Australian Hydrological Geospatial Fabric (Geofabric)

Product Guide

Geofabric Surface Cartography
Geofabric Surface Network
Geofabric Surface Catchments
Geofabric Groundwater Cartography
Geofabric Hydrology Reporting Catchments
Geofabric Hydrology Reporting Regions

Version 2.1 – November 2012

Australian Government
Bureau of Meteorology

Water Information
DATA · INFORMATION · INSIGHT

Contact details

Geospatial Data Unit

Bureau of Meteorology
GPO Box 2334 CANBERRA ACT 2601

Email: ahgf@bom.gov.au

Contents

List of tables

List of figures

1 General information

The intent of this document is to inform the user about the components of the Geofabric V2.1 Products, their foundation data inputs and how they are transformed to create derived data products.

1.1 Bureau of Meteorology – role in water information

The Bureau of Meteorology (the Bureau) is responsible for compiling and delivering comprehensive water information across the water sector. As part of the Water for the Future initiative (see www.environment.gov.au/water/australia/index.html), the Bureau was allocated $450 million by the Australian Government to administer the Improving Water Information Program. This program accurately monitors, assesses and forecasts the availability, condition and use of Australia's water resources. To achieve this, the Bureau is working with water managers, project partners and stakeholders across Australia to deliver high quality, national water information to government, industry and the community.

The Bureau is building the Australian Water Resources Information System (AWRIS) to provide high quality water information essential to managing Australia's valuable water resources.

AWRIS will be spatially enabled using the Geofabric, which is a spatial framework for discovering, querying, reporting and modelling water information.

The Geofabric is a specialised set of spatial features within a Geographic Information System (GIS) platform that registers the spatial relationships between important hydrologic features such as rivers, lakes, water storages, aquifers and catchments.

The spatial dimensions of these surface hydrological features and how they are related show how water is stored, transported and used through the landscape.

The vision for the Geofabric is based on similar implementations, such as the National Hydrography Dataset plus (NHDPlus) in the United States (US) which is an integrated suite of application-ready hydrological geospatial data (Horizon Systems 2008). The intention is to use the experience gained in the US and elsewhere, as a benchmark for acquiring related knowledge and therefore improving the Geofabric in Australia.

1.1.1 The *Water Act 2007*

The *Water Act 2007* came into effect on 3 March 2008 and gave the Bureau specific powers and obligations regarding water information in addition to its weather and climate functions under the *Meteorology Act 1955*.

The Bureau's statutory functions related to water information include:

- issuing national water information standards
- collecting and publishing water information
- conducting regular national water resources assessments
- publishing an annual National Water Account
- providing regular water availability forecasts
- advising on matters relating to water information
- enhancing understanding of Australia's water resources.

1.2 Project partners

The Geofabric is an ongoing project which is the result of considerable effort and consultation by several agencies, both within Australia and internationally. The project is being led by the Bureau in partnership with Geoscience Australia (GA), the Australian National University Fenner School of Environment and Society (ANU) and CSIRO Water for a Healthy Country Flagship (CSIRO).

The partnership provides a collaborative mechanism for obtaining foundation hydrological data, maintaining and upgrading the data and improving the product suite over time. These activities are guided by industry best practice, then tested and made operational through research and development. The Bureau wishes to acknowledge the contributions of agencies in the continuing effort to develop and improve the Geofabric.

1.3 Licensing and conditions of use

1.4 Feedback

The Bureau welcomes feedback on any aspect of this product or its services. Please direct your comments or queries regarding this document or the associated data via:

- website feedback form
- online survey
- email: ahgf@bom.gov.au

1.5 Release versioning

Versioning will follow a **Version X.Y.Z** protocol where X represents a major version release, Y represents a minor version release and Z represents a sub-minor version.

Major version – involves the addition or deletion of new feature classes, changes to data scale or resolution, or updates of a significant nature that require a change to the schema. This excludes maintenance of existing data.

Minor version – involves a minor change to the database that requires a change to the schema, but is minor in nature e.g. an attribute field name correction.

Sub-minor version – involves amendments to existing data (e.g. attribute correction) or the addition of single data entities within existing feature classes and other minor changes. The sub-minor version does not involve a change to the database schema.

1.6 Delivery phases

The Geofabric is a ten-year project that will evolve in phases:

- The Geofabric V1.0 release was part of Geofabric Phase 1 and was released on 15 October 2010.
- The Geofabric V2.0 release was part of Geofabric Phase 2 and was released on 15 November 2011.
- The Geofabric V2.0.1 release was part of Geofabric Phase 2 and was released in December 2011.
- This Geofabric V2.1 release is part of Geofabric Phase 2 and was released in September 2012
- Subsequent versions, with enhanced data and functionality, will follow in Phase 3.

2 Geofabric V2.1 release notes

2.1 Introduction

2.1.1 General information

This section provides release notes for the use and adoption of the Geofabric V2.1 by describing the upgrades and changes that have been made.

2.1.2 Geofabric V2.1 upgrade

Table 1 explains the upgrades that have been implemented in Geofabric V2.1. An explanation of each upgrade is detailed in Section 2.2:

Table 1 - Geofabric V2.1 upgrades

Product	Upgrade
Hydrology Reporting Catchments (HR_Catchments)	A simplification of the AHGFNode and AHGFLink features that give a dendritic representation of the node-link stream network topology.
Hydrology Reporting Regions (HR_Regions)	Updates to some River Region names and a graphical representation of the Topographic Drainage Divisions and River Regions.
Surface Network (SH_Network)	The addition of 479 ghost nodes linking stream gauge monitoring points to the AHGFNetworkStream surface network topology.
Surface Cartography (SH_Cartography) Surface Network (SH_Network)	An update of the AHGFWaterbody feature class to include references to a number of new Water Storages as listed at http://water.bom.gov.au/waterstorage/awris/
All products	Updates to the layer files.
All products	Updates to existing tutorials and addition of new tutorials.

2.2 Upgrades

2.2.1 Hydrology Reporting Catchments: simplification of the node-link network

The Hydrology Reporting Catchment product includes three feature classes, namely:

- **AHGFNode**: contains contracted nodes that are points of hydrological significance that carry identity. They include the confluence of major named streams, coastal stream termini, waterbody inflow and outflows and inland sinks. It also contains a new class of node called diffuse nodes that represent diffused flow from groups of nodes at coastal, delta or inter-catchment outlets.
- **AHGFLink**: the topological connectors between a subset of contracted nodes that participate in the simplified node-link network.
- **AHGFContractedCatchment**: catchment polygons generated for the subset of contracted nodes that participate in the simplified node-link network. These catchments form the basis of a catchment hierarchy that can be aggregated, based on upstream relationships, to build stable reporting regions.

This product comprises two related views of hydrological features used for analysis and reporting purposes. Firstly, a topological network view of the hydrology represented as a node-link network using a subset of contracted nodes (AHGFNode) and the links (AHGFLink) between them; and secondly, a catchments view of the hydrology using the contracted catchments (AHGFContractedCatchment).

In V2.1, the contracted catchments are based on a subset of the contracted nodes that participate in a simplified node-link network. The full node-link network that was published in V2.0 and V2.01 has been pruned to create a dendritic node-link view of the network by removing bifurcations and ensuring that water flows are uni-directional.

The resulting contracted catchments form a stable, logical, dendritic hierarchy that can be reliably reproduced when moving to a higher resolution or larger scale data. They also provide a stable set of catchments that, among other things, can be aggregated to a number of types of water reporting areas depending on the use case. This contracted catchment hierarchy has been used to create two candidate sets of stable reporting regions given in Hydrology Reporting Regions, namely the Topographic Drainage Divisions and River Regions as discussed in section 2.2.2.

Both this product and the Surface Network product, contain new attribution which identifies diffused contracted nodes, where the flow from groups of nodes (DiffusGrp) at coastal, delta or inter-catchment outlets (DiffusType) are represented by a single strategic contracted node (DiffusKey).

2.2.2 Hydrology Reporting Regions: Topographic Drainage Divisions and River Regions

Hydrology Reporting Regions includes two features classes, namely:

- **AWRADrainageDivision**: stable reporting regions at the Drainage Division level.
- **RiverRegion**: stable reporting regions at the River Region level.

Hydrology Reporting Regions is based on aggregations of the contracted catchment hierarchy, discussed in section 2.2.1. The primary use case for the contracted catchment hierarchy is to build stable reporting regions based on user requirements and is the basis for the Topographic Drainage Divisions and River Regions.

The user requirements for the Topographic Drainage Divisions and River Regions were provided by the Water Resources Assessment Section in the Bureau. A set of stable, topographically based reporting areas is required for the Australian Water Resources Assessment. A further requirement was that the reporting areas be based on current research, data and technology with reference to previous work of the Australia Water Resources Management Committee as shown in Australia's River Basins 1997 (ANZCW0703005427).

The Australian Water Resources Assessment 2010 report adopted the use of the Drainage Divisions (http://www.bom.gov.au/water/awra/2010/index.shtml) and may consider the use of the River Regions in future releases. As the River Regions reporting level is not being used in the current Australian Water Resources Assessment report, the AWRA prefix has been removed from references to River Region.

While the initial requirement for the development of the Topographic Drainage Divisions and River Regions was provided by the Bureau to meet its obligations under the *Water Act 2007*, these reporting regions are proposed for general adoption wherever stable, topographic based water reporting regions are required. To facilitate the adoption of the Topographic Drainage Divisions and River Regions they can be viewed in a graphical format, providing an easy reference for users

During consultation for developing the Topographic Drainage Divisions and River Regions, some minor amendments were made to the River Region names as shown in Table 2. The Edward River Region boundary was amended and renamed to Billabong-Yanco creeks.

Table 2 - Geofabric River Region changes from V2.0 to V2.1

V2.0 River Region name	V2.1 River Region name
Avon	Avon River–Tyrell Lake
Paroo–Kulkyne	Paroo River
Wimmera	Wimmera River
Lachlan	Lachlan River
Darling	Darling River
Goulburn	Goulburn River
Upper Murray	Upper Murray River
Lower Murray	Lower Murray River
Barwon-Condamine–Culgoa Rivers	Condamine–Culgoa rivers
Mallee East	Upper Mallee
Mallee West	Lower Mallee
Edward River	Billabong–Yanco creeks

2.2.3 Surface Network: Beta Stream Flow Monitoring Points

Surface Network includes four feature classes, namely:

- **AHGFWaterbody**: a body of fresh water with potential significance for water balance and water reporting purposes.
- **AHGFNetworkStream**: line segments describing where water would flow according to a hydrological enforced 9 second digital elevation model.
- **AHGFNetworkNode**: points located at the end of a network stream segment or at a strategic point along the network.
- **AHGFCatchment**: surface area that drains to a single stream segment.

A selected set of 479 hydrological monitoring points, that have been defined by the Bureau as important reference stations for hydrological prediction and Australian Water Resources Assessment modelling purposes, have been included in the Geofabric.

A semi-automated process has been used to associate the location (spatial co-ordinates) of these reference stations to the AHGFNetworkStream feature that is being measured. This process uses a combination of stream name matching, closest distance and manual verification and results in the creation of an AHGFNetworkNode feature with a subtype classification of NetworkGhostNode.

The representation of each reference station (as a NetworkGhostNode) on a AHGFNetworkStream segment has been verified internally using remote sensing images, topographic data and a review of available jurisdiction monitoring point details. The representations have been checked by Bureau hydrologists.

Creating these NetworkGhostNodes within the AHGFNetworkStream topology allows the creation of monitoring point catchments and reaches for hydrological modelling purposes.

A separate table called BetaSurfaceNetworkMonitoringPoints contains detailed attribution of the monitoring points. This table can be joined to the Surface Network product using

the HydroID. For further details, refer to the tutorial 'Use the Beta Monitoring Point table to extend node attribution'.

2.2.4 Surface Cartography and Surface Network: Water Storages update

Both Surface Cartography and Surface Network share the water body feature class as follows:

- **AHGFWaterbody**: a body of fresh water with potential significance for water balance and water reporting purposes.

A subset of the water bodies within the AHGFWaterBody Feature Class are associated with the Bureau's Water Storage Product (http://water.bom.gov.au/waterstorage/awris/) and are attributed by SLAKE_Name, SLAKE_Syst and SLAKE_URN. For further information on how to link the Water Storage features in the Geofabric to the Bureau's Water Storage Website, refer to the tutorial Access Water Storage information.

Since the Geofabric V2.0 release in November 2011 a number of new storages have been added to the Water Storages website, 22 of which have been attributed in this Geofabric release as listed in

Table 3:

Table 3 - New Bureau Water Storage attribution

SLAKE_Name	SLAKE_URN	STATE
Bostock Reservoir	urn:bom.gov.au:awris:common:codelist:feature:bostock	VIC
Cooby Creek	urn:bom.gov.au:awris:common:codelist:feature:cooby	QLD
Cressbrook Creek	urn:bom.gov.au:awris:common:codelist:feature:cressbrook	QLD
Harding	urn:bom.gov.au:awris:common:codelist:feature:lakepoongkaliyarra	WA
Kelly's Offstream Storage	urn:bom.gov.au:awris:common:codelist:feature:kellys	QLD
Korweinguboora Reservoir	urn:bom.gov.au:awris:common:codelist:feature:korweinguboora	VIC
Lake Awoonga	urn:bom.gov.au:awris:common:codelist:feature:lakeawoonga	QLD
Lake Kerferd	urn:bom.gov.au:awris:common:codelist:feature:lakekerford	VIC
Lake Morris	urn:bom.gov.au:awris:common:codelist:feature:lakemorris	QLD
Loombah Reservoir	urn:bom.gov.au:awris:common:codelist:feature:loombah	VIC
Mangrove Creek	urn:bom.gov.au:awris:common:codelist:feature:mangrovecreekdam	NSW
Mardi	urn:bom.gov.au:awris:common:codelist:feature:mardidam	NSW
McCall Say Reservoir	urn:bom.gov.au:awris:common:codelist:feature:mccallsay	VIC
Mooney Mooney	urn:bom.gov.au:awris:common:codelist:feature:mooneymooneydam	NSW
Mount Morgan No. 7	urn:bom.gov.au:awris:common:codelist:feature:mountmorgan7	QLD
Perseverance	urn:bom.gov.au:awris:common:codelist:feature:perseverance	QLD
Upper Stony Creek No. 1	urn:bom.gov.au:awris:common:codelist:feature:upperstonycreek1	VIC
Upper Stony Creek No. 2	urn:bom.gov.au:awris:common:codelist:feature:upperstonycreek2	VIC
Upper Stony Creek No. 3	urn:bom.gov.au:awris:common:codelist:feature:upperstonycreek3	VIC
West Barwon Reservoir	urn:bom.gov.au:awris:common:codelist:feature:westbarwon	VIC
West Gellibrand Reservoir	urn:bom.gov.au:awris:common:codelist:feature:westgellibrand	VIC
Wurdee Boluc Reservoir	urn:bom.gov.au:awris:common:codelist:feature:wurdeeboluc	VIC

2.2.5 All products: layer (LYR) files update

Layers are the mechanism used to display geographic datasets in ArcMap. Each layer references a dataset and specifies how that dataset is portrayed using symbols and text labels. When a layer is added to a map, its dataset is specified and its map symbols and labelling properties set.

All layer files associated with the V2.1 release have been updated to enhance user experience. Some of the more notable updates include:

Surface Cartography

Two LYR files, one to show the data structure (polygons, boundaries, nodes) and another without these structures for use when creating maps.

Groundwater Cartography

Symbology based on geological mapping standards used for the IAF_ID attribute for the following Feature Classes:

- AHGFSurficialHydrogeologicUnit
- AHGFWaterTableAquifer
- AHGFAquiferBoundary
- AHGFAquiferContour
- AHGFAquiferOutcrop

Symbology used for IAF_ID attribute has used the ArcGIS Style Geology 24K. If you experience any problems please turn this Style on.

The geological and aquifer mapping units used in the IAF_ID attribute can be displayed in their correct depth sequence by turning the Symbol Levels on.

The symbology used for the remaining Feature Classes is based on general conventions.

Hydrology Reporting Catchments

Symbology shows the relationship between AHGFNodes and AHGFContractedCatchments.

2.2.6 All products: updated existing tutorials and new tutorials

Geofabric tutorials are available to support the use of the Geofabric products. The four existing tutorials have been updated with new titles to make it easier for users to determine their content. Two new tutorials have been added. Included in the tutorials are differences between using ArcGIS V9.3 and ArcGIS V10. The list of tutorials is given below:

Current tutorials

- Calculate an upstream drainage area with ArcHydro
- Create a subset of Geofabric data
- Use the Pfafstetter table to extend catchment attribution
- Merge the Geofabric Surface Hydrology products

New tutorials

- Access Water Storage information
- Calculate rainfall summary statistics for a derived catchment.

