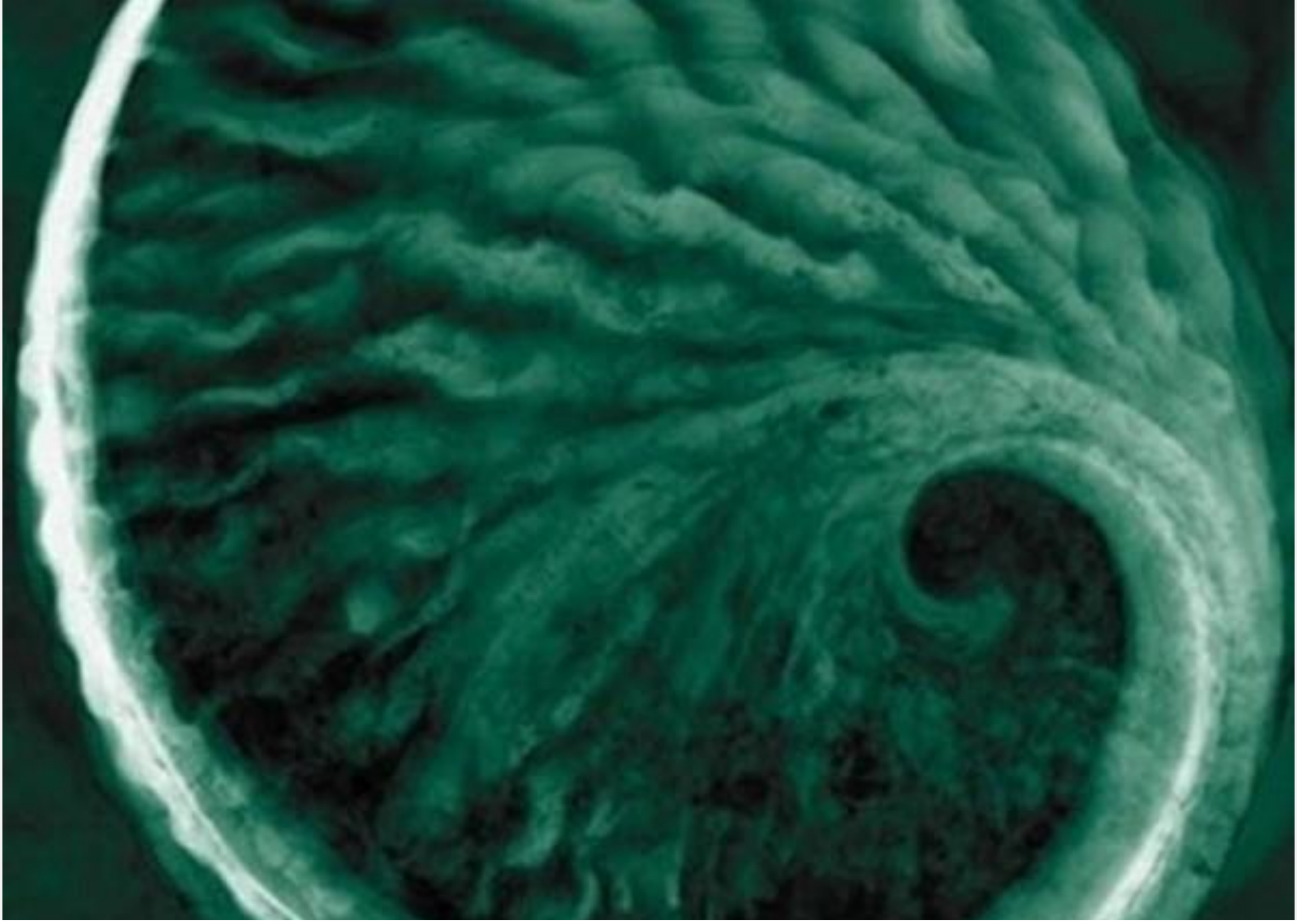

Huntsman Polyurethanes (UK) Ltd

BAT Derogation Application under Improvement Condition 17 for Chromium and Nickel Emissions Via Emission Point S1

11 January 2024

Project No.: 0469864

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11 January 2024

Huntsman Polyurethanes (UK) Ltd

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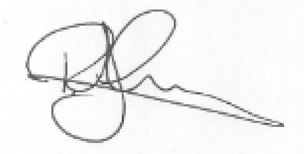

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Acronyms and Abbreviations

Name	Description
AA	Annual Average
AOX	Halogenated Organic Compounds
AR	Activity Reference
BAT	Best Available Techniques
BAT-AEL	BAT Associated Emission Levels
BATc	BAT Conclusion Document
BREF	BAT Reference Document
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
Cr	Chromium
CWW	Common Wastewater
DEFRA	Department for Environment, Food & Rural Affairs
EA	Environment Agency
ELV	Emission Limit Value
EP	Environmental Permit
EP Regulations	Environmental Permitting (England and Wales) Regulations 2016 (as amended)
ERM	Environmental Resources Management Ltd
EQS	Environmental Quality Standard
Huntsman	Huntsman Polyurethanes (UK) Ltd
IC	Improvement Condition
IED	Industrial Emissions Directive
kg/y	Kilograms per year
km	Kilometres
km²	Kilometres squared
LCP	Large Combustion Plant
LVOC	Large Volume Organic Chemicals
MAC	Maximum Allowable Concentration
MDI	Methylene diphenyl diisocyanate
mg/l	Milligrams per litre
MNB	Mononitrobenzene
N/A	Not Applicable
Ni	Nickel
Notice	Regulation 61(1) Notice
NPV	Net Present Value
NWEBS	National Water Environmental Benefits Survey
OPEX	Operating Expenditure
PBDE	Plybrominated diphenul ethers
RNAG	Reasons for Not Achieving Good
RFD	Reasons for Deterioration
TRaC	Transitional and Coastal Water
WFD	Water Framework Directive
WwTP	Wastewater Treatment Plant
µg/l	Micrograms per litre

1. INTRODUCTION

1.1 Background

Huntsman Polyurethanes (UK) Ltd (Huntsman) operates an installation for the manufacturing of aniline and mononitrobenzene (MNB) at their Wilton facility in Middlesbrough (the Site). The manufacturing activities fall under Schedule 1, Section 4.1A(1)(a)(iv) of the Environmental Permitting (England and Wales) Regulations 2016 (as amended) (EP Regulations) – producing organic chemicals containing nitrogen. The Site is regulated by the Environment Agency (EA) under Environmental Permit (EP) EPR/BS8656IX.

The main raw materials for the manufacture of MNB are nitric acid, imported by road tanker, and benzene, imported by pipeline. The MNB product is transported by pipeline to the adjacent aniline plant, which uses hydrogen, also imported by pipeline, to manufacture the aniline product. Aniline is exported by pipeline to a bulk storage installation for subsequent use in methylene diphenyl diisocyanate (MDI) manufacture.

The Site has two permitted discharges to water, with the ultimate receiving body being the River Tees. See **Section 2.2** for more information on the discharge points. Releases to water are via the Wilton Site Drainage System or to Bran Sands Wastewater Treatment Plant (WwTP):

- Wilton Site Drainage System – Known as Sembcorp, emission point S1. This is considered a direct discharge to water. Discharge consists of 'weak' process effluent from the aniline & MNB Plant.
- Bran Sands WwTP – Known as Bran Sands, emission point S2. This is considered an indirect discharge to water. Discharge consists of 'strong' process effluent flow.

The EP Regulations implement the requirements of the Industrial Emissions Directive 2010/75/EU (IED) including the concept of Best Available Techniques (BAT). BAT conclusions have been developed by the European Commission and are legally binding. Compliance with BAT associated emission levels (BAT-AEL) is mandatory unless derogation from those BAT-AELs is justified. The IED and BAT conclusions developed before the UK left Europe continue to be applicable within England.

The EA issued a Regulation 61(1) Notice to the Site (the Notice, 4th May 2018), following the publication of revised BATc for the Production of Large Volume Organic Chemicals[1] (LVOC) (refer to **Section 3.1** for more information on BAT review). The LVOC BATc review triggered the requirement for other associated secondary BATc to be reviewed and implemented, which included the Common Wastewater (CWW) BATc[2] and Large Combustion Plant (LCP) BATc[3]. A Regulation 61(1) response was provided by Huntsman on 26th April 2019 to the EA (see **Appendix A**).

During the permit review, the EA requested further information from the Site to demonstrate/provide justification that the effluent is not 'liable to contain' parameters such as chromium, copper, nickel, zinc and halogenated organic compounds (AOX). As part of the review process, chromium (Cr) and nickel (Ni) concentrations in the Site discharge were found to be present and in excess of direct discharge to water BAT-AELs. Following a process of review by the EA, the permit was varied and issued (6th December 2022) and included an Improvement Condition (IC17) to seek derogation from the BAT-AELs for Cr and Ni.

[1] European Union, (2017). *Best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of large volume organic chemicals.* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017D2117 Last accessed: 10/07/2023

[2] European Union, (2016). *Best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for common wastewater and waste gas treatment/management systems in the chemical sector.* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017D2117 Last accessed: 10/07/2023

[3] European Union, (2021). *Best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants.* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021D2326 Last accessed: 10/07/2023

1.2 Scope and Objectives

Environmental Resources Management Ltd (ERM) has been commissioned to produce a derogation application on behalf of Huntsman, to present the request for a formal derogation from BAT-AELs for Cr and Ni as required by IC17.

