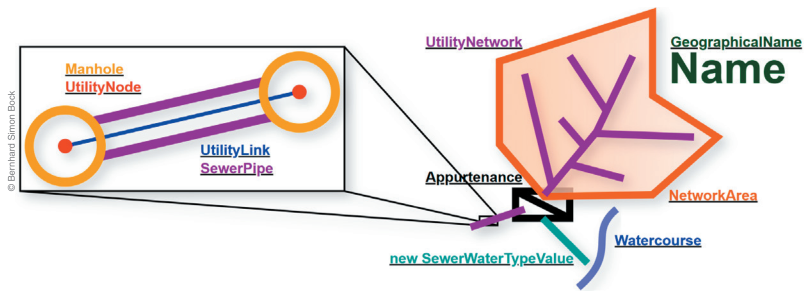
EU INSPIRE-based data model for Integrated urban wastewater management plans under the Urban Wastewater Treatment Directive (UWWTD)



Combining

Directive (EU) 2024/3019 of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment (recast) (Text with EEA relevance)

and

Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

28 April 2026

BWK
die Umweltingenieure

Abstract

This is the English version of the German article published on
https://www.springerprofessional.de/eu-inspire-basiertes-datenmodell-fuer-integrierte-plaene-der-eu-/52315820
in “Wasser und Abfall”, the journal of the German organisation BWK (www.bwk-bund.de)

Integrated urban wastewater management plans – required under UWWTD (Urban Wastewater Treatment Directive) – should be standardised across the EU and created digitally to ensure consistent implementation throughout the EU.

INSPIRE can effectively represent these plans in a data model to generate graphical plans based on it.

Article 5 of EU Directive 2024/3019 of 27 November 2024 on the treatment of urban wastewater requires the preparation of Integrated urban wastewater management plans.

The directive does not define the form of these plans. EU-wide consistency requires common guidelines for machine-readable data used to generate readable plans. A standardised digital process across Europe would therefore be beneficial.

Under the UWWTD, integrated urban wastewater management plans will be required for large networks (>100,000 PE) from 2033 (Figure 15). Preparing these plans requires early action and a harmonised data standard, such as the EU INSPIRE Directive. INSPIRE, established in 2007, provides a Europe-wide framework for spatial data and has already been transposed into national law by Member States [2].

It therefore makes sense to link the two directives.

This article shows how the two directives can be effectively linked.

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1 Project objectives

The Project's objective is to develop a machine-readable, standardised data model for integrated wastewater plans. The human-readable plan representation is to be generated using machine-readable presentation rules. This makes it possible to verify compliance with the 2 % rule set out in Article 5 of [1] on the same data model.

The plan representation should provide the following information:

- Where is it? (sewer network plan, see **Figure 8**)
- How does it work? (flow diagram, see **Figure 13**)
- What needs to be done? (allocation of measures in the sewer network plan and flow diagram)

Information on sewer catchment areas, including their networks, key parameters and interconnections, should be represented. Same to sewage treatment plants and their key parameters. The catchment area map is to be linked to the flow diagram.

In terms of content and the way the plans are presented, it is assumed that the integrated plans referred to in [1] are comparable to the wastewater management concepts (WMC) specified in some German federal states.

Guidance and requirements for the preparation of wastewater management concepts were found in the following federal states of Germany: Berlin [4], Brandenburg [5], North Rhine-Westphalia [6], Saxony-Anhalt [7] and Thuringia [8]. All previously mentioned sources are based on descriptions of human-readable plans, which are similar but not identical. A machine-readable data model based on GML with area references, to be used as the basis for drawing up these plans, could not be found. A point-based digital data collection was also found in North Rhine-Westphalia [6].

2 Procedure

2.1 Organisational procedure

First, an online search was conducted for existing INSPIRE datasets on this topic. The results of this research are described in the chapter 'Sample datasets'. The relevant EU department was informed about the project. At the German level, the Coordination Office of the German Spatial Data Infrastructure (GDI-DE) was informed [9] and, as the lead agency for national legal implementation in Germany, the Federal Environment Agency [10].

2.2 Technical Approach

The INSPIRE data model is freely accessible (open standard). A key aspect of the technical approach was to gain an overview of the existing INSPIRE data structures, which distinguish between Implementation Rules (**IR**) and Technical Guidelines (**TG**) as shown in **Figure 1.**

To ensure that no parts of the data model were overlooked, an automated evaluation of the INSPIRE model description in XMI format [17] was carried out as a first step. The **IR** version and the **TG** version of the data model are available in different XMI versions. Therefore they had to be evaluated using different programming methods.

As the XMI evaluation could not be carried out uniformly for **IR** and **TG,** a further, now uniform approach was subsequently chosen for both **IR** and **TG.** The INSPIRE data model is created using the data modelling software Enterprise Architect ©[24] – EA for short. This software stores its data in EAP files (EA's standard storage format [24]). The EAP files provided on the INSPIRE homepage were imported into EA in the **IR** and **TG** versions and stored in a relational database, a storage option also supported by EA. In consequence the **IR** and **TG** versions were available in a uniform and readable format and were evaluated on this basis (SQL) using software and could be used as basis for generating **Figure 9** to **Figure 12.**

The findings obtained were verified using the model description files provided at [25] in XSD format (XML schemas) as a third variant of the model description.

For the final validation of created sample datasets the INSPIRE validation tool should then be used [26].

Furthermore, a examination was carried out using mapping tables [17] and an examination of the textual data specifications in [18] to [22].

Following a review of the above-mentioned documents, the EAP documentation at [24] has emerged as the leading documentation in [17].

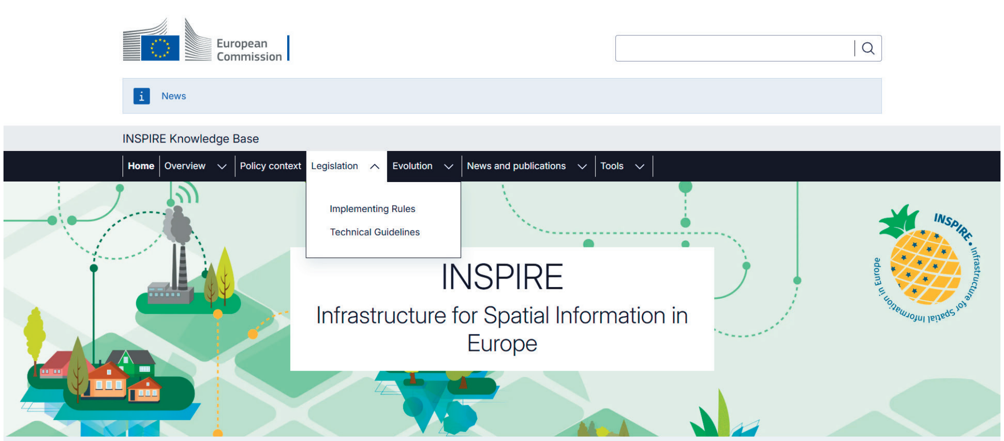


Figure 1:
INSPIRE.EU website[3] showing the distinction between Implementation Rules (IR) and Technical Guidelines (TG)

2.3 Terms of classes, inheritance and attributes

In the following chapters the terms 'class', 'inheritance' and 'attributes' are used.

To explain the terms 'class', 'inheritance', 'derivation' and 'attribute' used below, we draw a comparison with exemplary biological class descriptions (classes green, attributes blue):

A **conifer** class with the attribute **"has needles"** inherits the attributes of a **tree** class with the attribute **"has a trunk and branches"**. It is also said that the **conifer** class is "derived" from the **tree** class. Furthermore, it is also said that the **tree** class "inherits" the attributes of a **plant** class with the attribute **"has roots"**. This approach to derivation or inheritance has the advantage that the attributes of classes do not have to be redefined time and again. A further advantage is that one can refer to different classes collectively, e.g. that all species of the class **plant** require water, which then also encompasses the classes **tree** and **conifer.** At the same time, one could also say: a conifer 'is a' **tree,** a **tree** 'is a' **plant,** or a **conifer** 'is a' **plant.** In reality, there are indeed plants without roots (e.g. mosses). For the sake of this simplified explanation, however, we shall overlook this.

So, when a new class is derived from a superclass, it means that the attributes are inherited from the superclass. The system of inheritance to derived classes is an essential component of 'object-oriented programming'.

Aspect	INSPIRE (GML)	openBIM (IFC)
Scope	Europe	Worldwide
Main Purpose	Geospatial standard	Building data
Metamodel	UML	EXPRESS
Multiple Inheritance	Yes	No
Namespaces	Centralized	Not required
Code Proximity	Rather low	High
Code Lists	INSPIRE/national	bSDD

Figure 2: Comparison of INSPIRE and openBIM

2.4 Technical Approach – Comparison with openBIM

In the 06/2023 issue of "Wasser und Abfall", the article "openBIM in der Wasserwirtschaft am Beispiel der Abwasserableitung" [13] addressed the topic of cross-scale documentation of wastewater networks using the global openBIM standard IFC.

