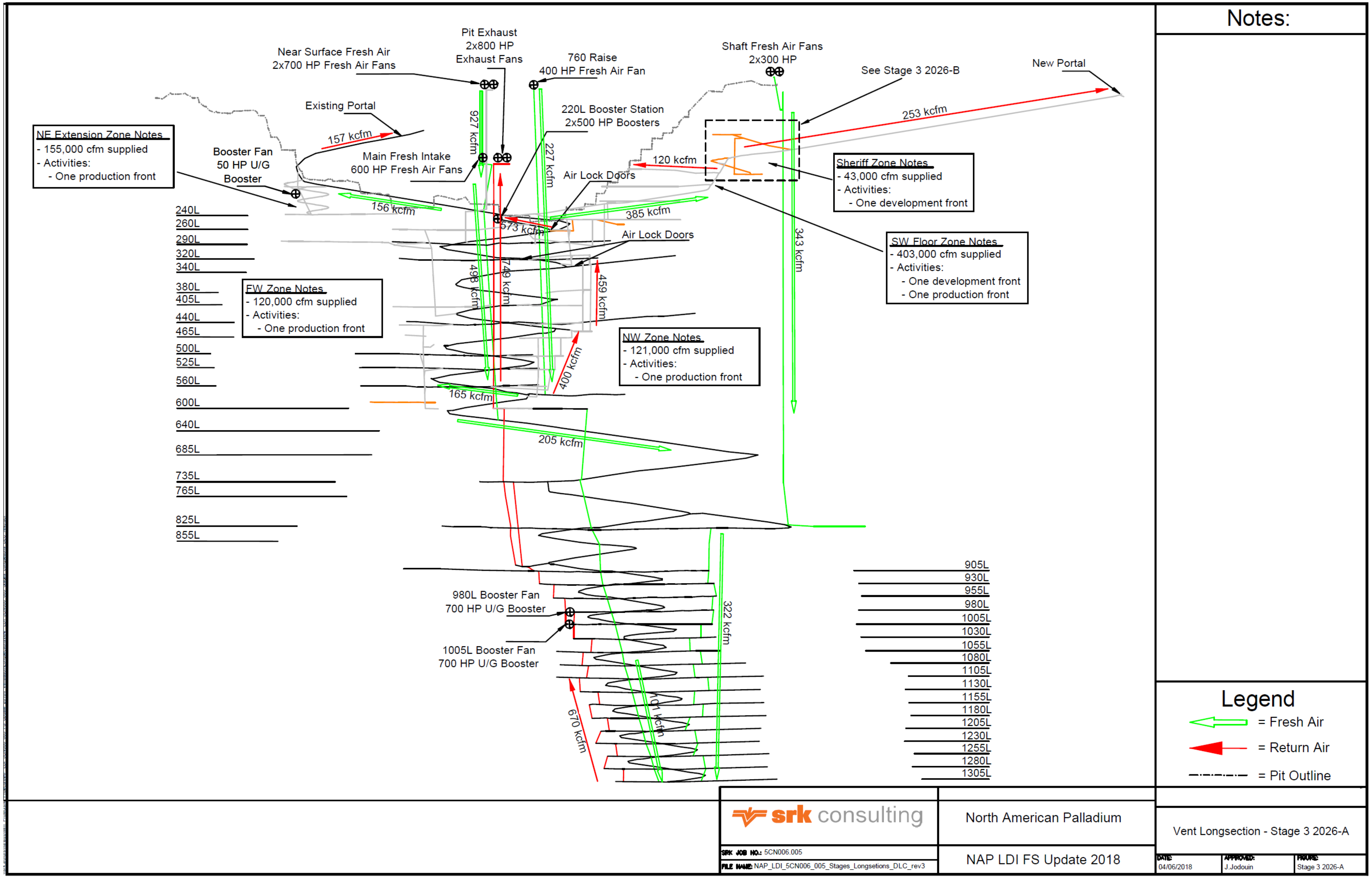


Figure 4: Near Surface Zones Milestone 3 2026 (A)

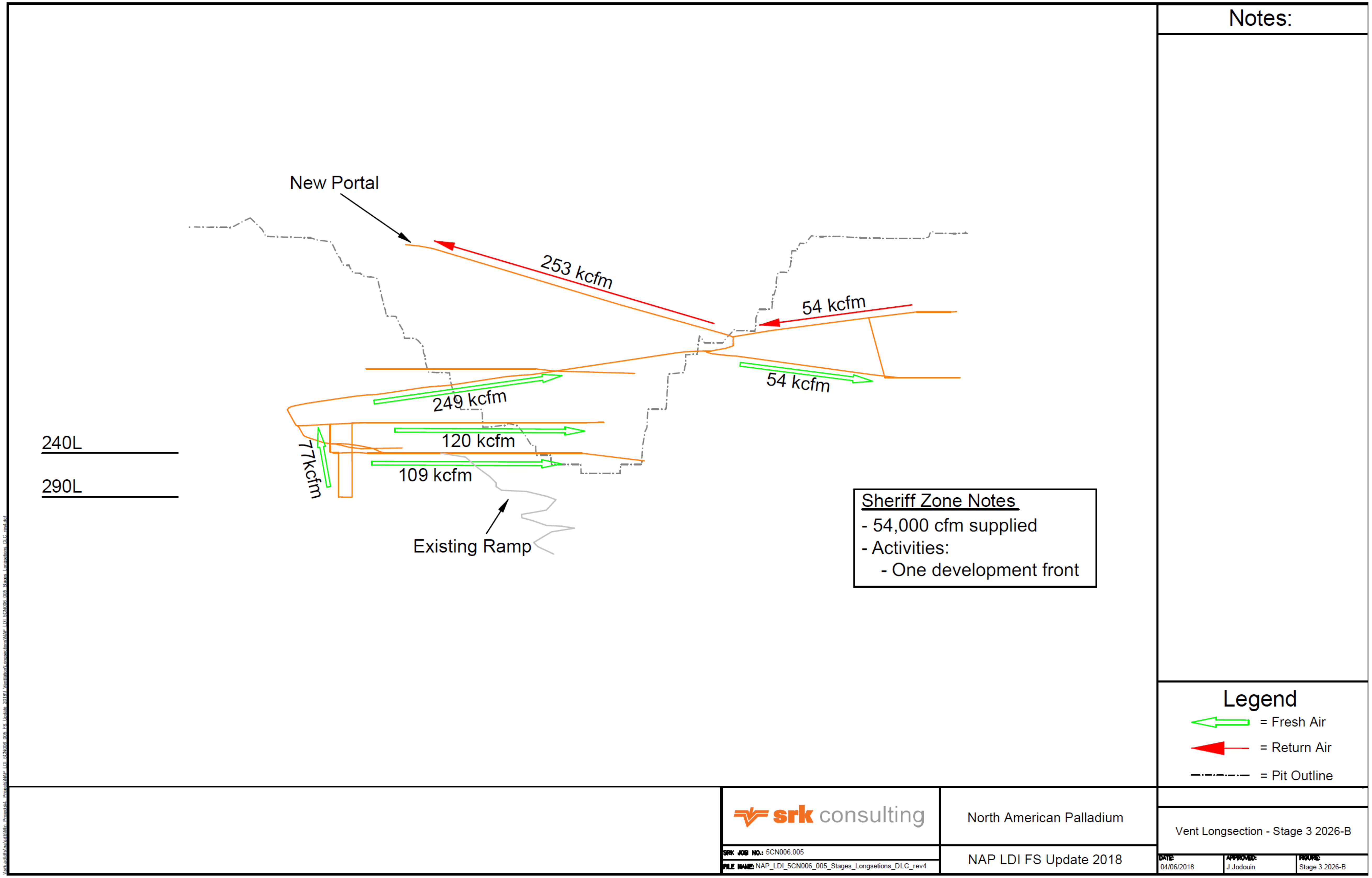


Figure 5: Near Surface Zones Milestone 3 2026 (B)

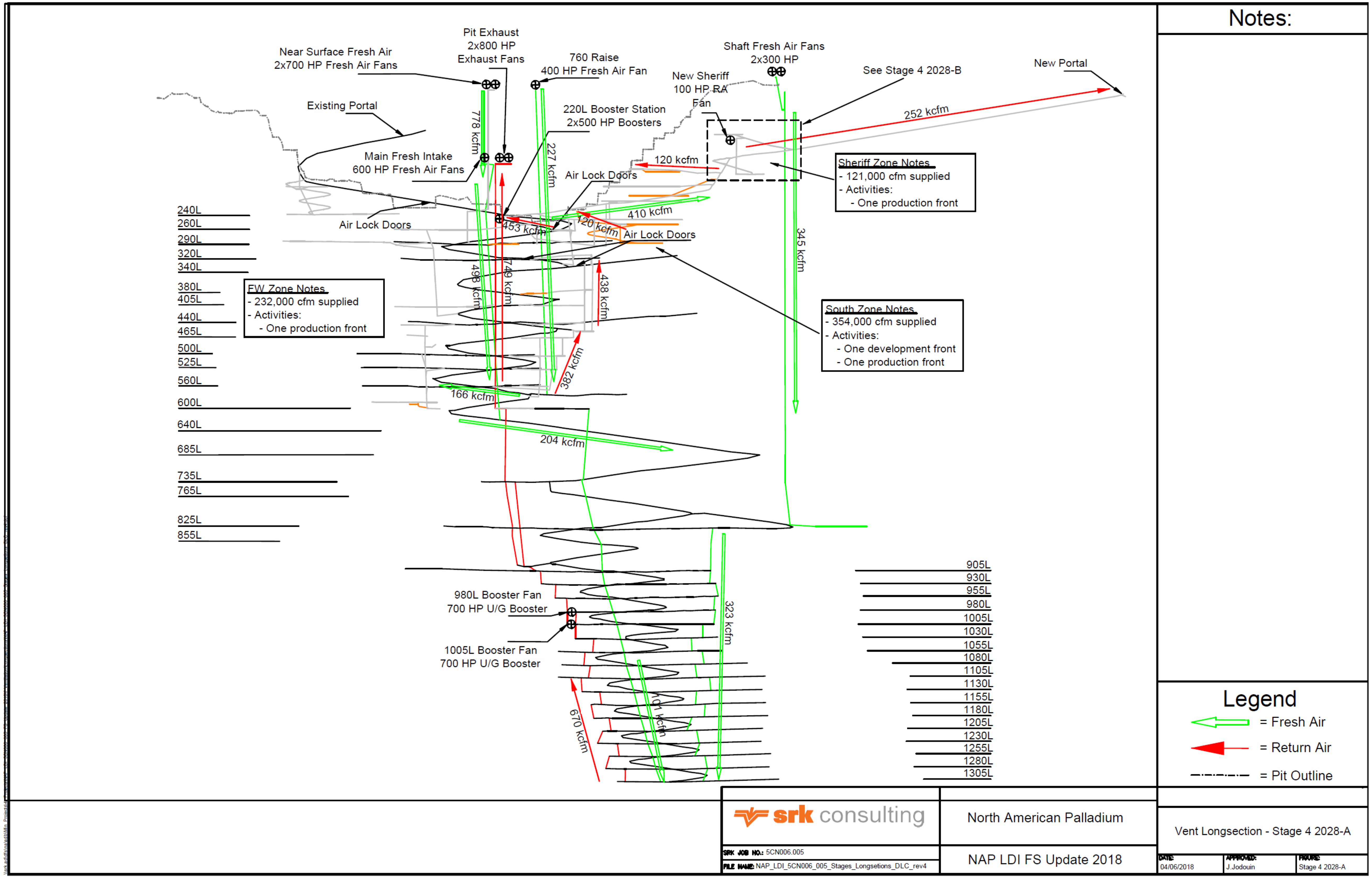


Figure 6: Near Surface Zones Milestone 4 2028 (A)

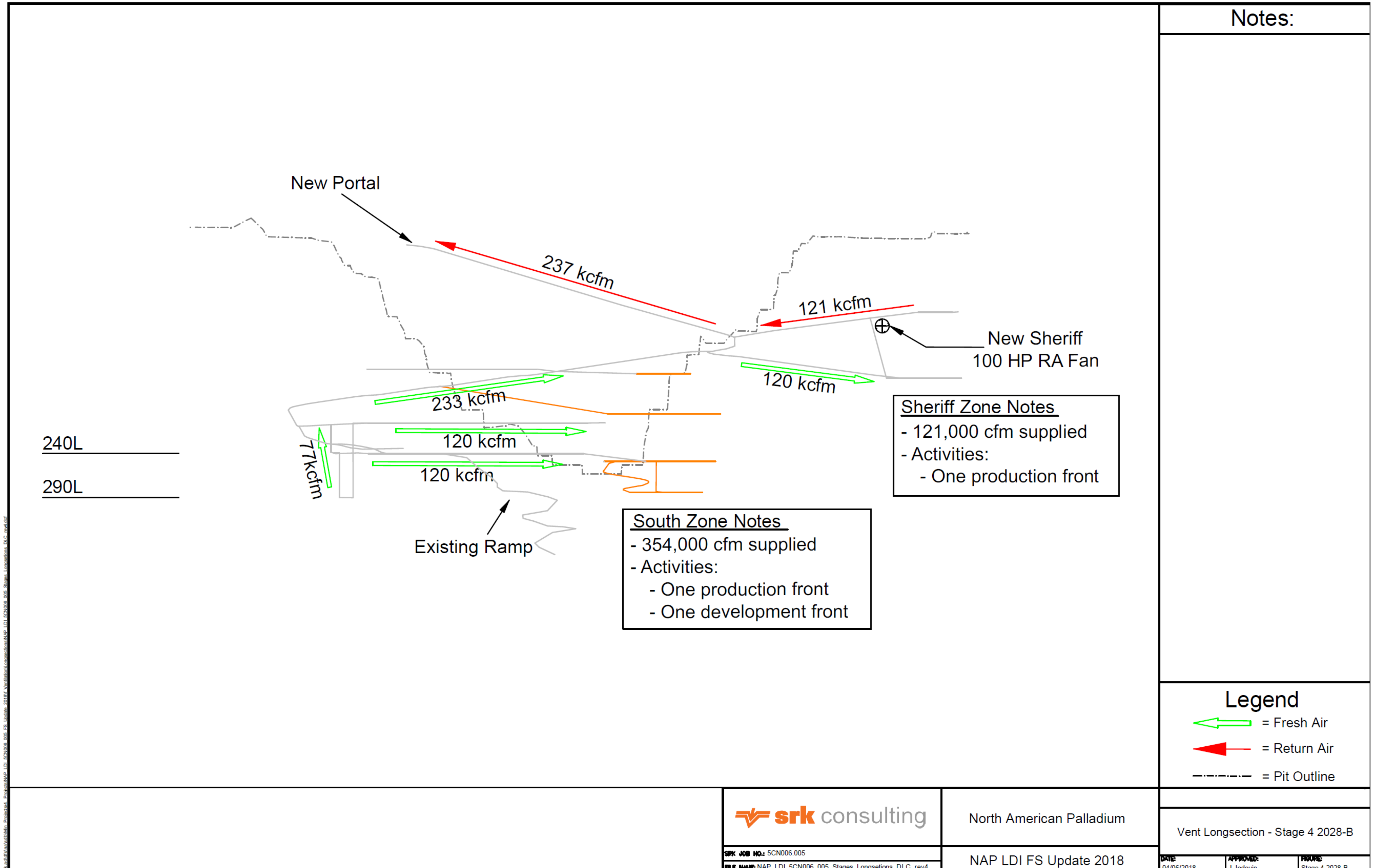


Figure 7: Near Surface Zones Milestone 4 2028 (B)

4.1 Main Fans

The design of the Near Surface Zones ventilation system is based on air quantity requirements determined from the estimated diesel fleet and considering the criteria provided by LDI engineering personnel.

The main ventilation system consists of the following installations:

- New Near Surface Zone main fresh air supply fans and propane direct-fired heaters.
- New RA underground booster fans at 220 Level.

Installation of variable frequency drives on all main fans will allow flexibility in the air volume capacity to meet the production requirements. General arrangement drawings of the proposed ventilation installations are provided in Appendix C.

Figure 8 illustrates the typical fresh air fan installation on surface. Figure 9 illustrate a typical underground RA booster fan installation. The main fan operating duty points are listed in Table 5.

Table 5: Main Fan Duty Points

System	Number of Fans	Operating Duty Point	Connected Fan kW	Mine Air Heater
Near surface fresh air	2	218.5 m^3/s at 1,020 Pascal SP	2 × 522 kW (700 HP)	2 × 12 MW
220 Level RA boosters	2	302 m^3/s at 1,470 Pascal SP	2 × 373 kW (500) HP	

4.2 Main Fresh Air Intake Raise Mine Air Heating

Fresh air mine air heating systems will be required to heat the mine air during the winter months. The heating system capacity is designed for a 47°C (80°F) temperature fluctuation range to allow for heating of the mine air at low temperatures. The direct propane gas fired heating systems includes heaters, common control room, valve trains, and electrics.

