



Netherlands Enterprise Agency

# Archaeological Desk Study

## Nederwiek Wind Farm Zone

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# RVO Approval for Publication

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# Windfarm Zones Nederwiek Noord & Nederwiek Zuid



## Archaeological Desktop Assessment

MSDS Marine and Vestigia



**MSDS**  
Marine



**MSDS**  
Heritage



# Windfarm Zones Nederwiek Noord & Nederwiek Zuid

## Archaeological Desktop Assessment

<b>Project Name</b>	Windfarm Zones Nederwiek Noord & Nederwiek Zuid: Archaeological Desktop Assessment
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Administrative details	
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Location	North Sea, Windfarm zone(s) Nederwiek Noord and Zuid
Client	Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland) PO Box 8242 NL-3503 RE Utrecht
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Surface area wind farm zone	947.78 square kilometres
Depth soil disturbance	Not yet known
Current use	Netherlands Exclusive Economic Zone
Survey registration number	5313992100
Type of survey	Desktop assessment
Coordinates wind farm zone	501892.90 / 5861912.42      531897.70 / 5934699.53
Coordinate system and projection	ETRS89/UTM zone 31N
Contractor	Vestigia BV Archeologie & Cultuurhistorie MSDS Marine / MSDS Heritage
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## Samenvatting en advies (Dutch version)

Vestigia Archeologie & Cultuurhistorie en MSDS Marine Ltd. hebben van de Rijksdienst voor Ondernemend Nederland (RVO) opdracht gekregen tot het uitvoeren van een aantal archeologische vooronderzoeken in verschillende nog aan te wijzen windmolenparken op de Noordzee binnen de Nederlandse Exclusieve Economische Zone (EEZ). Deze vooronderzoeken worden in drie stappen uitgevoerd: Een Bureauonderzoek conform KNA 4.1 protocol 4002 (stap 1), de archeologische analyse van in te winnen geofysische data conform KNA 4.1 4103 protocol IVO-Opwater (stap 2) en de archeologische analyse van in te winnen geotechnische (boor)data, eveneens volgens het protocol 4103 (stap 3). Vanwege het krappe tijdspad voor de opdrachtgever, zijn de onderzoeken gebieden qua volgorde nader geprioriteerd. Nederwiek Noord en Zuid zijn daarbij aangewezen om als eerste te worden opgeleverd.

Het Nederwiek Windmolenpark bestaat uit twee gescheiden gebieden aan de uiterste westrand van de Nederlandse Exclusieve Economische Zone, tegen die van het Verenigd Koninkrijk aan. De beide onderzoeksgebieden hebben een gezamenlijk oppervlak van 947 km<sup>2</sup>. Het onderzoeksgebied voor de archeologische opdracht beslaat niet alleen dit oppervlak, maar ook een bufferzone van 500 m daaromheen.

Het doel van het archeologisch bureauonderzoek is om de bekende archeologische resten in beide gebieden te inventariseren en een specifiek verwachtingsmodel op te stellen voor de te verwachten, nog niet ontdekte, Archeologie. Meer specifiek, door middel van deze studie maken we inzichtelijk of en zo ja welke archeologische resten in het gebied aanwezig zijn, of waarvan we mogen aannemen dat ze er kunnen zijn, en of deze (te verwachten) resten bedreigd of aangetast zouden kunnen worden door de te bouwen windturbines en bijbehorende verbindingenkabels.

Als we de generieke archeologische verwachting voor beide gebieden nader beschouwen dat kan een onderscheid gemaakt worden tussen twee soorten verwachting: 1) de verwachting voor prehistorische archeologische resten, die bij uitzondering te vinden zijn op de zeebodem, maar nog waarschijnlijker begraven zijn onder jongere sedimenten in de zeebodem; 2) de resten van historische schepen en vliegtuigen die terecht gekomen zijn op de zeebodem, en hooguit gedeeltelijk zijn afgedekt.

Tot op heden zijn nog geen prehistorische vondsten of vindplaatsen geïdentificeerd binnen de Nederwiek Noord en Zuid gebieden, noch de bufferzones van 500 m. De specifieke archeologische verwachting kan verder worden afgebakend tot vindplaatsen en vondstconcentraties van jagers-verzamelaarsgroepen uit het (Midden en Laat) Paleolithicum en de (Vroeg) Mesolithische periode. Na ca. 7000 voor Chr. is menselijke bewoning door de zeespiegelstijging in deel van het verdrinkende landschap van de Noordzee niet meer mogelijk. Vindplaatsen uit die vroege periode zijn bovendien nog eens dun gezaaid, vanwege de lage bewoningsdichtheid en zullen zich geconcentreerd hebben in de hogere delen van het landschap en op de oevers van rivieren en getijdengeulen. Die laatste waren daarbij ook nog eens extra gevoelig voor latere erosie. De resterende archeologische verwachting is mede daarom nauw gerelateerd aan de landschapsontwikkeling binnen de twee gebieden en lithostratigrafische eenheden die daarin te onderscheiden zijn. Op basis van de beschikbare geologische informatie mag verwacht worden dat archeologisch relevante lagen en afzettingen onder de zeebodem zijn afgedekt met jongere zandlagen met een dikte variërend tussen de 5 en 10 m. Gedetailleerdere gegevens hierover ontbreken vanwege het kleine aantal boorbeschrijvingen en andere geotechnische data uit de twee gebieden. Voor het nog uit te voeren geologische en geotechnische onderzoek zou daarom de focus gelegd moeten worden op het verzamelen van aanvullende informatie (via extra boringen) om het bestaande geoarcheologische beeld van de ondergrond van dit deel van de Noordzee aan te scherpen. Dit is in overeenstemming met het NSPRMF programma.

Voor wat betreft het andere deel van de archeologische verwachting, zijn in de beide gebieden samen 14 historische scheepswrakken aangewezen, waarvan er vier nader konden worden geïdentificeerd. Drie daarvan zijn recente wrakken van beperkte archeologische of historische waarde. Twee andere zijn wel van archeologische waarde en een daarvan is geïdentificeerd. Een daarvan is het wrak van de Duitse onderzeeër U97, die in 1918 zonk op weg naar Engeland, de andere een houten achtersteven met markeringen. De inventarisatie van vliegtuigcrashes uit de Tweede Wereldoorlog leverde 9 incidenten op, die volgens de gehanteerde selectiecriteria binnen de Nederwiek onderzoekslocaties zouden kunnen liggen. Dat hoeft echter nog niet te betekenen dat die wrakken ook daadwerkelijk in het gebied aanwezig zijn; het is niet meer dan een eerste indicatie, en aanduiding dat met dit soort resten in het gebied rekening dient te worden gehouden.

Dit rapport eindigt met een aantal aanbevelingen voor de volgende stappen in het archeologisch onderzoeksproces. Onderdeel daarvan zijn geofysische en geotechnische surveys, die ongetwijfeld meer data, onmisbaar voor verdere archeologische analyse gaan opleveren. De scope voor de geofysische survey in de Nederwiek gebieden was al grotendeels bepaald voor aanvang van het onderhavige bureauonderzoek. Deze zullen bestaan uit een combinatie van Multibeam, Sidescan sonar, Magnetometer en Seismische prospecties. Om er zeker van te zijn dat de specificatie voor deze survey (ook) voldoet aan alle eisen voor een archeologisch opwater-onderzoek conform KNA 4.1 (protocol 4103) is deze specificatie door MSDS/Vestigia getoetst. De surveyspecificatie en data-inwinningseisen voldoen ons inziens aan alle randvoorwaarden voor een archeologische prospectie. Wij adviseren echter om de posities van wrakken en andere obstakels die in dit bureauonderzoek zijn verzameld en vermeld aan de surveyer worden doorgegeven en door hem opgenomen in het vaar- en opnameplan, zodat extra aandacht kan worden gegeven aan deze locaties en de ingewonnen data voldoen aan wat nodig is om nadere uitspraken ten aanzien van het eventuele archeologische belang te kunnen doen. Indien maar enigszins mogelijk moeten over aangetroffen wrakken extra kruislijnen gevaren worden om deze preciezer af te bakenen en het mogelijke effect van akoestische schaduwwerking te beperken.

De precieze aanbevelingen voor de verdere geo-archeologische prospectie in de beide Nederwiek gebieden worden opgenomen in een apart Programma van Eisen (WSI GTA). Het gaat om een aantal diepere cpt- en ondiepere vibrocore boringen. De boorlocaties zijn aangewezen in samenspraak met TNO/Deltares en in overeenstemming met de aanbevelingen uit de geologische bureaustudie. Verdere uitleg en onderbouwing daarvoor kan in het PVE gevonden worden.

## Summary and Recommendations (English version)

Vestigia Archeologie & Cultuurhistorie and MSDS Marine Ltd are assigned by the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) to conduct a number of archaeological assessments for various wind farm zones (WFZ) on the Dutch Continental Shelf (DCS) or Dutch Exclusive Economic Zone (EEZ). The assessments are carried out in three parts or phases: a desktop assessment (phase 1), an assessment of geophysical survey data (phase 2) and an assessment of geotechnical survey data (phase 3). Due to time constraints for the contracting authority, there are first, second and third priority areas identified, of which Nederwiek is the first and therefore subject of this desk study.

The Nederwiek Windfarm zone (WFZ) consists of two separated areas which are located on the most western part of the Dutch Exclusive Economic Zone (EEZ), adjacent to the UK EEZ (see figure 1). The research areas have a combined surface of 947 km<sup>2</sup>. The study area of this assessment incorporates the full extent of the WFZ area, plus an extended 500 m area surrounding the WFZ.

The purpose of the archaeological desk-based assessment is to specify the known and potential archaeological resource within the two areas. More in detail, this study is to establish whether archaeological remains are, or are likely to be, present within the windfarm zones Nederwiek Noord and Zuid, and whether these (possible) remains could be affected by the construction of wind turbines and cable networks in both these areas.

Considering the general archaeological expectancy a distinction has been made between the expectancy for early prehistoric archaeological remains on, or more likely, buried under the seabed, and the remains of historic ships and aircraft on or directly beneath the seabed

To date no prehistoric finds or archaeological sites have been identified within the Nederwiek Noord and Zuid windfarm zones, nor their 500m buffers. Archaeological expectancy has been shown to be limited to sites and concentrations of finds from hunter-gatherer groups of the (Middle and Late) Paleolithic and (Early) Mesolithic periods. After c. 7000 BC human occupation will have been impossible in the then drowned landscape of the expanding North Sea. Sites from these periods are extremely low in density. Paleolithic and Early Mesolithic occupation sites would have been situated mainly on higher parts within the landscape, and/or the banks of river and tidal gully systems, which consequently were also more exposed to later erosion. The archaeological expectancy is strongly related to the geo-genesis of the two areas and remaining lithostratigraphic units. Current available geological information suggests that archaeologically relevant layers and deposits are covered by sea bed sand with a thickness varying between 5 and 10 metres. Specific knowledge is however limited due to the low numbers of borehole- and geotechnical data. The main focus of any additional geological survey should therefore be on the gathering of additional information to broaden the general geoarchaeological information on this part of the North Sea, as outlined in the NSPRMF program.

A total of 14 historic shipwrecks are known from the study areas, of which four have been identified so far. Three of these are recent wrecks and are of limited archaeological value. Two wrecks are certainly of archaeological value (of which one has been identified). The first of those two is the German WW1 era submarine the U97 which sank in 1918, and the other one is a wooden sternpost containing depth markings. A search within the register of WW2 aircraft losses using certain parameters resulted in 9 potential crash locations in or near the Nederwiek study areas. This does not mean these plane wrecks are indeed within these areas, but it provides a first indication, and reminder that aircraft remains can be present and thus expected.

In this report recommendations have been made for next steps in the archaeological assessment process. Both a geophysical and a geotechnical survey will be conducted, and provide essential additional data for further archaeological analysis. The scope of works for the geophysical survey for the Nederwiek Wind Farm Zone had been compiled before the start of this desktop survey. These will consist of a combination of Multibeam, Sidescan sonar, Magnetometer and Seismic surveys. To ensure the specification of the survey meets the requirements for archaeological assessment, and interpretation, this scope of works has been reviewed by MSDS/Vestigia. The survey specification and requirements cover all considerations that are required from an archaeological perspective. However, the positions of wrecks and obstructions detailed within this report should be noted by the surveyor and particular attention paid within these areas to ensure the data meets or exceeds expectations. Where possible, additional crosslines should be run over wrecks identified during the survey, to 'box' them in to minimise any potential effects of acoustic shadow.

Recommendations for additional geo-archaeological prospection in both Nederwiek areas by means of borehole/cpt drilling and vibrocores will be made in a separate document, the Written Scheme of Investigation for the Geo-Archaeological survey (WSI GTA) by Vestigia. Further explanation and motivation, as well as the operational requirements can be found in there.

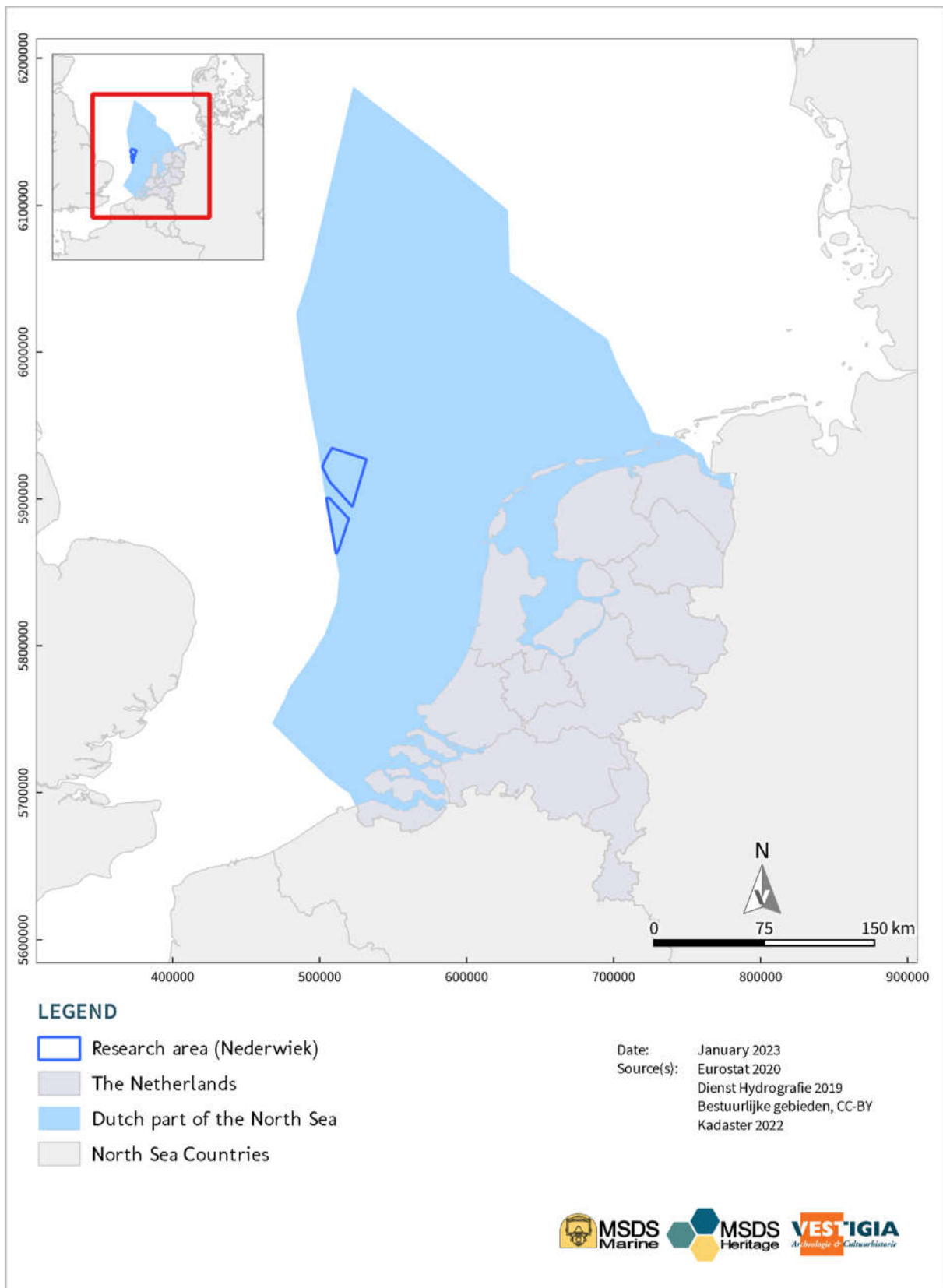


Figure 1 Research areas Nederwiek Noord (North) and Zuid (South)

## 1.0 Introduction

### 1.1 Project environment

- 1.1.1 Vestigia Archeologie & Cultuurhistorie and MSDS Marine Ltd (from here on Vestigia) are assigned by the Netherlands Enterprise Agency (in Dutch: Rijksdienst voor Ondernemend Nederland, RVO) to conduct a number of archaeological assessments for various wind farm zones (WFZ) on the Dutch Continental Shelf (DCS) or Dutch Exclusive Economic Zone (EEZ). The zones are Nederwiek, Doordewind, Lagelander, Hollandse Kust and an optional site. The assessments are carried out in three parts or phases: a desktop assessment (phase 1), an assessment of geophysical survey data (phase 2) and an assessment of geotechnical survey data (phase 3). Due to time constraints for the contracting authority, there are first, second and third priority areas identified, of which Nederwiek is the first and therefore subject of this desk study.
- 1.1.2 The upscaling of offshore wind power development is an important part of the Energy Agreement for Sustainable Growth (Energieakkoord voor Duurzame Groei) in 2013. In the Climate Agreement (Klimaatbesluit) (2019) and the Coalition Agreement (Coalitie-akkoord) (2021) the previously set out policy was continued and a new roadmap for offshore wind power was created. These plans were announced by the Dutch cabinet in September 2022 with the end goal being a carbon-free energy supply in 2050. The roadmap 2030 outlines the further development of offshore wind energy for the period up to 2031 (indication). This should provide a capacity of approximately 21 GW, providing 16% of all energy in the Netherlands and 75% of the current electricity consumption<sup>1</sup>.
- 1.1.3 The Dutch Government has developed a systematic framework under which offshore wind farm zones are designated. Any location outside these wind farm zones is not eligible to receive a permit. Within the designated wind farm zones, the government selects the specific sites where wind farms can be constructed using a so-called Wind Farm Site Decision ('Kavelbesluit'). This contains conditions for building and operating a wind farm on a specific site. The Dutch Government provides all relevant site data and Dutch transmission system operator TenneT is responsible for grid connection. Winners of the site development tenders will be granted a permit to build a wind farm according to the Offshore Wind Energy Act (Wet Windenergie op zee) and will be offered a grid connection to the mainland. The Ministry provides site data, which can be used for the preparation of bids for these tenders. This system is expected to contribute to cost savings and promote the development of offshore wind.
- 1.1.4 The Netherlands Enterprise Agency has been requested to prepare and collect all site data required for commercial developers to prepare a competitive bid. As part of the future Permit Call for Tender document(s), the participants will receive information packages in which detailed information about the offshore site is included. Detailed information on the subsurface and (potential) archaeological remains is part of this information package.
- 1.1.5 This archaeological desk assessment and report is part of this information package and has been carried out in accordance with the latest version of the Dutch Quality Standard (KNA 4.1) for archaeological research.

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<sup>1</sup> <https://www.rijksoverheid.nl/onderwerpen/duurzame-energie/windenergie-op-zee>

## 1.2 Definition and boundaries of the research area and consequences of future use (LS01)

### Site and study area

1.2.1 The Nederwiek Windfarm zone (WFZ) consists of two separated areas which are located on the most western part of the Dutch Exclusive Economic Zone (EEZ), adjacent to the UK EEZ (see figure 1). The research areas, which lie approximately 100 km off the coast of Texel have a combined surface of 947 km<sup>2</sup> (North: 674 km<sup>2</sup> and South: 273 km<sup>2</sup>). The study area of this assessment will incorporate the full extent of the WFZ area, plus an extended 500 m area surrounding the WFZ. The Nederwiek Noord and Zuid areas are adjacent to two windfarm zones in the British EEZ, Norfolk Boreas<sup>2</sup> and Norfolk Vanguard to the west, and other planned Dutch zones to the east, among those IJmuiden Ver<sup>3</sup> (see figure 2).

### Future use

1.2.2 The planned constructions (the installation of wind turbines and cables) are expected to have a direct impact on the seabed. Foundations for individual turbines need to be constructed on, and under the seabed, and trenches made for infield connection cables, which may have an effect on archaeological sites and other relics. In the long term the turbines may lead to changes in the seabed morphology due to change in tidal currents. This in turn may cause changes in sandbars and sediments covering shipwrecks and other objects on the seafloor, exposing them to erosion.<sup>4</sup>

## 1.3 Previous research

1.3.1 Several desk-studies have been carried out that partially overlap with the research areas:

Archis 3 zaak-ID number	Year	Toponiem	Type of investigation	Report Published	Archaeological contractor
4562271100	2017	Continental shelf block K11	Desktop assessment	Van den Brenk/van Lil 2018	Periplus Archeomare
4894112100	2020	Continental shelf block Q02	Desktop assessment	Forthcoming?	Transect
5091963100	2020	Continental shelf block K11	Desktop assessment	Forthcoming?	Trident Archeologie
5144645100	2021	Continental Plat bloc Q04	Desktop assessment	Forthcoming?	Periplus Archeomare
5283511100	2022	Continental shelf block P11	Desktop assessment	Forthcoming	Periplus Archeomare

*Table 1 list of previous archaeological research within the Nederwiek area, registered in Archis.*

<sup>2</sup> Mellett 2019.

