then ignore the Secondary Chamber and the associated burner and blower. Figure 5 and Figure 6 show photographs of the Single-Chamber (CY-1050-FA) and Dual-Chamber (CY-2050-FA) designs, respectively. Table 7 summarizes the components and their functions.

Table 5 Key Design Parameters of Westland's Forced Air Incinerators

Model	Air Blower Series No.	Burner Rating		PC Volume		Approximate Maximum Capacity* (Type 3 Waste)	
		1000 Btu/h	GJ/h	ft^3	m^3	lb/h	kg/h
CY-1013-FA	AMU 400	350	0.37	13	0.37	90	40
CY-1020-FA	AMU 400	490	0.51	20	0.5	110	50
CY-1050-FA	AMU 625	700	0.73	50	1.3	245	112
CY-2020-FA	PC: AMU 400 SC: AMU 245	PC: 490 SC: 280	PC: 0.51 SC: 0.29	20	0.5	110	50
CY-2050-FA	PC: AMU 625 SC: AMU 225	PC: 700 SC: 280	PC: 0.73 SC: 0.29	50	1.3	245	112

Notes: PC: Primary Chamber; SC: Secondary Chamber. * Actual capacity depends on properties of the waste being incinerated; see Table 2 for waste properties.

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Table 6 Combustion Air Blowers Characteristics

MODEL	HP	RPM	AIR DELIVERY (CFM AT R.P.M. SPECIFIED)							
			Free Air	1/8" SP	1/4" SP	3/8" SP	1/2" SP	3/4" SP	1" SP	1-1/4" SP
AMU-75	1/60	3000	75	61	54	43	–	–	–	–
AMU-130	1/70	1550	130	107	87	30	–	–	–	–
AMU-245	1/20	1550	245	225	210	190	162	–	–	–
AMU-400	1/12	1550	400	380	365	340	315	200	–	–
AMU-525	1/4	1725	525	500	480	460	420	240	120	–
AMU-625	1/4	1725	625	600	560	540	500	420	280	100
AMU-845	1/2	1725	845	825	790	760	730	650	570	425
AMU-1100	1/3	1140	1100	1050	1000	950	860	700	–	–
Tested by The Nozzle Chamber Method as directed in A.M.C.A. Bulletin #210 Figure #4										

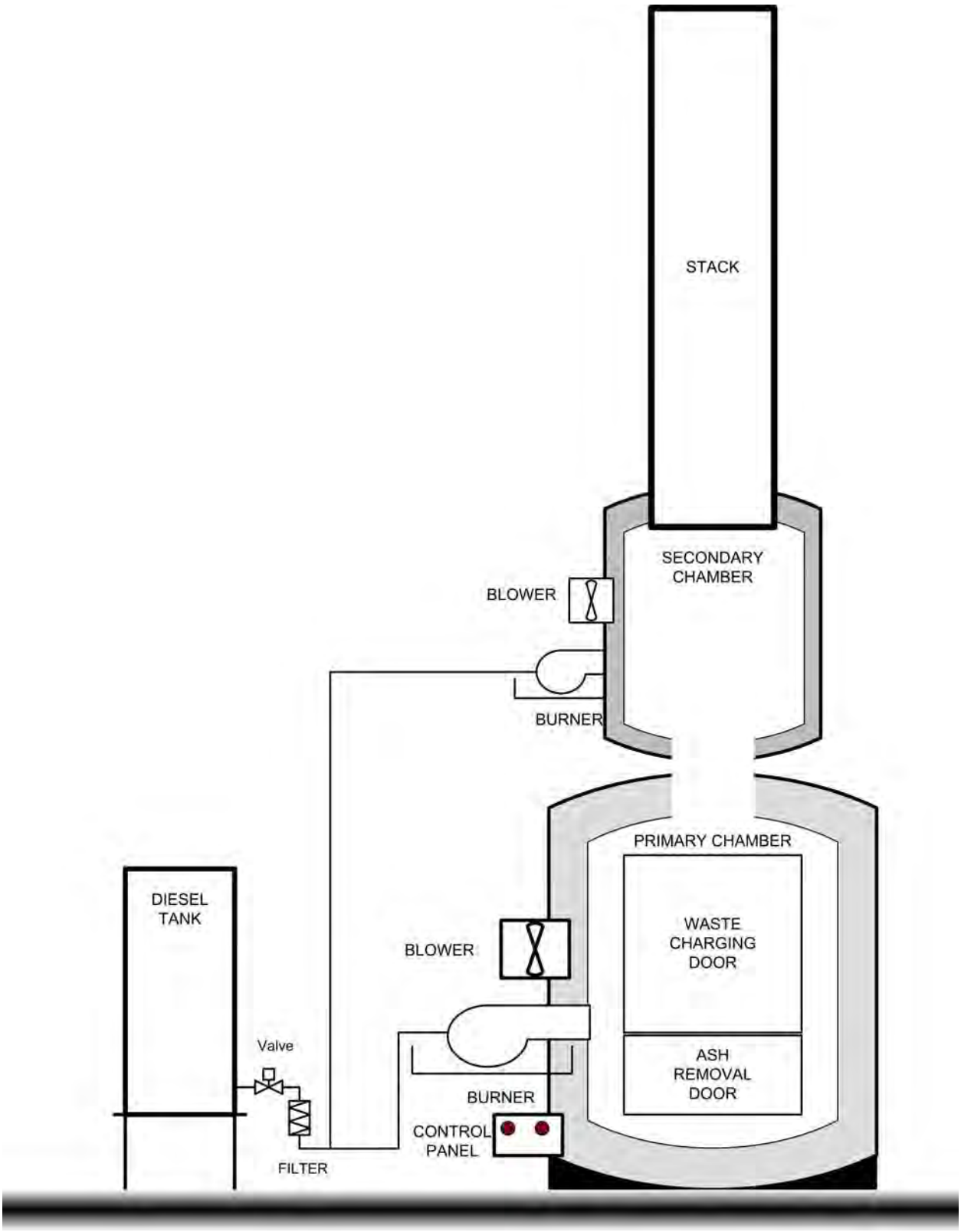


Figure 4 Schematic Diagram of Forced Air Dual-Chamber Design

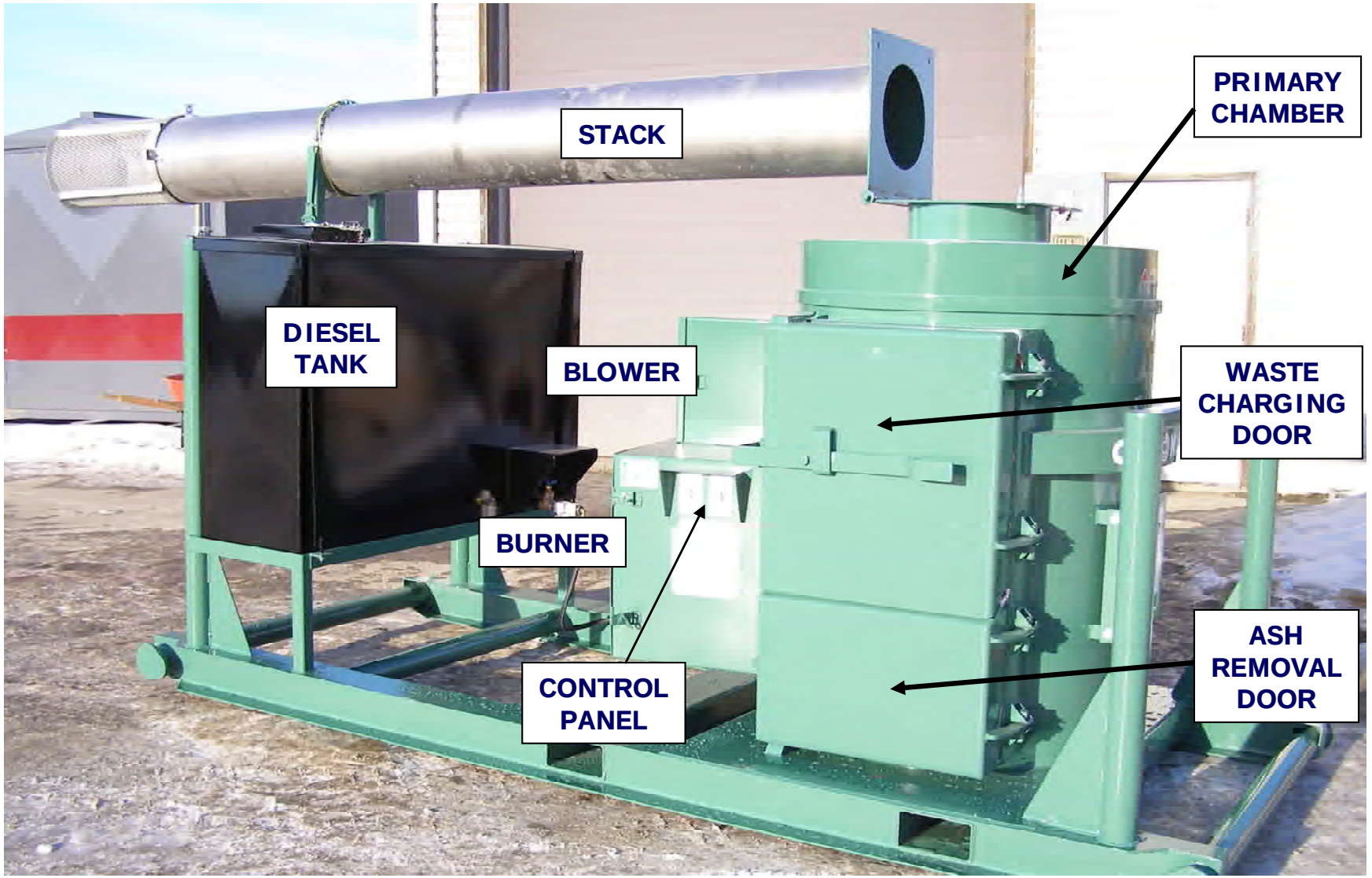


Figure 5 Photograph of the Single-Chamber Design

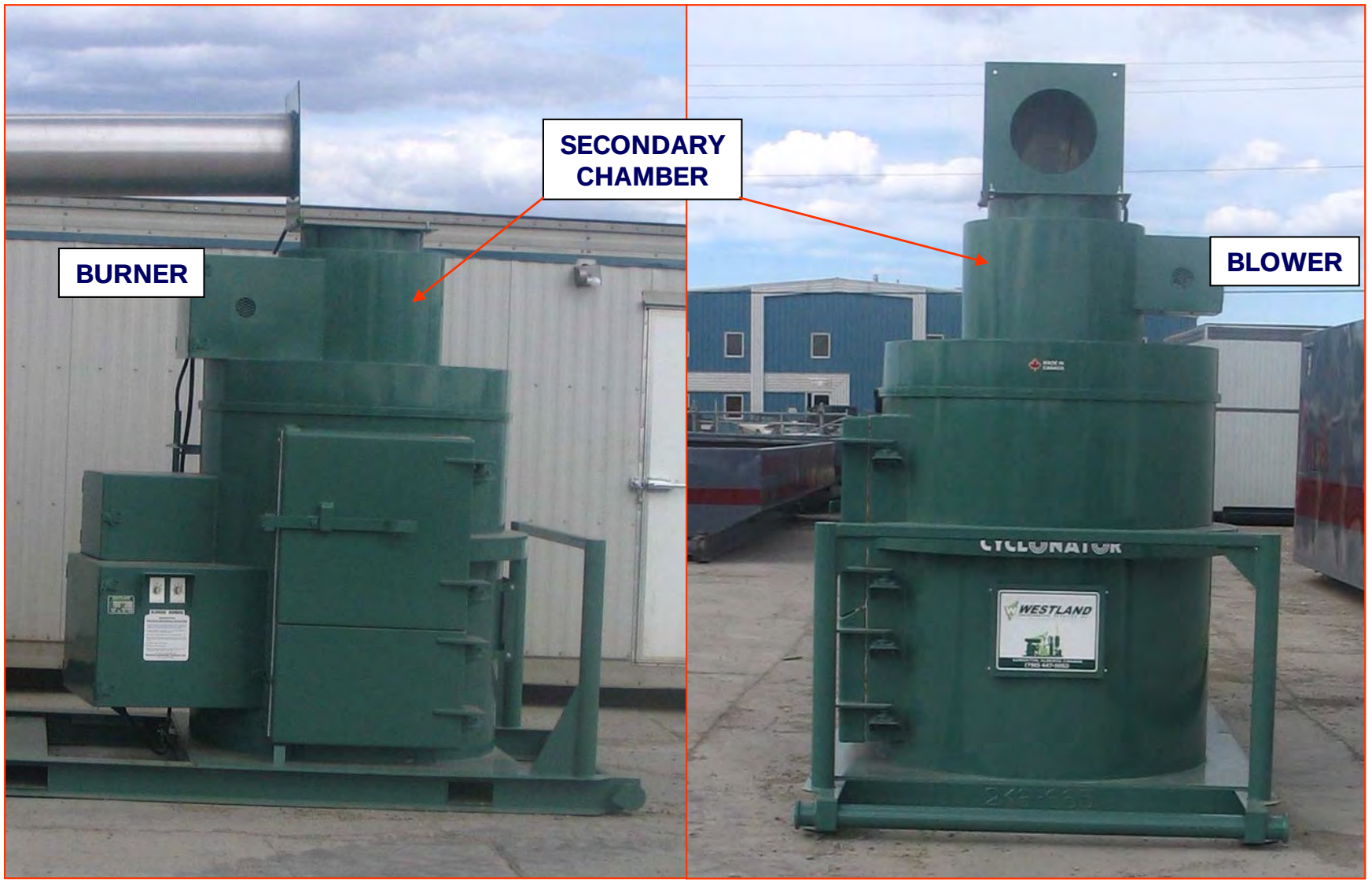


Figure 6 Photographs of the Dual-Chamber Design

Table 7 Components and Their Functions

COMPONENT	FUNCTION	DESCRIPTION
Primary Chamber	Waste combustion	WES *. Refractory lined (3 "), insulated (1")
▪ Burner	Supply heat to ignite and sustain combustion	Beckett SF or Midco Incinomite
▪ Blower	Supply air (oxygen) for combustion	AMU series
Secondary Chamber	Complete combustion	WES *. Refractory lined (3"), insulated (1")
▪ Burner	Supply heat to ignite and sustain combustion	Beckett SF or Midco Incinomite
▪ Blower	Supply air (oxygen) for combustion	AMU Series
Control Panel	Timers for burner and blower operations	Intermatic
Diesel Tank	Supply of auxiliary fuel	WES *
Valve	Cut off fuel to burner(s)	(General)
Filter	Prevent clogging of burner nozzle	LFF 22
Stack	Disperse hot flue gas	WES *. SS Stack
Electrical System	Burner and blower operations	WES *. 115 V, 60 Hz, Single Phase

Note: WES * : Manufactured in-house. Manuals for blowers and burners are in Appendix A: Information sheets and Manuals for Burners and Blowers

4 OPERATION AND MAINTENANCE

4.1 Safety equipment

The following personal protective equipment should be used while operating the incinerator system:

- Long sleeved shirt and long pants;
- Long cuffed, puncture resistant gloves;
- CSA approved, Grade 1 safety footwear;
- CSA/ANSI approved safety glasses.

The personal protective equipment related to specific tasks are listed below:

- Ash removal and handling: NIOSH N85 respirator
- Waste charging: (i) heat protective clothing and gloves, and (2) CSA/ANSI approved full face shield.

4.2 Routine inspection and maintenance

- Check fuel lines for leak and check connections
- Check spark arrestor to ensure no plugging
- During ash removal (see next section):
  - Inspect refractory for large cracks (not expansion cracks)

- Check combustion air hole for plugging
- Inspect door gaskets for damages

4.3 Ash removal

Typically the ash from previous operation was left to cool, and ash removal is done first prior to current operation.

- Make sure combustion chamber is sufficiently cool
- (Do NOT spray water into the combustion chamber)
- While removing ash, avoid plugging the combustion air holes and damaging the burner tip
- Use non-combustible container
- Minimize dust generation
- Light water spraying on ash in the container is OK to minimize dust generation
- Dispose of ash as specified in the guidelines or regulations

4.4 Pre-operational checks

- Install stack if necessary
- Check fuel tank to make sure enough fuel (Use 5 USG/h for single-chamber, and 7.5 USG/h for dual-chamber. Actual values depend on the size of the incinerator.)
- Open fuel valve
- Re-check that combustion chamber is empty and combustion air hoes are clear
- Connect electrical plug
- Prime pump if necessary

4.5 Waste batch preparation

As previously mentioned incinerator capacity in kg/h is dependent on the heating value of the waste, which is normally not known. The nominal capacity of your incinerator is as shown in Table 5 for Type 1 to Type 3 waste, and somewhat less for Type 0.

The following cautionary notes should be followed:

- NO explosives, aerosol cans or containers containing combustible liquids
- Make sure that every batch can go through the waste charging door easily, regardless of its weight. If others prepare the batches, the operator should tell them about the maximum batch size.
- Do not open batches and "rearrange" the contents for health reasons.

4.6 Incineration

1. Re-check the burner and blower operations
2. Pre-heat the combustion chambers for 10 minutes: close doors and set the burner timer for 10 minutes
3. Load waste to Primary Chamber up to 60% of its volume
4. Start incineration: close waste charging door, set blower timer for 120 minutes and burner timer for 30 – 60 minutes depending on the amount waste loaded.
5. Check status: set timers off, open waste charging door, inspect and rake if necessary

6. If combustion is not complete, repeat Steps 4 and 5 until it is.
7. If there is more waste to be burnt, repeat Steps 3 to 6. Otherwise, go to shut-down protocol.

4.7 Shut-down

- Make sure all timers are off
- Unplug electrical connection
- Turn off fuel valve
- Un-install stack if incinerator is to be moved elsewhere.

4.8 Maintenance

In addition to the routine inspection and maintenance previously mentioned, only the burner(s) and the blower(s) require maintenance, which is quite minimum; see manuals in Appendix A: Information sheets and Manuals for Burners and Blowers. The fuel filter should be replaced every three months.

4.9 Auxiliary Fuel Consumption Rate

Figure 7 shows the volumetric flow rates of propane and diesel as a function of burner rating.

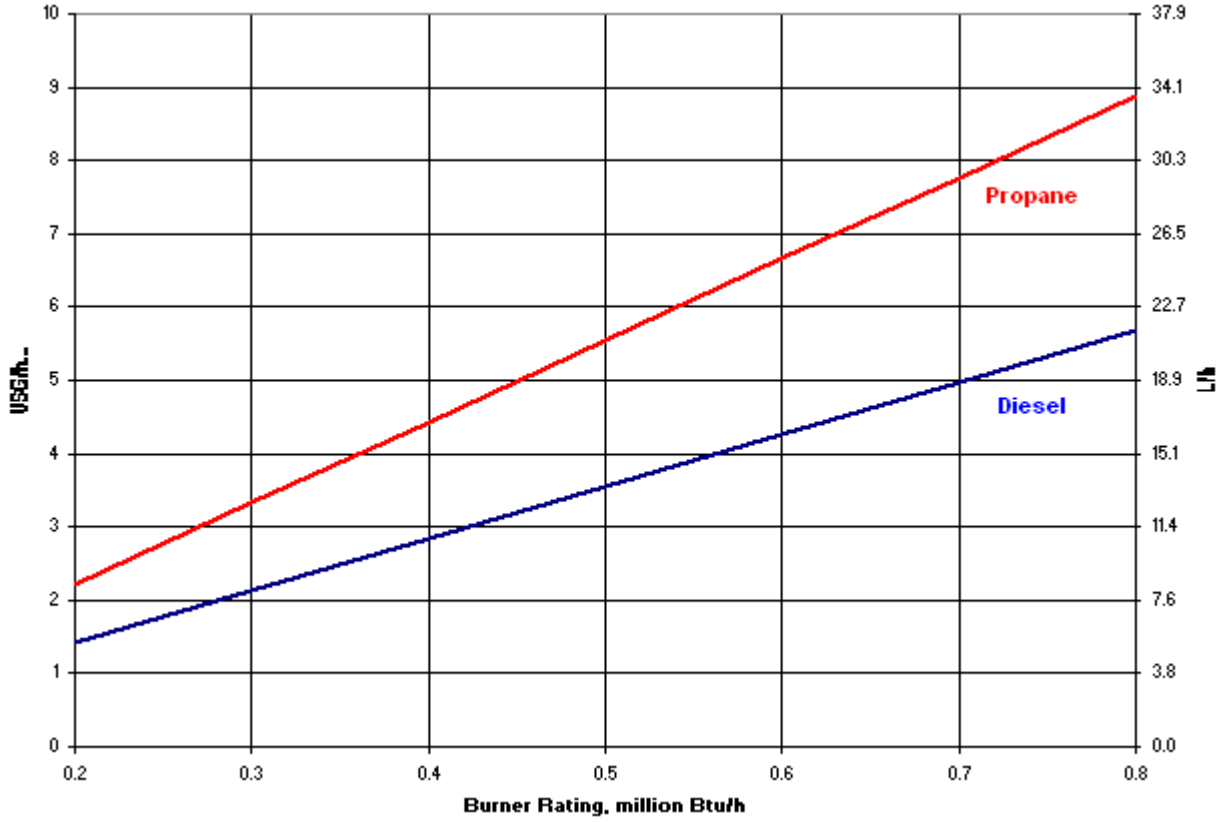


Figure 7 Consumption Rates of Propane and Diesel

5 WARRANTY

1. Westland Environmental Services Inc. hereby warrants to the Purchaser, for a one (1) year period of time from the date of acceptance and upon the conditions hereinafter set forth, each new product sold by it, to be free from defects in material and workmanship (specifically excluding therefrom component parts and accessories manufactured, furnished, and supplied by others) under normal use, maintenance and service. Except for the above Warranty, it is agreed and understood that no other WARRANTY or CONDITION whether express, implied, or statutory is made by Westland Environmental Services Inc.
2. The obligation of Westland Environmental Services Inc. under this Warranty shall be limited to the repair or replacement (**not in excess of its factory labour rate**) of its units; which, upon examination by Westland Environmental Services Inc., shall disclose to their satisfaction to have been defective in material and/or workmanship under normal use, maintenance, and service.
3. The foregoing shall be the Purchaser's sole and exclusive remedy whether in contract, tort, or otherwise; and Westland Environmental Services Inc. shall not be liable for injuries to persons, for damage to property or for loss of any kind which results (whether directly or indirectly) from such defects in material or workmanship, or for any other reason; and, it is agreed and understood that the Purchaser shall keep Westland Environmental Services Inc. indemnified against any such claim. In no event shall Westland Environmental Services Inc. be liable for incidental or consequential damages, or commercial losses, or for any loss or damage except as set forth in paragraph 2 herein.
4. This Warranty does not apply to, and no warranty or condition is made by Westland Environmental Services Inc. regarding any purchased components, parts, and accessories; manufactured, supplied and/or furnished by others, or any non-standard features or items specified by the Purchaser; nor does this Warranty expand, enlarge upon, or alter in any way, the warranties provided by the makers and suppliers of such component parts and accessories.
5. The liability of Westland Environmental Services Inc. under this Warranty shall cease and determine if:
   (a) The Purchaser shall not have paid in full all invoices as submitted by Westland Environmental Services Inc. or affiliated companies on or before their due dates:
   (b) Representatives of Westland Environmental Services Inc. are denied full and free right of access to the units:
   (c) The Purchaser permits persons other than the agents of Westland Environmental Services Inc. or those approved or authorized by Westland Environmental Services Inc. to effect any replacement of parts, maintenance, adjustments, or repairs to the units:
   (d) The Purchaser has not properly operated and maintained the units in accordance with instructions, pamphlets or directions given or issued by Westland Environmental Services Inc. at the time of the sale and/or from time to time thereafter:
   (e) The Purchaser uses any spare parts or replacements not manufactured by or on behalf of Westland Environmental Services Inc. and supplied by it, or by someone authorized by it, or fails to follow the instructions for the use of the same:
   (f) The Purchaser misuses, or uses this unit for any purpose other than that for which it was intended or manufactured:
   (g) The defective parts are not returned to Westland Environmental Services Inc. within 15 days of repair.

6. No condition is made or is to be implied, nor is any Warranty given or to be implied as to the life or wear of the units supplied; or that they will be suitable for use under any specific conditions; notwithstanding that such conditions may be known or made known to the seller.
7. Defects in material and/or workmanship must be brought to the attention of Westland Environmental Services Inc. by written notification within ten (10) days of discovery, and repairs must be commenced within forty-five (45) days thereafter.
8. It is agreed and understood that the Purchaser is responsible for and must pay for the transporting of the defective goods or of the replacement parts to the place of repair. Premium freight charges (such as air express or air fare charges for transportation of personnel, tools and for replacement parts) and other expenses, apart from servicemen's regular straight time travel, mileage, and regular straight time labour required to repair or replace defective parts and the cost of the parts, will be paid for by the customer at Westland Environmental Services Inc. regular billing rates on usual credit terms.
9. The liability of Westland Environmental Services Inc. under this Warranty is limited to the purchase price of the unit and in no case shall a claim be advanced for more than such amount.

10. All repairs and replacements are made and furnished subject to the same terms, conditions, warranties, disclaimer or warranty and limitations of liability and remedy as applied to each new unit sold.
11. This warranty and the Purchaser's rights under it, is not transferable, or is it assignable.

