Department of Sustainability and Environment

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VALUING OUR ENVIRONMENT

Glenelg Hopkins CMA Groundwater Model

Final model development report

A Victorian Government initiative

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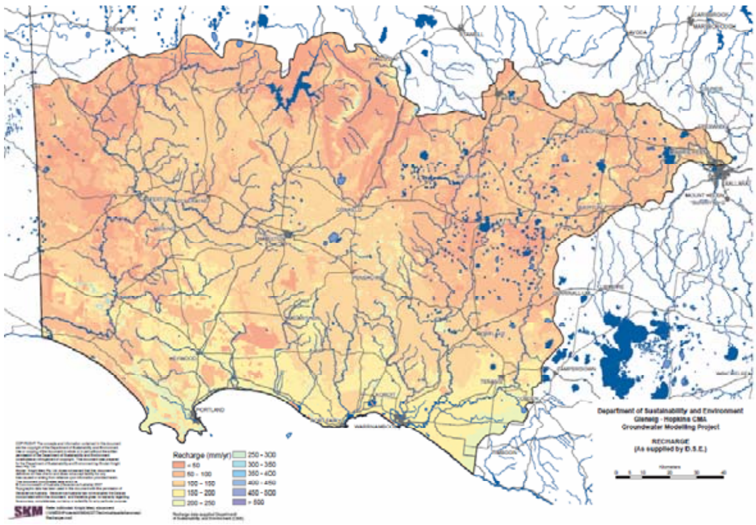
eco-Markets: Glenelg Hopkins Groundwater Model Development



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Sinclair Knight Merz
ABN 37 001 024 095
590 Orrong Road, Armadale 3143
PO Box 2500
Malvern VIC 3144 Australia
Tel: +61 3 9248 3100
Fax: +61 3 9248 3400
Web: www.skmconsulting.com

Executive Summary

Project Background

This project is being conducted for the Victorian Government Department of Sustainability and Environment (DSE) as part of the ecoMarkets initiative. This initiative incorporates spatially distributed physical process models representing various aspects of the water cycle and vegetation responses. The models will be used to estimate the impacts of land use change on groundwater levels. The aim being to quantify the impacts/benefits of land use change to support decision making.

As part of the modelling to support this initiative DSE has contracted a number of consultants to develop groundwater flow models of each of the Catchment Management Authority (CMA) areas. This report describes the compilation of the groundwater model of the Glenelg-Hopkins CMA (GHCMA).

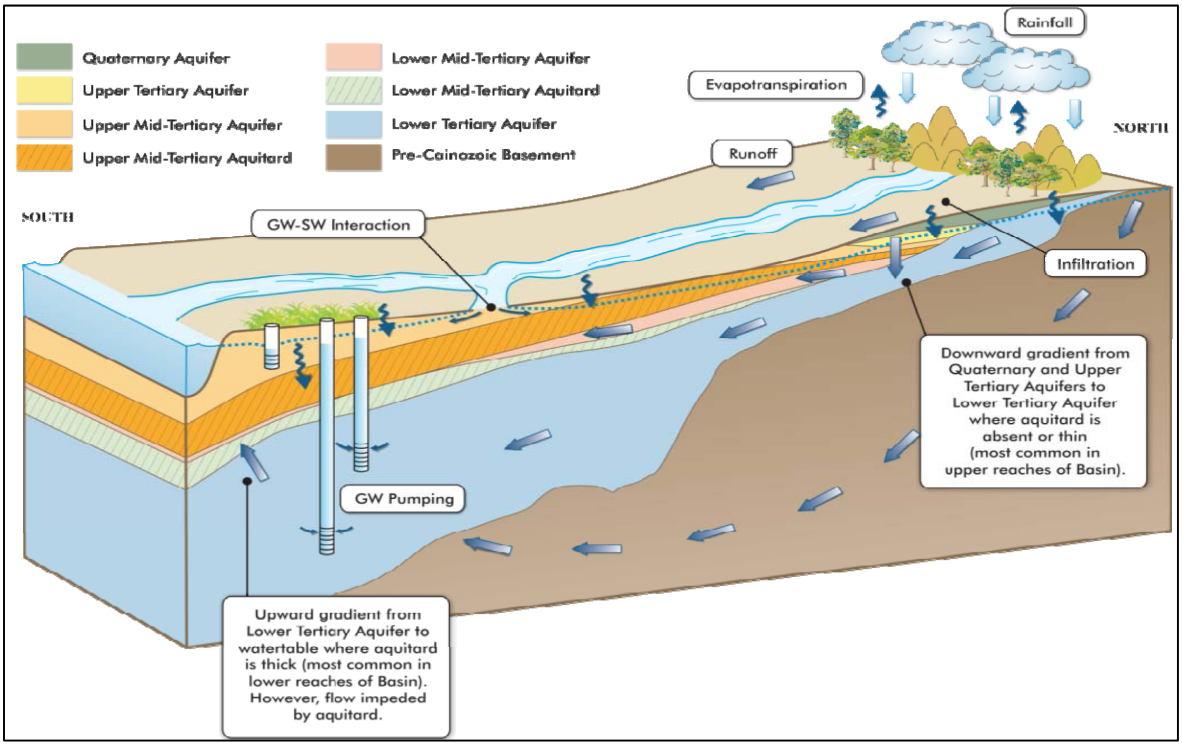
Hydrogeological Conceptual Model for the GHCMA

The Glenelg Hopkins Catchment Management Authority region encompasses 2.67 million Ha of south western Victoria. The area extends west from Balart to the South Australian Border and south to the coast and represents approximately 12% of the area of Victoria. The north is dominated by the Grampians, the Dundas and Merino Tablelands and the West Victorian Uplands with the flatter volcanic plains characterising the south.

The predominant land use of the region is agriculture, with 81% of the area developed for this purpose. The dominant agricultural land use in the region is dryland pasture with only a small percentage being irrigated land. The Grampians National Park lies within the region and makes up a significant proportion of the remaining land within the study area.

Geologically, the GHCMA is broadly dominated by the Tertiary aged sediments of the Otway Basin, at least in the southern half of the CMA. Underlying the sediments are Palaeozoic aged basement rocks of the Tasman Orogenic system (which underlie much of Victoria). In the northern half of the CMA, the basement rocks outcrop or sub-crop.

The Otway Basin comprises a number of hydrogeologically important units which form the basis for the groundwater model structure. The (mostly) confined Lower Tertiary Aquifer (predominantly comprising the Dilwyn Formation) forms the major aquifer of the region, whilst the Lower Mid Tertiary Aquifer (Clifton Formation) and Upper Mid Tertiary Aquifer (Limestone Aquifers) also provide important resources in the area. A diagrammatic summary of the conceptual model of the area is provided in Figure 1.



- **Figure 1 Conceptual groundwater model for the Glenelg-Hopkins CMA study area**

Groundwater Model Design

The groundwater model is structurally divided into 5 layers as follows:

- Layer 1 represents the Volcanics and Quaternary deposits
- Layer 2 of the model represents the Upper Tertiary (Pliocene) Aquifer and the Upper Mid Tertiary Aquifer.
- Layer 3 represents the remainder of the Miocene formation and combines the Upper Mid Tertiary Aquitard, Clifton Formation Aquifer and Lower Mid Tertiary Aquitard. The Clifton Formation unit was included in this model layer, as it is of limited spatial extent and thickness, and combining these units result in a greatly reduced level of model complexity.
- Layer 4 includes the Early Tertiary geological units, predominantly the Dilwyn Aquifer as well as the Lower Mepunga Aquifer unit (Miocene) and the Timboon Sand aquifer unit (Pre-Cainozoic).
- Layer 5 is the Pre Cainozoic units, the units in this model layer are largely very low permeability basement bedrock.

The model is set on a 200m by 200m finite difference grid using the Modflow 2000 groundwater modelling code. Recharge to the watertable is provided from outputs of the ENSYM unsaturated zone modelling and hence was not a feature of the calibration process. Groundwater evapotranspiration, rivers and groundwater bores are also represented within the model.

Groundwater Model Calibration

The modelling comprised a three stage approach which included initial steady state modelling to provide a first pass calibration of the model parameters. Stage 2, a transient model calibration to finalise the model parameterisation (including a verification period) and Stage 3, a post-development steady state model used as the basis for future land use change modelling. Time periods represented by the model are as follows:

- Pre-development steady state – 1985
- Transient model calibration period – Jan 1985 to Dec 1994
- Transient model verification period – Jan 1995 to Dec 1999
- Post-development steady state – 1995

The final calibrated model provides a good representation of the hydrogeological system and meets the assessment standards as defined in the Murray-Darling Basin Groundwater Flow Modelling Guidelines. The steady state model and transient model Normalised RMS error values were 2.47% and 2.24% respectively. Low error values such as these indicate that the ratio of the error to the total head differential is small and hence errors are only a small part of the overall model response. The Normalised RMS error for the verification period was 2.49% confirming that the model is also suitable for use in predictive mode.

Analysis of calibration hydrographs and modelled potentiometric surfaces highlighted that model errors do exist with regard to modelled groundwater heads in some locations. However, within each layer, flow paths/gradients and temporal trends were shown to be replicated well across the model domain.

Similar conclusions are drawn with respect to modelled water balances and in particular modelled baseflow volumes. The net quantity of groundwater discharging to rivers in some reaches was found to be considerably higher than estimates from gauged streamflow readings. However, whilst the volume was not considered representative, it was shown that the temporal trends in baseflow matched the anticipated trend well.

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1. Introduction

1.1. Background

This project is being conducted for the Victorian Government Department of Sustainability and Environment (DSE) as part of the ecoMarkets initiative. This initiative will incorporate spatially distributed physical process models representing various aspects of the water cycle and vegetation responses. These models will be used to estimate the impacts of land use change. The aim being to quantify the impacts/benefits of land use change to support decision making.

As part of the modelling to support this initiative DSE has contracted a range of groundwater modelling consultants to develop MODFLOW groundwater models of each of the Catchment Management Authority (CMA) areas. This report describes the compilation of a groundwater model of the Glenelg-Hopkins CMA (GHCMA) (area shown in Map 1).

The groundwater models developed as part of the ecoMarkets initiative are required to be on a scale that is consistent with other models that are being developed to represent other components of the water cycle (for instance unsaturated zone modelling). Therefore the terms of condition for the project require that the GHCMA model be developed on a 200 m regularly spaced grid, and that the model represent all geological units from the pre Cainozoic era onwards.

To this end, the model is considered to be of high complexity and can be described as an 'Aquifer Simulator' (Middlemis et al. 2000). Aquifer simulators are the sort of tool commonly required for regional groundwater models for developing sustainable resource management policies for systems under stress or for assessing impacts of stresses on the watertable.

- **Map 1. Glenelg Hopkins Catchment Management Authority location.**

(Refer Appendix D Mapping)

1.2. Scope of Works

The scope of works as defined by the project brief includes the following key tasks:

- Multi-layered conceptualisation of the groundwater system, accounting for mapped Groundwater Flow System data layers and pre-existing groundwater models.
- Collation of time-series groundwater bore data from state-wide databases and other sources, including those data sets held by the appropriate CMA. This data must be geo-referenced.
- Collation of time varying groundwater extraction data from state-wide databases and other sources, including water authorities and any data sets held by the appropriate CMA This data must be geo-referenced.
- Specification of those groundwater bores appropriate for use to calibrate the groundwater model. Selection of these bores will be based on location, length of record and other characteristics.
- Specification and development of spatial data layers of any river and drain networks in a form suitable for inclusion into MODFLOW.
- Initial development of spatial groundwater data layers for each aquifer system, including the extent of each aquifer, aquifer tops and bottoms, spatially assigned specific yield, spatially assigned specific storage, spatially assigned lateral and vertical conductivities.
- Assignment of appropriate boundary conditions as agreed with project staff.
- Preparation of a report detailing model conceptualisation, attribution and boundary conditions.
- Assignment of aquifer for each of the groundwater bores collated in Phase 1.
- Assignment of aquifer for each of the groundwater extraction points collated in Phase 1
- Assignment of appropriate boundary conditions as agreed with project staff.
- Development and calibration of a multi-layered MODFLOW groundwater model based on the conceptualization and multi-layered aquifer attributes defined in Phase 1. The calibration period is anticipated to be in the order of ten years and based on matching selected groundwater observation bore responses, baseflow trends and mapped groundwater discharge.
- Preparation of a report detailing model conceptualisation, attribution, boundary conditions, calibration data and results. The reporting shall include the results of its calibration and verification against all relevant water resource data held by relevant stakeholders.

The modelling will comprise a three stage approach included initial steady state modelling to provide a first pass calibration of the model parameters. Stage 2, a transient model calibration to finalise the model parameterisation and Stage 3, a post-development model used as the basis for future land use change modelling.

This report is the final combined report and pertains to all phases of work outlined in the scope of works.

2. Hydrogeological Conceptualisation

2.1. Study Area

The Glenelg Hopkins Catchment Management Authority region encompasses 2.67 million Ha of south western Victoria. The area (shown in Map 1) extends west from Balart to the South Australian Border and south to the coast and represents approximately 12% of the area of Victoria. The north is dominated by the Grampians, the Dundas and Merino Tablelands and the West Victorian Uplands with the flatter volcanic plains characterising the south.

2.2. Climate

The climate can vary significantly between the coast and further inland. The mean annual maximum temperature of Warnambool is 17.9°C whilst in Casterton it is 20.0°C. The mean maximum temperature for January is 22.2°C in Warnambool, whilst in Casterton it is 27.1°C (Source: Bureau of Meteorology Climate Averages website, accessed October 2008).

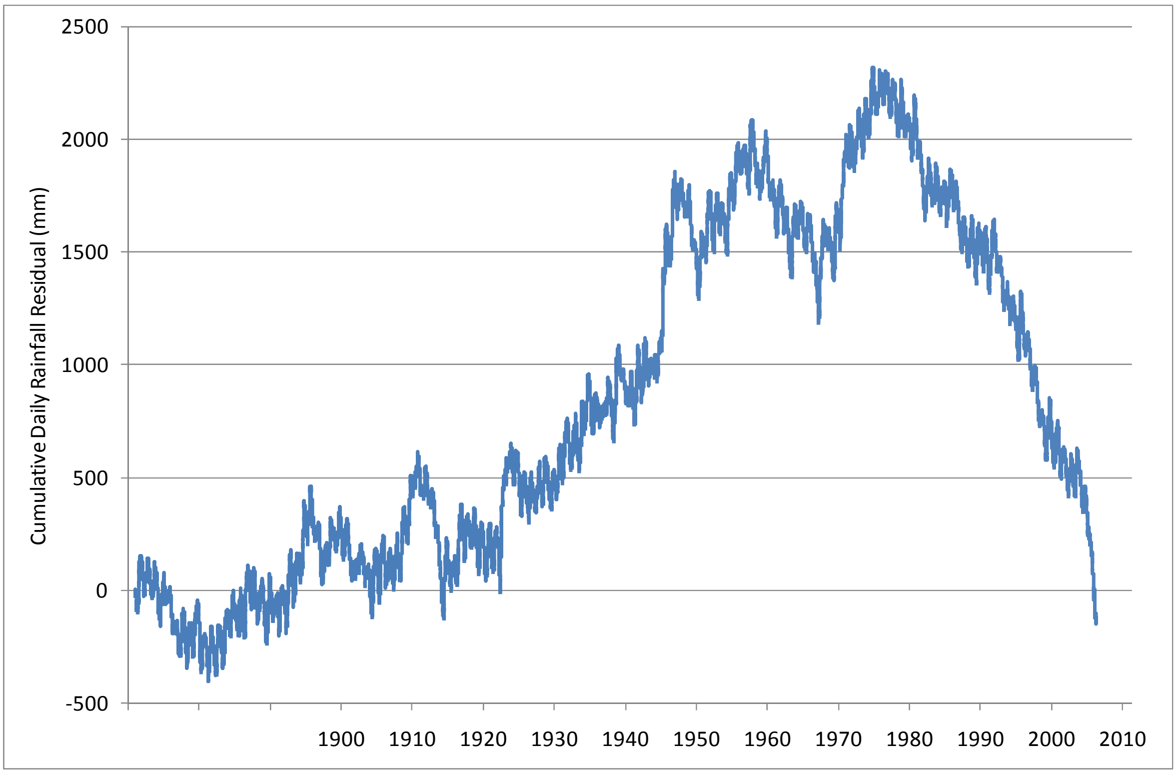
The average annual potential evaporation varies within the catchment from approximately 900mm/year to 1,000mm/year (refer Map 2).

Average annual rainfall (see Map 3) varies in the region from approximately 500mm/year to 1100mm/year. The highest rainfall occurs in the Grampians, and is also higher along the coast, particularly north-west of Portland and south of Terang. The area of lowest rainfall occurs around Lake Bolac in the northern part of the Hopkins River basin.

The longest recorded daily rainfall record in the region is at the Portland Rainfall Gauge 0090070 where records extend back to 1872. The average annual rainfall recorded at this site is 826mm/year. The long term average daily rainfall at the site is 2.26mm. Based on this long term average the cumulative rainfall residual was calculated and is plotted in Figure 2. This plot highlights a distinct downturn in rainfall since the late 1970s.

- **Map 2. Average annual potential evaporation.**
- **Map 3. Average annual rainfall.**

(Refer Appendix D Mapping)



- **Figure 2: Cumulative rainfall residual at Portland Rainfall Gauge (Site 0090070).**

Note: 1985 is the nominated year used to represent pre-development steady-state conditions for the model. The transient model will then be run from Jan 1985 to Dec 1994.

2.3. Topography

A digital terrain model (DTM) was supplied by DSE based on the 2008 state wide 20m DTM. This DTM was re-sampled to a 200m grid for use in the project and is shown in Map 4. The Glenelg Hopkins area is characterised by a generally north east to south west sloping terrain. The Grampians can reach has high as 1000m AHD, but typically the land in the north of the region is several hundred metres AHD sloping to 0m AHD at the coast.

- **Map 4. Digital terrain model of the Glenelg Hopkins CMA region.**

(Refer Appendix D Mapping)

2.4. Landuse

The predominant land use of the region is agriculture, with 81% of the area developed for this purpose (development occurred well before the study period which commences in 1985). This can be seen in Map 5 which shows that the vast majority of the region is classified as 'Grazing Modified Pastures'. The dominant agricultural land use in the region is dryland pasture with only a very small percentage being irrigated land. Irrigation is most prominent on the plains west of Portland and also immediately west of Dartmoor.

The Grampians National Park also lies within the region and makes up a significant proportion of the remaining land within the study area. Other hydrologically land uses include production forestry and irrigation.

An important landuse change over the past 30 years (approx) has been the growth in plantation forestry, particularly in the borderzone region. Plantations are known to have a strong influence on groundwater recharge. Under an establishing plantation recharge rates could be as low as 1% of rainfall, compared to crops or pastures which may be up to 20% of rainfall (SKM, 2007). Further to this it is possible that in areas, forests could be drawing water directly from the watertable. The majority of the plantation development occurred between 1992 and 2002 but there has been little change to the area covered by plantation forests since (SKM, 2007).

- **Map 5. Land use of the Glenelg Hopkins CMA region.**

(Refer Appendix D Mapping)

2.5. Hydrology

The Glenelg Hopkins region can be sub divided into several sub regions, namely:

- Hopkins River Basin (east)
- Portland Coastal (south central)
- Glenelg River Basin (north central and west)

The Hopkins River Basin includes the Hopkins River, which flows into the sea at Warrnambool. Major tributaries of the Hopkins River include Mount Emu Creek, Brucknell Creek, Salt Creek, Muston Creek and Fiery Creek. The area also includes the Merri River which also runs out to sea at Warrnambool. The two major surface water features in the basin are Lake Bolac and Lake Burrunmbeet.

The Portland Coast Basin is made up of the Moyne, Eumeralla, Fitzroy and Surry Rivers and also contains Back and Darlot Creeks.

The Glenelg River Basin includes the Glenelg River and its tributaries. A major tributary of the Glenelg River is the Wannon River, which flows west south west from the Grampians through the central part of the region to join the Glenelg River. Other tributaries in the upper part of the basin include the Chetwynd River and the Wando River. The Stokes River and the Crawford River flow into the Glenelg in the Lower part of the basin. The basin also contains Rocklands Reservoir, the region's largest body of water. Rocklands reservoir is used to supply water for agriculture in the Wimmera Mallee region.

2.6. Geological Summary

2.6.1. Tectonic Setting

Palaeozoic rocks of the N-S trending Tasman Orogenic system underlie all of Victoria. The Tasman Orogen is made up of three easterly younging, accreted and deformed belts, The Delamerian Orogen in the west, the Lachlan Oregen which encompasses most of Victoria and NSW and the New England Orogen in the east (not present in Victoria). The Delamarian underlies most of the Glenelg-Hopkins CMA with a small portion of the Lachlan in the far east of the region.

Within the Glenelg-Hopkins CMA, the Delamerian fold belt is characterised by three dominant structural zones; the Merino Uplift, the Gambier Embayment to its west and the Tyrrendarra Embayment to its east (refer Map 6). The rocks that form these structures act as the hydrogeological basement of the region.

The Merino Uplift is a structurally and topographically elevated inlier consisting predominantly of Lower Cretaceous Otway Group sediments. It is bounded to the north by the more elevated tablelands of the Dundas Ridge. This boundary appears to be defined by a series of approixmately E-W trending depositional faults. The Otway Group sediments are faulted and folded and bound to the southwest and south east by faults

and monoclines, including the Kanawinka Fault, which displace them downwards beneath the Tertiary and Upper Cretaceous sequences. The Kanawinka fault runs in an arc from the north western extent of the GHCMA south east to southerly towards Dartmoor.

The Kanawinka Fault dates back to the Paleocene with several later periods of movement, including the present day escarpments which are considered to have originated as fault scarps in the late Pliocene. South of the Kanawinka Fault, Tertiary sediments generally increase in thickness towards the coast. Between the Kanawinka Fault and the coast, sediments are displaced by a number of faults, most of which trend west-northwest and are downthrown to the south.

The Grampians Group have been estimated to reach 6,000 m of sediments in the main succession. These mature quartz-rich rocks were contemporaneously folded and faulted along north-northwest, north and north-northeast trends and were intruded by granodiorite, granite and porphyrites during the Carboniferous. (Wopfner, H. & Douglas, J.G. 1971).

The complexity of the surface geology is depicted in Map 7 which is followed by a simplified version of the surface geology in Map 8. This simplified geology scaffolds toward the 'lumping' of the complex geology into a series of model aquifers and aquitards.

- **Map 6. Structural setting of the Otway Basin (Birch, 2003)**
- **Map 7. Surface geology**
- **Map 8. Simplified Surface geology**

(Refer Appendix D Mapping)

2.6.2. Stratigraphic Interpretation

For the purposes of describing the sub surface geology of the study area, geological units of the following ages are described:

- Pre-Cainozoic
- Early Tertiary
- Miocene
- Pliocene
- Volcanics/Quaternary

The rocks of these time periods are arranged into stratigraphic groups and formations which are described in further detail in the following sections but are summarised in Figure 3 and Figure 4.

The aim of these geological descriptions is to provide the necessary background such that the reader can develop an understanding of the conceptual model for the study area. Following this section the detailed geological setting is broken down into the major hydrogeological units from which this modelling study will be based.

