



# Surface Water Pollution Risk Assessment – CO2 Recovery and Liquefaction Plant

**BOC Hydrogen Plant – EPR/BJ7522IJ**

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## 1.0 Introduction

BOC Limited (BOC) has submitted an application to vary Environmental Permit number EPR/BJ75221J to cover the addition of a CO<sub>2</sub> recovery and liquefaction plant (LIC Plant) at the BOC Hydrogen production facility (H<sub>2</sub> Plant) located on the North Tees complex in Teesside.

This report presents an assessment of the potential water quality and ecological impacts that may potentially arise as a result of the proposed discharges from the BOC installation into the SABIC North Tees Site drainage system for eventual discharge to the Tees Estuary.

The assessment, has where possible, been undertaken in accordance with the Environment Agency's guidance on 'surface water pollution risk assessment for your environmental permit'<sup>1</sup>.

## 2.0 Site Drainage Arrangements

All discharges from the BOC site enter the SABIC North Tees Site drainage system under an agreement with SABIC. The SABIC North Tees Site drainage arrangements are summarised in Figure 1.

BOC has been advised by SABIC that the drain from the BOC site runs to the Navigator plot area where it picks up their drainage / surface water and then on to the SABIC site areas where it picks up surface water etc. from across the SABIC site.

The drainage system then flows into the SABIC PPI Pit (oil-water separator). The flow is then pumped to a Lagoon (approximately 24m x 53m with a depth of between 1 and 2 m, and BOC has been advised that it has a capacity of approximately 2,000m<sup>3</sup>) and from here the water overflows a weir and discharges under gravity to the River Tees. SABIC has advised that the majority of flow is surface water so discharge volumes are primarily dependent on rainfall.

SABIC has advised that discharge to the River Tees is typically in the order of 50 – 200m<sup>3</sup> per day, although this can be higher after heavy rainfall.

This assessment has assumed that Dry Weather Flow (DWF) conditions will represent the worst-case scenario for water emissions dilution and dispersion. Under such conditions, the BOC effluent will represent the vast majority of the water being discharged to the Tees Estuary as the majority of the other sources across the North Tees Site entering the lagoon via the drainage system relate to surface water drainage from plot areas.

On this basis the DWF into the lagoon has been assumed to consist solely of the BOC wastewater with an associated flowrate of around 166 m<sup>3</sup>/day. Assuming a lagoon volume of approximately 2,000m<sup>3</sup>, this gives a typical residence time in the lagoon of around 17 days before eventual discharge to the Tees Estuary.

BOC has no control over the effluent after it is discharged into the BOC drainage system.

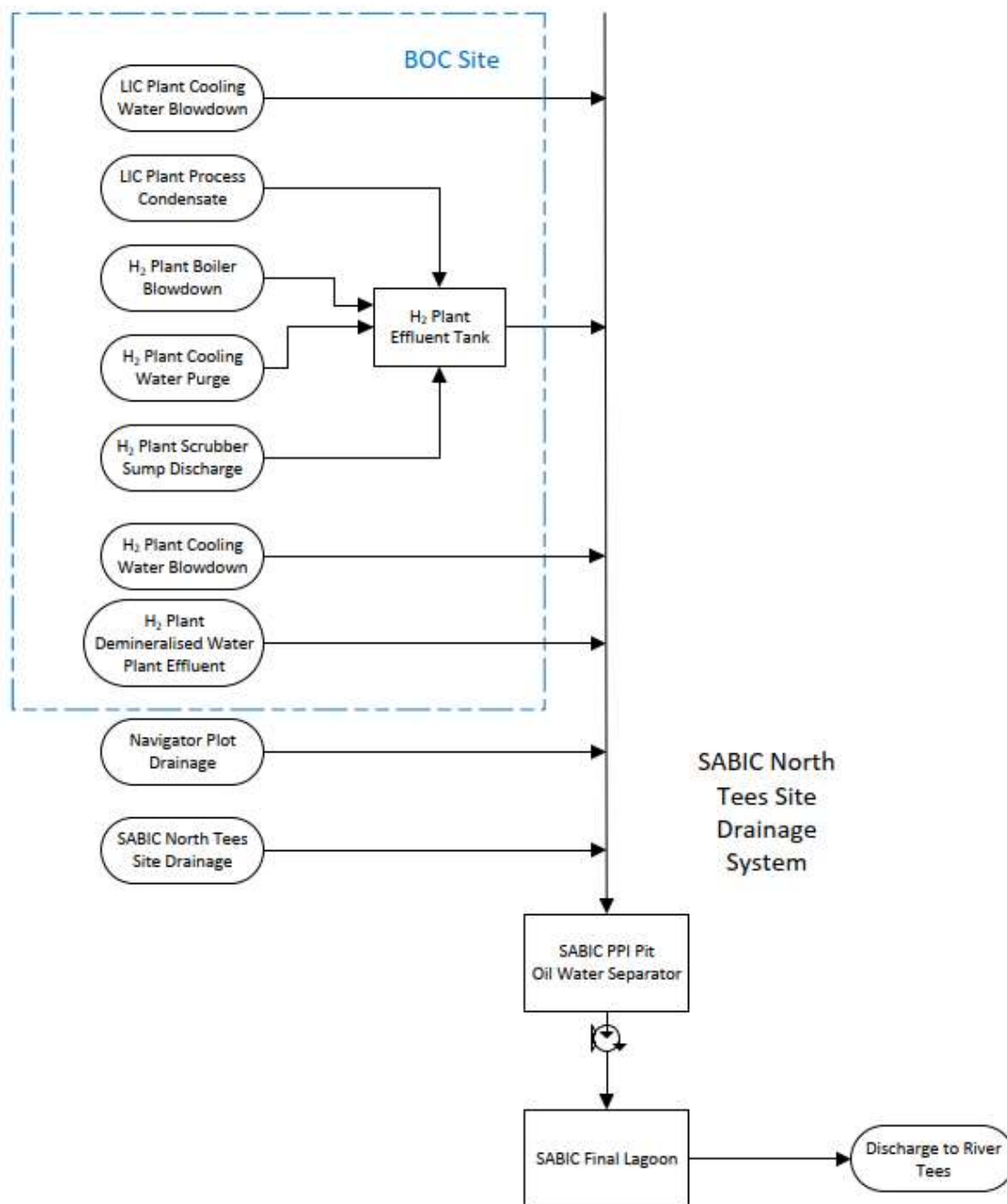
The discharge to the River Tees is regulated as emission point W1 under an Environmental Permit held by SABIC – Permit Number BU4503IW.