The scope of works includes the preparation for a request for an IED Article 15(4) derogation following the key listed steps:

- **Confirming the Installation is BAT** - Demonstrate the Site is compliant with the applicable BATc. (previously completed, **Appendix A**)
- **Request compliant with legal requirements** - Ensure compliance with legal requirements such as Environmental Quality Standards (EQS) and ensure no significant pollution is caused/high level of protection of the environment (see **Section 3.3**).
- **Justification of an IED Article 15(4) request** - Justify need for a derogation (see **Section 4**):
    - Geographical location or local environmental conditions of the installation concerned; or
    - Technical characteristics of the installation concerned.
- **Disproportionality statement** - Summarise disproportionality findings within a statement. Evidence based on Cost Benefit Analysis (CBA) output, any additional factors and expert judgement (see **Section 7 and 8**).

This report has been prepared using information provided to ERM by Huntsman. The derogation application is applicable to emission point S1 only. Further surface water risk assessment work requested in a separate improvement condition (IC18) does not form part of this report and will be considered separately.

2. PERMIT OVERVIEW

2.1 Improvement Condition 17

The Site operates an installation under permit under EP EPR/BS86561X. The EP covers the manufacturing of two products, aniline and MNB. The relevant listed activities are two production lines under the following section of Schedule 1, Part 2 of the EP Regulations:

- Section 4.1A(1)(a)(iv) – "Producing organic chemicals such as organic compounds containing nitrogen, such as amines, amides, nitrous-, nitro- or azo-compounds, nitrates, nitriles, nitrogen heterocyclics, cyanates, isocyanates, di-isocyanates and di-isocyanate prepolymers."

The Site received a Regulation 61(1) Notice (the Notice) dated 4th May 2018 from the EA regarding review and consolidation of the Site's EP and BAT review following publication of the LVOC BATc, CWW BATc and LCP BATs. This required a written report stating whether compliance against each of the BATc would be achieved within 4 years of their publication (as detailed in **Section 3.1**). As part of the review process, Cr and Ni concentrations in the Site discharge were found to be in excess of BAT associated emission limits (BAT-AELs) for direct discharge to water.

On 6th December 2022 the permit was varied and consolidated to include standards set out under the LVOC and CWW BATc, including BAT AELs for Cr and Ni. However, the EP included an Improvement Conditions (IC) to address the requirements of meeting BAT-AELs for Cr and Ni (IC17). IC17 requires that, unless a derogation is granted, the site must comply with the BAT-AELs for direct discharge to water of Cr and Ni.

Table 2.1 details the requirements of IC17.

Table 2.1 Improvement Program Requirements

Reference	Requirement	Date
IC17	<u>Derogation for Chromium and Nickel</u> The operator shall submit, for approval by the Environment Agency, reports setting out progress to achieving the BAT conclusion AELs or justification, including a detailed cost benefit assessment, of why the costs of treatment outweigh the environmental benefits, where a derogation has been applied for. The report shall include, but not be limited to, the following: 1) Current performance against the BATc AELs. 2) Methodology for reaching the AELs or justification, including a detailed cost benefit analysis (www.gov.uk/government/publications/industrial-emissions-directive-derogation-cost-benefit-analysis-tool) 3) Why the costs of treatment outweigh the environmental benefits. 4) Associated targets / timelines for reaching compliance of the BAT-AELs by 07/12/2023 (or otherwise agreed in writing with the Environment Agency) or justification, including a detailed cost benefit analysis, of why the costs of treatment outweigh the environmental benefits, for discharges from the MNB and Aniline Plant to emission point S1. The report shall address the following BAT Conclusion: • *Common Wastewater and Waste Gas Treatment/Management Systems in the Chemical Sector BAT Conclusions Document* (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1579188127132&uri=CELEX%3A32016D0902) section 3.4, Table 1 (compliance with BAT-AEL for Cr and Ni, emission point S1) under BAT 12 (wastewater treatment). Refer to BAT Conclusions for a full description of the BAT requirement.	Progress report by 07/01/2023 then at monthly intervals until the derogation submission is complete, which shall be no later than 07/06/2023. Final report by 07/07/2023 unless otherwise agreed in writing with the Environment Agency.

Reference	Requirement	Date
	Approval of reports under this Improvement Condition does not preclude the need for permit variation application(s) to operate the developed strategy and/or include any necessary ELVs.	

2.2 Site drainage and emission points

The Site has two effluent discharge streams (S1 and S2) to two separate discharge points as shown in **Figure 2.1**:

- S1: MNB plant weak effluent stripper, MNB cooling tower purge, aniline plant, boiler feed water purge and condensate quench pot effluent is discharged to the wider Wilton drainage system managed by Sembcorp Utilities (UK) Ltd; and
- S2: The MNB plant strong effluent from the second washing stage is discharged to the Bran Sands WwTP operated by Northumbria Water Limited.

Both of these effluent streams ultimately discharge into the Dabholm Gut, a tributary of the River Tees.

Figure 2.1 Site Drainage Diagram

3. BEST AVAILABLE TECHNIQUES

3.1 BAT Review

Article 13 of the IED requires the European Commission to organise an 'exchange of information' between Member States, the industries consented and environmental non-governmental organisations on BAT, associated monitoring, and development's and to publish the results as legally binding BATc. BAT Reference documents (BREFs) are published alongside BATc which describe the applied techniques, present AELs, techniques considered for the determination of BAT, BATc and any emerging techniques.

The EP Regulations transpose the requirements of the IED. Article 21(3) of the IED requires that, following publication of decisions on BATc, all permit conditions for an installation concerned are to be reconsidered and, if necessary, updated to implement all applicable BATc within 4 years of their publication.

The LVOC BATc was published on 7th December 2017. As such, the EA undertook a statutory review of the EP in 2018, to assess its applicability to comply with the requirements set out under the LVOC BATc. As a manufacturer of large volume chemicals, the LVOC BATc was considered applicable to the Site.

A Regulation 61(1) Notice dated 4th May 2018 was issued to the Site from the EA. This was regarding a review and consolidation of the Site's EP following the publication of the LVOC BATc. ERM undertook a review of the LVOC BATc and other applicable BATc's, on behalf of Huntsman, to demonstrate whether the operation of the installation met, or would subsequently meet, the revised standards described in the relevant BATc document by the compliance date of 7th December 2021. The following BATc were reviewed:

- BATc for Large Volume Organic Chemicals (LVOC) published 7th December 2017;
- BATc for Common Wastewater and Waste Gas treatment/ Management Systems in the Chemical Sector published 9th June 2016 (CWW); and
- BATc for Large Combustion Plant (LCP) published 17th August 2017.

The review found that the Site at the time were compliant with the LVOC BATc and CWW BATc. LCP BATc was considered not applicable since the Site did not have any combustion sources that either individually or in aggregate exceed 50 MWth thermal input. A response to the Notice was provided by Huntsman to the EA on 26th April 2019 (see **Appendix A**).

The Site is permitted to discharge process effluent to the River Tees via emission point S1 to water as detailed in **Section 2.2.** During the review process, the EA requested further information from the Site to demonstrate/provide justification providing that the effluent is not 'liable to contain' parameters such as Cr, copper, Ni, zinc and AOX and complies with the CWW BAT-AELs.

3.2 Applicability of the CWW BAT-AEL to the S1 Discharge

The CWW BATc introduces BAT-AELs for direct emissions to a receiving water body and apply from the point that the emission leaves the installation i.e. at the permit boundary.

The Scope section of the CWW BATc states that "These BAT conclusions concern the activities specific in Section 4 of Annex I to Directive 2010/75/EU[4]" namely:

- Section 4: Chemical Industry

[4] European Union (2016). *Best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for common waste water and waste gas treatment/management systems in the chemical sector*. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1579188127132&uri=CELEX%3A32016D0902 Last Accessed: 10/07/2023

Tables 1 – 3 of the BATc set out BAT-AELs applicable to direct emissions to a receiving waterbody. Table 3 is reproduced in this report (see **Figure 3.1**) as this contains the substances of focus for IC17.

Figure 3.1 BAT-AELs for direct emission of AOX and metals to a receiving waterbody

Table 3

BAT-AELs for direct emission of AOX and metals to a receiving water body

Parameter	BAT-AEL (yearly average)	Conditions
Adsorbable organically bound halogens (AOX)	0,20-1,0 mg/l (1) (2)	The BAT-AEL applies if the emission exceeds 100 kg/yr.
Chromium (expressed as Cr)	5,0-25 μg/l (3) (4) (5) (6)	The BAT-AEL applies if the emission exceeds 2,5 kg/yr.
Copper (expressed as Cu)	5,0-50 μg/l (3) (4) (5) (7)	The BAT-AEL applies if the emission exceeds 5,0 kg/yr.
Nickel (expressed as Ni)	5,0-50 μg/l (3) (4) (5)	The BAT-AEL applies if the emission exceeds 5,0 kg/yr.
Zinc (expressed as Zn)	20-300 μg/l (3) (4) (5) (8)	The BAT-AEL applies if the emission exceeds 30 kg/yr.

