NFLA Radioactive Waste Policy Briefing Number 87a: Joint response to the MMO in reference to EDF NNB proposals to dispose of dredged waste at Portishead, Somerset – FULL RESPONSE

Prepared for NFLA member authorities, April 2021

Joint submission to the Marine Management Organisation in reference to EdF/NNB 2021 proposals to dredge Bridgwater Bay sediments and dispose of dredge wastes at Portishead LU070

i. Overview of Policy Briefing

This edition of the NFLA Radioactive Waste Policy provides the full and detailed joint submission made by independent marine radioactivity consultant Tim Deere-Jones for the NFLA and Stop Hinkley. A brief summary of this is in NFLA Radioactive Waste Policy Briefing 87. This submission has gone to the Marine Management Organisation in reference to an application by EDF Energy's New Nuclear Build reactor company to dredge sediments from the Hinkley Point site at Bridgewater Bay and dispose of such waste at a site in Portishead, Somerset. This is a third application in addition from a previous dredging application and current second application that refers to the Cardiff Deep Grounds site close to Cardiff Bay. It would potentially reduce the amount of dredged material planned for Cardiff Deep Grounds and move some of it to a different site close to the coast off the small Somerset village of Portishead.

There has been considerable concern over the disposing of such large amounts of dredged sediment and mud from the Hinkley Point site at the Cardiff Deep Grounds. This has included a full debate in the Welsh Senedd and an expert panel considering the environmental and radiation concerns around such an application taking place. This third application by EDF will seek to move a good portion of this material to a new site off the Somerset coast.

The MMO consultation closes on the 1st April, though they have indicated that they will accept responses until the 6th April from public bodies. Responses should go to by email to: marine.consents@marinemanagement.org.uk

ii. Executive Summary of principal concerns

1. There is a major lack of data on the Chemical/Metal and PAH concentrations at, and adjacent to the proposed Portishead LU070 disposal site: this is in breach of the requirement to obtain sufficient data for comparison purposes between the dredge site and the disposal site in respect of their relative concentrations of these determinants.

2: There is a major lack of data on the radioactivity concentrations at, and adjacent to the proposed Portishead LU070 disposal site: this is in breach of the requirement to obtain sufficient data for comparison purposes between the dredge site and the disposal site in respect of their relative concentrations of these determinants.

3: There are major flaws and weaknesses in the protocols and techniques employed by CEFAS, on behalf of EDF, to sample and analyse for gamma, beta and alpha emitting

radio nuclides. These flaws mitigate against the production of accurate and precise radiological data concerning the concentration of radioactivity in the sediments of Bridgwater Bay, and relevant to the construction of potential dose estimates for local people who may be exposed to additional environmental radioactivity from the dredge plume, and impacts at the Portishead disposal site LU070.

4. There is a lack of coherent and clear explanation for the process of choice of dredge waste disposal sites. Initially EDF had committed to the disposal within the Hinkley sediment region (subject to meeting the MMO Criteria), then EDF appeared reluctant to follow this choice and to prefer the use of Cardiff Grounds. No information has been provided to explain which of the MMO Criteria had been failed and prohibited the disposal of the wastes "within the Hinkley sediment" region.

5. The Environment Agency proposed the use of Holm Deep, an offshore site relatively distant from any coastline (unlike both the Cardiff Grounds and the Portishead site) and otherwise very suitable for the disposal. This was rejected by EDF, on grounds that were relatively easily overcome, and the Cardiff Grounds became the site of choice for disposal of the first tranche of dredge wastes.

6. EDF have made a number of other unsubstantiated claims about the nature and characterisation of the sediments at Bridgwater Bay, Portishead LU070 and Cardiff Grounds as set out in the following chapters.

7. It is concluded that these failings and weaknesses clearly indicate that the Precautionary Principle must be invoked, and that in the absence of any scientific certainty regarding Submissions 1 to 6 above, a Public Inquiry is now required in order to clarify these issues and generate the required degree of scientific certainty necessary for a clear and well informed decision making process to be carried through.

8. It is the case, arguably on the basis of over 3 years of submissions of evidence from experts representing campaigners in Wales, and having previously refused campaigners requests, the NRW have confirmed that an environmental impact assessment will now be required for the dredge disposal marine licence application regarding the Cardiff Grounds. This decision has been made in line with Regulation 5 of Marine Works (EIA) Regulations (2017).

9. This Submission notes that these issues remain outstanding despite, and because, the MMO have had the opportunity to scrutinise the EDF proposals in the past, but they have been unable to resolve them and ensure that the appropriate degree of scientific certainty is achieved.

10. This Submission notes that in some circumstances the MMO can refer an application to government ministers for a decision rather than making a licensing decision itself. In the MMO's own words "When certain criteria apply, the MMO will refer an application to ministers so they can decide whether to recover it. If ministers recover the application, they will set up a public inquiry. Ministers will then make the final decision on the application: the relevant criteria are that:
    - it falls in band 3 of MMO's licence charging scheme, covering the larger and more complex projects
    - it is for an activity taking place wholly or partly in English waters up to 6 nautical miles from the coast
    - it could have a significant effect and raise issues appropriate for examination in an inquiry."

(This Submission adds that both the previous application and the current application have been, and are, clearly in breach of the Precautionary Principle (need for scientific certainty) quoted by MMO in regard to dredge and disposal projects).

11. This Submission therefore formally requests :

A: That the MMO "refer" the EDF applications (dredge at Bridgewater Bay and dispose of dredge wastes at Portishead LU070) to Government Ministers for a decision to set up a Public Inquiry in order to clarify the scientific and technical issues referenced above

B. That the MMO "refer" the EDF applications (dredge at Bridgewater Bay and dispose of dredge wastes at Portishead LU070) to Government Ministers for a decision to set up a Public Inquiry in order to clarify:
- the strategic and political decisions underlying the choice of Cardiff Grounds and/or Portishead LU070 as dump/disposal site:
- the reasons/justifications for EDFs' outright rejection of the Environment Agency offer of the offshore HOLM DEEP as dump/disposal site despite its several clear advantages over the 2 near-shore sites currently nominated by EDF

C. that the MMO initiate a full and detailed EIA and in depth of both applications, at both sites, in order to provide the appropriate level of high quality, detailed scientific evidence to inform a Public Inquiry

D. that (in the context of the 140,000 kilobyte application by EDF and the several years in which EDF have had to prepare that application with the benefit of professional and high cost input from various agencies, EDF clearly have a major advantage vis-a-vis the presentation of their case compared to Consultees presentation of their case) the MMO extend the Consultation period in order to provide Consultees with a better opportunity to present their case in a fair and proportionate manner so that the process is seen to do justice to Consultees including LPAs, local representatives, citizens campaigns and members of the public who wish to make Submissions.

The rest of this summary document highlights the core areas of concern. A longer version of each section can be found on the NFLA website. This summary gives member authorities the core areas of concern in each area.

1. Relevant Marine Management Organisation (MMO) Criteria for issuing a permit to dispose of dredge wastes at marine disposal sites: ***extracts from "Guidance: Deposits."***
(*published by MMO : 30 May 2019. https://www.gov.uk/guidance/deposits*)

1.1 There may be a potential impact risk, but scientific uncertainty about exactly what this might be. The precautionary principle is applied when making licensing decisions in such circumstances and prevents a lack of scientific certainty to be used as a reason to postpone cost-effective measures to prevent environmental harm.

1.2 Where the activity also relates to the disposal of dredged material, a marine licence is not required if the disposal is authorised by, and carried out in accordance with, a Harbour Order or Local Act and the additional conditions are met. The additional conditions are that:
- the activity involves the relocation of sediments inside surface waters
- the activity is for the purpose of: managing waters or waterways; preventing floods; mitigating the effects of floods or droughts; land reclamation
- the MMO is satisfied that you have proven that the sediments are not hazardous waste

1.3 Disposing of waste to sea: Only the following types of waste may be disposed of at sea, based on a detailed assessment of risks and a marine licence from the MMO:
- dredged material

- inert materials of natural origin
- fish waste – including shellfish and any part of a fish

When deciding whether to grant a disposal licence, the MMO has applied the waste hierarchy from the Waste Framework Directive, which specifies the order of preference for how waste should be dealt with:

- prevention - can include not carrying out an activity
- re-use – finding an alternative, beneficial use for waste material
- recycling - can include making high grade products from waste material
- other recovery - can include treatment to alter the physical nature of the waste material
- disposal at sea - the last resort

1.4 Whether this still stands post Brexit, is also a matter for the MMO to define. (This Submission formally requests that the MMO provide a current (post BREXIT) definition of waste hierarchy.)

1.5 With regard to Disposal sites, the MMO states that:
"If you intend to dispose of material to sea you must propose an area where the disposal is to take place. You can either propose a site that has been authorised for dredge disposal or an entirely new site.

You must also provide sufficient information for the MMO to assess the proposal. The MMO will decide if the material is suitable for sea disposal and whether the area proposed is appropriate.

MMO websites state that an applicant will need to provide site characterisation information to propose a new site. This is usually in the form of a site characterisation report that:

- assesses the need for a new site
- identifies suitable areas
- assesses requirements of the dredged material characteristics
- evaluates potential adverse effects
- compares candidate disposal sites

The report should also consider site selection and summarise any consultations. (Sample analysis may be needed to support an application for a disposal licence.)"

1.6 EdF Project description:
"NNB Generation Company Limited (part of EDF Energy) is seeking a Marine Licence from the MMO for the marine elements of the works required to construct a new nuclear power station at Hinkley Point (hereafter referred to as HPC and the HPC Project).

All of the activities discussed herein were considered within an Environmental Statement (ES) submitted to the IPC in October 2011 for a Development Consent Order (DCO).

Further details on some of the construction activities are now available but it should be noted that they are not new activities. That is, further detail is provided on the works below Mean High Water Springs (MHWS) for the purposes of the marine licence application on activities which were discussed and assessed as part of the HPC Project ES."

Ref: Extract from MMO's notice of the Application

1.7 This SUBMISSION formally requests that MMO respond to the following:

A: This Submission disputes the EdF claim that "all of the activities discussed herein were considered within an Environmental Statement (ES) submitted to the IPC in October 2011 for a Development Consent Order (DCO)."

Research towards the production of this Submission has been unable to find any information about, or discussion of "site characterisation" for either of the proposed dredge waste disposal sites (Cardiff Grounds or Portishead LU070).

The Submission formally requests that MMO interrogate EdF and obtain precise detailed references for EdF's detailed information on the site characterisation for both the Cardiff Ground and Portishead disposal sites contained within the DCO.

B: This Submission notes that MMO protocol stipulates that "candidate disposal sites" should be "characterised" and compared. This Submission notes the MMO statement/advice to applicants that "If you intend to dispose of material to sea you must propose an area where the disposal is to take place. You can either propose a site that has been authorised for dredge disposal or an entirely new site. You must provide sufficient information for the MMO to assess the proposal. The MMO will decide if the material is suitable for sea disposal and whether the area proposed is appropriate."

C: This Submission formally requests that MMO respond to this Submission's contention that Consultees cannot comment on such matters in the absence of the information stipulated by the above referenced MMO protocols (characterisation and provision of sufficient information for the MMO to "assess the proposal" in order to confirm "whether the area proposed is suitable) and the fact that PORSTISHEAD LUO7O was not named or discussed in the ES or the DCO.

D: This Submission formally requests that the MMO specifically responds to the Submission's concern that the stipulated assessments and site comparisons cannot be carried out without the acquisition and publication of appropriately detailed baseline data to illustrate the concentrations of chemical/metal/hydrocarbon and Radioactive determinands in the sedimentary environment of both the identified disposal sites and their adjacent and downstream sedimentary environments.

E: This Submission also contends that consideration "within an ES" was deeply inadequate because the 2011 application for a DCO did not fully, and in detail address those issues: and requests that MMO insist that EdF should:

E1 address the issues of alternative methods of disposal (marine or terrestrial) of dredge wastes (alternatives were dismissed in a few sentences)

E2 engage in an appropriate detailed review and discussion of alternative marine disposal sites

E3 name and appropriately discuss the possible use of the PORTISHEAD LUO7O disposal site

E4 reference and appropriately discuss the very large volume/tonnage of the final dredge waste arisings for disposal

E5 attempt to produce an appropriately detailed comment on, or analysis of, the potential end fate of radiologically and chemically contaminated suspended sediments (deposition in local and regional estuaries, sea to land transfer via coastal inundation mechanisms and marine sea spray and aerosols and the subsequent contamination of coastal zone agricultural produce, coastal zone air streams and sea foods.)

E6 produce an appropriately detailed comment on, or analysis of, the ingestion and inhalation radiation dose to coastal communities in the region of both dredge activity and disposal activity

E7 produce an appropriately detailed comment on, or analysis of, the ingestion and inhalation chemical/metals/hydrocarbon dose to coastal communities in the region of both dredge activity and disposal activity

F: THIS SUBMISSION notes that the MMO have stated that "There may be a potential impact risk, but scientific uncertainty about exactly what this might be. The precautionary principle is applied when making licensing decisions in such circumstances."

G This SUBMISSION requests that the MMO:

G1 Ensure that the EdF proposal is undertaken in the full understanding and pursuit of the Precautionary Principle as enunciated in the extracts from the MMO website quoted at the beginning of this chapter.

G2 Comment on the lack of, or the failure to provide, relevant characterisation data and scientific information in the context of the Precautionary Principle.

