Murrumbidgee Catchment Groundwater Availability Map And Accompanying Notes

LAND & WATER CONSERVATION

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A Component of the NSW State Water Reform

LAND & WATER CONSERVATION

Produced by
Centre of Natural Resources
in collaboration with the Murrumbidgee Region

Department of Land and Water Conservation

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Groundwater Availability Mapping

Objectives

These maps have been produced as part of the NSW State Water Reform. The maps are intended to increase awareness within the community of the state's groundwater resources. They are for use by planners, developers, landholders, government regulators, environment groups and educational facilitors.

Introduction

Groundwater availability maps are an assessment of the expected and dominant groundwater resources for a specified area. There are three components in the availability maps: geology, groundwater quality and groundwater yield. The major aquifer of an area is represented on the map with its associated water quality and yield. The major aquifer is defined in this context as the most utilised aquifer.

The geology has been classified according to the physical aspects of the rock as they relate to its hydraulic properties. The three main aquifer categories are unconsolidated, porous and fractured.

Quality and yield of groundwater has been classified based on general usage. Quality is divided into seven categories: Fresh, Moderate, Marginal, Brackish, Saline, Supersaline, and Hypersaline. Yield is classified into three categories: 0-5 litres/second, 5-50 litres/second and greater than 50 litres/second.

These maps are intended as a general guide only and are limited to the scale at which they are published. Differences can occur within a mapped classification zone, which are related to local variations and are not shown at this scale.

Groundwater Movement and The Water Cycle

Water enters the subsurface percolating through the unsaturated zone until it reaches the aquifer or saturated zone. Aquifers are rock formations or unconsolidated sediments, which bear useful quantities of water that can be readily abstracted.

Recharge to aquifers occurs predominantly through infiltration by rainfall and surface waters such as rivers, lakes, ponds etc. Further recharge can occur through additional waters from irrigation and floods.

Groundwater moves from recharge points through the subsurface to discharge areas. Groundwater discharges, such as springs, are generally found in topographically low lying areas including, swamps, rivers, lakes and oceans. Groundwater is an important contributor to rivers and other water bodies. Where the runoff from rainfall has ceased, river levels may be maintained by the inflow of groundwater into the riverbed, known as *baseflow*.

Water can be removed from the subsurface through evaporation, (generally only when the groundwater is within 2m of the surface), uptake via plants, transpiration, as well as abstraction from bores or wells. See Figure 1.

Methodology for Preparing Groundwater Availability Maps

Data used in the compilation of these maps is from a number of sources. Geological data was sourced from published reports, geological maps, and where available, recent unpublished and published digital geological data. The groundwater data was sourced from the Department of Land and Water Conservation (DLWC) database systems with individual Regions providing recent groundwater data.

A hydrogeological assessment was made on the available groundwater data, geology and physiology of an area to determine the expected quality and yield. For areas where data was sparse, assessments were based on hydrogeological principles.

Availability Mapping Components

Groundwater Quality

The quality of water in an aquifer is governed by a number of factors. Factors influencing groundwater quality include:

- the quality of water entering the aquifer; *recharge water*,
- the type of material through which it flows and the length of time water has spent in the subsurface; *residence time*.

Depositional environments can also play a part in the quality of the groundwater.

Aquifers that receive most of their recharge directly from rainfall will generally contain good quality water. Recharge from saline lakes and other water bodies with poor quality will result in aquifers with poorer quality water. Similarly polluted lakes and other contamination can have detrimental effects through leakage into aquifers.

Groundwater chemistry is related to the media through which it flows. Interactions that take place between the water and surrounding material will effect water quality. Different materials ie silts, sands, shale, granite will have differing effects on the groundwater, due to their composition. The longer the residence time, the greater the effect the surrounding material will have on the water quality.

Those mediums with a high percentage of inert ie non-reacting material such as quartz, will have very little effect on the water quality. Whereas shales and clays contain a large percentage of particles that are highly reactive and can have a considerable effect on the groundwater quality.

