



S-map WFS for Overseer
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S-map WFS for Overseer

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1 Introduction

The Interoperable S-map for OVERSEER Envirolink Tools Project has deployed a web data service based upon an International Standards Organisation/Open Geospatial Consortium (OGC) Web Feature Service (WFS) specification to provide spatially located S-map soil siblings and their properties to the OVERSEER nutrient budgeting tool. The WFS uses ANZSoilML, a trans-Tasman data standard for the exchange of soil descriptions and observations, as the definition of the structure of XML data returned by this service. This document summarises the WFS and ANZSoilML standards. It includes examples of the service requests anticipated to be needed by OVERSEER and explains where relevant data can be found in the responses.

2 Web Feature Service Overview

2.1 Brief description

The ISO/OGC Web Feature Service specification (Vretanos 2009) defines the expected behaviour (necessary set of operations and data formats) of a spatially enabled web service. The purpose of the standardisation effort is to allow similar data to be accessed in a consistent way from multiple sources. In GIS terms, a WFS provides structured vector data defined as Feature Types. (These are not to be confused with the ESRI Feature Class – while a Feature Type may be the same as a Feature Class, they can be very different, not least because they are not required to have a geometry property.) In simple terms a Feature Type may be thought of as a database table and a Feature (the basic unit of data returned by a WFS) is a record in that table. The reality is more complex as a Feature can be a structured object with other Features nested within and may have many multi-valued properties. The default (and mandatory) format for a Feature returned by a WFS is GML (the Geography Mark-up Language).

An instance of a WFS is intended as a facade over a data provider's internal systems, allowing data to be delivered by multiple organisations in the same way (from the perspective of the clients of a WFS) without allowing access to the underlying system or exposing the workings of this system. When used in conjunction with community standards that specialise the GML for the structure of the data delivered, a WFS is a useful means of providing data in a consistent, disciplined way without forcing providers to change their operational systems. It is therefore well suited to use by third parties that need to work independently of a data provider, and may need the same type of data from other providers, something they could do with minimal disruption if the other providers adopt the same standards.

2.2 Interacting with the WFS

The WFS specification defines an extensive set of operations and readers are referred to the implementation specification for the complete documentation (Vretanos 2009). This document will focus on the key requests that can be made to the S-map instance of the WFS, and the internet protocols used to make them. It is important to note that the WFS

specification has gone through several revisions and, while broadly consistent, each major revision does have some profound differences to its predecessor.

Broadly speaking, the user sends requests to the service using HTTP (Fielding et al. 1999), by way of an appropriately structured URL or XML document. The S-map for OVERSEER WFS uses a strict interpretation of version 2.0.0 of the WFS implementation specification. This strict interpretation extends to strict conformance to XML rules for structure and content – poorly formed or incomplete XML requests sent to the WFS will be rejected by the service.

A demonstration portal that provides working examples of useful requests, and guidance on how to create them, will be published at the same location as the S-map for OVERSEER WFS.

Binding to the WFS using HTTP

A WFS is published to an HTTP accessible location, or end-point, to which a user's agent (a browser or other application) 'binds', for example: `http://example.data.nz/service/smap-overseer/wfs`. All interaction with this service end-point uses one of two HTTP methods:

- **HTTP GET:** requests are sent using a URL comprising the service endpoint with additional WFS-specific parameters appended in a query string. The query string starts with a '?' and consists of a set of key value pairs (KVP) separated by an '&', for example:

```
http://example.data.nz/service/smap-overseer/wfs?service=WFS&acceptversions=2.0.0&request=GetCapabilities
```

- **HTTP POST,** where requests are sent as a block of data to the service. In this case as XML:

Service end-point URL:

```
http://example.data.nz/service/smap-overseer/wfs
```

XML encoded request:

```
<GetCapabilities service="WFS" version="2.0.0"
xmlns="http://www.opengis.net/wfs/2.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wfs/2.0
http://schemas.opengis.net/wfs/2.0.0/wfs.xsd"/>
```

The user may choose between Plain Old XML (POX) or the Simple Object Access Protocol (SOAP) for POST requests. Examples in this document will assume the use of POX.

There is no requirement for one method of binding to be used over another, although POX encoded HTTP POST requests are much easier to work with when complex filters are required.

Basic WFS Requests

The two most common requests made to the service are *GetCapabilities* and *GetFeature*. See section 4.2 'WFS Requests' for examples of the latter.