The openBIM data model and the INSPIRE data model are of a similar order of complexity. Both data models contain over 1,000 classes and use the principle of inheritance to avoid repetition in the attribute structure or to enable links between classes with the same base.

Figure 2 shows a comparison of the two modelling guidelines: INSPIRE (EU, GML-based) and openBIM (IFC from buildingSMART International).

Figure 3 shows a representation of a drainage system from [13] based on openBIM. A distinction is made there between macroscopic representation (1), mesoscopic representation (2) and microscopic representation (3). When considering integrated drainage plans / wastewater disposal plans, the focus is primarily on the macroscopic level.

Figure 4 shows how the terms from **Figure 3** are represented in the INSPIRE classification system.

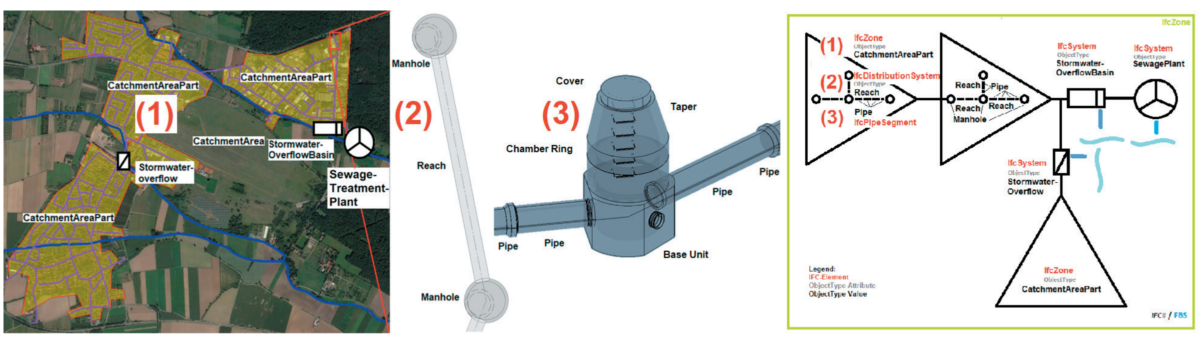


Figure 3: Possible representation of a sewer network in openBIM (from macroscopic to microscopic) from [13]

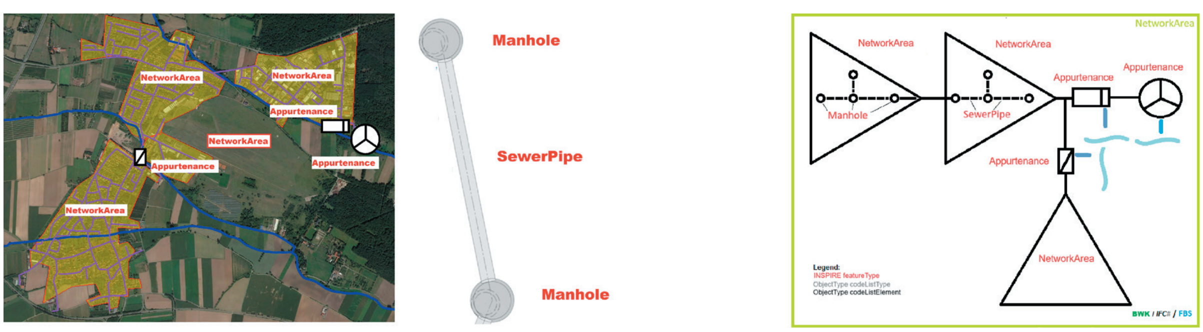


Figure 4: Sewer network map in INSPIRE

3. The EU INSPIRE Directive

3.1 INSPIRE Themes

The INSPIRE Directive contains three annexes (Annexes 1 – 3), which cover 35 themes listed in [18] and shown in **Figure 5.** One of these themes is 'Utility and governmental services' (abbreviated to 'us') in Annex 3, in which sewage (abbreviated to 'sw') is listed alongside gas pipes, electricity cables and water supply pipes, amongst others.

Figure 5: Overview of INSPIRE themes [18]

3.2 Mapping of hydrography in INSPIRE, including wastewater

Hydrography (abbreviated to 'hy') is a separate subject area in Annex 1. It is described in detail and illustrated in [19] (see **Figure 6,** supplemented with topics relating to the sewerage network).

3.3 Linking INSPIRE themes

In the case of sewer, there is a technical interface between the INSPIRE themes HY (water body network) and US-SW (utilities – sewer network). For example from direct discharges, effluent from treatment plants and combined sewer overflows.

For mapping these thematic interfaces, the INSPIRE example of a railway station was found in [21], where the interface between the rail network and the road transport network is shown. The technical modelling link is described in [22]. See **Figure 7.**

This interface between the road network and the rail network can also be applied to the sewerage network and the waterways network.

3.4 The use of UML class diagrams for the INSPIRE data model for sewerage systems

The following chapters describe the INSPIRE data model for sewerage systems using UML class diagrams in **Figure 9** to **Figure 12.** UML stands for 'Unified Modelling Language'. Class diagrams are a component of UML.

Between two subclasses positioned one above the other is a triangle with a connecting line. This is the inheritance symbol in UML notation and thus describes an 'is-a' relationship.

In some cases, a subclass may have two base classes. This means that the subclass contains the properties of both the first and second base classes, which is why the attributes are numbered consecutively across both base classes. The existence of multiple base classes at the same level is also known as multiple inheritance, for which there is no equivalent in the biological classification hierarchy, as multiple inheritance is not purely hierarchical. Multiple inheritance is, for example, directly supported by the C++ programming language, but not by the C# programming language.

Links between attributes and classes are sometimes depicted in UML notation. A filled diamond represents a composition ('has a'), which corresponds to an exclusive inclusion (analogous to a car engine, which can only be installed in one car), and is realised in XML/GML through embeddings.

An empty diamond corresponds to an aggregation (also 'has a'), which here, however, corresponds to a non-exclusive membership (analogous to students of a lecture who may also attend other lectures), which is realised in XML/GML through references.

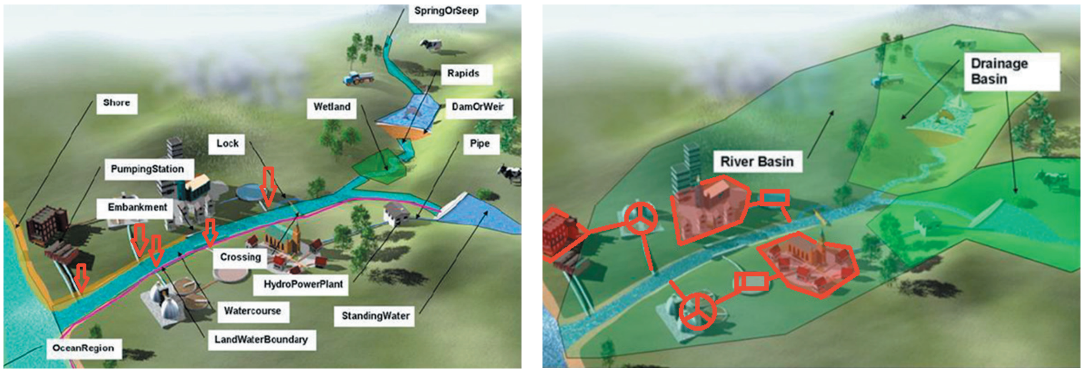
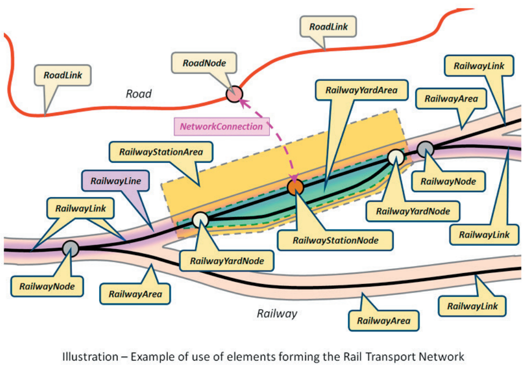
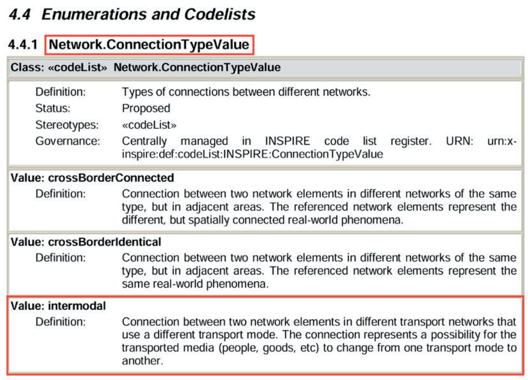


Figure 6: Hydrography in INSPIRE, images from [19] supplemented with red annotations relating to wastewater





4.4 Enumerations and Codelists

4.4.1 Network.ConnectionTypeValue

Class: «codeList» Network.ConnectionTypeValue	
Definition:	Types of connections between different networks.
Status:	Proposed
Stereotypes:	«codeList»
Governance:	Centrally managed in INSPIRE code list register. URN: urn:x-inspire:def:codeList:INSPIRE:ConnectionTypeValue
Value: crossBorderConnected	
Definition:	Connection between two network elements in different networks of the same type, but in adjacent areas. The referenced network elements represent the different, but spatially connected real-world phenomena.
Value: crossBorderIdentical	
Definition:	Connection between two network elements in different networks of the same type, but in adjacent areas. The referenced network elements represent the same real-world phenomena.
Value: intermodal	
Definition:	Connection between two network elements in different transport networks that use a different transport mode. The connection represents a possibility for the transported media (people, goods, etc) to change from one transport mode to another.