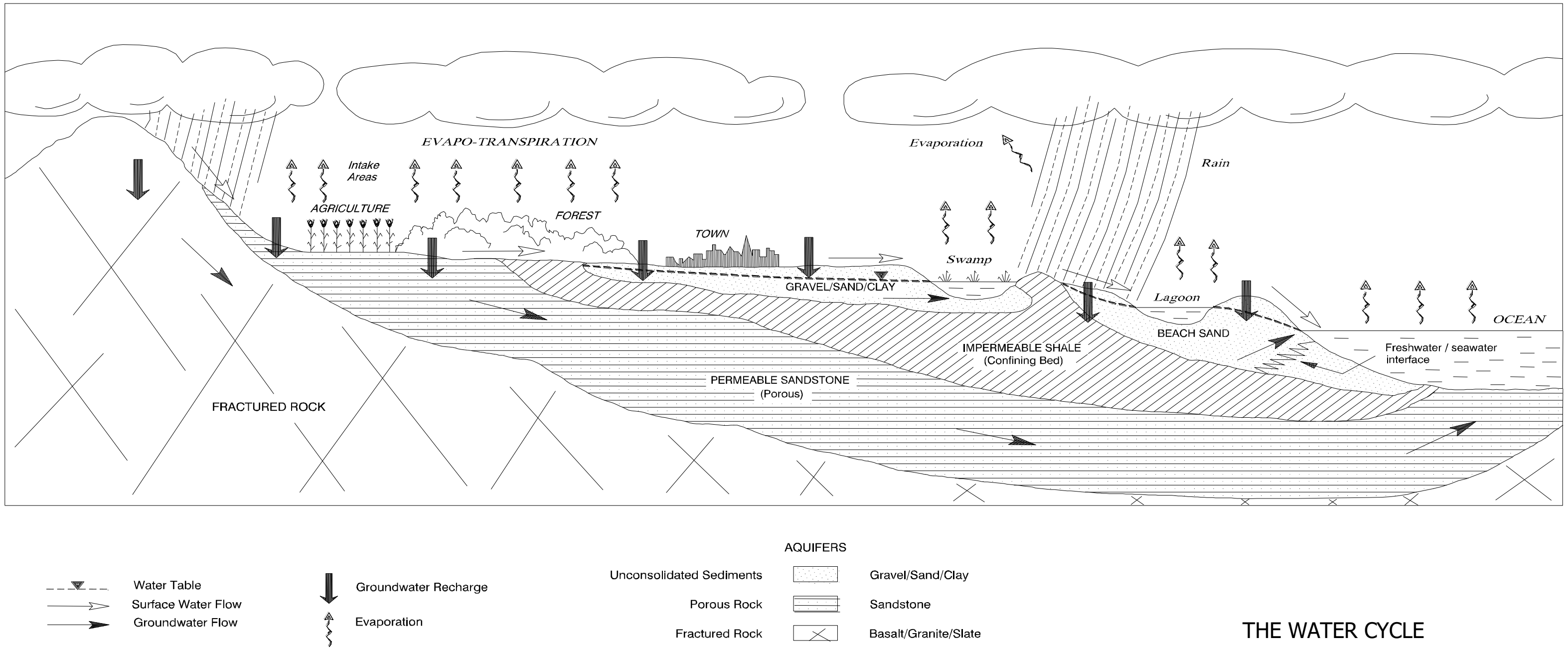

Figure 1: The Water Cycle

Excessive use of a groundwater resource can cause surrounding waters to migrate into an aquifer. Where surrounding waters are of a poorer quality or are polluted, degradation in quality of an aquifer may occur.

Quality Classification

The classification system for availability maps is based on general usage and is as follows:

TDS* (mg/L)	Classification	Usage
0-500	Fresh	Suitable for domestic, stock of all ages, some irrigation purposes as well as municipal use.
500-1500	Moderate	Suitable for domestic, stock and some irrigation purposes.
1500-3000	Marginal	Suitable for domestic, stock, limited irrigation usage
3000-7000	Brackish	Suitable for dairy cattle, beef cattle, horses and sheep
7000-14000	Saline	Limited stock use
14000-35000	Supersaline	Commercial and Industrial use
35000+	Hypersaline	Commercial and Industrial use

Table 1: Groundwater Quality Classification

*TDS: Total Dissolved Solids

Water quality is classified in terms of Total Dissolved Solids (TDS) contained within the water. General water quality is however often measured in terms of electrical conductivity with a conversion to TDS. The greater the concentrations of salts present the higher the electrical conductivity value and therefore the greater the TDS value.

The capacity of water to conduct electricity will vary depending on the type of salts present. Therefore the classifications on suitability for use are not precise. A more detailed analysis is recommended, as other criteria such as pH, hardness, composition of the major ions are needed to determine appropriate use of groundwater.

Groundwater Yield.

Yield is the rate at which water can be extracted from an aquifer by a bore or well. Water can be stored between grains or within fractures. *Porosity* is the percentage of voids in a rock that can contain water. *Permeability* is related to the connectedness ofpores and the ability of the rock to transmit water.