GetCapabilities provides basic metadata about the nature and functionality of the WFS. This includes a basic description of the service, contact details for the provider, the Feature Types that are provided and the supported filter operations. *GetCapabilities* responses are provided as GML.

The *GetFeature* operation is used to get data from the WFS. This is almost always done in conjunction with some sort of filter (unconstrained requests are discouraged, and sometimes rejected, due to the computational load they place on the provider's servers and databases). *GetFeature* responses are provided as GML, although other formats are permissible (at the time of writing, experimental S-map WFSs are providing JSON encoded responses but there is no accepted standard for JSON responses from a WFS). These Features are instances of Feature Types, and the structure of these is defined by the ANZSoilML exchange language.

3 ANZSoilML

The Australian and New Zealand Soil Mark-up Language (CSIRO & LCR 2013) is a community-defined GML Application Schema (in that it specialises the core set of GML types to apply them to a particular set of data) for the exchange of detailed soil descriptions and observations. It has a particular focus on encoding data from the morphological descriptions of soil profiles and subsequent data generated as a result of lab analyses.

It was originally called OzSoilML having been developed by CSIRO Land and Water to support the exchange of soil data between soil databases maintained by Australian state and federal government agencies. It was adopted by Landcare Research in New Zealand and ultimately became ANZSoilML once changes necessary to support New Zealand soil information systems (primarily S-map and OVERSEER and the new NZ National Soils Data Repository) were made. The S-map for OVERSEER WFS uses version 2.0.1 of ANZSoilML.

ANZSoilML imports the XML implementation of the ISO/OGC Observations and Measurements (O&M) specification for the exchange of sampling and observation data (Cox 2011a,b). This has proved to be beneficial, as a number of the soil properties defined by S-map do not have equivalents in ANZSoilML. ANZSoilML can provide features for S-map polygons and soil siblings and the O&M observation class can be used to attach the property values required by OVERSEER. Three Feature Types from ANZSoilML and O&M are served by this WFS (Figure 1, Table 1). How to parse the Feature GML for content is discussed in section 4.3 'WFS Responses'.

