

**Appendix G8: Alternatives Evaluation – Fuel Type for Mining Equipment**

Alternative Method Design Assumptions	
Diesel Fuel	Blended Liquefied Natural Gas (LNG) / Diesel Fuel
<ul style="list-style-type: none"> <li>Standard mining equipment using diesel as a fuel source would be used for the Project.</li> <li>No effects on the landscape anticipated, since this relates to equipment type.</li> </ul>	<ul style="list-style-type: none"> <li>Conversion kits for standard diesel equipment would be used (not currently available for the truck size required for the Project).</li> <li>No effects on the landscape anticipated, since this relates to equipment type.</li> </ul>

Alternative Method			
Valued Component (VC)/Criteria	Indicators	Diesel Fuel	Blended LNG / Diesel Fuel
<b>Natural Environment</b>			
Atmospheric Environment	Climate change as measured by change in greenhouse gases (GHGs)	<b>Construction/Operation/Closure:</b> Increased GHG emissions from the use of diesel in mining equipment.	<b>Construction/Operation/Closure:</b> Increased GHG emissions from the use of diesel and LNG in mining equipment, however the amount of GHG emissions would be substantially less than the use of full diesel.
	Change in ambient air quality parameters	<b>Construction/Operation/Closure:</b> Change in ambient air quality parameters expected because the use of diesel will result in emissions such as NOx and particulate matter through combustion.	<b>Construction/Operation/Closure:</b> Change in ambient air quality parameters expected because the use of diesel and LNG will result in emissions such as NOx and particulate matter through combustion, however the amount of emissions would be substantially less than the use of full diesel.
<b>Overall Atmospheric Environment Ranking</b> <i>Key differentiating factor – the potential for effects is different between identified alternatives.</i>		<b>Disadvantage</b> Effect on the atmospheric environment expected from the combustion of diesel resulting in emissions.	<b>Advantage</b> Effect on the atmospheric environment expected from the combustion of LNG and diesel resulting in emissions; however, the effect would be substantially lower than the use of full diesel as LNG results in lower emissions.
Acoustic Environment	Change in noise or vibration levels	<b>Construction/Operation/Closure:</b> Fuel type will not affect noise and vibration levels of heavy machinery.	<b>Construction/Operation/Closure:</b> Fuel type will not affect noise and vibration levels of heavy machinery.
<b>Overall Acoustic Environment Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No effect on the acoustic environment anticipated because the type of fuel used will not result in a change to noise and vibration levels.	<b>Neutral</b> No effect on the acoustic environment anticipated because the type of fuel used will not result in a change to noise and vibration levels.
Groundwater	Change in groundwater quantity or flow	<b>Construction/Operation/Closure:</b> No change in groundwater quantity and flow because the fuel supply will not interact with groundwater.	<b>Construction/Operation/Closure:</b> No change in groundwater quantity and flow because the fuel supply will not interact with groundwater.
	Change in groundwater quality	<b>Construction/Operation/Closure:</b> No change in groundwater quality because the fuel supply will not interact with groundwater. An appropriate spills management plan will be put in place to mitigate potential effects of accidental spills on water quality.	<b>Construction/Operation/Closure:</b> No change in groundwater quality because the fuel supply will not interact with groundwater. An appropriate spills management plan will be put in place to mitigate potential effects of accidental spills on water quality.
<b>Overall Groundwater Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No effect on groundwater anticipated because the fuel supply will not interact with groundwater.	<b>Neutral</b> No effect on groundwater anticipated because the fuel supply will not interact with groundwater.
Surface Water	Change in surface water quantity or flow	<b>Construction/Operation/Closure:</b> No change in surface water quantity and flow because the fuel supply will not interact with surface water features.	<b>Construction/Operation/Closure:</b> No change in surface water quantity and flow because the fuel supply will not interact with surface water features.
	Change in surface water quality	<b>Construction/Operation/Closure:</b> No change in surface water quality anticipated because the fuel source should not interact with surface water features. An appropriate spills management plan will be put in place to mitigate potential effects of accidental spills on water quality.	<b>Construction/Operation/Closure:</b> No change in surface water quality anticipated because the fuel source should not interact with surface water features. An appropriate spills management plan will be put in place to mitigate potential effects of accidental spills on water quality.
<b>Overall Surface Water Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No effect on surface water anticipated because the fuel supply will not interact with surface water features.	<b>Neutral</b> No change to surface water anticipated because the fuel supply will not interact with surface water features.

