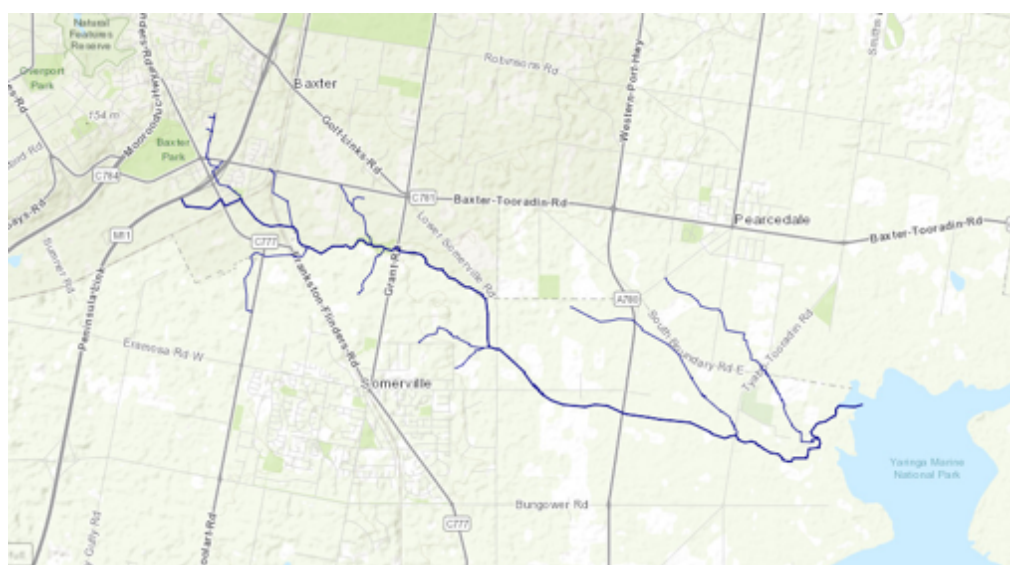


# Melbourne Water Stream Network Version 1.1

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WATERWAY ECOSYSTEM  
RESEARCH GROUP



## Technical Report

19.4a

# **Melbourne Waterway Research-Practice Partnership**

*Technical Report 19.4*

*Melbourne Water Stream Network. Version 1.1*

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**Cover photo:** Watsons Creek

## Summary

The Melbourne Water Stream Network represents the flow paths and catchments of the streams and rivers of the Greater Melbourne Region (the region managed by Melbourne Water). The Network is a spatial dataset that :

- improves the accuracy of stream alignments and extent throughout the region beyond existing stream maps;
- uses existing stream line data from several sources, ensuring downstream connectivity of lines, correcting delineation errors and augmenting the network to include small headwater streams missing from earlier stream data;
- standardises names of streams across the region, giving each stream a unique name and code;
- splits the stream lines into reaches at confluences and between confluences so that reaches are almost all less than 500 m long;
- provide a unique meaningful code for each reach, linked to existing codes such as Melbourne Water's asset identifiers;
- delineates a subcatchment boundary derived from a 5-m digital elevation model for each reach;
- is stored as two shapefiles (streams and subcatchments), and also as a spatial database structured to permit (with associated R functions) rapid calculation of upstream catchment statistics, such as land-use fractions, and rapid derivation of catchment boundaries. These functions can also be used through an application on the web.

Citation (for this report and for the use of any data downloaded from <https://tools.thewerg.unimelb.edu.au/mwstr/>: this site provides a direct interface to the data)

Kunapo, J., Walsh, C.J., Sammonds, M.J. (2020) The Melbourne Water Stream Network. Version 1.1. Melbourne Waterway Research-Practice Partnership Report 19.4a. School of Ecosystem and Forest Sciences, The University of Melbourne, Melbourne. URL. <https://tools.thewerg.unimelb.edu.au/mwstr/>