<sup>3</sup> Lil, van den Brenk, Cassee 2021.

<sup>4</sup> For further discussion on the potential archaeological impact of these constructions, see for instance, Waldus & Muller 2020.

1.3.2 Of these only the first has provided so far, an assessment of the archaeological potential (see table 1 and figure 3). Of the nearby areas the published reports on Norfolk Boreas and IJmuiden Ver – see footnote 2 and 3 - are of particular interest and have been included in this study.

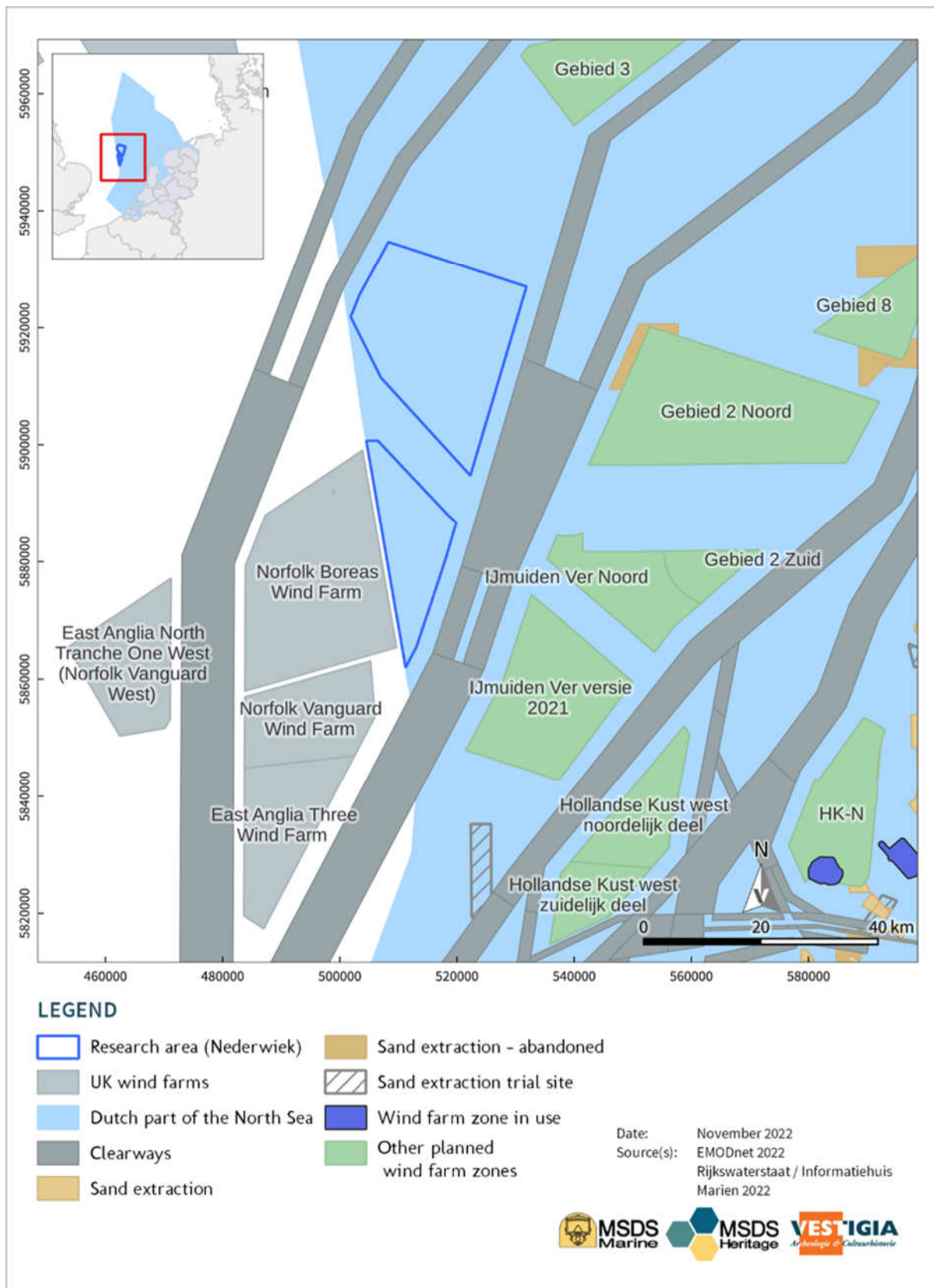


Figure 2 Research areas Nederwiek Noord (North) and Zuid (South) and other windfarm zones and sand extraction areas nearby. The indicated clearways are a combination of clearways and IMO ships routes.

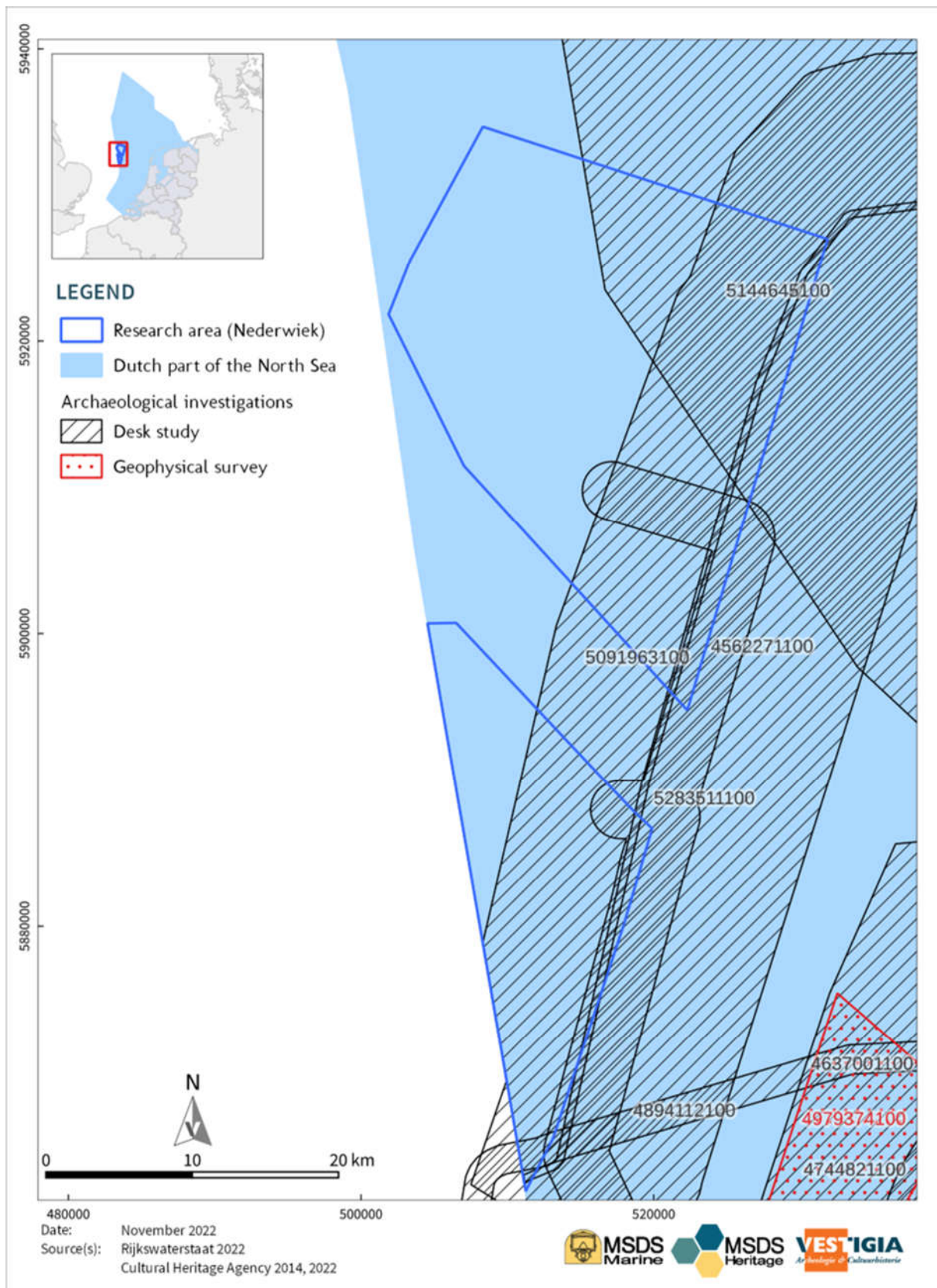


Figure 3 Research areas Nederwiek Noord (North) and Zuid (South) and previous archaeological research areas, according to Archis3 (February 2023).

## 2.0 Legal framework

- 2.0.1 In 1992, the Netherlands signed the European Convention on the Protection of the Archaeological Heritage, also called the ‘Valletta Convention’. Since then, the premise of (national and local) policy is that archaeological values should be taken into account in any and all decision making regarding spatial planning in the Netherlands. The basis of the Valletta Convention is that all traces of past human societies, which are preserved in the subsoil (i.e., the archaeological record), should be protected and managed as common European heritage. In order to do so:
- archaeological values should be considered from the outset in spatial planning;
  - archaeological remains should be preserved within the subsoil as much as possible (preservation in situ); and
  - initiators of soil disturbing activities can be held accountable for the costs of archaeological research if preservation in situ is not possible. This is the ‘developer pays’ principle.
- 2.0.2 In order to preserve the archaeological record for posterity and ensure that it can still be consulted in the future, archaeological heritage management (AMZ: Archeologische Monumentenzorg) aims at preserving, protecting, and managing the most valuable or representative archaeological remains. Planned activities, such as the installation of wind turbines and cables in the North Sea, may affect the archaeological values present. If effects on possible remains are expected, there is a statutory obligation under the Dutch Heritage Act (Erfgoedwet 2016) and Planning Act (Wro, Omgevingswet 2023) to conduct archaeological research. This principle and process are also outlined in the Water Act (Waterbesluit) and in the Act on Offshore Wind Energy (Wet Windenergie op zee).
- 2.0.3 *In situ* preservation is the starting point and preferred outcome of the AMZ process. Only if no other options remain, should an archaeological site be excavated. This is not only a task for archaeologists, but also and mainly for government bodies and all those who are responsible for spatial planning and development in the Netherlands. In the Netherlands, most spatial planning takes place at a municipal level. Most parts of the seafloor of the North Sea however, fall outside municipal or provincial boundaries. Here the Minister of Infrastructure and Watermanagement (I&W: Infrastructuur en Waterstaat) has the role of competent authority, Rijkswaterstaat (the executive agency of the Ministry of Infrastructure and Waterstaat) fulfils the role with regard to archaeological heritage management. This is the case in all projects situated in the Dutch part of the North Sea, including projects initiated by Rijkswaterstaat itself. How Rijkswaterstaat executes this role, is laid down in an agreement between Rijkswaterstaat and the Cultural Heritage Agency (RCE: Rijksdienst voor het Cultureel Erfgoed). The Cultural Heritage Agency acts as the archaeological consultant for Rijkswaterstaat.
- 2.0.4 The archaeological desktop assessment for the Nederwiek area is the first part of the ‘AMZ-cycle,’ a set sequence of steps and decisions within archaeological heritage management protocols accepted in the Netherlands. The procedure is embedded in the Quality Standard for Dutch Archaeology (KNA) as the mandatory workflow for archaeologists.

## 3.0 Objectives and Research Context

### 3.1 Objectives

- 3.1.1 The purpose of an archaeological desk-based assessment is to specify the known and potential archaeological resource within a specified area, or site. More in detail, this study is to establish whether archaeological remains are, or are likely to be, present within the windfarm zones Nederwiek Noord en Zuid, and whether these (possible) remains could be affected by the construction of wind turbines and cable networks in both these areas. If possible, this assessment should also provide further insight into the archaeological value, expressed in the extent of sites, their state of preservation, and scientific value. In these cases, the report will make recommendations regarding subsequent steps and follow-up actions to protect identified and expected archaeological remains in the areas.
- 3.1.2 The sequence of steps and decisions within archaeological heritage management in the Netherlands are defined in the archaeological management procedure (AMZ-cycle) and is embedded in the Dutch Quality Standard for Archaeology (KNA) Waterbodems 4.1, the mandatory workflow for archaeologists.

### 3.2 Research Questions and additional tasks

- 3.2.1 In general, for any archaeological desktop study, the following research questions are applicable:
- Are there any known/identified archaeological values, meaning sites or deposits of archaeological significance, present within the research area(s)? If so, what is the nature, extent, location and dating of these values?
  - Are there, in addition to any known values, archaeological remains to be expected? If so, what is the nature, extent location and date of the archaeological remains?
  - Will the proposed activities in the wind farm zones affect identified or expected archaeological values? If so, can the impact on archaeological assets be prevented or mitigated by planning adaptation?
  - If archaeological values cannot be saved: What kind of further research is needed to determine the presence of archaeological values and their size, location, type and date in such extent to make a considered decision on protection or mitigation?
- 3.2.2 In addition, the following tasks have been defined by RVO for Phase I of this series of assessments:
- **1:** Assess whether the following remains are likely to be present at the WFZ
    - **1A:** Archaeological remains (e.g., plane and shipwrecks and related maritime heritage)
    - **1B:** Potential preserved prehistoric landscapes
  - **2:** If 1a and/or 1b are present, discuss the known information (location, size, and dating) of these remains and landscapes
  - **3:** If 1a is present: assess possible risks of offshore wind farm installation to the archaeological remains
  - **4:** Determine whether further archaeological assessments should be carried out and make a recommendation on the scope of work for future investigations

- **5:** Specify recommendations for any activity carried out in the wind farm zone (including site investigations or monitoring activities, installation activities, and operational activities) that may affect the archaeological aspects. Be specific what further archaeological investigations or mitigation is required during following phases of development of the windfarms, and or potential additional research is needed in course of development of windfarms during consecutive phases of development (by builder) and for Phase II, III and IV (in this scope).
- 3.2.3 For this Vestigia/MSDS makes use of publicly available data, lessons learned from previous studies and of the geological desk study (if available). Contractor should participate in a workshop with the contractor for the geological desk study to discuss anticipated findings in the wind farm Area. This is meant to improve integration between these studies. In case there is no contractor for the geological desk study and no geological desk study is available (this is expected for the Search Areas other than Nederwiek, Lagelander and Doordewind), then participation in a workshop is not required.

### 3.3 Existing archaeological research and management frameworks

- 3.3.1 Compared to the state of research and information on landscape development and prehistoric occupation in Pleistocene and Early Holocene on land, our knowledge for the North Sea basin is still limited. This gap had been recognized in the National Research Agenda for Archaeology (NOaA, see the relevant chapter on Early Prehistory) and by the Dutch Cultural Heritage Agency (RCE) itself, resulting in 2009 in the publication of the first version of the 'North sea Prehistory Research and Management Framework' (NSPRMF). Sites and their surrounding phenomena that are located in paleo-landscape contexts that have not or hardly been investigated, are therefore by definition of major information value.
- 3.3.2 In 2019 the NSPRMF agenda was reassessed on the basis of the latest research results and other developments in the last ten years. The conclusion reached was that the themes and topics of the NSPRMF 2009 research agenda remain topical and relevant, also in respect to international programs (see table 2). Opportunities to collect new data to increase scientific insights into these themes and topics continue to exist. Hence, there seemed to be no reason to consider important changes, as priorities have not yet been met to such an extent that no further attention on these is needed.
- 3.3.3 At the same time, major steps have been taken with regard to some issues, notably data sharing, collaboration with private collectors, and public outreach. These steps are important, and the related efforts should be maintained.
- 3.3.4 NSPRMF 2019 concludes with a number of recommendations, meant to serve as guides for further discussion and for targeting actions in the near future. These recommendations are grouped under three headings:
- Contents (the subject of investigation);
  - Process (strategies, methods, techniques); and
  - Stakeholders (regulations, risk assessment, communication).

3.3.5 As these are also relevant for the AMZ-process in all new Windfarm zones, and indeed Nederwiek Noord and Zuid, these have been stated below.

Theme	Topics
A. Stratigraphic and chronological frameworks	A.1: Lithostratigraphic classification and chronological anchoring A.2: Sea level change and glacio-isostasy A.3: Survival of deposits of archaeological significance A.4: Biostratigraphies and absolute dating
B. Palaeogeography and environment	B.1: Middle/Late Pleistocene reshaping of topography and river drainage B.2: Development of the Weichselian/Devensian landscape B.3: Palaeogeographic evolution after the Last Glacial Maximum (LGM) B.4: Quaternary palaeoecology
C. Global perspectives on intercontinental hominin dispersals	C.1: North Sea coastal dynamics and human uses of the coastal zone C.2: Pleistocene North Sea level oscillations and population of islands
D. Pleistocene hominin colonisations of northern Europe	D.1: Early human exploitation strategies in changing environments D.2: Natural barriers for hominin expansion
E. Reoccupation of northern Europe after the Last Glacial Maximum (LGM)	E.1: Post-LGM occupation flux E.2: Occupation strategies
F. Post-glacial land use dynamics in the context of a changing landscape	F.1: Changing landscape structure F.2: Behavioural diversity among hunter-gatherers F.3: Maritime archaeologies of the North Sea
G. Representation of prehistoric hunter-gatherer communities and lifeways	G.1: Spatial perspectives on North Sea palaeolandscapes G.2: The distributional nature of early hominin communities G.3: Enculturated hunter-gatherer landscapes

*Table 2 research themes and topics in NSPRMF 2009 (reconfirmed in 2019). Source: Peeters e.a. 2009<sup>5</sup>; Peeters e.a. 2019<sup>6</sup>.*

### Contents

- 3.3.6 A. Define the meaning of a ‘good data point’ to involve accurately georeferenced results of a consistently conducted analysis of geological, paleo-environmental, or archaeological observations/recordings of which the archaeological taphonomy and relevance is explicitly made clear.
- 3.3.7 B. Accept the possibility of loss of information due to methodological and technological limitations.
- 3.3.8 C. Do not restrict paleo-landscape mapping to land-surface mapping. Instead, include paleo-environmental analysis in order to provide data for contextual models, which are crucial for the archaeological understanding of prehistoric human-environment relationships.
- 3.3.9 D. Support efforts to register and contextualize ex situ (stray) finds to increase their information value for the assessment of offshore potential and support of decision making.

### Process

- 3.3.10 A. Develop a clear strategy/work plan at the project level that covers the entire archaeological process (including assessment for archaeological potential) and that makes clear choices with respect to which questions are to be answered, and by means of which technology, for development areas where chances of follow-up are realistic.

<sup>5</sup> Peeters, Murphy & Flemming 2009.

<sup>6</sup> Peeters, Amkreutz, Cohen en Hijma 2019 (NAR 63).

- 3.3.11 B. Guarantee the reprocessing of data for the updating of spatial models in cases where a follow-up to ground-truth archaeological potential is unrealistic and put in place funding for this reprocessing.
- 3.3.12 C. Involve experts at the front end of any project, in order to anticipate the many uncertainties underlying the modelling, surveying, and sampling of submerged prehistoric archaeology and landscapes; the interpretation of data; and the development of strategies for sampling, dating, and sub-bottom profiling.
- 3.3.13 D. Stimulate (and co-finance) methodological experimentation at all stages of project execution between initial desktop study and final reporting.
- 3.3.14 E. Consistently evaluate projects in relation to locations of comparable geographical and archaeological potential, in order to support methodological development; set up an expert group for this purpose.

### Stakeholders

- 3.3.15 A. Ensure that geoarchaeological spatial models about the potential preservation of prehistoric remains and landscapes (i.e., potential for collecting good data points) express differences in spatial resolution (resulting from data availability) and are constantly updated using the latest insights. Make only the most up-to-date maps available to stakeholders, via a single national portal (e.g., the cultural heritage agency), and kept up to date on international portals (e.g., EMODnet).
- 3.3.16 B. Define (parameters of) 'archaeological potential' and define by which means potential can be assessed with regard to submerged prehistory and prehistoric landscapes.
- 3.3.17 C. Refrain from archaeological potential assessment of a development area where chances of any follow-up have already been deemed excluded or unrealistic. Instead, focus on geological mapping and paleo-environmental mapping for generic knowledge purposes, including archaeological purposes, such as the contextualisation of accidental finds.
- 3.3.18 D. Accept loss of information due to restrictions imposed by technology, logistics, and safety, in addition to those imposed by time and money.
- 3.3.19 E. Work towards a principle of financial reallocation in relation to developments where a reasonable assessment of archaeological potential and possible follow-up for research is excluded, whereby the developer is required to put aside a sum of money equivalent to what the developer would have to have paid had there been follow-up research and allow this money to be used for offshore archaeological research elsewhere, so as to broaden the basis for future decision-making.
- 3.3.20 F. Emphasize the potential attractiveness of submerged archaeology in public outreach and in contributing to the societal responsibility and role of the industry involved.