DATE IN SERVICE: _____

MODEL NUMBER: _____

SERIAL NUMBER: _____

6 APPENDIX A: INFORMATION SHEETS AND MANUALS FOR BURNERS AND BLOWERS

WESTLAND
ENVIRONMENTAL SERVICES INC.
www.westlandenvironmental.com

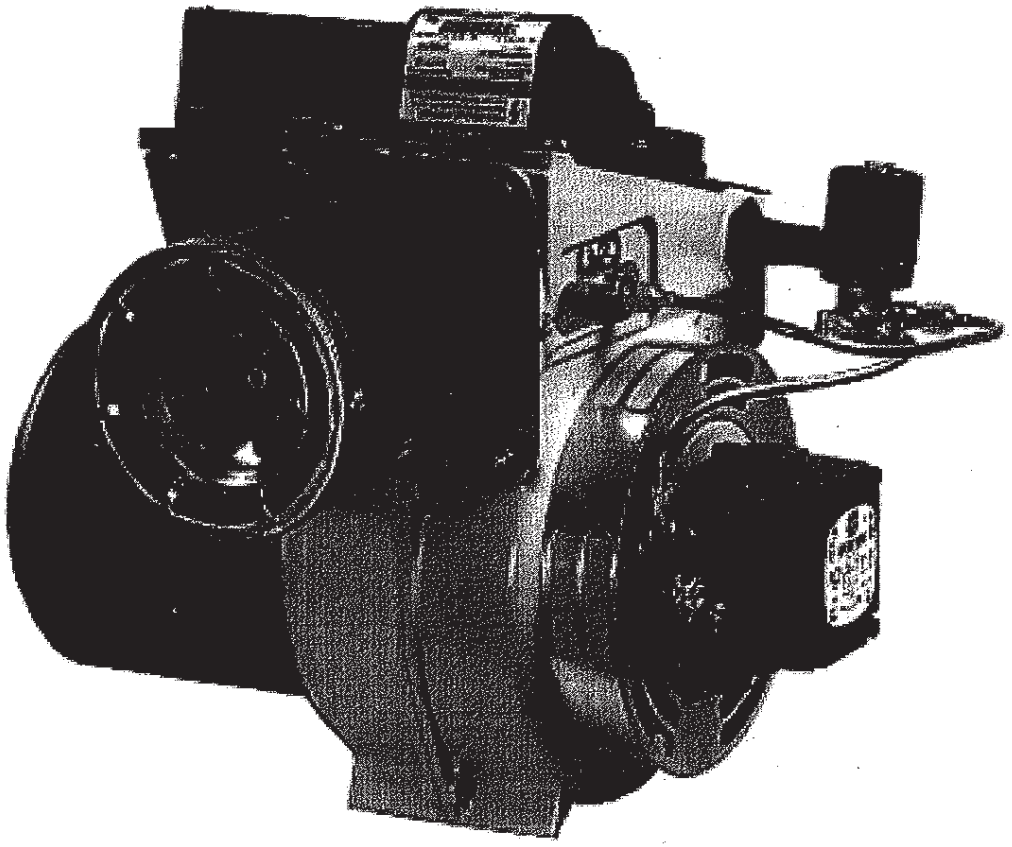
Forced Air Incinerator PARTS LIST
(CY 1013/1020/2020/1050/2050 FA "D")

Description	Part #
Gun Burner Beckett, WIC 201 x 6", diesel fired	7007006
Gun Burner Midco J83DS, natural gas or LPG fired	7009000
Air Tube Combination for WIC 201	7900188
Coupling, Flex for WIC 201	7009183
Fuel Pump A2YA7916 Suntec	7009182
Blower Wheel for WIC 201	7009184
Motor 1/3 HP for WIC 201	7009186
Transformer, Ignition "S" for WIC 201	7009187
Stainless Steel Stack, 15" dia x 10' (CY 1050/2050)	7030101
Stainless Steel Stack, 13" dia x 10' (CY 1020/2020)	7020101
Stainless Steel Stack, 10" dia x 2m (CY 1013)	
Spark Arrestor, Stainless Steel 15" (CY 1050/2050)	7030107
Spark Arrestor, Stainless Steel 13" (CY 1020/2020)	7020107
Spark Arrestor, Stainless Steel 10" (CY 1013)	
Stack crating for shipping 13" stack	7020102
Stack crating for shipping 15" stack	7030102
Nozzle (specify GPH, angle, pattern)	7006122
Gasket, Ceramic Fibre 1/8" x 2" (price per foot)	7000062
Gasket Cement, HT Silicone Tube	7000064
Refractory Cement Bag	7000120
Timer, 60 min Spring Wound	7000145
Timer, Blower 120m Spring Wound	7000146
Filter Adaptor	7001116
Filter, Fuel LFF22	7001117
Fuel Tank, 1000 L Double Wall Enviro	7041112
Delhi Blower D530 (CY 2050-models older than 2007)	7000054
AMU625 Blower (CY2050FA D)	7000058
AMU Secondary Blower 245 (CY2050/2020) (replaces the Delhi D530 on 2007 and newer models)	7000075
AMU 400 Blower (CY1020FA D) (CY 1020/ 2020/ 1013)	7000055

20204 - 110 Ave, Edmonton, Alberta, T5S 1X8, Canada. Tel: (780) 447-5052, Fax: (780) 447-4912.
Visit us at: www.westlandenvironmental.com

Models SF & SM Oil Burners

WIC 201 Burner



WARNING **Potential for Fire, Smoke and Asphyxiation Hazards**

Incorrect installation, adjustment, or misuse of this burner could result in death, severe personal injury, or substantial property damage.

To the Homeowner or Equipment Owner:

- Please read and carefully follow all instructions provided in this manual regarding your responsibilities in caring for your heating equipment.
- Contact a professional, qualified service agency for installation, start-up or service work.
- Save this manual for future reference.

To the Professional, Qualified Installer or Service Agency:

- Please read and carefully follow all instructions provided in this manual before installing, starting, or servicing this burner or heating system.
- The Installation must be made in accordance with all state and local codes having jurisdiction.

Table of Contents

Owner's Information 3
Hazard Definitions 4

Information To Be Used Only By Qualified Service Technicians

General Information 4
Table 1 Burner Specification 4
Notice Special Requirements 5
Table 2 Air Tube Combination (ATC) Codes 5
Inspect/Prepare Installation Site 5
Chimney or Vent 5
Combustion Air Supply 5
Clearances to burner and appliance 6
Combustion chamber - Burner Retrofitting 6
Prepare the Burner 6
Burner Fuel Unit 6
Attach Air Tube 6
Install Burner Nozzle 6
Check/Adjust Electrodes 7
Servicing nozzle line assembly 7
Check/Adjust 'Z' Dimension - F Heads 7
Mount Burner on Appliance 8
Mounting Options 8
Mounting Dimensions 8
Connect Fuel Lines 8
Wire Burner 10
Burner Packaged with Appliance 10
Burner Installed at Job Site 10
Start-up Burner/Set Combustion 10
Set Combustion with Test Instruments 12
Perform Regular Maintenance 13
Parts Diagram 14
Beckett Limited Warranty Information 16

Owner's Information

To the Owner:

Thank you for purchasing a Beckett burner for use with your heating appliance. Please pay attention to the Safety Warnings contained within this instruction manual. Keep this manual for your records and provide it to your qualified service agency for use in professionally setting up and maintaining your oil burner.

Your Beckett burner will provide years of efficient operation if it is professionally installed and maintained by a qualified service technician. If at any time the burner does not appear to be operating properly, **immediately contact your qualified service agency** for consultation.

We recommend annual inspection/service of your oil heating system by a qualified service agency.

Daily – Check the room in which your burner/appliance is installed. Make sure:

- Air ventilation openings are clean and unobstructed
- Nothing is blocking burner inlet air openings
- No combustible materials are stored near the heating appliance
- There are no signs of oil or water leaking around the burner or appliance

Weekly

- Check your oil tank level. Always keep your oil tank full, especially during the summer, in order to prevent condensation of moisture on the inside surface of the tank.

WARNING **Owner's Responsibility**

Incorrect installation, adjustment, and use of this burner could result in severe personal injury, death, or substantial property damage from fire, carbon monoxide poisoning, soot or explosion.

Contact a professional, qualified service agency for the installation, adjustment and service of your oil heating system. This work requires technical training, trade experience, licensing or certification in some states and the proper use of special combustion test instruments.

Please carefully read and comply with the following instructions:

- Never store or use gasoline or other flammable liquids or vapors near this burner or appliance.
- Never attempt to burn garbage or refuse in this appliance.
- Never attempt to light the burner/appliance by throwing burning material into the appliance.
- Never attempt to burn any fuel not specified and approved for use in this burner.
- Never restrict the air inlet openings to the burner or the combustion air ventilation openings in the room.

NOTICE

This manual contains information that applies to both SM and SF burners. These burners may appear to be basically identical, but there are differences in design and performance. Please review the comparison chart below:

Feature	SM	SF
Firing Rate Range	1.25 to 3.00 gph	1.25 to 5.50 gph
Motor	1/5 HP	1/4 HP
Fuel pump capacity	3 gph (standard)	7 gph (standard)
UL Air Tube Combinations	See Table 2	See Table 2
Blocking oil solenoid valve	Optional	Required above 3 gph
Primary control lockout timing	15 to 45 seconds (optional)	15 seconds maximum

Hazard Definitions

DANGER **Indicates an imminently hazardous situation, which, if not avoided, will result in death, serious injury, or property damage.**

WARNING **Indicates a potentially hazardous situation, which, if not avoided, could result in death, severe personal injury, and/or substantial property damage.**

CAUTION **Indicates a potentially hazardous situation, which, if not avoided, may result in personal injury or property damage.**

Within the boundaries of the hazard warning, there will be information presented describing consequences if the warning is not heeded and instructions on how to avoid the hazard.

NOTICE

Intended to bring special attention to information, but not related to personal injury or property damage.

General Information

Table 1 – Burner Specifications

Model SM Capacity (Note1)	Firing rate range: .....01.25 – 3.00 GPH Input: ..... 175,000 – 420,000 Btu/hr
Model SF Capacity (Note1)	Firing rate range:.....1.25 - 5.50 GPH Input: .....175,000 – 770,000 Btu/hr
Certifications/ Approvals	Model SM - UL listed to comply with ANSI/ UL296 & certified to CSA B140.0. Model SF - UL listed to comply with ANSI/UL 296 & certified to CSA B140.0.
Fuels	U. S: No.1 or No.2 heating oil only (ASTM D396) Canada: No. 1 stove oil or No. 2 furnace oil only
Electrical	Power supply: ..... 120 volts AC, 60 Hz, single phase Operating load (SM): .....5.8 Amps max Operating load (SF): .....7.1 Amps max Motor (SM): ..... 1/5 hp, 3450 rpm, NEMA 'N' flange, manual reset over load protection Motor (SF): ..... 1/4 hp, 3450 rpm, NEMA 'N' flange, manual reset over load protection Ignition: ... Continuous duty solid-state igniter
Fuel pump	Outlet pressure: ..... Note 2
Air tube	ATC code: .....See Table 2
Dimensions (Standard)	Height .....12.5 inches Width .....15 inches Depth ..... 8.50 inches Air tube diameter ..... 4.00 inches
Air tube	ATC code: .....See Table 2

Note 1: *Approval agency listed rating for Model SM is 1.25 to 3.00 gph and Model SF is 1.25 to 5.50 gph. However, the firing rate range is limited by the specific air tube combination being used. Refer to Table 2.*

Note 2. *UL Recognized to 4.0 GPH with a CleanCut pump for use in pressure washers.*

Note 3. *See appliance manufacturer's burner specifications for recommended pump discharge pressure.*

• Notice Special Requirements

- For recommended installation practice in Canada, refer to the latest version of CSA Standard B139 & B140.
- Concealed damage — If you discover damage to the burner or controls during unpacking, notify the carrier at once and file the appropriate claim.
- When contacting Beckett for service information — Please record the burner serial number (and have available when calling or writing). You will find the serial number on the silver label located on the left rear of the burner. Refer to Figure 1.

WARNING **Professional Service Required**

Incorrect installation, adjustment, and use of this burner could result in severe personal injury, death, or substantial property damage from fire, carbon monoxide poisoning, soot or explosion.

Please read and understand the manual supplied with this equipment. This equipment must be installed, adjusted and put into operation only by a qualified individual or service agency that is:

- Licensed or certified to install and provide technical service to oil heating systems.
- Experienced with all applicable codes, standards and ordinances.
- Responsible for the correct installation and commission of this equipment.
- Skilled in the adjustment of oil burners using combustion test instruments.

The installation must strictly comply with all applicable codes, authorities having jurisdiction and the latest revision of the National Fire Protection Association Standard for the installation of Oil-burning Equipment, NFPA 31 (or CSA B139 and B140 in Canada).

Regulation by these authorities take precedence over the general instructions provided in this installation manual.

Table 2 – Air Tube Combination (ATC) codes

Firing Rate (gph)	Head	Static plate size	ATC Codes for usable air tube lengths ('A' in inches; See Figure 3.)			
(min-max)		(inches)	6-5/8	9	13	16
For SF Burner Only						
1.25-2.25	F12	2-3/4	SF65VW	SF90VW	SF130VW	SF160VW
1.75-2.75	F22	2-3/4	SF65VP	SF90VP	SF130VP	SF160VP
1.75-3.25	F220	None	SF65FD	SF90FD	SF130FD	SF160FD
2.5-5.5	F310	None	SF65FU	SF90FU	SF130FU	SF160FU
For SM Burner Only						
1.25-2.00	F12	2-3/4	SM65VW	SM90VW	SM130VW	SM160VW
2.00-3.00	F220	None	SM65FF	SM90FF	SM130FF	SM160FF
2.00-3.00	F22	None	SM65VM	SM90VM	SM130VM	SM160VM

Inspect/Prepare Installation Site

• Chimney or vent

- Inspect the chimney or vent, making sure it is properly sized and in good condition for use.
- For those installations not requiring a chimney, such as through-the-wall vented appliances, follow the instructions given by the appliance and power venter (if used) manufacturers.

• Combustion air supply

WARNING **Adequate Combustion and Ventilation Air Supply Required**

Failure to provide adequate air supply could seriously affect the burner performance and result in damage to the equipment, asphyxiation, explosion or fire hazards.

- The burner cannot properly burn the fuel if it is not supplied with a reliable combustion air source.
- Follow the guidelines in the latest editions of the NFPA 31 and CSA-B139 regarding providing adequate air for combustion and ventilation.

See NFPA 31 Standard for complete details.

Appliance located in confined space

The confined space should have two (2) permanent openings: one near the top of the enclosure and one near the bottom of the enclosure. Each opening shall have a free area of not less than (1) one square inch per 1,000 BTU's per hour of the total input rating of all appliances within the enclosure. The openings shall have free access to the building interior, which should have adequate infiltration from the outside.

Exhaust fans and other air-using devices

Size air openings large enough to allow for all air-using devices in addition to the minimum area required for combustion air. If there is any possibility of the equipment room developing negative pressure (because of exhaust fans or clothes dryers, for example), either pipe combustion air directly to the burner or provide a sealed enclosure for the burner and supply it with its own combustion air supply.

- **Clearances to burner and appliance**

  - Provide space around burner and appliance for easy service and maintenance.
  - Check minimum clearances against those shown by the appliance manufacturer and by applicable building codes.

- **Combustion chamber — Burner retrofitting**

  Verify that the appliance combustion chamber provides at least the minimum dimensions given in Table 3.

Table 3. Chamber Dimensions

Chamber Dimensions (inches)					
Firing Rate (GPH)	Round I.D.	Rectangular		Height	Floor to nozzle
		Width	Length		
1.25	11	10	11	12	5-6
1.50	12	11	12	13	6-7
2.00	14	12	15	13	6-7
2.50	16	13	17	14	7-8
3.00	18	14	18	15	7-8
3.50	19	15	19	15	7-8
4.00	20	16	21	16	8-9
5.00	23	18	23	18	9-10
5.50	24	19	24	19	10-11

WARNING **Protect Steel Combustion Chamber From Burnout**

Failure to comply could result in damage to the heating equipment and result in fire or asphyxiation hazards.

- When retrofitting appliances that have unlined stainless steel combustion chambers, protect the chamber by lining the inside surfaces with a ceramic fiber blanket, such as a wet-pac or other suitable refractory material.
- Some steel chambers may not require liners because the appliance was designed and tested for use with flame retention burners. Refer to the manufacturer's instructions.

Prepare the Burner

- **Burner fuel unit**

  Verify that the burner fuel unit is compatible with the oil supply system. For more details, refer to "Connect fuel lines" later in this manual.

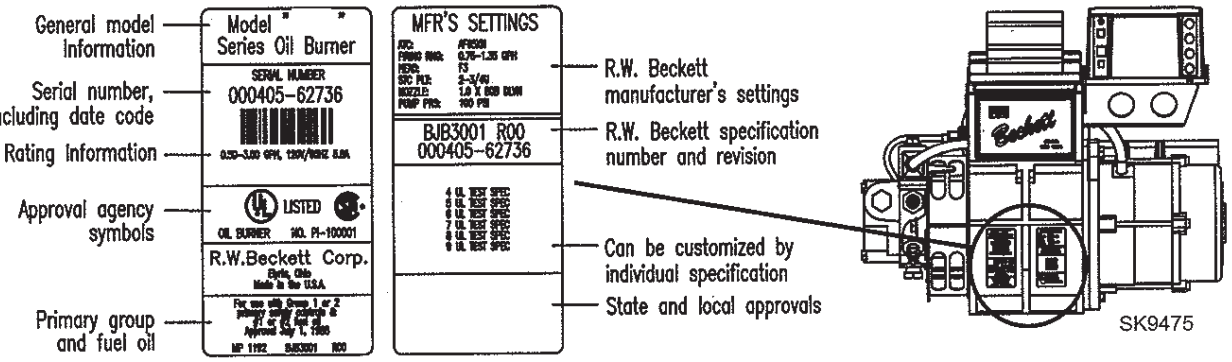
- **Attach air tube** (if not already installed)

  If using a flange and gasket, slide them onto the air tube. Then attach the air tube to the burner chassis using the four sheet metal screws provided. Refer to Figure 3 for details.

- **Install burner nozzle** (if not already installed)

1. Remove the plastic plug protecting the nozzle adapter threads
2. Place a ¾" open-end wrench on the nozzle adapter. Insert the nozzle into the adapter and finger tighten. Finish tightening with a ⅝" open-end wrench. Use care to avoid bending the electrodes.

Figure 1. Burner Label Location



WARNING Correct Nozzle and Flow Rate Required

Incorrect nozzles and flow rates could result in impaired combustion, under-firing, over-firing, sooting, puff-back of hot gases, smoke and potential fire or asphyxiation hazards.

Use only nozzles having the brand, flow rate (gph), spray angle and pattern specified by the appliance manufacturer.

Follow the appliance manufacturer's specifications for the required pump outlet pressure for the nozzle, since this affects the flow rate.

- Nozzle manufacturers calibrate nozzle flow rates at 100 psig.
- When pump pressures are higher than 100 psig, the actual nozzle flow rate will be greater than the gph stamped on the nozzle body. (Example: A 1.00 gph nozzle at 140 psig = 1.18 gph)

Securely tighten the nozzle (torque to 90 inch pounds). For typical nozzle flow rates at various pressures refer to Table 5.

Table 5. Nozzle Flow Rate by Size

Nozzle flow rate U. S. gallons per hour of No. 2 fuel oil when pump pressure (psig) is:					
Nozzle size (rated at 100 psig)	**125 psi**	**140 psi**	**150 psi**	**175 psi**	**200 psi**
1.25	1.39	1.48	1.53	1.65	1.77
1.35	1.51	1.60	1.65	1.79	1.91
1.50	1.68	1.77	1.84	1.98	2.12
1.65	1.84	1.95	2.02	2.18	2.33
1.75	1.96	2.07	2.14	2.32	2.48
2.00	2.24	2.37	2.45	2.65	2.83
2.25	2.52	2.66	2.76	2.98	3.18
2.50	2.80	2.96	3.06	3.31	3.54
2.75	3.07	3.25	3.37	3.64	3.90
3.00	3.35	3.55	3.67	3.97	4.24
3.25	3.63	3.85	3.98	4.30	4.60
3.50	3.91	4.14	4.29	4.63	4.95
3.75	4.19	4.44	4.59	4.96	5.30
4.00	4.47	4.73	4.90	5.29	-
4.50	5.04	5.32	5.51	-	-
5.00	5.59	-	-	-	-
5.50	-	-	-	-	-

Table 6. Nozzle Spray Angles

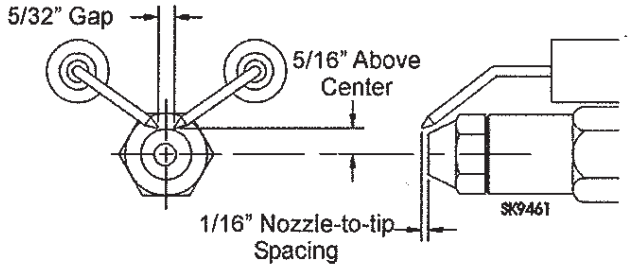
Recommended nozzle spray angles	
"F" head	70°, 80° or 90° nozzle

Note: Always follow the appliance manufacturer's nozzle specification, when available.

3. If the nozzle is already installed, remove the nozzle line assembly to verify that the nozzle size and spray pattern are correct for the application (per appliance manufacturer's information). Verify that the electrode tip settings comply with Figure 2.
4. If the nozzle is not installed, obtain a nozzle having the capacity and spray angle specified in the appliance manufacturer's information. For conversions or upgrades, when information is not available for the application:
   - Refer to Table 6 to select the mid-range nozzle spray angle for the head type being used.
   - Fire the burner and make sure the combustion is acceptable and the flame is not impinging on chamber surfaces.
   - If a shorter flame is needed, select a wider spray angle. If a longer flame is needed, select a narrower spray angle.
   - Either hollow or solid spray patterns may be used. If combustion results are not satisfactory with the selected spray pattern, try the other pattern.

• Check/adjust electrodes

Figure 2. – Electrode Tip Adjustment



Check the electrode tip settings. Adjust if necessary to comply with the dimensions shown in Figure 2. To adjust, loosen the electrode clamp screw and slide/rotate electrodes as necessary. Securely tighten the clamp screw when finished.

• Servicing nozzle line assembly

1. Turn off power to burner before proceeding.
2. Disconnect oil connector tube from nozzle line.
3. Loosen the two screws securing igniter retaining clips and rotate both clips to release igniter baseplate. Then tilt igniter back on its hinge.
4. Remove splined nut.
5. "F" head air tube. - Remove nozzle line assembly from burner, being careful not to damage the electrodes or insulators while handling. To ease removal of long assemblies (over 9 inches), rotate assembly 180° from installed position after pulling partially out of tube.
6. To replace the nozzle assembly, reverse the above steps.

Mount Burner on Appliance

WARNING **Do Not use Adjustable Mounting Flange on Mobile Units**

The shock and vibration could cause loss of burner alignment and insertion problems resulting in flame impingement, heavy smoke, fire and equipment damage.

- Only use specified factory-welded flange and air tube combinations.

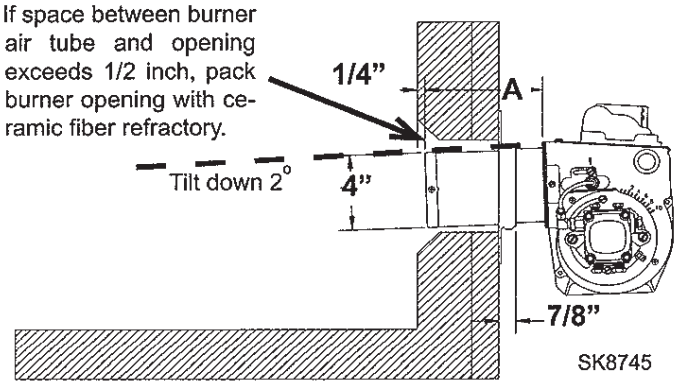
• Mounting options

Bolt the burner to the appliance using the factory-mounted flange or an adjustable flange.

• Mounting dimensions

1. When using the Beckett universal adjustable flange, mount the air tube at a 2° downward pitch unless otherwise specified by the appliance manufacturer.
2. Verify that the air tube installed on the burner provides the correct insertion depth. See Figure 3.
3. The end of the air tube should normally be ¼" back from the inside wall of the combustion chamber. Never allow the leading edge of the head assembly to extend into the chamber, unless otherwise specified by the heating appliance manufacturer. Carefully measure the insertion depth when using an adjustable flange. Verify the insertion depth when using a welded flange.

Figure 3. – Mounting Burner in Appliance



• Connect fuel lines

Carefully follow the fuel unit manufacturer's literature and the latest edition of NFPA 31 for oil supply system specifications.

WARNING **Do Not Install By-pass Plug with 1-Pipe System**

Failure to comply could cause immediate pump seal failure, pressurized oil leakage and the potential for a fire and injury hazard.

- The burner is shipped without the by-pass plug installed. **EXCEPTION**: Unless specified by the equipment manufacturer and noted on the label at top of pump cover.
- Install the by-pass plug in two-pipe oil supply systems ONLY.

CAUTION **Oil Supply Pressure Control Required**

Damage to the filter or pump seals could cause oil leakage and a fire hazard.

- The oil supply inlet pressure to the burner ***cannot exceed 3 psig***.
- Insure that a pressure limiting device is installed in accordance with the latest edition of NFPA 31.
- Do not install valves in the return line. (NFPA 31, Chapter 8)
- **Gravity Feed Systems:** Always install an anit-siphon valve in the oil supply line or a solenoid valve (RWB Part # 2182602U or 2233U) in the pump/nozzle discharge tubing to provide backup oil flow cut-off protection.

Fuel supply level with or above burner –
The burner may be equipped with a single-stage fuel unit for these installations. Connect the fuel supply to the burner with a single supply line if you want a one-pipe system (making sure the bypass plug is NOT installed in the fuel unit.) Manual bleeding of the fuel unit is required on initial start-up. If connecting a two-pipe fuel supply, install the fuel unit bypass plug.

Fuel supply below the level of the burner –
When the fuel supply is more than eight feet below the level of the burner, a two-pipe fuel supply system is required. Depending on the fuel line diameter and horizontal and vertical length, the installation may also require a two-stage pump. Consult the fuel unit manufacturer's literature for lift and vacuum capability.