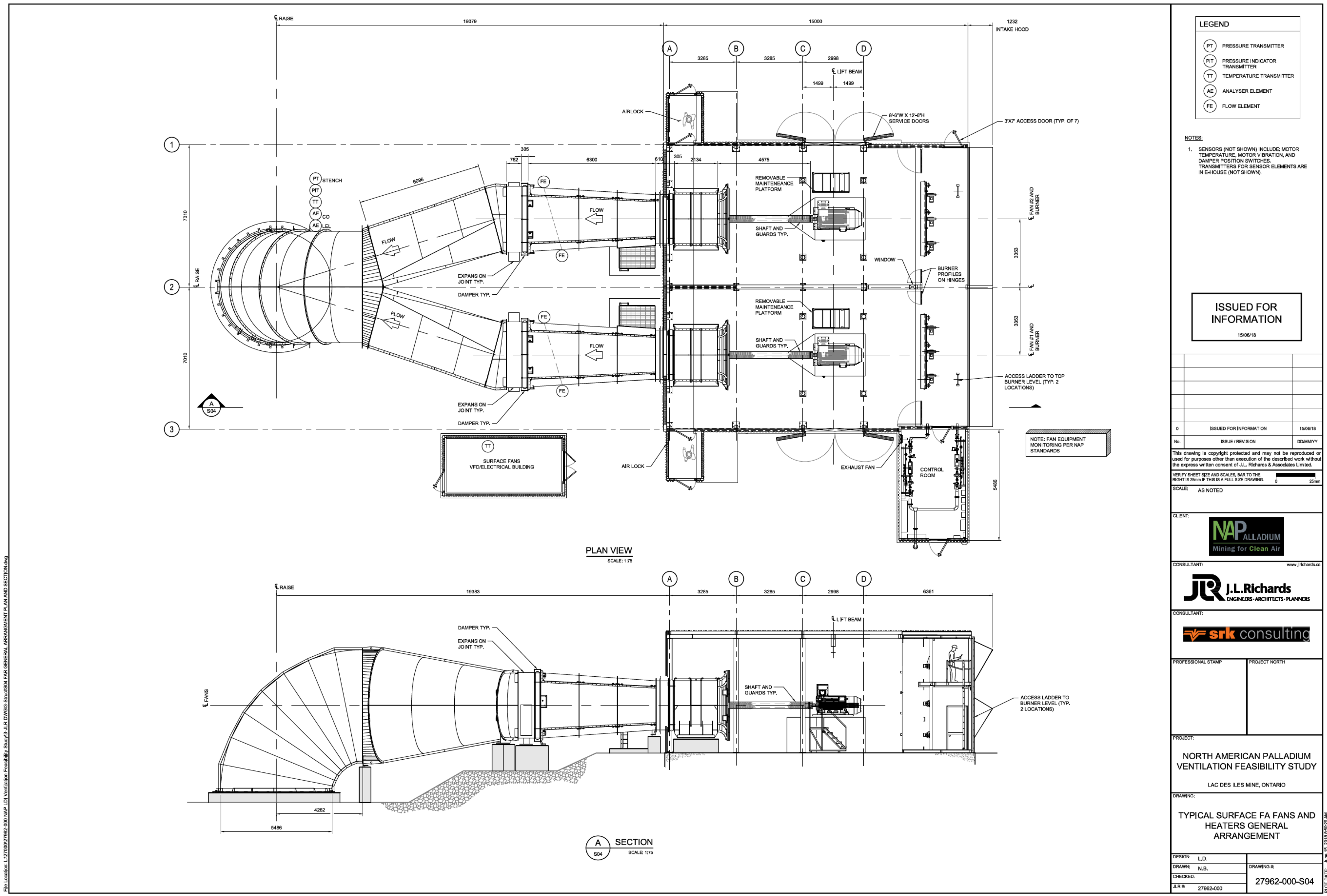


Figure 8: Typical Main Fresh Air System

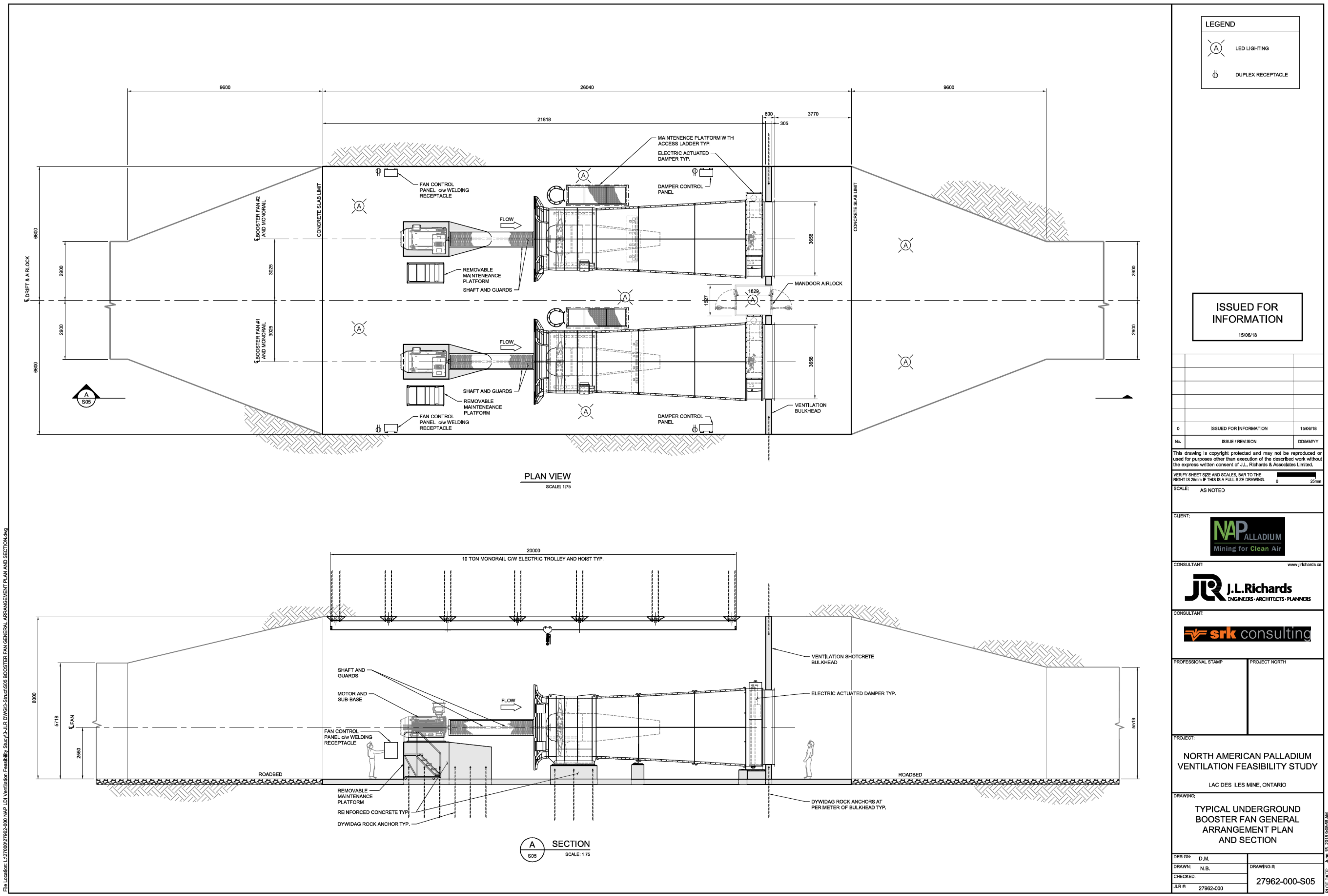


Figure 9: Typical Underground Return Air Booster Fans

4.3 Mine Air Heating Natural Gas Consumption

The mine air heaters are designed for a maximum temperature differential of 47°C (-40°F to +40°F) but will modulate to provide an output temperature setpoint in the intake raise collar of +2.0°C (35.6°F) during winter months. The estimated total mine propane gas consumption and associated costs (C$0.40 per litre) by milestone and per heating season are summarized in Table 6. Detailed heating calculations by location and milestone are provided in Appendix D.

Table 6: Total Mine Propane Gas Cost Summary (During Winter Months)

Milestone	Stage	Litres of Propane	Cost of Propane (C$)
Milestone 1	Year 2020	5,931,909	2,372,763
Milestone 2	Year 2024	7,285,464	2,914,185
Milestone 3	Year 2026	7,526,508	3,010,603
Milestone 4	Year 2028	6,976,185	2,790,474

5 Contingency

Due to the close proximity of the Near Surface Zones to the existing main fresh air and pit return air surface fans, LDI requested that SRK review the impacts of relocating both the main fresh air and pit return air surface fans, if required due to the expansion, as a contingency. It was determined, should the need for this replacement of facilities be required, it most likely would be during Milestone 2, 2024.

The contingency ventilation system consists of the following installations:

- Replacement of the main fresh air fan will consist of developing a new 218-metre long, 4.9-metre (16-foot) diameter fresh air raise from surface complete with fans, heaters and propane supply.
- Replacement of the pit RA surface fans will consist of the installation of new RA underground booster fans located at 600 Level.

Installation of variable frequency drives on all main fans will allow flexibility in the air volume capacity to meet the production requirements.

A site plan identifying the fan locations is provided in Figure 10 and Figure 11. A schematic of the mine with the contingency option is presented for illustration purposes in Figure 12. The main fan operating duty points are listed in Table 5.

The contingency main fan operating duty points are listed in Table 7.

Table 7:Contingency Main Fan Duty Points

System	Number of Fans	Operating Duty Point	Connected Fan kW
New Main FA Fans	2	118 m^3/s at 835 Pascal SP	2 × 224 kW (300 HP)
600 Level RA Boosters	2	173.5 m^3/s at 1524 Pascal SP	2 × 522 kW (700) HP

Figure 10: Contingency Site Plan

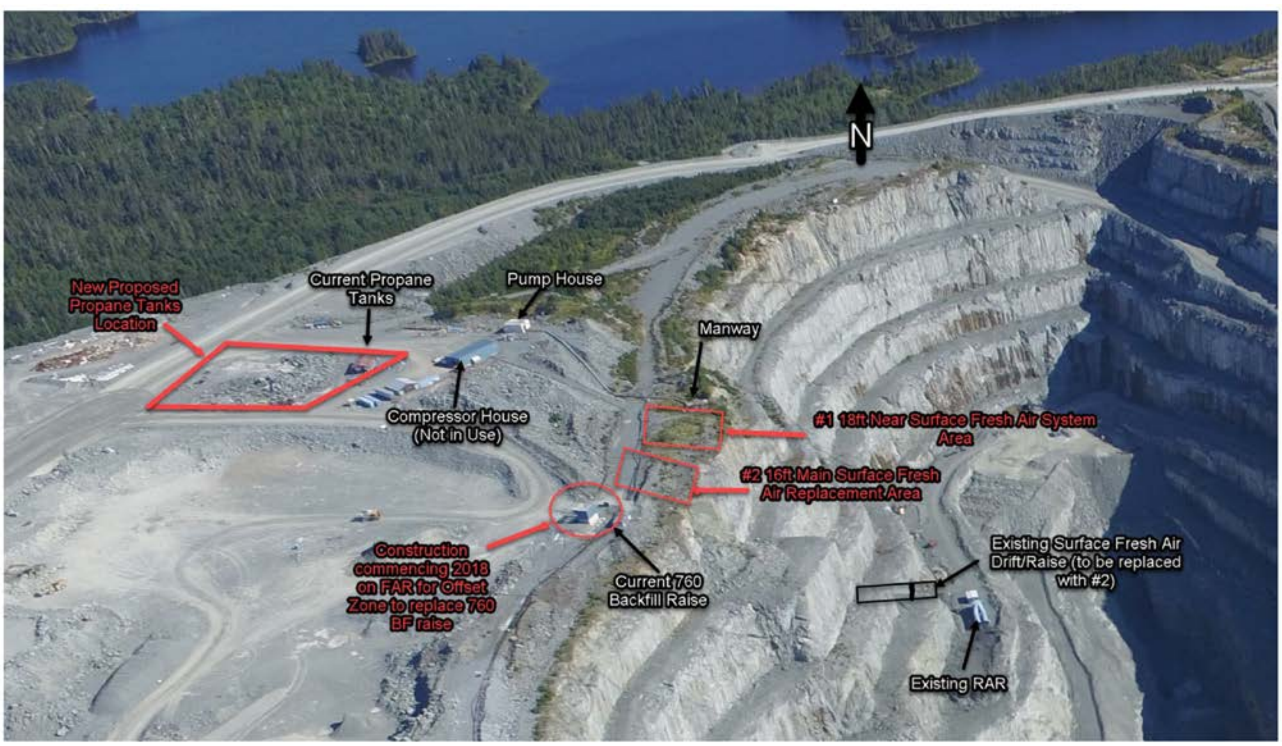


Figure 11: Contingency Site Plan

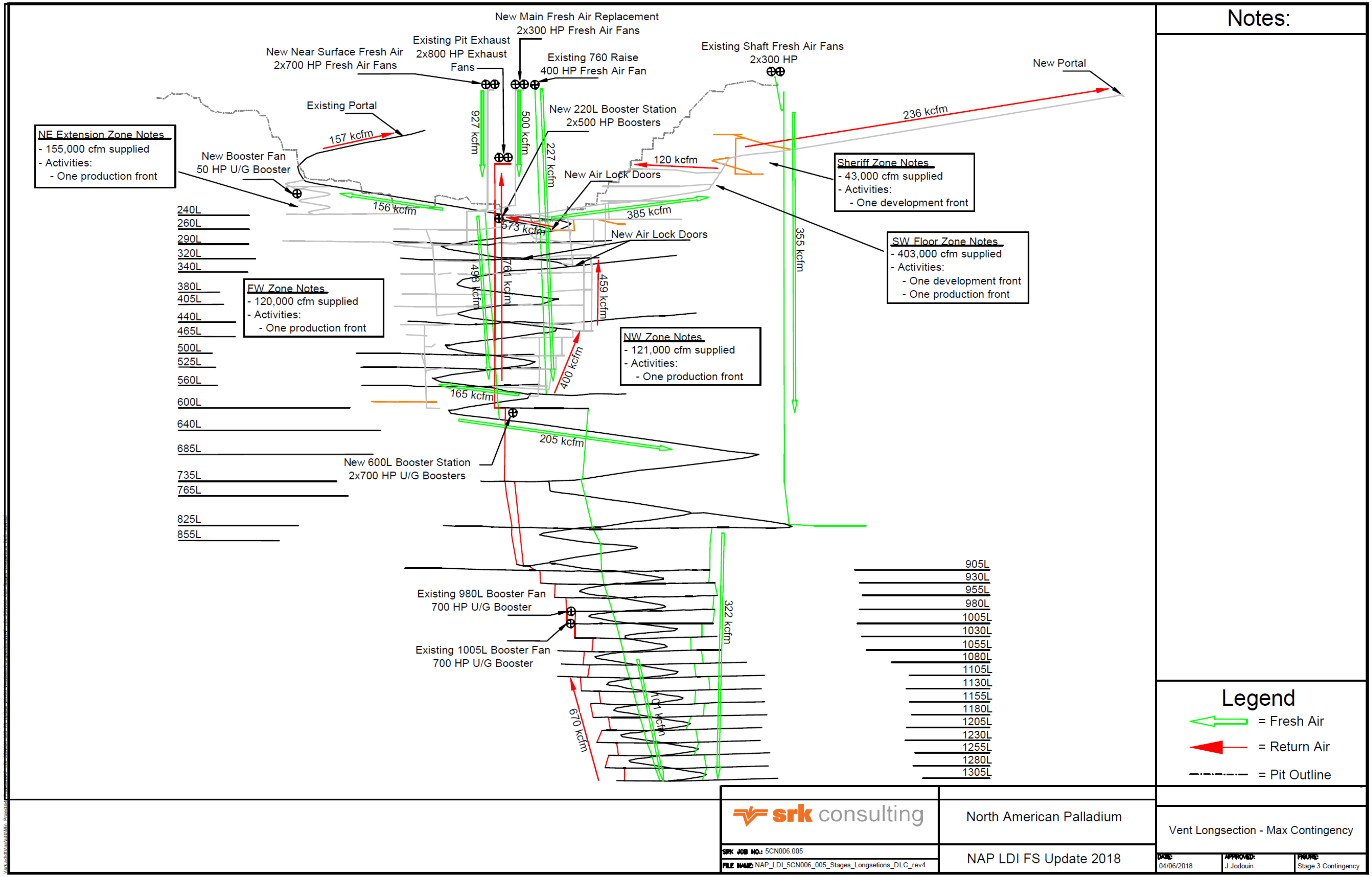


Figure 12: Contingency Schematic

6 Conclusion

Based on the evaluation of the information provided, the proposed ventilation system meets legislative and best practice ventilation design principles.