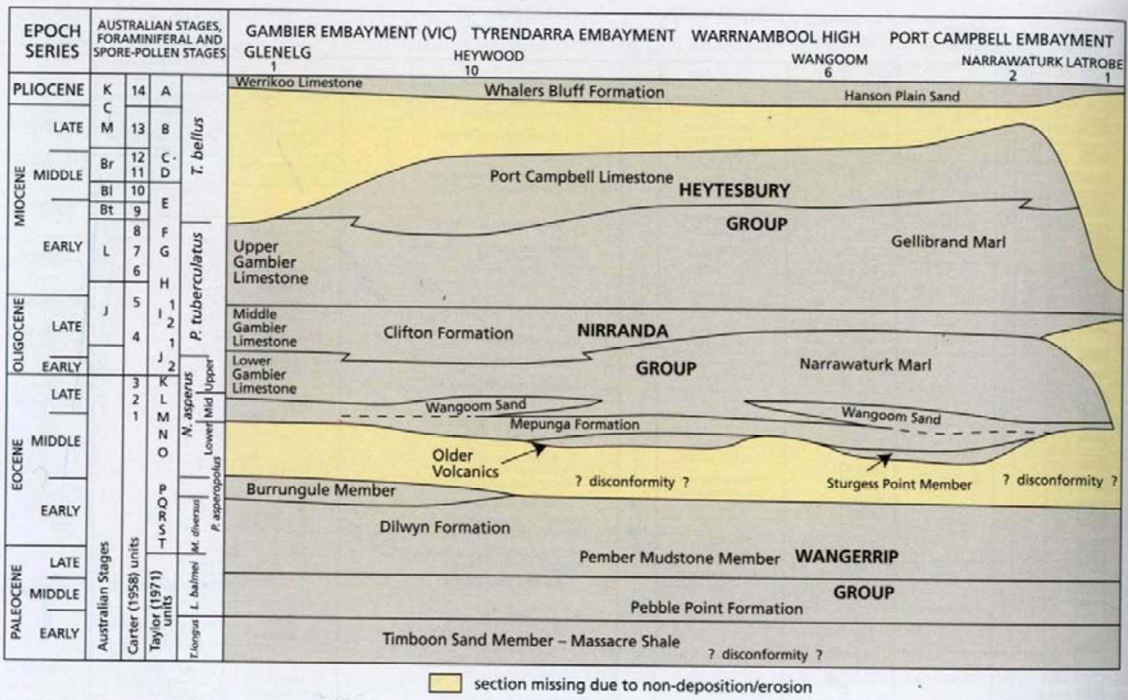
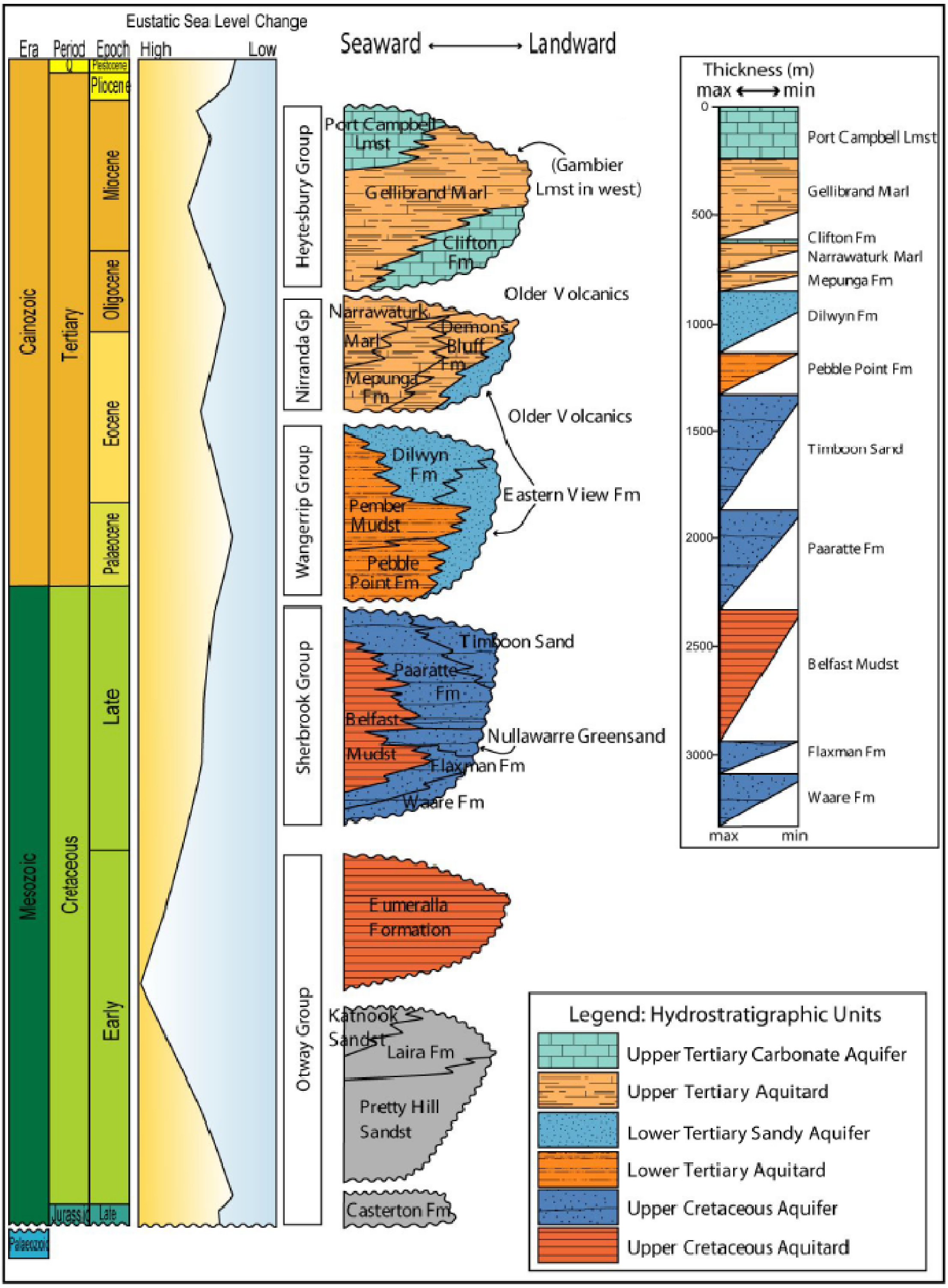


Fig. 10.3: Otway Basin rock correlation (modified from Abele *et al.*, 1988).

- **Figure 3. Stratigraphic setting of the Otway Basin, highlighting the different embayments. This study predominantly relates to the Tyrendarra Embayment (Birch, 2003).**



- **Figure 4. Stratigraphic interpretation of the Otway Basin with greater vertical discretization (Bush, 2009)**

2.6.2.1. Pre-Cainozoic

The Pre-Cainozoic Unit consists of the following sub-units:

- Timboon Sand
- Paaratte Formation
- Pre-Upper Cretaceous Strata

In the Otway Basin, the entire Jurassic and Early Cretaceous section overlying the Palaeozoic basement has been referred to as the Otway Group (Birch, 2003). The Otway Group comprises (from oldest to youngest) the Casterton Formation, the Crayfish Subgroup (comprising the Katnook Sandstone, Laira Formation and Pretty Hill Sandstone) and the Eumeralla Formation.

The Otway Group is overlain by the Late Cretaceous siliciclastic Sherbrook Group, which includes the Timboon Sand (Figure 4) and Paaratte Formation. These sediments were largely derived from the erosion of the Paleozoic basement from the basin margins and also from the erosion of the Eumeralla Formation. The Paaratte Formation consists of quartz sandstone, glauconitic sa ndstones, greywackes, siltstones, claystones and rare pebbly lags. The Timboon Sand is comprised almost entirely of quartz sandstone.

The Pre-Cainozoic Unit (excluding the Timboon Sand) is indurated rock material of generally low permeability. The Pre-Cainozoic Unit below the Timboon Sand is included in the model as a basal layer of nominal thickness and low permeability.

The Pre-Cainozoic bedrock slopes generally from north to south, and outcrops extensively in the northern half of the catchment. This outcropping includes the Grampians National Park area and the Merino Highlands near Casterton and Coleraine. Near the coast, the basement slopes down to levels between 1,000 and 2,000 m below sea level.

2.6.2.2. Early Tertiary Unit

The Early Tertiary Unit includes the following sub-units, which belong to the Wangerrip Group (Figure 4):

- AQUIFER: Early Tertiary Sands-Upper (Eastern View Formation, Dilwyn)
- AQUIFER: Older Volcanics Phase 1
- AQUITARD: Pember Mudstone.

- AQUIFER: Early Tertiary Sands-Lower (Pebble Point, Moomowroong, Wiridjil)

In the Gambier Embayment, the Pebble Point Formation outcrops along the Glenelg River. In the north-eastern part of the Port Campbell Embayment, facies equivalents of the Pebble Point Formation are present, including the Moomowroong Sand and Wiridgil Gravel. The Pebble Point Formation comprises ferruginous sandstone, grit and conglomerate, along with less common fossiliferous beds. On the Otway Basin margins it unconformably overlies the Otway Group, but away from the margins it disconformably overlies the Sherbrook Group.

The Pember Mudstone conformably overlies the Pebble Point Formation. It consists of tan to grey siltstones, mudstones and shales, usually pyritic, carbonaceous and micaceous. The Pember Mudstone is a low permeability unit limiting flow between the Pebble Point Formation and the Dilwyn Formation. Although the Pember Mudstone acts as an aquitard, it has been included here within the Lower Tertiary Aquifer.

The Dilwyn Formation is characterised by sandstones predominating over shales and by transgressive – regressive cycles of sandstone – siltstone – claystone sequences. In the north-eastern part of the Port Campbell Embayment, the Dilwyn Formation becomes more sandy and coaly and is transitional with the Eastern View Formation in the adjoining Torquay Basin.

Wopfner & Douglas (1971) document more than fifty isolated outcrops of Older Volcanic basaltic rocks in the Glenelg Valley between Mooree and Roseheath and in the dissected areas of the Dundas country. The basalts are consistently dark in colour and generally non-vesicular. The maximum observed thickness in the Glenelg valley is approximately 30 m.

The Early Tertiary Unit, together with the lower Mepunga Formation, which is of Miocene age, and the Timboon Sand, which is part of the Pre-Cainozoic Unit, can be considered to act as an aquifer (Lower Tertiary Aquifer).

2.6.2.3. Miocene Unit

The Miocene Unit includes the following sub-units (Figure 4):

- AQUIFER: Miocene Limestone (including the Port Campbell Limestone, Duddo Limestone)
- AQUITARD: Gellibrand Marl, Geera Clay
- AQUIFER: Clifton Formation
- AQUITARD: Older Volcanics Phase 2
- AQUITARD: Narrawaturk Marl
- AQUITARD: Demons Bluff Formation
- AQUITARD: Upper Mepunga Formation

The Nirranda Group consists of three formations; the Demons Bluff Formation, the Mepunga Formation, a calcareous sand, conformably overlain by the Narrawaturk Formation, a pale to dark brown marl and calcareous mudstone with minor thin calcarenite beds. The Mepunga Formation disconformably overlies and is readily distinguishable from the Dilwyn Formation. The top of the Nirranda Group (i.e. the top of the Narrawaturk Marl) is defined by the base of the Clifton Formation, which is the basal unit of the Heytesbury Group (Figure 4). The marly limestones of the Lower Gambier Limestone in South Australia and Western Victoria are lateral equivalents to the marls and mudstones of the Narrawaturk Formation. Outcrops of the Nirranda Group occur at the eastern end of the Otway Basin.

Phase 2 of the Older Volcanics, where present, also underlie the Heytesbury Group. These often lie between the Mepunga Formation and Narrawaturk Marl. They are basaltic in nature and are often highly weathered.

The Heytesbury Group contains Late Oligocene to Late Miocene carbonates, which are present throughout the Otway Basin. The Clifton Formation is the basal unit, overlain by the Gellibrand Marl and the Port Campbell Limestone. The Clifton Formation is comprised of limestones, sandy limestones, and sandy marls. The Port Campbell Limestone has a higher carbonate content and yellow appearance compared to the grey Gellibrand Marl.

The Port Campbell Limestone has equivalent Limestone Units such as the Duddo Limestone. These Miocene Limestone units can be considered an aquifer (Upper Mid Tertiary Aquifer) that is hydraulically separated from the Clifton Formation Aquifer by the Geera Clay and Gellibrand Marl (Upper Mid Tertiary Aquitard). The Clifton Formation Aquifer is of limited thickness (generally less than 45m thick) throughout the southern part of the study area between Portland, Hamilton and Warnambool and is underlain by

older units including the Narrawaturk Marl, Phase 2 Older Volcanics and Upper Mepunga, these units act as an aquitard (Lower Mid Tertiary Aquitard).

2.6.2.4. Pliocene Unit

The Pliocene Unit consists of the Pliocene Sands, which include the Parilla Formation, Calivil Formation and the Hanson Plain Sands. These units lie unconformably beneath the Quaternary Newer Volcanic Basalt and Alluvium/Colluvium.

The Parilla Sand is marine in origin and consists of sand and silt. The Calivil Formation consists of non-marine claystones and sandstones, which coarsen southwards into the Loddon deep lead system. The Baxter Formation is a succession of marginal to non-marine ferruginous conglomerates, sandstones and claystones, which may reach thickness of near 200 metres.

These formations can be considered to act as an aquifer (Upper Tertiary Aquifer).

2.6.2.5. Volcanics/Quaternary

The upper part of the sub surface within the study area comprises a mixture of Quaternary sand dune and alluvium deposits and volcanic basalts. The sand dunes and alluvium deposits act as aquifers.

The volcanic deposits of the Newer Volcanic Group comprise multiple lava flows resulting in layered basalt sheet-flow deposits, with minor scoria and ash deposits. Mainly at eruption centres. The terrain is hummocky and comprises a number of intermingled lava flows and eruption points (e.g. Mount Eccles). The transmissivity of the volcanics can be highly variable alternating between highly transmissive scoria cones and transmissive fractured basalt to weathered basalt clays of low permeability.

An assessment of surface geology (Map 7) has been used to identify the spatial extent of the Quaternary alluvial deposits (Map 9).

- **Map 9. Spatial Extent of Quaternary Alluvial deposits.**

(Refer Appendix D Mapping)

2.7. Hydrogeological Units and Reduction to Model Layer Structure

2.7.1. Context

It is not practical within the constraints of groundwater modelling to model the detail of the geology in complex areas such as the Otway Basin. Geological Units (as described above) are grouped into Hydrogeological Units which represent the major aquifers and aquitards within the basin. These major aquifers and aquitards are considered to control the dominant groundwater flow processes within the basin and hence are of importance to groundwater resource investigations. The groupings adopted within this study are based on those classified through the 'Hydrogeological Mapping of Southern Victoria' (SKM & GHD, 2009).

A summary of the grouping of Geological Units into Hydrogeological Units in the region is provided in Table 1. This table also depicts the transition from the hydrogeological conceptualisation to the groundwater model layering structure. Further discussion on the hydrogeology of each of the aquifers and the transition to the model layering structure is provided in the following text.

■ **Table 1: Summary of Hydrogeology and Model Layers**

Geological Units	Hydrogeological Units	Geological Period	Model Layer
Basalts, Dune Systems & Alluvium	Quaternary Aquifer	Volcanics Quaternary	1
Pliocene Sands (Parilla, Calivill, HPS, Baxter Fm)	Upper Tertiary Aquifer	Pliocene	2
Miocene Limestone (Duddo, PCL, Fyansford, Batesford, Sherwood Marl)	Upper Mid-Tertiary Aquifer	Miocene	
Geera Clay	Upper Mid-Tertiary Aquitard		3
Gellibrand Marl			
Clifton Fm	Lower Mid-Tertiary Aquifer		
Older Volcs P2	Lower Mid-Tertiary Aquitard		
Narrawaturk Marl			
Demons Bluff			
Upper Mepunga			
Lower Mepunga	Lower Tertiary Aquifer		4
Early Tertiary Sands-Upper (EVF, Dilwyn)		Early-Tertiary	
Older Volcs P1			
Pember Mst			
Early Tertiary Sands-Lower (PP, Moomowroong, Wiridjil)			
Timboon Sand		Pre-Cainozoic	
Paratte Fm	Basement		5
Pre-Upper Cretaceous			

2.7.2. Quaternary Aquifer (Layer 1)

In the north western portion of the study area, the Pliocene sands of the Upper Tertiary Aquifer outcrop and comprise the watertable aquifer. Elsewhere, the Quaternary basalts outcrop more extensively and provide confining layer to the Upper Tertiary Aquifer. The Quaternary basalt aquifer is thought to have a dual porosity; confining clay layers and ephemeral perched watertables are commonly found within this aquifer.

Hydraulic conductivities within the Quaternary basalts are typically in the range of 1 to 10 m/day and yields based on pumping tests are in the order of 1 to 12 L/sec (various sources, compiled by Bush, 2009) but typically less than 1.5 L/sec (Birch, 2003). Watertable elevation and groundwater flow direction within the study area are predominantly controlled by topography and the drainage network with a regional trend south west towards the coast (Map 10).

The eruption centres of the Quaternary basalt aquifer have a strong impact on shallow groundwater flow. Shallow, localised flow patterns, which deviate from the regional southwest flow trend are often associated with these centres. They are also thought to act as recharge and discharge 'conduits' for deeper aquifers such as the Lower Tertiary Aquifer (Bush, 2009).

Discharge from the aquifer generally occurs to the many natural surface water drainage systems and eventually to the coast, it also occurs via springs and evapotranspiration at shallow depressions and other areas where the watertable is shallow. Recharge is mostly via rainfall infiltration which is highest in areas of younger, less-weathered basalts.

On the mid western edge of the study area, near the South Australian border, watertable gradients are low and known to be influenced by groundwater extraction for irrigation in the area. Flow on the northern and eastern edges of the study area is controlled by a groundwater divide that approximately parallels the study boundary.

- **Map 10. Inferred Watertable Elevation Map**

(Refer Appendix D - Mapping. The watertable elevation map was produced based on work completed by SKM & GHD (2009), it utilises a methodology based on the assumption that the watertable is a subdued reflection of topography. There is not enough data to generate a surface purely from groundwater observations.

2.7.3. Upper Tertiary Aquifer and the Upper Mid-Tertiary Aquifer (Layer 2)

The Upper Tertiary Aquifer is confined in some areas when overlain by the Quaternary Basalt but is often unconfined to semi confined where it outcrops or sub-crops. The Hanson Plain Sands (HPS) can play an important role in both local and also in intermediate and regional flow systems, because of its hydraulic connectivity to underlying units.

The Upper Mid-Tertiary Aquifer can also be unconfined where it outcrops. The aquifer is characterised by local karstification, which effects porosity and therefore groundwater flow. This karstification can be observed near the township of Heywood, where depressions in the potentiometric surface evident. The depressions have created a strong downward gradient between the Upper Tertiary and Upper-Mid Tertiary Aquifers. Hydraulic conductivities in the cavernous Gambier Limestone have been estimated at up to 270 m/day (cited in Bush, 2009).

Potentiometric information is only available for the Upper Mid-Tertiary Aquifer where it is comprised mainly of the Port Campbell Limestone and the Duddo Limestone. Groundwater flow direction is regionally south west towards the coast with local flow towards surface water discharge features. In the west, groundwater gradients are low, with flow predominantly south, along the South Australian border with local flow influenced by groundwater extraction. Flow on the eastern edge of the study area is controlled by a groundwater divide that approximately parallels the study boundary. In the region of Port Fairy and Warrnambool, the aquifer is used as water supply for irrigated pasture. There is evidence that the potentiometric surface has been lowered to below sea level along the coast and evidence of potential seawater intrusion into the aquifer through the estuaries around Warrnambool (Bush, 2009)

Groundwater flow in the Upper Mid-Tertiary Aquifer also follows local flow patterns where it either outcrops or is close to the surface. These shallow flow patterns are similar to those observed in the watertable aquifer. Most groundwater flow within the aquifer, however, occurs on an intermediate or regional scale.

Upward gradients are also present at Dartmoor and it is conceptualised that the Glenelg River receives baseflow from the Upper Mid-Tertiary Aquifer.

- **Map 11. Inferred Upper-Mid Tertiary Aquifer Potentiometry**

(Refer Appendix D - Mapping. The potentiometric surface was created by SKM & GHD (2009) and subsequently clipped to the relevant study area)

2.7.4. Upper-Mid Tertiary Aquitard, Lower-Mid Tertiary Aquifer and Lower-Mid Tertiary Aquitard (Layer 3)

The main unit of the Upper-Mid Tertiary Aquitard is the Gellibrand Marl, which is a low permeability layer that impedes movement of water between the Upper Mid Tertiary Aquifer and the Lower Tertiary Aquifer. Very limited hydraulic property information is available on the aquitard due to the fact that it has not been developed for resource purposes. The Gellibrand Marl generally functions as a regional aquitard but there are some sandy beds towards the top of the unit that act as minor aquifers (Birch, 2003).

No potentiometric information has been compiled for the Upper-Mid Tertiary Aquitard however previous work (Bush, 2009) confirmed that flow is in a southerly direction (i.e. toward the coast) and is very similar in projection to overlying aquifers.

The Lower-Mid Tertiary Aquifer (Clifton Formation) forms a confined to semi-confined aquifer unit. Little is known of the aquifer due to its typically thin nature, less than 20m (Birch, 2003), although it does thicken toward the western parts of the basin. The most detailed study of this aquifer was produced by Bennetts (2005). Due to its relatively thin nature and minimal lateral extent the Clifton Formation will not be modelled as a discrete layer, however aquifer properties may be adjusted where it is present to allow for the increased transmissivity.

No potentiometric surface has been compiled for the LMTA due to a lack of reliable observation bores screening the aquifer. Only 4 bores are known to have good records of observations and therefore it is not possible to contour a potentiometric surface for this aquifer. However, the four available bores will be used as calibration points within the model.

The Lower-Mid Tertiary Aquitard forms a thin, less than 40m, leaky aquitard that extends across most of the Otway Basin. Little is known of its hydraulic properties but one measurement of vertical hydraulic conductivity in the Gambier Embayment is 10^{-7}–0.001 m/day (Love et al., 1993).

2.7.5. Lower Tertiary Aquifer (Layer 4)

The Lower Tertiary Aquifer (Dilwyn Formation & others) is a thick sand aquifer that extends over most of the Otway Basin. For the most part it is a confined to semi-confined aquifer lying beneath Lower-Mid Tertiary aquitard. It can have very high transmissivity values up to 1600 m^2/day (Bush, 2009). Flow processes within the aquifer have been the subject of much study but are considered to be complex with much discussion over recharge mechanisms for the aquifer.

Groundwater flow direction in the Lower Tertiary Aquifer is regionally south west towards the coast with local flow towards streams and groundwater depressions (Map 12). In the west, groundwater gradients are low, with flow predominantly south, along the South Australian border with local flow influenced by groundwater extraction. In the area west and south west of Hamilton, local flow is towards the Wannon River and its tributaries. This and other areas where the layer is close to the surface are considered as a potential recharge source for the aquifer. In the middle reaches of the Glenelg River, downstream of Casterton, groundwater flow is toward the river where the aquifer outcrops in the bed and banks of the river. Modelling of the groundwater geometry indicates the presence of a number of broad groundwater depressions in the vicinity of Portland, Port fairy and Warrnambool.

