	Option Name	Description	Option Availability				Environmental Consideration		Option Carried forward?
			Technically Feasibility	Operational practicability	Safety Implications	Available? (Y/N)	BAT-AELs	Cross media effect	
1	**Recovery of pollutants at source (BAT10)**	Change of raw material supplier (UK)	This option is technical unavailable as no other supplier of Nitric Acid in the UK.	Unable to operate as no other supplier in UK.	N/A	N			
2	**Recovery of pollutants at source (BAT10)**	Change of raw material supplier (international)	There are alternative international suppliers of Nitric Acid.	Will not have an effect on exisiting operations as no changes to infrastructure / onsite operational requirements.	Numerous safety implications with this project as increased safety risk through transportation of dangerous substances.	N	May not resolve issue/bring Cr and Ni down to BAT-AEL concentrations as Nitric Acid will leach Cr and Ni from stainless steel used (nitric acid used in passivation).	Large footprint/increased emissions from travel.	No. Does not resolve issue with Cr and Ni concentrations and numerous safety implications.
3	**Recovery of pollutants at source (BAT10)**	Review of source contamination in Nitric Acid	Cannot remove Cr and Ni at source as these metals are passivated by concentrated nitric acid.	Will not have an effect on exisiting operations as no changes to infrastructure / onsite operational requirements as source of nitric acid is offsite.	No known safety implications associated with this option.	N	May not resolve issue/bring Cr and Ni down to BAT-AEL concentrations as Nitric Acid will leach Cr and Ni from stainless steel used.	No known cross media effects.	No. Does not resolve issue with Cr and Ni concentrations.
4	**Process-integrated techniques - Prevent or reduce pollutants (BAT10)**	Treatment of Nitric Acid onsite	Technology not available to remove Cr and Ni from concentrated Nitric Acid	Potentially large footprint for infrastructure would be required to treat around 1000 te/day of Nitric Acid	Highly corrosive if human exposure during handling.	N			
5	**Process-integrated techniques - Prevent or reduce pollutants (BAT10)**	Change from Nickel Catalyst	No. Other metal catalysts have been trialled in the past but have not been successful.	Would not have an effect on exisiting operations as no changes to infrastructure / onsite operational requirements.	Safety implications on human exposure during handling of other catalysts	N			
6	**Process-integrated techniques - Prevent or reduce pollutants (BAT10)**	Alter management approach for Nickel catalyst	Theoretically possible to run the catalyst for shorter periods, however would result in operational practicability issues.	Running the catalyst for shorter durations before changeout would require more frequent change out resulting in operational burdens and increased raw material usage.	Safety implications with handling of nickel catalyst if exposed to air	N	Nickel catalyst not the largest contributor of Ni and Cr loading in the discharge, Nitric Acid is, so would only result in some Cr and Ni concentration removal.	Yes - Increased raw material usage for treatment process resulting in increased contaminants of other metals.	No. Does not resolve issue with Cr and Ni concentrations.
7	**Final waste water treatment (offsite) (BAT10, BAT12)**	Altered flow to Bran Sands treatment work (S1/S2)	Not practical to use exisiting infrastructure to divert flows offsite for treatment as exisiting infrastructure cannot accept increased flows.	No known operational issues with this option.	No known safety implications associated with this option.	N			
8	**Final waste water treatment (offsite) (BAT10, BAT12)**	New discharge route to Bran Sands treatment work	Could build infrastructure to transfer discharge to offsite treatment works.	Would have to design the system across site and around exisiting infrastructure.	Little safety implications and not introducing any new substances.	N	Does not remove Cr and Ni concentration from discharge to BAT-AELs as no end of line treatment at Bran Sands teatment work.	Yes - Transfer of impact from one location to another.	No. Does not resolve issue with Cr and Ni concentrations and transferring contaminaton from one location to another and would require significant infrastructure development.
9	**Final waste water treatment (offsite) (BAT10, BAT12)**	Tanker effluet to offsite facility	Option could be designed to have continuous tankering of the effluent discharge.	Not practical as would require substantial number of tankers to keep up with flows requiring significant traffic management. Exisiting infrastructure would not accommodate tankering but could be designed to enable tankering offsite.	Risk of accidental spills and exposure to contents on site. Health and safety implications from increase traffic.	N	Does not remove Cr and Ni concentration from discharge to BAT-AELs as no end of line treatment.	Yes - Transfer of impact from one location to another.	No. Does not resolve issue with Cr and Ni concentrations and transferring contaminaton from one location to another and would require significant traffic management to keep up with flows.
10	**Final waste water treatment (offsite) (BAT10, BAT12)**	Offsite treatment on wider Sembcorp footprint	Option could be designed to transfer discharge to wider Sembcorp site for further viable onsite end of line treatment.	Option would require infrastructure development (or tankering) to transfer discharge offsite, however would not require large footprint for infrastructure as treatment facility offsite.	As per the safety implications identified in final waste water treatment, although this would be offsite.	Y	Could treat discharge to permittable Cr and Ni concentrations by installating viable final waste water treatment options offsite.	As per the environmental considerations detailed in final waste water treatment options onsite.	Yes. Available technology that could be installed onsite, and would reduce Cr and Ni concentrations to permittable levels.