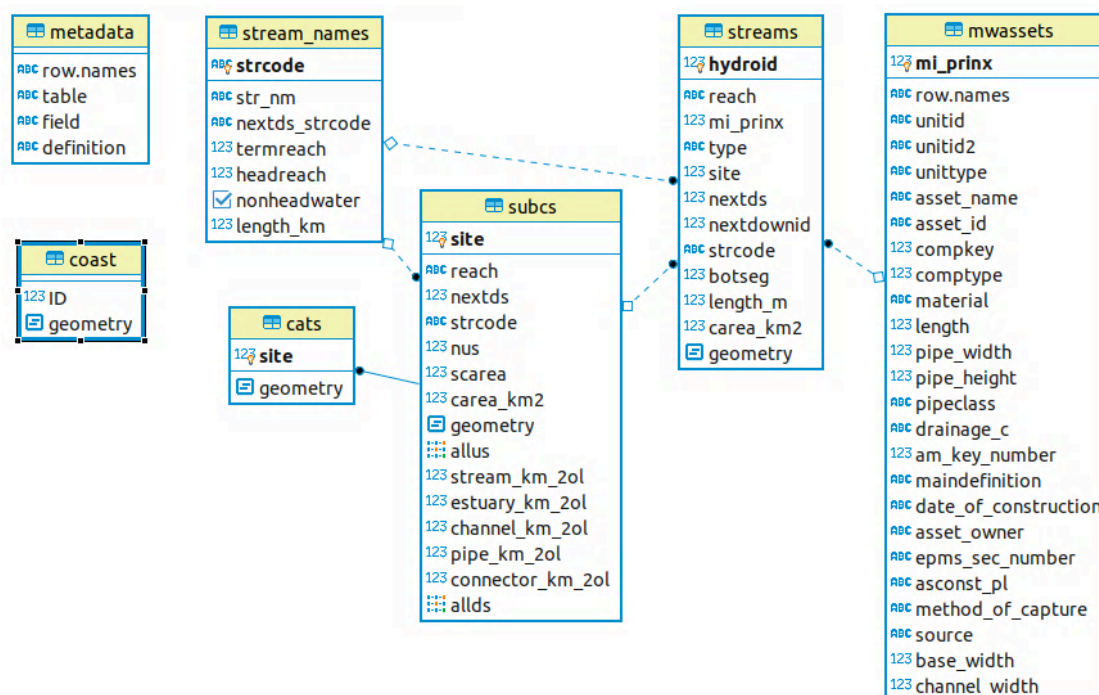
## Introduction

This document describes the structure of the Melbourne Water Stream Network dataset and provides illustrations of how to extract data from the dataset. The data are available in several forms (Table 1), with the most flexible for data extraction being a relational postgreSQL spatial database that can be accessed through the software program R using a library of functions. Currently this can only be accessed through the University of Melbourne network. However, a web application provides a simple interface for extracting data from the database. All data can be accessed through the web application at [tools.thewerg.unimelb.edu.au/mwstr/](https://tools.thewerg.unimelb.edu.au/mwstr/).

Version 1.1 improves on Version 1.0 in many ways that are detailed in Appendix 2<sup>1</sup>.

The tables of the database and their relationships are illustrated in Fig. 1. Each of the tables is described below.

Fig. 1. Table relationship diagram for the mwstr database, showing all fields in each table and connections between tables. Those with a geometry field are spatial tables. The 'coast' table is a polyline spatial table for adding a coast line to any stream-line maps.



<sup>1</sup> An archive of the version 1.0 data and manual can be found at [https://tools.thewerg.unimelb.edu.au/mwstr/mwstr\\_v1.0.zip](https://tools.thewerg.unimelb.edu.au/mwstr/mwstr_v1.0.zip).

Table 1. Melbourne Water stream network data components, structures and locations for access. The zip file containing shapefiles does not include the all-upstream and all-downstream arrays, nor the cats layer, all of which are too large to be included in this format.

Format	Description	File	Location
ESRI shapefiles	Stream layer Subcatchment layer Stream Name table MW asset table	mwstr_v1.1.shp mwsubc_v1.1.shp mwstr_v1.1_tables.xlsx	tools.thewerg.unimelb.edu.au/documents/mwstr/mwstr_v1.1.zip
Excel tables	Metadata table		
Postgres spatial database	Relational database with library of R functions for data extraction and manipulation	mwstr database mwstr_functions.R	tools.thewerg.unimelb.edu.au (MW version proposed) tools.thewerg.unimelb.edu.au/documents/mwstr/mwstr_functions.R
Web application	Shiny web application permitting extraction from the database	downloadable shapefiles	tools.thewerg.unimelb.edu.au/mwstr/
Documentation	This document in HTML, Word and Rmarkdown formats, the last containing source code used in producing this document	MWstreamNetworkManual.html MWstreamNetworkManual.docx MWstreamNetworkManual.Rmd	tools.thewerg.unimelb.edu.au/mwstr/

## The stream lines: table *mwstr*

The stream layer (table streams in the database) is made up of 140,920 lines, each with a unique combination of:

- reach code (reach), one of 133,575 unique reach/subcatchment codes made up of a three-character stream code and an integer equivalent to the reach's catchment area in ha (see below for more details). Each reach also has a unique numeric code called site, which is used for more efficient data extraction than is possible with the reach code (see subcs table, below).
- mi\_prinx, one of 15,878 unique identifiers that link to Melbourne Water's asset ID table. 86,827 reaches have no mi\_prinx value because they are small streams that augment the original Melbourne Water stream layers. 128,628 reaches have a single MI\_PRINX. It is usual for a single MI\_PRINX to extend over multiple subcs, however, 4,948 subcs have more than one MI\_PRINX.
- type, five types of streams derived mainly from the source data for the stream lines (Table 2).

Table 2. The five stream types in the Melbourne Water stream layer showing the total length of each type in the dataset, and the primary data source for each type. Sources beginning with "DR\_" are spatial layers used by Melbourne Water. For all types, we have made corrections to the original data where appropriate.

Type	Length (km)	Primary data source
stream	8,756	DR_Natural_Waterway_Centreline
stream extensions	13,842	Derived by GraceGIS, and augmented selectively in V1.1 by DR_Waterways_above_MW_Limit (See Appendix 1 methods)
channel or drain	1,441	DR_Channel_Centreline
estuary	209	Our estimates informed by Melbourne Water's estuary layer
connecting line through waterbody	196	DR_Waterway_Connector, with some added by us during assembly of the network
pipe	298	DR_UGround_Centreline

The primary data sources listed in Table 2 were corrected and augmented to produce the layer shown in Fig. 2.

While the Melbourne Water layer DR\_Natural\_Waterway\_Centreline was the base source for stream lines in the dataset, we corrected many lines using LiDAR (see appendix for more details), through manual checks (e.g. deletion of duplicate/overlapping/spurious lines) and in some cases filled in missing lines (sourceLayer "GraceGIS Links" in earlier versions of the stream layer).