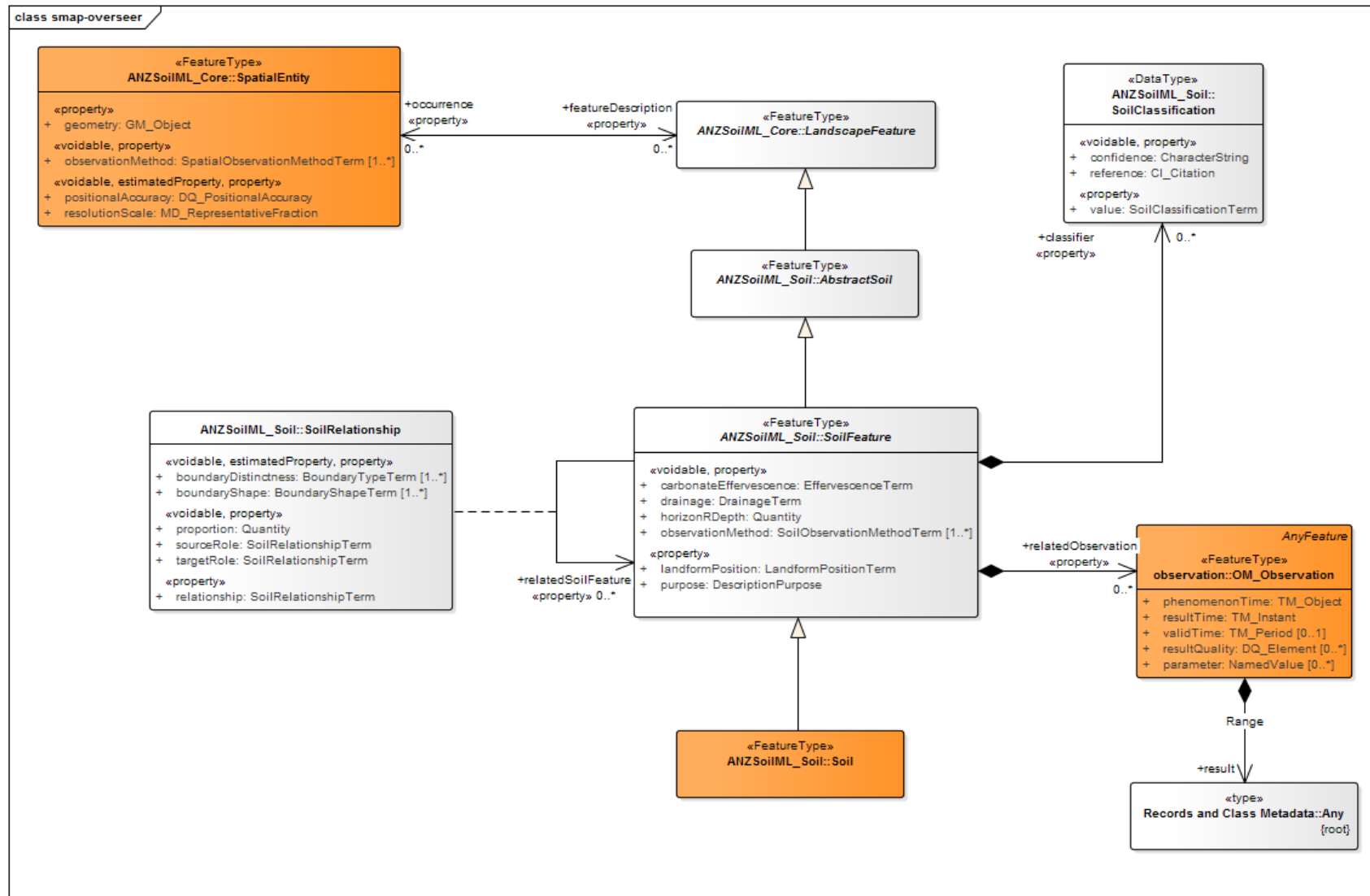


Figure 1 UML representation of ANZSoiML and O&M Feature Types served by the S-Map for OVERSEER WFS. See Table 1 for a brief description of the key Feature Types (highlighted in orange).

Table 1 ANZSoilML and O&M Feature Types served by the S-Map for OVERSEER WFS. The FeatureType names are presented as qualified XML element names with the form namespace-prefix:ElementName. Namespace declarations and feature definitions can be found in the GML schema. The prefixes map on to the UML packages shown in Figure 1: anzsmml is ANZSoilML_Core; anzsmmls is ANZSoilML_Soil; om is observation.

Source	FeatureType	Description	Schema Location
ANZSoilML	anzsmml:SpatialEntity	Each anzsmml:SpatialEntity holds a single S-map polygon. It contains a nested anzsmmls:Soil Feature that holds the soil siblings mapped by the polygon (see below).	http://anzsoil.org/def/sc_hema/soilcore/2.0.1/anzsoilml-core.xsd
ANZSoilML	anzsmmls:Soil	Two types of anzsmmls:Soil are provided: A soil 'map unit' that is attached to the S-map polygons and contains the member soil siblings (anzsmmls:Soil type 2). The soil sibling descriptions, including the sibling name, soil order and a set of om:OM_Observation features that hold the values of the properties needed by OVERSEER.	http://anzsoil.org/def/sc_hema/soil/2.0.1/anzsoilml-soil.xsd
O&M	om:OM_Observation	The om:OM_Observation Feature is a container for property values and their metadata. At its simplest it is a property value pair, but it also has placeholders for data describing the method used to generate the value and the quality or uncertainty of the value. Property values may be a measure or a labelled reference to a formally defined category.	http://schemas.opengis.net/om/2.0/observation.xsd

4 Getting data from the WFS

4.1 Note on Coordinate Reference Systems

The S-map for OVERSEER WFS uses the NZTM 2000 (EPSG:2913) coordinate reference system for its spatial data. The formal definition of this system requires that the coordinates are presented in northing, easting (or y, x) axis order. The WFS honours this requirement so users must be careful to frame spatial requests, and interpret the responses, using this axis order. For more information see the Land Information New Zealand discussion of the issue (LINZ 2015).

4.2 WFS Requests

The *GetFeature* request is used to get data from the WFS. While it is possible to make an unconstrained request for all data to the service, such requests are strongly discouraged – they place a significant load on the WFS server and database, and can crash certain clients (several hundred megabytes of XML will be streamed to the client). Filtered requests are encouraged and the WFS supports a variety of query operations on all of the properties returned for a given Feature Type. Table 2 documents the two query use cases defined for OVERSEER:

1. Query by soil sibling name
2. Query by location

Table 2 Example WFS *GetFeature* requests with sibling name and spatial filters. Requests may be sent as XML (via HTTP POST) or as URLs (HTTP GET). XML requests must be well formed and valid according to the relevant WFS and GML schema – the WFS will validate requests it receives and will throw an exception for poorly formed requests.

