RESPONSE TO

DEFRA

"Joint Agency Investigation into Teesside and Yorkshire Coast Crab and Lobster Mortalities

Investigation summary

Date: May 2022"

To

North East Fishing Collective

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Marine Pollution Research & Consultancy

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INTRODUCTION: This Response addresses issues raised in the DEFRA JOINT ACENCIES REPORT published in May 2022.

The DEFRA document reiterated the DEFRA view that chemical pollution (potentially from Pyridine) derived from the TEES PORT dredge and dump operations, which have re-suspended and redistributed chemically contaminated sediment, was **not** a causative factor for the Mass Mortality (MM) of marine animals. The DEFRA document also reiterated the DEFRA view that the MM was caused by a Harmful Algal Bloom (HAB), of Karenia spp, or possibly another phytoplankton.

On behalf of the regional NEFCs this Briefing provides a response to the DEFRA dismissal of dredge and dump derived chemical pollution (Pyridine) as a causative factor. This Briefing introduces additional peer reviewed scientific work which supports the argument that current and historical chemical pollution, previously sequestered in Tees estuary sediments, has been re-suspended and re-distributed to inshore waters as a result of the creation of regular and multiple suspended sediment plumes at both dredge and dumpsites.

On behalf of the regional NEFCs this Briefing also provides a response/refutation of the DEFRA hypothesis on HABs and introduces yet more information to support the proposition that the DEFRA HAB hypothesis is currently so poorly evidenced that it cannot be justified as the causative factor. Additionally, this Briefing introduces peer reviewed scientific work which supports the proposition that satellite imagery forming the principal base of the HAB hypothesis may have actually captured dredge plumes and not an algal bloom.

On behalf of the regional NEFCs this Briefing points out that DEFRA publications to date have mistakenly claimed that mortalities had ceased over the winter and had not returned in 2022. This is not the case. It is clear from reports from the fishing communities within the Mass Mortality impact zone that crustacean catch rates remain consistently and significantly reduced, that many fishers report that a high percentage of what is harvested is already dead or dying, that a significant percentage of live catches die in keep tanks on route to shore or in merchants onshore keep tanks and cannot be marketed.

The DEFRA Joint Agency Briefing focusses its reference to the Mass Mortality impact on the mortality of commercial decapod crustacean crabs and lobsters and barely references the mortality of any other species. This Briefing notes that many submissions from fishers, other regional marine stakeholders and beach users et alia clearly report the extensive and currently ongoing mortality and "wash up" of many marine species predominantly demersal (sea bed) species including fin fish, shellfish, urchins, starfish, seaweeds, and marine mammals representing the apex predators. While the DEFRA Agencies have not denied this fact, they have studiously avoided giving it any publicity. By doing so, the DEFRA PR machine has (intentionally or otherwise) managed to downplay the true magnitude and widespread environmental significance of the Mass Mortality.

This Briefing concludes that, 7 months after the initiation of the MM,

a: DEFRA is still adhering to its original attempted explanation for the MM

b: but the DEFRA HAB hypothesis still has no confirmed empirical base and thus remains un-evidenced

c: and that DEFRA has been unable to refute the NEFC proposal that dredging and dumping of chemically contaminated Tees estuary sediments is a causative factor for the MM and that, on the basis of the currently available evidence, Pyridine is strongly suspected.

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1: PYRIDINE

1:1 After initial difficulty identifying the correct chemical classification of Pyridine I can now confirm that it is a Basic Heterocyclic Organic Hydrocarbon Compound. Pyridine is widely reported to be structurally related to the aromatic hydrocarbon Benzene. Like Benzene, Pyridine can be extracted from coal tar, and is a by-product of coal gasification, shale oil and other hydrocarbon extraction and refining processes. The environmental behaviour and fate of pyridine has some similarities to that of the polycyclic aromatic hydrocarbons (PAHs)

1;2 As set out in my earlier reports to the NEFCs, Pyridine interacts with environmental surfaces (such as soils and sediments) via multiple pH-dependent mechanisms, including partitioning, by adsorption, to soil/sediment organic matter. ***REF: "Sorption of heterocyclic organic compounds to reference soils: column studies for process identification". Bi, E.; Schmidt, T. C.; Haderlein, S. B. (2006). Environ Sci Technol. 40 (19): 5962–5970.***

1;3 When Pyridine is discharged in liquid effluents to water courses, the available evidence suggests that adsorption to the surface of ambient water column soil/sediment particles will reduce the concentration of Pyridine in the water and increase it on the surface of sediment particles suspended in the water column. Under the electro/chemical conditions that occur when fresh and salt water mix in estuarine environments suspended fine sediment particles will aggregate together and form flocs. Eventually these flocs become heavier than water and deposit out in estuarine sediment deposits on the estuary floor or in fringing mud flats/salt marshes.

1:4 Chemicals which preferentially partition OUT of the liquid phase and into the sediment phase in estuarine environments thus become “sequestered” in estuarine fine sediments, where, in conditions of reduced UV light, reduced temperature and reduced oxygen the degradation rate is much reduced and, in some cases, may almost reach standstill. The process of adsorption followed by sequestration removes, or reduces, the toxicity from the water column and locks it into the deposited sediment thus reducing the toxic impact potential of the water while increasing it in the sediments.

1:5 However, if these sediments are disturbed and re-suspended then any toxins will be made bio-available. Depending on the nature of the chemicals involved some toxicity may be released from the sediment particles back into the water column, but often the majority of the toxicity will remain adsorbed to the sediment particles. In the case of Pyridine in marine environments there is no information on this aspect of its behaviour and fate.

2: Pyridine Toxicity As discussed in my previous report to the NEFCs (March 2022) there is a major absence of EC50 and LC50 Pyridine test data on marine species and the great majority of such testing has been carried out on mammalian and freshwater species. Additionally, the majority of the available LC50/EC50 data for Pyridine products was reported in the 1980s and 1990s. Information on the toxicity of Pyridine and its derivative compounds to aquatic organisms derived from these few earlier studies, are now considered insufficient to assess the hazards of Pyridine**.**

2:1 *Pyridine LC50 (lethal concentration for 50% of test subjects) tests for freshwater fish conducted in the 1980s found that the LC50 for Fathead Minnows was 99 mg/L* ***REF: “Acute***

toxicology of organic chemical mixtures to the fathead minnow" Broderius SJ & Kahl MD. Aquatic Toxicology 6: 307-322. 1985

2;2 By contrast, more recent improved analytical techniques reported the following:

Fathead minnow 96 hour Pyridine LC50 = 73.6 mg/l

European carp 96 hour Pyridine LC50 = 26 mg/l

Rainbow trout 96 hour Pyridine LC50 = 4.6 mg/l

REF: "Safety Data Sheet (PYRIDINE): ThermoFisher Scientific". Creation Date 02-0ct-2009.