## 4.0 Method (s) of investigation

- 4.0.1 This desktop assessment has been carried out in accordance with the Dutch Quality Standard for Archaeology (KNA), Protocol 4002 and the points of attention and specifications relating to maritime desktop studies. In this report, these are referred to as LS01wb, LS02wb etc. The report itself falls under specification LS06wb.
- 4.0.2 Vestigia/MSDS has made use of publicly available data, lessons learned from previous studies and of a first version of the geological desk study by TNO/Deltares. Vestigia/MSDS has participated in a workshop together with TNO/Deltares to discuss anticipated findings in the wind farm Area. This was meant to improve integration between these studies.
- 4.0.3 To fulfil the main objectives and answer the research questions as stated under paragraph 3.1 and 3.2, chapter 5 has been divided into the following components:
- 5.1 Definition of the study area and existing information on future use in relation to (possible) archaeological remains (LS01wb);
  - 5.2 Definition of current usage and general situation of the of the seafloor in the study area (LS02wb)
  - 5.3 Description of the historical development and information on (possible) disturbances of archaeological remains (LS03wb);
  - 5.4 Description of the geological development in relation to layers of possible archaeological interest (LS04wb);
  - 5.5 Inventory of registered archaeological sites and objects on the seafloor (LS04wb); and
  - 5.6 Specified model of archaeological expectancy (LS05).
- 4.0.4 The results will be summarised in chapter 6, and the research questions answered accordingly. On the basis of these, recommendations will be made in chapter 7 for further identification, validation, and mitigation of archaeological sites (and/or objects) and for further research of relevant geological layers or landscape units.

## 4.1 Sources

- 4.1.1 This study has been based on a large number of different sources, some of these can be publicly accessed, others have been made available by the specific organizations. The geological assessment and modelling have been based, in part, on non-published information shared by TNO-Deltares, for which Vestigia and MSDS Marine are very grateful.
- 4.1.2 Primary data from the following sources have been used in this study:
- ARCHIS3 RCE
  - National Contact Number database RWS (Rijkswaterstaat Zee & Delta, SONARREG)
  - Object database of the Hydrographic Service of the Royal Netherlands Navy
  - United Kingdom Hydrographic Ordnance (UKHO)
  - MACHU RCE
  - MASS RCE
  - Loss Register Aircraft Recovery group 1939-1945 (NFLA)
  - Geological maps (See literature list at end of report)

- Geological publications (See literature list at end of report)
- Annex 5 Scope of Work Archaeological Assessment for various wind farm zones, RVO 2022
- Annex 6 Starting points and assumptions Archaeological Assessment for various wind farm zones, RVO 2022
- TNO-Deltares, geological (DINO) borehole data and maps

4.1.3 Secondary data, websites and literature are listed at the end of this report.

4.1.4 The chronological periods referred to are listed in Section 0 (Appendix 1).

## 4.2 Methods for the assessment of submerged prehistoric landscapes

4.2.1 The report investigates the potential for submerged prehistoric remains to be present within the site. Existing geological data, findspots of prehistoric material (including archaeological evidence and faunal remains, for example) and key studies are important sources to establishing this potential.

4.2.2 The assessment of submerged prehistoric remains seeks to identify periods in which the site was dry land, and thus habitable, and periods in which the area lay under ice sheets or water masses, rendering the area inhabitable. Different geological formations are also associated with differing environmental conditions, and thus different archaeological potential and the report therefore investigates the Quaternary sequence within the site. The assessment also seeks to identify the previous environmental characteristics of the site and study area (e.g., marine, terrestrial, lacustrine, fluvial, marsh, riverine etc.) at different times during the Quaternary period, as this is key to understanding paleolandscape and paleoenvironmental potential, and also to how past human populations may have used the areas. Determining the potential for remains to survive is equally important. This involves consideration of the current geological makeup of the area, along with the effects of erosion and other geological forces, following the succession of glaciations and marine transgressions that have shaped the area.

## 4.3 Methods for the assessment of maritime and aviation remains

4.3.1 In order to provide an assessment of the known and potential maritime and aviation archaeological resources within the application area, records of known wrecks, recorded losses and casualty records, named locations, isolated finds and seabed features were collated. Searches of records held in the sources described above (Section 4.1) were undertaken and all details for the area recorded. The historical use of the area and shipping channels were also reviewed (Section 5.4) to provide a broad indication of maritime activity within the vicinity of the study area.

4.3.2 Once collected, all the data records were loaded into a project GIS to enable analysis and comparison between datasets. In addition, gazetteers of all the recorded maritime and prehistoric archaeological sites, features and materials were produced (see Section 5.0).

## 5.0 Results

### 5.1 Definition of the study area and existing information on future use in relation to (possible) archaeological remains (LS01wb)

5.1.1 This information can be found under Section 1.2.

### 5.2 Definition of current usage and general situation of the seafloor in the study area (LS02wb)

5.2.1 Water depth within the boundaries of the research area varies from 24.5 m LAT on top of the large north-south oriented dune like structures in the northern part of the Nederwiek area, to about 34.0-34.5 m LAT in the lowest parts of both the northern and southern parts of Nederwiek (see figure 4). The largest scale structures visible in the area are the aforementioned north-south orientated ridges. They vary in width from 1 to 7 km. The height of these structures varies between 4 and 8 m. In the southern part of the Nederwiek area, smaller scale sand waves are visible. These are broadly east-west orientated and are characterized by a distance between the crests of 350 to 500 m, and an average toe-to-crest height of 2 m.

5.2.2 Mega-current ripples, expected to have developed on top of the sand waves, cannot be distinguished in the available bathymetry data because of the cell size of the available grid data (20 m in Nederwiek North, and 20 to 70 m in Nederwiek South).

5.2.3 Other than existing cables and pipelines (see next paragraph), there is presently no commercial activity within the research area (apart from fishing).<sup>7</sup> The seabed is characterized by north-south orientated linear ridges and sand waves. These sand waves are mobile and are displacing in the dominant residual current. Along the Dutch coast the mobility increases from south to north from 3,5 m/y to c. 18 m/y near the island of Texel<sup>8</sup>.

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<sup>7</sup> Oil and Gas exploitation platforms and wells have been abandoned.

<sup>8</sup> Laban et al, 2022, 179.

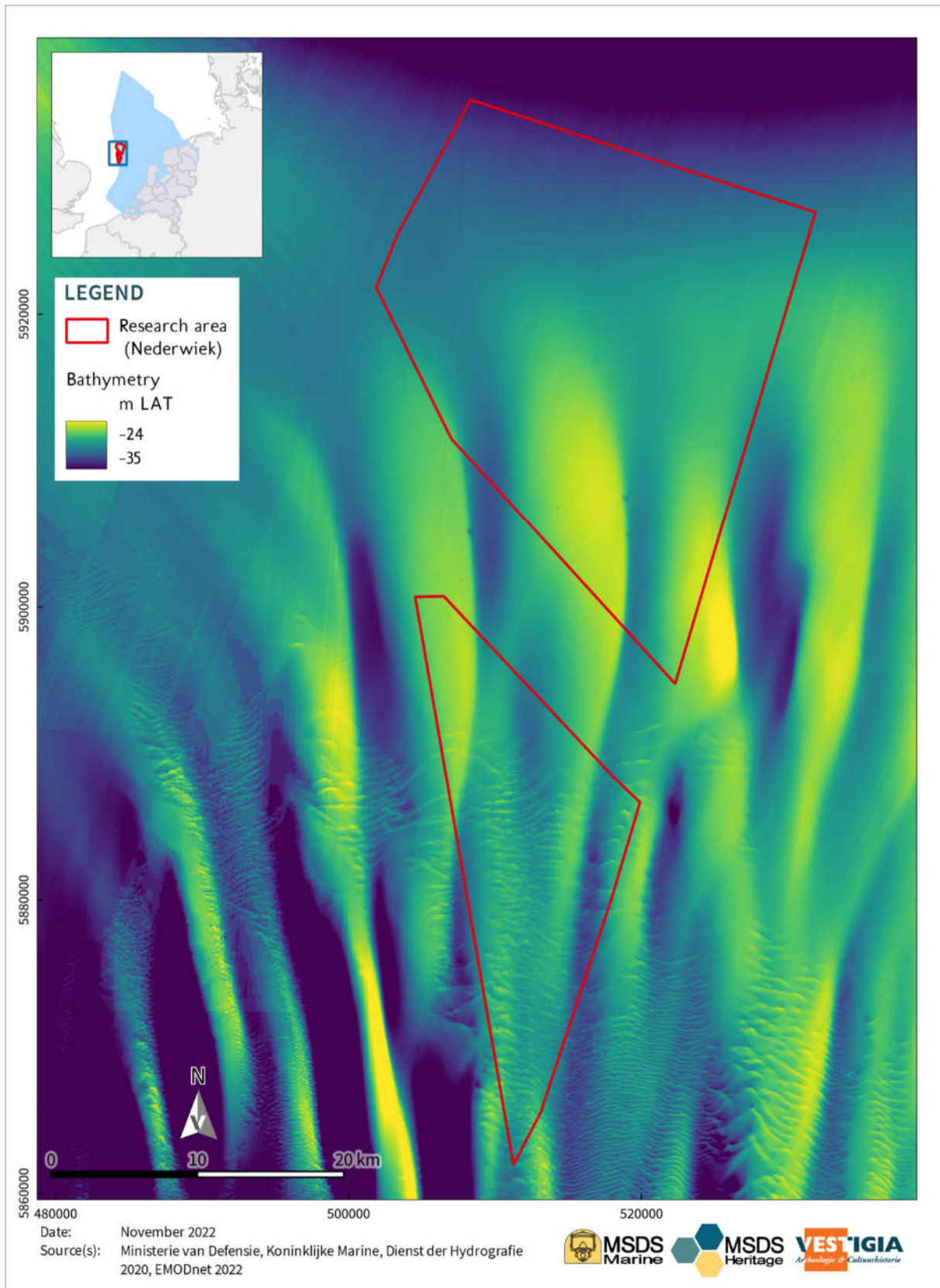


Figure 4 General bathymetry of the seabed in and around the research area.

## 5.3 General description of the historical development and information on (possible) disturbances of archaeological remains (LS03wb)

### Prehistory

- 5.3.1 The relevant part of the development of the North Sea area, with regard to the research area and the geological units described below, starts with the Eemian interglacial (130.000-115.000 years ago). At that time the area was transgressed by the sea. The waters of the English Channel and the North Sea were connected, and the mean sea level was a few meters higher than at present. Late in the Eemian and early in the succeeding Weichselian, the climate began to change; the sea level dropped and the research area became part of the deltaic plain of the Rhine (the 'Brown Bank delta plain'), which developed in a brackish-water lagoon. Recent analysis of sediments from the adjacent Norfolk Boreas Offshore Wind Farm (OWF) has shown that the Upper Brown Bank deposits were laid down in an outer estuarine environment which formed part of a shallow embayment between  $83.2 \pm 9.5$  and  $69.8 \pm 7.7$  ka (during MIS 5a – 4)<sup>9</sup>. As the sea level continued to fall (from about 25 to eventually approximately 90 meters below the present level), the character of this lagoon changed from a brackish-water to a fresh water setting, and by c. 57 ka (killoannum) sea levels had fallen sufficiently to expose the southern North Sea<sup>9</sup>. The Rivers (Rhine, Meuse, Scheldt and Thames) began to incise which led to erosion of large parts of the Brown Bank deposits.
- 5.3.2 During the late Weichselian, part of the British ice sheet seems to have entered the Dutch sector of the North Sea, flowing southward and eastward roughly between the current east coast of Britain and the Dogger Bank. During the last glacial maximum, the sea level dropped to 130 m below the present level. After this last glaciation, which ended around 11650 BP, the sea level rose rapidly as the glaciers and ice sheets melted due to rising temperatures. Initially this was noticeable due to a rise in groundwater levels which led to peat formation. Extensive channel systems dating to the Late Devensian ( $10435 \pm 66$  BP; 12550-12080 cal. BP) have been identified in the Norfolk Boreas OWF and may be present within the site.<sup>10</sup> Peat formation appears to have been instigated around the start of the Holocene,  $9992 \pm 51$  BP (11710-11260 cal. BP) continuing for approximately 700 years<sup>9</sup>. The North Sea basin gradually filled up. The higher (ground) water level also led to higher flood levels which caused overbank deposits to increase in thickness.
- 5.3.3 "The marsh landscape was drowned by the ongoing sea level rise and intertidal and shallow subtidal sediments were deposited during the Boreal and Atlantic in large parts of the North Sea. [...] In the Dutch sector, south-east of the Doggerbank in water depth of c. 45 m to 50 m – MSL a tidal basin occurs in which brackish marine clays have been deposited (Oele, 1969)." <sup>11</sup>
- 5.3.4 So, during the Pleistocene, large areas of the North Sea were dry land and characterized by extensive river systems with wide river channels and river planes, providing rich habitats for large herds of animals<sup>12</sup>. The coastal lowlands supported abundant game for hunting, and coastal and shallow marine waters offered opportunities for fishing. The thousands of mammal

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<sup>9</sup> Mellett (2019)

<sup>10</sup> Channel systems indicated on figure 20 have been provisionally identified by TNO-Deltares in the geological study.

<sup>11</sup> Laban & Van der meer 2022.

<sup>12</sup> Hublin et al. 2009, 777.

remains retrieved by modern fishing, dredging and sand extraction are testament to the fact that these landscapes were favourable to human occupation by hunter-gatherer groups<sup>13</sup>. Holocene sea level rising also caused increasing groundwater levels, resulting in the development of marshes in which peat was formed<sup>14</sup>. This marsh landscape was later drowned by the ongoing sea level rise and intertidal and shallow subtidal sediments (clay laminated with silt, shells and organic matter) were deposited. This fundamental change in physical features of fluvial systems and the location of coastlines deprives access to pre-existing resources resulted in migration of the last human occupants towards higher ground.

- 5.3.5 Around 6000 years ago the North Sea Basin was almost completely taken over by the sea (see figure 5), resulting in a situation where early Holocene and pre-Holocene deposits could be reworked by tidal currents. With ongoing sea level rise, remnants of these early Holocene and older deposits got covered by sand banks and sand waves.
- 5.3.6 The remains of the Pleistocene and early Holocene landscape in the Nederwiek wind farm zone are now located at a depth of about 35 to 40 meters below present day sea level. This means that around the transition from Late Paleolithic to early Mesolithic, most of the area in and around the wind farm zone had been submerged by the expanding North Sea; only the highest parts of the landscape would still be habitable during the early Mesolithic.

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<sup>13</sup> Heteren et al. 2014, 31.

<sup>14</sup> Laban et al. 2022, 197.

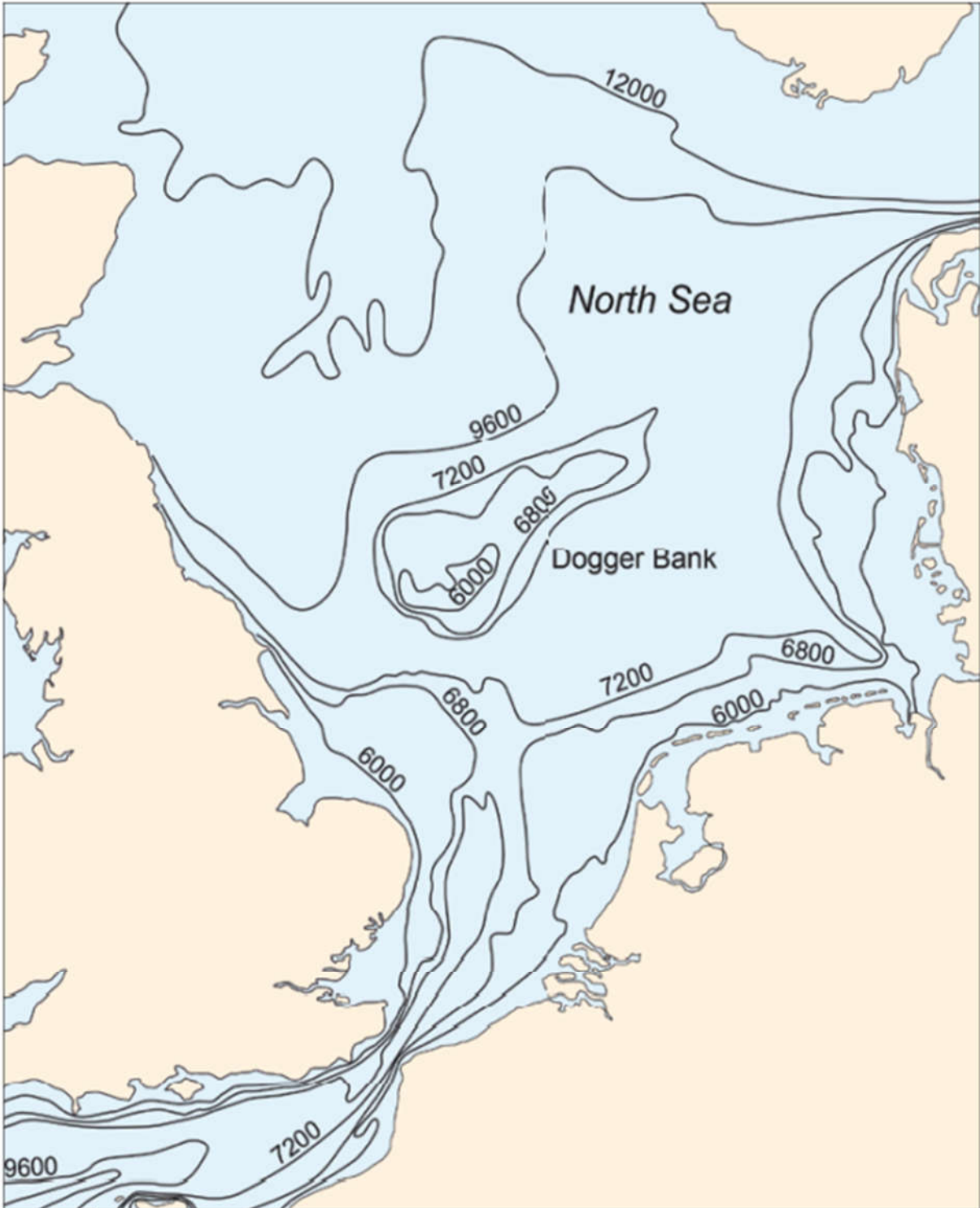
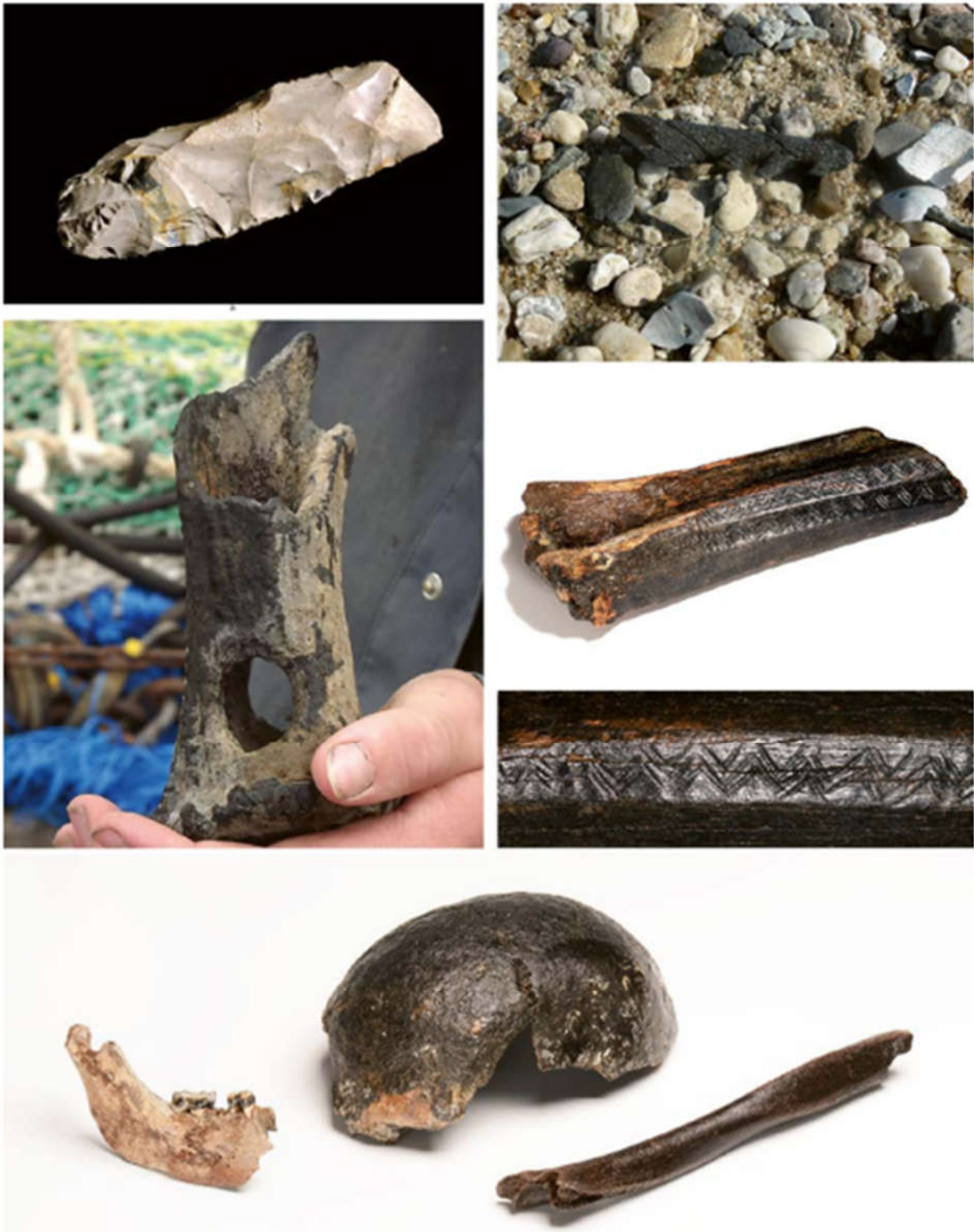


Figure 5 Receding landmass and the process of drowning of the North Sea in years before present (BP). Source RCE/Deltares



*Figure 6 Reconstruction of the receding coastlines in the North Sea basin during the Late Pleistocene and Early Holocene periods, featuring Doggerland. Source: McNulty & Cookson in National Geographic Magazine 2018.*

5.3.7 One such example of an elevated area is the Dogger Bank in the North of the Dutch continental Shelf, which is well known for being particularly bountiful in Mesolithic artifacts regularly found in the nets of fishermen (see figure 6). The Southern Bight of the North Sea has been a rich source of remains of fossil land mammals and Pleistocene and Early Holocene artifacts for more than 150 years, with the vast majority as a by-catch in the nets of beam trawlers. Other sources include expeditions aimed at collecting said remains by intensively dredging at locations recorded by chance finds from commercial fishing activities and large quantities of extracted fluvial sediments deposited on the beaches of artificially and reinforced coastlines in the Netherlands. Examples of such finds are shown in figure 7.