The less porous the rock, the less water it is able to store. The less permeable a rock, the lower the rate at which water can be extracted. A rock material such as clay can be highly porous, but have a low permeability. Therefore whilst the material may contain a lot of water it is not necessarily available for abstraction.

High yielding aquifers are mainly found in porous and permeable rocks such as sandstones and unconsolidated materials such as sands and gravel. Lower yielding aquifers are related to fractured rock aquifers, low porosity rocks including some older sandstones, and low permeability materials such as clay.

Yield Classification

The classification system for availability maps is based on general usage and is as follows:

Litres/second	Classification	Usage
< 5	Low	Suitable for domestic and stock use.
5 - 50	Medium	Commercial, Municipal and Industrial use
> 50	High	Commercial, Municipal and Industrial use

Table 2: Groundwater Yield Classification

Aquifer Systems

Hydraulic properties of a rock can be linked with characteristic geological environments of deposition or other rock forming processes. Geological environments have been characterised according to the hydraulic properties normally associated with these rocks. Each of these characteristic geological environments have been assigned to one of the three main aquifer systems:

- Unconsolidated,
- Porous,
- Fractured.

Aquifer System	Geological Environment
Unconsolidated	Coastal Beach
	Alluvial
Porous	Marine
	Non marine
Fractured	Igneous
	Volcanic (Tertiary Volcanics only)
	Metasediment (including Pre-Tertiary Volcanics)

Table 3: Aquifer Systems

Unconsolidated Sediments

Unconsolidated sediments are comprised of loose material such as silts, clays, sands and gravel. They can be deposited by wind, water or ice and are a result of erosional processes. Unconsolidated sediments contain the most important aquifers in the NSW which provide 80% of the low salinity groundwater in the state.

Unconsolidated sediments are often high yielding and generally receive direct recharge from surface waters and rainfall. They are more likely to have a better water quality and yield than other aquifer types. It is important to note that in some aquifer systems the regional water quality can be quite poor and the better quality water may be found only in localized areas ie near recharge zones such as rivers or lakes.

Aquifers bordering the ocean or saline water bodies such as inland seas have an interface between fresh and salt water. Coastal beach aquifers will generally contain fresher water overlying saline water. See Figure 1.

Porous Rocks

Porous rocks are those that are formed from unconsolidated material but are generally less porous than the unconsolidated sediments. They constitute the second most important source of groundwater in the state. Porous rock aquifers store and yield water from both within the porous media of the rock matrix and the bedding planes that were formed during deposition of the sediments.

Sediments deposited in various aqueous environments may have different effects on groundwater quality. Material that has been deposited in a marine environment may contain trapped salts known as connate salts. Due to the dissolution of these connate salts, sediments of marine origin can contribute a substantial amount of salts to the groundwater. With time, these salts can be flushed from the system.

Water quality is dependent on the rock type, quality of the recharge waters and residence time.

Fractured

Fractured rock aquifers store water in the partings such as fractures and joints found within the rock. This type of porosity is termed secondary porosity, as it not an original feature of the rock. These aquifers are found in rocks of volcanic and igneous origin as well as some metamorphic and older sedimentary rocks. Metamorphic and sedimentary rocks are placed in this classification when the primary porosity, (original porosity), is reduced and the development of secondary porosity predominates.

Tectonics, weathering, cooling and dissolution cause secondary porosity. Movement and weathering affects all rock types, cooling occurs in volcanic and igneous rocks and can form joint features. Dissolution affects limestone, and occurs where the rock is dissolved by weakly acidic water as it moves through it. Partings in the rock joints and fractures, are found to be more open near the surface. At depth, the fractures tend to be too narrow to allow any significant water storage or movement.

Murrumbidgee Catchment

Introduction

The Murrumbidgee Catchment is located in central southern NSW. The major townships servicing the region are Yass, Queanbeyan, Cooma, Cootamundra, Wagga Wagga, Narrandera, Leeton, Griffith, Hay and Balranald. The eastern section of the catchment is hilly with the western area fairly flat.

The most important aquifer in the catchment, the Calivil-Renmark, lies within the Murray Basin. Water quality varies extensively within the Murray Basin, with the better quality water located in the high yielding alluvial aquifers found in the east, with the salinity generally increasing towards the west.

Groundwater in the Murrumbidgee Catchment is used for a wide variety of activities including recreational, industrial, agricultural, domestic and municipal.

Hydrogeological setting

The Murrumbidgee Catchment drains an area of over 84 000 square kilometres. It contains a number of rivers, the most important being the Murrumbidgee River. Storages include; Burrinjuck, Blowering, Tantangara, and Talbinga.