Check/Adjust 'Z' Dimension for 'F' Heads

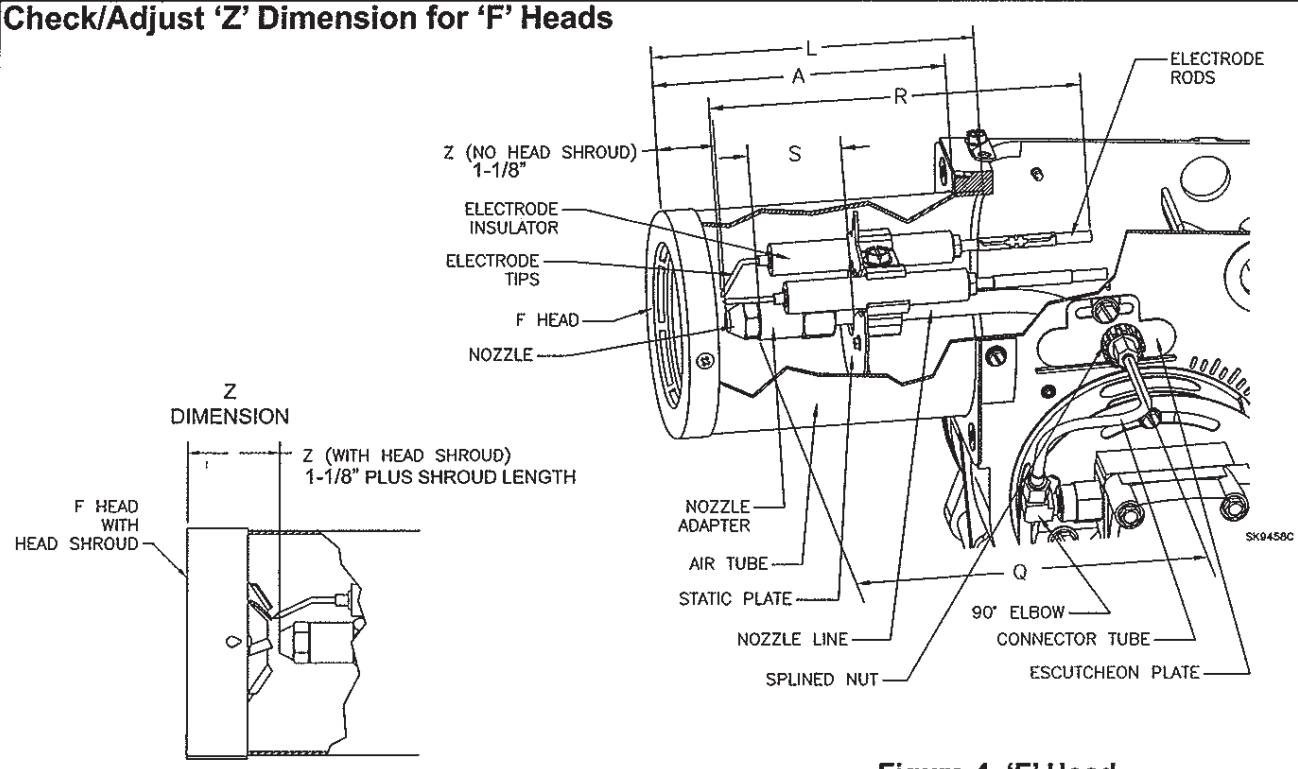


Figure 4. 'F' Head

• Check/Adjust 'Z' Dimension - 'F' heads

WARNING **Adjust the 'Z' dimension to the required specification.**

Incorrect Adjustments could cause combustion problems, carbon deposition from flame impingement, heavy smoke generation and fire hazard.

- Make all adjustments exactly as outlined in the following information.

1. The important 'Z' dimension is the distance from the face of the nozzle to the flat face of the head (or heat shield, if applicable). This distance for F heads is 1-⅛" (1-⅜" if the air tube has a heat shield). The "Z" dimension is factory set for burners shipped with the air tube installed. Even if factory set, verify that the "Z" dimension has not been changed.
2. Use the following procedure to adjust the "Z" dimension, if it is not correct:
   - Turn off power to the burner.
   - Disconnect the oil connector tube from the nozzle line
   - See above figure. Loosen the splined nut from the nozzle line. Loosen the hex head screw securing the escutcheon plate to the burner housing.
   - Place the end of a ruler at the face of the nozzle and, using a straight edge across the head, measure the distance to the face of the head. A Beckett T501 or T650 gauge may also be used.
   - Slide the nozzle line forward or back until the Z dimension for F heads is 1-⅛" (1-1/8" plus shroud length, if using a straight edge).
   - Tighten the hex head screw to secure the escutcheon plate to the burner chassis. Then tighten the splined nut and attach the oil connector tube.
3. Recheck the "Z" dimension periodically when servicing to ensure the escutcheon plate has not been moved. You will need to reset the "Z" dimension if you replace the air tube or nozzle line assembly. The Beckett Z gauge (part number Z-2000) is available to permit checking the F head "Z" dimension without removing the burner from the appliance.

• Burner Dimensions - Models SM & SF

Dimension (inches)	F Head
A = Usable air length (inches)	(Measure accurately)
L (Total tube length)	A+1/2
R (electrode length), ± 1/4	A+2-1/4
S (adapter to static plate), ± 1/16	(Note 1)
Q (nozzle line length),	A+ 15/16
Z (F head w/o head shroud) (F head-with head shroud)	1-1/8 1-1/8 + shroud length. (Note 2)

Note 1: 1-3/8 for dimension A less than 4"; 1-5/8 for dimension A from 4" through 4-1/2 ", 2-13/32 for dimension A greater than 4-1/2".
Note 2: When using a straight edge.

Fuel line installation –

CAUTION Do Not Use Teflon Tape

Damage to the pump could cause impaired burner operation, oil leakage and appliance soot-up.

- Never use Teflon tape on fuel oil fittings.
- Tape fragments can lodge in fuel line components and fuel unit, damaging the equipment and preventing proper operation.
- Use of Teflon tape will void the Suntec warranty.
- Use oil-resistant pipe sealant compounds.

Continuous lengths of heavy wall copper tubing are recommended. **Always use flare fittings. Never use compression fittings.**

- Always install fittings in accessible locations. Proper routing of fuel lines is required to prevent air cavitation and vibration.

Fuel line valve and filter –

- Install two high quality fusible-handle design shut-off valves in accessible locations on the oil supply line to comply with the NFPA 31 Standard and authorities having jurisdiction. Locate one close to the tank and the other close to the burner, upstream of the filter.
- Install a generous capacity filter inside the building between the fuel tank shutoff valve and the burner, locating both the filter and the valve close to the burner for ease of servicing. Filter should be rated for 50 microns or less.

Wire Burner

WARNING Electrical Shock Hazard

Electrical shock can cause severe personal injury or death.

- Disconnect electrical power before installing or servicing the burner.
- Provide ground wiring to the burner, metal control enclosures and accessories. (This may also be required to aid proper control system operation.)
- Perform all wiring in compliance with the National Electrical Code ANSI/NFPA 70 (Canada CSA C22.1)

• Burner packaged with appliance

Refer to appliance manufacturer's wiring diagram for electrical connections.

• Burner installed at jobsite

Refer to Figure 5, for typical burner wiring, showing cad cell primary controls. Burner wiring may vary, depending on primary control actually used.

The R7184 primary control with valve-on delay (prepurge) and burner motor-off delay (postpurge), requires a constant 120 volts AC power source supplied to the BLACK wire on the control. The RED wire goes to the appliance limit circuit. Please note that other control manufacturers may use different wire colors for power and limit connections.

Start Up Burner/Set Combustion

WARNING Explosion and Fire Hazard

Failure to follow these instructions could lead to equipment malfunction and result in heavy smoke emission, soot-up, hot gas puff-back, fire and asphyxiation hazards.

- Do not attempt to start the burner when excess oil has accumulated in the appliance, the appliance is full of vapor, or when the combustion chamber is very hot.
- Do not attempt to re-establish flame with the burner running if the flame becomes extinguished during start-up, venting, or adjustment.
- Vapor-Filled Appliance: Allow the unit to cool off and all vapors to dissipate before attempting another start.
- Oil-Flooded Appliance: Shut off the electrical power and the oil supply to the burner and then clear all accumulated oil before continuing.
- If the condition still appears unsafe, contact the Fire Department. Carefully follow their directions.
- Keep a fire extinguisher nearby and ready for use.

1. Open the shutoff valves in the oil supply line to the burner.
2. If the air control is not preset, close air band and partially open air shutter. This is an initial air setting for the pump bleeding procedure only. Additional adjustments must be made with instruments to prevent smoke and carbon monoxide generation.
3. Set the thermostat substantially above room temperature.

Typical Burner Wiring & Burner Sequence of Operation for R7184 Control.

Refer to the appliance manufacturer's wiring diagram for actual specifications.

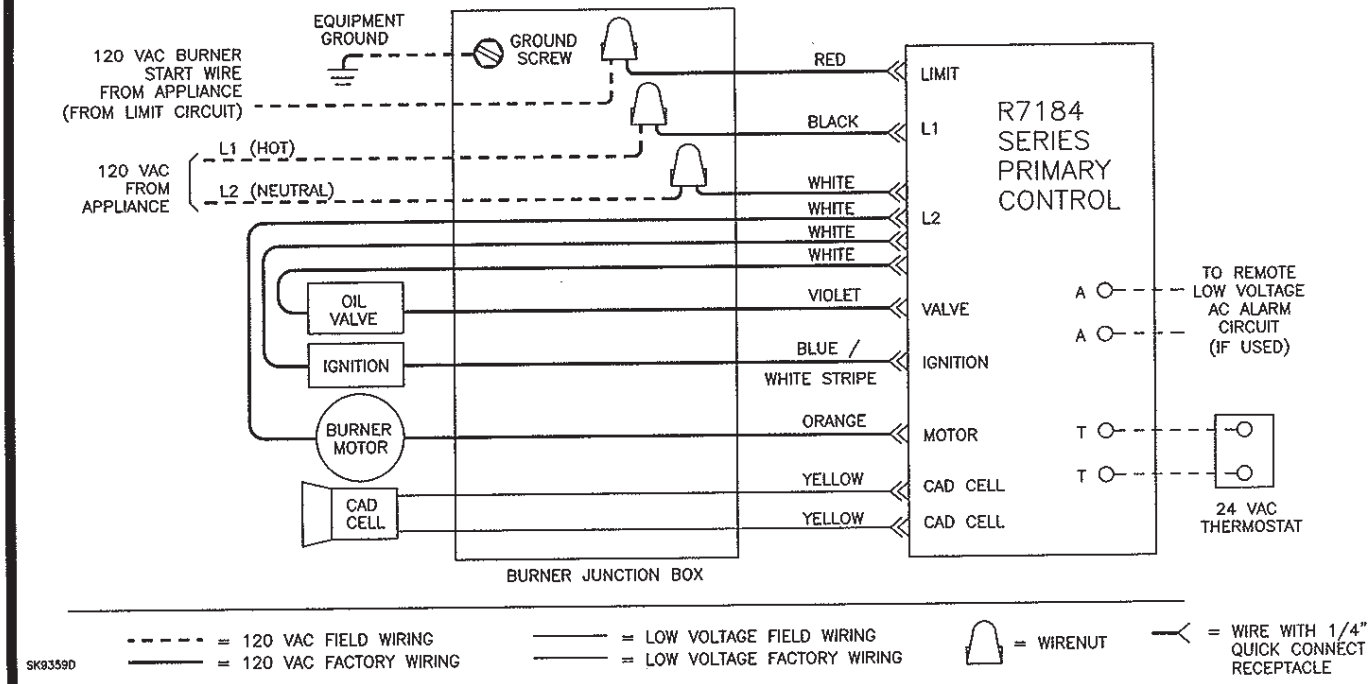
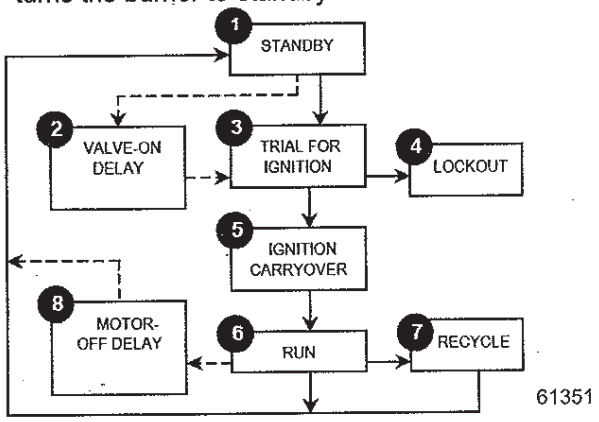


Figure 5. – Typical Burner Wiring

1. **STANDBY.** The burner is idle, waiting for a call for heat. When a call for heat is initiated, there is a 3-10 second delay while the control performs a safe start check.
2. **VALVE-ON DELAY.** The ignition and motor are turned on for a 15 second valve-on delay.
3. **TRIAL FOR IGNITION (TFI).** The fuel valve is opened. A flame should be established within the 15 second lockout time.
4. **LOCKOUT.** If flame is not sensed by the end of the TFI, the control shuts down on safety lockout and must be manually reset. If the control locks out three times in a row, the control enters restricted lockout.
5. **IGNITION CARRYOVER.** Once flame is established, the ignition remains on for 10 seconds to ensure flame stability before turning off. If the control is wired for intermittent duty ignition, the ignition unit stays on the entire time the motor is running.
6. **RUN.** The burner runs until the call for heat is satified. The burner is then sent to burner motor off delay, if applicable, or it is shut down and sent to standby.
7. **RECYCLE.** If the flame is lost while the burner is firing, the control shuts down the burner, enters a 60 second recycle delay, and then repeats the above ignition sequence. If flame is lost three times in a row, the control locks out to prevent cycling with repetitious flame loss due to poor combustion.
8. **BURNER MOTOR-OFF DELAY.** The fuel valve is closed and the burner motor is kept on for the selected motor-off delay time before the control returns the burner to standby.



Control System Features

Feature	Interrupted ignition	Limited reset, Limited recycle	Diagnostic LED, cad cell indicator	Valve-on delay	Burner motor off delay	Alarm Contacts
R7184A	YES	YES	YES	—	—	—
R7184B	YES	YES	YES	YES	—	—
R7184P	YES	YES	YES	YES	YES	Optional

4. Close the line voltage switch to start the burner. If the burner does not start immediately you may have to reset the safety switch of the burner primary control.
5. Bleed air from fuel unit as soon as burner motor starts rotating.
   - To bleed the fuel unit, attach a clear plastic hose over the vent fitting. Loosen the fitting and catch the oil in an empty container. Tighten the fitting when all air has been purged from the oil supply system.
   - If the burner locks out on safety during bleeding, reset the safety switch and complete the bleeding procedure. Note — Electronic safety switches can be reset immediately; others may require a three- to five-minute wait.
   - If burner stops after flame is established, additional bleeding is probably required. Repeat the bleeding procedure until the pump is primed and a flame is established when the vent fitting is closed.
   - For R7184 primary controls, see Technician's Quick Reference Guide, part number 61351 for special pump priming sequence.
   - Prepare for combustion tests by drilling a ¼" sampling hole in the flue pipe between the appliance and the barometric draft regulator.
6. Initial air adjustment — Test the flue gas for smoke. Adjust the air shutter (and air band, if necessary) to obtain a clean flame. Now the additional combustion tests with instruments can be made

• Set combustion with instruments

1. Allow the burner to run for approximately 5 to 10 minutes.
2. Set the stack or over-fire draft to the level specified by the appliance manufacturer.
   - **Natural Draft Applications;** typically over-fire draft is -0.01" or -0.02" w.c.
   - **Direct Venting**; typically may not require draft adjustment.
   - **High Efficiency/Positive Pressure Appliances**; also vary from traditional appliances (see manufacturer's recommendations).
3. Follow these four steps to properly adjust the burner:
   Step 1: Adjust the air shutter/band until a trace of smoke is achieved.
   Step 2: At the trace of smoke level, measure the CO_2 (or O_2) . This is the vital reference point for further adjustments. Example: 13.5% CO_2 (2.6% O_2)
   Step 3: Increase the air to reduce the CO_2 by 1.5 to 2 percentage points. (O_2 will be increased by approximately 2.0 to 2.7 percentage points.) Example: Reduce CO_2 from 13.5% to 11.5% (2.6% to 5.3% O_2).
   Step 4: Recheck smoke level. It should be Zero.
      - This procedure provides a margin of reserve air to accommodate variable conditions.
      - If the draft level has changed, recheck the smoke and CO2 levels and readjust the burner, if necessary
4. Once combustion is set, tighten all fasteners on air band, air shutter and escutcheon plate.
5. Start and stop the burner several times to ensure satisfactory operation. Test the primary control and all other appliance safety controls to verify that they function according to the manufacturer's specifications.

Perform Regular Maintenance

WARNING **Annual Professional Service Required**

Tampering with or making incorrect adjustments could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- Do not tamper with the burner or controls or make any adjustments unless you are a trained and qualified service technician.
- To ensure continued reliable operation, a qualified service technician must service this burner annually.
- More frequent service intervals may be required in dusty or adverse environments.
- Operation and adjustment of the burner requires technical training and skillful use of combustion test instruments and other test equipment.

- ❒ Replace the oil supply line filter. The line filter cartridge must be replaced to avoid contamination of the fuel unit and nozzle.
- ❒ Inspect the oil supply system. All fittings should be leak-tight. The supply lines should be free of water, sludge and other restrictions.
- ❒ Remove and clean the pump strainer if applicable.
- ❒ Replace the nozzle with the exact brand, pattern, gph flow rate and spray angle..
- ❒ Clean and inspect the electrodes for damage, replacing any that are cracked or chipped.
- ❒ Check electrode tip settings. Replace electrodes if tips are rounded.
- ❒ Inspect the igniter spring contacts.
- ❒ Clean the cad cell lens surface, if necessary.
- ❒ Inspect all gaskets. Replace any that are damaged or would fail to seal adequately.
- ❒ Inspect the combustion head and air tube. Remove any carbon or foreign matter. Replace all damaged units with exact parts.
- ❒ Clean the blower wheel, air inlet, air guide, burner housing and static plate of any lint or foreign material.
- ❒ If motor is not permanently lubricated, oil motor with a few drops of SAE 20 nondetergent oil at each oil hole. DO NOT over oil motor. Excessive oiling can cause motor failure.
- ❒ Check motor current. The amp draw should not exceed the nameplate rating.
- ❒ Check all wiring for secure connections or insulation breaks.
- ❒ Check the pump pressure and cutoff function.
- ❒ Check primary control safety lockout timing.
- ❒ Check ignition system for proper operation.
- ❒ Inspect the vent system and chimney for soot accumulation or other restriction.
- ❒ Clean the appliance thoroughly according to the manufacturer's recommendations.
- ❒ Check the burner performance. Refer to the section "Set combustion with test instruments".
- ❒ It is good practice to make a record of the service performed and the combustion test results.

• Replacing the blower wheel:

- When replacing the blower wheel, insure that the wheel is centered between the two sides of the burner housing as shown below.

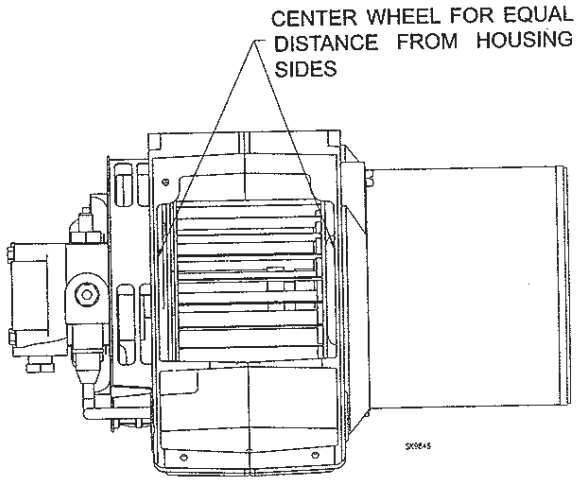
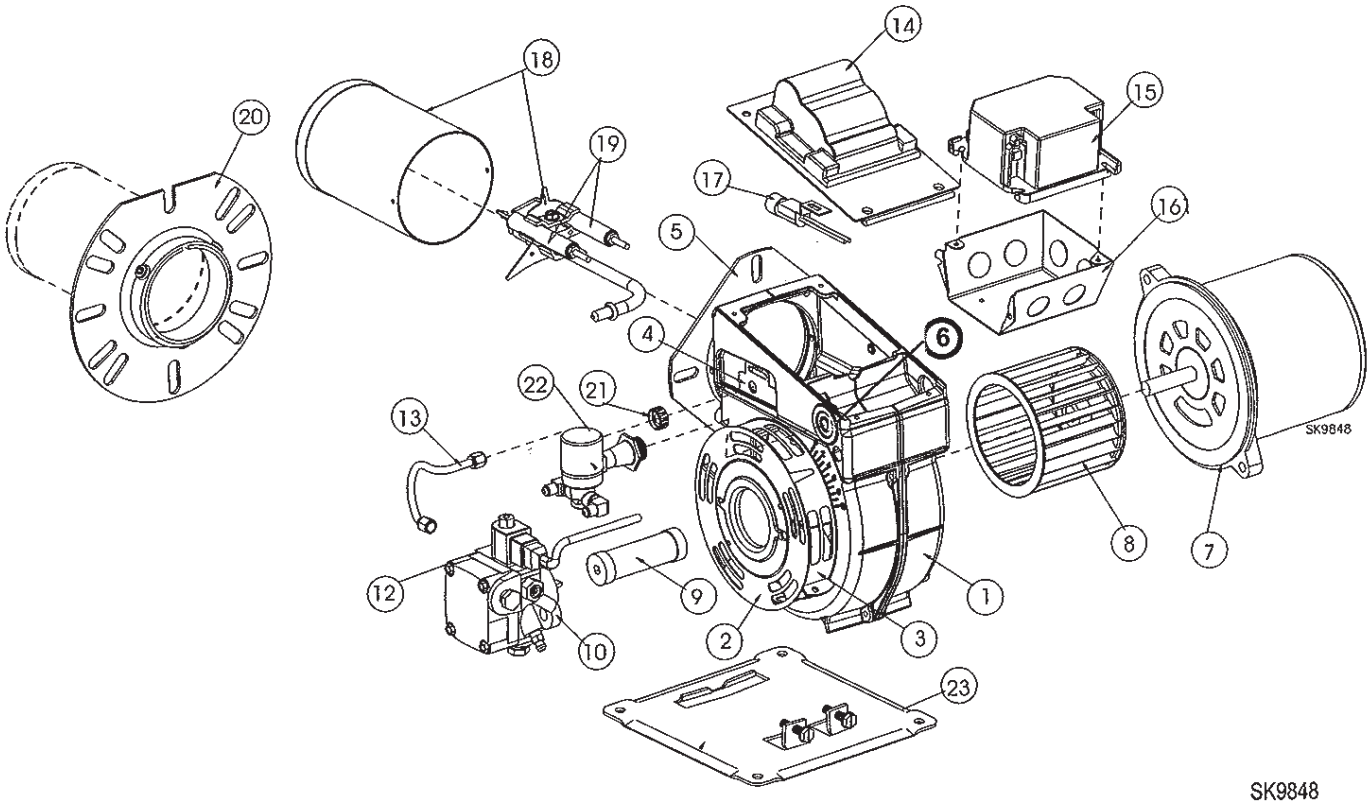


Figure 6. Blower Wheel Assembly

Burner Parts Diagram



SK9848

#	Part No.	Description
1		Burner Housing Assembly with Inlet Bell
2	3215	Air shutter, 10 Slot
3	3819	Bulk Air Band, 10 Slot
4	3493	Nozzle-line Escutcheon Plate
5	Specify ** 3399	Unit Flange or Square Plate
Not Shown	3416	Air Tube Gasket
6	2139	Hole Plug - Wiring Box
7	2900U 2364U	Drive Motor, 1/5 HP (SM Models) Drive Motor, 1/4 HP (SF Models)
8	2383U	Blower Wheel (6-1/4 X 3-7/16)
9	2433	Flexible Coupling (Fits 5/16" pump shaft)
10	 2591U 21188U	Fuel Units SF only Single-Stage 'A' Two-Stage 'B'
10	 2184404U 2460	Fuel Units SM only CleanCut Single-Stage 'A'
12	2256	Pump outlet fitting
	482	Pump holding screws (not shown)
13	5394	Connector tube assembly, pump to nozzle line

#	Part No.	Description
14	51824U	Igniter and Base Plate
14	2289U	Ignition Transformer (10,000 V/23mA)
15	7455U	R7184A - Interrupted Ignition
	7456U	R7184B - Pre-purge
	7457U	R7184P - Pre and Post-purge
	7458U	R7184P w/ Alarm Contacts
16	5770	Electrical Box
17	7006U	Cad Cell Detector
18	Specify **	Air Tube Combination
19	5780	Electrode Kit - F Head up to 9"
	5782	Electrode Kit - F Head over 9"
20	5432 3616	Universal Flange w/ Gasket Gasket Only
21	3666	Splined Nut
22	2182602U	Blocking Oil Solenoid Valve
23	5685	Base Pedestal Kit

** Contact your Beckett Representative for part number and pricing.

AIR MAKE-UP UNITS

AMU Series

Construction

Welded steel housing finished in grey enamel.

Application

Available in a wide range of sizes handling 75 c.f.m. to 1100 c.f.m.

Designed to use as Air Replacement and Air Make-Up Units, for permanent installation.

To exhaust foul air and replace with fresh outside air.

By drawing on its wide range of tooled, standard parts, **Airdex** engineers can design a blower to meet your specific needs whether high or low air flow. AC motors, high or low resistance, single or double inlet.

Performance Data

			Air Delivery (CFM) at R.P.M. Specified							
Description	H.P.	R.P.M.	Free Air	1/8" SP	1/4" SP	3/8" SP	1/2" SP	3/4" SP	1" SP	1 1/4" SP
AMU 75	1/60	3000	75	61	54	43	-	-	-	-
AMU 130	1/70	1550	130	107	87	30	-	-	-	-
AMU 160	1/40	1600	165	150	135	120	104	-	-	-
AMU 245	1/20	1550	245	225	210	190	162	-	-	-
AMU 265	1/20	1610	265	250	233	215	185	-	-	-
AMU 400	1/12	1550	400	380	365	340	315	200	-	-
AMU 465	1/15	1530	465	430	397	357	308	-	-	-
AMU 525	1/4	1725	525	500	480	460	420	240	120	-
AMU 625	1/4	1725	625	600	560	540	500	420	280	100
AMU 845	1/2	1725	845	825	790	760	730	650	570	425
AMU 1100	1/3	1140	1100	1050	1000	950	B60	700	-	-

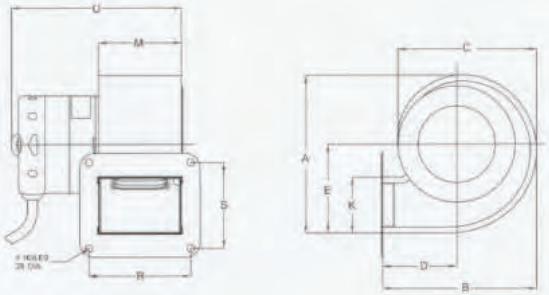
Tested by The Nozzle Chamber Method as directed in A.M.C.A. Bulletin #210. Figure #4.