H: This SUBMISSION requests that the MMO initiate a full Environmental Impact Assessment for the disposal of dredge wastes at both Portishead LU070 and the Cardiff Grounds proposed disposal sites in order to answer the questions raised above, provide the relevant characterisation data for both sites, and respond to the requirements of the Precautionary Principle according to the MMO criteria set out at the beginning of this Submission.

2. With regard to the proposed MMO Criteria TO BE TESTED:

2.1 Open ended requirement for disposal of dredge wastes - A proven need for dredge and disposal to take place. The need for the further dredge and subsequent disposal of Bridgewater Bay sediment is now deeply unclear. At the time of the first application (2013), EdF had requested permission to dredge and dispose of a maximum of 300,000 tonnes of material. At that stage there was no indication that EdF had any intention, or need, to apply for a permit to dredge and dispose of an additional, and larger, volume/tonnage of material.

2.2 In the event, the original 2013 license "ran out" in 2016 , before any dredging had taken place. No explanation for this failure to take up the permit in the allotted time was provided by EdF and none was demanded by either the dredge licensing authority or the disposal licensing authority.

A license "update" was issued in 2018 and further dredging took place in the summer of that year. However, despite having lobbied for permission to dredge and dispose of 300,000 tonnes, in the event EdF only dredged and disposed of approximately 120,000 tonnes (this was the capital dredge at the cooling water intakes). Again, no explanation has been provided by EdF and none demanded by either licensing authority.

The new application by EdF is for permission to dredge and dispose of up to **780,000 tonnes of material from Bridgwater Bay.**

2.3 In light of my personal experience, derived from a number of previous projects on marine dredging, I can confirm that there is a wide consensus that any excavation (ie dredge) on the seabed is likely to experience a certain amount of natural "infill" in response to the seabed transport of sub-tidal seabed material and that sand is more likely to behave thus than cobbles or gravel and that fine/silty sediments are more likely to behave thus than sandy materials.

It is my assessment that much of the cavity/cavities dredged in 2018 is/are, three years later, now infilled with predominantly fine or very fine sediment. This material is probably NOT consolidated and will therefore consist of a large percentage of pore/interstitial water and will certainly be a very major contributor to any future dredge plume when the dredging and disposal of those areas recommences.

2.4 In the context of previous action by EdF at Bridgwater Bay (lack of explanation, failure to take up permitted volume of dredge and disposal, utter failure of licensing authorities to pursue and clarify the matter) there is no certainty about what will actually occur. No explanation has been offered by EdF, or demanded by any of the Regulatory Authorities for the additional demand.

Concerned citizens and campaigners around the Bristol Channel are now justly concerned about the ongoing applications for permission to dispose of an apparently open ended and ever expanding volume of dredge waste.

2.5 Submission:

A: This Submission contends that the EdF response to the granting of previous (2013 and 2018) dredge and dispose applications has been both cavalier and erratic in that EdF have been granted permits and then:

A1 not carried out any of the initial (2013) permitted actions within the (generous) time scales and/or -

A2 dredged and disposed of less than 50% of the 2018 permitted maximum volume/tonnage

A3 and apparently failed to provide any form of publicised explanation, to permitting authorities, regulating authorities and the public, regarding these facts

B: This Submission also contends that both the dredge licensing authorities and the dredge waste disposal licensing authorities have been remiss/negligent in not demanding an explanation for the above.

C: This Submission recommends that MMO interrogate EdF for a full explanation for the erratic response and action following the permitting in 2013 and 2018 of dredge and disposal activity.

D: This Submission expresses the concern of many that, in the context of recent history regarding these matters and in the absence of any clarification there is no confidence that the EdF dredge process will NOT continue, on a piecemeal basis and with ever increasing volumes and/or tonnages being demanded by EdF for some time to come.

3. The PRECAUTIONARY PRINCIPLE as referenced by MMO:

3.1 MMO Criteria for issuing permit to dredge states that:
"There may be a potential impact risk, but scientific uncertainty about exactly what this might be. The precautionary principle is applied when making licensing decisions in such circumstances and prevents a lack of scientific certainty to be used as a reason to postpone cost-effective measures to prevent environmental harm."

3.2 "The precautionary principle is a broad epistemological, philosophical and legal approach to innovations with potential for causing harm when extensive scientific knowledge on the matter is lacking. It emphasizes caution, pausing and review before leaping into new innovations that may prove disastrous." Ref: Wikipedia

3.3 "The Precautionary Principle enables decision-makers to adopt precautionary measures when scientific evidence about an environmental or human health hazard is uncertain and the stakes are high. It first emerged during the 1970s and has since been enshrined in a number of international treaties on the environment, in the Treaty on the Functioning of the European Union and the national legislation of certain

Member States." REF: The precautionary principle: Definitions, applications and governance." 09-12-2015. European Parliament Think Tank.

3.4 "A definition in the 1992 Rio Declaration on Environment and Development. It applies when there are threats of serious or irreversible environmental damage and provides that a lack of scientific certainty shall not be a reason to postpone cost effective measures to prevent environmental degradation." REF: RESOURCE ID 6-203-2732 © 2021 THOMSON REUTERS. ALL RIGHTS RESERVED.

3.5 The UK Parliamentary Select Committee on Science and Technology (Fourth Report) states that "the Precautionary Principle implies that where there is uncertainty as to the existence of risks to human health, the institutions may take precautionary measures without having to wait until the reality and seriousness of those risks become fully apparent." & "those circumstances where scientific evidence is insufficient, inconclusive or uncertain and there are indications through preliminary objective scientific evaluation that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the chosen level of protection." REF: https://publications.parliament.uk/pa/cm200506/cmselect/cmsctech/1030/103007.htm

3.6 SUBMISSION:

A: It is this submission's contention that there are many "unknowns" relating to the proposed dredge at Bridgwater Bay as follows:
As a result of inadequacies in the programmes of radiological analysis carried out on those sediments already dredged, and those which are proposed for dredging, there is -

A1 "insufficient, inconclusive or uncertain" scientific evidence

A2 "reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the chosen level of protection."

A3 uncertainties remain as to the concentrations and distribution of radio nuclides through the relevant sedimentary environment

B: It is this submissions contention that there are many "unknowns" in the context of the proposed disposals of dredge wastes at PORTISHEAD LU070 and/or CARDIFF GROUNDS LU110. These unknowns consist of a major lack of baseline data due to:

B1 the absence of relevant historical and site specific analysis and research on the existing radiological and chemical concentrations in the water columns, sedimentary environments and biota at both LU070 and LU110 and in adjacent sediment and water column environments and biota.

B2 It is this Submission's contention that there are many scientific and unknown/ or unconsidered factors about the potential pathways of exposure of coastal populations (adjacent to both dredge and disposal sites) to doses of man-made radioactivity following the sediment disturbing activities proposed in the EdF application (dredging and disposal activities).

B3 It is this Submission's contention that, in the absence of the relevant information, a strictly Precautionary Principle approach should be adopted and an additional programme of research into, and consideration of, these issues should be initiated and carried through prior to any further action

C: It is this Submission's contention that a full EIA of both the proposed dredge in Bridgwater Bay and of the proposed disposal at either (or both) Portishead LU070 or Cardiff Grounds LU110 should be carried out in order to acquire the complete empirical

data required for informing the MMO criteria for characterisation, suitability and comparison of disposal sites.

4. ALTERNATIVE USES of DREDGE SPOIL

4.1 MMO CRITERIA for issuing dredge and disposal permits:
"When deciding whether to grant a disposal licence, the MMO applies the waste hierarchy from the Waste Framework Directive, which specifies the order of preference for how waste should be dealt with: this order includes the following:

- re-use – finding an alternative, beneficial use for waste material
- recycling - can include making high grade products from waste material
- other recovery - can include treatment to alter the physical nature of the waste material
- disposal at sea - the last resort"

4.2 The original application, by EdF, for a DCO regarding the construction of the proposed HPC contained what can be described as a "minimalist discussion" of the justifications for sea disposal of dredge wastes. In its DCO application EdF only briefly reviewed alternative end points for the disposal of the Bridgwater Bay/HPC dredge wastes, and the alternative uses received only a derisory few sentences of information.

4.3 EdF's original DCO application did not engage in any in-depth discussion of the possibility of terrestrial disposal of the dredge wastes despite the fact that there are a number of widely used strategies for land based disposal of dredge wastes. The options for land disposal of UK marine dredge wastes classified as low to medium contaminated include shoreline re-charging, land reclamation, creation of coastal wetland habitats, remediation of marine dredge sediments and subsequent horticultural/agricultural use, and storage of dredge wastes classified as highly contaminated in bunded waste storage sites, where if necessary leachate can be monitored, and the solid material could be capped with impermeable material such as clay.

4.4 The EdF discussion of land disposal of the HPC dredge wastes in terms of "alternative uses" or in bunded waste storage was completed in a few "throwaway" sentences. This is surprising given both the CEFAS lenient interpretation of the chemical analysis outcomes and the use of IAEA protocols and advice, that permit the multi-nuclide radioactivity content of the dredged material to be defined as "not radioactive under law", despite the absence of any empirical analysis for long lived alpha emitting radio activity such as the Plutonium nuclides which have been regularly and annually reported to be constituents of the liquid waste streams of HPA and HPB. Such lenient outcomes from CEFAS and the IAEA protocol would naturally lead to the assumption that such material would be perfectly safe for land disposal.

4.5 Agricultural use of marine dredged sediment -
In the context of those conclusions by CEFAS, and under the IAEA protocol, it may be assumed that there were no environmental impact grounds for rejecting alternative non-marine uses. This would appear to be reinforced by the fact that although the silts in the extensive tidal (saline) reaches of the River Parrett are shown to be contaminated (at similar concentrations) by a suite of radio nuclides (and presumably chemicals) apparently identical to those in the Bridgwater Bay silts, and these fluvial sediments have been habitually dredged and deposited on river side land and, on occasion, been spread on agricultural land to act as a soil improver. There is no evidence that the Environment Agency, Natural England, MMO or any other regulatory agency has made any objection to this long standing practice.

4.6 In the context of the agricultural use of marine dredged sediments the long running AGRIPORT research project has clearly demonstrated that land based phyto-remediation of marine (port) dredge wastes can be adopted to remediate low-level or moderately polluted sediments and convert them into a re-usable soil suitable for ornamental plant nurseries. Relying on previous experiments on ornamental plants, the use of remediated sediments for horticulture does not present significant apparent risks for human health and the environment. These results were derived from two pilot applications conducted in the ports of Livorno (Italy) and Kishon (Israel).
REF: "Agricultural Reuse of Polluted Dredge Sediments (AGRIPORT)". https://ec.europa.eu/environment/eco-innovation/projects/en/projects/agriport

4.7 The AGRIPORT project is reported to have a replication potential across Europe as it "offers an eco-sustainable alternative to the current expensive method for treatment and disposal of dredged sediment. The end product is land that can be employed for gardening, environmental restoration of degraded areas and landscaping"
REF: "Agricultural Reuse of Polluted Dredge Sediments (AGRIPORT)". https://ec.europa.eu/environment/eco-innovation/projects/en/project/agriport

4.8 The AGRIPORT final report records the following positive outcomes of the processes which have been developed:

a: optimisation of the process for decontaminating dredged sediments using plants (phyto-remediation) and the identification of crops suitable for growing on the recycled sediments

b: the reduction of the costs of treating the dredged sediments from ports and the production of a revenue stream for the process of generating good land usable for gardening/horticulture and agriculture, environmental restoration and landscaping

c: it was estimated that 1% of the European market had been reached within 2 years of the end of the project, ie: approx 300,000 cubic metres of polluted sediment (turnover of 9 million Euros)

d: expected future uptake of the AGRIPORT process to treat 30 million cubic metres (20%) of the average dredge of 150 million cubic metres of contaminated sediments dredged every year in Europe

e: creation of employment opportune in sectors related to AGRIPORT process and production (design and monitoring of treatment sites, chemical and biological labs, monitoring of remediation and re-cycling processes, horticultural/agricultural work)

4.9 In conclusion, the final report states that the methods developed offer an eco-sustainable and economical solution for recycling slightly polluted dredged sediments from ports into reusable soil using phyto-remediation processes.
REF: "Agricultural Reuse of Polluted Dredge Sediments (AGRIPORT)". https://ec.europa.eu/environment/eco-innovation/projects/en/projects/agriport

4.10 Following the completion of the AGRIPORT research, the HORTISHEAD project, a follow-on project (from 2015 through to 2018) tested the suitability of dredged remediated sediments to be re-used in the preparation of substrates for the propagation and cultivation of plants for food production. The LIFE HORTISED project demonstrated the suitability of remediated sediment for the production of lettuce seedlings from seeds and pomegranate saplings from rooted cuttings, and in food crop production (lettuce, strawberries and pomegranate fruits).

4.11 On the basis of previous experiences, decontaminated AGRIPORT marine sediments were subjected to a three months land-farming process, "with the aim to: i) homogenize the substrate; ii) increase the biological activity; and iii) further reduce organic

contamination and achieve better characteristics (e.g. structure, water holding capacity, aeration and biological activity) in order to obtain a substrate suitable for growing pomegranate, strawberries, and lettuce. During land-farming, sediments have been sampled monthly and characterized from a physical, chemical, biochemical, and toxicological point of view. On the basis of the results obtained at the end of the sediment treatment, it was concluded that three months land-farming process was effective in achieving the indicated goals, since physical and chemical characteristics of the treated sediment resulted comparable to those of a commercial agronomic substrate."