3 About Geofabric V2.1

The Geofabric is a collection of hydrological geospatial entities (feature classes, tables and raster datasets), representing Australia's hydrology. Geofabric V2.1 builds new information and functionality into the previously released V2.0 and V2.0.1.

The Geofabric is based on a set of integrated input data products, known as the foundation input data. It builds on these to produce a set of output products based on a defined set of user requirements. These user requirements are focused on the Bureau's need to meet its statutory requirements for water accounting, assessment and prediction under the *Water Act 2007.*

The Geofabric is publicly available and can be used as authoritative source data, suitable for a wide range of water information applications.

The foundation input data for Geofabric V2.1 includes:

- Topologically connected surface water hydrology, known as AusHydro V1.7.2 (AusHydro) based on GA GEODATA TOPO 250K Series 1 (GEODATA 1) and GEODATA TOPO 250 K Series 3 (GEODATA 3).
- Drainage enforced Digital Elevation Model (DEM) based on ANU and GA's GEODATA 9 Second Digital Elevation Model (DEM-9S) Version 3 (ANU Fenner School of Environment and Society and GA 2008).
- Topologically connected flow direction streamlines, known as ANUDEM Streams V1.1.2 (ANUDEM Streams) as developed by ANU using ANUDEM[1] that were cross-referenced and additionally informed by AusHydro vector streamlines.
- Physically-based stream segment catchments, known as the National Catchment Boundaries V1.1.4 (NCB), derived from the above mentioned ANUDEM Streams and the DEM-9S.
- Groundwater boundaries derived from the best available digital groundwater information sourced from Commonwealth, State and Territory jurisdictions as part of the Interim Ground Water Data (IGWD) project.

Data quality information about the foundation data inputs is given in Appendix 4.

From these foundation data, a suite of integrated data products were developed. These are:

- **Geofabric Surface Cartography**
  Geofabric Surface Hydrology Cartography 1:250,000 scale 2012
  SH_Cartography
  Cartographic representation of hydrological features

[1] ANUDEM is a computer program developed by the ANU Fenner School of Environment & Society for processing data into a digital elevation model.

- **Geofabric Surface Network**
  Geofabric Surface Hydrology Network 1:250,000 scale 2012
  SH_Network
  Network representation of hydrological features

- **Geofabric Surface Catchments**
  Geofabric 9 second Catchments 1:250,000 scale 2012
  SH_Catchments
  Stream segment catchments derived from DEM-9S organised into a hierarchy using the Pfafstetter reference system

- **Geofabric Groundwater Cartography**
  Geofabric Groundwater Hydrology Cartography 2012
  GW_Cartography
  Groundwater boundaries derived from the Interim Ground Water Data

- **Geofabric Hydrology Reporting Catchments**
  Geofabric Hydrology Reporting Catchments 1:250,000 scale 2012
  HR_Catchments
  Contracted nodes and contracted catchments derived from identification of important hydrological features

- **Geofabric Hydrology Reporting Regions**
  Geofabric Hydrology Reporting Regions 1:250,000 scale 2012
  HR_Regions
  Topographic Drainage Division and River Region reporting units, based on contracted catchments.

The Geofabric system is based on a conceptual architecture designed to produce a suite of data products at various spatial resolutions, using different representations of features, from a single maintenance environment. This is required to support the disparate needs of users. Key to this design are formal data product specifications that describe each product. Underpinning the Geofabric is a formal, modular conceptual model that allows for direct mapping between the input datasets and products. Figure 1 illustrates the Geofabric conceptual architecture.

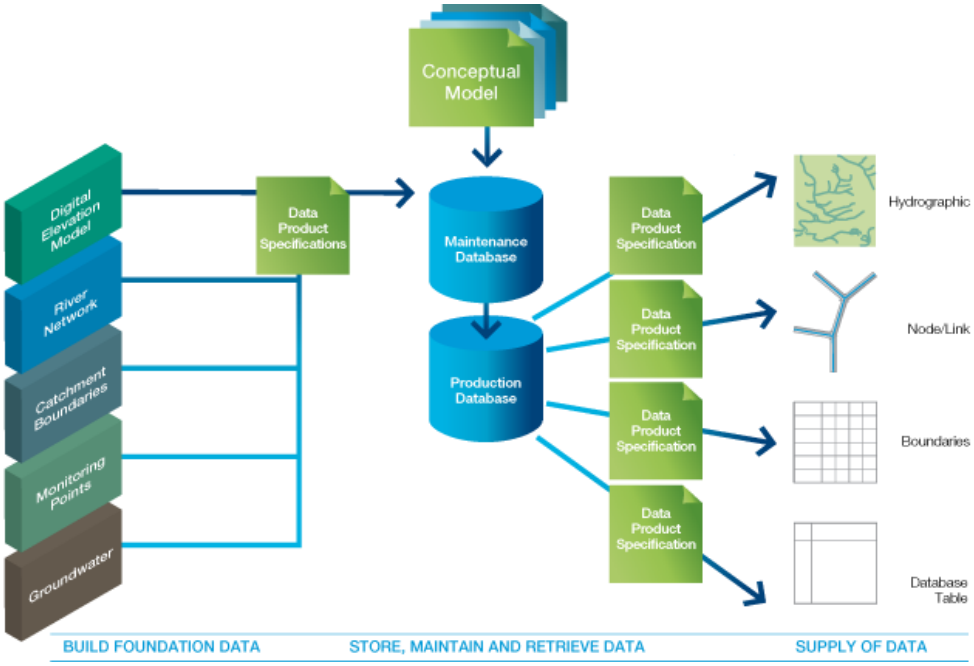

Figure 1 – Geofabric conceptual architecture showing data workflows

(source: Water Information Research and Development Alliance)

3.1 Special features of Geofabric V2.1

Traditionally, spatial products and datasets are created from traditional hard copy maps or via the digitisation of features by hand from aerial photography or satellite imagery. The representation of geographic features on paper maps requires that features be presented at certain scales, with certain symbology or legends. They are limited in accuracy to the scale to which they are printed and reproduced.

Similarly, the accuracy of data digitised from imagery depends upon the resolution of the imagery and the processes used for data capture. This means that the derived digital spatial products are also limited in both scale and accuracy. When higher levels of data accuracy are required, there is often inconsistent representation of the data between scales. For example, a water body feature location might be represented as a point location at one scale of map and its boundary represented as a polygon on a higher resolution map.

Additionally, paper maps often amalgamate both the geometry (how something looks or is represented), and the topology (how the features on the map might be connected or related spatially), of the represented features. Digital spatial data products are not necessarily organised by the traditional confines of a cartographic representation on a paper map. Spatial data products are organised by categories of specific types of information, usually within a Geographic Information System (GIS). This allows the user to amalgamate, layer or superimpose varying types of information in a way that is meaningful. The user is only restricted by the accuracy, precision and relevant content of the digital data.

The design and development of the Geofabric recognises the inherent problems of function, scale and accuracy in representing spatial data. The Geofabric product suite attempts to distinguish between the functional requirements of both topological and geometric representations of hydrological features. Topologically consistent spatial features are those that show connectivity, e.g. consistent direction, node-link connectivity, schematic networks and feature relationships. Geometric spatial features are those that are represented by points, lines or polygons (in ESRI's ArcGIS environment) and are commonly described as the blue lines for streams and the associated water features (e.g. cartographic representations).

Users can choose the most appropriate Geofabric product to suit their requirements. The user may also select one product to conduct analyses and then adopt the sister product to accomplish an associated task, such as cartographic representation of the same set of features. The value-add of the Geofabric products lies in the ability to reliably apply the products or inter-relate them in a repeatable way.

The products are ascribed to provide cross product integration by the use of related feature IDs, consistent naming conventions, and the application of contracted nodes that carry identity across products and between versions.

Figure 2 shows a model of the relationships between the features in the six Geofabric products providing an overview as to how these products both relate and, in some cases, overlap with one another.

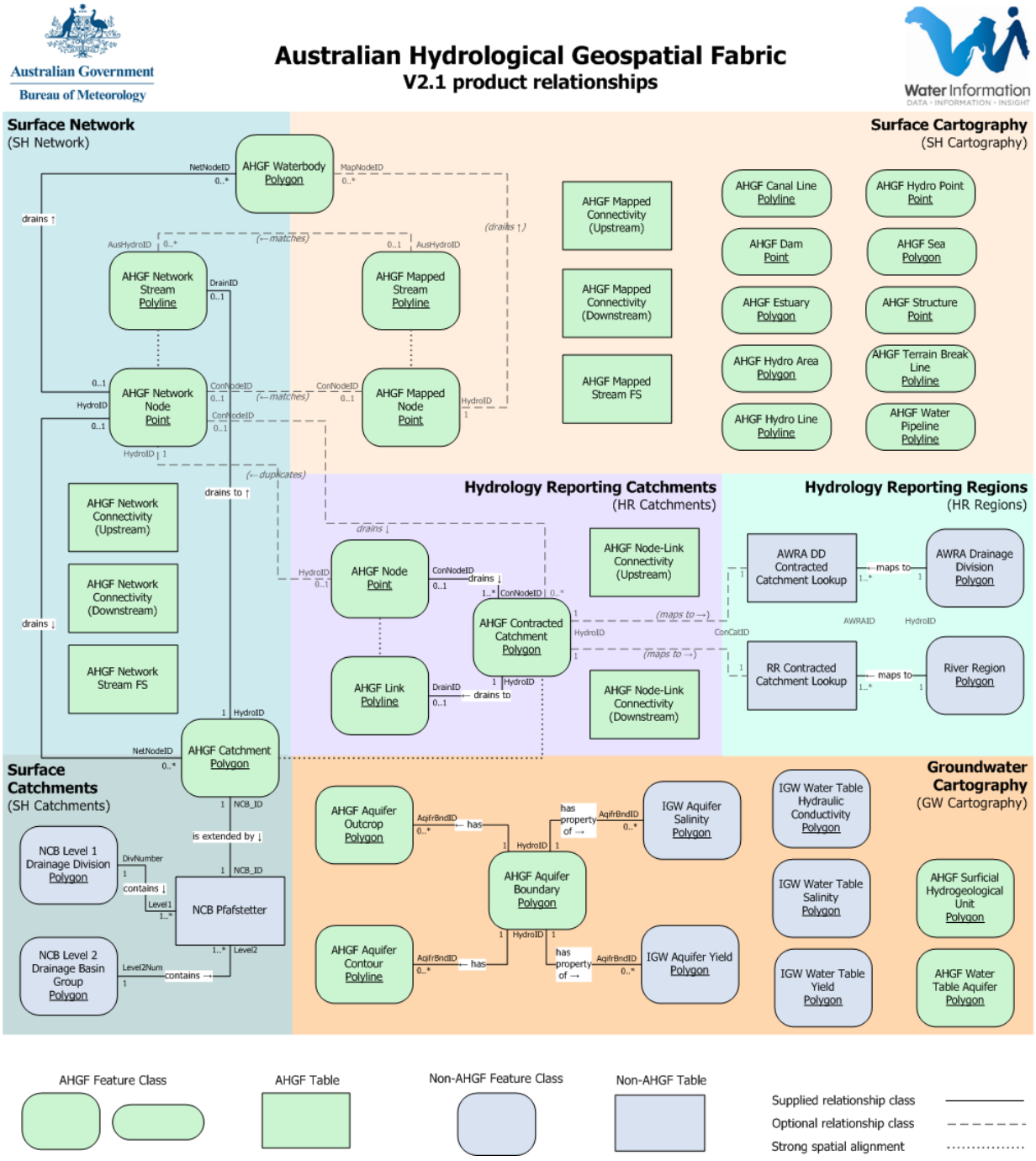

Figure 2 – Geofabric V2.1 relationships

(a high resolution version of this schema can be found at www.bom.gov.au/water/geofabric/documentation.shtml)

3.2 Conceptual model supporting the Geofabric design

A conceptual model is an abstraction of phenomena, or features, in the real world. It describes the essential features, captures their relationships, and may also represent behaviour. The design of the Geofabric is based around a flexible and evolvable information model. This design requires:

- A modular conceptual information model, capable of supporting many use cases and associated implementations as discussed in Atkinson et al (2008). This is the foundation on which implementations are developed.
- Consistent use of standardised Data Product Specifications (DPS) describing both the dataset inputs and the derived data products output from the Geofabric.
- Adoption of a nimble, iterative, requirements-focused development methodology that covers all aspects of the data product lifecycle and allows for evolution of technology, data products and user requirements.

The Geofabric design goal is to develop a single platform independent conceptual model that can be mapped to different implementation models as required. These implementation models can be structured to specifically support particular use cases.

The value of the conceptual model is that it is not influenced by the limitations of a chosen GIS implementation. Model development can focus on the phenomena being examined, how they are to be used and represented and their relationships to other phenomena. This means the underlying design of the Geofabric is based upon a repeatable information model and that the products are well documented and consistent in their behaviour over time.

The Geofabric conceptual model was developed according to International Organization for Standardization (ISO) conceptual modelling principles with a focus on modularity and re-use. It is specified in the Unified Modelling Language (UML) model with re-usable components clearly packaged. The Geofabric is the result of a physical implementation realising the concept model. Issues with data not being adequately expressed in the implementation (model) trigger a review of the conceptual model. Any redefinitions from this process flow to any derived data products. This ensures that any products derived from any platform specific implementation are able to rely on that product's consistency and feature behaviour.

In Geofabric V2.1, there is only one platform specific implementation model that is based upon ArcGIS software using ESRI's definitions of geodatabase models, schema, feature classes and relationship classes, etc. The products described in this Product Guide are derived from this implementation. Geofabric V2.1 conforms to the underlying conceptual model via the inclusion of a derived set of logical features, which represent contracted behaviours designed to persist over time.

4 Product overview

4.1 Product components

The Geofabric products consist of six distinct yet related geospatial datasets that are derived from the foundation input data. Specific spatial feature classes created by the Bureau also form a key part of the products. A list of the product geodatabase names, their file sizes and format is given in Table 4.

Table 4 – Product file sizes and formats

Product	~ File size (MegaBytes)	Format
SH_Cartography.gdb	1020	ESRI File Geodatabase
SH_Network.gdb	1030	ESRI File Geodatabase
SH_Catchment.gdb	870	ESRI File Geodatabase
GW_Cartography.gdb	790	ESRI File Geodatabase
HR_Catchments.gdb	80	ESRI File Geodatabase
HR_Regions.gdb	20	ESRI File Geodatabase

The products are represented at a nominal scale of 1:250,000 in ESRI ArcGIS vector format and are delivered in an ESRI File Geodatabase format.

The products use the following geographic coordinate system:

Datum: Geographic Datum of Australia (GDA 94)

Geographic coordinate units: decimal degrees

Latitude resolution: 0.0000005

Longitude resolution: 0.0000005

A complete description of the data products' spatial and geographic identifiers are contained within their accompanying Data Product Specification (DPS). The specifications are a formal description of the key features and attributes of each product and are based on the AS/NZS ISO 19131:2008 Geographic information – Data product specifications standard.

While the Geofabric products are delivered in a geographic coordinate system, it is recognised that users may need the data products to satisfy applications requiring differing units of measurement. For more information on selecting, reprojecting and using differing coordinate systems, please see:

http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=About%20coordinate%20systems%20and%20map%20projections

The Geofabric is organised in a manner that reflects the standard spatial data hierarchy of the ESRI ArcGIS product suite for geodatabases. The Data Dictionaries and Data Product Specifications adhere to the standard ESRI data hierarchy nomenclature and conventions. This documentation assumes that the user is familiar with this data

structure, hierarchy and its components, such as geodatabase (the overall delivery data package), including:

- feature dataset (a container for feature classes with shared properties and behaviours):
  - feature class by feature type (e.g. stream or water body represented by points, lines or polygons)
  - subtypes within the feature class (e.g. different types of water bodies within a water body feature class), i.e.:
    - attribution fields per each feature class and feature class subtype (the data fields that contain feature specific details)
    - attribute domains associated with feature class attributes to standardise the values for a given attribute field.

4.2 Relationships between Geofabric Surface Cartography and Geofabric Surface Network

Geofabric Surface Cartography and Geofabric Surface Network complement one another. Both are created from spatial data inputs that share definitions for stream segments and some feature attribution. The stream segmentation rules are based upon surface topographic features that are most likely to be common to both products. Whilst each product has its own set of unique attributes, the common attributes are limited to the simplest set of descriptors, e.g. common linked feature IDs, stream names and stream hierarchy. This means that the user can easily identify a stream segment in either product by a common ID, stream name (if it exists) or stream hierarchy (if it exists).

Geofabric Surface Network is intended to be used for the selection of hydrological observation points (if they exist) and as the source of stream segments for geoprocessing and hydrological modelling, whereas Geofabric Surface Cartography is intended for the production of maps which present the results of analyses.