Figure 7: INSPIRE thematic interfaces illustrated using a railway station as an example; sources: left: image on page 117 in [21]; right: excerpt from [22]

3.5 Mapping wastewater systems in INSPIRE

The topic of wastewater, as a sub-topic of Utility and Government Services [20], is described and illustrated only in a rudimentary manner in INSPIRE, as is the topic of hydrography. **Figure 8** shows the technical content conveyed via the INSPIRE data model.

The following figures provide a detailed representation of the data model associated with **Figure 8,** based on INSPIRE, which also shows all attributes of inherited classes. Furthermore, the **TG** and **IR** versions are shown together in the following figures, so that one can immediately see what has been added in **TG** compared to **IR.**

To provide better guidance for understanding the following figures, the individual classes are marked with large letters enclosed in circles. If a class has one or more successive base classes, these are numbered consecutively in addition to the letter designation.

The individual attributes are numbered consecutively across all base classes and subclasses, starting with the root base class. Before the class names and attribute names, brackets indicate whether the class or attribute is from **IR** or **TG. IR** identifiers are shown in green and **TG** identifiers in purple.

The overall class name shown here (bold heading of the stored frame) is displayed with the prefixed namespace in abbreviated form, followed by a full stop and the actual class name.

The following formatting is used in the descriptions below.

(A1)	Indexing a class
NetworkElement	Name of a class
InspireId	Name of a class attribute (including enumeration values)
featureType	Keyword

The individual subclasses (labelled with a letter followed by a number, e. g. (A1)) are shown with a white background; the namespace (topic) is displayed in plain text in the top-left corner,

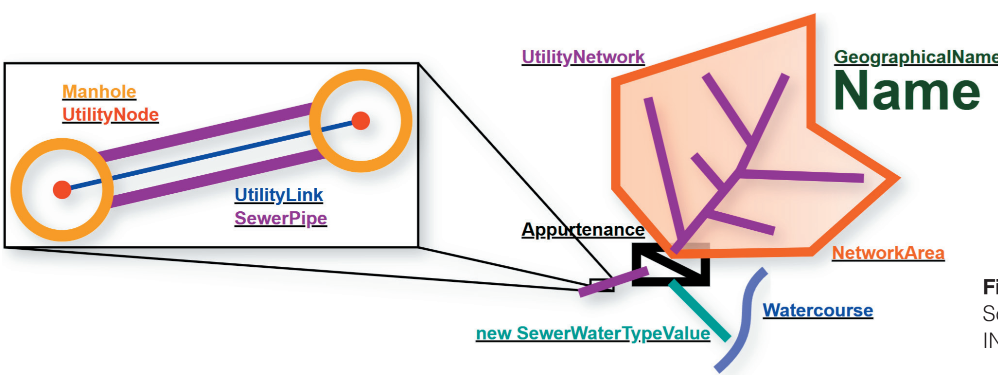


Figure 8: Schematic representation of the INSPIRE sewer data model from [22]

with the class type shown below it. Class types are distinguished as ***featureType*** (data class), ***dataType*** (embedded data or complex/composite attribute type) and ***codeList*** (value list). In the top right-hand corner, the namespace is shown in abbreviated form, followed by an equal sign and the corresponding XSD schema name:

The heading of each subclass begins with the **IR**/**TG** designation in green/purple, followed by the namespace in abbreviated form, the class name, and optionally the keyword ***abstract*** in brackets. ***abstract*** means that this class cannot be used (instantiated) directly, but only if a subsequent (derived/inheriting) class is not abstract.

Figure 9 shows the INSPIRE data schema for representing the topology of sewer networks in the form of nodes and edges. In INSPIRE, nodes and edges are represented by **UtilityNode (A)** and **UtilityLink (H)** for all supply and disposal systems according to the same schema.

The class **UtilityNode (A)** is abstract and therefore cannot be used (instantiated) directly, but only via the class **Appurtenance** (**(T)** in **Figure 12**) derived from **UtilityNode,** which will be discussed later.

UtilityNode (A) has **NetworkElement (A1)** as its top-level inherited class. Attributes 1 ***(beginLifespanVersion)*** and 3 ***(endLifespanVersion)*** describe the validity period of a version of an object description. ***[0..1]*** for attribute 3 means that it is optional. For example, when there is a reason to specify an end of validity or when it is unknown.

Attribute 2 ***(InspireId)*** can be used as a clear identifier for an object. InspireId is a dataType, a structured attribute of type **Identifier (B).**

Attribute 4 ***(inNetwork)*** contains a list of references ***(Association)*** to a **Network** object. ***[1..*]*** means that at least one Network object must be referenced, or that the node must be assigned to at least one network.

Attribute 5 ***(geometry)*** is located in the subclass **Node (A2).** ***geometry*** is of type **GM_Point,** which is a standard data type of GML and describes a point coordinate.

Attribute 6 ***(CurrentStatus)*** is located in the subclass **UtilityNetworkElement (A3),** which, together with **Node (A2),** forms a common base class of **UtilityNode (A4)** (multiple inheritance). ***CurrentStatus*** is of type **ConditionOfFacility Value (C)** and indicates whether a structure is ***disused, functional, projected, underConstruction*** or ***decommissioned.***

Attribute 7 ***(validFrom)*** and attribute 8 ***(validTo)*** specify the object's lifespan in the real world and not when it was recorded (see attribute 1 ***beginLifespanVersion***).

