HPC COMPANY DOCUMENT

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ENVIRONMENTAL PERMIT VARIATION APPLICATION: HINKLEY POINT C CONSTRUCTION WATER DISCHARGE ACTIVITY PERMIT – TUNNEL EFFLUENT

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Technical Reviewer	James Holbrook
Author	Dr Richard Mitchener

APPROVAL: ENVIRONMENTAL PERMIT VARIATION APPLICATION: HINKLEY POINT C CONSTRUCTION WATER DISCHARGE ACTIVITY

Prepared by:	**Name:** Dr Richard Mitchener **Title:** Site Environmental Engineering Lead	Date: Refer to EDRMS
Verified by:	**Name:** James Holbrook **Title:** Environmental Compliance Manager	Date: Refer to EDRMS
Approved by:	**Name:** Ross Pettigrew **Title:** Conventional Environmental Technical Manager	Date: Refer to EDRMS

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NON-TECHNICAL SUMMARY

NNB Generation Company (HPC) Limited (NNB HPC) is building a new nuclear power station on the northern coast of Somerset.

As part of the project, three tunnels are being advanced under the Bristol Channel to form the operational power station's cooling water system. These works generate an aqueous waste stream, termed "tunnel effluent," which comprises saline groundwater entering the tunnels from the surrounding rocks, as well as used potable water used for cleaning and to help the mining process. This effluent is treated to remove fine particles (suspended solids) and, if needed, to reduce the pH; it is then discharged to the Bristol Channel under Activity H of the site's Construction Water Discharge Activity (CWDA), issued by the Environment Agency (EPR/JP3122GM).

It has recently become apparent that natural concentrations of dissolved inorganic nitrogen, cadmium and chromium in the saline groundwater are higher than estimated from samples taken on land before the tunnelling works started, with the levels sometimes above the permit limit. These concentrations are not considered to present a risk to the environment, and treatment would not be a good option once the energy required is considered.

NNB HPC is therefore seeking to vary the permit to increase the levels within the permit for dissolved inorganic nitrogen, total cadmium and total chromium, to better reflect the naturally occurring groundwater chemistry.

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1 INTRODUCTION

NNB Generation Company (HPC) Limited (NNB HPC) is developing the first of a new generation of nuclear power stations on the north Somerset coast, approximately 13km northwest of Bridgwater. As part of this project, 3 tunnels have been advanced using a Tunnel Boring Machine under the Bristol Channel; two of which (known as IT1 and IT2) were drilled to 3.8km to draw in cooling water, while the third (OT) will discharge cooling water and treated effluent back into the channel under the Operational Water Discharge Activity (OWDA) permit (Permit reference EPR/HP3228XT). These tunnels will be connected to the estuary via vertical shafts. An approximately 30m-long tunnel, excavated sub-horizontally, will connect the bored tunnels to the vertical shafts.

Discharges from the construction of these tunnels, amongst other activities, are discharged to the Bristol Channel, after treatment where necessary, under the Construction Water Discharge Activity (CWDA) Permit (Permit reference EPR/JP3122GM/V009 & V010). This discharge includes groundwater that enters the tunnels, as well as used potable water used to support the works in various ways. The permit imposes numerical limits on flow rate and on the chemical composition of the discharge.

1.1 Purpose

The variation application, for which this report provides supporting information, seeks to amend the permit limits of dissolved inorganic nitrogen (DIN), cadmium and chromium to support the final phase of the works.

1.2 Scope

This application relates only to the construction phase of the project and only seeks to vary limits set for Activity H – discharge of tunnel effluent. There is no impact on any limits set under the OWDA.

1.3 Summary description of the proposed variation

NNB HPC is requesting:

- An increase in the permitted concentration of DIN from 8,146µg/l to 15,000µg/l;
- An increase in the permitted concentration of total chromium from 48µg/l to 144µg/l; and
- An increase in the permitted concentration of total cadmium from 1µg/l to 3µg/l.