Where there are equivalent mapped segments in Geofabric Surface Cartography to network segments in Geofabric Surface Network, an attempt was made to relate these through attribution. A complete set of attribution relationships is described in the individual sections of this Guide:

- Section 5.1 Geofabric Surface Cartography
- Section 5.2 Geofabric Surface Network
- Section 5.3 Geofabric Surface Catchments
- Section 5.4 Geofabric Groundwater Cartography
- Section 5.5 Geofabric Hydrology Reporting Catchments
- Section 5.6 Geofabric Hydrology Reporting Regions.

4.3 Spatial feature identifiers (IDs)

The field attribution of the six surface hydrology products includes a number of distinct identifier fields which serve different purposes. Each category of identifier can be described as follows:

SourceID/AusHydroID

All foundation input data products were supplied with a set of their own feature IDs. In order to maintain the link between the Geofabric and input features, these IDs are preserved as part of the feature level Geofabric metadata in an attribute field called SourceID.

The AusHydroID field included in the AHGFMappedStream and AHGFNetworkStream feature classes is a special case of SourceID. This ID provides one way of mapping stream features between Geofabric Surface Cartography and Geofabric Surface Network. While these IDs provide a useful way of locating the same stream segment in the two networks, these IDs are not persistent and may change between the Geofabric versions. The AusHydroIDs are further documented in the attribution of the Data Dictionaries.

HydroID

HydroIDs are specific and unique across the Geofabric products. They are created in the process of loading and post-processing the foundation data inputs into the Geofabric Maintenance Geodatabase. While these IDs are unique across all geodatabases within a Geofabric release, these IDs again are not persistent and are likely to change between the Geofabric versions. For more information on ArcHydro go to: resources.arcgis.com/content/hydrol

SegmentNo

The input foundation data products used to create the AHGFNetworkStream and AHGFCatchment feature classes included an identifier called SegmentNo. This identifier may be used to map AHGFNetworkStream features to related AHGFCatchment features or to relate vector features back to equivalent raster stream segments and catchments in the input foundation data products. Please note that no raster based Geofabric products are released in V1.0, V2.0 or V2.1.

ConNodeID (Contracted Node ID)

A process of identifying important hydrological features was used to determine a set of logical nodes which could be identified in both the stream networks within Geofabric Surface Cartography (AHGFNetworkNode) and Geofabric Surface Network (AHGFMappedNode). Each of these nodes was then assigned a unique identifier and a confidence level. These IDs (ConNodeID) and confidence levels (ConLevel) were attributed back to the corresponding representations of these nodes in the two stream networks, allowing identification of the logical nodes in both feature classes.

The idea of identifying a set of logical nodes and assigning them with a persistent identifier is aimed at providing the end-user with a set of contracted features that are likely to persist over time, regardless of any changes to the resolution and scale of future Geofabric product versions. The ConNodeID and ConLevel attributes are also assigned to the AHGFContractedCatchment feature class in Geofabric Hydrology Reporting Catchments. These features represent the sub-catchment areas drained by key contracted nodes.

4.4 Attributes common to all feature classes

As well as standard feature class metadata, each feature class also carries a standard set of attribute-level metadata, providing valuable information linking features to the foundation data. This allows the user to understand the data lineage and metadata that is available for the input products.

The following attributes, shown in Table 5, are common to all feature classes in the Geofabric products.

Table 5 – Feature class attributes common to all the Geofabric products

Field name	Alias name	Reference from data input
HydroID		Geofabric feature identifier, unique across all geodatabases within an AHGF release
AHGFFType	AHGFFeatureType	Feature type within the AHGF Data Model (e.g. 1: AHGFNetworkStream)
SrcFCName	SourceFeatureClassName	Feature class name from the input data source (e.g. Reservoirs)
SrcFType	SourceFeatureType	Feature type from the input data source (e.g. TownRuralStorage)
SrcType	SourceType	Feature subtype (numeric code) from the input data source (e.g. 2)
SourceID		Unique identifier for individual feature in the input data source (e.g. 3023726)
FeatRel	FeatureReliability	Reliability date of spatial object. Adjusted during spatial change/verification
FSource	FeatureSource	Name of agency that originally captured the spatial object
AttrRel	AttributeReliability	Reliability date of attribute object. Adjusted during attribute change/verification
AttrSource	AttributeSource	Name of agency that originally captured the attribute object
PlanAcc	PlanimetricAccuracy	Standard deviation of the horizontal positional accuracy in metres (e.g. 100)
Symbol		Symbol number for feature used in GA's GEODATA product
TextNote		Text note to accompany the feature

4.5 Geometric networks

Geometric networks are collections of line (edge) and point (junction) feature classes in a feature dataset that possess a connectivity relationship. Geometric networks provide extra behaviour to component features classes, in particular, an awareness that they are topologically connected to each other. Edges connect to other edges at junctions and in the network the flow from one edge to another is transferred through the junctions. When flow direction is set, flow can occur in only one direction.

A geometric network was built for Geofabric Surface Cartography, Geofabric Surface Network and Geofabric Hydrology Reporting Catchments. The networks are constructed from the respective node and stream (link for Geofabric Hydrology Reporting Catchments) feature classes, default parameters were used and flow direction was set.

Further information about geometric networks can be found at:
http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//002r00000001000000.htm

4.6 Relationship classes

Relationship classes help ensure referential integrity between feature classes and allow for the query of related features.

The Geofabric contains a number of relationship classes and an example from the Geofabric Surface Network product is the relationship class CatchmentDrainsToSegment. This defines a drainage relationship between the (polygon) AHGFCatchment and (line) AHGFNetworkStream feature classes.

Further information about relationship classes can be found at:
http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Benefits_of_relationship_classes/004t00000003000000/

4.7 Attribute domains

Attribute domains define rules for the allowable values for a specific attribute field. They help to enforce data integrity. Attribute domains can be either a range or coded value type. Range domains specify a valid range of values for a numeric domain, such as elevation. A coded value domain specifies a list of allowable values, such as State and Territory codes (WA, NT, etc).

Further information about attribute domains can be found at:
http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/A_quick_tour_of_attribute_domains/001s00000001000000/

4.8 Attribute subtypes

A data subtype is a subset of features in a feature class which share the same allowable attributes or relationships. The use of subtypes allows for the allocation of an attribute domain and/or the definition of a relationship class to a subset of features within a feature class. The AHGFNetworkNode feature class within Geofabric Surface Network is an example of a feature class containing a number of subtypes.

Further information about subtypes can be found at:
http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/A_quick_tour_of_subtypes/005r00000001000000/

5 Product descriptions

The Geofabric V2.1 release comprises six products. Each of these products, and guidance on use, are described below.

5.1 Geofabric Surface Cartography

Geofabric Surface Cartography provides a set of related feature classes to be used as the basis for production of consistent hydrological cartographic maps. This product contains a geometric representation of the surface water features of Australia (excluding external Territories). These are largely natural surface hydrology features but some artificial features; notably dams, pipelines, reservoirs, canals and other hydrographic features, are also included.

The product may be used for visualisation of surface hydrology within a GIS to support the selection of features for inclusion in cartographic map production.

The product's geometry is largely derived from a foundation input data product called AusHydro. Geofabric Surface Cartography includes water bodies such as swamps, reservoirs and lakes as derived from GEODATA 3, as well as the stream lines and their connectors through water bodies. Table 6 shows the Geofabric Surface Cartography feature class terminology and subtypes.

In addition, Geofabric Surface Cartography includes a set of contracted node attributes (embedded within AHGFMappedNode), which identify a subset of features common to both the cartographic stream network (AHGFMappedStream) and the topological stream network (AHGFNetworkStream). These attributes indicate the likely level of persistence for these features between Geofabric versions. The unique value-added feature of the contracted nodes is created by the Bureau and represents a persistent and coincident juncture between associated hydrologic features throughout the suite of products.

5.1.1 Understanding and using Geofabric Surface Cartography

Geofabric Surface Cartography is fully topologically correct. That is, the stream segments connect and flow in the correct direction (in relation to the overall stream line). Geofabric Surface Cartography represents the traditional sinuous blue line network and is designed to be used as a cartographic representation of Australian rivers and streams.

This product is suitable for users who need to analyse accurate stream length at a scale of 1:250,000.

The Geofabric Surface Cartography stream network and accompanying hydrological feature classes appear as similar to the GEODATA 3 hydrologic features. The nomenclature for the feature classes conforms to the Geofabric Surface Cartography data dictionary. The feature class nomenclature of Geofabric Surface Cartography is based upon the AusHydro data input which is derived from the GEODATA 3 hydrological feature classes. A complete mapping of the derived feature class nomenclature is described in the tables in Appendices 1 and 2.

Geofabric Surface Cartography can be used for any general GIS mapping or cartographic analysis available within the ArcGIS desktop environment. Features may be selected by

specific areas as described in Geofabric Surface Catchments, by boundaries, or by user-specified attributes such as stream names. Additionally, the geometric network supplied within the geodatabase can be used to do stream tracing operations.

Some applications of this product include:

- producing maps for reporting
- determining the locations of surface water features
- determining the relationship of surface water features with one another and with other natural features in the landscape
- intersecting areas of surface water features with gridded datasets to extract data
- finding associated hydrological observations in a river network, i.e. determining where monitoring stations are located in relation to surface water features
- running stream tracing operations using the geometric network.

5.1.2 Feature classes, feature types, related tables and key attributes

Table 6 – Feature classes and tables for Geofabric Surface Cartography

ObjectClass Name	Type	Geometry	Subtype
SH_Cartography			
AHGFCanalLine	Simple Feature Class	Polyline	-
AHGFDam	Simple Feature Class	Point	-
AHGFEstuary	Simple Feature Class	Polygon	-
AHGFHydroArea	Simple Feature Class	Polygon	CanalArea Flat ForeshoreFlat PondageArea RapidArea WatercourseArea

ObjectClass Name	Type	Geometry	Subtype
SH_Cartography			
AHGFHydroLine	Simple Feature Class	Polyline	CliffLine DamWall Levee RapidLine Shoreline ShorelineJunction Spillway Tunnel
AHGFHydroPoint	Simple Feature Class	Point	Bay GnammaHole NativeWell Pool Rockhole Soak Spring Waterhole WaterTank
AHGFMappedNode	Simple Feature Class	Point	MappedArtificialNode MappedCliffNode MappedGhostNode MappedHeadNode MappedJunctionNode MappedTerminusNode MappedWaterAreaNode
AHGFMappedStream	Simple Feature Class	Polyline	MappedArtificialFlowSegment MappedFlowSegment MappedWaterAreaSegment
AHGFSea	Simple Feature Class	Polygon	-
AHGFStructure	Simple Feature Class	Point	Bridge Ford Lock Waterfall
AHGFTerrainBreakLine	Simple Feature Class	Polyline	-
AHGFWaterbody	Simple Feature Class	Polygon	Lake Reservoir Swamp
AHGFWaterPipeline	Simple Feature Class	Polyline	-
Stand Alone ObjectClass(s)			
AHGFMappedConnectivityDown	Table	-	-
AHGFMappedConnectivityUp	Table	-	-
AHGFMappedSegment_FS	Table	-	-

Of the feature classes within Geofabric Surface Cartography, AHGFMappedNode is entirely created by the Bureau (from AHGFMappedStream) during the data input process. Both AHGFMappedNode and AHGFMappedStream feature classes contain Bureau designed subtypes which categorise the stream nodes and segments by type. AHGFMappedNode features represent the beginning or end node of a particular type of stream segment and are used to designate the transition of stream segment types. They generally indicate a specific break point in the stream network or the heads and termini of streams. The only AHGFMappedNode subtype which does not break the stream network segments is the MappedGhostNode.

Table 7 – Bureau generated feature classes (nodes and streams) included for Geofabric Surface Cartography

Feature class name	FCGeometry	Feature class subtype	Description
AHGFMappedNode	Point	MappedArtificialNode	Represents the boundary where a MappedFlowSegment/ MappedWaterAreaSegment changes to/from a MappedArtificialFlowHydroArea feature
		MappedCliffNode	Represents the locational break of a MappedStream segment intersection with an AHGFCliffline or AHGFTerrainBreakLine
		MappedGhostNode	Used for building spatial relationships to monitoring points. This is the only mapped node feature which does not coincide with a physical break in the stream segment network
		MappedHeadNode	The starting point of a MappedStream segment in the headwaters
		MappedJunctionNode	Any confluence/bifurcating node of two or more stream segments
		MappedTerminusNode	Represents the terminal end point of any MappedStream (i.e. coastal outlet or inland sink)
		MappedWaterAreaNode	Represents the entry or exit of a MappedArtificialFlow/ MappedArtificialFlowSegment into or out of an AHGFWaterbody or AHGFHydroArea feature
AHGFMappedStream	Polyline	MappedArtificialFlowSegment	Stream flow connectors that are not watercourse lines, i.e. connectors introduced to maintain certain key stream connectivity
		MappedFlowSegment	Watercourse lines
		MappedWaterAreaSegment	Stream flow connectors that pass through a water area polygon

The following tables describe the key attributes for Geofabric Surface Cartography.

Table 8 – Key attributes of the AHGFMappedNode feature class for Geofabric Surface Cartography

Key attribute	Alias	Description
NextDownID	NextDownID	The HydroID for the next downstream stream mapped node
ConNodeID	ContractedNodeID	Persistent unique identifier of related logical AHGF contracted node
ConLevel	ContractLevel	Confidence level of related logical AHGF contracted node
NetNodeID	NetworkNodeID	The HydroID of the equivalent node in AHGFNetworkNode

Table 9 – Key attributes of the AHGFMappedStream feature class for Geofabric Surface Cartography

Key attribute	Alias	Description
From_Node	From_Node	The HydroID for the AHGFMappedNode
To_Node	To_Node	The HydroID for the next downstream AHGFMappedNode
NextDownID	NextDownID	The HydroID for the next downstream AHGFMappedStream segment

Table 10 – Key attributes of the AHGFMappedConnectivityDown (downstream) table for Geofabric Surface Cartography

Key attribute	Alias	Description
From_ID	From_ID	The HydroID for the AHGFMappedNode
To_ID	To_ID	The HydroID for the next downstream AHGFMappedNode
Segment_ID	Segment_ID	The HydroID for the corresponding AHGFMappedStream segment

Table 11 – Key attributes of the AHGFMappedConnectivityUp (upstream) table for Geofabric Surface Cartography

Key attribute	Alias	Description
From_ID	From_ID	The HydroID for the AHGFMappedNode
To_ID	To_ID	The HydroID for the next upstream AHGFMappedNode
Segment_ID	Segment_ID	The HydroID for the corresponding AHGFMappedStream segment

Table 12 – Key attributes of the AHGFMappedSegment_FS table for Geofabric Surface Cartography (flow split table for use with ArcHydro tools)

Key attribute	Alias	Description
FeatureID	FeatureID	The HydroID for an AHGFMappedStream segment
NextDownID	NextDownID	The HydroID for the next downstream AHGFMappedNode

5.2 Geofabric Surface Network

Geofabric Surface Network is based upon the input from ANUDEM Streams, which is the vectorised version of the nine second ANUDEM derived raster streams product. The ANUDEM algorithm is informed by the AusHydro foundation input data used to populate the AHGFMappedStream feature class in Geofabric Surface Cartography and thus is inherently related to this product.

Geofabric Surface Network is intended to be used in stream flow tracing operations, which utilise its full topological connection. The product can support the spatial selection of associated hydrological features (such as water bodies and catchments) as inputs for spatial analysis/modelling. Table 13 shows the Geofabric Surface Network feature class terminology and feature subtypes.

As with Geofabric Surface Cartography, the network product includes a set of contracted node attributes (embedded within AHGFNetworkNode), which identify a subset of features common to both of the two stream networks (AHGFNetworkStream and AHGFMappedStream). These attributes indicate the likely level of persistency for these features between the Geofabric versions.

5.2.1 Understanding and using Geofabric Surface Network

The Geofabric Surface Network stream network is related to, but distinct from, the stream network contained within Geofabric Surface Cartography. The network product represents the flow direction of Surface Cartography streams over the surface of the terrain, based upon a DEM-9S. It is more generalised and represents the main channels of the streams, particularly in areas where streams are heavily anabranched or disconnected.

In addition, the stream connectivity of Geofabric Surface Network represents a stream flow over the terrain, regardless of the presence of a corresponding Geofabric Surface Cartography stream segment. This means that Geofabric Surface Cartography may represent a stream as an interrupted or intermittent feature, whereas Geofabric Surface Network represents the same stream as a continuous connected feature, i.e. the path that stream would take (according to the terrain model) if sufficient water were available for flow.

A complete mapping of the derived feature class nomenclature is described in the tables in Appendices 1 and 2.

Some applications for this product include:

- locating associated hydrological observations (monitoring points) in a river network
- tracing connectivity between hydrological features
- stream flow modelling
- selecting related features up or downstream of a point such as water bodies or catchments
- accumulating attribute values of upstream or downstream related features, e.g. calculating average stream heights upstream of a point.

