1 INTRODUCTION AND SCOPE

This document outlines the data prerequisites for Geographic Information Systems (GIS) to be used in all activities related to the proposed Offshore Windfarm. It also establishes a unified framework for data, drawings, and measurement systems to be followed by all stakeholders, including external consultants. Compliance with the requirements specified in this document is mandatory. In exceptional cases, deviations from these requirements may be considered, but approval from the GIS Manager is necessary before commencing the work.

To ensure that all contractors provide data that is compatible throughout the entire project, this GIS Data Specification must be included in all Invitations to Tender (ITTs), Scopes of Work (SoW), and contracts with third parties. If additional information or clarification is needed, please contact the GIS Team through the GIS Mailbox.

2 REFERENCES

Name	Link
IOGP SSDM Standards	https://www.iogp.org/workstreams/engineering/geomatics/seabed-survey-data-model/
MEDIN Data Standards	https://medin.org.uk/data-standards
CAD BIM Data Standards	ISO 19650 - Building Information Modelling (BIM) | BSI (bsigroup.com)

3 DATUMS, COORDINATE SYSTEMS AND UNITS

All data recorded, presented, or conveyed must be accompanied by a comprehensive declaration of the units, datums, and coordinate systems in use.

If the coordinates within a dataset have undergone any form of transformation, this process must be documented within the lineage statement of the metadata. This documentation should include information about the direction, method, source, and target coordinate reference system (CRS), as well as the accuracy and associated parameters, including their respective units of measurement. Moreover, it is essential to furnish example coordinates in both the source and target CRS within the datasets so that Vysus Group can verify the correct application of the transformation. In cases where the coordinate transformation definition is not available in the EPSG database, it must be thoroughly documented in an external file.

Furthermore, it is imperative to specify which datum is being used in conjunction with the coordinates for a given position.

4.1. Onshore and Offshore Horizontal Datums

Confirmation and approval from Vysus Group are required prior to commencing any work for establishing the suitable horizontal datum for both onshore and offshore locations.

Any procedures involving the transformation and correction of data obtained from different horizontal datums must also receive confirmation and approval from Vysus Group before their execution.

4.2. Coordinates Presentation

Accuracy pertains to the alignment of measurements with the actual values (e.g., within a range of +/- 10 cm), while precision relates to the level of detail in measurements (e.g., at the meter or centimeter scale). In cases where coordinates are presented, the level of precision should accurately mirror the positional accuracy. It is imperative to specify the coordinate system and units consistently and explicitly in use.

4.3. Projected Coordinates

Table 1 presents the example format required for onshore and offshore projected coordinates which shall be presented as numeric **Eastings and Northings** with the coordinate system and units clearly stated.

Table 1: Example format for Projected Coordinates

[Projected Coordinate System e.g. WGS84 UTM zone 30N] (m)	
Easting	**Northing**
445817.0	**6257413.00**

4.5. Geodetic Coordinates

Geodetic coordinates should be represented in Decimal Degrees (DD). Typically, survey and engineering data should be provided with a precision _Anof 7 decimal places, which is approximately equivalent to

1 centimeter at the equator. It is essential to clearly specify the coordinate system and units being utilized.

When expressing the position of coordinates concerning the prime meridian, sign notation must be used, signifying that coordinates to the west of the prime meridian are negative, and those to the east are positive. Similarly, for latitude coordinates, sign notation should be employed, indicating that coordinates north of the equator are positive, while coordinates south of the equator are negative. The usage of prefixes or suffixes to denote north, south, east, or west in relation to these lines is discouraged. You can refer to Table 2 for an example illustrating the required format for presenting geodetic coordinates.

Table 2: Example format for Geodetic Coordinates in Decimal Degrees

[Geodetic Coordinate System e.g. WGS84] (DD)	
Latitude	**Longitude**
56.45809	**8.1207932**

The sole circumstance in which geodetic coordinates are expressed in a format other than decimal degrees is when specific offshore vessel documentation mandates an alternative representation. In such instances, coordinates should also be provided in Degrees Decimal Minutes (DDM), with a precision of up to 6 decimal places. Furthermore, these coordinates should indicate the associated cardinal directions as N/S for latitude and E/W for longitude instead of utilizing positive and negative sign notation. For a visual reference of the format needed for presenting DDM geodetic coordinates, please consult Table 3.

