Testbed-12 WPS ISO Data Quality Service Profile Engineering Report

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Publication Date: 2017-06-30

Approval Date: 2017-01-26

Posted Date: 2016-11-11

Reference number of this document: OGC 16-041r1

Reference URL for this document: http://www.opengis.net/doc/PER/t12-A080

Category: Public Engineering Report

Editor: Liping Di, Eugene G. Yu, Md Shahinoor Rahman, Ranjay Shrestha

Title: Testbed-12 WPS ISO Data Quality Service Profile Engineering Report

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Abstract

This Data Quality Engineering Report describes data quality handling requirements, challenges and solutions. One focus is on data quality in general that needs to be communicated from one service to another. In addition, it discusses WPS data quality solutions. The ultimate goal is for it to be nominated as a WPS ISO Data Quality Service Profile. ISO 19139 is used as the base to encode the data quality. WPS and workflows are used to streamline and standardize the process of data quality assurance and quality control. The main topics include: (1) generalized summary and description of the design and best practices for analyzing data quality of all feature data sources used in the Citizen Observatory WEB (COBWEB) project, (2) solutions and recommendations for enabling provenance of data quality transparent to end users when the data is processed through a WPS, (3) best practices and recommendations for designing and prototyping the WPS profile to support data quality service conformant to the NSG Metadata Framework, and (4) general solution for data quality fit for both raster-based imageries and vector-based features.

Business Value

This Engineering Report (ER) captures the essence and best practice for data quality that were successfully established and applied in the Citizen Observatory Web (COWBWEB) project. It goes one step further to formalize and standardize the processes as OGC WPS processes to address data quality issues by using networks of "people as sensors" and by analyzing observations and measurements in real-time combination with authoritative models and datasets. The ER content can be summarized as follows:

- Innovative use of crowdsourcing and citizen sensors to solve data quality control and assurance with prescribed seven standard WPS processes,
- Formalize the processes to solve data quality issues using citizen sensors that harmonize the data and service interoperation across processes as Web services, and
- Achieve compatible data quality assurance levels.

Technology Value

The relevance and importance of the ER to WPS 2.0 SWG are obvious in two aspects. On the one hand, the best practice and solutions described in the ER utilizes WPS 2.0 as a general framework and service implementation specification to achieve data quality control and assurance in dealing with

networks of citizen sensors and their information offers. Each data quality operation is implemented as WPS process. The adoption of WPS not only benefits high level interoperation among services, but also prompts the applications of WPS in citizen sensor network applications. On the other hand, the formalization and standardization of seven processes identified in the COBWEB project lead to the development of a WPS profile with ISO Data Quality standards that are applicable for citizen sensor data quality control and assurance. Seven processes are to be specified as WPS process. The seven WPS processes are: (1) LBS-Positioning, (2) Cleaning, (3) Automatic Validation, (4) Authoritative Data Comparison, (5) Model-Based Validation, (6) Linked Data Analysis, and (7) Semantic Harmonization.

How does this ER relate to the work of the Working Group

This ER demonstrates a use case for web-based processing using the WPS 2.0 interface standard. Also, a basis for a data quality WPS profile is described. The goal of the hierarchical profiling approach specified in the WPS 2.0 standard is to foster interoperability among different WPS clients and servers. A data quality profile could serve as proof of concept of the WPS 2.0 profiling approach and could be used to incorporate data quality checks in (automated) geoprocessing workflows.

Keywords

ogcdocs, testbed-12, WPS, Web services, ISO 19139, ISO 19115, Workflow

Proposed OGC Working Group for Review and Approval

The ER will be submitted to WPS 2.0 SWG for review. The ultimate goal is to develop and promote it as a WPS profile with the approval of WPS 2.0 SWG.

Chapter 1. Introduction

1.1. Scope

This report captures the best practice of using WPS processes as the interoperation framework to support data quality assurance and control using networks of "people as sensors". Seven processes for data quality control shall be formalized and specified as WPS processes. The interoperation among processes as well as between citizen sensors shall be enabled at levels of data and services.

1.2. Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

Table 1.1. Contacts

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1.3. Future Work

Several future recommendations have been identified. Details will be discussed in the section on Future Recommendations. The recommendations are: (1) alignment with the evolution of geospatial standards, (2) data quality workflow enablement, and (3) data quality service test suites.

1.4. Foreword

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.

Chapter 2. References

The following documents are referenced in this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

- OGC 06-121r9, OGC® Web Services Common Standard

NOTE	This OWS Common Standard contains a list of normative references that are also applicable to this Implementation Standard.

- OGC 14-065, OGC® WPS 2.0 Interface Standard
- OGC 06-121r9, OGC® Web Services Common Standard
- ISO 19157:2013, Geographic information — Data quality
- ISO/DTS 19157-2, Geographic information — Data quality — Part 2: XML Schema Implementation
- ISO 19115:2003, Geographic information — Metadata

Chapter 3. Terms and definitions

For the purposes of this report, the definitions specified in Clause 4 of the OWS Common Implementation Standard [OGC 06-121r9] and in OGC® Abstract Specification Topic 11: Metadata [OGC 01-111] shall apply. In addition, the following terms and definitions apply.

3.1. data quality

```
Data quality is a concept used in the context to represent the geospatial data quality
with multiple components that include data validity, precision and accuracy. Data
validity may be described as “fitness for use,” i.e. the degree to which data are fit
for an application. Geospatial precision is related to resolution and variation.
Geospatial accuracy refers only to how close the measurement is to the true value.
```

3.2. positional accuracy

```
the quantifiable value that represents the positional difference between two
geospatial layers or between a geospatial layer and reality
```

3.3. lineage

```
description of the history of the spatial data, including descriptions of the source
material from which the data were derived, and the methods of derivation
```

3.4. attribute accuracy

```
the accuracy of the quantitative and qualitative information attached to each feature
```

3.5. consistency

```
description of the dependability of relationships encoded in the data structure of the
digital spatial data
```

3.6. completeness

```
the degree to which geographic features, their attributes and their relationships are
included or omitted in a dataset
```

Chapter 4. Conventions

4.1. Abbreviated terms

- APIApplication Program Interface
- BPMN Business Process Model and Notation
- COBWEB Citizen OBservatory WEB
- COMComponent Object Model
- CORBACommon Object Request Broker Architecture
- COTSCommercial Off The Shelf
- DCEDistributed Computing Environment
- DCOMDistributed Component Object Model
- DQ Data Quality
- DTS Draft Technical Specification
- GeoJSON Geographic JavaScript Object Notation
- GML Geography Markup Language
- IDLInterface Definition Language
- ISO International Organization for Standardization
- JSON JavaScript Object Notation
- NGA National Geospatial-Intelligence Agency
- NSG National System for Geospatial Intelligence
- UC Use Case
- WFS Web Feature Service
- WPS Web Processing Service
- XML EXtensible Markup Language

4.2. UML notation

Most diagrams that appear in this standard are presented using the Unified Modeling Language (UML) static structure diagram, as described in Subclause 5.2 of [OGC 06-121r9].

4.3. Used parts of other documents

This document uses significant parts of document [OGC 06-121r9]. To reduce the need to refer to that document, this document copies some of those parts with small modifications. To indicate those parts to readers of this document, the largely copied parts are shown with a light grey background (15%).

Chapter 5. Overview

Data quality services are the focus. Specifications and standards define how data quality is described and presented. Many processes to derive data quality share common solutions for different cases. This Engineering Report (ER) aims to enable automation of commonly required data quality measurements and assessments. Web Processing Service (WPS) is used as the vehicle to achieve such automation.

Chapter 6. Status Quo & New Requirements Statement

6.1. Status Quo

6.1.1. Data quality assurance and data quality control

The Citizen Observatory Web (COBWEB) is a citizen science project that explores the potential of combining citizen resources and open geospatial standards in supporting biosphere data collection, validation, and analysis[1]. The infrastructure sets a suite of technologies to form a citizens' observatory framework that effectively exploits technological developments in ubiquitous mobile devices, crowd-sourcing of geographic information and the operational applications of standards based spatial data infrastructure (SDI). The framework enables citizens to collect environmental information on a range of parameters including species distribution, flooding and land cover/use[1, 2]. Workflow was used to design different complex process from component services[3]. Dealing with diversified sources of data, the project had to tackle the data quality issues. One of the important and efficient approaches is its adoption of WPS processes to enable data quality assurance and validation. The data quality was addressed by using networks of "people as sensors" and by analyzing observations and measurements in real-time combination with authoritative models and datasets. The COBWEB project represents the status quo or starting point for the work done in testbed 12 to develop and formalize the WPS processes to facilitate data quality assurance.

6.1.2. Data quality assessment challenges

In the COBWEB project, the challenges of the quality assurance were: how to design and implement a system that was flexible enough to qualify data with different fitness for purpose requirements, different data schemas, recorded by different devices. More specifically, the challenges are as follows.

1. Fitness of data quality model: What to model? What is the proper model process? What are the variations in capture devices/persons?
2. Provenance: The history of data collection is important. It is related to what curation process is involved.
3. Metaquality: The questions for different data qualities need to be answered. What are the qualities of DQ metadata? How to define accuracy? How to define completeness? What criteria and strategies should be used to keep consistency?
4. Levels of DQ assessment: DQ assessment can be done at different levels. What should be the proper level? Is it needed to be as detailed as up to the level of dataset? Is it only necessary to evaluate at the level of collection?
5. Propagation of data uncertainty: Data error and uncertainty may be propagated through the chain of processes when multiple processes are involved. How to represent and record the propagation among workflows? How to track the propagation among data fusion?

6.2. Requirements Statement

The requirements for the sponsor, NGA, differ from the COBWEB project in the following ways:

- The data is authoritative.
- The data is likely to have a static structure.
- Metadata is likely to exist for the products, which can be utilized in the qualification process.
- In COBWEB the focus was on observations recorded as points, this project requires qualification to be performed on different types of data including points, lines, polygons and images.

By analyzing the requirements and the demand on data quality services, the following common requirements can be identified:

1. Quality assurance of data quality: This defines what to be assessed, how to assess, and required standard approach.
2. Fit data quality assessment approaches: The atomic process may be represented as a WPS process. The complex assessment process may be combining or chaining several atomic processes to form workflows. Enabling workflows and composition of atomic processes allows extended adaptivity and flexibility to meet various requirements with different complex levels. Efficiency can be achieved with enhanced reusability of atomic processes.
3. Provenance: This keeps track of data quality and data history.
4. Unified aggregating data quality to high levels: Approaches and methods to aggregate data quality need to be unified.
5. Standard mechanisms to encode, store, and retrieve data quality metadata at multiple levels: Different levels of details on data may adopt different encoding, storing, and accessing mechanism. Geospatial data may be dealt with two levels in general: dataset and data collection.
6. Data quality consumption: Processes and outputs for data quality should be clearly understood about who is the intended consumer of recorded DQ information. Typical, two distinguishable types of consumption should be considered: machine-readable and human-readable.

There are also extra requirements from the sponsor including adherence to specific standards for data and metadata. The main required standard is the NGA Metadata Framework and ISO 19115 metadata documents. Recently, the quality elements of ISO 19115 have been split into a separate document, ISO 19157. It is going to be adopted as the document recording the quality elements as the specifications from OGC and NGA evolve. In this testbed, all these will be taken into account in designing the WPS Data Quality processes.

Chapter 7. Solutions

7.1. Targeted Solutions

7.1.1. Overall Design Strategy and Architecture

Data quality (DQ) involves different aspects – completeness, positional accuracy, topological accuracy, domain consistency, conceptual consistency, format consistency, and correctness. The realization of such DQ functionality is recommended to be implemented as a series of atomic WPS process. WPS, as an OGC processing specification, is identified as a fit technology to enable the implementation of DQ processes in the Web environment[1, 2]. With considerations of dealing with complexity and multi-levels of granularity, each WPS process should be designed as atomic as possible to allow its reusability in composition through workflows.

As defined in ISO 19157, there are many DQ criteria tests. The DQ WPS should consist of a set of atomic DQ WPS test processes to meet the functional requirements defined in ISO 19157. Each DQ process should be configurable and atomic. They should be passed with metrics that correspond to the Universe of Discourse, or what the thresholds are for what is considered as quality in ISO 19157 terms. The WPS processes all follow a similar design to make them interoperable, suited for chaining and so that they conform to some uniform pattern. This is depicted in the following Figure.

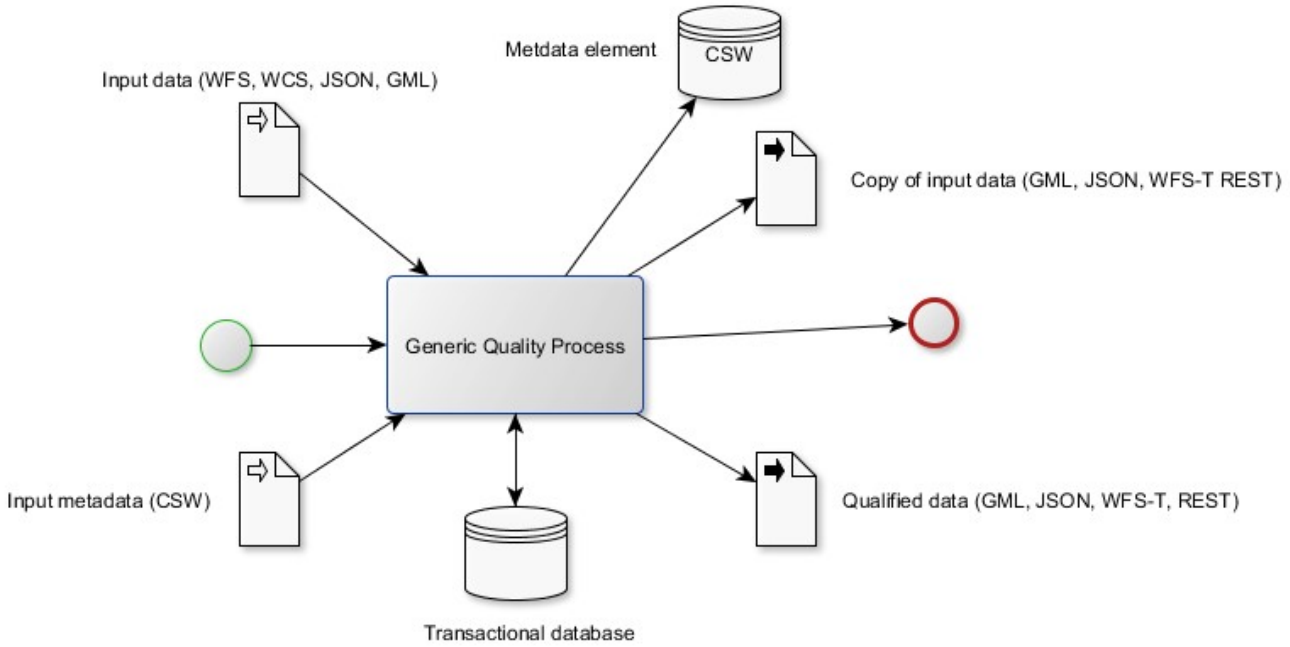


Figure 1. Atomic DQ WPS process

Each atomic DQ WPS process may take two types of inputs: data and reference data. Both data and reference data can be served through standard WCS or WFS services. They can be encoded in GML, GeoJSON, XML, or JSON. An atomic DQ WPS process may output metadata in XML and/or optionally non-conforming data in GML. The output should contain a statement to clarify its conformance.

There are three main aspects of data quality issues to be tested with DQ WPS processes. They are as follows.

1. Data Quality Assurance/Quantity Control WPS,
2. Encoding/curating data quality: correctness, completeness, consistency, and provenance, and
3. Standard data quality metadata consumption: making mapping to NSG metadata framework mandatory, and providing both machine-readable and human-readable formats.

7.1.2. Completeness Omission/Completeness Commission

Completeness has two connotations. One is to inspect omission, i.e. how much is not included in the geospatial database. Another is to inspect commission, i.e. how much is falsely included in the geospatial database. The measurements can be in quantity, rate, or duplicates. This can be implemented as one WPS process that completes the computation by comparing the geospatial database with the reference geospatial database.

7.1.3. Positional Accuracy

The position accuracy is related to the geometrical measurements. There are two cases that have quite distinguishing characteristics due to their different formats – vector or raster. Two separate processes are proposed to deal with such different geospatial databases.

Positional Accuracy (vector feature)

Vector-based geospatial features are often managed by database or database-like system. Each feature has a set of attributes. There would be one or more fields that form the primary key. By associating the database to the reference databases, one can verify if they have the required positional accuracy. This will be designed as a dedicated WPS process.

Positional Accuracy (gridded)

Raster-based geospatial features are concerned with spatial resolution and location displacement. The comparison and validation against reference raster-based dataset need to consider both spatial resolution and location displacement. This will be developed as one dedicated WPS process to check positional accuracy using a reference dataset.

7.1.4. Topological Consistency

Geometrical contradictions should not exist in the result geospatial database. This needs to verify that geospatial rules are met, such as one location for one point, polygon bound by lines, etc. A WPS process will be designed and developed to complete the consistency check in a single geospatial database.

7.2. Recommendations

ISO standards will be adopted to encode data quality. Specifically, ISO 19157 is one of the primary standards to support different aspects of data quality. The mapping of elements can be seen in the following table.

ISO19157					
Element Name	**Element Code**	**Data Type**	**Test Description**	**Formal Test**	**Possible result**
Scope	DQ_Scope	All	Defined by a domain code. codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#MD_ScopeCode".	Query metadata	dataset
Scope Description	**DQ_ScopeDescription**	All	Description. i.e. "Localities in Victoria"	Query Metadata	Localities in Victoria
Lineage	**DQ_Lineage**	All	Description of the lineage, probably from existing metadata	Query metadata	Created from TIGER data 2005
Completeness	**DQ_CompletenessOmmission**	Vector	Is there something missing from the dataset?	Compare attributes to a gazetteer	There are 25 roads missing from the dataset
Completeness	**DQ_CompletenessOmmission**	Raster	Is there something missing from the dataset?	Check the coverage boundaries/bands if an image	There are 25 square miles of data over 3 bands
Topological consistency	DQ_TopologicalConsistency	Vector	Check if there are any topology issues (dangles, overlaps, spaghetti)	Perform topology tests on data	There are 4 dangles, 3 overlaps and 10 potential missing links
Topological consistency	**DQ_TopologicalConsistency**	Raster	Check for missing cell data	check coverage regularity, check for pixels with missing values	There are 15 cells with no data
Conceptual consistency	**DQ_ConceptualConsistency**	Vector	Check for multipart roads	check the number of entries per road name	There are 10 entries with multiple parts
Conceptual consistency	**DQ_ConceptualConsistency**	Raster	Check for mosaiced imagery	Count number of constituant images	4 images make up this product from two different datasets
Positional Accuracy	**DQ_PositionalAccuracy**	Vector	Compare intersection locations with a reference dataset	take average difference between dataset intersections and reference dataset intersections	This dataset is displaced by an average of 0.5 m

Figure 7.2. ISO 19157 Element Map

In overall design, the following are recommended in dealing with data quality issues.

1. WPS workflow enablement with BPMN for flexibility
2. Seven important aspects for data quality control: location-based-service position correction, cleaning, model-based validation, authoritative data comparison, automatic validation, linked data analysis, and semantic harmonization (Meek, S Jackson, M Leibovici, DG (2014))
3. Recommended levels of data quality metadata: multiple levels of conformance to meet different requirements and standard information to make users aware of levels of data quality assurance and data quality control.

7.2.1. Completeness Omission/Completeness Commission WPS processes

The following table defines the generic WPS process for processing the Completeness Omission/Completeness Commission. There are two types: omission and commission. The processes can be further broken down to different processes for vector-based and raster-based features.

Table 7.1. Completeness WPS Process

Name:	iso19157.DQ_Completeness.DQ_Completeness
Description:	1. Calculate omission and commission of a dataset based on a reference dataset. 2. Calculate rate of omission and commission of a dataset based on a reference dataset. 3. Calculate duplicate features within a dataset vector-based and raster-based features.
Input:	Target dataset, field of interest, Reference dataset, field of interest declaration.

Algorithm:	1. Summarizes the data in each and calculates entry type and frequency for both datasets and compares the results. 2. Uses the summary table calculated in 1) and calculates a percentage of omission/commission. 3. Performs a multi-step check on the dataset. Compares geometries of a feature to all other features, if geometries match then compare each of the fields within the dataset, if the values all match then the entry is a duplicate.
Output:	One of the following: 1. A table listing all data types and frequency for both target and reference datasets. 2. A list of data types and rate of omission/commission 3. The number of duplicate features.

Completeness Omission WPS processes

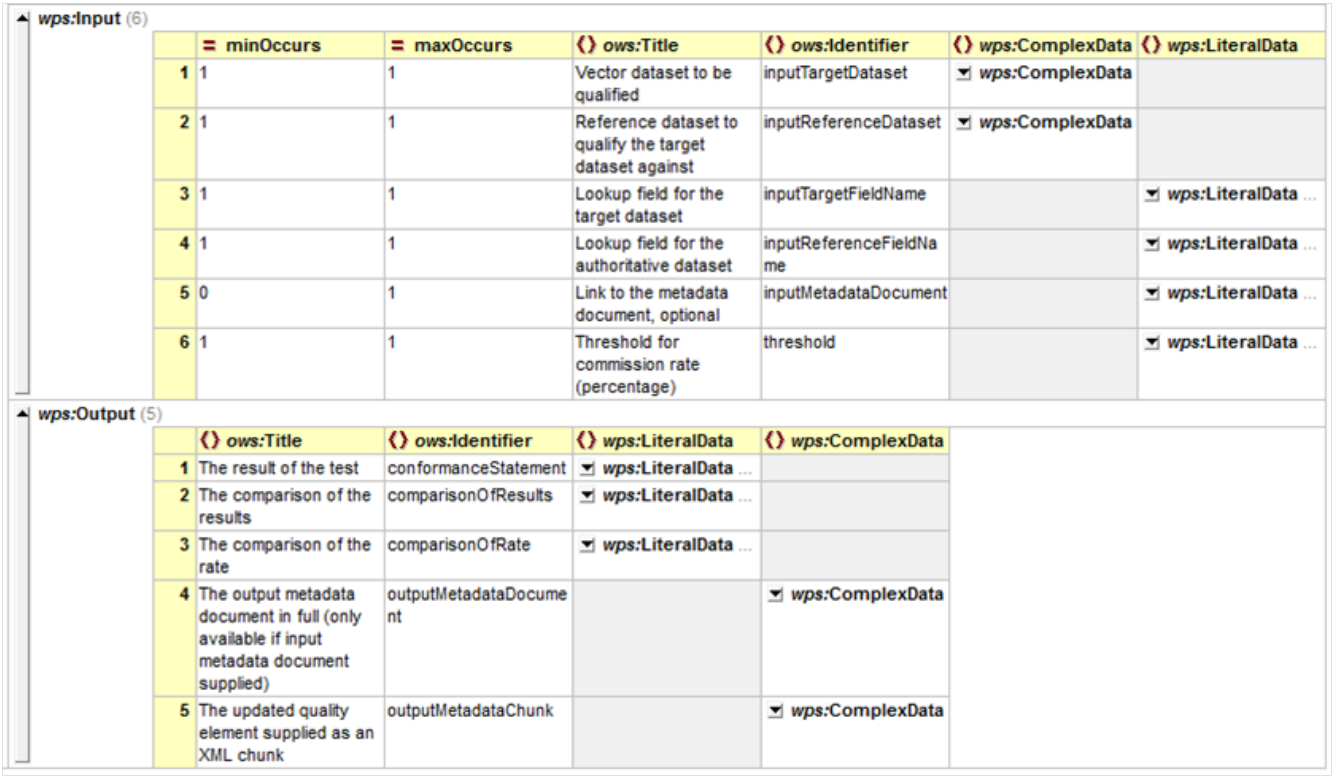
This section describes completeness omission WPS processes.

Completeness Omission WPS process for vector-based dataset

The following table defines the WPS process to evaluate the Completeness Omission of vector-based dataset.

Table 7.2. Completeness Omission WPS Process for vector-based dataset

Name:	iso19157.DQ_Completeness.DQ_CompletenessOmission
Description:	1. Calculate omission of a vector dataset based on a reference vector dataset. 2. Calculate rate of omission of a vector dataset based on a reference vector dataset. 3. Calculate duplicated features within a vector dataset.
Input:	1. Target vector dataset to be qualified 2. Reference vector dataset to qualify the target vector dataset against 3. Lookup field for the target vector dataset 4. Lookup field for the reference vector dataset 5. Link to metadata document (optional) 6. Threshold for omission rate (percentage)
Algorithm:	1. Summarizes the data in each and calculates entry type and frequency for both datasets and compares the results. 2. Uses the summary table calculated in 1) and calculates a percentage of omission. 3. Performs a multi-step check on the dataset. Compares geometries of a feature to all other features, if geometries match then compare each of the fields within the dataset, if the values all match then the entry is a duplicate.
Output:	One of the following: 1. A table listing all data types and frequency for both target and reference datasets. 2. A list of data types and rate of omission 3. The number of duplicate features.
UML:	See Figure 7.3.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table A.1. in Appendix A. **Response:** See example response shown in Table A.1. in Appendix A.



wps:Input (6)

	= minOccurs	= maxOccurs	{} ows:Title	{} ows:Identifier	{} wps:ComplexData	{} wps:LiteralData
1	1	1	Vector dataset to be qualified	inputTargetDataset	wps:ComplexData	
2	1	1	Reference dataset to qualify the target dataset against	inputReferenceDataset	wps:ComplexData	
3	1	1	Lookup field for the target dataset	inputTargetFieldName		wps:LiteralData
4	1	1	Lookup field for the authoritative dataset	inputReferenceFieldName		wps:LiteralData
5	0	1	Link to the metadata document, optional	inputMetadataDocument		wps:LiteralData
6	1	1	Threshold for commission rate (percentage)	threshold		wps:LiteralData

wps:Output (5)

	{} ows:Title	{} ows:Identifier	{} wps:LiteralData	{} wps:ComplexData
1	The result of the test	conformanceStatement	wps:LiteralData	
2	The comparison of the results	comparisonOfResults	wps:LiteralData	
3	The comparison of the rate	comparisonOfRate	wps:LiteralData	
4	The output metadata document in full (only available if input metadata document supplied)	outputMetadataDocument		wps:ComplexData
5	The updated quality element supplied as an XML chunk	outputMetadataChunk		wps:ComplexData

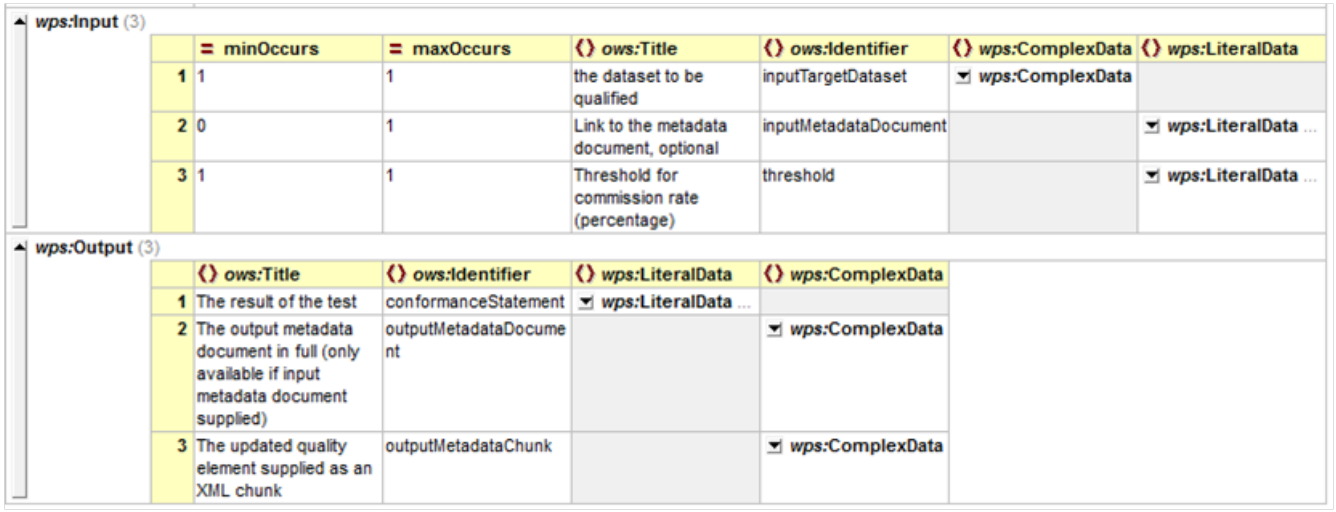
Figure 7.3. UML model for the Completeness Omission WPS process (vector-based dataset)

Completeness Omission WPS process for raster-based dataset

The following table defines the WPS process to evaluate the Completeness Omission of raster-based dataset.