4.12 The LIFE HORTISED project demonstrated the suitability of dredged remediated sediments as an alternative to peat in growing media for horticultural applications. In particular, it highlighted the potential of an innovative sediment-based horticultural medium for growing pomegranate, strawberries and lettuce. The overall marketability of crops (edible food crops and saplings), grown on experimental substrates made from mixtures of remediated sediments and peat/coconut fibre in various proportions, was proved to be good.

Similar crops of pomegranate saplings for planting, with equivalent market value, were obtained when grown on conventional substrates and on substrates with less than 70% volume per volume of treated sediments. Both strawberries and pomegranates showed amounts of several organic and non-organic contaminants but always below the allowed legal threshold. The quality of the resulting crops was acceptable.

4.13 It was found that an important environmental benefit of the project was that the new substrate for plant growth could reduce the use of peat, which is an over-exploited natural resource obtained from valuable habitats that provide ecosystem services and support unique species. In addition, the project's solution potentially reduces climate change impacts, and transforms dredged sediment from a hazardous to a non-hazardous waste so reducing pollutant emissions from disposal treatment processes. The project brings other environmental benefits, as the greenhouse gas (GHG) emissions generated by the process of recycling dredged sediments as horticultural substrates is less when compared to the pathway of disposing the sediments in landfill. Moreover, sediment-based substrates can be re-used for at least two crop growing cycles instead of one only, as happens for peat-based substrates, so further mitigating climatic impact. REF: "LIFE HORTISED- Demonstration of the suitability of dredged remediated sediments for safe and sustainable horticultural production." LIFE 14 ENV/IT/000113.

4.14 It may be remarked that the use of marine dredged sediments does not benefit from legislative support in the UK and Europe. In response it is pointed out that the sediments in the tidal reaches of the River Parrett evidently share the radiological characteristics of Bridgwater Bay sediments. That fact clearly implies that they will also share the chemical characteristics of the Bridgwater Bay sediments. In this context it is also clear that the tidal reaches of the Bristol Channel/Severn Estuary Rivers, evidently inevitably share the same radiological and chemical characteristics. In light of the River Parrett dredging outcomes (river bank dumping and agricultural use) it is assumed that sediments from the Bristol Avon and those other rivers discharging into the Bristol Channel and Severn estuary are similarly treated.

4.15 Submission:

A: it is requested that the MMO interrogate the various Somerset River Authorities, the Environment Agency and Natural England in order to confirm how dredge wastes from the tidal reaches of those rivers are disposed of (to river banks, agricultural use or other).

B: it is requested that MMO and those agencies named above (if it is confirmed that dredge wastes from those rivers are disposed of to land) explain how the criteria for river dredged wastes are different from the criteria for sea dredged wastes

C: it is requested that MMO and those (above named) agencies provide their explanation and justification for refusal to dispose of marine dredge wastes to land in the same way as dredge waste arisings from the tidal sectors of the Somerset rivers are disposed

D: it is requested that MMO interrogate EdF and acquire a reasoned and detailed justification, in the context of the evidence submitted above, from that company for its claim that there is/was no applicable beneficial alternative terrestrial use or disposal option for the dredge arisings.

4.16 Use of marine dredged fine sediments in building materials:
A research study published in 2015 demonstrated the practical re-use of dredged Port maintenance dredge sediments in paving block production. A full-scale industrial experiment test was carried at a paving blocks factory. Sediments already characterized in the laboratory were introduced into the mix-design with a substitution ratio of 19% as a partial replacement of quartz sand. Approximately 300 factory sediment-amended paving blocks (FSPB) were produced. These were then subjected to the main qualification tests (splitting tensile strength, water absorption, leaching test). The results showed that the substitution of quartz sand with sediments gave a splitting tensile strength (3.58 MPa), which was very close to the standards, but results were within regulatory limits. The paving blocks were also shown to have a lower water absorption ratio (4.05%) than ordinary paving blocks. Leaching tests-results showed that the quantities of heavy metal contaminants leached from crushed paving blocks were within the regulatory limits. Thus, FSPB can be considered as non-hazardous materials. Finally, this research has led to a new use case of sediments recycling in manufacturing environment. REF: “Reuse of Tunisian marine sediments in paving blocks: factory scale experiment”: Imen Said et al’. Journal of Cleaner Production. Vol’ 102. 1`st September 2015.pps 66-77.

Other studies have also reported beneficial construction uses in a similar positive vein. REFs: “ Design of new blended cement based on marine dredged sediment .“ Tuan AnhDang et al’. Construction and Building Materials. Vol’ 41. April 2013. Pps 602-611.

4.17 The use of marine dredged fine sediments in road construction:
Contrary to the EdF claim, other work has shown the viability of the use of large volumes of marine dredged fine sediments in certain aspects of road construction. For example, a 2009 study of the use of dredged marine sediments, from a harbour in the north of France, for road construction reported that, if the characteristics of the fine sediment were enhanced for use as a road material the materials were compatible with industrial constraints.

The water content of the fine sediments was reduced by natural decantation and dredged sand was added to the fine sediment to enhance the granular distribution and reinforce the granular skeleton. Finally, the characteristics of the mix were enhanced by incorporating binders (cement and/or lime).

The mechanical characteristics measured on the mixes are compatible with their use as a base course material. The obtained results demonstrate the effectiveness of lime in the mixes. In terms of environmental impacts, on the basis of leaching tests and according to available thresholds developed for the use of municipal solid waste incineration bottom ash in road construction, the designed dredged mixes satisfied the prescribed regulatory and construction thresholds. REF: “The use of marine sediments

as a pavement base material". Vincent DuBois et al'. Waste Management. Vol' 29. Issue 2, February 2009, Pages 774-782

4.18 Other studies have also reported the beneficial use of marine dredged sediments for road construction: e.g. REF: "Marine dredged sediments as new materials resource for road construction." Kamali Siham et al'. Waste management. Vol 28. Issue5. 2008. Pps 919-928

A series of subsequent research papers have provided detailed/in-depth validation of the French (Feb 2009) study conclusion, e.g. REF: "Compressibility behaviour of Dunkirk marine structured and reconstituted soils." Wang.D et al'. Marine Geo resources & Geo technology.

4.19 Submission:

A: It is requested that MMO challenge EdF in order to obtain a detailed explanation and justification for the EdF rejection of alternative terrestrial construction and road building uses for the marine dredged sediment from Bridgwater Bay.

B: It is requested that MMO challenge EdF and acquire a reasoned and detailed justification from EdF for its overall claim that there is/was no applicable beneficial alternative terrestrial use or disposal option for the dredge arisings.

C: it is requested that MMO request that Environment Agency and Natural England provide an Agency "view" or comment on the issue of the possible use of Bridgwater Bay dredge sediments for construction and road building uses.

4.20 Given EdF's failure to offer a detailed explanation of the rejection of land disposal, any argument against land disposal or any justification for opting for sea disposal as opposed to land disposal, the original MMO decision to permit sea disposal without either a full discussion of alternative disposal methods, or any questioning of the EdF rejection, appears to be a breach of the spirit of the dredge application process set out at the beginning of this chapter.

4.21 Submission:

A: It is this Submission's contention that, in the clear absence of any detailed discussion of the land based alternative disposal of historical and proposed future Bridgwater Bay dredge wastes, the disposal at sea of those dredge wastes was not, and will not be, "the last resort" as set out in bullet point 5 of the MMO Criteria quoted at the beginning of this document.

B: it is requested that MMO provide, in detail, the reasoning/justification behind its acceptance of the EdF minimalist rejection relating to the previous disposals of Bridgwater Bay dredge wastes

C: it is requested that MMO provide, in detail, the reasoning and justification of any future decision it makes concerning the alternative (land based) uses for the proposed disposal of future Bridgwater Bay dredge wastes

5. Choice of sites for sea dumping:
REVIEW of HINKLEY POINT C DREDGING historical proposal.

(Summary of process culminating in EdF's use of the Cardiff Grounds Port Maintenance dredge dispersal site as a disposal site for the dredge arisings from the Bridgwater Bay Capital dredge.)

5.1 Disposal in "Hinkley Local Sediment System:
September 2011:
Following consultation, Natural England forwarded a letter which welcomed EdF's proposal to retain capital dredge arisings within the Severn Estuary system and to "retain all maintenance dredge arisings within the local transport system "

October 2011
EdF submit their Development Consent Order Application + Environmental Statement to the Infrastructure Planning Commission: The EdF DOC and its appended ES makes several references to the dredge of temporary jetty berthing pocket and the disposal of Capital and Maintenance dredge waste arisings and states that these will be deposited locally, within the sediment transport system that exists at Hinkley Point, provided that the relevant MMO criteria are met, or at Cardiff Grounds if not.

5.2 FAILURE of CRITERIA: The content of this statement is repeated, with confirmation that dredged material from the cooling water infrastructure is also intended for local disposal: (the statements reproduced below are of major relevance to the issue at hand and must be addressed):
"If the relevant Marine License Criteria are met, it is proposed that any dredged material from the construction process (including from the creation of the berthing pocket for the temporary jetty and installation of the cooling water infrastructure) would be disposed of locally within the sediment transport system that exists at Hinkley Point." ... & ..."If the criteria are not met, the dredged material would be removed for disposal at a licensed site (eg Cardiff Grounds). A license for disposal of dredged material will be sought from the appropriate authorising body".

5.3 EdFs DOC/ES offers no Environmental Assessment or other impact assessments related to disposal of capital or maintenance dredge arisings to the Hinkley sediment system, or any other disposal site including the Cardiff Grounds.

5.4 SUBMISSION:
A: In the context of the statement above it may be assumed that, given that the eventual outcome was the EdF decision to use Cardiff Grounds, the relevant MMO criteria were not met. A close search of the available documentation has NOT been able to identify:
A1 any documentation from EdF presenting justification for the choice of Cardiff Grounds as a disposal site as opposed to the "local sediment cell" etc:
A2 any documentation from EdF or from MMO explaining exactly which MMO Marine Licensing Criteria were NOT met, or other reasons and justifications (scientific or legal) for the choice of the Cardiff Grounds and the abandonment of the original proposal to dispose of dredge wastes there
A3 This Submission requests that MMO publish the information relevant to this PRIOR to the close of the Consultation in order to inform the Consultation process and facilitate the process of submission construction.

5.5 February 2012:
From report to MMO & Sec State for Energy & Climate Change re the Public Inquiry (15 Nov – 2nd Dec 2011) for 2 marine licences re 1: building temporary jetty and 2: dredging berthing associated berthing pocket: Published Feb 2012.
"This Report did not address, discuss or comment on any form of dredging at the offshore intakes and outfalls. The Report notes that in September 2011: Natural England wrote a letter which welcomes EdF's proposal to retain capital dredge arisings within the Severn Estuary system and to "retain all maintenance dredge arisings within the local transport system "

5.6 The report of the Public Inquiry notes that Natural England's "letter of 27 September 2011 confirmed that ..... Dredging activities would not have a "likely significant effect on the SAC or Ramsar in relation to the Corallina turf feature. ..... EdF proposes to retain all maintenance dredged arisings within the local transport sediment system, as requested by NE (p2.4.2). Also, NE welcomes EDF's proposal to retain the capital dredge arisings in the Severn Estuary system (p 2.4.3).

5.7 In para 354 of the Report to MMO and Sec of State (Energy and Climate Change). 7th Feb. 2012. KG Smith (Inspector for Planning Inspectorate) referred to a license application for building the temporary jetty and harbour works and licences issued by the MMO Permitting/Authorising marine works, and to dredge and dispose of material from the capital Dredge of the berthing pocket and place material below mean high water springs (MHWS) for the construction of the jetty.

5.8 Environment Agency proposal to dispose at HOLM DEEP
August 2012
A Report to the MMO (licensing authority for the proposed dredge) records an Environment Agency letter (Ref: WX/2012/121678/01-L01: dated Aug 31 2012) which states that "while we note the applicant has preferences towards disposing the dredged material from the offshore infrastructure within an existing disposal ground at Cardiff, we would recommend that they apply for a new licensed disposal site such as at Holm Deep, that will ensure a more localised and sustainable disposal."
N.B. As of yet, this Review has found no further reference to any further discussion of this subject between the Env Agency and EdF .

5.9 Ref: WX/2012/121678/01-L01: dated August 31 also contains the following comment: Definition of Dredging Area and Disposal of Drill Arisings: Prior to commencement of the works, the limits of the capital dredging (primary and secondary) and subsequent disposal of arisings shall be confirmed in writing with a plan, and approved by the MMO. The dredging and disposal shall not extend beyond the approved limits.

5.10 EdF Justification for rejecting HOLM DEEP offer
September 2012: EdF, writing to Mark Wilson (Principal Case Officer: National Infrastructure Directorate: NID) stated that despite the EA advice re Holm Deep ..... "the work undertaken" by EdF, along with "consultation with relevant conservation bodies" (un-named) had "identified a preference to dispose of the arisings that do not have a use elsewhere at the designated Cardiff Grounds", and offering the following justifications:

A: it is preferable to limit the areas of the seabed impacted by disposal to grounds that are already designated for such purposes (where such grounds are available) as is the case re Cardiff grounds

B: the characterisation of a new ground closer to the works is an option but this would require significant data collection

C: the characterisation of a new ground closer to the works is an option but would require the approval of CEFAS and the MMO

D: the characterisation of a new ground closer to the works is an option but this would lead to an additional area of the seabed of the Severn Estuary being affected by disposal operations

E: Natural England has confirmed that the disposal of dredged material at the Cardiff Grounds would ensure that the dredged material would remain within the estuary feature.

