OS OPEN RIVERS
– TECHNICAL SPECIFICATION

Version history

Version	Date	Description
1.0	03/2015	Initial release.
2.0	10/2016	Minor updates.
2.1	07/2019	Minor updates.
2.2	05/2021	Introduction of vector tiles.

Purpose of this document

This is the Technical Specification for the OS Open Rivers product. This Specification provides greater insight into this product and its potential applications. For information on the contents and structure of OS Open Rivers, please refer to the Overview.

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Contents

1.   Introduction

OS Open Rivers provides a two-dimensional topologically connected link and node network of Great Britain's watercourses. A link represents the approximate central alignment of a watercourse. Links have been digitised in the direction of water flow. Attribution indicates the flow direction and name of each watercourse.

OS Open Rivers is a generalised product which has been automatically derived from Ordnance Survey large-scale data. Generalisation is the process of reducing the scale and complexity of map detail whilst maintaining the important elements and characteristics of the features.

1.1   Available formats

OS Open Rivers will be supplied in the following open source formats:

•   A national set of vector data in Geography Markup Language (GML) 3.2.1 Simple Features Profile – level 0

•   A national vector dataset in ESRI shapefile (.shp)

•   A national vector GeoPackage file (.gpkg)

•   A national vector tiles file (MBTiles)

1.2   Identifiers

Each feature will be given a unique identifier. The GML product will have the property gml:identifier, which will hold the feature's unique identifier. The ESRI shapefile will have the property identifier, which will hold each feature's unique identifier. The GeoPackage file will have the property id, which will hold each feature's unique identifier. The identifier will not be persistent between product versions, and therefore there will be no feature change history information.

1.3   Adherence to standards

OS Open Rivers is based on the INSPIRE Hydrography Data Specification, which itself is based on the ISO TC211 family of open standards.

1.3.1   Extending the INSPIRE specification

OS Open Rivers expands the INSPIRE specification by extending the INSPIRE WatercourseLink feature type with a number of additional properties.

1.3.2   UML diagram and table conventions

The data structure is described below by means of Unified Modeling Language (UML) class diagrams and accompanying tables containing text. The UML diagrams conform to the approach specified in ISO 19103 Conceptual schema language and ISO 19109 Rules for application schema, as adopted by INSPIRE.

Colour conventions have been used in the diagrams and tables to distinguish the INSPIRE specification from the additional properties that have been added in this specification.

In the UML diagram, classes from the INSPIRE Data Specification are coloured grey, whereas classes in the Ordnance Survey product specification are coloured orange and code lists are coloured blue, as can be seen in Figure 1. The tables which follow in this Technical Specification use orange for a feature type and blue for a code list.
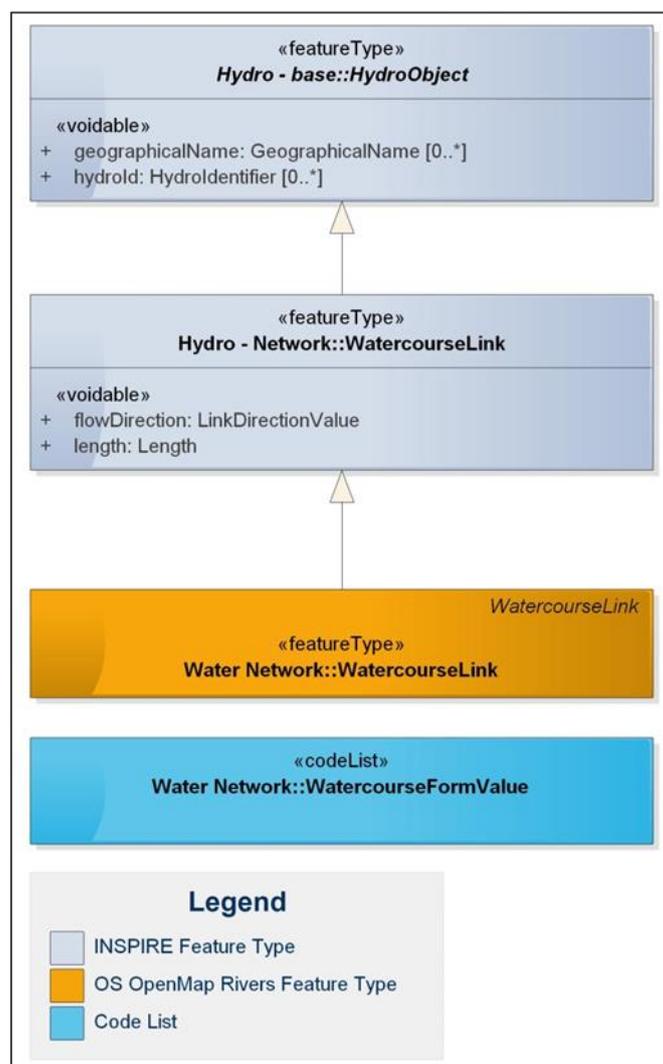