Toward the eastern half of the model, recharge to the Lower Tertiary Aquifer appears to occur around the eastern edges of the Dundas Plateau via areas of outcrop through the relatively thin cover of other units (Bush, 2009 and others). In this part of the plateau the Upper Tertiary Aquitard is absent. Bush (2009) also proposed that the volcanoes of Mount Napier and Mt Pierrepoint are probably conduits for recharge.

Further east, toward Warrnambool, recharge areas are more difficult to ascertain. However, Bush proposes that recharge is likely from the northern extents of the aquifer where a downward hydraulic gradient appears to exist across the Lower-Mid Tertiary Aquitard. A secondary (or complementary) hypothesis is that recharge occurs through a secondary porosity in the form of faults and volcanic pipes.

Toward the western half of the study area the major recharge zones appear to be a couple of large groundwater mounds around the margins of the Merino Block (Map 6) where the aquifer outcrops or sub-crops (Birch, 2003). One mound is south of Penola, just on the SA side of the border and the other one south of Strathdownie on the

Victorian side. These are inferred recharge points due to a predominant downward gradient in the area and relatively thin nature of the overlying aquitard.

There is also a degree of recharge inferred to occur along rivers where the Lower Tertiary outcrops (or is only covered by a thin veneer of overburden). Various other localised recharge and discharge mechanisms exist but will not be discussed here in the context of the regional flow system.

Map 13 shows the depth from surface to the top of the Lower Tertiary Aquifer. Areas where the aquifer is at or near the surface are considered likely recharge zones.

The Pember Mudstone sits at the base of the Dilwyn and forms an aquitard over much of the area. It sits above the Pebble Point Formation Aquifer which also occurs throughout the basin. Little is known of the hydrogeological properties of the Pember Mudstone and Pebble Point Formation due to quality of shallower resources (hence limited exploration at depth). Due to the extent and thickness of the Dilwyn aquifer within the study area, it is conceptualised to dominate the flow processes within the Lower Tertiary Aquifer, therefore the Pember Mudstone and Pebble Point Formation have not been modelled discretely.

- **Map 12. Lower Tertiary Aquifer Potentiometry**

(Refer Appendix D - Mapping. The potentiometric surface was created by SKM & GHD (2009) and subsequently clipped to the relevant study area)

- **Map 13. Depth to top of Lower Tertiary Aquifer**

(Refer Appendix D - Mapping)

2.7.6. Pre-Cainozoic Basement (Layer 5)

The Pre-Cainozoic Unit (excluding the Timboon Sand) is indurated rock material of generally low permeability. The Pre-Cainozoic Unit below the Timboon Sand is included in the model as a basal layer of nominal thickness and low permeability. Recharge to this unit is predominantly thought to occur where the basement rocks outcrop or sub-crop in the northern half of the Glenelg Hopkins CMA. Flow is typically in a southerly direction towards the coast and there is an upward vertical gradient between the basement and the shallow aquifers near the coast line. However flow of water is significantly limited by the

low permeability. Much of the flow is thought to occur through a secondary porosity (i.e. cracks and fractures).

2.7.7. Vertical Flow Processes

A review of the head difference between the Dilwyn Aquifer and the watertable produced a complex result (refer Map 14). In the upper parts of the basin, where the two layers are at minimum vertical separation, there is a general downward gradient between the two layers. This confirms thoughts of recharge occurring in the upper parts of the basin. Deeper into the basin, towards the coast, the head levels are more equal and eventually change relationship so that at the coast there is a clear upward gradient between the two. The situation is complicated because of features associated with topography. Groundwater mounds associated with hills and other rises in the topography produce more pronounced downward gradients, while valleys associated with the stream network produce more pronounced upward gradients. In the middle reaches of the Glenelg River, downstream of Casterton, groundwater gradients are upward, and flow is toward the river where the Dilwyn Formation outcrops in bed and banks of the river.

The review of the vertical gradients between the two layers did not take into account water density factors associated with salinity or temperature.

As a general rule, downward gradients exist between the Upper Tertiary and Lower Tertiary aquifers where the Upper Mid-Tertiary Aquitard is absent or thin, most commonly in the upper parts of the basin. Recharge to the Lower Tertiary Aquifer is likely to occur predominantly in these parts. Even when the aquitard is present, it is thought that recharge via slow leakage is still possible in many areas. However, given the thickness and low hydraulic conductivity of the aquitard, the rate of leakage is considered low.

- **Map 14. Difference in elevation of the Lower Tertiary Aquifer and the Watertable elevation**

(Refer Appendix D Mapping)

2.7.8. Aquifer Recharge Processes

The predominant source of groundwater inflow to the study area is via recharge from rainwater infiltration. Other sources of recharge include leakage from streams and open water bodies (described in more detail in Section 2.7.10), and some groundwater flux

across model boundaries, particularly the western boundary. An additional source of recharge is via irrigation accessions which are accounted for in the ENSYM recharge modelling being conducted by DSE as part of the ecoMarkets initiative.

The main regions of rainfall recharge are found in the elevated areas in the north of the study area. The Basalt Aquifer, the Upper Tertiary and Upper Mid-Tertiary aquifers all receive a large portion of recharge via rainfall. Map 15 provides an indication of which aquifer the watertable resides in and therefore which aquifer is the receiving aquifer for rainfall and irrigation recharge.

Recharge to the Lower Tertiary Aquifer has been discussed previously in Sections 2.7.5 and 2.7.7.

- **Map 15. Watertable Aquifer Map (highlighting which aquifer the watertable is inferred to reside in)**

(Refer Appendix D Mapping)

2.7.9. Groundwater Discharge

Major discharge processes in the study area include:

- Discharge to the ocean. The Glenelg Hopkins region is in contact with the ocean along the south coast. As groundwater levels trend towards the ocean it is the major source of groundwater discharge for the region.
- Evaporation at swales and other areas with elevated watertable.
- Discharge to rivers, depressions and open water bodies. For example, the Glenelg River receives baseflow from the Upper Mid-Tertiary Aquifer.
- Discharge to springs
- Discharge to other aquifers.
- Groundwater pumping (only in the transient model)

2.7.10. River/Groundwater Interaction

A Victoria wide estimate of sub catchment Base Flow Index (BFI) is available from a study conducted by DSE (DSE 2003). This BFI estimate is based on analysis of available gauged flow data. The analysis of gauged data has been extrapolated to ungauged sub catchments based on catchment characteristics.

These BFI values were used in conjunction with gauged flow data to estimate the base flow volume entering gauged rivers within the study area. It should be noted that the resultant estimated base flow volumes represent delayed surface runoff and unsaturated groundwater flows, as well as direct contributions to waterways from the saturated groundwater system, therefore modelled groundwater contributions should be less than the estimated base flow volumes.

Overall there is an inferred high degree of interaction occurring between the shallow groundwater systems and surface water features. This interaction occurs in both the 'losing' and 'gaining' forms with some rivers, such as the Glenelg, likely to alternate between losing and gaining along its length.

- **Map 16. Location of stream flow gauges and base flow estimates.**

(Refer Appendix D Mapping)

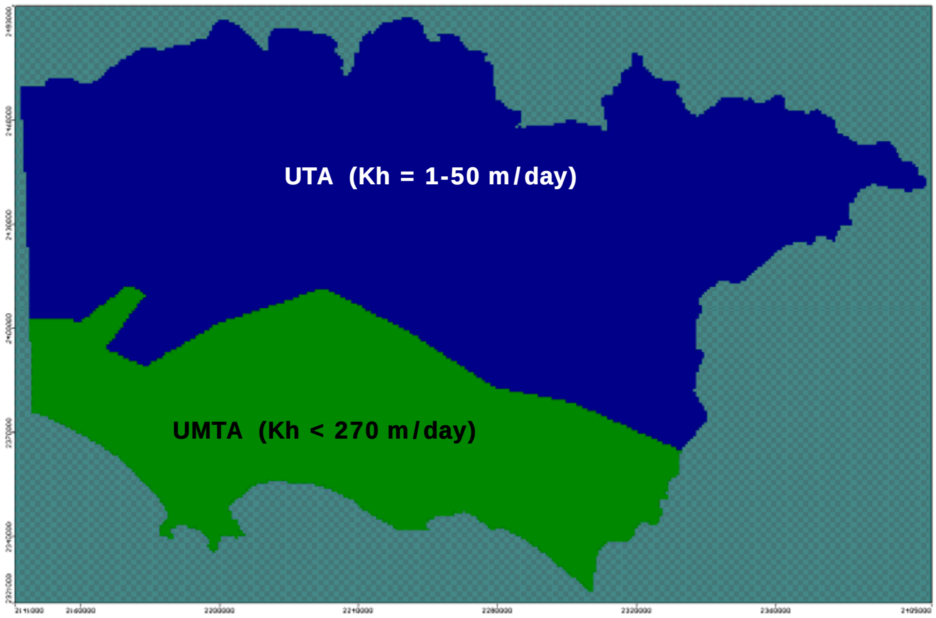
2.8. Summary of Conceptual Model

To represent the various hydrogeological units described in Section 2.7 a five layer modelling approach has been adopted. Expected hydraulic properties to be used in the model are presented in Table 2. These conductivity values show the range of values for each layer that will guide the calibration process. A summary of the conceptual model is presented as a block diagram in Figure 6 followed by example model cross-sections, showing the model layer structure in Figure 7 and Figure 8.

Layer 1 represents the Volcanics and Quaternary deposits. Spatially this layer has been separated into two zones for the definition of hydraulic parameters to represent the two different hydrogeological units. The spatial extent of Quaternary geological units presented in Map 9 has been used to define these zones.

Layer 2 of the model represents the Upper Tertiary (Pliocene) Aquifer and the Upper Mid Tertiary Aquifer. The Upper Mid Tertiary Aquifer represents part of the Miocene geological unit. It can be seen in Map 17 and Map 18 that the Upper Tertiary Aquifer is absent within the southern part of the study area, and the Upper-Mid Tertiary Aquifer is absent within the northern part of the study area. Therefore, as these units are both aquifers, and are spatially not coincident, they have been represented as one model layer,

with two zones of hydraulic conductivity used to represent the different hydraulic conductivities of the two units. These zones are shown in Figure 5.



- **Figure 5: Model Layer 2 hydraulic conductivity zones. In the north the Upper Tertiary Aquifer is present, in the south the Upper Mid Tertiary Aquifer.**

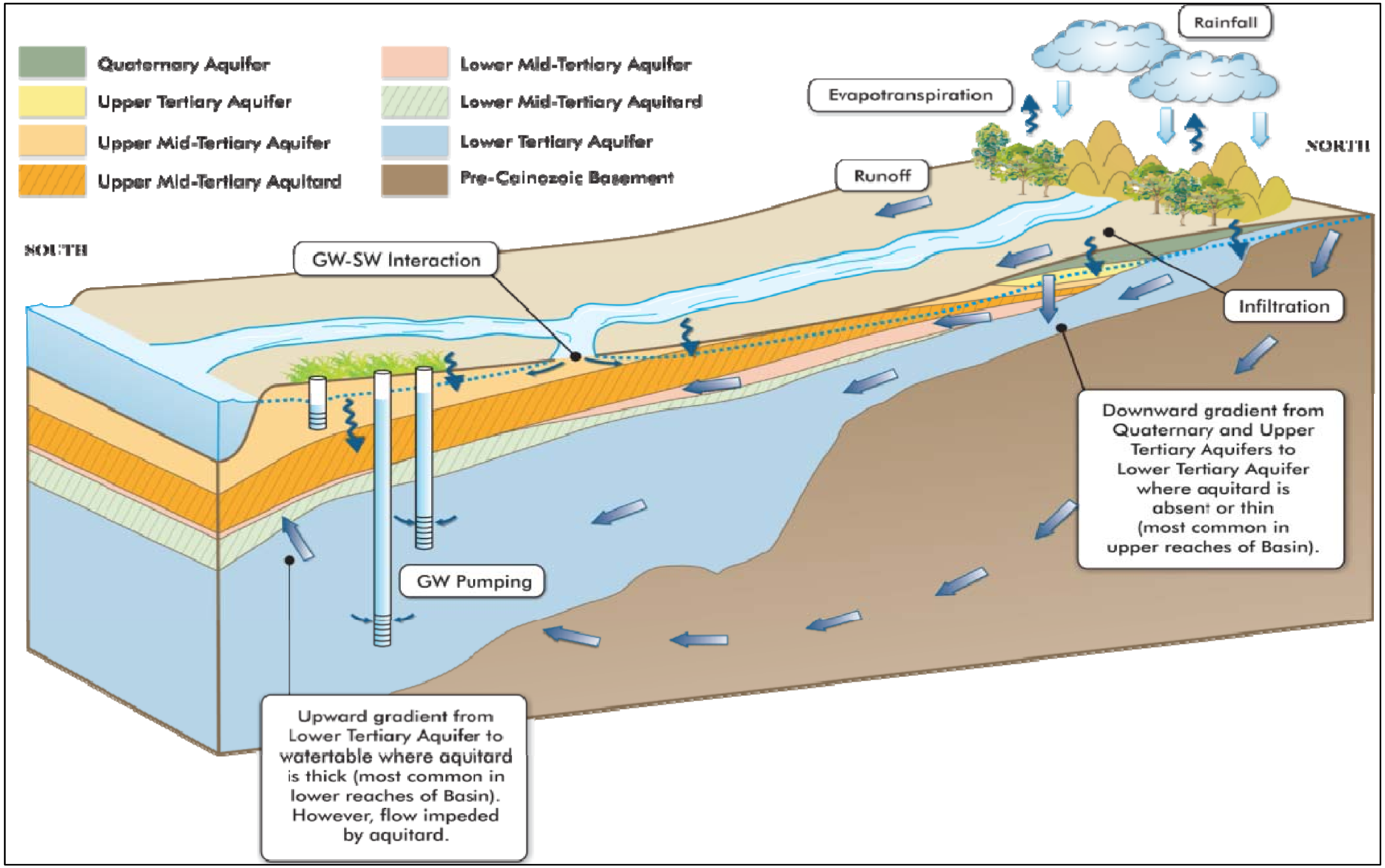
Layer 3 represents the remainder of the Miocene formation and combines the Upper Mid Tertiary Aquitard, Clifton Formation Aquifer and Lower Mid Tertiary Aquitard. The Clifton Formation unit has been included in this model layer, as it is of limited spatial extent and thickness, and combining these units result in a greatly reduced level of model complexity, and decreased model run times and better solution robustness. However where it is of significant thickness the hydraulic conductivity of this model layer has been adjusted to allow for greater transmissivity.

Layer 4 includes the Early Tertiary geological units, predominantly the Dilwyn Aquifer as well as the Lower Mepunga Aquifer unit (Miocene) and the Timboon Sand aquifer unit (Pre-Cainozoic). This model layer is described as the Lower Tertiary Aquifer.

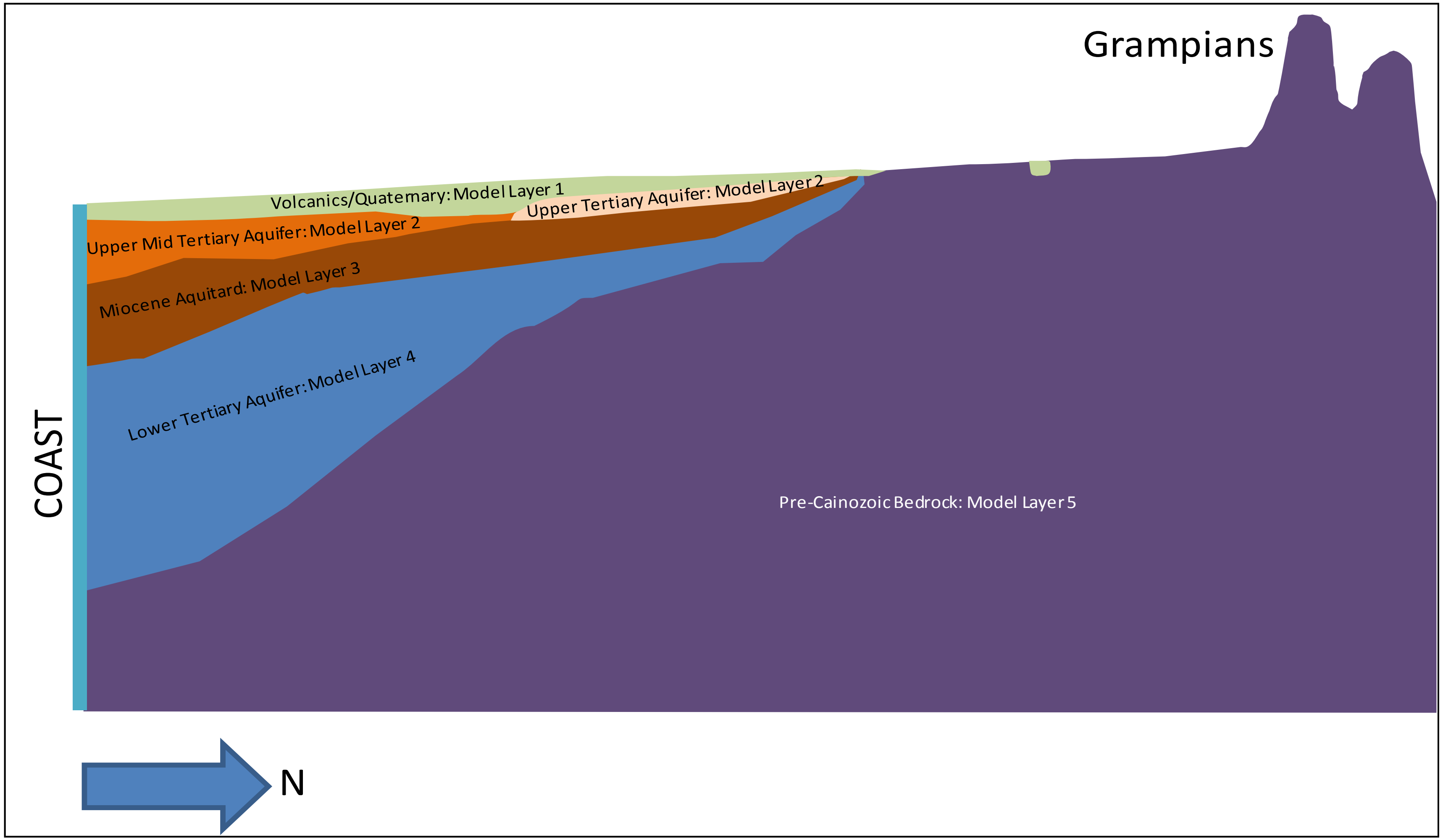
Layer 5 is the Pre Cainozoic units, except for the Timboon Sand unit which is included in Layer 4. The units in this model layer are largely very low permeability basement bedrock. Where the basement outcrops it can be weathered to the extent that it acts as a significant carrier of recharge to other units within the model domain.

▪ **Table 2. Summary of typical conductivity ranges that will be used as starting points for the model calibration and as a sanity check for the final calibrated model.**

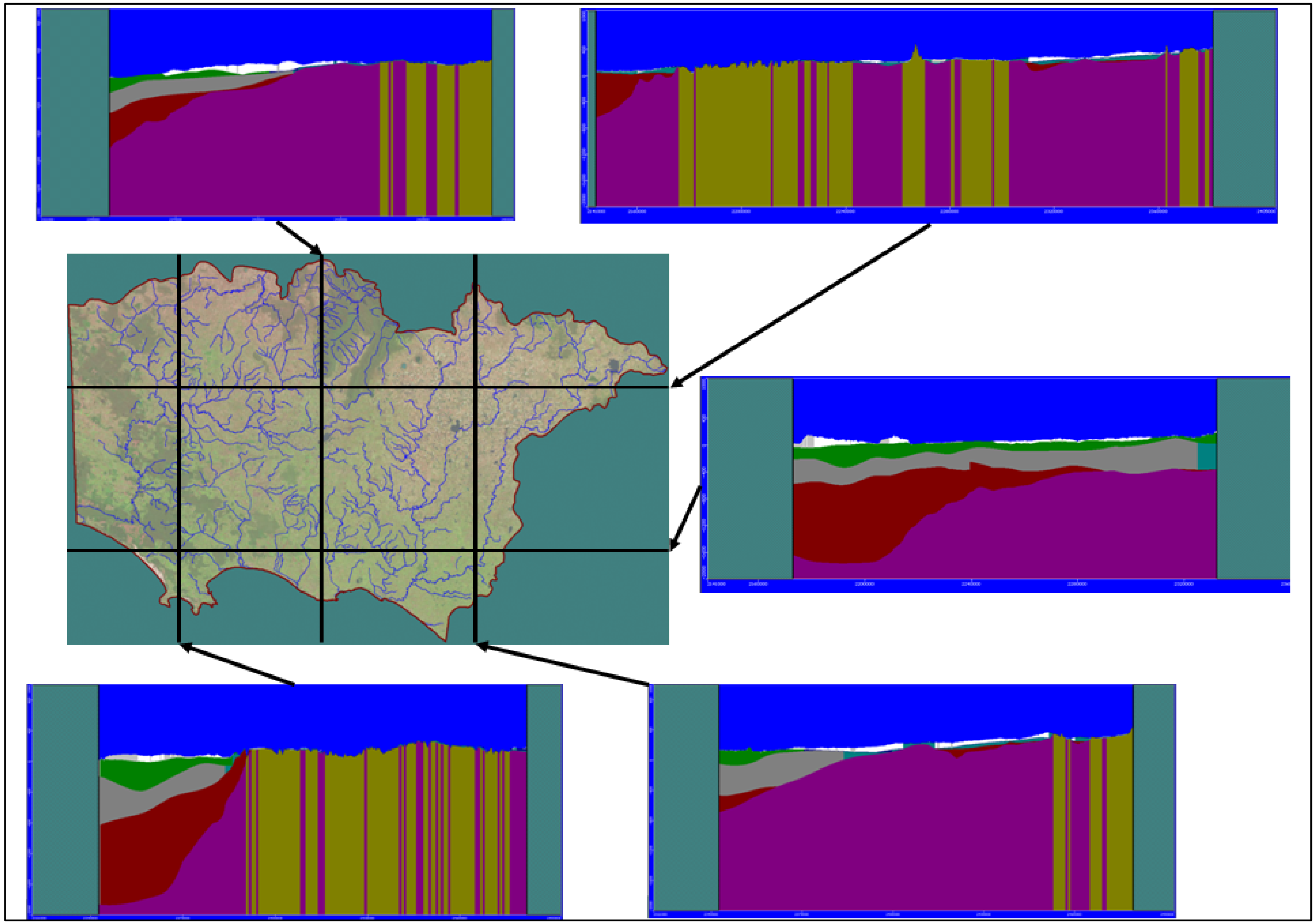
Layer	Unit Represented	Typical Conductivity Range from Literature (m/day)	Comments/Sources
1	Quaternary Alluvium	1-34	Various sources (compiled by Bush, 2009)
	Quaternary Basalts	1-10	Various sources (compiled by Bush, 2009)
2	Upper Tertiary Aquifer	1-50	Estimate, limited information available.
	Upper-Mid Tertiary Aquifer	Up to 270	Highly variable, high in cavernous limestone, but can be low < 1 m/day where limestone is unfractured. Various sources (compiled by Bush, 2009)
3	Upper-Mid Tertitiary Aquitard	10^{-7} – 10^{-3} (Gellibrand Marl) 3-18 (Clifton Formation)	Love et al. (1993) Bennetts (2005)
4	Lower Tertiary Aquifer	5 – 40	Various sources (compiled by Bush, 2009)
5	Pre-Cainozoic Basalt	N/A	No sources cited. Typically expected to be low to very low (<0.01m/day)



■ **Figure 6: Conceptual cross section of model layers.**



■ **Figure 7 Example model cross-section highlighting how the hydrogeological units have been incorporated in model layers.**



▪ **Figure 8 Example model cross-section vertically exaggerated 50 times (layer structure can be inferred from**

3. Numerical Model Design

3.1. Groundwater Modelling Software

The Glenelg Hopkins Model has been compiled and run in MODFLOW 2000 (Harbaugh et al 2000). The model inputs and outputs were processed using the Visual MODFLOW Version 4.3 software distributed by Schlumberger.