Table 7.3. Completeness Omission WPS Process for raster-based dataset

Name:	iso19157.DQ_Completeness.DQ_CompletenessOmissionR
Description:	1. Calculate omission of a raster dataset based on a reference raster dataset. 2. Calculate rate of omission of a raster dataset based on a reference raster dataset. 3. Calculate duplicated features within a raster dataset.
Input:	1. Target raster dataset to be qualified 2. Link to metadata document (optional) 3. Threshold for omission rate (percentage)
Algorithm:	1. Summarizes the data in each and calculates entry type and frequency for input dataset. 2. Uses the summary table calculated in 1) and calculates a percentage of omission. 3. Performs a multi-step check on the dataset. Compares the pixel of a feature to all other features, if the geometries match then compare each of the fields within the dataset, if the values all match then the entry is a duplicate.
Output:	One of the following as the result of the test: 1. A table listing all data types and frequency. 2. A list of data types and rate of omission 3. The number of duplicate features.
UML:	See Figure 7.4.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table A.2. in Appendix A. **Response:** See example response shown in Table A.2. in Appendix A.



wps:Input (3)

	= minOccurs	= maxOccurs	⟨⟩ ows:Title	⟨⟩ ows:Identifier	⟨⟩ wps:ComplexData	⟨⟩ wps:LiteralData
1	1	1	the dataset to be qualified	inputTargetDataset	wps:ComplexData	
2	0	1	Link to the metadata document, optional	inputMetadataDocument		wps:LiteralData
3	1	1	Threshold for commission rate (percentage)	threshold		wps:LiteralData

wps:Output (3)

	⟨⟩ ows:Title	⟨⟩ ows:Identifier	⟨⟩ wps:LiteralData	⟨⟩ wps:ComplexData
1	The result of the test	conformanceStatement	wps:LiteralData	
2	The output metadata document in full (only available if input metadata document supplied)	outputMetadataDocument		wps:ComplexData
3	The updated quality element supplied as an XML chunk	outputMetadataChunk		wps:ComplexData

Figure 7.4. UML model for the Completeness Omission WPS process (raster-based dataset)

Completeness Commission WPS processes

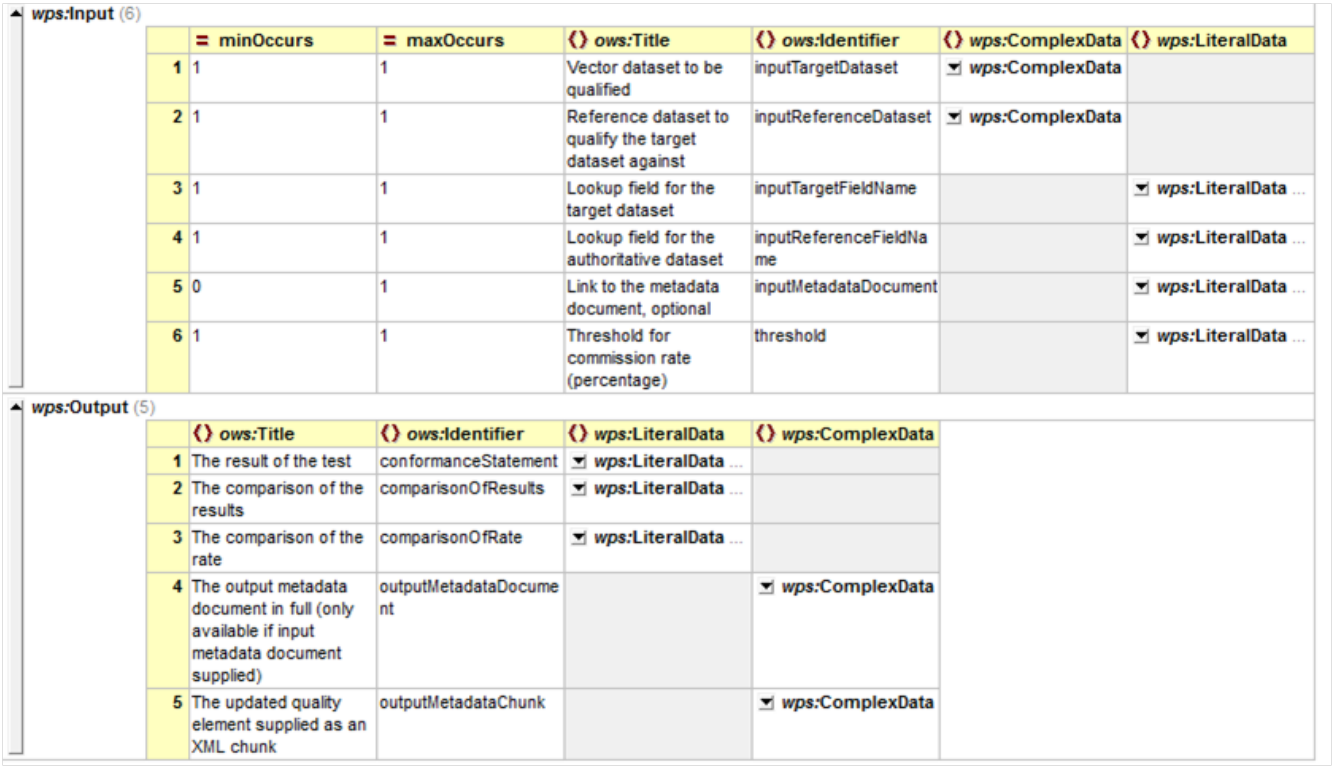
This section describes completeness commission WPS processes.

Completeness Commission WPS process for vector-based dataset

The following table defines the WPS process to evaluate the Completeness Commission of vector-based dataset.

Table 7.4. Completeness Commission WPS Process for vector-based dataset

Name:	iso19157.DQ_Completeness.DQ_CompletenessCommission
Description:	1. Calculate commission of a vector dataset based on a reference vector dataset. 2. Calculate rate of commission of a vector dataset based on a reference vector dataset. 3. Calculate duplicated features within a vector dataset.
Input:	1. Target vector dataset to be qualified 2. Reference vector dataset to qualify the target vector dataset against 3. Lookup field for the target vector dataset 4. Lookup field for the reference vector dataset 5. Link to metadata document (optional) 6. Threshold for omission rate (percentage)
Algorithm:	1. Summarizes the data in each and calculates entry type and frequency for both datasets and compares the results. 2. Uses the summary table calculated in 1) and calculates a percentage of omission. 3. Performs a multi-step check on the dataset. Compares geometries of a feature to all other features, if geometries match then compare each of the fields within the dataset, if the values all match then the entry is a duplicate.
Output:	One of the following: 1. A table listing all data types and frequency for both target and reference datasets. 2. A list of data types and rate of commission 3. The number of duplicate features.
UML:	See Figure 7.5.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table A.3. in Appendix A. **Response:** See example response shown in Table A.3. in Appendix A.



wps:Input (6)

	= minOccurs	= maxOccurs	ows:Title	ows:Identifier	wps:ComplexData	wps:LiteralData
1	1	1	Vector dataset to be qualified	inputTargetDataset	wps:ComplexData	
2	1	1	Reference dataset to qualify the target dataset against	inputReferenceDataset	wps:ComplexData	
3	1	1	Lookup field for the target dataset	inputTargetFieldName		wps:LiteralData
4	1	1	Lookup field for the authoritative dataset	inputReferenceFieldName		wps:LiteralData
5	0	1	Link to the metadata document, optional	inputMetadataDocument		wps:LiteralData
6	1	1	Threshold for commission rate (percentage)	threshold		wps:LiteralData

wps:Output (5)

	ows:Title	ows:Identifier	wps:LiteralData	wps:ComplexData
1	The result of the test	conformanceStatement	wps:LiteralData	
2	The comparison of the results	comparisonOfResults	wps:LiteralData	
3	The comparison of the rate	comparisonOfRate	wps:LiteralData	
4	The output metadata document in full (only available if input metadata document supplied)	outputMetadataDocument		wps:ComplexData
5	The updated quality element supplied as an XML chunk	outputMetadataChunk		wps:ComplexData

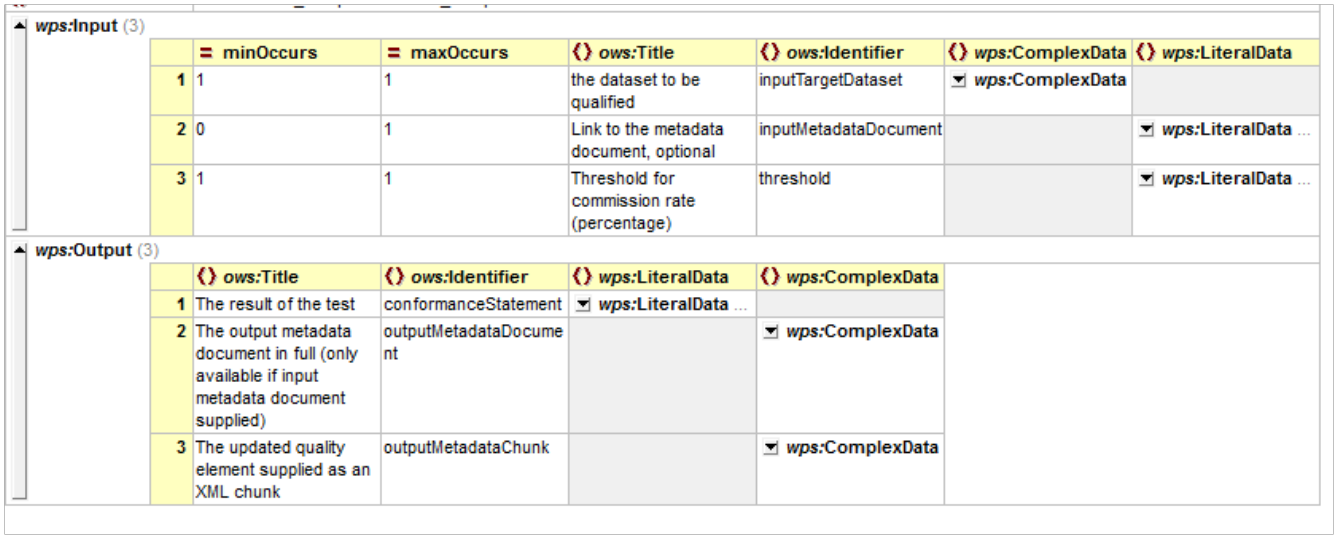
Figure 7.5. UML model for the Completeness Commission WPS process (vector-based dataset)

Completeness Commission WPS process for raster-based dataset

The following table defines the WPS process to evaluate the Completeness Commission of raster-based dataset.

Table 7.5. Completeness Commission WPS Process for raster-based dataset

Name:	iso19157.DQ_Completeness.DQ_CompletenessCOmmissionR
Description:	1. Calculate commission of a raster dataset based on a reference raster dataset. 2. Calculate rate of commission of a raster dataset based on a reference raster dataset. 3. Calculate duplicated features within a raster dataset.
Input:	1. Target raster dataset to be qualified 2. Link to metadata document (optional) 3. Threshold for commission rate (percentage)
Algorithm:	1. Summarizes the data in each and calculates entry type and frequency for input dataset. 2. Uses the summary table calculated in 1) and calculates a percentage of omission. 3. Performs a multi-step check on the dataset. Compares the pixel of a feature to all other features, if the geometries match then compare each of the fields within the dataset, if the values all match then the entry is a duplicate.
Output:	One of the following as the result of the test: 1. A table listing all data types and frequency. 2. A list of data types and rate of commission 3. The number of duplicate features.
UML:	See Figure 7.6.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table A.4. in Appendix A. **Response:** See example response shown in Table A.4. in Appendix A.



wps:Input (3)

	minOccurs	maxOccurs	ows:Title	ows:Identifier	wps:ComplexData	wps:LiteralData
1	1	1	the dataset to be qualified	inputTargetDataset	wps:ComplexData	
2	0	1	Link to the metadata document, optional	inputMetadataDocument		wps:LiteralData ...
3	1	1	Threshold for commission rate (percentage)	threshold		wps:LiteralData ...

wps:Output (3)

	ows:Title	ows:Identifier	wps:LiteralData	wps:ComplexData
1	The result of the test	conformanceStatement	wps:LiteralData ...	
2	The output metadata document in full (only available if input metadata document supplied)	outputMetadataDocument		wps:ComplexData
3	The updated quality element supplied as an XML chunk	outputMetadataChunk		wps:ComplexData

Figure 7.6. UML model for the Completeness Commission WPS process (raster-based dataset)

7.2.2. Positional Accuracy WPS processes

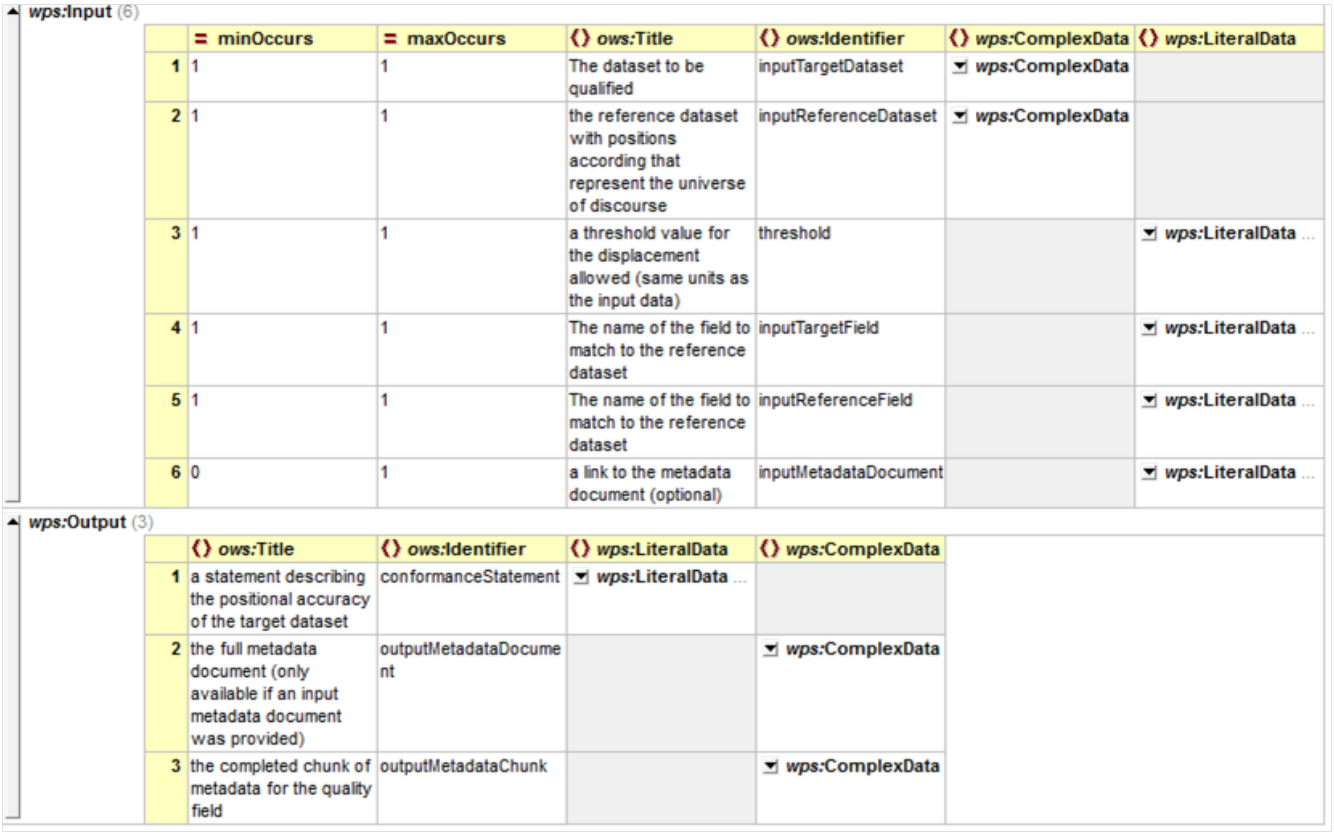
This section describes positional accuracy WPS processes.

Positional Accuracy (vector feature) WPS process

The following table defines the Positional Accuracy (vector feature) WPS processes.

Table 7.6. Positional Accuracy (vector feature) WPS processes

Name:	iso19157.DQ_PositionalAccuracy.DQ_AbsoluteExternalPositionalAccuracy
Description:	Calculates the positional accuracy of a target dataset given a reference dataset and lookup field
Input:	Target dataset, target dataset field ID, reference dataset, reference dataset field ID
Algorithm:	It takes the target dataset and matches up its entries with those in the reference dataset by comparing their Identifiers (IDs) (they must be identified as an integer) - i.e. target dataset field ID and reference dataset field ID defined in the inputs.
Output:	The mean uncertainties as defined by ISO 19157
UML:	See Figure 7.7.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table B.1. in Appendix B. **Response:** See example response shown in Table B.1. in Appendix B.



wps:Input (6)

	= minOccurs	= maxOccurs	ows:Title	ows:Identifier	wps:ComplexData	wps:LiteralData
1	1	1	The dataset to be qualified	inputTargetDataset	wps:ComplexData	
2	1	1	the reference dataset with positions according that represent the universe of discourse	inputReferenceDataset	wps:ComplexData	
3	1	1	a threshold value for the displacement allowed (same units as the input data)	threshold		wps:LiteralData
4	1	1	The name of the field to match to the reference dataset	inputTargetField		wps:LiteralData
5	1	1	The name of the field to match to the reference dataset	inputReferenceField		wps:LiteralData
6	0	1	a link to the metadata document (optional)	inputMetadataDocument		wps:LiteralData

wps:Output (3)

	ows:Title	ows:Identifier	wps:LiteralData	wps:ComplexData
1	a statement describing the positional accuracy of the target dataset	conformanceStatement	wps:LiteralData	
2	the full metadata document (only available if an input metadata document was provided)	outputMetadataDocument		wps:ComplexData
3	the completed chunk of metadata for the quality field	outputMetadataChunk		wps:ComplexData

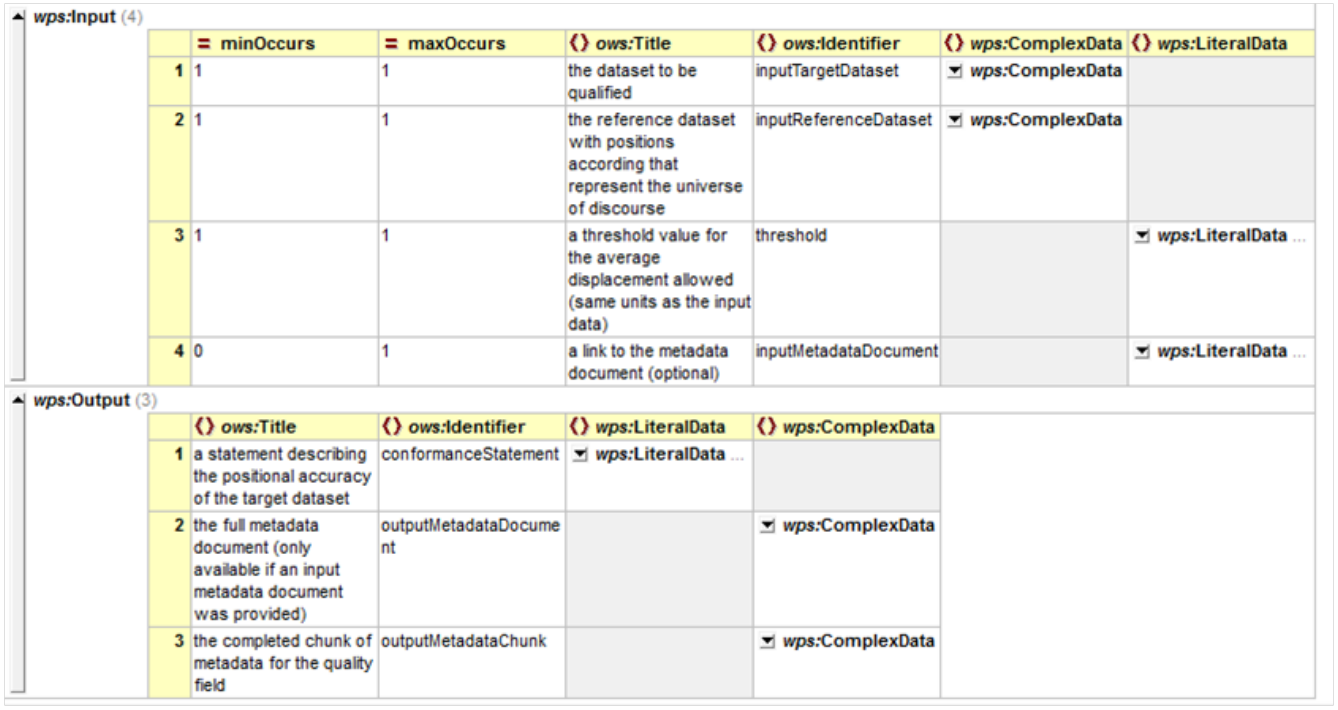
Figure 7.7. UML model for the Positional Accuracy WPS process (vector-based dataset)

Positional Accuracy (gridded) WPS process

The following table defines the Positional Accuracy (gridded) WPS processes.

Table 7.7. Positional Accuracy (gridded) WPS processes

Name:	iso19157.DQ_PositionalAccuracy.DQ_GriddedDataPositionalAccuracy
Description:	Calculates the positional accuracy of a raster dataset based upon edges of buildings matched to a vector reference dataset.
Input:	A georeferenced raster dataset as a GeoTIFF, set of reference polygons, threshold for edge detect (0-255), area for noise removal (very small area polygons usually removed as they constitute noise).
Algorithm:	The process does the following: •Histogram stretch •Laplace filter •Black and White conversion •Black and white binary image creation •Black and white binary to polygons •Polygon distance to nearest reference polygon.
Output:	The mean distance uncertainty as defined by ISO 19157, the Laplace image, the generated polygons.
UML:	See Figure 7.8.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table B.2. in Appendix B. **Response:** See example response shown in Table B.2. in Appendix B.



wps:Input (4)

	= minOccurs	= maxOccurs	⟨⟩ ows:Title	⟨⟩ ows:Identifier	⟨⟩ wps:ComplexData	⟨⟩ wps:LiteralData
1	1	1	the dataset to be qualified	inputTargetDataset	wps:ComplexData	
2	1	1	the reference dataset with positions according that represent the universe of discourse	inputReferenceDataset	wps:ComplexData	
3	1	1	a threshold value for the average displacement allowed (same units as the input data)	threshold		wps:LiteralData ...
4	0	1	a link to the metadata document (optional)	inputMetadataDocument		wps:LiteralData ...

wps:Output (3)

	⟨⟩ ows:Title	⟨⟩ ows:Identifier	⟨⟩ wps:LiteralData	⟨⟩ wps:ComplexData
1	a statement describing the positional accuracy of the target dataset	conformanceStatement	wps:LiteralData ...	
2	the full metadata document (only available if an input metadata document was provided)	outputMetadataDocument		wps:ComplexData
3	the completed chunk of metadata for the quality field	outputMetadataChunk		wps:ComplexData

Figure 7.8. UML model for the Positional Accuracy WPS process (raster-based dataset)

7.2.3. Logical Consistency WPS processes

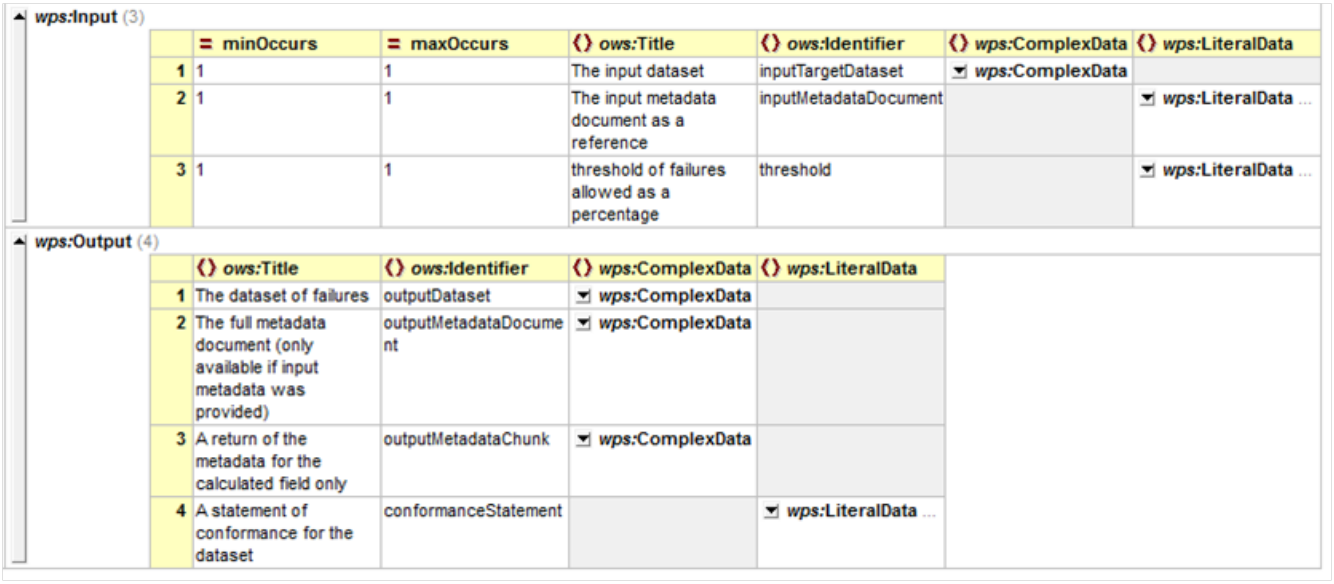
This section describes logical consistency WPS processes.

Topological Consistency WPS process

The following table defines the Topological Consistency WPS processes.