Figure 1: A UML class diagram using the colour conventions specified in this Technical Specification.

1.3.3   Lexical conventions

•   Class names are conceptually meaningful names (singular noun) in UpperCamelCase

•   Class names end in *Value* where the class is assigned the stereotype <<CodeList>> or
    <<Enumeration>>

•   Property names (attributes and associations) are in lowerCamelCase

1.3.4   Stereotypes

The following stereotypes are used on UML elements:

Stereotype	UML element	Description
Application schema	Package	Parent package containing sub-packages and elements that comprise part of the modular specification.
FeatureType	Class	A spatial object type [ISO 19136].
Type	Class	A structured data type with identity.
CodeList	Class	A controlled set of values for a free text data type that may be extended.
Voidable	Property	A property that is required but is either not currently captured (unknown) or is partially populated (unpopulated).

1.3.5   Relationships and associations

There are four key types of relationship that can be defined between classes; only the following two exist in
OS Open Rivers (Figure 2):

1. **Generalisation/Specialisation** – This is used to denote either:

    •   An extension relationship – The target class represents the same real-world phenomenon, so it
        shall have the same name as the class it is extending. It simply includes additional properties.
        OR
    •   A sub-typing relationship – The target class defines a specialised sub-type of a parent feature. For
        example, a TransportNetwork is a sub-type of a generic Network class.

2. **Directed association** – This is used to denote relationships between features. These relationships are
    by reference only (that is, they are implemented by a property whose value is the identifier of the
    related feature or object). The directed end shall always be assigned a name which describes the
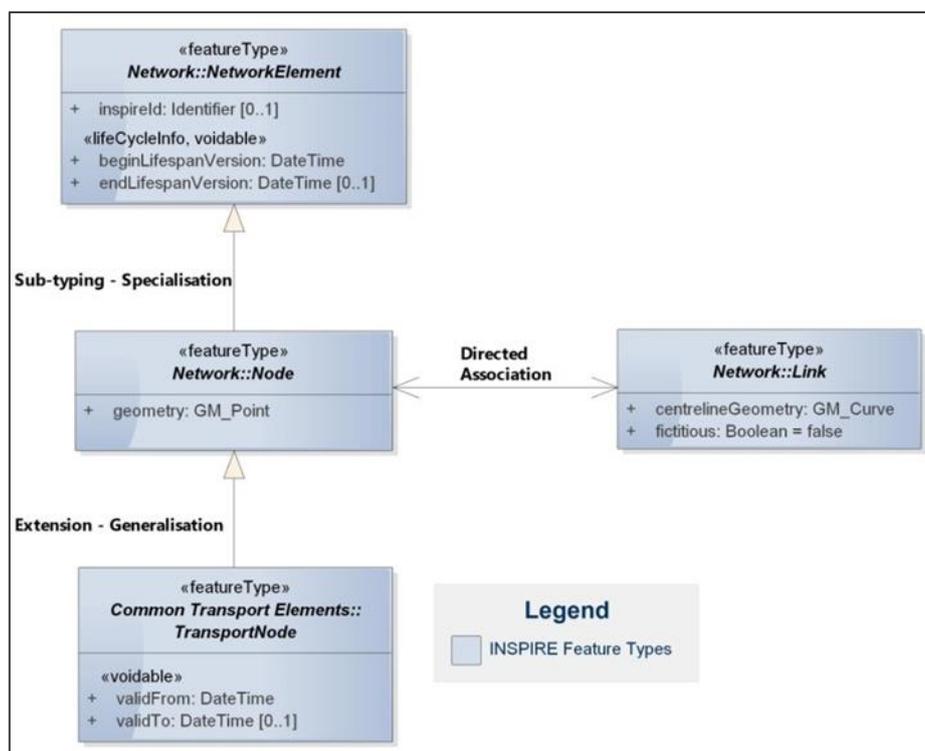   relationship and a multiplicity.