3.2. Modelling Methodology

A three stage process has been used in the development of the Glenelg-Hopkins CMA groundwater model:

Stage 1 – Pre-Development Steady State Model

Stage 2 – Transient Model (utilising the results of stage 1 as initial conditions)

Stage 3 – Post-Development Steady State Model

Stage 1 is used to perform the bulk of the model calibration and obtain initial conditions for the transient model run. The transient model run is used to fine tune the model calibration and stage 3 utilises the final calibrated model to find a post-development "dynamic equilibrium".

3.3. Model Extent, Gridding and Boundary Conditions

The model extent is the Glenelg Hopkins CMA boundary. The model has been discretised as a uniform 200 m square grid cell of 1320 columns 860 rows. The model has been compiled in VICGRID 1994 projection and the co-ordinates of the south west corner of the model 2,141,000 m East, 2,321,000 m North. There are 5 model layers as described in the model conceptualisation.

Along the coast a General Head Boundary condition has been applied with a conductance of 1000. The head is set at a constant level of 0m AHD for Layers 1 to 3 and at 5m AHD for Layers 4 and 5 to account for the implied upward vertical gradient.

Along the western extremity of the region (South Australian Border), the steady state model boundary is specified as no flow. This is in line with the conceptualisation that

groundwater flow in the Borderzone is predominantly in a southerly direction toward the coast.

3.4. Model Layers & Parameterisation

A summary of the model layering and how it relates to the geological units being represented is given in Section 2.7.1. Provided in this section are figures showing the surface elevations and thicknesses of these model layers.

Figures showing the top of surface elevation for the Upper Tertiary Aquifer (Top of Layer 2), Upper Mid Tertiary Aquifer (included within Layer 2), Upper Mid Tertiary Aquitard (top of Layer 3), Lower Tertiary Aquifer (top of Layer 4) and Pre Cainozoic (top of Layer 5) are provided in Map 17 to Map 21. The thicknesses (isopachs) of Layer 1 to Layer 4 of the model are provided in Map 22 to Map 25.

The calibrated model input parameters for each of these layers is defined below in Table 3.

- **Table 3. Hydraulic properties in the final calibrated model**

Layer	Unit Represented	Kh (m/day)	Kv (m/day)	Sy (-)	Ss (1/m)
1	Quaternary Alluvium	20	2	0.1	$5x10^{-6}$
	Quaternary Basalts	10	1	0.1	$5x10^{-6}$
2	Upper Tertiary Aquifer	75	7.5	0.1	$5x10^{-6}$
	Upper-Mid Tertiary Aquifer	100	10	0.1	$5x10^{-6}$
3	Upper-Mid and Lower- Mid Tertiary Aquitard	0.1	0.01	0.1	$5x10^{-6}$
	Lower-Mid Tertiary Aquifer (Clifton Formation)	10	0.01	0.1	$5x10^{-6}$
4	Lower Tertiary Aquifer	50	5	0.1	$5x10^{-6}$
5	Pre-Cainozoic Basalt	0.001	1	0.1	$5x10^{-6}$

- **Map 17. Surface elevation: Top of Upper Tertiary Aquifer.**
- **Map 18. Surface elevation: Top of Upper Mid Tertiary Aquifer.**
- **Map 19. Surface elevation: Top of Upper Mid Tertiary Aquitard.**
- **Map 20. Surface elevation: Top of Lower Tertiary Aquifer.**
- **Map 21. Surface elevation: Top of Basement (Pre Cainozoic).**
- **Map 22. Thickness of Model Layer 1**
- **Map 23. Thickness of Model Layer 2**
- **Map 24. Thickness of Model Layer 3.**

- **Map 25. Thickness of Model Layer 4.**

(Refer Appendix D - Mapping for all maps)

Note: Areas shown as 'absent' on thickness maps are zones of nominal thickness in the model. This is an unavoidable modelling limitation.

3.5. Model Recharge & Discharge Features

3.5.1. Groundwater Abstraction

The input required for MODFLOW to simulate extraction rates is a model layer, row and column reference, and usage rate for model stress period. Groundwater abstractions are not required for the pre-development steady state model run.

Information on groundwater abstraction was provided by Southern Rural Water. The information provided included:

- Metered use per license per GMA for the year 2007/2008.
- Total GMA groundwater use for the years 2003/2004, 2004/2005 and 2005/2006.
- License (SPG) numbers and the correlating bore number and location/depth/date completed information.

It was found that not all of the SPG numbers from the metered use information for 2007/2008 could be matched with a bore number, and therefore not all of the metered use information could be used. To account for this the use per licence for 2007/2008 was prorated such that the sum of all the licenses in the GMA equated to the total GMA use.

For years when metered use on a per licence basis was not available, however total GMA use was provided, the proportion of each bores use in 2007/2008 to total GMA use in 2007/2008 was used to estimate each bores use.

For historic years, (i.e. prior to 2003) the groundwater use was estimated as the average of 2003-2008, with the start date of abstraction set at the bore completion date.

In addition to abstraction information provided by SRW, there is abstraction that occurs in the borderzone (adjacent to the south Australian border. Allocation information for the borderzone was available from the State Water Report for 2004/2005 (DSE, 2006). Metering in the borderzone has occurred since 2005, but is not complete; therefore a percentage of the allocated volume was used to estimate use for all years post the construction date of each bore. The percentage use of allocation calculated for the 2004/2005 year was 30%.

Map 26 shows the locations of bores included in the groundwater model. There are a total of 650 bores included in the model with a total annual abstraction of 45 GL/year. Approximately 28 GL/year of this occurs near Warnambool, Karoit and Port Fairy predominately from the Upper Mid Tertiary Aquifer. Another 9 GL/year occurs in the borderzone (the area near the South Australian Border). This abstraction occurs from predominately shallow bores (less than 10m deep), and coincide with the very upper part of model layer 3. In reality this abstraction would occur in Quaternary alluvium deposits. The remainder of abstraction is somewhat scattered between these two main concentrations of pumping. Mostly from the Upper Mid Tertiary Aquifer. There is a concentration of bores near the Coleraine area that abstract from the Lower Tertiary Aquifer, as well as some abstraction from model layer 3 (which includes the Clifton Formation) near the township of MacArthur.

A complete list of all groundwater abstraction wells and modelled abstraction rates is provided in Appendix B.

- **Map 26. Location of groundwater abstraction bores.**

(Refer Appendix D Mapping)

3.5.2. River Features

A map of key surface water features in the study area is shown in Map 27. The model includes all river features shown in this figure. The river features have been modelled using the MODFLOW River package.

River elevation at each model cell was determined using a process which accounts for topographical variability through use of the model DTM. The process is summarised below:

1) River reaches are initially defined in the model through the Visual Modflow GUI. River reaches are defined between gauges (where available) or the mapped point at which streams commence and stream confluences. Visual Modflow only allows for streams to be defined with a linear gradient within any one reach. This therefore does not account for natural variability of stream gradients.

2) To allow for the variability in stream gradients the defined river cells (from step 1) are ‘draped’ across the model DTM. This is based on the assumption that stream profiles are generally strongly related to surrounding topography.
3) A forcing factor is used to ensure that the river is always flowing downhill, thus allowing for some of the discretisation effects associated with digital terrain models. Herein there is an assumption that the river flows through the lowest point in the topography therefore if the dtm has a slight rise in topography then the model forces the river elevation to continue to slightly flow downhill or at least flat until the dtm shows the topography to drop away again. This helps the model account for river reaches that flow through steep sided gorges or valleys.
4) A final forcing factor was used along the coastline to ensure all rivers discharging to the ocean finished at 0 mAHD at the coast.

The above methodology, based on ‘draping’ rivers over a DTM has been used on numerous other projects and has been proven to significantly improve the representation of rivers within groundwater models (when compared to the traditional linear approach).

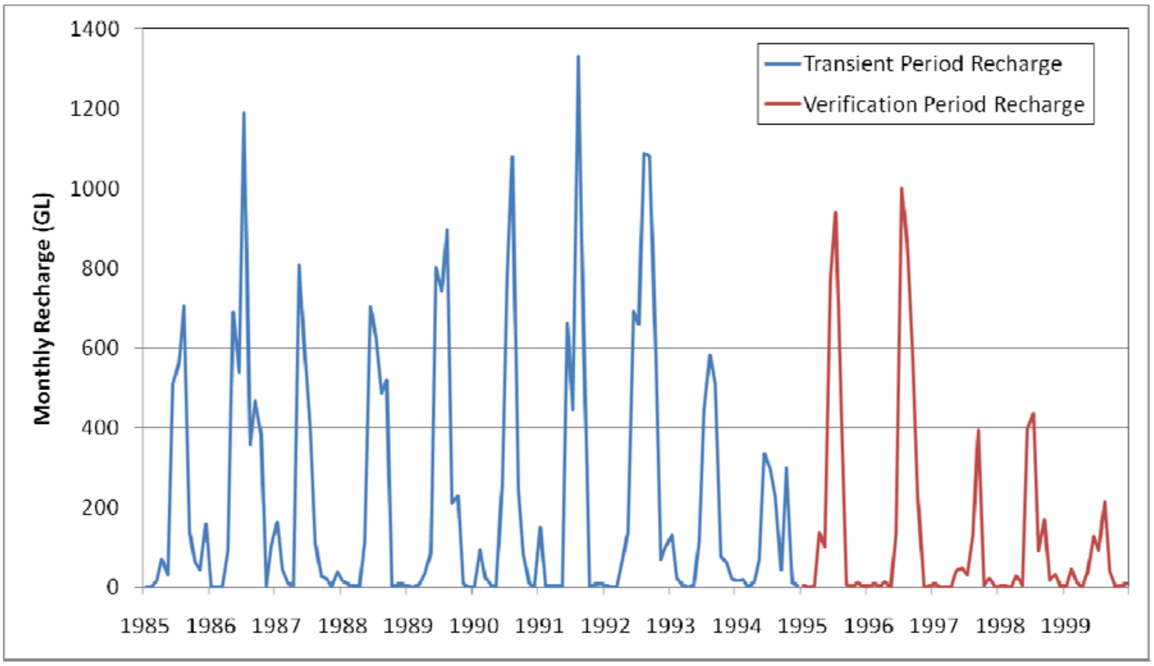
- **Map 27. Surface Water Features**

(Refer Appendix D Mapping)

3.5.3. Net GW Recharge (DSE supplied)

An objective of the model design is to ensure consistency with unsaturated zone modelling being undertaken by DSE using the ENSYM model (refer below for further details on the ENSYM model). This model has been used to estimate net recharge to the saturated zone on a 200m grid square interval. To this end the MODFLOW input for recharge is taken directly from the outputs of the ENSYM modelling. A map of the recharge layer supplied for the steady state model is provided in Map 28. A timeseries plot of the total recharge across the entire CMA area is provided in Figure 9. This figure provides an understanding of how recharge changes over time across the modelling period.

- **Map 28. Steady state model net groundwater recharge (as supplied by DSE) (Refer Appendix D Mapping)**



- **Figure 9 Estimated monthly recharge for the entire Glenelg-Hopkins CMA area for the relevant modelling periods.**

EnSym

EnSym (Environmental Systems Modelling Platform) is a computer program designed by the Victorian Government to provide:

- simple and intuitive access to complex science that helps prioritise natural resource investment
- an understanding of the environmental benefits delivered by actions undertaken in the landscape; and
- a framework for scientists and researchers to test and apply empirical and process based scientific models.

Ensym employs scientific models to improve understanding about the impacts that actions such as revegetation, weed control and riparian management, have on the landscape. Users can visualise, test and interpret results of changes in climate, land use and land management practices through a single interface. Models are grouped into 5 toolboxes that relate to different sections of the landscape and analytical capabilities. The toolbox

that simulates surface water dynamics and thus provides the recharge values is known as Biosym.

Biosym

Biosym (biophysical systems toolbox) is the name given the biophysical modelling toolbox within the Ensym model. BioSym originated from the Catchment Analysis Tool, also known as CAT1D (Beverley, 2007) which was jointly developed by DSE and DPI. From December 2008 onward, DSE and DPI followed different paths in further developments and modifications of the CAT1D module, thus to distinguish and to reflect the divergence of the simulation codes, BioSym was the name adopted as the computer program for biophysical modelling within the Ensym model.
BioSym solves for physical processes conceptually by using simplied analytical solutions and empirical equations. The code for BioSym was written with the objective of simulating all major hydrologic components as simply and realistically as possible, and to use inputs readily available over large spatial scales to enhance the likelihood that the model would become routinely used in planning and water resource decision making.

The model components of BioSym can be placed into eight major categories - hydrology, weather, sedimentation, soil temperature, crop growth, nutrients, agricultural management, and pesticides.

Water entering the soil profile is initially determined by subtracting the calculated surface runoff from the total daily precipitation and irrigation. Once in the soil profile, water can be removed by evapotranspiration, lateral flow, downward movement if soil capacity is exceeded. Water fills up lower soil layers until it exits the soil profile and becomes drainage. Drainage is then partioned into sub surface lateral flow and recharge.

The Biosym modelling approach, results in several limitations in regards to recharge calculations, the most major of which are:

- no recharge time lags are taken account of, thus it is assumed that water partitioned for recharge instantly hits the water table. This limitation is of most concern in areas of deeper water tables and of little concern in shallow water table areas.
- surface runoff does not cascade from upstream modelling cells to downstream modelling cells, thus no pooling can be modelled or accumulation of water in low lying areas. This may result in the underestimation of recharge is low lying areas.

- similarly floods are not modelled thus recharge events caused by flood waters will be missed. Obviously recharge still tends to peak during flood events as a result of high rainfall however recharge will be underestimated in areas where flood waters contribute to recharge.
- all biophysical processes are simulated on a daily timestep thus processes that occur on a smaller timestep may be poorly accounted for, such as short high intensity storm events.
- any influence that underlying geology has on impeding or aiding recharge is not taken into account, for example in some areas of upland Victoria the deeper regolith is suspected to throttle recharge depending on it's water content.
- the soil mapping used is the best currently available across the state however it is primarily a landsystem map thus large variations in soil types can exist within each of the Biosym soil units.
- Biosym assumes no temporal changes in landuse, thus for example, recharge changes from afforestation are not modelled during the groundwater model time period.
- Biosym doesn't take into account areas where the soil profile is saturated due to groundwater discharge.

It is important that these recharge modelling limitations are taken into account when assessing the overall limitations of a groundwater model using Biosym recharge values.

For further detail on the Biosym toolbox please refer to the CAT1D technical manual (Beverley, 2007) and to the Programmer's Guide for BioSym (Ha, in preparation)

3.5.3.1. Irrigation

Irrigation was accounted for through the unsaturated zone ENSYM modelling.

3.5.4. Evapotranspiration

Evapotranspiration processes that occur on the ground surface and in the unsaturated zone are included within the ENSYM modelling being undertaken by DSE as part of the ecoMarkets initiative. The recharge outputs from the ENSYM model are used to define the recharge input for the groundwater model, therefore this component of the water

balance does not need to be represented by the groundwater model. The ENSYM model does not however simulate evaporation directly from the saturated zone (water table). Therefore the groundwater model will include the MODFLOW evaporation package which assumes that actual evaporation varies linearly from 0 at a user defined extinction depth, to a user defined maximum evaporation rate at depth = 0.

The maximum possibly rate of evapotranspiration from the land surface is defined by the Potential Evapotranspiration (PET). This includes ET from both the saturated and unsaturated zone. Given the unsaturated zone ET has already been quantified through the ENSYM model a maximum saturated zone ET was defined as per Equation 1.

Equation 1. Groundwater ET_{max} *= Potential ET – ENSYM Model ET*

The gridded surface of Groundwater ET_{max} was provided by DSE for direct input into the groundwater model. This surface is shown in Map 29.

- **Map 29. Groundwater ET_{max} (as supplied by DSE)**

(Refer Appendix D Mapping)

3.6. Model Timeframes

The pre-development steady state is modelled 'loosely' on 1985 hydrological conditions. In this way, no groundwater abstraction wells are included in the model.

The transient model incorporates a 10 year period with monthly stress periods and is designed to simulate Jan 1985 to Dec 1994 conditions. Due to the complexity of the model the inputs that vary on a monthly timestep are recharge, ET (as supplied by DSE) and groundwater abstractions. River levels remain constant throughout the model run, as do all specified head boundary conditions.

Model verification will then extend the transient period by 5 years and run from Jan 1995 to Dec 1999.

4. Model Calibration

4.1. Observation Wells

A total of 720 observation wells were found within the rectangular model domain. Each of these 720 wells had at least one water level reading post 1985. However only 399 of these wells fall within the active model domain.

For the purposes of the steady state model all bores that had a water level reading within ten years of 1985 were considered to be of use. This further reduced the number of useful bores to 320. For each of the 320 bores the water level reading closest to January 1985 was used as the pre-development steady state observation point. Water level observations were extracted from the state Groundwater Management System (GMS).

For the transient model run all observations post 1985 are used as calibration points.

The steady state observation bores were distributed amongst the model layers as follows.

- Model Layer 1 32 bores
- Model Layer 2 15 bores
- Model Layer 3 79 bores
- Model Layer 4 16 bores
- Model Layer 5 177 bores

The location of these observation bores is shown in Map 30. It is clear that there are a large number of bores shown to be in layer 5. Many of these are relatively shallow bores in the northern section of the model where the basement outcrops. It is also possible that the depth of the bores has been overestimated in some cases. This is due to the large number of bores that do not have recorded screened intervals. In these cases, the best surrogate for screened interval is the bore depth which could in some circumstances push bores into deeper layers than they should be. However, in the absence of better data this is the best approximation we can make.

A complete list of all sites used is provided in Appendix C.

- **Map 30. Observation bore network.**

(Refer Appendix D Mapping)

4.2. Pre-development Steady State Calibration

4.2.1. Steady-state methodology

The Glenelg-Hopkins CMA groundwater model is a complex region model discretised at a fine resolution. Consequently a significant hurdle to calibrating the model is numerical instability and model run time. Within this context, it was found that the traditional approach to steady state modelling was not feasible (i.e. the model would not converge to a reasonable solution using the Modflow steady state run setting).

A number of differing solver packages, solver parameters and convergence criteria were tested. The convergence criteria was set at 0.1 m for both the max head change and max residual. Higher values, up to 0.5 m, were tested. At 0.5 m the model converged but it was obviously a poor solution as large areas of the model dried up.

An alternative approach was used to approximate a steady state solution by running a transient model with constant inputs for 'a very long time'. In this case, 100 years was found to be suitable for the groundwater system to be considered to be near equilibrium (i.e. minimal storage changes and no observable potentiometric fluctuations). Specifically, the methodology was to run a 10 year transient model, ten times in batch mode, with the final heads of one run being extracted and input as the initial heads to the subsequent run. In each run all inputs remain constant in time. When the groundwater system is observed to be in a near equilibrium state, the heads at the conclusion of the final run are used to assess model calibration. Final volumetric budgets at the conclusion of each 10 year run are provided in Appendix A.

4.2.2. Calibration Statistics

The final calibration statistics for the pre-development steady state model are provided in Table 4 and Figure 10. The model statistics suggest that the model has achieved a reasonable calibration as suggested by the low Scaled RMS error of 2.47%. These statistics suggest that errors are only a minor part of the overall model response. The XY scatter plot of observed versus calculated values in Figure 10 also shows that there is no significant bias in the model. The 95 percent error bands suggest that the model is possibly slightly skewed to underestimate observed heads, however it appears as if this may be skewed by a small number of outliers. The scatter plot also colours each of the results by layer indicating that there is no obvious bias within or between any of the model layers.

This is also supported by Table 5 which indicates that all layers fall within the bounds of a good calibration. Statistically the lowest calibration was for layer 2, however this is likely a result of the minimal number of observation bores available here.