(1) The lower end of the range is typically achieved when few halogenated organic compounds are used or produced by the installation.
(2) This BAT-AEL may not apply when the main pollutant load originates from the production of iodinated X-ray contrast agents due to the high refractory loads. This BAT-AEL may also not apply when the main pollutant load originates from the production of propylene oxide or epichlorohydrin via the chlorohydrin process due to the high loads.
(3) The lower end of the range is typically achieved when few of the corresponding metal (compounds) are used or produced by the installation.
(4) This BAT-AEL may not apply to inorganic effluents when the main pollutant load originates from the production of inorganic heavy metal compounds.
(5) This BAT-AEL may not apply when the main pollutant load originates from the processing of large volumes of solid inorganic raw materials that are contaminated with metals (e.g. soda ash from the Solvay process, titanium dioxide).
(6) This BAT-AEL may not apply when the main pollutant load originates from the production of chromium-organic compounds.
(7) This BAT-AEL may not apply when the main pollutant load originates from the production of copper-organic compounds or the production of vinyl chloride monomer/ethylene dichloride via the oxychlorination process.
(8) This BAT-AEL may not apply when the main pollutant load originates from the production of viscose fibres.

The Site incorporates activities that fall under the scheduled activity definitions as shown in **Table 3.1**.

Table 3.1 Scheduled Activities under EP EPR/BS86561

Activity Reference	Activity listed in Schedule 1 of the EPR	Description of Specified Activity	Limits of Specified Activity
AR1	Section 4.1A(1)(a)(iv) – producing organic chemicals containing Nitrogen	Producing mononitrobenzene	Receipt of raw materials to despatch/use of finished product
AR2	Section 4.1A(1)(a)(iv) – producing organic chemicals containing Nitrogen.	Producing aniline	
Directly Associated Activity			

Activity Reference	Activity listed in Schedule 1 of the EPR	Description of Specified Activity	Limits of Specified Activity
AR5	Storage, handling and despatch of finished products, wastes, and other materials	Storage of finished products. Process waste segregation and storage	Internal and external storage of finished products, storage of waste in designated areas and loading for transit off site

Process effluent from the aniline and MNB plant is a result of AR1 and AR2 activities. For the S1 effluent stream, the emissions are discharged offsite to Sembcorp's drainage system. ERM understands that Sembcorp's EP is solely for a water discharge activity. Sembcorp collects effluents from several sites, including its own, prior to discharging to the Dabholm Gut. No further effluent treatment is undertaken within the Sembcorp system.

Paragraph 92 of the UK Cross-Cutting BAT guidance [5] states that "*Wastewater emissions are considered to be direct where the emission is to the receiving environment (e.g. a river or the sea), and indirect where the emission is to another treatment facility (e.g. a municipal Sewage Treatment Works)*."

Since the Sembcorp EP covers discharge to water activities only and no treatment of effluent is undertaken within the Sembcorp's drainage system, the S1 stream is considered a direct emission.

For the S2 stream, which discharges to the Bran Sands Treatment Works, it is considered an indirect discharge as it is treated by an off-site sewage treatment works. The CWW BATc introduces BAT-AELs for direct emissions only, and as such the BAT-AELs are not applicable to the S2 discharge.

As the requirement under the CWW BATc relate solely to the effluent generated directly from Section 4 activities, compliance with BAT-AELs for direct emissions of Total Organic Carbon, Chemical Oxygen Demand, Total Suspended Solids, Nutrients, AOX and metals, were reviewed for S1 only.

3.3 Compliance with CWW BAT-AELs

During the Reg 61 review process, the Site undertook monitoring of the S1 effluent to assess compliance with the CWW BAT-AELs. **Table 3.2** shows the release concentrations for Cr and Ni measured in the S1 effluent between 2015 - 2019, along with the relevant discharge limits (CWW BAT-AELs). Cr and Ni concentrations were typically an average of 52 µg/l and 88 µg/l respectively, which are in excess of the BAT-AELs. All other parameters listed under the CWW BAT-AELs were found to be compliant.

Table 3.2 Effluent Quality 2015 - 2019

	Measured Values (µg/l)		BAT-AEL (µg/l)
Parameter	Average	Maximum	
Nickel (Ni)	88	229	50
Chromium VI (Cr)	52	176	25

To review legal requirements with Environmental Quality Standards (EQS) and assess the potential for impact to the environment being caused by the discharge, the EA further requested an H1 surface water risk assessment be completed. As such, a H1 surface water risk assessment for emission point S1 was

[5] UK Cross-Cutting Interpretation Guidance and Permitting Advice on the Best Available Techniques (BAT) Conclusions, May 2020 UK Cross Cutting BATc Interpretation Guidance.pdf (environment-agency.gov.uk) Last Accessed: 10/07/2023

undertaken via the EA's H1 methodology for surface water to screen hazardous chemicals and elements present in the discharge[6].

The H1 methodology entails screening tests to determine whether pollutants can be screened out as "insignificant". It requires input of both annual average (AA) and maximum allowable concentrations (MAC) of each substance of concern, for assessment of both long-term and short-term impacts.

For the purpose of the assessment, the discharge is to transitional and coastal (TRaC) water as per the original H1 assessment (see **Appendix B** for a copy of the H1 workbook used). As per the EA's guidance, EQS for estuaries and coastal waters (marine) were used for Ni and Cr. Sample data was used from 2015 – 2019.

Applying Test 1 to the release of Ni and Cr to TRaC waters, failed both annual average (AA) and Maximum Allowable Concentration (MAC) in that the pollutant is more than 10% of the EQS.

The Dabholm Gut is an intertidal channel influenced by the tide. This is most likely not an area where the water is mainly fresh. As the discharge point is to a water body classified as a transitional water body to the estuary mouth (and is described as an intertidal channel), Test 2 is not applicable and there was no need to refer to freshwater screening tests, and so progressed to Test 3.

Tests 3 and 4 consider dilution. Through discussion with the EA on 14th April 2022, it was confirmed that Tests 3, 4, and 5 were not appropriate given the limited dilution of the effluent discharge (being only 50 m wide). As such, further detailed modelling work was required to understand dilution and dispersion of these concentrations in the receiving waters (results of dispersion modelling presented in **Section 6.2**).

3.4 Root cause of exceedance

In order to establish the root cause(s) of the Ni and Cr exceedance in the discharge, Huntsman undertook an investigation comprising of methodical sampling at various points throughout the process, working backwards from the point of discharge. Through sampling, it was identified that Cr was entering the Huntsman process in a raw material – nitric acid. Ni was found to be entering the process both in nitric acid and as a result of carry-over of Ni catalyst from the Aniline Reaction System. Upon further review, the source supplier of the nitric acid confirmed the elevated concentrations of Cr and Ni. The Huntsman production process relies upon large quantities of nitric acid which is an important raw material used in nitration of benzene, in the presence of a sulphuric acid catalyst, to produce MNB.

The Nickel catalyst used is the recognised catalyst for the hydrogenation of Nitrobenzene. Huntsman have previously explored the use of other metal-based catalyst, but none have been found to be as effective compared to the existing Nickel catalyst.

3.5 Review of potential options

As these Cr and Ni limits are in excess of the BAT-AEL, Huntsman reviewed their ability to reduce Cr and Ni down to BAT-AEL levels. As per the requirements of the CWW BREF, BAT is to use an integrated wastewater management and treatment strategy to reduce emissions to water (BAT 10) as well as using an appropriate combination of final wastewater treatment techniques (BAT 12). Review summary:

BAT 10 - Huntsman reviewed their ability to integrate wastewater management and treatment strategies and then final wastewater treatment techniques (as detailed in **Section 5.1.1**).

- Process integrated techniques (such as treatment of nitric acid on Site and a change from Ni catalyst) were deemed feasible. The aniline process uses a solid Ni catalyst in the reduction step. However, changing from a Ni catalyst was not considered to resolve the problem since the process

[6] Environment Agency (2016). *Surface water pollution risk assessment for your environmental permit*. https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit Last Accessed: 10/07/2023

relies upon the nitric acid, which is the main source of contamination which was assessed to be a larger contributor to Ni loading, rather than the Ni catalyst).

- Huntsman then reviewed their ability to recover pollutants at the source. The supplier has been unable to reduce the Ni and Cr in the acid and no other suppliers of nitric acid are found in the UK. As such, this was also not deemed feasible.
- Finally, Huntsman reviewed wastewater pre-treatment and final wastewater treatment options that could be used to abate pollutants prior to discharge to the receiving water body. Wastewater pre-treatment was considered potentially feasible if part of a future integrated wastewater management and treatment strategy. Whilst the Huntsman site does not currently have an effluent treatment plant this was also considered potentially feasible and required further review.

BAT 12 – Huntsman also reviewed a combination of end of pipe/ final wastewater treatment techniques (as detailed in **Section 5.1.2**):

- Huntsman employed Arcadis (UK) Limited to provide engineering support, conduct a high-level review to identify all available technical options and, make recommendations to reduce Cr and Ni for end of line treatment
- The requirement of removing Cr and Ni from the treatment of wastewater at end of line was found to be challenging using conventional methods due to the low starting concentrations and the elevated volumes to treat continuously.

As such, Huntsman considered that a derogation may be required, and so a formal derogation from the requirements of BAT AELs was requested from the EA (see **Section 4** for justification).