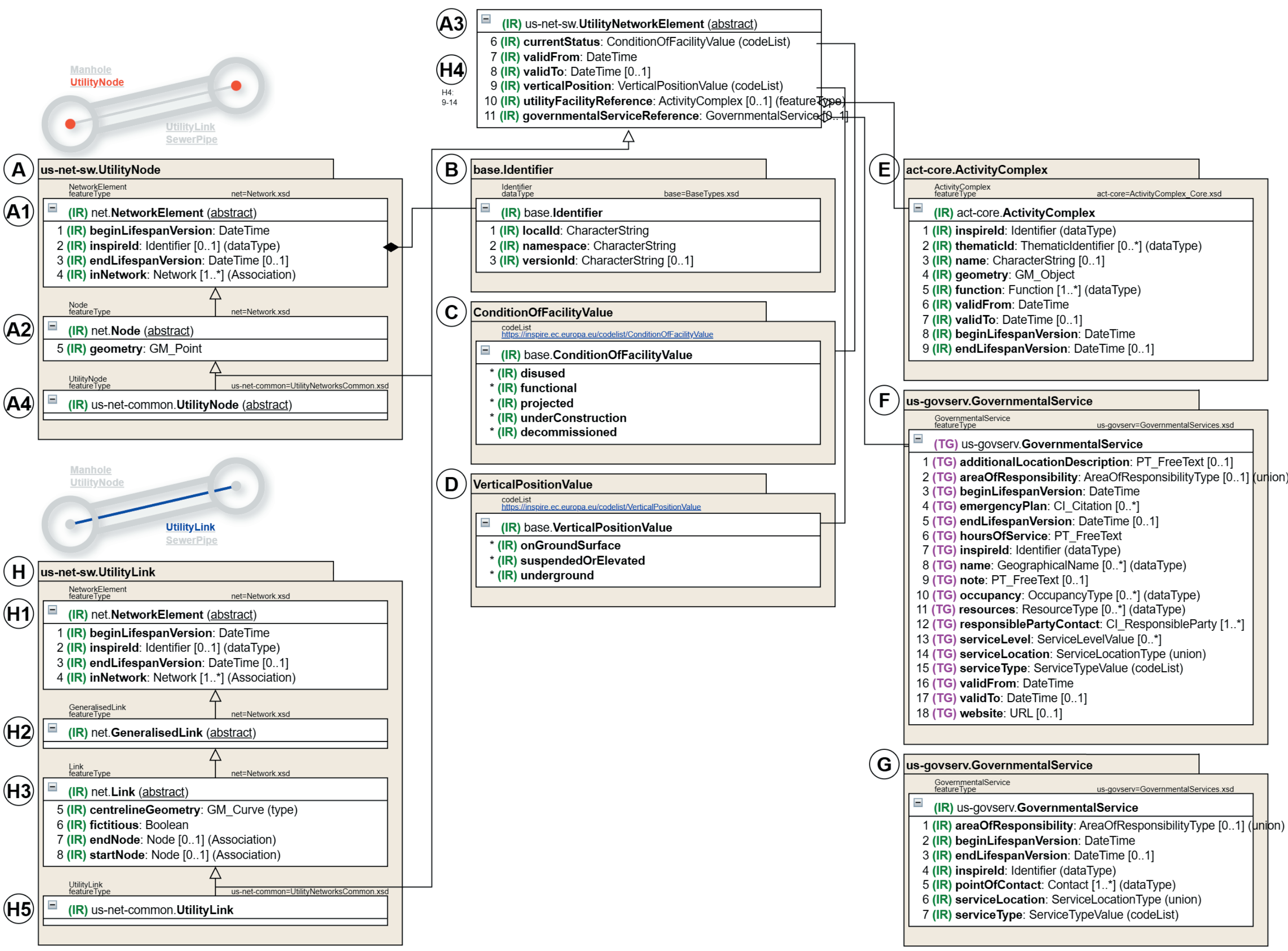


Figure 9: UML diagram of the sewer network topology (nodes and edges)

Attribute 9 ***(verticalPosition)*** is of type **VerticalPosition Value** and indicates whether a structure is located ***onGround-Surface, suspendedOrElevated or underground.***

Attribute 10 ***(utilityFacilityReference)*** refers, where applicable ***([0..1]),*** to the class ***ActivityComplex*** ***(E),*** whose attributes are not explained, only attribute 3 ***(name).*** It is assumed that ***ActivityComplex*** may be the structure associated with a topological node and may therefore also contain the structure name via the ***name*** attribute.

The final attribute 11 ***(governmentalServiceReference)*** of the subclass **UtilityNetworkElement** **(A3)** refers, where applicable ***([0..1]),*** to the class ***GovernmentalService*** ***(F)/(G)*** for **TG/IR.** GovernmentalService is interpreted here as an operator, which is described in much greater detail in the Technical Guidelines (**TG**) than in the Implementation Rules (**IR,** legally binding).

In the **GovernmentalService** class, attribute 2 **(TG)** or 1 **(IR)** ***(areaOfResponsibility)*** is also worth mentioning, which is of type **union. union** is a variable data type which corresponds to the SELECT data type of openBIM (IFC).

The **GovernmentalService** class **(F)/(G)** is not explained further here.

The class **UtilityLink** **(H)** has **NetworkElement** **(A1)** as its top-level inherited class, in the same way as **UtilityNode** **(A).** Consequently, attributes 1 to 4 are the same as those of **Utility Node.**

The next (abstract) subclass, **GeneralisedLink** **(H2),** has no attributes; nevertheless, an 'is a' relationship can be expressed or referred to it and all classes derived from it.

Derived from **GeneralisedLink** is the class **Link** **(H3),** which begins with attribute 5 ***(centrelineGeometry)*** of the superclass **UtilityLink.** ***centrelineGeometry*** is of type **GM_Curve,** a standard GML data type for a curve (in the simplest case, a connecting line).

Attribute 6 ***(fictitious)*** is a boolean value (yes/no) and specifies whether the connection is fictitious. This is typically between a structure node and a discharge node, between which a discharge weir is located.

Attribute 7 ***(endNode)*** and attribute 8 ***(startNode)*** may, if required ***([0..1]),*** refer to a node of type **Node** **(A3),** which also includes **UtilityNode** **(A4).**

The subclass **UtilityNetworkElement** **(H4)** (same as **(A3)**) is, together with Link (H3), a common base class of **UtilityLink** **(H5).** **UtilityLink** itself has no attributes of its own, but inherits attributes 9 to 14 from **UtilityNetworkElement** **(H4).**

Figure 10 shows the INSPIRE data schema for representing manholes (**ManholeExtended** (**TG**) or **Manhole** (**IR**) and sections (reaches) (**SewerPipeExtended** (**TG**) or **SewerPipe** (**IR**).

The class **ManholeExtended** (I) has **UtilityNetworkElement** **(I1)** as its top-level base class, which was already discussed in (A3) and (H4).

This is followed by the abstract subclass **UtilityNode Container** **(I2),** which contains a point coordinate in attribute 7 (analogous to attribute 5 in **(A2)**), an ***inspireId*** in attribute 8 (analogous to attribute 2 in **(A1)**) and a list of **UtilityNode** references ***([0..*])*** in attribute 9 **(*nodes*).** This means that, a coordinate can also be assigned directly without a node. An agreement is therefore required on how to proceed here: i.e. with or without a reference to at least one **UtilityNode,** or a network with or without topology. To enable flow path tracking, it is assumed that topological links are used. Multiple **Utility-Node** entries are useful for several connection points within a

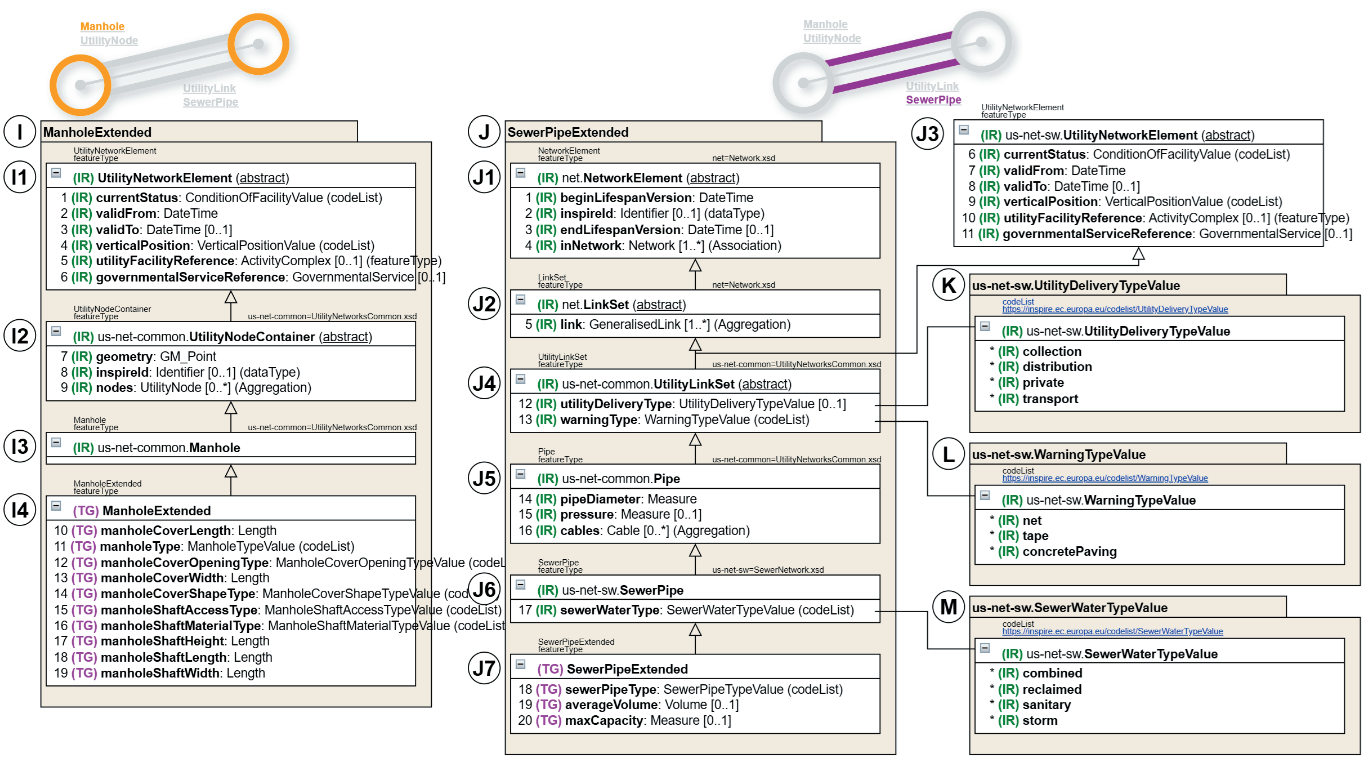


Figure 10: UML diagram of manholes and sections (reaches)

structure. Conversely, a reference from multiple manholes to the same node is useful when a manhole is interpreted as an entrance.

The physical manhole is represented by the subclass **Manhole (I3),** which has no attributes of its own. This is also where the **IR** schema ends.