2;3 Even more recent academic research published in 2013, on the toxicity of Pyridine based anti-foulings, has reported that the degradation products of Pyridine anti-foulings may have an influence on marine organisms, at concentrations lower than the previously reported toxic values. The 2013 study reported that initiation of Pyridine product toxicity, measured by 24 hour EC 50 (effective concentration resulting in chronic toxicity for 50% test subjects) for the marine crustacean shrimp T. japonicus, occurred at concentrations as low as 6.6 micro grams per litre. ***REF: "Toxicity of Degradation Products of the Antifouling Biocide Pyridine Triphenylborane to Marine Organisms." Toshimitsu Onduka et al'. Arch' Environ' Contam' Toxicol'. (2013) 65:724–732 (table 2 p.728)***

2:4 There is a very long list of compounds based around, or containing Pyridine and or its derivatives. In recent years, Pyridine-containing neonicotinoids have been the fastest-growing and most important class for the insecticide market. Neonicotinoids containing significant levels of Pyridine include Imidacloprid and Thiacloprid, both of which have been referenced as having severe toxic impacts on aquatic invertebrates including arthropods (a group which including lobsters, crabs and shrimps). Multiple papers published in peer reviewed journals reference the significant toxic impacts of Imidacloprid and Thiacloprid to aquatic invertebrates.

2:5 Imidacloprid is highly toxic on an acute basis to aquatic invertebrates, with EC 50 values = 0.037 - 0.115 ppm. It is also highly toxic on a chronic basis to marine crustaceans, with effects on growth and movement shown to occur at concentrations between 0.06/1.3 micro grams per litre (or Kg) in the marine mysid shrimp. ***(REF: Imidacloprid-Wikipedia)***

2:6 Although there is a consensus that the toxicity to fish is relatively low, the US EPA has requested review of secondary effects on fish with food chains that include sensitive aquatic invertebrates. ***REF: "Environmental Fate and Effects Division Problem Formulation for the Registration Review of Imidacloprid." Federoff NE et al'. 13th Nov' 2008. US EPA***

2:7 Subsequent research published in 2018 has clearly demonstrated accumulation of Imidacloprid in the blood of rainbow trout which contradicted claims from the manufacturer that persistence and bioaccumulation does not occur. ***REF: "Toxicokinetic of the neonicitinoid insecticide Imidacloprid in rainbow trout (Oncorhynchus mykiss)". Comp Biochem Physiol C Toxicol Pharmacol. 205: 34;42***

2:8 A 2021 study of the impact of Pyridine based Imidacloprid (IMI) on the freshwater crayfish Procambarus clarkia investigated the effects of IMI on the locomotion, antioxidative status, digestion and intestinal microbiota of the crayfish. The results showed that IMI caused locomotion impairment with reduced crawl velocity, reduced aggressiveness and reduced reversal ability. ***REF: "Imidacloprid induces locomotion impairment of the freshwater crayfish, Procambarus clarkii via neurotoxicity and oxidative stress in digestive system". Yi Huang et al' . Aquatic Toxicology. Vol' 238. September 2021, 105913***

2:9 A 2020 study investigated the effects of the Pyridine containing neonicotinoid insecticide on the marine mussel Mytilus galloprovincialis after short-term exposure to sublethal concentrations. Mussels were tested for seven days to 0, 1, 5 and 10 mg and 0, 10, 50 and 100 mg L^{-1}. The exposed mussels showed significant imbalance negative impact on digestive gland and gills, caused a significant decrease in the chemical activity necessary for correct function of chemical reactions in gills. Results of histological analyses showed severe damage in both digestive gland and gills in a time- and concentration-dependent manner. This study provides useful information about the acute toxicity of a neonicotinoid compound and a commercial insecticide on mussels. Considering that neonicotinoids are still widely used and that mussels are very important species for marine environment and human consumption, the study's authors recommended further researches to better comprehend the potential risk posed by such compounds to aquatic non-target species. ***REF: "Acute effects of neonicotinoid insecticides on Mytilus galloprovincialis: A case study with the active compound thiacloprid and the commercial formulation calypso 480 SC." Alzabeta Stara et al' . Ecotoxicology & Environmental Safety. Volume 203. 15 Oct' 2020.***

2:10 It is clear from the above examples that Pyridine and its derivatives and compounds are highly toxic to a range of marine species including filter feeding shellfish which are relatively low down on trophic food webs and decapod crustaceans which are relatively high up the trophic food webs. In the context of the reported bio-accumulation of Pyridine in aquatic species this is potentially significant.

It is evident from the evidence above that the toxicity inducing concentrations, reported by these academic and peer reviewed studies, for marine crustacean, are very low (less than 5 micro grams/kg) compared to the peak of 430mg/kg* (430,000 micrograms/kg) *found in the most Pyridine contaminated crab sample from the impact zone.

2:11 "Control" and "comparison" crab samples The DEFRA Joint Agency Report and other comments issued by DEFRA have repeated the statement that Pyridine could be being formed naturally post-mortem in the crab tissue as it has been reported amongst other amines monitored as indicator of freshness in fish.
However, the DEFRA comments failed to mention that sources report "low levels" of Pyridine as a result of mortality. This would appear to correlate with the reported 5 mg/kg of Pyridine observed in the "control" crab samples from Penzance as reported by the original CEFAS chemical analyses undertaken at the start of the investigations into the Mass Mortality.

2:12 If the DEFRA argument is that Pyridine is a product of mortality…DEFRA have yet to explain the very low concentrations (5 mg/kg) in the dead Penzance control samples relative to the 80 times greater concentration found in the peak NE dead crab samples.

Is it the DEFRA view that such hugely disparate concentrations are both the product of mortality? Can DEFRA explain this disparity?

3: DEFRA and CEFAS sample collection methodology in this case has been an interesting and unusual process.

3:1 Analysis of samples for suspected toxicity is most usually set against analysis of a "control sample" or "samples" from a sample site known, or justifiably expected, to be free of the presence of the toxins being analysed for. In this case the "suspect" toxins appear to have been chosen because the impact region was the receiving environment of a wide range of toxic chemicals characteristic of regional industries situated on the N.E. coast and estuaries.

3:2 Control samples were taken from Penzance , an area distant from, and upstream of, such industries and therefore representative of a clean and uncontaminated environment. In this way, the normal methodology permits assessment of the degree of contamination (elevation of concentration) of impact zone samples compared to the concentrations detected in the control samples which reflect those conditions of "normal" or "background" concentrations .

3:3 The DEFRA introduction of "comparison" samples in this case has not been justified or explained by the DEFRA Agencies. The comparison samples are taken from areas which are clearly also exposed to potential source of a number of chemicals including Pyridine. Thus, samples from North Shields and St Mary's Lighthouse are both adjacent to the Tyne estuary, a site with a history of coal gasification, hydrocarbon activities etc strongly likely to have generated the by-production of Pyridine by-production.