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<sup>1</sup> <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>



**Figure 1: Drainage System Overview**



BOC has been advised that the eventual discharge to the River Tees is via a pipeline through the riverbank which flows onto a spillway which is partially submerged depending on the tide. The eventual discharge point is located at Grid Reference NZ534230 (X (Easting) 453421 , Y (Northing) 523090). The location of the discharge point is shown in Figures 2 – 4.

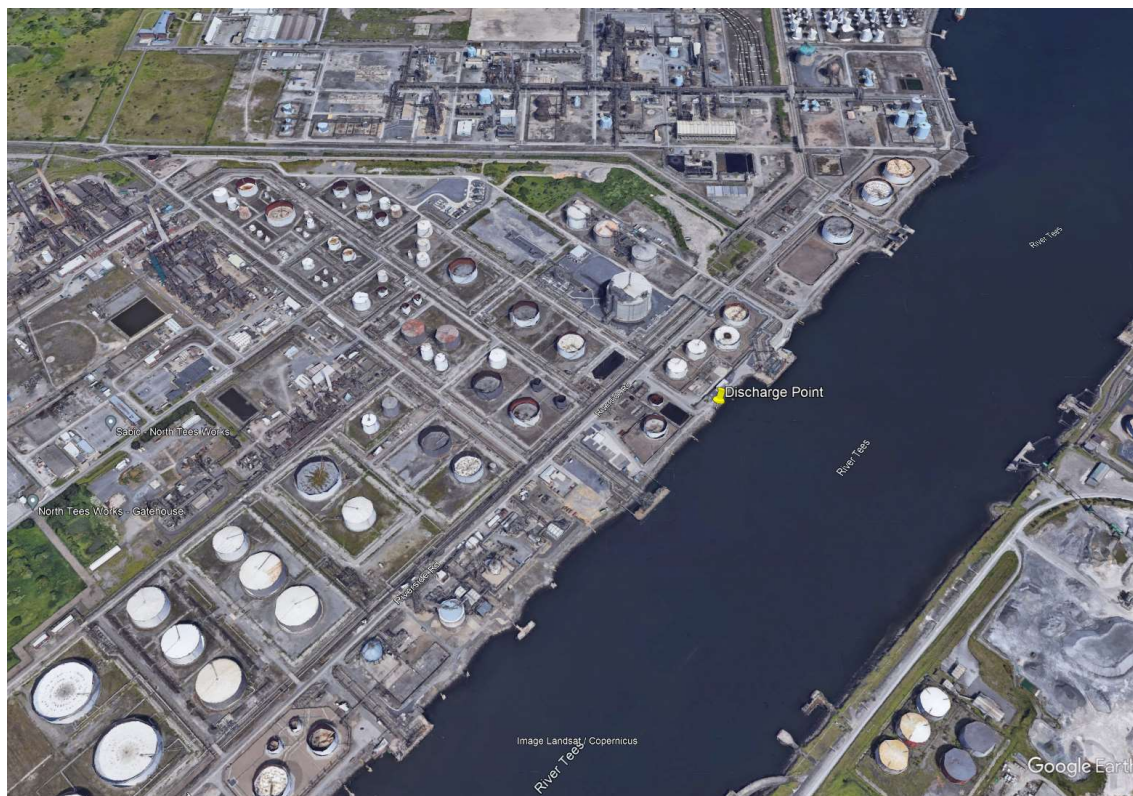


**Figure 2: Discharge Point Location Map**



Google, Image: Landsat / Copernicus

**Figure 3: Discharge Point Location**



Google, Image: Landsat / Copernicus



**Figure 4: Discharge Point**



Google, Image: Landsat / Copernicus

According to data Published by PD Ports<sup>2</sup>, The main channel of the River Tees in this area is dredged to 10.4m below lowest astronomical tide (LAT), and the area adjacent to Jetty 3. And directly in front of the discharge point is dredged to 11.8m below LAT. The small area of river between the discharge point and the dredged channel (around 8 -10m in length) is understood to be continually submerged. It has therefore been assumed for the purposes of this assessment that the discharge is into a deep-water channel and is continually submerged.