Table 3: Example format for Geodetic Coordinates in Degrees Decimal Minutes

[Geodetic Coordinate System e.g. WGS84 (DDM)	
Latitude	**Longitude**
56° 27.485844' N	**008° 07.247592' E**

4.6. Units

The ISO International System of Units (SI) will be used in all works carried out as defined in ISO/IEC 80000. Metric measurements shall be used as follows:

- Length: meter(m) or appropriate multiple for onshore / nautical miles (nm) or appropriate multiple for offshore;

- Mass: kilogram (kg) or appropriate multiple;
- Temperature: Celsius (ºC);
- Time shall be referenced and recorded in Coordinated Universal Time (UTC) which can be considered equivalent to Greenwich Mean Time (GMT) when fractions of a second are not important;
- Dates shall use the form "dd mmm yyyy"(e.g. 21 APR 2024); except for file names which shall use '_yyyymmdd' (_20240421);
- All time stamps shall also be stored as UTC, regardless of local time setting used, and the time stamp shall state that it is as UTC;
- All time stamps on time series data shall apply to the end of the averaging period, if applicable.

4 EXISTING DATA QUALITY

Contractors engaged in project-related tasks, including design studies, assessments, surveys, and consent applications, may find it necessary to utilize pre-existing GIS datasets not specifically gathered for the project. These datasets could encompass public data, third-party data, or historical records.

In such instances, it is imperative to perform a minimum number of quality checks and maintain meticulous records to ensure the suitability of the data for the task at hand and to create a catalog for future reference and utilization. Contractors are responsible for guaranteeing that any pre-existing data used for a project activity closely aligns with the final maps, drawings, results, and reports generated from that activity. For example, any layers depicted in a map or drawing should also be included in the corresponding GIS deliverable that adheres to Vysus Group's requirements. Furthermore, contractors must secure data licenses and sharing agreements to facilitate the transfer and complete use of such data by Vysus Group.

In cases where contractors modify or expand existing datasets, this should be documented in the metadata, and the original, unaltered datasets must be preserved for potential submission to Vysus Group upon request. Any disparities between the anticipated data and the data presented in the project activity results should be thoroughly investigated to provide a robust explanation for these discrepancies.

It is important to note that if there is any uncertainty regarding GIS data quality and the requisite data checks, contractors should reach out directly to Vysus Group GIS for a discussion before proceeding with their project activity.

5 DATA DELIVERABLES

GIS data constitutes a crucial element among the deliverables expected from Contractors at every phase of the project, encompassing onshore and offshore aspects. These deliverables encompass a wide range of data, including but not limited to engineering design data, surveys, construction and installation data, final as-built records, and the outcomes of relevant studies and analyses with a spatial dimension.

The precise timeline for the submission of GIS deliverables will be established within the contracts and scopes of work provided to each Contractor. For instance, certain GIS deliverables may be required within 24/48 hours of specific tasks, such as during Unexploded Ordnance (UXO) investigations. Other deliverables, like those arising from consultant studies or fully integrated survey results, will be expected to align with contractors' reporting milestones.

It is imperative that GIS data is structured in a manner that facilitates its seamless transfer to Vysus Group throughout the course of the project and in full upon project completion, along with the relevant GIS models and metadata.

All deliverables from Contractors will follow codification and distribution procedures in accordance with the Document Control Management system outlined for the project. Any information provided by contractors that does not meet this requirement will be rejected by the GIS team.

Contractors providing GIS data are required to maintain an official tracker of the deliverables, documenting their status, submission dates, and whether they have been superseded.

Just like other project deliverables, all GIS deliverables will undergo a review by the Employer, and Contractors will be responsible for incorporating any amendments and updates, as necessary.

While this GIS Specification outlines general requirements for GIS data, it is important to note that the Scope of Work, Technical specifications, and the Contract will contain additional details concerning the format, accuracy, and content of GIS deliverables expected from Contractors. In some cases, Contractors may be asked to provide data in accordance with specific data templates provided by the Employer.