Figure 2: A UML class diagram illustrating the key types of relationships in OS Open Rivers.

2. OS Open Rivers structure

2.1 Product structure

OS Open Rivers consists of two core features:

1. **WatercourseLink** – A feature which represents all or part of a watercourse.

2. **HydroNode** – A feature which represents a river's source, end or where three or more links meet at a junction and places where the real-world related attribution recorded changes, for example, a watercourse becoming tidal.

This product has been based upon the INSPIRE Hydrography Data Specification. The result is a product that inherits attribution from INSPIRE. An overview of the product's structure can be found in Figure 3, which highlights the inherited INSPIRE feature types and attribution. Properties of the INSPIRE specification which are voidable have not been included in Figure 3 or the following tables. For information on the INSPIRE properties which are not included in this product, please see the INSPIRE Hydrography Data Specification.

The GML naming of attributes is used in the main text of this guide; the naming of the attributes in shapefiles will be different due to the limitations of the shapefile format, whereas the naming of attributes in GeoPackage files will be very similar to GML as there are no character length limitations with the GeoPackage format.

A mapping between the GML attributes and shapefile attributes can be found in Section 4.1. A mapping between the GML attributes and GeoPackage attributes can be found in Section 5.1. A mapping between the GML attributes and the vector tiles attributes can be found in Section 6.2.
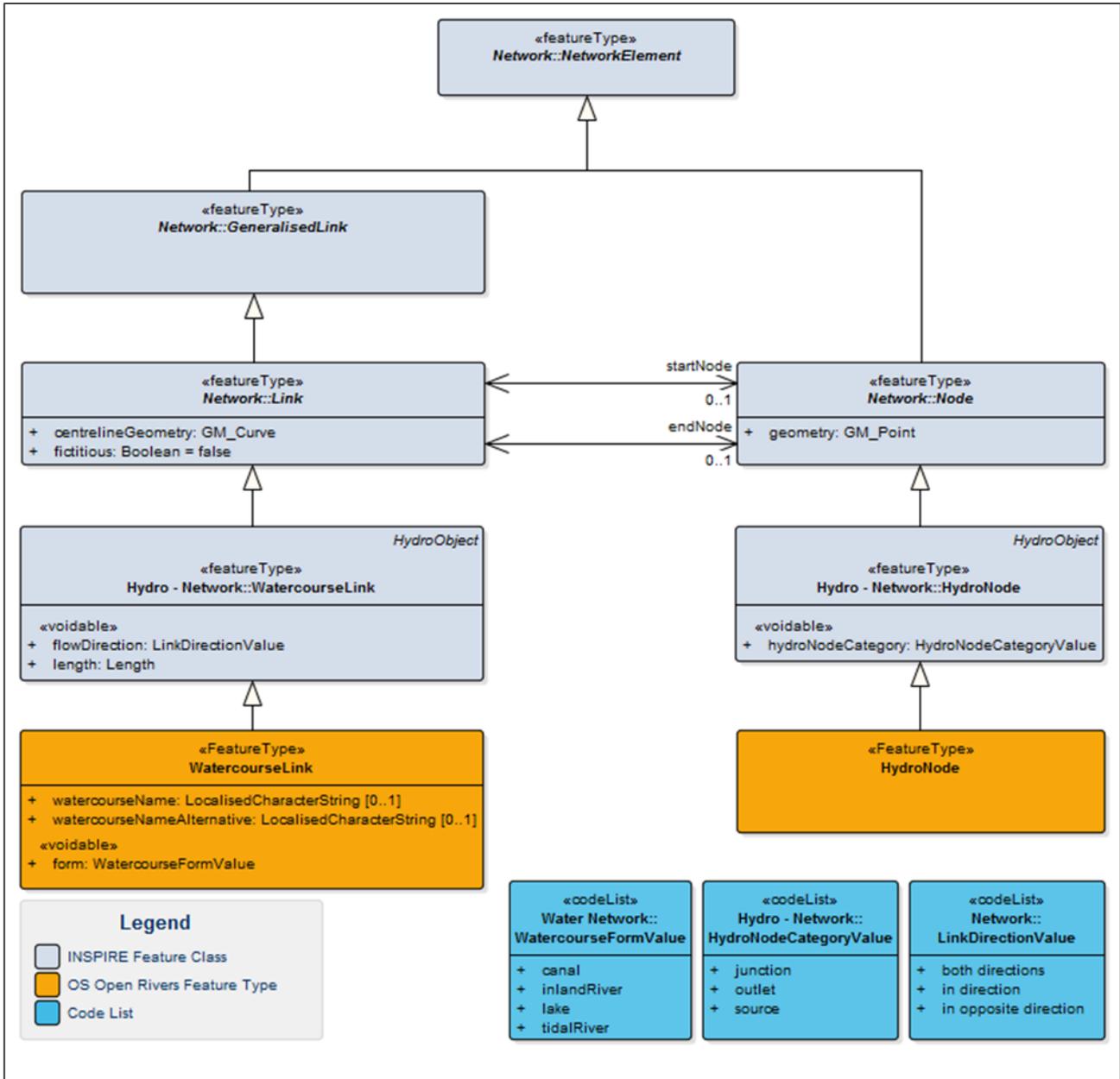

Figure 3: A UML class diagram illustrating the data structure of OS Open Rivers and how it has been extended from the INSPIRE Hydrography Data Specification.

2.2 Features