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Fish and Fish Habitat	Change in fish habitat	<b>Construction/Operation/Closure:</b> No change in fish habitat or mortality or sub-lethal effects expected because the fuel supply will not interact with fish or fish habitat. An appropriate spills management plan will be put in place to mitigate potential effects of accidental spills on fish and fish habitat.	<b>Construction/Operation/Closure:</b> No change in fish habitat or mortality or sub-lethal effects expected because the fuel supply will not interact with fish or fish habitat. An appropriate spills management plan will be put in place to mitigate potential effects of accidental spills on fish and fish habitat.
	Change in fish		
<b>Overall Fish and Fish Habitat Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No effect on fish and fish habitat anticipated because the fuel supply will not interact with fish or fish habitat.	<b>Neutral</b> No effect on fish and fish habitat anticipated because the fuel supply will not interact with fish or fish habitat.
Vegetation Communities	Change in abundance of vegetation species of interest	<b>Construction/Operation/Closure:</b> No change in abundance of vegetation species of interest or change in abundance and condition of upland vegetation communities expected because the type of fuel supply will not interact with upland vegetation.	<b>Construction/Operation/Closure:</b> No change in abundance of vegetation species of interest or change in abundance and condition of upland vegetation communities expected because the type of fuel supply will not interact with upland vegetation.
	Change in abundance and condition of upland vegetation communities		
	Change in wetland function or connectivity	<b>Construction/Operation/Closure:</b> No change in wetland function and connectivity expected because the type of fuel supply will not interact with wetlands.	<b>Construction/Operation/Closure:</b> No change in wetland function and connectivity expected because the type of fuel supply will not interact with wetlands.
<b>Overall Vegetation Communities Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No effect on upland vegetation or wetlands anticipated because the type of fuel used will not result in any vegetation removal.	<b>Neutral</b> No effect on upland vegetation or wetlands anticipated because the type of fuel used will not result in any vegetation removal.
Wildlife and Wildlife Habitat	Change in movement, health or mortality risk of wildlife	<b>Construction/Operation/Closure:</b> No change in movement, health and mortality risk of wildlife or change in wildlife habitat expected because the fuel type will not result in any removal of wildlife habitat, barriers to movement or mortality of wildlife.	<b>Construction/Operation/Closure:</b> No change in movement, health and mortality risk of wildlife or change in wildlife habitat expected because the fuel type will not result in any removal of wildlife habitat, barriers to movement or mortality of wildlife.
	Change in wildlife habitat		
<b>Overall Wildlife and Wildlife Habitat Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No effect on wildlife and wildlife habitat expected because the fuel type will not result in any removal of wildlife habitat, barriers to movement or mortality of wildlife.	<b>Neutral</b> No effect on wildlife and wildlife habitat expected because the fuel type will not result in any removal of wildlife habitat, barriers to movement or mortality of wildlife.