6.1. Data Formats and Guidelines

The Contractor is required to furnish Geospatial data in vector, raster, and project formats compatible with both ESRI ArcGIS and QGIS. Specifically, data should be provided in ESRI ArcGIS Shapefile, ESRI File Geodatabase, or Geopackage format, complete with corresponding metadata and layer files or QGIS projects (.qgz or .qgs) used for map production. It is the responsibility of the Contractor to ensure that all data adheres to the predetermined Scope of Work, Technical Specifications, and Contract. Compliance with relevant industry standards is mandatory, and all processed spatial data should be compatible with either:

- ESRI ArcGIS Pro [2.4.0] or later
- ArcGIS ArcMap [v.10.3] or later
- QGIS [3.10] or later

For specific requirements regarding GIS data deliverables related to nearshore and offshore surveys, please refer to Section 6.9.

6.2. Language

All aspects of the data delivery will be provided in **English**. This includes, but is not limited to, the following:

- Document Names
- Geodatabase names;
- Group Layer names;
- Feature class names
- Field names
- Attribute values
- Lineage statements
- Metadata provide in the feature class item description or accompanying format such as XML

6.3. Data Naming Conventions

File names and folder paths of data submitted should be kept short to avoid problems copying data to servers. Total file paths must be less than 100 characters.

Data should be provided in a zipped folder. Top level folders, drawings and reports must be codified using Vysus Group document numbers, to be requested from document control. For all GIS data and files within the delivery, the naming convention shown in ***Table 4*** should be followed. Shapefiles must not start with a number, and no spaces or special characters should be used in file names: underscores (_) may be used instead.

Table 4: Example Data Naming Convention

File Type	Name	Example
Top Level Folder	Document_Number_Revision_Description.zip	**GLB_GEN_GIS_SPE_AGR_000011_Rev01_GIS**
Or Zip File		**Data_Specifications**
Zipped Folder /	Project_Code_Data_Description_Consultant_ID	**GLB_SSS_Contacts_FUGRO_20190131.zip**
Subfolder	_YYYYMMDD.zip	
Shapefiles /	Project_Name_Description_Consultant_ID	**GLB_SSS_Contacts_FUGRO_20190131.shp**

Feature Classes	**_YYYYMMDD.shp**	

Any data provided to a consultant by Vysus Group which has not been subsequently modified by the consultant, should maintain the original filename upon return of the data to Vysus Group.

6.4. Accuracy

GIS data shall be accompanied by a statement of accuracy. This information should be stored in the metadata compatible with both ESRI and QGIS standards. Metadata should be embedded within the data files or provided as separate XML files where applicable. For example, a clear statement of resolution, vertical, horizontal, and positional accuracy should accompany height data. For example, "Bathymetry data gridded to 25cm, accurate to 5cm in X and Y and 10cm in Z". Or, if boundaries were digitized from 1:10000 base mapping, the statement of accuracy should be given as accurate to 1:10,000.

6.5. Vector data

Vector data should adhere to the following spatial integrity requirements:

- No overlapping features;
- No duplicated features;
- No zero-dimension features;
- The number of spatial features shall correspond to the number of records in the associated attribute table.

Any attribute coding shall be supplied with an associated lookup table with descriptive explanations of the features represented. Column names should avoid blanks and special characters and names should begin with a letter not a number. Null or Missing Values should be replaced with the following:

- NA – not applicable
- UNKNOWN – for no known value
- NONE – if it is known that no attribute exists.

6.6. Raster Data / Images

The Contractor is responsible for the following:

- All photographs, whether onshore or offshore, must have geotags and be provided in JPEG format. They should be date-stamped and include compass bearing information.
- Survey data, such as bathymetry, must be presented as a single, fully processed raster dataset with seamless edge matching. No processing artifacts should be visible in the data; any data with such artifacts will not be accepted.
- In cases where data has been divided for processing and is not provided as a mosaic, high-resolution raster data must be accompanied by a raster location plan.
- Raster Grid data should be supplied in ESRI Grid or ESRI File Geodatabase Raster Datasets. Alternatively, uncompressed files like GeoTIFF may be used, including projection files where applicable (e.g., .tfw, .jpw, .jgw). Merged data can be delivered as compressed ECW files if the file size is unmanageable.
- Each cell in raster grid data should contain a value at the center of the grid cell, such as depth, rather than RGB values.
- XYZ files should be transformed into Raster Grids.
- Raster data should be referenced to the appropriate project-compliant coordinate system and vertical datum. Values below Lowest Astronomical Tide (LAT) should be represented as negative values.
- Raster data must be accompanied by relevant metadata.
- Original raster tiles should be provided alongside a mosaicked raster.
- When colors are used to depict the values of multiple layers in charts, a consistent stretching method should be applied to all layers to ensure that the data is presented coherently when displayed.
- Sidescan sonar and similar data should be supplied as tiled GeoTIFF files or as ECW compressed wavelet images.