The EA decided to issue the permit variation with the BAT-AELs for Cr and Ni whilst a derogation application is prepared for submission. On 6th December 2022 the EA varied and consolidated the EP to include standards set out under the CWW BATc as well as the LVOC BATc that was not previously included. This derogation therefore focuses on the requirements of the CWW BATc and a derogation for not being able to meet CWW BAT-AELs for a direct discharge via S1 only.

4. DEROGATION PROCESS

4.1 Justification for Derogation

The IED requires all installations to employ BAT noting that the BATc documents are the reference for BAT. The requirements of Article 15(3) of IED means that BAT-AELs must be set as an emission limit on the permit. Where BAT-AELs cannot be met, a derogation can be requested under Article 15(4) of IED, allowing the regulator to set less strict ELVs that exceed the BAT-AEL range. Such a derogation may apply only where an assessment shows that the achievement of emission levels associated with the BAT as described in BAT conclusions would lead to disproportionately higher costs compared to the environmental benefits due to:

- the geographical location or the local environmental conditions of the installation concerned; or
- the technical characteristics of the installation concerned.

As detailed in **Section 3.1**, during a review following a Regulation 61(a) Notice from the EA in 2018, compliance with the LVOC BATc, CWW BATc, and LCP BATc were assessed. The Site were found to be compliant with the requirements under the LVOC BATc and LCP was found to be not applicable to the Site. However, Huntsman identified Cr and Ni concentrations above BAT-AELs (under the CWW BATc) and therefore are not compliant with the CWW BATc. Because the discharge limits on the EP issued in December 2022 are already at the top of the range of BAT-AELs, increasing the limits to current concentrations would require a formal derogation. The EA considers several cases for justification as detailed below.

4.1.1 Technical Characteristics of the Installation

EA guidance[7] sets out that technical characteristics of an installation can include:

- The recent history of pollution control investment in the installation in respect of the pollution(S) for which the derogation is sought;
- The general investment cycle for a particular type of installation;
- The configuration of the plant on a given site, making it more technically difficult and costly to comply;
- The practicability (particularly bearing in mind Health and Safety and other relevant legal obligations) or interrupting the activity so as to install improved emission control upon pollutant(s)
- The effect of reducing the excess emissions(s) upon other pollutant emissions, energy efficiency, water use or waste arising from the installation as a whole; and
- The intended remaining operational lifetime of the installation as a whole or of the part of it giving rise to the emission of the pollutant(s)

4.1.2 Geographical Location or local environmental conditions of the installation

The reasons that could justify derogation to be considered on the grounds of the geographical location or the local environmental conditions might include[8]:

- Higher construction and/or energy costs due to remote location;

[7] DEFRA (2013). *Industrial emissions Directive EPR Guidance on Part A installations.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/221044/pb13898-epr-guidance-part-a-130222.pdf Last accessed: 10/07/2023

[8] SEPA (2018). *IED-TG-44 Pollution Prevention and Control (Scotland) Regulations 2012. Regulation 25(12) – Derogation from BAT-AEL. Guidance on appraising a request for derogation*. P.7-8. https://www.sepa.org.uk/media/399169/ied_tg_44_derogation_guidance.pdf Last Accessed: 10/07/2023

- The installation uses a locally available raw material that affects the emissions, and importing the raw material upon which compliance with BAT-AEL depends would require substantial infrastructure investment and increased transport costs;
- The uses of alternative techniques at the installation would require additional infrastructure locally (e.g. remote locations without interconnector for power supply);
- The use of certain techniques is impossible due to the location, specifically techniques that do not operate effectively at very high or low temperatures, or at high altitudes;
- The built-up nature of the local area may result in higher costs (e.g. because of higher land prices, or lack of available land on or adjacent to the site);
- Local planning restrictions limit the nature of developments or their costs; or SEPA Guidance | IED-TG-44 | Version 2 | Issued November 2018 page 8 of 10
- The installation is located where there are fewer people or environmental receptors, resulting in lower impacts (and damage costs) than would apply to a typical installation.

4.2 Huntsman Derogation Case

As described in **Section 3.3**, Huntsman reviewed their ability to meet BAT AELs for Cr and Ni for business-as-usual operations. An options appraisal and engineering review since the release concentrations was identified in November 2021 (see **Appendix F**) has been carried out and found that this was not considered feasible based on the characteristics of the installation described in **Section 4.1.2** and **Section 4.2.2**.

The justification for a derogation was issued to the EA on 12th May 2022 (see **Appendix C**) which was on the basis of the geographical characteristics of the installation. The EA officer at the time confirmed that the derogation should be applied on technical grounds with geographical justification secondary (see **Appendix D**). Following this feedback, a final derogation request was issued to the EA on 6th June 2022, with a formal confirmation of receipt received from the EA on 7th June 2022 (see **Appendix E**).

The concentration levels of Cr and Ni within the source nitric acid and therefore the potential means of removing it from Huntsman's effluent is not expected to alter over time, therefore Huntsman has requested that a non-time limited derogation is justified for the BAT-AELs for Cr and Ni on the technical grounds.

The EA agreed to include the request for derogation as an improvement condition (IC17) on the EP on the condition a cost benefit analysis is carried out (see **Appendix E** for EA agreement). Since the justification for request for derogation were accepted by the EA, this report focuses on demonstrating the disproportionality of the extra costs against the environment benefit they would bring when achieving BAT-AELs for Cr and Ni.

4.2.1 Technical Characteristics of the Installation

Findings to date indicate that if the Site were to treat the effluent to reduce the marginally elevated Cr and Ni emissions down to BAT-AEL levels:

- The treatment of Cr and Ni would result in the use of considerable quantities of dosing chemicals to precipitate the metals due to the low concentration of Cr and Ni. This will consequently result in increases in additional raw material use for the treatment process;
- A consequent release into the Tees Estuary, increased energy usage; and increased waste arisings from the installation as a whole;
- The result would be a transfer of impact from the release of Cr and Ni to the impact from the treatment process, disproportionate to the scale of the reduction of the contaminant metals; and
- Reducing the emissions of one pollutant would be more than offset by the increase in the emissions of another.

4.2.2 Geographical Location

The installation uses a locally available raw material that affects the emissions, and importing raw material upon which compliance with BAT-AEL depends upon would require substantial infrastructure investment and increased transport costs:

- The installation uses locally available nitric acid that contains sufficient Cr and Ni to result in the Huntsman S1 discharge not meeting BAT-AELs for those substances;
- There is nowhere else in the UK / no other supply that can be used as an alternative;
- Importing of the raw material from other countries would result in the material travelling over significant distances, result in dramatically increased transportation costs, represent a safety risk through transportation of dangerous substances and may still not resolve the issue as nitric acid will leach Cr and Ni from stainless steel.

5. BAT OPTIONS APPRAISAL

Following the justification for request for a derogation being accepted by the EA, a BAT options appraisal has been completed. The purpose of the BAT options appraisal is to review the options that could be applied at the Site for the associated discharge activity (S1) to achieve compliance with BAT-AEL for Cr and Ni. **Section 5.1.1** reviews the applicability of the techniques listed under the CWW BATc 12 for the Huntsman discharge via S1. In addition to the BAT 12 options considered applicable, **Section 5.1.2** reviews technical end of line options to achieve compliance. Both technical and non-technical options considered, and their screening process are presented in **Section 5.2**. Those options not considered feasible are screened out from further assessment as detailed in **Section 5.3**.

5.1 BAT Options Considered

5.1.1 BAT Techniques

The CWW BATc defines a number of options that could be applied to achieve compliance with the BAT-AEL for Ni and Cr within the effluent discharged from the Site, and these are defined within CWW BATc 10 and also CWW BATc 12 a-k.

The applicability of these options to the Huntsman installation is reviewed in **Table 5.1** and **Table 5.2.** More details on the applicability of options can be found in **Appendix H**.

Table 5.1 Review of Applicability of BATc 10

BAT Reference	Technique	Description	Applicability to Huntsman
BAT 10	In order to reduce emissions to water, BAT is to use an integrated wastewater management and treatment strategy that includes an appropriate combination of the techniques in the priority order given below.		
(a)	Process integrated techniques – Prevent or reduce pollutants	Techniques to prevent or reduce the generation of water pollutants.	Huntsman does not have any process integrated techniques to reduce Cr and Ni as these were not identified as an issue until very recently due to a change in specification of a raw material, ie long after the plant was built. To reduce Ni and Cr concentrations in the discharge, Huntsman could integrate treatment options such as the treatment of nitric acid or a change from nickel catalyst as part of future operations.
(b)	Recovery of pollutants at source	Techniques to recover pollutants prior to their discharge to the wastewater collection system.	At present Huntsman have only one supplier of Nitric Acid in the UK. In order to reduce/eliminate pollutants from the source, Huntsman could potentially look at changing the raw material supplier or further investigate the cause of contamination in the raw material as part of future operations.