This section describes the two features available in the OS Open Rivers product, giving the following information about each attribute and association:

Name and Definition – The name of the attribute and what it is describing.

Attribute Type – The nature of the attribute, for example, a numeric value or a logical indicator.

Multiplicity – Describes how many times this element is expected to be populated in the data. An attribute may be optional, mandatory and may have multiple occurrences. For example:

- '1' – There must be a value
- '2' – There must be two values
- 'n' – There may be one or more values
- '0' – Population is optional

These values may be used in combination.

Association – An association identifies the relationship between features. These relationships are by reference only and the value will be the identifier of the referenced feature.

2.2.1 WatercourseLink

The WatercourseLink feature is a generalised representation of the watercourse alignment. WatercourseLink features are split where their real-world related attribution changes or where they meet to form a junction.

«featureType» WatercourseLink	
Definition: A segment that forms part of a watercourse.	
Attribute: flowDirection «voidable»	
Definition: Direction of water flow in the segment relative to digitisation of segment geometry.	
Type: LinkDirectionValue	Multiplicity: [1]
Attribute: length «voidable»	
Definition: Length of network segment.	
Type: Length	Multiplicity: [1]
Attribute: centrelineGeometry	
Definition: The geometry that represents the centreline of the link.	
Type: GM_Curve	Multiplicity: [1]
Attribute: fictitious	
Definition: Indicator that the centreline geometry of the link is a straight line with no intermediate control points – unless the straight line represents the geography in the resolution of the data set appropriately.	