Features

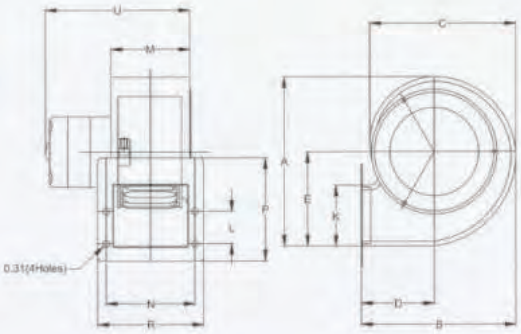
115 Volt, 60 Hz

- Thermal overload protection
- Conduit wiring box
- Permanently lubricated bearings
- Horizontal or vertical operation
- Counter clockwise rotation drive side
- AMU 245, 400, 525, 625, 845 and 1100 supplied with inlet collars.
- Sleeve bearings with oilers
- 4 discharge positions

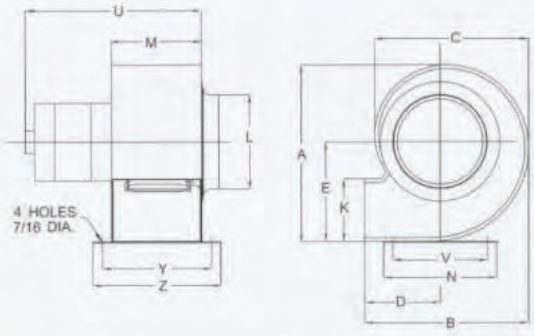
Specification Charts



Description	A	B	C	D	E	K	M	R	S	U	Weight (lbs)
AMU 75	5.34	5.17	4.68	2.50	3.02	1.92	2.75	3.38	2.88	5.35	3.4
AMU 130	7.59	7.09	6.58	3.31	4.30	2.72	3.75	4.69	3.75	6.75	4

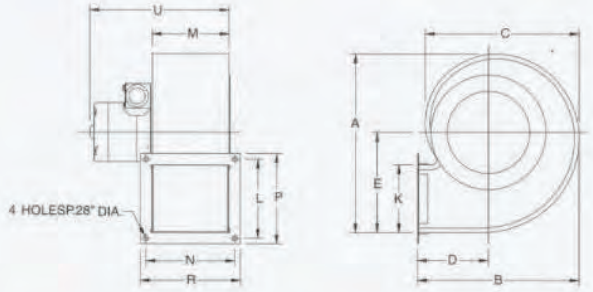


Description	A	B	C	D	E	K	L	M	N	P	R	U	Weight (lbs)
AMU 160	7.80	7.08	6.69	3.34	4.34	2.80	1.50	3.60	4.05	4.75	4.85	6.40	5.4

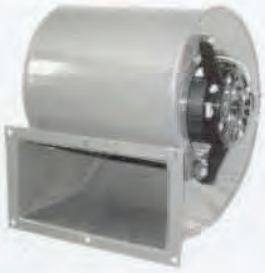


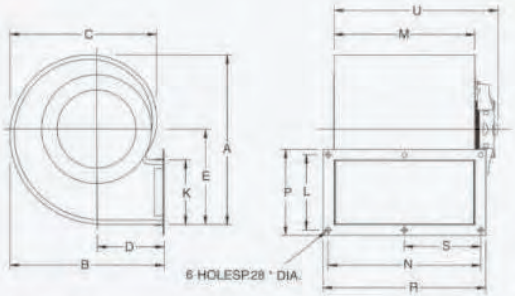
Description	A	B	C	D	E	K	L	M	N	U	V	Y	Z	Weight (lbs)
AMU 245	9.41	8.73	8.17	4.0	5.33	3.36	5.0	4.75	6.0	9.0	5.0	5.75	6.75	8
AMU 400	10.61	9.76	9.24	4.44	6.01	3.79	6.0	5.25	6.0	10.75	5.0	6.25	7.25	13

Specification Charts

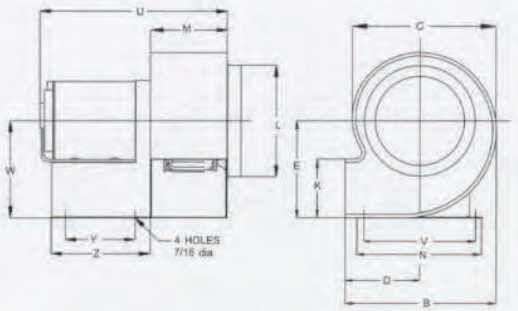


Description	A	B	C	D	E	K	L	M	N	P	R	S	U	Weight (lbs)
AMU 265	9.93	9.0	8.46	3.9	5.55	3.75	4.37	4.22	4.87	5.0	5.5	-	7.65	8.05



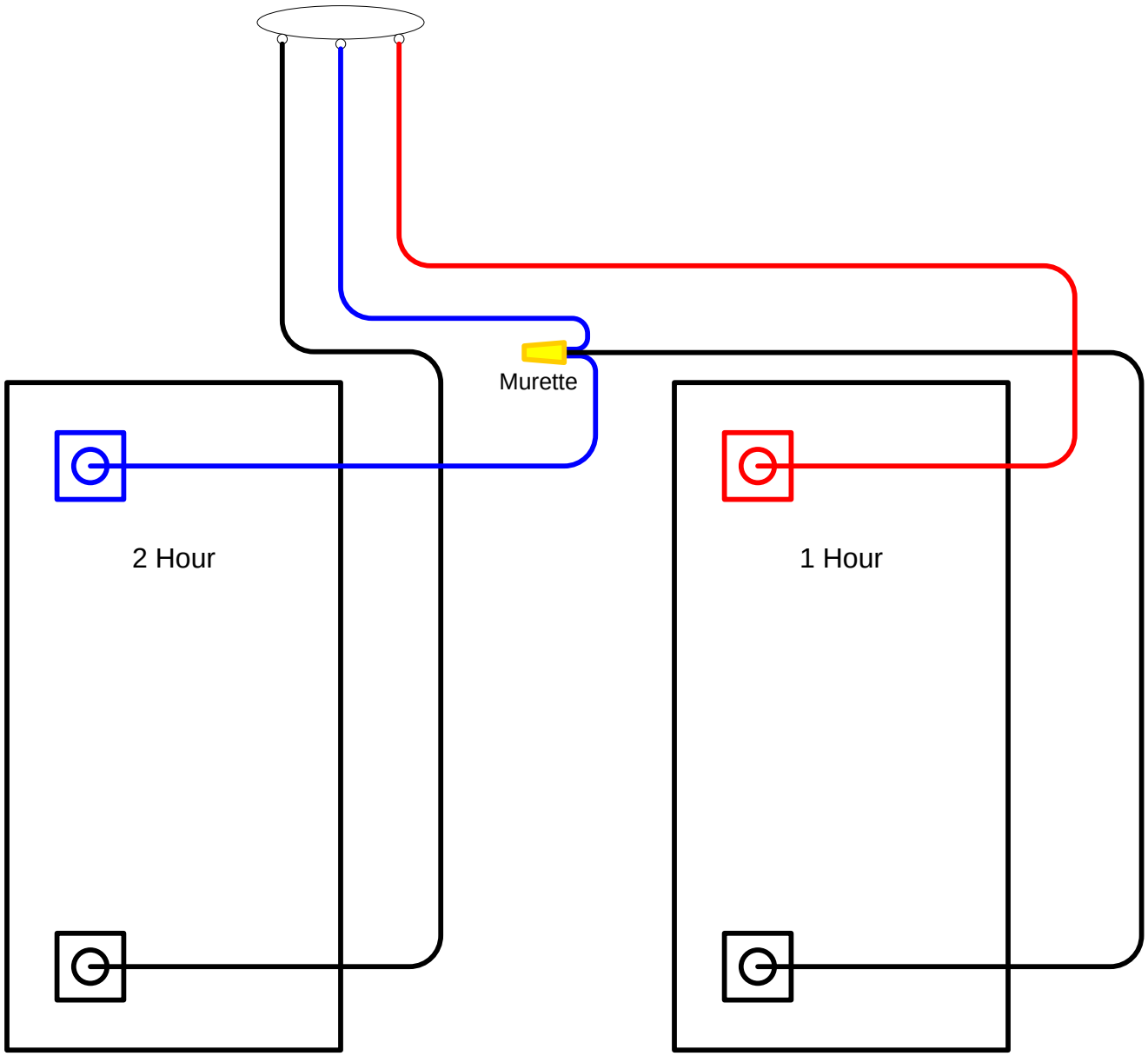


Description	A	B	C	D	E	K	L	M	N	P	R	S	U	Weight (lbs)
AMU 465	9.93	9.0	8.46	3.9	5.55	3.75	4.37	8.12	8.82	5.0	9.4	4.41	9.46	11.0



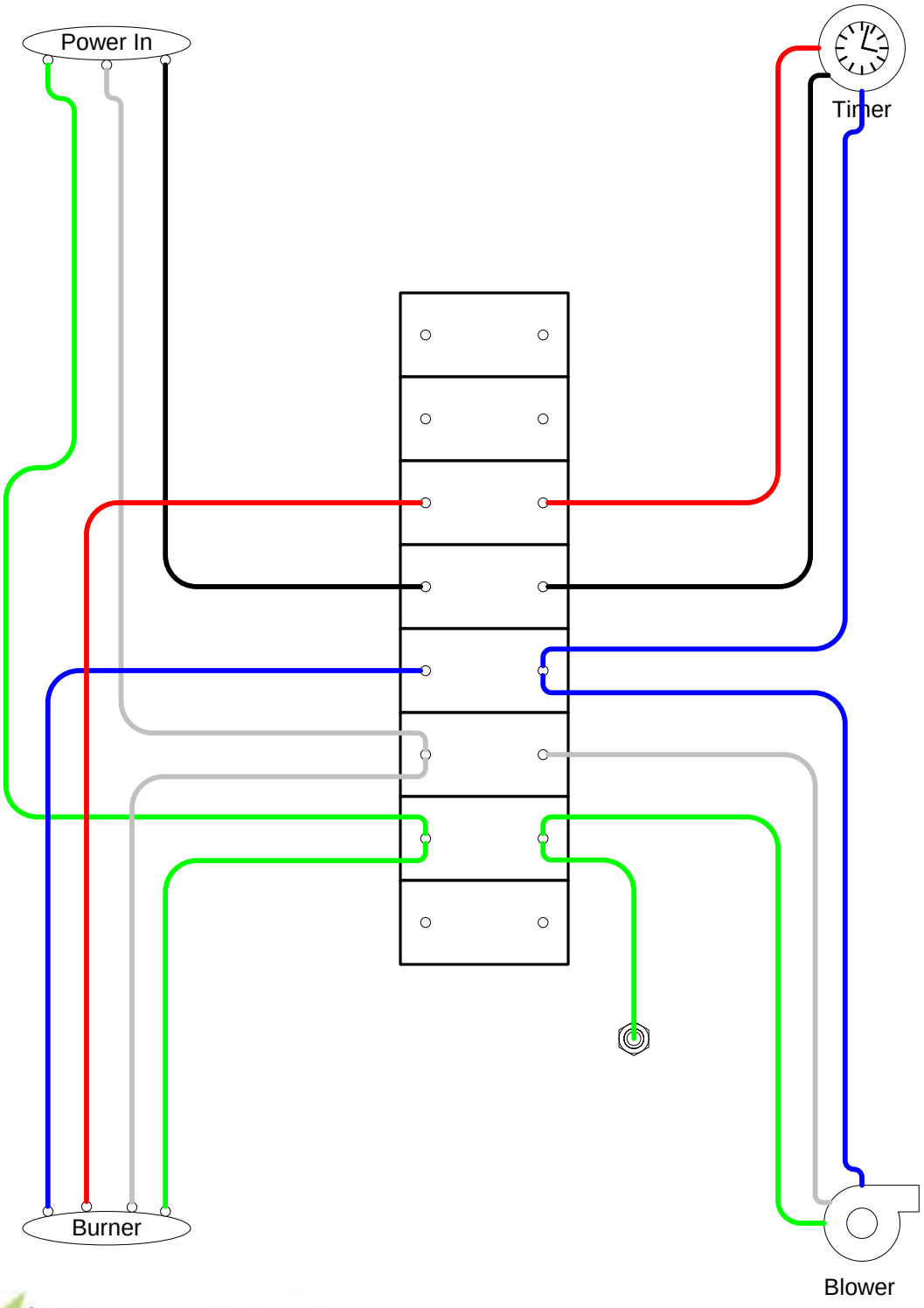
Description	A	B	C	D	E	K	L	M	N	U	V	W	Y	Z	Weight (lbs)
AMU 525	11.91	10.85	10.36	4.88	6.98	4.24	8.0	5.5	9.0	13.6	8.0	7. 23	5.0	7.02	24
AMU 625	11.91	10.85	10.36	4.88	6.98	4.24	8.0	6.0	9.0	14.1	8.0	7.23	5.0	7.02	24
AMU 845	13.43	12.19	11.66	5.44	7.60	4.76	8.0	6.0	9.0	14.8	8.0	7.85	5.0	7.02	30
AMU 1100	16.58	14.62	14.06	6.34	9.51	6.28	9.0	7.0	9.0	16.6	8.0	9.81	5.0	7.02	53

Cyclonator Timers
Wiring
CY-1020/1050 FA”D”
CY-2020/2050 FA”D”



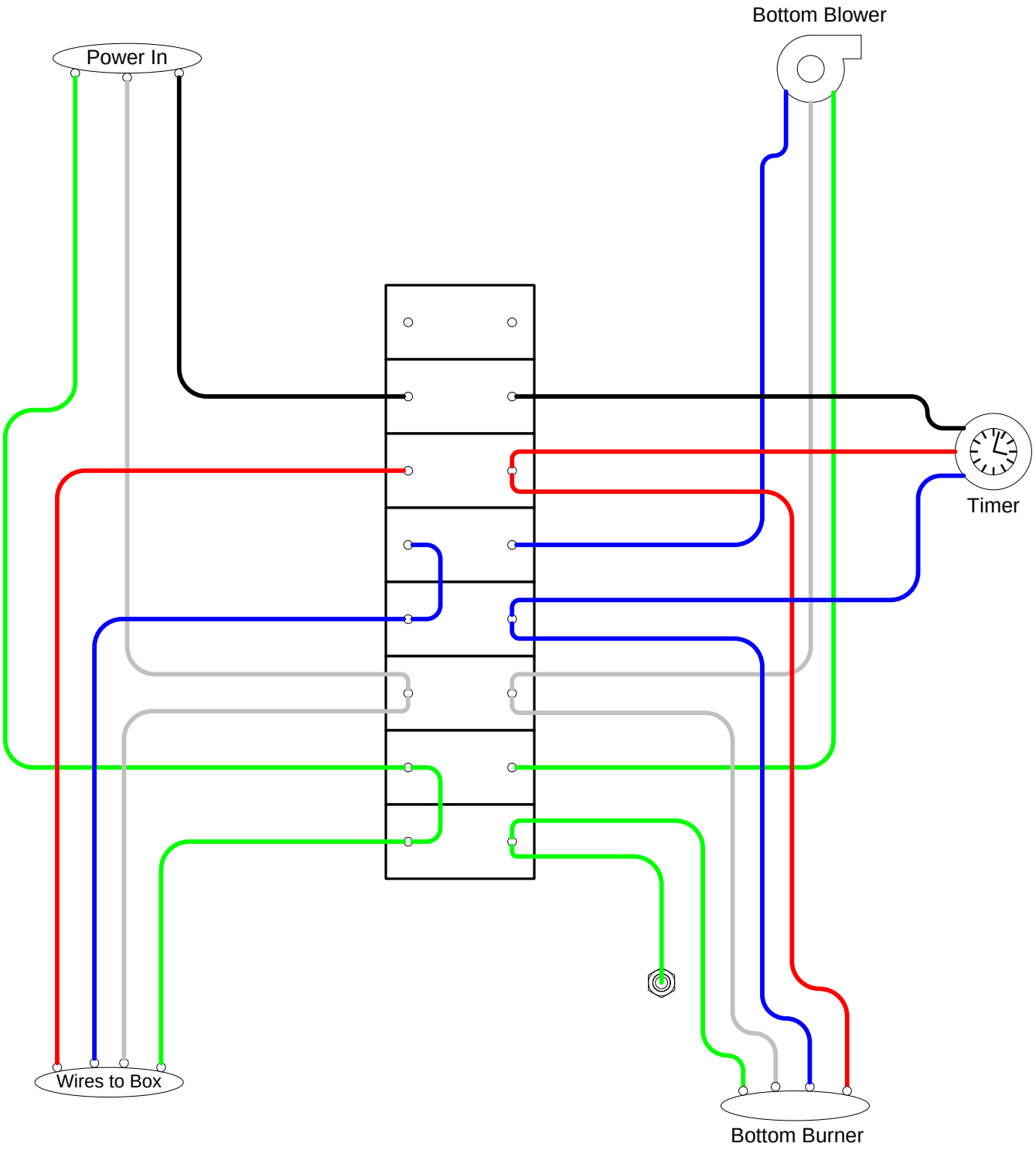
WESTLAND
ENVIRONMENTAL
SERVICES INC.

Burner Wiring (Beckett)
CY-1020/1050 FA”D”



WESTLAND
ENVIRONMENTAL
SERVICES INC.

Wiring (Beckett)
CY-2020/2050 FA”D”
Bottom Box



Burner Wiring (Beckett)
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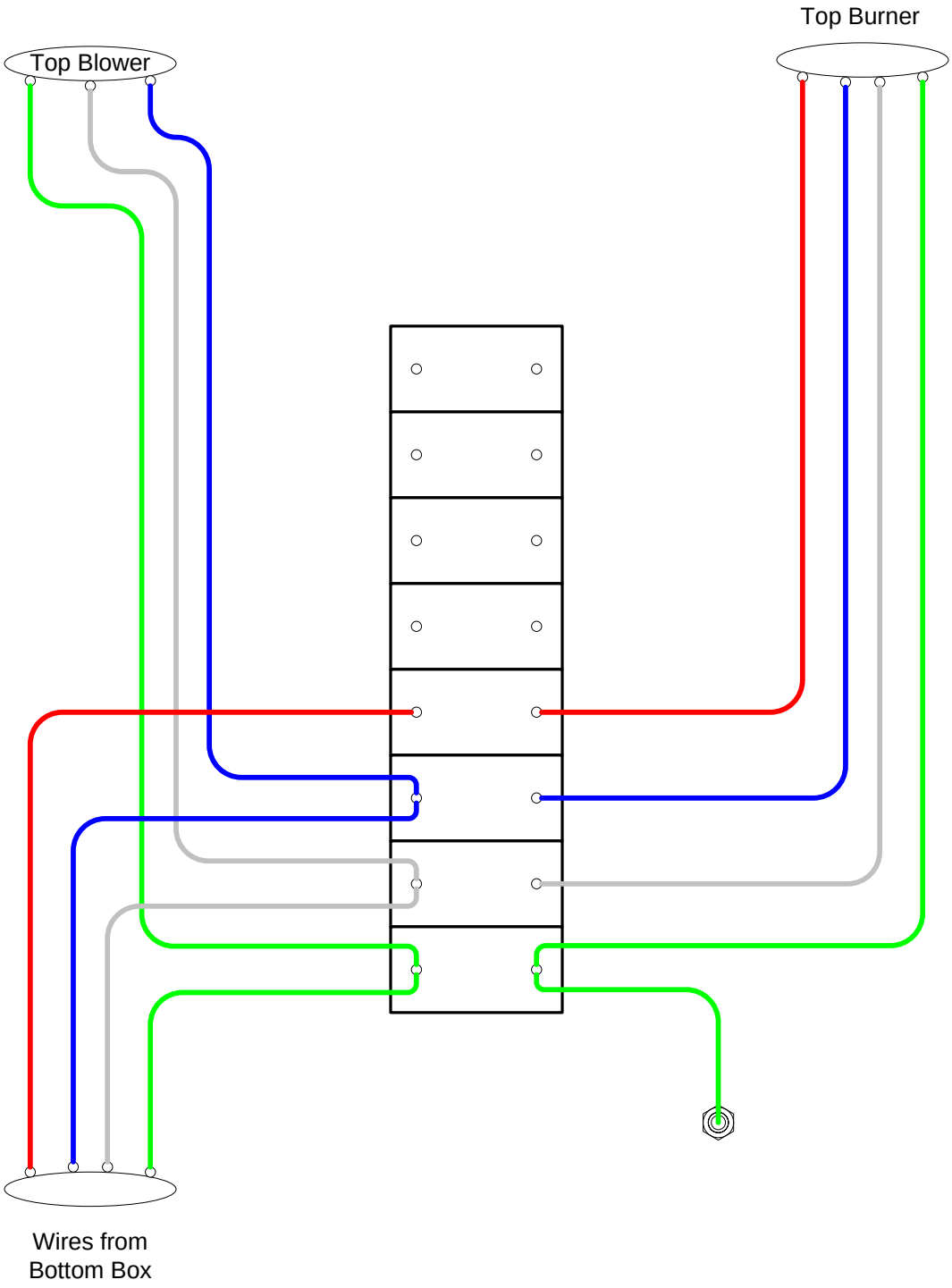
Top Box



WESTLAND
ENVIRONMENTAL
SERVICES INC.

INCINERATOR MANAGEMENT PLAN

MODULE B: WINDY

Conformity Table

Licence	Part	Item	Topic	Report Section
2BE-HOP1222	D	3	The Licensee is authorized to dispose of all acceptable food waste, paper waste and untreated wood products in an incinerator.	Main Document and this Module

B1. Introduction

The Type B Water Licence No. 2BE-HOP1222 issued to TMAC by the Nunavut Water Board (NWB) for the Regional Exploration Program allows the incineration of approved waste streams.

Old Windy Camp was closed for operations in 2008 and is undergoing closure and reclamation. A New Windy Camp is permitted under the current water licence, but has not yet been constructed. No domestic wastes are produced at Windy Camp and there is no incinerator operated under this Licence. Waste produced in support of the Regional Exploration surface drilling program or generated during water management and licence compliance activities executed under this licence is transported to Doris Camp and managed as part of the Doris Camp waste stream. This waste undergoes the same comprehensive sort-at-source and segregation processes as domestic wastes generated at the Doris Camp. Waste is collected and transferred to the centralized waste management area at Robert Bay for timely incineration.

The Incinerator Management Plan has been prepared and is being submitted by TMAC to address the requirement specified in Part G, Item 5 of the 2AM-DOH1323 Water Licence, and also includes the plan for incineration throughout the Hope Bay belt. The plan addresses all relevant aspects of waste stream management, and the operation, maintenance and monitoring of incinerator units used to burn permitted wastes. The plan includes the management and disposal of all residual ash waste generated by the operation of the incinerator.

B1.1 BACKGROUND

B1.1.1 Overview of Windy Incineration Compliance

Domestic waste is not produced at Windy Camp and is managed as part of the Doris Camp waste stream. Incineration at Doris North, under the prior project owner, was demonstrated to comply with the relevant Canada-wide Standards for incinerator emissions, through effective waste segregation and efficient burn practices. It is the aim of TMAC to continue implementing the practices that reduce the probability of formation of pollutant compounds during waste incineration.

B2. Incinerator Management at Windy

There is no incinerator operated at Windy Camp at this time.

B3. Monitoring and Evaluation

TMAC is required to report a summary of waste disposal activities in the 2BE-HOP1222 Licence Annual Report by March 31 of each year. No wastes are currently deposited under the 2BE-HOP1222 Licence. All incinerator monitoring is reported under the 2AM-DOH1323 Licence Annual Report.

Records of materials deposited to the landfill (when constructed), including qualifying incinerator ash, will be reported annually to the NWB per the relevant requirements of the Licence.

INCINERATOR MANAGEMENT PLAN

MODULE C: BOSTON AND MADRID

Conformity Table

To be updated following issuance of applicable permits and licences.

C1. Introduction

For the purposes of the Phase 2 Project, existing incineration facilities at Doris will be used as described in the Module A above, with incineration of wastes generated at Madrid and Doris, and, as a contingency, from Boston.

Incineration facilities will also be established used at Boston, and are described herein. Management Procedures for the Boston facilities during active mining will align with those undertaken at Doris, and as such the below module is a direct reflection of the existing Doris Module attached to the April 2016 Incinerator Management Plan.

C2. Incinerator Management at Boston

Two dual chamber controlled air incinerators will be used for incineration at Boston, these provide contingency for maintenance or repair. Both incinerator units will be CY-2050-A-FA models with a capacity of burning 75 kg of waste per hour or similar.

Waste management at Boston will involve the same comprehensive sort-at-source and segregation of domestic wastes generated, return of all food waste attractants from remote worksites to the domestic waste stream, and collection of wastes for transfer to the centralized waste management area at Boston for timely incineration.

C3. Monitoring and Evaluation

TMAC will conduct and report on Annual Incinerator Stack Testing conducted as prescribed under the CWS for Dioxins and Furans, and the CWS for Mercury. A third-party consultant will be contracted to conduct the test.

Bottom ash for incinerators will be sampled as outlined in Section 2.5.1 of the main body of this Incinerator Management Plan.

Records of materials deposited in the landfill (when constructed), including qualifying incinerator ash, will be maintained and reported as per any relevant requirements.

Annex 17

Hope Bay Project Quarry Management and Monitoring Plan

Hope Bay Project
Quarry Management and Monitoring Plan – Revision 02

Prepared for

TMAC Resources Inc.

Prepared by

SRK Consulting (Canada) Inc.
1CT022.001
December 2014

Hope Bay Project
Quarry Management and Monitoring Plan – Revision 02

December 2014

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Project No: 1CT022.001

File Name: Quarry_ManagementPlan_Report_1CT022.001_LNB_KSS_20141211.docx

Table of Contents

1 Introduction 4
2 Background 8
2.1 Regulatory Approvals 8
2.2 Quarry Development and All-Season Road Construction 8
3 Quarry Management 10
3.1 Pre-Development 10
3.1.1 Quarry Material Characterization 10
3.1.2 Archaeology Survey 10
3.1.3 Notification of Intent to Enter Quarry Lands 11
3.2 Operations 11
3.2.1 Residual Explosives 11
3.2.2 Blast Management 12
3.2.3 Precipitation/Snow Melt Water Management 12
3.2.4 Dust Management 14
3.2.5 Materials Quarried and Removed 14
3.2.6 Equipment Re-fuelling 14
3.3 Post-Operations 14
4 Operational Inspections and Monitoring 16
4.1 Quarry Operations 16
4.1.1 Quarry Visual Inspections 16
4.1.2 Quarry Rock Sampling 16
4.1.3 Quarry Sump Monitoring 17
4.1.4 Blast Vibration Monitoring 18
4.1.5 Dust 18
4.2 Infrastructure and All-Weather Roads 18
4.2.1 Visual Inspection 18
5 Post-Construction Inspections and Monitoring 19
5.1 Quarry 19
5.2 Infrastructure and All-Weather Roads 19
5.2.1 Road Seep Survey and Sampling 19
5.2.2 Road Material Sampling 20
5.2.3 Infrastructure Seep Survey and Sampling 21
5.2.4 Contingency - Inappropriate Construction Material Identified 21
5.3 Summary of Inspections and Monitoring 21
6 Concordance with Licence 2AM-DOH1323 and 2BE-HOP1222 Items 23

7 Reporting 24
8 References 26

List of Figures

Figure 1: Quarry 1, 2, 4, and 5 Locations 5
Figure 2: Quarry 2, 3, 4, A, B, D and I Locations 6
Figure 3: Quarry G and H Locations 7

List of Tables

Table 1: Location and Status of Hope Bay Quarries 9
Table 2: Quarry Effluent Quality Limits[1] (Part D Item 18 of Water Licence 2BE-HOP1222) 13
Table 3: Hope Bay Quarry & All-Weather Road Monitoring Summary 22
Table 4: Concordance Table for Licence 2AM-DOH1323 23
Table 5: Concordance Table for Licence 2BE-HOP1222 23

1 Introduction

TMAC Resources Inc. is conducting advanced exploration and developing the infrastructure at the Hope Bay Mining Project in the Hope Bay Belt, Nunavut, Canada. The Project site is located on Inuit Owned Land (IOL) in the West Kitikmeot region of Nunavut approximately 125 km southwest of Cambridge Bay and 75 km northeast of Umingmaktok.