6.7. Raw Data

The original survey datasets must be provided to the Company in their unaltered, as collected/surveyed format. Any modifications to the original raw data will be treated as distinct new datasets. Data should be meticulously organized within a well-documented folder structure, akin to the BGS folder structure, with each survey dataset allocated a separate folder identified by its survey ID.

For vector data, TIFFs, and raster data, attribute data should encompass survey results and magnitude values corresponding to the specific survey technique employed (e.g., seismic velocity for refraction or width, height, and length for side-scan sonar). These attributes should be complemented by descriptive metadata detailing the content and the process of creation.

Examples of raw data encompass:

- Bathymetry (referenced to the project's standard vertical datum in meters), including point clouds: Files with extensions like *.all, *.tid, and *.xyz.
- Side-scan sonar: Files with extensions such as *.xtf and *.con.
- Seismic data (measured in meters per second m/s): Files with extensions like *.sgy, *. coda, and *.tid.
- Magnetometer data in nanoTesla (nT), typically in geometrix format, which includes survey files, GPS files, line number files, and related TXT and page files.
- Geotechnical data: Files with extensions such *.ags and *. asci.
- PAM (Passive Acoustic Monitoring) data: Original high/medium frequency raw data.
- AWAC (Acoustic Wave and Current) and MetMast raw data: Files with extensions like *.ndf, *.raw, and *.spt.
- Video, imagery, and media data: Files with extensions like *.seq.
- Any other types of raw data, including TXT files and Excel spreadsheets when relevant.

6.8. Seabed Survey Data Model (SSDM)

Please take note that for surveys and interpretations pertaining to nearshore and offshore geophysical, geotechnical, and benthic surveys, in addition to raw data, fully processed and interpreted data should be supplied in accordance with version 2 of the IOGP Seabed Survey Data Model (SSDM) guidelines [1]. The IOGP SSDM model and accompanying documentation are readily accessible for download, providing all the necessary information to assist survey contractors in crafting a comprehensive GIS data model and associated metadata after the survey work is completed. The IOGP package incorporates the following components to facilitate adherence to the SSDM model:

- Data Dictionary
- Data Model Templates (in ESRI ArcGIS format)
- Data Model Guidelines
- Symbology
- Metadata requirements

Survey Contractors, operating on behalf of the project, are tasked with developing and delivering a fully compliant GIS SSDM, featuring primary feature datasets and classes. Additionally, any deliverable items that cannot be integrated into the SSDM must be provided in suitable formats. It is important to acknowledge that not all surveys will require the population of every part of the SSDM. For instance, a geophysical survey may not generate Environmental Sample data. Therefore, contractors should populate the relevant feature layers and remove any non-relevant feature layers.

Any deviations from these requirements should be discussed and approved by the Vysus Group GIS Team before the commencement of the survey. Survey Contractors are encouraged to enhance the value of all surveys by incorporating extra fields and information into GIS deliverables whenever possible.

"The Seabed Survey Data Model (SSDM) is founded on geographic representations of seabed survey objects (classes), their attributes, inheritance, and relationships. A class is defined as either an Abstract or Concrete class. Abstract classes serve as templates used to generalize common attributes and behaviors that would otherwise be duplicated across (sub)classes – Concrete classes. A Concrete class inherits base attributes and relationships, resulting in the creation of the concrete feature during the physical implementation of the model.

The SSDM is represented by eight abstract classes and thirty-eight concrete classes organized into four feature datasets (Survey Measurements, Seabed Features, Shallow/Intermediate Geology, and Environmental Samples). Concrete classes within a feature dataset share a common coordinate reference system. This grouping of datasets allows Oil and Gas companies to establish topology rules, relationship classes, and geometry networks as dictated by their business processes" [1].