5.2.2 Feature classes, feature types, related tables and key attributes

Table 13 - Feature classes and tables for Geofabric Surface Network

ObjectClass Name	Type	Geometry	Subtype
SH_Network			
AHGFCatchment	Simple FeatureClass	Polygon	-
AHGFNetworkNode	Simple FeatureClass	Point	NetworkArtificialNode NetworkCliffNode NetworkGhostNode NetworkHeadNode NetworkJunctionNode NetworkTerminusNode NetworkWaterAreaNode
AHGFNetworkStream	Simple FeatureClass	Polyline	NetworkArtificialFlowSegment NetworkFlowSegment NetworkWaterAreaSegment
AHGFWaterbody	Simple FeatureClass	Polygon	Lake Reservoir Swamp
Stand Alone ObjectClass(s)			
AHGFNetworkConnectivityDown	Table	-	-
AHGFNetworkConnectivityUp	Table	-	-
AHGFNetworkStream_FS	Table	-	-

Of the feature classes within Geofabric Surface Network, AHGFNetworkNode is entirely created by the Bureau (from AHGFNetworkStream) during the data input process.

Both AHGFNetworkNode and AHGFNetworkStream feature classes contain Bureau designed subtypes and field attribution which categorise the stream nodes and segments by type and facilitate their use in stream network analysis.

AHGFNetworkNode features represent the beginning or end node of a particular type of stream segment and are used to designate the transition of stream segment types. They generally indicate a specific break point in the stream network or the heads and termini

of streams. The only AHGFNetworkNode subtype that does not break the stream network segments is the NetworkGhostNode.

Table 14 – Bureau generated feature classes (nodes and streams) included for Geofabric Surface Network

Feature class name	FCGeometry	Feature class subtype	Description
AHGFNetworkNode	Point	NetworkArtificialNode	Represents the boundary where a NetworkFlowSegment/ NetworkWaterAreaSegment changes to/from a NetworkArtificialFlowHydroArea feature
		NetworkCliffNode	Represents the locational break of a NetworkStream segment intersection with an AHGFCliffline or AHGFTerrainBreakLine
		NetworkGhostNode	Used for building spatial relationships to monitoring points. This is the only network node feature which does not coincide with a physical break in the stream segment network
		NetworkHeadNode	The starting point of a NetworkStream segment in the headwaters
		NetworkJunctionNode	Any confluence/bifurcating node of two or more stream segments
		NetworkTerminusNode	Represents the terminal end-point of any NetworkStream segment (i.e. coastal outlet or inland sink)
		NetworkWaterAreaNode	Represents the entry or exit of an AHGFNetworkStream into or out of an AHGFWaterbody or AHGFHydroArea feature
AHGFNetworkStream	Polyline	NetworkArtificialFlowSegment	Stream flow connectors that are not watercourse lines, i.e. derived connectors which maintain the stream network connectivity between NetworkFlowSegment features but have no corresponding feature in AHGFMappedStream
		NetworkFlowSegment	ANUDEM vectorised stream segments that correspond to MappedFlowSegment features
		NetworkWaterAreaSegment	Stream flow connectors that pass through a water area polygon and coincide with a MappedFlowSegment in AHGFMappedStream

The following tables describe the key attributes for Geofabric Surface Network.

Table 15 – Key attributes of the AHGFNetworkNode feature class for Geofabric Surface Network

Key attribute	Alias	Description
NextDownID	NextDownID	The HydroID for the next downstream stream network node
ConNodeID	ContractedNodeID	Persistent unique identifier of related logical AHGF contracted node
ConLevel	ContractLevel	Confidence level of related logical AHGF contracted node
MapNodeID	MappedNodeID	The HydroID of the equivalent node in AHGFMappedNode

Table 16 – Key attributes of the AHGFNetworkStream feature class for Geofabric Surface Network

Key attribute	Alias	Description
SegmentNo	SegmentNo	Identifier of related raster stream segment in input data source
DrainID	DrainID	The HydroID for the AHGFCatchment in to which the AHGFNetworkStream drains
From_Node	From_Node	The HydroID for the AHGFNetworkNode
To_Node	To_Node	The HydroID for the next downstream AHGFNetworkNode
NextDownID	NextDownID	The HydroID for the next downstream AHGFNetworkStream feature

Table 17 – Key attributes of the AHGFNetworkConnectivityDown (downstream) table for Geofabric Surface Network

Key attribute	Alias	Description
From_ID	From_ID	The HydroID for the AHGFNetworkNode
To_ID	To_ID	The HydroID for the next downstream AHGFNetworkNode
Segment_ID	Segment_ID	The HydroID for the corresponding AHGFNetworkStream feature

Table 18 – Key attributes of the AHGFNetworkConnectivityUp (upstream) table for Geofabric Surface Network

Key attribute	Alias	Description
From_ID	From_ID	The HydroID for the AHGFNetworkNode
To_ID	To_ID	The HydroID for the next upstream AHGFNetworkNode
Segment_ID	Segment_ID	The HydroID for the corresponding AHGFNetworkStream feature

Table 19 – Key attributes of the AHGFNetworkSegment_FS table for Geofabric Surface Network (flow split table for use with ArcHydro tools)

Key attribute	Alias	Description
FeatureID	FeatureID	The HydroID for an AHGFNetworkStream segment
NextDownID	NextDownID	The HydroID for the next downstream AHGFNetworkNode

5.3 Geofabric Surface Catchments

The feature class contained within this data product is based upon the stream segment level catchments of the NCB foundation input data. These data define a catchment for every stream segment contained within Geofabric Surface Network (AHGFNetworkStream) according to DEM-9S. It is these catchments which serve as direct input into the AHGFCatchment feature class. Table 20 shows the Geofabric Surface Catchments feature class terminology and feature subtypes. A complete mapping of the derived feature class nomenclature is described in the tables in Appendices 1 and 2.

5.3.1 Understanding and using Geofabric Surface Catchments

The AHGFCatchment feature class is designed to represent geographic surface boundaries that have a hydrological relationship to surface water features. These catchment boundaries in their current form may not completely satisfy legislative or local government requirements, but they may be used for surface hydrological analysis. Some of these applications include:

- providing a system boundary for surface water modelling
- identifying areas of interest for reporting
- producing maps for reporting
- aggregating small catchments to form required hydrological modelling boundaries.

5.3.2 Feature classes, feature types, related tables and key attributes

Table 20 – Feature classes and tables for Geofabric Surface Catchments

ObjectClass Name	Type	Geometry	Subtype
SH_Catchments			
AHGFCatchment	Simple FeatureClass	Polygon	-
NCBLevel1DrainageDivision	Simple FeatureClass	Polygon	-
NCBLevel2DrainageBasinGroup	Simple FeatureClass	Polygon	-
Stand Alone ObjectClass(s)			
NCBPfafstetter	Table	-	-

The following tables describe the key attributes for Geofabric Surface Catchments.

Table 21 – Key attributes of AHGFCatchment feature class for Geofabric Surface Catchments

Key attribute	Alias	Description
NetNodeID	NetworkNodeID	HydroID of the AHGFNetworkNode feature to which the catchment drains
NCB_ID	NCB_ID	Unique NCB identifier. Can be used to join Pfafstetter attribution
SegmentNo	SegmentNo	Identifier of related raster stream segment in input data source
StreamName	StreamName	Name of the associated stream segment in AHGFNetworkStream

Table 22 – Key attributes of NCBLevl1DrainageDivision feature class for Geofabric Surface Catchments

Key attribute	Alias	Description
DivNumber	DivisionNum	9 second DEM Drainage Division Number
Division	Division	9 second DEM Drainage Division Name

Table 23 – Key attributes of NCBLevel2DrainageBasinGroup feature class for Geofabric Surface Catchments

Key attribute	Alias	Description
DivNumber	DivisionNumber	9 second DEM Drainage Division Number
Level2num	Level2Number	NCB Level 2 number (internal 9 second basins merged with basins draining to the coast or into Lake Eyre, aggregated to approximate the AWRC Basins)
Level2name	Level2name	NCB Level 2 name (based on AWRC basin names)

5.3.3 Using the base level catchments with extended Pfafstetter attribution

The Geofabric Surface Catchments delineate hierarchically-nested catchments derived using an automated drainage analysis procedure based on a multi-flow extension of the GEODATA 9 Second Flow Direction Grid (D8-9S) associated with the DEM-9S (ANU Fenner School of Environment and Society and GA 2008).

At the highest levels in the hierarchy, the Geofabric Surface Catchments aggregate the nine second drainage basins into 12 topographically defined drainage divisions (Level 1) and 191 catchment units (Level 2) approximating the drainage basins from GA (1997) where possible. At lower levels, the Level 2 catchment units are subdivided into successively finer sub-catchments using a modified version of the Pfafstetter procedure (Stein, Hutchinson & Stein 2008a; Stein & Hutchinson 2008b).

The Pfafstetter reference system is supplied as part of Geofabric Surface Catchments. The NCBPfafstetter table can be used to extend (via a join on NCB_ID) the set of attributions present in AHGFCatchment with the Pfafstetter attribution. Attribute descriptions for the Pfafstetter table is given in Appendix 3.

5.3.4 NCBLevel1DrainageDivison and NCBLevel2DrainageBasinGroup

Geofabric Surface Catchments provides a hierarchy of nested catchments from drainage divisions at the top level all the way down to a separate catchment for every stream segment in Geofabric Surface Network.

The top two levels of this hierarchy, Level 1 and Level 2, have been extracted as separate feature classes. The NCBLevel1DrainageDivision feature class consists of 12 topographically defined drainage divisions and represent the highest level of the catchment hierarchy.

At the next level down, the NCBLevel2DrainageBasinGroup represent 191 catchment units approximating the Australian Water Resources Management Committee (WRMC) river basins as described in GA (1997).

5.4 Geofabric Groundwater Cartography

Geofabric Groundwater Cartography is a national groundwater dataset bringing together existing groundwater mapping by collating and integrating the best available, Commonwealth, State and Territory and regional groundwater mapping datasets across Australia. Although there are some gaps in the information, every effort was made to reduce or minimise inconsistencies and conflicts in overlapping and abutting datasets and in attribution and definitions of the input datasets.

In generating the various national aquifer datasets, an interim national groundwater (IGW) framework was developed to relate geological units and regional and State and Territory groundwater aquifer mapping units to a nationally consistent set of aquifers and aquitards.

The purpose of this framework is to provide a transparent mapping of aquifers from geological units, State and Territory or regional groundwater aquifer mapping (where available) and the interim national product. Such an approach was necessary to resolve inconsistencies in aquifer naming and definition across State and Territory borders.

Table 24 shows the Geofabric Groundwater Cartography feature class terminology and feature subtypes.

5.4.1 Understanding and using Geofabric Groundwater Cartography

Geofabric Groundwater Cartography was developed to collate and integrate State and Territory and regional groundwater mapping datasets across Australia. The dataset is intended to be used at the regional to national scale and does not support local scale groundwater conceptualisation and modelling. It has not incorporated local and regional groundwater modelling data.

Geofabric Groundwater Cartography was generated from available groundwater mapping data from the various State and Territory jurisdictions. Given the interim nature of Geofabric Groundwater Cartography, no groundwater borehole data were collated or reviewed in its generation.

Some of the applications of Geofabric Groundwater Cartography include:

- cartographic map production
- groundwater hydrologic analysis
- groundwater feature visualisation.

5.4.2 Feature classes, feature types and key attributes

Table 24 – Feature classes and tables for Geofabric Groundwater Cartography

ObjectClass Name	Type	Geometry	Subtype
GW_Cartography			
AHGFAquiferBoundary	Simple FeatureClass	Polygon	-
AHGFAquiferContour	Simple FeatureClass	Polyline	AquiferContourBottom AquiferContourTop BedrockContourTop
AHGFAquiferOutcrop	Simple FeatureClass	Polygon	-
AHGFSurficialHydrogeologicUnit	Simple FeatureClass	Polygon	-
AHGFWaterTableAquifer	Simple FeatureClass	Polygon	-
IGWAquiferSalinity	Simple FeatureClass	Polygon	-
IGWAquiferYield	Simple FeatureClass	Polygon	-
IGWWaterTableHydraulicConductivity	Simple FeatureClass	Polygon	-
IGWWaterTableSalinity	Simple FeatureClass	Polygon	-
IGWWaterTableYield	Simple FeatureClass	Polygon	-

The following tables describe the key attributes for Geofabric Groundwater Cartography.

Table 25 – Key attributes of AHGFAquiferBoundary feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
IAF_ID	IAF_ID	Aquifer classification based on the Interim Aquifer Framework
NameSynonym	NameSynonyms	Other names used for aquifer unit
DLithology	DominantLithology	Dominant lithology
LitholDesc	LithologyDescription	Description of lithology
GeoUnits	GeologicalUnits	Geological unit from GA's Stratigraphic Units Database
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured

Table 26 – Key attributes of AHGFAquiferContour feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
IAF_ID	IAF_ID	Aquifer classification based on the Interim Aquifer Framework
NameSynonm	NameSynonyms	Other names used for aquifer unit
AqifrBndID	AquiferBoundaryID	Unique identifier for related aquifer unit
ContValue	ContourValue	Elevation value for contour feature in meters Australian Height Datum (mAHD)
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Description of the data source including: - name of source for feature and attributes (e.g. organisation) - identifier for in source's system - category of source (e.g. digitised from map, shapefile)

Table 27 – Key attributes of AHGFAquiferOutcrop feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
IAF_ID	IAF_ID	Aquifer classification based on the Interim Aquifer Framework
NameSynonm	NameSynonyms	Other names used for aquifer unit
AqifrBndID	AquiferBoundaryID	Unique identifier for related aquifer unit
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Description of the data source including: - name of source for feature and attributes (e.g. organisation) - identifier for in source's system - category of source (e.g. digitised from map, shapefile)

Table 28 – Key attributes of AHGFSurficialHydrogeologicUnit feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
IAF_ID	IAF_ID	Aquifer classification based on the Interim Aquifer Framework
DLithology	DominantLithology	Dominant lithology
NameSynonm	NameSynonyms	Aquifer classification based on the Interim Aquifer Framework
LitholDesc	LithologyDescription	Description of lithology
GeoUnits	GeologicalUnits	Geological unit from GA's Stratigraphic Units Database
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Description of the data source including: - name of source for feature and attributes (e.g. organisation) - identifier for in source's system - category of source (e.g. digitised from map, shapefile)

Table 29 – Key attributes of AHGFWaterTableAquifer feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
IAF_ID	IAF_ID	Aquifer classification based on the Interim Aquifer Framework
NameSynonm	NameSynonyms	Other names used for aquifer unit
GWProvince	GroundwaterProvince	Groundwater province
GWFlowSysP	GWFlowSystemPrimary	Primary scale of groundwater flow system
GWFlowSysS	GWFlowSystemSecondary	Secondary scale of groundwater flow system
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GwNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Description of the data source including: - name of source for feature and attributes (e.g. organisation) - identifier for in source's system - category of source (e.g. digitized from map, shapefile)

Table 30 – Key attributes of IGWAquiferSalinity feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
IAF_ID	IAF_ID	Aquifer classification based on the Interim Aquifer Framework
NameSynonm	NameSynonyms	Other names used for aquifer unit
AqifrBndID	AquiferBoundaryID	Unique identifier for related aquifer unit
SalinValue	SalinityValue	Salinity range in mg/L (milligrams per litre)
SalinClass	SalinityClass	Category for salinity (e.g. saline, non-saline)
SalinMin	SalinityMinimum	Minimum value for salinity in mg/L (milligrams per litre)
SalinMax	SalinityMaximum	Maximum value for salinity in mg/L (milligrams per litre)
SalinMed	SalinityMedian	Median value for salinity in mg/L (milligrams per litre)
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Description of the data source including: - name of source for feature and attributes (e.g. organisation) - identifier for in source's system - category of source (e.g. digitised from map, shapefile)

Table 31 – Key attributes of IGWAquiferYield feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
IAF_ID	IAF_ID	Aquifer classification based on the Interim Aquifer Framework
NameSynonm	NameSynonyms	Other names used for aquifer unit
AqifrBndID	AquiferBoundaryID	Unique identifier for related aquifer unit
YieldValue	YieldValue	Bore yield range in L/s (litres per second)
YieldClass	YieldClass	Category for bore yield (e.g. <5L/s, >5L/s)
YieldMin	YieldMinimum	Minimum value for bore yield in L/s (litres per second)
YieldMax	YieldMaximum	Maximum value for bore yield in L/s (litres per second)
YieldMed	YieldMedian	Median value for bore yield in L/s (litres per second)
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Description of the data source including: - name of source for feature and attributes (e.g. organisation) - identifier for in source's system - category of source (e.g. digitised from map, shapefile)

Table 32 – Key attributes of IGWWaterTableHydraulicConductivity feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
IAF_ID	IAF_ID	Aquifer classification based on the Interim Aquifer Framework
HydKValue	HydraulicConductivityValue	Range for hydraulic conductivity in m/d (metres/day)
SpecYield	SpecificBoreYield	Range for specific yield (unitless)
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Description of the data source including: - name of source for feature and attributes (e.g. organisation) - identifier for in source's system - category of source (e.g. digitised from map, shapefile)

Table 33 – Key attributes of IGWWaterTableSalinity feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
SalinValue	SalinityValue	Salinity range in mg/L (milligrams per litre)
SalinClass	SalinityClass	Category for salinity (e.g. saline, non-saline)
SalinMin	SalinityMinimum	Minimum value for salinity in mg/L (milligrams per litre)
SalinMax	SalinityMaximum	Maximum value for salinity in mg/L (milligrams per litre)
SalinMed	SalinityMedian	Median value for salinity in mg/L (milligrams per litre)
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Description of the data source including: - name of source for feature and attributes (e.g. organisation) - identifier for in source's system - category of source (e.g. digitised from map, shapefile)

Table 34 – Key attributes of IGWWaterTableYield feature class for Geofabric Groundwater Cartography

Key attribute	Alias	Description
YieldValue	YieldValue	Bore yield range in L/s (litres per second)
YieldClass	YieldClass	Category for bore yield (e.g. <5L/s, >5L/s)
YieldMin	YieldMinimum	Minimum value for bore yield in L/s (litres per second)
YieldMax	YieldMaximum	Maximum value for bore yield in L/s (litres per second)
YieldMed	YieldMedian	Median value for bore yield in L/s (litres per second)
ReliabCode	ReliabilityCode	Code indicating the level of reliability or confidence in the data
GWNote	GroundwaterNote	Other relevant comments concerning feature (e.g. link to source).
Scale	Scale	Scale at which feature was captured
SrcDesc	SourceDescription	Name of source (e.g. organisation) of feature Identifier for feature in source's system. Category of source (e.g. digitised from map, shapefile etc.).