The project is owned and operated by TMAC Resources Inc.:

Toronto Corporate Office
95 Wellington St. W.,
Suite 1010, PO Box 44
Toronto, Ontario
M5J 2N7

Hope Bay Project
#18 Yellowknife Airport
Yellowknife, NT X1A 3T2

Construction of many of the facilities associated with the advanced exploration and infrastructure development program at the Hope Bay Project site has made use of or will continue to require rock from various quarries developed or approved for development at the site, including Quarry 1, 2, 3 and 4 (Figure 1), and Quarry A, B, and D (Figure 2). The proposed construction and development at Madrid South, including the Madrid South Road that connects to the existing Doris-Windy Road (TMAC 2014), would make use of rock from Quarry G and H (Figure 3). The proposed expansion of the Doris deposit will also require a small quarry (Quarry I) in the Doris Central area (Figure 2), (TMAC 2013).

This *Hope Bay Project Quarry Management and Monitoring Plan – Revision 02* has been prepared by TMAC in accordance with Quarry Permit Agreements KTP307Q010 and KTP308Q010, issued by the Kitikmeot Inuit Association, and Water Licences 2BE-HOP1222 and 2AM-DOH1323 issued by the Nunavut Water Board (NWB). The plan was originally prepared to address the management requirements for Quarry A, B and D, but has been expanded to include three new Quarries (G, H and I) which have been proposed to support expanded mining activities in the Doris area (TMAC in preparation), and exploration activities for Madrid South (TMAC in preparation). Additionally, the plan addresses ongoing management requirements for Quarry 2 and 3 in the Doris area.

Tail Lake

Doris Lake

Quarry 4

Doris North Camp

Quarry 1

Roberts Bay

Quarry 2

Quarry 5

434,000 E

433,000 E

432,000 E

7,564,000 N

7,563,000 N

7,562,000 N

7,561,000 N

7,560,000 N

7,559,000 N

LEGEND

Permitted Quarry Boundary

NOTES

1. Topographic contour data for the terrain model were provided by Hope Bay Mining, and is based on 2007 Aerial Photography. Contour intervals are 1m.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.

0 100 200 300 400 500
Scale in Metres

srk consulting

SRK JOB NO.: 1CH022.001

FILE NAME: 1CT022.001_Rob Bay-Doris.dwg

TMAC RESOURCES

HOPE BAY PROJECT

Quarry Management Plan

Quarry 1 ,2, 4, and 5 Locations

DATE:	APPROVED:	FIGURE:
June 2014	LW	1

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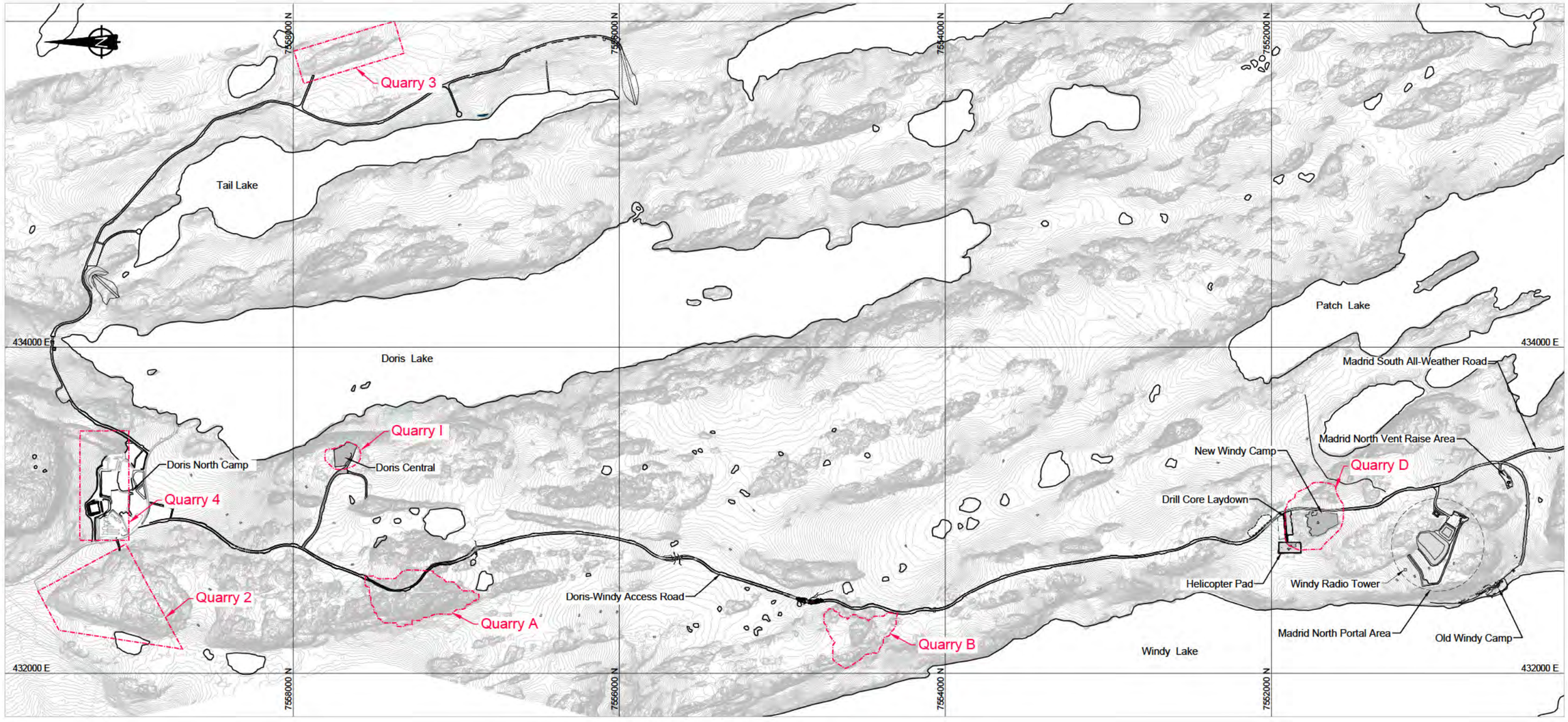

LEGEND

Permitted Quarry Boundary

NOTES

1. Topographic contour data for the terrain model were provided by Hope Bay Mining, and is based on 2007 Aerial Photography. Contour intervals are 0.5m.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.

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Scale in Metres

srk consulting

SRK JOB NO.: 1CH022.001
FILE NAME: 1CT022.001_Doris-Windy.dwg

TMAC RESOURCES

HOPE BAY PROJECT

Quarry Management Plan

Quarry 2, 3, 4 ,A, B, D, and I Locations

DATE: June 2014 | APPROVED: LW | FIGURE: 2

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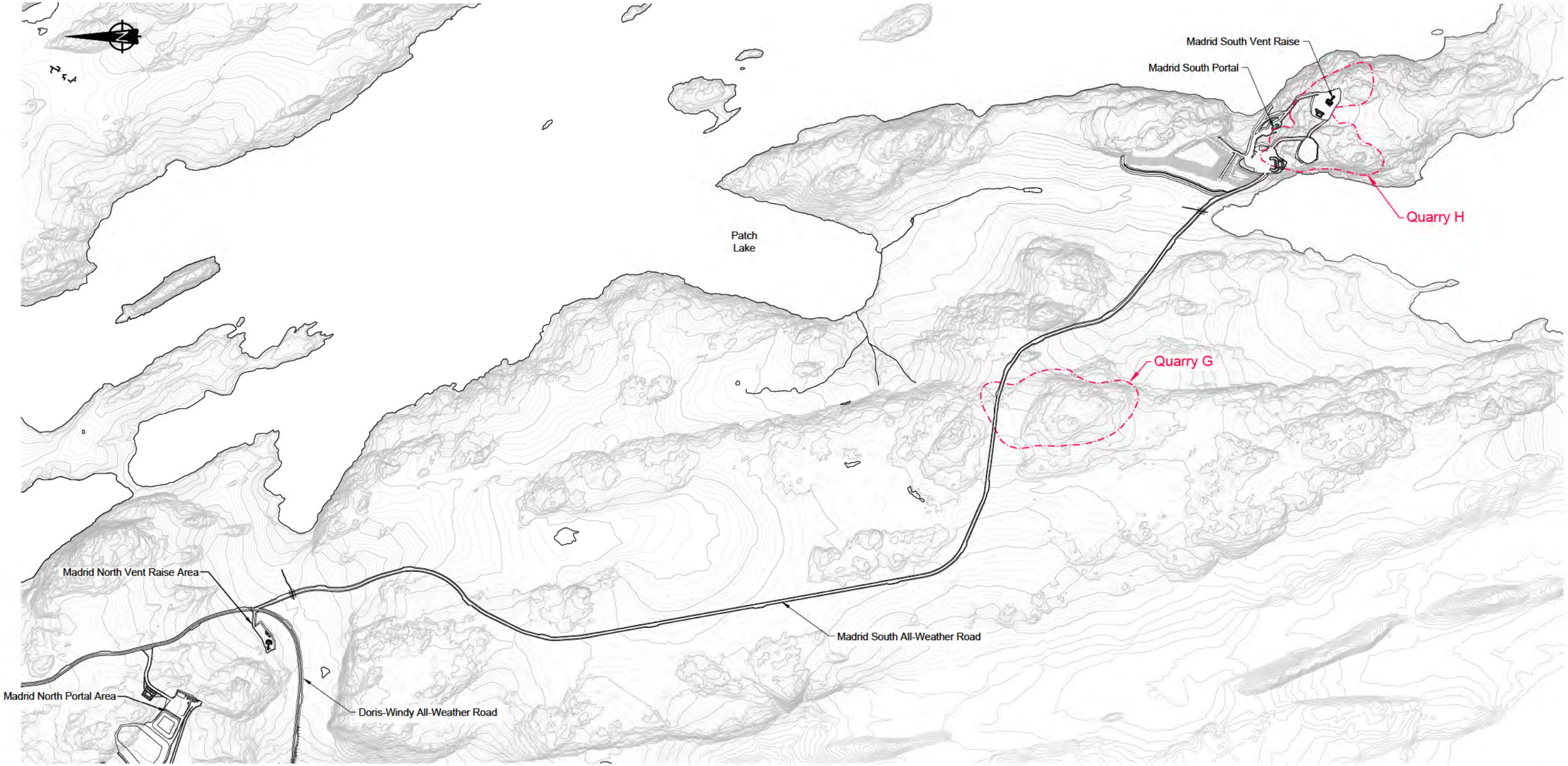

LEGEND

Permitted Quarry Boundary

NOTES

1. Topographic contour data for the terrain model were provided by Hope Bay Mining, and is based on 2007 Aerial Photography. Contour intervals are 0.5m.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.

0 100 200 300 400 500
Scale in Metres

srk consulting

SRK JOB NO.: 1CH022.001
FILE NAME: 1CT022.001_Windy-Madrid South.dwg

TMAC RESOURCES

HOPE BAY PROJECT

Quarry Management Plan

Quarry G and H Locations

DATE:	APPROVED:	FIGURE:
June 2014	LW	3

C:\01_SITES\Hope Bay\Quarries\1CT022.001_Windy-Madrid South.dwg

2 Background

2.1 Regulatory Approvals

Pursuant to the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada*, the Nunavut Water Board issued:

- Nunavut Water Board Type B Water Licence No. 2BE-HOP1222 to the Hope Bay Regional Exploration Project – Windy Camp; and
- Nunavut Water Board Type A Water Licence 2AM-DOH1323 to the Doris North Project.

Quarry operations also require approval by the Kitikmeot Inuit Association (KIA) to access Inuit Owned Lands (IOL). For example, Quarries A, B, and D are authorized by Quarry Permit Agreement KTP308Q010 and Quarries 2, 3, and 4 are authorized by Quarry Permit Agreement KTP307Q010.

TMAC are planning to submit applications to the Nunavut Water Board to amend the Type A water licence 2AM-DOH1323, and to obtain a Type B water licence for the Madrid North and South deposits, and applications to the Kitikmeot Inuit Association for quarry permit agreements for Quarry G, H, and I.

The existing licences and permits contain a number of specific conditions which apply to quarrying, infrastructure construction, management and monitoring. To ensure that the highest regulatory requirements for management of construction rock are uniformly applied throughout the Hope Bay Belt, the previous owner, HBML opted to implement Part D and Schedule D – Conditions Applying to Construction related to quarrying and placement of rock from the Type A Doris Water Licence 2AM-DOH0713 (renewed as 2AM-DOH1323) in their management plan for Quarry A, B and D (SRK 2010). TMAC have adopted this same approach in expanding the scope of the quarry management plan to include all of the quarries and has opted to implement Part D – Conditions Applying to Waste Disposal related to quarry drainage discharge from Type B Hope Bay Regional Exploration Project Water Licence 2BE-HOP1222 in their management plan. The relevant sections from 2AM-DOH1323 are Part D Items 9, 10, 20 and 21 and Schedule D a, b, c, f, k and n and from 2BE-HOP1222 are Part D Item 18 and Part J Items 5, 6 and 20.

This *Hope Bay Project Quarry Management and Monitoring Plan - Revision 02* has been prepared on behalf of TMAC to address the management and monitoring requirements related to quarrying, infrastructure and road construction – as specified in the aforementioned licences, and the applications that are currently under review.

2.2 Quarry Development and All-Season Road Construction

Figures 1 through 3 show the locations of all of the Quarries that have been developed, approved for development, or proposed at Hope Bay. The status of each of these quarries, including a description, and the approximate size is provided in Table 1.

In general, the amount of quarry rock that will be required from these areas is only a small proportion of the rock that could be extracted. Therefore, the actual size of most of these quarries is expected to be much smaller than indicated in Table 1.

The quarrying, infrastructure and road construction activities consist of drilling, blasting, mucking crushing, haulage to usage locations (e.g. the advancing road limit), end dump and levelling. Detailed design and/or as-built drawings for approved quarries have been issued in various submissions to NWB.

Table 1: Location and Status of Hope Bay Quarries

Quarry	Status	Description	Approximate Size
1	closed	Site is currently used for the Fuel Tank Farm.	21,000 m^2
2	active	Located west of the Doris camp.	308,000 m^2
3	approved but not yet developed	Located east of Tail Lake. Material will be required for construction of the South Dam.	133,000 m^2
4	closed	Doris Camp is located on the former quarry site.	201,000 m^2
5	proposed	Located at the south apron of the Doris North Airstrip Expansion.	352,000 m^2
A	not active	Located at the northern end of the Doris Windy Road. Site is currently used for storage of explosives.	155,000 m^2
B	not active	Located on the Doris Windy Road. Site has been proposed for storage of explosives.	98,000 m^2
D	not active	Site has been approved for construction of a new camp.	117,000 m^2
G	proposed	Located on the proposed Madrid South All-weather Road.	125,000 m^2
H	proposed	Located on the proposed Madrid South All-weather Road at the Madrid South Portal.	106,400 m^2
I	proposed	Located at Proposed Doris Central Vent Raise.	27,000 m^2

3 Quarry Management

3.1 Pre-Development

3.1.1 Quarry Material Characterization

Geochemical characterization studies of all potential quarry sites for the Hope Bay Project have been carried out by AMEC (2005), and SRK (2007, 2008, 2011, and 2014).

The 2002-2007 characterization programs (AMEC 2005, SRK 2007) included over 90 samples from Quarries 1 to 4. The samples were subjected to acid-base accounting (ABA), elemental analyses, and shake flask extraction tests. Humidity cell tests (HCTs) and mineralogical analyses were also completed on three sample composites.

The 2008 characterization program included a total of 120 samples from Quarries A, B and D. The samples were subjected to ABA and elemental analysis. Eight (8) samples were subjected to shake flask extraction to assess mineral weathering and nine (9) samples were subjected to quantitative mineralogy by Rietveld-XRD in order to investigate carbonate composition.

The 2010 characterization program for Quarry G, H, and I made use of a backpack-type drill. Shallow drill core samples were obtained across the strike of the geology with the objective of examining geochemical variability according to lithology and/or sample location. Additionally, for Quarry H, two drillholes (SRK-GC-10-A2 and SRK-GC-10-A5) were located in overburden to determine the recessive geology. The program included a total of 36 samples, which were subjected to ABA analyses including paste pH, total sulphur, sulphate sulphur, TIC, and modified NP, and elemental analysis by aqua regia digestion with ICP-MS finish.

Based on these geochemical characterization programs, the material from all of the quarries is considered to have a low potential for acid rock drainage (ARD) generation based on NP/AP ratios and low sulphur content. Accordingly, material from these quarries is suitable to be used as construction material.

3.1.2 Archaeology Survey

Archaeological surveys of the quarries and the Doris-Windy and Madrid South all-weather road routes were conducted. Based on the results of the survey, buffers were established to ensure that the development of Quarry A, B, D, G, H, and I and the Doris-Windy and Madrid South all-weather roads do not impact any archaeological sites.

TMAC provides training on “chance-find” procedures to relevant field staff to ensure that any archaeological sites that were not identified during pre-development surveys are recognized and treated in an appropriate manner (i.e. SOP for Archaeological Site Protection, and Hope Bay Archaeology Awareness for Field Workers).

3.1.3 Notification of Intent to Enter Quarry Lands

Article 27 of the Quarry Permit Agreement KTP307Q010 issued by the Kitikmeot Inuit Association (KIA) for Quarry 2, 3 and 4, and Quarry Permit Agreement KTP308Q010 for Quarry A, B, and D, requires that the KIA be notified of intent to enter the lands defined in the licence at least ten (10) business days prior to the commencement of activities. For Quarry G, H and I, TMAC will adhere to the same notification process outlined in Article 27. TMAC will give the KIA notice of its intent to enter upon the lands defined in the licence at least ten (10) business days prior to the commencement of activities.

3.2 Operations

3.2.1 Residual Explosives

The majority of the rock fill will be blasted using a bulk form of Ammonium Nitrate (AN) and fuel oil mixture to make the blasting product ANFO. ANFO is soluble in water and nutrient rich in environmental terms. From a blasting perspective, ANFO is only ideally suited for dry hole application. In the event that ANFO is loaded into a wet borehole inadvertently, an incomplete detonation of the product may occur. In such instances, residual ammonium nitrate may remain in the rock fill and be inadvertently transferred with the infrastructure or road construction material, causing nutrient loadings to the receiving environment.

The potential for wet-holes in the quarries is considered to be low due to the land-based nature of the quarry sites and the presence of permafrost below the outcrops. However, even though the quarry area is assumed to be dry, a contingency will be available. The potential for wet holes will be assessed at the time of drilling and without fail at the time of loading each blast hole. The blaster responsible for loading and firing the drilled pattern begins the loading process by walking the entire pattern and checking the actual drilled depth of each hole versus the plan and noting any conditions such as water in each hole. This information is recorded on the blast pattern record sheet required by regulation to determine the amount and type of explosive required in each hole including the delay detonators used. The presence of water in any drill hole requires one of several approaches to be taken to ensure proper and complete explosive detonation. One way is to attempt to dewater the hole using a down hole dewatering pump and truck so that a poly borehole liner can be lowered into the hole and ANFO poured inside the bag.

In the event that an incomplete detonation of the product occurs, it is likely that an orange colour smoke plume would be observed rising from the affected area. The blaster is required by the regulations to make an inspection of the blasted area, make note of blast holes that may have experienced incomplete detonation and mark those locations with flagging.

Information from the blaster's inspection will be noted in the blast pattern log and the daily operations shift log communicated to all field supervision personnel. The flagged off area will remain until the excavation equipment advances up to within half the hole spacing distance at which time the suspect material would be more closely inspected for the presence of ANFO.

Contingency - Identification of Un-detonated or High ANFO Residue Areas

Material considered un-detonated or high in ANFO residue, which will contain potentially elevated level of nutrients (primarily ammonia) will be selectively excavated and hauled to an established waste rock management area with any runoff from the area reporting to Pollution Control Ponds for ultimate disposal in the Tailings Impoundment Area (TIA).

Contingency - Spill of ANFO

In the unlikely event that a spill of the ANFO occurs during the charging of the holes for blasting, all activities within the quarry will be suspended until the clean-up is complete. The clean-up of the spilled material will be initiated immediately and the material disposed of in accordance with the Explosives Management Plan.

3.2.2 Blast Management

The quarry sites have been deemed suitable for use providing that the archaeological site buffer zone is kept intact; therefore, due care will be taken in order to maintain the integrity of these sites. The blasts will be designed to shoot away from the archaeological sites. Prior to any blast, the rock face will be cleaned to minimize the potential of fly rock.

The following blasting method will be applied for a 10 m bench using a 115 mm diameter borehole:

- Powder factor - 1.40 kg/m^3
- Stemming – 2.3 m (with 3/8” crushed rock)
- Pattern - 2.3 m x 2.3 m
- Delays - Single hole delay with offset timing, of 12 ms, will be used in order to limit the blasting to one hole at a time which will reduce the vibration to a minimum.

Single hole delays will also be used for maximum shot placement away from any identified archaeological sites and row timing will be increased to prevent back break and ensure all rock is moving in a forward motion away from the archaeological sites.

As an additional precaution, the blast limits will be set 60 m from the recommended 30 m buffers zones located in the quarries. This extra buffer will offer further protection from any possible disturbance to archaeological sites.

3.2.3 Precipitation/Snow Melt Water Management

The development of each quarry will proceed in a manner that, to the extent possible, ensures that all water entering the quarry as a result of precipitation or snow melt is retained within the quarry boundaries. Generally, this will be accomplished by ensuring that the quarry floors are sloped toward a natural low area of the quarry and, if required, the creation of a quarry sump to collect the waters and settle out suspended solids.

In the event that the quarry sump requires pumping, a sample of the ponded water will be collected, preserved in the appropriate manner, and submitted to an accredited laboratory for the analysis of specified parameters. These parameters are outlined in Part D Item 18 and Part J Item 6 of Water Licence 2BE-HOP1222 and the quarry effluent quality limits for these aforementioned parameters are listed at Part D Item 18 (reproduced herein as Table 2). Monitoring results will be reported as part of the monthly monitoring reporting.

Additionally, notification will be provided to the Inspector, at least fifteen (15) days prior to the planned pumping. The notification will include the volume proposed for discharge and the discharge location. Following receipt of the laboratory results, water meeting the discharge requirements will be discharged. As the governing permits for Quarry G, H and I are not presently defined, the discharge requirements are assumed to be the same as those outlined in Table 2.

Table 2: Quarry Effluent Quality Limits[1] (Part D Item 18 of Water Licence 2BE-HOP1222)

Parameter	Maximum Average Concentration	Maximum Concentration in Any Grab Sample
pH	6.0 to 9.0	9.0
Electrical Conductivity	500 µS/cm	500 µS/cm
Total Ammonia	2 mg/L	4 mg/L
Total Suspended Solids	15 mg/L	30 mg/L
Oil and Grease	5 mg/L and no visible sheen	10 mg/L and no visible sheen
Total Aluminum	1.0 mg/L	2.0 mg/L
Total Arsenic	0.05 mg/L	0.10 mg/L
Total Copper	0.02 mg/L	0.04 mg/L
Total Iron	0.30 mg/L	0.60 mg/L
Total Lead	0.01 mg/L	0.02 mg/L
Total Nickel	0.05 mg/L	0.10 mg/L
Total Zinc	0.01 mg/L	0.02 mg/L

Care will be taken not to disturb settled solids in the bottom of the sump and pumping of the sump will only take place when conditions are suitable. Care will also be taken to ensure that discharged water does not enter fish bearing waters and that the pump discharge is positioned in a manner that minimizes erosion and siltation of the area downstream of the discharge.

Contingency - Sump Water Requires Special Handling

In the event that the quarry water does not meet the discharge criteria, an inquiry of the cause of the noted exceedance will be conducted, and appropriate mitigation developed. Any non-compliant water that needs to be discharged would be transported to Pollution Control Ponds for management and/or transported directly to the Doris North TIA for disposal.

In previous versions of the Quarry Management Plan, the option of using the Pollution Control Ponds and/or the Doris North TIA to manage non-complaint water was not available. Therefore,

there was a requirement in the licence for investigating and reporting non-compliant quarry water to the Inspector. However, now that these alternatives are available, TMAC believes that this specific reporting requirement should be removed from the licence. Any non-compliant water that needs to be discharged from a quarry would be transported to Pollution Control Ponds for management and/or transported directly to the TIA. All compliant and non-compliant monitoring results are summarized in the monthly SNP reports to the NWB and a copy is provided to the Inspector. This monthly report would include details of the disposal of any non-complaint water.

3.2.4 Dust Management

The major source of dust generation during the operations of the quarries will be in the vicinity of the crusher while it is operating. Dust suppression, where required, will consist of using water as permitted by licences 2AM-DOH1323 and 2BE-HOP1222. A record of the volume of water used for this purpose will be maintained.

3.2.5 Materials Quarried and Removed

Article 25 of IOL Quarry Permit Agreement KTP308Q010 issued by the KIA for Quarry A, B, and D and Quarry Permit Agreement KTP307Q010 issued by the KIA for Quarry 2, 3, and 4, requires that a record of the quantity of granular materials quarried and the quantity of granular materials removed from each quarry will be maintained. It is assumed the reporting requirements for Quarry G, H and I will be the same as for the other quarries. TMAC will adhere to the same process outlined in Article 25 of KTP308Q010 and KTP307Q010 unless otherwise required by the quarry permit issued for Quarry G, H, and I.