As detailed in Section 2.3.2 of the report, this is required to allow the discharge of naturally occurring levels of these substances that are present in the saline groundwater that is beneath the Bristol Channel. Given the low concentrations of these substances, the low flow rates generally observed, the temporary nature of the activity and, in the case of cadmium and chromium, the sporadic nature of the elevated concentrations, it is not considered practicable or environmentally beneficial to attempt to treat the water to reach the existing permit limits (see section 3.2).

1.4 Contents of this report

The report includes the following sections:

- Section 2 summarises the Water Discharge Activity as currently permitted, including a description of the plant and the measures that NNB HPC has taken to address the challenges at HPC;
- Section 3 sets out the proposed variation, including the assessment of the potential environmental effects, and further improvement measures that may be implemented; and
- Section 4 summarises the conclusions.

1.5 Definitions

Abbreviation	Definition
HPC	Hinkley Point C
NNB HPC	NNB Generation Company (HPC) Limited
CWDA	Construction Water Discharge Activity (Permit)
DIN	Dissolved Inorganic Nitrogen (the sum of total ammonia, nitrate and nitrite expressed as mass of nitrogen).
OWDA	Operational Water Discharge Activity (Permit)

2 CURRENT WATER DISCHARGE ACTIVITY

2.1 Description of current operations

The tunnelling works at HPC, of necessity, generate a wastewater comprising:

- Groundwater released from the rock during mining and entering the tunnels as seepage;
- Process water added to assist mining;
- Process water from the cleaning of equipment, cleaning of the tunnels, dust suppression etc.; and
- Testing of fire mains and smoke curtains

The key contaminants in these waters are total suspended solids (TSS) generated by disturbing the ground, and elevated pH from the concrete and grout utilised within the tunnelling works. Naturally occurring substances present in the groundwater are also present.

These waters are collected within the tunnels and pumped to a dedicated treatment plant known as the Tunnel Effluent Treatment System (TETS). The TETS comprises 2 plants operating in parallel to ensure that the permit limits for TSS and pH are met. Each plant adds coagulant (ferric chloride) and flocculent (anionic polyacrylamide) so that the silt and clay particles clump together before passing the effluent through lamella separators, which encourage these particles to settle. Carbon dioxide can also be introduced, where necessary, to lower the pH. Continuous monitoring is provided, which prevents discharge of water where the permit limits for TSS and pH are not met. In this case, the effluent is re-circulated through the TETS until the limits are met.

The treated effluent is discharged from a position at the distal end of the site's jetty, known as Outlet 12.

The sludge generated by the treatment is subject to further conditions and passed through a filter press with the excess water returned into the treatment process. The filter cake produced by the TETS is retained on site for use in landscaping works.

It should be noted that the TETS does not explicitly treat for metals, although the removal of TSS will inevitably remove much of the contribution to "total" metals which are set in the permit. Based on the information available at the time that tunnel effluent was added to the permit there was no reason to suggest that treatment would be required. Similarly, the TETS does not treat for DIN which is highly soluble and difficult to remove.

2.2 Effluent characterisation

The groundwater component of the tunnel effluent was characterised based on groundwater composition data gathered from boreholes on the main (terrestrial) site. The data set included information gathered during early site-investigations before works commenced, as well as from routine testing of the pumped wells, which form part of the site's dewatering system; the effluent from which is discharged from site under Activity E2 of the permit, also via Outlet 12.

The modelling to support the current permit was based on the mean and 95th percentiles of this data set, making reasonable-worst case assumptions where appropriate. The assessment is described in detail in the previous application (NNB HPC, 2018), with the modelling described by CEFAS (2021)[1]. Numerical modelling was only undertaken where this was required, by applying the approach set out by the Environment Agency (2022). DIN, cadmium and chromium all "passed" test 5, i.e., had effective volume fluxes (EVF) below the allowable effective volume flux, and thus were not explicitly modelled. Zinc, however, was modelled, as it was the substance in the groundwater with the highest effective volume flux.

The potential nutrient effects of DIN were considered by CEFAS (2021) utilising the CPM model (Aldridge et al., 2008). This demonstrated that increases in DIN, including from the sewage and cold commissioning effluents that are much higher than that in groundwater, would not have an adverse effect.