5.4.3 Description of Geofabric Groundwater Cartography feature classes

Geofabric Groundwater Cartography includes the feature classes listed below.

Surficial hydrogeology

The hydrogeological unit (aquifer or aquitard) at the land surface whether saturated or unsaturated. This involved aggregation of the GA national surface geology dataset to aquifers or aquitards of similar hydrogeological characteristics. Attribution of the features was derived from the GA national geology dataset, State and Territory and regional groundwater mapping (WA, NT, Great Artesian and Murray–Darling Basins), the Victorian Aquifer Framework and liaison with State and Territory agency groundwater teams.

Watertable aquifer

Interpretation of the (afore-mentioned) surficial hydrology dataset to identify the uppermost unconfined aquifer. Attribution of the features was derived from the GA national geology dataset, State and Territory and regional groundwater mapping (WA, NT, Great Artesian and Murray–Darling Basins), the Victorian Aquifer Framework and liaison with State and Territory agency groundwater teams.

Watertable hydraulic conductivity

This dataset depicts hydraulic conductivity and specific yield for various groundwater flow systems defined as part of the CSIRO Commercial Environmental Forestry program. In some cases, the groundwater flow system contains a number of different component geologies which have different hydraulic characteristics. Therefore, the stated aquifer hydraulic conductivity and specific yield are indicative only and should be considered to be representative of the dominant geology contained within each groundwater flow system.

Watertable salinity

Collation of watertable salinity mapping (where available) at State and Territory and regional scale. The watertable aquifer was defined by the source datasets. Units are mg/L.

Watertable yield

Collation of watertable yield mapping (where available) at State and Territory and regional scale. The watertable aquifer was defined by the source datasets. Units are L/s.

Aquifer boundaries

Collation of available aquifer extent boundaries (where available) at State and Territory and regional scale. The extent of the dataset relates to the availability of data. The aquifers defined in the source groundwater mapping were retained and related to the interim aquifer framework (IAF).

Aquifer salinity

Collation of aquifer salinity mapping (where available) at State and Territory and regional scale for confined and unconfined aquifers in the aquifer boundary dataset. The aquifers defined in the source groundwater mapping were retained and related to the IAF aquifers. Units are mg/L.

Aquifer yield

Collation of underlying aquifer yield mapping (where available) at a regional scale. The aquifers defined in the source groundwater mapping were retained and related to the IAF. Units are L/s.

Aquifer structure contours

Collation of available elevation contours for the top and bottom of aquifers (where available) mapped at a regional scale. The presence and absence of contours relates to the availability of data. Units are elevation in metres Australian Height Datum (mAHD).

The aquifers defined in the source groundwater mapping were retained and related to the IAF aquifers.

Aquifer outcrop

Outcropping portion of aquifers which are confined for at least some of their extent. The outcrop can be considered to be the intake areas for rainfall recharge to the otherwise, confined aquifers. The Aquifer outcrop and the watertable aquifer polygons are co-incident where the aquifer is unconfined.

5.5 Geofabric Hydrology Reporting Catchments

Geofabric Hydrology Reporting Catchments comprises two related views of hydrological catchments to be used for analysis and reporting purposes. Firstly, a topological network view of hydrological catchments represented as a simplified node-link network using a subset of the contracted nodes (AHGFNode) and the links (AHGFLink) between them; and secondly, a catchments view of the hydrology using the contracted catchments (AHGFContractedCatchment).

The AHGFNode feature class contains contracted nodes that are points of hydrological significance that carry identity. They include the confluence of major named streams, coastal stream termini, waterbody inflow and outflows and inland sinks. It also contains a new class of node called diffuse nodes that represent diffused flow from groups of nodes at coastal, delta or inter-catchment outlets.

The AHGFLink feature class provides the topological connectors between a subset of contracted nodes that participate in the simplified node-link network.

The AHGFContractedCatchment feature class contains catchment polygons (that are aggregations of AHGFCatchments) for the subset of contracted nodes that participate in the simplified node link network. These catchments are part of a hierarchy that can be aggregated based on upstream relationships. Table 35 shows the Geofabric Hydrology Reporting Catchments feature class terminology and feature subtypes. A complete mapping of the derived feature class nomenclature is described in the tables in Appendices 1 and 2.

The AHGFContractedCatchments can be subdivided by type as follows:

- ContractedArea – the upstream catchment area draining to a contracted node that participates in the simplified node-link network. It identifies the area upstream that will drain to that node (bounded wherever other upstream contracted nodes are encountered).
- NonContractedArea – the upstream catchment area draining to areas with contracted nodes of low confidence level (i.e. catchments containing AHGFNetworkStream features without corresponding AHGFMappedStream features)
- NoFlowArea – areas lacking both related network stream features and sensible catchments with which to be merged such as small islands.

5.5.1 Understanding and using Geofabric Hydrology Reporting Catchments

Geofabric Hydrology Reporting Catchments is designed to meet two specific use cases. Firstly, the contracted catchments are designed to build stable reporting regions and secondly, the simplified node-link network is designed to be used as input to hydrological modelling environments, to identify nodes, reporting reaches and their associated catchments.

The AHGFContractedCatchment feature class is designed to represent geographic surface boundaries that have a hydrological relationship to surface water features. These catchment boundaries in their current form may not completely satisfy legislative or business requirements, but are intended to provide the building blocks for reporting regions such as those given in Geofabric Hydrology Reporting Regions. The AHGFNode and AHGFLink feature classes provide a simplified, dendritic node link network for input into hydrological models.

Some applications of Hydrology Reporting Catchments include:

- identification of important and persistent hydrological features
- providing a system boundary for surface water modelling
- providing a simplified, dendritic, node-link network for input into hydrological models
- aggregation of contracted catchment units into stable reporting regions.

5.5.2 Feature classes, feature types, related tables and key attributes

Table 35 – Feature classes and tables for Geofabric Hydrology Reporting Catchments

ObjectClass Name	Type	Geometry	Subtype
HR_Catchments			
AHGFContractedCatchment	Simple FeatureClass	Polygon	ContractedArea NoFlowArea NonContractedArea
AHGFLink	Simple FeatureClass	Polyline	-
AHGFNode	Simple FeatureClass	Point	NetworkArtificialNode NetworkCliffNode NetworkGhostNode NetworkHeadNode NetworkJunctionNode NetworkTerminusNode NetworkWaterAreaNode
Stand Alone ObjectClass(s)			
AHGFNodeLinkConnectivityDown	Table	-	-
AHGFNodeLinkConnectivityUp	Table	-	-

The following tables describe the key attributes for Geofabric Hydrology Reporting Catchments.

Table 36 – Key attributes of AHGFContractedCatchment feature class for Geofabric Hydrology Reporting Catchments

Key attribute	Alias	Description
ConNodeID	ContractedNodeID	Persistent unique identifier of related logical AHGF contracted node
ConLevel	ContractLevel	Confidence level of related logical AHGF contracted node
TConNodeID	ToContractedNodeID	The next downstream ConNodeID
NetNodeID	NetworkNodeID	HydroID of node that represents the contracted node in AHGFNetworkNode
MapNodeID	MappedNodeID	HydroID of node that represents the contracted node in AHGFMappedNode

Table 37 – Key attributes of AHGFLink feature class for Geofabric Hydrology Reporting Catchments

Key attribute	Alias	Description
FConNodeID	FromContractedNodeID	The next upstream ConNodeID
TConNodeID	ToContractedNodeID	The next downstream ConNodeID
DrainID	DrainID	The HydroID for the AHGFCatchment into which the AHGFLink drains

Table 38 – Key attributes of AHGFNode feature class for Geofabric Hydrology Reporting Catchments

Key attribute	Alias	Description
ConNodeID	ContractedNodeID	Persistent unique identifier of related logical AHGF contracted node
ConLevel	ContractLevel	Confidence level of related logical AHGF contracted node
MapNodeID	MappedNodeID	HydroID of node that represents the contracted node in AHGFMappedNode
NextDownID	NextDownID	The HydroID for the next downstream AHGFNode

Table 39 – Key attributes of AHGFNodeLinkConnectivityDown table for Geofabric Hydrology Reporting Catchments

Key attribute	Alias	Description
From_ID	From_ID	The next upstream AHGFNode ID
To_ID	To_ID	The next downstream AHGFNode ID
Link_ID	Link_ID	HydroID of the Link feature

Table 40 – Key attributes of AHGFNodeLinkConnectivityUp table for Geofabric Hydrology Reporting Catchments

Key attribute	Alias	Description
From_ID	From_ID	The next downstream AHGFNode ID
To_ID	To_ID	The next upstream AHGFNode ID
Link_ID	Link_ID	HydroID of the Link feature

5.5.3 Description of Geofabric Hydrology Reporting Catchments data

All contracted catchment features of type ContractedArea are aggregations of the AHGFCatchment units that participate in a relationship of common geographic extent based upon the location of a contracted node from both Geofabric Surface Cartography and Geofabric Surface Network or a data sink as defined within the DEM-9S. Levels of confidence for contracted nodes are further described in the following section of the Geofabric Product Guide.

Each ContractedArea is assigned with the contracted node identifier (ConNodeID) and the confidence level (ConLevel) of the contracted node to which they drain. The ContractedArea features are the drainage areas of a combination of Levels 1 and 2 contracted nodes. These drainage areas also incorporate catchment areas where there is no discernable flow (at 1:250,000 scale) in the form of stream flow segment features. The allocation of no flow areas to contracted catchments is performed based on the most likely destination of water falling in these areas in flood type conditions.

Contracted catchment hierarchy

In previous versions of the Geofabric, the set of contracted catchment features provided a collection of drainage areas for a set of persistent contracted nodes. In V2.1 these areas have been further processed to aggregate these features into a contracted catchment hierarchy. This hierarchy of contracted catchments includes only those catchments for key contracted nodes taken from a full set of contractible river confluences, sinks, monitoring points and the inflow and outflow points of water storages. These key contracted nodes form a stable, logical, dendritic hierarchy of catchments that can be reliably reproduced when moving to higher resolution or larger scaled data. The contracted catchment hierarchy provides a reliable and stable set of catchments that, among other things, can be mapped to a number of types of water reporting areas (depending on the use case) as exemplified by the stable reporting regions given in Hydrology Reporting Regions.

5.5.4 Contracted nodes and confidence attribution

Contracted node attributes are a special feature of the Geofabric that identify important hydrological features such as stream confluences, stream coastal outlets, inland sinks and inflow and outflow of water storages. Once identified, a contracted

node is given a persistent identifier across the suite of products that is designed to persist through subsequent versions. As the products evolve, and the base information becomes more detailed, more contracted nodes will be added.

The business rule for the creation of a candidate contracted node is that the stream segments flowing into a node must be attributed according to a series of contracted confidence levels and be identifiable in both products (AHGFNetworkStream and AHGFMappedStream). For example, a confluence node of two or more streams that have attributes of both NAMED (i.e. the name attribute is populated) and MAJOR (a hierarchy classification of Major), and exist in both Geofabric Surface Cartography and Geofabric Surface Network, will be designated as a contracted node of the highest confidence level. Therefore, this contracted node and its Attribute ID (ConNodeID) will be highly likely to persist and have representations within both Geofabric Surface Cartography and Geofabric Surface Network, regardless of future product updates. Refer to Table 41 and Table 42 for contracted node creation rules.

Table 41 – Candidate contracted node creation rules for stream confluences and stream coastal outlets

Contracted confidence level			**Stream confluences**				**Stream coastal outlets**	
			Stream segment 1		**Stream segment 2 or more**		**Stream segment 1**	
Node attribute	**Confidence rank**	**Usage**	**Name attribute**	**Hierarchy attribute**	**Name attribute**	**Hierarchy attribute**	**Name attribute**	**Hierarchy attribute**
Level 1	highest	recommended	named	major	named	major	named	major
Level 2		usable	named	major	named	minor/empty	named	minor/empty
Level 2		usable	named	minor/empty	named	minor/empty	named	minor/empty
Level 3		marginal	unnamed	major	unnamed	major	unnamed	major
Level 3		marginal	named	major	unnamed	major	unnamed	major
Level 4	lowest	not recommended	unnamed	minor/empty	unnamed	minor/empty	unnamed	minor/empty

Table 42 – Candidate contracted node creation rules for water bodies and inland sinks

Contracted confidence level			**Water body inflow and outflow**		**Inland sinks**		
			Water body	**DEM-9S Data sink**	**Stream segment 1**		**DEM-9S Data sink**
Node attribute	**Confidence rank**	**Usage**	**Name attribute**	**Sink confidence level**	**Name attribute**	**Hierarchy attribute**	**Sink confidence level**
Level 1	highest	recommended	Named	1	named	major	1
Level 1		usable	Named	2	named	minor/empty	2
Level 2		usable	Unnamed	1	named	minor/empty	1
Level 2		usable	Named	Null	unnamed	major	2
Level 2		usable	Unnamed	2			

This page intentionally left blank

5.6 Geofabric Hydrology Reporting Regions

Geofabric Hydrology Reporting Regions is derived from aggregations of contracted catchments from Geofabric Hydrology Reporting Catchments. This product contains two candidate reporting regions, namely AWRA Drainage Division for national scale reporting purposes and River Region for regional scale reporting purposes. More reporting regions may be added in future releases based on user requirements.

The AWRA Drainage Division is defined for the purpose of providing a stable set of reporting regions specifically for the purpose of the Bureau's Australian Water Resources Assessment 2010 and are referred to as the 2010 Assessment Reporting Regions.

The River Regions were based on a specification developed by Bureau hydrologists involved in water resources assessment in consultation with the Geofabric team and scientists from CSIRO and ANU. These boundaries were developed for use in regional scale reporting and hydrological modelling. The River Region boundaries were not used in the Australian Water Resources Assessment 2010 but may be considered in the future as the resolution of reporting increases.

Though the Geofabric Hydrology Reporting Regions have been developed for the purposes of the Australian Water Resources Assessment, it is envisaged that these units can be used more generally as a standard for hydrological reporting at the national and regional scale, and thus replace the Australia River Basins 1997 (www.ga.gov.au/meta/ANZCW0703005427.html).

Table 43 shows the Geofabric Hydrology Reporting Regions feature class terminology and feature subtypes.

5.6.1 Understanding and using Geofabric Hydrology Reporting Regions

The purpose of Geofabric Hydrology Reporting Regions is to provide a stable set of reporting boundaries at both the national and regional scale. It contains two levels of hydrological reporting regions. The first delineates national level drainage divisions and the second delineates regional level river regions across Australia.

While the Geofabric Hydrology Reporting Regions were developed on the basis of Bureau requirements for water resources assessment, it is envisaged that these units can be more generally used as the standard for hydrological reporting at the national and regional scale and thus replace GA's River Basins (1997).

The Reporting Region products exist as polygon feature classes and can be used for reporting hydrological phenomena within a given catchment or catchments. Alternately, the contracted catchment features can be accessed through a lookup table, namely AWRADDContractedCatchmentLookup or RRContractedCatchmentLookup tables.