3:4 The Norfolk Wash sample sites are also likely to have been receiving environments of Pyridine containing insecticides from river systems, draining intensely arable/horticultural areas and discharging into the Wash, which have been reported as having elevated levels of Imidacloprid and Thiacloprid. ***REF: https://www.buglife.org.uk/news/heavy-neonicotinoid-insecticide-contamination-damaging-british-rivers/***

3:5 The Norfolk Wash samples sites are also likely to have been the receiving environments of Pyridine containing herbicides. The US EPA has listed 7 herbicides it classifies as members of the Pyridine and/or Pyrimidine class. Herbicides of the Pyridine/Pyrimidine class have multiple targets and are used on most commercial plant species (grains, vegetables, fruit, pasture) and during field, garden and roadside application. The US EPA has identified a number of ecological toxicity and persistence risks and mitigation strategies for the use of these products. ***REF: https://www.epa.gov/ingredients-used-pesticide-products/registration-review-pyridine-and-pyrimidine-herbicides#:~:text=The%20pyridine%20and%20pyrimidine%20classes%20are%20herbicides%20with,settings.%20Use%20sites%20vary%20from%20herbicide%20to%20herbicide.***

3:6 The intense agricultural activity and productivity of the river basins draining into the Wash mean that the presence of both insecticides and herbicides containing Pyridine and its derivatives is indicated in the marine environment of the Norfolk Wash.

One outcome of the DEFRA use of "comparison" crab samples from such compromised sites and the introduction of the "Pyridine caused by mortality" concept is to imply a reduction in the significance of the Pyridine concentrations detected and reported in the impact zone crab samples. This would be a mistake.

The additional "comparison" crab samples are clearly not representative of anything other than conditions at a number of sites LESS contaminated with Pyridine than the impact area. Relative to the Penzance "control" samples, "comparison" samples have demonstrated that they were taken from sites already contaminated with pyridine. The significantly greater pyridine concentrations in impact zone samples, relative to "comparison" and "control" samples, demonstrates that the Tees estuary and downstream samples have excess levels of pyridine.

4: The DEFRA JOINT AGENCY testing regime: the Joint Agency report makes the following statement: "*based on the evidence available the licensed activities including cabling and offshore windfarm activity and dredging or disposal of sediment to designated disposal grounds was not likely to be the cause of the decapod mortalities".*

4:1 The testing regime required by the MMO must ensure that sediment analysis is consistent with defined CEFAS action levels for an extensive list of heavy metals and chemicals which has been in place with only minor adaptions since at least the 1990s.

However, the class of chemicals defined as Basic Heterocyclic Organic Compounds, which includes Pyridine, and many of its derivatives and compounds, is not included in that list.

4:2 There is ample evidence that Pyridine has been produced on Tees side as an industrial by product/waste product from coal tar production and coal gasification etc since the early 20th century.

4:3 Since the mid-20th C Pyridine manufacture has been deliberate as increasing industrial and agricultural applications have been found or it. By the late 20th C the demand was increasing almost exponentially and there were two companies (ICI and Vertullus) manufacturing Pyridine on Tees side. Since the early 2000s Vertullus has become the world's largest producer of Pyridine. Vertullus UK Ltd, at Bran Sands, is the UK division of a US based multinational.

4:4 In the context of the extreme toxicity of Pyridine to those marine crustacea which have been subjected to toxicity tests it is evident that the DEFRA JOINT AGENCIES have failed to keep abreast of the unfolding scientific evidence about the high toxicity of Pyridine to the marine crustacea which have been the subject of toxicity testing.

4:5 The rationale for the Joint Agency conclusion is illogical because it is based on a false premise.

The testing regime required by the MMO does not require testing for a major marine enviro-toxin known to have been an industrial by product on Teesside for well over a century and to have been deliberately manufactured on Tees side in recent decades.

The claim that the testing regime ensures "that the deposit of dredged material will not cause significant harm to marine life" is illogical because is clearly based on inadequate/incomplete data.

5: A DEFRA PowerPoint presentation entitled "Pyridine Slides for Discussion" was made by Alison Miles of the Env' Agency was given to the FCAs on 17/03/2022. A small number of the slides offered some evidence that had not been previously offered by DEFRA and its Joint Agencies.

The PPT stated that the DEFRA agencies had analysed for many chemicals, including newer chemicals not "standard" within normal monitoring and assessment.

No explanation has been provided for the decision to undertake sampling of newer, non-standard chemicals or the specific choice to include Pyridine among these newer non-standards

5:1 Slide 10 introduced confusing and incomplete historical water sampling for Pyridine. Slide 10 appears to be dated 10 Nov 2021. It is unclear if this is the date when the slide was compiled, or the date of the retrieval of the data presented.

The water samples were taken in 2012, 2015, 2016 and 2018. None of the reported water samples were contemporary with the 2021 dredging activity and the data which was presented was intermittent and unable to provide a detailed chronological breakdown of Pyridine concentrations over the 7 year period.

5:2 Flaws/omissions in slide 10

Slide 10 reports that "in over 20 water samples only 3 had positive detects of <0.5 micrograms/litre".

a: This aspect of slide 10 is confusing as "<" signifies "less than" and, in the context of environmental sample analysis usually indicates that the sample has returned a concentration below detection level which, in this case would be less than 0.5 micrograms/litre.

b: Slide 10 presents a Table of only 13 sample analysis results, not the 20 results referred to in the accompanying text. There is no reference to the fate/availability of the missing 7 results.

c: Of the 13 tabulated sample results none are defined as "less thans" and may thus be assumed to be positives.

d: 7 of the 13 tabulated results are shown to have concentrations less than 0.5 micrograms, while the remaining 6 had concentrations ranging from1 microgram/litre to 2.3 microgram/litre.

e: No description was given about the sample sites (or site), no detail was provided of the ambient conditions at the time of sampling.

The lack of such information reduces the usefulness of the analytical outcomes because the results cannot be contextualised against sea states, weather conditions and the dredging regime current at the time of sampling.

f: Slide 10 notes that positive detects of Pyridine have also been identified in Southampton Water, site of the Fawley Oil Refinery and a number of sites listed as manufacturers of agricultural chemicals including pesticides and herbicides which may be based on Pyridine or its compounds. Slide 10 also notes that positive detects were also identified in the river Orwell. The Orwell is a river draining the extensive arable and horticultural regions of Suffolk. ***Both the Orwell and Southampton Water are indicated as waters likely to the receiving environment of Pyridine based compounds and Pyridine waste product discharge. Slide 10 has not referenced the likely Pyridine inputs to these waters.***

5:3 Slide 11 reports that 3 samples of sediment were collected from Bran Sands (surface scrape only) representative of recent deposition. 33% of samples (1 of 3) showed a positive detect at 0.018mg/kg (18micrograms/kg).