Type: Boolean	Multiplicity: [1]

Attribute: form «voidable»

Definition: Classification of the type of watercourse that is formed by the WatercourseLink.

Type: WatercourseFormValue	Multiplicity: [1]

Attribute: watercourseName

Definition: Recognised name assigned to the watercourse.

Note 1: The language used to define the name shall also be provided as a three-digit ISO 639-2 code ('eng', cym' gla').
Note 2: Where a watercourse has a name in more than one language, then this attribute will be the Welsh or Gaelic version.

Type: LocalisedCharacterString	Multiplicity: [0..1]

Attribute: watercourseNameAlternative

Definition: An alternative name of the main watercourse the link is part of.

Note 1: The language used to define the name shall also be provided as a three-digit ISO 639-2 code ('eng', cym' gla').
Note 2: Where a watercourse has a name in more than one language, then this attribute will be the English version.

Type: LocalisedCharacterString	Multiplicity: [0..1]

Association Role: startNode

Definition: The HydroNode coincident with the first vertex for this WatercourseLink.

Multiplicity: [0..1]

Association Role: endNode

Definition: The HydroNode coincident with the last vertex for this WatercourseLink. On very rare occasions, the end HydroNode may be the same instance as the start HydroNode.

Multiplicity: [0..1]

2.2.2   HydroNode

HydroNode features are added at the start and end of every WatercourseLink feature. They can represent the source of a watercourse, the end of a watercourse, a junction along a watercourse or a change of real-world related attribution.

«featureType» HydroNode	
Definition: A feature at the end of one or more WatercourseLink features that indicates either the confluence or two or more watercourses and/or a change in the attribution of the WatercourseLink features.	
Attribute: hydroNodeCategory «voidable»	
Definition: Nature of the HydroNode.	
Type: HydroNodeCategoryValue	Multiplicity: [1]
Attribute: geometry	
Definition: The location of the HydroNode.	
Type: GM_Point	Multiplicity: [1]

2.3   Code lists

A code list is a controlled set of values for an attribute. This section identifies the code lists used within OS Open Rivers and describes their values.

2.3.1   LinkDirectionValue

The watercourseLink feature is attributed with a *flowDirection* with a data type of *LinkDirectionValue*. The following table describes the codes which will be used to populate this field and the description for each code.

The code list has been inherited from INSPIRE and is not extendable.

Code List: LinkDirectionValue List of values for directions relative to a link http://inspire.ec.europa.eu/codelist/LinkDirectionValue/	
Code	**Description**
both directions	In both directions.
in direction	In direction of the link.
in opposite direction	In the opposite direction of the link.

Where the flow direction has not been determined, this attribute is set to null and a *nilReason* is given.

- Where the value of nilReason is set to *unknown*, then the flow direction is not known to Ordnance Survey. A correct value may exist, but the methods employed by Ordnance Survey to date have not facilitated capture.
- Where the value of nilReason is set to *missing*, then the flow can be considered indiscernible. Ordnance Survey has attempted to identify the flow on the ground, but no flow has been determined.

2.3.2   WatercourseFormValue

The watercourseLink feature is attributed with a *form* with a data type of *WatercourseFormValue*. The following table lists the codes which will be used to populate this field and the description for each code.

Code List: WatercourseFormValue Classification value defining the type of WatercourseLink	
Code	**Description**
canal	A manmade watercourse originally created for inland navigation.
inlandRiver	A river or stream that is not influenced by normal tidal action.
lake	A large area of non-tidal water without an obvious flow that is enclosed by land.
tidalRiver	Tidal river or stream (i.e. below Normal Tidal Limit).

2.3.3   HydroNodeCategoryValue

The HydroNode feature is attributed with a *hydroNodeCategory* with a data type of *hydroNodeCategoryValue*. The following table lists the codes which will be used to populate this field and the description for each code. The code list has been inherited from INSPIRE and is not extendable.