5.11 None of these EdF "justification" issues for rejecting the proposed use of the HOLM DEEP as a disposal site appear insurmountable. This Submission considers that most independent/non-partial commentators would consider the issues rejected by EdF to be fairly standard and neither abnormal nor punitively rigorous.

5.12 Evidence from the very detailed Government & Industry sponsored, August 2000 BCMA report on Bristol Channel/Severn Estuary dredging, confirms that the HOLM DEEP site proposed by the Environment Agency is a deep water area which lies in the Inner Bristol Channel between Flat Holm and Steep Holm. It is a "paleo-valley", a remnant feature of the ice age, when the sea level in the Bristol Channel was many

metres lower than today, which would have lowered the bed of the ice-age River Severn and its various feeder rivers. As such it represents one of the deeper water areas of the Inner Bristol Channel, and part of the deep water channel, including the Bristol Deep, which provide deep water access to Bristol/Portbury Docks. It is widely reported that the seabed of this paleo -valley is scoured and largely consists of exposed bedrock, thus demonstrating that it is an area of very active tidal regimes and highly dispersive. These factors contribute to the potential of the Holm Deep to be a highly effective "dispersive" disposal site for a major dredge waste dumping exercise.

5.13 In addition, it is evident that the proposed HOLM DEEP site offers the additional advantage of being the most far offshore (least inshore) disposal site available and thus offering immediate improvement over the inshore sites where "disposed of" wastes are clearly more likely to impact adjacent shorelines in less diluted/dispersed concentrations.

The tidal transport regimes at the HOLM DEEP tend to flood eastwards and ebb westward, thus keeping sediments within the Inner Bristol Channel/Severn Estuary sedimentary cells.
REF: "Bristol Channel Marine Aggregates : Resources and Constraints Research Project:" Final Report. August 2000. Vol 1. paras 2:10, 2:15, 2:25: figs 2(2) & 2(6), Technical Appendix 01.

5.14 In this context the available evidence implies that the EdF policy has been based on cost/time costs to EdF and not on an attempt to adopt a precautionary approach or one seeking to avoid all possible and potential risks to coastal environments and human communities arising from radiological or chemical exposure.

5.15 SUBMISSION REQUEST:
That the MMO, in its role of regulator in the matter of dredge permitting and the associated role in regard of dredge disposal site identification:

A: Initiate a transparent and public discussion of the choice of marine disposal sites and
B: ensure that the HOLM DEEP proposal is re-instated and integrated into the decision making process regarding "disposal sites" and
C: ensure that EdF does not dismiss the proposal out of hand as it did in the past and
D: that EdF provide a thoroughly detailed technical analysis and justification for final choice of site and for their final rejection of other sites.

5.16 Flawed definition of the geographical Severn Estuary:
The EdF HPC Environmental Impact Assessment, Volume 1: Non Technical Summary (the NTS) has employed the term/concept "Severn Estuary Sediment Cell" .

5.17 This phrase implies that the Severn Estuary is, in terms of its sediment cell composition, a single, unitary body. This specific concept is of questionable accuracy in light of the most recent in depth scientific studies and reviews of relevant academic literature. The validity of the EdF statement is contradicted by EdF's additional use of such terms as "LOCALLY WITHIN THE SEDIMENT TRANSPORT SYSTEM THAT EXISTS AT HINKLEY POINT", and LOCAL TRANSPORT SYSTEM", and clearly differentiating between that LOCAL SYSTEM and the Cardiff Grounds site which will be used IF MMO CRITERIA ARE NOT MET.

5.18 "The Severn Estuary is located between the south west of England and south east of Wales and extends from Haw Bridge to the North of Gloucester to a line between Lavernock Point and Brean Down (ABPmer and Atkins, 2010)." REF: The Sediment Regime of the Severn Estuary Literature Review 29 June 2016: Bristol City Council.

5:19 According to the above definition, West of the line between Lavernock Point and Sand Point is the Bristol Channel, which in turn discharges to the Atlantic Ocean and the Irish Sea. The islands of Flat Holm and Steep Holm and the HOLM DEEP channel are located close to that line, in the middle of the estuary. REF: WIKIPEDIA. This definition is supported by a wide consensus of academic and consultant opinion and reporting.

5.20 For most purposes this definition is also accepted and used by the Severn Estuary Partnership responsible for much of the academic review of Severn Estuary parameters (see Map below). This definition directly contradicts the EdF repeated claim that Bridgwater Bay dredge wastes must be kept "within the River Severn sediment cell", because Bridgwater Bay is clearly out-side the geographical definition of the Severn Estuary.

5.21 The Severn Estuary Partnership Map of the Severn Estuary report study area clearly shows the dividing line between the Severn estuary and the Inner Bristol Channel. It can be seen that Bridgwater Bay clearly lies in the Inner Bristol Channel and more than 10km distant from the nearest sector of the Severn Estuary.

The Severn Estuary SSSI designation includes most of the foreshore upstream (east) from Cardiff and Brean Down and extends eastwards up the estuary as far as Sharpness, also excluding Bridgwater Bay. The Bridgwater Bay is NOT recognised as part of the Severn Estuary SSI.

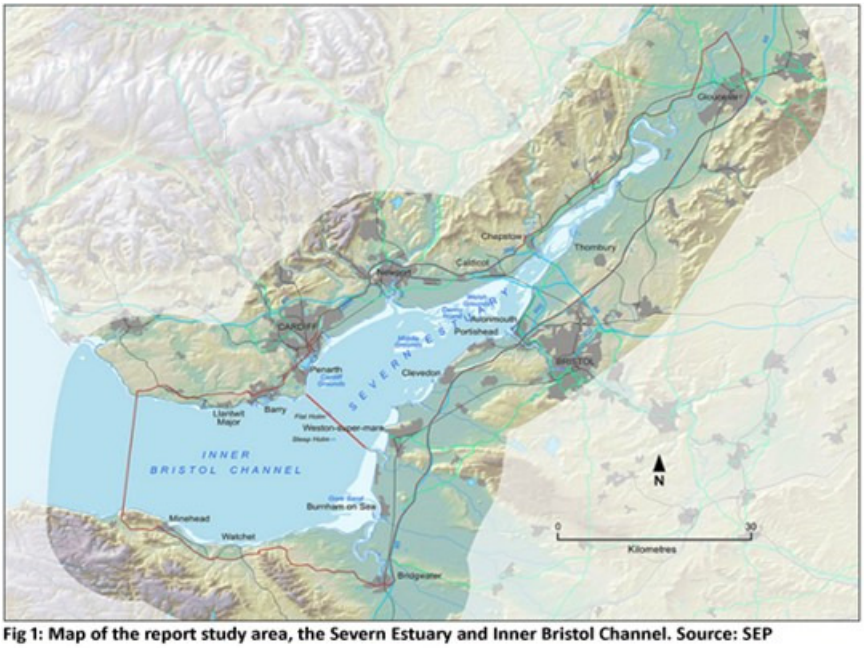


Fig 1: Map of the report study area, the Severn Estuary and Inner Bristol Channel. Source: SEP


Fig 2: Clevedon Pier, © Roger Coleman

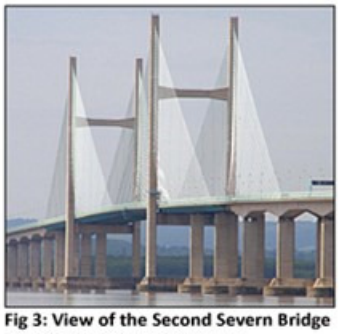


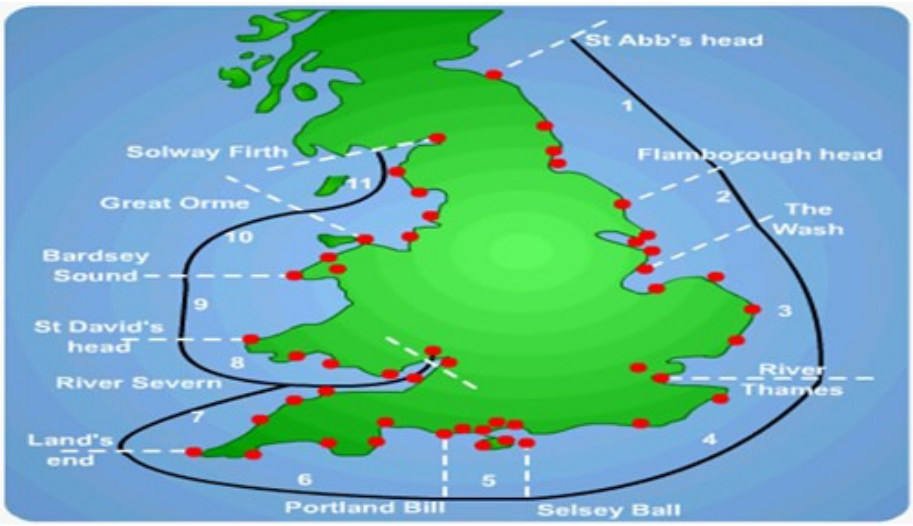
Fig 3: View of the Second Severn Bridge at low tide. © Gwilym Owen

5.22 Submission

This Submission contends that, in effect, the recent EdF historical disposal of dredge wastes from Bridgwater Bay at the Cardiff GROUNDs has been an exercise of introducing alien material (dredge wastes) INTO the Severn Estuary environment from OUTSIDE it.

6. Critique of EdFs definition of "sediment cells"

On the next page is an important map and diagram of littoral sediment cells and SMP units around England and Wales



Littoral sediment cells and SMP units around England and Wales
(from: http://thebritishgeographer.weebly.com/coastal-processes.html)

6.1 Littoral sediment cells are largely self contained stretches of coastline. They are considered to be closed systems in which only relatively small quantities of sediment are transferred from one cell to another. Each major sediment cell typically has many smaller sub-cells.
REF: https://www.alevelgeography.com/sediment-cells

6.2 The diagram above makes it clear that the Severn Estuary does NOT consist of a single sediment cell, as the EdF material implies, and rather that the Severn Estuary and the Bristol Channel are in fact divided between Littoral Cell System 7 (consisting of the south coast of the Bristol Channel and the Severn Estuary) and Littoral Cell System 8 (consisting of the north coast of the Bristol Channel and the Severn Estuary) each consisting of a number of sub-cells.

In effect, the recent EdF historical disposal of dredge wastes from Bridgwater Bay at the Cardiff Deeps has been an exercise of moving dredge waste sediments from one Littoral cell (7) to another littoral cell (8).

6.3 Submission:
This submission contends that

A: in effect, the recent EdF historical disposal of dredge wastes from Bridgwater Bay at the Cardiff GROUNDs has been an exercise of introducing alien material (dredge wastes) INTO sediment Littoral Cell system 8 from Littoral Cell system 7.

B: that in effect the EdF historical disposal of dredge waste into the Cardiff Grounds site removed material from the Bridgwater Bay/Hinkley C "local sediment" sub-cell of Littoral Cell 7 and introduced it into the Cardiff Grounds site which is located within Littoral Cell system 8

6.4 Figure 2:1 of the most recent 2018 UK/Welsh Government Publication on Sediment Budget Analysis clearly states that a sediment sink is a feature "which permanently removes sediment from the system." REF: Figure 2:1 of "Sediment budget analysis: practitioner guide Report: SC150011: Flood & Coastal Risk Erosion Risk Management Research & Development Programme" Environment Agency, DEFRA, Welsh Government, Natural Resources Wales. MARCH 2018

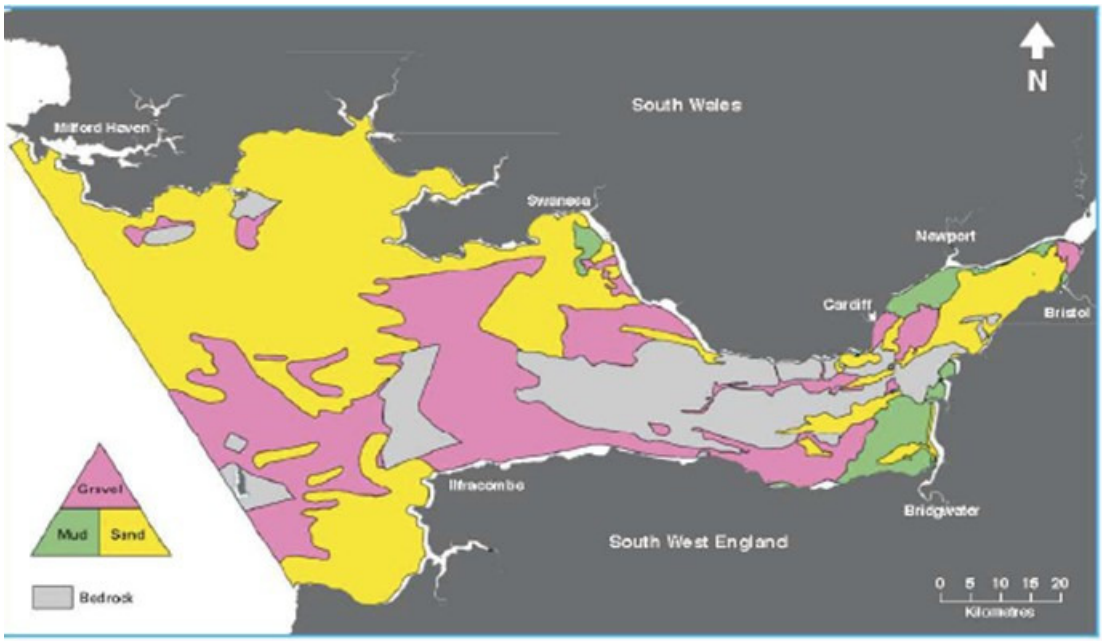
Fig 2:1 of the 2018 UK/Welsh Government Study also defines a coastal sediment cell as: “a bounded unit of coast within which the sediment is largely self contained” and notes that interruption of the movement of sediment within one cell should not affect a neighbouring sediment cell.
REF : as for previous paragraph.