Table 7.8. Topological Consistency WPS processes (vector features)

Name:	iso19157.DQ_LogicalConsistency.DQ_TopolgicalConsistency
Description:	Calculates and reports on potential topological issues inside a single dataset.
Input:	Target dataset.
Algorithm:	For line data, check the number of dangles. For polygon data, check the number of overlaps. When an optional parameter for buffer distance or tolerance is entered, polygon overlap or line dangle should be determined as those over such given distance and the threshold would be evaluated as the percentage of failures.
Output:	Number of overlapping polygons equals 2.
UML:	See Figure 7.9.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table C.1. in Appendix C. **Response:** See example response shown in Table C.1. in Appendix C.



wps:Input (3)

	= minOccurs	= maxOccurs	⟨⟩ ows:Title	⟨⟩ ows:Identifier	⟨⟩ wps:ComplexData	⟨⟩ wps:LiteralData
1	1	1	The input dataset	inputTargetDataset	wps:ComplexData	
2	1	1	The input metadata document as a reference	inputMetadataDocument		wps:LiteralData ...
3	1	1	threshold of failures allowed as a percentage	threshold		wps:LiteralData ...

wps:Output (4)

	⟨⟩ ows:Title	⟨⟩ ows:Identifier	⟨⟩ wps:ComplexData	⟨⟩ wps:LiteralData
1	The dataset of failures	outputDataset	wps:ComplexData	
2	The full metadata document (only available if input metadata was provided)	outputMetadataDocument	wps:ComplexData	
3	A return of the metadata for the calculated field only	outputMetadataChunk	wps:ComplexData	
4	A statement of conformance for the dataset	conformanceStatement		wps:LiteralData ...

Figure 7.9. UML model for the Topological Consistency WPS process (vector-based dataset)

Conceptual Consistency WPS process

The following table defines the generic Conceptual Consistency WPS processes.

Table 7.9. Conceptual Consistency WPS processes

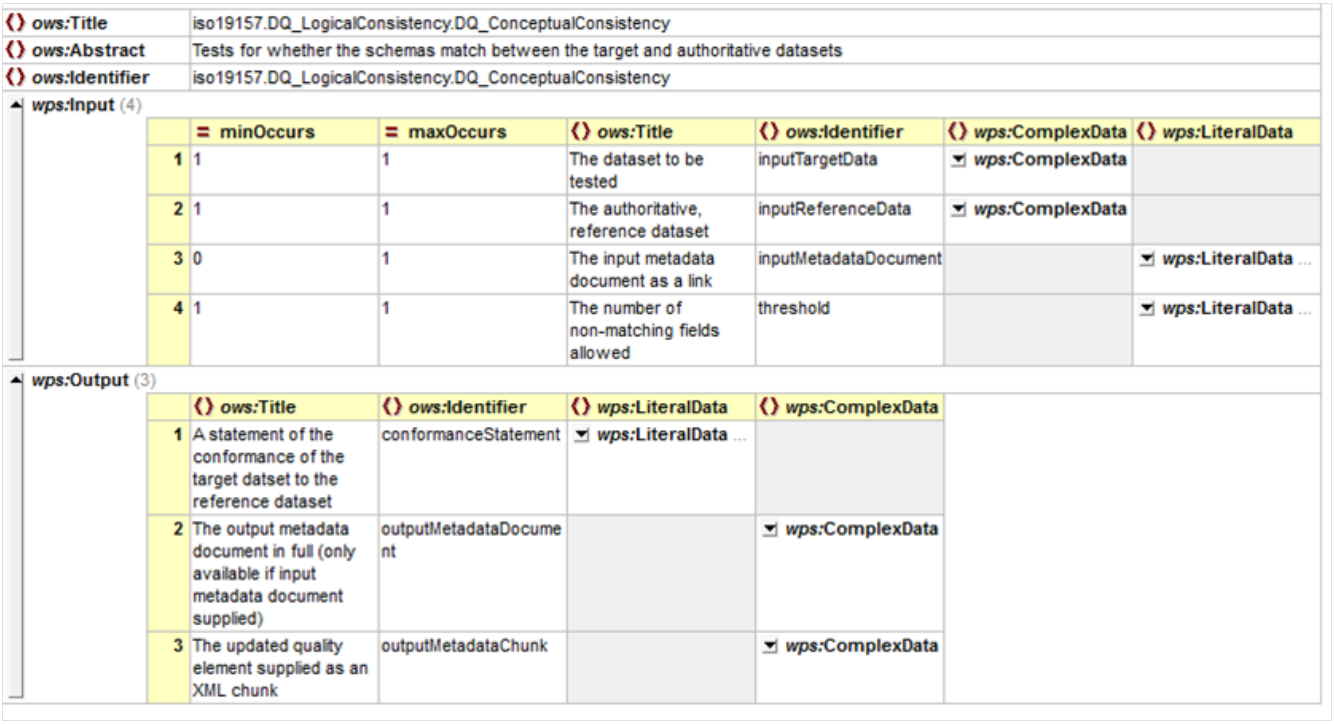
Name:	iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistency
Description:	Compares the input dataset with the conceptual schema.
Input:	input image, metadata link, conceptual schema.
Algorithm:	Dependent on the conceptual schema, it will involve a comparison between the target dataset and the schema depending on how it is expressed.
Output:	Updated metadata, conformance statement

Conceptual Consistency WPS process (vector features)

The following table defines the Conceptual Consistency WPS processes for vector dataset.

Table 7.10. Conceptual Consistency WPS processes (vector features)

Name:	iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistency
Description:	Compares the input dataset with the conceptual schema.
Input:	input image, metadata link, conceptual schema.
Algorithm:	Dependent on the conceptual schema, it will involve a comparison between the target dataset and the schema depending on how it is expressed.
Output:	Updated metadata, conformance statement
UML:	See Figure 7.10.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table C.2. in Appendix C. **Response:** See example response shown in Table C.2. in Appendix C.



ows:Title	iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistency
ows:Abstract	Tests for whether the schemas match between the target and authoritative datasets
ows:Identifier	iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistency

wps:Input (4)

	minOccurs	maxOccurs	ows:Title	ows:Identifier	wps:ComplexData	wps:LiteralData
1	1	1	The dataset to be tested	inputTargetData	wps:ComplexData	
2	1	1	The authoritative, reference dataset	inputReferenceData	wps:ComplexData	
3	0	1	The input metadata document as a link	inputMetadataDocument		wps:LiteralData ...
4	1	1	The number of non-matching fields allowed	threshold		wps:LiteralData ...

wps:Output (3)

	ows:Title	ows:Identifier	wps:LiteralData	wps:ComplexData
1	A statement of the conformance of the target datset to the reference dataset	conformanceStatement	wps:LiteralData ...	
2	The output metadata document in full (only available if input metadata document supplied)	outputMetadataDocument		wps:ComplexData
3	The updated quality element supplied as an XML chunk	outputMetadataChunk		wps:ComplexData

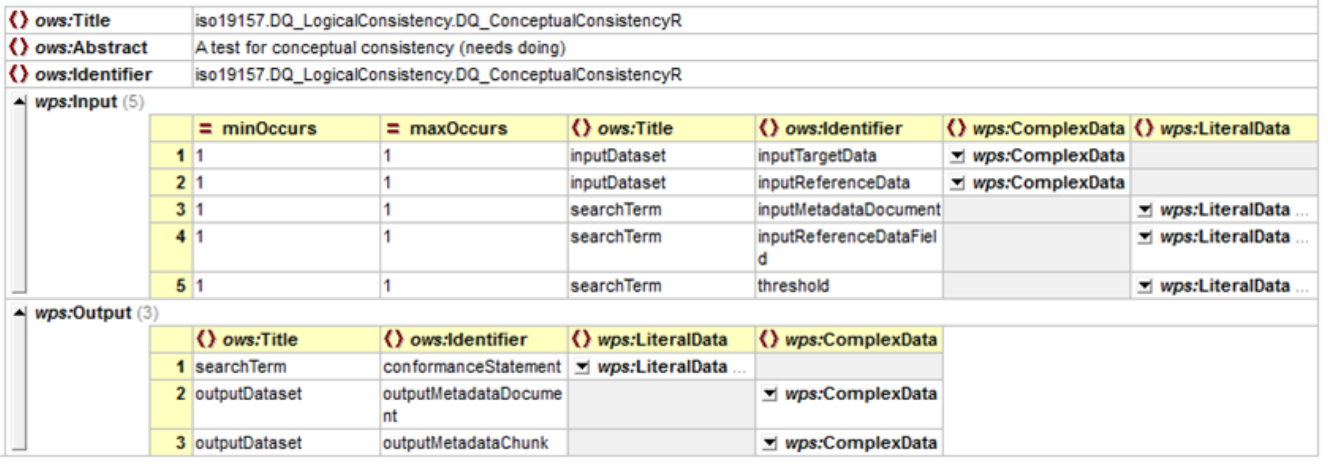
Figure 7.10. UML model for the Conceptual Consistency WPS process (vector-based dataset)

Conceptual Consistency WPS process (raster dataset)

The following table defines the Conceptual Consistency WPS processes for raster dataset.

Table 7.11. Conceptual Consistency WPS processes (raster dataset)

Name:	iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistencyR
Description:	Compares the input dataset with the conceptual schema.
Input:	input image, metadata link, conceptual schema.
Algorithm:	Dependent on the conceptual schema, it will involve a comparison between the target dataset and the schema depending on how it is expressed.
Output:	Updated metadata, conformance statement
UML:	See Figure 7.11.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table C.3. in Appendix C. **Response:** See example response shown in Table C.3. in Appendix C.



ows:Title	iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistencyR					
ows:Abstract	A test for conceptual consistency (needs doing)					
ows:Identifier	iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistencyR					
wps:Input (5)						
	= minOccurs	= maxOccurs	ows:Title	ows:Identifier	wps:ComplexData	wps:LiteralData
1	1	1	inputDataset	inputTargetData	wps:ComplexData	
2	1	1	inputDataset	inputReferenceData	wps:ComplexData	
3	1	1	searchTerm	inputMetadataDocument		wps:LiteralData
4	1	1	searchTerm	inputReferenceDataField		wps:LiteralData
5	1	1	searchTerm	threshold		wps:LiteralData
wps:Output (3)						
	ows:Title	ows:Identifier	wps:LiteralData	wps:ComplexData		
1	searchTerm	conformanceStatement	wps:LiteralData			
2	outputDataset	outputMetadataDocument		wps:ComplexData		
3	outputDataset	outputMetadataChunk		wps:ComplexData		

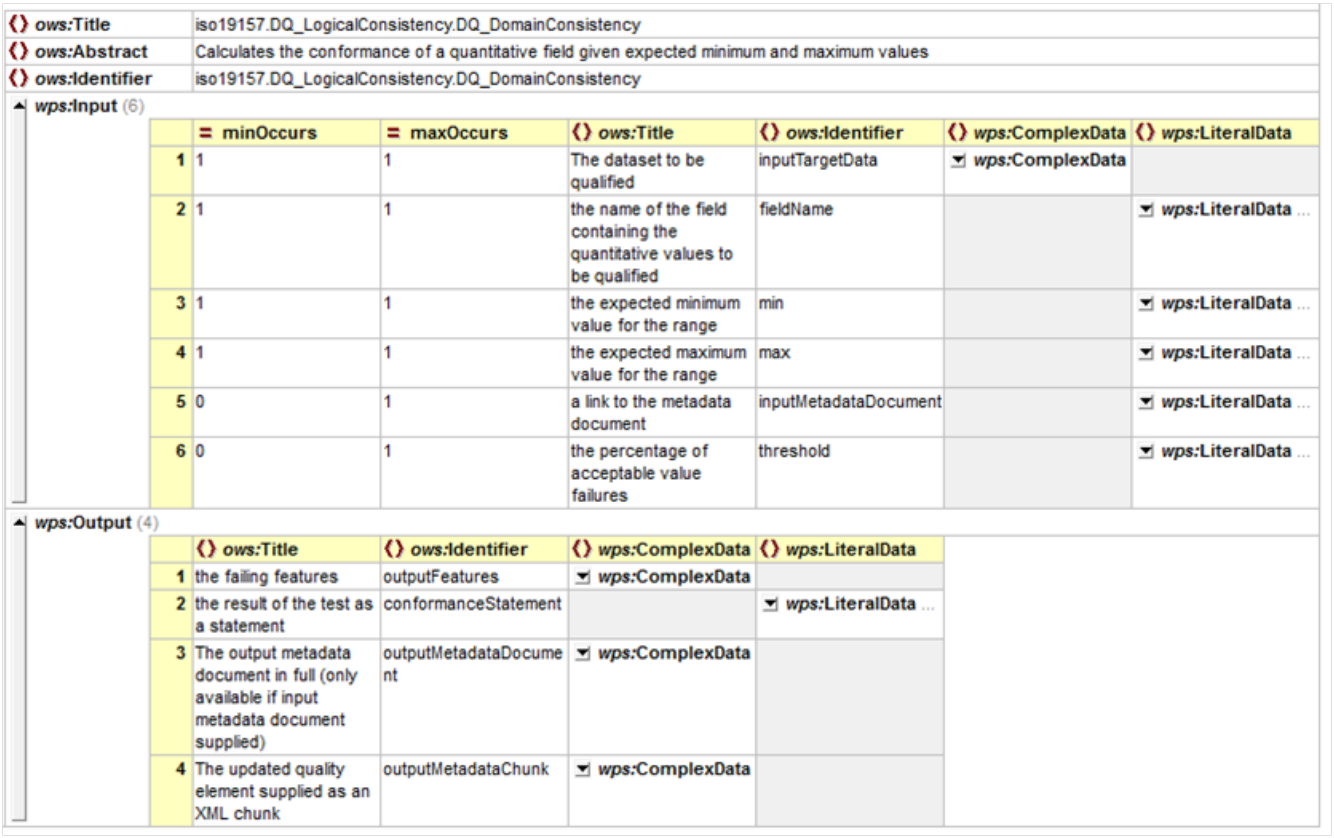
Figure 7.11. UML model for the Conceptual Consistency WPS process (raster-based dataset)

Domain Consistency WPS process

The following table defines the Domain Consistency WPS processes.

Table 7.12. Domain Consistency WPS processes

Name:	iso19157.DQ_LogicalConsistency.DQ_DomainConsistency
Description:	Calculate and reports on a quantitative data field based on bounds.
Input:	Target dataset, field name, minimum bound, maximum bound, metadata document link.
Algorithm:	For numerical data only, check each record in a field for conformance to the bounds.
Output:	The nonconforming features, a statement of the domain consistency, the metadata document with the updated Domain Consistency field.
UML:	See Figure 7.12.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table C.4. in Appendix C. **Response:** See example response shown in Table C.4. in Appendix C.



ows:Title	iso19157.DQ_LogicalConsistency.DQ_DomainConsistency
ows:Abstract	Calculates the conformance of a quantitative field given expected minimum and maximum values
ows:Identifier	iso19157.DQ_LogicalConsistency.DQ_DomainConsistency

wps:Input (6)

	minOccurs	maxOccurs	ows:Title	ows:Identifier	wps:ComplexData	wps:LiteralData
1	1	1	The dataset to be qualified	inputTargetData	wps:ComplexData	
2	1	1	the name of the field containing the quantitative values to be qualified	fieldName		wps:LiteralData
3	1	1	the expected minimum value for the range	min		wps:LiteralData
4	1	1	the expected maximum value for the range	max		wps:LiteralData
5	0	1	a link to the metadata document	inputMetadataDocument		wps:LiteralData
6	0	1	the percentage of acceptable value failures	threshold		wps:LiteralData

wps:Output (4)

	ows:Title	ows:Identifier	wps:ComplexData	wps:LiteralData
1	the failing features	outputFeatures	wps:ComplexData	
2	the result of the test as a statement	conformanceStatement		wps:LiteralData
3	The output metadata document in full (only available if input metadata document supplied)	outputMetadataDocument	wps:ComplexData	
4	The updated quality element supplied as an XML chunk	outputMetadataChunk	wps:ComplexData	

Figure 7.12. UML model for the Domain Consistency WPS process (vector-based dataset)

7.2.4. Thematic Consistency WPS process

This section describes thematic consistency WPS processes.

Classification Correctness WPS process

The following table defines the Classification Correctness WPS processes.

Table 7.13. Classification Correctness WPS processes

Name:	iso19157.DQ_ThematicAccuracy.DQ_ThematicClassificationCorrectness
Description:	This process is for domain classified raster datasets that have been generated from imagery. For example, soil, land use, agricultural datasets.
Input:	input GeoTiff, input reference data (polygon) metadata link.
Algorithm:	Check classifications against the universe of discourse provided by an input. Checks each pixel against the corresponding polygon for correctness.
Output:	Updated metadata, conformance statement.

Classification Correctness WPS process (vector features)

The following table defines the Classification Correctness WPS processes for vector features.

Table 7.14. Classification Correctness WPS processes (vector features)

Name:	iso19157.DQ_ThematicAccuracy.DQ_ThematicClassificationCorrectness

Description:	This process is for domain classified raster datasets that have been generated from imagery. For example, soil, land use, agricultural datasets.
Input:	input target data (raster) in GeoTiff, input reference data (polygon) metadata link..
Algorithm:	Check classifications against the universe of discourse provided by an input. Checks each pixel against the corresponding polygon for correctness.
Output:	Updated metadata, conformance statement.
UML:	See Figure 7.13.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table D.1. in Appendix D. **Response:** See example response shown in Table D.1. in Appendix D.

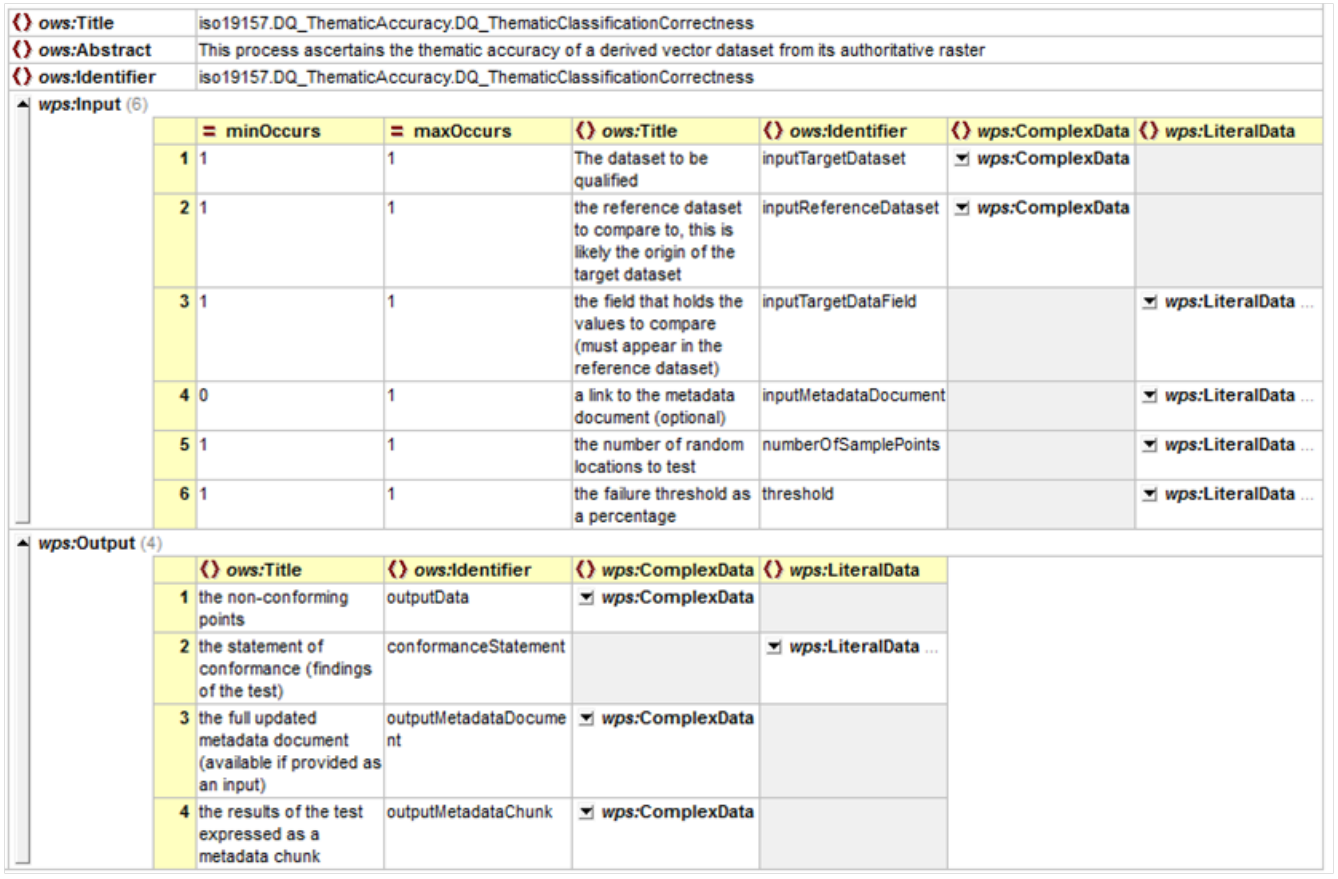


Figure 7.13. UML model for the Classification Correctness WPS process (vector-based dataset)

Classification Correctness WPS process (raster dataset)

The following table defines the Classification Correctness WPS processes for raster dataset.

Table 7.15. Classification Correctness WPS processes (raster dataset)

Name:	iso19157.DQ_ThematicAccuracy.DQ_ThematicClassificationCorrectnessR
Description:	This process is for classified raster datasets that have been generated from imagery. For example, soil, land use, agricultural datasets.
Input:	input GeoTiff, input reference data (polygon) metadata link..

Algorithm:	Check classifications against the universe of discourse provided by an input. Checks each pixel against the corresponding polygon for correctness.
Output:	Updated metadata, conformance statement.
UML:	See Figure 7.14.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table D.2. in Appendix D. **Response:** See example response shown in Table D.2. in Appendix D.

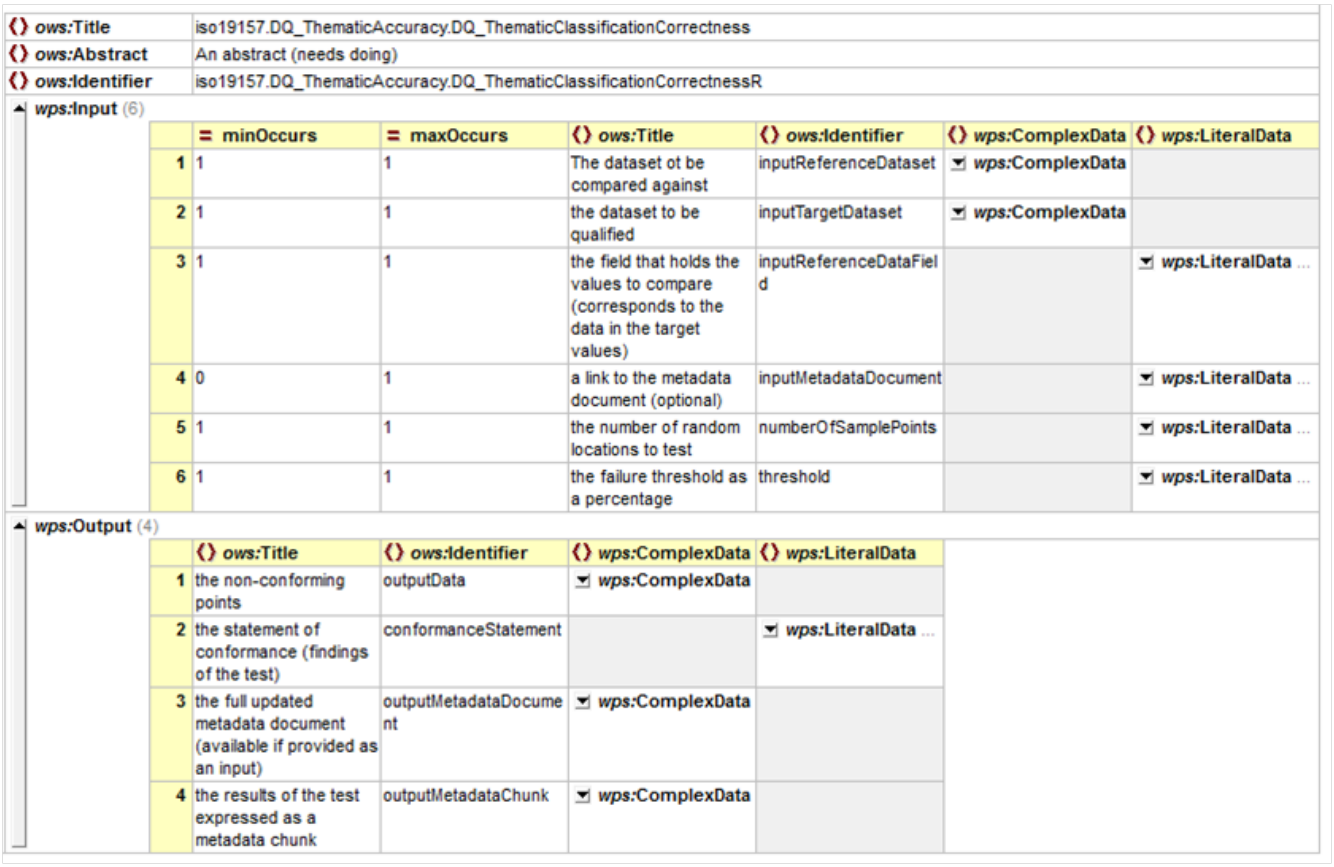


Figure 7.14. UML model for the Classification Correctness WPS process (raster-based dataset)

Non-Quantitative Attribute Accuracy WPS process

The following table defines the Non-Quantitative Attribute Accuracy WPS processes.

Table 7.16. Non-Quantitative Attribute Accuracy WPS processes

Name:	iso19157.DQ_ThematicAccuracy.DQ_NonQuantitativeAttributeAccuracy
Description:	Check non-quantitative attribute consistency.
Input:	target dataset, the dataset to be be used as an authoritative source, the field that holds the non-quantitative values in the target dataset, the field that holds the values in the reference dataset, a link to the metadata document (optional), and the failure threshold as a percentage.
Algorithm:	Check the consistency of the dataset against the reference dataset.

Output:	List of the non-conforming points, the statement of conformance (findings of the test), the full updated metadata document (available if provided as an input), and the results of the test expressed as a metadata chunk.
UML:	See Figure 7.15.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table D.3. in Appendix D. **Response:** See example response shown in Table D.3. in Appendix D.