Rainfall intensity within the catchment decreases westward from a high of up to 1,500 mm/yr in the headwaters of the Tumut River (Batlow), to a low of about 300 mm/yr at Balranald with a winter/spring rainfall pattern throughout the catchment.

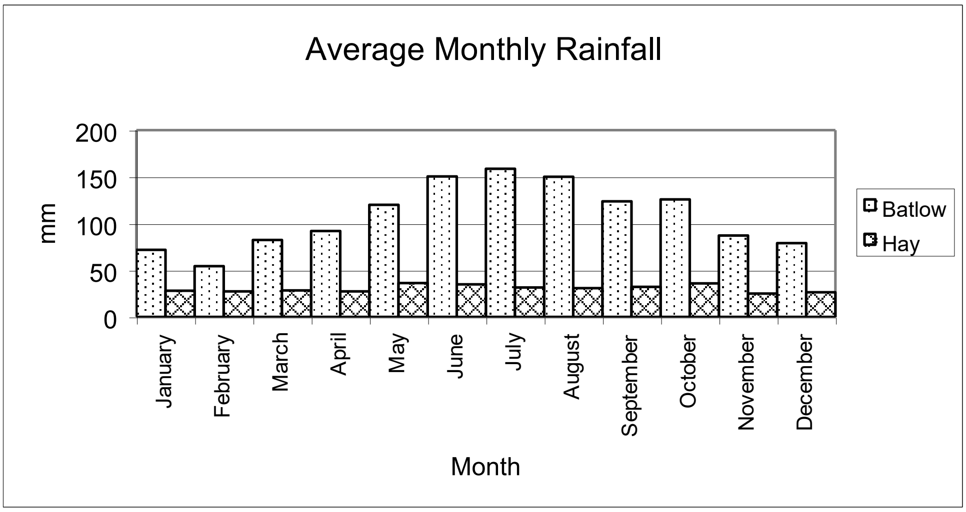

Figure 2: Rainfall at Batlow and Hay

East of Wagga Wagga the groundwater setting is dominated by a fractured aquifer system. Yields are generally low, less than 5 L/s, with fresh to marginal water quality.

West of Wagga Wagga unconsolidated sediments form the most important aquifer system for the Murrumbidgee Catchment. High yielding good quality water is found in the alluvium associated with the Murrumbidgee River as well as in the Calivil-Renmark sediments of the Murray Basin.

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Glossary

Alluvial: Material deposited by a river. Unconsolidated material.

Aeolian: Material deposited by wind.

Aquifer: Rock formations or unconsolidated sediments that provide water in useful quantities.

Artesian: Water freely overflows the bore or well without being pumped.

Baseflow: Discharge of water in a stream or river that is maintained by the inflow of groundwater. Particularly evident during drought periods and between rainfall events.

Cementation: Geological processes where loose grains are held together by a cementing material. The secondary material can be introduced or as a result of dissolution of some grains.

Compaction: Geological processes where over time grains are packed closer together reducing pore space in a rock.

Connate salts: Salts trapped during deposition of the rock material. Amount and type is related to the depositional environment ie marine or freshwater

Crystallisation: Formation of crystals.

Diagenesis: Geological process relating to the change in a rock's properties due to compaction, cementation and crystallization.

Dissolution: The process whereby a rock dissolves, normally associated with limestone and weakly acidic waters.

Electrical conductivity (EC): Ability of water to conduct an electrical current is related to the amount of salts and the type of salts in the water. EC is often measured in micro-Siemens per centimetre (µS/cm).

Emplaced: Formation of a rock within another rock, refers to igneous rocks.

Fracture: A general term used to denote a breakage in a rock due to tectonic process such as earthquakes or as a result or cooling.

Fractured Aquifer: An aquifer where most water is stored in fractures, joints, cleavages, bedding planes and other partings

GAB: Great Artesian Basin

Glaciation: Erosion and deposition of material by an ice mass.

Groundwater: Water found beneath the land surface in the saturated zone.

Hardness: Characteristic of water, related to the proportion of calcium and magnesium in the water.

Hydrogeology: The study of groundwater in relation to geology.

Igneous: One of the three main rock types. Formed from molten material that solidifies within the earth's crust.

Joint: A fracture found in a rock due to cooling, desiccation, erosion and folding.

Lithification: Geological processes whereby loose sediments such as clays, sands and gravels form consolidated material. These processes include cementation, crystallisation and compaction

Metasediment: Sedimentary rock that has undergone change by the action of heat, pressure and/or by the influence of fluid.