This concentration is many times higher than those shown for the water samples in Slide 10, and provides some evidence that there has been a (post 2018) increase in regional Pyridine concentrations. It may also demonstrate the preference of pyridine to not partition to the aqueous phase

5:5 Flaws & Omissions of slide 11.

Slide 11 fails to note that Bran Sands sediments, situated at the mouth of the estuary, are not representative of the sediments dredged from within the Tees estuary proper. Tees estuary intertidal sediments are largely composed of organic/mineral silts and clay. Study of satellite imagery of the Tees estuary (Google maps) clearly shows that Bran Sands is visually distinct (more yellow sand) from the inter-tidal sediments further up the estuary (grey/brown muds and silts) which are representative of the fine sediments which have been dredged.

No detail was given of the 3 Bran Sands sample site locators or granulomtry, no details was provided for the ambient marine and meteorological conditions preceding and during the collection of samples.

5:6 Slide 13 of the Env' Agency PPT: 3 X 2D sediment plume tracking models of Pyridine releases at one of the TEES disposal site.is not representative of real time events.

These modelled (not actual) releases consist of 3 hypothetical releases: a 100 litre, a 1,000 litre and a 10,000 litre release/disposal, apparently of Pyridine alone (with no sediment). It is clear from the accompanying graphics on the PPT slide, that the model predicts that dispersion of any disposal site "plume" would be principally from the north to the south, with some relatively minor attendant eastward and westward spread. A text box accompanying the graphic states that the maximum dissolved concentrations for each release would be as follows:

100 litre release =3 mg/cubic metre: 1,000 litre release=38mg/cubic metre: 10,000 litre release=453mg/cubic metres.

5:7 Omissions and flaws in the slide 13 presentation

a: If the modelling exercise is supposed to show the movement and distribution of sediment plumes associated with the dredging activity it has failed dismally.

A major flaw in the modelling exercise is that it fails to take account of the fact that resuspension of dredged sediments does not occur only at the disposal site.

b: The resuspension of dredged sediments also occurs at the Tees dredge sites, where there is a strong potential for dredge plumes to exit the estuary and disperse southwards under the influence of the regional residual inshore current.

c: Each of the three modelled releases is a one off, whereas the dredging and the dredge disposals have been and are multiple/repeated over an extended time frame of weeks and months. The modelled releases cannot replicate this effect or impact.

d: The dispersive behaviour and fate of purely liquid releases will not be the replicate of wet sediment releases and plumes.

d: No details have been provided to characterise/describe the ambient environmental parameter inputs to the hypothetical release at the release point and the release time: ie:
1: *sea state: direction/speed of tidal current, direction speed of residual current, sea surface conditions (waves/calm), upwelling/downwelling.*

2: *meteorological state: wind speed/direction, high/low pressure.*

e: Any such model run should have been repeated with a range of differing input parameters to replicate the varying conditions existing at both the dredge and the disposal sites throughout the 2021 (and subsequent) dredge and dispose exercise.

5:8 Because the Bran Sands samples have a higher proportion of coarse material (sand) than in estuary sediment, the Bran Sands sample concentration of Pyridine is likely to be dis-similar to, and lower than, the concentrations present in sediments dredged from the more contaminated fine sediment in-estuary areas.

It is recommended that FoI requests are submitted to the TEES PORT authorities for this information

In the absence of evidence to the contrary, it may be assumed that the dredge plumes generated at the dredging site are of approximately the same volume as the disposal plumes.

6: Settling/dispersion of dredge sediments. Sediment particles and associated pollutants do not dilute and disperse in the same way as a liquid…they will not “mix” relatively quickly with the rest of the water column, they will take time to deposit out of the water column, heavier/larger particles first, the finest particles take the longest time to deposit out. Turbulence and strong currents will slow deposition and transport the particles

downstream. There is a strong residual current running from north to south along the regional coast.

6:1 There is no current data to indicate whether or not sediment adsorped heterocyclic hydrocarbon organic compounds such as Pyridine will de-sorp from sediments and partition back into the marine water column. In the absence of any evidence to the contrary it should be assumed that any dredge associated Pyridine will be bonded to the dredge sediment and when released at the disposal site is likely to remain bonded to sediment, at least for some time, if not permanently.

In the context of the evidence discussed above, there is no basis for the conclusion that any plume extents were relatively confined along the tidal excursion at the disposal site and did not have the same geographic extent that would be consistent with the known mortalities.

6:2 The Joint Agency report states that the Agencies have undertaken a detailed search of the academic/scientific literature searches for information including the ecotoxicology and background levels of, and impact of, pyridine in crabs and lobsters.

It is evident that the DEFRA agencies claimed extensive literature search for Pyridine data has not produced any further data or information than that already referenced by the earlier reports compiled on behalf of the NEFCs

The Joint Agencies have been unable to bring forward any additional information on either the behaviour and fate of Pyridine in marine and estuarine environments or the toxic impacts of pyridine to marine crustaceans and certainly none that have refuted the arguments and information put forward in the NEFC reports.

6:3 ***From the Joint Agency reference to, and discussion of information relevant to a laboratory pyridine standard in order to validate that the screening technique was identifying pyridine, it is clear that the DEFRA agencies have little experience and knowledge of such matters.***

It is evident that there is indeed a significant data shortfall on many aspects of Pyridine fate and toxicology in marine environments.

There are clearly many data gaps in the understanding of the fate and behaviour of Pyridine in marine environments.

The Joint Agencies have been unable to provide a reason for the very high levels of Pyridine in impact zone crab samples

There has been no response to the NEFC reports which have referenced the very low concentrations of Pyridine shown to induce acute toxicity impacts in marine crustacean.

On the basis of the information and evidence set out above there is, in the context of the currently available evidence, no sound reason for concluding that Pyridine is NOT a causative factor for the ongoing mortality of marine life along the Tees and Yorkshire coast.

……

7: Review of the current standing of the DEFRA Karenia mikimotoi HAB hypothesis.

7:1 Bullet point 5 of the Executive Summary of the DEFRA May report states that "No consistent causative factor was identified. However, a harmful algal bloom present in the area coincident with the event was identified as of significance."

This statement is a subtle modification of the previously established DEFRA position, has argued that the HAB hypothesis present the only serious explanation for the Mass Mortality.