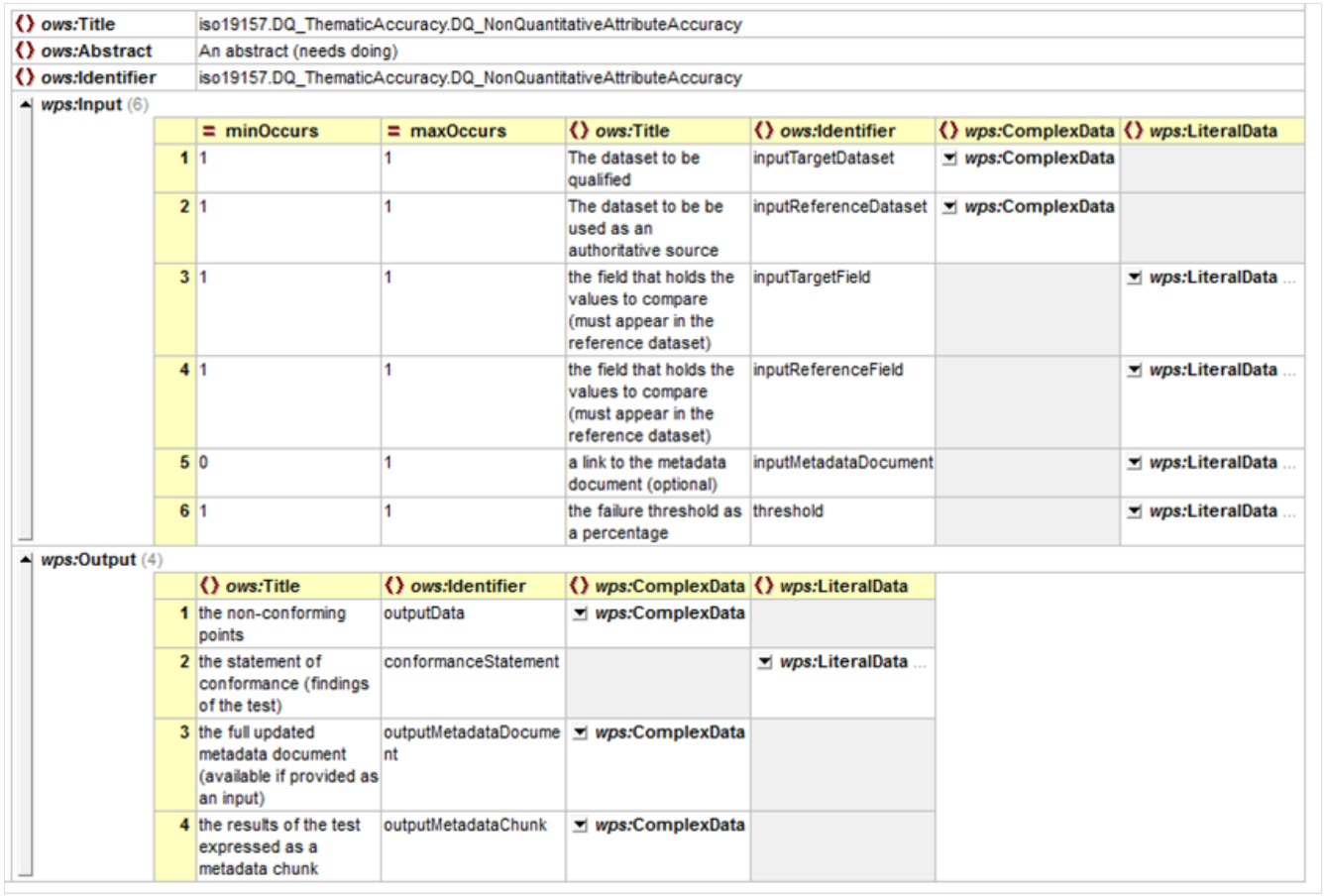


Figure 7.15. UML model for the Non-Quantitative Attribute Accuracy WPS process (vector-based dataset)

Quantitative Attribute Accuracy WPS process

The following table defines the Quantitative Attribute Accuracy WPS processes.

Table 7.17. Quantitative Attribute Accuracy WPS processes

Name:	iso19157.DQ_ThematicAccuracy.DQ_QuantitativeAttributeAccuracy
Description:	Compares a quantitative field from two datasets.
Input:	The dataset to be qualified, the dataset to be be used as an authoritative source, the field that holds the quantitative values in the target dataset, the field that holds the values in the reference dataset, a link to the metadata document (optional), and the failure threshold as a percentage.
Algorithm:	Compares two datasets quantitatively on selected quantitative fields.

Output:	The statement of conformance (findings of the test), the full updated metadata document (available if provided as an input), and the results of the test expressed as a metadata chunk .
UML:	See Figure 7.16.
Example:	**Endpoint:** http://54.201.124.35/wps/WebProcessingService **Request:** See example shown in Table D.4. in Appendix D. **Response:** See example response shown in Table D.4. in Appendix D.

ows:Title	iso19157.DQ_ThematicAccuracy.DQ_QuantitativeAttributeAccuracy
ows:Abstract	Compares a quantiative field from two datasets
ows:Identifier	iso19157.DQ_ThematicAccuracy.DQ_QuantitativeAttributeAccuracy

wps:Input (8)

	minOccurs	maxOccurs	ows:Title	ows:Identifier	wps:ComplexData	wps:LiteralData
1	1	1	The dataset to be qualified	inputTargetDataset	wps:ComplexData	
2	1	1	The dataset to be be used as an authoritative source	inputReferenceDataset	wps:ComplexData	
3	1	1	the field that holds the values to compare (must appear in the reference dataset)	inputTargetLookupField		wps:LiteralData ...
4	1	1	the field that holds the values to compare (must appear in the reference dataset)	inputReferenceLookupField		wps:LiteralData ...
5	1	1	The field that holds the quantitative values in the target dataset	inputTargetDataField		wps:LiteralData ...
6	1	1	The field that holds the values in the reference dataset	inputReferenceDataField		wps:LiteralData ...
7	0	1	a link to the metadata document (optional)	inputMetadataDocument		wps:LiteralData ...
8	1	1	the failure threshold as a percentage	threshold		wps:LiteralData ...

wps:Output (3)

	ows:Title	ows:Identifier	wps:LiteralData	wps:ComplexData
1	the statement of conformance (findings of the test)	conformanceStatement	wps:LiteralData ...	
2	the full updated metadata document (available if provided as an input)	outputMetadataDocument		wps:ComplexData
3	the results of the test expressed as a metadata chunk	outputMetadataChunk		wps:ComplexData

Figure 7.16. UML model for the Quantitative Attribute Accuracy WPS process (vector-based dataset)

Chapter 8. Use Cases

8.1. Use Case 1 - Completeness Omission/Completeness Commission

This to test the capabilities in evaluating data quality for Completeness Omission/Completeness Commission.

8.1.1. Use Case 1.1 - Evaluate Data Quality on Completeness Omission

Use Case 1.1.1 Evaluate Data Quality on Completeness Omission (vector feature)

Table 8.1. Use Case for the WPS Process of Data Quality Completeness Omission (vector feature)

Use Case Number	UC1.1.1
Description	This use case demonstrates using the DQ WPS process to check missing data in a dataset against a reference dataset in vector format. Processing two identical vector datasets should return "passed" (or boolean value 1) as expected.
Area map or study area description	In this demonstration, both target dataset and reference dataset used the same OpenStreetMap dataset of Canada on place names. The following figure shows the map area. Target dataset (vector features, points): See Figure 8.1. URL: http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3 Reference dataset (vector features, points): See Figure 8.2. URL: http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3
Test Page	http://54.201.124.35/wps/test_client
Request File	Completeness.CompletenessOmission2.0.xml
Example Execution	See example request and response in Table A.1. in Appendix A.

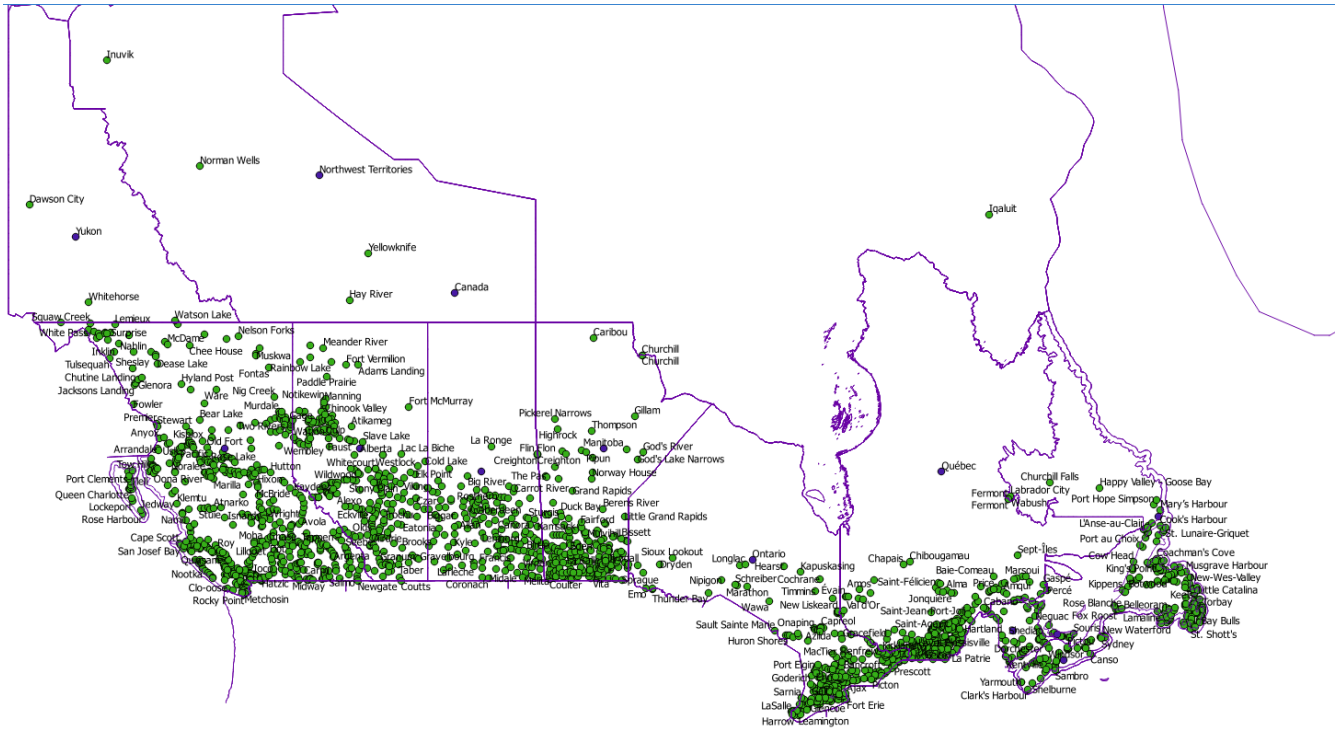


Figure 8.1. Target dataset for Use Case 1.1.1

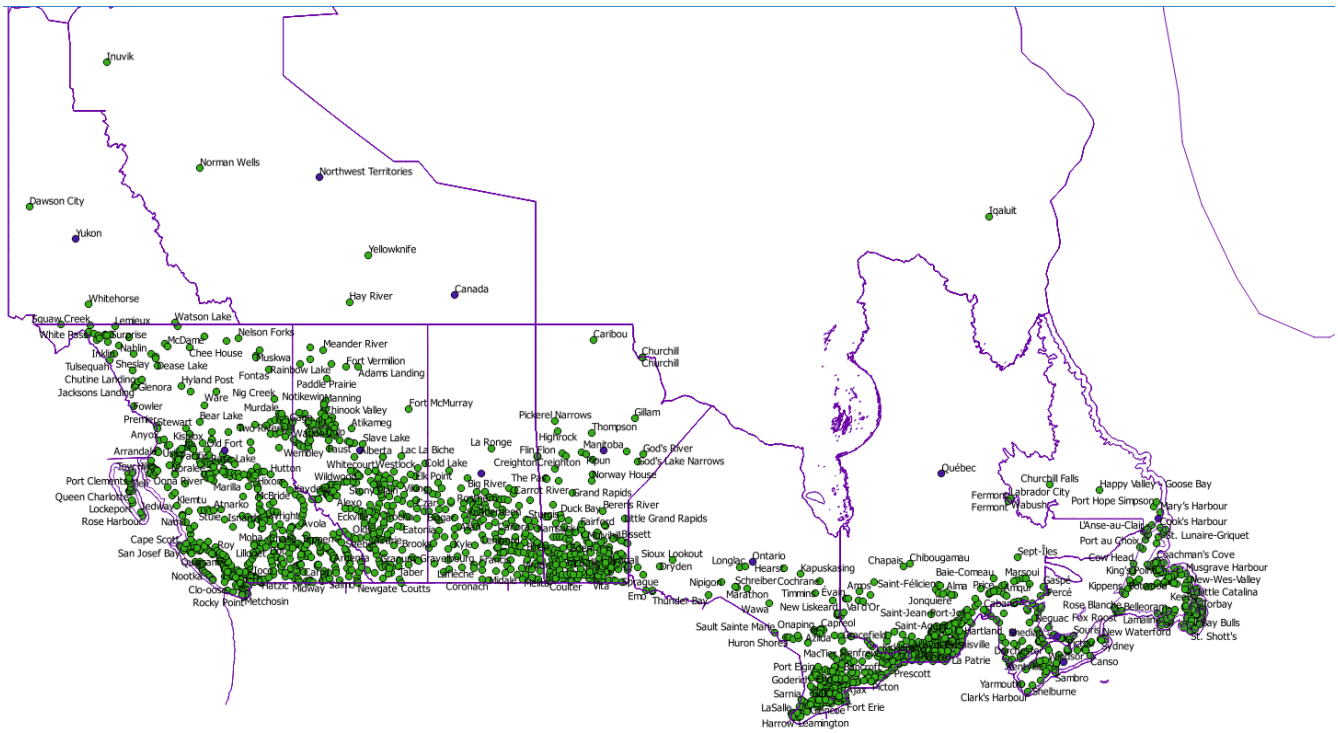


Figure 8.2. Reference dataset for Use Case 1.1.1

Use Case 1.1.2 Evaluate Data Quality on Completeness Omission (raster dataset)

Table 8.2. Use Case for the WPS Process of Data Quality Completeness Omission (raster dataset)

Use Case Number	UC1.1.2
Description	This use case demonstrates using the DQ WPS process to check missing data by comparing the dataset resolution to a required resolution in raster format. The value of "passed" (or boolean value 1) should be returned if the resolution of the dataset is less than the given threshold value.

Area map or study area description	A GeoTIFF dataset was used with resolution of 0.004000087833889381 in geographic coordinate system. The test checks if the resolution is below threshold 1. Therefore, the test is passed as expected. The following figure shows the dataset used. Test dataset (raster): See Figure 8.3.
Test Page	http://54.201.124.35/wps/test_client
Request File	Completeness.CompletenessOmissionR2.0.xml
Example Execution	See example request and response in Table A.2. in Appendix A.

Figure 8.3. Test dataset for Use Case 1.1.2

Use Case 1.2.1 Evaluate Data Quality on Completeness Commission (vector features)

Table 8.3. Use Case for the WPS Process of Data Quality Completeness Commission (vector features)

Use Case Number	UC1.2.1
Description	This use case demonstrates using the DQ WPS process to check data commission by verifying if there is too much data within a dataset in vector format. Processing two identical vector datasets should return "passed" (or boolean value 1) as expected.
Area map or study area description	In this demonstration, both target dataset and reference dataset used the same OpenStreetMap dataset of Canada on place names. The following figure shows the map area. Target dataset (vector, points): See Figure 8.4. URL: http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3 Reference dataset (vector, points): See Figure 8.5. URL: http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3
Test Page	http://54.201.124.35/wps/test_client

Request File	Completeness.CompletenessCommission2.0.xml
Example Execution	See example request and response in Table A.3. in Appendix A.

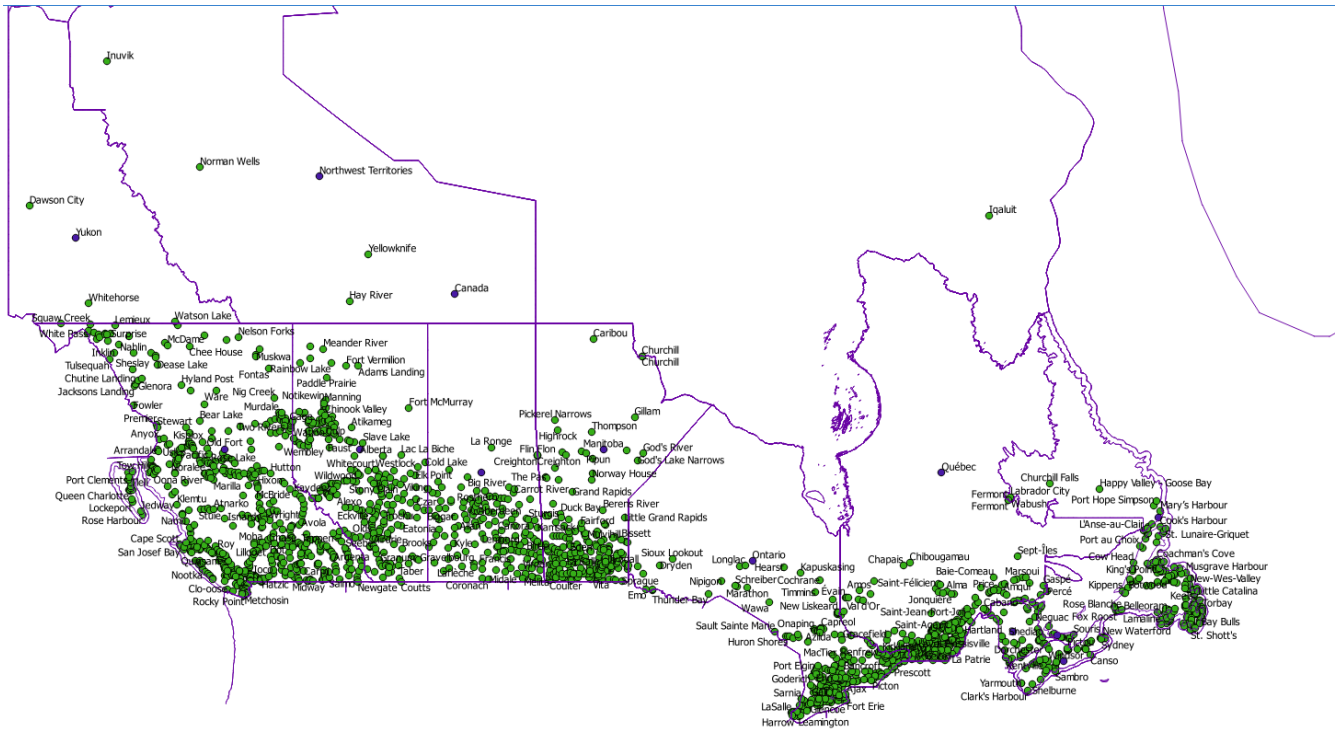


Figure 8.4. Target dataset for Use Case 1.2.1

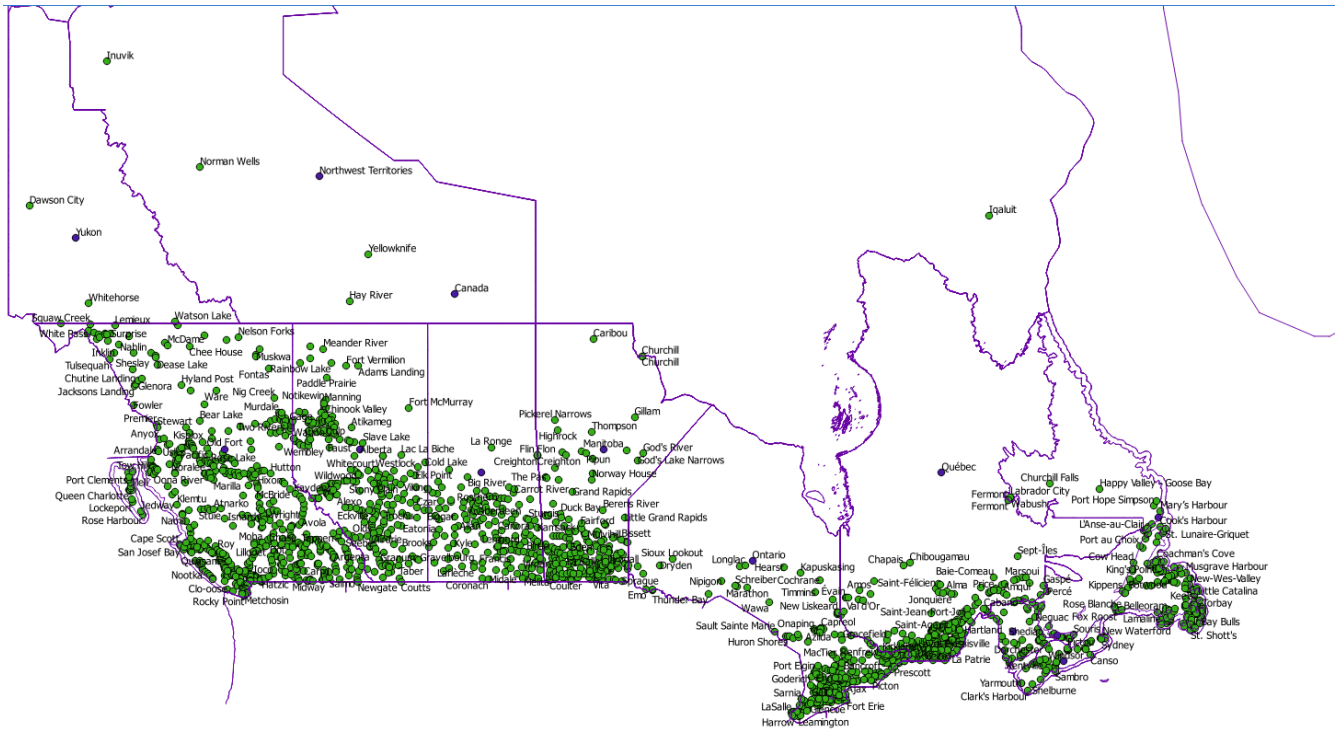


Figure 8.5. Reference dataset for Use Case 1.2.1

Use Case 1.2.2 Evaluate Data Quality on Completeness Commission (raster dataset)

Table 8.4. Use Case for the WPS Process of Data Quality Completeness Commission (raster dataset)

Use Case Number	UC1.2.2

Description	This use case demonstrates using the DQ WPS process to check data commission by comparing the dataset resolution to a required resolution in raster format. The value of "passed" (or boolean value 1) should be returned if the resolution of the dataset is less than the given threshold value.
Area map or study area description	A GeoTIFF dataset was used with resolution of 0.004000087833889381 in geographic coordinate system. The test checks if the resolution is above threshold 1. Therefore, the test is failed (or return boolean value 0) as expected. The following figure shows the dataset used. Test dataset: See Figure 8.6.
Test Page	http://54.201.124.35/wps/test_client
Request File	Completeness.CompletenessCommissionR2.0.xml
Example Execution	See example request and response in Table A.4. in Appendix A.

Figure 8.6. Test dataset for Use Case 1.2.2

8.2. Use Case 2 - Positional Accuracy

This section covers the use cases for utilizing Positional Accuracy WPS DQ processes.

8.2.1. Use Case 2.1 - Positional Accuracy (vector feature)

Table 8.5. Use Case for the WPS Process of Data Quality Positional Accuracy (vector features)

Use Case Number	UC2.1
Description	This use case demonstrates using the DQ WPS process to check the positional displacement by using a reference dataset to match pairs to a target dataset and establishing any displacement in vector format. The average displacement is compared against the given threshold to determine if the given dataset passed the verification as overall.

Area map or study area description	In this demonstration, two datasets were used to map the movement of bugs (e.g. beetles). The following figures shows a small section of the bug maps in Lawrence county, South Dakota, USA. The result showed that the test failed to pass the given threshold of 10 since the mean displacement from the authoritative data is 94.84364940038897 for the two given datasets. Bug map (before their move): See Figure 8.7. Dataset URL: http://54.244.142.1/geoserver/cite/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=cite:bugsites&outputFormat=gml3 Bug map (after their move): See Figure 8.8. Dataset URL: http://54.244.142.1/geoserver/cite/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=cite:bugsites_moved&outputFormat=gml3 Displacement map (yellow dots - before; red dots - after): See Figure 8.9.
Test Page	http://54.201.124.35/wps/test_client
Request File	PositionalAccuracy.AbsoluteExternalPositionalAccuracy2.0.xml
Example Execution	See example request and response in Table B.1. in Appendix B.