11	**Final waste water treatment (onsite) (BAT10, BAT12)**	Sulphide precipitation followed by addition of polymer coagulant	Traditional precipitation method for heavy metals is done using hydroxides. Sulphide precipitation is widely used and more efficient that hydroxide precipitation. To aid with the filtration step a coagulant is added such as aluminium suphate, ferric suphate, or a polymer.	Additional filtration setup would be required to reduce Cr VI to oxidation state (Cr III) requiring reduced pH. Multi-stage plant would be required with large footprint for equipment.	Sodium suphide is highly toxic if human exposure during handling.	N	Uncertainty of success and projected low efficiency. Difficult to achieve Cr and Ni reduction using traditional hydroxide or sulphide precipitation due to very small amount of solid generated in large volume of water.	Addition of multiple chemicals to achieve redoz and pH. Toxic solid sludge generatred during the precipitation process.	No. Uncertainty of success and projected low efficiency.
12	**Final waste water treatment (onsite) (BAT10, BAT12)**	Coagulation by SUEZ- Metclear trademark coagulants and filtration	Can use SUEZ technology combining precipitation agent, flocculating agents and membrane filtratration.	Depending on the Cr oxidation state, there may be a requirement for an additional treatment step requiring additional infrastructure.	Handling of hazardous sludge might be toxic.	Y	Would treat waste water so Ni and Cr concentrations are within permittable concentrations.	Supplier located in the USA resulting in a large footprint (increase of greenhouse gas emissions). Moderate quantity of hazardous sludge generated.	Yes. Available technology that could be installed onsite, and would reduce Cr and Ni concentrations to permittable levels.
13	**Final waste water treatment (onsite) (BAT10, BAT12)**	Ion exchange and/or chelating resin	Ion exchange and/or chelating resin would allow ion metal removal from the wastewater stream providing the right media can be identified in consultation with the supplier(s). Vast number of different resins that are commercially available.	Possible pre-treatment required if resin is to be used again. May require increased size of set up depending on type of resins required for Cr and Ni.	Ion exchange resins generally are not considered hazardous.	Y	Would treat waste water so Ni and Cr concentrations are within permittable concentrations.	Hazardous waste from regeneration solutions.	Yes. Available technology that could be installed onsite, and would reduce Cr and Ni concentrations to permittable levels.
14	**Final waste water treatment (onsite) (BAT10, BAT12)**	Absorption onto polymer media (Metal Zorb)	Technology is available but polymer media has been used for limited volumes.	Easy opertion and simple design Employed as a stationary bed in a tank or column.	Non toxic sponge is used to adsorb metals.	N	Difficult to achieve Cr and Ni reduction as system unsuitable due to high daily flows and significant quantities of polymer media required to treat flows.	Supplier located in the USA resulting in large footpring (increase of greenhouse gas emissions). Contaminated polymer disposal.	No. Unsuitable for application due to high daily flows.
15	**Final waste water treatment (onsite) (BAT10, BAT12)**	Reverse Osmosis	Reverse osmosis is a widely used and efficient method to treat water to high levels of purity.	Potentially large footprint for infrastructure. Would require maintenance of membranes (periodic washing to remove the contaminents that accumulate one side of the membrane).	No safety implications associated with this option.	Y	Would treat waste water so Ni and Cr concentrations are within permittable concentrations. Possibility that the stream concerned may contain too many impurities for this method but only detailed analysis and possibly laboratory trials will ascertain this.	Small amount of contaminated brine for disposal, energy consuming.	Yes. Available technology that could be installed onsite, and would reduce Cr and Ni concentrations to permittable levels.
16	**Final waste water treatment (onsite) (BAT10, BAT12)**	Electrodeposition (electrolysis)	Uncertainty of succcess and projected low efficiency. Technology has not been widely applied and none of the waste water treatment third parties contacted would consider this method.	Potentially large footprint for infrastructure. Would need a large tank(s) installing to hold electrodes and 4000m3 / day of effluent.	Handling / disposal of deposited metals might be toxic if human exposure.	N			
17	**Final waste water treatment (BAT10, BAT12)**	Adsorption on non-functionalized multi-walled carbon nanotube	While technology is available and has been used in remediation of low concentrations, there is a lack of scale up knowledge and this has not been tried previously at commercial scale. Adsoption is a non-functionalized multi-walled carbon nano-tube that is still experimental technology.	Potentially large footprint for infrastructure would be required in order to be able to treat a flowrate of 4000 m3/day of effluent using this technology	No safety implications associated with this option.	N			
18	**Cessation of activity**	Permanent stop to activity	No technical issues associated with this option.	Not practical as process relies upon Nitric Acid to produce MNB. Option not carried forward.	No safety implications associated with this option.	N			