The TG subclass **ManholeExtended (I4)** contains further details about the manhole (entry), which will not be discussed further here as they are not required for the creation of the integrated plans.

The class **SewerPipeExtended (J)** has **NetworkElement (J1)** as its top-level base class, which is also the top-level base class of UtilityNode (A) and (A1).

This is followed by the subclass **LinkSet (J2),** which has only attribute 5 (link), which refers to at least one **GeneralisedLink** (see **(H2)** in the class **UtilityLink**) and thus, in this use case, to at least one **UtilityLink.** In this way, single pipes can also be referenced.

Together with the subclass **UtilityNetworkElement (J3),** analogous to **(A3)** and **(A4)** (here with attributes 6 to 11), **LinkSet** forms the common base classes for the subclass **UtilityLinkSet (J4).**

UtilityLinkSet contains attribute 12 ***(utilityDeliveryType),*** which, where required ***([0..1]),*** refers to the list class **UtilityDeliveryTypeValue (K)** and thus to an entry from [27], which may be ***collection, distribution*** (not applicable for wastewater discharge), ***private*** or ***transport.***

Attribute 13 ***(warningType)*** contains a list entry from the **WarningTypeValue** class **(L),** which can have the values ***net*** (Netz), ***tape*** (Band), or ***concretePaving,*** which can be used, for example, to describe safety markings. Query [28] shows that the list can be extended with any values.

Next comes the subclass ***Pipe (J5),*** which contains the nominal diameter in SI units – here metres – in attribute 14 ***(pipeDiameter)*** [23].

Attributes 15 and 16 are not relevant for the creation of integrated plans.

The actual section (reach) is represented by the subclass **SewerPipe (J6),** which contains attribute 17 (***sewerWaterType*** = drainage system) of type **SewerWaterTypeValue (M),** which includes the values ***combined, reclaimed, sanitary*** or ***storm.*** According to [29], the list entries are extensible. The **IR** schema ends here.

The **TG** subclass **SewerPipeExtended (J7)** contains further details of a section (reach), which will not be discussed further here as they are not required for the creation of the integrated plans.

Figure 11 shows the INSPIRE data schema for the sewer network and its catchment areas, featuring the **UtilityNetwork (N)** class. Attribute 1 ***geographicalName*** of the subclass **Network (N1)** refers to the class **GeographicalName (O),** whose attribute 6 ***spelling*** refers to the class **SpellingOfName (R),** which contains the name of the catchment area in its attribute 1 ***text.*** Attribute 3 ***utilityNetworkType*** in the subclass **UtilityNetwork (N2)** refers to the **CodeList UtilityNetworkTypeValue (P),** where only the entry ***sewer*** is relevant here. The attribute 4 ***authorityRole*** of **utilityNetwork (N2)** refers to one or more instances of the class **RelatedParty (Q),** through which authori-

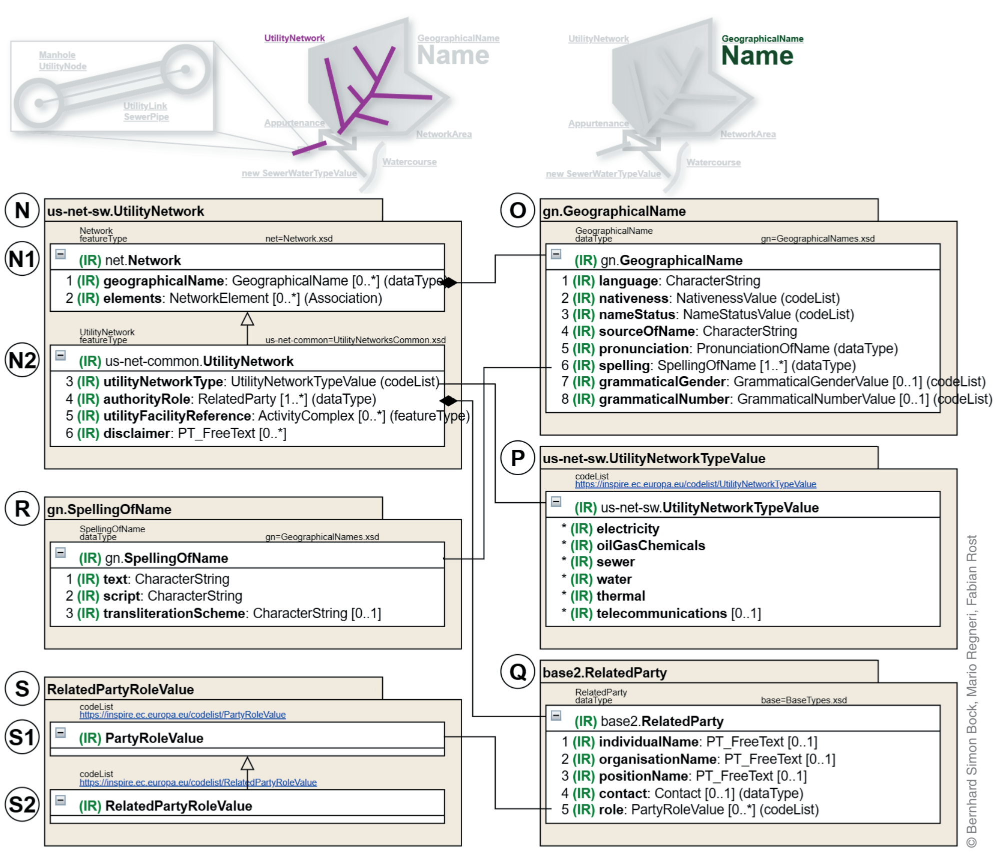


Figure 11:
UML diagram of the sewer network and its label

ties, operators and owners can be assigned using the attribute 5 ***role*** via the ***CodeList*** **RelatedPartyRoleValue (S2). RelatedPartyRoleValue (S2)** inherits from **PartyRoleValue (S1),** which is why these values can also be used in the attribute type **PartyRoleValue** of ***role.*** The **RelatedPartyRoleValue** values are only available via the URL of this code list.

Figure 12 shows the INSPIRE data schema for structures via class **Appurtenance (T)** which refers to **(U)** and **(V). (T1) – (T4)** is identical to **(A1) – (A4)** in **Figure 9. Appurtenance (T5)** inherits from **UtilityNode (T4)** or **(A4). Appurtenance** is the only way to create instances of **UtilityNode.** In this context, **SewerAppurtenanceTypeValue (U)** or **(U2)** may take the value node for purely topological nodes.

The values of **SpecificAppurtenanceTypeValue (V)** are only available via the URL of this code list.

For integrated wastewater plans according to [31], ***specific AppurtenanceType*** always has the value "Sewer Appurtenance Type" or a country specific name for it.

The INSPIRE data schema for representing a catchment boundary uses **NetworkArea (W). (W1)** has already been described in **(A1)** in **Figure 9.** Attribute 5 ***geometry*** in **(S2)** is of type **GM_Surface, GM_Surface** is a standard GML data type and, in this case, describes the surface of the catchment. The assignment of the area to one or more ***([1..*])*** catchment areas is carried out via attribute 5 ***inNetwork*** of type **Network (N1)** in Figure 11. In this way, a name assignment to catchment areas can also be made in **UtilityNetwork (N),** because **UtilityNetwork** is derived from **Network (N1)** and **UtilityNetwork** refers to **GeographicalName (O),** which in turn refers to **SpellingOfName (R),** which contains the text attribute for naming. The **NetworkArea** class is abstract. However, no class derived from **NetworkArea** was found. There is likely still a need for adaptation in the INSPIRE data model.

3.6 Code lists

Some code lists and their values are still included in the data model in [20] or in **Figure 8** to **Figure 12.** The complete and easily accessible code lists (e.g. for drainage systems or types of structures) can be accessed via ***URL***s.

Machine-readable access to all list types in English is available via inspire.ec.europa.eu/codelist/codelist.en.xml (in German via codelist.**de**.xml, in Dutch via codelist.**nl**.xml, etc.)

Plain text retrieval of code lists in the current national language is carried out without a file extension and without repeating the code list name in the URL, e.g. using inspire.ec.europa.eu/codelist or [31].