Query	HTTP Method	Operator	Example
Soil Sibling Name	POST	equal to	<pre><?xml version="1.0" encoding="UTF-8"?> <wfs:GetFeature service="WFS" version="2.0.0" outputFormat="application/gml+xml; version=3.2" xmlns:anzsmls="http://anzsoil.org/ns/soil/2.0.1" xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:wfs="http://www.opengis.net/wfs/2.0" xmlns:fes="http://www.opengis.net/fes/2.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd http://www.opengis.net/gml/3.2 http://schemas.opengis.net/gml/3.2.1/temporal.xsd"> <wfs:Query typeName="anzsmls:Soil"> <fes:Filter> <fes:PropertyIsEqualTo> <fes:ValueReference>gml:name</fes:ValueReference> <fes:Literal>Airf_3a.1</fes:Literal> </fes:PropertyIsEqualTo> </fes:Filter> </wfs:Query> </wfs:GetFeature></pre> <p>This is a wfs:GetFeature request for the Feature Type (typeName attribute) anzsmls:Soil.</p> <p>The fes:ValueReference is the name of the property being filtered (soil sibling names are provided in the gml:name property) and the fes:Literal is the query value – this is the only part that needs to be changed between requests.</p>
Location	GET	bounding box	<pre>http://example.data.nz/service/smap-overseer/wfs?service=wfs&version=2.0.0 &request=GetFeature&typename=anzsml:SpatialEntity &BBOX=5036885,1413480,5036890,1413485</pre> <p>Sent as a single URL. This is a GetFeature request for the Feature Type (typename parameter) anzsml:SpatialEntity.</p> <p>BBOX filter is composed of coordinate pairs ymin,xmin,ymax,xmax. Expressed as NZTM (EPSG:2193) coordinates (note the coordinate axis order).</p>

POST

intersects

```
<?xml version="1.0" encoding="UTF-8"?>
<wfs:GetFeature service="WFS" version="2.0.0" outputFormat="application/gml+xml; version=3.2"
  xmlns:anzsml="http://anzsoil.org/ns/soilcore/2.0.1"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:wfs="http://www.opengis.net/wfs/2.0"
  xmlns:fes="http://www.opengis.net/fes/2.0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wfs/2.0
http://schemas.opengis.net/wfs/2.0/wfs.xsd
http://www.opengis.net/gml/3.2
http://schemas.opengis.net/gml/3.2.1/temporal.xsd">
  <wfs:Query typeName="anzsml:SpatialEntity">
    <fes:Filter>
      <fes:Intersects>
        <fes:ValueReference>anzsml:geometry</fes:ValueReference>
        <gml:Polygon srsName="urn:ogc:def:crs:EPSG::2193" gml:id="gml.polygon.id">
          <gml:exterior>
            <gml:LinearRing>
              <gml:posList srsDimension="2" count="5">5486560.0558684 1576284.5266962
5486690.5835757 1576284.52669625486690.5835757 1576429.165507 5486560.0558684 1576429.165507
5486560.0558684 1576284.5266962</gml:posList>
            </gml:LinearRing>
          </gml:exterior>
        </gml:Polygon>
      </fes:Intersects>
    </fes:Filter>
  </wfs:Query>
</wfs:GetFeature>
```

This is a wfs:GetFeature request for the Feature Type (typeName attribute) anzsml:SpatialEntity.

The fes:ValueReference is the name of the property being filtered and the fes:Polygon is the query geometry - this is the only part that needs to be changed between requests. The geometry may be any valid GML geometry (eg a gml:Point, or a complex, irregular gml:Polygon matching a paddock boundary).

4.3 WFS Responses

The WFS responds to *GetFeature* requests (Table 2) with Feature data encoded as GML according to the relevant application schema (ANZSoilML or O&M). Three Feature Types are used (Table 1) by the WFS for all the data. This section describes each Feature Type, explaining where relevant data are found and how they interrelate. Line numbers given relate to the numbers on the left hand side of the relevant figure showing the example XML. For clarity, only the minimum amount of XML is shown in each example – where more data are available a yellow circle with a '+' symbol indicates the element can be expanded.