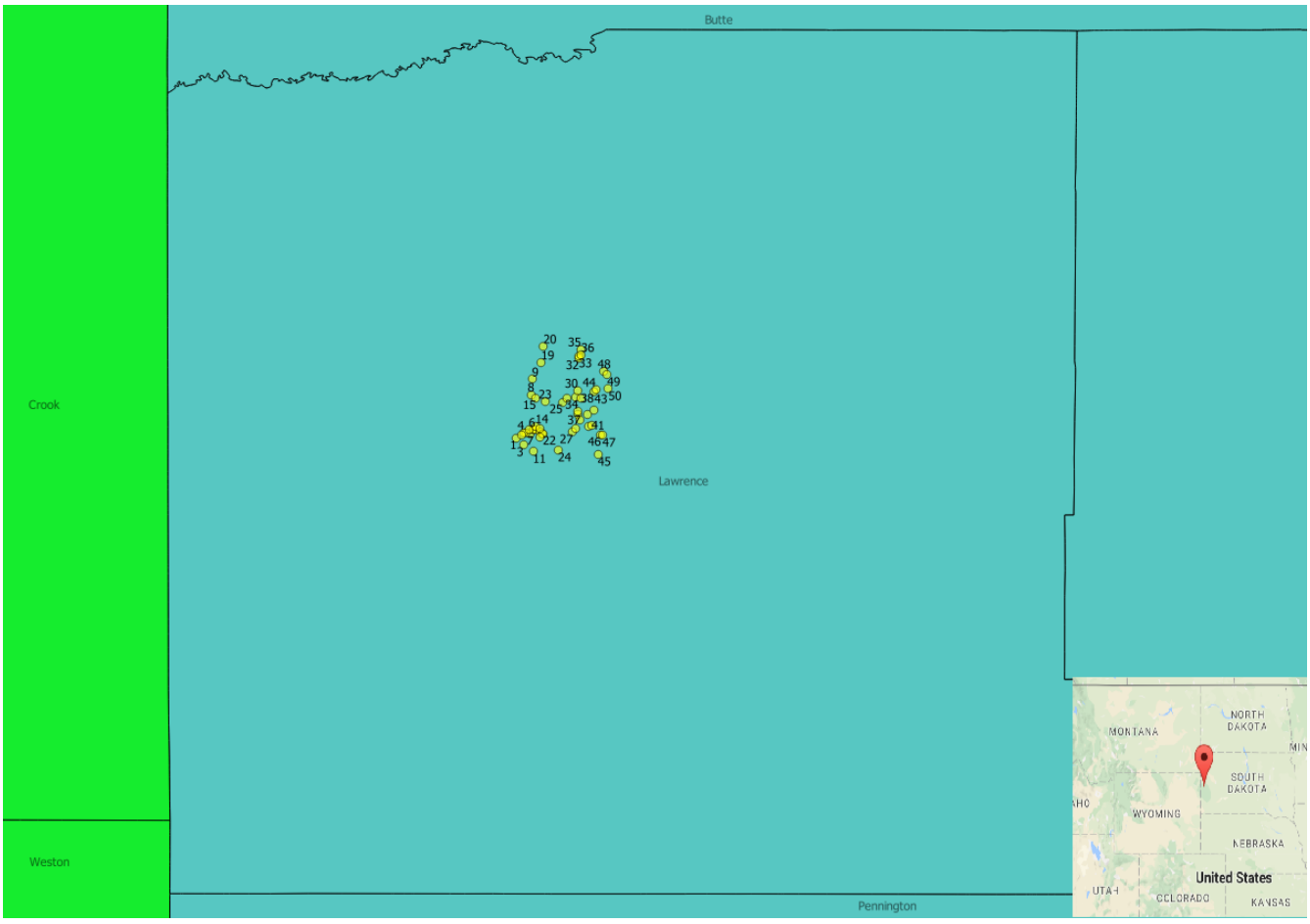


Figure 8.7. Target dataset for Use Case 2.1

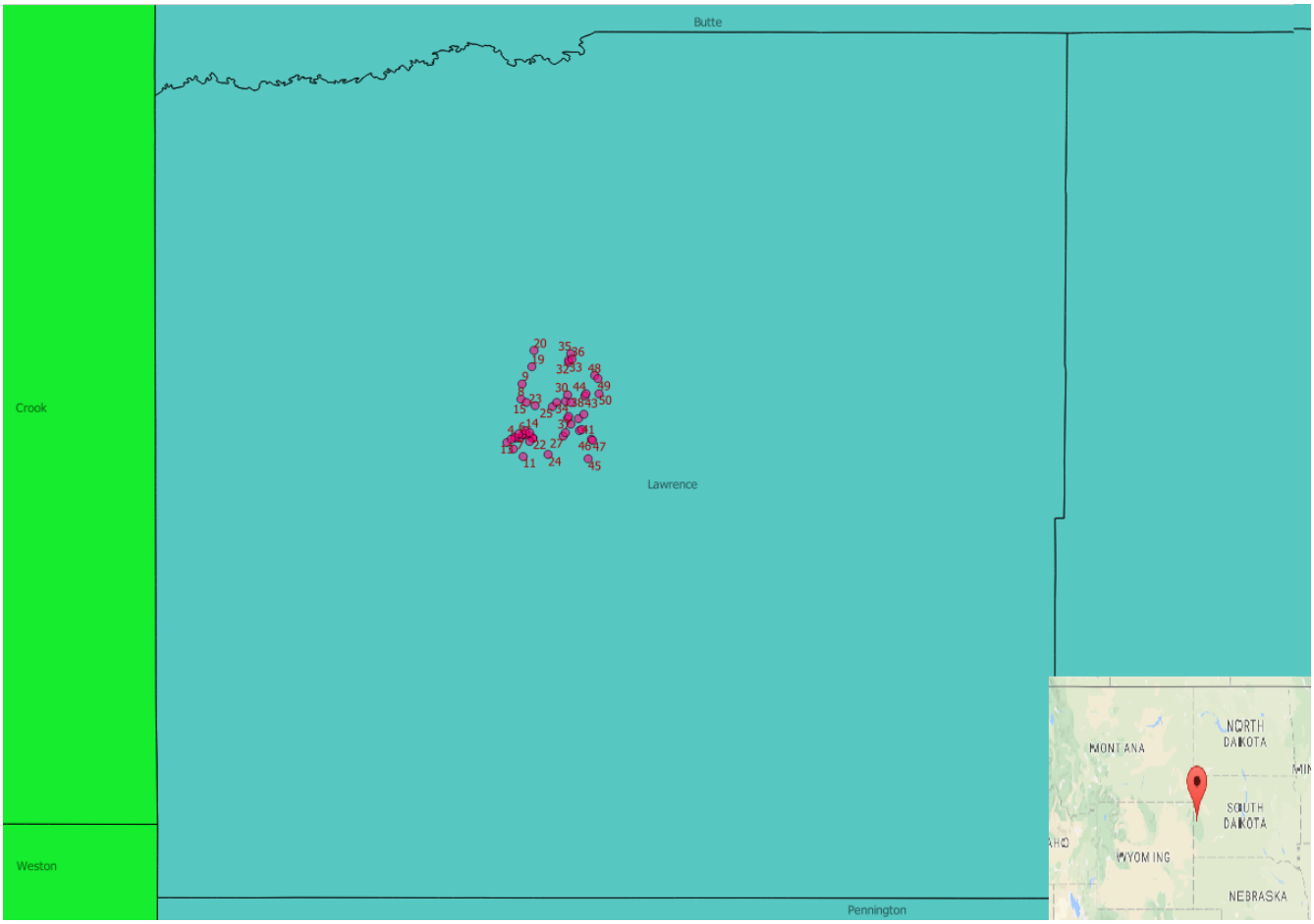


Figure 8.8. Reference dataset for Use Case 2.1

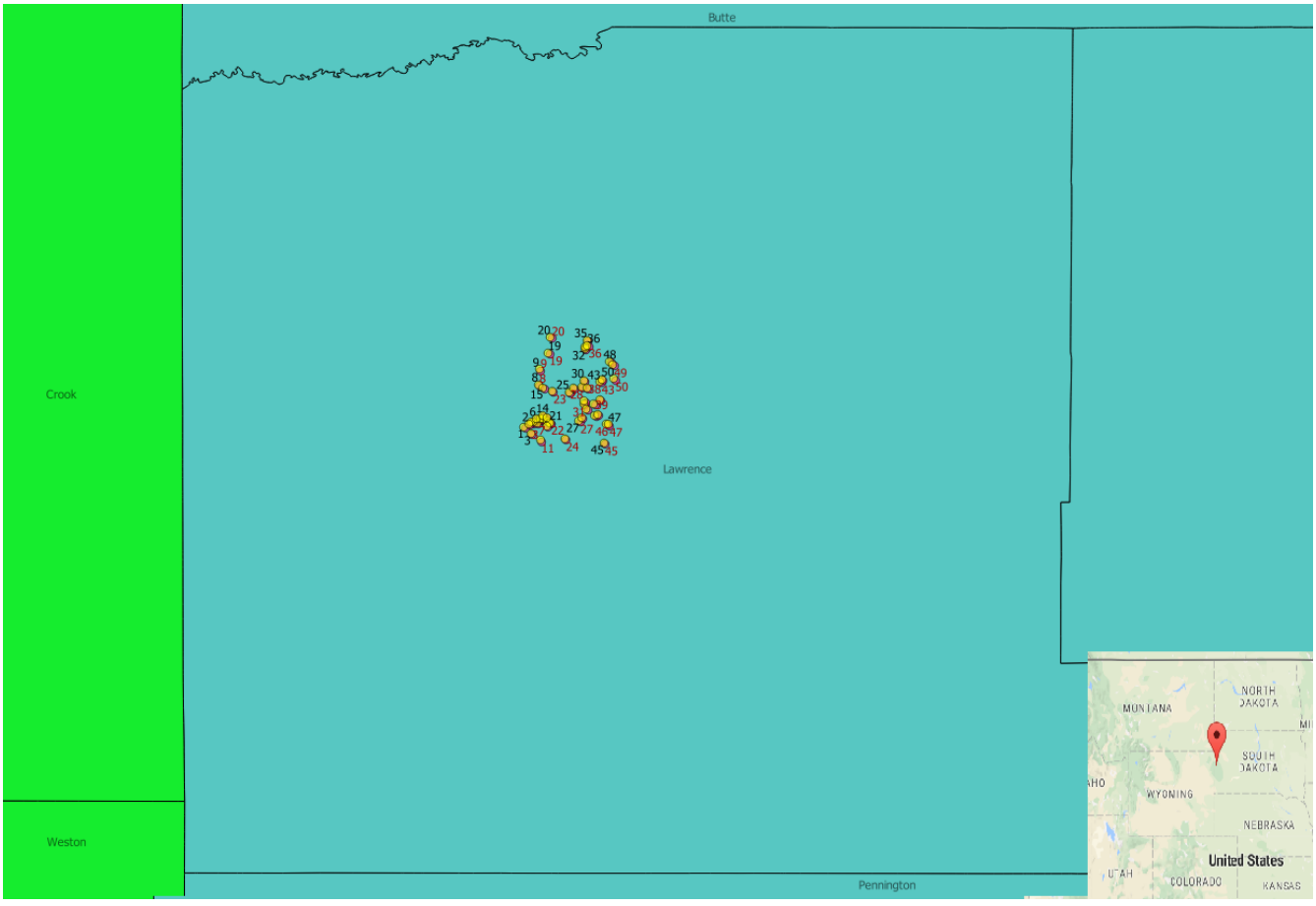


Figure 8.9. Displacement of points in target dataset and reference dataset for Use Case 2.1

8.2.2. Use Case 2.2 - Positional Accuracy (gridded)

Table 8.6. Use Case for the WPS Process of Data Quality Positional Accuracy (raster dataset)

Use Case Number	UC2.2
Description	This use case demonstrates using the DQ WPS process to check data positional accuracy by verifying the bounding box of a raster dataset against the bounding box of an authoritative dataset in gridded dataset. The value of "passed" (or boolean value 1) should be returned if the resolution of the dataset is less than the given threshold value.
Area map or study area description	A small portion of data was processed and generated using raster data that covers portion of Pennsylvania, USA. The calculated accuracy for the dataset is 0.000000005172098205179317 which is below the given threshold of 10. Therefore, the test is passed (or return boolean value 1) as expected. The following figure shows the dataset used. Target dataset (raster dataset): See Figure 8.10. Target dataset URL: http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF Reference dataset (vector dataset): See Figure 8.11. Reference dataset URL: http://54.244.142.1/geoserver/cite/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=cite:conceptual_consistency&outputFormat=gml3
Test Page	http://54.201.124.35/wps/test_client
Request File	PositionalAccuracy.GriddedDataPositionalAccuracy2.0.xml
Example Execution	See example request and response in Table B.2. in Appendix B.

Figure 8.10. Target dataset for Use Case 2.2

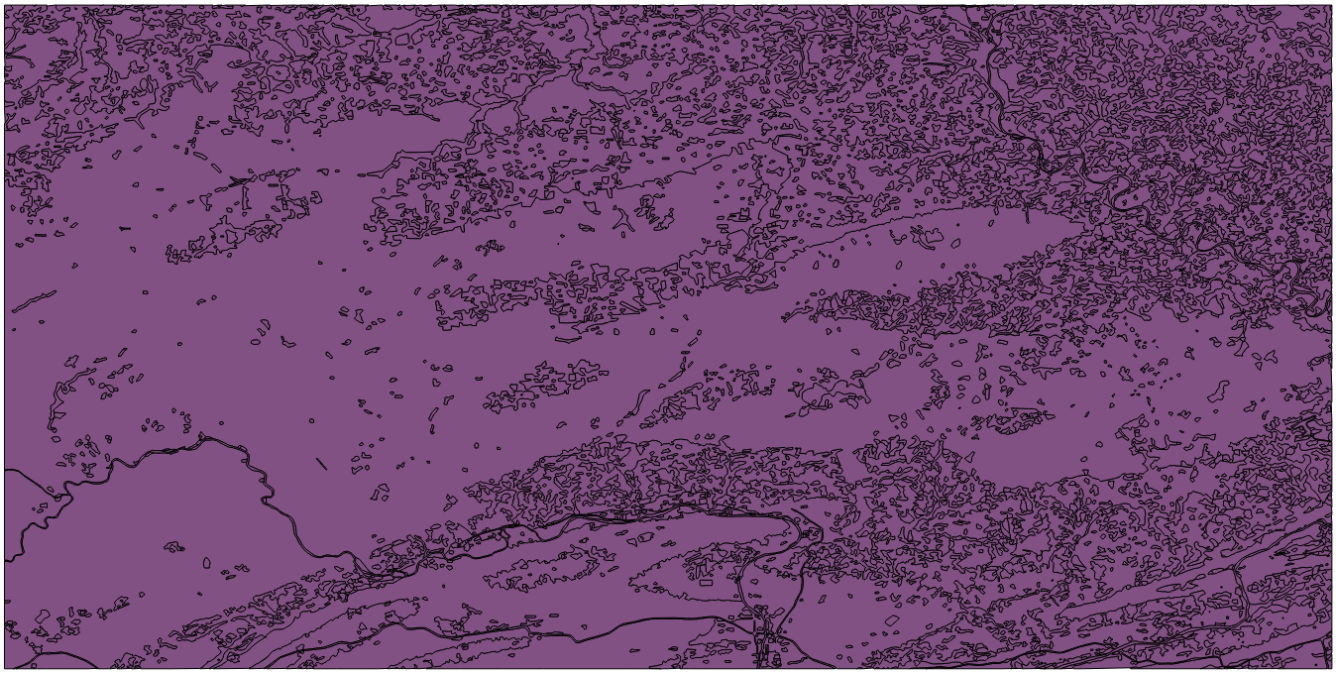


Figure 8.11. Reference dataset for Use Case 2.2

8.3. Use Case 3 - Logical Accuracy

This section covers the use cases for logical accuracy WPS DQ processes.

8.3.1. Use Case 3.1 - Topological Consistency

Table 8.7. Use Case for the WPS Process of Data Quality Topological Consistency

Use Case Number	UC3.1
Description	This use case demonstrates using the DQ WPS process to check topological consistence by examining polygon datasets for overlaps and line datasets for dangles. The value of "passed" (or boolean value 1) should be returned if the error rate is less than the given threshold value.
Area map or study area description	In the demonstration, the administrative boundaries (a set of linear features) map was used. The number of dangles in linear features is the measure to be compared and verified. The given threshold is to allow 10 dangles at maximum. The result found that there is one dangle in the dataset. Therefore, the test passes with the return value of boolean 1. The following shows the map used in the test case. The test map contains administrative boundaries, i.e. international boundaries, disputed boundaries, indefinite boundaries, and/or limits. Test map: See Figure 8.12. URL: http://demo.opengeo.org/geoserver/ne/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=ne%3Ane_10m_roads_north_america&maxFeatures=50&outputformat=gml3
Test Page	http://54.201.124.35/wps/test_client
Request File	LogicalAccuracy.TopologicalConsistency2.0.xml
Example Execution	See example request and response in Table C.1. in Appendix C.

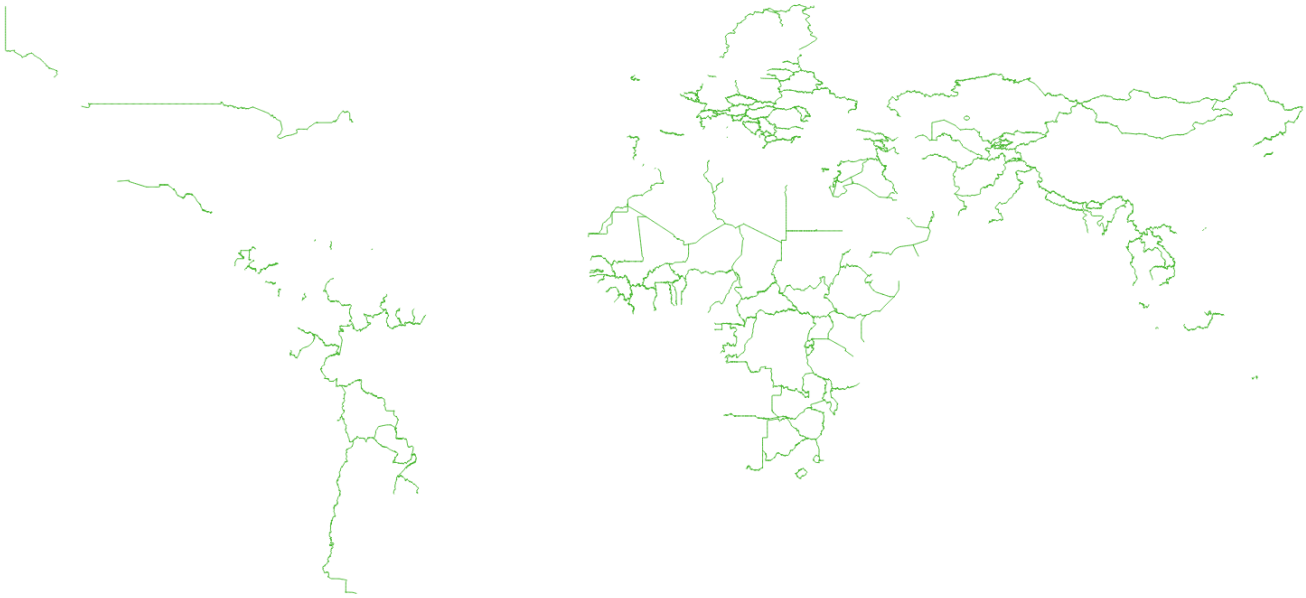


Figure 8.12. Test dataset for Use Case 3.1

8.3.2. Use Case 3.2 - Conceptual Consistency

Use Case 3.2.1 - Conceptual Consistency (vector features)

Table 8.8. Use Case for the WPS Process of Data Quality Conceptual Consistency (vector features)

Use Case Number	UC3.2.1
Description	This use case tests the DQ Conceptual Consistency process by matching the target dataset schema to an authoritative schema (i.e. the universe of discourse To be detailed) for vector feature dataset. The number of consistent features and inconsistent features are counted against reference dataset. The result is then compared to the given threshold. If the actual number of inconsistent features is larger than the given threshold, the test would be failed. Otherwise, the test would be marked as "passed" (or boolean value of 1 is returned).
Area map or study area description	In this test case, the identical dataset was used for both target dataset and reference dataset. The dataset is the international boundaries between countries which contains boundaries categorized as verified, disputed, indefinite, and/or limit. The running result is that all features passed the testing and marked as consistent features. None of the features is marked as inconsistent features. Therefore, the test is passed (or boolean value of 1 is returned. The following shows the map. Target dataset (vector features): See Figure 8.13. URL: http://demo.opengeo.org/geoserver/ne/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=ne%3Ane_10m_roads_north_america&maxFeatures=50&outputformat=gml3 Reference dataset (vector features): See Figure 8.14. URL: http://demo.opengeo.org/geoserver/ne/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=ne%3Ane_10m_roads_north_america&maxFeatures=50&outputformat=gml3
Test Page	http://54.201.124.35/wps/test_client

Request File	LogicalAccuracy.ConceptualConsistency2.0.xml
Example Execution	See example request and response in Table C.2. in Appendix C.

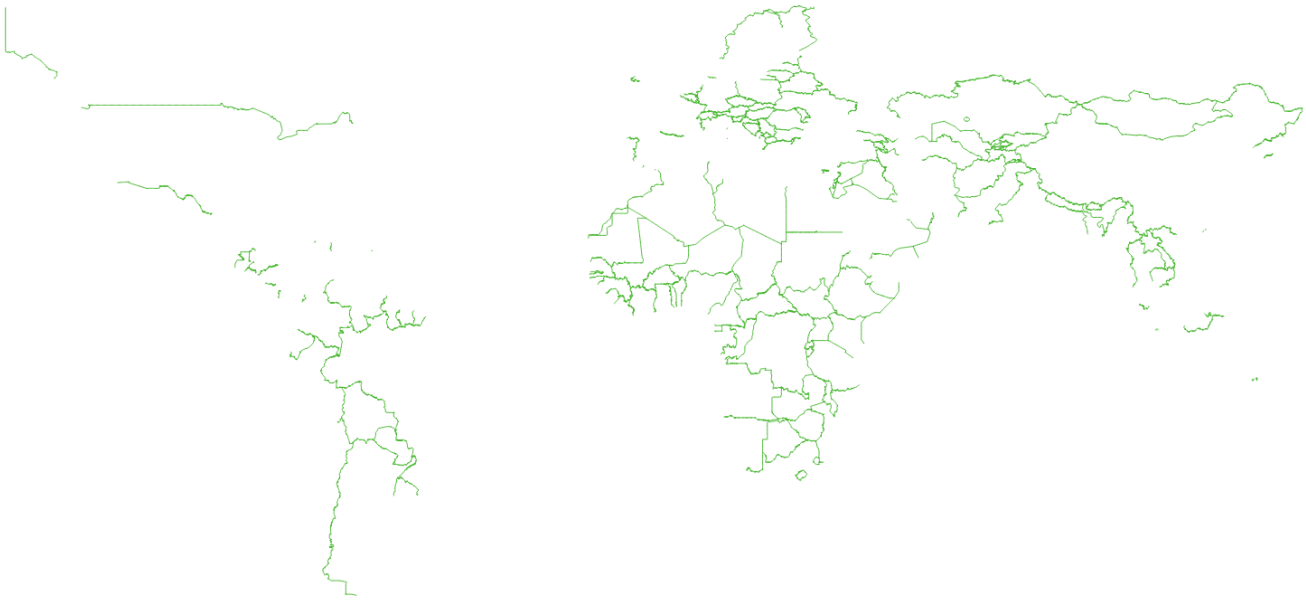


Figure 8.13. Target dataset for Use Case 3.2.1

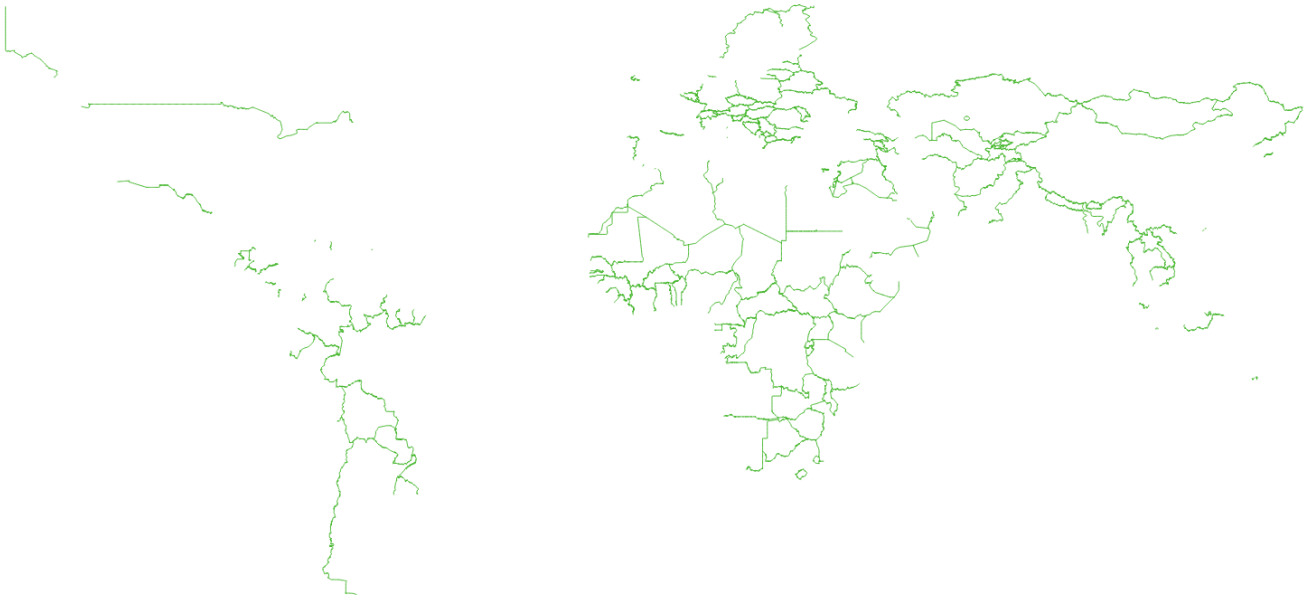


Figure 8.14. Reference dataset for Use Case 3.2.1

Use Case 3.2.1 - Conceptual Consistency (raster dataset)

Table 8.9. Use Case for the WPS Process of Data Quality Conceptual Consistency (raster dataset)

Use Case Number	UC3.2.2

Description	This use case tests the DQ Conceptual Consistency process by matching the target dataset schema to an authoritative schema (i.e. the universe of discourse) in gridded data format. The authoritative schema is determined by a vector dataset with a classification column. The test would pass (or boolean value of 1 is returned if the number of errors/inconsistencies is less than the given threshold.
Area map or study area description	In this test case, a small portion of dataset was used that covers part of Pennsylvania, USA. The land use classes were compared between target dataset and reference dataset. The test revealed that there are several differences between these two datasets.For example, it was reported that there are 1.7600772946712827E-4m squared of class 33.0 in the target dataset and 1.1212216383238426E-4 m squared of class 33.0 in the authoritative dataset. Another error reported that there are 0.028801264821894452m squared of class 42.0 in the target dataset and 0.033437663054329395 m squared of class 42.0 in the authoritative dataset. The given threshold tolerate one error. More than one error are reported in the test. Therefore, the test reported "failed" (or boolean value of 0 is returned). Target raster dataset (raster): See Figure 8.15. Target dataset URL: http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF Reference dataset (vector feature): See Figure 8.16. Reference dataset URL: http://54.244.142.1/geoserver/cite/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=cite:conceptual_consistency&outputFormat=gml3
Test Page	http://54.201.124.35/wps/test_client
Request File	LogicalAccuracy.ConceptualConsistencyR2.0.xml
Example Execution	See example request and response in Table C.3. in Appendix C.