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<b>Social Environment</b>			
Community Services and Infrastructure	Change in capacity of housing and accommodation	<b>Construction/Operation/Closure:</b> No change in capacity of housing and accommodation, capacity of health and emergency services and infrastructure, or capacity of recreation and entertainment services and infrastructure expected because the fuel type would not result in an increase in population or demand on services and infrastructure. Diesel could be sourced relatively locally, providing the potential to improve community services and infrastructure through local contract sourcing.	<b>Construction/Operation/Closure:</b> No change in capacity of housing and accommodation, capacity of health and emergency services and infrastructure, or capacity of recreation and entertainment services and infrastructure expected because the fuel type would not result in an increase in population or demand on services and infrastructure. However, sourcing LNG for the Project may provide an opportunity to increase the availability of LNG for local residents and Aboriginal communities, potentially reducing costs to acquire LNG in the region.
	Change in capacity of health and emergency services and infrastructure		
	Change in the capacity of recreation and entertainment services and infrastructure		
	Change in the capacity provincial and municipal services and infrastructure		
<b>Overall Community Services and Infrastructure Ranking</b> <i>Key differentiating factor – the potential for effects is different between identified alternatives.</i>		<b>Disadvantage</b> Potential opportunity to enhance community services and infrastructure through local contract sourcing of diesel fuel, but no opportunity to enhance LNG availability for local residents and Aboriginal communities in the region.	<b>Advantage</b> Sourcing LNG for the Project may provide an opportunity to increase the availability of LNG for local residents and Aboriginal communities, potentially reducing costs to acquire LNG in the region.
Operational Health and Safety	Health and safety of mine workers	<b>Construction/Operation/Closure:</b> No effect on the health and safety of mine workers expected because the Project will be designed in consideration of avoiding the potential for operational failures that could lead to injury of workers.	<b>Construction/Operation/Closure:</b> No effect on the health and safety of mine workers expected because the Project will be designed in consideration of avoiding the potential for operational failures that could lead to injury of workers.
	Health and safety of local residents	<b>Construction/Operation/Closure:</b> No change in the health and safety of local residents expected because the fuel will be used in equipment within the Project development area (PDA) where access will be restricted to local residents.	<b>Construction/Operation/Closure:</b> No change in the health and safety of local residents expected because the fuel will be used in equipment within the PDA where access will be restricted to local residents.
<b>Overall Operational Health and Safety Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No effects on health and safety for the Project as planned are expected because the type of fuel used would not change the potential for health and safety risks.	<b>Neutral</b> No effects on health and safety for the Project as planned are expected because the type of fuel used would not change the potential for health and safety risks.
<b>Economic Environment</b>			
Cost	Capital cost, Operational/maintenance cost, Rehabilitation/closure cost	<b>Construction:</b> Lower initial capital costs for establishing fuelling infrastructure. <b>Operation:</b> Comparable maintenance costs. Higher operational costs due to the higher price of diesel over LNG. <b>Closure:</b> Comparable closure costs for the removal of infrastructure.	<b>Construction:</b> Higher initial capital costs for establishing fuelling infrastructure and acquiring or upgrading equipment. <b>Operation:</b> Comparable maintenance costs. Lower operational costs due to the reduced price of LNG over diesel. <b>Closure:</b> Comparable closure costs for the removal of infrastructure.
<b>Overall Cost Ranking</b> <i>Key differentiating factor – the potential for effects is different between identified alternatives.</i>		<b>Advantage</b> Lower capital costs, with higher fuel costs spread over the life of mine (LOM).	<b>Disadvantage</b> Higher capital costs but lower fuel costs over the LOM. The substantial investment early in development required may be cost prohibitive until production ramps up. Consideration of truck delivery of LNG before plant commissioning will be made depending on the economics.

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Labour and Economy	Change in labour	<b>Construction/Operation/Closure:</b> The fuel type will not result in additional labour force or income for local business or government.	<b>Construction/Operation/Closure:</b> The fuel type will not result in additional labour force or income for local business or government.
	Change in economy		
<b>Overall Labour and Economy Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> The fuel type will not result in additional labour force or income for local business or government.	<b>Neutral</b> The fuel type will not result in additional labour force or income for local business or government.
Technical Feasibility	Ability to implement /commonly used technology in similar applications	<b>Construction/Operation/Closure:</b> Diesel is a widely used and readily available fuel type for heavy industrial machinery.	<b>Construction/Operation/Closure:</b> Technology for blended LNG/diesel use has been trialed successfully for the size class of trucks required for the Project. Conversion kits are not currently commercially available for the specific truck size required, however it is expected that development of the technology will continue and it will be available in the future.
	Effectiveness/reliability	<b>Construction/Operation/Closure:</b> Diesel is a reliable source of fuel used in many industries.	<b>Construction/Operation/Closure:</b> Blended LNG/diesel is a reliable source of fuel.
<b>Overall Technical Feasibility Ranking</b> <i>Key differentiating factor – the potential for effects is different between identified alternatives.</i>		<b>Advantage</b> Provides a commonly used, reliable fuel supply.	<b>Disadvantage</b> Provides a successfully tried technology, when commercially available, however conversion kits are not currently commercially available for the specific truck size required.
<b>Cultural Environment</b>			
Heritage Resources	Change in archaeological sites	<b>Construction/Operation/Closure:</b> No change in heritage resources expected because the type of fuel used will not result in any removal, disruption or displacement of archaeological sites or architectural or historical resources.	<b>Construction/Operation/Closure:</b> No change in heritage resources expected because the type of fuel used will not result in any removal, disruption or displacement of archaeological sites or architectural or historical resources.
	Change in architectural or historical resources		
<b>Overall Heritage Resources Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No changes to heritage resources anticipated because the type of fuel used will not result in any removal, disruption or displacement of archaeological sites or architectural or historical resources.	<b>Neutral</b> No changes to heritage resources anticipated because the type of fuel used will not result in any removal, disruption or displacement of archaeological sites or architectural or historical resources.
Traditional Land and Resource Use	Change in Aboriginal communities' cultural practices	<b>Construction/Operation/Closure:</b> No change in Aboriginal community's cultural practices or traditional land uses anticipated because the type of fuel used will not have any effects on the use of cultural or spiritual sites or traditional land use areas.	<b>Construction/Operation/Closure:</b> No change in Aboriginal community's cultural practices or traditional land uses anticipated because the type of fuel used will not have any effects on the use of cultural or spiritual sites or traditional land use areas.
	Change in Aboriginal communities' traditional land uses (including hunting, fishing, trapping and harvesting)		
<b>Overall Traditional Land and Resource Use Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No change to traditional land and resource use in anticipated because the type of fuel used will not have any effects on the use of cultural or spiritual sites or traditional land use areas.	<b>Neutral</b> No change to traditional land and resource use in anticipated because the type of fuel used will not have any effects on the use of cultural or spiritual sites or traditional land use areas.