Stream extensions were added from a fine-scale stream network derived from LiDAR using hill-shade to identify the head of gullies as the most upstream point, and in V1.1, further stream extensions were added to match those in the Melbourne Water layer DR\_Waterways\_above\_MW\_Limit, but only where those lines matched a channel visible on the LiDAR hill-shade (see Appendix 1).

"Connecting lines through waterbody" lines should not be interpreted as stream channels, but serve only to maintain the hydrologic connectivity of the network through large waterbodies, such as reservoirs.

We have excluded most of the network of underground urban stormwater pipes in Melbourne Water's DR\_UGround\_Centreline layer. However, we have retained all pipes

that connect upland sections of streams with either their outlet to the sea or with more downstream sections of streams or channels. We have also retained small segments of pipes at their outlets to the sea or to streams. These collectively make up 298 km of pipes in the dataset (Table 1).

We estimated estuary extent by visually inspecting aerial imagery and contours, cross-checking with Melbourne Water's estuary layer (HWS 2018 estuaries layer) and our on-ground experience. Several of the lines in Melbourne Water's layer extended too far into the catchments. The estuary extent in Fig. 1 is more correct, but likely retains some errors and omissions.

The streams table also contains the following fields (in addition to *reach*, *mi\_prinx*, *type*, and *site* considered above)

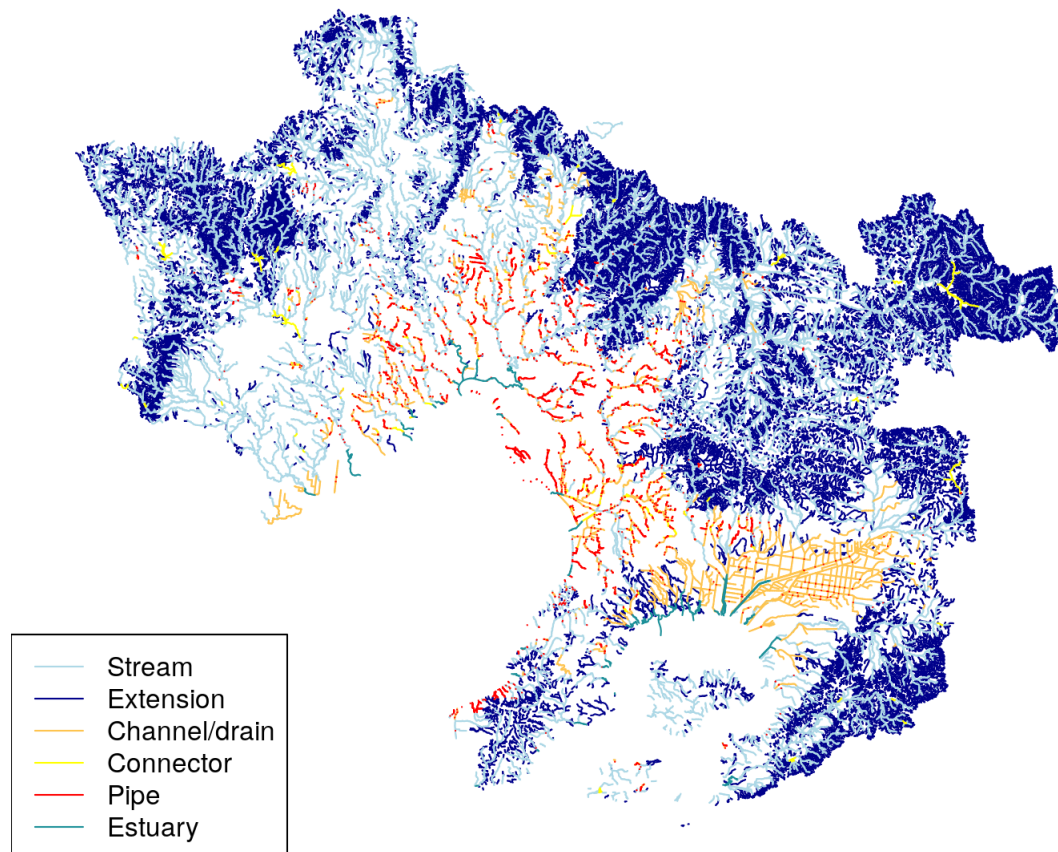
*nextds*, the next site downstream (see *subcs*, below).

*hydroid*, a unique integer code for every line segment. This differs from *site* because 4948 subcatchments (identified by *site* codes) contain more than one stream segment (when a subcatchment contains more than one line *type* or *mi\_prinx* value).

*nextdownid*, the next *hydroid* downstream of each line segment. This permits calculation of network relationships at a finer level than the *site* level.

*strcode*, the three-character stream code for the line flowing through the subcatchment. See *stream\_names* table below.

Fig. 2. Melbourne Water stream network colour-coded by type.





*bot\_seg*, = 1 if the line segment is the most downstream segment in the subcatchment, = 0 if not.

*length\_m*, length of the line segment in m.

*area\_km2*, the upstream catchment area in km<sup>2</sup> see *subcs*, below.

## The subcatchments: table *subcs* (and table *cats*)

The subcatchments layer (*subcs* table in the database) contains 133,576 subcatchments (Fig. 3). Subcatchments were derived from a 5-m digital elevation model, by selecting 'pourpoints' just upstream of each confluence of stream lines and of major stormwater drains with stream lines using an automated process. Pourpoints were also placed between confluences to avoid reaches exceeding 500 m long. Pourpoints were added near the uppermost point of most streams to permit delineation of headwater catchments, and the length of stream segment in these subcatchments can be short (<5 m). Excluding headwater catchments, the mean reach length is 236 m (1st and 99th percentiles 23 and 498 m respectively). Some longer reaches persist in the dataset (maximum length 4444 m) as a result of manual corrections and additions (e.g. the manual addition of reaches in the Wallaby Creek catchment to the north of the region).