*Figure 7 Early prehistoric finds and human remains from the North Sea found by fishermen as well as beach crawlers. Photos: RCE.*

5.3.8 As said, By 6000 BP the entire North Sea basin was fully submerged and now only influenced by tidal currents, reworking the early Holocene end pre-Holocene deposits. The tidal waves and currents changed the morphology of the seafloor into linear sand banks and sand waves.

## 5.4 Historic shipping and sea lanes<sup>15</sup>

- 5.4.1 Following the melting of the ice sheets, and the gradual filling of the North Sea basin, people had to look for different means of transport to move between the different regions around the North sea. Close contacts never ceased, as a number of islands surviving with the rising sea made it easier to stay connected throughout the Mesolithic and the beginning of the Neolithic. Long distance exchange of exotic objects and artefacts, like pottery, jewellery, gold adornments, bronze weapons and tools etc. demonstrate these contacts continued throughout the Neolithic and Bronze age. Between c. 1500 and 800 cal BC bronze became more widely available as a result of local smelting and recasting, resulting in shrinking of long distance journeys. During the Iron Age, further decrease in demand for copper and tin, due to the wider availability and better usability of iron ore, led to the collapse of the long standing exchange systems around the North Sea.
- 5.4.2 From the beginning of the first century BC the levels of exchange around the North Sea basin noticeably increased following the expansion of the Roman empire and the conquest of subsequently Northern Gaul, the Rhine estuary and Britain. The Roman period signifies a period of high levels of trade and movement of people, and the Roman military and economy created a high demand for food and equipment on both sides of the North Sea.
- 5.4.3 The collapse of the Roman Empire resulted in a new decline in movement, trade, and exchange in the lands around the North Sea, although contacts never ceased to exist. From the sixth century AD onwards a resurgence in trade and exchange can be noticed, including the rise of the Frisians as the major trading factor in the region. In the late eight, ninth and tenth centuries their dominant role is taken over by the Vikings. Early state formation and urbanization in the tenth century created new demands for trade goods and products around the North Sea Basin. The Hanseatic League became a dominant trading power from the 13th century onward, many emerging towns around the North Sea joining this organization.
- 5.4.4 From the late middle ages the North sea can be seen as the one of the busiest shipping routes in the world. As a side effect international trade and other mercantile maritime activities attracted pirates, mainly active in the area from the 16<sup>th</sup> to the early 18<sup>th</sup> century. In the 19<sup>th</sup>, but especially in the 20<sup>th</sup> century, the wars between the European powers were partly fought on the North Sea. Apart from the accidental losses due to weather and other natural causes, casualties of war have resulted to a high concentration of shipwrecks and other archaeological remains on the sea floor of the North Sea.
- 5.4.5 Both Nederwiek areas are situated in the middle of the North Sea. On the basis of historic maps and other historic mentioning no special area of use as shipping lane(s), battlegrounds or specific rich fishing grounds can be pointed out. As the illustrations from the 17<sup>th</sup> and 18<sup>th</sup> centuries in figures 8 and 9 show both areas have neither been marked out specifically for shallows, obstacles, and water depths. Specific historic events that may have led to the deposition of wrecks in the Nederwiek areas are the 1<sup>st</sup> and 2<sup>nd</sup> World Wars, the four Anglo-Dutch wars from the middle of the 17<sup>th</sup> century until the second half of the 18<sup>th</sup> century, and the Napoleonic wars in the late 18<sup>th</sup> and early 19<sup>th</sup> century.

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<sup>15</sup> Largely based on van de Noort. 2011.

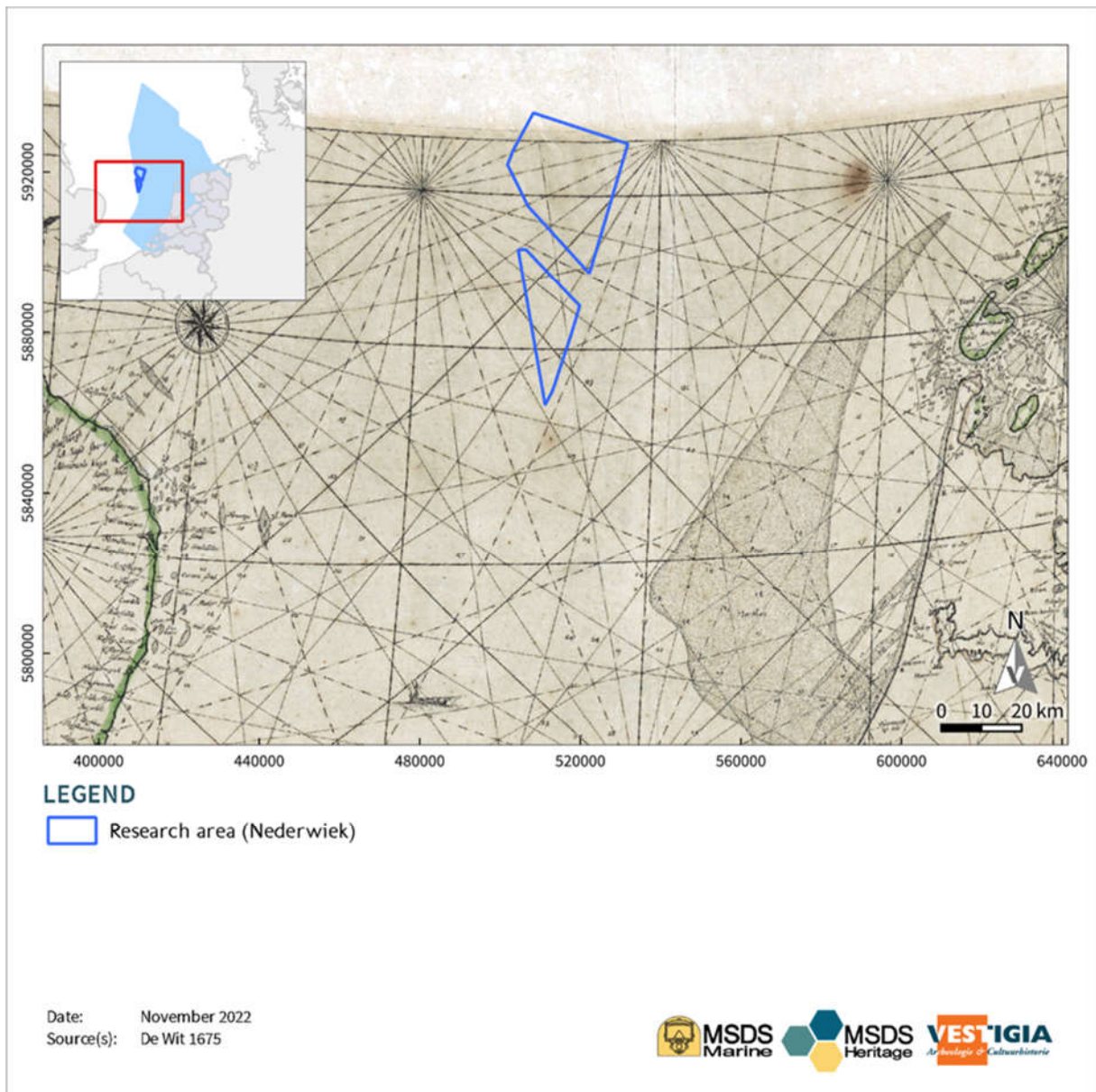


Figure 8 Historic map of the central North Sea by De Witt 1675, showing existing shallows and water depths.

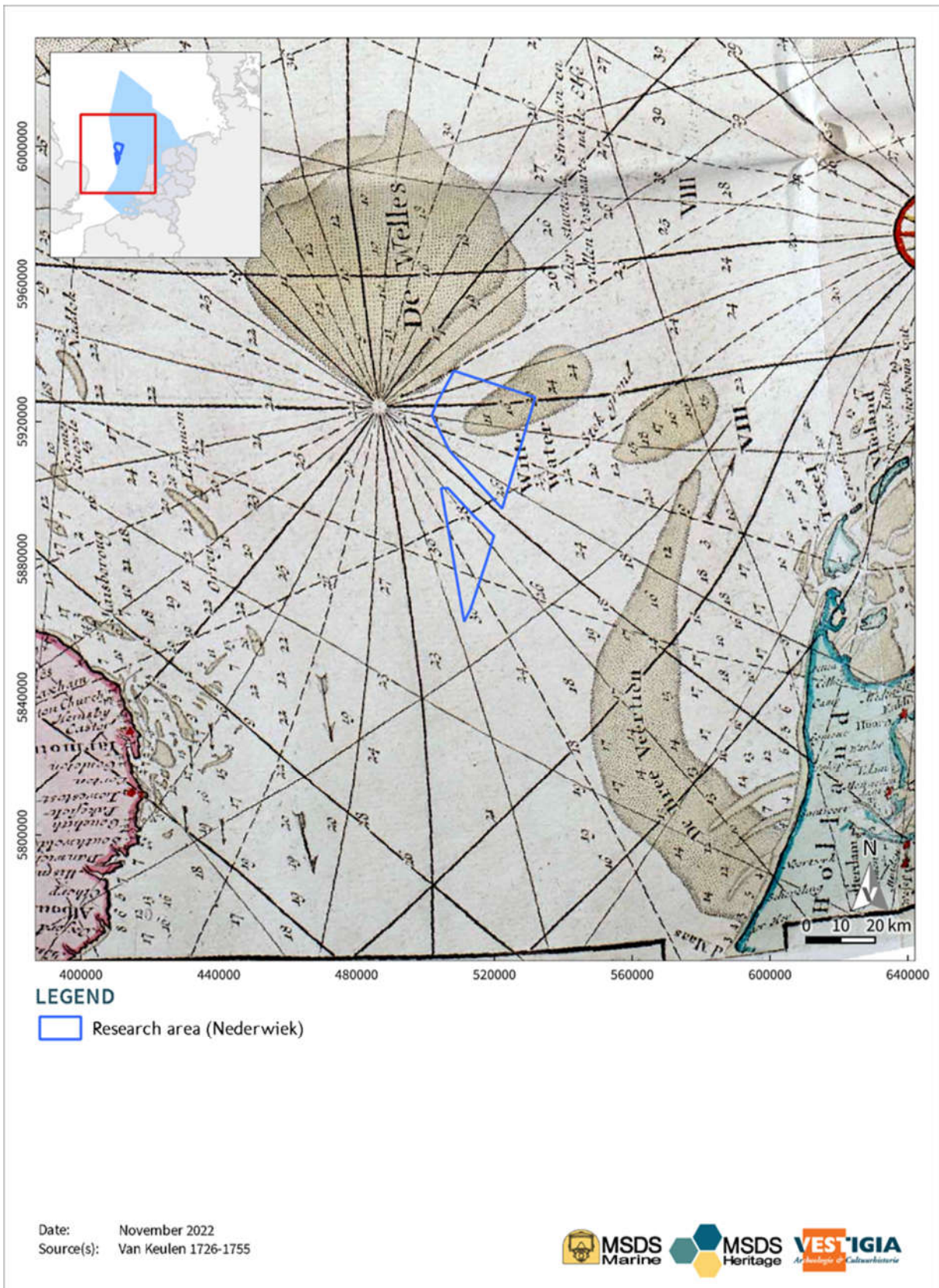


Figure 9 Historic map of the central North Sea area by Van Keulen 1726-1755, showing shallows, water depths and currents. Nederwiek North overlaps partly with one of these shallows

## 5.5 Recorded disturbances on or below the seafloor (LS03wb);

No large scale sand extraction activities have been recorded in the two areas. Small parts of the seabed have been disturbed by trenches, and sub-bottom coring for cables and pipelines and the installation of production platforms. The vertical position of these cables and pipelines is unknown, but it is assumed that most cables are laid at a depth less than 2 meters below the seabed. All locations are listed in table 3 and projected on figure 10a -10c on the basis of information provided by NCM, RWS and DINO-loket in November 2022.

Name	Infrastructure	Status	
K10-BP	Platform	Out of use	
K10-BW	Platform	Out of use	
K10-C	Platform	Removed	
K10-CC	Platform	Removed	
K10-V	Platform	Removed	
K11-FA-1	Platform	Removed	
K13-CP	Platform	Removed	
K13-CW	Platform	Removed	
K13-D	Platform	Removed	
K8-FA-1	Platform	In use	
K8-FA-1A	Platform	In use	
Sidetap K10-V	Sidetap	In use	
Sidetap K13-C	Sidetap	In use	
Sidetap K13-C#2	Sidetap	In use	

Number	Operator	Route	Status	Type
PL0004_PR	Wintershall Noordzee B.V.	K13-AP	Active	Gas 36-inch
PL0007_PR	Nederlandse Aardolie Maatschappij B.V.	-	Active	Gas 24-inch
PL0014_PR	Nederlandse Aardolie Maatschappij B.V.	K11-FA-1 to K8-FA-1	Abandoned	Gas 6.625-inch
PL0015_PR	Nederlandse Aardolie Maatschappij B.V.	K8-FA-2 to K8-FA-1	Active	Gas 10.75-inch
PL0017_HS	Wintershall Noordzee B.V.	K13-D to K13-C	Abandoned	Methanol 2-inch
PL0017_PR	Wintershall Noordzee B.V.	K13-D to K13-C	Abandoned	Gas 10-inch
PL0018_PR	Wintershall Noordzee B.V.	-	Abandoned	Gas 20-inch
PL0019_PR	Wintershall Noordzee B.V.	Sidetap K13C#2 to K13-AP of K13-AW	Abandoned	Gas 20-inch
PL0023_PR	Nederlandse Aardolie Maatschappij B.V.	K7-FA-1P to K8-FA-1	Active	Gas 18-inch
PL0027_HS	Wintershall Noordzee B.V.	K10-C to K10-B	Abandoned	Methanol 2-inch
PL0027_PR	Wintershall Noordzee B.V.	K10-C to K10-B	Abandoned	Gas 10-inch
PL0028_PR	Wintershall Noordzee B.V.	K10-B to K13-C	Abandoned	Gas 20-inch
PL0072_PR	Wintershall Noordzee B.V.	K13-CP of K13-CW to Sidetap K13C	Active	Gas 20-inch

PL0076_PR	Nederlandse Aardolie Maatschappij B.V.	K8-FA-2 to K8-FA-1	Active	Gas 10-inch
PL0098_PR	Wintershall Noordzee B.V.	-	Active	Gas 24-inch
PL0110_HS	Wintershall Noordzee B.V.	K10-V to K10-C	Abandoned	Methanol 2-inch
PL0110_PR	Wintershall Noordzee B.V.	K10-V to K10-C	Abandoned	Gas 10-inch
PL0111_HS	Wintershall Noordzee B.V.	K10-V to J6-A \ K13-A	Active	Methanol 2-inch
PL0111_PR	Wintershall Noordzee B.V.	K10-V to J6-A \ K13-A	Active	Gas 10-inch
PL0136_PR	Nederlandse Aardolie Maatschappij B.V.	K7-FD-1 to K8-FA-1	Active	Gas 12-inch
PL0137_PR	Nederlandse Aardolie Maatschappij B.V.	K8-FA-1AP of K8-FA-1P to K14-FA-1C	Active	Gas 24-inch
PL0176_PR	BBL Company V.O.F.	Balgzand (NL) to Bacton (GB)	Active	Gas 36-inch
PL0186_PR	Statoil ASA	Sleipner (N) to Zeebrugge (B)	Active	Gas 40-inch
PL0187_PR	Statoil ASA	Draupner (N) to Duinkerken (F)	Active	Gas 42-inch
PL0076_UM	Nederlandse Aardolie Maatschappij B.V.	-	Active	Umbilical 4.5 inch
PL00136_UM	Nederlandse Aardolie Maatschappij B.V.	K7-FD-1 to K8-FA-1	Active	Umbilical 3.6 inch
BK030_UM	Nederlandse Aardolie Maatschappij B.V.	-	Active	Umbilical 4 inch

KB0061	T Systems International / Deutsch Telekom	Oostende (B) to Norden (D)	Active	Fibre Optic (Telecom)
KB0025	Unknown	Winterton (GB) to Romo (DK)	Abandoned	Coax (Telecom)
KB0035	Unknown	Winterton (GB) to Fano (DK)	Abandoned	Coax (Telecom)
KB0069	British Telecom	Winterton (GB) to Juist (D)	Abandoned	Fibre Optic (Telecom)
KB0014	Unknown	Winterton (GB) to Spiekeroog (D)	Abandoned	Coax (Telecom)
KB0073	Unknown	Winterton (GB) to Borkum (D)	Abandoned	Coax (Telecom)
KB0112	Neuconnect Britain Limited	Isle of Grain (UK) to Wilhelmshaven	Planned	Copper (Electra)
KB0010	Unknown	Winterton (GB) to Borkum (D)	Abandoned	Unknown (Telecom)

*Table 3 Registered platforms (K) cables (KB) and pipelines (PL) within the Nederwiek Noord and Zuid areas. For the locations see figure 10. An overview of the distribution of boreholes is also given on the map in figure 10a -10c. Source: NCM, TNO-Dinoloket.*

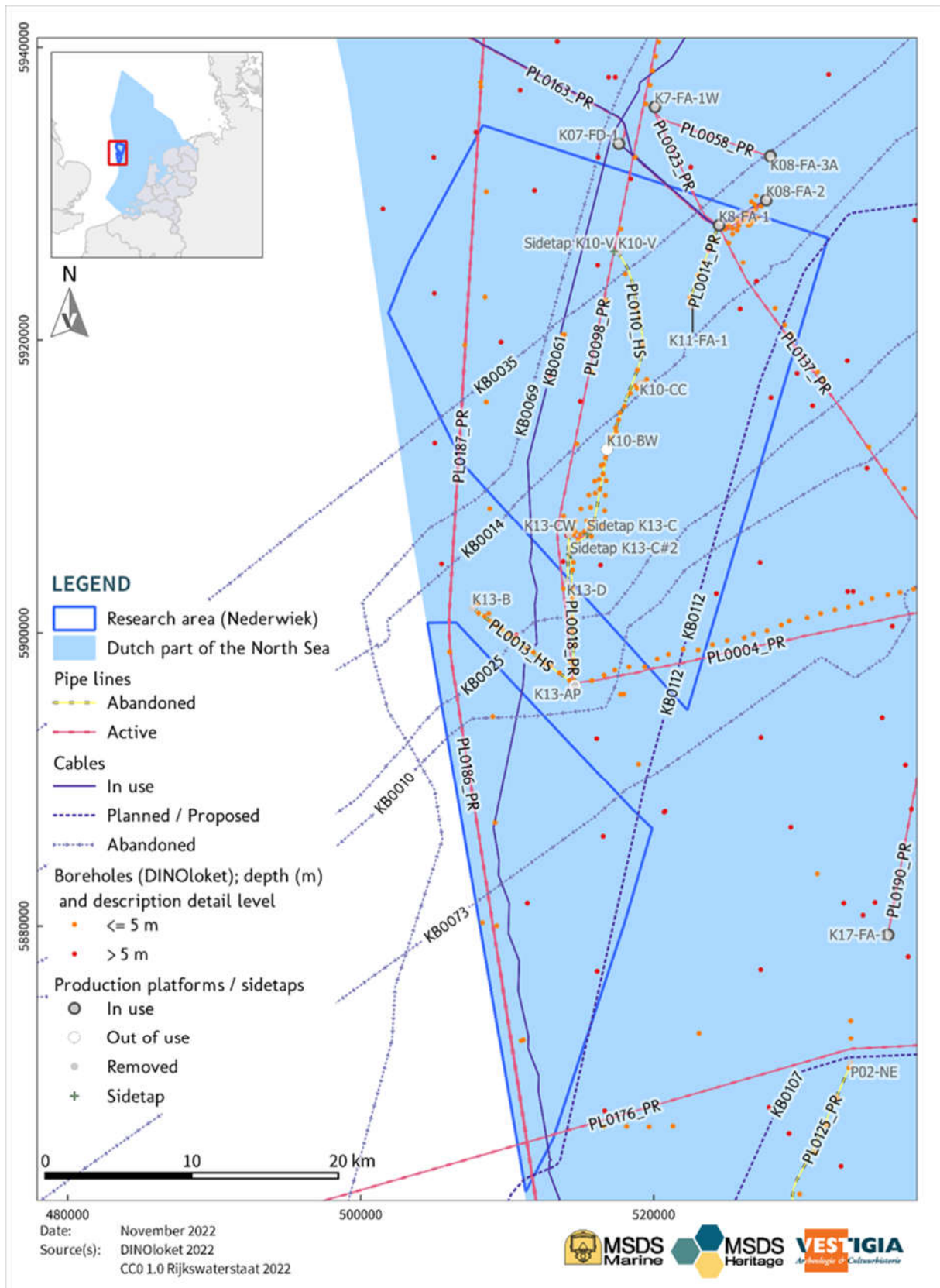


Figure 10a Distribution of pipelines, cables, production platforms, sidetaps and boreholes within the Nederwiek Noord and Zuid areas.