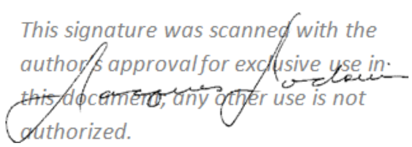
SRK recommends that as LDI continues to finalize life of mine planning, it will be important to update the numerical model and associated staged scenarios to define ventilation requirements and more precisely define main fan operating requirements.

SRK also suggest LDI undertake a mine wide ventilation survey in order to adequately correlate the numerical models prior developing and purchasing major ventilation mine infrastructure items.

The scope of the ventilation survey will be to measure pressure and quantity in all areas of the underground mining complex. Also, all other ventilation controls, main fans, and booster fans will be measured throughout the mine. Data collected during the survey will be used to calculate friction factors and resistances for future mine development as well as make recommendations for system optimization and any energy saving changes to the ventilation system.

Regards

SRK Consulting (Canada) Inc.



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Principal Consultant (Mine Ventilation)

APPENDIX A

Airflow Determination

North American Palladium - Lac Des Iles Mine

Preliminary - UG Diesel Equipment Fleet - Milestone 1

Unit		Quantity	Hp each	kW each	Utilization (diesel engine)	Total Hp	Total kW	Total CFM (100cfm/hp)	Total M3/Sec
South Ramp Development									
Development									
	Jumbo	0.5	99	74	25%	12	9	1,238	1
	8yd LHD	0.5	343	256	100%	172	128	17,150	8
	Maclean Bolter	0.5	160	119	25%	20	15	2,000	1
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	0.5	128	95	50%	32	24	3,200	2
								23,588	11
Production									
	8 yd LHD	0	343	256	100%	0	0	0	0
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	0	128	95	50%	0	0	0	0
	Maclean Bolter	0	160	119	25%	0	0	0	0
								0	0
Ramp									
	63t Truck	0.33	758	565	100%	250	187	25,014	12
	Grader	0.33	138	103	50%	23	17	2,277	1
	Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
	Boom Truck	0.33	173	129	50%	29	21	2,855	1
								30,146	14
Summary									
	Development	1			100%			23,588	11
	Production	0			100%			0	0
	Ramp	1			100%			30,146	14
Subtotal								53,733	25
								53,733	25
SUBTOTAL U/G Density						0.075	0.075	53,733	
Total								**53,733**	**25**
FW Zone									
Development									
	Jumbo	1	99	74	25%	25	18	2,475	1
	8yd LHD	1	343	256	100%	343	256	34,300	16
	Maclean Bolter	1	160	119	25%	40	30	4,000	2
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	1	128	95	50%	64	48	6,400	3
								47,175	22
Production									
	8yd LHD	3	343	256	100%	1,029	767	102,900	49
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	1	128	95	50%	64	48	6,400	3
	Maclean Bolter	0	160	119	25%	0	0	0	0
								109,300	52
Ramp									
	63t Truck	2.33	758	565	100%	1,766	1317	176,614	83
	Grader	0.33	138	103	50%	23	17	2,277	1
	Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
	Boom Truck	0.33	173	129	50%	29	21	2,855	1
								184,600	87
Summary									
	Development	1			100%			47,175	22
	Production	1			100%			109,300	52
	Ramp	1			100%			184,600	87
Subtotal								341,075	161
								341,075	161
SUBTOTAL U/G Density						0.075	0.075	341,075	
Total								**341,075**	**161**
South West Floor									
Development									
	Jumbo	0.5	99	74	25%	12	9	1,238	1
	8yd LHD	0.5	343	256	100%	172	128	17,150	8
	Maclean Bolter	0.5	160	119	25%	20	15	2,000	1
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	0.5	128	95	50%	32	24	3,200	2
								23,588	11
Production									
	8yd LHD	0	343	256	100%	0	0	0	0
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	0	128	95	50%	0	0	0	0
	Maclean Bolter	0	160	119	25%	0	0	0	0
								0	0
Ramp									
	63t Truck	0.33	758	565	100%	250	187	25,014	12
	Grader	0.33	138	103	50%	23	17	2,277	1
	Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
	Boom Truck	0.33	173	129	50%	29	21	2,855	1
								33,000	16
Summary									
	Development	1			100%			23,588	11
	Production	1			100%			0	0
	Ramp	1			100%			33,000	16
Subtotal								56,588	27
								56,588	27
SUBTOTAL U/G Density FA REQUIRED						0.075	0.075	**56,588**	**27**
SUBTOTAL ALL ZONES								**451,396**	**213**
Contingency/Leakage						10%		**45,140**	**21**
Total Mine Surface								**496,535**	**234**

North American Palladium - Lac Des Iles Mine

Preliminary - UG Diesel Equipment Fleet - Milestone 2

Unit	Quantity	Hp each	kW each	Utilization (diesel engine)	Total Hp	Total kW	Total CFM (100cfm/hp)	Total M3/Sec
FW Zone								
Development								
Jumbo	0	99	74	25%	0	0	0	0
8yd LHD	0	343	256	100%	0	0	0	0
Maclean Bolter	0	160	119	25%	0	0	0	0
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0	128	95	50%	0	0	0	0
							0	0
Production								
8 yd LHD	2	343	256	100%	686	512	68,600	32
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	1	128	95	50%	64	48	6,400	3
Maclean Bolter	0	160	119	25%	0	0	0	0
							75,000	35
Ramp								
63t Truck	3	758	565	100%	2,274	1696	227,400	107
Grader	0.33	138	103	50%	23	17	2,277	1
Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
Boom Truck	0.33	173	129	50%	29	21	2,855	1
							232,532	110
Summary								
Development	0			100%			0	0
Production	1			100%			75,000	35
Ramp	1			100%			232,532	110
Subtotal							307,532	145
							307,532	145
SUBTOTAL U/G Density					0.075	0.075	307,532	
Total							**307,532**	**145**
South West Floor								
Development								
Jumbo	0.5	99	74	25%	12	9	1,238	1
8yd LHD	0.5	343	256	100%	172	128	17,150	8
Maclean Bolter	0.5	160	119	25%	20	15	2,000	1
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0.5	128	95	50%	32	24	3,200	2
							23,588	11
Production								
8yd LHD	3	343	256	100%	1,029	767	102,900	49
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	1	128	95	50%	64	48	6,400	3
Maclean Bolter	0	160	119	25%	0	0	0	0
							109,300	52
Ramp								
63t Truck	3.5	758	565	100%	2,653	1978	265,300	125
Grader	0.33	138	103	50%	23	17	2,277	1
Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
Boom Truck	0.33	173	129	50%	29	21	2,855	1
							273,286	129
Summary								
Development	1			100%			23,588	11
Production	1			100%			109,300	52
Ramp	1			100%			273,286	129
Subtotal							406,174	192
							406,174	192
SUBTOTAL U/G Density					0.075	0.075	406,174	
Total							**406,174**	**192**
NE EXT								
Development								
Jumbo	0.5	99	74	25%	12	9	1,238	1
8yd LHD	0.5	343	256	100%	172	128	17,150	8
Maclean Bolter	0.5	160	119	25%	20	15	2,000	1
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0.5	128	95	50%	32	24	3,200	2
							23,588	11
Production								
8yd LHD	0	343	256	100%	0	0	0	0
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0	128	95	50%	0	0	0	0
Maclean Bolter	0	160	119	25%	0	0	0	0
							0	0
Ramp								
63t Truck	0.5	758	565	100%	379	283	37,900	18
Grader	0.33	138	103	50%	23	17	2,277	1
Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
Boom Truck	0.33	173	129	50%	29	21	2,855	1
							45,886	22
Summary								
Development	1			100%			23,588	11
Production	1			100%			0	0
Ramp	1			100%			45,886	22
Subtotal							69,474	33
							69,474	33
SUBTOTAL U/G Density FA REQUIRED					0.075	0.075	**69,474**	**33**
SUBTOTAL ALL ZONES							**783,179**	**370**
Contingency/Leakage					10%		**78,318**	**37**
Total Mine Surface							**861,496**	**407**

North American Palladium - Lac Des Iles Mine

Preliminary - UG Diesel Equipment Fleet - Milestone 3

Unit		Quantity	Hp each	kW each	Utilization (diesel engine)	Total Hp	Total kW	Total CFM (100cfm/hp)	Total M3/Sec
FW Zone									
Development									
	Jumbo	0	99	74	25%	0	0	0	0
	8yd LHD	0	343	256	100%	0	0	0	0
	Maclean Bolter	0	160	119	25%	0	0	0	0
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	0	128	95	50%	0	0	0	0
								0	0
Production									
	8 yd LHD	1	343	256	100%	343	256	34,300	16
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	1	128	95	50%	64	48	6,400	3
	Maclean Bolter	0	160	119	25%	0	0	0	0
								40,700	19
Ramp									
	63t Truck	1	758	565	100%	758	565	75,800	36
	Grader	0.2	138	103	50%	14	10	1,380	1
	Fuel and lube Truck	0.2	173	129	50%	17	13	1,730	1
	Boom Truck	0.2	173	129	50%	17	13	1,730	1
								78,910	37
Summary									
	Development	0			100%			0	0
	Production	1			100%			40,700	19
	Ramp	1			100%			78,910	37
Subtotal								119,610	56
								119,610	56
SUBTOTAL U/G Density						0.075	0.075	119,610	
Total								**119,610**	**56**
South West Floor									
Development									
	Jumbo	0.5	99	74	25%	12	9	1,238	1
	8yd LHD	0.5	343	256	100%	172	128	17,150	8
	Maclean Bolter	0.5	160	119	25%	20	15	2,000	1
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	0.5	128	95	50%	32	24	3,200	2
								23,588	11
Production									
	8yd LHD	3	343	256	100%	1,029	767	102,900	49
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	1	128	95	50%	64	48	6,400	3
	Maclean Bolter	0	160	119	25%	0	0	0	0
								109,300	52
Ramp									
	63t Truck	3.5	758	565	100%	2,653	1978	265,300	125
	Grader	0.2	138	103	50%	14	10	1,380	1
	Fuel and lube Truck	0.2	173	129	50%	17	13	1,730	1
	Boom Truck	0.2	173	129	50%	17	13	1,730	1
								270,140	127
Summary									
	Development	1			100%			23,588	11
	Production	1			100%			109,300	52
	Ramp	1			100%			270,140	127
Subtotal								403,028	190
								403,028	190
SUBTOTAL U/G Density						0.075	0.075	403,028	
Total								**403,028**	**190**
NE EXT									
Development									
	Jumbo	0	99	74	25%	0	0	0	0
	8yd LHD	0	343	256	100%	0	0	0	0
	Maclean Bolter	0	160	119	25%	0	0	0	0
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	0	128	95	50%	0	0	0	0
								0	0
Production									
	8yd LHD	2	343	256	100%	686	512	68,600	32
	63t Truck	0	758	565	100%	0	0	0	0
	Toyota Jeep	1	128	95	50%	64	48	6,400	3
	Maclean Bolter	0	160	119	25%	0	0	0	0

							75,000	35
Ramp								
63t Truck	1	758	565	100%	758	565	75,800	36
Grader	0.2	138	103	50%	14	10	1,380	1
Fuel and lube Truck	0.2	173	129	50%	17	13	1,730	1
Boom Truck	0.2	173	129	50%	17	13	1,730	1
							80,640	38
Summary								
Development	0			100%			0	0
Production	1			100%			75,000	35
Ramp	1			100%			80,640	38
Subtotal							155,640	73
							155,640	73
SUBTOTAL U/G Density FA REQUIRED					0.075	0.075	**155,640**	**73**
NW								
Development								
Jumbo	0	99	74	25%	0	0	0	0
8yd LHD	0	343	256	100%	0	0	0	0
Maclean Bolter	0	160	119	25%	0	0	0	0
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0	128	95	50%	0	0	0	0
							0	0
Production								
8yd LHD	1	343	256	100%	343	256	34,300	16
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	1	128	95	50%	64	48	6,400	3
Maclean Bolter	0	160	119	25%	0	0	0	0
							40,700	19
Ramp								
63t Truck	1	758	565	100%	758	565	75,800	36
Grader	0.2	138	103	50%	14	10	1,380	1
Fuel and lube Truck	0.2	173	129	50%	17	13	1,730	1
Boom Truck	0.2	173	129	50%	17	13	1,730	1
							80,640	38
Summary								
Development	0			100%			0	0
Production	1			100%			40,700	19
Ramp	1			100%			80,640	38
Subtotal							121,340	57
							121,340	57
SUBTOTAL U/G Density FA REQUIRED					0.075	0.075	**121,340**	**57**
Sherriff								
Development								
Jumbo	0.5	99	74	25%	12	9	0	0
8yd LHD	0.5	343	256	100%	172	128	0	0
Maclean Bolter	0.5	160	119	25%	20	15	0	0
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0.5	128	95	50%	32	24	0	0
							0	0
Production								
8yd LHD	0	343	256	100%	0	0	0	0
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0	128	95	50%	0	0	0	0
Maclean Bolter	0	160	119	25%	0	0	0	0
							0	0
Ramp								
63t Truck	0.5	758	565	100%	379	283	37,900	18
Grader	0.2	138	103	50%	14	10	1,380	1
Fuel and lube Truck	0.2	173	129	50%	17	13	1,730	1
Boom Truck	0.2	173	129	50%	17	13	1,730	1
							42,740	20
Summary								
Development	1			100%			0	0
Production	0			100%			0	0
Ramp	1			100%			42,740	20
Subtotal							42,740	20
							42,740	20
SUBTOTAL U/G Density FA REQUIRED					0.075	0.075	**42,740**	**20**
SUBTOTAL ALL ZONES							**842,358**	**398**
Contingency/Leakage					10%		**84,236**	**40**
Total Mine Surface							**926,593**	**437**

North American Palladium - Lac Des Iles Mine

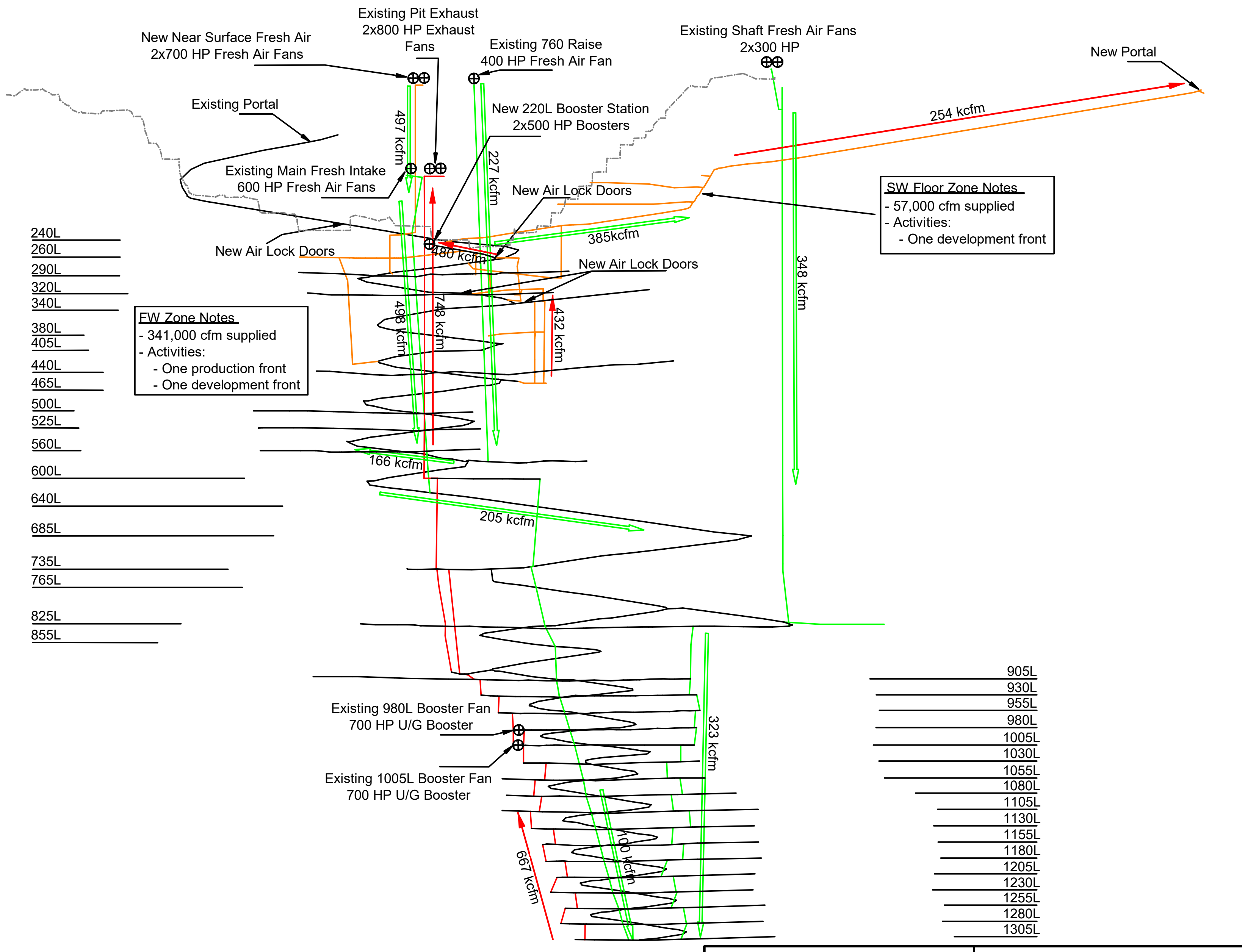
Preliminary - UG Diesel Equipment Fleet - Milestone 4