S-map/OVERSEER Datasets

All data returned by the WFS are given membership of a dataset. There are two types:

A root level dataset based on the date the S-map update was run to generate the data being served. This dataset is identified with an HTTP URI that includes the date the update was run, for example: <http://example.data.nz/dataset/soil/smap/smap-overseer-2015-04-20>.

Sub datasets that define the level of attribution. An instance of an `anzsmls:Soil` Feature Type describing a sibling that has been attributed to S-map/OVERSEER level one will belong to a level one dataset or a level two dataset if attributed to that level. These sub datasets are identified by appending the level to the master dataset HTTP URI, for example: <http://example.data.nz/dataset/soil/smap/smap-overseer-2015-04-20/2>.

Datasets are referred to by `gml:metaDataProperty` elements on all `anzsmls:Soil` Features.

wfs:FeatureCollection

By default every WFS *GetFeature* request response is contained within a `wfs:FeatureCollection` element (Figure 2). The individual Features that meet the request's filter criteria are returned as `wfs:member` elements, for example an `anzsml:SpatialEntity` (Figure 2, lines 9 and 10). Key content includes:

- XML namespace prefix declarations (Figure 2, lines 2 to 5);
- the locations of the XML schema documents that define the response Feature Types presented as namespace, schema location pairs (Figure 2, lines 6 and 7); and
- the request timestamp (Figure 2, line 8).

```

1  <?xml version="1.0" encoding="UTF-8"?>
2  <wfs:FeatureCollection xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xs="http://www.w3.org/2001/XMLSchema"
3    xmlns:wfs="http://www.opengis.net/wfs/2.0" xmlns:xlink="http://www.w3.org/1999/xlink"
4    xmlns:anzsmls="http://anzsoil.org/ns/soil/2.0.1" xmlns:gml="http://www.opengis.net/gml/3.2"
5    xmlns:om="http://www.opengis.net/om/2.0" xmlns:anzsml="http://anzsoil.org/ns/soilcore/2.0.1"
6    xsi:schemaLocation="http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd
7    http://anzsoil.org/ns/soil/2.0.1 http://anzsoil.org/def/schema/soil/2.0.1/anzsoilm1-soil.xsd"
8    timeStamp="2015-07-29T15:30:11" numberMatched="unknown" numberReturned="0">
9    <wfs:member>
10     <anzsml:SpatialEntity gml:id="anzsml.spatialentity.smap-overseer-2015-03-16.1914038">
624    </wfs:member>
625    <wfs:member>
640    <wfs:member>
647    <wfs:member>
660  </wfs:FeatureCollection>

```

Figure 2 wfs:FeatureCollection example.

anzsml:SpatialEntity

The `anzsml:SpatialEntity` (Figure 3) is the core Feature Type returned by the WFS. Each instance contains a single S-map polygon in the `anzsml:geometry` element (Figure 3, lines 4 to 12). The `gml:Polygon` is made up of a set of `gml:LinearRings` – one exterior ring (`gml:exterior`) and an optional set of interior rings for each hole within a polygon (`gml:interior`).

Each `anzsml:SpatialEntity` contains a full description of the soil siblings mapped by the polygon inside the `anzsml:featureDescription/anzsmls:Soil` element (Figure 3, lines 13 to 614). Each `anzsmls:Soil` and `om:OM_Observation` Feature providing the sibling description and OVERSEER property values is nested inside this 'map unit' Feature (see 'anzsmls:Soil - map unit' below).

```

1  <?xml version="1.0" encoding="UTF-8"?>
2  <anzsml:SpatialEntity gml:id="anzsml.spatialentity.smap-overseer-2015-03-16.1914038">
3    <gml:identifier codeSpace="http://www.landcareresearch.co.nz">http://dev-data.scinfo.org.nz/soil/id/anzsml/spatialentity/smap-overseer-2015-03-16/1914038</gml:identifier>
4    <anzsml:geometry>
5      <gml:Polygon srsName="urn:ogc:def:crs:EPSG::2193" gml:id="LOCAL_ID_0">
6        <gml:exterior>
7          <gml:LinearRing>
8            <gml:posList srsDimension="2" count="50">5261703.5417 1557596.8032 <!-- clipped response --> 5261703.5417 1557596.8032</gml:posList>
9          </gml:LinearRing>
10         </gml:exterior>
11       </gml:Polygon>
12     </anzsml:geometry>
13     <anzsml:featureDescription>
14       <anzsmls:Soil gml:id="anzsmls.soil.smap-overseer-2015-03-16.mapunit.92210">
614     </anzsml:featureDescription>
615   </anzsml:SpatialEntity>