- **Table 4 Pre-development steady state model calibration statistics**

Statistic	Result	Comments
No. of Observations	294	Some of the observation wells were found to be screened within dry cells and therefore could not be calibrated against.
Mean Sum of Residuals (MSR)	-4.5 m	This statistic can be skewed by the range in the measured values
Scaled Mean Sum of Residuals (SMSR)	-0.99 %	An intuitive relative measure independent of sample size and measurement range
Root Mean Square (RMS)	11.23 m	
Scaled Root Mean Square (SRMS)	2.47 %	Values of less than 5% are generally considered to be a reasonable calibration (MDBC Groundwater Flow Modelling Guidelines, 2000). Low values indicate that the ratio of the error to the total head differential is small and hence errors are only a small part of the overall model response.
Max Head	446.8	
Min Head	-8	From observed data (therefore possible error)
Mean Head	198.6	

- **Table 5 Pre-development steady state model calibration statistics by layer**

Layer	Unit Represented	Number of Bores	Scaled RMS
1	Quaternary Alluvium	31	2.06 %
	Quaternary Basalts		
2	Upper Tertiary Aquifer	14	4.79 %
	Upper-Mid Tertiary Aquifer		
3	Upper-Mid and Lower- Mid Tertiary Aquitard	55	3.81 %
	Lower-Mid Tertiary Aquifer (Clifton Formation)		
4	Lower Tertiary Aquifer	16	2.92 %
5	Pre-Cainozoic Basalt	177	2.70 %

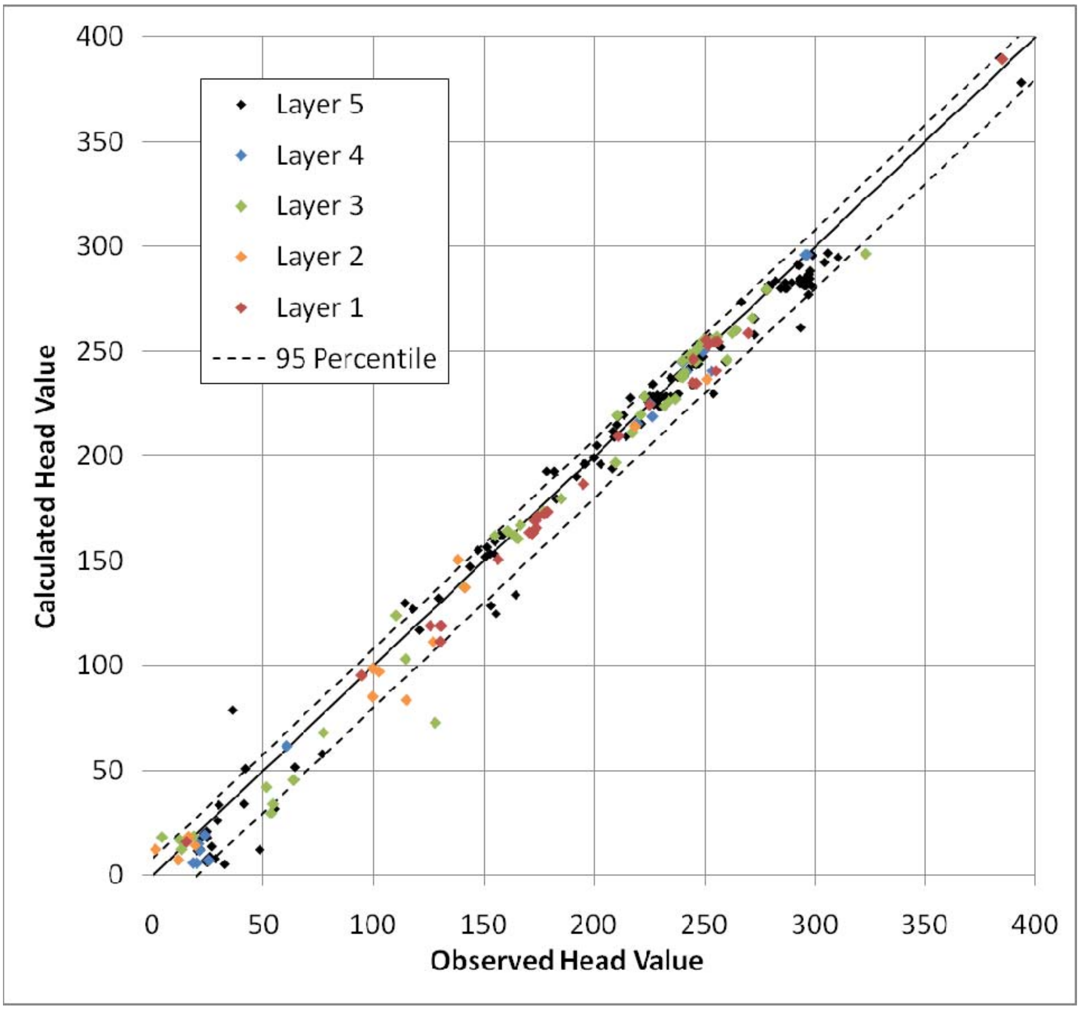


Figure 10. Pre-development steady state model calibration plot

Calibration residuals are also shown by layer and locality in Map 31 to Map 35. These highlight that there is no significant bias in the calibration toward certain areas, however also highlights which areas achieved a better fit.

- **Map 31. Layer 1 calibration point residuals with aquifer status shown in background**
- **Map 32. Layer 2 calibration point residuals with aquifer status shown in background**
- **Map 33. Layer 3 calibration point residuals with aquifer status shown in background**
- **Map 34. Layer 4 calibration point residuals with aquifer status shown in background**
- **Map 35. Layer 5 calibration point residuals with aquifer status shown in background**

(Refer Appendix D Mapping)

4.2.3. Potentiometric Surfaces

Potentiometric surface plots for each of the model layers have been produced to graphically present the steady state model results and ensure the model response agrees with the hydrogeological conceptualisation of the aquifer systems.

The potentiometry maps are provided in Map 36 (layer 1), Map 37 (Layer 2), Map 38 (Layer 3), Map 39 (Layer 4), Map 40 (Layer 5).

When compared with the inferred potentiometric surfaces presented within the conceptual model section of this report these maps highlight that the predicted model flow paths are generally in good agreement with inferred flow paths. As a general rule both inferred and modelled surfaces indicate flow in a southerly direction towards the coast in all aquifers. A good example of local variations to this is in the area around the southern reaches of the Glenelg River where in the Dilwyn aquifer is shown to be flowing toward the river (i.e. discharge) in both the inferred and modelled surfaces.

Naturally, there are likely to be numerous areas where the modelled heads do not match inferred or measured heads. Significant discrepancies (in excess of 20m) can be expected even though the calibration statistics are within the limits defined by the modelling guidelines and as adopted by this project. Given the scale and complexity of the model, it is natural that errors will occur for a number of reasons, the key ones being:

1) The inferred surfaces are, by definition, estimations based on available data. The measured data on which the observed surfaces are based are sparsely distributed

throughout the model domain and hence there are significant uncertainties associated with the measured groundwater surfaces. To this end it is considered important to optimise the match between measured and predicted data at the location of the measured data and hence reduce reliance on matching surfaces.

2) Model error. There is likely to be numerous areas where the model is over or under-predicting heads. Again, given the scale and complexity of this model, and within the bounds of practical time constraints, it is not possible to analyse every erroneous area in the model to produce a "perfect" fit. Nor would this be a sensible approach given that we would be aiming for a perfect match with an imperfect dataset.

- **Map 36. Pre development steady state model run potentiometric surface - Layer 1**
- **Map 37. Pre development steady state model run potentiometric surface - Layer 2**
- **Map 38. Pre development steady state model run potentiometric surface - Layer 3**
- **Map 39. Pre development steady state model run potentiometric surface - Layer 4**
- **Map 40. Pre development steady state model run potentiometric surface - Layer 5**

(Refer Appendix D Mapping)

4.2.4. Watertable Elevation

The watertable resides in different layers across the model domain, therefore it is difficult to infer a consistent watertable elevation from the potentiometric surface maps. To aid visualisation of the watertable across the whole model domain a modelled watertable elevation has been created by looking at the head in the upper most active cell of each layer. This merged watertable elevation map is shown in Map 41.

Based on the merged watertable elevation map, and the inferred watertable elevation maps (previously shown in Map 10), a residual map has been created to help understand the certainty in the modelled watertable. Generally the modelled watertable provides a good representation, with most of the modelled area within 25m of the inferred watertable. The areas where it breaks from this classification are typically in steep terrain such as the Grampians.

- **Map 41. Pre development steady state model run watertable elevation**
- **Map 42. Inferred versus modelled watertable elevation residual map**

(Refer Appendix D Mapping)

4.2.5. Mass Balance

The water balance for the pre development steady state model run is provided in Figure 11. The mass balance is based on the final (10^{th}) run and therefore presents a 10 year cumulative mass balance.

The mass balance indicates that there is a significant amount of groundwater – surface water interaction occurring in the Glenelg Hopkins region. However, this is likely to be caused by the large network of streams represented in the model and the significant interaction that would be occurring between the streams and the shallow aquifer system. Whilst these are likely to represent real continual processes it does tend to overstate the importance of groundwater – surface water interactions in the overall basin. For example, the net river interaction (total outflow minus total inflow) is 448 GL/y, net discharge to river. This compared to diffuse recharge (2848 GL/yr) is still a significant but only small proportion of the total aquifer mass balance.

Overall, the mass-balance presents a relatively simple balance owing to the fact that this model focuses solely on the groundwater system. Recharge is a fixed volume supplied to the model through the ENSYM modelling of the unsaturated zone. Evapotranspiration (ET) is relatively low because it only includes direct groundwater ET and not ET from the unsaturated zone.

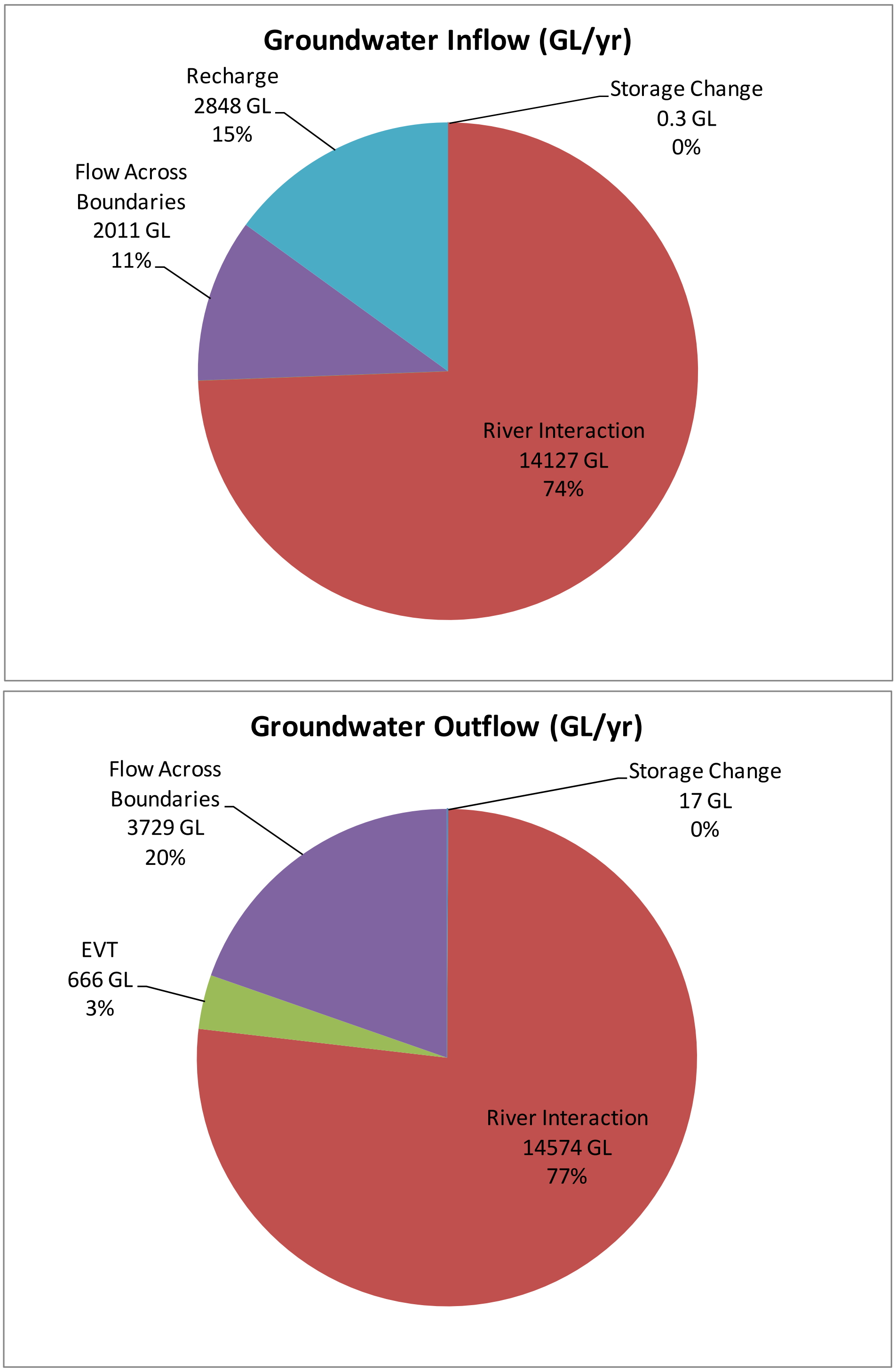


Figure 11. Mass Balance for the pre development steady state model run (based on a 10 year cumulative mass balance)

4.2.6. Groundwater-Surface Water Interactions

A quick comparison of the model river interaction results with the baseflow assessments at the stream gauges suggests that the net discharge of approximately 450 GL/yr is likely to be in the appropriate order of magnitude. The total baseflow for all gauges was approximately 800 GL/yr (excluding Rocklands Reservoir which is obviously a highly altered flow regime and therefore baseflow indices are not appropriate). The 800 GL/yr would also overstate the interaction because it does not account for flow accumulation along the rivers where there are multiple gauges. Therefore whilst the figures cannot be compared directly it does indicate that model results are likely to be in an appropriate order of magnitude.

There are also some individual gauges which correlate strongly with implied discharges based on the potentiometric surface maps. For example the Glenelg River at Dartmoor was indicated as having high baseflow. The potentiometric surface plots in this area indicate strong groundwater gradients towards the river, therefore supporting the baseflow estimates. Similar patterns are observed further upstream in the area of Casterton and Merino and even high in the catchment downstream of Rocklands Reservoir, where the near river potentiometric gradients are supportive of groundwater discharge to the rivers and the baseflow assessment carried out.

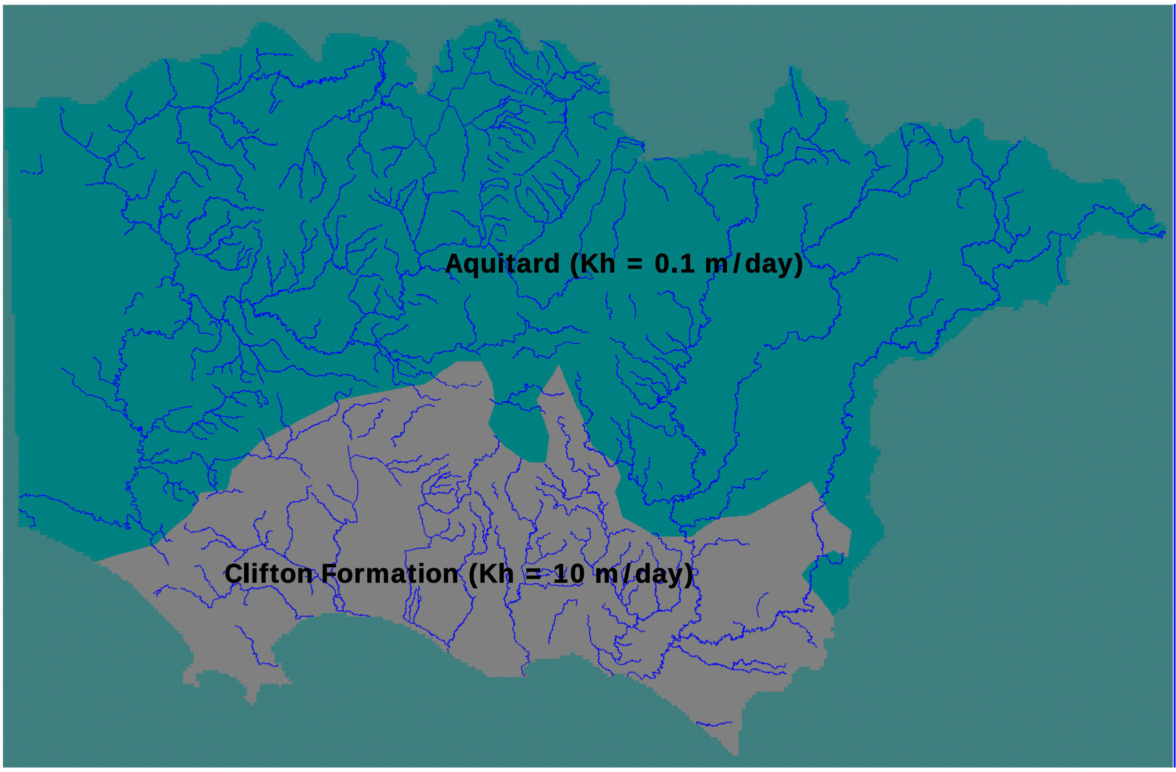
More subtle results can also be inferred in the lower reaches of the Hopkins and Mount Emu Creek catchments. The baseflow assessments indicated a high volume of streamflow is provided from the groundwater system. The potentiometric surface results subtly support this although flow is typically parallel to the river system and some of the localised near river processes may have been lost in the context of the regional model.

4.3. Transient Model Calibration

4.3.1. Improvements from the pre-development steady state model

A number of changes were made prior to and during the transient model calibration process. These are summarised below:

1) All transient inputs were extended to cover the period January 1985 to Dec 1994. In particular the recharge was updated with the timeseries data provided by DSE. Rivers and ET and boundary conditions were all updated however these inputs are non-time varying.
2) Groundwater extractions were introduced into the model (these inputs were created as per the discussion in section 3.5.1)
3) The hydraulic conductivity in the Pre-Cainozoic Basement Aquifer was decreased from 0.01 to 0.001 m/day. This resulted in an improved RMS error (although negligible change to bore hydrographs). The lower conductivity provides a better fit with the conceptual model for the basement aquifer and therefore was adopted in the final model.
4) The hydraulic conductivity in the Upper Mid Tertiary Aquifer (Limestone Aquifer) was increased from 50 to 100 m/day. This resulted in a slightly improved RMS and an observable improvement in hydrographs monitoring the Limestone with no significant change to other aquifers. Conceptually this is considered to reflect the highly fractured nature of the Limestone which can lead to very high conductivity in places.
5) A new conductivity zone was added to model layer 3. This new zone was incorporated to discretely represent the presence of the Clifton Formation as distinct from the overlying and underlying aquitards. In this zone the horizontal hydraulic conductivity was increased from 0.1 to 10 m/day whilst the vertical conductivity remained at 0.01 m/day. This differentiation of the horizontal and vertical conductivities allows us to replicate the presence of the higher permeability Clifton Formation whilst still replicating the overlying and underlying aquitards which restrict its interaction with, for example, the Dilwyn Formation. The area represented by this new zone is shown in Figure 12.



- **Figure 12. Hydraulic conductivity zone added to represent the Clifton Formation in Layer 3 (grey area)**

4.3.2. Calibration Statistics

The final calibration statistics for the transient model are provided in Table 6 and Figure 13. The model statistics suggest that the model has achieved a reasonable calibration as suggested by the low Scaled RMS error of 2.24%. These statistics suggest that errors are only a minor part of the overall model response. The XY scatter plot of observed versus calculated values in Figure 13 also shows that there is no significant bias in the model. If anything there is a slight underestimation of heads in the model as suggested by the 96% confidence interval however this is believed to be skewed by a couple of sites that lie at high elevations.

Maps of the calibration residuals at individual bore sites and within individual aquifers were presented in the steady state model results section (4.2.2). These are still considered to be applicable for the transient calibration as there were no significant trends during the transient calibration period (as will be shown in hydrographs in the

following section). Therefore these maps have not been reproduced for the transient model run.

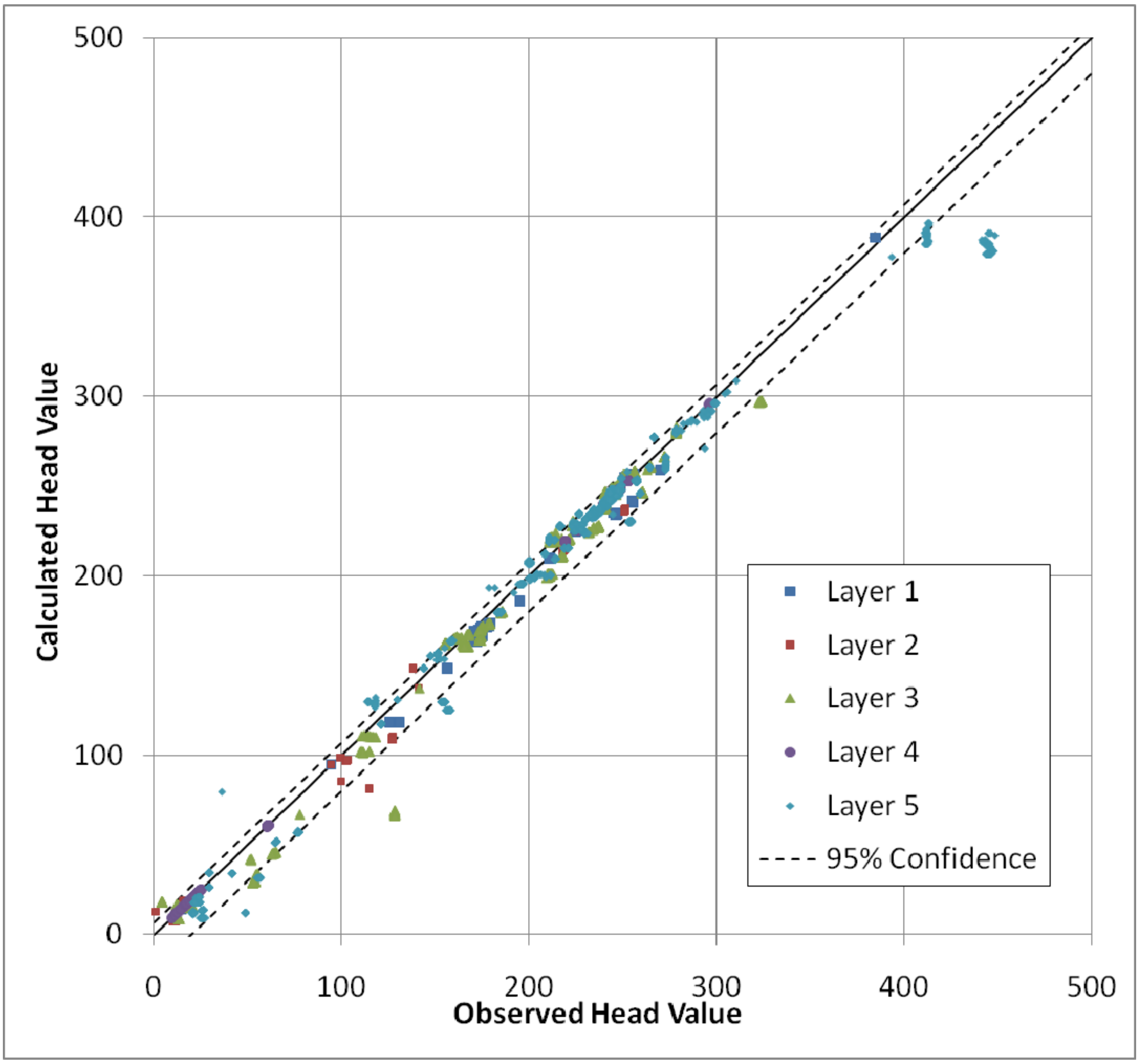
Calibration statistics for each individual layer are provided in Table 7. These statistics highlight that all model layers fall well within the model calibration criteria. The very low RMS error values for the Quaternary aquifers and the Lower Tertiary suggest particularly good calibrations in these key aquifers.