3.2.6 Equipment Re-fuelling

In the event that re-fuelling of mobile equipment is required in one of the active quarries, it will be conducted in a location and at a time that will ensure that any spill of fuel or lubricants is effectively contained within the quarry area and clean-up is easily accomplished. During this activity, all re-fuelling equipment will be equipped with a Spill Kit suitable for the materials being handled and a functioning fire extinguisher suitable for the materials being transferred.

Contingency - Spill during Re-fuelling

In the unlikely event that a spill does occur during re-fuelling activities, clean-up of the spilled material will be initiated immediately and all activities within the quarry suspended until the clean-up is complete. The material will be disposed of in an appropriate manner as per the requirements specified in the Hope Bay Project Spill Contingency Plan.

3.3 Post-Operations

Once quarrying activities in each individual quarry are completed, all equipment, materials and supplies will be removed for appropriate reuse or disposal. Vertical walls within the mined out quarry will be inspected to ensure that they do not pose an unreasonable safety risk and, if required, remediation activities undertaken to address residual safety concerns.

The quarries may be used for laydown areas or for the development of other infrastructure components. In the event that a particular mined out quarry is to be re-commissioned or employed in a new role, appropriate applications will be made to the respective regulatory authorities.

4 Operational Inspections and Monitoring

4.1 Quarry Operations

4.1.1 Quarry Visual Inspections

During quarrying operations, a visual inspection of the quarry face to verify the geological characteristics of the rock will be conducted by a qualified field geologist or geochemist at least once per week. The purpose of the inspection will be to confirm the presence of the expected rock types and that disseminated sulphides only (e.g. not veins) are being exposed and therefore used in construction. A secondary objective of the inspection will be to confirm the absence of any fibrous forms of actinolite in the quarry material.

Prior to the inspections, site personnel will develop a traffic control plan to ensure that it is safe to work within the quarry and will inform any vehicle operators as to the location and timing of the inspection work.

The inspectors will walk from one side of the quarry around to the other side examining both the surface and the exposed bedding material along the side of the quarry for any anomalous rock types or significant amounts of sulphide. If present, these materials will be examined, described, and located on a map. In addition, at regular 100 metre intervals, the inspector will stop and complete a close inspection of the rocks, breaking open several rock clasts and describing what they see. The results of each inspection will be recorded on data sheets, and reported in the Construction Monitoring Report submitted by March 31 of the year following construction.

Contingency - Identification of Inappropriate Quarry Rock

In the unlikely event that the visual inspection identifies potentially acid generating rock, the geologist will “tag” the material for avoidance or removal. If the material is excavated, it will be hauled back to one of the previously mined-out quarries. The rock fill will then be placed within the quarry and covered with a minimum of 2 metres of the more typical Mg-theolite basalt that was approved for construction use or temporarily stored in an appropriate manner prior to eventual disposal underground. In the quarry stored rock, permafrost is expected to slowly aggrade into the rock fill, slowing the rates of sulphide oxidation substantially, and eventually shutting off seepage pathways. The clean rock cover would act as a thermal blanket to keep the active freeze/thaw zone away from the more reactive rock.

In the unlikely event that the visual inspection identifies fibrous actinolite, the geologist will “tag” the material for avoidance or removal. If the material is excavated, it would be hauled back to one of the previously mined-out quarries and covered with a 1.0 m layer of benign rock and a record of the location maintained.

4.1.2 Quarry Rock Sampling

During quarrying activities blast material from each quarry will be collected at two different stages of quarry development and samples will be submitted to an accredited external lab for sulphur analysis. Two samples of the same material will be collected: a whole rock sample and a sample

sieved to pass a -2 mm screen. This sampling method and frequency will result in up to 4 samples from each quarry. The sample locations will be pre-determined to ensure that they reflect a random selection of the rock fill material used in road construction. In the event that the results return a sulphur value of greater than (>) 0.1 % sulphur, the samples will be subjected to ABA and other confirmatory test work including shake flask extraction tests on a representative subset of samples.

The objective of this program will be to confirm previous rock characterization results and to assess the ARD potential of the fine fraction, which tends to concentrate sulphide minerals.

The following information will be recorded for each sample collected:

- Location of sample point;
- GPS coordinates of the sample point;
- Name of the quarry from which the rock fill originated;
- The name of the person who performed the sampling;
- Date and time of sampling;
- Date of analysis;
- Name of person who performed the analysis;
- Analytical method or techniques used; and
- Results of analysis.

The results of the analysis will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and submitted by March 31 of the year following construction. The report will include a discussion and interpretation of the geochemical data collected.

4.1.3 Quarry Sump Monitoring

The development of each quarry will proceed in a manner that, to the extent possible, ensures that all water generated as a result of precipitation or snow melt is retained within the quarry boundaries. Generally this will be accomplished by ensuring that the quarry floors are sloped toward the centre and, if required the creation of a quarry sump to collect the waters and settle out suspended solids.

After significant precipitation events, the quarry area will be inspected and the water level in the quarry sump assessed. In the event that the quarry sump requires pumping, the procedures or contingencies outlined in Section 3.2.3 of this plan will be followed.

4.1.4 Blast Vibration Monitoring

Shock waves from blasting in close proximity to fish bearing water can lead to potential for causing detrimental shock wave effects on fish. Guidelines for the use of explosives in or near Canadian fisheries waters (Wright and Hopky 1998) indicate that "*no explosive shall be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swimbladder of a fish*". The guidelines also provide specific methods for calculating the setback distance required to stay below this threshold based on different amounts of explosive and the type of substrate. To ensure that there are no detrimental effects on fish from quarry activities, these guidelines will be used to establish final setback distances for each of the quarries. Additionally, blast vibration monitoring will be undertaken to avoid potential effects when detonation distances approach the recommended setbacks to ensure appropriate vibration thresholds that are protective of fish and vulnerable life stages of fish are maintained.

4.1.5 Dust

The major source of dust generation during the operations of the quarries will be from the crusher when it is operating. Passive (observation) dust monitoring after blasting in all quarries and during operations of the crusher will be limited to an assessment conducted during the other regularly scheduled visual inspections of operations (i.e. the pre-blast inspection, the post blast inspection, and regular environmental personnel inspections). The results will be recorded by the site personnel. Dust suppression will be limited to the application of clean water to affected areas and a record of the volume of water used for this purpose will be maintained.

4.2 Infrastructure and All-Weather Roads

4.2.1 Visual Inspection

During all construction activities a visual inspection by site personnel will be conducted of the quarries, equipment storage and re-fuelling areas, construction areas and the advancing area of road construction activity at least once per week. The inspection will focus on identification and removal of foreign and/or spilled materials, assessing the extent of erosion and sedimentation resulting from rock placement (particularly during periods of precipitation), the extent of dusting and the transport of dust onto the surrounding tundra.

In addition, an inspection of each watercourse crossing along the all-weather roads throughout the annual ice-free period will be conducted in order to confirm structural integrity, confirm soil and permafrost stability in the immediate area and to confirm that the crossings have been located adequately with respect to the watercourses.

A record of the time, place and results of each inspection will be maintained as will a photographic record of "items of interest" (i.e. dusting, wildlife encounters, spilled material, etc.) identified during the inspection.

5 Post-Construction Inspections and Monitoring

5.1 Quarry

A visual inspection of each mined out quarry will be completed at least once per year in order to ensure that the site remains safe and no environmental or public health and safety concerns have developed. In the event that potentially acid generating waste rock has been placed in one or more of the mined-out quarries, the area will be inspected to ensure that the 2 metre cover remains intact and that seeps from the material are not in evidence.

In the event that the inspection identifies ponded water within the mined out quarry in sufficient volume to require pumping, the procedures or contingencies outlined in Section 3.2.3 of this plan will be followed.

Records of the inspections and findings of each will be maintained and reported in the appropriate manner.

5.2 Infrastructure and All-Weather Roads

5.2.1 Road Seep Survey and Sampling

During the spring freshet in the year following completion of the construction of the road and pad areas, an inspection will be conducted by a qualified field geologist or geochemist in order to characterize the rock used in construction and to identify and sample ephemeral seeps occurring through the road construction material. The objective of this program will be to confirm that an environmentally-significant level of metal leaching (ML) is not occurring from the road materials.

Seeps will be located by walking along the downstream side of the roads and looking and listening for signs of flowing water. In low lying areas where the direction of surface water flow is not evident, both sides of the structure will be inspected. Where surface flows are identified, the upstream side will be inspected to determine whether the flow originates from the upstream side or whether it is likely to originate from within the rock fill material. Most samples will target the latter, more ideal type of seep. However, a modest number (maximum of one location for every two km of road) will be collected at locations where there is moderate upstream flow component. In these cases, samples will be collected from both upstream and downstream of the roads.

A survey stake will be installed to mark the location of each seep sampled and the following information recorded:

- Description of the seep location;
- GPS location of the seep;
- A photographic record of the seep;
- A description of the flow pattern and magnitude of flow;
- Field pH, EC, Eh and temperature readings; and

- Field pH, EC, Eh and temperature measurements at a reference site located away from the influence of the road or other mine related activities.

At a minimum, a water sample will be collected from 10% of the identified ephemeral seeps (regardless of the field measurement values) appropriately preserved and submitted for laboratory analysis. The following information will be recorded:

- The name of the person who performed the sampling;
- Date and time of sampling;
- Date of analysis;
- Name of person who performed the analysis;
- Analytical method or techniques used; and
- Results of analysis.

All of the samples collected will be preserved in an appropriate manner, labelled and submitted to an accredited laboratory for analysis of pH, TDS, acidity and/or alkalinity, sulphate, total ammonia, nitrate, and a full suite of dissolved metals by ICP-MS. The results of the seep survey will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and submitted by March 31 of the year following construction. The Addendum will include a discussion of the interpretation of the geochemical data collected.

5.2.2 Road Material Sampling

Once the construction of the road and pad areas is complete, an inspection of these facilities will be conducted by a qualified field geologist or geochemist to characterize the rock used in construction. That inspection will include collection of in situ rock fill from pre-determined points along the road route (approximately 1 sample per 0.5 kilometres of road, and five samples from each of the pad areas). At each sample location, a whole rock sample will be collected as well as a -2 mm sieved sample when available. The sample locations will be pre-determined to ensure that they reflect a random selection of a representative sample of the in situ rock fill from each quarry used to construct the road and pad areas.

All of the samples will be submitted to an accredited external lab for sulphur analysis. In the event that the results return a sulphur value of greater than (>) 0.1 % sulphur, the samples will be subject to ABA and shake flask extraction tests on a representative subset of samples. Testing will be completed on both the fines and the whole sample.

The objective of this program is to confirm previous rock characterization results and assess the ARD potential of the fine fraction, which tends to concentrate sulphide minerals.

The following information will be recorded for each sample collected:

- Description of the sample point;

- GPS Coordinates of sample point;
- An estimate of which quarry the rock fill originated from;
- The name of the person who performed the sampling;
- Date and time of sampling;
- Date of analysis;
- Name of person who performed the analysis;
- Analytical method or techniques used; and
- Results of analysis.

The results will be reported in the Waste Rock and Quarry Monitoring Report (which is referenced in the Construction Monitoring Report) and will include a discussion and interpretation of the geochemical data collected.

5.2.3 Infrastructure Seep Survey and Sampling

In the event that clean quarry rock from any of the quarries is used in the construction of any other infrastructure, the area in which the rock is used will be incorporated in the ongoing seep and rock sampling program currently established for the project. This includes, at a minimum, incorporating the requirements specified in Part D and Schedule D - Conditions Applying to Construction in the Type A Water Licence 2AM-DOH1323 related to quarrying and placement of rock. The monitoring and sampling will be completed in order to ensure that the highest regulated requirement for the management of construction rock is uniformly applied throughout the Hope Bay Belt.

5.2.4 Contingency - Inappropriate Construction Material Identified

In the unlikely event that the results of the seep monitoring/sampling program or the road material sampling program indicate the presence of potential ML or ARD further investigations will be undertaken to define the extent and assess the potential impacts of the material. If warranted, and after discussion with the appropriate regulatory agencies, the material will be excavated and hauled to one of the previously mined-out quarries or temporarily stored in an appropriate manner prior to eventual disposal underground. The quarry stored rock fill will be placed within the quarry and covered with a minimum of 2 m of the more typical Mg theolite basalt. Permafrost is expected to slowly aggrade into the rock fill, slowing the rates of sulphide oxidation substantially, and eventually shutting off seepage pathways. The clean rock cover will also act as a thermal blanket to keep the active freeze/thaw zone away from the more reactive rock.

5.3 Summary of Inspections and Monitoring

Table 3 provides a summary of the monitoring required during and after quarry mining and construction of the new roads or infrastructure areas.

Table 3: Hope Bay Quarry & All-Weather Road Monitoring Summary

Aspect	Monitoring Activity	Monitoring Type	Data Management & Reporting
Pre-development	Geochemical characterization of quarry material.	Sample and analysis of rock.	Complete (see summary in Section 3.1).
	Archaeological survey.	Field inspections and establishment of buffers.	Survey report kept on file.
Quarry Operations	Pre-blast inspection.	Identify "wet holes" and clean spilled ANFO	Maintain field notes.
	Post-blast inspection.	Confirm ANFO consumption (minimal misfires).	Maintain field notes.
	Weekly visual inspection by field geologist or geochemist.	Confirm rock types (no fibrous actinolite) and presence of disseminated sulfides (not veins).	Maintain field notes. Report results in subsequent Waste Rock and Quarry Monitoring Report.
	Representative samples of blast material (two from each quarry) during quarry operations (whole rock and screened), sampled twice during quarry development.	Sulphur analysis and, if required, ABA and shake flask extraction analysis of representative subset of samples.	Maintain field notes. Report results in subsequent Waste Rock and Quarry Monitoring Report.
	Weekly inspection by site personnel.	Visual inspection	Maintain field notes on inspection time and results.
	Amount of material quarried and amount removed.	Amount of material quarried in m^3. Amount of material removed in m^3.	Maintain record and monthly reporting to Kitikmeot Inuit Association.
Post-precipitation Event	Inspect quarry for ponded water (sump).	If ponded water is present and in quantities requiring discharge, collect sample for discharge criteria screening.	Maintain field notes. Report results in monthly monitoring reports.
	Prior to pumping and discharge of sumps.	Water sample collected for analysis of parameters outlined in Table 2 (pH, EC, Eh, Total Suspended Solids, Total Sulphate, Total Ammonia, Nitrate, Alkalinity, ICP Metals Scan (including Total Aluminum, Total Arsenic, Total Copper, Total Iron, Total Lead, Total Nickel & Total Zinc) and Oil and Grease).	Notification of Inspector at least fifteen (15) days prior to the planned pumping – Notification will include the volume proposed for discharge and the discharge location. Results of water quality sampling reported in monthly monitoring reports.
Post-Construction	Representative samples of *in situ* construction material (1 per 0.5 km, and 5 per pad area). Samples to include whole rock and screened (-2 mm) samples, where possible).	Sulphur analysis and, if required, ABA and shake flask extraction analysis of representative subset of samples	Maintain field notes. Report results in subsequent Waste Rock and Quarry Monitoring Report.
	Field identification of seeps &/or runoff from road and pads during spring freshet (2 years).	Field pH and EC of seeps and runoff Field pH and EC at reference site.	Maintain field notes. Report results in subsequent Waste Rock and Quarry Monitoring Report.
		Water sample submitted for pH, TDS, Total Sulphate, Total Ammonia, Nitrate, Alkalinity, ICP-MS Dissolved Metals Scan.	Maintain field notes. Report results in subsequent Waste Rock and Quarry Monitoring Report.
	Annual inspection of mined out quarries. If ponded water is present.	Sample and analysis of pH, EC, Eh, Total Suspended Solids, Total Sulphate, Total Ammonia, Nitrate, Alkalinity, ICP Metals Scan (including Total Aluminum, Total Arsenic, Total Copper, Total Iron, Total Lead, Total Nickel & Total Zinc) and Oil and Grease).	Maintain field notes. Results of water quality sampling reported in monthly monitoring reports.
	Inspection of watercourse crossings along the all-weather road during ice-free period.	Structural Integrity, soil and permafrost stability and confirmation of appropriate location.	Maintain field notes. Report results in Annual Geotechnical Inspection Report.

6 Concordance with Licence 2AM-DOH1323 and 2BE-HOP1222 Items

Tables 4 and 5 provide concordance tables to demonstrate where the applicable conditions of Licence 2AM-DOH1323 and 2BE-HOP1222 have respectively been incorporated into the *Hope Bay Project Quarry Management and Monitoring Plan – Revision 02, December 2014.*

Table 4: Concordance Table for Licence 2AM-DOH1323

Licence 2AM-DOH1323	*Quarry Management and Monitoring Plan – Revision 02*
Part D: Conditions Applying to Construction	-
Item 9	Section 4.1.2 & 5.2.2
Item 9b	Section 4.1.2 & 7
Item 10	Section 4.1.1
Item 20	Section 5.2.1 & 5.2.3
Item 21	Section 5.2.1 & 7
Schedule D, Conditions Applying to Construction	-
Item a	Section 4.1.4
Item b	Section 4.2.1
Item c	Section 4.2.1
Item f.i.	Section 4.1.1, 5.2.1, 5.2.2, 5.2.3 & 7
Item f.ii.	Section 5.2.1, 5.2.3 & 7
Item f.iii.	Section 4.1.2, 4.1.3, 5.1, 5.2.2 & 7
Item f.iv.	Section 5.2.4
Item k	Section 4.2.1 & 7
Item n	Section 5.2. 1 & 7

Table 5: Concordance Table for Licence 2BE-HOP1222

Licence 2BE-HOP1222	*Quarry Management and Monitoring Plan – Revision 02*
Part D: Conditions Applying to Waste Disposal	-
Item 18	Section 3.2.3 & 5.1
Part J: Conditions Applying to the Monitoring Program	-
Item 5	Section 3.2.3 & 5.1
Item 6	Section 3.2.3 & 5.1
Item 20	Section 3.2.3, 5.1 & 7

7 Reporting

To address the requirements specified in Nunavut Water Board Type A Water Licence 2AM-DOH1323, Nunavut Water Board Type B Water License No. 2BE-HOP1222 and Nunavut Water Board Type B Water Licence for Madrid Advanced Exploration Program when it is issued, the following reports will be prepared:

- Construction Monitoring Report;
- Waste Rock and Quarry Monitoring Report;
- Construction Summary Report;
- Monthly Monitoring Report; and
- Annual Geotechnical Inspection Report.

All of the aforementioned reports are to be submitted no later than March 31 of the year following construction, with the exception of the Monthly Monitoring Report, which is submitting on a monthly basis.

Generally, these reports will include, but not necessarily be limited to:

- A summary of all inspections conducted during quarry activities and road construction;
- A summary of all monitoring conducted;
- All data generated from the analysis of monitoring samples;
- The results of all samples collected and submitted for analysis;
- A summary of all mitigation activities undertaken as a result of monitoring;
- The results of the follow-up geochemical sample analysis of quarried rock used in construction to verify that the rock used is non-acid generating as predicted;
- The results of monitoring of dust generation and use of water by the contractor to manage dust emissions from crushing and construction activity;
- A summary of post-operational activities and condition of each quarry; and
- Updated “As-built” drawings of the constructed infrastructure and all-weather roads.

This report, Hope Bay Quarry Management and Monitoring Plan – Revision 02, was prepared by SRK Consulting (Canada) Inc.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Annex 18

Quarry Blasting Operations Management Plan

Quarry Blasting Operations Management Plan

TMAC RESOURCES Inc.

Hope Bay Nunavut

September 2015

Table of Contents

1. Objective....1
1.1 Purpose of Document....1
2. Environmental Management Plan....2
2.1 Introduction....2
2.2 Setbacks....2
2.3 Archeological Sites....2
2.4 Explosives Usage....2
2.5 Training....3
2.6 Management of grubbing and disposal of related debris....3
2.7 Till Management....4
2.8 Storm Runoff and Snow Melts....4
2.9 Water Sampling....4
2.10 Blasting near water....4
2.11 Performance Monitoring....4
3. Blast Pattern Design....6
3.1 Objective....6
3.2 Introduction....6
3.3 Definitions....6
3.4 Tasks....6
3.5 Blasting Parameters – Burden and Spacing....6
3.6 Blasting Parameters – Bench height and wall slops....6
3.7 Typical Blast Pattern Designs....7
4. Drill and Blast Employee Responsibilities....8
4.1 Typical Blast Pattern Designs....8
4.1.1 Objective....8
4.1.2 Scope....8
4.1.3 Introduction....8
4.1.4 Definitions....8
4.1.5 Preparation....8
4.1.6 Tasks....8
4.2 Drill and Blast Supervisors' Daily Duties....8

4.2.1 Objective 8
4.2.2 Scope 9
4.2.3 Introduction 9
4.2.4 Preparation 9
4.2.5 Tasks 9
5. Drilling and Loading Procedures 12
5.1 Re-Drill and Explosives Loading Procedure 12
5.1.1 Objective 12
5.1.2 Scope 12
5.1.3 Introduction 12
5.1.4 Definitions 12
5.1.5 Preparation 12
5.1.6 Task 13
5.2 Explosives Management 14
5.2.1 Objective 14
5.2.2 Scope 14
5.2.3 Introduction 14
5.2.4 Preparation 14
5.2.5 Tasks 14
6. Blasting Protocol and Procedure 16
6.1 General Protocol 16
6.2 Guarding Typical Quarry Excavation 16
6.3 Guarding Procedure 17
6.3.1 Objectiv 17
6.3.2 Scope 17
6.3.3 Introduction 17
6.3.4 Definitions 17
6.3.5 Preparation 18
6.3.6 Tasks 18
6.4 Blasting Procedure 18
6.4.1 Objective 18
6.4.2 Scope 18
6.4.3 Introduction 18

6.4.4 Definitions 19
6.4.5 Preparation 19
6.4.6 Tasks 19
6.5 Misfires or Cut-off Holes 20
6.5.1 Objective 20
6.5.2 Scope 20
6.5.3 Introduction 20
6.5.4 Definitions 21
6.5.5 Preparation 21
6.5.6 Tasks 21
7. Excavating Blasted Muck 23
7.1 Dig Limits for Loading Equipment 23
7.1.1 Objective 23
7.1.2 Scope 23
7.1.3 Introduction 23
7.1.4 Preparation 23
7.1.5 Tasks 24

1. Objective

1.1 Purpose of Document

At the request of TMAC RESOURCES, Nuna Contracting Ltd. (NUNA) developed a document that would provide a site specific blasting operational management plan for the Hope Bay (Q2) Quarry based in part on TMAC's Resources. NUNA endeavors to work pro-actively with TMAC Resources to develop quarries in an environmentally acceptable manner that meets the requirements of all Project permits and authorizations.

2. Environmental Management Plan

2.1 Introduction

The information provided, herein, supplements that provided in the related documents:

- Borrow Pit and Quarry Management Plan, and
- Quarry Management Plan – Hope Bay Quarry (Q2)

2.2 Setbacks

A 100 meter buffer zone will be established between the construction areas directly adjacent to fish bearing streams. Buffers will be surveyed in before any construction can proceed. It is NUNA's understanding based on a review of the Quarry Management Plan for the Hope Bay Quarry (Q2) that the nearest fish bearing receiver is Doris Lake.

2.3 Archeological Sites

An archeologist has been brought to site at the owner's discretion to complete archaeological surveys for all areas of potential disruption due to work programs. The archaeologist reports that within the quarry development area there are no archaeological resources. If a relevant archaeological site is identified during the course of the operations, all work will cease and the archaeologist will be contacted and brought to the site. Work in the area would only proceed based on the recommendations of the archaeologist with input from the government of Nunavut. If needed, a buffer zone will established around the archaeological site as required by the site regulations. No construction is to take place within the buffer zone and no employees will be permitted to enter the site.

2.4 Explosives Usage

High quality pre-packaged emulsion explosives have been selected for blasting operations. The pre-packaged explosives utilize an optimally mixed hydrophobic emulsion compound that works to repel water and keep AN out of the surrounding ecosystem. Industry best practices will be adopted to maximize source control and to minimize the potential for AN dissolution to downstream waters. The following protective measures will be taken:

- When handling, transporting or storing explosives, care will be taken to avoid any spillage. Any spilled product will be promptly reported, cleaned up, and properly disposed in accordance to approved site waste management practices. A Spill Report detailing the incident will be submitted to the TMAC Environment department. A follow-up report will be provided that details basic cause of the spill and any corrective actions taken to minimize the type of incident from reoccurring.

- Prior to loading explosives, blast holes will be inspected for the presence of water. If water is detected, plastic liners will be installed prior to the loading of holes. This will minimize deterioration and dissolution of the explosives within the blast hole.

- Stand time for explosives will be minimized and the lag time between load and blast will be kept to a minimum.

- If there is a miss hole resulting in incomplete detonation of explosives, the event will be reported to the Nuna supervisor. If the residual blasted material in the vicinity of the miss hole represents a

potential source of nitrogen compounds, this material will be appropriately stored and managed to minimize the potential for soluble nitrogen compounds from entering fish bearing waters.

- Upstream overland flows that impinge on quarry operations and have the potential to contaminate clean upstream water will be diverted around the active pit area by means of berms, check dams, or minor diversions. Based on the site drainage plan, the upstream flows from the quarry development area are anticipated to be minor.

- In the event that there is the potential for nitrogen compounds to adversely impact downstream fish bearing waters contingency actions will be taken that could include:
    - Storage of impacted water within the pit in constructed sumps.
    - Pumping of water into tanker trucks for disposal in holding ponds or the sewage treatment plant.
    - Other treatment options such as the careful discharge to the tundra or where there is abundant surface vegetation (approval may be required) after meeting regulatory requirements for water quality.

2.5 Training

Training is seen as a key element in the safe usage and proper environmental management of explosives and blasting. All employees working on or around blasting operations will undergo rigorous employee orientation and training procedures for: managing, transporting and loading explosives into blast holes. Experienced competent employees are an essential part of blasting best management practices.

2.6 Management of grubbing and disposal of related debris

The principle concerns associated with grubbing and disposal of related debris are:

- Potential effects on water quality caused by erosion and sedimentation;
- Disturbance of the permafrost leading to ground failure (slumping and erosion)

NUNA is committed to meeting the Client's and or the Territorial regulations for maximum allowable concentrations of total suspended solids (TSS).