```

Figure 3 anzsml:SpatialEntity example.

anzsmls:Soil - map unit

As more than one sibling can be present within a S-map polygon, a 'map unit' `anzsmls:Soil` Feature is provided to group these siblings together (Figure 4). Each sibling is held within an `anzsmls:relatedSoilFeature/anzsmls:SoilRelationship` element (Figure 4, lines 23 to 36). In turn, the sibling is returned in a nested `anzsmls:relatedFeature/anzsmls:Soil` element (Figure 4, lines 32 to 34). The `anzsmls:SoilRelationship` includes:

- the proportion of the mapped area comprised of the sibling:
`anzsmls:proportion` (Figure 4, lines 25 to 30); and
- the sibling's rank: `anzsmls:targetRole/@xlink:title` (Figure 4, line 31).

The map unit's polygons *may* be returned as one or more `anzsml:occurrence/anzsml:SpatialEntity` elements if the map unit has been returned from a `GetFeature` request that directly specified `anzsml:Soil` as the desired Feature Type. If the `anzsmls:Soil` Feature Type is returned within an `anzsml:SpatialEntity` then the `anzsml:occurrence` values are suppressed.

```

1  <?xml version="1.0" encoding="UTF-8"?>
2  <anzsmls:Soil gml:id="anzsmls.soil.smap-overseer-2015-03-16.mapunit.92210">
3    <gml:metaDataProperty xlink:title="Overseer S-map Data - Release: 2015-04-20"
4      xlink:href="http://dev-data.scinfo.org.nz/soil/id/gmd/ds_dataset/smap-overseer-2015-04-20"
5      xlink:role="gmd:DS_DataSet"/>
6    <gml:identifier codeSpace="http://www.landcareresearch.co.nz">http://dev-data.scinfo.org.nz/soil/id/anzsmls/soil/smap-overseer-2015-03-16/mapunit/92210</gml:identifier>
7    <gml:name codeSpace="http://www.landcareresearch.co.nz">DryGW\DryGW-L-W/N/E</gml:name>
8    <anzsml:occurrence>
9      <anzsml:SpatialEntity gml:id="anzsml.spatialentity.smap-overseer-2015-03-16.1877205">
10        </anzsml:SpatialEntity>
11      </anzsml:occurrence>
12    <anzsml:purpose>typicalNorm</anzsml:purpose>
13    <anzsmls:relatedSoilFeature>
14      <anzsmls:SoilRelationship gml:id="LOCAL_ID_23497">
15        <anzsmls:proportion>
16          <swe:Quantity>
17            <swe:uom xlink:href="http://www.opengis.net/def/uom/UCUM/percent"/>
18            <swe:value>35</swe:value>
19          </swe:Quantity>
20        </anzsmls:proportion>
21        <anzsmls:targetRole xlink:href="http://dev-data.scinfo.org.nz/x/soil/def/relationship/role/smap/sibling/2" xlink:title="sibling(rank 2)"/>
22        <anzsmls:relatedSoilFeature>
23          <anzsmls:Soil gml:id="anzsmls.soil.smap-overseer-2015-03-16.sibling.15638">
24            </anzsmls:Soil>
25          </anzsmls:relatedSoilFeature>
26        </anzsmls:SoilRelationship>
27      </anzsmls:relatedSoilFeature>
28    </anzsmls:Soil>
29  </anzsmls:Soil>

```

Figure 4 `anzsmls:Soil` example - map units.

anzsmls:Soil - soil sibling

Individual soil siblings are provided as `anzsmls:Soil` Feature Types (Figure 5), either:

- directly as a response to a *GetFeature* request that filtered the Feature Type using the sibling name (see the 'Soil Sibling Name' query in Table 2); or
- inside an `anzsmls:SpatialEntity` Feature Type, typically returned as the result of a spatially constrained *GetFeature* request (see the 'Location' queries in Table 2).

OVERSEER property values are provided as

`anzsmls:relatedObservation/om:OM_Observation` elements (Figure 5, lines 15 to 30).