Table 6 Transient model calibration statistics

Statistic	Result	Comments
No. of Observations	6564	From 399 observation sites
Mean Sum of Residuals (MSR)	-3.36	This statistic can be skewed by the range in the measured values
Scaled Mean Sum of Residuals (SMSR)	-0.74	An intuitive relative measure independent of sample size and measurement range
Root Mean Square (RMS)	10.24	
Scaled Root Mean Square (SRMS)	2.24 %	Values of less than 5% are generally considered to be a reasonable calibration (MDBC Groundwater Flow Modelling Guidelines, 2000). Low values indicate that the ratio of the error to the total head differential is small and hence errors are only a small part of the overall model response.
Max Obs Head	448.3	
Min Obs Head	-8.0	From observed data (therefore possible error)
Mean Obs Head	186.1	

Table 7 Transient model calibration statistics by layer

Layer	Unit Represented	Number of Observations	Scaled RMS
1	Quaternary Alluvium	663	1.73 %
	Quaternary Basalts		
2	Upper Tertiary Aquifer	296	3.31 %
	Upper-Mid Tertiary Aquifer		
3	Upper-Mid and Lower- Mid Tertiary Aquitard	1542	3.76 %
	Lower-Mid Tertiary Aquifer (Clifton Formation)		
4	Lower Tertiary Aquifer	476	2.86 %
5	Pre-Cainozoic Basalt	3587	2.48 %



■ **Figure 13. Transient model calibration plot**

4.3.3. Key Observation Bore Hydrographs

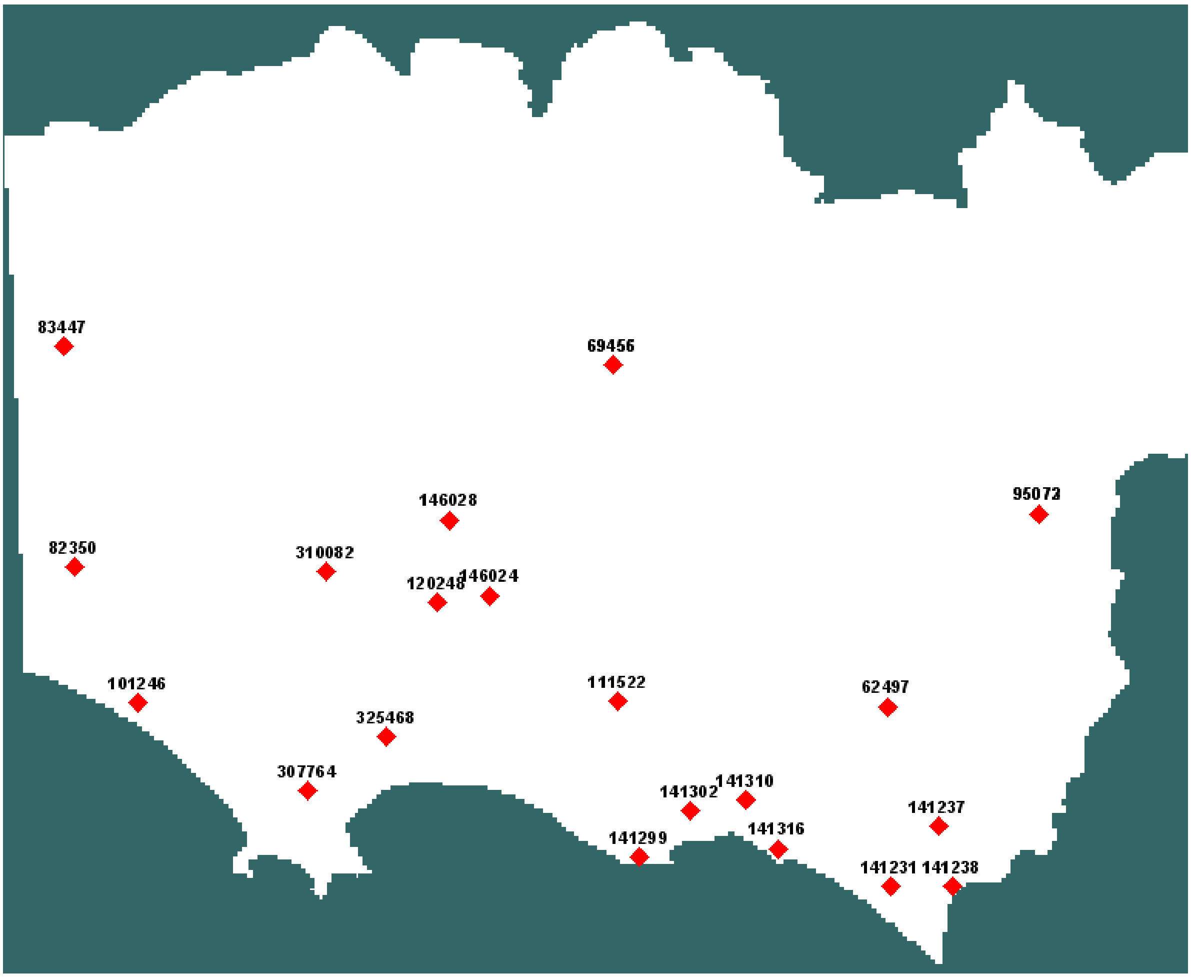
Twenty-two sites were selected as 'key observation bores' that would be used to display a representative set of hydrographs across the model domain (Table 8 and Figure 14). The majority of the sites used are those selected by DSE as key monitoring sites (pers. comm., Jill McNamara, DSE, 9th March 2010). These sites were used because they have a good geographical spread within each of the relevant groundwater management units and the groundwater management units cover all the major aquifers within the study area.

Key monitoring sites were provided for the Glenelg WSPA, Portland GMA, Yangery WSPA, Condah WSPA and Nullawarre WSPA.

In addition to DSE's key monitoring sites, sites were added in the Hawkesdale GMA and unincorporated areas. These were randomly chosen to provide a good geographical spread.

Table 8 Key Observation Bores

Site ID	WSPA / GMA	Aquifer Monitored	
120248	Condah WSPA	Clifton Formation	Lower Mid Tertiary Aquifer (Layer 3)
146024			
146028			
82350	Glenelg WSPA	Limestone	Upper Mid Tertiary Aquifer (Layer 2)
83447			
101246			
111522	Hawkesdale GMA		
141302			
141231	Nullawarre WSPA		
141237			
141238			
307764	Portland GMA	Mepunga Formation	Lower Tertiary Aquifer (Layer 4)
310082		Dilwyn Formation	
325468		Dilwyn Formation	
141299	Yangery WSPA	Limestone	Upper Mid Tertiary Aquifer (Layer 2)
141310			
141316			
62497	Unincorporated	Limestone	Upper Mid Tertiary Aquifer (Layer 2)
69455		Basement	Pre-Cainozoic Basement (Layer 5)
69456		Volcanics	Quaternary Aquifer (Layer 1)
95072		Basement	Pre-Cainozoic Basement (Layer 5)
95073		Clifton Formation	Lower Mid Tertiary Aquifer (Layer 3)



▪ **Figure 14. Key observation bores**

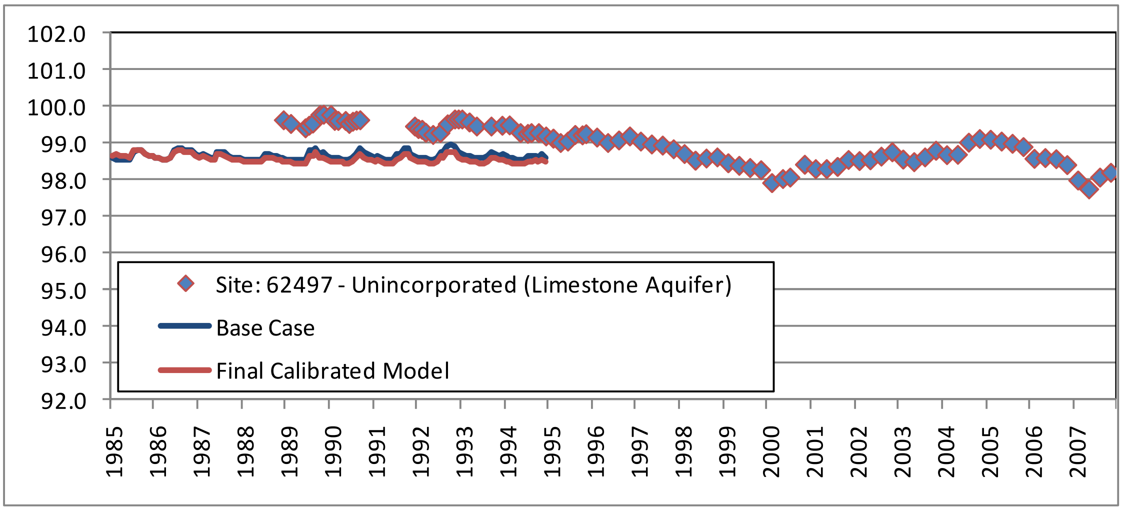
Hydrographs for each of the key observation bores are provided below. The key observation bores were chosen in the final stages of the calibration process. This avoided the possibility of calibrating to a small sub-set of bores. Therefore the hydrographs present a 'warts and all' depiction of the transient calibration (it would have been easy to select the 20 best sites which may have led the reader to an incorrect assumption of a near perfect calibration).

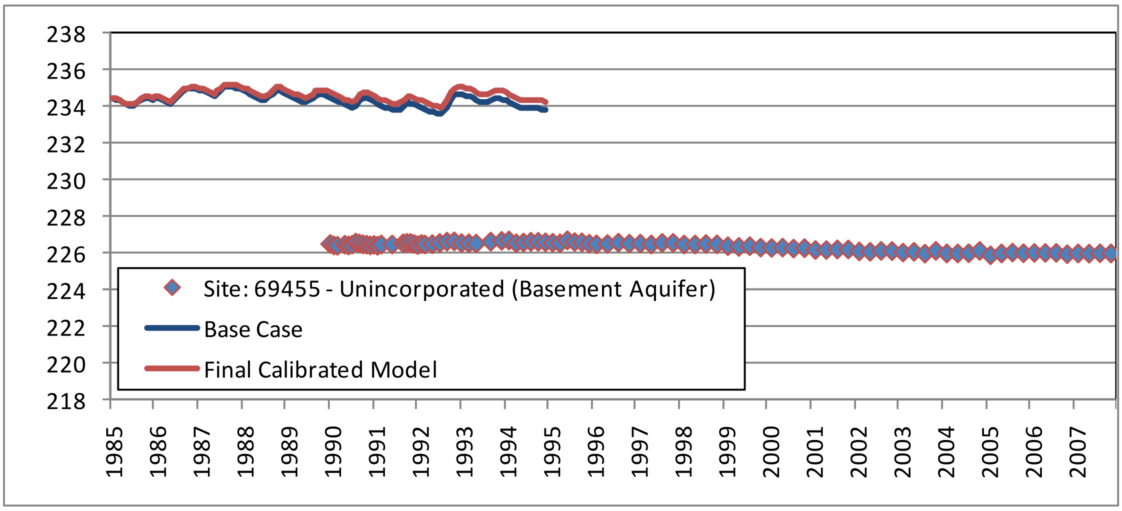
Some of the hydrographs present a good match to observed values and some show a significant under or overestimation of water levels. During the calibration period (1985 to 1995) there was no significant long-term trend in water levels. As a general rule, the modelled levels also show little or no long-term trend across this period. This may suggest that even where water levels are offset, trends over time appear to be replicated by the model. This conclusion is common in regional groundwater modelling and it is

recommended that results from the model be used in a comparative sense as opposed to an absolute sense (i.e. it is considered more appropriate to look at differences between model runs).

The final calibrated model hydrographs shown below are presented against a base case run which was the first transient model run completed following the steady state modelling. This shows the improvement in model results across the calibration process. In many hydrographs there is minimal change as significant effort was put into the steady state model and therefore the first transient run was already considered to have a reasonably good calibration.

Note: A complete set of 410 calibration model hydrographs are provided in Appendix C.





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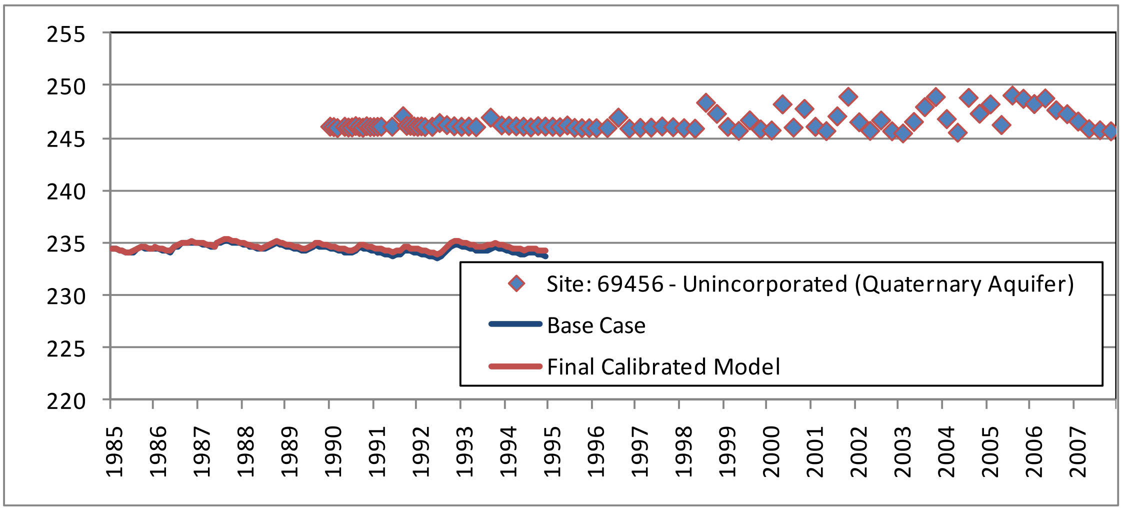
Site: 69455 - Unincorporated (Basement Aquifer)
Base Case
Final Calibrated Model



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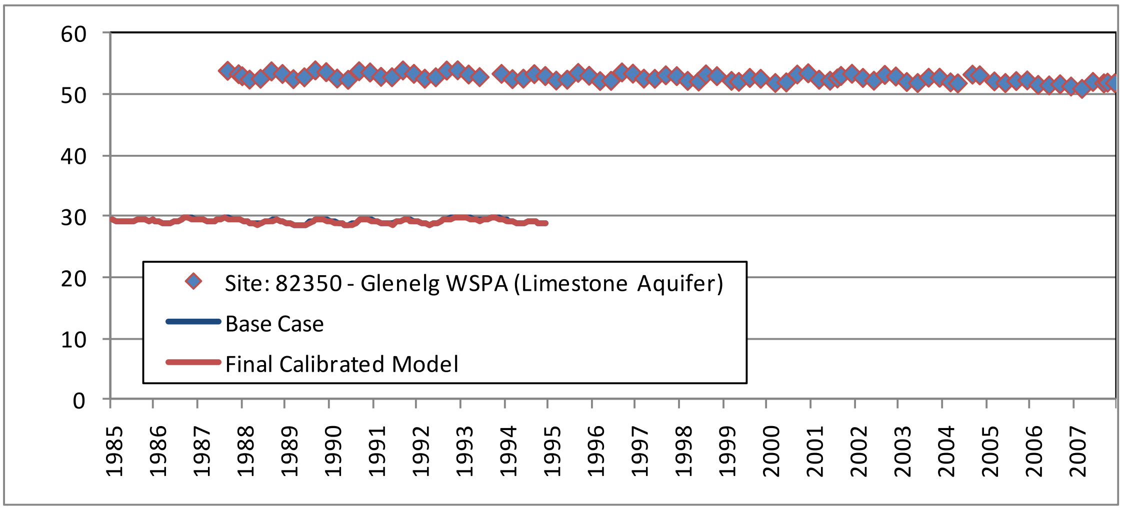
Site: 69456 - Unincorporated (Quaternary Aquifer)
Base Case
Final Calibrated Model



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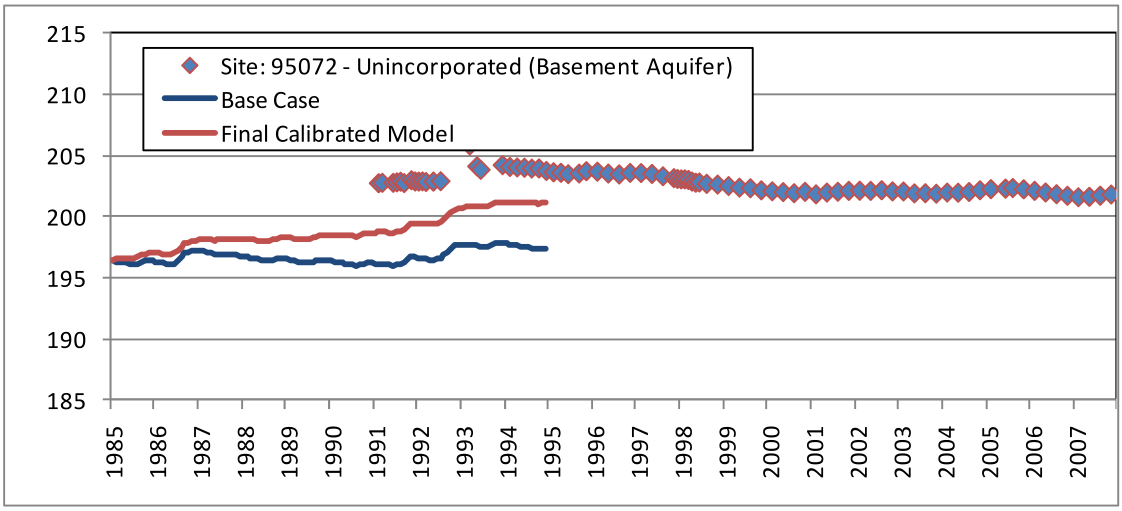
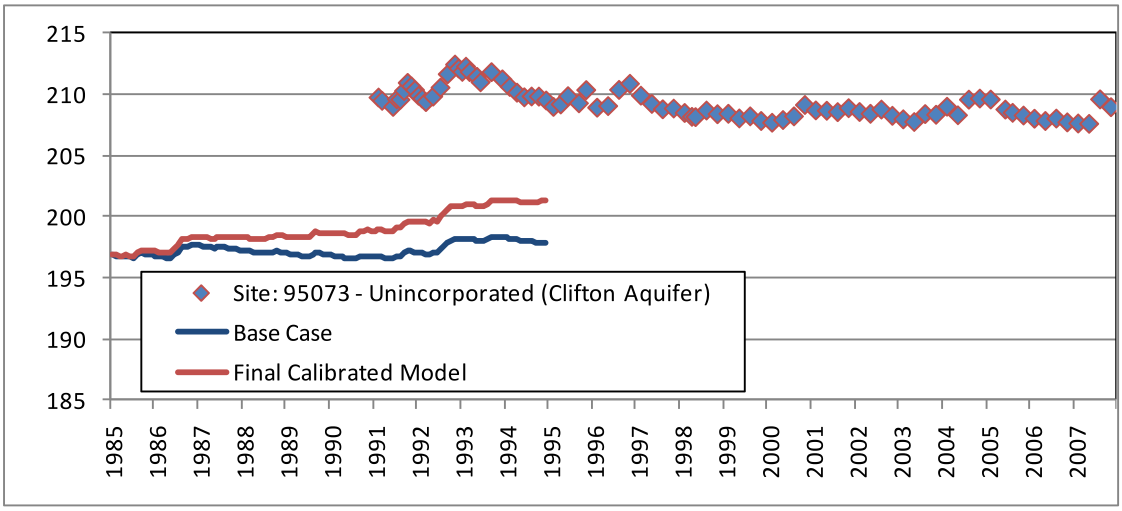
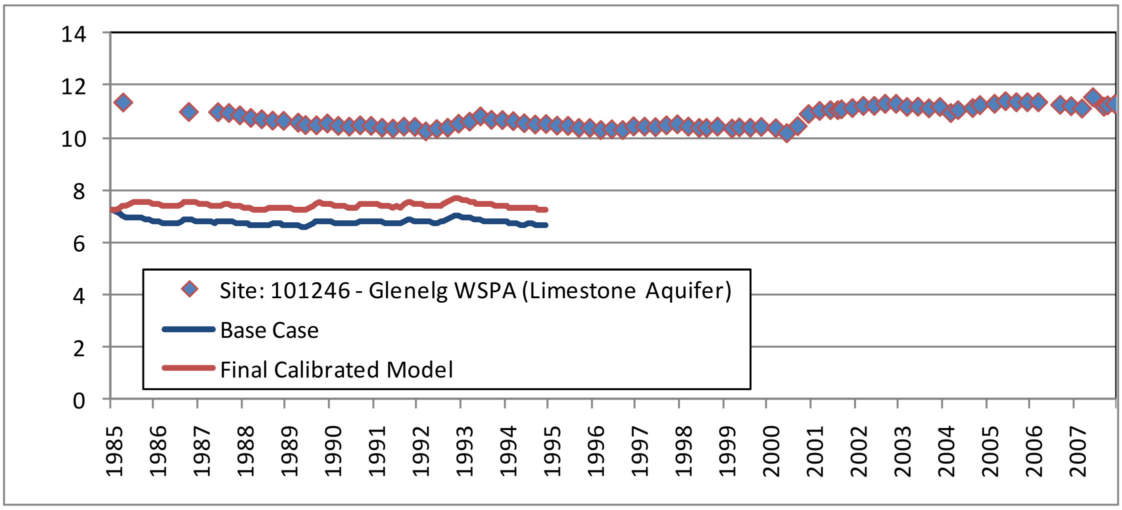
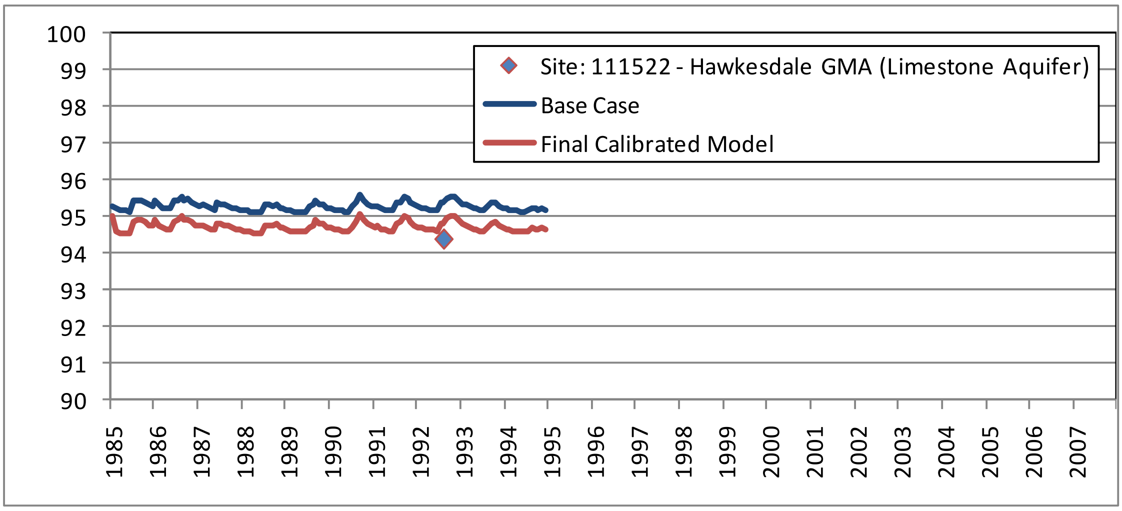
Site: 82350 - Glenelg WSPA (Limestone Aquifer)
Base Case
Final Calibrated Model