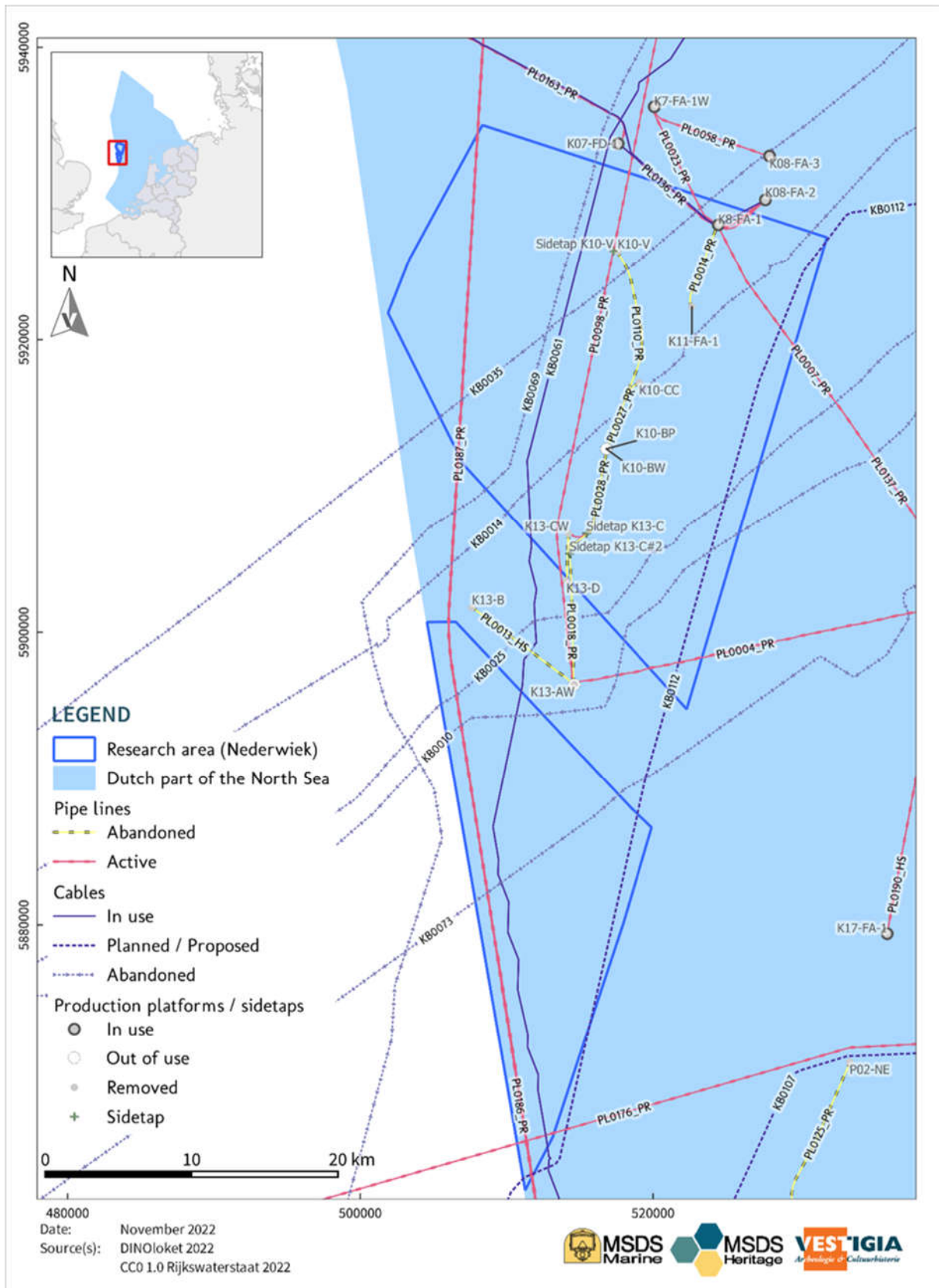


Figure 10b Distribution of pipelines, cables, production platforms, and sidetaps within the Nederwiek Noord and Zuid areas.

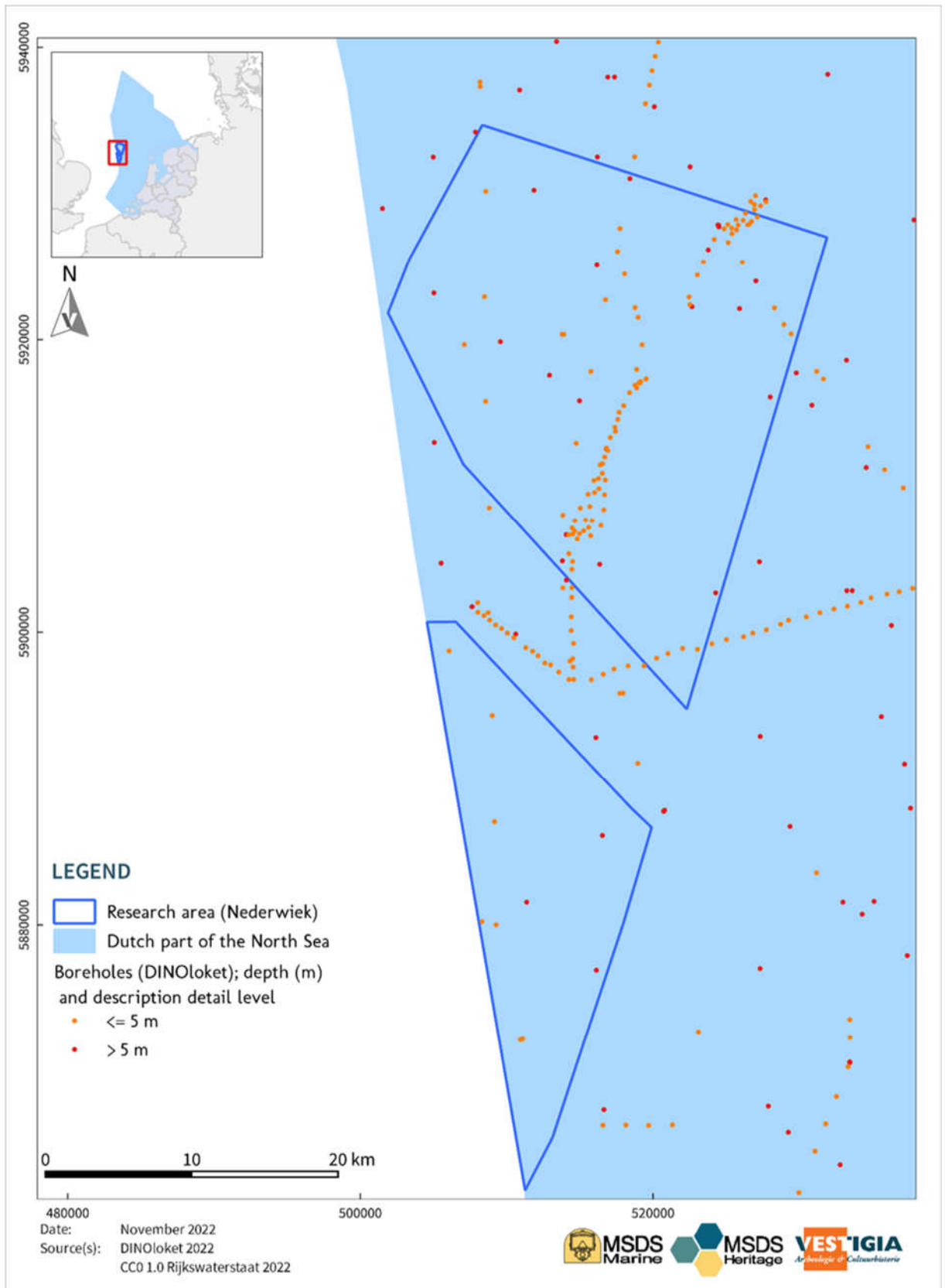


Figure 10c Distribution of boreholes within the Nederwiek Noord and Zuid areas.

## 5.6 Description of the geological development in relation to layers of possible archaeological interest (LS04wb)

5.6.1 Publicly available geological source data for the Nederwiek Noord and Zuid areas are scarce: To date there are 149 locations registered with some form of geological information within both wind farm zones: 125 of these locations are marked as geological bore or coring logs<sup>16</sup>, resulting in a density of 0.157 and 0.132 per square kilometre respectively. When selecting the bore logs giving a description of - at least - the first 2 meters of the subsurface, only 58 records remain. When we consider a minimum of the first 5 meters of the subsurface, only 24 records remain. As a result, the current analysis of the geological characteristics in relation to their archaeological potential is based on information (both maps and cross sections) aimed for use on a much larger scale than just the area of the wind farm zone and its direct surroundings.

### Pleistocene (see figure 11)

5.6.2 Within the research area, both the undifferentiated Eem Formation, and the Brown Bank Member, part of the same Formation, have been mapped as subcropping Pleistocene units. The Brown Bank Member is of particular geo-archaeological interest. It consists of partly consolidated silty clay with sand laminae. Desiccation cracks, rooting and even soil horizons have been identified at the top of the unit. They represent a regressive marine and partly stream-fed lacustrine or even a terrestrial setting<sup>17</sup>.

5.6.3 The Brown Bank is a ridge on the seafloor some 85 km off the Dutch coast in the central part of the southern North Sea. The bank is approximately 25 km long and 2 km wide and sits 22-16m below sea level with a swale between 40 and 42m deep on the eastern side. The seabed surrounding the bank is between 28 and 32m below sea level. The Brown Bank is an area rich in material relating to the Mesolithic occupation of Doggerland.

5.6.4 In the remaining parts of the research area, the (undifferentiated) Eem Formation is shown as the subcropping Pleistocene unit. The calcareous, often shell-rich clays and sands represent a more marine depositional setting<sup>18</sup> than the Brown Bank Member.

5.6.5 Other units recognized in the vicinity of the research area, are the Swarte Bank Member of the Peelo Formation and the Boxtel Formation. They could also be present as subcropping units in the Nederwiek area. The silty to sandy clays and fine to coarse sands of the Swarte Bank Member (Peelo Formation) represent the glacial deposits that are ascribed to the Elsterian glaciation<sup>19</sup>. The aeolian sands (Wierden Member) and small scale local fluvial deposits (Singraven Member) of the Boxtel Formation could subcrop below a cover of Holocene deposits in parts of the research area. These sediments were formed during the last glacial period, the Weichselian, and early Holocene.

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<sup>16</sup> DINoloket ([www.dinoloket.nl](http://www.dinoloket.nl)), accessed November 1<sup>st</sup>, 2022.

<sup>17</sup> TNO-GDN 2022a, Rijdsdijk et al. 2005, Oele 1971.

<sup>18</sup> TNO-GDN 2022b, Cleveringa et al. 2000.

<sup>19</sup> Rijdsdijk et al. 2005.

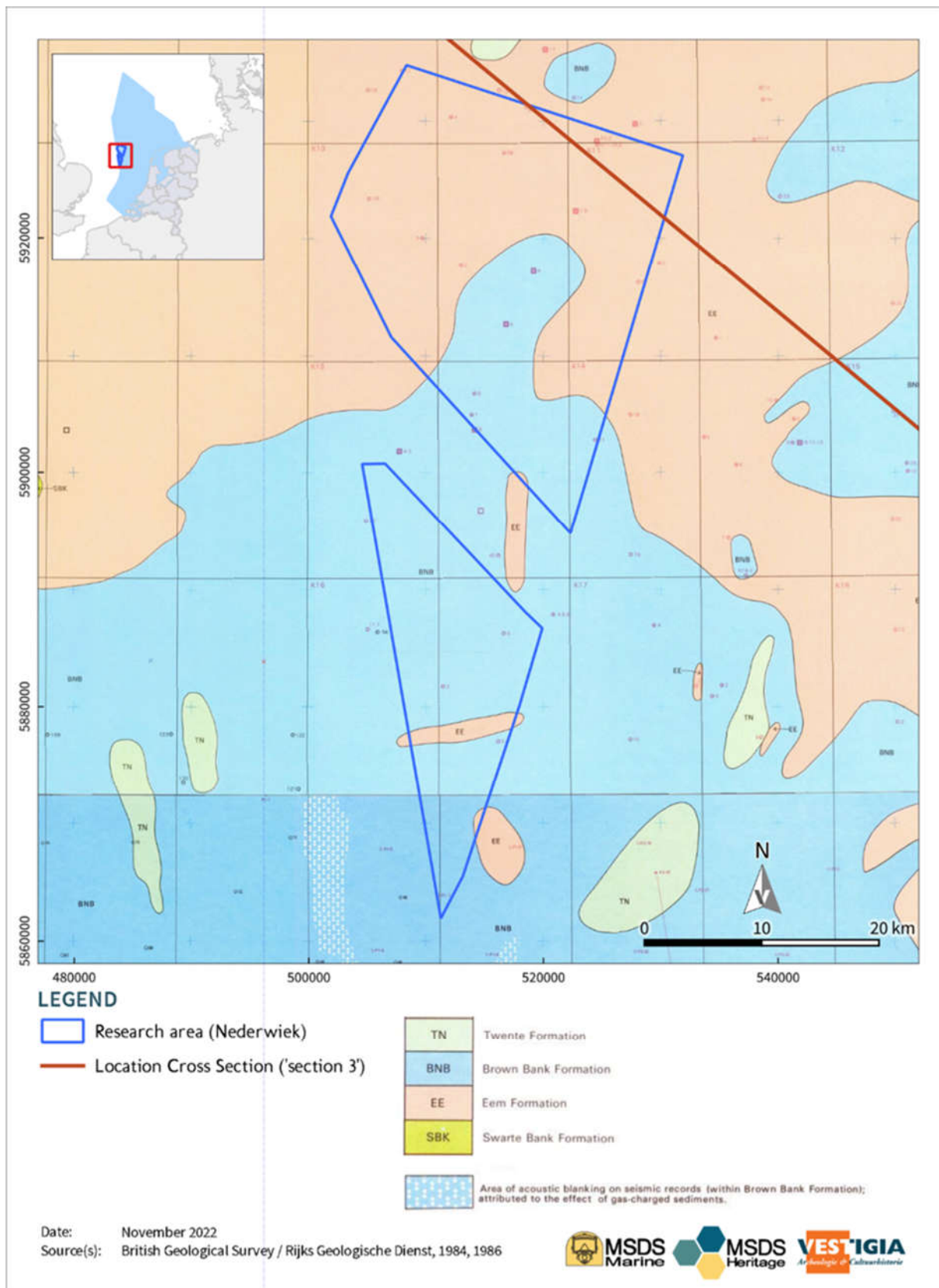


Figure 11 Sub crops of Pleistocene formations and older sediments beneath a cover of Holocene sediments. The formation names in the map are old names of stratigraphical units. In the revised stratigraphy for the Dutch sector of the North Sea (Rijsdijk et al. 2005) these correspond to: TN (Twente Formation) = Boxel Formation, BNB (Brown Bank Formation) = Eem Formation, Brown Bank Member, EE (Eem Formation) = Eem Formation; SBK (Swarte Bank Formation) = Peelo Formation. Part of the cross section is shown in Figure 12.

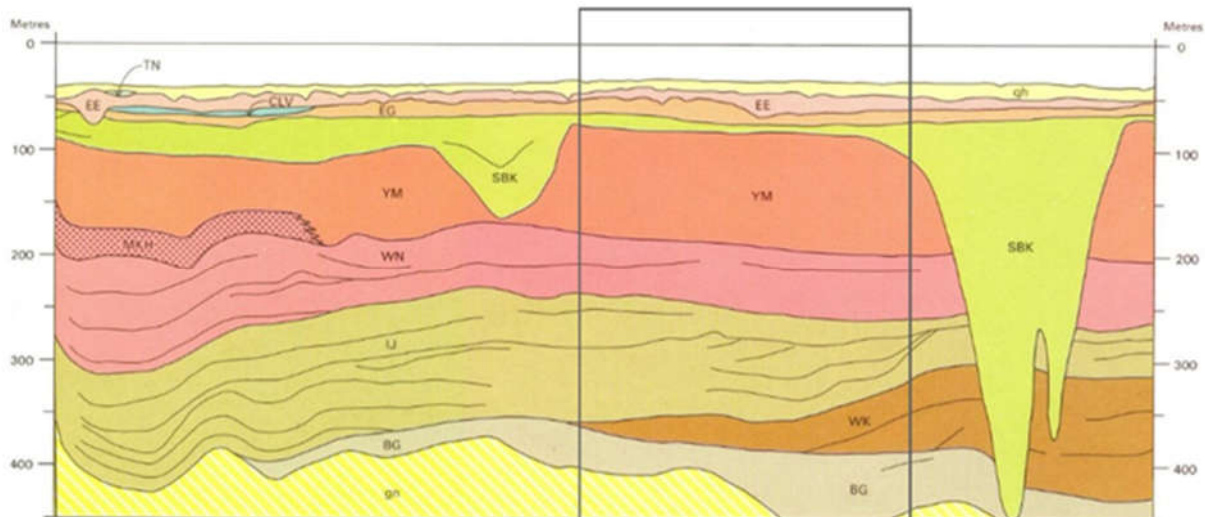


Figure 12 part of the cross section 'Section 3' from Cameron et al. 1986. The grey rectangle depicts the part where it intersects with the research area, as seen in figure 11. The capitalised abbreviations in the cross section refer to old names of stratigraphical units. In the revised stratigraphy for the Dutch sector of the North Sea (Rijsdijk et al. 2005) these correspond to: TN (Twente Formation) = Boxel Formation, BNB (Brown Bank Formation) = Eem Formation, Brown Bank Member, EE (Eem Formation) = Eem Formation; CLV (Cleaver Bank Formation) = Drenthe Formation, Uitdam Member; EG (Egmond Ground Formation) = Egmond Ground Formation; SBK (Swarte Bank Formation) = Peelo Formation; YM (Yarmouth Roads Formation) = 'Formation 4.1.1.'; MKH (Markham's Hole Formation) = Markhams Hole Formation; WN (Winterton Shoal Formation) = Winterton Shoal Formation; IJ (Ijmuiden Ground Formation) = Ijmuiden Ground Formation; WK (Westkapelle Ground Formation) = Westkapelle Ground Formation; BG (Brielle Ground Formation) = Brielle Ground Formation. 'qh' represents the Holocene cover layer, 'gn' refers to undivided Neogene and older units.

## Holocene

- 5.6.6 In large parts of the study areas, early Holocene terrestrial deposits seem to cover the (Late) Pleistocene deposits (see figure 13). The Basal Peat Bed (Nieuwkoop Formation) is of early to earliest middle Holocene age. It started to form when downstream advance of sea-level rise led to groundwater-table rise<sup>20</sup>. Locations where the Basal Peat Bed is present indicate towards the preserved remnants of a late Pleistocene to early Holocene landscape. These locations are "[...] of importance for in situ offshore Late Paleolithic and Mesolithic archaeology"<sup>21</sup>. Because of the way the deposits are mapped (only as part of the former Elbow Formation), the extent to which they are present in the Nederwiek area is, currently, unclear. At the time of the mapping of the distribution of the (former) Elbow Formation, Cameron, Laban, and Schüttenhelm state that "... A basal discontinuous early Boreal peat bed with intercalations of wind-blown or fluvialite sand is up to 1 m thick in the north-west, but is present only locally in the Dutch sector. There is evidence of a stratigraphic hiatus before deposition of the marine sands of the overlying Bligh Bank Formation"<sup>22</sup>.
- 5.6.7 Both the Elbow Formation and Bligh Bank Formations are old names, not part of the revised stratigraphy. Apart from the Basal Peat, the Elbow Formation also includes sediments which are now part of the Wormer Member of the Naaldwijk Formation, with the Velsen Bed at its

<sup>20</sup> Hijma et al. 2012.

<sup>21</sup> Hijma et al. 2012.

<sup>22</sup> Cameron/Laban/Schüttenhelm 1984a.

base<sup>23</sup>. Both the Basal Peat Bed (Nieuwkoop Formation) and the Velsen Bed (comprising lagoonal clays) could indicate that the underlying Pleistocene landscape is still intact. The exact extent to which either of these units are present within the research area is still unclear.