The level of attribution, and therefore the number of `om:OM_Observations` provided, is expressed (level one or two) through the membership of the relevant S-map for OVERSEER dataset, identified by `gml:metaDataProperty` (Figure 5, lines 3 to 5).

Other important content includes:

- the soil sibling name: `gml:name` (Figure 5, line 8);
- a text description of the sibling: `gml:description` (Figure 5, line 6); and
- the NZSC soil order: `anzsmls:classifier/anzsmls:SoilClassification` (Figure 5, lines 9 to 13).


```

1  <?xml version="1.0" encoding="UTF-8"?>
2  <anzsmls:Soil gml:id="anzsmls.soil.smap-overseer-2015-03-16.sibling.15638">
3    <gml:metaDataProperty xlink:title="Overseer S-map Level 2 Data"
4      xlink:href="http://dev-data.scinfo.org.nz/soil/id/gmd/ds_dataset/smap-overseer-2015-04-20/2"
5      xlink:role="gmd:DS_DataSet"/>
6    <gml:description>shallow, well drained, silty loam</gml:description>
7    <gml:identifier codeSpace="http://www.landcareresearch.co.nz">http://dev-data.scinfo.org.nz/soil/id/anzsmls/soil/smap-overseer-2015-03-16/sibling/15638</gml:identifier>
8    <gml:name codeSpace="http://www.landcareresearch.co.nz">Glennr_5a.2</gml:name>
9    <anzsmls:classifier>
10     <anzsmls:SoilClassification>
11       <anzsmls:value xlink:href="http://dev-data.scinfo.org.nz/x/soil/def/taxonomy/nzsc/order/P" xlink:title="P"/>
12     </anzsmls:SoilClassification>
13   </anzsmls:classifier>
14   <anzsmls:purpose>typicalNorm</anzsmls:purpose>
15   <anzsmls:relatedObservation>
16     <om:OM_Observation gml:id="om.om_observation.smap-overseer-2015-04-20.45770">
30     </anzsmls:relatedObservation>
31   </om:OM_Observation>
32 </anzsmls:Soil>

```

Figure 5 anzsmls:Soil exmaple - soil siblings.

om:OM_Observation

The om:OM_Observation Feature Type (Figure 6) holds the individual OVERSEER property values for each S-map soil sibling as a property value pair. The property is specified by the om:observedProperty element (Figure 6, line 12) and the value by the om:result element. Depending on the data type of the value, the om:result may have one of two formats:

- A gml:ReferenceType for categorical values (Figure 6, line 27). The value is held in xlink attributes: a xlink:title for the category term/label; and a xlink:href (optional) for the ID of the category in a controlled vocabulary.
- A gml:MeasureType for numerical values (Figure 7, line 4). The value includes a uom attribute for the value's unit of measure.

Note on om:result categories

At present the dictionaries holding the definitions of om:result categories are appended to the end of a WFS response as gml:Definition elements within gml:Dictionary elements. The om:result/@xlink:href value matches the gml:Definition/gml:identifier value.

This is a temporary measure until a more robust way of handling controlled vocabularies is established.

Other useful properties include:

- The time the result was generated: om:resultTime (Figure 6, lines 6 to 10).
- The soil sibling: om:featureOfInterest/anzsmls:Soil (Figure 6, line 13 to 26).

```

1  <?xml version="1.0" encoding="UTF-8"?>
2  <om:OM_Observation gml:id="om.om_observation.smap-overseer-2015-04-20.45770">
3    <gml:identifier codeSpace="http://www.landcareresearch.co.nz">http://dev-data.scinfo.org.nz/soil/id/om/om_observation/smap-overseer-2015-04-20/45770</gml:identifier>
4    <om:type xlink:href="http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_CategoryObservation"/>
5    <om:phenomenonTime xlink:href="http://www.opengis.net/def/nil/OGC/0/unknown"/>
6    <om:resultTime>
7      <gml:TimeInstant gml:id="LOCAL_ID_0">
8        <gml:timePosition>2015-04-23T10:33:19.921+12:00</gml:timePosition>
9      </gml:TimeInstant>
10   </om:resultTime>
11   <om:procedure xlink:href="http://www.opengis.net/def/nil/OGC/0/template" xsi:nil="true"/>
12   <om:observedProperty xlink:title="drainage code"/>
13   <om:featureOfInterest>
14     <anzsmls:Soil gml:id="anzsmls.soil.smap-overseer-2015-03-16.sibling.15638">
26     </om:featureOfInterest>
27   <om:result xsi:type="gml:ReferenceType" xlink:href="http://dev-data.scinfo.org.nz/x/soil/overseer/def/voc/drainagecode/6.2/w" xlink:title="well drained"/>
28 </om:OM_Observation>