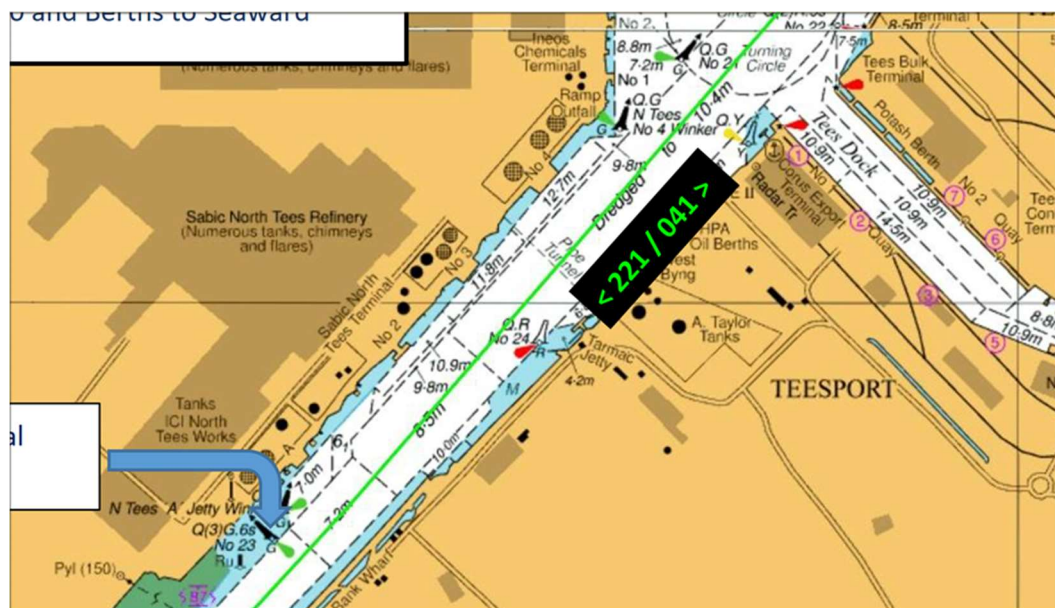
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<sup>2</sup> PD Teesport – River Tees Passage Plan Version 4 – October 2023





**Figure 5: Tees Estuary Depth Data**



### 3.0 Site Water Emissions Data

Whilst the application for environmental permit variation solely covers the addition of the LIC plant, the water impact assessment has reviewed the potential cumulative impacts associated with the combined effluent discharge from the BOC installation.

#### 3.1 Water Emission Sources

The discharges from the BOC site include the following existing sources:

- H<sub>2</sub> plant boiler blowdown;
- H<sub>2</sub> plant cooling water purge;
- H<sub>2</sub> plant scrubber / sump discharge;

All of which are discharged via the H<sub>2</sub> plant effluent tank, and

- H<sub>2</sub> plant demineralised water plant effluent;
- H<sub>2</sub> plant cooling water blowdown.

These discharges to the SABIC North Tees Site drainage system and then into the Tees Estuary are existing discharges which have been ongoing since the commencement of operation of the H<sub>2</sub> plant.

The addition of the LIC plant will add the following sources:

- LIC process condensate - which will be discharged via the H<sub>2</sub> plant effluent tank; and
- LIC plant cooling water blowdown.

Figure 1 presents an overview of the water emission sources on the BOC site and how they link into the North Tees Site drainage system.



## 3.2 Water Discharge and Monitoring Data

For the exiting H<sub>2</sub> plant effluent volumetric discharges have been calculated either:

- Based upon the tank volume, level control set points and pump rating; or
- Calculated based upon the known flows at the typical plant operating load of 85%.

For the new LIC plant – effluent generation and flow data has been developed from a combination of:

- Process design data;
- Mass balances; and
- Known pump ratings (where available).

Table 1 presents an overview of the emission monitoring or design data used to define and quantify the potential pollutants present in the effluent discharged into the SABIC Drainage system and eventually to the Tees Estuary.

The detailed flow and composition data used in the assessment and the associated data handling is presented in the Excel spreadsheet presented in Appendix A.

Flows and loads entering the North Tees Site drainage system from the BOC site have been assessed on a daily average basis for the following reasons:

- For those wastewater sources that are routed into the H<sub>2</sub> plant effluent tank, the effluent flows into the tank where it is mixed (and if required neutralised to meet discharge requirements) with pump out being controlled on a level basis and typically discharging around once every 18 hours. The discharge from this tank will therefore be fairly uniform in nature.
- The wastewater from the H<sub>2</sub> plant demineralised water plant is collected into a dedicated tank where it is mixed (and if required neutralised to meet discharge requirements) with pump out being controlled on a level basis and typically discharging around once every 2 – 3 days, so the discharge from this tank will be fairly uniform in nature.
- Cooling water is continuously purged from the BOC site systems at a predetermined rate, so again the discharge from these systems will be fairly uniform in nature.
- The combined effluent from the BOC site will eventually enter the SABIC Final Lagoon where it will have a predicted residence time within the Lagoon of around 17 days (under dry weather flow conditions) which will remove any short-term variance in flow or composition from the effluent eventually discharged from the lagoon.