7:2 The DEFRA position was made clear earlier this year when regional MPs had a meeting with the Fisheries Minister and representatives of DEFRA agencies from which they emerged saying: "Today we raised alternative explanations for the deaths with DEFRA, the EA, the MMO and CEFAS and I was very convinced by the quality of their evidence and the logic of their conclusions. They maintain that the most likely cause was algal bloom and there comes a point where I - as an MP - must defer to DEFRA and their expertise in this field." ***REF: https://www.thenorthernecho.co.uk/news/19913901.algal-bloom-leading-theory-north-east-crab-deaths/***

7:3 The timing of the original announcement concerning the proposed HAB is relevant. My understanding of the chronology of the public announcement of the HAB (harmful algal bloom) hypothesis is as follows:

a: The DEFRA agencies had produced the results of extensive chemical analysis of crab tissue and reported that this had shown no obvious causative factor.

b: My subsequent analysis of the chemical data highlighted the fact that the toxic chemical pyridine was present in crab tissue in such high concentrations that it appeared to be the most likely causative factor for the Mass Mortality (in the context of the available evidence) and reported this fact to Commercial Fishing Associations (NEFCs) initially in informal briefing notes and later in a formal Report delivered in January 2022.

c: After the delivery of the briefings and Report, the DEFRA agencies publicised their hypothesis of an HAB. It appears that the HAB hypothesis was a response to the identification of Pyridine as a causative factor.

7:4 The two statements that "no consistent causative factor was identified" and that a harmful algal bloom "was present in the area" are factually incorrect because Pyridine **had** been identified by the Jan' NEFCs Report as a consistent causative factor, and because there is absolutely no empirical evidence to support the claim that a harmful algal bloom was present.

7:6 The evidence put forward by DEFRA in support of its initial proposition that an HAB of Karenia was the causative factor has always been circumstantial and weak at best. With the May report DEFRA has appeared to introduced the implication that a bloom of some

other toxic algal species may have been implicated in the Mass Mortality of regional marine species. The evidence for this proposition is also weak and circumstantial, not supported by the transparent presentation of any sampling outcome data and therefore based on a series of un-evidenced claims.

8: Analysis of the validity of the DEFRA Agency HAB hypothesis

8:1 Following the NEFC disclosure, DEFRA advanced the HAB hypothesis in a commentary on a briefing paper from the Plymouth Marine Laboratory (PML) which contained satellite imagery of an event occurring on the regional sea surface during September and October of 2021. DEFRA agencies postulated that this event was a bloom of toxic Karenia mikimotoi. This DEFRA hypothesis only appeared AFTER the Whitby Commercial Fishing Associations first report. This preliminary comment was followed by a second, more detailed PML briefing entitled "Analysis of Karenia mikimotoi HAB risk around Tees Estuary: (Sept/Oct 2021)", presumably requested by DEFRA.

8:2 As was the case with the original DEFRA suggestion, the PML briefing was based on satellite imagery, but this had been extended by the addition of further imagery constructed from "7 day composite maps" of postulated algal activity in the regional coastal waters of the N.E coast.

8:3 However, although the PML briefing made multiple reference to the "Karenia mikimotoi HAB risk" or "high risk" it was unable to provide empirical evidence, derived from sampling or analytical work, of the actual presence of any of the 12 recognised Karenia species.

8:4 On the contrary, the PML briefing warned that the observed postulated algal concentrations "may well be a dense bloom of another phyto-plankton species that resembles Karenia". This PML statement clearly confirmed a significant degree of uncertainty about the nature of the phenomenon recorded by the satellite images.

8:5 It is clear, from the PML statements, that the DEFRA agencies had no definitive empirical evidence to support their original claim that the phenomenon imaged by satellite photography was either an HAB or specifically, a bloom of Karenia mikimotoi.

9: Quantification of algal blooms

9:1 From the original 2021 satellite data DEFRA agencies estimated that the concentration of algae in the water was 6.8 micrograms per litre. Defra's May 2022 report has introduced additional information in support of the Karenia HAB hypothesis, stating that a Karenia mikimotoi bloom had also been detected at Beadnell Bay on the Northumbrian coast in September 2021. The DEFRA document reported that the concentration of Karenia cells at Beadnell Bay was 385,000 per litre and defining this as a "high density" event.

9:2 However, although such calculations are somewhat imprecise, "rule of thumb" workings have indicated that the 385,000 cells per litre roughly equates to around 6 micrograms per litre. By comparison to the reporting of densities of empirically identified/confirmed Karenia blooms it is an exaggeration to refer to the Beadnell Bay 6 microgram concentration as "high density".

9:3 Reporting of developed Karenia blooms in UK and Irish waters, accompanied by significant marine species mortality, records that Karenia cell concentrations were as follows: English Channel bloom: 100 micrograms per litre; North Wales bloom: 40 micrograms per litre, Irish bloom: 32 per litre. There is a consensus that concentration levels warranting classification as a ”developed bloom” would be around 30 micrograms per litre.

9:4 Some sources put the concentration of algal cells in a developed bloom much higher: “algal blooms are typified by single algal species reaching concentrations of over a billion cells per litre over large tracts of water bodies. Harmful red tides caused by toxic dinoflagellates such as *Karenia brevis* and *Alexandrium fundyense* are well-known examples of such community takeovers. In addition to causing water discoloration, they often produce toxins which can decimate fisheries and cause paralytic shellfish poisoning in humans.” ***REF: Algal blooms and viruses: Issue: Water: 17 November 2014 article”*** ***https://microbiologysociety.org/publication/past-issues/water/article/algal-blooms-and-viruses-water.html***

9:5 Although there is clearly some debate about what exactly constitutes an HAB of Karenia species phyto-plankton it is evident that the concentrations put forward by DEFRA (6.8 micrograms per litre and 385,000 cells per litre) do not accord with the DEFRA claimed “high density event” and fall a long way short of the observed figures at which significant marine mortalities occur. In corroboration of this, it is also relevant to note that at Beadnell Bay, the site where analysis of water samples showed 385,000 cells per litre of Karenia, there was no reported mass mortality of crustaceans or other demersal (bottom dwelling) species. It is also relevant to report that there have been no reports of “water discolouration” at either Beadnell Bay nor within the Tees (and southward) Mass Mortality impact zone.

9:6 It is also relevant to note that low levels of the great majority of phyto-plankton species may be present in many coastal waters and that such low concentrations of algal cells form the seed stock of algal blooms which may form, usually within estuaries, fjords and sheltered enclosed embayments, when favourable ambient conditions such as nutrient enrichment, elevated temperature and low turbulence prevail.

9:7 Despite its long term dissemination of the Karenia hypothesis DEFRA has failed to undertake any form of regional empirical field work to support it and no water samples were taken and analysed for the presence and/or the concentration of any phyto-plankton species, including Karenia, in the areas where the major Mass Mortality of marine species occurred.

9:8 Furthermore, the reporting of marine algal (including Karenia) blooms, in and around the UK have noted that concentrations in fully developed blooms range between 30 and 100 micrograms per litre. It is clear that the phyto-plankton concentrations referenced by DEFRA (6.8 micrograms per litre and 385,000 cells per litre) from satellite imagery and water sample from Beadnell Bay, are by comparison, very low and nowhere near the range quoted for confirmed and developed Karenia spp blooms at concentrations sufficient to initiate major marine mortalities.

10 Crab samples and HAB neuro-toxins

10:1 One of the most characteristic features of the presence of HABs is the identification of algal biotoxins in the body tissues and/or organs sampled from dead and dying marine animals during a mortality event.