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<sup>23</sup> Rijdsijk et al. 2005.

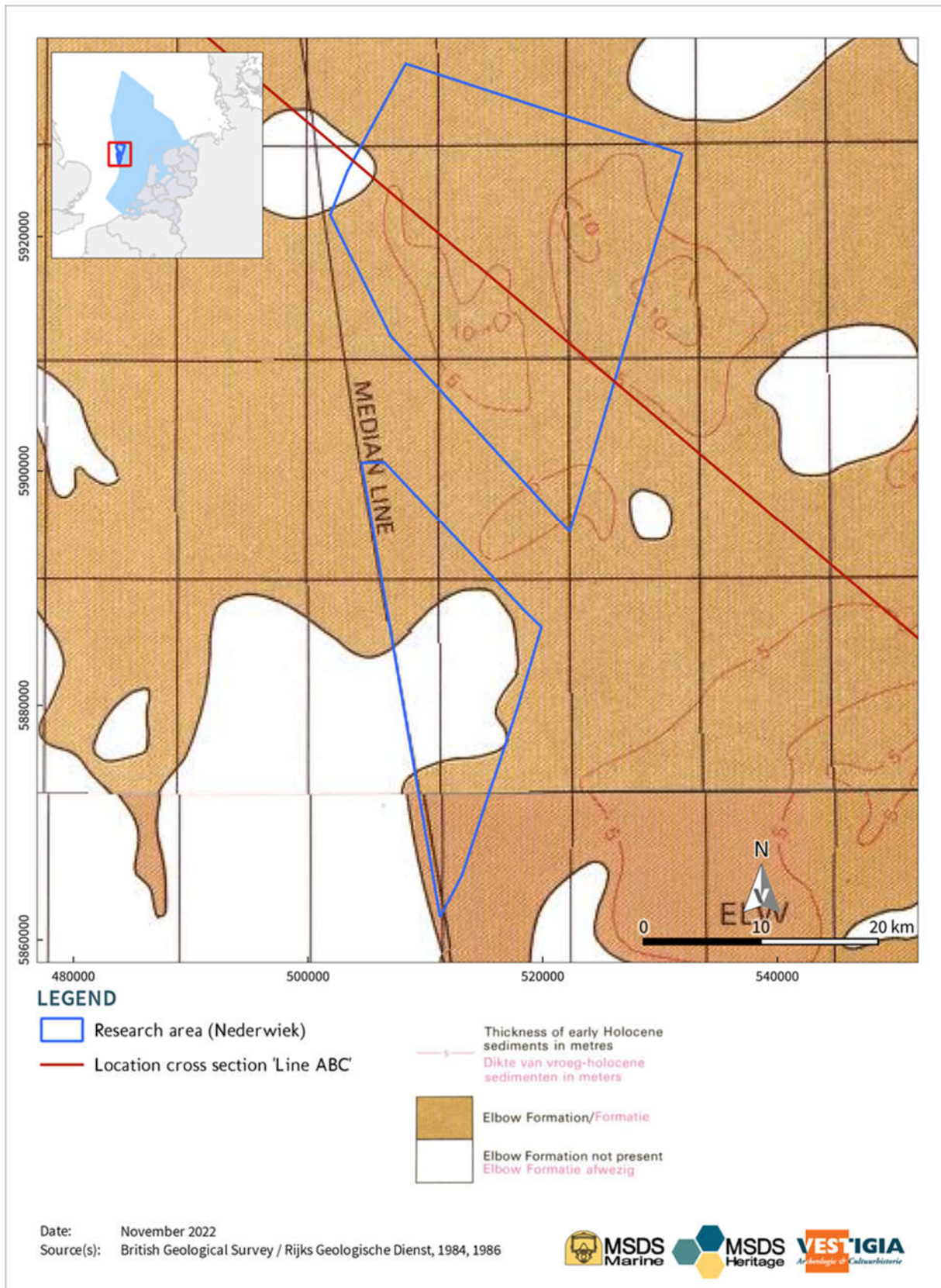


Figure 13 Distribution of Early Holocene Sediments. The Elbow Formation mentioned in the legend is an old stratigraphical unit. In the revised stratigraphy for the Dutch sector of the North Sea (Rijsdijk et al. 2005), this can correspond to the Naaldwijk Formation (marine-coastal deposits) or the Nieuwkoop Formation (Sedentary deposits). Part of the cross section is shown in Figure 14.

5.6.8 The uppermost part of the deposits that are present in the Nederwiek wind farm zones, is formed by the open marine deposits of the Southern Bight Formation, in particular the Bligh Bank Member (or former Bligh Bank Formation), as present in the cross section shown in Figure 14, and the low energy open marine deposits of the Urania Formation.

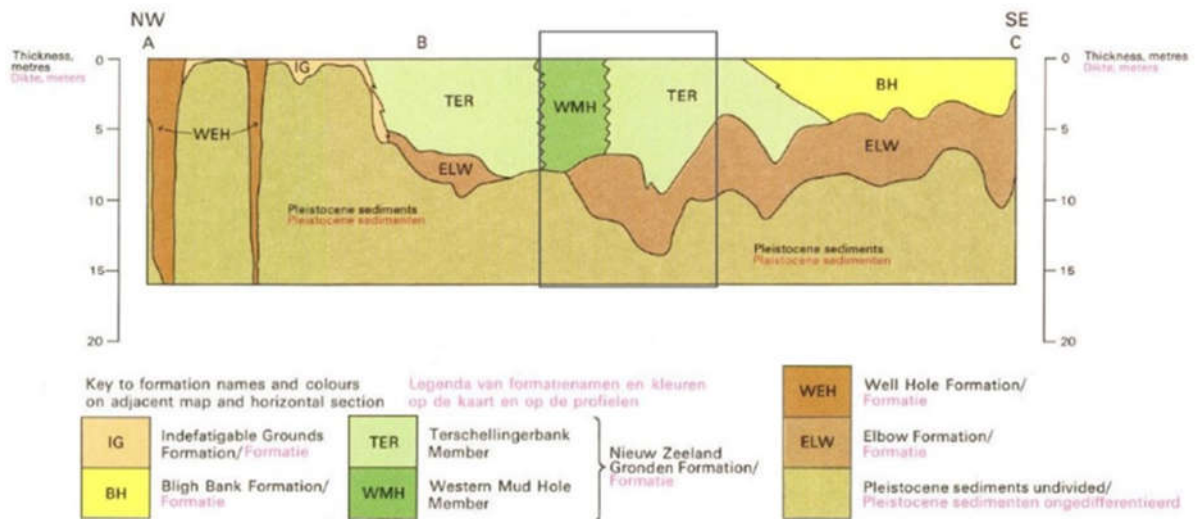


Figure 14 part of the cross section 'line ABC' from Harrison et al. 1987. The grey rectangle depicts the part where it intersects with the research area, as shown in Figure 13.

5.6.9 The latter is present in the northernmost part of the research area, as shown in figure 13. The older and now disused Well Hole Formation is now part of the Urania Formation, downgraded to the Well Hole Member. The Nieuw Zeeland Gronden Formation, which is also present in the cross section shown in figure 14, has been split up: its members are now part of two different formations, based on the energy level: the low energy marine deposits of the Western Mud Hole Member are now part of the Urania Formation, whereas the higher energy deposits of the Terschellingerbank Member are part of the newly formed Southern Bight Formation. This formation also contains the already mentioned Bligh Bank Member. The distribution of the lower-energy deposits of the Urania Formation and the higher energy Southern Bight Formation is also visible in the grain size distribution of the sea bed sediments, as shown in figure 14. The total thickness of the Holocene deposits ranges from less than 5 meters in several areas in the southern part of the research area, to potentially more than 15 m in the northern part and below the highest parts of the ridges (see figures 13, 15 and 16). In the lowest areas between the ridges, local Pleistocene outcrops can occur.

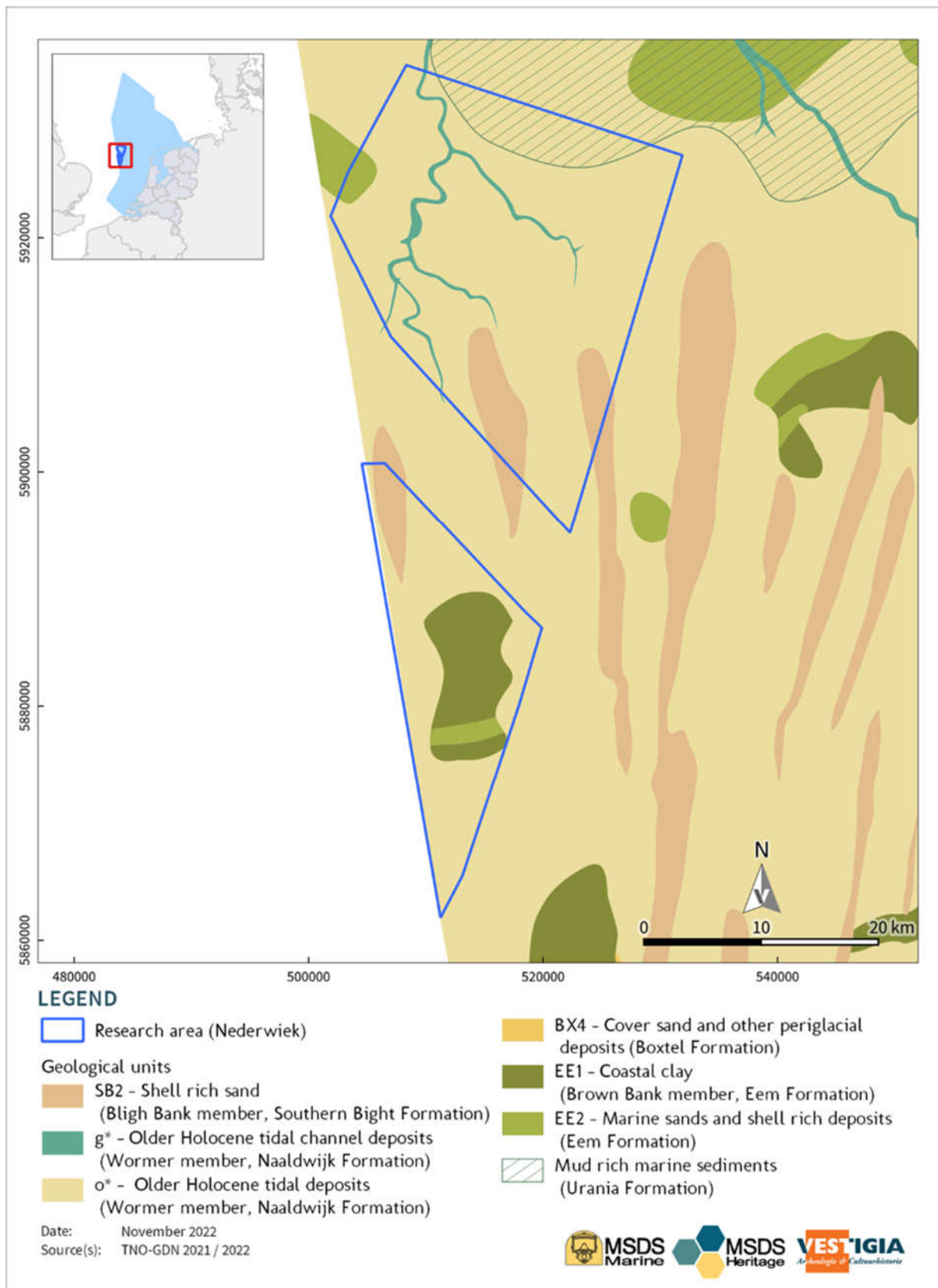


Figure 15 Geological map of the shallow subsurface in and around the research area.

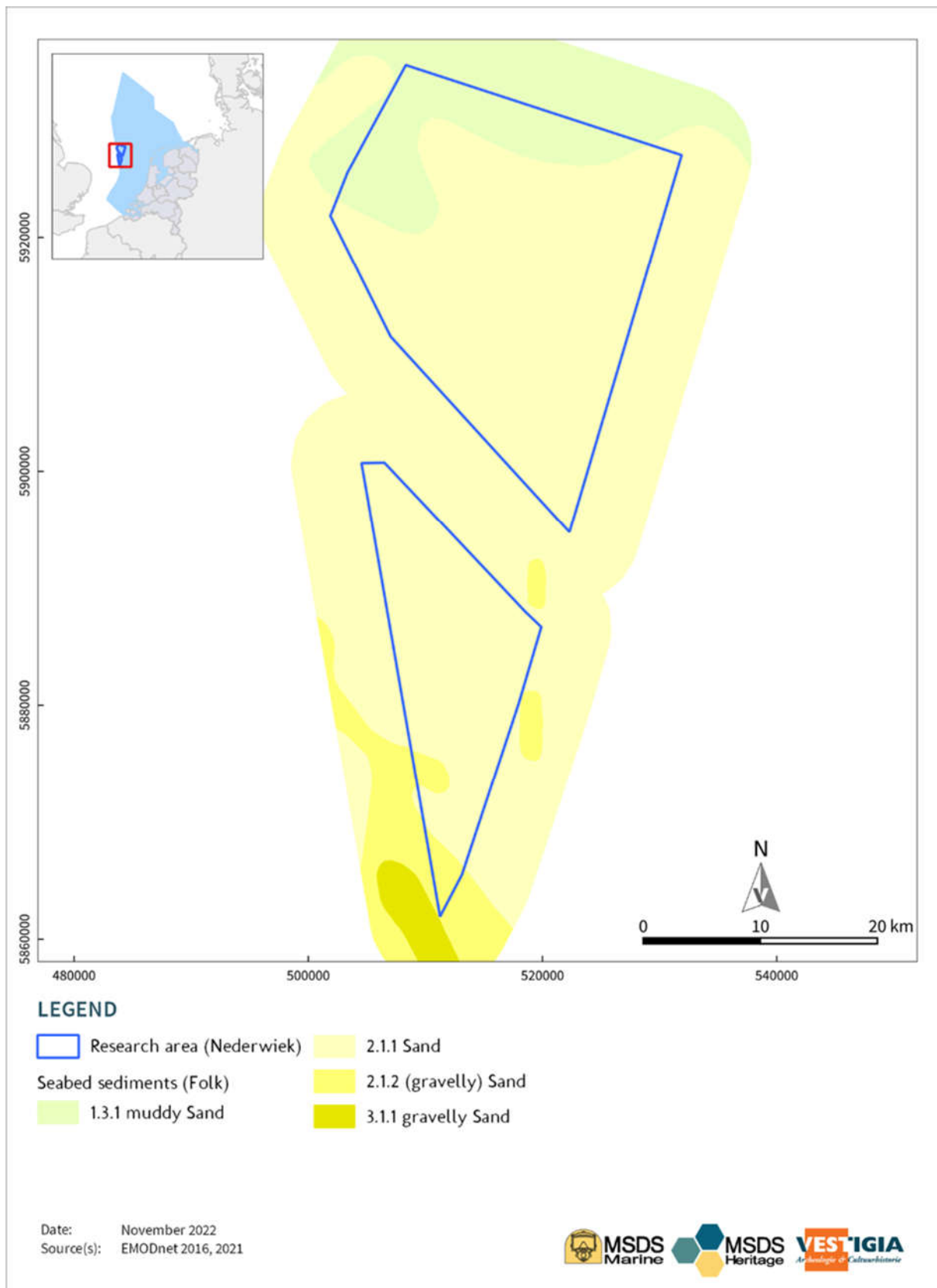


Figure 16 Grain size classification of the Seabed sediments in and around the research area.

## Mapping archaeological expectancy

- 5.6.10 Little is known about the early inhabitants of the North Sea region, their settlements and in which ways they maintained themselves in a rapidly changing landscape. The information value of expected settlements can therefore be considered as considerable. This has been underlined in the National Archaeological Research Agenda for Archaeology (NOaA 2.0 question 6): "When and in which way are the regions, which are now submerged, used by men, what are the characteristics of these zones and how does this compare with sites on land of which we know of".
- 5.6.11 In 2007, the Cultural Heritage Agency (RCE) published the map "Continentele plaat". The map is more or less a copy of the "Globale Archeologische kaart van het continentaal plat" (published in 2000). This map gives an indication of the probability of archaeological remains under water and in the seafloor and categorizes them as either a high, medium high, low or very low probability, based on geological and archaeological observations (see figure 17)<sup>24</sup>. Nowadays the map is of limited reliability, partly due to its scaling (1:500.000), but more so because of the rapid progression of available data. The map shows areas where peat and clay are still present. The presence of these early Holocene sediments – also in Nederwiek Noord and Zuid - could indicate the presence of well preserved prehistoric landscapes.
- 5.6.12 During the last decade, several new investigations have begun or gained new momentum, not least because of improved technologies for marine exploration and remote sensing, intensified industrial exploitation of the seabed, and collaboration between offshore industries, government agencies, and commercial archaeologists. In 2012-2013 a pilot-study was conducted by Deltares in cooperation with TNO (Dutch Geological Service) in order to create an improved Indicative Map for Archaeological Values (IKAW) for the North Sea region. This turned out to be impossible due to the limited amount of data. In continuation of this study another assignment was given that focused on the creation of a geological-archaeological map which can aid in the policy for the protection of submerged prehistoric landscapes and the potential presence of habitation/settlement remains up to a depth of 30 m underneath the seafloor. The underlying data consist mainly of lithostratigraphic units, where sedimentary origin, layer sequence and age determine the allocation of an archaeological value (i.e., expectancy). This approach is in line with the proposed method by Ward & Larcombe (2008) and fits within the research agenda of the North Sea Prehistory Research and Management Framework (NSPRMF, 2019). This resulted in a new indicative model "the Archaeological Potential of the Dutch Continental Shelf" (see figure 18). The map shows that archaeological remains from the Middle Paleolithic and the Mesolithic periods are to be expected within the Nederwiek study areas, but Late Paleolithic being absent in this model. Map and expectancy models are reproduced in a two dimensional presentation. It is important to realize that the vertical stratigraphy is at least as important as the horizontal one. As has been shown above levels relevant for archaeology may have been covered by younger sediments but can still be intact and informative.

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<sup>24</sup> <https://www.cultureelerfgoed.nl/onderwerpen/bronnen-en-kaarten/overzicht/archeologie-in-nederland-amk-en-ikaw>

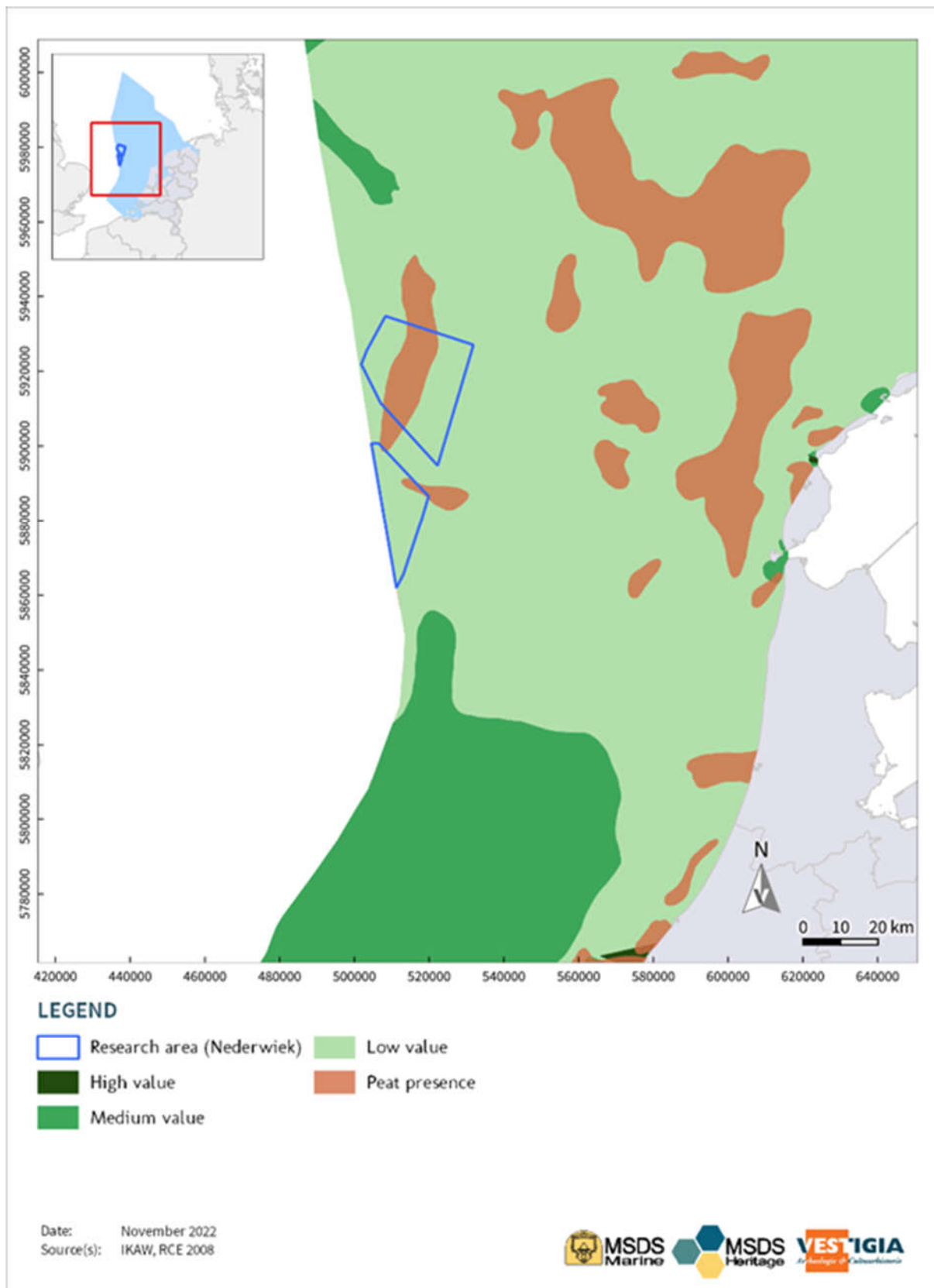


Figure 17 Section out of the Global indicative archaeological map of the (Dutch) continental shelf 2007.