**Table 1: Water Emissions Monitoring Data**

Water Emission Source	Monitoring Undertaken	Justification For Selection of Analytical Determinands	Number Of Samples Used to Generate Data	Explanation
Existing H <sub>2</sub> plant effluent tank containing effluent from: <ul style="list-style-type: none"> <li>• H<sub>2</sub> plant boiler blowdown;</li> <li>• H<sub>2</sub> plant cooling water purge;</li> <li>• H<sub>2</sub> plant scrubber / sump discharge;</li> </ul>	Spot sampling via 24h composite Analysis for : pH Phosphorus (total) Total Suspended Solids BOD + ATU (5 day) COD (Total) Nitrate as N by IC Orthophosphate as PO <sub>4</sub>	<p>The analysis for these species aligns with the chemical species which could be present within the water discharged as a result of the upstream activities e.g.</p> <p>Boiler water blowdown will include residual traces of the boiler water dosing chemicals used.</p> <p>Cooling water purge will contain residual traces of the cooling water dosing chemicals used.</p> <p>And the H<sub>2</sub> Plant Scrubber sump will predominately contain water, but may contain some traces of materials absorbed into the water from the process scrubber.</p> <p>The suite of analysis has been defined through review of the MSDS's for the boiler and cooling water dosing systems and review of the H<sub>2</sub> plant scrubber design and mass balances to identify potential pollutant species that could be present.</p> <p>The selected suite of analysis is considered to provide a suitable assessment of potential pollutants present either through direct analysis of the pollutant species (e.g. phosphorous, nitrate and orthophosphate), or through monitoring of a suitable surrogate (e.g. pH, COD / BOD for potential organic content etc.)</p>	1	<p>BOC acknowledges the statistical limitations in the use of a single sample to generate data for use in the assessment.</p> <p>However, it should be noted that:</p> <ul style="list-style-type: none"> <li>• The H<sub>2</sub> plant tends to run in a relatively steady state with relatively stable emissions;</li> <li>• The effluent is collected into the H<sub>2</sub> plant effluent tank where it is mixed (and if required neutralised to meet discharge requirements) with pump out being controlled on a level basis and typically discharging around once every 18 hours;</li> <li>• Hence the emissions from the effluent tank are understood to be relatively stable in their nature.</li> </ul> <p>BOC does not routinely sample this effluent stream, as there is no requirement in the Environmental Permit or the agreement with SABIC to do so. Hence BOC has no available historical emissions data for use in this assessment.</p> <p>So, in order to provide at least some data, a single sample has been taken to provide an initial indication of the composition of the water for use in this assessment. It is proposed that BOC will undertake further analysis over time to provide a more statistically robust set of data for use in verification of the data and assumptions used in this assessment in the future.</p>



Water Emission Source	Monitoring Undertaken	Justification For Selection of Analytical Determinands	Number Of Samples Used to Generate Data	Explanation
Existing H <sub>2</sub> plant demineralised water plant effluent	Spot sampling via 24h composite Analysis for : pH Phosphorus (total) Total Suspended Solids BOD + ATU (5 day) COD (Total) Nitrate as N by IC Orthophosphate as PO <sub>4</sub>	The analysis for these species aligns with the chemical species which could be present within the water discharged as a result of the upstream activities i.e. the operation of the demineralised water plant and the generation of reject water from that plant.	1	BOC acknowledges the statistical limitations in the use of a single sample to generate data for use in the assessment. However, it should be noted that: <ul style="list-style-type: none"> <li>• The H<sub>2</sub> plant demineralised water plant tends to run in a relatively steady state with relatively stable emissions;</li> <li>• The effluent is collected into a dedicated tank where it is mixed (and if required neutralised to meet discharge requirements) with pump out being controlled on a level basis and typically discharging around once every 2 – 3 days</li> <li>• Hence the discharge from the demineralised water plant are understood to be relatively stable in their nature.</li> </ul> BOC does not routinely sample this effluent stream, as there is no requirement in the Environmental Permit or the agreement with SABIC to do so. Hence BOC has no available historical emissions data for use in this assessment. So, in order to provide at least some data, a single sample has been taken to provide an initial indication of the composition of the water for use in this assessment. It is proposed that BOC will undertake further analysis over time to provide a more statistically robust set of data for use in verification of the data and assumptions used in this assessment in the future.



Water Emission Source	Monitoring Undertaken	Justification For Selection of Analytical Determinands	Number Of Samples Used to Generate Data	Explanation
Existing H <sub>2</sub> plant cooling water blowdown/ purge	Spot sampling of the cooling water blowdown is undertaken on a monthly basis for the following determinands: <ul style="list-style-type: none"> <li>• pH</li> <li>• Ca Hardness (as CaCO<sub>3</sub>)</li> <li>• Conductivity</li> <li>• Free chlorine</li> <li>• TVC / Dipslide</li> <li>• Ortho-Phosphate (as PO<sub>4</sub>)</li> <li>• Site Conductivity (uS/cm)</li> <li>• Oxygen reduction potential (ORP)</li> <li>• Temperature</li> </ul>	The analysis for these species aligns with the nature of the chemical dosing regime for the cooling towers which includes the use of the following materials: <ul style="list-style-type: none"> <li>• Performax PM3610</li> <li>• 14-15% Sodium Hypochlorite</li> <li>• 77% Sulphuric Acid</li> </ul> The MSDS's for these materials have been reviewed and the selected suite of analysis is considered to provide a suitable assessment of potential pollutants present either through direct analysis of the pollutant species (e.g. free chlorine/ orthophosphate), or through monitoring of a suitable surrogate (e.g. pH)	12	12 monthly samples present 12 months of suitable data which accounts for process and seasonal variation
New LIC plant process condensate  Note that this will be transferred into the H <sub>2</sub> plant effluent tank and combined with the existing H <sub>2</sub> plant water discharged prior to discharge to the site drains.	None – Plant is not yet constructed	N/A	0	Composition of the process condensate has been estimated based upon the process design data and the mass balance calculations for the LIC plant which advise that the condensate will primarily be water with the potential for up to 50ppmw of ammonia in solution and 60ppmw of formaldehyde in solution.  No other pollutants are expected to be present



Water Emission Source	Monitoring Undertaken	Justification For Selection of Analytical Determinands	Number Of Samples Used to Generate Data	Explanation
New LIC plant cooling water blowdown /purge	None – Plant is not yet constructed	N/A	0	As the LIC cooling system will be operated in the same manner as the existing H <sub>2</sub> plant cooling system and will be maintained by the same contractor using the same dosing chemicals and purge rates, it has been assumed that the chemical composition of this cooling water will be identical to the existing H <sub>2</sub> plant cooling water blowdown.