6.9. Data Guidelines Offshore (MEDIN)

In addition to the SSDM data guidelines, the MEDIN Data Guidelines shall be used to inform what specifically is captured. The MEDIN Data Guidelines provide a list of information that should be collected with data to ensure the data can be re-used in the future. The guidelines are tailored to different methods and arranged by theme and include data templates which standardise attribute field names. The MEDIN Data Guidelines can be downloaded here:

- https://medin.org.uk/medin/sites/medin/files/documents/MEDIN_Schema_Documentation_3_1_2_full-1.pdf

6.10. QGIS Data Quality and Validation

For datasets provided in QGIS formats, ensure that:

- All vector data in Geopackage format adheres to the spatial integrity requirements outlined in Section 6.6.
- Raster data should be in a format supported by QGIS, such as GeoTIFF, and include appropriate metadata.
- All QGIS project files (.qgz or .qgs) should reference relative paths to ensure portability.
- Perform quality checks on QGIS data similar to those required for ESRI formats, documenting any modifications and maintaining original datasets.

6.11. Metadata

6.11.1. Offshore

All offshore survey data must be accompanied by a MEDIN-compliant Discovery metadata file in XML format, provided at both the Project and Dataset levels. A dataset signifies a collection of data, such as bathymetry data for a particular survey. It is not necessary to supply Discovery metadata for each individual file within a dataset. The definitions of "dataset" and "series," as specified by MEDIN, are available at the following link:

- MEDIN data guidelines | MEDIN – Marine Environmental Data and Information Network

You can create and verify metadata, ensuring that the XML file complies with MEDIN standards, using either the downloadable MEDIN Maestro tool or the online MEDIN Discovery Metadata Editor accessible through the provided link.

For all GIS deliverables, evaluation metadata should be provided. The minimal data requirements for evaluation metadata include:

- Title.
- Keywords describing the feature.
- Summary (purpose).

- Description (abstract): A concise overview of the feature and its content, featuring the feature's creation date and a statement of accuracy.
- Lineage.
- Company contact details (company, address, email, etc.).
- Scale at which data was derived.
- Coordinate system, always adhering to the project's conventions.
- Use limitations.
- Field descriptions.

In addition to the MEDIN metadata prerequisites, for survey work with SSDM feature class deliverables, Contractors must also adhere to the supplementary SSDM guidelines for Metadata [1].

6.11.2. Onshore

All survey data sets with a spatial extent exclusively onshore shall be supplied with INSPIRE compliant metadata. The minimum information within this should include:

- Title.
- Summary (purpose).
- Description (abstract): Brief description of the feature and the information that it contains. Feature creation date should be included. As well as a statement of accuracy.
- Feature creation date.
- Lineage.
- Key words.
- Contact details (company, address, email, etc.).
- Scale on which data was derived;
- Use limitations;
- Field descriptions.

6.12. Data Transfer

All data sent shall be provided via the projects designated Document Management System accompanied with a completed signed data transmittal. Datasets over 100GB will be sent via recorded courier on encrypted portable media, supplied at the expense of the data provider.

6.13. Data Approval

After completion of works, a report and draft data is transferred to Vysus Group and the GIS team is notified. The GIS team and technical experts will check and validate the data and ensure it is compliant with the GIS Specifications and scope of work. If approved, the contractor will transfer the final GIS data and approved report. If not approved, the data creator may need to reprocess or modify the deliverables before resubmitting.

6.14. As-Built Data and BIM

Any As-Built information should be BIM Level 2 Compliant to BS EN ISO 19650-2 and fully compliant to the company's 3D Modelling and CAD specification.

6.15. Data Retention

The Contractor must guarantee the submission of all raw, processed, GIS, CAD, and other project-related data to Vysus Group upon work completion. Additionally, this data should be made accessible to Vysus Group upon their request, for a duration of 5 years following the project's conclusion.

6.16. Data Licenses

The Contractor will be responsible for obtaining any necessary licenses for secondary data. However, wherever feasible, Vysus Group should be designated as the licensee and granted legal rights to the data. Vysus Group will retain ownership of all primary, processed, and analyzed data.