2.3 Effluent development

2.3.1 Dissolved Inorganic Nitrogen

Discharge of tunnel effluent commenced in February 2020 and the concentration of DIN was consistently below the current permit limit (8,146 µg/l) until October 2022 (Figure 1). DIN levels then rose markedly and have generally remained above the permit limit since that time. Extensive investigations were undertaken to identify any potential anthropogenic sources. No such sources were identified, but testing of water entering the tunnels through pressure relief holes in the area of the TSC works showed elevated levels of ammoniacal nitrogen and sampling along the length of the tunnels indicated that this was likely oxidising into nitrate and

[1] The limits for ammoniacal nitrogen (but not for DIN) were raised in a subsequent variation as more date became available (NNB HPC 2021).

nitrate. It was therefore concluded that the observed levels of DIN were due to the natural composition of the saline groundwater encountered at the far end of the tunnels.

It is likely that naturally occurring water quality is different in the saline-dominated groundwater at the far ends of the tunnels than that observed in the terrestrial boreholes, likely due to differences in the hydrogeochemistry, where there are much higher concentrations of major ions present than in fresh water. The outfall tunnel is 1.8km long with each of the intake tunnels being c.3.4km long and this the closest terrestrial boreholes to the current working areas were 1.8km away. Therefore, it was not possible to fully characterise this water under long-term flow conditions prior to work starting. During the main TBM works, it is likely that the higher volumes of potable water masked the DIN levels present in the groundwater. Since the completion of TBM works in the autumn of 2022, the saline groundwater quality has become dominant. Whilst the commencement of TSC works will result in the use and discharge of more potable water, it is still