Some applications for this product include:

- use of the AWRADrainageDivisions for national scale hydrological reporting
- use of the RiverRegions for regional scale hydrological reporting

- aggregation of data or statistics according to hydrological significant units
- presentation of information for maps which make comparisons across reporting regions. For example, a map of water availability by region
- use as a boundary layer for searching and locating data of interest within a given region.

5.6.2 Feature classes, feature types, related tables and key attributes

Table 43 – Feature classes and tables for Geofabric Hydrology Reporting Regions

ObjectClass Name	Type	Geometry	Subtype
HR_Regions			
AWRADrainageDivision	Simple FeatureClass	Polygon	-
RiverRegion	Simple FeatureClass	Polygon	-
Stand Alone ObjectClass(s)			
AWRADDContractedCatchmentLookup	Table	-	-
RRContractedCatchmentLookup	Table	-	-

The following tables describe the key attributes for Geofabric Hydrology Reporting Regions.

Table 44 – Key attributes of AWRADrainageDivision feature class for Geofabric Hydrology Reporting Regions

Key attribute	Alias	Description
DivNumber	DivisionNumber	The number assigned to the AWRADrainageDivision
Division	Division	The name assigned to the AWRADrainageDivision

Table 45 – Key attributes of RiverRegion feature class for Geofabric Hydrology Reporting Regions

Key attribute	Alias	Description
Division	Division	The corresponding AWRADrainageDivision name
RivRegName	RiverRegionName	The name assigned to the RiverRegion

Table 46 – Key attributes of AWRADDContractedCatchmentLookup table for Geofabric Hydrology Reporting Regions

Key attribute	Alias	Description
ConCatID	ContractedCatchmentID	The HydroID for a contracted catchment
AWRADDID	AWRADDID	Numeric ID of the Drainage Divisions

Key attribute	Alias	Description
ConNodeID	ContractedNodeID	ConNodeID corresponding to AHGFNode
CCHydroID	ContractedCatchmentHydroID	HydroID of the contracted catchment

Table 47 – Key attributes of RRContractedCatchmentLookup table for Geofabric Hydrology Reporting Regions

Key attribute	Alias	Description
ConCatID	ContractedCatchmentID	The HydroID for a contracted catchment
RRID	RRID	Numeric ID of the River Regions
ConNodeID	ContractedNodeID	ConNodeID corresponding to AHGFNode
CCHydroID	ContractedCatchmentHydroID	HydroID of the contracted catchment

6 Database schemas by product

Database schemas are available for each product:

- Geofabric Surface Cartography
- Geofabric Surface Network
- Geofabric Surface Catchments
- Geofabric Groundwater Cartography
- Geofabric Hydrology Reporting Catchments
- Geofabric Hydrology Reporting Regions.

These are available: www.bom.gov.au/water/geofabric/documentation.shtml

7 Data dictionaries

Data dictionaries are available for each product:

- Geofabric Surface Cartography
- Geofabric Surface Network
- Geofabric Surface Catchments
- Geofabric Groundwater Cartography
- Geofabric Hydrology Reporting Catchments
- Geofabric Hydrology Reporting Regions.

These are available at: www.bom.gov.au/water/geofabric/documentation.shtml

8 Data Product Specifications (DPS)

The Data Product Specifications are based upon the AS/NZS ISO 19131:2008 Geographic information – Data product specifications standard (AS/NZS, July 21, 2008), http://www.saiglobal.com/online/. This document provides a framework for the completion of a DPS for the geographic data product produced as part of the Geofabric project.

Data Product Specifications are available for each product:

- Geofabric Surface Cartography
- Geofabric Surface Network
- Geofabric Surface Catchments
- Geofabric Groundwater Cartography
- Geofabric Hydrology Reporting Catchments
- Geofabric Hydrology Reporting Regions.

These are available at: www.bom.gov.au/water/geofabric/documentation.shtml

References

Atkinson, R, Power, R, Lemon, D, O'Hagan, R, Dee, D & Kinny, D 2008, *The Australian Hydrological Geospatial Fabric – development methodology and conceptual architecture*, CSIRO Water for a Healthy Country National Research Flagship report, Australia.

Fenner School of Environment and Society, ANU and Geoscience Australia 2008, *GEODATA 9 Second DEM and D8 Digital Elevation Model Version 3 and Flow Direction Grid, User Guide*, Geoscience Australia, (www.ga.gov.au/image_cache/GA11644.pdf).

Geoscience Australia 1997, *Australia's River Basins 1997: GA Metadata*, www.ga.gov.au/meta/ANZCW0703005427.html

Horizon Systems Corporation 2008, *NHDPlus Home,* www.horizon-systems.com/NHDPlus/index.php

Stein, JL, Hutchinson, MF & Stein, JA 2008a, Appendix 7: "Development of a continent-wide spatial framework", in *Ecohydrological regionalisation of Australia: a tool for management and science, Innovations Project GRU36, Final Report to Land and Water Australia,* BJ Pusey, MJ KennardJL Stein, JD Olden, SJ Mackay, MF Hutchinson & F Sheldon (eds).

Stein, JL & Hutchinson, MF 2008b, *A review of nested catchment reference systems for Version 1.0 of the National Catchments and Reporting Units*, Report to the Bureau of Meteorology Australia, Fenner School of Environment and Society, Australian National University, Australia.

Appendix 1: Data mappings – foundation input data to Geofabric Maintenance Geodatabase

In order to process Geofabric foundation data, the data from four primary input datasets, namely AusHydro, ANUDEM Streams, the National Catchment Boundaries and OzCoasts were mapped as given in the following five tables. The data received from the Interim Groundwater Data was transferred directly from the delivery geodatabase into the Geofabric and as such did not need to be re-mapped.

These input data are post-processed into the Geofabric Maintenance Geodatabase. The data are then extracted from this geodatabase and packaged into the discreet Geofabric V2.1 product suite. As part of the creation of the Geofabric Maintenance Geodatabase, there are features and subtypes created by the Bureau as a result of loading, transforming or otherwise manipulating the input data.

Table 48 – Mapping of AusHydro data to Geofabric Maintenance Geodatabase

AusHydro Input Feature Classes	Feature Class Geometry	AusHydro Feature Class + AusHydro Subtypes (if applicable)	AGHF_Hydrography - Feature Class.Subtype	AHGF Feature Type Number
CanalAreas	polygon	CanalAreas.	AHGFHydroArea.CanalArea	55
CanalLines	line	CanalLines.	AHGFCanalLine	30
DamWalls	line	DamWalls.	AHGFHydroLine.DamWall	48
Discontinuities	line	Discontinuities.Cliff	AHGFHydroLine.CliffLine	49
Flats	polygon	Flats.LandSubjectToInundation	AHGFHydroArea.Flat	56
		Flats.MarineSwamp	AHGFHydroArea.Flat	56
		Flats.SalineCoastalFlat	AHGFHydroArea.Flat	56
		Flats.Swamp	AHGFWaterbody.Swamp	27
ForeshoreFlats	polygon	ForeshoreFlats.	AHGFHydroArea.ForeshoreFlat	59
FrameworkBoundaries	line	FrameworkBoundaries.Shoreline	AHGFHydroLine.Shoreline	51
		FrameworkBoundaries.Junction	AHGFHydroLine.ShorelineJunction	52
		FrameworkBoundaries.LimitOfData	none	
		FrameworkBoundaries.StateBorder		
Lakes	polygon	Lakes	AHGFWaterbody.Lake	26
Levees	lines	Levee	AHGFHydroLine.Levee	50
Locations	points	Locations.Bay	AHGFHydroPoint.Bay	44
		Locations.Beach	none	
		Locations.Cape		
		Locations.Gorge		
		Locations.Mountain		
		Locations.Pass		
		Locations.RoadJunction		
		Locations.WaterbodyIsland		
		Locations.Placename		
Locks	points	Locks	AHGFStructure.Lock	33

AusHydro Input Feature Classes	Feature Class Geometry	AusHydro Feature Class + AusHydro Subtypes (if applicable)	AGHF_Hydrography - Feature Class.Subtype	AHGF Feature Type Number
Pipelines	line	Pipelines.GasPipeline	none	
		Pipelines.OilPipeline		
		Pipelines.PipelineOther		
		Pipelines.WaterPipeline	AHGFWaterPipeline	29
PondageAreas	polygon	PondageAreas.AquacultureArea	AHGFHydroArea.PondageArea	57
		PondageAreas.SaltEvaporator	AHGFHydroArea.PondageArea	57
		PondageAreas.SettlingPond	AHGFHydroArea.PondageArea	57
RailwayBridgePoints	points	RailwayBridgePoints.	AHGFStructure.Bridge	35
RailwayTunnelLines	line	RailwayTunnelLines.	AHGFHydroLine.Tunnel	53
RapidAreas	polygon	RapidAreas.	AHGFHydroArea.RapidArea	58
RapidLines	line	RapidLines.	AHGFHydroLine.RapidLine	46
Reservoirs	polygon	Reservoirs.FloodIrrigationStorage	AHGFWaterbody.Reservoir	25
		Reservoirs.TownRuralStorage	AHGFWaterbody.Reservoir	25
RoadCrossingPoints	points	RoadCrossingPoints.FordPoint	AHGFStructure.Ford	36
		RoadCrossingPoints.RoadBridgePoint	AHGFStructure.Bridge	35
RoadTunnelLines	line	RoadTunnelLines.	AHGFHydroLine.Tunnel	53
Seas	polygon	Seas	AHGFSea	32
Spillways	line	Spillways	AHGFHydroLine.Spillway	47
Springs	points	Spring.	AHGFHydroPoint.Spring	37
WatercourseAreas	polygon	WatercourseAreas.	AHGFHydroArea.WatercourseArea	54
WatercourseLines	line	WatercourseLines.Watercourse	AHGFMappedStream.MappedFlowSegment	11
		WatercourseLines.Connector (Non-WaterArea)	AHGFMappedStream.MappedArtificialFlowSegment	12
		WatercourseLines.Connector (WaterArea)	AHGFMappedStream.MappedWaterAreaSegment	13
Placeholder for new WCfeatures	line		AHGFMappedStream.MappedConstructedSegment	14
WaterfallPoints	points	WaterfallPoints	AHGFStructure.Waterfall	34
Waterholes	points	Waterholes	AHGFHydroPoint.Waterhole	45

AusHydro Input Feature Classes	Feature Class Geometry	AusHydro Feature Class + AusHydro Subtypes (if applicable)	AGHF_Hydrography - Feature Class.Subtype	AHGF Feature Type Number
WaterPoints	points	WaterPoints.GnammaHole	AHGFHydroPoint.GnammaHole	38
		WaterPoints.NativeWell	AHGFHydroPoint.NativeWell	39
		WaterPoints.Pool	AHGFHydroPoint.Pool	40
		WaterPoints.Rockhole	AHGFHydroPoint.Rockhole	41
		WaterPoints.Soak	AHGFHydroPoint.Soak	42
WaterStoragePoints	points	WaterStoragePoints.Dam	AHGFDam	31
		WaterStoragePoints.SwimmingPool	none	
		WaterStoragePoints.WaterTank	AHGFHydroPoint.WaterTank	43

Table 49 – Mapping of ANUDEM Streams to Geofabric Maintenance Geodatabase

ANUDEM Input Feature Classes	Feature Class Geometry	Feature Class Subtypes	Stream Segment Type Attribute	Water Body Segment Type Attribute	AGHF_Framework – Feature Class.Subtype	AHGF Feature Type Number
ANUDEMDerivedStreams	line	none	watercourse		AHGFNetworkStream.NetworkFlowSegment	1
				lake connector	AHGFNetworkStream.NetworkWaterAreaSegment	3
				lake inlet	AHGFNetworkStream.NetworkFlowSegment	1
				lake outlet	AHGFNetworkStream.NetworkFlowSegment	1
				reservoir connector	AHGFNetworkStream.NetworkWaterAreaSegment	3
				reservoir inlet	AHGFNetworkStream.NetworkFlowSegment	1
				reservoir outlet	AHGFNetworkStream.NetworkFlowSegment	1
			DEM connector		AHGFNetworkStream.NetworkArtificialFlowSegment	2
				lake connector	AHGFNetworkStream.NetworkWaterAreaSegment	3
				lake inlet	AHGFNetworkStream.NetworkArtificialFlowSegment	2
				lake outlet	AHGFNetworkStream.NetworkArtificialFlowSegment	2
				reservoir connector	AHGFNetworkStream.NetworkWaterAreaSegment	3
				reservoir inlet	AHGFNetworkStream.NetworkArtificialFlowSegment	2
				reservoir outlet	AHGFNetworkStream.NetworkArtificialFlowSegment	2
			DEM connector V1*		AHGFNetworkStream.NetworkFlowSegment	1
				lake connector	AHGFNetworkStream.NetworkWaterAreaSegment	3
				lake inlet	AHGFNetworkStream.NetworkFlowSegment	1
				lake outlet	AHGFNetworkStream.NetworkFlowSegment	1
				reservoir connector	AHGFNetworkStream.NetworkWaterAreaSegment	3
				reservoir inlet	AHGFNetworkStream.NetworkFlowSegment	1

ANUDEM Input Feature Classes	Feature Class Geometry	Feature Class Subtypes	Stream Segment Type Attribute	Water Body Segment Type Attribute	AGHF_Framework – Feature Class.Subtype	AHGF Feature Type Number
ANUDEMDerivedStreams	line	none	vector connector**		AHGFNetworkStream.NetworkFlowSegment	1
				lake connector	AHGFNetworkStream.NetworkWaterAreaSegment	3
				lake inlet	AHGFNetworkStream.NetworkFlowSegment	1
				lake outlet	AHGFNetworkStream.NetworkFlowSegment	1
				reservoir connector	AHGFNetworkStream.NetworkWaterAreaSegment	3
				reservoir inlet	AHGFNetworkStream.NetworkFlowSegment	1
TerrainDiscontinuities	line	none			AHGFTerrainBreakline	28
ANUDEMDataSinks	point	none			None (used only in processing)	na

* DEM connector V1 features are former DEM connector features that were subsequently added into AusHydro as WatercourseLines.
** Vector connector features are AusHydro features that do not exist in a raster environment due resolution issues.

Table 50 – Mapping of the National Catchment Boundaries to Geofabric Maintenance Geodatabase

NCB Feature Classes/Tables to Geofabric Maintenance Geodatabase – Framework (and external)					
ANUDEM Input Feature Classes	**Feature Class Geometry**	**Feature Class + Subtypes**	**Attributes**	**AGHF_Framework/external – Feature Class.Subtype**	**AHGF Feature Type Number**
NationalCatchmentBoundaries	polygon		Catchment Atts	AHGFCatchment	21
NCBPfafstetter	table		Pfafstetter Atts	NCBPfafstetter	table
NCBLevel1Vector	polygon	none		NCBLevel1DrainageDivision	na
NCBLevel2Vector	polygon	none		NCBLevel2DrainageBasin	na

Table 51 – Mapping of the OzCoasts to Geofabric Maintenance Geodatabase

ANUDEM Input Feature Classes	Feature Class Geometry	Feature Class + Subtypes	Hydrography – Feature Class	AHGF Feature Type Number
OzCoast (NSW)	polygon	geohab_nsw_v2	AHGFEstuary	72
OzCoast (NT)	polygon	geohab_nt_v2	AHGFEstuary	72
OzCoast (QLD)	polygon	geohab_qld_v2	AHGFEstuary	72
OzCoast (SA)	polygon	geohab	AHGFEstuary	72
OzCoast (TAS)	polygon	geohab_tas	AHGFEstuary	72
OzCoast (VIC)	polygon	geohab_vic	AHGFEstuary	72
OzCoast (WA)	polygon	geohab_wa_v2	AHGFEstuary	72

Table 52 – Features created by the Bureau to augment the foundation input data in the Geofabric Maintenance Geodatabase

Feature classes created for Geofabric Maintenance Geodatabase – Hydrography, AHGF_Framework, AHGF_Tables and Groundwater