10:2 The DEFRA Joint Agency report of May 2022 notes that samples of frozen crab and lobster were initially screened for two types of marine algal neurotoxins ASP (Amnesic Shellfish Poisoning) and PSP (Paralytic Shellfish Poisoning).
ASP is strongly associated with the neuro-toxin Domoic Acid and PSP is strongly associated with the neuro toxin Saxitoxin. This initial screening reported that there was no evidence for either of the toxins "at levels which would cause a concern".

10:3 The DEFRA report adds that further crab and lobster samples were analysed for additional algal toxins in light of the low level of Karenia spp found in the samples discussed in the paragraphs above. In this instant crab tissue was sampled for lipophilic toxins associated with various other algae species.
Two neuro-toxins, Okadaic acid and Dinophysistoxin 2 were detected and quantified in all crab samples, some exceeded the regulatory limits or bivalve molluscs. The DEFRA report states "the consistent detection and quantification of these compounds, sometimes at high concentrations…….. confirmed exposure to algal toxins" .
DEFRA reported that two lobster samples were also tested at the same time for algal toxins, but only trace levels were detected.

10:4 Okadaic acid and Dinophysistoxin 2 are most commonly associated with Dinophysis algae and not particularly associated with Karenia spp algae. No other evidence has been presented which indicates the presence of Dinophysis algae, or any other algal species in the regional marine environment

10.5 Inexplicably the DEFRA report has failed to provide any detail of the concentrations of the named neurotoxins toxins in crab or lobster samples. This is a surprising omission of data in the context of reporting what the DEFRA report claims as confirmation that crabs etc "had been exposed to algal toxins" and that "the consistent detection and quantification of these compounds, sometimes at high concentrations…….. confirmed exposure to algal toxins" .

10:6 In the context of the DEFRA reports' tendency to exaggerate the significance of reported levels of Karenia cells in Beadnell Bay (see "Quantification of Algal Blooms: above) it is important that precise empirical data should be provided.
Confirmed exposure to algal toxins does not confirm algal toxicity as the causative factor for mortality. Confirmation of causality can only be proved by transparent disclosure of the concentrations of algal toxins in all crustacean samples tested. The failure of the DEFRA report to provide the sample outcome data leaves the implied DEFRA claim without any empirical supporting evidence.

10:7 The DEFRA report states that "brevetoxins were not detected".
There is a wide consensus that brevetoxins (first identified in Karenia brevis algae) are widely agreed to be the characteristic algal toxin produced by Karenia spp algae.

The non-detection of brevetoxins is a significant indicator that no (or only very levels) of Karenia spps were present in the crustacean samples or the food web the crabs were part of.

The DEFRA statement strongly indicates that Karenia spp were not present at significant levels in the samples of dead crustaceans, were therefore also unlikely to have been present in the regional marine environment at significant concentrations and should therefore be discounted as a causative factor.

11: Recommended Public Health response to toxic Karenia blooms

11:1 Karenia species blooms are also known to cause toxic impacts as a marine aerosol. A report from the US National Office for Harmful Algal Blooms states that Karenia species cells " are easily broken during any turbulence such as wave action" and that when this happens "the toxins are released and have the potential to be aerosolized, inhaling aerosolized brevotoxins can lead to respiratory problems. Studies have shown that these Brevotoxin aerosols can be blown from the coast as far as a mile inland…." As a result, blooms are heavily monitored……. To warn the public of aerosolised toxins along beaches."
REF: "KARENIA" U.S National Office for Harmful Algal Blooms.
https://hab.whoi.edu/species/species- by-name/karenia/

11:2 In the context of the above it is relevant to point out that despite the DEFRA espousal of the Karenia HAB hypothesis, there has been no attempt by DEFRA or the UK public health agencies to "warn the public of aerosolised toxins along beaches". Additionally, it should be noted that there have been no reports of any form of "respiratory problems" such as those linked to aerosolised brevotixins.

11:3 *The facts presented above are further indication that an HAB of Karenia spp has not occurred in the impacted area and that such an HAB must now be categorically discounted as a causative factor.*

12: Optimum conditions for the development of algal blooming

12:1 It is relevant to note that, as reported above, algal blooms tend to initiate in spring when sea surface temperatures (SSTs) begin to rise and that they tend to die off in late summer/early autumn as SSTs decline. The pattern of the evolution of the NE coast phenomenon recorded by the satellite imagery does not accord with the normally reported season life cycle of algal blooms.

12:2 My second report to the NEFC (March 2022) noted that the experience of other Karenia blooms was that they developed and evolved in the spring in tandem with warming sea temperatures, that they peaked in tandem with peak sea temperatures and declined markedly and died off as autumn approached in tandem with declining sea temperatures.

12:3 The March NEFC Report quoted an optimum temperature for algal blooming from the US reporting of a Karenia caused mortality at Cape Cod (U.S) which noted that the optimal temperature range for Karenia mikimotoi was between 68 and 75-degrees Fahrenheit (20 C to 23.8 C).
An additional study reports that Karenia spp blooms evolved in temperatures from 60 to 83

degrees Fahrenheit range (15.5 degrees C to 27.7 C) ***REF: Effects of temperature on growth, photophysiology, Rubisco gene expression in Prorocentrum donghaiense and Karenia mikimotoi": Anglu Shen et al'. Ocean Science Journal. 51 (4).pps 581-589. Dec' 2016***

12:4 The March NEFC report commented on the failure of DEFRA to provide any temperature data in their support of the HAB hypothesis. This DEFRA failure was remedied in the May Joint Agencies Report, where section 3.4 introduces graphing and text which clearly demonstrate a marked fall in the ambient sea temperature through September, October and December of 2021.

12:5 The DEFRA text reports that "Over the period 26 September to 7 October the water temperature dropped by 2 degrees C" to about 13 degrees C. The text does not comment further on temperature declines, but the graphing shows that the temperature decline continued to 11.5 degrees C by 24th October.

12:6 From the PML satellite imagery it can be deduced that the peak of the hypothesised HAB occurred around mid to late October. DEFRAs data reports that by this time temperatures had dropped significantly, to less than 12degrees C (53.6 F). This does not accord with the temperature ranges reported as optimum reported by the scientific literature, for the development and peak of algal bloom production.
The temperature data presented by the DEFRA Joint Agency May report presents strong evidence in support of the proposition that the Satellite imagery may not have captured an algal bloom.