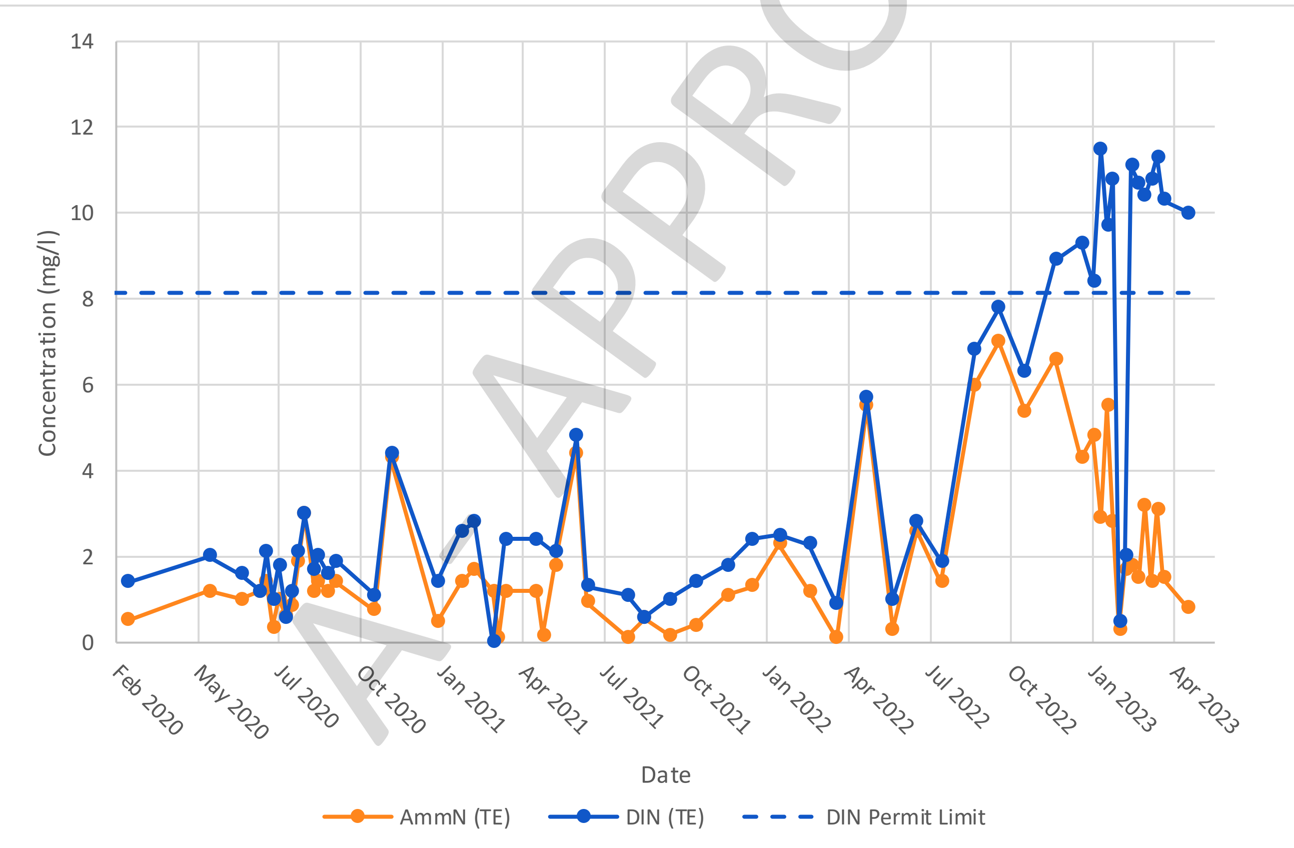

Figure 2.1: DIN and Ammoniacal Nitrogen levels in tunnel effluent

likely that groundwater will dominate, and this would especially be the case if any high-flow zones are encountered.

2.3.2 Cadmium and Chromium

Figure 2.2 shows the recorded concentrations of total cadmium and total chromium in tunnel effluent since the start of tunnelling in February 2020. The permit limits have been breached 2 times for each substance. Extensive investigations were undertaken and reported to the Environment Agency in each case and no clear anthropogenic sources were identified. Whilst it is possible that incidental releases of concrete or cement grout may give rise to slightly elevated chromium levels, there is no source for the cadmium except for natural occurring concentrations within the rock and groundwater. It is noted that as the permit limits are for “total” metals, small amounts of suspended materials in the small portion of the sample that is analysed could give rise to sporadic breaches. Given the nature of tunnelling works, there is a higher probability of this entrainment for the groundwater system, where carefully engineered wells yield water with very low suspended solids content.

Chromium is commonly found in two forms; chromium (III) and chromium (VI). The transition and coastal EQSs for chromium specify that is it is the dissolved chromium (VI) concentration that is regulated. However, for the purposes of the current assessment total chromium concentrations have been used for both the effluent concentrations and the background values. This is a highly conservative assumption.