Every subcatchment has a unique *reach* code matching the reach code of the stream lines flowing through it, and a unique integer code named *site*. The field *nextds* contains the next downstream subcatchment's 'site' code. Subcatchments of reaches that flow to the sea have a *nextds* value of -1.<sup>2</sup> The relationships between *site* and *nextds* permit network calculations such as aggregating statistics for all upstream subcatchments, or dissolving all upstream catchments to derive the catchment boundary for each reach.

We have structured the data to speed up the catchment calculations by:

- a) compiling a vector of all upstream 'site' codes for each subcatchment, saved as an 'array' field *allus* in the PostgreSQL database, to allow rapid calculation of upstream catchment statistics.
- b) deriving the full catchment boundary polygon for each subcatchment, and compiling them into the *cats* table in the database. Individual catchments can be retrieved quickly using the database, but the shapefile of the *cats* data is >2 Gb, and unweildy to use outside a database environment.
- c) compiling a vector of all downstream 'site' codes for each subcatchment, saved as an 'array' field *allus* in the, to allow rapid calculation of distances between reaches. This field is used by the [mwstr app](#) when 'show downstream' option is checked to plot downstream reaches.

---

<sup>2</sup> There are a few streams that are treated as terminal in the dataset, and have terminal segments (*nextds* = -1) that do not drain to the sea. These are: The upper reaches of Wallaby Creek, which drains to the Goulburn River; several small tributaries east of Sugarloaf reservoir that drain to the Maroondah aqueduct; and several small streams that drain to the Steeles Creek floodplain without any clear drainage connection to Steeles Creek.



Other fields in the subcs table (besides, *reach*, *site*, *nextds*, *allus* and *allds*) are:

*strcode*, the three-character stream code for the line flowing through the subcatchment. See *stream\_names* table below.

*scarea*, the area of the subcatchment polygon in m<sup>2</sup>. This is used to calculate upstream catchment areas (see below).

*carea\_km2*, the total area of all subcatchments including and upstream of each reach in km<sup>2</sup> (Fig. 5). This was calculated using the *allus* field above, and took ~6 min to calculate for the all reaches;

*stream\_km\_2ol*, *estuary\_km\_2ol*, *channel\_km\_2ol*, *pipe\_km\_2ol*, and *connector\_km\_2ol*\*, the total length of line segments of each type to the sea (or most downstream segment for inland 'terminal' streams) in km.

## Stream names: table *stream\_names*

The table *stream\_names* contains summary information about each of the 33,420 streams of the region.

Past stream map data for the Melbourne region has lacked a systematic, unambiguous approach to naming streams. We have ensured, in compiling the stream network data, that every stream (a continuous collection of lines from a headwater reach to a most downstream reach before it flows into another stream or to the sea) has a unique name that is consistent with its 'official' name, if it has one.

For instance, there are eight 'Deep Creeks' in the region, and each of them have been given a unique name describing their locality (*str\_nm*) and a unique three-digit stream code (*strcode*, Table 3).

The *stream\_names* table also lists:

- *nextds\_strcode*, the *strcode* of the stream to which each stream flows (*nextds\_strcode*, = "sea" if its outlet is marine);
- *nreach*, the number of reaches making up each stream;
- *headreach*, the most upstream reachcode (linked to tables *mwsbc*, *mwsbc\_streams*) of each stream;
- *termreach*, the most downstream reachcode of each stream;
- *nonheadwater*, = 0 for most streams, but = 1 for those which headreach is not a headwater. For instance, the Maribyrnong River is a non-headwater stream because it is the product of Deep and Jacksons Creeks (their termreaches flow to the headreach of the Maribyrnong);
- *length\_km*, the total length of all reaches of each stream.

Table 3. A subset of the stream\_names table showing details of the seven streams variously referred to as “Deep Creek”.

strcode	str_nm	nextds_strcode	termreach	headreach	nonheadwater	length_km
DPE	DEEP CREEK (KOOWEERUP)	Westernport North	98032	134544	FALSE	33.4
DP2	DEEP CREEK SOUTH D.S.	DPE	92507	92507	FALSE	0.0
USJ	DEEP CREEK (WESTERNPORT NEAR CORINELLA)	Westernport Southeast	107643	138676	FALSE	4.8
IC6	DEEP CREEK CATCH DRAIN	DPE	97702	348331	FALSE	9.5
DPW	DEEP CREEK (TRIB OF MARIBYRNONG)	MRB	44243	347931	FALSE	154.4
XWS	DEEP CREEK (TRIB OF DRY IN MARIBYRNONG CAT)	DRM	1223	111773	FALSE	5.2
DPC	DEEP CREEK (TRIB OF OSHANNASSY)	OSH	29722	120247	FALSE	12.0
Y66	DEEP CREEK (TRIB OF RUNNING IN DIAMOND CAT)	RUN	25195	115748	FALSE	10.2

Stream names can be used to quickly plot (and save) the lines of a stream, and optionally its tributaries and catchment boundary. For instance, the following code produced the three plots of the moderately large catchment of Deep Creek (Trib of Maribyrnong) shown in Fig. 4. Fig. 4A, showing just the main stem of Deep Creek took less than 1 s to extract and plot, Fig. 4B, including all of its tributaries took Fig. 4C, including tributaries and catchment boundary each took ~1.5 s.