Unit	Quantity	Hp each	kW each	Utilization (diesel engine)	Total Hp	Total kW	Total CFM (100cfm/hp)	Total M3/Sec
FW Zone								
Development								
Jumbo	0	99	74	25%	0	0	0	0
8yd LHD	0	343	256	100%	0	0	0	0
Maclean Bolter	0	160	119	25%	0	0	0	0
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0	128	95	50%	0	0	0	0
							0	0
Production								
8 yd LHD	2	343	256	100%	686	512	68,600	32
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	1	128	95	50%	64	48	6,400	3
Maclean Bolter	0	160	119	25%	0	0	0	0
							75,000	35
Ramp								
63t Truck	2	758	565	100%	1,516	1130	151,600	72
Grader	0.33	138	103	50%	23	17	2,277	1
Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
Boom Truck	0.33	173	129	50%	29	21	2,855	1
							156,732	74
Summary								
Development	0			100%			0	0
Production	1			100%			75,000	35
Ramp	1			100%			156,732	74
Subtotal							231,732	109
							231,732	109
SUBTOTAL U/G Density					0.075	0.075	231,732	
Total							**231,732**	**109**
South								
Development								
Jumbo	1	99	74	25%	25	18	2,475	1
8yd LHD	1	343	256	100%	343	256	34,300	16
Maclean Bolter	1	160	119	25%	40	30	4,000	2
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	1	128	95	50%	64	48	6,400	3
							47,175	22
Production								
8yd LHD	2	343	256	100%	686	512	68,600	32
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0.5	128	95	50%	32	24	3,200	2
Maclean Bolter	0	160	119	25%	0	0	0	0
							71,800	34
Ramp								
63t Truck	3	758	565	100%	2,274	1696	227,400	107
Grader	0.33	138	103	50%	23	17	2,277	1
Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
Boom Truck	0.33	173	129	50%	29	21	2,855	1
							235,386	111
Summary								
Development	1			100%			47,175	22
Production	1			100%			71,800	34
Ramp	1			100%			235,386	111
Subtotal							354,361	167
							354,361	167
SUBTOTAL U/G Density					0.075	0.075	354,361	
Total							**354,361**	**167**
Sherriff								
Development								
Jumbo	0	99	74	25%	0	0	0	0
8yd LHD	0	343	256	100%	0	0	0	0
Maclean Bolter	0	160	119	25%	0	0	0	0
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0	128	95	50%	0	0	0	0
							0	0
Production								
8yd LHD	1	343	256	100%	343	256	34,300	16
63t Truck	0	758	565	100%	0	0	0	0
Toyota Jeep	0.5	128	95	50%	32	24	3,200	2
Maclean Bolter	0	160	119	25%	0	0	0	0
							37,500	18
Ramp								
63t Truck	1	758	565	100%	758	565	75,800	36
Grader	0.33	138	103	50%	23	17	2,277	1
Fuel and lube Truck	0.33	173	129	50%	29	21	2,855	1
Boom Truck	0.33	173	129	50%	29	21	2,855	1
							83,786	40
Summary								
Development	0			100%			0	0
Production	1			100%			37,500	18
Ramp	1			100%			83,786	40
Subtotal							121,286	57
							121,286	57
SUBTOTAL U/G Density FA REQUIRED					0.075	0.075	**121,286**	**57**
SUBTOTAL ALL ZONES							**707,379**	**334**
Contingency/Leakage					10%		**70,738**	**33**
Total Mine Surface							**778,116**	**367**

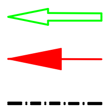
APPENDIX B

Staged Long sections

Notes:



Legend



srk consulting

North American Palladium

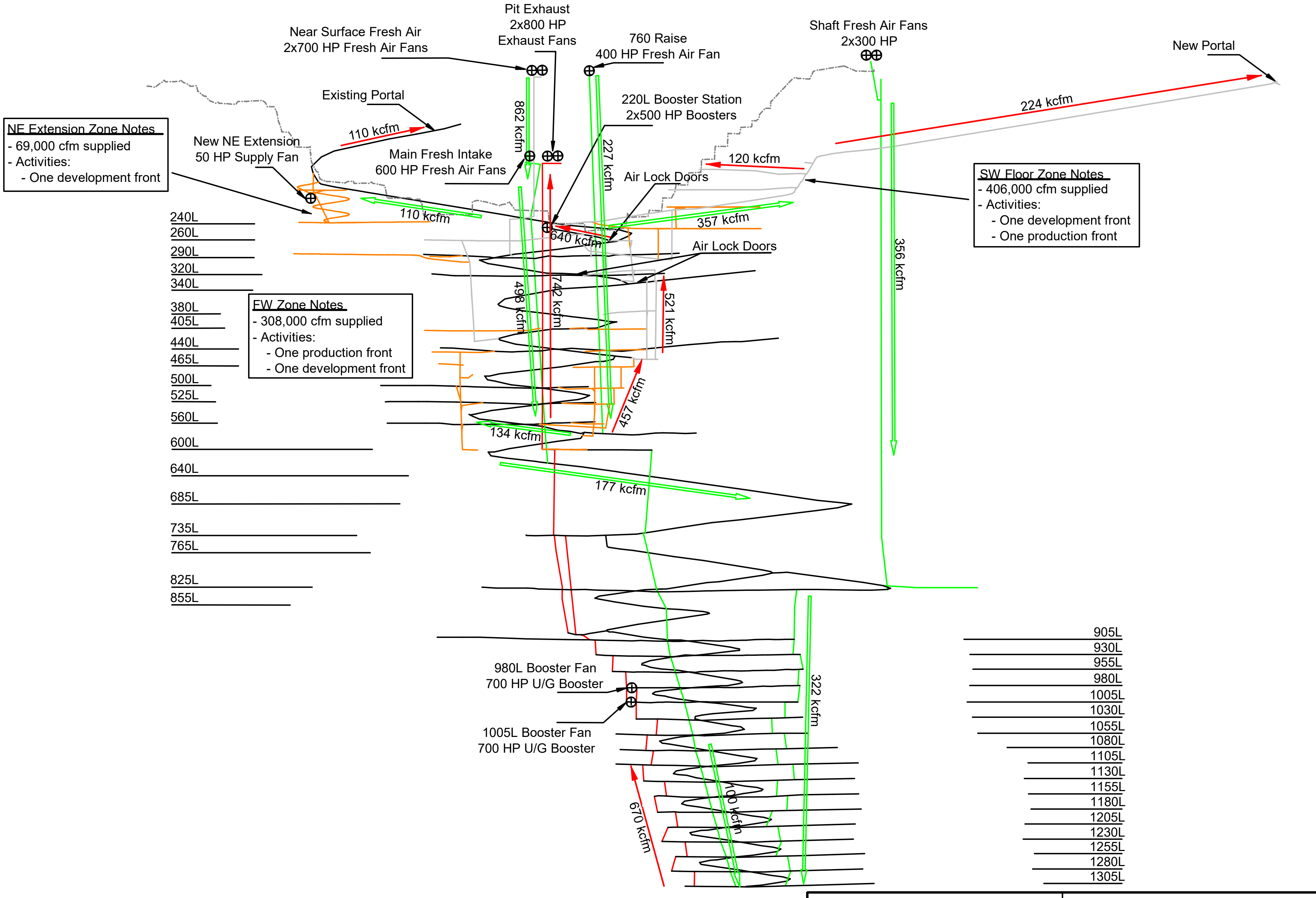
NAP LDI FS Update 2018

Vent Longsection - Stage 1 2020

SRK JOB NO.: 5CN006.005

FILE NAME: NAP_LDI_5CN006_005_Stages_Longsetions_DLC_rev3

DATE:	APPROVED:	FIGURE:
04/06/2018	J.Jodouin	Stage 1 2020



Notes:

Legend

= Fresh Air

= Return Air

= Pit Outline

srk consulting

SRK JOB NO.: 5CN006.005

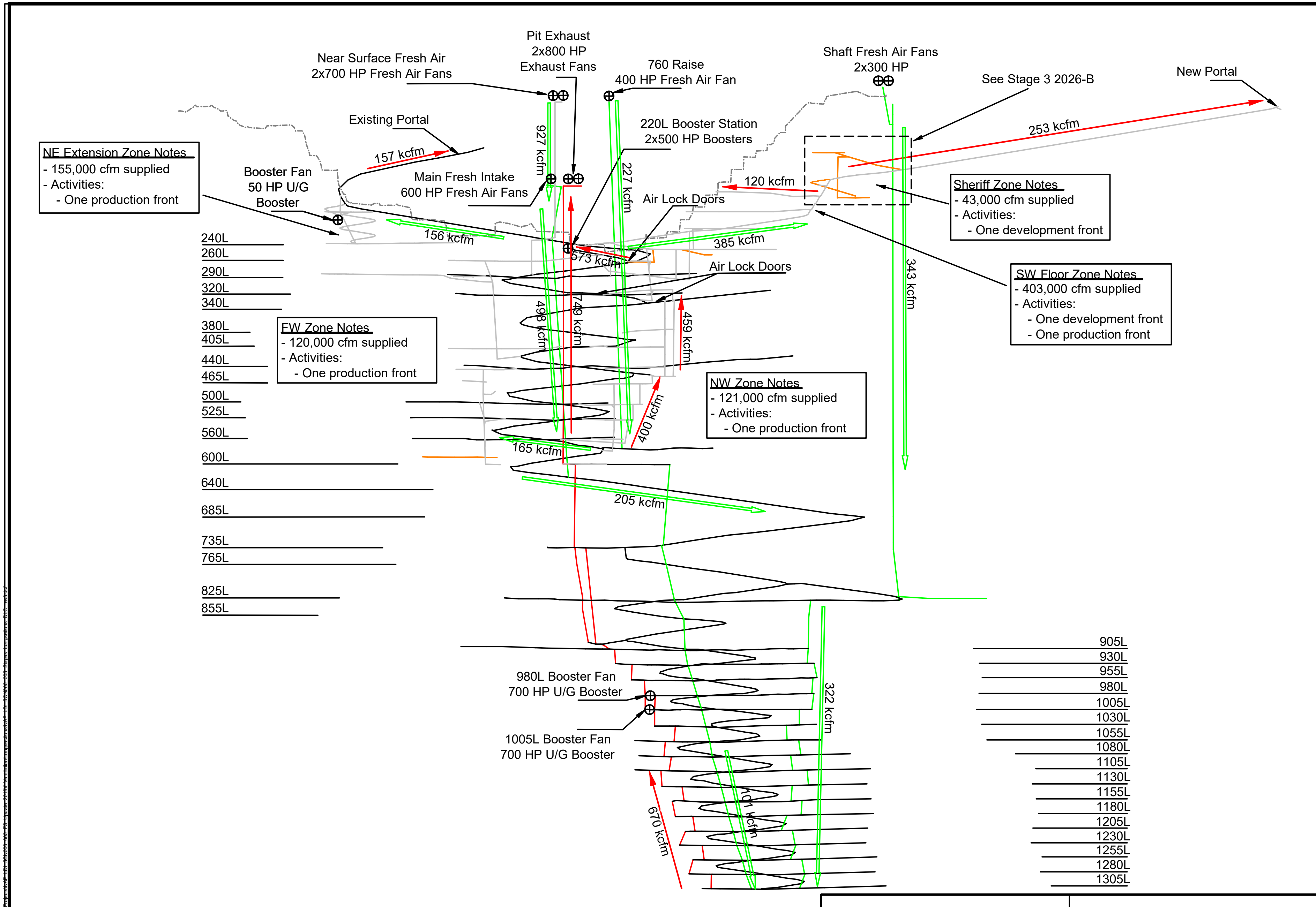
FILE NAME: NAP_LDI_5CN006_005_Stages_Longsetions_DLC_rev3

North American Palladium

NAP LDI FS Update 2018

Vent Longsection - Stage 2 2024

DATE:	APPROVED:	FIGURE:
04/06/2018	J.Jodouin	Stage 2 2024



Notes:

Legend
= Fresh Air
= Return Air
= Pit Outline

srk consulting

North American Palladium

NAP LDI FS Update 2018

Vent Longsection - Stage 3 2026-A

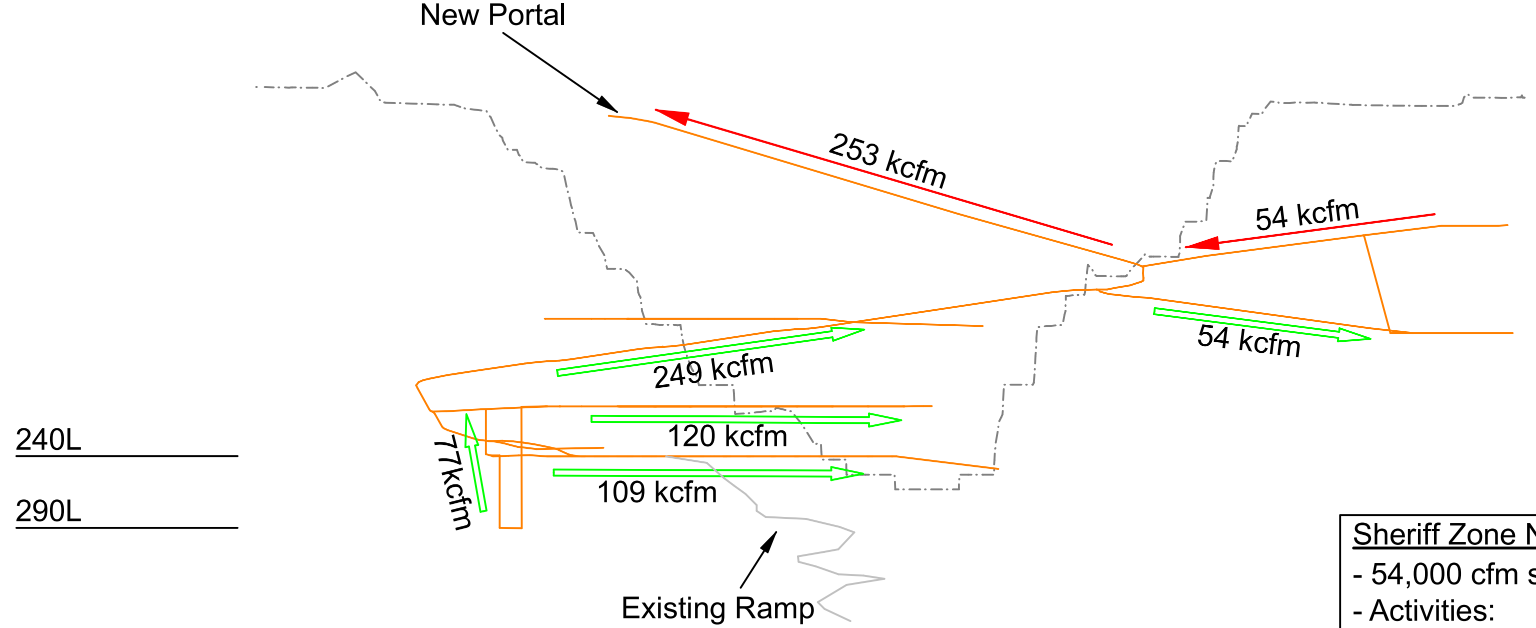
SRK JOB NO.: 5CN006.005

FILE NAME: NAP_LDI_5CN006_005_Stages_Longsetions_DLC_rev3

DATE: 04/06/2018

APPROVED: J.Jodouin

FIGURE: Stage 3 2026-A



Sheriff Zone Notes

- 54,000 cfm supplied
- Activities:
  - One development front

Notes:

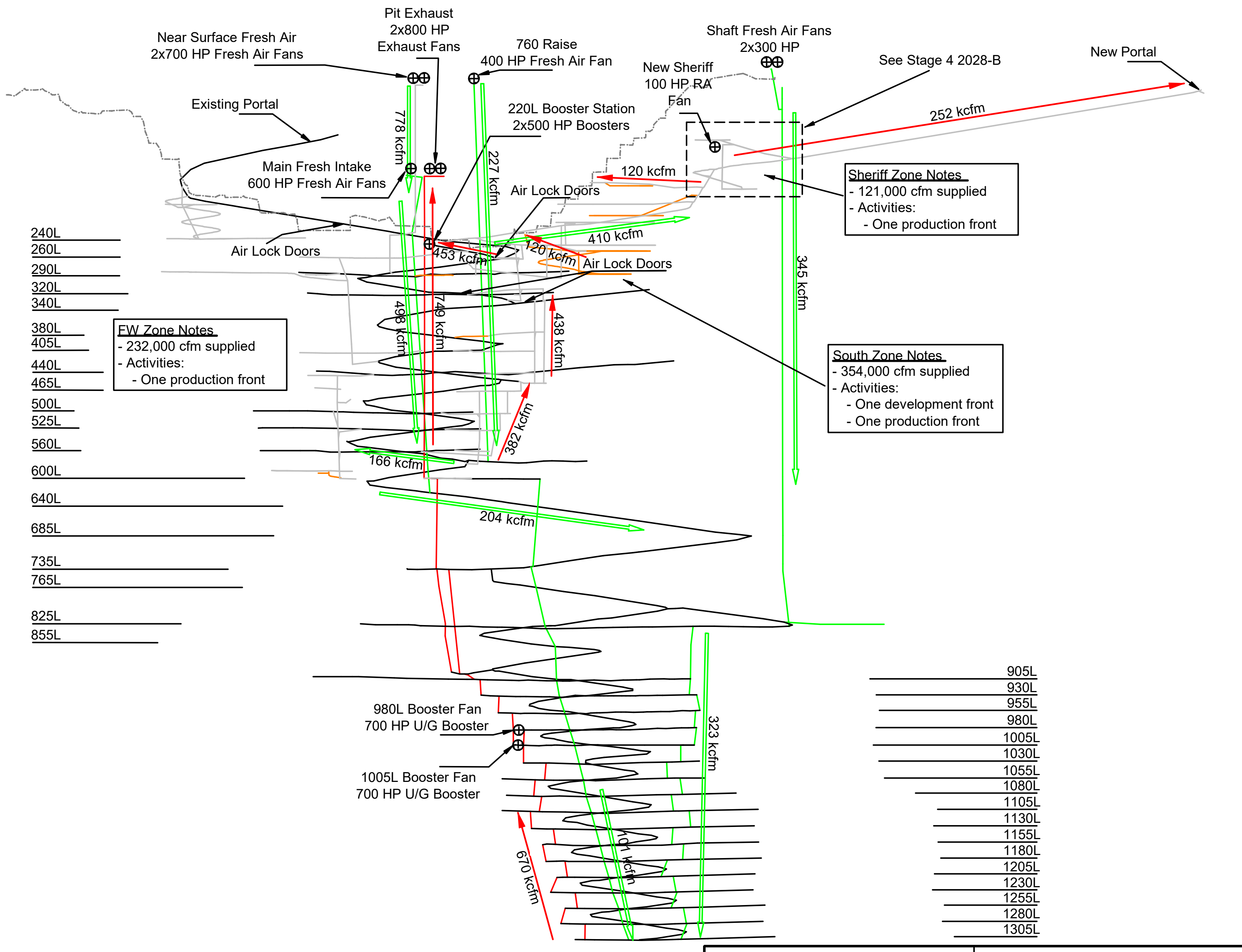
Legend

= Fresh Air

= Return Air

= Pit Outline

srk consulting	North American Palladium	Vent Longsection - Stage 3 2026-B
SRK JOB NO.: 5CN006.005	NAP LDI FS Update 2018	DATE: 04/06/2018
FILE NAME: NAP_LDI_5CN006_005_Stages_Longsetions_DLC_rev4		APPROVED: J.Jodouin
		FIGURE: Stage 3 2026-B



Notes:

Legend

= Fresh Air

= Return Air

= Pit Outline

srk consulting

North American Palladium

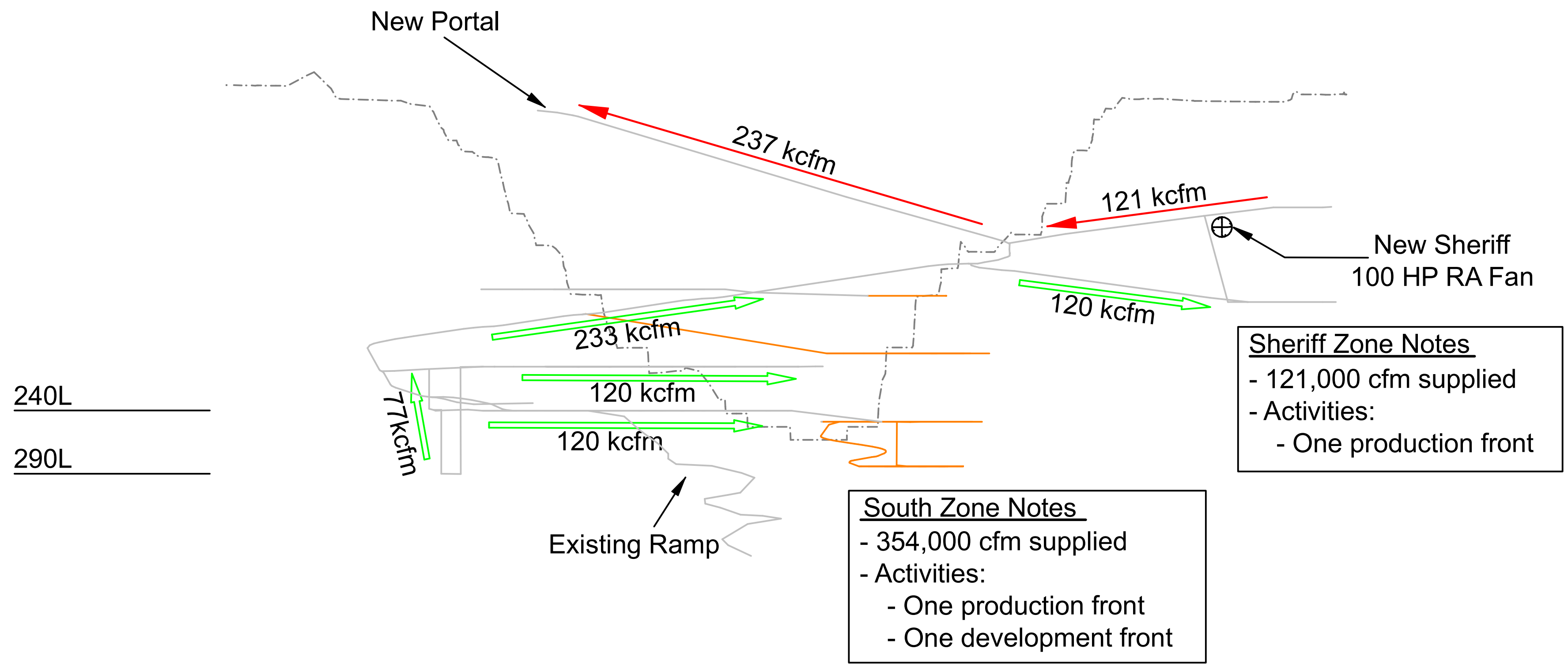
NAP LDI FS Update 2018

Vent Longsection - Stage 4 2028-A

SRK JOB NO.: 5CN006.005

FILE NAME: NAP_LDI_5CN006_005_Stages_Longsetions_DLC_rev4

DATE:	APPROVED:	FIGURE:
04/06/2018	J.Jodouin	Stage 4 2028-A



Notes:

Legend

= Fresh Air

= Return Air

= Pit Outline

srk consulting

North American Palladium

NAP LDI FS Update 2018

Vent Longsection - Stage 4 2028-B

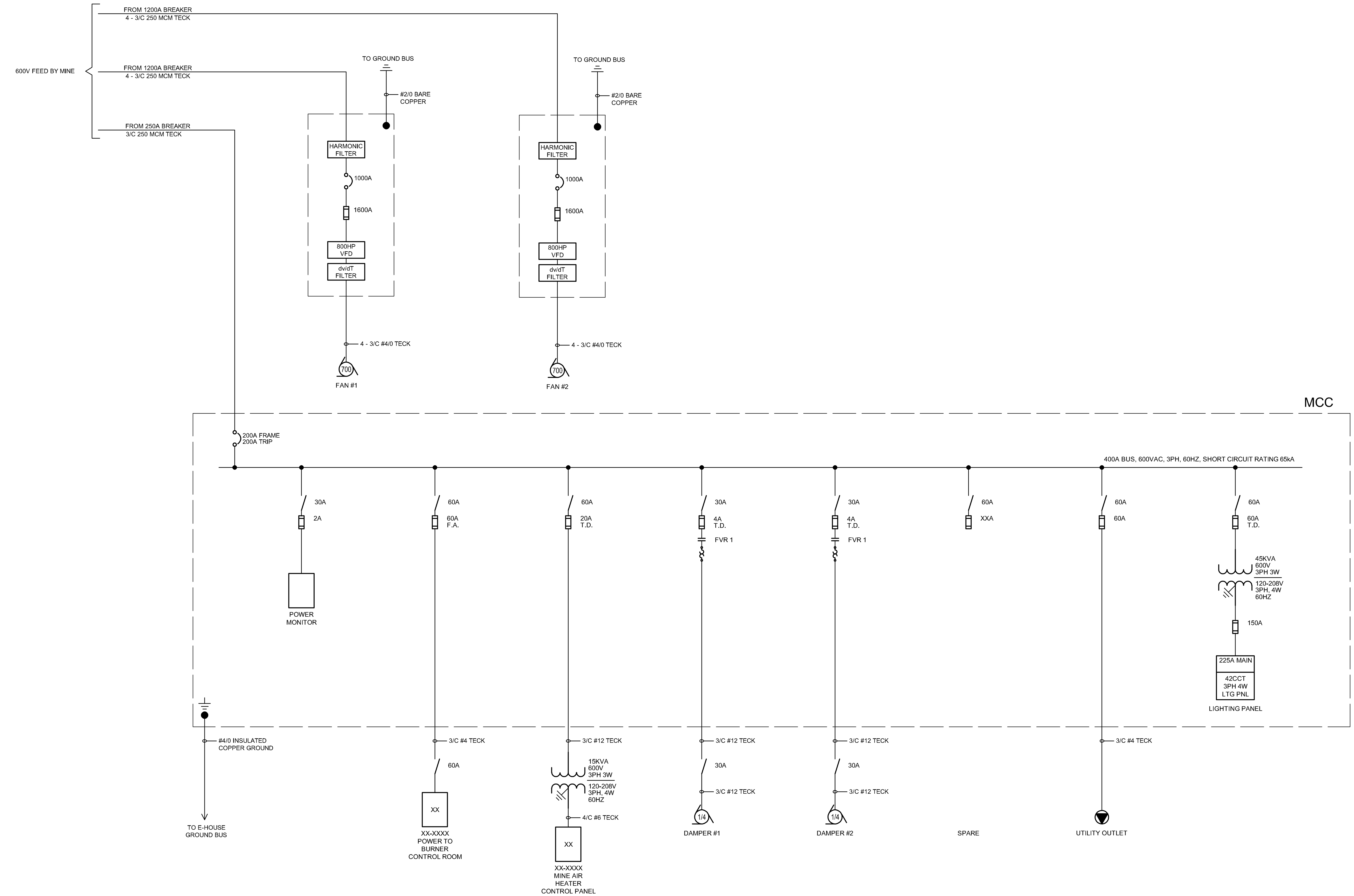
SRK JOB NO.: 5CN006.005

FILE NAME: NAP_LDI_5CN006_005_Stages_Longsetions_DLC_rev4

DATE:	APPROVED:	FIGURE:
04/06/2018	J.Jodouin	Stage 4 2028-B

APPENDIX C

General Arrangement Drawings



1 E01 SINGLE LINE
SCALE: NTS

File Location: L:\27000\27962-000 nap lol ventilation feasibility study\3-jlr dwg\6-Elect\E01 TYPICAL SURFACE FA FANS SINGLE LINE.dwg

ISSUED FOR CLIENT REVIEW
20/06/18

No.	ISSUE / REVISION	DD/MM/YY
B	ISSUED FOR CLIENT REVIEW	20/06/18

VERIFY SHEET SIZE AND SCALES. BAR TO THE RIGHT IS 25mm IF THIS IS A FULL SIZE DRAWING. 0 25mm

SCALE: AS NOTED

CLIENT: NAP ALLADIUM Mining for Clean Air

CONSULTANT: J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS www.jlrichards.ca

CONSULTANT: srk consulting

PROFESSIONAL STAMP

PROJECT NORTH

PROJECT:
NORTH AMERICAN PALLADIUM VENTILATION FEASIBILITY STUDY
LAC DES ILES MINE, ONTARIO

DRAWING:
TYPICAL SURFACE FA FANS SINGLE LINE

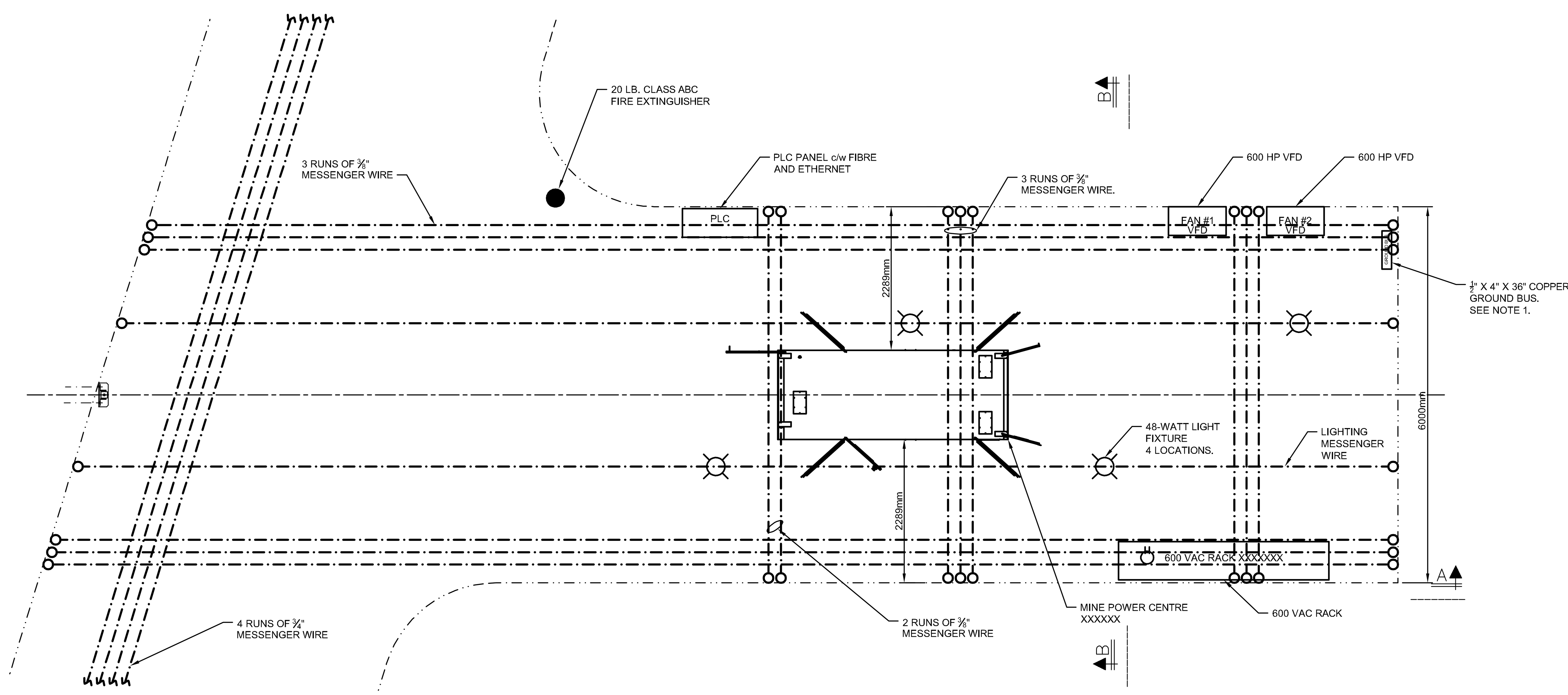
DESIGN: S.MARTIN
DRAWN: E.FRATIN
CHECKED: K.BOUFFARD
JLR #: 27962-000