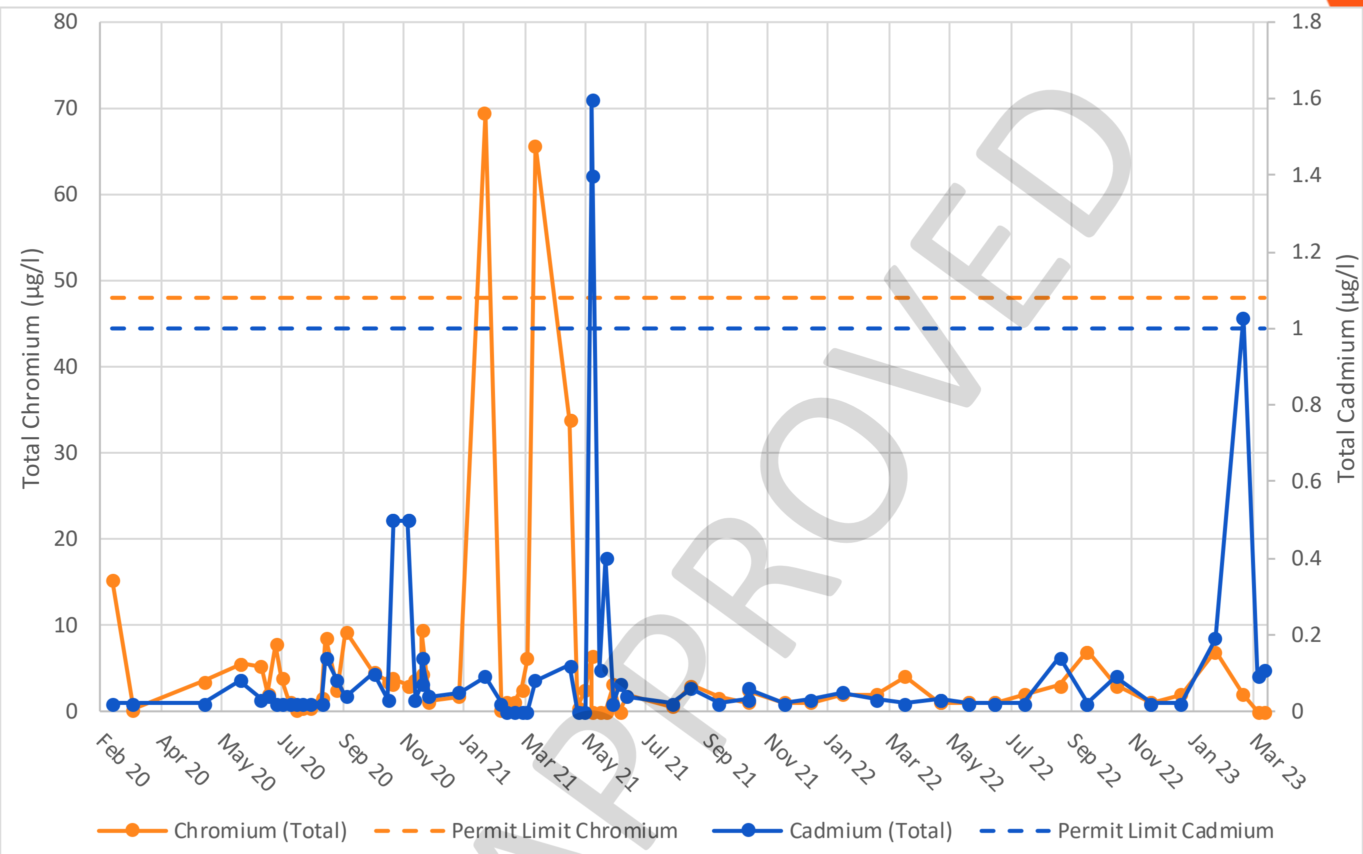

Figure 2.2 : Cadmium and chromium in tunnel effluent

3 PROPOSED VARIATION

To support the project and the delivery of Net Zero, it is proposed to vary the permit to allow the discharge of increased concentrations of DIN, chromium and cadmium. As set out below, it is not considered that developing treatment options to reduce the already low limits to below the permit limits would be a good environmental outcome. Any potential treatment technology would require energy and chemical inputs and would generate relatively large volumes of dilute waste, that would require off-site disposal. Given the low risk presented by the observed concentrations, it is considered disproportionate.

3.1 Environmental assessment

CEFAS (2021) sets out the environmental risk assessment undertaken to support the currently permitted levels, with each of the three contaminants of interest having effective volume fluxes (EVFs) well below the acceptable levels. The calculations have been repeated with the higher levels and, for simplicity, the elevated levels have been assumed to be present in both groundwater *sensu stricto* (activity E2) and tunnelling effluent (Activity H), which is conservative. Also, for simplicity, the maximum concentration proposed has been utilised, whereas the original CEFAS calculations utilised the 95th percentile of the data.

Table 3.1: Effective Volume Flux Calculations

Contaminant	Assessed Discharge concentration (µg/l)	Saltwater AA EQS (µg/l)	Background concentration (µg/l)	EVF Case C	TraC Water test 5 EVF< 3.0
DIN	15,000	2,520	1,050	0.228	PASS
Total Cadmium	3	0.2	0	0.3	PASS
Total Chromium	144	0.6	0.05	0.276	PASS

Table 3.1 shows that the proposed limits do not require detailed modelling under the Environment Agency's guidance. Notwithstanding this, detailed modelling was undertaken to consider the impact of, inter alia, zinc contained within groundwater (CEFAS, 2021). This modelling demonstrated that even with an EVF of 20.37, concentrations within the receiving water were reduced to the relevant environmental quality standard within 5 metres on the seabed, and that the species of interest within the estuary were not impacted by elevated concentrations. It can therefore be concluded that the proposed increase in limits will not have any adverse impact on the receiving water.