Machine-readable retrieval of a list of wastewater accessories in English is available via inspire.ec.europa.eu/codelist/SewerAppurtenanceTypeValue/SewerAppurtenanceTypeValue.en.json

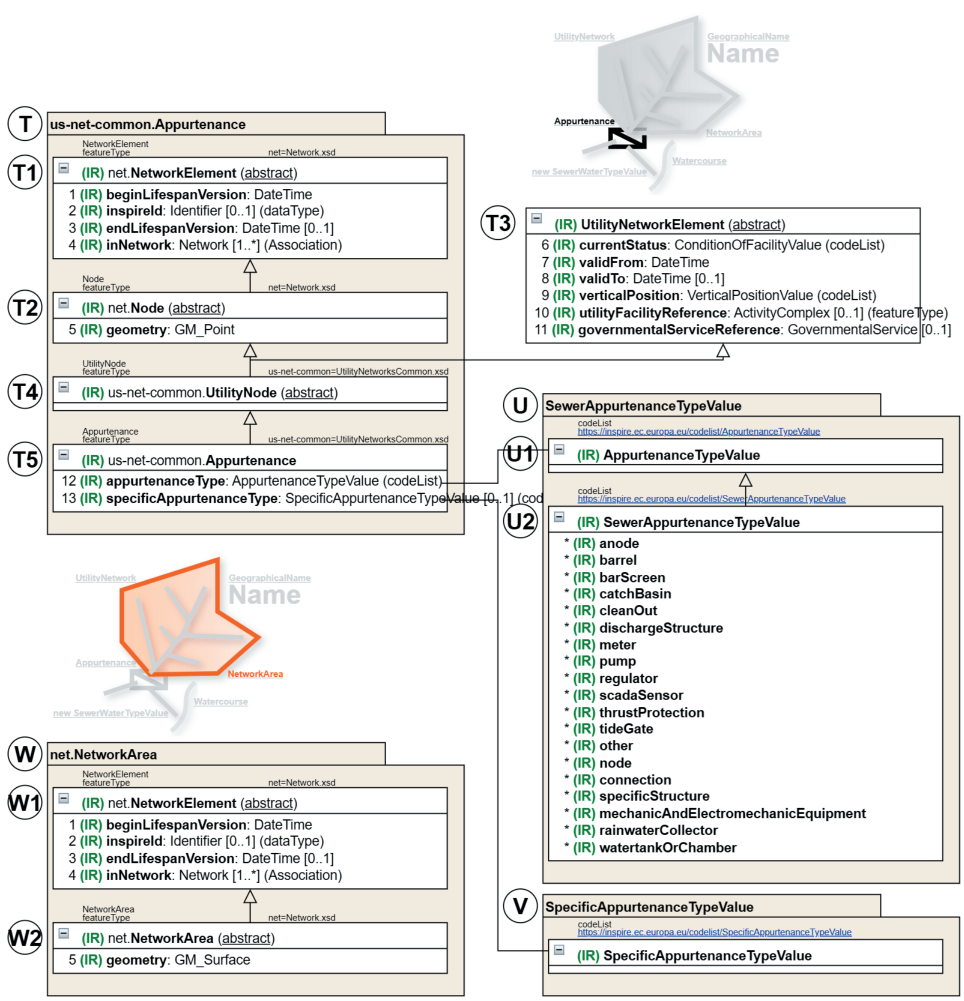


Figure 12:
UML diagram of structures and catchment area boundaries of sewer systems

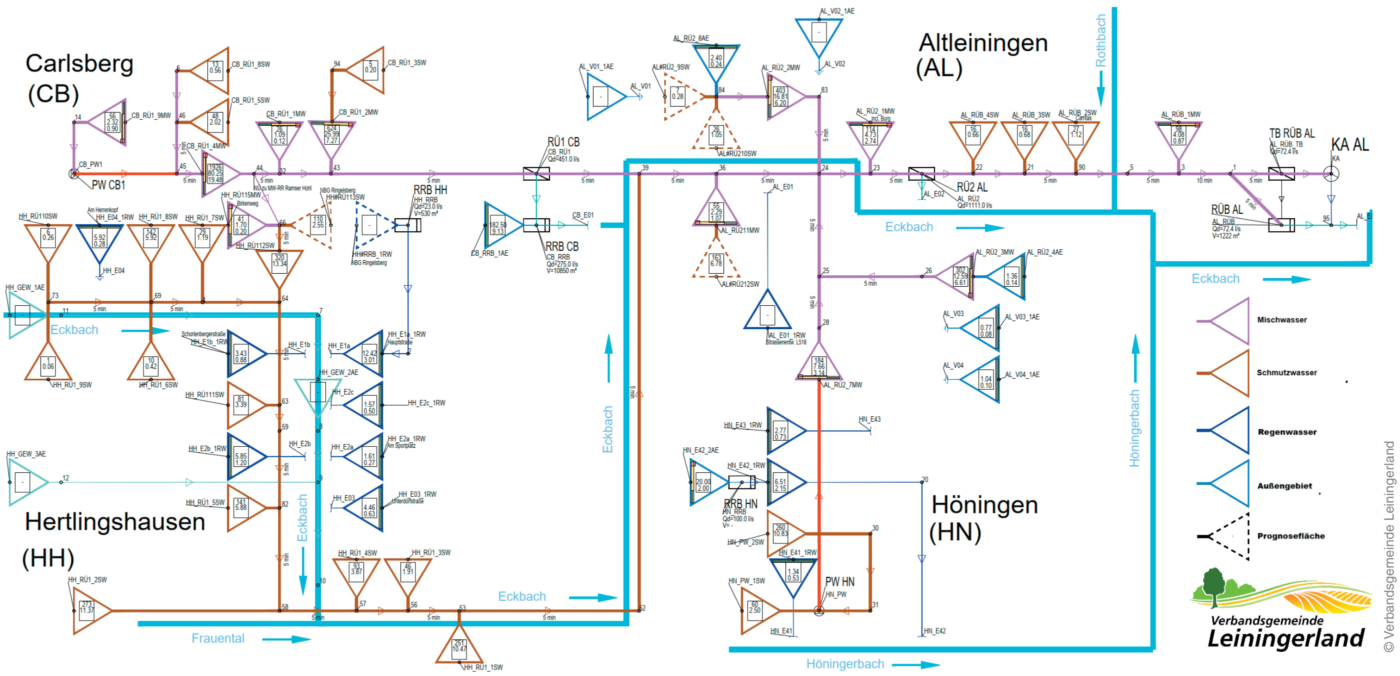


Figure 13: Example of a flowchart

In German for example (other countries according to the same principle)

inspire.ec.europa.eu/codelist/SewerAppurtenanceTypeValue/SewerAppurtenanceTypeValue.de.json

For all query types, information is also provided on whether and how the lists can be extended. For example, the list of drainage systems (**SewerWaterTypeValue** [29]) or that of sewer appurtenances (**SewerAppurtenanceTypeValue** [30]) can be extended.

The extension can be implemented at a purely national level via other URLs.

In this case, the extension of drainage systems **(SewerWaterTypeValue)** and structure types **(SewerAppurtenanceTypeValue)** was initially carried out as a national entry for Germany in the GDI-DE Registry [9]. In [9], there are code lists – not only for INSPIRE – which can be accessed via https://registry.gdi-de.org/codelist.

In Germany **SewerWaterTypeValue** and **SewerAppurtenanceTypeValue** will be entered under the namespace **“de.bwk.inspire.us.sw”**, which will contain additional list entries.

4 Flowcharts

Flowcharts do not describe physical objects and do not have a direct reference to geographical coordinates. However, they do relate to the grouping and topology of physical objects that do have a direct reference to geographical coordinates. It is now necessary to establish this relationship.

Flow diagram elements have plan coordinates and symbols with attributes. Furthermore, they have topological links. **Figure 13** shows such a sewage flow diagram.

5 Plan layout

Up to this we focused on the aspects of interoperability and compatibility relating to machine readability. To create human-readable plans, presentation rules are required now. These rules themselves must be machine-readable.

For the field of hydrography (HY), style rules have already been developed in [19] within the ***Styled Layer Descriptor (SLD)*** [42] and ***Symbology Encoding (SE)*** [43] standards. An excerpt from these is shown in **Figure 14.** This is now also required for the subject of wastewater, i.e. colouring and line type for pipe representation, distinguishing between drainage systems or structure symbols.

A comparable approach is also found in the German cadastral representation in [44].

Currently, in Germany such ‘style guidelines’ for WMCs are only available in PDF format in a human-readable form as in the German DIN 2425-4 [45] or in [46].

6 Sample records

Data sets related to Annex III (Utility and Government Services) can be accessed via [32]. In most cases, these are metadata, information indicating that data is available in principle.

Concrete data sets relating to wastewater were found in only two countries: Luxembourg [33] and Sweden [34]. The datasets contain point data on sewage treatment plants rather than entire networks, as required for integrated plans. All other datasets searched were not INSPIRE-compliant and were therefore not examined further.

Moving beyond the wastewater sector, numerous datasets can already be found. Examples for Germany can be found in [35] to [41].