Code List: HydroNodeCategoryValue Classification value defining the type of hydrographic node http://inspire.ec.europa.eu/codelist/HydroNodeCategoryValue/	
Code	**Description**
junction	A split in the network to indicate where three or more watercourses meet at the same level, such as confluences or bifurcations.
outlet	The end terminal of a set of one or more interconnected links that does not have any downstream flow, for example, sinks or the point where a river enters the sea.
source	The start terminal of a set of one or more interconnected links that has downstream flow, for example, springs or collects.

Where the hydroNodeCategory has not been identified, this attribute is set to null and a *nilReason* of *inapplicable* is given. This will indicate where an attribute of the watercourse changes which requires a watercourseLink to split, for example, watercourseName. In the ESRI shapefile, these will be given the attribute value of *pseudo*.

3.   GML overview

This section describes the GML format for OS Open Rivers. It is recommended that you read this section in conjunction with the Open Geospatial Consortium (OGC) document, Geography Markup Language v3.2.1.

The XML specifications that GML is based on are available from the World Wide Web Consortium (W3C) website: http://www.w3.org.

Information about Unicode and UTF-8, the character encoding we have chosen, is available on the Unicode Consortium website: http://www.unicode.org/.

3.1   Schema overview and location

XML schemas are used to define and validate the format and content of the GML. The GML v3.2.1 specification provides a set of schemas that define the GML feature constructs and geometric types. These are designed to be used as a basis for building application-specific schemas, which define the data content.

The Ordnance Survey application schema OSOpenRivers.xsd, which is referenced by the data, is available on our website. It imports the INSPIRE Hydrography application schema, which in turn imports the GML 3.2.1 schemas. These in turn import schemas produced by the W3C, which are available from the W3C website at: http://www.w3.org/XML/1998/namespace.html.

All these schemas are defined in XML Schema Definition language (XSD), as defined by the W3C.

The 'OS Open Rivers' schema document defines the http://namespaces.os.uk/Open/Rivers/1.0 namespace; this is defined in the XSD at https://www.ordnancesurvey.co.uk/xml/open/rivers/1.0/OSOpenRivers.xsd.

The application schema uses the following XML namespaces, for which definitions are available as given here:

Prefix	Namespace identifier	Definition available at
gml	http://www.opengis.net/gml	http://schemas.opengis.net/gml/3.2.1/gml.xsd
xsi	http://www.w3.org/2001/XMLSchema-instance	Built into XML, see http://www.w3.org/TR/xmlschema-1/
xlink	http://www.w3.org/1999/xlink	http://www.w3.org/1999/xlink.xsd

3.2   Simple Features Profile – Level 0

GML is designed to support a wide variety of capabilities, ranging from simple contextual mapping, such as OS OpenMap, to products that include complex geometric property types or even spatial and temporal topology. The Simple Features Profile of GML 3.2.1 defines a restricted subset of GML, allowing scope for greater interoperability.

This product conforms to Simple Features Profile – Level 0.

4.   ESRI shapefile overview

OS Open Rivers is supplied as an ESRI shapefile. An ESRI shapefile is an open file format to store geometry and attribute information about spatial features.

4.1   Attribute mapping

The naming of attributes between GML and ESRI shapefile will be different as shapefiles are limited to 11 characters for an attribute name. Therefore, the following tables in Sections 4.1.1 and 4.1.2 map the GML attribute name to the attribute name in the ESRI shapefile.

The GML contains an attribute which describes the geometry of the feature; this is not applicable for a shapefile as they are separated by their geometry. Please note that the use of an asterisk symbol (*) in the following tables indicates that a particular attribute is not mapped in that format (e.g. geometry is mapped in GML but not in ESRI shapefile).