Most streams plot significantly faster than this: for instance, a similar plot of Deep Creek, trib of O’Shannassy (see Table 3) took < 1 s to plot. The longest such calculation in the dataset (mouth of the Yarra River downstream of Maribyrnong River, more than one-third of the entire region) took 0.4 s, 9 s and 9.5 s respectively.

The [mwstr app](#) provides a web-based means of deriving such subsets of the data, allowing download of the derived catchment boundaries as GIS files.

Fig. 4. Code and resulting maps of an example stream (Deep Creek, trib of Maribyrnong), showing A. the main stem; B. main stem and tributaries; C. main stem, tributaries and catchment boundary.

```
strcodei <- "DPW"
site <- sqlQuery(paste("SELECT termreach FROM stream_names WHERE strcode = '", strcodei, "'
;", sep = ""), "mwstr_dev")$termreach
par(mar = c(0,0,0,0), mfrow = c(1,3))
plot_allus(site, plotTribs = FALSE, plotCatchment = FALSE)
title(main = " A.", adj = 0, line = -1)
plot_allus(site, plotTribs = TRUE, plotCatchment = FALSE)
title(main = " B.", adj = 0, line = -1)
plot_allus(site, plotTribs = TRUE, plotCatchment = TRUE)
title(main = " C.", adj = 0, line = -1)
```

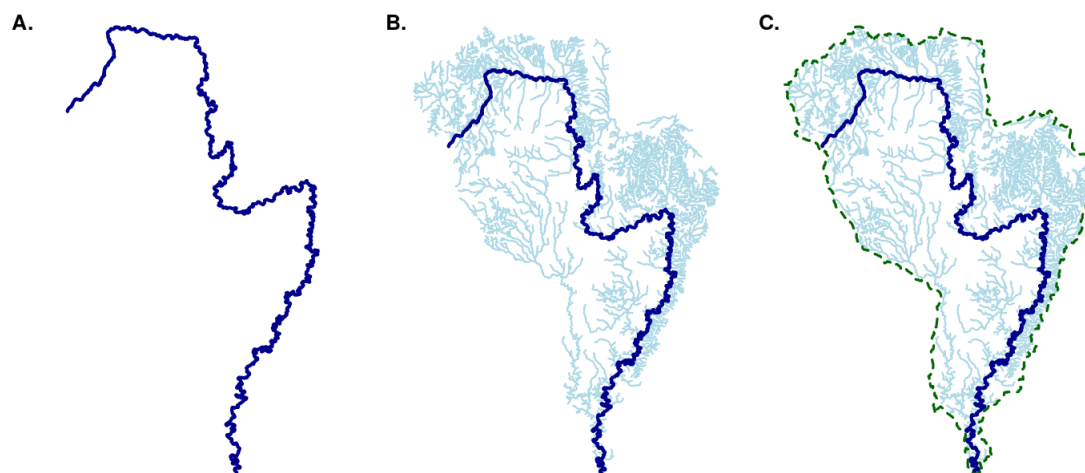
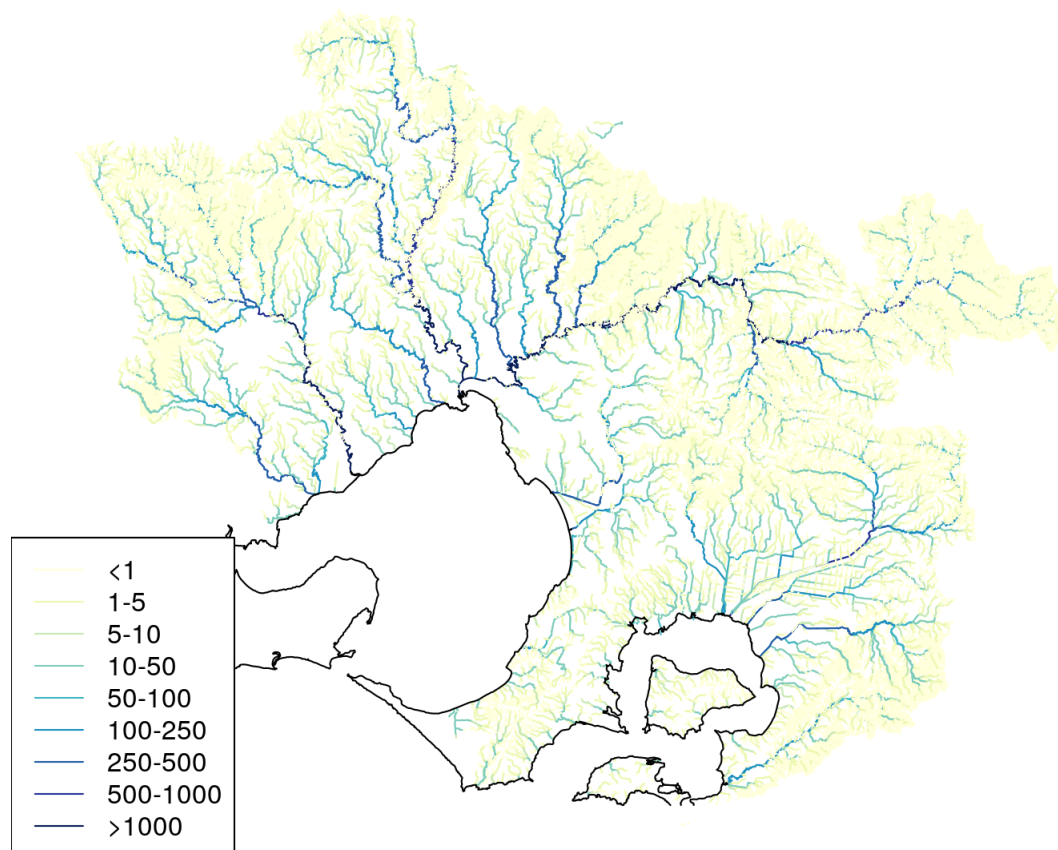


Fig. 5. Melbourne Water stream network colour-coded by catchment area in km<sup>2</sup>.