DRAWING #: E01

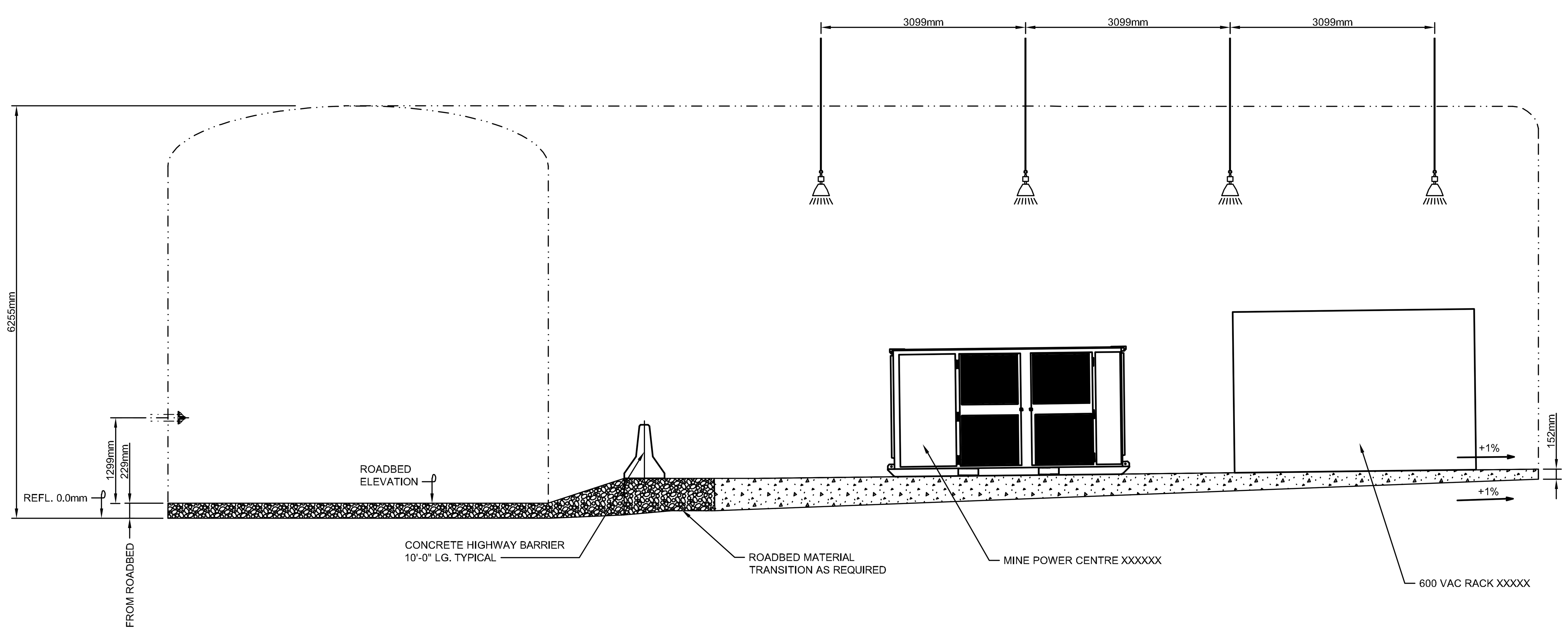
PLOT DATE: June 20, 2018 8:42:16 AM

NOTES

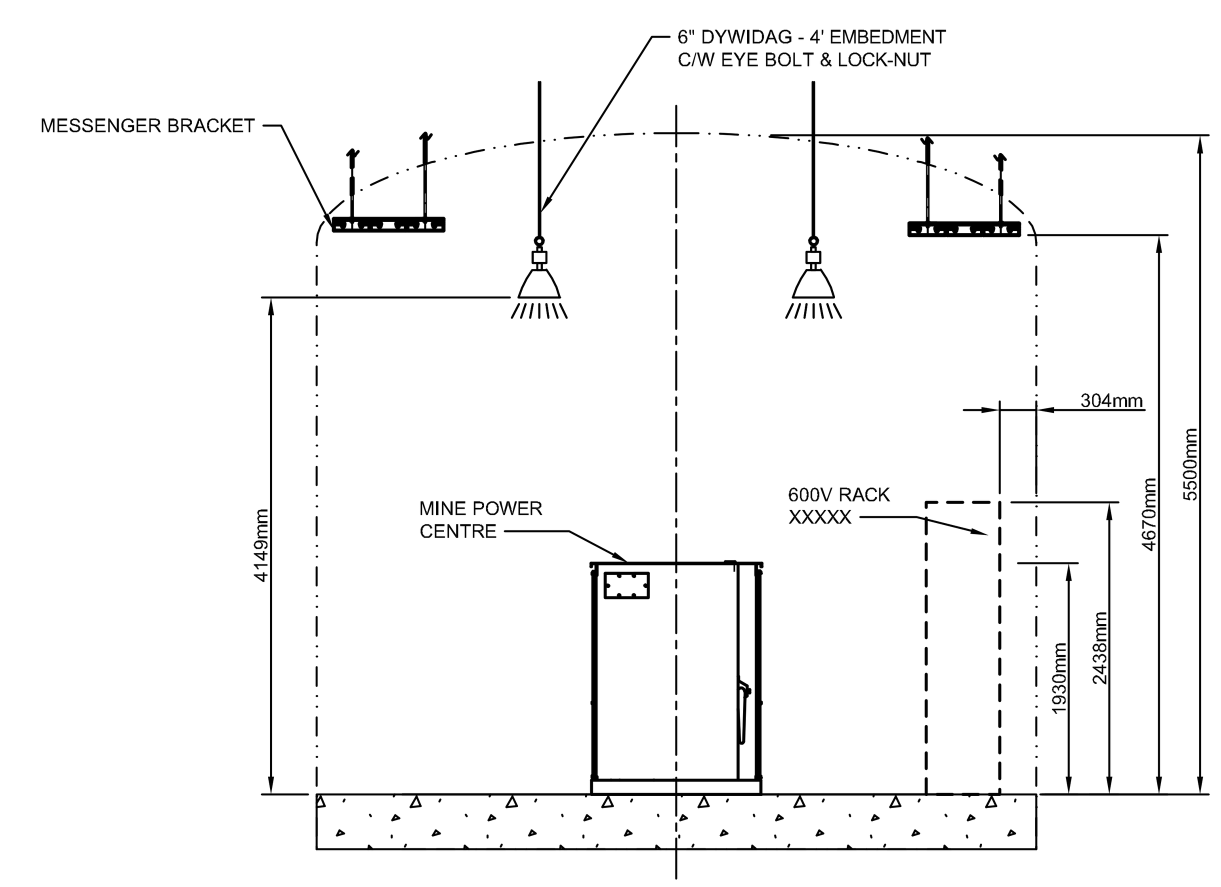
1. INSTALL A ½" X 4" X 36" COPPER GROUND BUS AS SHOWN.
2. ELECTRICAL INSTALLATION SHALL CONFORM TO LATEST CANADIAN ELECTRICAL CODE AND CSA-M421 "USE OF ELECTRICITY IN MINES".



1 SWITCHROOM PLAN VIEW
E02
SCALE: 1:50



2 SWITCHROOM SIDE ELEVATION - SECTION AA
E02
SCALE: 1:50



3 SWITCHROOM PLAN ELEVATION - SECTION BB
E02
SCALE: 1:50

ISSUED FOR CLIENT REVIEW
20/06/18

No.	ISSUE / REVISION	DD/MM/YY
B	ISSUED FOR CLIENT REVIEW	20/06/18

VERIFY SHEET SIZE AND SCALES. BAR TO THE RIGHT IS 25mm IF THIS IS A FULL SIZE DRAWING. 0 25mm

SCALE: 1:50

CLIENT: NAP PALLADIUM Mining for Clean Air

CONSULTANT: www.jlrichards.ca J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

CONSULTANT: srk consulting

PROFESSIONAL STAMP

PROJECT NORTH

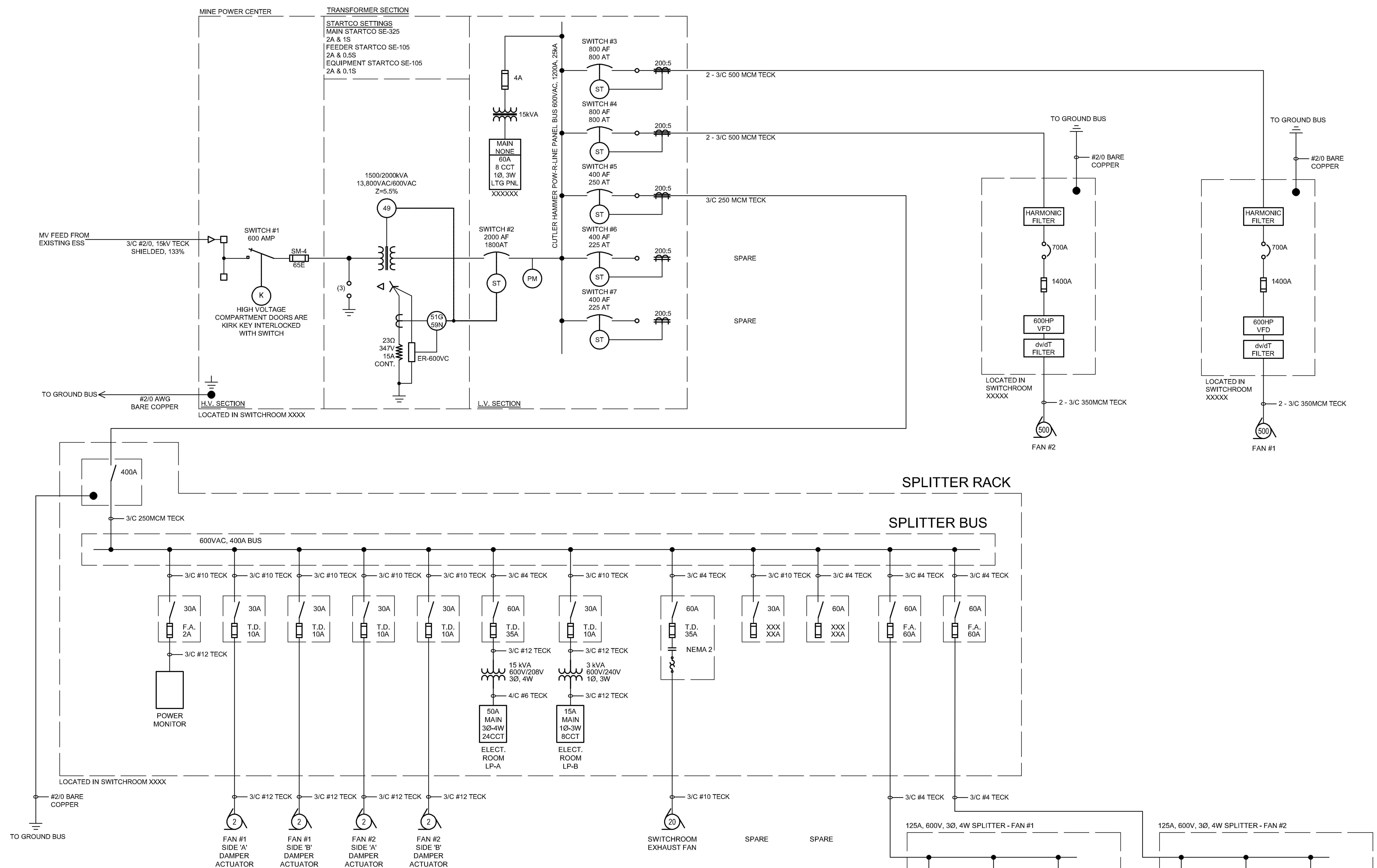
PROJECT:
NORTH AMERICAN PALLADIUM VENTILATION FEASIBILITY STUDY
LAC DES ILES MINE, ONTARIO

DRAWING:
TYPICAL UNDERGROUND BOOSTER FAN SWITCHROOM LAYOUT

DESIGN: S. MARTIN
DRAWN: E. FRATIN
CHECKED: M. WEAVER
JLR #: 27962-000
DRAWING #: E02

PLOT DATE: June 20, 2018 8:39:59 AM

File Location: L:\27000\27962-000 nap ldi ventilation feasibility study\3-jlr dwg\6-Elect\E02 TYPICAL UNDERGROUND BOOSTER FAN SWITCHROOM LAYOUT.dwg



1 SINGLE LINE
E03
SCALE: NTS

PANEL A

120/208 VOLT, 3PH, 4W,
50 AMP MAIN BREAKER
SURFACE MOUNTED
10kA

LOAD	DESCRIPTION	BRKR	CCT	S.N.	CCT	BRKR	DESCRIPTION	LOAD
	SW RM LIGHTING	15A	1		2	15A	SW RM LIGHTING	
	SW RM RECEPT.	15A	3		4	15A	SW RM RECEPT.	
	FAN #1 LIGHTING	15A	5		6	15A	FAN #2 LIGHTING	
	FAN #1 RECEPT.	15A	7		8	15A	FAN #2 RECEPT.	
	FAN #1 HEATER	15A	9		10	15A	FAN #2 HEATER	
	PLC PANEL	15A	11		12	15A	SPARE	
	SPARE	15A	13		14	15A	SPARE	
	SPARE	15A	15		16	15A	SPARE	
	SPARE	15A	17		18	15A	SPARE	
	SPARE	15A	19		20	15A	SPARE	
	SPARE	15A	21		22	15A	SPARE	
	SPARE	15A	23		24	15A	SPARE	

PANEL B

120/240 VOLT, 1PH, 3W,
15A MAIN BREAKER
SURFACE MOUNTED,
10kA

LOAD	DESCRIPTION	BRKR	CCT	S.N.	CCT	BRKR	DESCRIPTION	LOAD
	UPS	15A	1		2	15A	PRE-START WARNING	
	SPARE	15A	3		4	15A	SPARE	
	SPARE	15A	5		6	15A	SPARE	
	SPARE	15A	7		8	15A	SPARE	

2 PANELS
E03
SCALE: NTS

ISSUED FOR CLIENT REVIEW
20/06/18

No.	ISSUE / REVISION	DD/MM/YY
B	ISSUED FOR CLIENT REVIEW	20/06/18

VERIFY SHEET SIZE AND SCALES. BAR TO THE RIGHT IS 25mm IF THIS IS A FULL SIZE DRAWING. 0 25mm

SCALE: AS NOTED

CLIENT: NAP PALLADIUM Mining for Clean Air

CONSULTANT: www.jlrichards.ca J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