## 4.0 Assessment

The assessment of potential water quality impacts has been split into 3 stages:

- Assessment of compliance with BAT-AELs;
- Initial contaminant screening; and
- Modelling.

### 4.1 Assessment of Compliance with BAT-AEL's

The predicted emission from the site has been compared against the BAT Associated Emission Levels (BAT-AEL's) as defined in the following EU BAT Reference Documents (BREF) which are applicable to the Installation,

Environment Agency Sector Guidance Note IPPC S4.03 - Guidance for the Inorganic Chemicals Sector – (applicable to the operation of the steam methane reformer only)

Common Wastewater and Waste Gas Treatment / Management in the Chemical Sector (CWW) - May 2016

The applicable BAT-AEL's are defined in BAT Conclusion (BATc) 12 of the CWW BREF and compliance with these limits is summarised in Table 2.

As can be seen the predicted emissions comply with all the relevant BAT-AEL's.



**Table 2: Demonstration of BAT-AEL Compliance**

Parameter	BAT-AEL (Yearly Average)	Predicted Emission Concentration (as Combined Effluent entering the SABIC Drainage System (Daily Average)	Compliant (Yes / No)
Total Organic Carbon (TOC) (1)	10 - 33 mg/l	N/A	N/A
Chemical Oxygen Demand (COD) (1)	30 - 100 mg/l	7.49	Yes
BOD	Indicative BAT AEL - 20 mg/l	0.59	Yes
Total Suspended Solids (TSS)	5 - 35 mg/l	2.90	Yes
Total Nitrogen (2)	5-25 mg/l	0.315 mg/l Nitrate (as N) 0.97 mg/l as Ammonia in solution	Yes
Total Inorganic Nitrogen (2)	5-20 mg/l	0.315 mg/l	Yes
Total Phosphorus	0.5-3.0 mg/l	0.626 mg/l	Yes
Adsorbable organically bound halogens (AOX)	0.2 - 1.0 mg/l	0.49 mg/l as free Chlorine	Yes
Chromium (expressed as Cr)	5 - 25 µg/l	Not Applicable – Material is not used on site	N/A
Copper (expressed as Cu)	5 - 50 µg/l	Not Applicable – Material is not used on site	N/A
Nickel (expressed as Ni)	5 - 50 µg/l	Not Applicable – Material is not used on site	N/A
Zinc (expressed as Zn)	20 - 300 µg/l	Not Applicable – Material is not used on site	N/A
(1)	Either BAT-AEL for TOC or COD applies		
(2)	Either the BAT-AEL for total nitrogen or the BAT-AEL for total inorganic nitrogen applies		





## 4.2 Initial Screening Assessment

A number of the pollutant species which are anticipated to be present within the water discharged into the SABIC North Tees drainage system are known to either degrade or come out of solution over time, and hence with a calculated residence time of around 17 days in the final lagoon, the actual emission concentrations of these materials entering the Tees Estuary will be significantly lower than the concentrations present at point of discharge into the drainage system from the BOC Site.

This particularly applies to the following pollutant species:

- Ammonia – Which has a half-life of 0.25 days <sup>3</sup>
- Acetaldehyde – Which has a half-life of 1.9 hours <sup>4</sup>
- Free Chlorine - Which has a half-life of 1.3 – 5 hours<sup>5</sup>

Table 3 presents the calculated residual concentration of these species in the effluent upon eventual discharge from the lagoon to the Tees Estuary.

**Table 3: Prediction of Residual Pollutant Concentrations on Exit from the Lagoon**

Substance	Concentration Entering Lagoon (mg/l)	Half Life (hours)	Number of Half Lives in Lagoon Residence Time (17 days)	Approximate Residual Concentration at Discharge to Tees Estuary (mg/l)	NOEC or PNEC	Below NOEC / PNEC
Ammonia	0.97	6	68	1.68 e-21	NOEC 0.0135	Yes
Acetaldehyde	1.16	1.9	215	3.20 e-66	PNEC 0.19	Yes
Free Chlorine	0.49	5	82	5.98 e-26	NOEC 0.0021	Yes

Hence, these substances can all be discounted from further assessment.

As a result, the final discharge into the Tees Estuary will not contain any hazardous pollutants listed in the EA guidance, and no further assessment of such pollutants is required.

The remaining sections of this assessment will therefore focus on those substances that are expected to be present in the water discharged to the Tees Estuary i.e. sanitary and other pollutants.

<sup>3</sup> [https://canadachemicals.oecd.org/WebHandler\\_Document\\_Data.axd?Id=9bd6dd50-d871-498f-b692-6237dcf56c2d#:~:text=Results-Endpoints%20%2F%20values%20%2F%20units%20\(do%20not%20assess%20this%20item\),criteria%20for%20persistence%20in%20water.](https://canadachemicals.oecd.org/WebHandler_Document_Data.axd?Id=9bd6dd50-d871-498f-b692-6237dcf56c2d#:~:text=Results-Endpoints%20%2F%20values%20%2F%20units%20(do%20not%20assess%20this%20item),criteria%20for%20persistence%20in%20water.)

<sup>4</sup> <https://www.inchem.org/documents/ehc/ehc/ehc167.htm#:~:text=Reported%20half%2Dlives%20of%20acetaldehyde,average%20%20%2C%2B5g%2Fm3.>

<sup>5</sup> USEPA Factsheet for Chlorine gas  
[https://www3.epa.gov/pesticides/chem\\_search/reg\\_actions/reregistration/fs\\_PC-020501\\_1-Feb-99.pdf](https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/fs_PC-020501_1-Feb-99.pdf)



### 4.3 Water Quality Within the Tees Estuary

Water quality data for the Tees Estuary has been collated for relevant pollutant species.