Style Name	HY.PhysicalWaters.ManMade Object.Default	
No scale limits		Example

11.2.7. HY.PhysicalWaters.Wetland

<table>
<tr><td>Style Name</td><td>HY.PhysicalWaters.Wetland.Default</td></tr>
<tr><td>Default Style</td><td>yes</td></tr>
<tr><td>Style Title</td><td>Wetlands default style</td></tr>
<tr><td>Style Abstract</td><td>Wetlands are depicted with blue-green (#00CCCC).</td></tr>
<tr><td>Symbology</td><td><pre>
  <sld:NamedLayer>
    <se:Name>HY.Wetland</se:Name>
    <sld:UserStyle>
      <se:Name> HY.PhysicalWaters.Wetland.Default </se:Name>
      <sld:IsDefault>1</sld:IsDefault>
      <se:FeatureTypeStyle version="1.1.0">
        <se:Description>
          <se:Title>Wetlands default style</se:Title>
          <se:Abstract>Wetlands are depicted with blue-green
(#00CCCC).</se:Abstract>
        </se:Description>
        <se:FeatureTypeName>Wetland</se:FeatureTypeName>
        <se:Rule>
          <se:PolygonSymbolizer>
            <se:Geometry>
              <ogc:PropertyName>geometry</ogc:PropertyName>
            </se:Geometry>
            <se:Fill>
                    <se:SvgParameter
name="fill">#00CCCC</se:SvgParameter>
            </se:Fill>
          </se:PolygonSymbolizer>
        </se:Rule>
      </se:FeatureTypeStyle>
    </sld:UserStyle>
  </sld:NamedLayer>
</pre></td></tr>
<tr><td>Minimum & maximum scales</td><td>No scale limits</td></tr>
<tr><td>Example</td><td></td></tr>
</table>

Figure 14: Example of a machine-readable layout specification from [20]

7 Summary and outlook

This report describes the current status of the work aimed at enabling the uniform implementation of the Regulation across the EU with regard to integrated plans based on INSPIRE.

An analysis of INSPIRE's sewer data model shows that INSPIRE is well suited to representing integrated plans.

The sewer network can be represented using classes **(A), (H), (I)** and **(J),** aggregated into catchment areas via **(N)** and named using **(O).** Structures can be represented using **(T)** and named using **(E),** whilst catchment area boundaries are defined using **(W).**

It is evident that INSPIRE has succeeded in mapping all types of infrastructure descriptions in such a way that there are no duplicate definitions. This is the reason for the high level of abstraction present in the INSPIRE modelling of wastewater networks. Given the high degree of general applicability of INSPIRE, the type of data model for sewerage networks presented here is understandable.

In [47], the "risk posed by the publication of critical infrastructure" is cited as a reason for not applying the INSPIRE Directive on publication in the wastewater sector in Germany. This does not affect the need for Europe-wide standardisation of the data for [1].

The topic of 'Integrated Wastewater Management Plans' was already addressed in [48] using the example of the city of Rostock.

The next steps in mapping integrated wastewater plans include:
- Taking indirect dischargers and measures into account
- Creating sample datasets
- Identifying classes, attributes and code lists that still need to be added
- Creating display rules
- Generating integrated plans

These steps will then be described again in a report. **Figure 15** shows the chronological context of the topic.

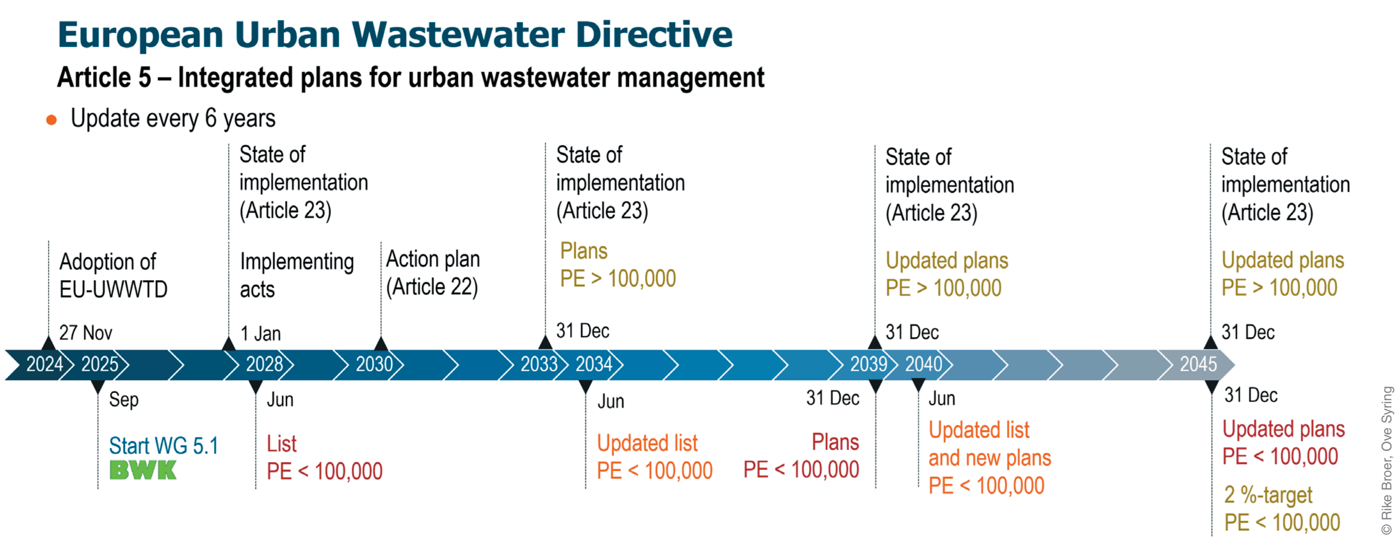


Figure 15: Timeline for the implementation of the Integrated Municipal Wastewater Management Plans (from [48])

8 Glossary

Abbreviation	Full form	Description
WMC	Wastewater Management Concept	Strategic planning for the collection, treatment, and discharge of wastewater
EC	European Commission	Executive body of the EU; coordinates INSPIRE (e.g. DG ENV, JRC)
EU	European Union	Association of states
HY	Hydrography	Annex I theme; hydrography network
HY-N	Hydrography – Network	Submodel of the Hydrography (HY) theme
GML	Geographic Markup Language	Global standard for geographic information systems
INSPIRE	INfrastructure for SPatial InfoRmation in Europe	EU Directive 2007/2/EC on spatial data infrastructure
IFC	Industry Foundation Class	Open, standardized data model for Building Information Modeling (BIM) by buildingSMART international
IR	Implementation Rules	Legally binding implementing rules (regulations)
SE	Symbology Encoding	Standard for defining the cartographic representation of geodata
SLD	Styled Layer Descriptor	OGC standard for map styling
SW	Sewer	INSPIRE theme
TG	Technical Guidelines	Detailed technical guidelines for implementation
UML	Unified Modeling Language	For application/data models in INSPIRE
URL	Uniform Resource Locator	Address of a web resource location
US	Utility and governmental services	INSPIRE theme
XMI	XML Metadata Interchange	Standardized XML format for exchanging UML models
XML	eXtensible Markup Language	Basis of many INSPIRE formats
XSD	XML Schema Definition	Validation of XML/GML structures

9 Working group members

Current members of the BWK Working Group 5.1 openStandard are:

- Dipl.-Ing. Bernhard Simon Bock, BWK Landesverband HRPS (Chair)
- M.Sc. Rike Broer, University of Rostock
- Dipl.-Ing. (FH) Normann Geisler, Verbandsgemeindewerke Leiningerland
- M.Sc. Larissa von Marschall, Thüringer Landesamt für Umwelt, Bergbau und Naturschutz
- Dipl.-Ing. Timm Menkens, Thüringer Landesamt für Umwelt, Bergbau und Naturschutz
- Dr. techn. Mario Regneri, InCA, Luxembourg
- Dipl.-Ing. Fabian Rost, Ruhrverband Essen
- Dr. Magnus Schneider, BWK Landesverband HRPS

10 References

The links were last accessed on March 9, 2026.
In [4] – [8] and [46] ‘ABK’ means WMC (Wastewater Management Concepts)

[1] Richtlinie (EU) 2024/3019 des Europäischen Parlaments und des Rates vom 27. November 2024 über die Behandlung von kommunalem Abwasser (Neufassung) (Text von Bedeutung für den EWR) <https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=OJ:L_202403019 > (Directive (EU) 2024/3019 of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment (recast) (Text with EEA relevance)< https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202403019>)

[2] Rechtsgrundlage der INSPIRE- Richtlinie – 2007/2 – EN – EUR-Lex <https://eur-lex.europa.eu/legal-content/DTXT/?uri=celex%3A32007L0002>
(Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32007L0002>)

[3] INSPIRE- Richtlinie, INSPIRE Knowledge base – INSPIRE Knowledge Base – European Commission

[4] ABKs Berlin, https://www.berlin.de/sen/uvk/umwelt/wasser-und-geologie/abwasser/abwasserbeseitigungsplan/