6.5 Sediment inputs to Severn Estuary:
Many studies provide evidence of very large inputs of fine sediment from the estuary’s feeder rivers (Wye, Avon and Severn). Typical “ball-park” figures cited by academic studies are around 1,600,000 tonnes per year from those 3 rivers.
Ref: “Sediment dynamics of the Severn estuary & Inner Bristol Channel :” McLaren P et al’: Journ geological Society of London. Vol 150.1993 pages 589-603

There is an equally wide consensus that additional tonnages of input sediment are derived from erosion of coastal features in response to climate change and increased storminess. Additionally, it is estimated that at spring tides in the Severn Estuary and the adjacent section of the Inner Bristol Channel up to 13,400,000 tonnes of fine sediments are suspended and mobile in the water column.

6.6 Submission:
This submission contends that the text and map evidence in the preceding paragraphs demonstrates that there is no shortage of sediment input to the Severn Estuary and Inner Bristol Channel systems and reduces the scientific standing and relevance of the EdF claim that it is important to ensure that the dredge waste sediments should remain within the Severn Estuary sediment cells and the SAC.

6.7 There is a consensus that Bridgwater Bay is the major inter and sub-tidal sediment sink of the Inner Bristol Channel and that the Newport Deep is the major sediment sink of the Severn estuary. This is supported by the available map evidence (above and below), from which it also clear that each of these sinks occur in different/separate sediment cells. .



Simplified BGS map showing the distribution of sediment on the bed of the Severn Estuary and Bristol Channel (Mackie et al, 2006).

6.8 Submission:
This Submission contends that It is clear from the evidence cited above that EdF's historical and proposed removal of thousands of tonnes of dredge wastes from Bridgwater Bay to be dumped into the Cardiff Grounds or at Portishead is in fact transferring a large volume of material which had been sequestered (permanently removed from the system) and injecting it into a system where it was/is not naturally present.

EdF's submissions and applications regarding the proposed dredge and disposal operations has notably failed to identify this issue or to address its ramifications.
MMO, Env' Agency, Natural England have also failed to address this issue and explain the beneficial outcomes, the negative outcomes and the technical and legal justifications of the removal of sequestered material from a sediment sub-cell of one larger Littoral cell and its subsequent injection into a distant sub-cell which is part of a separate Littoral cell.

This submission requests that MMO provide its own analytical justification of this scenario and that it interrogate the Env' Agency, Natural England and EdF with the aim of acquiring their analytical justification of this scenario and that MMO then publicise those justifications for public consideration.

This submission requests that MMO extend this consultation period in order to allow public consideration of the MMO, Env' Agency, Natural England and EdF response to these submissions

7. EdF characterisation of dredge sediments, sediment type, chemicals, metals and hydrocarbons (PAHs).

7.1 EdF have once again retained CEFAS to report on the sediment, chemical and radiological characterisation of the dredge waste from the NPC offshore construction works. CEFAS is the Westminster Government contractor of choice for such work and has either carried out, or overseen, all of the EdF work on these issues since the inception of the HPC project, including the work carried out in relation to the 2018 dredge and disposal.

7.2 MMO will be fully aware of the fact that, following the 2018 disposal, Natural Resources Wales which originally expressed total satisfaction with the CEFAS/EdF sediment characterisation work for the 2018 disposal has demanded, and been granted, a modification and improvement of the methodology based on the in-depth technical information provided by experts opposed to the disposal of dredge wastes at Cardiff Grounds.

7.3 As a result of those modifications CEFAS has published "BEEMS Technical Report TR536, Sediment sample chemical and physical analysis results for dredging application - Hinkley Point C (2020). Part 1 - cooling water intakes and outfalls" which reports on the non radiological aspects of the characterisation of the proposed dredge material in respect of the proposed forthcoming dredge and disposal operations.

7.4 EdF claim on sediment:
EdF has regularly and frequently claimed in its publicity material, and even in some of its submissions to both English and Welsh Regulators and the Welsh Senedd Petitions Committee, that "The sediment is typical of sediment found elsewhere in the Bristol Channel." REF: "Dredging Mud in the Bristol Channel: is the mud and sediment radioactive?". EdF. 2020.

7.5 The 2020 CEFAS report comments that sediment composition at the various HPC dredge sites was consistent, with generally fine silts with varying fractions of mostly gravel and clay. There is multiple evidence for many sources including the BGS, academic studies, and resource assessments associated with aggregate extraction to deny and refute the EdF claim and clearly demonstrate that the majority of the Bristol Channel and Severn Estuary intertidal and subtidal environments are composed of material other than “fine silts” with gravelly and clay fractions.

7.6 SUBMISSION:
The EdF statement, which by its context clearly means to imply that the claim relates to sedimentary and radiological characteristics, is utterly baseless and lacking in any scientific rigour for the following reasons:

A: as can be seen from the “simplified BGS map” shown above, the BGS report that the sedimentary environment of the Bridgwater Bay is far from typical of that found elsewhere in the Bristol Channel, the Inner Bristol Channel or the Severn Estuary and EdF have provided no evidence to support their claim that sediments are homogeneous throughout the entire system or from its identified sub-sectors.

B: in terms of the radiological characteristics of the Inner Bristol Channel and/or Severn Estuary sediments the EdF statement is equally inaccurate in claiming that the Bridgwater Bay sediments are typical of the rest of the Bristol Channel and its sub-sectors. It is clear that the only routine radiological analyses of sediment samples has been, and is, carried out on samples recovered from the immediate vicinity of Bristol Channel/Severn Estuary licensed nuclear discharges (within about 12 miles either side of the outfalls). There is no evidence that more wide scale analysis of regional sediments has been carried out. Certainly EdF has introduced no evidence to support the claim.

C: the same Submission is made in respect of any implied claim by EdF relating to the chemical characteristics of the Bridgwater Bay sediment. Chemical analyses have been a little more frequent and geographically distributed throughout the Bristol Channel and Severn Estuary but are still restricted to work within, and closely adjacent to, some marinas and ports. However, as with the radiological work, there has been no attempt to launch a detailed study of the chemical characteristics of Bristol Channel and Severn estuary sediments at sites distant from ports and marinas. Certainly EdF has introduced no evidence to support the claim.

D: This Submission contends that the EdF statement quoted above is contrary to the very wide consensus of scientific, academic and industrial knowledge.

E: This Submission requests that MMO interrogate EdF in order to identify the evidential basis for the EdF statement and that MMO then provide public comment on the EdF response.

7.7 The 2020 CEFAS REPORT provides the results of the Chemical analysis carried out on the sediments to be dredged: and notes that Cefas Action Levels indicate the suitability of dredged material for disposal at sea and are used to inform marine disposal licence applications as part of a weight of evidence approach (MMO 2015). REF: “BEEMS Technical Report TR536, Sediment sample chemical and physical analysis results for dredging application - Hinkley Point C (2020). Part 1 - cooling water intakes and outfalls” which reports on the non-radiological aspects of the characterisation of the proposed dredge material in respect of the proposed forthcoming dredge and disposal operations.

7.8 The CEFAS REPORT states that, for metals/and chemicals, Two Action Levels are employed as follows:

- results below Cefas Action Level 1 – are of no environmental concern and are unlikely to influence the licensing decision;

- results between Cefas Action Level 1 and 2 – require further consideration before a decision is made, typically through comparison with local background levels and consideration of the disposal operation;
- results above Cefas Action Level 2 – are generally considered unsuitable for disposal to sea.

It is evident from the results of "metals" analysis from outfall and intake sites that no samples are above Cefas action level 2.

7.9 It can be calculated from the various tables (Figs 4:1 – 4:19) presented in the CEFAS REPORT that, across the "metals" and PCB analysis from outfall and intake sites, 24% of the samples exceeded the Cefas Action Level 1 criteria and therefore require "further consideration through comparison with local background levels and consideration of the disposal operation."
N.B. Although not clearly stated by CEFAS. it is assumed that the above quote is intended to mandate comparison of outcomes of dredge material analysis with the analysis results from the "local background levels" at the intended disposal site.

7.10 SUBMISSION
This Submission notes that:

- 1 of the sample sets analysed for metals/chemicals (Arsenic) returned a 0% exceed of Action Level 1.
- 5 of the sample sets analysed for metals/chemicals returned low percentages (less than 10%) which exceeded Action level 1
- 7 of the sample sets analysed for metals/chemicals returned percentages between 10% and 25% exceeding Action Level 1
- 4 of the sample sets analysed for metals/chemicals returned percentages between 55.5% and 86% exceeding Action Level 1 Nickel (86% and 65%) and Chromium 63% and 55.5%)

It can be calculated from the CEFAS REPORT tables that, approx 22% of sample sets analysed for PAH analyses also exceeded the LMW ERL and that those failed samples should also be given some further consideration, by also being compared to disposal site background levels of PAHs.

The CEFAS REPORT does not detail any prescriptive level or percentage of the number of results above Action Level 1 or LMW ERL which will mandate the "further consideration" referenced in the Report.

This Submission notes that the CEFAS REPORT under discussion did not undertake or address the issue of the required "further consideration through comparison with local background levels and consideration of the disposal operation" and simply stated that: "There were no exceedances of Action Level 2 for any sample, and therefore the material can be considered for disposal to sea."

This Submission therefore contends that the required action (in relation to CEFAS Action Level 1 exceedances) has not been undertaken and that no justification has been provided for the failure to do so.

This Submission formally requests that the MMO interrogate CEFAS and discover on what scientific/technical basis the requirement for further consideration was not carried out. Publication of the outcome of that interrogation is requested in the interest of transparency.

8: RADIOLOGICAL ISSUES:

8.1 Introduction:
Article 24 of the "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management", drawn up by the nuclear industry, includes the following commitment: "Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited: (i) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account". Clearly the Convention permits and encourages the inclusion of economic factors (i.e. cost limitation) as a major consideration when planning the management of discharges from nuclear sites. It is the view of this Submission that "as low as reasonably achievable, economic and social factors taken into account" has permeated every aspect of the regulation, management and quantification of marine anthropogenic radioactivity

8.2 Not radioactive under law:
EdF make frequent reference to the fact that "under law", as arrived at by analytical work carried out according to protocols drawn up and promulgated by the IAEA, sediments dredged from Bridgwater Bay are defined as "de minimis", "legally" not radioactive, and hence suitable for sea disposal (despite the clear evidence that radioactivity is actually present).

8.3 The majority of the IAEA protocols have been largely unmodified for decades, despite the ongoing improvement in the consensual understanding of the fate and behaviour of anthropogenic radioactivity in marine environments.

8.4 There is nothing in national or international law that prevents Sovereign states from initiating and deploying their own improved protocols for radiological monitoring, analysis, and dose estimation and modelling. It should be assumed that the IAEA protocols now represent only the most basic of standards and that, in many respects, they are currently out of date and "behind the science".

8.5 As can be seen from the various CEFAS reports that have been commissioned by EdF, and widely publicised in support of the EdF contention that the dredge wastes are suitable for disposal and pose no threat to environmental or public health, the IAEA analytical protocols have been vital to the EdF case.

However, this Submission contends that the IAEA protocols followed by CEFAS in respect of the Bridgwater Bay dredge and disposal operations are deeply inadequate in a number of very significant respects as follows:

8.6 The majority of the CEFAS reports have, in accord with the IAEA protocols, analysed for gamma emitting nuclide only (using gamma spectroscopy) and produced results for Cobalt 60, Caesium 137 and Americium 241 only, thus failing to detect the pure beta emitters and pure alpha emitters and also failing to search for and identify the presence of any other of the 50+ radioniclides discharged to sea from Magnox (Hinkley Point A) and AGR (Hinkley Point B) reactor sites.

9. Restricted analysis of alpha and beta emitters

9.1 Only once, in 2020, after Consultation Submissions had argued at length (and with fully referenced supporting evidence) that the lack of alpha and beta analysis was a major failing, has CEFAS, acting for EdF, been prepared to carry out analysis for pure alpha and pure beta emitters, but this work was restricted to identification of only the alpha emitting 238, Pu 239/240, Am 241 and the beta emitting Tritium and Organically

Bound Tritium (OBT) and excluding other alpha emitters (Neptunium, Curium, etc) and beta emitters (Strontium 90 etc). Thus only 1 of 4 recent CEFAS surveys of the Bridgwater Bay sediments has carried out specific alpha or beta analysis.

9.2 The 2020 alpha analyses referenced above were actually carried out on 8 sub-samples of only 3 cores of a total of 21 cores taken from the areas to be dredged (ie alpha and beta specific analysis was carried out on only 15% of cores.)