Data from the Environment Agency Water Quality Archive for the Tees at Smiths Dock (Sampling Point NE-45400834), which is slightly upstream of the emission point, has been used to provide an indication of background water quality. The data for the last 18 months sampled (Nov 2022 – April 2024) has been presented in the excel spreadsheet presented in Appendix 1 and is summarised in Table 4.

**Table 4: Tees Estuary Water Quality Data**

Parameter	Units	Maximum	Average	Minimum
Ammoniacal Nitrogen, Filtered as N	mg/l	0.510	0.286	0.110
Nitrogen, Total Oxidised, Filtered as N	mg/l	2.600	1.021	0.170
Nitrate, Filtered as N	mg/l	2.580	1.009	0.165
Orthophosphate, Filtered as P	mg/l	0.120	0.072	0.028
Oxygen, Dissolved, % Saturation	%	101.200	92.889	86.300
Oxygen, Dissolved as O <sub>2</sub>	mg/l	10.600	8.978	7.320

### 4.4 Water Quality Impact Assessment Modelling

#### 4.4.1 Modelling Methodology

EA guidance on modelling<sup>6</sup> suggests that substances which are not screened out by an initial screening assessment are further assessed via an iterative approach, starting with simple calculations and modelling techniques. In this case, due to the tidal influence at the point of discharge into the estuary a simple approximation of mixing zones was carried out using a spreading disc plume model.

The aim of this modelling was to determine whether or not the extent of the mixing zones is “clearly acceptable” or not, as defined in the European Technical Guidelines for the Identification of Mixing Zones<sup>7</sup>.

The *BasicPlumeModel.xls* spreadsheet tool (previously acquired from the EA) requires the following inputs:

- Discharge rate (m<sup>3</sup>/s);
- Dispersion coefficient (ky);

<sup>6</sup> Environment Agency (2014). LIT 10419 Modelling: surface water pollution risk assessment. [Available at]: <https://www.gov.uk/government/publications/modelling-surface-water-pollution-risk-assessment>

<sup>7</sup> European Commission (2010), *TECHNICAL GUIDELINES FOR THE IDENTIFICATION OF MIXING ZONES*



- Depth of mixing (m); and
- Flow Velocity (m/s).

An average discharge rate of 0.019 m<sup>3</sup>/s was used as per the initial screening assessment.

A dispersion coefficient of 0.1ky was used as a typical value in the absence of site-specific data.

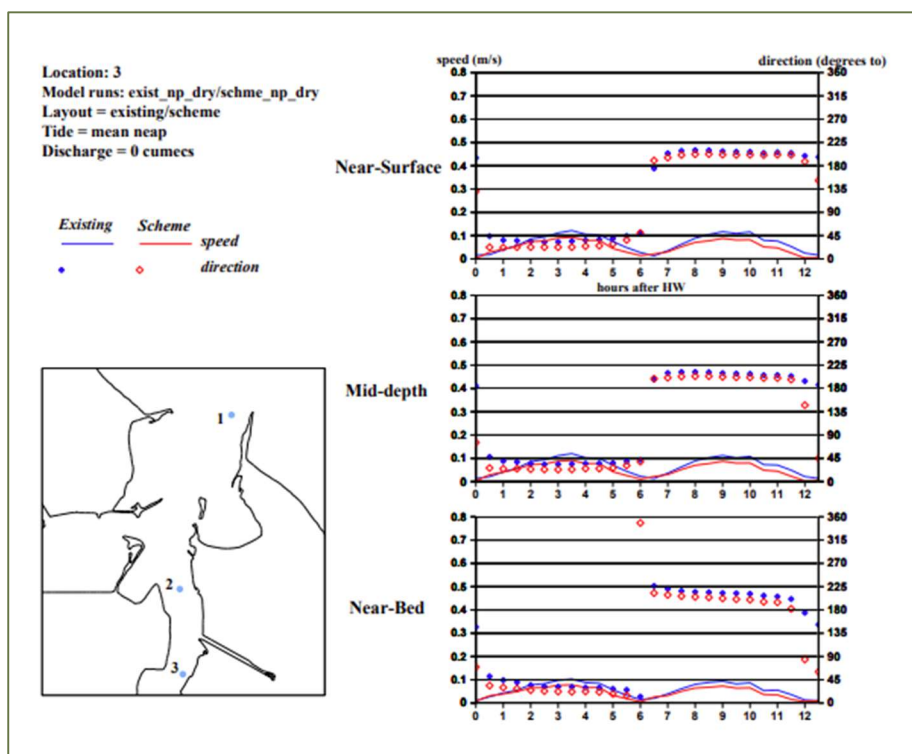
Depth of mixing was set at 0.25 m to reflect minimal depth of mixing (a conservative assumption) in the absence of detailed information about the exact position of the discharge pipe.

Mixing zones were estimated at hourly intervals over the course of a tide cycle with varying flow velocity values, in order to assess mixing zones at all states of the tide and identify worst case scenarios.

In order to maintain a conservative approach, velocities for dry (0 cumecs fluvial flow) and neap tide conditions were used to determine mixing zones in conditions with the most conservative environment.

Flow velocity values were obtained from a publicly available report<sup>8</sup> conducted by HR Wallingford on hydrodynamic and sedimentation studies for a proposed Northern Gateway Container Terminal. Flow velocities were extracted at hourly intervals from the appendices of the HR Wallingford report. Figure 6 shows an extract from the report which details flow velocities over the course of a 12-hour tide cycle at a location close to point of discharge. Due to the assumed shallow depth of mixing, the near surface velocities were used. It is understood that the scheme referred to in the report is not yet implemented and therefore the “existing” flow velocities were used.