BAT Reference	Technique	Description	Applicability to Huntsman
(c)	Wastewater pre-treatment	Techniques to abate pollutants before the final wastewater treatment. Pre-treatment can be carried out at the source or in combined streams.	The Huntsman site does not currently have an effluent treatment plant. Wastewater pre-treatment could potentially form part of a future integrated wastewater management and treatment strategy should one be required. Options for wastewater pre-treatment are review in **Table 5.2** which reviews the applicability of BATc 12.
(d)	Final wastewater treatment	Final wastewater treatment by, for example, preliminary and primary treatment, biological treatment, nitrogen removal, phosphorus removal and/or final solids removal techniques before discharge to a receiving water body.	The Huntsman site does not currently have an effluent treatment plant. Wastewater pre-treatment could potentially form part of a future integrated wastewater management and treatment strategy should one be required. Options for wastewater pre-treatment are review in **Table 5.2** which reviews the applicability of BATc 12.

Table 5.2 Review of Applicability of BATc 12

BAT Reference	Technique	Description	Applicability	Applicability to Huntsman
BAT 12	In order to reduce emissions to water, BAT is to use an appropriate combination of final wastewater treatment techniques. Final wastewater treatment is carried out as part of an integrated wastewater management and treatment strategy (see BAT 10). Appropriate final wastewater treatment techniques, depending on the pollutant, include:			The Huntsman site does not currently have an effluent treatment plant.
Preliminary and Primary Treatment				
(a)	Equalisation	All pollutants	Generally applicable.	The Huntsman site does not currently have an effluent treatment plant. Preliminary and primary treatments such as equalisation, could potentially form part of a future effluent treatment plant at the site,
(b)	Neutralisation	Acids, alkalis		
(c)	Physical separation e.g. screens, sieves, grit separators, grease separators or primary settlement tanks	Suspended solids, oil/grease		

BAT Reference	Technique	Description	Applicability	Applicability to Huntsman
				should one be constructed (there would be significant costs associated with the installation of a new effluent treatment plant).
Biological treatment (secondary treatment)				
(d)	Activated sludge process	Biodegradable organic compounds	Generally applicable.	Not applicable to compliance with BAT-AEL for Cr and Ni.
(e)	Membrane bioreactor			
Nitrogen removal				
(f)	Nitrification/denitrification	Total nitrogen, ammonia	Nitrification may not be applicable in case of high chloride concentrations (i.e. around 10 g/l) and provided that the reduction of the chloride concentration prior to nitrification would not be justified by the environmental benefits. Not applicable when the final treatment does not include a biological treatment.	Not applicable to compliance with the BAT-AEL for Ni and Cr.
Phosphorus removal				
(g)	Chemical precipitation	Phosphorus	Generally applicable.	Not applicable to compliance with the BAT-AEL for Cr and Ni
Final solids removal				
(h)	Coagulation and flocculation	Suspended solids	Generally applicable.	Not applicable to compliance with the BAT-AEL for Ni and Cr. The Cr and Ni loading is not linked to suspended solids.
(i)	Sedimentation			
(j)	Filtration (e.g. sand filtration, microfiltration, ultrafiltration)			
(k)	Flotation			

Implementation of an effluent treatment plant to treat Cr and Ni to acceptable concentrations that would comply with the BAT-AELs is one option to be considered. Consideration has also been given to offsite treatment by rerouting to Bran Sands Treatment Works.

5.1.2 BAT Options Review

In addition to reviewing techniques listed under the CWW BAT 10 and 12, Huntsman appointed Arcadis UK Limited (Arcadis) in April 2022 to provide engineering support, conduct a high-level review to identify all available technical options and, make recommendations to reduce Cr and Ni for end of line treatment. The technical feasibility study conducted by Arcadis considered 40 different techniques available for heavy metal removal from aqueous waste streams in relation to their efficiency for Cr and Ni reduction or removal from the wastewater (see **Appendix F**). It was suggested a combination of techniques may be appropriate given the low starting concentrations and, subject to further laboratory analysis, seven techniques were shortlisted according to their likely efficiency and implementation costs as detailed in the following section.

5.2 Options Screening process

The methods detailed in the review presented a theoretical ability to meet BAT-AELs based on Arcadis industry specialists and/or external suppliers of water treatment solutions. Arcadis undertook a further review in April 2022 to provide costings for feasible options (see **Appendix G**). The seven options considered to have a theoretical chance of success included:

- Sulphide precipitation followed by addition of a polymer coagulant
- Coagulation by SUEZ-Metclear trademark coagulants and filtration
- Ion exchange and/or chelating resin
- Absorption onto polymer media
- Reverse Osmosis
- Electrodeposition (electrolysis)
- Adsorption on non-functionalized multi-walled carbon nanotube

The requirement of removing Cr and Ni from the treatment of wastewater at end of line was found to be challenging using conventional methods due to the low starting concentrations and the elevated volumes to treat continuously. As such, only three of the presented options were considered feasible for further review (coagulation by SUEZ, ion exchange and/or chelating resin, and reverse osmosis).

The review did not consider other technical and non-technical options such as the recovery of pollutants at the source and process integrated techniques to achieve compliance. Huntsman have since considered these other options. Together, both technical and non-technical options were reviewed based on their likely efficiency, large-scale availability, environmental impact, and associated costs. Those that were considered feasible based on these aspects have been carried forward to the next stage, the cost benefit analysis. A copy of the feasibility review for each option is presented in **Appendix H**.

5.3 Options carried forward to modelling and CBA

Options not considered feasible, first by option availability, and subsequently through environmental considerations as detailed in the screening process in **Section 5.2,** have not been considered any further by Huntsman. The options presented in **Table 5.3** have been considered as part of the justification for derogation from BAT and used in the CBA.

Table 5.3 Options considered as part of the BAT Derogation Justification

Option	Description
Business as Usual	No change to current operations.

Option	Description
Option 1 – Proposed Derogation	No additional technology as facility will continue operating as it currently does. Cr and Ni concentrations remain at current levels in effluent discharge via S1.
Option 2 – BAT-AEL - Precipitation and filtration suing SUEZ technology	Use of SUEZ technology combining precipitation agent, flocculating agents, and membrane filtration to reduce Cr and Ni concentrations within BAT AELs in the final discharge.
Option 3 – BAT-AEL - Ion Exchange	Ion exchange and/or chelating resin would allow ion metal removal from the wastewater stream using the right media to reduce Cr and Ni concentrations within BAT AELs in the final discharge.
Option 4 – BAT-AEL – Reverse Osmosis (e.g. polyamide thin-film composite)	Separation process that uses pressure to force a solution through a membrane, allowing pure solvent to pass to the other side, reducing Cr and Ni concentrations within BAT AELs in the final discharge.
Option 5 – BAT-AEL – Transfer for offsite treatment	Transfer of the discharge to the wider Sembcorp site for further viable final wastewater treatment to meet Cr and Ni BAT AELs.

5.3.1 Business as usual

This is the base case, which assumes ongoing operation at current discharge levels. There would be no change to environmental impact from emissions via S1.

5.3.2 Option 1 – Proposed Derogation

This option is the same as the base case, and so there would be no change to environmental impact from emissions via S1.

5.3.3 Option 2 – Precipitation and filtration using SUEZ technology

This option considers end of line treatment of the effluent prior to discharge via S1 to reduce Ni and Cr concentrations. Ni and Cr would be compliant with the 50 µg/l BAT-AEL for Ni and 25 µg/l BAT-AEL for Cr.

SUEZ's flocculant and coagulant trademark products along with SUEZ's MetClear heavy metal precipitants are designed to improve the precipitation of heavy metals to lower residual levels than traditional hydroxide. Combined with the membrane filtration system, ZeeWeed fine precipitates can be efficiently captured reducing contaminants concentration in water to below traditional methods.

5.3.4 Option 3 – Ion Exchange

This option considers end of line treatment of the effluent prior to discharge via S1 through the provision of Ion Exchange resins and would also reduce Ni and Cr concentrations down to BAT-AELs.

Ion Exchange resins are insoluble granular substances containing acidic or basic radicals in their molecular structure. The positive or negative ions fixed on these radicals can be replaced by ions of the same sign in solution in the liquid in contact with them. This process occurs without deterioration or solubilisation of the resin. The exchange is reversible, and this allows, with appropriate stripping and rinsing steps, to re-use the resin.

Chelating resins operate in the same manner as ion exchange resins, however the type of bond formed with the solute to be removed is stronger in nature and more specific. These are often used for dissolved metal ions removal. Nowadays there is a vast number of different resins commercially available, each can fulfil different requirements in different conditions. For Ni and Cr removal different resins would have to be considered as they will form bonds with different functional groups.

For Ni removal a chelating resin would be most efficient. For Cr it is dependent on oxidation state. Some resins used to purify water for drinking purposes are highly efficient at removing hexavalent Cr.

Resins are used in columns set up, the size of which depends on both the concentration of contaminants and volume of solution to treat. The flow through the columns is calculated and adjusted to achieve optimum extraction.

Once all the sites available for ion exchange or chelation have been used on the available resin's surface the solute will no longer be extracted. Best practice is to operate two identical columns in a row and to sample at the outlet of the first column to detect saturation point. In this manner the second column acts as polishing step and allows time to detect breach of the first column without loss of contaminants. At this point a stripping step is undertaken to remove contaminants from the resin. This is usually done by circulating an acid of predetermined strength through the spent resin.

The contaminants are transferred from the resin to the stripping solution which is collected and disposed of. A rinsing and/or regenerating step may be required for the resin to be used again.

5.3.5 Option 4 – Reverse Osmosis

The fourth BAT-AEL option presented is reverse osmosis which would bring Cr and Ni concentrations down to BAT-AELs. Reverse osmosis is a separation process that uses pressure to force a solution through a membrane that retains the solute on one side and allows the pure solvent to pass to the other side.