9.3 Failure to investigate the spatial distribution of radio nuclides across the dredge area From the CEFAS REPORT tables and figures of gamma spectroscopy results it is clear that the distribution of the 3 anthropogenic gamma emitting radionuclides (Cs 137, Co 60 and Am241) across the proposed Bridgwater Bay dredge areas is NOT homogenous and that there is very wide variation. This Submission offers the following analysis of that variation:

A: Caesium 137 analysis results for the three subsamples from the upper 0.5 metre of each of the 22 cores show that 43% of samples were reported as < ("less thans") N.B. ("less than" refer to samples below detection capability of the analytical method, but not necessarily absent from the sample...closer accuracy would have been achieved with longer counting times)

B: analysis results for the three upper 0.5 metre subsamples in each core reported approx 27% subsamples with concentrations from 0-9 bq/kg (relatively low)

C: analysis results for the three upper subsamples in each core reported approx 18% subsamples with concentrations between 10 and 19 Bq/Kg (relatively moderate)

D: analysis results for the three upper subsamples in each core reported approx 15% subsamples with concentrations ranging from 20 to 59.9 Bqs/Kg (relatively high).

9.4 Further analysis reveals that the 5 cores with the highest concentrations of Cs 137 in their upper 0.5 metre (OS 11A total Cs 137 =44.8 Bq/kg, OS 11B total Cs 137=55 Bq/kg, OS 11C total Cs 137=59.9 Bq/kg: OS 21B total Cs 137=48.5 Bq/kg: OS 23A total Cs 137=50.7 Bq/kg) are all situated in the offshore areas defined by EdF/CEFAS as "intakes".

9.5 This data reinforces previous Submissions (to NRW consultation on proposed monitoring of Bridgwater Bay dredge sediments) by this author which, based on fully referenced, peer reviewed work, clearly confirmed that the (horizontal) spatial variability of seabed sediment types, and the radioactivity concentrations thereof, vary widely: e.g.

"From Para 17:7 "Technical Report P3-057 initially reported that a 66.6% range difference between dose rates from samples at the 100x12m scale was of significance, the additional reported evidence of variation within a one metre square at perhaps "greater than that of the larger scale" significance, clearly implies that the widespread distribution of sampling sites (ie fewer sites) may militate against accurate assessment of radio nuclide concentration over the broad spatial scale and that more accurate and precise data may be gathered by initiating the use of a greater number of closer together sample sites". REF: "Micro-Scale Variability of Contaminants in Surface Sediments: The implications for sampling". S.M. Mudge et al'. R&D Technical Report P3-057/TR.

REF: from "CONSULTATION RESPONSE re HPC Sediment Sampling Plan SP191:" Tim Deere-Jones (Marine Radioactivity Research & Consultancy) From: the Senedd Petition Campaign to Stop the Dump of Radioactively Contaminated Sediments at the Cardiff Grounds dump site

9.6 It is evident that some offshore areas of the Bridgewater Bay sediments hold significantly greater quantities/concentrations of Cs 137 (and therefore also of other un-analysed for gamma emitting radionuclides) than others.

In the absence of data to the contrary, this Submission concludes that there is a possibility that the monitoring regime used by EdF and CEFAS may not have generated sufficiently detailed results because the sampling points were spaced too widely to provide a detailed understanding of the concentration distribution throughout the areas to be dredged.

9.7 Failure to identify relevant cores for alpha and beta analysis:
This Submission draws attention to the fact that despite the maximum concentrations of Cs 137 recorded in the upper 0.5 metre sub samples of the 5 cores with highest total concentration of Cs 137 (44.5 to 59.9 Bq/Kg) in the offshore "intake" areas: EdF and CEFAS chose not to use those core samples for the additional alpha and beta analysis. This is surprising since many documents note that

"Caesium-137 is easily detected using in vivo bioassay techniques and can serve as a good indicator radionuclide for intakes of fission products." REF: Cesium-137. Cs – PubChem: pubchem.ncbi.nlm.nih.gov › compound › Cesium-137

"Caesium-137 (Cs-137) is a radioactive substance with a half-life of about 30 years. Cs-137 is soluble in sea water and mainly follows the ocean currents. It can attach to sediment. It is necessary to monitor and document the levels of caesium due to a large number of potential sources of future radioactive pollution."
REF: pollution https://www.mosj.no/en/influence/pollution/radioactivity-fish.html

"the long-lived 137Cs is an important indicator of radioactive pollution in aquatic environments." and " because of its abundance and ease of measurement, 137Cs has most likely received a good amount of study than all of the other radionuclides combined."
REF: "Cesium-137: Radio-Chemistry, Fate, and Transport, Remediation, and Future Concerns" MUHAMMAD AQEEL ASHRAF et al'. Critical Reviews in Environmental Science and Technology, 44:1740–1793, 2014

9.8 It is clear that, in agreement with the comments above, the UK monitoring and regulatory authorities strategy generally relies on Caesium 137 analysis as a major indicator of the presence of other nuclides and this is why the gamma spec' techniques deployed by CEFAS have focused so largely on the concentration of Cs 137, as opposed to other nuclides, in Bridgwater Bay sediments. In addition it is noted for its "ease of measurement" provides a cost benefit over longer term gamma counting regimes and alpha/beta analysis.

9.9 In the context of the analyses discussed above it is clear that the most significant concentrations of Cs 137 reported were NOT used by EdF/CEFAS as an indicator of the likely presence of other fission products, including the alpha and beta emitters. This Submission requests that MMO interrogate EdF and CEFAS in order to discover:

A: why cores for the analysis for alpha and beta emitters were not chosen from those with the maximum Cs 137 concentrations

B: which of the 3 were representative of those with the lowest total Cs 137 in their upper 0.5 metre and 1 was representative of those with the moderate total Cs 137

C: what were the criteria for identifying the 3 cores that were chosen for alpha and beta analysis.

9.10: Restricted number of radio nuclides analysed in study:
As referenced in 1 above: the majority of the analyses of HPC dredge waste sediments only report concentrations of 3 anthropogenic gamma emitting radionuclides, the additional (2020) core subsection alpha/beta analyses referenced above reported on the presence of an additional 3 anthropogenic radionuclides. However, it is widely

reported that Magnox (HPA) and AGR (HPB) normal operational liquid effluent discharges consist of approx 50 radionuclides. Thus, the current reporting, as permitted by IAEA protocols and used by CEFAS, only provides data on 6 of the approx' 50 radionuclides in the combined liquid nuclear waste discharges of the 4 Hinkley reactors.

9.11 In accord with the IAEA protocols and CEFAS methodology for both radiological analysis/monitoring and dose estimate construction for coastal critical groups and representative persons, it is the data from only 6 of approx' 50 radionuclides which is input to models for dose estimation. No empirical studies have informed the dose estimate construction for the HPC dredge and dump project and such dose estimates are all the products of "modelling".
N.B. It is a universally accepted axiom that models are only as effective/useful as the data which is put into them; or to put it another way, the less empirical data fed into to a model the further away from empirical truth the end conclusion of that model will be.

9.12 On that basis this Submission contends that, because the radiological analysis and modelling exercises carried out in support of the claim that the proposed dredge and disposal will not harm the environment or pose a threat to public health, are deeply flawed and inadequate, and as explained above, they are incapable of properly informing any dose estimates or modelling.

9.13 "Counting Times"
There is also a consensus among independent academics (if not the IAEA, CEFAS and some regulatory bodies) that "counting times" exert a major influence on the accuracy of radionuclide analyses. The CEFAS methodology used for the Bridgwater Bays sediment surveys "counted" the samples for approximately 55,000 seconds (approx' 15 hours).

However, many papers indicate/recommend much longer counting times for maximum statistical efficiency and state "Better average values can be obtained by acquiring data over longer time periods" and " for the analysis of environmental samples with low radioactivity, a relatively long counting time is required e.g. up to 1-2 days to obtain accurate and precise results".
Ref: UNSCEAR Report to the General Assembly. Annex B: Exposures from Natural Radiation Sources (2000)
Ref: IAEA-TECDOC-1401: "Quantifying Uncertainty in Nuclear Analytical Measurements", International Atomic Energy Authority, (2004)
Ref: Nuclear Forensic International Technical Working Group, Guidelines Task Group, high resolution gamma spectrometry general overview: INFL-GSOV (2013)

N.B. Highly relevant to note that these three sources are close to the IAEA and yet appear to contradict the methodology used by CEFAS who state that their methodology is based on IAEA protocols.

9.14 A 2017 paper reports (in graph form) the Relative Error (in terms of percentage) , related to Specific Activity (Bq/Kg) of nine radio nuclides over fourteen set count times and confirms that, after approximately 36 hours counting, the Relative Error for all nine radio nuclides is approaching its minimum level and that the lowest error is achieved after 72 hours (259,200 seconds).
REF: "Optimal Measurement Counting Time and Statistics in Gamma Spectrometry Analysis: The Time Balance" Joel et al': American Institute of Physics, Conf Proceedings 1792 100001 (2017); doi: 10.1063/1.4969040

9.15 It is clear from the above and from other references

REF: chapter 15 (page 35) of "CONSULTATION RESPONSE re HPC Sediment Sampling Plan SP1914" (compiled by Tim Deere-Jones (Marine Radioactivity Research & Consultancy) From: the Senedd Petition Campaign to Stop the Dump of Radioactively Contaminated sediments at the Cardiff Grounds dump site (available from the author). that the 15 hours gamma spectroscopy counting time employed by CEFAS for the majority of their analyses of Bridgwater Bay sediments is a long way from the best available technique for the acquisition of the most accurate data. It is postulated that the decision to use such methodology is based on "economic factors".

9.16 Furthermore, this Submission contends that the use of such truncated "counting times" has provided data that skews the interpretation of Bridgwater Bay sediment radioactivity in favour of the claim for "de minimis" " and non-radioactve under law", and has allowed EdF to publicly and frequently claim that the sediments "are not radioactive".

10. Failure to identify major pathways of exposure to radioactivity

10.1 The EdF/CEFAS reporting of modelled dose estimates in the context of claimed "de minimis radioactivity" is also deeply flawed. With regard to the potential exposures of members of the public to radioactivity, this Submission notes that IAEA protocols advises that members of the public in the vicinity of a disposal site are considered to be exposed via the following pathways:

1: ingestion of seafood caught in the vicinity of the disposal site
2: external exposure to radio nuclides deposited on the shore
3: inadvertent ingestion of beach sediment
4: inhalation of re-suspended beach sediment
5: inhalation of sea spray

and that both EdF and CEFAS have uncritically accepted and deployed the IAEA protocol in regard to the Bridgwater Bay HPC dredge and disposal proposals.

10.2 However, the IAEA protocol offers a set of basic and extremely simplistic exposure pathway assumptions for anthropogenic marine radioactivity which have been in place for many years and have not kept pace with the growing scientific evidence from independent empirical research, which now shows them to be outdated, inadequate and incomplete.

10.3 This Submission reports that a number of studies have demonstrated additional exposure pathways of significance for sea to land transfer processes. These occur as a result of a number of mechanisms such as coastal inundation events and the production of sea spray, and more importantly, marine aerosols in breaking waves in the surf zone during periods of onshore wind. More detail on these processes and mechanisms, including the outcomes of empirical field studies along the west coast of the UK are provided in the ANNEX.

10.4 These pathways, coastal urban inundation, inundation of coastal saltmarsh grazing and tide washed pasture, and sea to land transfer via sea spray and marine aerosol (the latter demonstrated to carry radioactivity at least 10 miles inland into the coastal zone) are clear sources of dietary, contact and inhalation doses of radioactivity to coastal zone populations which have been utterly ignored by the IAEA protocols and the methodology employed by CEFAS on behalf of their client EdF.

10.5 The IAEA have published a limited list of some (but by no means all) of the radio nuclides present in the liquid effluent discharges of reactor sites and offered the IAEA summary of the odes exposure pathways of those radio nuclides as follows:

"H-3 Ingestion C-14 Ingestion, P-32 Ingestion, Co-60 Ingestion and external irradiation from deposited activity, Sr-90 Ingestion, Ru-106 Ingestion and external irradiation from deposited activity, I-131 Ingestion, Cs-137 Ingestion and external irradiation from deposited activity, Pu-239 Ingestion, U-238+ Ingestion of water, U-235+ Ingestion of water, Th-228+ External irradiation, Ra-228+ Ingestion of water and fish, Ra-226+ Ingestion of water and fish, Pb-210+ Ingestion of fish, Po-210 Ingestion of water and fish." REF: IAEA-TECDOC-1638 Setting Authorized Limits for Radioactive Discharges: Practical Issues to Consider Report for Discussion 2010

However, in the context of the empirical field evidence detailed, and fully referenced in the ANNEX below, it is clear that this IAEA list is once again deeply inadequate.

10.6 There is a consensus that the majority of the radioactivity waste contained in nuclear power station waste discharges to sea, is initially present in dissolved form.

Some of those radionuclides such as the alpha emitting Plutoniums and Americium migrate out of the dissolved form and preferentially Ad-sorb onto sedimentary particles suspended in the marine water column environment. Such alpha enriched sedimentary particles readily undergo environmental concentration and enrichment mechanisms in sedimentary deposits or during aerosol production at the surf line. During marine aerosol production alpha radio nuclides are reported by the UKAEA to be enriched by factors of several hundred times, relative to ambient sea water concentrations, during aerosol sea to land transfer processes.