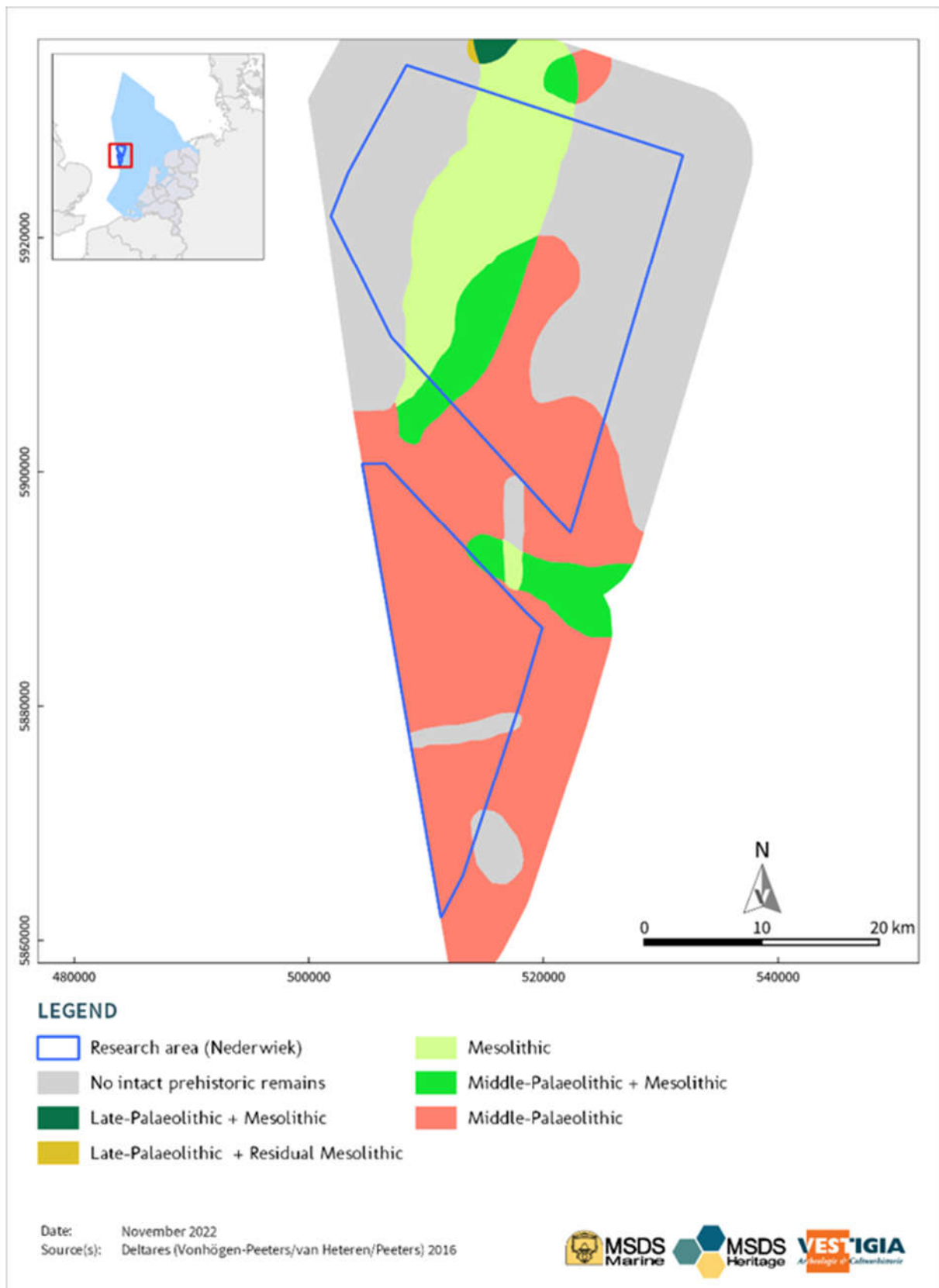


Figure 18 Section out of the Indicative model of archaeological potential of the North Sea/ (Dutch) continental shelf by Deltares 2016.

5.6.13 Another consideration in relation to this study is the thickness of younger seabed formations on top of the Late Pleistocene and Early Holocene formations with archaeological potential. The possibilities for further research in these may be limited if relevant levels are buried under 5-10 meters of sand (see figure 20).

## 5.7 Inventory of registered archaeological sites and objects on the seafloor (LS04wb)

5.7.1 Archaeological sites and objects on the North Sea seafloor consist of shipwrecks, crashed airplanes, mainly from WWII, lost cargo and equipment, such as anchors, guns etc. Most eye-catching and of potential high archaeological value are historic wrecks. However, it should be emphasized that not every wreck is historic and therefore of historic or archaeological value. Shipwrecks and lost aircraft of both World Wars are of extra interest, not only because of their historic importance, but also because of their status as war graves and the risk of explosives still present.<sup>25</sup>

5.7.2 Data for these objects have been collected from different sources. Some of them, such as the NCN and Dutch Navy databases contain other information than is archaeologically relevant, so selections have been made. Both Nederwiek areas have not been regularly surveyed, so a limited number of data is available. It is also important to realize that common survey techniques aimed at establishing obstacles on the seafloor are better in recognizing metal objects than wooden ones, especially when these have partly been buried in sediment. Wooden ships may therefore be underrepresented in the inventory.

5.7.3 The most up to date list of objects and shipwrecks on the seafloor is the NCN (National Contact Number) database. This database combines the data from three governmental sources:

- The Dutch Continental Shelf and Westerschelde wrecks register of the Hydrographic Service of the Royal Netherlands Navy (RNNHS)
- The SonarReg92 object database of Rijkswaterstaat (RWS)
- The ARCHIS database of the Cultural Heritage Agency (RCE)

In addition to these the database of:

- United Kingdom Hydrographic Office (UKHO)

has been compared with the Dutch data, and differences noted (see below).

5.7.4 Due to some delay in accessibility of the NCN database, in this study, the database of the Hydrographic Service and Archis were consulted separately in order to cross reference any additional data that (possibly) had not conveyed to the NCN database. Various other sources were also consulted to retrieve additional information on wrecks and objects in both study areas. These will be discussed below.

5.7.5 According to the NCN database, a total of 34 registered wrecks and objects are present in both study areas (see table 4 and figure 19).

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<sup>25</sup> In fact all wrecks of warships and military craft – also those dating outside the war periods – are seen as war graves and of high historic value.

Type	Number
Obstruction	20
Wellhead	1
Wreck	14
<b>Total</b>	<b>34</b>

*Table 4 Summary of registered objects in the Nederwiek Noord and Zuid areas. Source: NCM.*

#### Shipwrecks (table 5 and figure 19)

- 5.7.6 A total of 14 shipwrecks are known from the study areas, of which four have been identified so far. Three of these are recent wrecks and are of limited archaeological value. Two wrecks are certainly of archaeological value (of which one has been identified). The first one is the German WW1 era submarine the U97 which sunk in 1918 (see below under Archis), and the other one is a wooden sternpost containing depth markings, which has been salvaged by the fishing vessel TX68.
- 5.7.7 The remaining eight wrecks have not been identified and lack details like names, types, and date of sinking. Additional investigation is required to determine any cultural historical value. A possible additional wreck has been registered by the United Kingdom Hydrographic Office under registration number 28293, just outside the study area of Nederwiek Noord. This wreck however has been given the status “dead” i.e. not been recognised after 1987.

NCN	Description	RWS	DHY	ARCHIS	Easting	Northing	R95	Arch. significance
545	Unknown wreck, survey 1992	-	35	-	515942.31	5910109.01	20	Unknown
979	Unknown wreck, survey 2005	-	620	-	526237.92	5924881.12	5	Unknown
980	Unknown wreck, survey 2005, possibly U97 (see also NCN 20054) <sup>26</sup> or other submarine	-	621	-	531514.12	5924607.24	5	Likely <sup>27</sup>
1211	Unknown wreck HY 908, survey 1992	-	908	4030724100	518976.59	5881629.76	20	Unknown
1832	Wreck Alpha-H, survey 1990	-	1949	-	503866.17	5922725.14	5	No
2237	Wreck fishing vessel Janne Maria (UK 185), sunk in 1983 <sup>28</sup> , survey 1991	-	2448	-	513805.08	5931669.16	20	No
2266	Wreck Spera B, survey 1992	-	2486	-	521011.60	5905604.50	20	No
2380	Unknown wreck, possibly a Russian submarine, sunk in 1990, <sup>29</sup> survey 1992	-	2713	-	515561.10	5880133.19	20	Possibly
2699	Unknown wreck, survey 2006	-	3203	-	509048.71	5890234.25	5	Unknown
9342	Unknown wreck Noordzee, possibly an old merchant vessel, dating unknown, <sup>30</sup> Leman and Ower Bank	-	0	303450100	510770.98	5886563.10	-	Yes

<sup>26</sup> U-97 is mentioned, under two NCN codes with different locations. When analysing the survey data this should be noted.

<sup>27</sup> Part of the information is from a still unpublished version of the *Wrakkentelling* (wreck count): see <https://www.cultureelerfgoed.nl/publicaties/publicaties/2021/01/01/wrakkentelling> (this additional data was provided by the RCE).

<sup>28</sup> For source information see footnote 27.

<sup>29</sup> For source information see footnote 27.

<sup>30</sup> For source information see footnote 27.

18756	Wreck remains, survey 2002	1101	0	-	513273.00	5866589.00	-	Unknown
20054	Wreck U97	-	0	4030035100	510985.53	5918675.45	-	Yes
100	Wreck Interocean II, survey 2018	253	-	-	519051.00	5926533.00	5	No
UKHO 28293	Unknown Wreck Status: dead	-	0	-	530737,5	5925181,4	-	Det.year 1971,1987

*Table 5 Registered shipwrecks in the Nederwiek Noord and Zuid areas. Source: NCM; UKHO database.*

### Airplane crashes

- 5.7.8 During World War II approximately 6,000 airplanes crashed on land and at sea in the Netherlands. The number of aircraft that went missing over the North Sea runs well into the thousands<sup>31</sup>. Many of these aircraft have been salvaged in the course of time, but hundreds of them are still missing. Remains of crashed World War II aircraft are still found on a regular basis during fishing or dredging activities in the North Sea.
- 5.7.9 The *Studie Groep Luchtoorlog 1939-1945* (Dutch Study Group Air War 1939-1945) has compiled a Loss Register, containing basic data on all aircraft losses within Dutch territory and in territorial waters. This register enables users to specify searches aiming at a certain location. Whilst this is useful for searches on land (based on placenames, landowners etc.), it is not possible to specify locations on the North Sea.
- 5.7.10 A search within the register with the location set to the North Sea results in 793 records. Most of these are near the Dutch or English coasts. Since the research area is located approximately 100 km or 50 nautical miles from the nearest shore (both NL and UK), another search using these parameters narrowed the results down to 9 (see table 5a). This does not mean these plane wrecks are indeed within the two study areas, but it provides a first indication, and reminder that aircraft remains can be present and thus expected.

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<sup>31</sup> Wessex Archaeology 2008

SGLO	Location	Aircraft	Mk	Serial	Unit
T1052	Ditched at North Sea 100 km w of Texel	Wellington	Ic	W5666	300 Sqdn
T1054A	Ditched at North Sea 100 km w of Texel	Hampden	I	AE127	44 Sqdn
T1369	Ditched at North Sea 100 km w of Petten	Wellington	Ic	T2553	311 sqdn
T3555	Ditched at North Sea 100 km of Cromer	Halifax	III	LW626	192 sqdn
T3796	Crashed into North Sea 100 km w of Zandvoort	Halifax	III	M2292	102 sqdn
T3559A	Ditched at North Sea 50 nm w of IJmuiden	B-17 Flying Fortress	F	42-3506	91BG/324BS
T5630	Ditched at North Sea 80 km w Texel	Wellington	Ic	T2737	149 sqdn
T1297A	Crashed into North Sea 130 km wnw of Den Helder	Blenheim	IV	V5875	114 sqdn
T3240C	Pilot bailed out 110 km e of Cromer UK	P-51 Mustang	B	42-12170	354FG/353FS

*Table 6 Registered aircraft crashes from WW2, possibly in Nederwiek Noord and Zuid areas. Source: Dutch Study Group Air War 1939-1945.*

### Other known objects (table 6 and figure 19)

Apart from the twelve shipwrecks, another 22 other objects have been registered in the NCN database, of which two are clearly of no archaeological importance (a wellhead and the wreck of the drilling platform Interocean II). The archaeological value of the other objects is yet unknown and should be further investigated. All these obstructions form a potential risk for the construction of the windfarms.

NCN	Description	RWS	DHY	ARCHIS	Easting	Northing	R95	Arch
100	Obstruction Interocean II, survey 2018	253	-	-	519051.00	5926533.00	5	No
2788	Obstruction	-	3382	-	522649.91	5922250.95	5	Unknown
19482	Obstruction	-	100864	-	517356.00	5912059.00	0	Unknown
19483	Wellhead	-	100516	-	517572.57	5926067.72	0	No
19491	Obstruction	-	4119	-	516811.00	5912545.00	0	Unknown
19617	Obstruction	-	100142	-	524482.00	5927885.00	0	Unknown
32934	Obstruction	-	494	-	524684.31	5905501.58	1000	Unknown
32935	Obstruction	-	495	-	509508.40	5886066.61	5	Unknown
32943	Obstruction	-	156	-	515559.90	5918043.43	0	Unknown
32948	Obstruction	-	383	-	513090.75	5866055.05	5	Unknown
33102	Obstruction	-	168	-	529791.11	5921119.14	0	Unknown
33111	Obstruction	-	100154	-	519064.03	5917071.14	0	Unknown
33112	Obstruction	-	100187	-	514226.29	5906720.84	0	Unknown
33116	Obstruction	-	100186	-	514083.50	5903516.37	0	Unknown
33124	Obstruction	-	218	-	516236.23	5883023.61	0	Unknown
33133	Obstruction	-	217	-	515360.59	5885193.14	0	Unknown
33141	Obstruction	-	155	-	512634.56	5916037.43	0	Unknown
33142	Obstruction	-	191	-	515095.10	5890751.12	0	Unknown
33152	Obstruction	-	152	-	510384.12	5912493.16	0	Unknown
33155	Obstruction	-	200	-	524321.41	5902424.89	0	Unknown
33159	Obstruction	-	151	-	516567.12	5927021.79	0	Unknown
33160	Obstruction	-	183	-	511697.37	5893699.45	0	Unknown

Table 7 Other registered objects in the Nederwiek Noord and Zuid areas. Source: NCM.



### Additional Information from Archis

5.7.11 The Dutch Cultural Heritage Agency (RCE) manages an extensive database on all archaeological monuments, sites, finds and archaeological interventions within the Netherlands, including the Dutch North Sea. Three historic shipwrecks from the Nederwiek wind farm zones or its immediate surroundings have been registered in this database.

ID-number	NCN-number	Year of discovery/notification	Type	Archaeological period	Remarks
3038450100	9342	2003/2004	Wooden sternpost	AD 1500-1850	With depth markings
4030035100	20054	Unknown/2017	German U-boat	AD 1914-1918	U97
4030724100	1211	2014/2017	Shipwreck	Unknown	Toponym: Wreck HY 908

*Table 8 Archis information on shipwrecks within Nederwiek Noord and Zuid areas. Source: Archis3.*

5.7.12 The oldest find registered in Archis (ID 3038450100) is a wooden sternpost, approximately 5 m in size with depth markings. It was hauled up by the fishing vessel TX68.

5.7.13 The U97 (ID 4030035100) is a German U-boat of the Type U 93 (Mittel U). It sank on 18 November 1918 due to a “unfall” or accident on its voyage to Harwich, England, where all U-boats had to be handed over after the end of WWI. All crew survived<sup>32</sup>. The U97 was built in Kiel and commissioned in Wilhelmshaven by the Kaiserliche Marine in 1917. With an overall length of 70 meters, a beam of 6 meters and a draught of 4 meters it displaced a total of 1,160 tons. It could support a crew of up to 39 men. The U97 was armed with 4 bow and 2 stern torpedo tubes and an 88 mm and a 105 mm deck gun. It could carry up to 16 torpedoes and 220 rounds of ammunition<sup>33</sup>. It is not clear if there was any ammunition on board when it sank, although this seems unlikely, since the war had ended, and the boat was sent to England for demolishing. During its active service it made five patrols and during these, sank a total of 4 ships and severely damaged another one. The wreck was discovered in 2010 by a salvaging company searching for wrecks with valuable cargo. An air flask was salvaged containing an ID-tag with the inscription U-97 on it<sup>34</sup>.

5.7.14 Apart from the date of discovery very little is known about the wreck with the toponym Wreck HY 908 (ID 4030724100).

### MACHU – Mastering Archaeological Cultural Heritage Underwater

5.7.15 Only one object came up in the MACHU database, the wooden sternpost mentioned before. This is the same as what is registered in the Archis database with the ID-number 3038450100.

<sup>32</sup> <https://www.wrakkenmuseum.nl/u-97> (visited 15-11-2022)

<sup>33</sup> <https://web.archive.org/web/20070219203603/http://www.uboot.net/wwi/types/index.html?type=Mittel+U> (visited 15-11-2022)

<sup>34</sup> <https://www.wrakkenmuseum.nl/u-97> (visited 15-11-2022)

## MaSS - Maritime Stepping Stones

- 5.7.16 Maritime Stepping Stones (MaSS) is a database of stories about wrecks and underwater sites. MaSS aims to give a complete picture of a site in its archaeological and historic environment without giving exact positions. The application is made so that everyone interested in Underwater Cultural Heritage can contribute by adding new sites, information, images etc<sup>35</sup>. Due to the setup of this web application it is not possible to load the MaSS Map layer in a GIS program. Therefore, a raster image was made and roughly georeferenced in order to determine if any wrecks or sites are present within the two study areas. This resulted in two possible shipwrecks, the Neeltje Catharina (IJM 170) and the Burgemeester Vening Meinesz (IJM 97). Both were steam trawlers operating from the port of IJmuiden. According to newspapers the Neeltje Catharina left port on the 21<sup>st</sup> of December 1915 and the Burgemeester Venig Meinesz on 15<sup>th</sup> of September 1916. Both ship and crew were never seen, or heard of, again<sup>36</sup>.
- 5.7.17 As mentioned above due to the public accessibility of this application no exact positions are given and therefore it cannot be guaranteed that these wrecks sank within the study areas. As both wrecks were never found, and there is no indication given as to why or how it was determined that these ships sank in this area.

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<sup>35</sup> <https://mass.cultureelerfgoed.nl/nl/over> (visited 15-11-2022)

<sup>36</sup> <https://mass.cultureelerfgoed.nl/neeltje-catharina-ijm-170> / <https://mass.cultureelerfgoed.nl/burgemeester-vening-meinesz> (visited 15-11-2022)

## 6.0 Specified Archaeological Expectancy for the Nederwiek North and South Windfarm zones (LS05)

### 6.1 Summary of results for various archaeological features

#### Shipwrecks

6.1.1 Both study areas have a high expectancy for shipwrecks from all periods. A total of twelve shipwrecks have so far been registered. Four of these have been identified. Two shipwrecks are of archaeological value, the German submarine U97 and a sternpost of a wooden ship, salvaged by fishermen. Of the other eight wrecks, historic information is missing. Further investigations are needed to determine any archaeological or historical value. These locations and other registered but unidentified objects in the two areas should be included as points of attention in the geophysical surveys. All these remains are present on the seafloor. Other (undiscovered) wrecks in the study areas are also likely, and the presence of mobile sand waves within the area (see Section 5.2) supports this potential as such features may mask wreck sites. Considering the “visibility” of shipwrecks when carrying out geophysical surveys, one should take into account the site formation process after a sinking ship ends up on the seabed. In general, tidal currents will create scouring around the wreck, gradually burying it down to a harder level within the subsoil. The thicker the sandy top layer of the seabed, the more the wreck is likely to become covered and more and more “invisible” (see figure 19A). However, especially in sediments with a high clay content, wooden wreck remains become sealed and may be well preserved. In sandy areas preservation is generally poorer. Uncovered wooden beams and planks may be effected by naval shipworm, and dislodged elements may be spread out over a large area.