Libraries of environmental variables such as land cover, climatic and hydrologic variables are being developed at the time of writing. Variables will be calculated at the scale of subcatchment/reach and stored in a `subc_env` table in the stream network database.

The catchment area values were used to derive unique, meaningful reach codes for every reach. The reach codes consist of the three-character strcode (see `streamNames`, above) and a variable-length integer suffix equal to the catchment size of the reach in ha. To avoid any potential confusion with 7-character sitecodes used in earlier datasets (which used, in many cases, the same stream codes, but a different catchment area convention), the strcode and suffix are separated by a hyphen in the new reachcodes.

Thus, for instance, the reach of the Yarra River at Whittons Reserve, Wonga Park (YAR-223518) has a catchment area of 2235 km<sup>2</sup>, Little Stringybark Creek at the gauge in Wandin North (LIS-453) has a catchment area of 4.5 km<sup>2</sup>, and a spring in the headwaters of Ythan Creek near Mt Donna Buang (9YF-6, on 'TRIB (9YF) OF TRIB (9YE) OF TRIB (9YB) OF TRIB (LQD) OF YTHAN CREEK') has a catchment area of 6 ha.

## Appendix 1.

### streams

We chose to build the new stream network by adopting, adjusting and augmenting where necessary, the lines in the DR\_Natural\_Waterway\_Centreline to retain links to the MI\_PRINX asset identifications in the original data. We developed flow lines using an unconditioned LiDAR DEM with ESRI ArcHydro tools. We used these flow lines, in conjunction with a hillshade model (from the LiDAR DEM) to adjust the alignment of DR\_Natural\_Waterway\_Centreline, DR\_Channel\_Centreline and DR\_Waterways\_above\_MW\_Limit lines.

The Melbourne Water layers DR\_Channel\_Centreline and DR\_UGround\_Centreline were added to the stream lines where necessary to ensure a continuous hydrologically connected network. The complete DR\_UGround\_Centreline layer was not used, but we have retained all pipes that connect upland sections of streams with either their outlet to the sea or with more downstream sections of streams or channels. We have also retained small segments of pipes at their outlets to the sea or to streams. There were instances where the direction of the lines in the Melbourne Water layers were upstream. These were adjusted manually. Thus a non-duplicated, non-overlapping, fully node-to-node connected network was developed.

Version 1.1 was the product of several iterations as part of several projects, led by Grace Detailed-GIS Services, using data from different LiDAR acquisitions, and has resulted in results of varying quality across the region.

The first project added upstream extensions to the DR\_Natural\_Waterway\_Centreline layer, using 2009 LiDAR data where available (Fig A1-1A), and a lower-resolution DEM derived from available contour maps (5–10-m intervals) for the rest of the region. Lines with type = “stream extensions” in the area covered by the 2009 LiDAR are therefore of high quality.

The second project, was commissioned in 2019 to correct alignments of lines from the first project with stream order > 2 in areas covered by the 2018 LiDAR acquisition (Fig. A1-1B: at that time, we were not aware of the complete coverage of the 2016 LiDAR data). Alignments of stream lines with stream order >2 are therefore of high quality in the area covered by the 2018 LiDAR.

The third project was commissioned in 2020 after Melbourne Water discovered that we had compiled the stream network without reference to the DR\_Waterways\_above\_MW\_Limit layer, of which we were unaware. (For this project we also discovered the existence of the 2016 LiDAR data; Fig. A1-1B.) This project required checking of the DR\_Waterways\_above\_MW\_Limit layer and correcting the alignment and adding any of the lines in that layer that were omitted from previous versions (including adding nodes and splitting the existing lines to ensure hydrologic connectivity of the network). This step was taken in collaboration with Melbourne Water staff, and it was agreed that small cut drains without a clear place in the dendritic hydrologic network would not be included in the final product. The added lines in areas (including in areas outside the 2009 LiDAR extent) are of high quality.

The process of the third project involved substantial manual checking, correction and augmentation across the network, particularly in areas such as the southern slopes of Mt Donna Buang, where we had ground-truthed data on headwater locations. This process



of manual checking identified that further re-alignment and augmentation of headwater streams in the areas outside the 2009 LiDAR area (Fig. A1-1A), and further re-alignment of some larger streams in the upper Yarra (greyscale area in Fig. A1-1B) are still required. While alignments are broadly of high quality in these areas, Fig. A1-2 show examples of two areas in the upper Yarra region with larger streams needing re-alignment, and some small tributary channels requiring addition.