Other radionuclides are reported to behave more conservatively in marine environments and show a greater tendency to remain in the dissolved form in the marine water column. Caesium (Cs) 137 for example is reported by UKAEA studies to only be enriched by factors of around 2 during aerosol production, apparently due to a reduced association with sedimentary particles. Tritium, as tritiated water, is reported by the nuclear industry to behave exactly as would any other form of water. Thus one would expect both Cs and Tritium to transfer readily from the sea to land in sea spray and the wet element of marine aerosols.

Clearly both forms (conservative and AD-sorbed) will transfer readily during inundation episodes.

10.7 A very detailed research project by a medical team on a Hebridean island has provided clear evidence that some coastal dwellers can ingest far greater levels of marine radioactivity from terrestrial produce grown in the coastal zone (and impacted by deposition of marine radioactivity onto agricultural produce) than was ingested from sea foods.

10.8 Unlike the vast majority of the official dose estimates, which are modelled and hypothetically calculated from inadequate monitoring and analysis, the doses recorded by the Hebridean study WERE NOT MODELLED but where the product of whole body monitoring, urine analyses and radiological analysis of foodstuffs.

10.9 A west Wales / Dyfed CC study showed that deposition of marine radioactivity transferred from the sea to the land could impact agricultural produce at least ten miles inland, enter the agricultural food chain and thus provide an ingestion dose via produce grown that far inland.

This study also provided a very strong implication that, because the Cs 137 was airborne for such a distance, there was a high likelihood of inhalation doses being delivered to regional coastal zone populations.

A nuclear industry (UKAEA) study demonstrated that when onshore winds transferred radioactivity from the sea to the land in sea sprays and marine aerosols, inhalation doses were inevitable.

10.10 None of the pathways of exposure for individual nuclides (including Caesium, Plutonium and Americium) , listed by the IAEA, report inhalation or ingestion (of coastal zone terrestrial foodstuffs) despite the well attested observations from the late 1970s/early 1980s that both pathways of dose delivery occur, and both pathways deliver significant doses to people on the UK west coasts as a result of the sea to land transfer of man-made radioactivity.

This Submission concludes that this is yet another example of the inadequacy of IAEA protocols, as employed by CEFAS on behalf of EdF, and requests that MMO respond to this issue on behalf of the communities of the Somerset coast, by ensuring that CEFAS and EdF carry out appropriate relevant assessments of the likely radiological impact of both the dredge and the disposal activity in respect of sea to land transfer factors.

11. Possible impacts of dredge and dump activity

11.1 When concern was initially raised about the effects of 2017 proposals to dredge at Hinkley Point and dispose of dredge wastes at the Cardiff Grounds in Welsh inshore waters campaigners repeatedly requested that baseline radio analysis be conducted along the Welsh coastline in order to generate PRE disposal data against which POST disposal impacts could be compared and this allow quantification of any impacts. This request was repeatedly denied by both EdF and the Welsh regulator/environmental protection agency the NRW.

As a result, although a large volume dredge waste disposal, with the accompanying dispersal of radioactively contaminated sediment, was carried out in 2018, neither pre-disposal baseline data nor post disposal data are available to permit any discussion of environmental or public health impacts.

11.2 In an attempt to gather some data that might fill in this information “black hole”, a 2020 independent Review of the possible impacts of three years of HPC building and construction activity in the subtidal and intertidal zones was undertaken with the support, and on behalf of campaign groups concerned about the effects of dredge and disposal.

This Review analysed the official data (from the government sponsored RIFE reports for the three years 2016 to 2018 inclusive) which reported on radiological concentrations in marine sediments and dose rates received by “representative persons” from the Hinkley coast through the three years in order to identify any effects of sediment disturbance caused by three years of construction activity in the HPC subtidal and intertidal zones. REF: “Summary Review of relevant sediment radioactivity concentrations recorded in the RIFE reports 19, 20 &21 (covering the years 2013, 2014 and 2015) and compared to outcomes for 2016, 2017 & 2018”. Tim Deere-Jones. (Marine Radioactivity Research & Consultancy) March 2020: (available, on request, from the author)

12. Independent review of possible dredge and disposal impacts:

12.1 The activity in question consisted of intertidal and subtidal marine borehole drilling and core extraction, pile driving, jetty construction and sea wall construction in the intertidal

zone. It is possible that the tail end of the 2018 dredging activity may also have been detected by late summer or early autumn sampling for the RIFE reports (however RIFE reports do not provide information about when samples were taken.)

12.2 The independent Review reported that, on the basis of the officially reported radiological analysis of marine samples (sediments and some shellfish) generated as a result of officially adopted protocols (short “count times”, analysis of strictly limited number of gamma and emitters, wide spatial distribution between sample sites etc), there was some partial evidence of steadily elevated levels of gamma emitters in sediments and clear evidence of a rise in the concentration of beta emitters in shellfish over the three years.

N.B. These outcomes would have been more clearer had there been longer count times generating more accurate and precise results.

12.3 The most significant outcome of the Review of the three years data was a very clear steady and incremental rise in the dose to “representative person”. It was calculated from the official data that gamma dose rates had increased, each year over the three-year period, and that over that time scale doses had risen by 215%.

12.4 It should be noted that both EdF and the Environment Agency contested the proposal that gamma emitters concentrations had actually increased in sediments, though each offered different explanations for the outcome.

Neither EdF nor the Environment Agency contested the proposal that the beta emitter concentrations in shellfish had increased over the time scale.

Neither EdF nor the Environment Agency have contested the observation that the gamma dose had risen by 215%.

12.5 Campaigners propose that the outcome of the Review provides insight into the nature of the likely impacts and effect of the disposal of dredge waste arisings when sediment is dispersed and a plume of suspended sediment is released at one or other of the named possible disposal sites (Portishead and Cardiff Grounds).

This can be linked to the observation that the most recent (2020) CEFAS sediment analysis on behalf of EdF has clearly identified ”offshore” areas of sediment with significantly elevated gamma emitting nuclides, where sediment Cs137 concentrations reached peaks of between 30 and 60 Bq/Kg compared to shoreline intertidal sediments where a maximum concentration of 16 Bq/Kg (RIFE 25: 2019) was reported downstream of the HP site.

Clearly there is a strong possibility that dredge disturbance and dispersal of these high concentration offshore sediments has contributed to the elevated intertidal gamma dose rates as recorded by RIFE reports. REF: RIFE-24 (2018) page 124. Doses to the Public: para 1

12.6 As referenced above, during the earlier Campaign against the proposal to dispose of HPC dredge waste at Cardiff Grounds, there were requests, from Campaigners, to the Welsh Government, NRW and EdF and others for the acquisition of baseline radiological data in order to discover the pre disposal concentrations of man-made radioactivity in the Welsh coastal inter tidal sediments.

12.7 This would have permitted the opportunity to decide on the potential radiological impacts of the proposed dump at Cardiff Grounds and would also have permitted comparison between pre and post dump concentrations of radioactivity in the Welsh

sediments. The request was ignored and never discussed or responded to by Welsh Government, NRW or any other body and no reasons were provided for the lack of response and action.

13. RELEVANCE of REVIEW FINDINGS to PORTISHEAD LU070 and adjacent coast

13.1 This Submission notes that EdF has provided no baseline radiological data for:

A: the Portishead Disposal Site LU070, (which may act as reservoir of disposed radioactivity for longer term dispersal to adjacent areas),

B: the adjacent extensive coastal intertidal and foreshore areas (extending from Avonmouth to Portishead Point and then south west to Woodspring Bay) or

C: for the intertidal sediments of adjacent river estuaries (Bristol Avon, Axe, Banwell, Congresbury Yeo).

13.2 It is therefore assumed that no such work has been carried out and the radiological status of the area of the proposed disposal site and its adjacent shoreline and estuarine intertidal area is currently unknown. Thus, it will not be possible to assess current radioactivity doses to local/adjacent coastal populations and it will not be possible to assess the radiological impact of any future disposal at LU070.

13.3 The absence of any attempt to collect both pre disposal baseline AND post dispersal data shows that EdF and the various regulating agencies have a complete disregard for the acquisition of relevant knowledge and clearly militates against any attempt to understand the potential impacts of disposal and is a gross failure of scientific rigour and deeply careless of human and environmental health.
N.B. This Submission notes that this is comprehensively in breach of the Precautionary Principle. The failure to collect such radiological data for LU070 and its adjacent areas parallels the failure to gather chemical/metals data referenced elsewhere in this Submission.

13.4 CONCLUDING SUBMISSION: Radiological Issues:
In the context of the information submitted above, this Submission calls on the MMO to insist that EdF commission the following radiological research:

A: Baseline radiological analytical study of gamma, beta and alpha emitting radioactivity in subtidal marine sediments and biota within the boundaries of the Portishead Disposal site LU070, the adjacent regional estuarine and foreshore intertidal zones

B: Ensuring that both core samples (divided into sub-samples) and surface grab samples are taken and analysed

C: Ensuring that a SUFFICIENT number of samples are acquired from the Portishead Disposal LU070 site to provide a reasonable horizontal coverage of the site (at the very least to the same spatial frequency as that employed at Bridgewater Bay dredge sites)

D: Ensuring that more than 2 anthropogenic gamma emitters and more than 1 beta emitter are analysed for, in order to provide a more representative picture of the TOTAL radioactivity dose from ALL the radio nuclides that have been discharged in liquid waste effluents from the four HPA/HPB reactors.

E: Ensuring that such analysis employs extended gamma analysis counting times (72 hours rather than 15 hours) capable of providing the lowest error bands

F: Ensuring that gamma analysis is NOT used to predict/model or otherwise hypothesise the beta or alpha content of samples

G: Fully publicising all results and full details of the methodology employed during sample gathering and analytical work (including details of the modelling run data inputs)

H: Ensuring full publication of all results and full details of the methodology (including empirical data inputs) employed during dose estimation for ingestion doses, contact

doses, inhalation doses to dredger operatives, marine resource users/stakeholders, foreshore users (walkers etc), near field, intermediate and far field coastal zone inhabitants, workers, seafood consumers, coastal zone agricultural produce consumers.

13.5 SUBMISSION REQUESTS:

In the context of the data presented above, this Submission contends that sea to land transfer of radio nuclides, via both the inundation and marine aerosol pathway, is EMPIRICALLY demonstrated to be a pathway of significance and that it is at least as important as any of the other parameters referenced by EdF in accord with IAEA protocol (all of which appear to be supported only by hypothetical model outcomes and NOT by EMPIRICAL evidence).

In this context, this Submission proposes and urges that the MMO recognise these phenomena and act upon them, by insisting that EdF commission the monitoring and analytical research advised and recommended in earlier paragraphs in order to establish baseline data on the extent and inland penetration of radiological impacts, arising from both coastal inundation and the sea to land transfer of marine aerosols, in respect of all of the nuclides know to have been discharged in liquid effluents to the Bridgwater Bay from the Hinkley A & B stations.

Additionally, this Submission requests and proposes that the MMO commission Severn Estuary specific studies of the sea to land transfer of radio nuclides in order to confirm whether or not, given that the suspended sediment concentration of Severn estuary water is so much higher than that of the Sellafield waters, it is the case that the concentration of Plutonium, Americium and Caesium 137 (and other sediment adsorbed radio nuclides) in Severn estuary surf zone sea spray is “proportional to the concentration of sediment in the water”.

This Submission urges the MMO to demand that EdF ensure that radiological sampling and analysis of sediments should, as is the case at Hinkley Point, extend for approximately ten miles upstream and downstream of the disposal site. This will provide pre-disposal baseline data against which to compare post disposal radiological data and to inform the understanding of the dispersion and end fate of dumped radioactively contaminated sediments.

This Submission requests that the MMO call for a full Environmental Impact Assessment relating to the proposals to dispose of dredge wastes at both the Portishead LU070 disposal site as indicated in earlier chapters (above), and the Cardiff Grounds disposal site, in order to acquire the data necessary for comparison studies between both sites.

ANNEX: Radiological Issues:
Detail of sea to land transfer Pathways of Exposure to marine anthropogenic radioactivity for Coastal Populations -

Coastal inundation of Urban environments:
Coastal inundation of urban environments is a regular occurrence (more so in the current phase of sea level rise) but only rarely is any attempt made to investigate the impact of marine pollution arising from such events.

In 1990, at Towyn, on the North Wales coast, a storm surge caused extensive flooding of the coastal zone, damaging caravan/holiday parks, shops and houses. Many tonnes of near-shore, marine sediment were deposited as a result of the storm surge. 14 samples of this sediment were collected and sent to an independent radiological analyst who carried out laboratory analysis of all 14 samples for BOTH Am241 and Cs 137.

The analysis showed that both Americium 241 and Caesium 137 were present in the marine sediment and that Americium levels in most samples exceeded 20 Bq/Sq metre, the "Contamination GDL" for Am. 8 of the 14 samples exceeded the GDL level by "more than ten times) (ie above 200Bqs/Sq metre)

N:B: GDLs (Generalised Derived Limits) were the concentrations in environmental media that were estimated to result in an annual dose, to members of the public, of 1mSv, the dose limit recommended at the time, by the International Radiological Protection Committee and endorsed by the then UK National Radiological Protection Board. It was recommended that where GDLs were exceeded by 25%, further investigations into the public implications should be undertaken. There is no evidence that such further action was taken at Towyn.