Naturally solvents flow through a membrane from an area of low solute concentration to an area of high solute concentration, this is the normal osmosis process. By applying a pressure in excess of the osmotic pressure the reverse can be achieved forcing the solvent from an area of high solute concentration through a membrane to an area of low solute concentration.

The membrane being semipermeable, it allows the passage of solvent but not of solute. The membranes used for reverse osmosis have a dense barrier layer in the polymer matrix where most separation occurs.

The membrane is designed to allow only water to pass through this dense layer while preventing the passage of solutes such as metal ions.

Periodically a washing step is required to remove the contaminants that accumulate on one side of the membrane. These need to be disposed of and the reverse osmosis process can be resumed.

Before going through the reverse osmosis set up a pre-filtration step may be required to remove sediments from the water to be treated, this is to avoid damaging the membrane and prolong its use.

5.3.6 Option 5 – Transfer for offsite treatment

For the purpose of this assessment, it has been assumed that any treatment would be undertaken off the Huntsman site. This could be on the wider Sembcorp site or at an offsite treatment facility suitable for the treatment of Cr and Ni in industrial effluent.

Initially a wastewater treatment system provided by Sembcorp was discussed as a collective by the Environmental Health and Safety Managers of the individual installations on the Wilton Site with Sembcorp. At the time, Sembcorp were not able to provide a sitewide treatment facility due to the feasibility to achieve effective treatment to the wide and varied treatment requirements to all the individual site users.

The Site has no connection into the municipal sewer system, and no direct pipeline linking to the wider Sembcorp site. As such, any transfer of process effluent would need to be undertaken using road tankers.

6. DISPERSION MODELLING

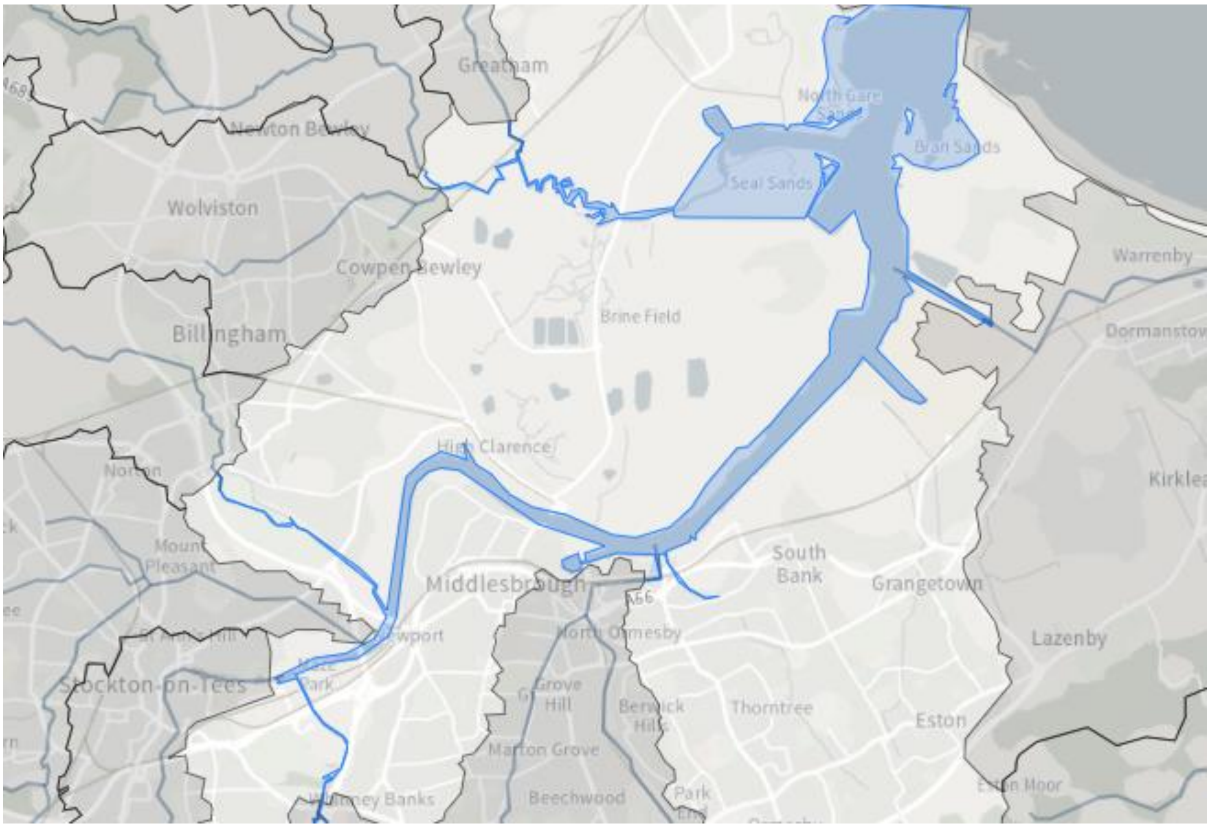
As detailed in **Section 2.2**, current Cr and Ni concentrations in the S1 discharge are in excess of the BAT-AELs**.** Water dispersion modelling work has been carried out to understand the dilution and dispersion of these concentrations in the receiving waters in order to be able to assess the benefits or otherwise of the proposed options in **Section 5.3.**

- **Section 6.1** reviews the existing quality of the receiving waters (Dabholm Gut)
- **Section 6.2** Summarises modelled dilution and dispersion of existing discharge concentrations.

6.1 Receiving Waters

The Site's two discharge routes (S1 – Sembcorp – considered direct and S2 – Bran Sands – indirect) both ultimately release into Dabholm Gut. The EA's Catchment Data Explorer indicates that the River Tees is classed as the Tees Water Body (see **Figure 6.1** taken from the EA's Catchment Data Explorer). This is, therefore, the relevant waterbody for this assessment as the Dabholm Gut falls within this transitional water body boundary. The River Tees at the point of S1 discharge is directly into the Teesmouth and Cleveland Coast, which is designated as a Special Protection Area (SPA) under the EU Habitats Directive.

Figure 6.1 Tees Water Body



6.1.1 Current status of the waterbody

The most recent (2019) Water Framework Assessment (WFD) assessment of the Tees Water Body shows that the overall water body status is moderate[9], as was also the case for all previous

[9] Environment Agency (2021). *Catchment Data Explorer: TEES Water Body.* https://environment.data.gov.uk/catchment-planning/WaterBody/GB510302509900 Last Accessed: 10/07/2023

assessments. The overall classification is made up of several separate elements, including concentrations of specific substances, and in 2019 the following species were noted as failing:

- Benzo(g-h-i)perylene
- Mercury and Its compounds
- Plybrominated diphenul ethers (PBDE)
- Tributyltin Compounds
- Cypermethrin

Reasons for not achieving good (RNAG) and reasons for deterioration (RFD) are shown in **Figure 6.2.**

Figure 6.2 Reasons for waterbody not achieving good status – Tees Water Body

Reason Type	SWMI	Activity	Category	Classification Element	More information
RNAG	Diffuse source	Poor nutrient management	Agriculture and rural land management	Dissolved Inorganic Nitrogen	Details
RNAG	Diffuse source	Poor nutrient management	Agriculture and rural land management	Macroalgae	Details
RNAG	Diffuse source	Contaminated water body bed sediments	Industry	Tributyltin Compounds	Details
RNAG	Point source	Sewage discharge (continuous)	Water Industry	Dissolved Inorganic Nitrogen	Details
RNAG	Point source	Trade/Industry discharge	Industry	Macroalgae	Details
RNAG	Point source	Trade/Industry discharge	Industry	Dissolved Inorganic Nitrogen	Details
RNAG	Point source	Sewage discharge (continuous)	Water Industry	Macroalgae	Details
RFD	Unknown (pending investigation)	Unknown (pending investigation)	Sector under investigation	Fish	Details
RNAG	Unknown (pending investigation)	Unknown (pending investigation)	Sector under investigation	Benzo(g-h-i)perylene	Details
RNAG	Unknown (pending investigation)	Unknown (pending investigation)	Sector under investigation	Cypermethrin (Priority)	Details
RNAG	Physical modification	Ports and harbours - structures	Navigation	Macroalgae	Details
RNAG	Physical modification	Coastal squeeze	Industry	Angiosperms	Details
RNAG	Physical modification	Other (not in list, must add details in comments)	Local and Central Government	Mitigation Measures Assessment	Details
RNAG	Physical modification	Coastal squeeze	Industry	Macroalgae	Details
RNAG	Physical modification	Recreation	Navigation	Macroalgae	Details
RNAG	measures delivered to address reason, awaiting recovery	Not applicable	No sector responsible	Mercury and Its Compounds	Details
RNAG	measures delivered to address reason, awaiting recovery	Not applicable	No sector responsible	Polybrominated diphenyl ethers (PBDE)	Details

At present, the WFD assessment in the Tees Waterbody of Cr and Ni are classified as High and Good respectively. None of the stated RNAGs are likely associated with Huntsman's trade effluent discharge, and pollution to surface water by Cr and Ni is not listed as an important threat. On this basis, it is judged that the existing discharges from the Site does not have a significant negative impact on the reasons for deterioration.