[5] ABKs Brandenburg, https://bravors.brandenburg.de/verwaltungsvorschriften/vv_abk_2019

[6] ABKs Nordrhein-Westfalen, https://www.lanuk.nrw.de/themen/wasser/abwasser/abwasserbeseitigungskonzept/abk-startseiten

[7] ABKs Sachsen-Anhalt, https://lau.sachsen-anhalt.de/boden-wasser-abfall/abwasser/abwasserbeseitigungskonzepte

[8] ABKs Thüringen, https://umwelt.thueringen.de/themen/boden-wasser-luft-und-laerm/abwasserentsorgung-u-wasser gefaehrdende-stoffe/abwasserbeseitigungskonzepte

[9] GDI-DE Registry – zentrales Register für geodatenbezogene Inhalte der Geodateninfrastruktur Deutschland (GDI-DE), https://registry.gdi-de.org/

[10] Nationale Umsetzung der KARL in Deutschland, https://www.umweltbundesamt.de/themen/wasser/abwasser/faq-zur-kommunalabwasserrichtlinie-karl#institutionen

[11] Wasser und Abfall 06/2025, Aufruf zur Mitarbeit Integrierte Pläne auf Basis von INSPIRE

[12] openData – Historie und rechtliche Grundlagen, B.Bernsdorf, B.Bock, Wasser und Abfall 05/2025

[13] openBIM in der Wasserwirtschaft am Beispiel der Abwasserableitung, B.Bock, Wasser und Abfall 06/2023

[14] INSPIRE-Richtlinie, in „Datenstandards in der Wasserwirtschaft", BWK Seminar Mainz, 27.04.2017, Y.Ackermann, B.Bock

[15] Projektbericht OKWAWI Querbauwerke, 23.12.2015, LAWA / DWA AG BIZ12.1 / Wupperverband / ahu AG, https://www.laenderfinanzierungsprogramm.de/static/LFP/Dateien/LAWA/AO/o-7-14-abschlussbericht.pdf

[16] INSPIRE Maintenance and Implementation, https://github.com/INSPIRE-MIF

[17] INSPIRE UML-Modelle und Mapping Tables, https://inspire-mif.github.io/uml-models/

[18] INSPIRE-Themen, https://knowledge-base.inspire.ec.europa.eu/tools/inspire-themes_en

[19] INSPIRE Datenspezifikation Hydrologie, https://inspire-mif.github.io/technical-guidelines/data/hy/dataspecification_hy.pdf

[20] INSPIRE Datenspezifikation Ver- und Entsorgung, öffentliche Dienste https://inspire-mif.github.io/technical-guidelines/data/us/dataspecification_us.pdf

[21] INSPIRE Datenspezifikation Transportnetzwerke, https://inspire-mif.github.io/technical-guidelines/data/tn/dataspecification_tn.pdf

[22] INSPIRE Datenspezifikation Basis-Modelle – generisches Netzwerkmdoell, https://knowledge-base.inspire.ec.europa.eu/document/download/706b1719-cbc8-4e10-9c0a 64d78a442dd5_en?filename=d2.10.1_genericnetwork-model_v1.0rc3.pdf

[23] “12.4 Units of measurement” in INSPIRE Generic Conceptual Model, https://knowledge-base.inspire.ec.europa.eu/document/download/bb551703-c8ab-4fbd-a556-f7cf-75feabe3_en?filename=d2.5_v3.4.pdf

[24] Modellierungssoftware Enterprise-Architect, https://de.wikipedia.org/wiki/Enterprise_Architect

[25] INSPIRE XML-Schema-Dateien, https://inspire.ec.europa.eu/schemas

[26] INSPIRE Datensatzprüfung https://inspire.ec.europa.eu/validator/home/index.html

[27] INSPIRE-codeList Verteilungssystem, https://inspire.ec.europa.eu/codelist/UtilityDeliveryTypeValue

[28] INSPIRE-codeList Schutzsystem, https://inspire.ec.europa.eu/codelist/WarningTypeValue

[29] INSPIRE-codeList Abwassertyp, https://inspire.ec.europa.eu/codelist/SewerWaterTypeValue

[30] INSPIRE-codeList Zubhörtypen, https://inspire.ec.europa.eu/codelist/AppurtenanceTypeValue

[31] INSPIRE-codeList spezifischer Zubehörtyp, https://inspire.ec.europa.eu/codelist/SpecificAppurtenanceTypeValue

[32] Datensätze zu Annex III (Utility und Goverment Services), https://inspire-geoportal.ec.europa.eu/srv/eng/catalog.search#/overview?view=themeOverview&theme=us

[33] INSPIRE sewer data records Luxembourg, https://inspire-geoportal.ec.europa.eu/srv/eng/catalog.search#/datasetdetails?country=lu&view=themeOverview&theme=none&resourceId=7806D2F4-2FB8-48DF-816E-849F80CFA81B

[34] INSPIRE sewer data records Sweden, https://inspire-geoportal.ec.europa.eu/srv/eng/catalog.search#/datasetdetails?country=se&view=themeOverview&theme=none&resourceId=84ec6102-56e4-40c3-9633-ff-e54871fb93

[35] INSPIRE Geoportal, INSPIRE Schutzgebiete in Deutschland, https://inspire-geoportal.ec.europa.eu/srv/api/records/

7115422a-78df-4f35-bb3f-3ab41dd420f5, darin https://geodienste.bfn.de/ogc/wms/INSPIRE_PS_DE?SERVICE=WMS&Request=GetCapabilities

[36] Geoportal der BfG, https://geoportal.bafg.de/csw-client/?searchtext=inspireidentifiziert, darin geoportal.bafg.de/arcgis1/services/INSPIRE/HY/MapServer/WMSServer?VERSION=1.3.0&SERVICE=WMS&REQUEST=GetCapabilities

[37] Bundesamt für Kartografie und Geodäsie, INSPIRE Daten und Dienste, https://gdz.bkg.bund.de/index.php/default/inspire.html

[38] Bundesanstalt für Gewässerkunde, INSPIRE-Angebot der BfG, https://geoportal.bafg.de/CSWView/inspire.xhtml

[39] Landesamt für Geologie und Bergbau, INSPIRE Themen, https://www.lgb-rlp.de/karten-und-produkte/inspire-themen

[40] Hessisches Landesamt für Naturschutz, Umwelt und Geologie (HLNUG), Geodienste Boden, Datei-Download INSPIRE HE SO BFD50, https://www.hlnug.de/themen/geografische-informationssysteme/geodienste/boden

[41] Bundesamt für Kartographie und Geodäsie, Transportnetze / Transport Networks, INSPIRE-WFS https://gdz.bkg.bund.de/index.php/default/inspire/inspire-verkehrsnetze/inspire-wfs-digital-landscape-model-1-250-000-wfs-dlm250-inspire.html, darin sgx.geodatenzentrum.de wfs_dlm250_inspire?request=GetCapabilities&service=wfs und https://sgx.geodatenzentrum.de/wfs_dlm250_inspire?SERVICE=WFS&VERSION=2.0.0&REQUEST=GetFeature&typeNames=hy-p:Crossing&COUNT=10

[42] Styled Layer Descriptor (SLD), Open Geospatial Consortium (OGC), https://www.ogc.org/de/standards/sld/

[43] Symbology Encoding (SE), Open Geospatial Consortium (OGC), https://www.ogc.org/de/standards/se/

[44] AAA-Signaturenkatalog, Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland, https://www.adv-online.de/GeoInfoDok/Signaturenkataloge/AAA-Signaturenkatalog-2.1-ALKIS-und-ATKIS/index.html

[45] DIN 2425-4:2022-11, Planwerke für die Versorgungswirtschaft, die Wasserwirtschaft und für Fernleitungen – Teil 4: Entwässerungssysteme außerhalb von Gebäuden, https://www.dinmedia.de/de/norm/din-2425-4/359001613

[46] ABK-Planzeichen in Thüringen, https://umwelt.thueringen.de/fileadmin/001_TMUEN/Unsere_Themen/Boden_Wasser_Luft_Laerm/Abwasser/Abwasserbeseitigungskonzepte/2025/Anlage_4_Planzeichen.docx.pdf

[47] Bereitstellung INSPIRE relevanter Geodaten und -dienste durch Ver- und Entsorgungsunternehmen, DVGW Deutscher Verein des Gas- und Wasserfaches e.V. und weitere mitherausgebende Institutionen/Verbände, https://www.gdi-de.org/download/Handlungsempfehlung_INSPIRE_EVU_Teil2.pdf

[48] Broer, Syring, Integrierte Pläne für die Abwasserbewirtschaftung – Eine Standortbestimmung für Rostock, Tagungsband 14. Rostocker Abwassertagung, https://abwassertagung.auf.uni-rostock.de/docs/pub/Tagungsband_14_Rostocker_Abwassertagung.pdf

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