**Figure 6: Flow Velocities**



<sup>8</sup> HR Wallingford (2006), *Northern Gateway Container Terminal Hydrodynamic and Sedimentation Studies*



#### 4.4.2 EQS Values

Generic EQS limits for BOD, Phosphate and Suspended Solids are not provided in assessment guidance. Instead, they are derived for each specific discharge assessment based on the environment of the receiving watercourse.

The BOD standard for rivers is determined by site altitude, alkalinity (as mg/l CaCO<sub>3</sub>) of receiving watercourse and the water quality status of the river (i.e. High, Good, Moderate, Poor). The site altitude is less than 80 m and in the absence of alkalinity data for the receiving watercourse a conservative approach was taken assuming the lowest alkalinity bracket in the guidance<sup>9</sup> (type 1 river type). The receiving watercourse has a High quality status for dissolved oxygen according to the EA's catchment explorer<sup>10</sup> (Tees from Skerne to Tidal Limit Water Body). Therefore, the 90<sup>th</sup> percentile BOD standard equates to 3 mg/l.

The Phosphate standard for rivers is determined by site altitude, alkalinity (as mg/l CaCO<sub>3</sub>) of receiving watercourse and the status of the river (i.e. High, Good, Moderate, Poor). The site altitude is less than 80 m and in the absence of alkalinity data for the receiving watercourse a conservative approach was taken assuming the lowest alkalinity bracket in the guidance<sup>8</sup> (type 1n river type). The receiving watercourse has a poor status for Phosphate. Therefore, the annual mean Phosphorus standard equates to 0.5 mg/l.

The Suspended Solids guideline standard of 25 mg/l (25,000 µg/l) has been taken from the Freshwater Fish Directive.

#### 4.4.3 Modelling Outcome

The dilution required in order to reduce the concentration of contaminants to their respective EQS concentration was calculated from the sum of the average release concentration plus the background concentration, divided by the EQS value.

As shown in Table 5, the only remaining contaminant requiring dilution to meet its EQS is phosphate. Therefore, the modelling exercise focused on the mixing zones required for phosphate to meet its EQS concentration.

**Table 5: Dilution Factors Required**

Substance	Average Estimated Release Concentration (mg/l)	Receiving Water Background Concentration (mg/l)	AA-EQS (mg/l)	Dilution Factor Required to Meet EQS
BOD	0.59	1.5 <sup>[1]</sup>	3	N/A
Phosphate	10.32	0.072	0.5	20.78
Suspended Solids	2.90	12.5 <sup>[1]</sup>	25	N/A
<sup>[1]</sup> Taken as 50% of EQS in absence of background concentration data				

<sup>9</sup> Environment Agency, (2014). H1 Annex D2: Assessment of Sanitary and Other Pollutants within Surface Water Discharges (v1.0). [Available at]: <https://www.gov.uk/government/publications/h1-annex-d2-assessment-of-sanitary-and-other-pollutants-in-surface-water-discharges>

<sup>10</sup> Environment Agency Catchment Data Explorer - <https://environment.data.gov.uk/catchment-planning/>



#### 4.4.4 BOD

The estimated release concentration of BOD is below the derived EQS limit of 3 mg/l. Whilst no background data for BOD concentration was available, EA guidance typically allows for an assumption that the background concentration is 50% of the EQS. On this basis the BOD concentration would be less than the background water quality. Therefore, the discharge of BOD into the Tees is unlikely to have any significant detrimental effect on the downstream water quality and no further assessment was deemed necessary.

#### 4.4.5 Suspended Solids

The estimated release concentration of suspended solids is below the derived EQS limit of 25 mg/l. Whilst no background data for suspended solids concentration was available, EA guidance typically allows for an assumption that the background concentration is 50% of the EQS. On this basis the suspended solids concentration would be less than the background water quality. Therefore, the discharge of suspended solids into the Tees is unlikely to have any significant detrimental effect on the downstream water quality and no further assessment was deemed necessary.

#### 4.4.6 Phosphate

The extent of the mixing zones for phosphate were determined using the *BasicPlumeModel.xls* spreadsheet tool as described in Section 4.4.1.

Figure 7 shows the output of the modelling spreadsheet for the states of tide with the joint largest mixing zone, high water (hour 6) and low water (hour 12).