6.1.2 Current Water Quality

The EA manages a water quality archive with sample results for certain determinands. Data is available for the River Tees at Dabholm Gut Confluence (sample point ID NE-45401365[10]) for dissolved Cr and dissolved Ni. It is noted that this is the nearest sample point to the S1 point of discharge (see **Figure 6.3** below). However, it is located at the confluence with the River Tees which may be subject to some dilution. The results therefore may not show the immediate impacts to the Dabholm Gut by the effluent discharge. Likewise, the data is limited in that dissolved Ni data is only available between October 2019 and March 2021, and Cr data is not available after March 2021. The last 23 analytical results (2019 – 2023) for this sample point have therefore been taken and presented in **Table 6.1.**

Figure 6.3 River Tees at Dabholm Gut Confluent Sample Point

Table 6.1 River Tees Water Quality Data

Date of Sample	Nickel, Dissolved (µg/l)	Chromium, Dissolved (µg/l)
11 September 2019	0.48	-
2 October 2019	2.2	< 0.5
6 December 2020	0.71	-
12 January 2020	1.3	< 0.5
9 February 2020	0.84	-
5 March 2020	2.6	-
31 March 2021	1.1	< 0.5
12 May 2021	5	-
6 April 2022	0.59	-
10 May 2022	0.67	-
11 June 2022	0.51	-

[10] Environment Agency (2023). *Water Quality Archive: River Tees At Dabholme Gut Confluence.* https://environment.data.gov.uk/water-quality/view/sampling-point/NE-45401356 Last Accessed:10/07/2023

Date of Sample	Nickel, Dissolved (µg/l)	Chromium, Dissolved (µg/l)
11 July 2022	0.45	-
7 Aug 2022	0.45	-
13 September 2022	1.2	-
13 October 2022	0.59	-
14 November 2022	-	-
14 November 2022	1.7	-
02 December 2022	-	-
02 December 2022	-	-
09 January 2023	-	-
10 February 2023	0.73	-
8 March 2023	0.92	-
31 March 2023	0.63	-

The marine EQS standard for dissolved Cr is 0.6 µg/l (long term/ annual average (AA)) and 32 µg/l (short term/maximum allowable concentration (MAC)). The EQS standard for Ni is 8.6 µg/l (AA) and 34 µg/l (MAC).

Generally, the measured Cr and Ni concentrations recorded in this background data of the waterbody are below the EQS values, although Cr has an average of 2.4 µg/l which is above the EQS values (Ni an average of <0.5 µg/l).

6.2 Modelling Assessment

6.2.1 Overview

As detailed in **Section 2.2**, Cr and Ni concentrations in the S1 discharge are in excess of the BAT-AEL. HR Wallingford was appointed by Huntsman to complete dispersion modelling in order to assess the mixing and dilution of the existing Cr and Ni concentrations in the S1 effluent to the River Tees and identify the area of the Tees Estuary that could be adversely impacted by this discharge.

To assess the existing potential for impacts from the S1 discharge, flows and composition used in the modelling assessment derive from analysis of Huntsman effluent data for S1 (see **Section 2.2** for release concentrations of Cr and Ni). Marine EQSs, both AA and MAC were used in the assessment.

The assessment considered the following scenarios:

- Scenario 1 - Combined flows from Huntsman discharge, Sembcorp drain and Bran Sands WwTW
- Scenario 2 - Huntsman S1 discharge in isolation

The aim of Scenario 2 was to consider the dispersion of the S1 discharge in isolation. That is, assuming no dilution in the drain (no Sembcorp flows) and disregarding the dilution from the Brans Sands WwTW.

6.2.2 Modelling results

The modelling results generated maximum (MAC) and mean (AA) concentrations for each of the scenarios listed above, as well as an area of the Tees Waterbody that potentially could be impacted (i.e. in excess of the EQS). A copy of the full modelling report is presented in **Appendix I.**

A summary of the modelling assessment results is presented in **Table 6.2** and **Table 6.3**.

Table 6.2 Maximum Area of the Tees Estuary Impacted by S1 Cr Concentrations

		Maximum Area of the River Impacted (km^2)		Comment
Scenario	**Description**	**AA**	**MAC**	
1	Direct discharge at existing concentrations with combined flows	0.058	0.0	■ MAC not predicted to be exceeded as sufficiently diluted in the drain. ■ AA value only predicted to be exceeded in upper 100 m of the Gut.
2	Direct discharge at existing concentrations with no dilution from combined flows	0.091	0.051	■ MAC predicted to be exceeded in upper 1000 m of the Gut. ■ AA predicted to be exceeded along the whole Gut, but not in the estuary itself.

Table 6.3 Maximum Area of the Tees Estuary Impact by S1 Ni Concentrations

		Maximum Area of the River Impacted (km^2)		Comment
Scenario	**Description**	**AA**	**MAC**	
1	Direct discharge at existing concentrations with combined flows	0.0	0.0	■ Neither MAC or AA value are predicted to be exceeded as sufficiently diluted in the drain.
2	Direct discharge at existing concentrations with no dilution from combined flows	0.039	0.055	■ MAC predicted to be exceeded in upper 1300m of Gut. ■ AA predicted to be exceeded in upper 100 m of Gut.

6.2.3 Potential impacts

The potential impacts identified by the modelling set out an effective 'worst case' scenario for the purposes of the derogation. The options identified in **Section 5.3** all seek to reduce Cr and Ni concentrations to below the BAT-AEL levels, i.e. a reduction from the current emission rates.

For the purpose of the environmental benefit analysis detailed in **Section 7**, the largest areas of predicted impact have been carried forward, as this presents a conservative, worst-case prediction of the potential impacts from the existing S1 discharge.

7. REVIEW OF POTENTIAL ENVIRONMENTAL DAMAGE COSTS

7.1 NWEBS

With discharges to water, there are no recognised “damage costs” that can be used to monetise impacts. As requested by the EA, a calculation of environmental damage costs has therefore been undertaken based upon the published National Water Environmental Benefits Survey (NWEBS) 2021 annual environmental damage cost values (see email sent from the EA on 24th October 2022 with environmental damage costs in **Appendix J**).

The NWEBS analysed the value of improved water environments through a willingness to pay study of over 1,500 UK residents. The value has been embodied in £ figures per km (for rivers) and km² (for lakes, coastal and transitional waters) relating to each catchment across the country. The difference in values between catchments is due to the population density and the existence of substitutes.

7.1.1 Inputs

As discussed in **Section 6.1**, the Dabholm Gut and River Tees is classed as a transitional water body in the Northumbria Region. NWEBS values for this region and type of water body are shown in **Table 7.1.**

Table 7.1 Values for transitional waters in the Northumbria Region

	Annual value per km² (2021 prices)	
Change in Status	**Central Value**	**Range**
Bad to Poor	£1201.87	£984.82 – £1418.92
Poor to Moderate	£1374.44	£11126.29 - £1622.59
Moderate to Good	£1588.66	£1301.89 - £1875.43

As the Site S1 effluent discharges into the Tees Estuary, which is a Transitional or Coastal Water (TRaC), the environmental damage cost applied per component is taken for ‘good’ water quality for the Northumbria Region since this would be a change in status from the current ‘moderate’ classification. Whilst moderate to good has a high and low classification, the highest annual value of £1,875.43 per component per km² has been used. Using the highest costs estimate might be considered an overestimate, but this provides a precautionary valuation.

There are six ecosystem components as indicators of aquatic environmental quality that were used as part of the original survey and are listed in **Table 7.2.** For the Site, it is proposed that four ecosystem components are relevant (fish, other animals such as invertebrates, plant communities and safety of the water for recreational contact). The S1 discharge is not silty in nature and therefore not considered to have an impact on the clarity of water. Likewise, the discharge is not being made to a river channel and so it is not expected to alter the condition of the river channel or flow.

Table 7.2 Ecosystem Components as indicators of aquatic environmental quality accounted in assessment

	Ecosystem Component	Applicable?
1	Fish	Yes
2	Other animals such as invertebrates	Yes
3	Plant communities	Yes
4	Clarity of water and presence or absence of pollution	N/A
5	The condition of the river channel and flow of water	N/A
6	The safety of the water for recreational contact	Yes

The four components have been applied to the calculation of the environmental damage costs which gives an overall maximum Environmental Damage cost of £6,716 per km², this was calculated as:

$$£1,875.43\ (highest\ annual\ value)\ x\ 4\ (number\ of\ components) = £7,501.72/km^2$$

7.1.2 Modelling assessment outputs

The results from the dispersion modelling can be combined with the NWEBS values per kilometre to arrive at a 'damage cost' associated with the current discharge for S1. These are set out in **Table 7.3.**

Table 7.3 Calculated Environmental Damage Costs

Description	Maximum Area of the River Impacted (km^2)		Calculated Environmental Damage Cost per Annum Based upon £7,501.72 per km^2 (GBP)	
	MAC	AA	MAC	AA
Direct Discharge with no dilution – Cr at 229 mg/l	0.051	0.091	£382.59	£683.20
Direct Discharge with no dilution – Ni at 176 mg/l	0.055	0.039	£412.59	£292.57

In the event that the Options in **Section 5.3** result in a reduction of emissions of Cr and/or Ni, then the avoided damage cost would be equivalent to a reduction in the damage costs set out in **Table 7.3**. For the purpose of reviewing the CBA findings detailed in **Section 9**, a combined total of £1095.79 will be used (highest calculated environmental damage costs per annum presented for Cr and Ni).