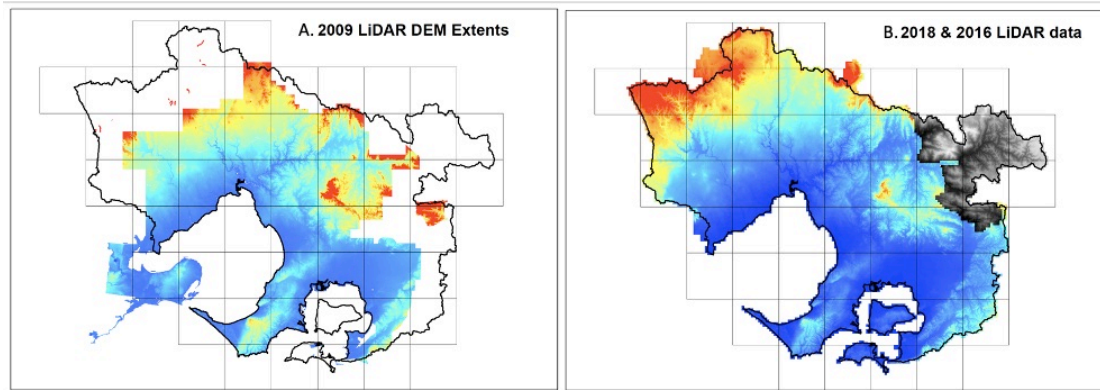


Fig.

A1-1. The Melbourne Water region (black-bordered polygon) and LiDAR availability in three years. A. Extent of LiDAR acquisition in 2009 (spectral colouring); B. Extent of LiDAR acquisition in 2018 (spectral colouring) and in 2016 (grey-scale).

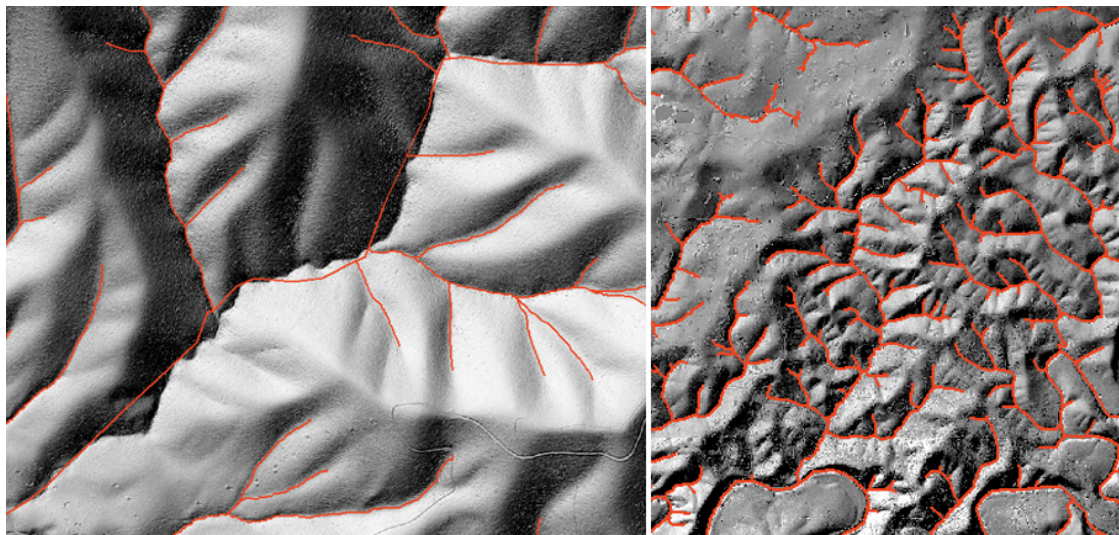


Fig.

A1-2. Screenshots of the hillshade model in two parts of the Upper Yarra catchment, with the stream layer in red, to illustrate areas of low-quality alignment and some missing headwater streams from the final product (left panel), and an area where the stream delineation is of high quality (right panel) for comparison.

## subcs

We developed the subcatchment layer by:

1. producing an engineered 5-m cell-size Digital Elevation Model (DEM) by forcing the stream network lines and council pipes into the original LiDAR DEM. Any sinks were identified and removed to develop the final hydrological DEM.
2. generating flow direction and flow accumulation grids, using the ArcGIS hydrological tools, and then deriving a 1-ha drainage network from flow accumulation model to ensure a minimum subcatchment area of 1 ha.
3. identifying the pour points to which the subcatchments should be derived on a 1-ha drainage network.
  - a. At the most upstream point of each stream. Because the line vectors did not necessarily sit on the optimal cell of the flow accumulation grid, these points were snapped to the nearest optimal flow accumulation cell of 5m raster.
  - b. At council pipe-stream confluences of the stream network. This was laborious because most of the council-pipe lines are not digitized to touch streams at their confluence. Because it was difficult to manually fix these gap for the entire region, the engineered DEM was used to create an automated network at a scale that represents the council pipe network and its relation to the stream network. Pour points upstream of confluence were selected from this automated network.
  - c. At stream-stream confluences of the stream network. These confluence points were first identified from the original stream network. Then the pour points from the automated network within a threshold of the original were identified. Further upstream-downstream tracing methods were used to identify the best confluence points to represent the original vector-based confluence points.
  - d. Between confluences of the stream network to avoid reaches exceeding 500 m long. These points were snapped to the optimal nearest flow cell. Any of these points which were within 100m of existing points generated in steps a-c were ignored.
  - e. At the upper limit of estuaries (as currently estimated). These points were also snapped to the optimal nearest flow cell
4. With the pour-points selected, subcatchments were developed using ESRI ArcHydro tools. The tool use input pour-points, rasterized stream network and the flow direction grid that was developed from the engineered DEM to derive subcatchments. From this automated subcatchments output, single pixel polygons were eliminated, island polygons were fixed and the upstream downstream connectivity for the derived subcatchments were established via next downstream id attribute.