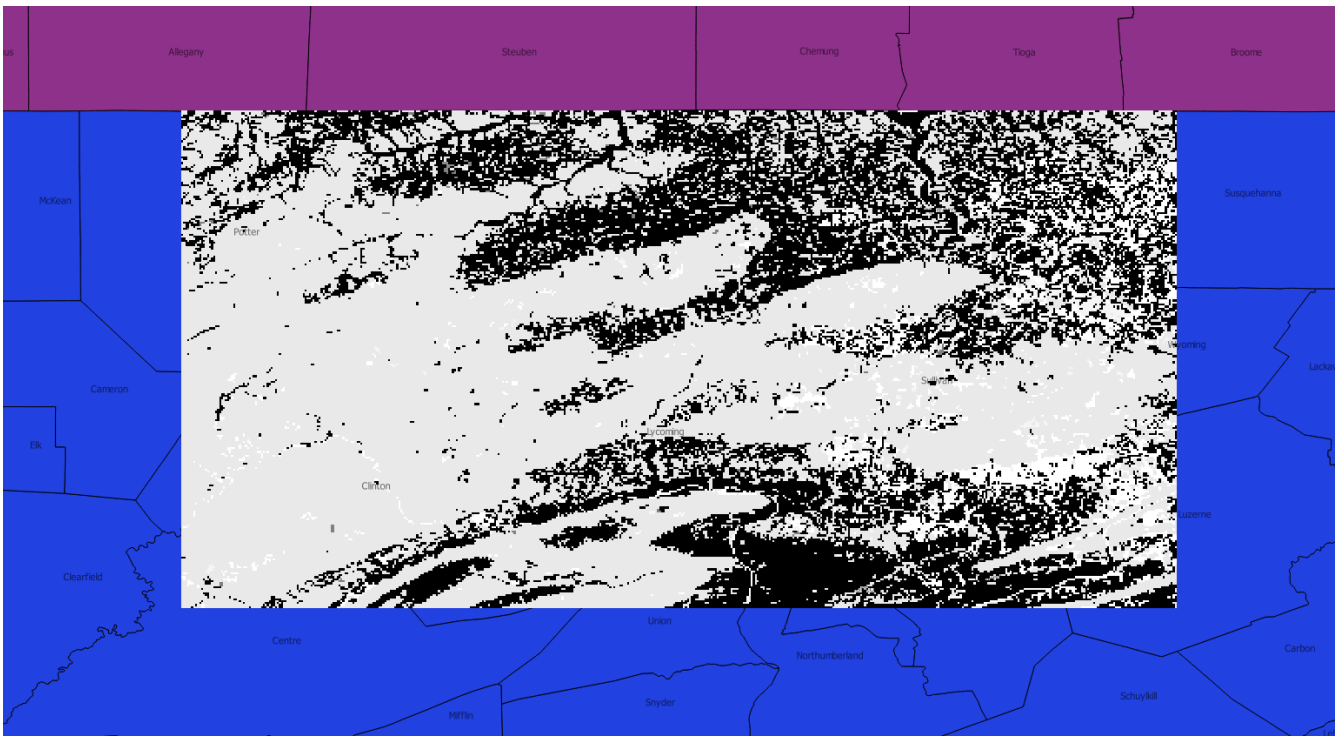


Figure 8.15. Target dataset for Use Case 3.2.2

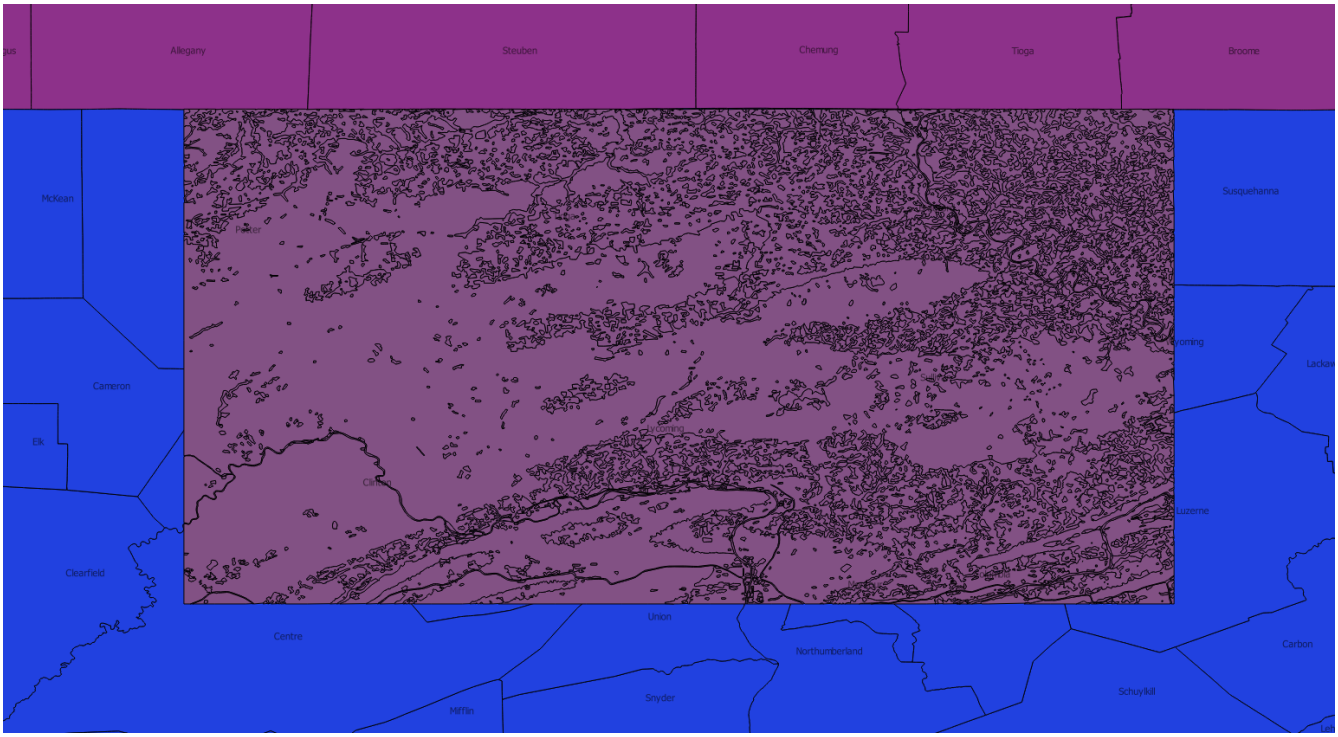


Figure 8.16. Reference dataset for Use Case 3.2.2

8.3.3. Use Case 3.3 - Domain Consistency

Table 8.10. Use Case for the WPS Process of Data Quality Domain Consistency

Use Case Number	UC3.3
Description	This use case tests the DQ Domain Consistency process by using a max and min value to determine the validity of values in a quantitative field. If the value in the numeric field is beyond the range defined by the max and min values, the test returns "failed" status (or boolean value of 0). Otherwise, the test returns "passed" status (or boolean value of 1).
Area map or study area description	In this test case, the state map of United States was used. The field, LAND_KM, is used the numerical field. The example test case used thresholds of max at 1000000 and minimum at 143986. The results return as follows. *"The number of features conforming to the minimum of 143986.0 and a maximum of 1000000.0 equals 23. The number of non-conforming features is 26 this represents a percentage of 53.06122448979592. This is from a total of 49."* Therefore, the test failed (or boolean value of 0 is returned). The following is the map of United States. Red renders those states with LAND_KM beyond the range between 143986 and 1000000. Green renders those states with LAND_KM within the defined range. Test dataset (vector features): See Figure 8.17. Test dataset URL: http://demo.opengeo.org/geoserver/topp/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=topp%3Astates&maxFeatures=50&outputformat=gml3
Test Page	http://54.201.124.35/wps/test_client
Request File	LogicalAccuracy.DomainConsistency2.0.xml
Example Execution	See example request and response in Table C.4 in Appendix C.

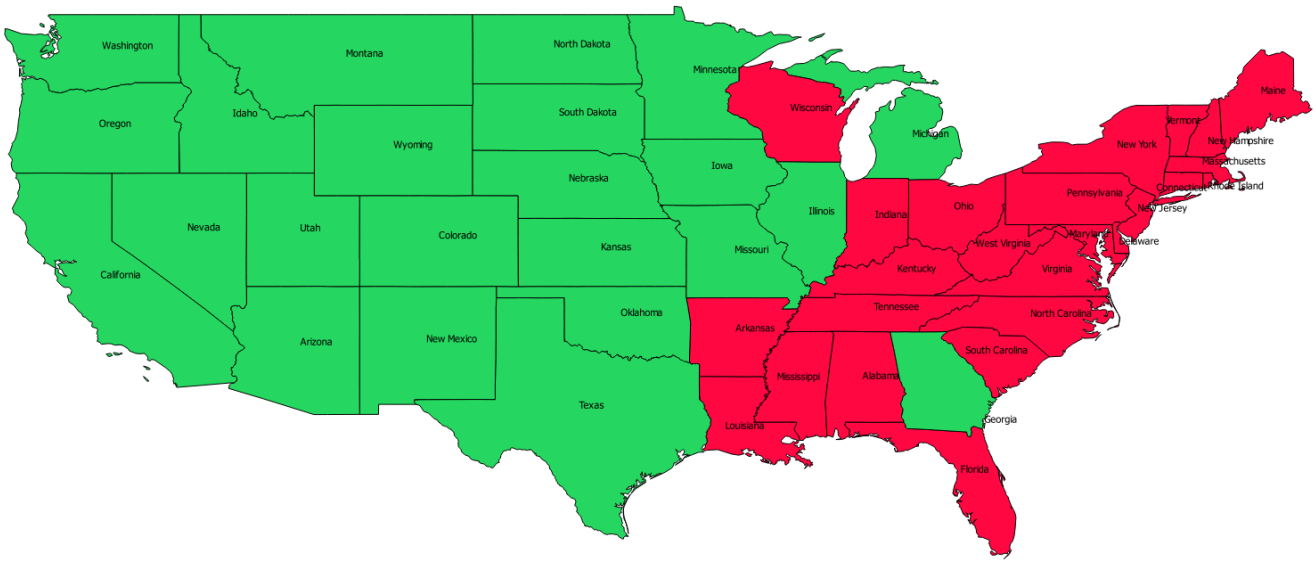


Figure 8.17. Test dataset for Use Case 3.3.

8.4. Use Case 4 - Thematic Accuracy

This section covers the use cases for utilizing thematic Accuracy WPS DQ processes.

8.4.1. Use Case 4.1 - Classification Correctness

This section contains use cases that demonstrate the DQ processes for Classification Correctness.

Use Case 4.1.1 - Classification Correctness (vector features)

This section contains an example that demonstrates the use of DQ Classification Correctness process for vector feature dataset.

Table 8.11. Use Case for the WPS Process of Data Quality Classification Correctness

Use Case Number	UC4.1.1
Description	This use case tests the DQ Classification Correctness process by randomly sampling the extent of a polygon dataset and checking whether it matches the source raster. Given the number of sample points, polygons were selected to test if they match the classification. If there is mismatch, the test failed and boolean value of 0 is returned. Otherwise, the test passes.
Area map or study area description	In the test case, a small portion of dataset in Pennsylvania, USA was used. This verifies the land use classification by comparing the classified vector dataset to its original raster dataset. Of the selected 20 samples, the test returns "17 match and 3 do not", which leads to the result of failed test (boolean value of 0 is returned). Target dataset (vector feature): See Figure 8.18. Target dataset URL: http://54.244.142.1/geoserver/cite/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=cite:conceptual_consistency&outputFormat=gml3 Origin reference dataset (raster): See Figure 8.19. Origin reference dataset URL: http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF
Test Page	http://54.201.124.35/wps/test_client

Request File	ThematicAccuracy.ThematicClassificationCorrectness2.0.xml
Example Execution	See example request and response in Table D.1. in Appendix D.

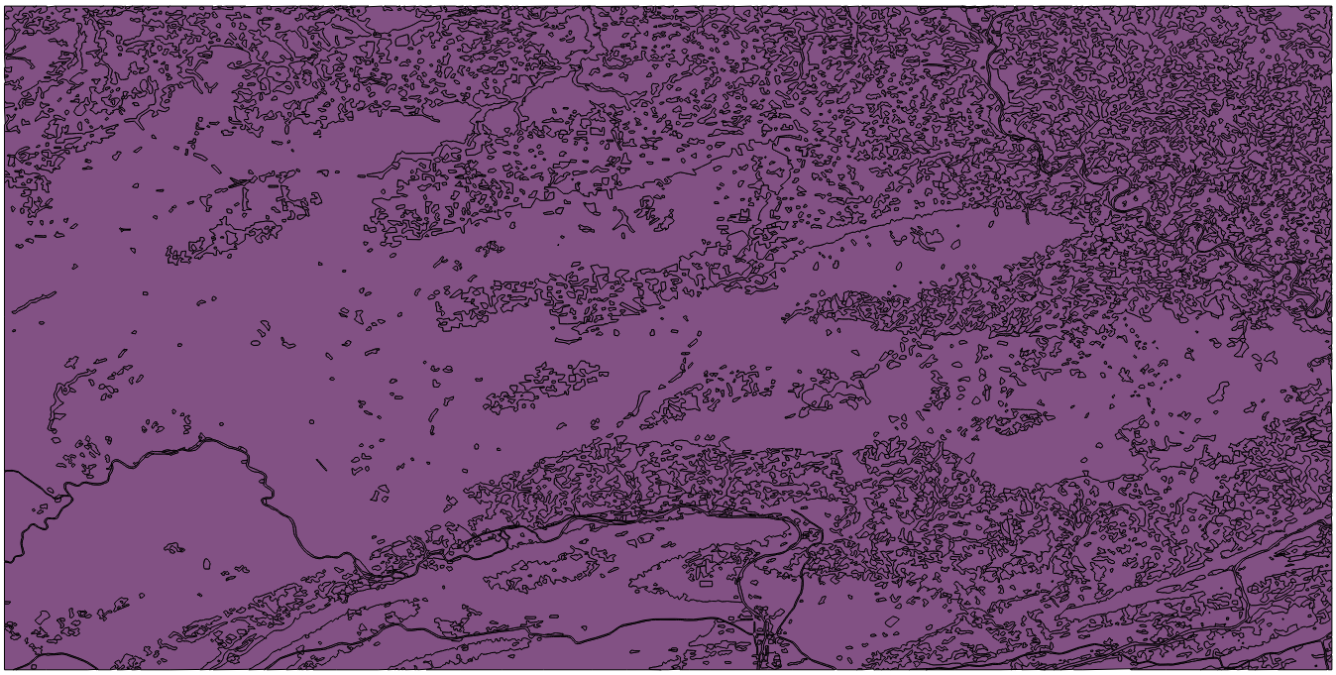


Figure 8.18. Target dataset for Use Case 4.1.1.

Figure 8.19. Reference dataset for Use Case 4.1.1

Use Case 4.1.2 - Classification Correctness (raster dataset)

This section contains an example that demonstrates the use of DQ Classification Correctness process for raster dataset.

Table 8.12. Use Case for the WPS Process of Data Quality Classification Correctness

Use Case Number	UC4.1.2

Description	This use case tests the DQ Classification Correctness process by randomly sampling a target raster dataset and checking the samples against the source vector. Given the number of sample points, polygons were selected to test if they match the classification. If there is mismatch, the test failed and boolean value of 0 is returned. Otherwise, the test passes.
Area map or study area description	In the test case, a small portion of dataset in Pennsylvania, USA was used. This verifies the land use classification by comparing the classified raster dataset to the reference vector dataset. Of the selected 20 samples, the test returns "19 match and 1 do not", which leads to the result of failed test (boolean value of 0 is returned). Target dataset (raster): See Figure 8.20. Target dataset URL: http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF Reference dataset (vector feature): See Figure 8.21. Reference dataset URL: http://54.244.142.1/geoserver/cite/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=cite:conceptual_consistency&outputFormat=gml3
Test Page	http://54.201.124.35/wps/test_client
Request File	ThematicAccuracy.ThematicClassificationCorrectnessR2.0.xml
Example Execution	See example request and response in Table D.2. in Appendix D.

Figure 8.20. Target dataset for Use Case 4.2.1

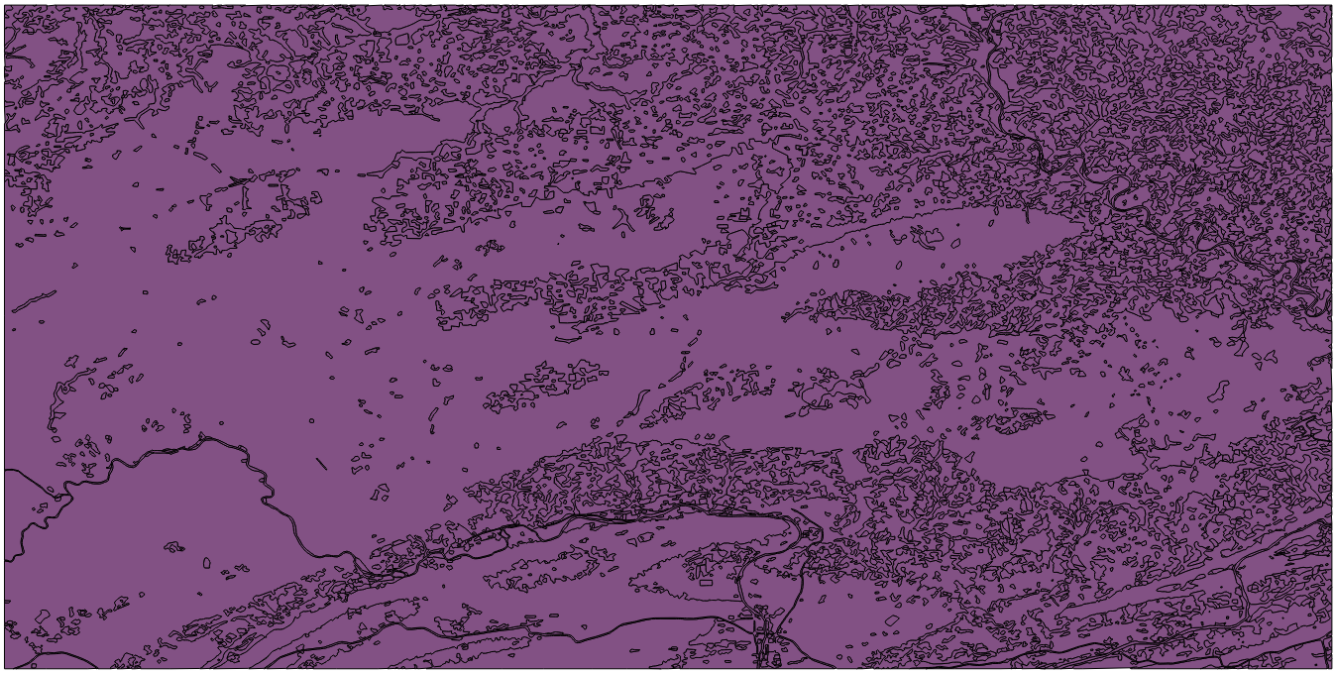


Figure 8.21. Reference dataset for Use Case 4.2.1

8.4.2. Use Case 4.2 - Non-Quantitative Attribute Accuracy

This section contains an example that demonstrates the use of the DQ Non-Quantitative Attribute Accuracy process.

Table 8.13. Use Case for the WPS Process of Data Quality Non-Quantitative Attribute Accuracy

Use Case Number	UC4.2
Description	This use case demonstrates the use of DQ Non-Quantitative Attribute Accuracy WPS process. It tests if a string matches on a given target field against an authoritative source. If there is any mismatch, the test would fail with the return of boolean value 0. Otherwise, the test would succeed with the return of boolean value 1.
Area map or study area description	In this test case, the map of Canada is used to test the spelling of place names. Identical vector datasets were used for target and reference. There is no misspelling found in the field of name. Therefore, the test passes with the return of boolean value 1. Target dataset: See Figure 8.22. Target dataset URL: http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3 Reference dataset: See Figure 8.23. Reference dataset URL: http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3
Test Page	http://54.201.124.35/wps/test_client
Request File	ThematicAccuracy.NonQuantitativeAttributeAccuracy2.0.xml
Example Execution	See example request and response in Table D.3. in Appendix D.

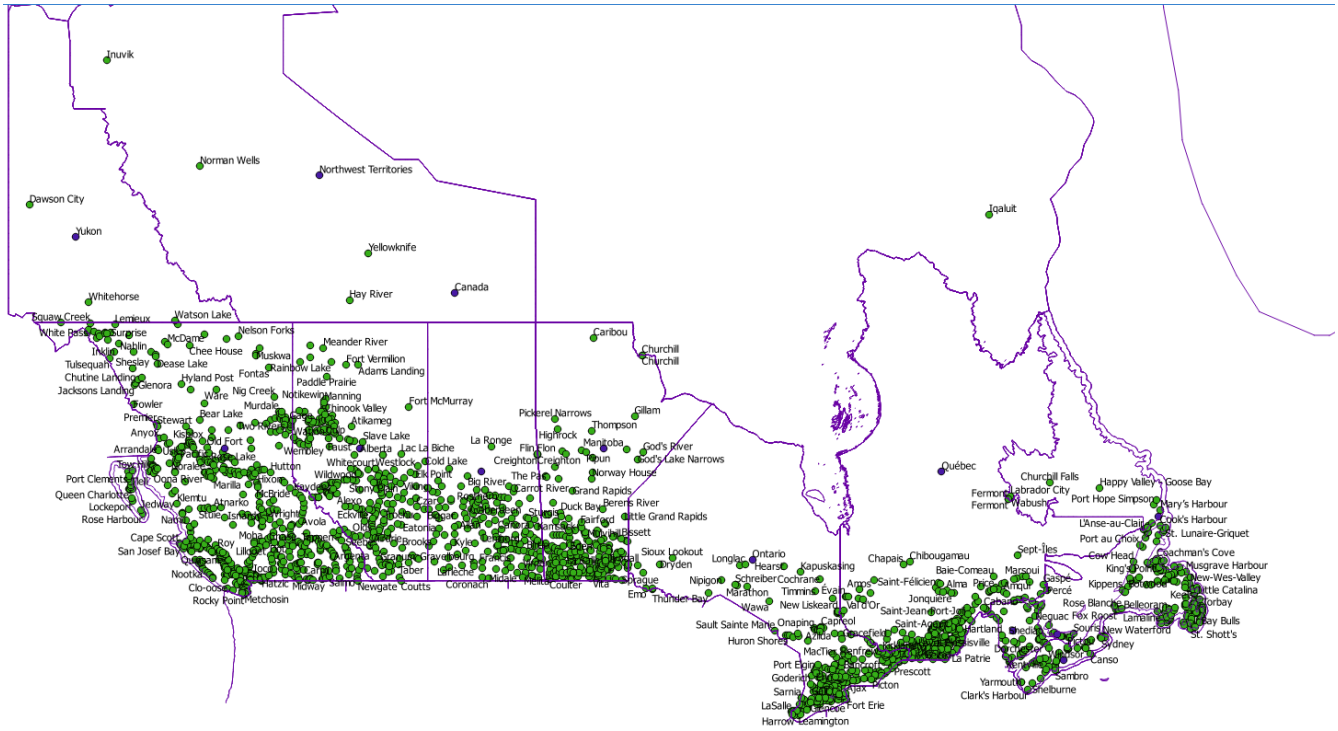


Figure 8.22. Target dataset for Use Case 4.2.2

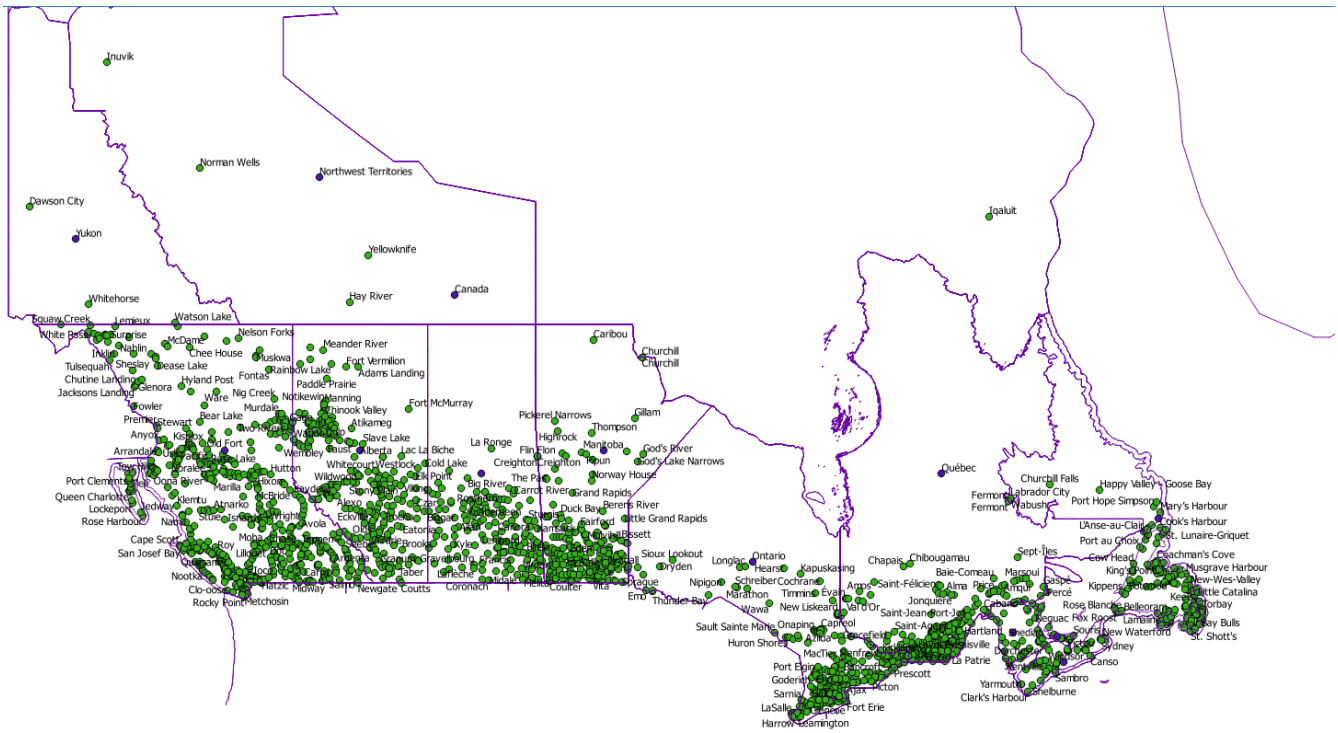


Figure 8.23. Reference dataset for Use Case 4.2.2

8.4.3. Use Case 4.3 - Quantitative Attribute Accuracy

This section contains an example that demonstrate the use of DQ Quantitative Attribute Accuracy WPS process.

Table 8.14. Use Case for the WPS Process of Data Quality Quantitative Attribute Accuracy

Use Case Number	UC4.3

Description	This use case demonstrates the use of DQ Quantitative Attribute Accuracy WPS process. It checks whether a given field is equal to an authoritative field. If the incorrect entry leads to more than the percentage of given threshold, the test fails (or the boolean value of 0 is returned). Otherwise, the test succeeds with the return of boolean value 1.
Area map or study area description	In this test case, the world population map of 1:10m was used for both target and reference dataset. The filed of POP_MAX is examined to see if there is any incorrect entries. The results returned "The number of incorrect entries is 0.0. This represents 0.0% of the dataset". Therefore, the test passes with the return value of boolean 1. Target dataset: See Figure 8.24. Target dataset URL: http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=osm%3Ane_10m_populated_places&maxFeatures=50&outputformat=gml3 Reference dataset: See Figure 8.25. Reference dataset URL: http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&request=GetFeature&typeName=osm%3Ane_10m_populated_places&maxFeatures=50&outputformat=gml3
Test Page	http://54.201.124.35/wps/test_client
Request File	ThematicAccuracy.QuantitativeAttributeAccuracy2.0.xml
Example Execution	See example request and response in Table D.4. in Appendix D.

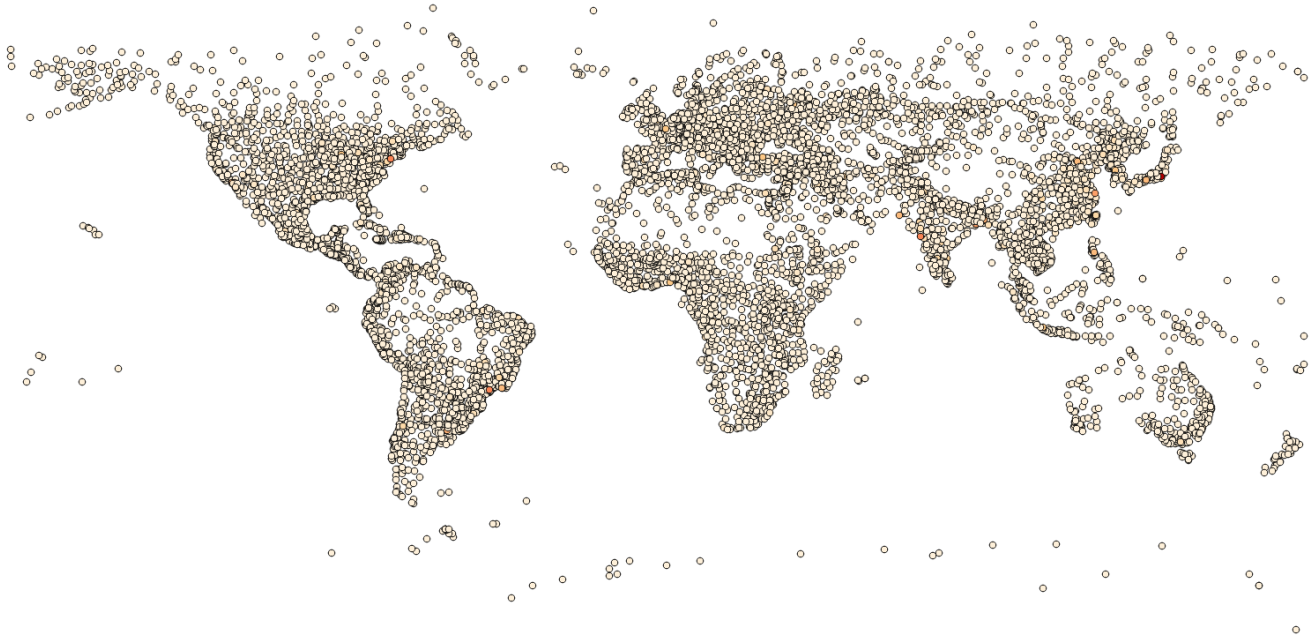


Figure 8.24. Target dataset for Use Case 4.3.