Feature Types created by input process or owned by the Bureau	Feature Class Geometry	Hydrography – Feature Class.Subtype	AHGF_Framework – Feature Class.Subtype	Ground water – Feature Class. Subtype	AHGF_Tables – Table Name	AHGF Feature Type Number
AtmosphericMonitoringPoint	point	AHGFMonitoringPoint. AtmosphericMonitoringPoint				60
SurfaceWaterMonitoringPoint	point	AHGFMonitoringPoint. SurfaceWaterMonitoringPoint				61
GroundwaterMonitoringPoint	point	AHGFMonitoringPoint. GroundwaterMonitoringPoint				62
StorageMonitoringPoint	point	AHGFMonitoringPoint. StorageMonitoringPoint				63
OfftakeReturnMonitoringPoint	point	AHGFMonitoringPoint. OfftakeReturnMonitoringPoint				64
MappedJunctionNode	point	AHGFMappedNode. MappedJunctionNode				14
MappedTerminusNode	point	AHGFMappedNode. MappedTerminusNode				15
MappedArtificialNode	point	AHGFMappedNode. MappedArtificialNode				16
MappedWaterAreaNode	point	AHGFMappedNode. MappedWaterAreaNode				17
MappedGhostNode	point	AHGFMappedNode. MappedGhostNode				18
MappedHeadNode	point	AHGFMappedNode. MappedHeadNode				19
MappedCliffNode	point	AHGFMappedNode. MappedCliffNode				20
NetworkTerminusNode	point		AHGFNetworkNode.NetworkHeadNode			4
NetworkJunctionNode	point		AHGFNetworkNode.NetworkJunctionNode			5
NetworkArtificialNode	point		AHGFNetworkNode.NetworkArtificialNode			6
NetworkWaterAreaNode	point		AHGFNetworkNode.NetworkWaterAreaNode			7
NetworkGhostNode	point		AHGFNetworkNode.NetworkGhostNode			8
NetworkHeadNode	point		AHGFNetworkNode.NetworkTerminusNode			9

Feature Types created by input process or owned by the Bureau	Feature Class Geometry	Hydrography – Feature Class.Subtype	AHGF_Framework – Feature Class.Subtype	Groundwater – Feature Class.Subtype	AHGF_Tables – Table Name	AHGF Feature Type Number
NetworkCliffNode	point		AHGFNetworkNode. NetworkCliffNode			10
ContractedNode	table				AHGFContractedNode	
ContractedArea	polygon		AHGFContractedCatchment. ContractedArea			22
NonContractedArea	polygon		AHGFContractedCatchment. NonContractedArea			23
NoFlowArea	polygon		AHGFContractedCatchment. NoFlowArea			24
MappedStream_FS	table				AHGFMappedStream_FS	
NetworkStream_FS	table				AHGFNetworkStream_FS	
NetworkConnectivityUp	table	-	-	-	AHGFNetworkConnectivity Up	-
NetworkConnectivityDown	table	-	-	-	AHGFNetworkConnectivity Down	-
MappedConnectivityUp	table	-	-	-	AHGFMappedConnectivity Up	-
MappedConnectivityDown	table	-	-	-	AHGFMappedConnectivity Down	-
NodeLinkConnectivityUp	table	-	-	-	AHGFNodeLinkConnectivity Up	-
NodeLinkConnectivityDown	table	-	-	-	AHGFNodeLinkConnectivity Down	-
Link	line		AHGFLink			65
AquiferBoundary	polygon			AHGFAquiferBoundary		66
AquiferOutcrop	polygon			AHGFAquiferOutcrop		67
AquiferContourTop	line			AHGFAquiferContour.AquiferContourTop		68
AquiferContourBottom	line			AHGFAquiferContour.AquiferContourBottom		69
BedrockContourTop	line			AHGFAquiferContour.BedrockContourTop		73
SurficialHydrogeologicUnit	polygon			AHGFSurficialHydrogeologicUnit		70
WaterTableAquifer	polygon			AHGFWaterTableAquifer		71
AquiferSalinity	polygon			IGWAquiferSalinity		na

Feature Types created by input process or owned by the Bureau	Feature Class Geometry	Hydrography – Feature Class.Subtype	AHGF_Framework – Feature Class.Subtype	Groundwater – Feature Class.Subtype	AHGF_Tables – Table Name	AHGF Feature Type Number
AquiferYield	polygon			IGWAquiferYield		na
WaterTableSalinity	polygon			IGWWaterTableSalinity		na
WaterTableYield	polygon			IGWWaterTableYield		na
WaterTableHydraulicConductivity	polygon			IGWWaterTableHydraulicConductivity		na
Estuary	polygon	AHGFEstuary				72

Note: All of these features are created by the data input process.

Highlighted text indicates a Bureau created feature.

This page intentionally left blank

Appendix 2: Data mappings – Geofabric Maintenance Geodatabase to Geofabric V2.1 product suite

The following six tables show the feature type registries of the Geofabric Maintenance Geodatabase and their mappings to the Geofabric V2.1 product suite.

Table 53 – Product feature type registry for Geofabric Surface Cartography

SH_Hydrographic – Feature Class/TableName.Subtype(Type)	Feature Class Geometry	AHGF Feature Type Number
AHGFMappedStream.MappedFlowSegment	line	11
AHGFMappedStream.MappedArtificialSegment	line	12
AHGFMappedStream.MappedWaterAreaSegment	line	13
AHGFMappedNode.MappedJunctionNode	points	14
AHGFMappedNode.MappedTerminusNode	points	15
AHGFMappedNode.MappedArtificialNode	points	16
AHGFMappedNode.MappedWaterAreaNode	points	17
AHGFMappedNode.MappedGhostNode	points	18
AHGFMappedNode.MappedHeadNode	points	19
AHGFMappedNode.MappedCliffNode	points	20
AHGFWaterbody.Reservoir	polygon	25
AHGFWaterbody.Lake	polygon	26
AHGFWaterbody.Swamp	polygon	27
AHGFTerrainBreakline	line	28
AHGFPipeline	line	29
AHGFCanalLine	line	30
AHGFDam	points	31
AHGFSea	polygon	32
AHGFStructure.Lock	points	33
AHGFStructure.Waterfall	points	34
AHGFStructure.Bridge	points	35
AHGFStructure.Ford	points	36
AHGFHydroPoint.Spring	points	37
AHGFHydroPoint.GnammaHole	points	38
AHGFHydroPoint.NativeWell	points	39
AHGFHydroPoint.Pool	points	40
AHGFHydroPoint.Rockhole	points	41
AHGFHydroPoint.Soak	points	42
AHGFHydroPoint.WaterTank	points	43
AHGFHydroPoint.Bay	points	44
AHGFHydroPoint.Waterhole	points	45
AHGFHydroLine.RapidLine	line	46
AHGFHydroLine.Spillway	line	47
AHGFHydroLine.DamWall	line	48
AHGFHydroLine.CliffLine	line	49
AHGFHydroLine.Levee	lines	50

SH_Hydrographic – Feature	Feature Class	AHGF Feature

Class/TableName.Subtype(Type)	Geometry	Type Number
AHGFHydroLine.Shoreline	line	51
AHGFHydroLine.ShorelineJunction	line	52
AHGFHydroLine.Tunnel	line	53
AHGFHydroArea.WatercourseArea	polygon	54
AHGFHydroArea.CanalArea	polygon	55
AHGFHydroArea.Flat	polygon	56
AHGFHydroArea.PondageArea	polygon	57
AHGFHydroArea.RapidArea	polygon	58
AHGFHydroArea.ForeshoreFlat	polygon	59
AHGFMappedStream_FS	na	table
MappedConnectivityUp	na	table
MappedConnectivityDown	na	table
AHGFEstuary	polygon	72

Note: Highlighted text indicates a Bureau created feature.

Table 54 – Product feature type registry for Geofabric Surface Network

SH_Network – Feature Class/TableName.Subtype(Type)	Feature Class Geometry	AHGF Feature Type Number
AHGFNetworkStream.FlowSegment	line	1
AHGFNetworkStream.ArtificialFlowSegment	line	2
AHGFNetworkStream.WaterAreaSegment	line	3
AHGFNetworkNode.NetworkJunctionNode	points	4
AHGFNetworkNode.NetworkTerminusNode	points	5
AHGFNetworkNode.NetworkArtificialNode	points	6
AHGFNetworkNode.NetworkWaterAreaNode	points	7
AHGFNetworkNode.NetworkGhostNode	points	8
AHGFNetworkNode.NetworkHeadNode	points	9
AHGFNetworkNode.NetworkCliffNode	points	10
AHGFCatchment	polygon	21
AHGFContractedCatchment.ContractedArea	polygon	22
AHGFContractedCatchment.NonContractedArea	polygon	23
AHGFContractedCatchment.NoFlowArea	polygon	24
AHGFWaterbody.Reservoir	polygon	25
AHGFWaterbody.Lake	polygon	26
AHGFWaterbody.Swamp	polygon	27
AHGFNetworkStream_FS	na	table
NetworkConnectivityUp	na	table
NetworkConnectivityDown	na	table

Note: Highlighted text indicates a Bureau created feature.

Table 55 – Product feature type registry for Geofabric Surface Catchments

SH_Catchments – Feature Class/TableName.Subtype(Type)	Feature Class Geometry	AHGF Feature Type Number
AHGFCatchment	polygon	21
NCBPfafstetter	na	table
NCBLevel1DrainageDivision	polygon	na
NCBLevel2DrainageBasin	polygon	na

Table 56 – Product feature type registry for Geofabric Groundwater Cartography

GW_Cartographic – Feature Class/TableName.Subtype(Type)	Feature Class Geometry	AHGF Feature Type Number
AHGFAquiferBoundary	polygon	66
AHGFAquiferOutcrop	polygon	67
AHGFAquiferContour.AHGFAquiferContourTop	line	68
AHGFAquiferContour.AquiferContourBottom	line	69
AHGFAquiferContour.BedrockContourTop	line	73
AHGFSurficialHydrogeologicUnit	polygon	70
AHGFWaterTableAquifer	polygon	71
IGWAquiferSalinity	polygon	na
IGWAquiferYield	polygon	na
IGWWaterTableSalinity	polygon	na
IGWWaterTableYield	polygon	na
IGWWaterTableHydraulicConductivity	polygon	na

Note: Highlighted text indicates a Bureau created feature.

Table 57 – Product feature type registry for Geofabric Hydrology Reporting Catchments

HR_Catchments - Feature Class/TableName.Subtype(Type)	Feature Class Geometry	AHGF Feature Type Number
AHGFNode.NetworkJunctionNode*	points	4
AHGFNode.NetworkTerminusNode*	points	5
AHGFNode.NetworkArtificialNode*	points	6
AHGFNode.NetworkWaterAreaNode*	points	7
AHGFNode.NetworkGhostNode*	points	8
AHGFNode.NetworkHeadNode*	points	9
AHGFNode.NetworkCliffNode*	points	10
AHGFContractedCatchment.ContractedArea	polygon	22
AHGFContractedCatchment.NonContractedArea	polygon	23
AHGFContractedCatchment.NoFlowArea	polygon	24
AHGFLink	line	65
NodeLinkConnectivityUp	na	table
NodeLinkConnectivityDown	na	table

* Subset of AHGFNetworkNode features corresponding to logically contracted nodes.

Note: Highlighted text indicates a Bureau created feature.

Table 58 – Product feature type registry for Geofabric Hydrology Reporting Regions

HR_Regions - Feature Class/TableName.Subtype(Type)	Feature Class Geometry	AHGF Feature Type Number
NCBLevel1DrainageDivision	polygon	na
NCBLevel2DrainageBasin	polygon	na
AWRADrainageDivisionCatchmentLookup	na	table
RiverRegionCatchmentLookup	na	table

* Subset of AHGFNetworkNode features corresponding to logically contracted nodes.

Note: Highlighted text indicates a Bureau created feature.

Appendix 3: The Pfafstetter reference system and attribute descriptions for the Pfafstetter table

The Pfafstetter reference system (Verdin and Verdin 1999) is the most widely used of the hierarchical catchment reference schemes. It was adopted for the European-wide stream and catchment database (Vogt, Colombo & Bertolo 2003) following a comprehensive review of alternative coding schemes (Britton 2002). Phillips, Redfern and Bain (2002) used the Pfafstetter system to delineate nested catchment units for the trial of a new method of conservation assessment for the Burnett River catchment in Queensland. It is also the basis of the global HYDRO1k nested catchment coverage (U.S. Geological Survey 2001) and applied in both China and Austria to support hydrological modelling activities (Fürst & Horhan *in press*; Jia et al. 2006; Zhang et al. 2007).

The Pfafstetter system, based on concepts developed by a Brazilian engineer, Otto Pfafstetter, delineates a hierarchical, spatially nested catchment reference system. It defines and numerically codes topographically defined sub-basin units guided by the topology of the drainage network and the size of the drainage area. The system is efficient, using only the digits zero to nine for each level of subdivision, which is significantly fewer digits than other coding schemes (Verdin & Verdin 1999). Consequently, continents can be subdivided into a large number of hydrological units with relatively short and manageable identification numbers.

The codes convey useful information about topological relations in a catchment. For example, all sections of a river network either up or downstream of any feature of interest are readily inferred from the codes using simple algebraic queries.

The system delineates hydrological units that it labels as basins and inter-basins. A Pfafstetter basin is the area drained by a tributary. The area directly drained by the reach of the main stem lying between two tributaries is labelled an inter-basin. The Pfafstetter system defines the main stem as the one draining the larger area, even where this may contradict usual naming conventions. Basins and inter-basins are repeatedly subdivided into four major tributary sub-basins, coded with the even digits, and five inter-basins, coded with the odd digits, as many times as supported by the DEM. A closed basin, that is the area draining to an internal sink, is assigned a code of zero.

The Pfafstetter coding scheme restricts subdivision of a single hydrological unit to no more than nine sub-units. When applied to a continent with many thousands of drainage basins, an additional procedure for aggregating basins is needed to keep the number of units within these limits. Verdin and Verdin's (1999) method is to treat the adjacent groups of small coastal draining basins that lie between the four largest drainage basins as coastal inter-basins. The first (Level 1) subdivision of a continent thus delineates the largest closed basin and the four largest of the coastal basins, and allocates the remaining coastal areas to coastal inter-basins.

The Pfafstetter reference system description above is an excerpt from Stein & Hutchinson (2008).

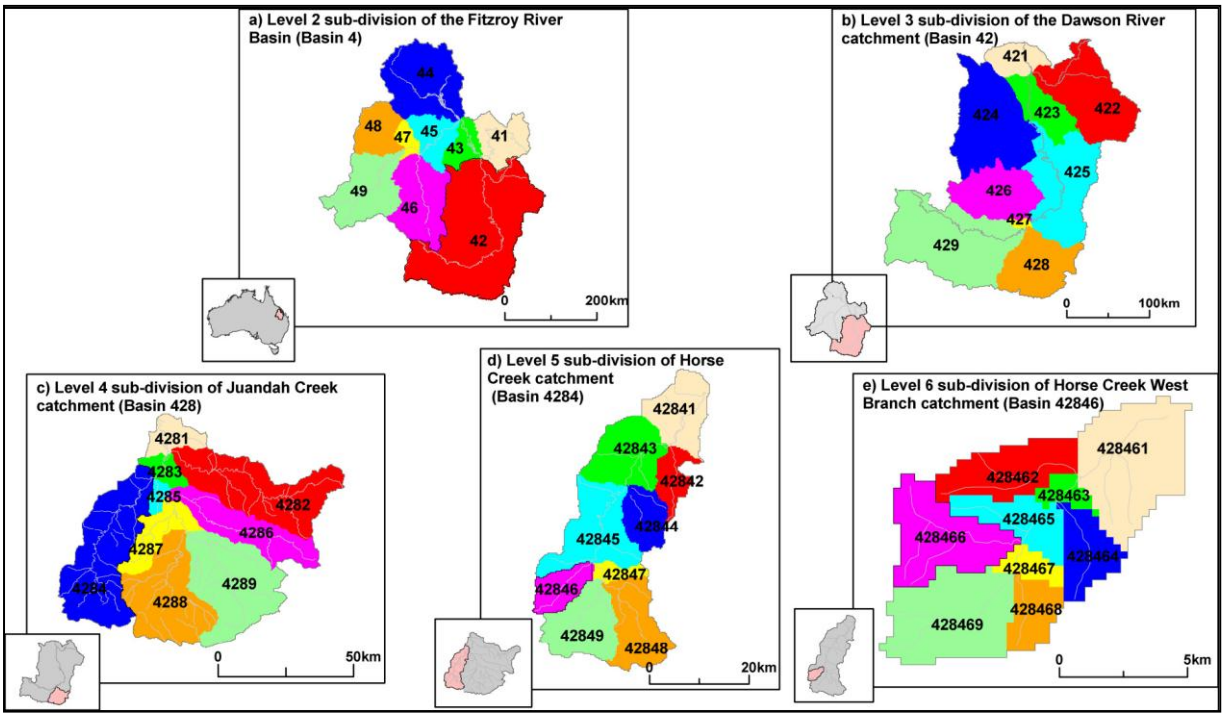

Figure 3 – Pfafstetter subdivision of the Fitzroy River basin (Level 1 basin 4)

(Source: Stein & Hutchinson 2008)

Relationship between AHGFCatchments and the Pfafstetter table

Geofabric Surface Catchments contains the attribute field NCB_ID. This attribute links the NCB_Pfafstetter table to the AHGFCatchment feature class using a relationship class called CatchmentIsExtendedbyPfafstetter. Table 59 lists the fields and attribute definitions for the NCB_Pfafstetter table.