Site: 95072 - Unincorporated (Basement Aquifer)
Base Case
Final Calibrated Model


Site: 95073 - Unincorporated (Clifton Aquifer)
Base Case
Final Calibrated Model


Site: 101246 - Glenelg WSPA (Limestone Aquifer)
Base Case
Final Calibrated Model


Site: 111522 - Hawkesdale GMA (Limestone Aquifer)
Base Case
Final Calibrated Model
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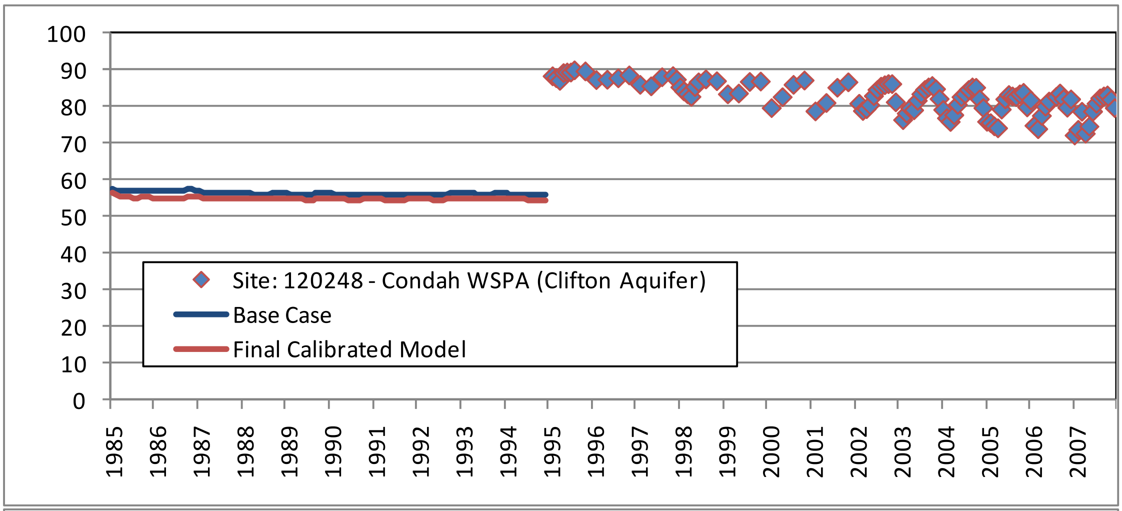
Site: 120248 - Condah WSPA (Clifton Aquifer)
Base Case
Final Calibrated Model
100
90
80
70
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1992
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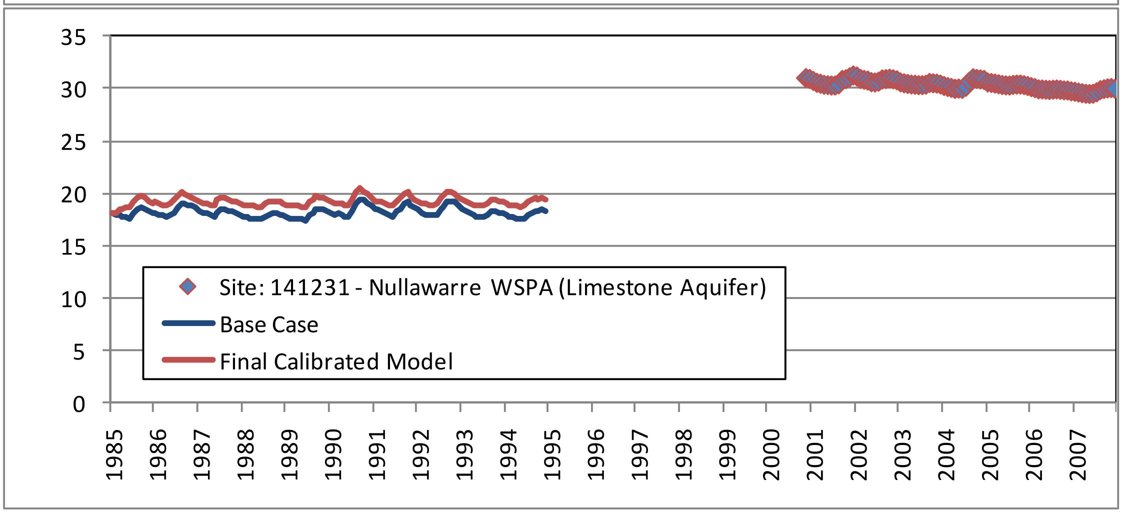
2007


Site: 141231 - Nullawarre WSPA (Limestone Aquifer)
Base Case
Final Calibrated Model
35
30
25
20
15
10
5
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
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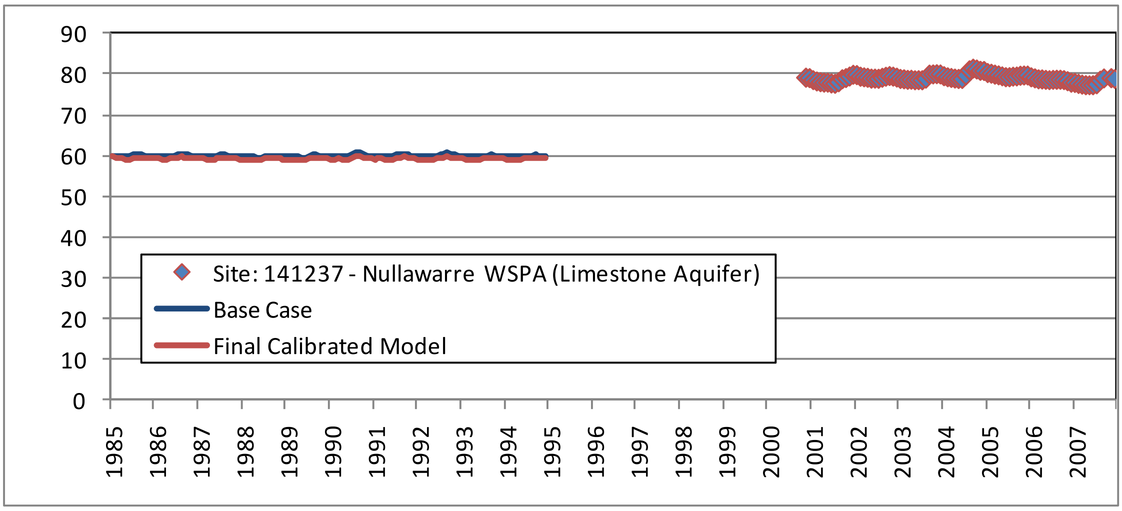
2006
2007



90
80
70
60
50
40
30
20
10
0
Site: 141237 - Nullawarre WSPA (Limestone Aquifer)
Base Case
Final Calibrated Model
1985
1986
1987
1988
1989
1990
1991
1992
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1998
1999
2000
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2002
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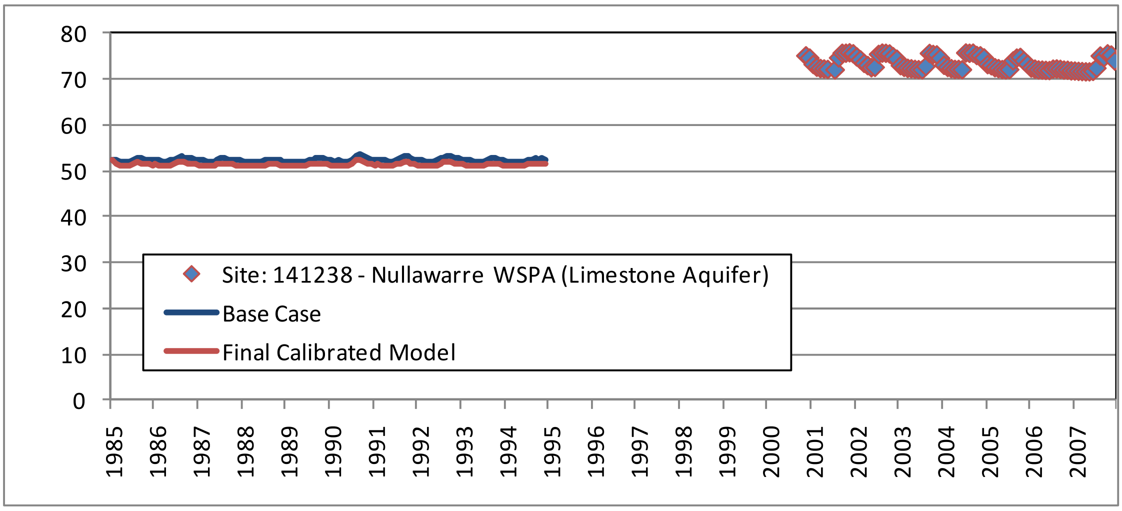
2005
2006
2007



80
70
60
50
40
30
20
10
0
Site: 141238 - Nullawarre WSPA (Limestone Aquifer)
Base Case
Final Calibrated Model
1985
1986
1987
1988
1989
1990
1991
1992
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1994
1995
1996
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1998
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2000
2001
2002
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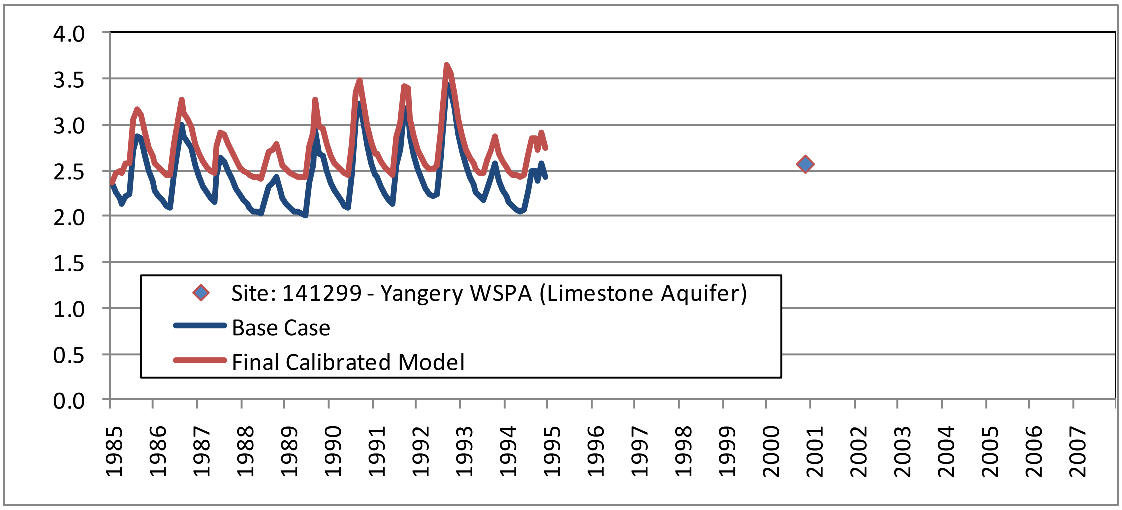

4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Site: 141299 - Yangery WSPA (Limestone Aquifer)
Base Case
Final Calibrated Model
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
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2004
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2006
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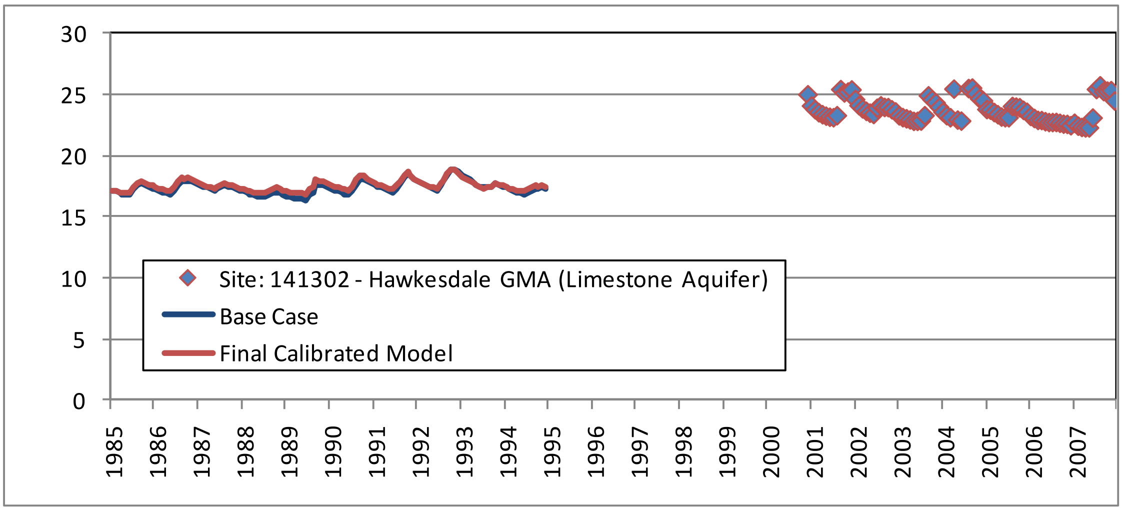
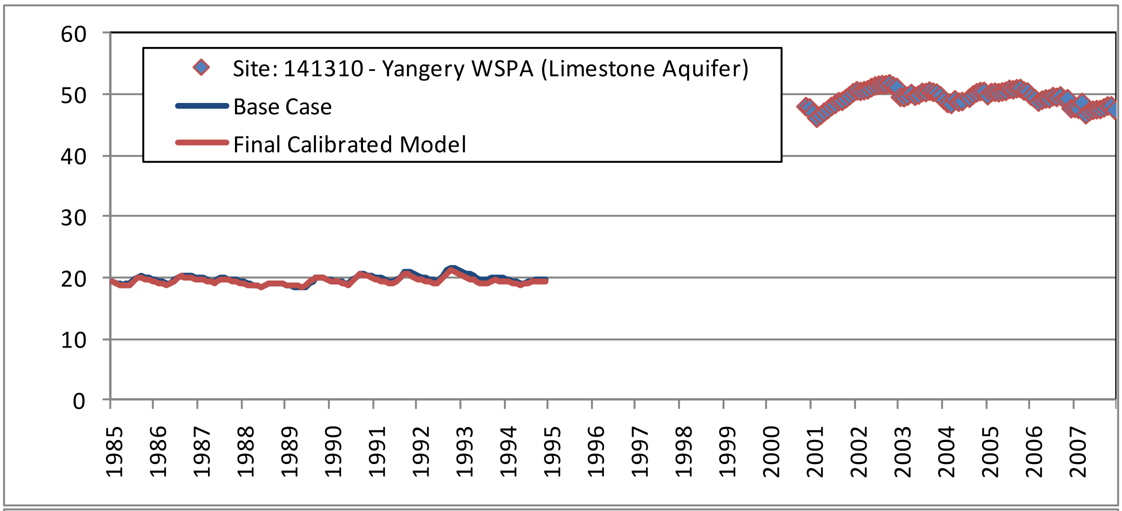
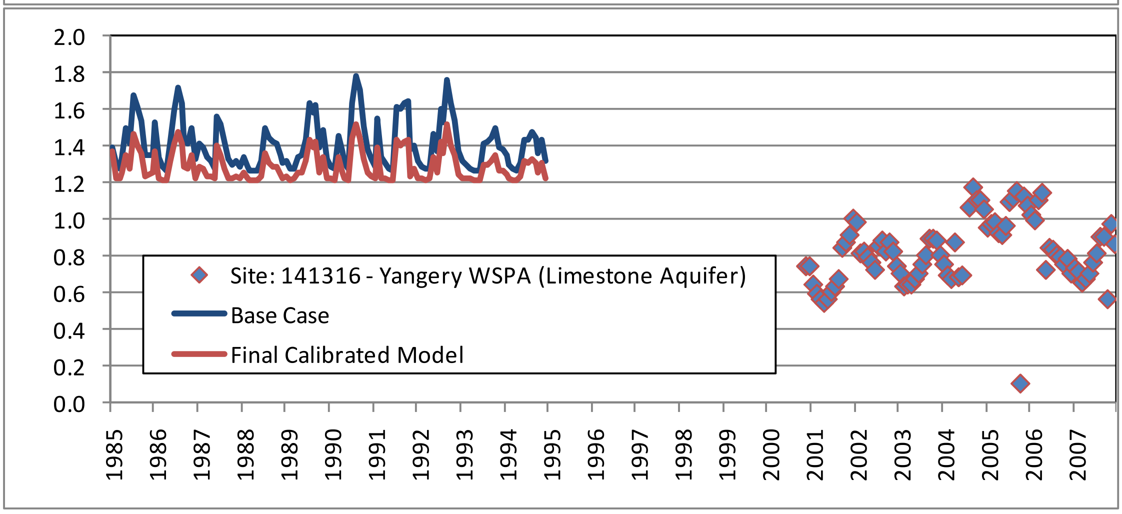
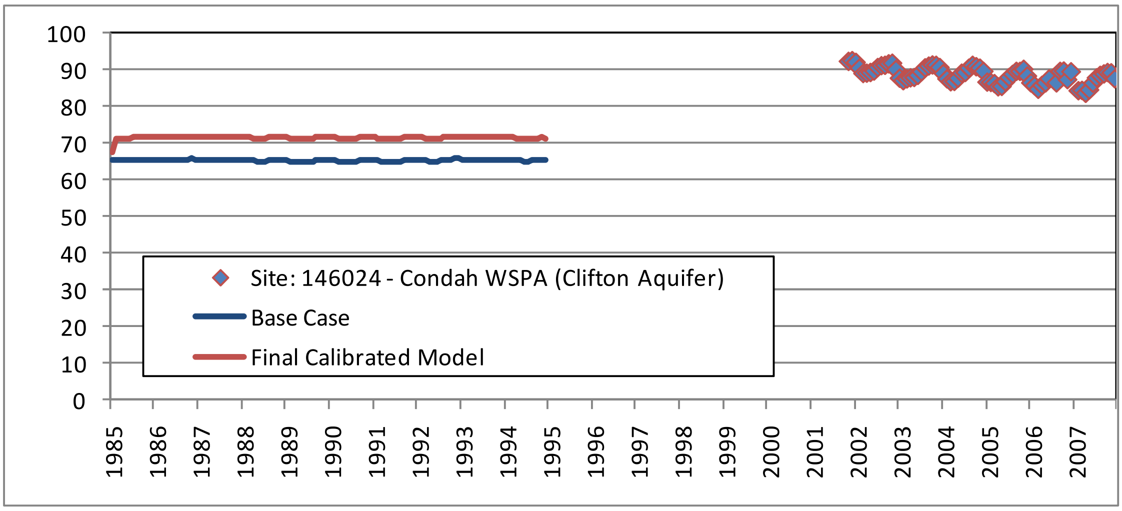

Site: 141302 - Hawkesdale GMA (Limestone Aquifer)
Base Case
Final Calibrated Model


Site: 141310 - Yangery WSPA (Limestone Aquifer)
Base Case
Final Calibrated Model


Site: 141316 - Yangery WSPA (Limestone Aquifer)
Base Case
Final Calibrated Model


Site: 146024 - Condah WSPA (Clifton Aquifer)
Base Case
Final Calibrated Model
100
90
80
70
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1992
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1994
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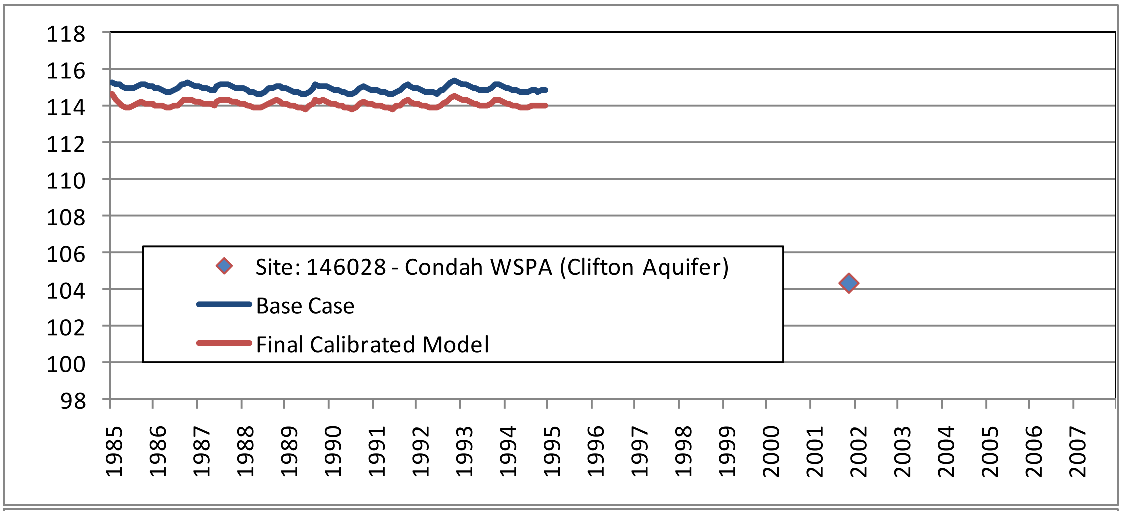
2007


Site: 146028 - Condah WSPA (Clifton Aquifer)
Base Case
Final Calibrated Model
118
116
114
112
110
108
106
104
102
100
98
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
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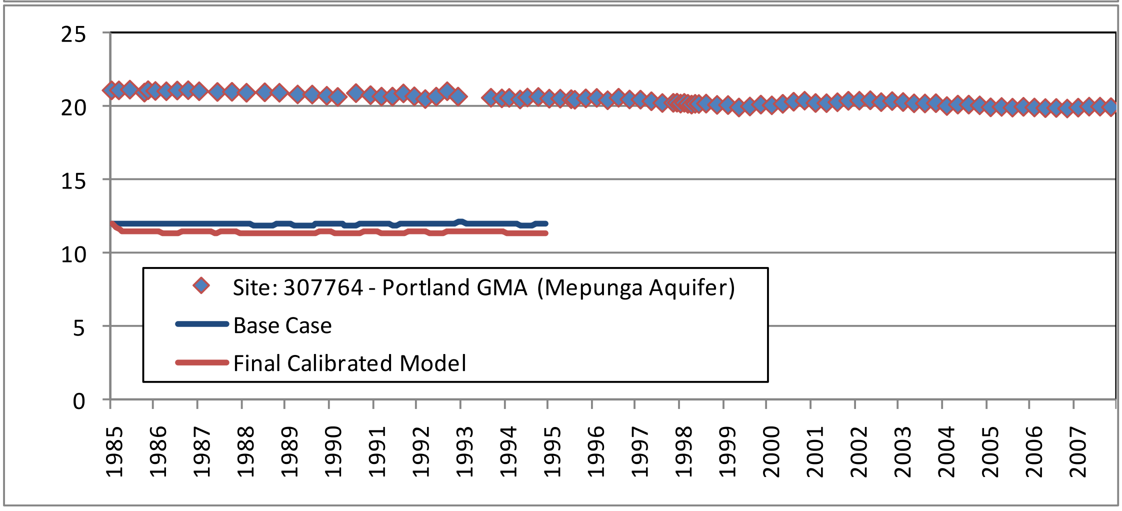
Site: 307764 - Portland GMA (Mepunga Aquifer)
Base Case
Final Calibrated Model
25
20
15
10
5
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
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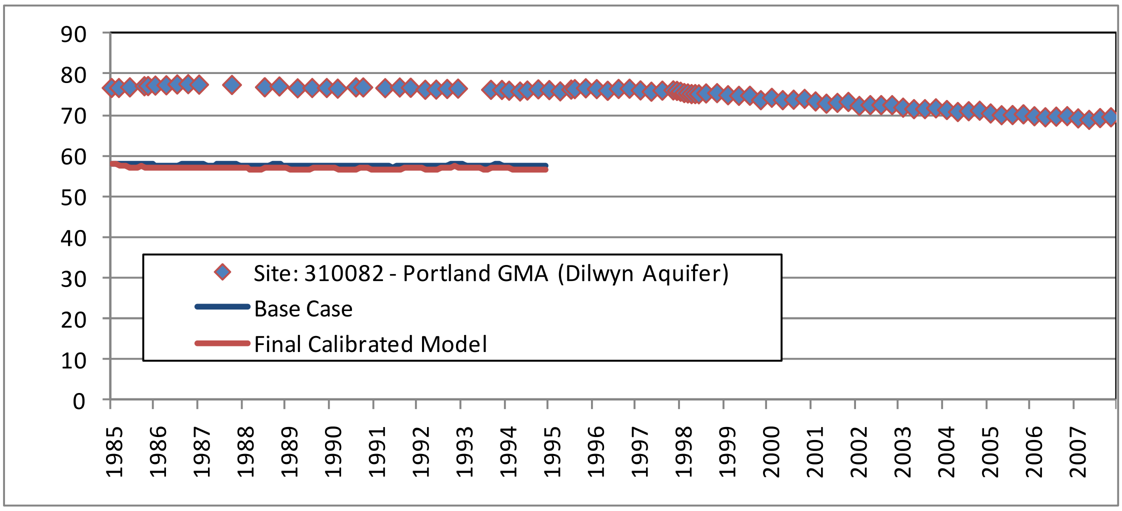
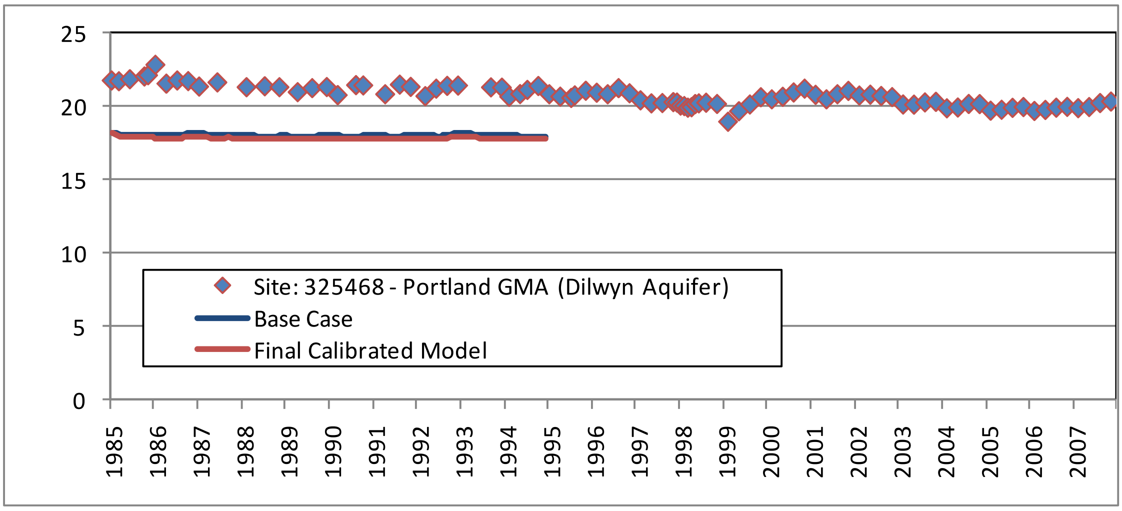
2007





4.3.4. Potentiometric Surface Plots

Potentiometric surface plots for each of the model layers have been produced to graphically present the transient model results and ensure the model response agrees with the hydrogeological conceptualisation of the aquifer systems. The plots are based on the final time step of the transient model run, i.e. Dec 1994.