The Consultant's report also stated that:

A: the presence of Am 241 "also implies the presence of the plutonium isotopes Pu 238, Pu 239, Pu 240 and Pu 241 and quite probably the GDLs for these will also be exceeded"

B: "contamination due to americium, and probably also of plutonium isotopes….. is generally greater than limit set….for further investigations". (ie the GDL)

C: "the values suggest that, when the sediment dries out, there is a possible radiation hazard due to the inhalation of radioactive dust containing the isotopes of americium and plutonium"

REF: Edinburgh Radiation Consultants: "Radiation Survey of Towyn ": March 1990. (copy of report available from Tim Deere-Jones)

This Submission comments that the significant evidence from this single (privately funded) analytical research project should have been acted upon by the UK and Welsh Governments at the time, and as soon as it was made known to them, both by carrying out the "further investigations" recommended under GDL protocol and by carrying out ongoing and in depth investigations of the radiological impact of urban coastal inundations.

The failure of both governments to investigate further the very significant outcomes of this study of pathways of exposure of coastal urban communities to marine anthropogenic radioactivity in the event of coastal flooding and to calculate the potential doses to workers and residents is inexplicable, represents a clear failure of duty of care and was of considerable benefit to the pro-nuclear cause, in that it avoided the possibility of negative publicity.

This Submission contends that the IAEAs reference to “external exposure to radio nuclides deposited on the shore” is clearly inadequate because it clearly does not cover incidents such as that at Towyn i.e. the inundation (from the sea) of coastal communities located in areas where the water column and the marine sediments are known to be contaminated with anthropogenic radioactivity.

Noting that there is no legal insistence that National Governments must not /can not improve upon the existing inadequate IAEA protocols, this Submission requests that the MMO take note of the evidence from Towyn, and insist that EdF produce an estimate of the likely radiological impact of urban inundations along the Somerset coast and associated dose estimate to cover such events.

Noting that, in the current context of increasing flooding of estuarine and coastal terrestrial zones in the context of climate change and sea level rise, such inundation events are manifestly on the increase, this Submission recommends that any community known to have experienced tidal or coastal inundation over recent years (ideally at least 20 years) be given the benefit of such investigation/research prior to any further, large scale (1000s of cubic metres) dumping of radioactively contaminated sediments into the coastal waters of south Wales

Coastal Inundation of Salt Marsh grazing land/ride washed pasture:

This Submission notes that both Regulatory and Monitoring/Analytical agencies recognise that radiological contamination of salt marsh and tide washed pasture is an established and relatively frequent occurrence.

Table 4.6 of RIFE 3 (1997) provides results of the monitoring of “Radioactivity in Sediment from the Cumbrian coast and further afield”. This table focuses principally on clearly intertidal materials such as mud and sand, however it does report analytical results for 6 samples of “turf” and one of “Salt Marsh”. These, particularly those designated as “turf”, are clearly definable as terrestrial, but certainly subjected to tidal inundation on occasion. Table 4:6 shows positive results for Cs 137 and Am 241 in turf and Salt Marsh and also shows positive results for Pu 238, 239 and 240 in the Salt Marsh sample and in many of the adjacent “mud” and “sand” sediments intertidal samples.

Although the “Salt Marsh” sample is recorded to have held Pu 238 concentrations of 57 Bq/Kg and Pu 239/240 concentrations of 290 Bq/K, it is surprising to note that the “turf” samples were not analysed for Plutonium nuclides

RIFE 3 (1997) Table 4:14 provides results of radioactivity sampling of “tide washed pasture” at 8 coastal locations relatively close to Sellafield. Tabulated results of this work show positive results for 9 anthropogenic radio nuclides in coastal soil including Am 241, Cs 137, Co 60, Tc 99, I 129, Cs 134, Ru 106, 125 Sb, and Eu 155.

This table also omits any results for Pu 238, 239 and 240 and it is presumed that these nuclides were not analysed for in this study. However, despite the unexplained failure (or refusal) to analyse terrestrial “tide washed” turf for Plutonium nuclides it is also clear that tide washed salt marsh will contain Pu as per the “salt marsh” sample.

There is indisputable evidence that radioactivity contaminating salt marsh grazing and tide washed pasture (Co 60, Nb 95, Ru 106, Cs 134, Cs 137, Pu 238, Pu 239/240 and Am 241) is readily passed to grazing animals reared upon such land or fed with produce harvested from it. It is reported that such transferred radioactivity has been detected in ewes milk, lambs and adult sheep from such environments.

REF: “The Transfer of radio nuclides from salt marsh vegetation to sheep tissues and milk”. NA Beresford et al’. Journal of Environmental Radioactivity. 2007. 98 (1-2): pps 36-49.

All of these radio nuclides are reported to be constituents of the combined liquid effluent discharges from the four Hinkley Point reactors.

NB: Salt Marsh is generally less likely to experience inundation than the standard “intertidal” zone and may be regarded as a transitional zone between the true intertidal and the true terrestrial zone. “Tide washed pasture” or coastal grazing marsh is a specific term applied to land derived from the enclosure of Salt Marsh. Thus the two are virtually identical in all respects except that one has been enclosed.

The paragraphs above prove that at least 12 radio nuclides are capable of being transferred from the marine environment into coastal urban environments, and terrestrial “tide washed” marshland grazing environments. There are no scientific or technical grounds for assuming that such phenomena do not occur in the Bristol Channel/Severn estuary.

This Submission contends that it is clear that the nuclides named in preceding paras are readily transferred from marine environments into urban environments where urban populations may be exposed, and onto coastal marshland and tide washed pasture where they may be consumed by grazing animals and provide dietary/ingestion doses to human consumers of animal products (milk, other dairy products and meat).

In the context of the evidence above, and given the number and volume of nuclides discharged from the HPA and HPB sites (+ those discharged from the Berkeley and Oldbury sites) over a 50 years+ time scale, and the acreage of both urban coastal environments and intertidal and tide washed pastures along the Somerset and Avon coast, this Submission concludes that tide washed pastures and marshland grazing along those coastline will have been radiologically contaminated in the past and are highly susceptible to further radiological contamination in the future.

Accordingly, this Submission contends that baseline investigation involving the collection of EMPIRICAL (pre disposal) field data (not modelled hypothetical data) must now be undertaken in order to assess the pre disposal concentrations of Hinkley derived marine radioactivity in those areas distant from the Hinkley Point nuclear site, which have NOT been the subject of regular, annual , radiological monitoring and analysis, in order to quantify the current pre disposal concentrations of radioactivity in flooded urban environments, tide washed pastures and Salt Marsh grazing against which to measure any impact of disposal operations. This is clearly of major importance along the Portishead coastline and adjacent areas (including the various river estuaries)

Noting that there is no legal insistence that National Governments must or can not improve upon the existing inadequate IAEA protocols, this Submission requests that MMO take note of the evidence discussed above and insist that EdF commission both baseline surveys of Portishead coastal environments to determine their current radiological status, and post (second) dump in order to identify any subsequent (post disposal) variations in radiological status.

Noting that, in the current context of increasing flooding of estuarine and coastal terrestrial zones such inundation events are plainly on the increase, this Submission recommends that any such environments known to have experienced tidal or coastal inundation over recent years (ideally at least 20 years) are prioritised and given the benefit of such investigation.

Sea to Land Transfer via seaspray and marine aerosols

These processes involve the airborne transfer of radio nuclides (entrained in water droplets or attached to fine sediments), in marine aerosols, across the shoreline during periods of onshore wind. The IAEA, CEFAS and EdF have chosen to ignore the issue of sea to land transfer via marine aerosoling mechanisms and to focus instead on "inhalation of re-suspended beach sediment" and "inhalation of sea spray".

Definition: beach sediments: coastal geo-morphologists define "beach" thus: "Beaches form through erosion of rock or coral reefs near the edge of the ocean. Rocks are worn away slowly over millions of years into tiny particles, like sand or pebbles. The particles that make up beaches may travel from many miles away in the ocean to reach the beach. Water waves carry the particles and deposit them on the shore.
REF:
https://study.com.academy/lesson/what-is-a-beach-definition-formation-characteristics.html

A beach is a narrow strip of land separating a body of water from inland areas. Beaches are usually made of sand, tiny grains of rocks and minerals that have been worn down by constant pounding by wind and waves.
REF: https://www.nationalgeographic.org/encyclopaedia/beach

Clearly neither of the above definitions have any relevance to the extensive fine sediment/muddy intertidal zone of the shorelines of the Severn estuary, which are composed largely of silts, clay mineral particles and organic particles (micro organisms etc) small and fine enough to be suspended in the Severn estuary water column for relatively prolonged periods of transport before being deposited in the Severn estuary intertidal zone, largely as a result of flocculation processes.

There is a clear consensus among oceanographers, coastal geomorphologists and other coastal experts that "beach sediments" consist of particles both larger and heavier than silts/clay mineral particles or organic particles.

As such, beach sediments are generally most likely to come under the size definition of "sands" and hence are:
A: unlikely to be suspended for very long in the coastal water column or
B: injected into the coastal atmosphere at normal inhalation heights or
C: very unlikely to be of respirable size (ie small enough to enter the lung) &
D: very unlikely to remain suspended in the coastal airstreams over time scales sufficiently prolonged to permit them to penetrate deep in to the coastal zone (ie more than a few score yards.)

Oceanographers distinguish between sea spray (larger droplets sheared away from the upper surface of cresting and breaking waves) and sea water aerosols (micro-droplets/film droplets/jet drops produced from bubbles bursting within breaking waves)
REF: "The effects of the marine aerosol on infrared propagation over the world oceans". Stuart G. Gathman: Oceanologia 41 (4) 1999. pps 489-513.

In windy conditions, water droplets mechanically torn off from the crests of breaking waves are defined as "spray". Sea spray droplets generated this way are called "spume droplets" and are typically larger in size than aerosol droplets and therefore have less residence time in air. Impingement of plunging waves on sea surface also generates sea spray in the form of splash droplets which are also larger than aerosol droplets. Such droplets, as is the case with "sands", are generally too large and too heavy to have significant potential to penetrate deep in to the coastal zone.

By contrast, in the case of marine aerosols, "film droplets" make up the majority of the smaller particles created by the initial bubble burst, while "jet droplets" (also small) are generated by

a collapse of the bubble cavity and are ejected from the sea surface in the form of a vertical jet.
REF: "Ocean Spray". F. Veron Annual Review of Fluid Mechanics. : 2015: 47 (1): 507–538
REF: F. McIntyre.. "Flow patterns in breaking bubbles". Journal of Geophysical Research: 1972: 77 (27): 5211–5228.
REF: "The Impact of Sea Spray on Air-Sea Fluxes in Coupled Atmosphere-Ocean Models". Edgar Andreas. 2002. Fort Belvoir, VA

On behalf of the UK Nuclear Free Local Authorities and others, this author has reviewed a number of nuclear industry and non-aligned independent and academic studies of sea to land transfer issues, some of which have been published in peer reviewed journals, others of which were produced by County Councils and General Medical Practitioners. These studies, universally focussed on the sea to land transfer of only 5 radio nuclides (Caesium 137, Americium 241, Plutonium 238, Plutonium 239 and Plutonium 240), have confirmed that the sea to land transfer of these nuclides does occur by way of sea spray and marine aerosol micro droplets carried inland during periods of onshore winds.

These studies from the fully referenced Technical briefing published by the Nuclear Free Local Authorities, are summarised below:

A study by the UK AERE provided EMPIRICAL data showing that these nuclides are all enriched by various degrees during the process, with Cs 137 showing enrichment factors (EFs) of about 2 relative to ambient sea water concentrations. The alpha emitting Pu's and Am were shown to have EFs, relative to filtered ambient seawater, of up to 800. It was noted that the sea spray and aerosols were generated by breaking waves in both the offshore zone and at the surf line. Alpha emitters were found to be associated (by ad-sorbtion) with micro particles of sedimentary and organic material suspended in the marine water column and ejected into the atmosphere as aerosol micro droplets by bursting bubbles in breaking waves.

REF: NFLA Radioactive Waste Policy Briefing Number 78: Sea to Land Transfer of Man-made Radioactivity – an update. July 2019
www.nuclearpolicy.infoRad_Waste_Brfg_78_Sea_to_Land_Transfer

A study from Dyfed County Council provided EMPIRICAL data showing that sea to land transferred nuclides penetrate deep inland (sea borne Cs 137 shown to penetrate at least 10 miles inland into the Welsh coastal zone) and then contaminate pasture grass, thus providing a public dose exposure pathway via the consumption of meat and dairy produce.
There are no comparable studies for the 4 alpha emitting nuclides of Plutonium and Americium.

The reviewed studies have also provided EMPIRICAL data showing that in coastal communities, people consuming locally grown produce grown from affected coastal zones have higher radioactivity body burden than those not consuming locally grown produce. REF: NFLA Radioactive Waste Policy Briefing Number 78: Sea to Land Transfer of Man-made Radioactivity – an update. July 20

A study carried out by a team of GPs (with the assistance of the Scottish Universities Research and Reactor Centre, East Kilbride) has also provided EMPIRICAL data showing that individuals from affected coastal zone communities derive larger dietary doses of marine sourced man made radioactivity, from terrestrial produce grown in the coastal zone, than from sea foods harvested from local waters.

REF: NFLA Radioactive Waste Policy Briefing Number 78: Sea to Land Transfer of Man-made Radioactivity – an update. July 2019
www.nuclearpolicy.infoRad_Waste_Brfg_78_Sea_to_Land_Transfer