8. COST BENEFIT ANALYSIS

8.1 CBA overview

It is a requirement of the derogation process that once options have been identified and screened relating to the potential to deliver BAT, and the environmental benefits or disbenefits have been assessed, an operator should consider the costs associated with the implementation of the available options.

A cost benefit analysis (CBA) tool has been developed by the EA to undertake assessments using a standard methodology when applying for a derogation from the requirements of the IED[11]. The latest version of this tool is v6.23.

The following IED and UK guidance has been used to support this:

- IED derogation cost-benefit analysis tool: user guide[12]

8.2 CBA tool inputs

The options under consideration (as detailed in **Section 5.3)** have had a Net Present Value (NPV) calculated based upon both CAPEX and OPEX cost data provide by Huntsman (see *Section 8.2.1* to *Section 8.2.5*).

In order to carry out sensitivity analysis, the CBA tool also requires an estimate of the uncertainty around the additional operating costs, which has been assumed to be ± 30%. An additional input to the CBA tool is the weighted average cost of capital, which has been estimated between 2 – 10%.

8.2.1 Business as usual

There would be no change to the existing costs. Operating costs for other scenarios are defined in addition to the operating costs of the business as usual (BAU) which have been provided by Huntsman based on their current operating costs. These include labour and maintenance costs, energy, and produced waste used in the Site process.

8.2.2 Option 1 – Proposed derogation

This option remains the same as the BAU costs as this assumes no change to current operations.

8.2.3 Option 2 – Precipitation and filtration using SUEZ technology

Upfront investment costs would be required for the initial purchase of equipment and has been estimated based on industry supplier quotations. Labour costs have been estimated on the assumption that 1-2 additional people would be required to operate the plant. The process will also produce a mixture of both hazardous (including sludge) and non- hazardous waste which will require additional associated costs for disposal off-site per annum.

8.2.4 Option 3 – Ion Exchange

As with Option 2, upfront investment costs would be required for the first year of operation and has been estimated based on industry supplier quotations. Labour costs have been estimated based on the assumption that 1-2 additional people would be required to operate the plant. Maintenance costs are not anticipated until the assumed operational start date of 2027. Other costs include energy and hazardous waste from regeneration solutions which are also not anticipated until 2027.

[11] Environment Agency (2020). *Industrial Emissions Directive derogation: cost-benefit analysis tool.* https://www.gov.uk/government/publications/industrial-emissions-directive-derogation-cost-benefit-analysis-tool Last Accessed: 10/07/2023

[12] Environment Agency (2020). *IED derogation cost-benefit analysis tool: user guide.* https://www.gov.uk/government/publications/industrial-emissions-directive-derogation-cost-benefit-analysis-tool/ied-derogation-cost-benefit-analysis-cba-tool-user-guide Last Accessed: 10/07/2023

8.2.5 Option 4 – Reverse Osmosis

As with the previous options, the upfront investment costs of setting up a reverse osmosis plant are high due to the need to install equipment with large spatial requirements, the instrumentation, and make necessary modifications. There are also set up costs associated with this option including civil engineering costs, importing of materials and site preparation.

While labour costs are anticipated to be similar to the previous options (based on 1-2 additionally employed persons a year), reverse osmosis would require higher maintenance costs to maintain the membranes (periodic washing to remove contaminants). Notably, this results in large amounts of hazardous waste for disposal with significant associated costs.

This option is also highly energy consuming compared to the other BAT-AEL options.

8.2.6 Option 5 – Offsite Treatment

In order to comply with the BAT-AELs for Ni and Cr, all of the Site process weak effluent would need to be sent for offsite treatment, which equates to approximately 1,000,000 / m^3 per year.

Installation of equipment, including primary control equipment, instrumentation and modifications of existing equipment would be required and have been costed for.

The operational costs of tankering is based on the requirement of needing 30,000 tankers a year (each tanker with a capacity of 30 m^3) and each tanker costing £1,050 (total of £31,500,000 / year to tanker).

8.3 CBA tool outputs

The EA's CBA tool generates the NPV of each option under consideration. The completed version of the tool is supplied as **Appendix K**.

A summary of the central estimate of the NPV of each option is presented in **Table 8.1**.

Table 8.1 NPV Calculation Output

Option	NVP (£m)
Option 0 – Business as Usual	-
Option 1 – Proposed Derogation	0
Option 2 – BAT AEL - Coagulation by SUEZ	-9.6
Option 3 – BAT AEL - Ion Exchange	-22.87
Option 4 – BAT AEL - Reverse Osmosis	-129.87
Option 5 – BAT AEL - Offsite Treatment	-28.80

The operating costs entered into the CBA tool along with DEFRA's central estimate of the damage costs of the relevant pollutants provide the central estimate of the NPV. In addition to this, different values of these parameters using ranges of damages costs and the operating cost uncertainty detailed in **Section 8.2**, are used in the tool to undertake a sensitivity analysis. The sensitivity analysis included in the CBA tool also confirms that there are no circumstances where the NPV of the BAT-AEL options are positive.

9. FINDINGS OF THE COST BENEFIT ANALYSIS

Table 9.1 compares the calculated NPV against the environmental benefit, and allows the options to be ranked. The environmental benefit cost has been estimated based on the annual environmental damage cost presented in **Section 7.1.2** (£1095.79 per annum for Cr and Ni combined) with the BAT-AEL end date (2045), providing a total of £24,107.38.

Table 9.1 NPV Calculation Output vs Environmental Benefit

Option	NPV	Environmental Benefit	Ranking
Option 0 – Business as Usual	-	None	-
Option 1 – proposed derogation	0	None	1
Option 2 – BAT AEL - Coagulation by SUEX (onsite treatment)	£-9.6M	Insignificant £0.024M	2
Option 3 – BAT AEL - Ion Exchange (onsite treatment)	£--22.87M	Insignificant £0.024M	3
Option 4 – BAT AEL - Reverse Osmosis (onsite treatment)	£-129.87M	Insignificant £0.024M	5
Option 5 – BAT AEL - Tankering for offsite treatment	£-28.80M	Insignificant £0.024M	4

As discussed in **Section 7,** the environmental damage costs have been derived using the highest annual value per km^3 for the Northumbria region, against the maximum areas of impact. As such, the environmental benefit to achieve BAT-AEL levels are a worst-case conservative estimate and in reality, may be lower.

The calculated avoided environmental damage costs demonstrate that the benefit achieved by Huntsman reducing Ni and Cr emissions from S1 from the proposed BAT derogation level to the BAT-AEL level would be relatively minimal; estimated at £24,107.38. This value of avoided damage (benefit), when set against the cost of achieving the benefit is disproportionate for all but the proposed derogation option, that is to say to continue to operate at levels slightly in excess of the BAT-AELs for Cr and Ni.

10. SUMMARY AND CONCLUSIONS

ERM has been commissioned by Huntsman to undertake an assessment of meeting BAT-AELs for Cr and Ni (25 µg/l and 50 µg/l respectively) in the Site's S1 effluent discharge to the River Tees. A BAT assessment and CBA has been carried out in order to identify the BAT option for effluent treatment.

The BAT assessment and CBA tool have been completed based on data provided by Huntsman.

Huntsman is requesting a derogation for discharge point S1 from the BAT-AEL for Cr and Ni of 25 µg/l and 50 µg/l, respectively:

- The derogation is requested based on the technical characteristics of the installation. It is however noted that there are also geographical location characteristics which need to be considered.
- The technical reasons for being unable to achieve the BAT-AELs are not time-bound, therefore the derogation request is for a non-time-limited derogation to 75 µg/ for Cr and 150 µg/ for Ni (annual averages).
- No additional treatment of the Cr and Ni within the S1 discharge is proposed.
- A cost benefit assessment has been undertaken, which clearly demonstrates that the proposed derogation position is BAU, with the other identified options being disproportionate in terms of cost when compared to the environmental benefits achievable. This is due to the additional CAPEX involved to develop the infrastructure required to replace the current operations as well as OPEX to maintain and run the plant items.

Huntsman recognises that the discharge of Cr and Ni above BAT-AELs is not preferable, however with the technical and geographical characteristics of the operation it is not cost beneficial, indeed may not even be feasible, to reduce what is already a very low concentration of metals to be able to meet the BAT-AELs. For this reason, a non-time-limited derogation is sought.

APPENDIX A HUNTSMAN RESPONSE TO EA REG 61 NOTICE 26.04.19

APPENDIX B H1 ASSESSMENT

APPENDIX C DEROGATION REQUEST TO THE EA 12.05.2022

APPENDIX D DEROGATION REQUEST TO THE EA 19.05.2022

APPENDIX E DEROGATION REQUEST TO THE EA 07.06.2022

APPENDIX F ARCADIS REVIEW REPORT APRIL 2022

APPENDIX G ARCADIS REVIEW REPORT AUGUST 2022

APPENDIX H BAT FEASIBILITY REVIEW

APPENDIX I HR WALLINGFORD MODELLING REPORT

APPENDIX J EA EMAIL WITH NWEB COSTS

APPENDIX K COST BENEFIT ANALYSIS

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