## Appendix 2. Version changes.

Version 1.1 January 2020.

Many reaches of the stream layer in version 1.0 had many small non-contiguous segments allocated to incorrect reaches. These have all been corrected now so that all confluences meet at the terminal nodes of the relevant segments.

The subcatchment layer was recalculated using the corrected stream layer, and now every subcatchment contains a matching stream reach (in v1.0 7,546 subcatchments had no matching stream reach). This improvement removed the need for a linking table (*mwsbmc\_streams* in v1.0) between the streams and subcs tables. All information that was in the *mwsbmc\_streams* table in v1.0 is in the *subcs* table of v1.1).

Selecting and calculating related reaches upstream and downstream in the network is handled more efficiently in v1.1 using array fields in the PostgreSQL database for the *allus* (all upstream) and *allds* (all downstream) fields. This increased efficiency, and the derivation of the *cats* table removed the need for the 'florets' table, which was a feature of v1.0, no longer included in v1.1.

~1,100 km of additional stream length have been added with additional stream extensions

The reach code conventions have been revised from version 1.0. Instead of each reach being identified by a set four-digit code equal to 1000 times  $\log_{10}(\text{catchment area in } 100\text{-m}^2)$ , a variable-length integer of the catchment area in ha is now used. All subcatchments differ from their neighbouring subcatchments on the same stream line by at least 1 ha. 16 subcatchments downstream of small tributaries differed by <1 ha. For those cases, catchment areas were rounded up or down to ensure no duplicate reach codes.

Numerous minor changes made to reachcode field of small segments of *mwstr* to correct mismatches with *mwsbmc*, in most cases where the subcatchment boundaries (angular polygons based on 5-m gridcell DEM) crossed the finer-resolution stream lines. This class of errors affects a small percentage of stream lines, and have been corrected opportunistically as we use the network. Certainly other errors remain, but should not cause significant errors in stream length estimation. Please report any such remaining errors to Chris Walsh for correction in future versions.

The strcode for WLB (trib of QC7) was recoded to Q71, and WLB was used for consistency with past practice for Wallaby Creek in the Goulburn catchment in the north of Kinglake State Park. Stream lines and new subcatchments were added for Wallaby Creek (as this stream is managed by Melbourne Water). Therefore two new stream names (WLB, Wallaby Creek, and PO1 Poley Creek) were added to the *stream\_names* table (and Q71 revised); and five new stream lines added to *mwstr* and five new subcatchments added to *mwsbmc*.

Twenty streamcodes such as 3E3 were easily misread by computers as scientific notation (e.g. 3E3 could be 3000), causing potential confusion. All 20 were converted to non-ambiguous codes in all tables. The altered codes and stream names are listed in Table A2-1.

Finally we checked the stream layer and subcatchment spatial data for topological errors in ArcGIS. The "Repair Geometry" tool was used to remove null geometries. Topology checks found numerous overlaps in stream lines at catchment boundaries,

self-intersections and overlaps in the subcatchment polygons, all of which we fixed manually.

Table A2-1. Ambiguous stream codes using in v1.0 of the stream database and the new codes that replace them in v1.1.

Old code	New code
3E3	GL9
3E4	GHR
3E5	GFR
3E6	FSC
3E7	NE8
3E8	N6U
3E9	LFC
4E3	MQW
4E4	L9H
4E5	KRO
4E6	KNI
4E7	JQB
4E8	H89
5E3	FP3
5E4	FL4
5E5	EST
5E6	ESJ
5E7	DGO
5E8	YM6
5E9	NUI

The nextds\_strcode field in the stream\_names table was updated for all streams that drain to the sea. In v1.1 nextds\_strcode equalled “sea”. This field now specifies the marine segment to which the stream drains or, in the case of several inland streams, the Goulburn catchment. The marine segments used in the table are listed in Table A2-2.

Table A2-2. Marine Segments listed in the nextds\_strcode field of the stream\_names table.

Marine.segment	Note
Bass Strait	Streams draining southern coast of the Mornington Peninsula
Bass Strait (Phillip Island)	Streams draining southern coast of Phillip Island
Goulburn catchment	Wallaby Creek, north of the Plenty River catchment
Maroondah Aqueduct	Small streams east of Sugarloaf Reservoir, draining to the Maroondah Aqueduct
Port Phillip Bay East	Streams draining into Port Phillip south of Ricketts Point to Kananook Ck
Port Phillip Bay North (Yarra plume)	The Yarra River and drains south to Ricketts Point
Port Phillip Bay Northwest	Streams west of Hobsons Bay
Port Phillip Bay South	Streams draining to the bay on the west coast of the Mornington Peninsula
Steeles Creek Floodplain	Small streams draining to the Steeles Creek Floodplain
Westernport North	Streams draining from the north into Westernport
Westernport North (French I)	Streams draining the north and eastern coasts of French Island
Westernport Southeast	Streams draining the mainland to the southeast of Westernport
Westernport Southeast (French I)	Streams draining the southern coast of French Island
Westernport Southeast (Phillip I)	Streams draining the east coast of Phillip Island
Westernport Southwest	Streams draining the east cost of the Mornington Peninsula
Westernport Southwest (Phillip I)	Streams draining the west coast of Phillip Island