Murray Basin: Large sedimentary basin comprising of recently deposited alluvials. Contains a number of aquifers Shepparton, Calivil and Renmark

Permeable: The ability of a material to transmit water. (opp: impermeable)

Porosity: The percentage of space between the grains of a rock that can contain fluid.

Porous Aquifer: An aquifer where the main storage of water occurs in pores.

Primary Porosity: Original porosity of a rock and is related to the space between grains that can contain water.

Recharge: The addition of water to an aquifer.

Residence Time: Amount of time waters have spent within an aquifer, can be up to 1.5 million years as in the Great Artesian Basin.

Salinity: The concentration of salts in water.

Saturated Zone: Area beneath the land surface where ideally 100% of all spaces are filled by water.

Secondary Porosity: Porosity in a rock developed after the rock has formed for example, fractures and joints.

Strata: Subsurface material.

Sub-surface water: see groundwater

Sustainable Yield: Rate of water abstraction from an aquifer that does not cause a negative impact on the aquifer or associated ecosystems.

TDS: Total Dissolved Solids analogous to salinity.

Topography: The height variation in the land surface.

Transpiration: The evaporation of water by vegetation.

Unconsolidated: Loose material such as clays, sands, gravels.

Unconsolidated Aquifer: Loose material that is saturated with water and allows abstraction of water in useable volumes.

Volcanic: Rock formed from molten material that solidifies outside the earth's crust.

Weathering: The process by which a rock is eroded. Wind, rain, ice, temperature fluctuations, vegetation and bacteria can all contribute to the break down of a rock.

Yield: Rate at which water can be abstracted from an aquifer. Flow is normally recorded as litres per second.

Appendix

Maps Produced to date in this Series

Catchment	*Year*	*Scale*
Bega	2000	1:250 000
Castlereagh	2000	1:500 000
Hawkesbury Nepean	1998	1:250 000
Hunter	1995	1:250 000
Lachlan	2000	1:500 000
Lake Hume	2000	1:500 000
Macquarie	2000	1:500 000
Murray	2000	1:500 000
Murrumbidgee	2000	1:500 000
Newcastle Bight	1996	1:150 000
Tweed-Brunswick	1997	1:250 000

Accessing Groundwater

Bore Licensing Requirements

Any bore, well or excavation work connected to the groundwater needs a licence as required under the Water Act of 1912. DLWC is the licensing authority for any such works. All bore licences are issued for a particular purpose and with conditions.

Types of Licenses

Bores are licensed for a specific purpose, with licences being made renewable after a set period, dependent on intended purpose. Stock and domestic, and monitoring bores have licences which are generally issued for 20 years. Irrigation, industrial, recreation, mining, sand and gravel, pisciculture, town water and other high yielding bores with a specific purpose normally require their licence to be renewed more frequently

License Conditions

All renewable licences are issued with a volumetric allocation and licensing conditions. Issuing of a renewable license is dependent on the Department of Land and Water Conservation assessment of the impact of bore construction and abstraction on the aquifer. The licences are issued for a specific time period and renewed at the end of each licensing period. Licenses come with conditions which can be altered at any stage by the Department to ensure protection of the resource.

License Application

Application for a groundwater licences can be obtained from your local Department of Land and Water Conservation office, listed in this booklet. A fee may apply to the licence application depending on intended purpose. The applicant is required to fill and submit the license application form with all requested information, and appropriate fee, to the relevant DLWC office. The DLWC assesses the application and, if satisfied within the charter of the Water Act, issues the licence subject to such terms, conditions and limitations as it may deem fit and proper.

The applicant is required to sink a bore or well within three years of issue of the licence. According to the Water Act of 1912, the bore or well must be drilled by an appropriately licenced driller.

Drillers License

Only licensed drillers are permitted to drill and construct groundwater bores for the class for which they are licensed.

The following NSW Drillers' Licensing Classes apply:

Class 1 Allows construction of water level and water quality monitoring bores.

Class 2 Allows construction of non-flowing stock & domestic supply bores up to 152 mm nominal diameter bore casing.

Class 3 Allows the activities of a class 2 licence and also allows the construction of non-flowing supply bores of any diameter.

Class 4 Allows the activity of class 3 licence and use of gravel filter envelope completion techniques.

Class 5 Allows the activity of class 4 licence and construction of flowing and non-flowing bores of the Great Artesian Basin and flowing bores elsewhere in NSW.

Class 6 Covers all licence classes.

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