6 MAP REQUIREMENTS

The GIS Team will provide mapping templates in ArcGIS format for the Contractor's use. If a Contractor intends to deviate from the Vysus Group Drawing Procedure or opt for an alternate mapping template, it is necessary to initiate a discussion with the GIS Team. All maps included as part of any deliverable, such as those within reports, must incorporate the following elements:

- A drawing number, which corresponds to a source map document (native file), enabling the later identification of the data used in the map if needed.
- A distinct figure number that should be referenced in any written report.
- A drawing version number or revision identifier (e.g., rev 1 or rev 2).
- The Coordinate Reference System (both horizontal and vertical).
- A scale bar.

- A scale ratio indicating the original plot size for which the ratio is applicable.
- A North arrow.
- An appropriate grid or graticule.
- A title suitable for the map's content.
- Copyright notices and other relevant information.

7.1. Drawing Numbers

For guidance on obtaining drawing numbers for the Project, please consult the GIS Team.

7.2. Deliverables

Electronic mapping shall be provided in two formats: separate PDF files and corresponding ESRI ArcGIS native files. The native files should be in the aprx format, compatible with ESRI ArcGIS Pro [2.4.0], or in the MXD format, compatible with ESRI ArcMap [v10.3]. These files should be saved with relative paths, and all shapefiles (.shp), geodatabases (.gdb), and rasters referenced in the drawings should be included. To prevent redundancy, GIS data should be supplied without duplication. For map series, a combined geodatabase should be created with all MXDs referencing the data therein. Other formats like ESRI Map Packages (MPK or MPKX) may be requested.

If single layers need to be shared, the preferred format is an ESRI Layer Package. However, ESRI shapefiles (.shp) or feature classes stored in geodatabases (.gdb) may also be utilized. All GIS data should be produced in accordance with established GIS best practices.

The Contractor is responsible for providing all necessary equipment, hardware, and software for data processing to ensure that deliverables meet the GIS specification. Additionally, the Contractor is responsible for transferring data to Vysus Group at their own expense.

8. CAD REQUIREMENTS

Any CAD data should be converted to an ArcGIS compatible format by the consultant.

CAD files should only be used in exceptional circumstances, where agreed with Vysus Group and must adhere to the below requirements. This will ensure that the amount of time spent incorporating CAD data into the GIS system is minimized.

8.1. Mapping

CAD drawings should not be used for mapping. All geospatial data supplied shall be created natively in GIS software or converted to an ArcGIS compatible format (such as .shp) from CAD by the consultant and delivered in compliance with this GIS Data Specification.

The following considerations should be noted and are expanded on within the "CAD Data Specifications Document."

8.2. Exporting Geospatial CAD Files to Shapefiles

The contractor shall provide all geospatial information in shapefile format or another GIS compatible format. Various software is available to export to shapefiles. Contractors shall provide a single shapefile per layer. A description of each layer shall be provided in an Excel table as complementary information.

There are a number of methodologies for undertaking a conversion from CAD to ArcGIS, including using the extension 'ArcGIS for AutoCAD'.

8.3. Importing Shapefiles into CAD

Geospatial project information will be provided by Vysus Group in shapefile format. The extension 'ArcGIS for AutoCAD' also enables importing GIS data directly into CAD. A separate document has been prepared which summarizes how to work with GIS data in AutoCAD and can be provided on request.

8.4. AutoCAD Layers

Layer names should follow the same naming convention as shapefiles. Each feature (points, lines, polygons) should be stored in a separate layer with only one thematic type per layer. For example, a site boundary layer would only contain the boundary data and would not contain turbine points or cable route data. Layer attributes should be stored within the layer and not as annotation.

8.5. Coordinate Space for Geospatial Data

All data must be presented in real world coordinates at 1:1 scale, the use of paper and model space view ports to combine presentation layout and real-world coordinates is acceptable.

8.6. Drawing Entities

Splines: It is preferable that drawings do not contain splines as the reading of spline lines are not fully supported in all GIS packages.

Hatching: Where hatching is used to define a polygon feature, polygons must also be produced for the boundaries of the feature. All hatching should be placed in a separate layer to the features to which it is associated.

Polygons: Polygons should be represented as AutoCAD polygon shapes (e.g. circles, rectangles, squares etc.).