Cadmium is a priority hazardous substance under the Water Framework Directive, and therefore, to satisfy the Environment Agency's (2022) guidance, an annual significant load of cadmium has been calculated assuming a continuous discharge at the requested rate in both groundwater and tunnel effluent. This is highly conservative as:

- detectable levels of cadmium are rare in both groundwater and tunnel effluent, such that an average concentration would be much lower; and
- It is unlikely that both groundwater and tunnel effluent would have detectable concentrations at the same time, and thus a degree of dilution would occur.

Notwithstanding the above, the total loading, using these worst-case assumptions, is 4.35kg/year, which is below the 5kg/year standard.

3.2 Treatment options

Whilst consideration has been given to providing treatment to reduce the concentrations of DIN, total cadmium and total chromium to below the currently permitted concentrations, this is not considered a practical, environmentally responsible solution. This is because:

- The effluent, being saline, has high levels of dissolved substances which will interfere with common treatment options, including for example ion exchange reducing removal efficiency significantly;
- In order to ensure overcome these interferences, multiple treatment steps are likely to be needed, each consuming energy and resources and generating dilute wastes;
- Due to the very high solubility of DIN it is likely that reverse osmosis would be the only suitable technology to achieve the low permit limits,– this technology is highly energy intensive and would generate a very dilute effluent;
- The wastes produced by any treatment options would be dilute (non-hazardous) and would likely be disposed of via road transport to a water recycling centre which would be able to discharge the effluent, along with other inputs, without specific treatment into the same receiving water; and
- The period during which this effluent will be produced is limited and any treatment plant would be temporary – some waste would inevitably be generated by the installation and removal of any plant .

It is therefore concluded that the energy and raw materials (e.g. treatment chemicals, and infrastructure) that would be used would not be proportionate to the environmental impact that may be avoided. This is because the risk assessment has shown that there is no significant environmental effect.

4 CONCLUSIONS

Naturally occurring dissolved inorganic nitrogen, chromium and cadmium have been identified in saline groundwater that contributes to the tunnel effluent waste stream (Activity H). DIN levels have been consistently elevated since the main bored tunnelling works were completed, whilst elevated l concentrations of cadmium and chromium are more sporadic. For all contaminants, treatment is not considered practicable or to be the best environmental option and it is therefore requested to vary the permit.

The Environment Agency's (2022) risk assessment methodology has been used to assess the potential impact of these changes. Although not required due to the low concentrations involved, reference has also been made to previously undertaken complex hydrodynamic and hydro-chemical modelling of potential effects on the Bristol Channel to ensure that in-combination effects are properly assessed. These assessments have concluded that:

- The additional extent of any plume is very small with concentrations reducing to EQS within 46.04 metres of the discharge point compared to less than 7.16m under the already permitted limit;
- The area of the SAC with levels above the EQS is less than 0.002%; and
- The key species and habitats of interest are not exposed to concentrations above the EQS and therefore further assessment of any potential effects is not needed.

It is therefore concluded that the proposed variation will not have any likely significant effects on the protected site. Similarly, it is concluded that, due to the very localised effects, there will be no impact of Water Framework Directive status of either the Bridgwater Bay or River Parrett waterbodies.

It is therefore requested that the permit is varied such that the limits set out I Schedule 3, Table S3.1 of the permit is increased as follows:

- For dissolved inorganic nitrogen to 15,000µg/l;
- For total cadmium to 3µg/l; and
- For total chromium to 144µg/l

5 REFERENCES

CEFAS (Centre for Ecology, Fisheries and Aquaculture Science), 2021. Hinkley Point C construction discharge modelling assessment at the temporary jetty location. CEEMS Technical Report TR428. Revision 14.

Environment Agency, 2022. Surface water pollution risk assessment for your environmental permit. [online] Available at https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit. Accessed 23/06/2023.

Aldridge, J.N., Painting, S.J., Mills, D.K., Tet, P., Foden, J. and Winpenny. K. 2008. The Combined Phytoplankton and Macroalgae (CPM) Model: predicting the biological response to nutrient inputs in different types of estuaries in England and Wales. Report to the Environment Agency. CEFAS Contract C1882.

APPENDIX A APPLICATION FORMS