All grubbing and disposal of related debris near watercourses will comply with approvals from respective regulators and the landlord. At a minimum measures to be undertaken to minimize effects on aquatic habitat and resources are as follows:

- Grubbing of the organic vegetation mat and/or the upper soil horizons will be minimized, and left in place where possible due to the sensitivity of arctic soils;
- If needed, the organic vegetation mat and upper soil horizon material, which has been grubbed, will be spread in a manner that attempts to cover exposed areas. Any surplus of such material will be stored or stockpiled for site rehabilitation and re-vegetation purposes elsewhere in the project area. Topsoil will be stockpiled separately from the overburden. The location of the stockpiles will be recorded and accessible for future rehabilitation purposes;
- During grubbing, care will be taken to ensure that grubbed material will not be pushed into areas which are to be left undisturbed.

2.7 Till Management

Till stripped from the quarries will be placed in an area approved by the Client or the onsite environmental personnel. These areas can be an area currently identified for till/topsoil storage area or an area close to a quarry that is unlikely to erode into any water bodies during spring thaw.

Till can be used for building a berm around quarry as a means to prevent runoffs and snow melts into nearby natural drainage systems. If seepage through a berm wall is occurring, sediment control mats will be laid the foot of the berm wall to minimize transportation of fines into water courses.

2.8 Storm Runoff and Snow Melts

The final quarry configuration will consist of a flat surface graded at approximately 1% in the down slope direction, adjoining a steeper angle rock surface that forms the transition to natural ground on the ridge above. Storm and snow melts water will be diverted away from the quarry by a small 0.5 m berm on the upslope edges of the excavation. All runoffs and snow melts will be contained in a lined designated location within the quarry. Runoffs will be released onto the tundra after meeting regulatory requirements for water quality.

2.9 Water Sampling

Water sampling will be conducted at locations and frequency specified by the TMAC Environmental department. Water sampling locations will be based on the location of quarry operations, site drainage configuration (refer to site drainage plan), and seasonality. The sampling will be undertaken by the onsite environmental personnel.

2.10 Blasting near water

Particular care must be taken when blasting near water bodies. This includes proper explosives handling, selection of the correct explosive (see: Section 2.3), and utilization of best management practices. All quarries blasting on the Hope Bay Project will adhere to the Department of Fisheries and Oceans (DFO) "Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters"[1].

2.11 Performance Monitoring

A performance monitoring program will be implemented to ensure that AN release to receiving waters from AN explosives is minimized and remains non-acutely toxic to aquatic organisms. NUNA is committed to working with the Client and their regulators to develop effective site specific performance targets. These targets and methods to monitor performance will be developed during quarry start up. Initially, the following types of monitoring procedures are anticipated:

- Procedure for blast performance monitoring to optimize blasting efficiency and to minimize the potential for unexploded product.
- Procedure for monitoring and auditing of field operations related to explosive storage, handling, and blast hole loading.

[1] Wright and Hopky 1998, Guidlines for the USE of Explosives In or Near Canadian Fisjeries Waters

- Procedure for auditing and assessing individual employee environmental awareness and effectiveness of training with regard to blasting operations and the procedures related to environmental management.
- Ammonia and nitrate monitoring of surface water flows to fish bearing waters.

In the event that performance monitoring indicates that targets are not being met, corrective actions will be taken to improve performance and contingency measures will be taken to prevent the discharge of acutely toxic ammonia discharges to the aquatic receiving environment.

3. Blast Pattern Design

3.1 Objective

To provide the engineering department with a safe procedure for designing blasting patterns.

3.2 Introduction

This procedure was developed to ensure that the engineering department, including sub-contractors, are aware of their safety responsibilities while designing and staking blast patterns at the Hope Bay Project.

3.3 Definitions

Criteria: All personnel involved in engineering and survey of blast patterns are to follow the responsibilities outlined in this procedure.

3.4 Tasks

Table 3.4-1: Requirements and Responsibilities for Blast Pattern Design

Task	Person Responsible
All borehole locations designed by engineering are to be placed at a distance of one meter or greater from any bootleg locations.	Site Engineer
If any holes designed by engineering cannot be drilled in the design location due to ground conditions, then a new location can be used only if it is picked up by survey and found to be one meter or further away from any bootleg locations.	Surveyor / Mine Engineer
No holes are to be designed in a location within five meters of a misfired hole.	Mine Engineer
Prior to firing any blast, all borehole locations loaded with explosives are to be picked up by survey, and entered into the engineering database by the mining engineer. This will be called the as-built map of each blast pattern.	Surveyor / Mine Engineer

3.5 Blasting Parameters – Burden and Spacing

In order to produce a rock gradation profile suitable for specified use, the final blast hole spacing will need to be determined from field testing.

3.6 Blasting Parameters – Bench height and wall slops

Quarry locations have been selected, in areas that present stable geological characteristics. The benches will be designed according the topography of the natural grade at the quarry site. A 5 m bench height with a minimum 8 m catchment will be used based on safety and the capabilities of our loading equipment

3.7 Typical Blast Pattern Designs

The following summaries may vary depending on bench height.

Table 3.7-1: Initial Blasting Parameters – 160 mm

Borehole	
Product	**ANFO**
Density (g/cc)	0.82
Load per meter of borehole (kg)	16.21
Bench Height (m)	5
Sub-Drill (m)	0.9
Collar (m)	2.5
Load Column (m)	3.4
Load per hole (kg)	55
Pattern Type	Equilater
Spacing (m)	3.7
Burden (m)	3.2
Rock released per hole (m^3)	59.2
Powder Factor (kg/m3)	0.93

Table 3.7-2: Initial Blasting Parameters – 90 mm

Borehole	
Product	**ANFO**
Density (g/cc)	0.82
Load per meter of borehole (kg)	5.08
Bench Height (m)	5
Sub-Drill (m)	0.5
Collar (m)	2
Load Column (m)	3.5
Load per hole (kg)	17.8
Pattern Type	Equilater
Spacing (m)	2.1
Burden (m)	1.8
Rock released per hole (m^3)	18.9
Powder Factor (kg/m^3)	0.94

4. Drill and Blast Employee Responsibilities

4.1 Typical Blast Pattern Designs

4.1.1 Objective

To provide Drill and Blast (D&B) Supervisors, blasters and blaster helpers with a procedure for assisting a blaster in the preparation of a blast.

4.1.2 Scope

The D&B Supervisor is responsible to ensure that blast helpers assisting in the preparation of a blast are trained and understand the procedure.

4.1.3 Introduction

This standard operating procedure is to be used for drill and blast operations.

4.1.4 Definitions

- D/B Supervisor: Drill & Blast Supervisor.

4.1.5 Preparation

- Tool: PPE
- Hazards: Slips, trips, and falls; Personal injury or Death; Premature detonation.

4.1.6 Tasks

Table 4.1-1: Requirements and Responsibilities for Blast Helpers

Task	Person Responsible
Before assisting in the preparation of a blast, the blast helper will be trained on the safe handling and preparation of the explosives used during the loading procedure.	Drill & blast Supervisor
Either, D&B Supervisor or the blaster in charge of the blast pattern to be loaded will explain exactly the duties of the blast helper before the work begins.	Drill & blast Supervisor
The blast helper will remain under the direction of the D&B Supervisor or the blaster at all times.	Drill & blast Supervisor
The blast helper will conduct only that part of the blasting operation as directed by the D&B Supervisor or the blaster.	Drill & blast Supervisor

4.2 Drill and Blast Supervisors' Daily Duties

4.2.1 Objective

To provide the Drill/Blast Supervisors with a comprehensive inventory of duties to be completed on a daily basis.

4.2.2 Scope

The Superintendent is responsible to ensure all Drill/Blast Supervisors are trained and understand this procedure.

The Drill/Blast Supervisor is responsible to follow this procedure as directed by the Superintendent.

4.2.3 Introduction

NWT / Nunavut Mine Health and Safety Act and Regulations: require a supervisor to ensure his charges are working safely in a safe environment and in compliance with the regulations, company policy and procedures.

4.2.4 Preparation

Hazards: Work about charged drill holes, work with explosives, falling rock, slips, trips & falls

Tools: Blasting Certificate, Supervisor Level I Certificate, PPE.

4.2.5 Tasks

Table 4.2-1: Requirements and Responsibilities of a Drill and Blast Supervisor

Task	Person Responsible

The Drill / Blast Supervisor will: • Do a pre shift site tour. • Read and sign the Daily logbook from the previous shift prior to line up. • Review maintenance problems and equipment down time with superintendent and previous shifter. • Prepare D/B crews work assignments with superintendent. • Prepare daily safety toolbox meeting notes • Provide instructions to the D/B crew for the daily work assignments • Directs the blaster and helper to prepare all explosives for the day's activities. • Drill crews are transported to the drill locations. Review previous shift with the off-going driller. • The area is inspected and the drillers' duties are reviewed. • The night shift crews are transported to the line-up area • Record all information in the D/B Daily Logbook. Completed the required documentation for the night-shift crews. • Participate and provide information during the daily production meeting for all Mine Supervisors and Managers. • Inspect the area of his/her responsibility, identifying and correcting hazards, sub-standard conditions or non-compliance of Nuna procedures, or the NWT / Nunavut Mine Regulations or client.	Drill & Blast Supervisor

Table 4.2-1: Requirements and Responsibilities of a Drill and Blast Supervisor

Task	Person Responsible
The Drill / Blast Supervisor will: • Provide on the job observations and instructions to the drill/blast crews. • Ensure the mining/quarrying plan is followed regarding drill and blast patterns, as directed by the Superintendent. • Ensure the drill/blast crew has the required supplies to complete their daily tasks. • Ensure the Mine Supervisor is informed of any hazards that may affect the safety of the mine employees or equipment. • Provide directions and instructions to all employees during the blasting operations regarding the notification and guarding during the blast.	Drill & Blast Supervisor

Miscellaneous Duties: • Develop and present timely safety topics at the regular crew Safety meetings. • Provide developmental training for drill/blast crews. • Under the direction of the Superintendent, provide up-to-date information regarding manpower, production targets or delays, order and track consumables, complete special assignments, ensure that explosives are handled properly and security is maintained.	Superintendent / Supervisor / Safety

5. Drilling and Loading Procedures

5.1 Re-Drill and Explosives Loading Procedure

5.1.1 Objective

To provide Supervisors and workers with a procedure, which will ensure the safety of all personnel on or near a drill pattern where re-drilling of caved or frozen holes on a loaded pattern is necessary.

5.1.2 Scope

The D&B Supervisor shall be responsible to ensure that the workers are trained and follow the procedures.

The driller is responsible to ensure that the procedures are followed as directed by the D&B Supervisor.

5.1.3 Introduction

This procedure was developed to ensure the safety of all personnel involved or close to the blast area.

5.1.4 Definitions

- D&B: Drill & Blast
- D/B Supervisor: Drill & Blast Supervisor

5.1.5 Preparation

- Requirements: Blasters Certificate, Supervisor Level I
- Tools: Drill, PPE
- Hazards: Charged holes, slips, trips, falls, explosion

5.1.6 Task

Table 5.1-1: Re-Drill and Explosive Loading Procedure

Task	Person Responsible
All holes shall be jigged and visually checked in patterns that have the potential for frozen or caved holes, before loading operations commence.	Blaster / Blast helper / D&B Supervisor
Drill holes that are caved and or frozen and that require re-drilling are to be marked out with flagged stakes.	Blaster / Blast helper / D&B Supervisor
Holes noted for re-drilling will be immediately brought to the attention of the blaster in charge and the D/B Supervisor.	Blaster / D&B supervisor
The holes requiring re-drilling will be marked in the daily log and noted on the daily blast hole sheets as re-drilled.	D&B Supervisor
No loading of holes closer than **8** meters to the re-drilling operation shall be permitted except under the direct supervision of the D/B Supervisor.	Blaster
The re-drilling shall take place in a retreat direction; all loading operations shall take place away from the travel direction of the drill.	D&B Supervisor
Only personnel directly involved with the drilling and blast hole loading activities are to be within 30 meters of re-drilling operations.	Blaster / D&B Supervisor
No surface delays or detonating cord is to be present within the blast pattern during re-drilling operations.	D&B Supervisor
All down hole Nonel delay detonator ends are to be neatly bundled and tied to the blast hole stake to ensure visibility and minimize the potential of any inadvertent machinery contact.	Blaster
The D/B Supervisor will ensure that the drill operator and blaster walk through the drill pattern prior to moving the drill onto the pattern. The drill operator will be made aware of any loaded blast holes that may come within **2 m** of the machine.	D&B Supervisor
The D/B Supervisor will advise the drill operator which blaster will guide the drill onto the loaded pattern, for the purpose of re-drilling.	Blaster / D&B Supervisor
The D/B Supervisor will ensure that the drill is guided to the re-drill location and, when drilling is complete, ensure a guide is provided for the route of travel out of the loaded pattern.	D&B Supervisor

5.2 Explosives Management

5.2.1 Objective

To provide Supervisors with a safe and effective standard which will ensure the safety of all employees and equipment.

5.2.2 Scope

The Manager shall appoint a person(s) who is/are qualified, certified and authorized under the Mine Health and Safety Act and Regulations of the Northwest Territories / Nunavut to conduct/supervise all blasting operations on the mine site. The Manager shall also be responsible for authorizing persons to enter the explosive magazine for inspection, receiving and issuing of all explosives materials.

5.2.3 Introduction

The NWT / Nunavut Mine, Health & Safety Act and Regulations require a manager to ensure his charges are working safely in a safe environment and in compliance with the regulations, company policy and procedures.

5.2.4 Preparation

- Hazards: Explosives, detonators, delays
- Tools: Blasters Certificate, Supervisor Level I Certificate, Log Book, broom, Mag key

5.2.5 Tasks

Table 5.2-1: Explosives Management

Task	Person Responsible
Ensure a copy of the explosives magazine permit is posted inside the magazine.	Area Manager
Carry out a weekly inspection of the magazine and record the results in a logbook. Inspection shall include; a) Confirm that all weekly entries are properly filled in and accurate. b) Verify that physical counts match with balance. c) Any corrections or adjustments made shall be clearly noted in the log book. d) Inspections will take place and be recorded for each individual product within the mag. e) Any discrepancy identified shall be immediately reported to the supervisor.	Blast / Supervisor
Ensure a record of all explosives issued and received and the inventory of the magazine is kept, and authorized persons sign all entries.	Blaster / Supervisor
Ensure the magazine is kept clean, dry and free from grit at all times.	Blaster / Supervisor
Ensure the stock of explosives is rotated so that the oldest stock is used first.	Blaster / Supervisor

Task	Person Responsible
Ensure all signage is visible and in good condition.	Blast / Supervisor
Ensure that the magazine is locked at all times except when an authorized person is present.	Blast / Supervisor
Ensure all mobile equipment transporting explosives meets or exceed requirements as set out in the Mine Health and Safety Act and Regulations of the NWT / Nunavut.	Blaster / Supervisor
Ensure appropriate records of each primary blast are kept.	Blaster / Supervisor
Ensure all warnings, guarding of access routes and clearance of areas has taken place prior to initiating any blasts.	Blaster / Supervisor
The appointed person has the authority to safely conduct and direct all activities within the blasting area. All employees must support the blaster in exercising this authority	Blaster / Supervisor
Ensure all blasters have a valid blasting certificate issued by the Chief Inspector of Mines.	Blaster / Supervisor
Ensure all persons who are assisting in the preparation or firing of charges is under the direct supervision of a person who is a valid holder of a blasting certificate.	Blaster / Supervisor
All blasters shall deliver their blasting certificates to the Manager or his designate when commencing employment. The certificate will be returned upon termination with the company.	Blaster / Supervisor

6. Blasting Protocol and Procedure

6.1 General Protocol

- All blasting operations will follow all protocol of The Northwest Territories / Nunavut Mine Health and Safety Act and Regulations, as well as standard operating procedures from both TMAC Resources Inc. and subcontractors, whichever is more stringent.
- All records of blasting shall be kept by the Nuna engineering department.
- All blasts will be numbered according to location (i.e. quarry number, bench elevation at grade, and individual blast).
- All loaded boreholes will be recorded by survey prior to blasting, and as-built mapping entered into survey database to eliminate possibility of drilling into bootlegs on benches at lower elevations.
- Daily records of all holes loaded and explosive products used will be maintained, recorded, and submitted with blast reports.
- All blast design will be subject to change and improvement, as site specific geological conditions dictate.
- Wall control issues will be negligible with the plan of day lighting all benches.
- Standard Operating Procedures regarding drilling proximity to bootlegs or misfired holes will be reviewed with all drilling and blasting crews and adhered to for all drilling and blasting operations.
- All production holes are to be drilled vertically, to ensure the integrity of projected bootleg locations.
- Borehole liners are to be used for wet or fractured areas

6.2 Guarding Typical Quarry Excavation

It is imperative that the guards follow the instructions and not leave their assigned area until told so by the Drill & Blast Supervisor. The positions assigned will be outside the Blast Danger Area as determined by the Drill & Blast Supervisor / Blaster.

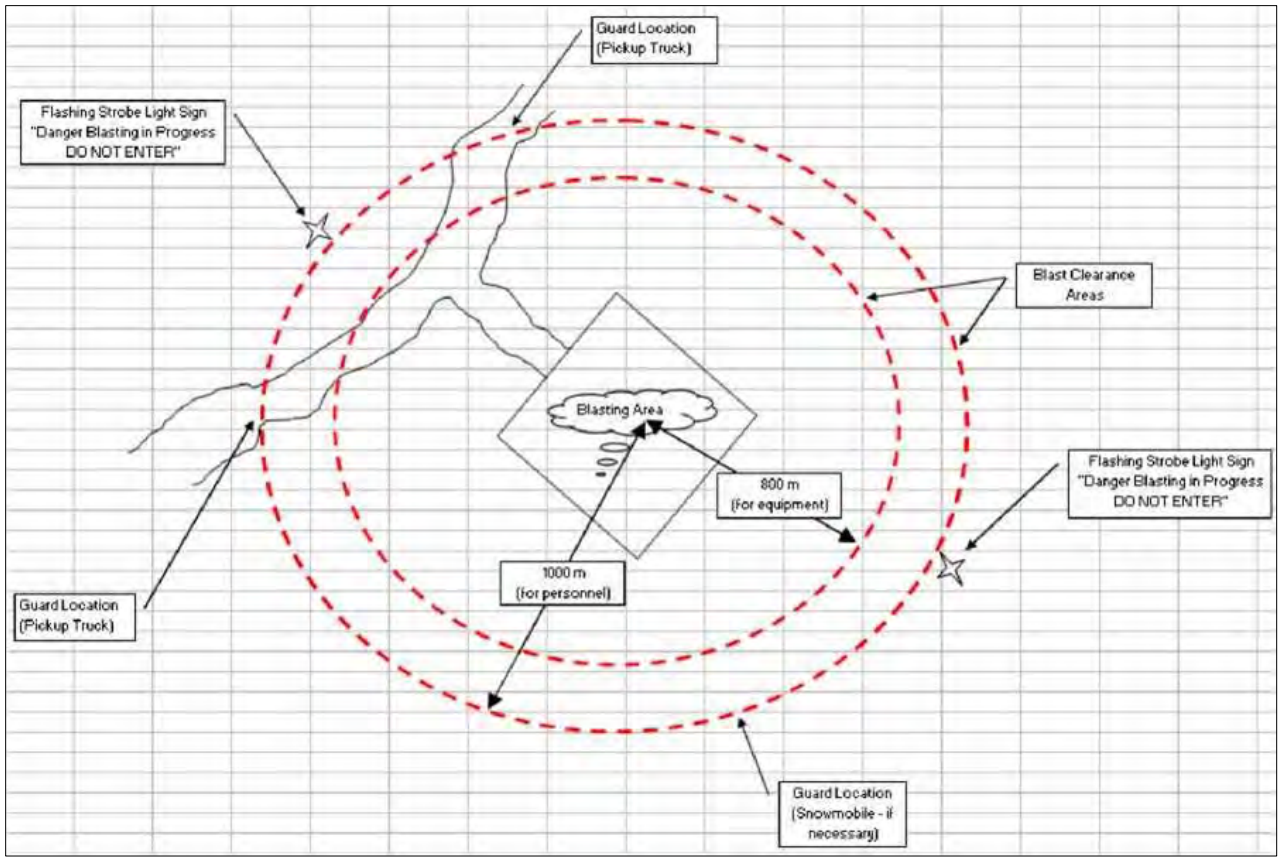
In addition to the guards posted at strategic locations around the blast area, flashing strobe light warning signs are recommended to be placed at the outer perimeter of the blasting danger area. The signs shall be deployed prior to the initiation of each blast, and collected afterwards.

While guarding a blast area, the vehicle window facing the “tundra” side must be rolled down slightly. The vehicle must be turned off and put in auxiliary such that the radio remains functional (alternatively: use a hand held radio).

All blasting will be scheduled during daylight hours. Due to the possibility of shallower cuts, the blasting clearance zones have been increased to 1000 m and 800 m for personnel and equipment respectively.

A typical guarding schematic is as follows:

Figure 6-1: Typical Blast Guarding Layout



6.3 Guarding Procedure

6.3.1 Objective

To provide the Drill & Blast (D&B) Supervisor with a safe and effective procedure for guarding of a blasting operation.

6.3.2 Scope

The D&B Supervisor is responsible to ensure that all employees engaged in the guarding procedure are trained and understand their duties.

The employees assigned the task of guarding are responsible to follow this procedure as directed by the D&B Supervisor.

6.3.3 Introduction

As per NWT / Nunavut Mine Health and Safety Act and Regulations, these precautions are required.

6.3.4 Definitions

- D&B Supervisor: Drill & Blast Supervisor.

6.3.5 Preparation

- Tools: PPE
- Hazards: Slips, Trips, Falls, Personal injury or death

6.3.6 Tasks

Table 6.3-1: Requirements and Responsibilities for guarding a blast.

Task	Person Responsible
The D&B Supervisor, in consultation with the Operations Supervisor, will be responsible for appointing all guards and ensuring each guard is fully versed in their responsibilities	Drill & Blast Supervisor / Operations Supervisor
The D&B Supervisor is responsible for establishing the limits of the danger zone and the guard post locations.	Drill & Blast Supervisor
Upon notification from the D&B Supervisor, all guards will ensure their assigned areas are clear of all personnel and equipment and proceed to their designated guard posts.	Drill &Blast Supervisor / Guards
All guards will notify the D&B Supervisor when they have arrived at their assigned positions, and give a status report of their assigned area.	Drill & Blast Supervisor / Guards
No guard shall leave their position or allow any person to enter the blast area until the D&B Supervisor gives the “All Clear”	Drill & Blast Supervisor
The D&B Supervisor will ensure all guards are in their assigned location.	Drill & Blast Supervisor
The D&B Supervisor will then proceed with the blast as per SWP #IV-0001.1	Drill & Blast Supervisor
Following the blast, the D&B Supervisor will announce on the radio, the “All Clear” message. All guards will be removed, crews can return to work in the blast area and regular radio communications can recommence	D&B Supervisor

6.4 Blasting Procedure

6.4.1 Objective

To provide the Drill & Blast (D&B) Supervisor with a Pre-Blast, Guarding and a Post Blast procedure that will ensure the safety of all personnel and equipment.

6.4.2 Scope

The D&B Supervisor shall ensure that all workers who are assigned the duties of a guard during the blasting operations are trained and understand this procedure.

The workers who are assigned guarding duties during the blasting operations will follow this procedure as directed by the D&B Supervisor.

6.4.3 Introduction

This standard operating procedure is to be used to ensure all employees involved, are trained to understand the blasting procedure.

6.4.4 Definitions

- D&B Supervisor: Drill and Blast Supervisor.

6.4.5 Preparation

- Tools: PPE, Portable radio, Electric blasting cap, Detonating cord, Blasting wire, Blasting machine.
- Hazards: Slips, Trips, Falls, Personal injury of death; Premature detonation.

6.4.6 Tasks

Table 6.4-1: Requirements and Responsibilities for initiation of a Blast Pattern.

Task	Person Responsible
The D&B Supervisor will notify all employees of the impending blasting times during the daily crew line up at the beginning of each shift.	Drill & Blast Supervisor
The D&B Supervisor will ensure that the daily blasting times are posted at quarry entrances and accommodation building blast board 2 hours before the blasting operation is conducted.	Drill & Blast Supervisor
The D&B Supervisor will give a 2 hour blast warning, by radio, to the following people: Operations Supervisor, and Warehouse/Airport operator. Each of these people will acknowledge, by radio, that they have received and understood the 2 hour blast warning.	Drill & Blast Supervisor
The Operations Supervisors will instruct all workers and equipment operators to evacuate the blasting area at the appropriate time.	Operations Supervisor
The D&B Supervisor, in consultation with the blaster, will determine the “Blast Danger Zone”.	Drill & Blast Supervisor / Blaster
The D&B Supervisor, will assign required personnel the duties of guards during the blasting procedure.	Drill & Blast Supervisor / Operations Supervisor
The D&B Supervisor, will designate the areas to be guarded	Drill & Blast Supervisor / Operations Supervisor
The Guards will follow the instructions of the D&B Supervisor as per the SOP	Guards
The D&B Supervisor will give a 10 minute blast warning, by radio, to the following people: Operations Supervisor, and Warehouse/Airport operator. Each of these people will acknowledge, by radio, that they have received and understood the 10 minute blast warning.	Drill & Blast Supervisor
The D&B Supervisor will inspect the Blast Danger Zone and instruct the blaster to begin the pre-blast procedure when the Blast Danger Zone has been cleared of personnel and equipment. The Blaster will lay out the shooting line (detonating cord) from the pattern initiating point to a location approximately 100 m from the blaster’s firing location	Drill & Blast Supervisor

Task	Person Responsible
The Blaster will connect an electric blasting cap to the detonating cord, and then roll out the 100 m of blasting wire from the blasting cap to a safe firing location, ensuring that the blasting wire is kept clear of electrical sources. The blaster will notify the D&B Supervisor when the blast is ready to be initiated.	Blaster
The D&B Supervisor will give a 2 minute blast warning, by radio, and **RADIO silence on Blast Channel 4 only**, to the Operations Supervisor. The Operations Supervisor will acknowledge, by radio, that he has received and understood the 2 minute blast warning.	Drill & Blast Supervisor / Operations Supervisor
The D&B Supervisor will ensure that the blast warning signal siren is sounded for 1 full minute	Drill &Blast Supervisor
At the completion of the 1 minute siren warning, the D&B Supervisor will instruct the blaster to proceed with the initiation of the blast.	Drill & Blast Supervisor / Blaster
The D&B Supervisor will ensure that the all- clear siren is sounded for 20 seconds and announce that regular radio communications may resume.	Drill & Blast Supervisor
The D&B Supervisor will notify the following people of completion of blasting activities: Operations Supervisor, and Warehouse / Airport operator. Each of these people will respond that they have received and understood the blasting activities are complete.	Drill &Blast Supervisor / Medic
The D&B Supervisor will instruct all guards to resume their regular duties	Drill & Blast Supervisor

6.5 Misfires or Cut-off Holes

6.5.1 Objective

To establish a procedure to ensure all misfires/cut-off holes are handled safely and all blasting personnel are fully trained prior to commencing this task

6.5.2 Scope

The Drill/ Blast Supervisor shall be responsible for ensuring the blaster follows all safe work practices when performing work on misfired or cut-off holes. These procedures will be reviewed annually or updated when required.