4.1.1   WatercourseLink

GML attribute	ESRI shapefile attribute
gml:identifier	identifier
flowDirection	flow
length	length
fictitious	fictitious
form	form
watercourseName	name1
watercourseNameAlternative	name2
startNode	startNode
endNode	endNode
centrelineGeometry	*

4.1.2   HydroNode

GML attribute	ESRI shapefile attribute
gml:identifier	identifier
hydroNodeCategory	formOfNode
geometry	*

5. GeoPackage overview

OS Open Rivers is supplied as a national GeoPackage file. [GeoPackage](#) (*.gpkg) is an open, standards based, data format, as is defined by the Open Geospatial Consortium (OGC). It is designed to be a lightweight format that can contain large amounts of varied and complex data in a single, easy to distribute and ready to use file.

GeoPackage can be used in most GIS software in its native format without translation. GeoPackage attribute names are not limited in length. A GeoPackage file has no size limit and it supports raster, vector and database formats, making it a highly versatile solution.

5.1 Attribute mapping

The naming of attributes between GeoPackage and GML file is very similar as GeoPackage files are not limited in the number of characters for an attribute name. Therefore, the following tables map the GML attribute name to the attribute name in the GeoPackage files. The GML contains an attribute which describes the geometry of the feature; this is not applicable for a GeoPackage file as they are separated by their geometry. Please note that the use of an asterisk symbol (*) in the following tables indicates that a particular attribute is not mapped in that format (e.g. geometry is mapped in GML but not in GeoPackage).

5.1.1 WatercourseLink

GML attribute	GeoPackage attribute
gml:identifier	id
flowDirection	flowDirection
length	length
fictitious	fictitious
form	form
watercourseName	watercourseName
watercourseNameAlternative	watercourseNameAlternative
startNode	startNode
endNode	endNode
centrelineGeometry	*

5.1.2 HydroNode

GML attribute	GeoPackage attribute
gml:identifier	id
hydroNodeCategory	hydroNodeCategory
geometry	*

6.   Vector tiles overview

OS Open Rivers is supplied as a national vector tiles set in a single MBTiles file. This is a lightweight set of tiles that are efficient and fast to render in your software, provide high-resolution data and give a seamless experience when zooming in and out. The data is supplied in Web Mercator projection (ESPG:3857).

6.1   Vector tiles schema

The vector tiles schema is detailed in the following table. In the zoom levels columns within the table, the letter *N* indicates that the specified layer and attribute are not mapped within that zoom level, whereas the letter *Y* indicates that the specified layer and attribute are mapped within that zoom level.

Layer	Attribute	Zoom levels						
		0 to 8	9	10	11	12	13	14
watercourse_link	id	N	Y	Y	Y	Y	Y	Y
	flow_direction	N	Y	Y	Y	Y	Y	Y
	length	N	Y	Y	Y	Y	Y	Y
	form	N	Y	Y	Y	Y	Y	Y
	watercourse_name	N	Y	Y	Y	Y	Y	Y
	watercourse_name_lang	N	Y	Y	Y	Y	Y	Y
	watercourse_name_alternative	N	Y	Y	Y	Y	Y	Y
	watercourse_name_alternative_lang	N	Y	Y	Y	Y	Y	Y
hydro_node	id	N	Y	Y	Y	Y	Y	Y
	hydronode_category	N	Y	Y	Y	Y	Y	Y

6.2 Attribute mapping

The naming of attributes between vector tiles and GML file is very similar as the vector tiles set within the MBTiles file is not limited in the number of characters for an attribute name. The following tables map the GML attribute name to the attribute name in the vector tiles. Please note that the use of an asterisk symbol (*) in the following tables indicates that a particular attribute is not mapped in that format (e.g. the fictitious attribute is mapped in GML but not in vector tiles).

6.2.1 WatercourseLink

GML attribute	Vector tiles attribute
gml:identifier	id
flowDirection	flow_direction
length	length
fictitious	*
form	form
watercourseName	watercourse_name
*	watercourse_name_lang
watercourseNameAlternative	watercourse_name_alternative
*	watercourse_name_alternative_lang
startNode	*
endNode	*
centrelineGeometry	*

6.2.2 HydroNode

GML attribute	Vector tiles attribute
gml:identifier	id
hydroNodeCategory	hydro_node_category
geometry	*