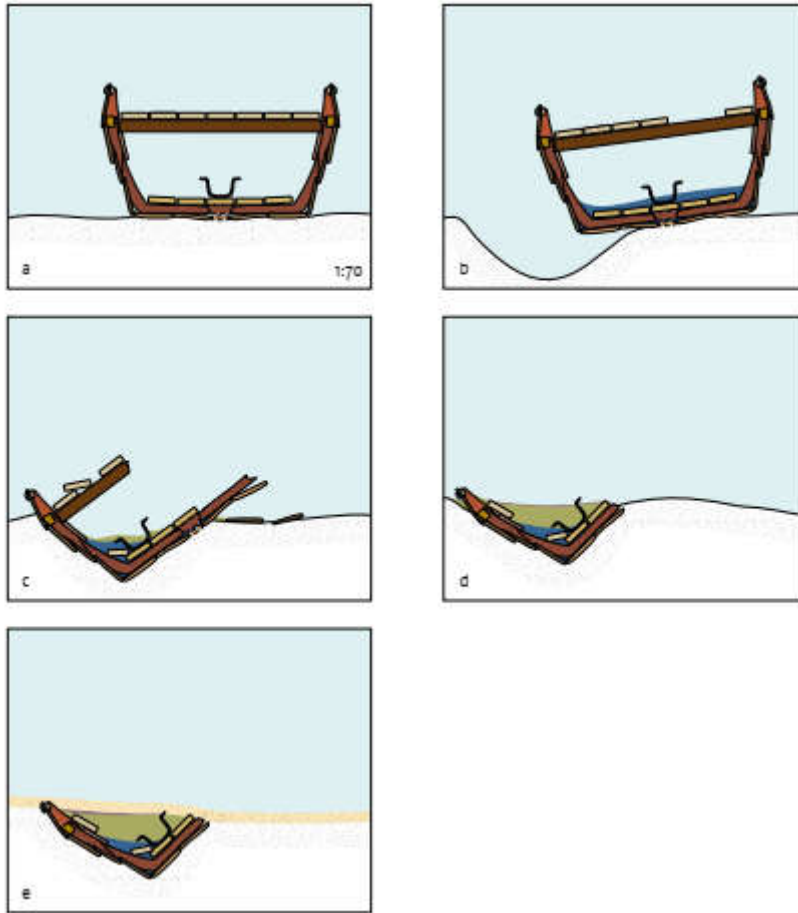


Figure 19A An example of the wreck site formation process after the sunken ship ended up on the seabed. Source: J. Opdebeeck & T. Coenen (red.), 2021: *Kleine schepen in een wereldeconomie*, RAM nr. 268.

### Lost aircraft

6.1.2 The area also has a high expectancy for aircraft wrecks from WWII. Hundreds of aircraft that went down in the North Sea are still missing. These wrecks are not only of archaeological or cultural-historical of importance, but also have a memorial or emotional value. Many of them are war graves and possible risk areas for explosives. No crash sites have been registered with certainty in the two study areas so far, but a possible 15 planes have been provisionally located in the vicinity. All remains will be present on the seafloor. Other (undiscovered) wrecks or parts of aircraft in the study areas are also likely, and the presence of mobile sand waves within the area supports this potential as such features may mask aviation crash sites. The archaeological formation process can be more or less identical to those of shipwrecks (see above 6.1.1.).

### Prehistory

6.1.3 To date no prehistoric finds or archaeological sites have been identified within the Nederwiek Noord and Zuid windfarm zones, nor their 500m buffers.

6.1.4 Archaeological expectancy has been shown to be limited to sites and concentrations of finds from hunter-gatherer groups of the (Middle and Late) Paleolithic and (Early) Mesolithic periods. After c. 7000 BC human occupation will have been impossible in the then drowned landscape of the expanding North Sea. Sites from these periods are extremely low in density. Paleolithic

and Early Mesolithic occupation sites would have been situated mainly on higher parts within the landscape, and/or the banks of river and tidal gully systems, which consequently were also more exposed to later erosion.

- 6.1.5 The archaeological expectancy is strongly related to the geo-genesis of the two areas and remaining lithostratigraphic units. Current available geological information suggests that archaeologically relevant layers and deposits are covered by sea bed sand with a thickness varying between 5 and 10 metres (See figure 20). Specific knowledge is however limited due to the low numbers of borehole- and geotechnical data. The main focus of any additional geological survey should therefore be on the gathering of additional information to broaden the general geoarchaeological information on this part of the North Sea, as outlined in the NSPRMF program.
- 6.1.6 Possible relevant formations and members for Late Pleistocene and Early Holocene archaeology have been mentioned in paragraph 5.6.

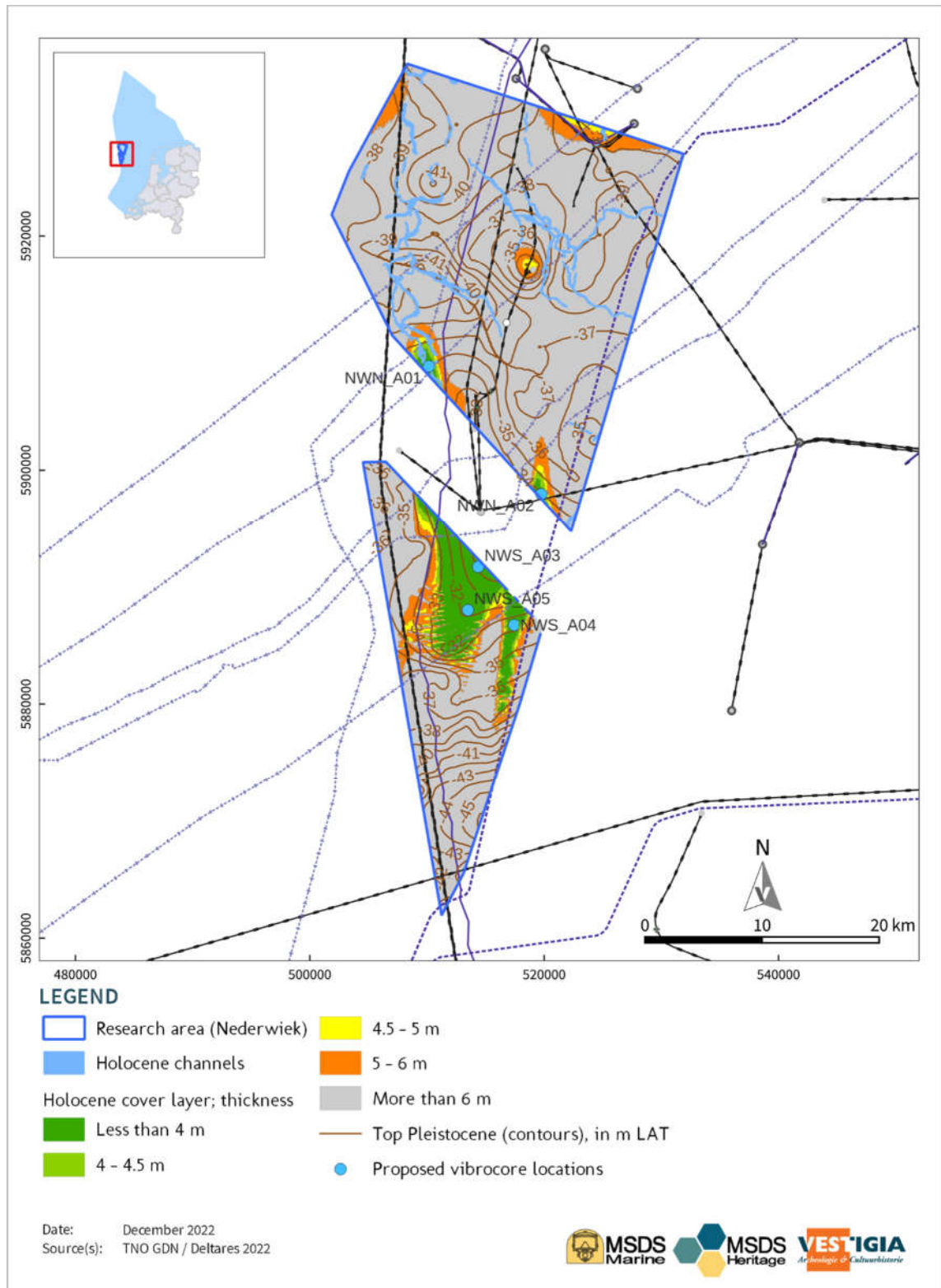


Figure 20 Contour map (in m LAT) of the top of Pleistocene layers and the thickness of the Holocene cover layers (in m) within the Nederwiek Noord and Zuid areas

## 6.2 Recent disturbances

6.2.1 In Section 5.5 and figures 10a - 10c an overview has been given of recent disturbances of the seafloor in both the study areas. No large scale sand extraction activities has taken place. Small

parts of the seabed have been disturbed by trenches, and sub-bottom coring for cables and pipelines and the installation of production platforms. These areas and locations should be avoided anyway when constructing individual wind turbines. Cables, trenches and the installation of platforms may have caused destruction of objects, including historical wrecks, on or in the seabed. As prehistoric sites are not expected within the first 5 meters below the current seafloor, any damage on the archaeological remains, if present at all, is not very likely.

### 6.3 Research questions and answers

6.3.1 In general, for any archaeological desktop study, the following research questions are applicable:

- Are there any known/identified archaeological values present within the research area(s)? If so, what is the nature, extent, location and dating of these values?
  - Yes, at least two wrecks of archaeological value are present within the study areas. These are a part of the stern of a wooden ship of unknown date and the wreck of a German submarine from WWI. Locations are given in Section 0. A further eight wrecks are also known within the study areas, the value of which is unknown but may be high.
  - Although prehistoric finds have not been allocated to the study areas themselves, the Brown Bank area as a whole is rich in Paleolithic and Mesolithic finds recovered by fishermen.
- Are there, in addition to any known values, archaeological remains to be expected? If so, what is the nature, extent location and date of the archaeological remains?
  - Yes, a total of 34 contacts are known from the seabed, among these at least 12 shipwrecks. All contacts are listed in Section 0. Additional information is in general not available. In addition, at specific locations and depths below the seafloor early prehistoric landscapes and/or even sites may have been preserved. Density of sites however, is anticipated to be low as compared to more recent archaeological periods. Intact archaeological sites consist mainly of small temporary camp sites or other areas of activity containing artefacts and environmental information, and none are currently known within the study areas.
- Will the proposed activities in the wind farm zones affect identified or expected archaeological values? If so, can the impact on archaeological assets be prevented or mitigated by planning adaptation?
  - Building on or nearby the two shipwrecks of historic value should be avoided. Further investigation is needed on these two, and other expected archaeological sites to determine their physical extents, exact nature and context before any mitigation strategies can be discussed or applied.
- If archaeological values cannot be saved: What kind of further research is needed to determine the presence of archaeological values and their size, location, type and date in such extent to make a considered decision on protection or mitigation?

This will be further discussed under Section 7.0. In general the next step of the Archaeological Heritage management (AMZ-)process is in order. This means geophysical survey of the area by means of sidescan sonar, multibeam and magnetometer to trace shipwrecks, aircraft, and related objects on the seafloor. Mapping of the prehistoric landscapes can be done by coring, for instance vibrocore techniques and by sub-bottom seismic or acoustic techniques.

In addition, the specific additional tasks defined by RVO in the Scope of Work for Phase I of this series of assessments have been included in this report and its recommendations or will be included within the Written Schemes of Investigation (PvE's) for the geophysical and geotechnical surveys.

## 7.0 Recommendations for mitigation and further investigations (LS06)

### 7.1 Geophysical and Hydrographic Survey

7.1.1 The geophysical survey scope of works for the Nederwiek Wind Farm Zone was provided during the compilation of this report<sup>37</sup>. The scope of works outlined the minimum specification for the geophysical survey from which tender responses will be received.

7.1.2 To ensure the specification of the survey meets the requirements for archaeological assessment, and interpretation, the scope of works was reviewed by an experienced, KNA senior marine archaeologist.

7.1.3 The full specification is detailed within the scope of works but is summarised here for completeness.

#### Survey extents

7.1.4 The survey will provide full coverage of the area to be occupied by the windfarm sites, including a 500 m buffer. To note, the buffer will not extend across the United Kingdom / Netherlands maritime border, which will impact the buffer size to the north-west.

7.1.5 The survey contractor will determine line planning to ensure the required data quality, density, and coverage without relying on infill lines. However, parallel primary lines cannot exceed 70 m in separation, and parallel cross lines cannot exceed 420 m in separation.

#### Survey sensors

7.1.6 The survey will deploy a full suite of geophysical and hydrographic sensors, to ensure that data is collected to fulfil the requirements of the Environmental Impact Assessment (EIA) process, and Front End Engineering Design (FEED). The sensors, along with the broad specification for data collection, are detailed below in table 9.

Sensor	Specification
Multibeam	All MBES data will obtain 100% coverage of the seabed and will be collected to a standard exceeding IHO Special Order. The system used will be capable of achieving a minimum data density of six hits per 0.5 m <sup>2</sup> cell.
Sidescan Sonar	The SSS survey will provide >100% High Frequency coverage of the seabed. Two frequencies, >300 kHz and >600 kHz, will be collected simultaneously. The minimum object detection size will be <0.5 m in any dimension.
Magnetometer	Magnetic data will be collected at the overall survey lines spacing, and at target altitude of <4 m, and no greater the 7 m. the magnetometer will have a sensitivity of >0.01nT and a sample rate of >10 Hz. The

<sup>37</sup> RVO, 2022. Geophysical Survey Nederwiek Wind Farm Zone. Seabed Survey and 2D-UHRD Survey. Scope of Work.

	recommended target identification threshold will be 5 nT peak to peak.
Seismic surveys	The seismic component of the survey is multi-faceted, including shallow sub-bottom profiler, 2D-UHRS, and 3D-UHRS. The specification for the overall survey varies by depth but will meet the following parameters;  0-5 m below seabed – vertical resolution of 0.2 m  5-40 m below seabed – vertical resolution of 0.5 m  40->100 m below seabed – vertical resolution of 1.5 m

*Table 9: Sensor specifications*

### Suitability of the survey specification for archaeological assessment

- 7.1.7 The review of the survey specification indicates that it meets the requirements for archaeological assessment at the pre-consent phase of an offshore windfarm development.
- 7.1.8 The coverage will be 100% of the seabed with both MBES and SSS, with a minimum detection size of 0.5 m. This is suitable for the identification of anthropogenic material, of potential archaeological interest, on the seabed.
- 7.1.9 The magnetometer line spacing, whilst quite wide, is suitable for the identification of small ferrous anomalies beneath, or close to, the magnetometer, and larger anomalies as the distance from the sensor increases.
- 7.1.10 The overall seismic survey strategy, including the penetration and resolution, will be suitable for the production of a ground model, and the archaeological interpretation of the geological units forming the paleolandscape. The required depth of penetration exceeds the depth of potential impact from construction.

### Considerations

- 7.1.11 The survey specification and requirements, within the scope of work, covers all considerations that are required from an archaeological perspective. However, the positions of wrecks and obstructions detailed within this report should be noted and particular attention paid within these areas to ensure the data meets or exceeds expectations.
- 7.1.12 Where possible, additional crosslines should be run over wrecks identified during the survey, to 'box' them in to minimise any potential effects of acoustic shadow.

## 7.2 Geotechnical Survey

- 7.2.1 Recommendations for additional geo-archaeological prospection in both Nederwiek areas by means of borehole/cpt drilling and vibrocores will be made in a separate document, the Written Scheme of Investigation for the Geo-Archaeological survey (WSI GTA) by Vestigia. Further explanation and motivation, as well as the operational requirements can be found in there.



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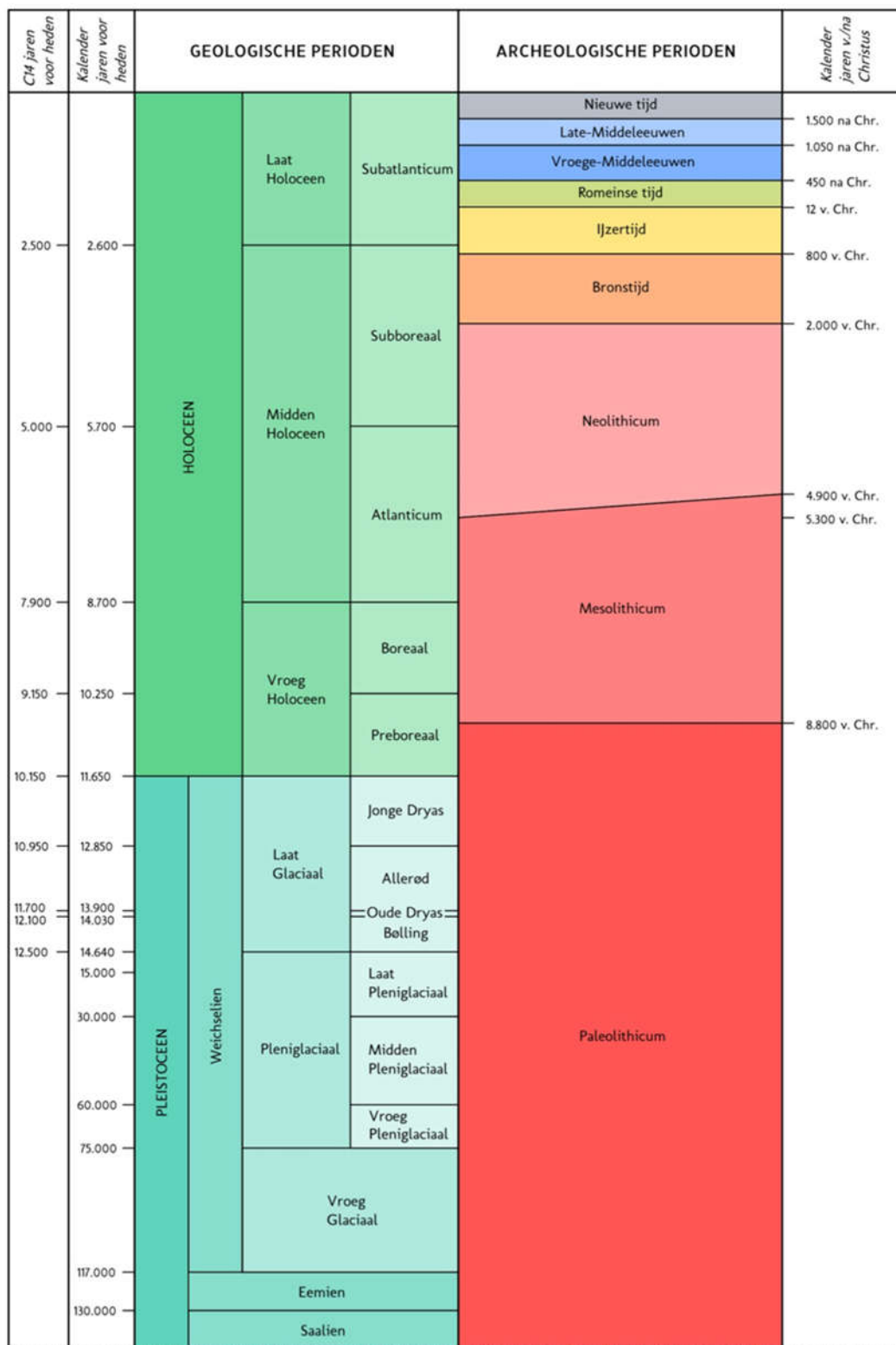
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## Appendix 1: Nomenclature of archaeological and geological periods (Dutch)



C14 ouderdommen en gekalibreerde ouderdommen van het Holocene volgens Van Geel et al. (1980/1981), C14 ouderdom van het Laat Glaciaal volgens Hoek (2001/2008) en gekalibreerde ouderdommen van het Laat Glaciaal volgens Rasmussen et al. (2006). Overige pleistocene chronostratigrafie volgens Westerhoff et al. (2003). Archeologische perioden van de prehistorie volgens Louwe Kooijmans et al. (2005) en overige archeologische perioden volgens Archis.

Archaeological Period	From - Until
Early Paleolithic	Until 300,000 BC
Middle Paleolithic	300,000 BC – 35,000 BC
Late Paleolithic	35,000 BC – 8,800 BC
Early Mesolithic	8,800 BC – 7,100 BC
Middle Mesolithic	7,100 BC – 6,450 BC
Late Mesolithic	6,450 BC – 4,900 BC
Early Neolithic	5,300 BC – 4,200 BC
Middle Neolithic	4,200 BC – 2,850 BC
Late Neolithic	2,850 BC – 2,000 BC
Early Bronze Age	2,000 BC – 1,800 BC
Middle Bronze Age	1,800 BC – 1,100 BC
Late Bronze Age	1,100 BC – 800 BC
Early Iron Age	800 BC – 500 BC
Middle Iron Age	500 BC – 250 BC
Late Iron Age	250 BC – 12 BC
Early Roman Period	12 BC – 70 AD
Middle Roman Period	70 AD – 270 AD
Late Roman Period	270 AD – 450 AD
Early Middle Ages	450 AD – 1,050 AD
Late Middle Ages	1,050 AD – 1,500 AD
Modern Era A	1,500 AD - 1,650 AD
Modern Era B	1,650 AD – 1,850 AD
Modern Era C	1,850 AD – 1,950 AD

*Table 10 Archaeological periods*

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