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<b>Built Environment</b>			
Land and Resource Use	Change in recreational land and resource use	<b>Construction/Operation/Closure:</b> No change in recreational or commercially-based land and resource use or navigation expected because the type of fuel used will not result in any land and resource access or navigation restrictions.	<b>Construction/Operation/Closure:</b> No change in recreational or commercially-based land and resource use or navigation expected because the type of fuel used will not result in any land and resource access or navigation restrictions.
	Change in navigation		
	Change in commercially-based land and resource use		
<b>Overall Land and Resource Use Ranking</b> <i>Not a key differentiating factor – the potential for effects is comparable across all identified alternatives.</i>		<b>Neutral</b> No change to land and resource use anticipated because the use of diesel fuel will not result in any additional land and resource access or navigation restrictions.	<b>Neutral</b> No change to land and resource use anticipated because the use of LNG/diesel blended fuel will not result in any additional land and resource access or navigation restrictions.

**OVERALL ALTERNATIVE RANKING BASED ON KEY DIFFERENTIATING FACTORS**

Key Differentiating Factors	Diesel Fuel	Blended Diesel/LNG Fuel
<b>Atmospheric Environment</b>	<b>Disadvantage</b> - Effect on the atmospheric environment expected from the combustion of diesel resulting in emissions.	<b>Advantage</b> - Effect on the atmospheric environment expected from the combustion of LNG and diesel resulting in emissions; however, the effect would be substantially lower than the use of full diesel as LNG results in lower emissions.
<b>Community Services and Infrastructure</b>	<b>Disadvantage</b> - Potential opportunity to enhance community services and infrastructure through local contract sourcing of diesel fuel, but no opportunity to enhance LNG availability for local residents and Aboriginal communities in the region.	<b>Advantage</b> - Sourcing LNG for the Project may provide an opportunity to increase the availability of LNG for local residents and Aboriginal communities, potentially reducing costs to acquire LNG in the region.
<b>Cost</b>	<b>Advantage</b> - Lower capital costs, with higher fuel costs spread over the LOM.	<b>Disadvantage</b> - Higher capital costs but lower fuel costs over the LOM. The substantial investment early in development required may be cost prohibitive until production ramps up. Consideration of truck delivery of LNG before plant commissioning will be made depending on the economics.
<b>Technical Feasibility</b>	<b>Advantage</b> - Provides a commonly used, reliable fuel supply.	<b>Disadvantage</b> - Provides a successfully tried technology, when commercially available, however conversion kits are not currently commercially available for the specific truck size required.
<b>OVERALL</b>	<b>PREFERRED</b> (required regardless of the application of LNG technology)	<b>PREFERRED - for Long-term Consideration</b> (higher complexity and initial cost, but increased environmental and potential economic benefits over the LOM)