CONSULTANT: srk consulting

PROFESSIONAL STAMP

PROJECT NORTH

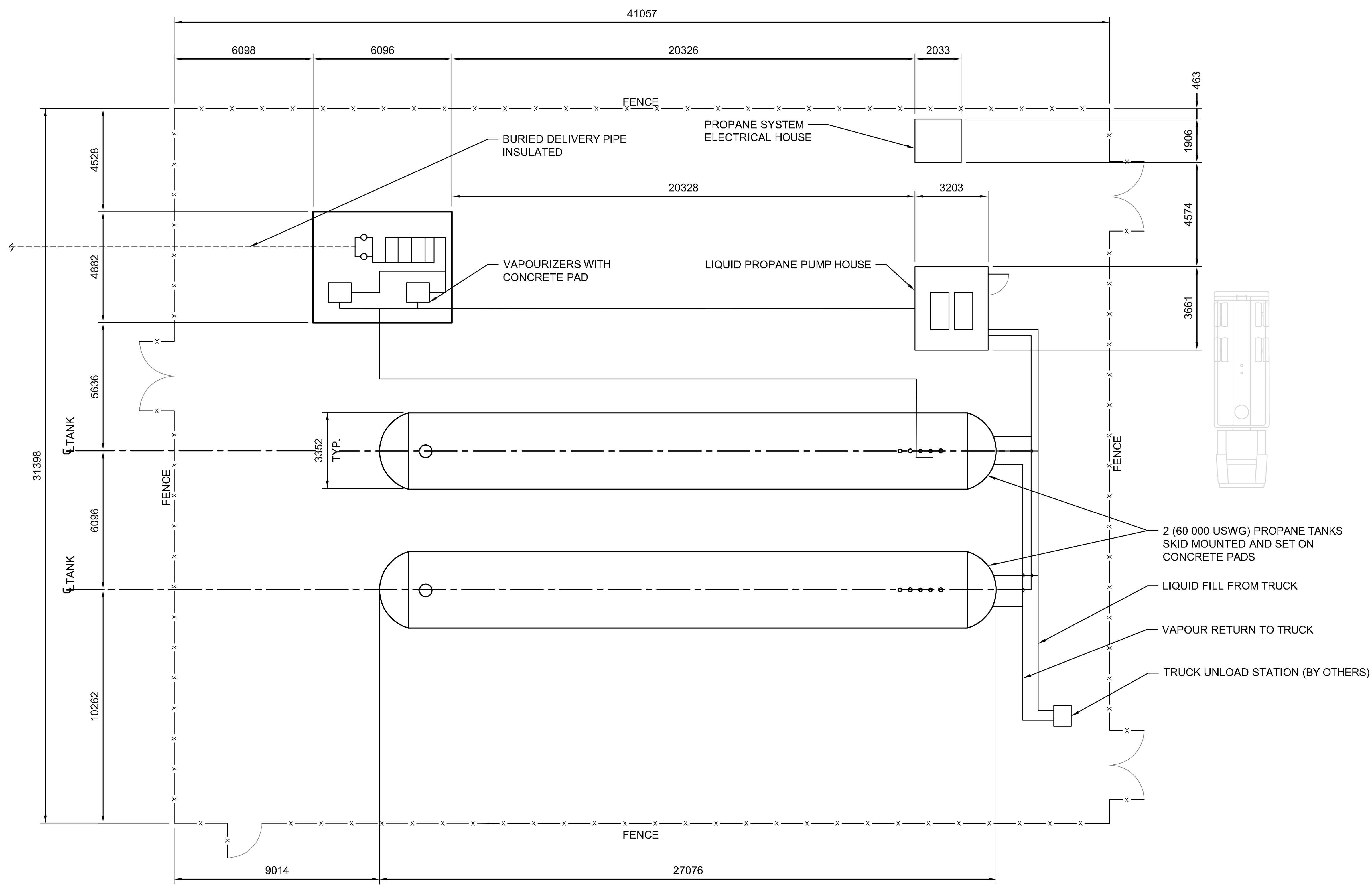
PROJECT:
NORTH AMERICAN PALLADIUM
VENTILATION FEASIBILITY STUDY
LAC DES ILES MINE, ONTARIO

DRAWING:
TYPICAL UNDERGROUND
BOOSTER FAN SINGLE LINE

DESIGN: S.MARTIN
DRAWN: E.FRATIN
CHECKED: K.BOUFFARD
JLR #: 27962-000
DRAWING #: E03

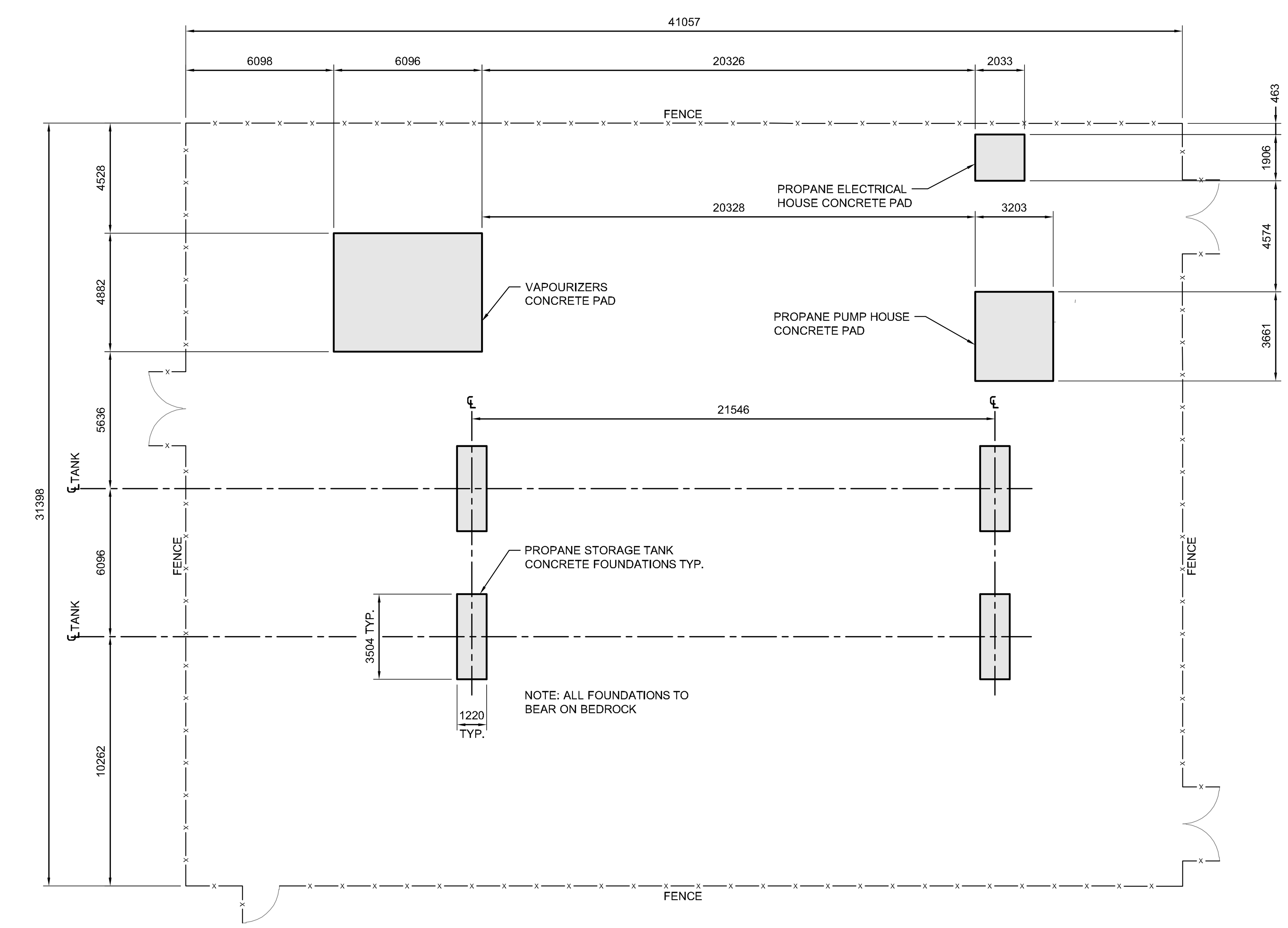
PLOT DATE: June 20, 2018 8:41:16 AM

File Location: L:\27000\27962-000 nap lid ventilation feasibility study\3-jlr dwg\6-Elect\E03 TYPICAL UNDERGROUND BOOSTER FAN SINGLE LINE.dwg



PROPANE TANK FARM GENERAL ARRANGEMENT

SCALE: 1:150



PROPANE TANK FARM FOUNDATION PLAN

SCALE: 1:150

File Location: L:\27000\27962-000 NAP LDI Ventilation Feasibility Study\3-JLR DWG\3-Struct\S03 PROPANE TANK FARM.dwg

ISSUED FOR CLIENT REVIEW

07/06/18

No.	ISSUE / REVISION	DD/MM/YY
B	ISSUED FOR FINAL CLIENT REVIEW	07/06/18
A	ISSUED FOR CLIENT REVIEW	06/06/18

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SCALE: AS NOTED

CLIENT: NAPALLADIUM Mining for Clean Air

CONSULTANT: www.jlrichards.ca J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

CONSULTANT: srk consulting

PROFESSIONAL STAMP

PROJECT NORTH

PROJECT:

NORTH AMERICAN PALLADIUM VENTILATION FEASIBILITY STUDY

LAC DES ILES MINE, ONTARIO

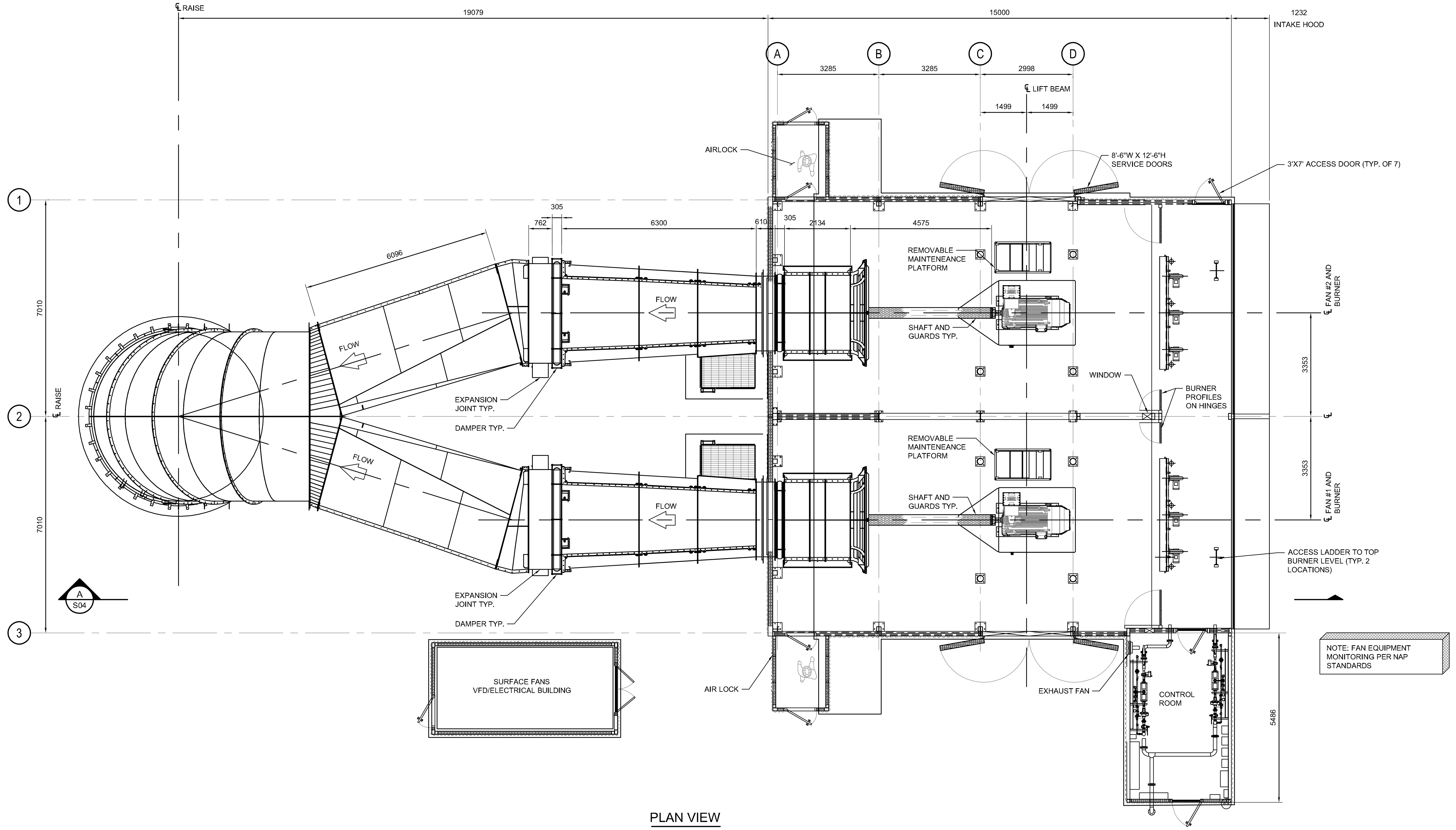
DRAWING:

TYPICAL PROPANE TANK FARM GENERAL ARRANGEMENT PLANS

DESIGN: L.D.
DRAWN: D.M.
CHECKED:
JLR #: 27962-000

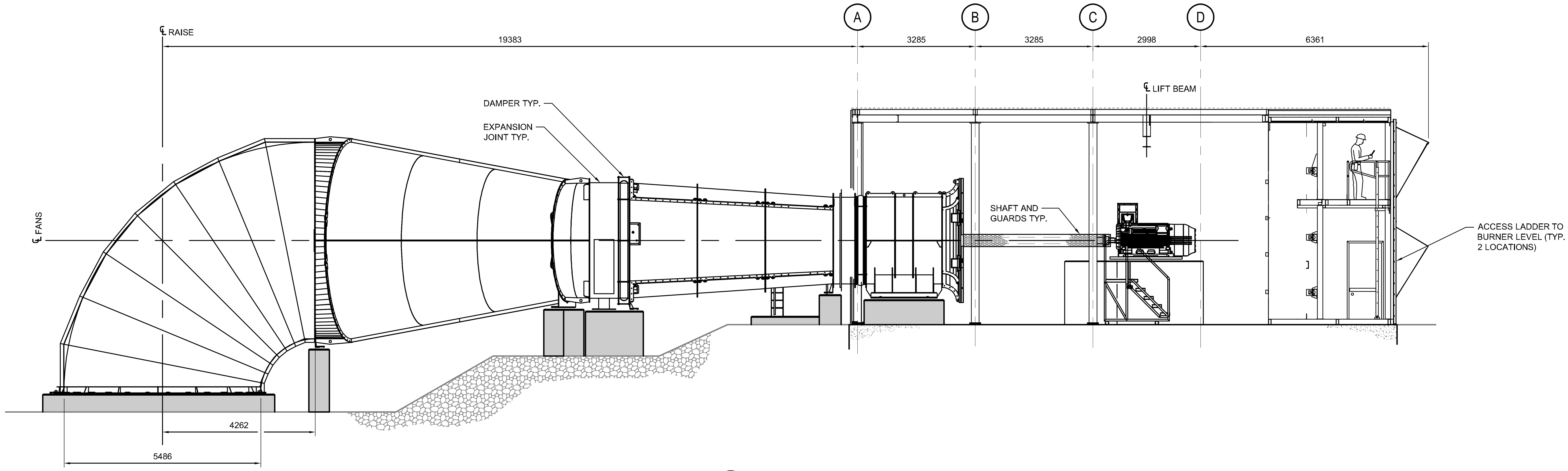
DRAWING #: S03

PLOT DATE: June 7, 2018 11:00:45 AM



PLAN VIEW

SCALE: 1:75



A SECTION S04

SCALE: 1:75

ISSUED FOR CLIENT REVIEW

07/06/18

No.	ISSUE / REVISION	DD/MM/YY
B	ISSUED FOR FINAL CLIENT REVIEW	07/06/18
A	ISSUED FOR CLIENT REVIEW	06/06/18

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SCALE: AS NOTED

CLIENT: NAP ALLADIUM Mining for Clean Air

CONSULTANT: www.jlrichards.ca J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

CONSULTANT: srk consulting

PROFESSIONAL STAMP

PROJECT NORTH

PROJECT:

NORTH AMERICAN PALLADIUM VENTILATION FEASIBILITY STUDY

LAC DES ILES MINE, ONTARIO

DRAWING:

TYPICAL SURFACE FA FANS AND HEATERS GENERAL ARRANGEMENT

DESIGN: L.D.

DRAWN: N.B.