**Figure 7: Disc Plume Model Output**

Discharge Rate (m <sup>3</sup> /s)	0.019					
Dispersion Coefficient (ky)	0.10					
Depth of Mixing (m)	0.25					
Flow Velocity (m/s)	0.015					
Transverse Distance, y (m)	0.0	1.0	2.0	3.0	4.0	5.0
Longitudinal Distance from virtual source, x(m)	Values of Dilution					
5.00	4.04	4.07	4.16	4.32	4.55	4.87
10.00	5.71	5.73	5.80	5.91	6.07	6.27
15.00	7.00	7.01	7.07	7.16	7.28	7.45
20.00	8.08	8.09	8.14	8.22	8.32	8.47
25.00	9.03	9.05	9.09	9.16	9.25	9.38
30.00	9.89	9.91	9.94	10.01	10.09	10.21
35.00	10.69	10.70	10.73	10.79	10.87	10.98
40.00	11.43	11.44	11.47	11.52	11.60	11.70
45.00	12.12	12.13	12.16	12.21	12.28	12.37
50.00	12.77	12.78	12.81	12.86	12.93	13.02
55.00	13.40	13.41	13.43	13.48	13.54	13.63
60.00	13.99	14.00	14.03	14.07	14.13	14.21
65.00	14.56	14.57	14.60	14.64	14.70	14.78
70.00	15.11	15.12	15.15	15.19	15.24	15.32
75.00	15.64	15.65	15.68	15.72	15.77	15.84
80.00	16.16	16.17	16.19	16.23	16.28	16.35
85.00	16.66	16.66	16.68	16.72	16.77	16.84
90.00	17.14	17.15	17.17	17.20	17.25	17.32
95.00	17.61	17.61	17.64	17.67	17.72	17.78
100.00	18.06	18.07	18.09	18.13	18.17	18.24
105.00	18.51	18.52	18.54	18.57	18.62	18.68
110.00	18.95	18.95	18.97	19.00	19.05	19.11
115.00	19.37	19.38	19.40	19.43	19.47	19.53
120.00	19.79	19.80	19.81	19.84	19.89	19.94
125.00	20.20	20.20	20.22	20.25	20.29	20.35
130.00	20.60	20.60	20.62	20.65	20.69	20.75
135.00	20.99	21.00	21.01	21.04	21.08	21.14
140.00	21.37	21.38	21.40	21.43	21.47	21.52



Dilution values were taken from the spreadsheet at a transverse distance of 0m to determine the maximum longitudinal distance until sufficient dilution would be achieved. These values are presented in Table 6.

**Table 6: Dilution Values**

Hourly Interval from Low Neap Tide	Flow Velocity (m/s)	Longitudinal Distance to Reach Required Dilution (m, at 0m Transverse Distance)
0hr – Low Water	0.025	80
1hr - Flood	0.04	50
2hr - Flood	0.08	25
3hr – Peak Flood	0.115	20
4hr – Flood	0.115	20
5hr – Flood	0.075	30
6hr – High Water	0.015	135
7hr - Ebb	0.04	50
8hr - Ebb	0.085	25
9hr – Peak Ebb	0.11	20
10hr - Ebb	0.105	20
11hr - Ebb	0.075	30
12hr – Low Water	0.015	135

The longitudinal distances required for phosphate to be diluted to its EQS value varies between different states of the tide as the flow velocity changes. The increased distance at low and high water is markedly greater than other states of the tide. Despite this significantly increased difference, the longest longitudinal extent of the mixing zones was found to be 135m.

At the point of discharge the river is approximately 370m wide (transverse direction).

With reference to the European Technical Guidelines for the Identification of Mixing Zones<sup>11</sup>, *“In order to ensure that EQS exceedance does not impair the quality of the overall water body and to ensure that the extent of the mixing zone is restricted to the proximity of the discharge point, it is therefore recommended that a precautionary approach is taken at Tier 2 so that the extent of EQS exceedance in rivers that can be considered acceptable without further assessment should be the lesser of 10\*W (river width) or 1 kilometre provided that the extent of mixing zone does not exceed 10% of water body length overall.”* Given that the size of the largest mixing zone is significantly less than the width of the river (and hence significantly less than 10 times river width) at the point of mixing, less than 1 kilometre and less than 10% of the water body length, it is suggested that the mixing zone is acceptable.

<sup>11</sup> European Commission (2010), *TECHNICAL GUIDELINES FOR THE IDENTIFICATION OF MIXING ZONES*



## 5.0 Nutrient Neutrality

The Tees Estuary is within a nutrient neutral catchment.

Table 2 within Annex C of guidance issued by Natural England<sup>12</sup> indicates that the Teesmouth & Cleveland Coast SPA / Ramsar (through which the Tees Estuary flows) is designated as a nutrient neutral catchment for nitrogen only.

The potential impacts associated with the proposed additional discharge from the BOC installation have been assessed and emissions of nitrate (as nitrogen) have been demonstrated to be at very low levels and at concentrations below the average concentrations within the receiving water and hence unlikely to have any significant effect on the Teesmouth & Cleveland Coast SPA / Ramsar.

## 6.0 Conclusions

BOC has submitted an application to vary Environmental Permit number EPR/BJ7522IJ to cover the addition of a CO<sub>2</sub> recovery and liquefaction plant (LIC Plant) at the BOC Hydrogen production facility located on the North Tees complex in Teesside.

Trade effluent produced at the facility is discharged into an existing drainage system under an agreement with SABIC, from where it will be held in a lagoon prior to discharge into the River Tees.

The development of a LIC plant will contribute additional load on the effluent being discharged from the site in the form of process condensate and cooling water blowdown.

Available effluent monitoring data has been collated and assessed, with comparison against BAT-AELs and screening of substances which are unlikely to pose a significant impact to the receiving water quality.

Following the initial screening, phosphate was assessed further via simple 2-dimensional plume modelling in order to determine the extent of mixing zones as different states of tide. The largest mixing one was found to be significantly less than the width of the river at the point of discharge and therefore deemed to be acceptable with reference to the European Technical Guidelines for the Identification of Mixing Zones.

Therefore, the discharge of effluent from the site is not anticipated to pose a significant risk to the downstream surface water quality in the River Tees.

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<sup>12</sup> Natural England Water Quality and Nutrient Neutrality Advice (16 March 2022) (NE785)  
<https://publications.naturalengland.org.uk/publication/4792131352002560>





# **Appendix A    BOC Water Emissions Data**

## **Surface Water Pollution Risk Assessment – CO2 Recovery and Liquefaction Plant**

**BOC Hydrogen Plant – EPR/BJ7522IJ**

**BOC Limited**

SLR Project No.: 416.065113.00001

5 August 2024



See Attached Excel Spreadsheet





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