Figure 8.25. Reference dataset for Use Case 4.3

Chapter 9. Future Recommendations

9.1. Evolution of Data Quality Standards

Mapping the seven elements of ISO 19157-2 to Data Quality (DQ) WPS processes: as the DQ standard of ISO evolves (i.e. development of ISO 19157 concept and encoding), the data quality WPS processes should develop further to follow the DQ standard. The reports from DQ WPS processes should be aligned to the elements specified with ISO 19157 concepts and encoding. The six elements of ISO 19157 should be supported with WPS DQ processes. These elements are completeness, logical consistency, positional accuracy, thematic accuracy, temporal quality, and usability. Mappings across those of COBWEB-derived seven pillar processes, ISO 19157 DQ elements, and NSG Metadata Framework need to be further developed and documented. Relevant new mapping processes may be developed to achieve the automatic mapping among each other.

9.2. Data Quality Workflow

It is often required for complex workflow to deal with multiple aspects of data quality for a given dataset. This requires further implementation and testing of a Workflow solution to chain atomic tests for data quality metadata to be produced. Different use cases require different types of testing to produce relevant compliant metadata. An ideal solution is to have a process bank held in a WPS that could be reused through process chaining. BPMN solution outlined in COBWEB would be one to be recommended to be adopted.

9.3. Data Quality Test Suites

A superset of use cases should be derived in order to produce tests that are generic rather than specific as they are at the moment. This, coupled with the chaining solution enables maximum flexibility and reuse with minimal repetition.

Appendix A: ISO Data Quality WPS Process Examples - Test examples for DQ Completeness Omission/Completeness Commission

This appendix includes actual examples in executing different data quality WPS processes.

A.1 Test examples for DQ Completeness Omission

This section contains examples for testing processes of DQ Completeness Omission.

A.1.1 Test examples for DQ Completeness Omission (vector feature)

This is the section for test examples on DQ Completeness Omission (vector feature).

Table A.1. A Test Example for the WPS Process of Data Quality Completeness Omission (vector feature)

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	Completeness.CompletenessOmission2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">
  <ows:Identifier>iso19157.DQ_Completeness.DQ_CompletenessOmission</ows:Identifier>
  <wps:Input id="inputTargetDataset">
    <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&reques
t=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3"/>
  </wps:Input>
   <wps:Input id="inputReferenceDataset">
    <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&reques
t=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3"/>
  </wps:Input>
    <wps:Input id="inputTargetFieldName">
    <wps:Data>
    <wps:LiteralValue>name</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
    <wps:Input id="inputReferenceFieldName">
    <wps:Data>
    <wps:LiteralValue>name</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
   <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>1</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>d0ae49b8-6cfc-440c-94c7-86501e51612c</wps:JobID>
  <wps:Output id="outputMetadataChunk">
```

```
    <wps:Data mimeType="text/xml">
      <DQ_CompletenessOmission>
        <nameOfMeasure>
          <CharacterString>Completeness of target dataset against the universe of
discourse</CharacterString>
        </nameOfMeasure>
        <measureDescription>
          <CharacterString>Check for completeness of the target dataset against the
universe of discourse provided by the reference dataset</CharacterString>
        </measureDescription>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directExternal">Direct
external</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-13T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Completeness test</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-10-28</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>There
 are 1 Nadu in the target dataset and 1 Nadu  in the authoritative
dataset There are 1 Galbraith in the target dataset and 1 Galbraith  in
the authoritative dataset There are 1 Sheslay in the target dataset and 1
 Sheslay  in the authoritative dataset There are 1 Squaw Creek in the
target dataset and 1 Squaw Creek  in the authoritative dataset There are
 1 Lawnhill in the target dataset and 1 Lawnhill  in the authoritative
dataset There are 1 Teepee in the target dataset and 1 Teepee  in the
authoritative dataset There are 1 Port Edward in the target dataset and 1
 Port Edward  in the authoritative dataset There are 1 Pennington in the
```

```
 target dataset and 1 Pennington  in the authoritative dataset There are
 1 Watson Island in the target dataset and 1 Watson Island  in the
authoritative dataset There are 1 Telegraph Creek in the target dataset
and 1 Telegraph Creek  in the authoritative dataset There are 1 Taku in
the target dataset and 1 Taku  in the authoritative dataset There are 1
Atlin in the target dataset and 1 Atlin  in the authoritative dataset
There are 1 Metlakatla in the target dataset and 1 Metlakatla  in the
authoritative dataset There are 1 Pike in the target dataset and 1
Pike  in the authoritative dataset There are 1 Ben-My-Chree in the
target dataset and 1 Ben-My-Chree  in the authoritative dataset There
are 1 Oona River in the target dataset and 1 Oona River  in the
authoritative dataset There are 1 Rose Harbour in the target dataset and
 1 Rose Harbour  in the authoritative dataset There are 1 Hunts Inlet in
 the target dataset and 1 Hunts Inlet  in the authoritative dataset
There are 1 Surprise in the target dataset and 1 Surprise  in the
authoritative dataset There are 1 Fraser in the target dataset and 1
Fraser  in the authoritative dataset There are 1 Jacksons Landing in the
 target dataset and 1 Jacksons Landing  in the authoritative dataset
There are 1 Lockeport in the target dataset and 1 Lockeport  in the
authoritative dataset There are 1 Masset in the target dataset and 1
Masset  in the authoritative dataset There are 1 Osland in the target
dataset and 1 Osland  in the authoritative dataset There are 1 Refuge
Bay in the target dataset and 1 Refuge Bay  in the authoritative dataset
 There are 1 Port Clements in the target dataset and 1 Port Clements  in
 the authoritative dataset There are 1 Sandspit in the target dataset
and 1 Sandspit  in the authoritative dataset There are 1 Nakina in the
target dataset and 1 Nakina  in the authoritative dataset There are 1
Tulsequah in the target dataset and 1 Tulsequah  in the authoritative
dataset There are 1 Scotia Bay in the target dataset and 1 Scotia
Bay  in the authoritative dataset There are 1 Haida in the target
dataset and 1 Haida  in the authoritative dataset There are 1 Pacofi in
the target dataset and 1 Pacofi  in the authoritative dataset There are 1
 Port Simpson in the target dataset and 1 Port Simpson  in the
authoritative dataset There are 1 Engineer in the target dataset and 1
Engineer  in the authoritative dataset There are 1 Alliford Bay in the
target dataset and 1 Alliford Bay  in the authoritative dataset There
are 1 Chutine Landing in the target dataset and 1 Chutine Landing  in
the authoritative dataset There are 1 Lemieux in the target dataset and 1
 Lemieux  in the authoritative dataset There are 1 Glenora in the target
 dataset and 1 Glenora  in the authoritative dataset There are 1 Inklin
in the target dataset and 1 Inklin  in the authoritative dataset There
are 1 White Pass in the target dataset and 1 White Pass  in the
authoritative dataset There are 1 Skidegate in the target dataset and 1
Skidegate  in the authoritative dataset There are 1 Nahlin in the target
 dataset and 1 Nahlin  in the authoritative dataset There are 1 Tlell in
 the target dataset and 1 Tlell  in the authoritative dataset There are 1
 Prince Rupert in the target dataset and 1 Prince Rupert  in the
authoritative dataset There are 1 Jedway in the target dataset and 1
Jedway  in the authoritative dataset There are 1 Queen Charlotte in the
target dataset and 1 Queen Charlotte  in the authoritative dataset There
 are 1 Defot in the target dataset and 1 Defot  in the authoritative
```

```
dataset There are 1 Tow Hill in the target dataset and 1 Tow Hill  in
the authoritative dataset There are 1 Fowler in the target dataset and 1
 Fowler  in the authoritative dataset There are 1 Hale in the target
dataset and 1 Hale  in the authoritative dataset There is 100.0% of type
 Nadu when compared to the universe of discourse There is 100.0% of type
 Galbraith when compared to the universe of discourse There is 100.0% of
 type Sheslay when compared to the universe of discourse There is 100.0%
 of type Squaw Creek when compared to the universe of discourse There is
 100.0% of type Lawnhill when compared to the universe of discourse
There is 100.0% of type Teepee when compared to the universe of
discourse There is 100.0% of type Port Edward when compared to the
universe of discourse There is 100.0% of type Pennington when compared
to the universe of discourse There is 100.0% of type Watson Island when
compared to the universe of discourse There is 100.0% of type Telegraph
Creek when compared to the universe of discourse There is 100.0% of type
 Taku when compared to the universe of discourse There is 100.0% of type
 Atlin when compared to the universe of discourse There is 100.0% of
type Metlakatla when compared to the universe of discourse There is
100.0% of type Pike when compared to the universe of discourse There is
100.0% of type Ben-My-Chree when compared to the universe of discourse
There is 100.0% of type Oona River when compared to the universe of
discourse There is 100.0% of type Rose Harbour when compared to the
universe of discourse There is 100.0% of type Hunts Inlet when compared
to the universe of discourse There is 100.0% of type Surprise when
compared to the universe of discourse There is 100.0% of type Fraser
when compared to the universe of discourse There is 100.0% of type
Jacksons Landing when compared to the universe of discourse There is
100.0% of type Lockeport when compared to the universe of discourse
There is 100.0% of type Masset when compared to the universe of
discourse There is 100.0% of type Osland when compared to the universe
of discourse There is 100.0% of type Refuge Bay when compared to the
universe of discourse There is 100.0% of type Port Clements when
compared to the universe of discourse There is 100.0% of type Sandspit
when compared to the universe of discourse There is 100.0% of type
Nakina when compared to the universe of discourse There is 100.0% of
type Tulsequah when compared to the universe of discourse There is
100.0% of type Scotia Bay when compared to the universe of discourse
There is 100.0% of type Haida when compared to the universe of discourse
 There is 100.0% of type Pacofi when compared to the universe of
discourse There is 100.0% of type Port Simpson when compared to the
universe of discourse There is 100.0% of type Engineer when compared to
the universe of discourse There is 100.0% of type Alliford Bay when
compared to the universe of discourse There is 100.0% of type Chutine
Landing when compared to the universe of discourse There is 100.0% of
type Lemieux when compared to the universe of discourse There is 100.0%
of type Glenora when compared to the universe of discourse There is
100.0% of type Inklin when compared to the universe of discourse There
is 100.0% of type White Pass when compared to the universe of discourse
There is 100.0% of type Skidegate when compared to the universe of
discourse There is 100.0% of type Nahlin when compared to the universe
of discourse There is 100.0% of type Tlell when compared to the universe
```

```
 of discourse There is 100.0% of type Prince Rupert when compared to the
 universe of discourse There is 100.0% of type Jedway when compared to
the universe of discourse There is 100.0% of type Queen Charlotte when
compared to the universe of discourse There is 100.0% of type Defot when
 compared to the universe of discourse There is 100.0% of type Tow Hill
when compared to the universe of discourse There is 100.0% of type
Fowler when compared to the universe of discourse There is 100.0% of
type Hale when compared to the universe of discourse . The number of
duplicate features is 0</CharacterString>
            </explanation>
            <pass>
              <Boolean>1</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_CompletenessOmission>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

A.1.2 Test examples for DQ Completeness Omission (raster)

This section contains an example for testing DQ Completeness Omission (raster).

Table A.2. A Test Example for the WPS Process of Data Quality Completeness Omission (raster dataset)

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	Completeness.CompletenessOmissionR2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">
  <ows:Identifier>iso19157.DQ_Completeness.DQ_CompletenessOmissionR</ows:Identifier>
  <wps:Input id="inputTargetDataset">
   <wps:Reference mimeType="image/geotiff"
xlink:href="http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF"/>
  </wps:Input>
   <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>1</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>ae9e341e-9fd2-4ad4-9e27-3e614338b49b</wps:JobID>
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_CompletenessOmission>
        <nameOfMeasure>
          <CharacterString>Completeness of target dataset against the universe of
discouse</CharacterString>
        </nameOfMeasure>
        <measureDescription>
          <CharacterString>Check for completeness of the target dataset against the
universe of discourse provided by the reference dataset</CharacterString>
        </measureDescription>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directInternal">Direct
internal</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-13T00:00:00</DateTime>
```

```
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Completeness test</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-10-28</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>The resolution of the data is 0.004000087833889381 and
the required resolution is 1.0</CharacterString>
            </explanation>
            <pass>
              <Boolean>1</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_CompletenessOmission>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

A.2 Test examples for DQ Completeness Commission

This section contains examples for testing DQ Completeness Commission.

A.2.1 Test examples for DQ Completeness Commission (vector feature)

This section contains an example for testing DQ Completeness Commission (vector features).

Table A.3. A Test Example for the WPS Process of Data Quality Completeness Commission (vector feature)

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	Completeness.CompletenessCommission2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">
  <ows:Identifier>iso19157.DQ_Completeness.DQ_CompletenessCommission</ows:Identifier>
  <wps:Input id="inputTargetDataset">
    <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&reques
t=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3"/>
  </wps:Input>
   <wps:Input id="inputReferenceDataset">
    <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&reques
t=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3"/>
  </wps:Input>
    <wps:Input id="inputTargetFieldName">
    <wps:Data>
    <wps:LiteralValue>name</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
    <wps:Input id="inputReferenceFieldName">
    <wps:Data>
    <wps:LiteralValue>name</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
   <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>1</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
```

```
  <wps:JobID>fe962ca7-fbe4-4b40-a031-8d155aeb5e95</wps:JobID>
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_CompletenessCommission>
        <nameOfMeasure>
          <CharacterString>Completeness of target dataset against the universe of
discouse</CharacterString>
        </nameOfMeasure>
        <measureDescription>
          <CharacterString>Check for completeness of the target dataset against the
universe of discourse provided by the reference dataset</CharacterString>
        </measureDescription>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directExternal">direct
external</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-13T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Completeness test</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-10-28</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>There
 are 1 Nadu in the target dataset and 1 Nadu  in the authoritative
dataset There are 1 Galbraith in the target dataset and 1 Galbraith  in
the authoritative dataset There are 1 Sheslay in the target dataset and 1
 Sheslay  in the authoritative dataset There are 1 Squaw Creek in the
target dataset and 1 Squaw Creek  in the authoritative dataset There are
 1 Lawnhill in the target dataset and 1 Lawnhill  in the authoritative
dataset There are 1 Teepee in the target dataset and 1 Teepee  in the
```

```
authoritative dataset There are 1 Port Edward in the target dataset and 1
 Port Edward  in the authoritative dataset There are 1 Pennington in the
 target dataset and 1 Pennington  in the authoritative dataset There are
 1 Watson Island in the target dataset and 1 Watson Island  in the
authoritative dataset There are 1 Telegraph Creek in the target dataset
and 1 Telegraph Creek  in the authoritative dataset There are 1 Taku in
the target dataset and 1 Taku  in the authoritative dataset There are 1
Atlin in the target dataset and 1 Atlin  in the authoritative dataset
There are 1 Metlakatla in the target dataset and 1 Metlakatla  in the
authoritative dataset There are 1 Pike in the target dataset and 1
Pike  in the authoritative dataset There are 1 Ben-My-Chree in the
target dataset and 1 Ben-My-Chree  in the authoritative dataset There
are 1 Oona River in the target dataset and 1 Oona River  in the
authoritative dataset There are 1 Rose Harbour in the target dataset and
 1 Rose Harbour  in the authoritative dataset There are 1 Hunts Inlet in
 the target dataset and 1 Hunts Inlet  in the authoritative dataset
There are 1 Surprise in the target dataset and 1 Surprise  in the
authoritative dataset There are 1 Fraser in the target dataset and 1
Fraser  in the authoritative dataset There are 1 Jacksons Landing in the
 target dataset and 1 Jacksons Landing  in the authoritative dataset
There are 1 Lockeport in the target dataset and 1 Lockeport  in the
authoritative dataset There are 1 Masset in the target dataset and 1
Masset  in the authoritative dataset There are 1 Osland in the target
dataset and 1 Osland  in the authoritative dataset There are 1 Refuge
Bay in the target dataset and 1 Refuge Bay  in the authoritative dataset
 There are 1 Port Clements in the target dataset and 1 Port Clements  in
 the authoritative dataset There are 1 Sandspit in the target dataset
and 1 Sandspit  in the authoritative dataset There are 1 Nakina in the
target dataset and 1 Nakina  in the authoritative dataset There are 1
Tulsequah in the target dataset and 1 Tulsequah  in the authoritative
dataset There are 1 Scotia Bay in the target dataset and 1 Scotia
Bay  in the authoritative dataset There are 1 Haida in the target
dataset and 1 Haida  in the authoritative dataset There are 1 Pacofi in
the target dataset and 1 Pacofi  in the authoritative dataset There are 1
 Port Simpson in the target dataset and 1 Port Simpson  in the
authoritative dataset There are 1 Engineer in the target dataset and 1
Engineer  in the authoritative dataset There are 1 Alliford Bay in the
target dataset and 1 Alliford Bay  in the authoritative dataset There
are 1 Chutine Landing in the target dataset and 1 Chutine Landing  in
the authoritative dataset There are 1 Lemieux in the target dataset and 1
 Lemieux  in the authoritative dataset There are 1 Glenora in the target
 dataset and 1 Glenora  in the authoritative dataset There are 1 Inklin
in the target dataset and 1 Inklin  in the authoritative dataset There
are 1 White Pass in the target dataset and 1 White Pass  in the
authoritative dataset There are 1 Skidegate in the target dataset and 1
Skidegate  in the authoritative dataset There are 1 Nahlin in the target
 dataset and 1 Nahlin  in the authoritative dataset There are 1 Tlell in
 the target dataset and 1 Tlell  in the authoritative dataset There are 1
 Prince Rupert in the target dataset and 1 Prince Rupert  in the
authoritative dataset There are 1 Jedway in the target dataset and 1
Jedway  in the authoritative dataset There are 1 Queen Charlotte in the
```

```
target dataset and 1 Queen Charlotte  in the authoritative dataset There
 are 1 Defot in the target dataset and 1 Defot  in the authoritative
dataset There are 1 Tow Hill in the target dataset and 1 Tow Hill  in
the authoritative dataset There are 1 Fowler in the target dataset and 1
 Fowler  in the authoritative dataset There are 1 Hale in the target
dataset and 1 Hale  in the authoritative dataset There is 100.0% of type
 Nadu when compared to the universe of discouse There is 100.0% of type
Galbraith when compared to the universe of discouse There is 100.0% of
type Sheslay when compared to the universe of discouse There is 100.0%
of type Squaw Creek when compared to the universe of discouse There is
100.0% of type Lawnhill when compared to the universe of discouse There
is 100.0% of type Teepee when compared to the universe of discouse There
 is 100.0% of type Port Edward when compared to the universe of discouse
 There is 100.0% of type Pennington when compared to the universe of
discouse There is 100.0% of type Watson Island when compared to the
universe of discouse There is 100.0% of type Telegraph Creek when
compared to the universe of discouse There is 100.0% of type Taku when
compared to the universe of discouse There is 100.0% of type Atlin when
compared to the universe of discouse There is 100.0% of type Metlakatla
when compared to the universe of discouse There is 100.0% of type Pike
when compared to the universe of discouse There is 100.0% of type
Ben-My-Chree when compared to the universe of discouse There is 100.0%
of type Oona River when compared to the universe of discouse There is
100.0% of type Rose Harbour when compared to the universe of discouse
There is 100.0% of type Hunts Inlet when compared to the universe of
discouse There is 100.0% of type Surprise when compared to the universe
of discouse There is 100.0% of type Fraser when compared to the universe
 of discouse There is 100.0% of type Jacksons Landing when compared to
the universe of discouse There is 100.0% of type Lockeport when compared
 to the universe of discouse There is 100.0% of type Masset when
compared to the universe of discouse There is 100.0% of type Osland when
 compared to the universe of discouse There is 100.0% of type Refuge Bay
 when compared to the universe of discouse There is 100.0% of type Port
Clements when compared to the universe of discouse There is 100.0% of
type Sandspit when compared to the universe of discouse There is 100.0%
of type Nakina when compared to the universe of discouse There is 100.0%
 of type Tulsequah when compared to the universe of discouse There is
100.0% of type Scotia Bay when compared to the universe of discouse
There is 100.0% of type Haida when compared to the universe of discouse
There is 100.0% of type Pacofi when compared to the universe of discouse
 There is 100.0% of type Port Simpson when compared to the universe of
discouse There is 100.0% of type Engineer when compared to the universe
of discouse There is 100.0% of type Alliford Bay when compared to the
universe of discouse There is 100.0% of type Chutine Landing when
compared to the universe of discouse There is 100.0% of type Lemieux
when compared to the universe of discouse There is 100.0% of type
Glenora when compared to the universe of discouse There is 100.0% of
type Inklin when compared to the universe of discouse There is 100.0% of
 type White Pass when compared to the universe of discouse There is
100.0% of type Skidegate when compared to the universe of discouse There
 is 100.0% of type Nahlin when compared to the universe of discouse
```

```
There is 100.0% of type Tlell when compared to the universe of discouse
There is 100.0% of type Prince Rupert when compared to the universe of
discouse There is 100.0% of type Jedway when compared to the universe of
 discouse There is 100.0% of type Queen Charlotte when compared to the
universe of discouse There is 100.0% of type Defot when compared to the
universe of discouse There is 100.0% of type Tow Hill when compared to
the universe of discouse There is 100.0% of type Fowler when compared to
 the universe of discouse There is 100.0% of type Hale when compared to
the universe of discouse . The number of duplicate features is 0</CharacterString>
            </explanation>
            <pass>
              <Boolean>1</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_CompletenessCommission>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

A.2.2 Test examples for DQ Completeness Commission (raster)

This section contains an example for testing DQ Completeness Commission (raster).

Table A.4. A Test Example for the WPS Process of Data Quality Completeness Commission (raster dataset)

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	Completeness.CompletenessCommissionR2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">
<ows:Identifier>iso19157.DQ_Completeness.DQ_CompletenessCommissionR</ows:Identifier>
  <wps:Input id="inputTargetDataset">
   <wps:Reference mimeType="image/geotiff"
xlink:href="http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF"/>
  </wps:Input>
   <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>1</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>d438680a-5cff-4d70-9384-4bd48d8efd50</wps:JobID>
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_CompletenessCommission>
        <nameOfMeasure>
          <CharacterString>Completeness of target dataset against the universe of
discouse</CharacterString>
        </nameOfMeasure>
        <measureDescription>
          <CharacterString>Check for completeness of the target dataset against the
universe of discourse provided by the reference dataset</CharacterString>
        </measureDescription>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directInternal">Direct
internal</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-13T00:00:00</DateTime>
```

```
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Completeness test</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-09-30</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>The resolution of the data is 0.004000087833889381 and
the required resolution is 1.0</CharacterString>
            </explanation>
            <pass>
              <Boolean>0</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_CompletenessCommission>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

Appendix B: ISO Data Quality WPS Process Examples - Test examples for DQ Positional Accuracy

This appendix includes actual examples in executing different data quality WPS processes.

B.1 Test examples for DQ Positional Accuracy (vector feature)

This section contains an example for test DQ Positional Accuracy (vector feature).

Table B.1. A Test Example for the WPS Process of Data Quality Positional Accuracy (vector feature)

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	PositionalAcuracy.AbsoluteExternalPositinalAccuracy2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">
<ows:Identifier>iso19157.DQ_PositionalAccuracy.DQ_AbsoluteExternalPositionalAccuracy</
ows:Identifier>
  <wps:Input id="inputTargetDataset">
  <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://172.31.6.105/geoserver/cite/ows?service=WFS&version=1.0.0&request=G
etFeature&typeName=cite:bugsites&outputFormat=gml3"/>
</wps:Input>
   <wps:Input id="inputReferenceDataset">
  <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://172.31.6.105/geoserver/cite/ows?service=WFS&version=1.0.0&request=G
etFeature&typeName=cite:bugsites_moved&outputFormat=gml3"/>
</wps:Input>
  <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>10</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="inputTargetField">
    <wps:Data>
    <wps:LiteralValue>cat</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="inputReferenceField">
    <wps:Data>
    <wps:LiteralValue>cat</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>1182206d-36b3-4fe1-81d7-af94db28a791</wps:JobID>
```

```
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_AbsoluteExternalPositionalAccuracy>
        <nameOfMeasure>
          <CharacterString>Test of accuracy of the target data against an
authoritative reference</CharacterString>
        </nameOfMeasure>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directExternal">Direct
external</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-10T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Accuracy of position test</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-09-30</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>The mean displacement from the authoritative data is
94.84364940038897</CharacterString>
            </explanation>
            <pass>
              <Boolean>0</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_AbsoluteExternalPositionalAccuracy>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

B.2 Test examples for DQ Positional Accuracy (gridded)

This section contains an example for test DQ Positional Accuracy (gridded).

Table B.2. A Test Example for the WPS Process of Data Quality Positional Accuracy (gridded dataset)

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	PositionalAcuracy.GriddedDataPositinalAccuracy2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">
<ows:Identifier>iso19157.DQ_PositionalAccuracy.DQ_GriddedDataPositionalAccuracy</ows:I
dentifier>
  <wps:Input id="inputTargetDataset">
      <wps:Reference mimeType="image/geotiff"
xlink:href="http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF"/>
</wps:Input>
   <wps:Input id="inputReferenceDataset">
      <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://172.31.6.105/geoserver/cite/ows?service=WFS&version=1.0.0&request=G
etFeature&typeName=cite:conceptual_consistency&outputFormat=gml3"/>
</wps:Input>
  <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>10</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>4f0668bb-78f8-466a-a31d-a57c0fc0dc91</wps:JobID>
```

```
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_GriddedDataPositionalAccuracy>
        <nameOfMeasure>
          <CharacterString>Gridded external postional accuracy determined by a
reference</CharacterString>
        </nameOfMeasure>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directExternal">Direct
external</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-10T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Accuracy determined by a comparison of a target
bounding box to a reference bounding box</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-09-30</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>The required accuracy is 10.0 and the observed accuracy
is 5.172098205179317E-9</CharacterString>
            </explanation>
            <pass>
              <Boolean>1</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_GriddedDataPositionalAccuracy>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

Appendix C: ISO Data Quality WPS Process Examples - Test examples for DQ Logical Accuracy

This appendix includes actual examples in executing different data quality WPS processes.

C.1 Test example for DQ Topological Consistency

This section contain an example for testing DQ Topological Consistency.

Table C.1. A Test Example for the WPS Process of Data Quality Topological Consistency

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	LogicalConsistency.TopologicalConsistency2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">

<ows:Identifier>iso19157.DQ_LogicalConsistency.DQ_TopologicalConsistency</ows:Identifi
er>
  <wps:Input id="inputTargetDataset">
    <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"

xlink:href="http://demo.opengeo.org/geoserver/ne/ows?service=WFS&version=1.0.0&request
=GetFeature&typeName=ne%3Ane_10m_roads_north_america&maxFeatures=50&outputformat=gml3"
/>
  </wps:Input>
  <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>10</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>1065e9e6-4ee3-4e3c-9b1d-a207c7161a1f</wps:JobID>
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_TopologicalConsistency>
        <nameOfMeasure>
          <CharacterString>Topological Consistency determined by the number of dangles
in the dataset of lines</CharacterString>
        </nameOfMeasure>
        <measureDescription>
          <CharacterString>Check for Topological Consistency in a dataset of lines or
polygons</CharacterString>
        </measureDescription>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directInternal">Direct
internal</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-14T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Test of number of dangles in the lines
dataset</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-09-30</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="revision">revision</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
```

```
            <explanation>
              <CharacterString>The number of dangles equals 1</CharacterString>
            </explanation>
            <pass>
              <Boolean>1</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_TopologicalConsistency>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

C.2 Test examples for DQ Conceptual Consistency

This section contains examples for testing DQ Conceptual Consistency.