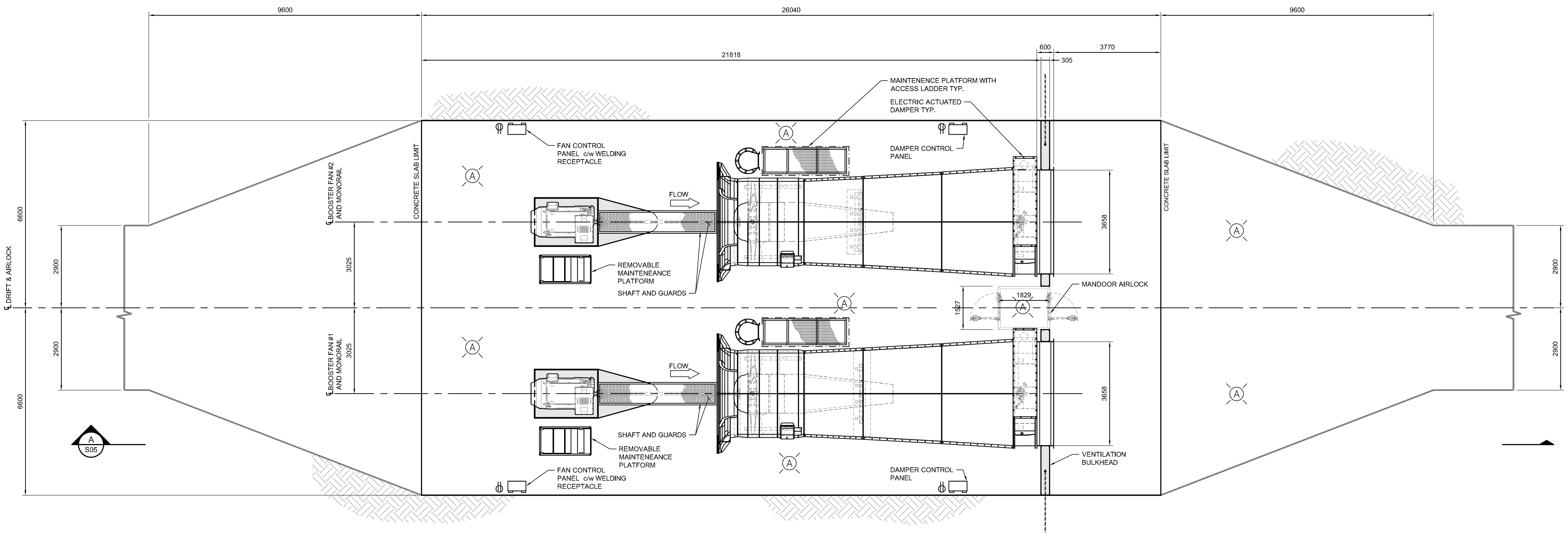
CHECKED:

JLR #: 27962-000

DRAWING #: S04

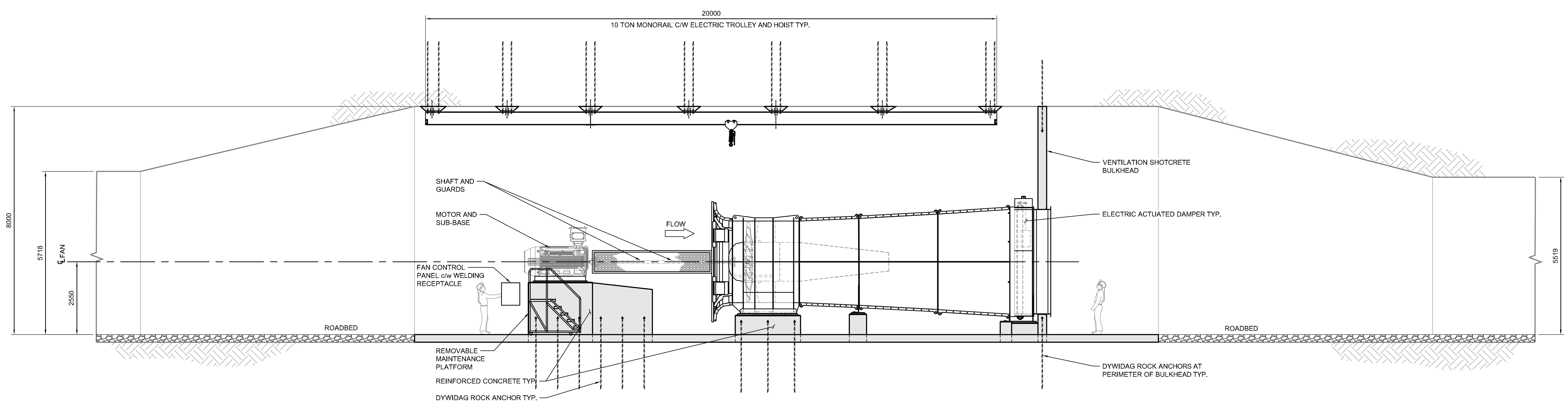
PLOT DATE: June 7, 2018 1:00:14 PM

File Location: L:\27000\27962-000 NAP LDI Ventilation Feasibility Study\3-JLR DWG\3-Struct\S04 FAR GENERAL ARRANGEMENT PLAN AND SECTION.dwg



PLAN VIEW

SCALE: 1:75



A S05 SECTION

SCALE: 1:75

LEGEND

(A)	LED LIGHTING
(symbol)	DUPLEX RECEPTACLE

ISSUED FOR CLIENT REVIEW

11/06/18

No.	ISSUE / REVISION	DD/MM/YY
B	ISSUED FOR FINAL CLIENT REVIEW	11/06/18
A	ISSUED FOR CLIENT REVIEW	08/06/18

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SCALE: AS NOTED

CLIENT: NAP PALLADIUM Mining for Clean Air

CONSULTANT: www.jlrichards.ca J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

CONSULTANT: srk consulting

PROFESSIONAL STAMP

PROJECT NORTH

PROJECT:

NORTH AMERICAN PALLADIUM VENTILATION FEASIBILITY STUDY

LAC DES ILES MINE, ONTARIO

DRAWING:

TYPICAL BOOSTER FAN GENERAL ARRANGEMENT PLAN AND SECTION

DESIGN: D.M.

DRAWN: N.B.

CHECKED:

JLR #: 27962-000

DRAWING #: S05

PLOT DATE: June 11, 2018 4:03:09 PM

File Location: L:\27000\27962-000 NAP LDI Ventilation Feasibility Study\3-JLR DWG\3-Struct\S05 BOOSTER FAN GENERAL ARRANGEMENT PLAN AND SECTION.dwg

APPENDIX D

Heating Calculations

Baseline Data - Thunder Bay

Month	Days / Month	Mean Temperature Outside (°F)	Temperature Setpoint (°F)	Heating Required?
October	31	41	35.6	No
November	30	26.6	35.6	Yes
December	31	11	35.6	Yes
January	31	5.4	35.6	Yes
February	29	10	35.6	Yes
March	31	22	35.6	Yes
April	30	37.22	35.6	No

Propane Cost ($/L)	0.4

Thunder Bay, Ontario Canada Climate Data

Thunder Bay Average Monthly Climate Data & Extremes

Forecasts & Conditions | Canada Radar | Canada Satellite | Weather Alerts | Climate Directory

Temperature:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Daily Average (°C)	-14.8	-12	-5.5	2.9	9.5	14	17.6	16.6	11	5	-3	-11.6	2.5	C
Standard Deviation	3.1	3.4	2.5	1.7	1.6	1.1	1.2	1.5	1.3	1.7	2	3.4	0.9	C
Daily Maximum (°C)	-8.6	-5.6	0.3	9	16.4	20.6	24.2	23.1	17.1	10.4	1.7	-6.1	8.5	C
Daily Minimum (°C)	-21.1	-18.4	-11.2	-3.3	2.5	7.3	11	10.1	4.9	-0.5	-7.7	-17	-3.6	C
Extreme Maximum (°C)	8.3	12.2	22.8	28.3	35.2	35.6	37.2	**40.3**	31.7	28.3	21.7	12.2		
Date (yyyy/dd)	1942/23	1976/25	1946/28	1942/24+	1986/30	1956/12	1975/30	**1983/07**	1976/11	1943/08	1975/04	1962/03		
Extreme Minimum (°C)	**-41.1**	-40	-36.7	-22.2	-8.9	-2.8	0	-1.1	-8.3	-13.3	-30.6	-37.8		
Date (yyyy/dd)	**1951/30**	1951/01+	1943/02	1954/04	1954/04+	1949/07+	1969/06	1976/29	1942/25+	1942/28+	1976/30	1976/13		
Precipitation:														
Rainfall (mm)	2.5	2.8	17.5	29.5	65	85.7	89	87.5	87.5	57	31.5	3.6	559	C
Snowfall (cm)	41.2	26.9	26.8	12.4	1.7	0	0	0	0.5	6.1	27.8	44.1	187.6	C
Precipitation (mm)	31.3	24.9	41.6	41.5	66.5	85.7	89	87.5	88	62.6	55.6	37.5	711.6	C
Average Snow Depth (cm)	31	31	24	5	0	0	0	0	0	0	3	15	9	C
Median Snow Depth (cm)	30	30	23	3	0	0	0	0	0	0	1	14	8	C
Snow Depth at Month-end (cm)	34	32	13	0	0	0	0	0	0	0	9	24	9	C
Extreme Daily Rainfall (mm)	25.4	17.8	26.7	69.3	76.2	49.3	53.8	87.1	**131.2**	47.8	63	42.7		
Date (yyyy/dd)	1975/10	1971/26	1957/14	1954/30	1971/24	1947/04	1973/27	1973/19	**1977/08**	1968/09	1973/21	1948/05		
Extreme Daily Snowfall (cm)	**51.6**	33.5	37.8	24.1	21.6	0	0	0	9.2	16.3	34.5	42		

Propane Users Data

Stage 1		
Area	Temperature Setpoint (°F)	Airflow (Acfm)
Shaft FA	35.6	372000
Main FA	35.6	498000
Near Surface FA	35.6	496500
760 FA Raise	35.6	233100

Stage 2		
Area	Temperature Setpoint (°F)	Airflow (Acfm)
Shaft FA	35.6	372000
Main FA	35.6	498000
Near Surface FA	35.6	861500
760 FA Raise	35.6	233100

Stage 3		
Area	Temperature Setpoint (°F)	Airflow (Acfm)
Shaft FA	35.6	372000
Main FA	35.6	498000
Near Surface FA	35.6	926500
760 FA Raise	35.6	233100

Stage 4		
Area	Temperature Setpoint (°F)	Airflow (Acfm)
Shaft FA	35.6	372000
Main FA	35.6	498000
Near Surface FA	35.6	778100
760 FA Raise	35.6	233100

Currently using December Temperature Setpoint for all months

Propane Consumption Sheet

Basic Calculation is as Follows

Volume of Propane = [(Airflow in Acfm) * (Temp Setpoint-Temp Outside) * (1.08 Btu/(Acfm*F*hr)) * 24 hr/day * (Days in Month)] / [(21897 Btu / L of Propane)]

Stage 1

Area	Temperature Setpoint (°F)	Airflow (Acfm)	Propane Consumption November (Litre)	Propane Consumption December (Litre)	Propane Consumption January (Litre)	Propane Consumption February (Litre)	Propane Consumption March (Litre)	Total Winter Consumption (Litre)
Shaft FA	35.6	372,000	118,893	335,807	412,251	326,912	185,650	**1,379,514**
Main FA	35.6	498,000	159,164	449,548	551,885	437,641	248,531	**1,846,768**
Near Surface FA	35.6	496,500	158,684	448,194	550,222	436,322	247,782	**1,841,206**
760 FA Raise	35.6	233,100	74,500	210,421	258,322	204,847	116,330	**864,421**
Subtotal	-	1,599,600	511,241	1,443,971	1,772,680	1,405,723	798,293	**5,931,909**

Stage 2

Area	Temperature Setpoint (°F)	Airflow (Acfm)	Propane Consumption November (Litre)	Propane Consumption December (Litre)	Propane Consumption January (Litre)	Propane Consumption February (Litre)	Propane Consumption March (Litre)	Total Winter Consumption (Litre)
Shaft FA	35.6	372,000	118,893	335,807	412,251	326,912	185,650	**1,379,514**
Main FA	35.6	498,000	159,164	449,548	551,885	437,641	248,531	**1,846,768**
Near Surface FA	35.6	861,500	275,340	777,683	954,716	757,083	429,938	**3,194,761**
760 FA Raise	35.6	233,100	74,500	210,421	258,322	204,847	116,330	**864,421**
Subtotal	-	1,964,600	627,897	1,773,460	2,177,174	1,726,484	980,449	**7,285,464**

Stage 3

Area	Temperature Setpoint (°F)	Airflow (Acfm)	Propane Consumption November (Litre)	Propane Consumption December (Litre)	Propane Consumption January (Litre)	Propane Consumption February (Litre)	Propane Consumption March (Litre)	Total Winter Consumption (Litre)
Shaft FA	35.6	372,000	118,893	335,807	412,251	326,912	185,650	**1,379,514**
Main FA	35.6	498,000	159,164	449,548	551,885	437,641	248,531	**1,846,768**
Near Surface FA	35.6	926,500	296,114	836,359	1,026,749	814,205	462,377	**3,435,805**
760 FA Raise	35.6	233,100	74,500	210,421	258,322	204,847	116,330	**864,421**
Subtotal	-	2,029,600	648,671	1,832,136	2,249,207	1,783,605	1,012,888	**7,526,508**

Stage 4

Area	Temperature Setpoint (°F)	Airflow (Acfm)	Propane Consumption November (Litre)	Propane Consumption December (Litre)	Propane Consumption January (Litre)	Propane Consumption February (Litre)	Propane Consumption March (Litre)	Total Winter Consumption (Litre)
Shaft FA	35.6	372,000	118,893	335,807	412,251	326,912	185,650	**1,379,514**
Main FA	35.6	498,000	159,164	449,548	551,885	437,641	248,531	**1,846,768**
Near Surface FA	35.6	778,100	248,685	702,397	862,292	683,792	388,317	**2,885,483**
760 FA Raise	35.6	233,100	74,500	210,421	258,322	204,847	116,330	**864,421**
Subtotal	-	1,881,200	601,242	1,698,174	2,084,750	1,653,192	938,828	**6,976,185**

Stage 2									
Area	Temperature Setpoint (°F)	Airflow (Acfm)	Propane Cost November	Propane Cost December	Propane Cost January	Propane Cost February	Propane Cost March	**Total Winter Cost**	**Cost per 1000 Acfm**
Shaft FA	35.6	372,000	$ 47,557	$ 134,323	$ 164,900	$ 130,765	$ 74,260	**$ 551,805**	**$ 1,483**
Main FA	35.6	498,000	$ 63,665	$ 179,819	$ 220,754	$ 175,056	$ 99,412	**$ 738,707**	**$ 1,483**
Near Surface FA	35.6	861,500	$ 110,136	$ 311,073	$ 381,886	$ 302,833	$ 171,975	**$ 1,277,904**	**$ 1,483**
760 FA Raise	35.6	233,100	$ 29,800	$ 84,168	$ 103,329	$ 81,939	$ 46,532	**$ 345,768**	**$ 1,483**
Subtotal	-	1,964,600	$ 251,159	$ 709,384	$ 870,870	$ 690,593	$ 392,180	**$ 2,914,185**	**$ 1,483**

Stage 3									
Area	Temperature Setpoint (°F)	Airflow (Acfm)	Propane Cost November	Propane Cost December	Propane Cost January	Propane Cost February	Propane Cost March	**Total Winter Cost**	**Cost per 1000 Acfm**
Shaft FA	35.6	372,000	$ 47,557	$ 134,323	$ 164,900	$ 130,765	$ 74,260	**$ 551,805**	**$ 1,483**
Main FA	35.6	498,000	$ 63,665	$ 179,819	$ 220,754	$ 175,056	$ 99,412	**$ 738,707**	**$ 1,483**
Near Surface FA	35.6	926,500	$ 118,446	$ 334,543	$ 410,700	$ 325,682	$ 184,951	**$ 1,374,322**	**$ 1,483**
760 FA Raise	35.6	233,100	$ 29,800	$ 84,168	$ 103,329	$ 81,939	$ 46,532	**$ 345,768**	**$ 1,483**
Subtotal	-	2,029,600	$ 259,468	$ 732,854	$ 899,683	$ 713,442	$ 405,155	**$ 3,010,603**	**$ 1,483**

Stage 4									
Area	Temperature Setpoint (°F)	Airflow (Acfm)	Propane Cost November	Propane Cost December	Propane Cost January	Propane Cost February	Propane Cost March	**Total Winter Cost**	**Cost per 1000 Acfm**
Shaft FA	35.6	372,000	$ 47,557	$ 134,323	$ 164,900	$ 130,765	$ 74,260	**$ 551,805**	**$ 1,483**
Main FA	35.6	498,000	$ 63,665	$ 179,819	$ 220,754	$ 175,056	$ 99,412	**$ 738,707**	**$ 1,483**
Near Surface FA	35.6	778,100	$ 99,474	$ 280,959	$ 344,917	$ 273,517	$ 155,327	**$ 1,154,193**	**$ 1,483**
760 FA Raise	35.6	233,100	$ 29,800	$ 84,168	$ 103,329	$ 81,939	$ 46,532	**$ 345,768**	**$ 1,483**
Subtotal	-	1,881,200	$ 240,497	$ 679,270	$ 833,900	$ 661,277	$ 375,531	**$ 2,790,474**	**$ 1,483**

Propane Consumption Summary Sheet

Data for calculations taken from Volume and Cost sheets

Total Mine Summary Heating requirements per heating season		
Period	Total Litres of Propane	Total Cost of Propane
Stage 1	5,931,909	$ 2,372,763
Stage 2	7,285,464	$ 2,914,185
Stage 3	7,526,508	$ 3,010,603
Stage 4	6,976,185	$ 2,790,474