12:7 Algal blooms often evolve in shallow shelf seas and are transported towards coastal/inshore waters by onshore winds . A large and prolonged bloom of *Karenia mikimotoi* was observed during 2006 in Scottish waters. Analysis of multiple data sets suggested that the bloom developed in the "shelf sea" offshore region prior to its transport to coastal waters. An earth observation (EO) based harmful bloom classifier for *K. mikimotoi* recognised areas of elevated *K. mikimotoi* cell density but generated false positives in areas of high reflectance. ***REF:*** **"A large and prolonged bloom of Karenia mikimotoi in Scottish waters in 2006:"** **http://marine.gov.scot/sma/content/large-and-prolonged-bloom-karenia-mikimotoi-scottish-waters-2006**

12:8 The satellite introduced in support of the DEFRA HAB hypothesis does not provide any evidence that any bloom existed in the offshore shelf sea zone prior to its appearance in the inshore waters of the NE coast. ***This further militates against the veracity of the hypothesis that an HAB was the causative factor or the Mass Mortality.***

12:9 ***The facts presented above are further indication that an HAB of Karenia, or of other algal species, has not occurred in the impacted area, and that such an HAB must now be categorically discounted as a causative factor.***

12:10 The PML satellite imagery does however coincide with one other significant event, and this was the period of intense autumnal dredging and dumping of the Tees sediments widely reported to be some of the most highly polluted estuarine sediments found in UK waters.

13: Interpreting satellite imagery of sea surface phenomena :

13:1 From the PML quotes above, it is evident that satellite imagery "may well" be unable to differentiate between algal species or specifically identify individual species of algae. It is evident that there is a considerable academic consensus that this can be an issue when attempting to interpret satellite imagery.

13:2 I have undertaken a desk review of scientific literature relevant to the interpretation of such imagery. This desk review has identified a body of peer reviewed research confirming that there is also clear scientific evidence that satellite imagery may generate false positive bloom detection when mistaking surface sediment plumes for algal blooms. Three examples of such research are summarised below.

13:3 A 2019 review study carried out in the US reported that HABs often occurred in nutrient rich waters that are relatively shallow, warm, and protected from persistent offshore winds. It was reported that these productive waters are optically complex with the colour of the water being determined by the concentrations of three colour-producing agents (CPAs): chlorophyll (CHL), coloured dissolved organic matter (CDOM), and suspended mineral (SM) particles.

13:4 The 2019 study reported that "Traditional marine water colour retrieval algorithms developed for the open ocean, whose optical properties are dominated by phyto-plankton absorption and scattering alone, typically fail in optically complex waters. Additionally, traditional marine atmospheric correction procedures often yield erroneous water leaving radiance values in optically complex water further reducing the ability of traditional ocean-colour retrieval algorithms to produce reliable results." ***REF: "Satellite monitoring of harmful algal blooms in the Western Basin of Lake Erie: A 20-year time-series": Michael J Sayers et al'. Journal of Great Lakes Research: Vol 45. Issue 3. June 2019.pps 508-521***

13:5 On November 16, 2016, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite captured a colour image of the Spencer Gulf of Australia which appeared to be an algal bloom. But, after a closer look at the image, the geography, and the scientific literature, ocean scientists began to formulate a different diagnosis and concluded that instead of algae, the colours in Spencer Gulf were likely to be the result of churning waters that have disturbed sea bed sediments, re-suspended them and distributed them into the surface waters of the Spencer Gulf. ***REF: https://earthobservatory.nasa.gov/images/89154/algae-bloom-or-swirling-sediment (recovered 11/02/2022).***

13:6 A 2020 peer reviewed research paper reported that typical ocean Colour Dissolved Organic Matter (CDOM) algorithms developed for open ocean waters use blue and green spectral bands to determine chlorophyll-*a* concentrations and that these algorithms were shown to confuse CDOM and sediment as chlorophyll, which can lead to "high rates of false positive bloom detection". ***REF: "Current and Future Remote Sensing of Harmful Algal Blooms in the Chesapeake Bay to Support the Shellfish Industry": Jennifer L. Wolny et al'. Front. Mar. Sci., 26 May 2020***

13:7 Responding to a query from Joe Redfern (Whitby Commercial Fishermen's Association), in an email of 8/02/2022, a Plymouth Marine Laboratory scientists confirmed that "*The spectral properties of sediments should be similar to the spectral properties of Karenia HAB to produce ambiguities*" and also confirmed that PML "*did not conduct any experiments to identify sediment composition that may lead to ambiguities*."
N.B. In this context the "ambiguities" referred to by PML are "false positive" identifications of algal blooms.

13:8 ***The facts presented above are further indication that an HAB of Karenia, or of other algal species, may not have occurred in the impacted area, and that such an HAB must now be categorically discounted as a causative factor.***

14: A possible relationship between satellite imagery and dredging?

14:11 In the context of the evidence discussed above it is relevant to note that there is evidently a "chronological fit" between the PML imaged phenomenon and the TEES estuary dredge and disposal activity. Detailed FoI requests submitted to DEFRA agencies including the Marine Management Organisation (responsible for licensing and overseeing the dredge activity) and the TEESPORT management (overseeing the dredging and disposal work) have been submitted in order to confirm the volume and frequency of dredge and disposal activities. To date these FoI requests have not been responded to.

14:2 The dredging, and subsequent sea disposal of organically enriched, fine sediment estuarine environments is widely understood to generate substantial, relatively long lived and geographically extended plumes of both suspended mineral (SM) and colour dissolved organic matter (CDOM). Settling time of such suspended material will be dependent on floc forming condition (highly unlikely in the open sea) and the speed/energy of ambient residual currents. Conditions in the open waters of the North Sea coast do not conform to parameters likely to lead to rapid settlement of dredge and dump plumes. Such dredge and dump plumes are often clearly visible with the naked eye at sea level and from the air and there is clearly good scientific evidence (see above) that they are visible from space.

14:3 In the context of the intense dredging programme carried out in the Tees estuary during the period when the satellite imagery was captured, and the in-estuary dredge plumes and disposal site dump plumes which would have been generated by that activity , it is inevitable that both suspended mineral (SM) and coloured dissolved organic matter (CDOM) were present in the regional sea surface and near surface waters at the time when the satellite imagery was captured.

14:4 The Commercial Fishing Associations have raised this issue with the DEFRA agencies, proposed that the sea area covered by the PML satellite imagery may well, as a result of the intense dredging and disposal activity be an "optically complex" water and have requested that DEFRA initiate additional, in-depth analysis of the images in order to rule out, or confirm the presence of SM and CDOM.

14:5 To date this request has not been responded to by the DEFRA agencies. It is therefore concluded that DEFRA has no intention to, or interest in, pursuing this matter

further. In the absence of a response to the request, DEFRAs reasoning and justification for not undertaking this work remains unexplained.

14:6 The absence of confirmed empirical information derived from detailed analysis of the available satellite imagery strongly militates against acceptance of the DEFRA HAB hypothesis, which in this respect remains un-evidenced. The apparent refusal, to date , to undertake or commission such analysis does not inspire confidence in the DEFRA hypothesis.