C.2.1 Test examples for DQ Conceptual Consistency (vector features)

This section contains an example for testing DQ Conceptual Consistency (vector features).

Table C.2. A Test Example for the WPS Process of Data Quality Conceptual Consistency (vector features)

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	LogicalConsistency.ConceptualConsistency2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">

<ows:Identifier>iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistency</ows:Identifie
r>
  <wps:Input id="inputTargetData">
    <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"

xlink:href="http://demo.opengeo.org/geoserver/ne/ows?service=WFS&version=1.0.0&request
=GetFeature&typeName=ne%3Ane_10m_roads_north_america&maxFeatures=50&outputformat=gml3"
/>
  </wps:Input>
  <wps:Input id="inputReferenceData">
    <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"

xlink:href="http://demo.opengeo.org/geoserver/ne/ows?service=WFS&version=1.0.0&request
=GetFeature&typeName=ne%3Ane_10m_roads_north_america&maxFeatures=50&outputformat=gml3"
/>
  </wps:Input>
  <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>10</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>45053709-82e0-44e6-99a5-00184fe0478f</wps:JobID>
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_ConceptualConsistency>
        <nameOfMeasure>
          <CharacterString>Check for fields present against the universe of
```

```
discourse</CharacterString>
        </nameOfMeasure>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directInternal">Direct
internal</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-10T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Test of conceptual consistency with the
authoritative data used as the conceptual schema</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-09-30</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>Number of conceptually constent properties equals 19
total number of inconsistent properties equals 0</CharacterString>
            </explanation>
            <pass>
              <Boolean>1</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_ConceptualConsistency>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

Table C.3. A Test Example for the WPS Process of Data Quality Conceptual Consistency (gridded dataset)

Service Endpoint	http://54.201.124.35/wps/WebProcessingService

Test Page	http://54.201.124.35/wps/test_client
Request File	LogicalConsistency.ConceptualConsistencyR.2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">

<ows:Identifier>iso19157.DQ_LogicalConsistency.DQ_ConceptualConsistencyR</ows:Identifi
er>
  <wps:Input id="inputTargetData">
   <wps:Reference mimeType="image/geotiff"
xlink:href="http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF"/>
  </wps:Input>
  <wps:Input id="inputReferenceData">
 <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://172.31.6.105/geoserver/cite/ows?service=WFS&version=1.0.0&request=G
etFeature&typeName=cite:conceptual_consistency&outputFormat=gml3"/>
 </wps:Input>
 <wps:Input id="inputReferenceDataField">
    <wps:Data>
    <wps:LiteralValue>LUCODE</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
   <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>1</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>325413c6-1bbe-459f-8473-def1c600f170</wps:JobID>
```

```
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_ConceptualConsistency>
        <nameOfMeasure>
          <CharacterString>Compares Conceptual Consistency of the dataset against the
universe of discourse</CharacterString>
        </nameOfMeasure>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directInternal">Direct
internal</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-10T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>compares the area covered by each class in the
target and authoritative datasets</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-10-28</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>There
 are 1.7600772946712827E-4m squared of class 33.0 in the target dataset
and 1.1212216383238426E-4 m squared of class 33.0 in the authoritative
dataset There are 0.003280144049160127m squared of class 32.0 in the
target dataset and 0.003197666192765192 m squared of class 32.0 in the
authoritative dataset There are 1.2131412757028652m squared of class
41.0 in the target dataset and 1.213062033891802 m squared of class 41.0
 in the authoritative dataset There are 0.028801264821894452m squared of
 class 42.0 in the target dataset and 0.033437663054329395 m squared of
class 42.0 in the authoritative dataset There are 0.12085330733321185m
squared of class 43.0 in the target dataset and 0.14446772718468723 m
squared of class 43.0 in the authoritative dataset There are
```

```
0.013648599385042025m squared of class 11.0 in the target dataset and
0.01380961980727628 m squared of class 11.0 in the authoritative dataset
 There are 0.00340814967059076 7m squared of class 12.0 in the target
dataset and 0.0032411899476691743 m squared of class 12.0 in the
authoritative dataset There are 0.008960393500144706m squared of class
51.0 in the target dataset and 0.008816653143768782 m squared of class
51.0 in the authoritative dataset There are 0.0020640906455690463m
squared of class 52.0 in the target dataset and 0.002492436409161388 m
squared of class 52.0 in the authoritative dataset There are
0.004704206587575976m squared of class 53.0 in the target dataset and
0.00515752857307987 m squared of class 53.0 in the authoritative dataset
 There are 0.0024481075098609665m squared of class 13.0 in the target
dataset and 0.00291216072135618 m squared of class 13.0 in the
authoritative dataset There are 0.004800210803648954m squared of class
14.0 in the target dataset and 0.004754232715294028 m squared of class
14.0 in the authoritative dataset There are 3.8401686429191624E-4m
squared of class 61.0 in the target dataset and 4.383292776858254E-4 m
squared of class 61.0 in the authoritative dataset There are
7.200316205473422E-4m squared of class 62.0 in the target dataset and
7.279930034353726E-4 m squared of class 62.0 in the authoritative
dataset There are 0.001056046376802768m squared of class 16.0 in the
target dataset and 0.0010657462906585823 m squared of class 16.0 in the
authoritative dataset There are 0.0012160534035910659m squared of class
17.0 in the target dataset and 0.0013472468538966284 m squared of class
17.0 in the authoritative dataset There are 0.0015520681598464915m
squared of class 75.0 in the target dataset and 0.001690191097261005 m
squared of class 75.0 in the authoritative dataset There are
0.004768209398291295m squared of class 76.0 in the target dataset and
0.004832718798864574 m squared of class 76.0 in the authoritative
dataset There are 0.6002663609960214m squared of class 21.0 in the
target dataset and 0.6024108167408133 m squared of class 21.0 in the
authoritative dataset There are 9.760428634086189E-4m squared of class
22.0 in the target dataset and 9.280854700718368E-4 m squared of class
22.0 in the authoritative dataset There are 1.2800562143063874E-4m
squared of class 24.0 in the target dataset and 1.3082679804684032E-4 m
squared of class 24.0 in the authoritative dataset</CharacterString>
            </explanation>
            <pass>
              <Boolean>0</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_ConceptualConsistency>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

C.3 Test examples for DQ Domain Consistency

This section contain an example for testing DQ Domain Consistency.

Table C.4. A Test Example for the WPS Process of Data Quality Domain Consistency

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	LogicalConsistency.DomainConsistency2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">
  <ows:Identifier>iso19157.DQ_LogicalConsistency.DQ_DomainConsistency</ows:Identifier>
  <wps:Input id="inputTargetData">
   <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/topp/ows?service=WFS&version=1.0.0&reque
st=GetFeature&typeName=topp%3Astates&maxFeatures=50&outputformat=gml3"/>
  </wps:Input>
   <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>1</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="fieldName">
    <wps:Data>
    <wps:LiteralValue>LAND_KM</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="max">
    <wps:Data>
    <wps:LiteralValue>1000000</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="min">
    <wps:Data>
    <wps:LiteralValue>143986</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>4cecbb38-23f4-44b6-a1e4-107e13ae7f5f</wps:JobID>
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_DomainConsistency>
        <nameOfMeasure>
          <CharacterString>Domain Consistency of a field determined by minimum and
maximum values, field: LAND_KM</CharacterString>
        </nameOfMeasure>
        <measureDescription>
          <CharacterString>Check for domain consistency of a numerical
field</CharacterString>
        </measureDescription>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directInternal">Direct
internal</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-10T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Test of Domain Consistency of
LAND_KM</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-09-30</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>The
 number of features conforming to the minimum of 143986.0 and a maximum
```

```
of 1000000.0 equals 23. The number of non-conforming features is 26 this
 represents a percentage of 53.06122448979592. This is from a total of
49</CharacterString>
            </explanation>
            <pass>
              <Boolean>0</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_DomainConsistency>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

Appendix D: ISO Data Quality WPS Process Examples - Test examples for DQ Thematic Accuracy

This appendix includes actual examples in executing different data quality WPS processes.

D.1 Test example for DQ Classification Correctness

This section contains examples for DQ Classification Correctness.

D.1.1 Test example for DQ Classification Correctness (vector feature)

This section contains an example for DQ Classification Correctness (vector feature).

Table D.1. A Test Example for the WPS Process of Data Quality Classification Correctness

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	ThematicClassificationCorrenctness2.0.xml

Example Request

```
 <?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">

<ows:Identifier>iso19157.DQ_ThematicAccuracy.DQ_ThematicClassificationCorrectness</ows
:Identifier>
  <wps:Input id="inputTargetDataset">
      <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://172.31.6.105/geoserver/cite/ows?service=WFS&version=1.0.0&request=G
etFeature&typeName=cite:conceptual_consistency&outputFormat=gml3"/>
</wps:Input>
   <wps:Input id="inputReferenceDataset">
      <wps:Reference mimeType="image/geotiff"
xlink:href="http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF"/>
</wps:Input>
  <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>10</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="inputTargetDataField">
    <wps:Data>
    <wps:LiteralValue>LUCODE</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="numberOfSamplePoints">
    <wps:Data>
    <wps:LiteralValue>20</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
  <wps:Output id="outputData" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>f96fa9fd-cf21-4396-9c02-06e934bdccab</wps:JobID>
```

```
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_ThematicClassificationCorrectness>
        <nameOfMeasure>
          <CharacterString>Classification correctness determined by a sample
points</CharacterString>
        </nameOfMeasure>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directExternal">Direct
external</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-10T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Classification correctness determined by comparing
derived vector product with source data</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-10-01</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>Of the 20.0 features, 17.0 match and 3.0 do
not</CharacterString>
            </explanation>
            <pass>
              <Boolean>0</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_ThematicClassificationCorrectness>
    </wps:Data>
  </wps:Output>
  <wps:Output id="outputData">
```

```
    <wps:Data schema="http://schemas.opengis.net/gml/3.1.1/base/gml.xsd"
mimeType="text/xml; subtype=gml/3.1.1">
      <gml:FeatureCollection xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:gml="http://www.opengis.net/gml" xmlns:n52="http://www.52north.org/8937d58a-
c326-4355-85f3-f33ebe3f5e8a" xsi:schemaLocation="http://www.opengis.net/gml
 http://schemas.opengis.net/gml/3.1.1/base/feature.xsd
http://www.52north.org/8937d58a-c326-4355-85f3-f33ebe3f5e8a
http://localhost:8080/wps/static/schemas/8937d58a-c326-4355-85f3-f33ebe3f5e8a.xsd">
        <gml:featureMembers>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID0">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-77.24296316110465 41.219801399138</gml:lowerCorner>
                <gml:upperCorner>-77.24296316110465 41.219801399138</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-77.24296316110465 41.219801399138</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID1">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.13695618936288
41.924056035122724</gml:lowerCorner>
                <gml:upperCorner>-76.13695618936288
41.924056035122724</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.13695618936288 41.924056035122724</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
```

```
            <n52:targetAtt>21</n52:targetAtt>
            <n52:refAtt>21</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID2">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.202960554095 41.50926818000841</gml:lowerCorner>
                <gml:upperCorner>-76.202960554095 41.50926818000841</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.202960554095 41.50926818000841</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>52</n52:targetAtt>
            <n52:refAtt>52</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID3">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.1516802643486
41.490588075103666</gml:lowerCorner>
                <gml:upperCorner>-76.1516802643486
41.490588075103666</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.1516802643486 41.490588075103666</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>43</n52:targetAtt>
            <n52:refAtt>43</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID4">
```

```
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.45368220346023
41.264518306220374</gml:lowerCorner>
                <gml:upperCorner>-76.45368220346023
41.264518306220374</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.45368220346023 41.264518306220374</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>21</n52:targetAtt>
            <n52:refAtt>43</n52:refAtt>
            <n52:match>0</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID5">
            <gml:boundedBy>
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srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.8689627644149 41.73009462301711</gml:lowerCorner>
                <gml:upperCorner>-76.8689627644149 41.73009462301711</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.8689627644149 41.73009462301711</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>43</n52:targetAtt>
            <n52:refAtt>43</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID6">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-77.35492387190017
41.570863480961705</gml:lowerCorner>
```

```
                <gml:upperCorner>-77.35492387190017
41.570863480961705</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-77.35492387190017 41.570863480961705</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID7">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-77.75105351851823
41.94000615046096</gml:lowerCorner>
                <gml:upperCorner>-77.75105351851823
41.94000615046096</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-77.75105351851823 41.94000615046096</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>21</n52:targetAtt>
            <n52:refAtt>21</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID8">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.99977731107855
41.73145055238553</gml:lowerCorner>
                <gml:upperCorner>-76.99977731107855
41.73145055238553</gml:upperCorner>
              </gml:Envelope>
```

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            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
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                </gml:pointMember>
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            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID9">
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srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
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41.07592998398257</gml:lowerCorner>
                <gml:upperCorner>-77.15545054861454
41.07592998398257</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-77.15545054861454 41.07592998398257</gml:pos>
                  </gml:Point>
                </gml:pointMember>
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            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID10">
            <gml:boundedBy>
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srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
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41.59607355055363</gml:lowerCorner>
                <gml:upperCorner>-76.72709778028292
41.59607355055363</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
```

```
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
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                    <gml:pos>-76.72709778028292 41.59607355055363</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID11">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.67907116342622
41.96628204840368</gml:lowerCorner>
                <gml:upperCorner>-76.67907116342622
41.96628204840368</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.67907116342622 41.96628204840368</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID12">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-77.7730666123925
41.019639743830474</gml:lowerCorner>
                <gml:upperCorner>-77.7730666123925
41.019639743830474</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
```

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                  <gml:pos>-77.7730666123925 41.019639743830474</gml:pos>
                </gml:Point>
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            </gml:MultiPoint>
          </n52:the_geom>
          <n52:targetAtt>21</n52:targetAtt>
          <n52:refAtt>41</n52:refAtt>
          <n52:match>0</n52:match>
        </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
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          <gml:boundedBy>
            <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
              <gml:lowerCorner>-76.36545241052643 41.8349207625119</gml:lowerCorner>
              <gml:upperCorner>-76.36545241052643 41.8349207625119</gml:upperCorner>
            </gml:Envelope>
          </gml:boundedBy>
          <n52:the_geom>
            <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
              <gml:pointMember>
                <gml:Point srsDimension="2">
                  <gml:pos>-76.36545241052643 41.8349207625119</gml:pos>
                </gml:Point>
              </gml:pointMember>
            </gml:MultiPoint>
          </n52:the_geom>
          <n52:targetAtt>21</n52:targetAtt>
          <n52:refAtt>43</n52:refAtt>
          <n52:match>0</n52:match>
        </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
        <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID14">
          <gml:boundedBy>
            <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
              <gml:lowerCorner>-77.83160086124352
41.74054426383264</gml:lowerCorner>
              <gml:upperCorner>-77.83160086124352
41.74054426383264</gml:upperCorner>
            </gml:Envelope>
          </gml:boundedBy>
          <n52:the_geom>
            <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
              <gml:pointMember>
                <gml:Point srsDimension="2">
                  <gml:pos>-77.83160086124352 41.74054426383264</gml:pos>
                </gml:Point>
              </gml:pointMember>
            </gml:MultiPoint>
          </n52:the_geom>
```

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            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID15">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.37728664830125
41.774863552525275</gml:lowerCorner>
                <gml:upperCorner>-76.37728664830125
41.774863552525275</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.37728664830125 41.774863552525275</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>21</n52:targetAtt>
            <n52:refAtt>21</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID16">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.7696354471789 41.59854748848217</gml:lowerCorner>
                <gml:upperCorner>-76.7696354471789 41.59854748848217</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.7696354471789 41.59854748848217</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID17">
```

```
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-77.88647989312123
41.98260844565126</gml:lowerCorner>
                <gml:upperCorner>-77.88647989312123
41.98260844565126</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
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                    <gml:pos>-77.88647989312123 41.98260844565126</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
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            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:lowerCorner>-76.18527898629931
41.96654630974893</gml:lowerCorner>
                <gml:upperCorner>-76.18527898629931
41.96654630974893</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-76.18527898629931 41.96654630974893</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
          <n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a gml:id="ID19">
            <gml:boundedBy>
              <gml:Envelope srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
```

```
                <gml:lowerCorner>-77.45913903382096
41.24499453371804</gml:lowerCorner>
                <gml:upperCorner>-77.45913903382096
41.24499453371804</gml:upperCorner>
              </gml:Envelope>
            </gml:boundedBy>
            <n52:the_geom>
              <gml:MultiPoint srsDimension="2"
srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                <gml:pointMember>
                  <gml:Point srsDimension="2">
                    <gml:pos>-77.45913903382096 41.24499453371804</gml:pos>
                  </gml:Point>
                </gml:pointMember>
              </gml:MultiPoint>
            </n52:the_geom>
            <n52:targetAtt>41</n52:targetAtt>
            <n52:refAtt>41</n52:refAtt>
            <n52:match>1</n52:match>
          </n52:Feature-8937d58a-c326-4355-85f3-f33ebe3f5e8a>
        </gml:featureMembers>
      </gml:FeatureCollection>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

D.1.2 Test example for DQ Classification Correctness (raster dataset)

This section contains an example for DQ Classification Correctness (raster dataset).

Table D.2. A Test Example for the WPS Process of Data Quality Classification Correctness

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	ThematicClassificationCorrenctnessR2.0.xml

Example Request

```
 <?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">

<ows:Identifier>iso19157.DQ_ThematicAccuracy.DQ_ThematicClassificationCorrectnessR</ow
s:Identifier>
  <wps:Input id="inputReferenceDataset">
      <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://172.31.6.105/geoserver/cite/ows?service=WFS&version=1.0.0&request=G
etFeature&typeName=cite:conceptual_consistency&outputFormat=gml3"/>
</wps:Input>
   <wps:Input id="inputTargetDataset">
      <wps:Reference mimeType="image/geotiff"
xlink:href="http://meekbaa1.miniserver.com/dl/conceptual_raster.TIF"/>
</wps:Input>
  <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>10</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="inputReferenceDataField">
    <wps:Data>
    <wps:LiteralValue>LUCODE</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="numberOfSamplePoints">
    <wps:Data>
    <wps:LiteralValue>20</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>87309b97-3aa4-4fd1-9340-469699fc2344</wps:JobID>
  <wps:Output id="outputMetadataChunk">
```

```
    <wps:Data mimeType="text/xml">
      <DQ_ThematicClassificationCorrectness>
        <nameOfMeasure>
          <CharacterString>Classification correctness determined by a sample
points</CharacterString>
        </nameOfMeasure>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directExternal">Direct
external</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-10T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Classification correctness determined by comparing
raster data with a vector product</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-10-01</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>Of the 20.0 features, 15.0 match and 5.0 do
not</CharacterString>
            </explanation>
            <pass>
              <Boolean>0</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_ThematicClassificationCorrectness>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

D.2 Test examples for DQ Non-quantitative Attribute Accuracy

This section contains examples for DQ Non-Quantitative Attribute Accuracy.

Table D.3. A Test Example for the WPS Process of Data Quality Non-Quantitative Attribute Accuracy

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	ThematicAccuracy.NonQuantitativeAttributeAccuracy2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">

<ows:Identifier>iso19157.DQ_ThematicAccuracy.DQ_NonQuantitativeAttributeAccuracy</ows:
Identifier>
  <wps:Input id="inputTargetDataset">
      <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&reques
t=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3"/>
  </wps:Input>
   <wps:Input id="inputReferenceDataset">
      <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&reques
t=GetFeature&typeName=osm%3Aplacenames_medium&maxFeatures=50&outputformat=gml3"/>
  </wps:Input>
   <wps:Input id="inputTargetField">
    <wps:Data>
    <wps:LiteralValue>name</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
   <wps:Input id="inputReferenceField">
    <wps:Data>
    <wps:LiteralValue>name</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>10</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
```

```
  <wps:JobID>9a176ce7-5e75-4234-b4d8-062085486e75</wps:JobID>
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_NonQuantitativeAttributeAccuracy>
        <nameOfMeasure>
          <CharacterString>Test of accuracy of entries in a field against a reference
dataset</CharacterString>
        </nameOfMeasure>
        <measureDescription>
          <CharacterString>Check for spelling mistakes in a vector dataset against a
reference dataset</CharacterString>
        </measureDescription>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directExternal">Direct
external</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-14T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Accuracy of position test</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-10-01</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>The number of spelling mistakes in the dataset is
0</CharacterString>
            </explanation>
            <pass>
              <Boolean>1</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
```

```
      </DQ_NonQuantitativeAttributeAccuracy>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

D.3 Test examples for DQ Quantitative Attribute Accuracy

This section contains examples for DQ Quantitative Attribute Accuracy.

Table D.4. A Test Example for the WPS Process of Data Quality Quantitative Attribute Accuracy

Service Endpoint	http://54.201.124.35/wps/WebProcessingService
Test Page	http://54.201.124.35/wps/test_client
Request File	ThematicAcuracy.quantitativeAttributeAccuracy2.0.xml

Example Request

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Execute
  xmlns:wps="http://www.opengis.net/wps/2.0"
  xmlns:ows="http://www.opengis.net/ows/2.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd"
  service="WPS" version="2.0.0" response="document" mode="sync">

<ows:Identifier>iso19157.DQ_ThematicAccuracy.DQ_QuantitativeAttributeAccuracy</ows:Ide
ntifier>
  <wps:Input id="inputTargetDataset">
      <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&reques
t=GetFeature&typeName=osm%3Ane_10m_populated_places&maxFeatures=50&outputformat=gml3"/
>
    </wps:Input>
   <wps:Input id="inputReferenceDataset">
      <wps:Reference schema="http://schemas.opengis.net/gml/3.1.0/base/feature.xsd"
mimeType="text/xml; subtype=gml/3.1.0"
xlink:href="http://demo.opengeo.org/geoserver/osm/ows?service=WFS&version=1.0.0&reques
t=GetFeature&typeName=osm%3Ane_10m_populated_places&maxFeatures=50&outputformat=gml3"/
>
    </wps:Input>
   <wps:Input id="inputTargetLookupField">
    <wps:Data>
    <wps:LiteralValue>POP_MAX</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
   <wps:Input id="inputReferenceLookupField">
    <wps:Data>
```

```
    <wps:LiteralValue>POP_MAX</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
   <wps:Input id="inputTargetDataField">
    <wps:Data>
    <wps:LiteralValue>POP_MAX</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
   <wps:Input id="inputReferenceDataField">
    <wps:Data>
    <wps:LiteralValue>POP_MAX</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Input id="threshold">
    <wps:Data>
    <wps:LiteralValue>5</wps:LiteralValue>
      </wps:Data>
  </wps:Input>
  <wps:Output id="outputMetadataChunk" transmission="value"/>
</wps:Execute>
```

Example Response

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:Result xmlns:wps="http://www.opengis.net/wps/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/2.0
http://schemas.opengis.net/wps/2.0/wps.xsd">
  <wps:JobID>84d4e15a-ce04-4cfc-b2d0-49c0f78623c1</wps:JobID>
  <wps:Output id="outputMetadataChunk">
    <wps:Data mimeType="text/xml">
      <DQ_QuantitativeAttributeAccuracy>
        <nameOfMeasure>
          <CharacterString>Test of quantitative accuracy</CharacterString>
        </nameOfMeasure>
        <measureDescription>
          <CharacterString>Check the accuracy of a target record against an
authoritative source</CharacterString>
        </measureDescription>
        <evaluationMethodType>
          <DQ_EvaluationMethodTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#EvaluationMe
thodTypeCode" codeListValue="directExternal">Direct
external</DQ_EvaluationMethodTypeCode>
        </evaluationMethodType>
        <dateTime>
          <DateTime>2006-11-14T00:00:00</DateTime>
        </dateTime>
        <result>
          <DQ_ConformanceResult>
```

```
            <specification>
              <CI_Citation>
                <title>
                  <CharacterString>Accuracy of a quantitative field
test</CharacterString>
                </title>
                <date>
                  <CI_Date>
                    <date>
                      <Date>2016-10-01</Date>
                    </date>
                    <dateType>
                      <CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelist.xml#CI_DateTypeC
ode" codeListValue="creation">creation</CI_DateTypeCode>
                    </dateType>
                  </CI_Date>
                </date>
              </CI_Citation>
            </specification>
            <explanation>
              <CharacterString>The number of incorrect entries is 0.0. This represents
0.0% of the dataset</CharacterString>
            </explanation>
            <pass>
              <Boolean>1</Boolean>
            </pass>
          </DQ_ConformanceResult>
        </result>
      </DQ_QuantitativeAttributeAccuracy>
    </wps:Data>
  </wps:Output>
</wps:Result>
```

Appendix E: Revision History

Table E.1. Revision History

Date	Release	Editor	Primary clauses modified	Descriptions
March 3, 2016	.1	Eugene Yu	all	initial abstract
April 12, 2016	.2	Eugene Yu	all	Initial Draft
June 29, 2016	.3	Eugene Yu	all	First Complete Draft
August 17, 2016	.4	Eugene Yu	all	Reference format, Requirements, Solutions
September 30, 2016	.5	Eugene Yu	all	Complete draft with all the content for solution, implementation, example request/response, and test cases.
October 24, 2016	.6	Eugene Yu	all	Revised the ER according to the comments from Scott Serich. Added details to use cases in Chapter 8.
October 28, 2016	.7	Eugene Yu	preface, clause-solutions, Appendices A through D	Revised the ER according to the feedback from Dr. Sam Meek. High-res figures are embedded. Examples reflected the revised reference implementation by Helyx. Comments from Md. Shahinoor Rahman are also incorporated.

Date	Release	Editor	Primary clauses modified	Descriptions
October 31, 2016	.8	Eugene Yu	all	Formatting for PDF generation
November 10, 2016	.9	Eugene Yu	all	Revisions in responding to the comments from Mr. Dave Wesloh (NGA). Re-formatting for PDF generation that is fit for AsciiDoctor (moving out all embedded figures and source list from tables).

Appendix F: Bibliography

[1] OGC,: OGC Testbed 11 Demonstration. (2015).

[2] Higgins, C., Williams, J., Leibovici, D., Simonis, I., Davis, M., Muldoon, C., van Genuchten, P., O'Grady, M.: Citizen observatory web (cobweb): A generic infrastructure platform to facilitate the collection of citizen science data for environmental monitoring. In: Proceedings of the Workshop on Environmental Infrastructures and Platforms (2015).

[3] Meek, S., Jackson, M., Leibovici, D.G.: A BPMN solution for chaining OGC services to quality assure location-based crowdsourced data. Comput. Geosci. 87, 76–83 (2016).

[4] Wiemann, S., Bernard, L.: Spatial data fusion in Spatial Data Infrastructures using Linked Data. Int. J. Geogr. Inf. Sci. 30, 613–636 (2016).