```

Figure 6 om:OM_Observation example - categorical result type.

```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <om:OM_Observation gml:id="om.om_observation.smap-overseer-2015-04-20.5416">
3   <!--... clipped response ...-->
4   <om:result xsi:type="gml:MeasureType" uom="http://www.opengis.net/def/uom/UCUM/percent">20.00000000000000</om:result>
5 </om:OM_Observation>

```

Figure 7 om:OM_Observation example - measure result type. All other properties are as per Figure 6.

Repeated Features

In some cases the same Feature may be repeated in a wfs:FeatureCollection (this can be anywhere in the XML document tree). For example, if multiple polygons (anzsml:SpatialEntities) are returned for a request and two or more of them contain the same soil sibling then that sibling's anzsmls:Soil will be repeated in each anzsml:SpatialEntity. This will cause invalid XML if not handled in a specific way.

Every Feature has a gml:id attribute this is of type xs:id (e.g. <anzsmls:Soil gml:id="anzsmls.soil.smap-overseer-2015-03-16.sibling.15638">) and XML strictly forbids the repetition of elements with the same xs:id value. To prevent this happening repeated elements are only returned once in a document and subsequent instances refer back to the first example using a 'hash reference' in an xlink attributes. For example, for a repeated soil sibling, the first is returned:

```

<anzsmls:relatedSoilFeature>
  <anzsmls:Soil gml:id="anzsmls.soil.smap-overseer-2015-03-
16.sibling.15638">
    <!--... clipped response ...-->
  </anzsmls:Soil>
</anzsmls:relatedSoilFeature>

```

while subsequent instances are references (using the gml:id) to the first:

```

<anzsmls:relatedSoilFeature xlink:href="#anzsmls.soil.smap-overseer-
2015-03-16.sibling.15638"/>

```

HTTP URIs

HTTP URIs are used to provide unique identifiers for resources (e.g. Features, property types and category values). These URIs are designed to endure indefinitely, i.e. once used it will never be changed and have two roles:

1. to provide a unique identifier string; and
2. to provide a location, or list of locations, for a description of the resource.

The first role is essential while the second role is essential but sometimes not possible, often because the identified resource is experimental or unstable. In the case of the latter, a '/x/' token is included in the URI to indicate it is unstable and to be treated with caution, for example:

```
http://dev-data.scinfo.org.nz/x/soil/def/taxonomy/nzsc/order/P
```

URIs may be specific to versions of data, for example drainage codes as defined for a specific version of OVERSEER:

`http://dev-data.scinfo.org.nz/x/soil/overseer/def/voc/drainagecode/6.2/w;`

or a feature belonging to a specific dataset:

`http://dev-data.scinfo.org.nz/soil/id/om/om_observation/smap-overseer-2015-04-20/45770.`

When 'dereferencing' (going to the location implicit in) an HTTP URI the target server will respond with a redirect (using the HTTP Response Code '303 - see other') to a resource that provides a representation of the identified resource, or nothing (using the HTTP Response Code '404 - not found'). At the time of writing, the only available representations will be XML created by a redirect to an appropriately filtered S-map OVERSEER WFS request. In future, other types of redirect may be possible using HTTP Content Negotiation. For example, a user may specifically request an XML or HTML formatted representation and then be redirected to the appropriate location.

5 Access to the Web Feature Service

Access to the service is restricted. To gain access to the S-map for OVERSEER WFS contact Linda Lilburne, Landcare Research (NZ) Ltd.

6 Abbreviated Terms

Abbreviation	Term	Reference
ANZSoilML	Australia and New Zealand Soil Mark-up Language	link
GML	Geography Markup Language	link
HTTP	Hyper Text Transfer Protocol	link
ISO	International Organization for Standardization	link
JSON	Java Script Object Notation	link
O&M	ISO/OGC Observations and Measurements standard	link
OGC	Open Geospatial Consortium	link
UML	Unified Modelling Language	link
URI	Uniform Resource Identifier	link
URL	Uniform resource Location	link
WFS	Web Feature Service	link
XML	Extensible Mark-up Language	link

7 References

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