The blaster is responsible to follow this procedure as required by the D/B Supervisor.

6.5.3 Introduction

The NWT / Nunavut Mine Health Safety Act and Regulations require all personnel be adequately trained to do their jobs safely, inspect their worksite or machinery and understand the lock out procedure and fire prevention apparatus and use.

6.5.4 Definitions

- Bootleg: Part of a drilled blast hole that remains when the force of the explosion does not break the rock completely to the bottom of the hole.
- D/B Supervisor: Drill & Blast Supervisor.

6.5.5 Preparation

- Tools: PPE
- Hazards: Slips, trips, and falls, personal injury or death

6.5.6 Tasks

Table 6.5.-1: Misfires or Cut off Holes

Task	Person Responsible
All workers on a blast pattern will be fully trained in all procedures associated with misfires/cut-off holes.	Workers
Before drilling is commenced, the blaster shall walk the complete pattern to check for any misfire/cut-off holes. The blaster will look for any signs of explosives or lack of ground movement that might indicate a misfire or cutoff hole.	Blaster
No person shall drill in loose rock produced by blasting unless the rock has been thoroughly examined by the blaster for explosives, the pattern has been designed to prevent the overlaying of holes and where a hole is discovered containing explosives, drilling will not be closer than 5 m from the hole.	Driller / Blaster
The D/B Supervisor and driller shall not drill or allow drilling to be conducted within 1 m of any part of a bootleg on a blasting pattern or within 5 m of a misfired hole, a cut-off hole or a hole containing explosives.	D/B Supervisor / Blaster
Where an explosive charge has been misfired or cut-off, no work may be performed in the area other than that required making the area safe.	D/B Supervisor / Blaster
All holes must be inspected for detonators or explosives, the blasting area will remain guarded and the hole re-blasted.	Blaster
Once the hole has been cleaned out, the hole may be re-charged, re-stemmed and blasted	Blaster
A hole may be re-drilled for the purpose of reblasting a missed hole once a Supervisor has determined, after consultation with the driller, the location angle and depth of the hole to be drilled.	D/B Supervisor / Driller
The D/B Supervisor shall supervise the drilling of the hole.	D/B Supervisor
The new hole shall not be closer than 5 m to any part of the missed hole.	Driller
The only explosives that can be removed by washing or lancing from a misfired or cut-off hole include ANFO or slurry/emulsion.	D/B Supervisor / Blaster

Task	Person Responsible
The blast pattern shall not be abandoned until it has thoroughly been examined for the presence of explosives in misfired or cut-off holes.	Blaster
Note: If the blaster suspects a misfire, wait ten minutes, and then proceed to check the blast area.	Blaster

7. Excavating Blasted Muck

7.1 Dig Limits for Loading Equipment

7.1.1 Objective

To provide Supervisors and Equipment Operators with a procedure that will enhance safe-working conditions when mucking to a Loaded Blast Face.

7.1.2 Scope

The Supervisor is responsible to ensure that all Loading Equipment Operators (Backhoe, Face Shovel and Wheel Loaders) are trained and understand this procedure.

All Loading Equipment Operators are responsible to follow the procedure as directed by the Supervisor.

7.1.3 Introduction

NWT / Nunavut Mine Health and Safety Act and Regulations: require all personnel be adequately trained to do their jobs safely, inspect their work site or machinery and understand the lock out procedure and fire prevention apparatus and use.

7.1.4 Preparation

- Hazards: Slips, Trips, and Falls
- Tools: Metric measuring tape, red fluorescent paint, survey instrument, stakes, hammer, PPE

7.1.5 Tasks

Table 7.1-1: Requirements and Responsibilities for mucking into a loaded blast face.

Task	Person Responsible
Prior to loading material from any blasted muck pile, the Supervisor will inspect the blasted area. He will consult with the Drill & Blast Supervisor, to ascertain if there is a charged blast pattern adjacent to the Blasted Material.	Supervisor
The Drill & Blast Supervisor will measure 8 meters perpendicular in front of each charged blast hole in the direction of the blasted material that is to be loaded and position red fluorescent pylons (construction cones) parallel to the charged blast holes.	D&B Supervisor/ Surveyor
The Supervisor is responsible for ensuring that the “Dig Limits” Pylons are in place before loading operations commence.	Supervisor
When facing up the Loading Equipment Operators must stop at the pylons. If a pylon falls down the muck pile the operator must inform the Supervisor immediately. The Loading Equipment will then move laterally to continue progressive loading of the muck pile.	Operator

Annex 19

Air Quality Management Plan

AIR QUALITY MANAGEMENT PLAN

HOPE BAY PROJECT, NUNAVUT

September 2016

PLAIN LANGUAGE SUMMARY

This Air Quality Management Plan (AQMP; the Plan) describes the air quality management and monitoring practices for the Hope Bay Project (the Project).

The AQMP outlines legislation and guidance relevant to the Plan, and describes the potential Project-related sources of emissions to the air, including dust, and the mitigation measures that TMAC will implement during mine construction, operations and care and maintenance. The Plan also describes the air quality monitoring that will be conducted. The Plan is intended primarily for use by TMAC and its contractors to ensure that best practices are employed at the Project, thus ensuring water licence and project certificate conditions are met and minimal environmental impacts occur.

REVISION RECORD

Revision #	Date	Section	Summary of Changes	Author	Approver
0	October 2006	Throughout	Original. Approved plan under 2AM-DOH1323	Golder	HBML (Hope Bay Mining Ltd.)
1	March 2011	Throughout	General revision	Rescan	HBML
2	October 2012	Throughout	Modification for care and maintenance, general revision	Newmont, Hope Bay Mining Company Ltd.	HBML, NWB
3	June 2015	Throughout	Update TMAC as current licensee, revised plan management responsibilities and template change. Added tailings deposition as a point source, snow core dustfall monitoring, tailings dustfall monitoring, and control measures to mitigate dustfall arising from tailings deposition.	ERM/TMAC	TMAC
4	September 2016	Throughout	Modularization in alignment with other TMAC plans, revisions in consideration of project amendment, revisions to dustfall monitoring program, inclusion of pollutant release quantification and reporting (NPRI and GHG reporting), and removal of passive air quality monitoring.	TMAC/ERM	TMAC

GLOSSARY AND ACRONYMS

TERM	DEFINITION
Air Quality Standards	Objectives for maximum concentrations of criteria air contaminants in the atmosphere developed to ensure long-term protection of public health and the environment.
AAAQO	Alberta Ambient Air Quality Objective
AEP	Alberta Environment & Parks
Ambient Air Quality	The outdoor air quality at a particular site.
AQMP	Air Quality Management Plan
ASTM	American Society for Testing and Materials
BC MoE	British Columbia Ministry of Environment
CAAQS	Canadian Ambient Air Quality Standards
CALA	Canadian Association for Laboratory Accreditation
Carbon Monoxide (CO)	Carbon monoxide is a colourless, odourless gas emitted from combustion processes. CO can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues.
CCME	Canadian Council of Ministers of the Environment
CEPA	Canadian Environmental Protection Act
CO_2e	CO_2 equivalent is the measure of the global warming potential of greenhouse gases relative to CO_2, which has a global warming potential of 1.
Criteria Air Contaminants (CACs)	Contaminants for which environmental regulatory agencies have established ambient air concentration limits.
CWS	Canada Wide Standards
Dioxins	Polychlorinated dibenzodioxins (PCDDs), or simply dioxins, are a group of polyhalogenated compounds which are significant because they act as environmental pollutants. They are commonly referred to as dioxins for simplicity in scientific publications because every PCDD molecule contains a dioxin skeletal structure. Members of the PCDD family have been shown to bioaccumulate in humans and wildlife due to their lipophilic properties.
Doris	The Doris North Project
Dustfall	The fraction of heavier airborne particulate material that quickly falls out of the atmosphere and settles on the ground surface when particulate matter is released in to the atmosphere.
ECCC	Environment and Climate Change Canada
EC-EPS	Environment Canada–Environmental Protection Service
FEIS	Final Environmental Impact Statement

TERM	DEFINITION
Fugitive Dust	Particulate matter, often sand or mineral dust, released to the atmosphere by mechanical disruption of soil or by wind scouring.
Furans	Polychlorinated dibenzofurans (PCDFs), or simply furans, are a group of halogenated organic compounds which are toxic environmental pollutants. PCDFs tend to co-occur with polychlorinated dibenzodioxins (PCDDs). PCDFs can be formed by pyrolysis or incineration at temperatures below 1,200°C of chlorine containing products, such as PVC, PCBs, and other organochlorides, or of non-chlorine containing products in the presence of chlorine donors.
GHG	Greenhouse Gas
GHGRP	Greenhouse Gas Emissions Reporting Program
GN	Government of Nunavut
HBML	Hope Bay Mining Ltd.
Mercury	Mercury is a natural and persistent bioaccumulative element which can be transported many miles in the atmosphere; mercury can have impacts many years and many miles removed from its original source. A common thread through all mercury impacts is that deposition to waterbodies from anthropogenic emissions poses a threat to human and ecosystem health. Mercury also enters into the environment through the disposal (e.g., land filling, incineration) of certain products. Products containing mercury include: auto parts, batteries, fluorescent bulbs, medical products, thermometers, and thermostats.
NAAQO	National Ambient Air Quality Objectives
NAPS	National Air Pollution Surveillance Program
NIRB	Nunavut Impact Review Board
NPRI	National Pollutant Release Inventory
NWB	Nunavut Water Board
Oxides of Nitrogen (NO_x)	NO_x gas primarily consists of nitrogen oxide (NO) and nitrogen dioxide (NO_2). The gases are emitted with exhaust from combustion engines and products from blasting operations. NO_x can be converted to nitric acid in the atmosphere and thus contribute to acid deposition.
PM_{10}	Inhalable particulate matter. PM_{10} particles are airborne particles that have a diameter of 10 µm or less and are thus a subset of total suspended particulate. The majority of PM_{10} particles are from fugitive dust sources. PM_{10} can enter the respiratory system and have been linked to health problems.

TERM	DEFINITION
$PM_{2.5}$	Respirable particulate matter $PM_{2.5}$ particles are a subset of PM_{10} and are defined as particles with a diameter less than 2.5 µm. These particles are small enough to enter deep into the respiratory system. The majority of PM emitted in diesel engine exhaust is $PM_{2.5}$.
PVC	Polyvinylchloride; a type of plastic
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
Sulphur Dioxide (SO_2)	Fossil fuel contains a small amount of organic compounds. During fuel combustion, the sulphur is oxidized and emitted as SO_2 gas with the engine exhaust. In the atmosphere, SO_2 can further oxidize to sulphate particles, which contribute to acid deposition.
TIA	Tailings Impoundment Area
TIA OMS	Tailings Impoundment Area Operations, Maintenance, and Surveillance Manual
the Project	The Hope Bay Project
TMAC	TMAC Resources Inc.
Total Suspended Particulates (TSP)	TSP are solid matter or liquid droplets having aerodynamic particle sizes from 0.01 to 100 µm in diameter and larger from smoke, dust, fuel ash, or condensing vapours that can be suspended in the air.
US EPA	United States Environmental Protection Agency. The US EPA has promulgated a variety of guidelines, objectives, emission factors, air dispersion modelling procedures and statutes for the protection of ambient air quality.

TABLE OF CONTENTS

1. Introduction 7
1.1. Purpose 7
1.2. Relevant Legislation and Guidance 7
1.3. Related TMAC Documents and Programs 8
1.4. Plan Management 9
2. Air Quality Mitigation and Management 9
3. Adaptive Management and Continuous Improvement 10
Module A: Doris 12
A1. Introduction 15
A2. Monitoring and Evaluation 19
A3. Reporting and Management Feedback 26
References 28

List of Figures

Figure A.1 Doris Air Quality Management Area 16
Figure A.2 Doris Air Quality Monitoring Program Stations 20

List of Tables

Table 1: Regulations, Standards, Guidelines and Objectives Pertinent to the Air Quality Management Plan 8
Table 2: Documents Related to the Air Quality Management Plan 8
Table A.1 Relevant Ambient Air Quality Guidelines, Objectives & Standards 17
Table A.2 FEIS Predictions for the Doris North Project 18
Table A.3 Canada Wide Standards for Dioxins and Furans and Mercury 18
Table A.4 Doris North Air Quality Monitoring Program 19
Table A.5 Reasons for Dustfall Sampling Location Selection 21

1. INTRODUCTION

This AQMP has been prepared by TMAC Resources Inc. (TMAC) in accordance with authorizations held by TMAC associated with developments throughout the Hope Bay Belt region.

The Plan is intended primarily for use by TMAC and its contractors to ensure that best practices for air quality are followed, and that the conditions of regulatory requirements are met. This Plan is applicable to mining construction, operations and care and maintenance phases.

This AQMP is structured in a manner such that one plan pertaining to air quality is approved and implemented across all Project sites, while still addressing site- and licence-specific requirements. The main document outlines the approach to air quality management and mitigation as it pertains to all Project sites. Subsequent modules outline the monitoring that will be conducted for each site, which are dictated by the associated water licence and Project Certificate (where applicable) or site-specific environmental assessment predictions. In the event of a new water licence or an existing licence or certificate amendment, only the specific modules pertaining to that site will need to be revised. This plan format is intended for consistency and efficiency in compliance management and across operations.

1.1. PURPOSE

The purpose of the AQMP is to outline the mitigation and management measures that will be implemented to manage and reduce air emissions resulting from the Project and to outline the continual assessment, monitoring, and reporting of emissions that will take place during mine construction, operations and care and maintenance phases.

Through implementation of this Plan, TMAC will:

- Ensure air quality emissions are minimized, and are within expectations and applicable limits where applicable;
- Comply with monitoring requirements outlined in applicable water licences, project certificates, and regulations;
- Ensure air emissions are quantified where and as required.

Monitoring will be conducted as outlined in the licence-specific modules attached to this document.

1.2. RELEVANT LEGISLATION AND GUIDANCE

Table 1 provides a summary of federal and territorial regulations, standards, guidelines and objectives with relevance to the Hope Bay Project AQMP, as well as supplementary provincial guidance where territorial regulations, standards, guidelines or objectives are absent.

Table 1: Regulations, Standards, Guidelines and Objectives Pertinent to the Air Quality Management Plan

Regulation	Year	Governing Body	Relevance
Canadian Environmental Protection Act – National Pollutant Inventory Release Reporting Program	1993 and amendments	Environment and Climate Change Canada (ECCC)	Report on emissions meeting NPRI reporting thresholds.
Canadian Environmental Protection Act – Greenhouse Gas Emissions Reporting Program	2004 and amendments	ECCC	Facilities emitting 50,000 tonnes or more of greenhouse gases in carbon dioxide equivalent (CO_2e) per year are required to submit a report.
Standard/Guideline/Objective	**Year**	**Issued by**	**Relevance**
Canada Wide Standards (CWS) for Dioxins and Furans and Mercury	2001	Canadian Council of Ministers of the Environment (CCME)	Requirements for stack emissions of Dioxins and Furans and Mercury
Canadian Environmental Quality Guidelines	1999 and amendments	CCME	Outlines Canadian Ambient Air Quality Standards (CAAQSs) for Particulate Matter with diameter < 2.5 µm ($PM_{2.5}$)
National Ambient Air Quality Objectives (NAAQO);	2013	ECCC	Objective for Total Suspended Particulate (TSP)
Government of Nunavut (GN) Environmental Guideline for Air Quality	2011	GN	Standards for $PM_{2.5}$ and TSP
Alberta Ambient Air Quality Objective (AAAQO) for Dustfall	2013	Alberta Environment & Parks (AEP)	Dustfall guideline
British Columbia Ministry of Environment (BC MoE) Level B Objective for PM_{10} (BC MoE 2011)	2011	BC MoE	Objective for PM_{10}

1.3. Related TMAC Documents and Programs

Table 2 provides a summary of documents related to the Hope Bay *Air Quality Management Plan*.

Table 2: Documents Related to the Air Quality Management Plan

Document Title	Relevance
Tailings Impoundment Area Operations, Maintenance and Surveillance Program	Management of dust from the tailings impoundment area (TIA)

Incinerator Management Plan	Outlines management of the Incinerator for the reduction of dioxins, furans, and mercury emissions
Non-Hazardous Waste Management Plan	Outlines waste segregation, including appropriate wastes for incineration
Wildlife Mitigation and Monitoring Plan	Evaluation of TIA dust impacts to caribou
Hope Bay Spill Contingency Plan	Spill response and clean-up procedures

1.4. PLAN MANAGEMENT

The AQMP is reviewed annually and updated as needed. Personnel responsible for implementing and updating the AQMP are identified in Table 3.

Table 3: Roles and Responsibilities

Role	Responsibility
Vice President, Environmental Affairs	• Overall responsibility for this AQMP • Provide the necessary resources to operate and maintain monitoring and analysis within the AQMP
Vice President, Operations (or designate)	• Provide the on-site resources to implement the mitigation measures in accordance with this management plan • Ensure equipment maintenance and usage records are kept as required for reporting or audit
Director, Environmental Affairs (or designate)	• Review and update this AQMP as required • Maintain database of collected air quality samples analysis • Ensure reporting requirements are met

This plan is designed to be adaptive, effective, and achievable in both the short and long term. Components of the AQMP may need to be revised over the life of the Project based on regulatory changes and/or technological advances. Any modifications made to the overall Plan will be provided to regulatory authorities for review.

2. AIR QUALITY MITIGATION AND MANAGEMENT

Management and mitigation measures have been designed to protect ambient air quality during all phases of mining. Key project activities that will require management and mitigation include:

- All phases of mining: operation of light vehicles and heavy equipment and stationary equipment such as generators;
- Construction: blasting and crushing; and
- Operation: activities associated with mining, ore processing, and tailings deposition.

The AQMP outlines:

- Control measures that are already in place or that will be established to mitigate combustion and fugitive emissions from all mining phases;
- Control measures to mitigate dustfall arising from tailings deposition; and

- Monitoring programs to collect on-site air quality and meteorological data to allow for an adaptive approach to air quality management during all phases of mine development and operation.

TMAC is committed to complying with applicable licences and authorizations, and has worked with regulators to develop appropriate on-site air quality mitigation measures and monitoring plans. In an ongoing effort to mitigate air contaminant and dust emissions during mine construction, operations, and care and maintenance phases, TMAC is currently implementing or plans to implement the following measures:

- Vehicles are driven at designated speeds on site roads;
- Vehicle and equipment idling is minimized when not in use and able to do so;
- All mobile and stationary engines are regularly serviced to maintain efficiency;
- A preventive maintenance program is in place for all machinery and equipment;
- On-site staff at all levels have the necessary training and instruction in their duties relating to process control and air emissions (e.g., the required measures to be implemented during start-up, shut down and abnormal conditions);
- Dust suppression is applied to roadways to minimize dust from ore and waste rock haulage, site road traffic and maintenance (grading) when ambient air temperatures permit. The methods used are implemented either in accordance with the Nunavut Environmental Guideline For Dust Suppression (GN 2002) or as otherwise approved with all water usage tracked;
- Discharge heights from the crushers onto conveyers, and conveyors onto stockpiles are minimized. In addition, the discharge from crushers onto conveyors or into other equipment is enclosed where practicable;
- Water or suitable suppressants as listed in the TIA Operations, Maintenance, and Surveillance (OMS) Manual or otherwise approved by the Nunavut Water Board (NWB) will be utilized to suppress dust generation from tailings in the TIA.
- Storage areas are kept in a condition that does not give rise to visible dust emissions;
- Waste oil burners are equipped with a settling tank and filter system for particulate removal from the waste oil;
- Only appropriate materials are open burned, in accordance with applicable licence requirements and relevant guidance; and
- Incinerator waste streams are carefully managed to reduce emissions of dioxins and furans, and mercury.

Specific mitigation measures in place for the operation of incinerators include:

- Implementation of a waste reduction program to reduce overall waste incinerated;
- Waste segregation to divert materials that are unsuitable for incineration (e.g., chlorinated plastics such as polyvinylchloride [PVC] plastic);
- Properly trained incinerator operators;
- Stack testing to determine compliance with standards when required; and
- All permits, authorizations and approvals are complied with.

3. Adaptive Management and Continuous Improvement

The primary dust control adaptive management measure will be the use of environmentally suitable dust suppressants when visible dust concerns are noted. The application method will be in accordance with the Nunavut Environmental Guideline for Dust Suppression (GN 2002) or as otherwise approved. The application of suppressants will be reviewed on an ongoing basis to ensure that dust is controlled in high activity areas. Generally, annual application of chemical suppressants will be completed; however it is

recognized that more frequent applications may be required as dust source locations change throughout the year. Water dust suppression will also be used where appropriate.

Should additional dust mitigation be needed, measures may include, but are not limited to:

- Contouring of stockpiles to reduce wind erosion on the stockpiles;
- Covering or enclosure of stockpiles or other dust sources to reduce wind contact;
- Installation of other engineering controls such as wind fences;
- Additional training of employees and contractors on dust mitigation measures; and
- Enhancement of the maintenance and mitigation measures presented above.

Exceedances of dustfall guidelines or predictions will be investigated to determine the potential source(s). Based on the investigation, TMAC will identify and implement specific mitigation measures to suppress the most likely sources of fugitive dust emissions.

If monitoring data for other parameters are found to be in exceedance of applicable standards, objectives, or predictions, or are showing an increasing trend in contaminant concentrations, adaptive management options will also be assessed and applied. The need for any corrective actions to reduce on-site emissions or install additional control measures will be determined on a case-by-case basis.

AIR QUALITY MANAGEMENT PLAN

MODULE A: DORIS

September 2016

CONFORMITY TABLE

Licence	Part	Item	Topic	Document Section
2AM-DOH1323	G	5	The Licensee shall dispose of all food waste in an incinerator designed for this purpose and meets the requirements of the Canada-Wide Standards for Dioxins and Furans and Canada-Wide Standards for Mercury emissions or other standards as they become available.	A1.2 & A2.3
	Schedule B	12	[the Annual Report shall include] Incineration stack testing results	A3
	Schedule D	1	The Construction Monitoring Report referred to in Part D, Item 8 shall include the following: Item i. Monitoring of dust generation and use of water by the contractor to manage dust emissions from crushing and construction activity.	2 & A2.1
No. 003		8	HBML will fund and install a weather station at the mine site to collect atmospheric data, including air temperature and precipitation. The design and location of this station shall be developed in consultation with Environment Canada officials.	A2.5
		8	Commentary: Prior to closure and reclamation, NIRB expects [TMAC] to undertake consultation with appropriate agencies including INAC and EC, to discuss the possibility of the continued operation of the station, including transfer of ownership, for the collection of regional meteorological data.	A2.5
		30	HBML will install and fund an atmospheric monitoring station. This station and its location shall be developed in consultation with environment Canada and Health Canada air quality officials and focus on particulates of concern generated at the mine site. The results of air-quality monitoring are to be reported every six months to NIRB through the Monitoring Officer, and from there to all of the parties.	A2.1 & A2.2
		30	Commentary: NIRB expects that Canada Wide Standards for Dioxins and Furans and the Canada Wide Standards for Mercury will apply and should be followed including stack testing of incinerators.	A2.3

No.003 NIRB Recommended Revisions		8	**The Proponent** will fund and install a weather station at the mine site to collect atmospheric data, including air temperature and recipitation. The design and location of this station shall be developed in consultation with Environment **and Climate Change** Canada **(ECCC)** officials.	A2.5
		8	Commentary: Prior to closure and reclamation, NIRB expects MHBL **the Proponent** to undertake consultation with appropriate agencies including **Indigenous and Northern Affairs Canada** INAC and EC**CC**, to discuss the possibility of the continued operation of the station, including transfer of ownership, for the collection of regional meteorological data.	A2.5
		30	The Proponent will install and fund an atmospheric monitoring station. This station and its location shall be developed in consultation with Environment and Climate Change Canada and Health Canada air quality officials and focus on particulates of concern generated at the mine site. The results of air-quality monitoring are to be reported every six (6) months to the Nunavut Impact Review Board through the Monitoring Officer, and from there to all of the parties.	A2.1 & A2.2
		30	**Commentary:** NIRB expects the Canada Wide Standards for Dioxins and Furans and the Canada Wide Standards for Mercury will apply and should be followed including stack testing of incinerators. **The Nunavut impact Review Board has noted that atmospheric monitoring station has been installed on site.**	A2.3

A1. INTRODUCTION

This Module of the AQMP applies to the amended Doris North Project (Doris) which includes all surface infrastructure associated with the mineralized zones that can be accessed from the existing Doris Portal including those zones known as Connector and Central. Figure 1-1 shows the air quality management area covered under the Doris AQMP.

The main document of this Plan outlines the mitigation and management measures applied throughout the Hope Bay Belt Project, whereas this module focuses on the monitoring related to the Doris North Project applicable to Construction, Operations, and Care and Maintenance phases.

The following permits related to air quality are currently held for Doris:

- Doris North Gold Mine Project Certificate No. 003 (issued September 15, 2006); and
- Nunavut Water Board Type A Water Licence No. 2AM-DOH1323 (issued August 16, 2013).

Further, The Doris North Project also reports Greenhouse Gas (GHG) emissions to the ECCC Greenhouse Gas Emissions Reporting Program (GHGRP) as well as Criteria Air Contaminants (CACs) under the ECCC National Pollutant Release Inventory (NPRI) reporting program.

A1.1. Air Emission Sources

The Doris North Project has a variety of potential sources of point and non-point air emissions during construction, operations, and, to a lesser extent, care and maintenance phases. These include, but are not limited to:

- Generators;
- Portable heaters (e.g., Herman Nelson heaters), and light plants (e.g., Whacker Light Plants);
- Waste oil burners;
- Mine air heaters;
- Mill and processing plant;
- Heavy equipment and vehicles (underground and surface);
- Light duty equipment (surface, e.g., skidsteers);
- Light duty vehicles;
- Incinerators;
- Burn pans;
- Unpaved roads;
- Quarries;
- Crushing activities;
- Tailings Impoundment Area; and
- Crushed rock/overburden stockpiles.

Emissions sources are inventoried, and releases quantified, annually for the purpose of GHG and NPRI reporting.