14:7 ***The facts presented above are further indication that an HAB of Karenia, or of other algal species, has not occurred in the impacted area, and that such an HAB must now be categorically discounted as a causative factor.***

15: CONCLUSIONS (HAB):

15:1 It is concluded that, on the basis of the current evidence submitted by DEFRA agencies in support of the claim that HAB is the cause of the Mass Mortality of NE coast marine life, there is no empirical evidence to support that claim.

15:2 It is clear that the available Plymouth Marine Laboratory submissions on the issue of HAB confirm that there are a number of "doubts" and "ambiguities", surrounding the DEFRA claims, which militate against acceptance of the DEFRA claim.

It is evident that the DEFRA HAB hypothesis has been concocted in the absence of "spectral property" analysis of satellite imagery which would clarify these "ambiguities"

15:3 It is concluded that the currently available evidence advanced by DEFRA sources confirms that the current level of analysis of the satellite imagery of the Tees mouth marine area "phenomenon" is not sufficient to clarify
a: whether the observed phenomenon was an algal bloom of Karenia mikimotoi
b: whether the observed phenomenon was a bloom of any other specific algal species

And that there is sufficient academic evidence to give some credence to an alternative hypothesis regarding the "observed phenomenon": i.e. that there is a possibility that the observed phenomenon could be a surface plume of suspended sediment

16: Recommendations:

It is recommended that independent academic (not DEFRA based) analysis of the TEES *estuary sediments is undertaken in order to confirm whether or not the TEES estuary* ***sediments have "similar spectral properties" to those of any algal bloom species (including Karenia mikimotoi).***

It is further recommended that independent academic (not DEFRA based) analysis of the PML TEES estuary satellite imagery is carried out, in order to provide empirical proof

whether or not the imagery shows any indication that the "spectral properties" of TEES estuary sediments are causing "ambiguities".

Only when such work has been completed can it be empirically confirmed that the PML satellite imagery has not been misinterpreted as a "false positive" identification of a Karenia spp Harmful Algal Bloom, when it may have been imagery of some other algal bloom or suspended sediment.

……

17: I have acquired copy of a permit awarded to the company Vertullus by the Environment Agency in 2019, under "Notice of variation and consolidation with introductory note The Environmental Permitting (England & Wales) Regulations 2016"

RE: VERTULLUS SPECIALITIES UK Ltd: Variation application EPR/BU0311IX/V005 and Permit number EPR/BU0311IX

Sections of the document relevant to the production of Pyridine on Teesside are copied below:

17:1 From "Introductory Notes"
This permit variation authorises the operator Vertullus Specialities UK Ltd to manufacture a new chemical, caprylene, and also adds a new scheduled activity to the permit, which is: • Section 4.1 A (1) (a) (i) – production of organic compounds such as hydrocarbons. Vertellus Specialties UK Limited operate a chemical manufacturing facility near the north bank of the Tees estuary. The National Grid Reference for the site is NZ5369324704. It is located less than 1km from the Teesmouth and Cleveland Coast Special Protection Area (SPA), Ramsar site and Site of Special Scientific Interest (SSSI).

17:2 The facility is located at Seal Sands where it manufactures fine organic and speciality chemicals for a range of industrial uses including; pharmaceutical, photographic, oil extraction, plastics, polymers and agrochemicals. **Production is undertaken in seven process buildings one of which is a plant dedicated to pyridine and its derivatives, including aminopyridines and sulphonamido-pyridine.**
What volume of liquid effluent wastes does this plant produce? What chemical analysis of these effluents is undertaken? Please provide outcomes of any such monitoring

17:3 Liquid emissions are processed in the on-site Effluent Blending Plant (EBP) where they are mixed with effluents from other areas of the site on a batch-wise basis. From the EBP the wastewater is transferred to the on-site biological effluent treatment plant (EFT).

17:4 The EFT plant treats the blended effluent and is operated by Veolia ES (UK) Limited under environmental permit, EPR/WP3030DT, as a multi-operator installation. However, at time of this permit variation, blended effluent was being transferred off-site by tanker to a water authority treatment plant. This Variation and consolidation (application number

EPR/BU0311IX/V005 3) is set to continue until a dedicated route from Vertellus Specialties (UK) Limited to this treatment works has been established.

17:5: Possible FoI submissions
Has such a "dedicated route" been established? If so, please provide information about the method, the route and the receiving environment end point.
Please provide details of the "water authority treatment plant" which liquid effluents were transferred to.
Please provide detail of the waste water treatment process used at the WTP to treat the effluents from the Vertullus site.
Please provide details of the monitoring regime and oversight of the Vertullus liquid effluent during treatment at the WTP and at the WTP point source of discharge to the environment.
At the time of issuing the permit, for how long had the Veolia operated EFT not been used to treat the blended liquid effluents.
For how long had the blended liquid effluents been transported off site, by tanker, to the WTP?

17:6 The permit for the on-site EFT plant, as part of the multi-operator installation, was originally issued to Shanks Chemical Services Limited (BU5364IJ) on 27/11/03. It was transferred to Veolia Water Industrial Outsourcing Limited (EP3139CH) on 02/02/12 and then transferred to Veolia ES (UK) Limited on 22/07/16.

17:7 From Table S1.3 Improvement programme requirements
(IC7) states that "The operator shall undertake a review of the HAZOP and any change controls for the following processes: SASMAC, DMAP, Topanol and amino pyridine manufacture to ensure that all actions resulting from such HAZOP and change control have been carried out. The order in which the reviews are to be carried out is to be determined by the operator on a risk basis. A written report of the review including as a minimum details of incomplete actions, what remedial action is to be taken, the time scale for the action to be completed shall be sent to the Environment Agency within 14 days of the review of each process for evaluation."
Please provide a copy of this report

17:8 (IC10) The operator shall carry out a review of the Site Protection and Monitoring Programme (SPMP) to demonstrate that it is suitable and sufficient for identifying any risks to soil/groundwater. The review shall include: - The physical condition of boreholes; - The number and location of boreholes; - The testing suite and frequency of sampling. The operator shall submit a report to the Environment Agency for approval that outlines any changes necessary to the SPMP. Any agreed proposals shall be implemented by the operator in line with timescales agreed by the Environment Agency.
Please provide a copy of this review

Please provide copy of the records in respect of liquid effluent sampling, analysis and analytical results submitted by the Operator (Vertullus or successor company)

Please provide copy of the records in respect of liquid effluent sampling, analysis and analytical results of Environment Agency monitoring of both on site process liquid effluents, and at the Waste Water Treatment plant receiving the tankered mixed effluents from the Vertullus site.

Please provide copy of the annual reports of previous years (2018 to 2021), produced by the operator and supplied to the Env' Agency, covering site monitoring and the results of monitoring and assessments.

When was the last round of "periodic monitoring" of in-site ground water and soil undertaken? Is such monitoring "based on a systematic appraisal of the risk of contamination"?

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Tim Deere-Jones Marine Pollution Research and consultancy July 2022