Table 59 – NCB_Pfafstetter table with field attributes and definitions

Feature Class attribute field	Attribute description
NCB_ID	Unique NCB (National Catchment Boundaries) identifier
BASIN	9 second DEM basin number, links to same field in BASINS9S feature layer
BASINNAME	Name of 9 second DEM basin (generally the name of the largest stream or if no named streams or the largest lake has an area greater than 100km^2 the name of the largest lake, NULL where there is neither a named stream or lake)
NCB_CODE	NCB Code in the form Division_Level2_PfafstetterCode
PfafNo	Pfafstetter number

Feature Class attribute field	Attribute description
LEVEL1	NCB Level 1 number (= 9 second DEM Drainage Division Number)
DIVISION	NCB Level 1 name (= 9 second DEM Drainage Division Name)
LEVEL2	NCB Level 2 number (internal 9 second basins merged with basins draining to the coast or into Lake Eyre, aggregated to approximate the AWRC Basins)
LEVEL2NAME	NCB Level 2 name (based on AWRC basin names)
PFAFL3	NCB Level 3 Pfafstetter Code
PFAFL4	NCB Level 4 Pfafstetter Code
PFAFL5	NCB Level 5 Pfafstetter Code
PFAFL6	NCB Level 6 Pfafstetter Code
PFAFL7	NCB Level 7 Pfafstetter Code
PFAFL8	NCB Level 8 Pfafstetter Code
PFAFL9	NCB Level 9 Pfafstetter Code
PFAFL10	NCB Level 10 Pfafstetter Code
PFAFL11	NCB Level 11 Pfafstetter Code
PFAFL12	NCB Level 12 Pfafstetter Code
PFAFL13	NCB Level 13 Pfafstetter Code
PFAFL14	NCB Level 14 Pfafstetter Code
PFAFL15	NCB Level 15 Pfafstetter Code
BasinLevel	Indicates at what Pfafstetter level a basin is first separately identified
LastPfaf	Last Pfafstetter level that is valid for the catchment
BasinPfaf	Basin-specific Pfafstetter code
BasinD8	AWRC basin number of the AWRC basin occupying the majority of the NCB catchment
AWRCBNUM	AWRC basin number of the AWRC basin occupying the majority of the NCB catchment unit
AWRCRNUM	AWRC region number of the AWRC basin occupying the majority of the NCB catchment unit
AWRCDNUM	AWRC division number of the AWRC basin occupying the majority of the NCB catchment unit
AWRCBNAME	AWRC basin name of the AWRC basin occupying the majority of the NCB catchment unit
AWRCRNAME	AWRC region name of the AWRC basin occupying the majority of the NCB catchment unit
AWRCDNAME	AWRC division name of the AWRC basin occupying the majority of the NCB catchment unit
AnaBrLevel	Level of sub-division at which the anabranch or anabranch downstream of the stream segment is coded separately from the main stem
MainStemUp	NCB_ID of main stem stream segment upstream of an anabranch (0 if not an anabranch offtake)
AnaBrDown	NCB_ID of anabranch segment immediately downstream (0 if not an anabranch offtake)

Appendix 4: Data quality information for the foundation data inputs

The quality of the spatial data and attribution is largely based upon the input data from AusHydro and ANUDEM Streams and the National Catchment Boundaries.

Additional post-processing of these feature classes creates the resulting feature classes within the Geofabric products. The data quality information cited here is from documentation that accompanies the AusHydro dataset inputs.

AusHydro and ANUDEM Streams

Lineage

It is anticipated that AusHydro will be used for a large range of applications. This lineage information is provided so that the user can understand the data sources, their history, characteristics, how they were incorporated, and the accuracy and limitations of the resultant data.

AusHydro is an amalgamation of two parent datasets to produce a single, authoritative, national stream network and a surface water feature dataset suitable for hydrological analysis at national scales. All features were populated with an AusHydro_ID field and data source code in the FeatureSource Field.

AusHydro reconciles the natural watercourse geometry from an enhanced, ANU Fenner School for Environment and Society (ANU) GEODATA 1 Surface Hydrography dataset, and the relevant attribute data from GEODATA 3. Some line work from GEODATA TOPO 250K Series 3 was also integrated. The resulting WatercourseLines feature class encapsulates the topologically correct flow paths from the ANU enhanced GEODATA 1, but with updated, quality assured and quality controlled attribute information of GEODATA 3.

The attributes from GEODATA Series 3 were transferred using spatial queries to identify common features between the two datasets. Additional semi-automated and manual editing was undertaken to ensure connectivity and continuity of attribution along the entire network. Intensive network analysis and quality assurance were also carried out to verify the accuracy of the flow directed geometric network.

The working names of the three source surface hydrography datasets used in the creation of AusHydro are:

- GEODATA TOPO 250K Series 1 (GEODATA 1)
- GEODADAT TOPO 250K Series 2 (GEODATA 2)
- GEODATA TOPO 250K Series 3 (GEODATA 3)
- GEODATA 9 Second Digital Elevation Model (DEM-9S) Version 3
- GEODATA 9 Second Flow Direction Grid (D8-9S).

WatercourseLines feature class

The first source dataset is based on the GEODATA 1 WatercourseLines completed by GA in 1994 as a cartographic product, but whose geometry was comprehensively revised and augmented by researchers from the ANU. This was done in conjunction with development of the DEM-9S Version 3 and D8-9S.

ANU integrated data digitised from scanned national topographic 1:100,000 maps and other products to improve the representation of surface water flow, as well as updated material from GEODATA 2 (2003) and GEODATA 3 (2006). Features incorporated include: revised spot heights/elevation points, sinks, streamlines, connectors, cliff lines, water bodies, trigonometric points from the National Geodetic Database and additional elevation, streamline and sink point data digitised by the ANU from 1:100,000 source material.

Approximately 700,000 additional stream segments were captured from the 1:100,000 digital datasets and other source materials, adding significant detail and value to the national drainage network, and for this reason the ANU dataset was chosen over GEODATA 3.

DEM derived streams

The ANUDEM program generalised the input data streamlines (AusHydro – WatercourseLines) to the grid of the DEM-9S. The resulting DEM raster network consists of flow pathways defined by the national flow direction grid (D8-9S) traced from channel heads to coastal outlets (or inland sinks) to ensure full network connectivity (Stein 2006). The process turns the raster stream network into a fully connected DEM derived stream network, suitable for use in the generation of the catchment boundaries. Further information on of ANUDEM can be found on the Fenner School of Environment and Society website (http://fennerschool.anu.edu.au/research/publications/software-datasets).

The following outputs are derived from the DEM-9S using the ANUDEM program:

- multi-flow direction grid (focused on representing flow directions for catchments rather than hillsides)
- DEM derived streams network.

The ANUDEM D8-9S is then modified to:

- add multi-directional junctions to ensure that anabranching connections are appropriately represented
- manually adjust flow directions to make sure that connections between catchments that should not exist (but do as a result of resolution issues, e.g. multi-directional streams present in a single grid cell) are removed.

The ANUDEM Streams network is used to determine cells that represent stream heads. These equate to any cell containing the head of a first order stream in the ANUDEM

Stream network. The flow direction on the modified flow direction grid is then traced, cell by cell, until the coast or an inland sink is reached, as shown in Figure 4.

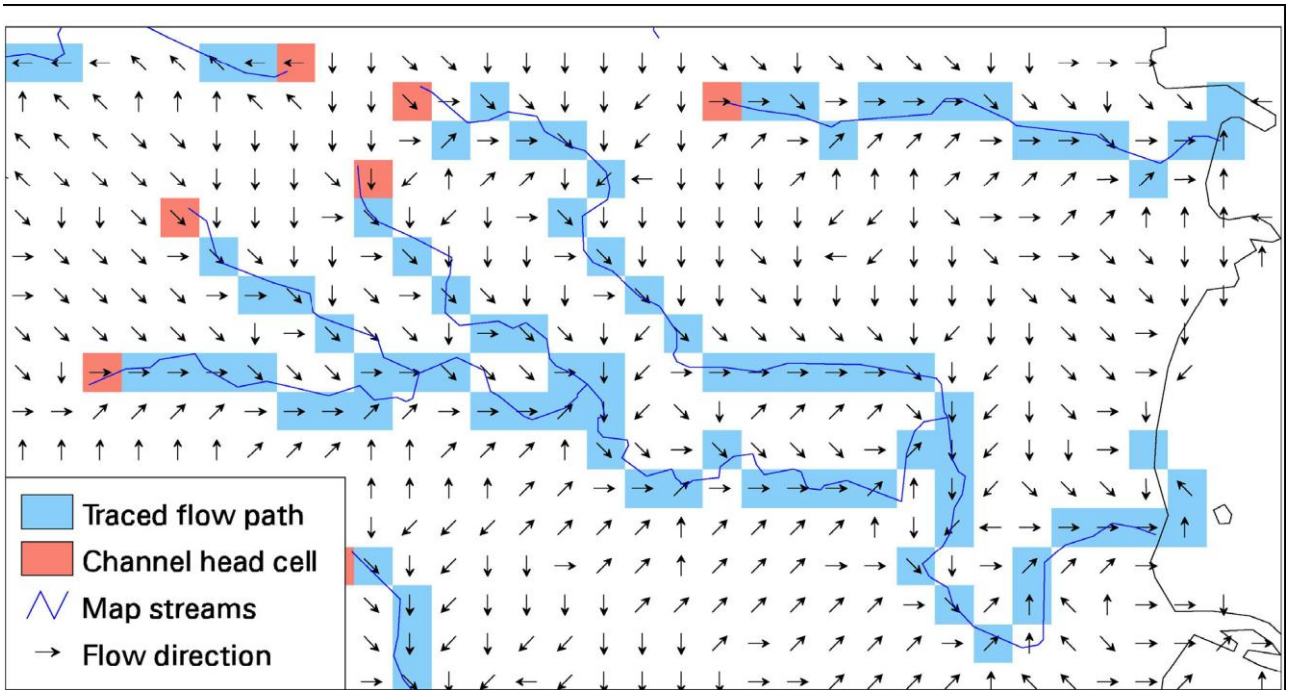

Figure 4 – Example of tracing the stream network from channel head grid cells to an outlet on the coast

(Source: Stein 2006)

In order to distinguish the actual channelised flow network from sections and to maintain connectivity (connectors), the ANUDEM Streams are broken wherever there are disjunctions in the mapped streams as represented in the ANUDEM Streams network.

All source channels (excluding main stem, i.e. first order segments) with a contributing area of less than 1.25km2 are pruned from ANUDEM Streams network. A main stem segment is determined by traversing up the network and ascertaining which of the tributaries has the largest drainage area at each junction (i.e. confluence/bifurcation).

Finally, the remaining network is broken into segments based upon segmentation rules, which enforce breaks at heads, termini, confluences and bifurcations.

For further documentation on the DEM-9S and the D8-9S, including complete lineage and limitations information, see:
ga.gov.au/topographic-mapping/digital-elevation-models/index.jsp

GEODATA TOPO 250K Series 3

Released by GA in 2006, the GEODATA 3 product is primarily sourced from GEODATA 2 and 1:250,000 scale map reproduction material (from the National Topographic Map Series and Defence Joint Operation Graphics). A key revision source for the data is satellite imagery taken from the SPOT Panchromatic and LANDSAT Thematic Mapper Sensors, as well as material from a variety of other respected sources. This includes naming from the Gazetteer of Australia, the authoritative source for geographic names in Australia.

More information about the sources for this data can be found in GA's TOPO 250K Topographic Data and Map Specifications: www.ga.gov.au/mapspecs/250k100k

The following hydrographical features from the GEODATA 3 dataset were incorporated into AusHydro in their original, unmodified form: canal lines, locks, rapid lines, spillways, waterfall points, bores, canal areas, flats, lakes, pondage areas, rapid areas, reservoirs, springs, watercourse areas, waterholes, water points, marine hazard areas, marine hazard points and foreshore flats.

The AusHydro dataset also contains cultural and transport features that may intersect hydrography features: railway tunnels, rail crossings, railway bridges, road tunnels, road bridges, road crossings and water pipelines.

Since ANU watercourse augmentation did not include updating feature attribution, GEODATA 3 was primarily used for this purpose as it had the most accurate attribution on a national scale. The following attributes were transferred from GEODATA 3: name, perenniality and hierarchy.

The geometries of some watercourse features from the GEODATA 3 layer were added as well. Specifically, some watercourses that did not exist in the ANU dataset, but matched the D8-9S flow paths derived from the DEM-9S, were added manually.

Modified feature classes from GEODATA TOPO 250K Series 3

The following table lists feature classes that were derived from GEODATA 3. Please note that these feature classes are not identical to GEODATA 3 and were modified. Feature classes that were derived from, but are not identical to those in GEODATA 3, and the changes that were made to them, are as follows:

Table 60 – Feature classes derived from GEODATA TOPO 250K Series 3

Feature classes	Source	Modification
RailwayCrossingLines and RailBridgePoints	GEODATA TOPO 250K Series 3	Feature classes were merged to form a single point feature class, RailwayBridgePoints (AusHydro)
RailwayTunnelLines and RailwayTunnelPoints	GEODATA TOPO 250K Series 3	Feature classes were merged to form a single point feature class, RailwayTunnelLines (AusHydro)
RoadCrossingLines and RoadCrossingPoints	GEODATA TOPO 250K Series 3	Feature classes were merged to form a single point feature class, RoadCrossingPoints (AusHydro)
RoadTunnelLines and RoadTunnelPoints	GEODATA TOPO 250K Series 3	Feature classes were merged to form a single point feature class, RoadTunnelLines (AusHydro)
Pipelines	AusHydro	Contains all features of feature subtype WaterPipeline from the feature class Pipelines (GEODATA 3) (features of subtype GasPipeline, OilPipeline and PipelineOther were not included)
Locations	AusHydro	Contains all features of feature subtype Bay from the feature class Locations (GEODATA 3) (features of subtype Beach, Cape, Gorge, Mountain, Pass, RoadJunction, WaterbodyIsland and PlaceName were not included)
TerrainDiscontinuities	ANU FSES modified cliffs layer derived from the previous and current versions of the Geodata datasets and the 9 Second DEM.	This feature class was used to create breakpoints and segmentation rules to aid in the creation of the WatercourseLines layer
Discontinuities	AusHydro	Contains all features of feature subtypes Cliffs and Levees from GEODATA 3 (features of subtype Cutting and Embankment were not included)

References (Appendices 1 to 4)

Britton, P. (2002) Review of Existing River Coding Systems For River Basin Management and Reporting (Draft). Version 1.9. European Coding Systems, WFD GIS Working Group, 29 pp. Retrieved from: http://193.178.1.168/River_Coding_Review.pdf

Fürst, J. and Horhan, T. (2009) Coding of watershed and river hierarchy to support GIS-based hydrological analyses at different scales. Computers & Geosciences 35(3): 688–696.

Jia, Y, Wang, H, Zhou, Z, Qiu, Y, Luo, X, Want, J, Uan, D & Qin, D 2006, 'Development of the WEP-L distributed hydrological model and dynamic assessment of water resources in the Yellow River Basin', *Journal of Hydrology*, vol. 331, no. 3–4, pp. 606–629.

Phillips, N, Redfern, F & Bain, J 2002, *Determining the Conservation Value of Waterways – Burnett River Catchment Trial*, Queensland Environmental Protection Agency, Brisbane.

Stein, JL 2006, 'A continental landscape framework for systematic conservation planning for Australian rivers and streams', PhD thesis, Centre for Resource and Environmental Studies, Australian National University (https://digitalcollections.anu.edu.au/handle/1885/49406).

Stein, JL & Hutchinson, MF 2008, *A review of nested catchment reference systems for Version 1.0 of the National Catchments and Reporting Units*, Report to the Bureau of Meteorology Australia, Fenner School of Environment and Society, Australian National University, Australia.

U.S. Geological Survey 2001, *HYDRO1K Elevation Derivative Database*, U.S. Geological Survey EROS Data Centre (http://eros.usgs.gov/#/Find_Data/Products_and_Data_Available/gtopo30/hydro).

Verdin, KL & Verdin, JP 1999, 'A topological system for delineation and codification of the Earth's river basins', *Journal of Hydrology*, vol. 218, no. 1–2, pp. 1–12.

Vogt, J, Colombo, R & Bertolo, F 2003, 'Deriving drainage networks and catchment boundaries: a new methodology combining digital elevation data and environmental characteristics', *Geomorphology*, vol. 53, no. 3–4, pp. 281–298.

Zhang, L, Wang, Q, Dai, BX & Li, TJ 2007, 'Classification and codification methods of stream networks in a river basin: a review', *Environmental Informatics Archives*, vol. 5, pp. 364–372

Water Information
DATA › INFORMATION › INSIGHT

Through the *Water Act 2007*, the Australian Government has given the Bureau of Meteorology responsibility for compiling and delivering comprehensive water information across Australia.

For more information
Visit our website at www.bom.gov.au/water
Send an email request to waterinfo@bom.gov.au

Australian Government
Bureau of Meteorology