The potentiometry maps are provided in Map 43 (layer 1), Map 44 (Layer 2), Map 45 (Layer 3), Map 46 (Layer 4), Map 47 (Layer 5).

Please refer to discussion in section 4.2.3 (steady-state model potentiometric surfaces) for a discussion on the two most likely sources of error when comparing modelled and inferred potentiometric surfaces

- **Map 43. Transient model run potentiometric surface - Layer 1**
- **Map 44. Transient model run potentiometric surface - Layer 2**
- **Map 45. Transient model run potentiometric surface - Layer 3**
- **Map 46. Transient model run potentiometric surface - Layer 4**
- **Map 47. Transient model run potentiometric surface - Layer 5**

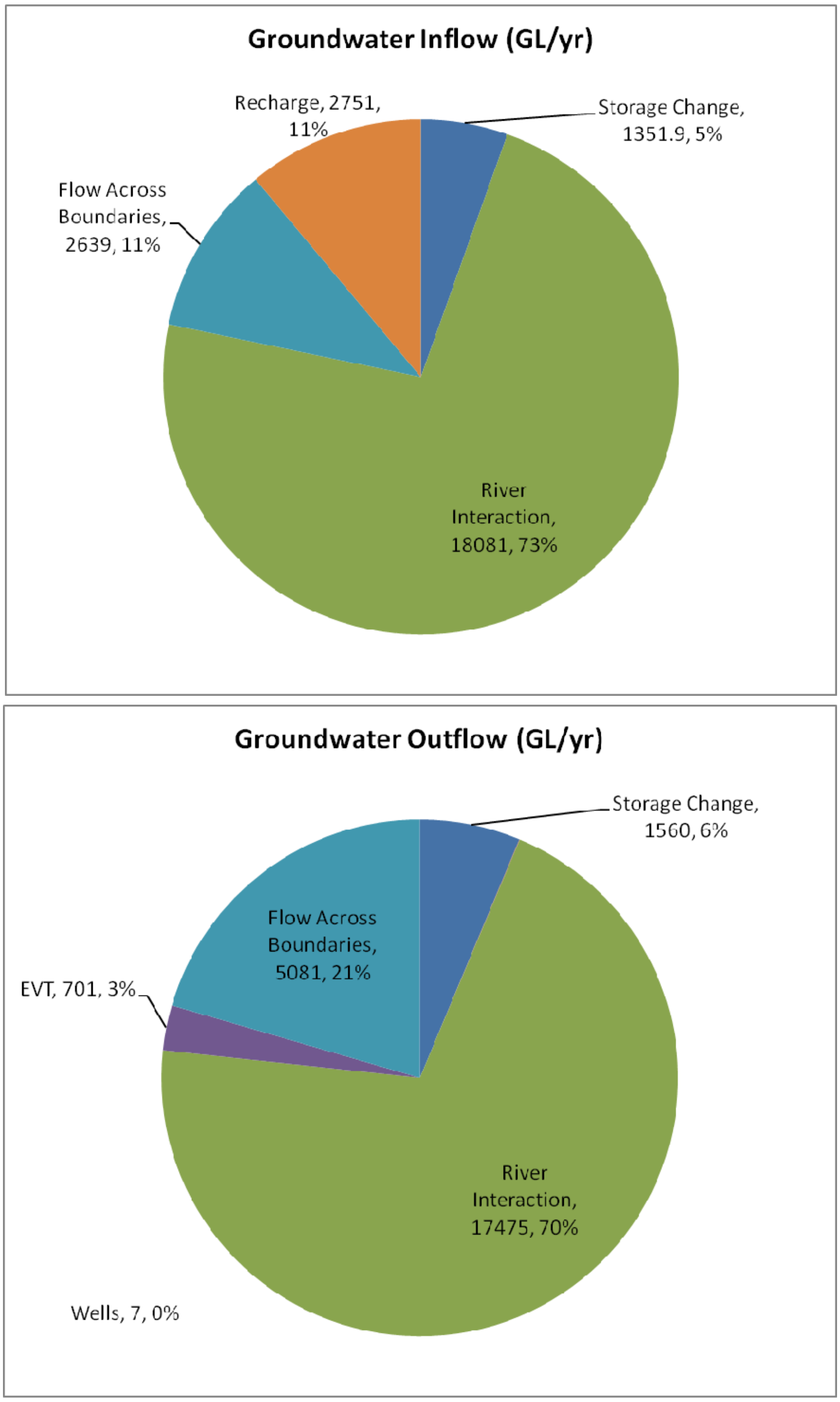
(Refer Appendix D Mapping)

4.3.5. Transient Model Mass Balance

The average annual mass balance for the transient model is displayed in Figure 15. These depict a very similar result to that shown in the steady state modelling and therefore the discussions surrounding those results are still considered valid.

In particular the mass balance still indicates that there is a significant amount of groundwater – surface water interaction occurring in the Glenelg Hopkins region. However, this is likely to be caused by the large network of streams represented in the model and the significant interaction that would be occurring between the streams and the shallow aquifer system. Whilst these are likely to represent real continual processes it does tend to overstate the importance of groundwater – surface water interactions in the overall basin. For example, the net river interaction (total inflow minus total outflow) is 606 GL/y, a net river loss. This compared to diffuse recharge (2751 GL/yr) is a significant but only small proportion of the total aquifer mass balance.

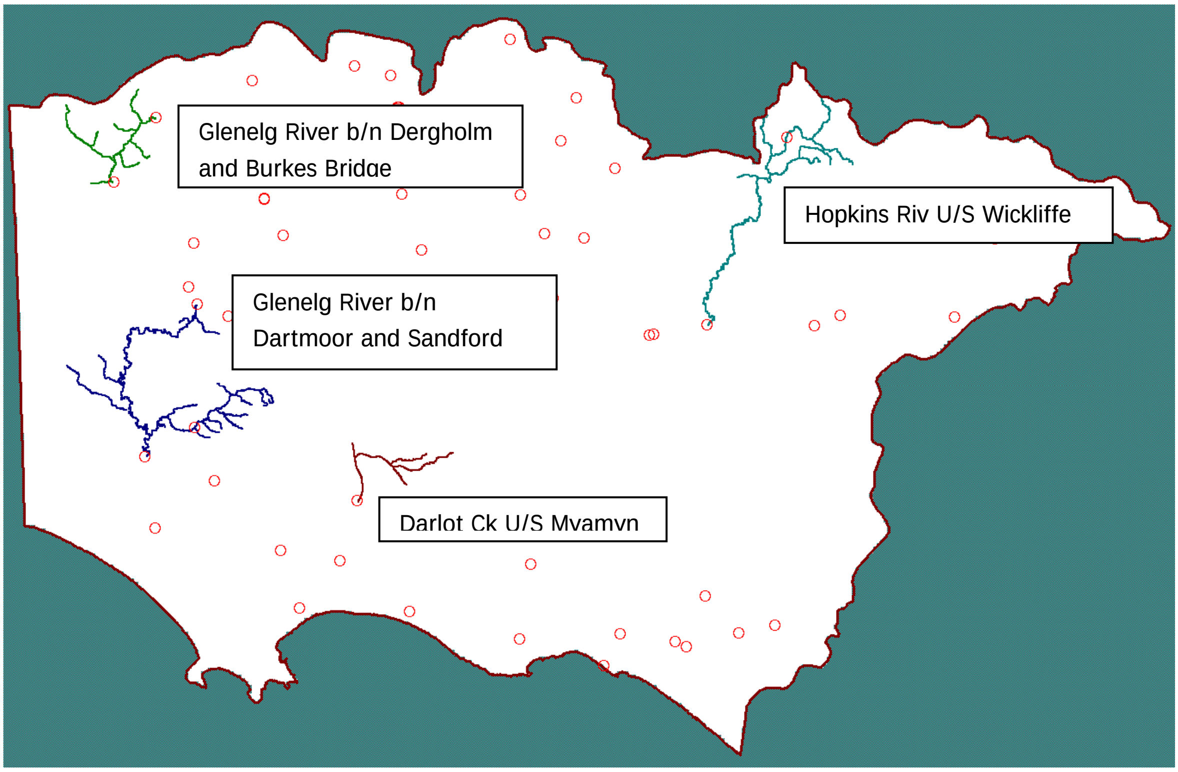
However, the 606 GL/yr net river loss represents a change in the net river interaction. In the pre-development steady state model there was a 448 GL/yr net river gain. This change is directly attributable to decreased recharge to the aquifer system and lower groundwater levels across the region. There is also a small volume attributable to groundwater extractions however in the period 1985 to 1995 these were still relatively small in the context of the overall water balance.



- **Figure 15 Transient Model Mass Balance**

4.3.6. Groundwater-Surface Water Interactions

In order to assess the nature of modelled groundwater-surface water interactions over the transient model period, four river reaches were analysed using the modflow zone budget program. The four reaches are shown in Figure 16.



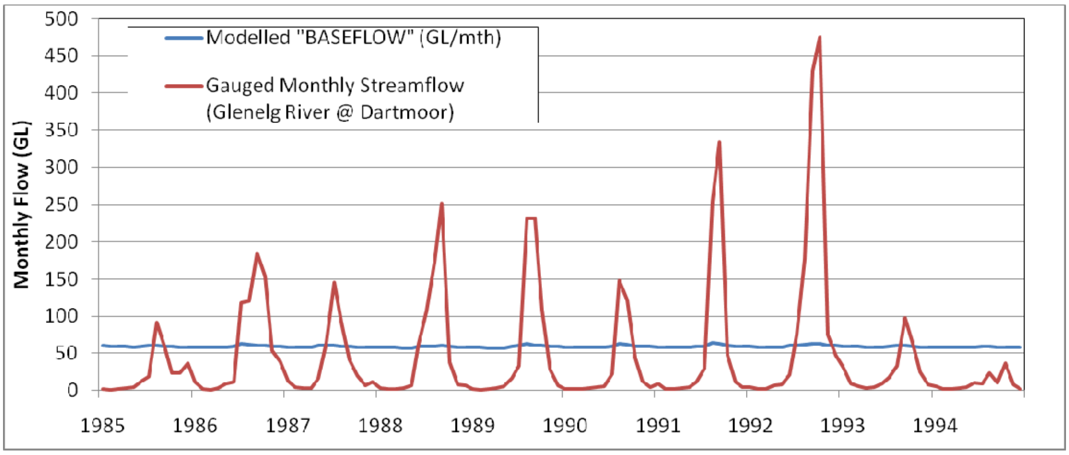
▪ **Figure 16 Model reaches selected for further analysis using the zone budget program.**

Based on the mass-balance results for both the steady state and transient models, it was expected that modelled baseflow volumes were unlikely to correlate well with gauged streamflow or the inferred baseflow estimates (as presented in the conceptual model). The dominant reasons for this were:

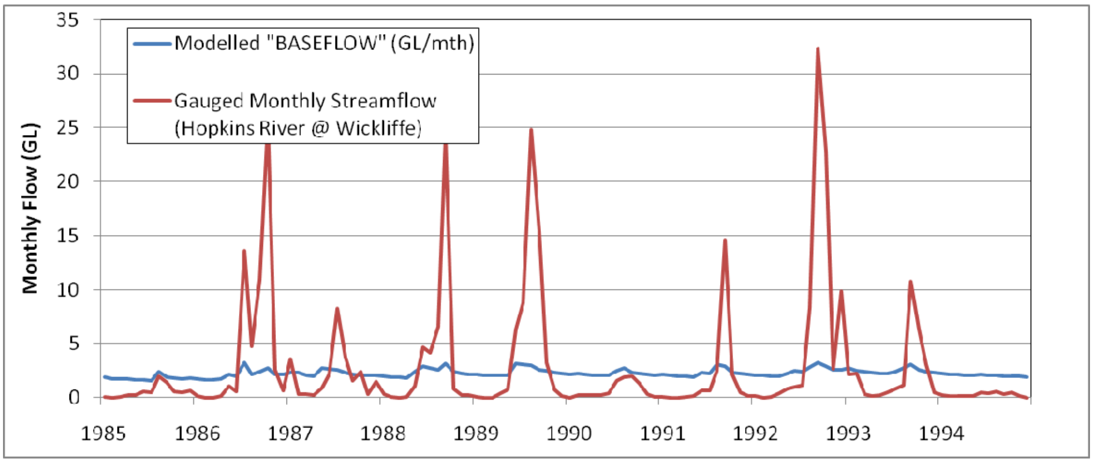
- Many of the rivers were flowing through areas dominated by outcropping basement rock. As part of the calibration process it became known that it was necessary to invoke high river conductance values in order to allow water to get into and out of the basement (otherwise there were significant problems trying to maintain water levels in the basement). This is likely to mean greater river-aquifer interactions than expected.

- It was suspected that recharge across the model was too high and caused an elevated watertable. A simple means of removing this water was through the rivers (i.e. as modelled baseflow). This implies that the overestimates in model recharge are somewhat counteracted by overestimates in model baseflow.

Baring in mind the preceding discussion, timeseries plots of modelled “baseflow” with gauged streamflow for the period 1985 to 1994 are provided in Figure 17 and Figure 18 (Gauged streamflow data was not comprehensive across the relevant time period in Darlot Creek or for the Glenelg River at Dergham and therefore are not shown here). Both of these figures indicate that, as expected, modelled baseflow is too high, particularly in summer months when flows should be quite low.



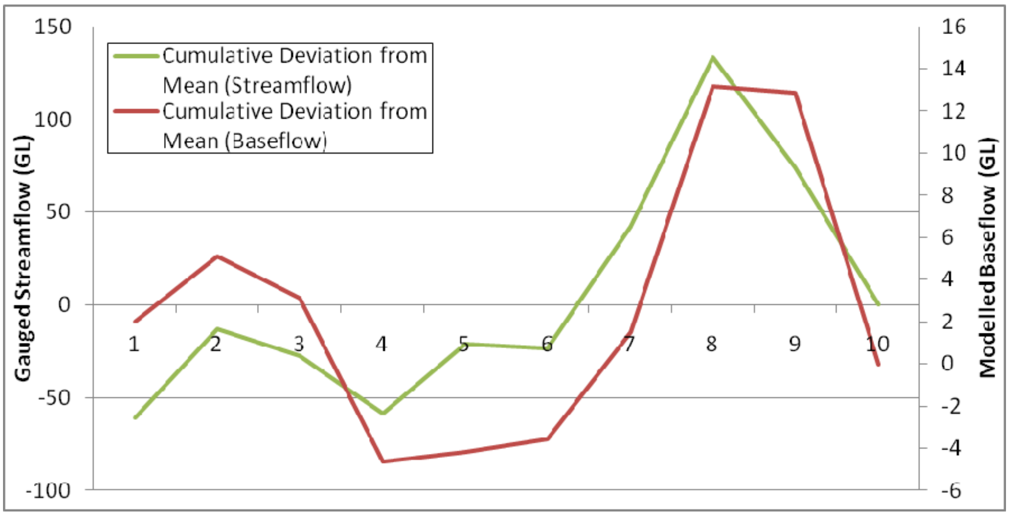
- **Figure 17 Modelled baseflow for the Glenelg River between Dartmoor and Stanford**



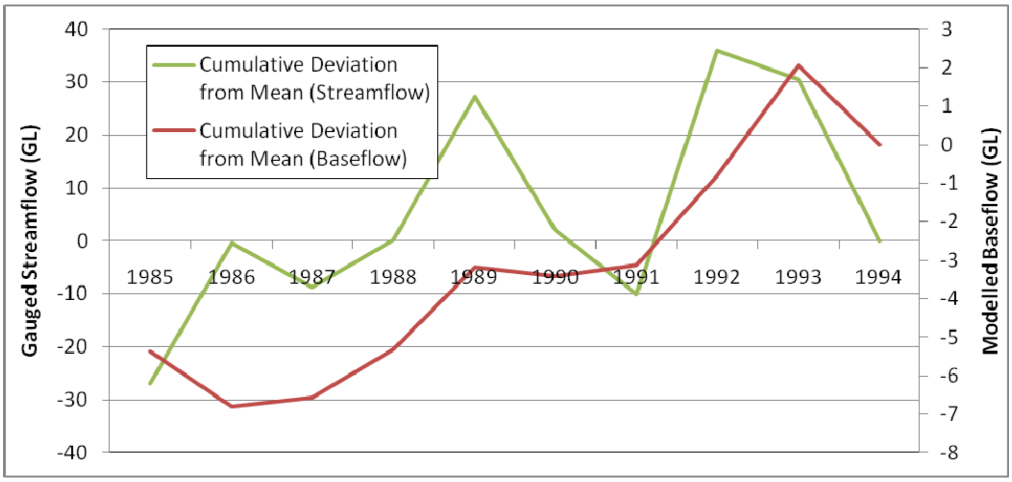
- **Figure 18 Modelled baseflow for the Hopkins River upstream of Wickliffe**

Despite the overestimates in baseflow volumes, further analysis suggests that the trends over time in baseflow do actually provide a reasonable guide for the impacts of recharge on baseflow. Figure 19 and Figure 20 display cumulative deviation from the mean plots of modelled baseflow and streamflow. In both the Glenelg River and the Hopkins River it can be seen that the trends in modelled baseflow match the streamflow trends quite well (albeit at a different magnitude as previously discussed).

These results imply that the model is not recommended for use to analyse baseflow volumes, however the model is deemed suitable for use in analysing baseflow trends.



- **Figure 19 Glenelg River between Dartmoor and Stanford – Cumulative deviation from the mean**



- **Figure 20 Hopkins River upstream of Wickliffe – Cumulative deviation from the mean**

4.3.7. Transient Model Sensitivity Analysis

Throughout the calibration process a run log was kept to ascertain the sensitivity of the various hydraulic parameters used in the model. A summary of the key results from this process are provided below in Table 9 (qualitative analysis) and Table 10 (quantitative analysis, also expressed diagrammatically in Figure 21). The quantitative indicators of model sensitivity were the Scaled RMS value and the mean head (at observation points) which were used to define each parameter into one of four sensitivity types as defined in

the MDBC Groundwater Modelling Guidelines (Middlemis, 2000). A more qualitative consideration was also given to the fit of modelled hydrographs.

As a general rule, the calibration process followed a systematic approach of increasing and decreasing the base case parameter value within reasonable bounds as indicated by the conceptual model. A discussion of the results is provided following the tables.

- **Table 9 Transient model run log with qualitative discussion on parameter sensitivity**

Run	Description **	Run Length	Comments on Key Bore Hydrographs	Initial Comment on Parameter Sensitivity
BASE CASE	As per SS model	10		
BASE CASE 2	"	2		
3	LTA Kh reduced from 50 to 5 m/day	2	Minor improvement in most Dilwyn hydrographs, worse elsewhere	LTA - Low sensitivity within realistic boundaries
4	LTA Kh increased from 50 to 100 m/day	2	Minor improvement in some Dilwyn, worse in others, negligible change elsewhere	
5	PCZ Kh reduced from 0.01 to 0.001	2	Negligible change to Key Bore hydrographs (but probably minor improvement to a large number of basement hydrographs.	High sensitivity to increases in PCZ Kh
6	PCZ Kh increased from 0.01 to 0.1	2	Large drop (worse) in basement levels	
7	UMT Aquitard L3 Kh reduced from 0.1 to 0.01	2	Significantly worse in limestone and Dilwyn	High sensitivity to decreases in aquitard conductivity. Prevents water from entering the Dilwyn.
8	UMT Aquitard L3 Kh increased from 0.1 to 1	2	Mostly improved in limestone, higher K allows more water into Dilwyn, Dilwyn often better. However violates conceptual model for aquitard. Possible indicator of Clifton Formation, see Run 18.	
9	UTA Kh increased from 75 to 150	2	Negligible change	Very low sensitivity
10	UTA Kh decreased from 75 to 7.5	2	Negligible change	
11	UMTA increased from 50 to 100	2	Observable improvement in most (but not all) limestone aquifer, negligible elsewhere	Localised sensitivity in UMTA, but low impact on other aquifers.

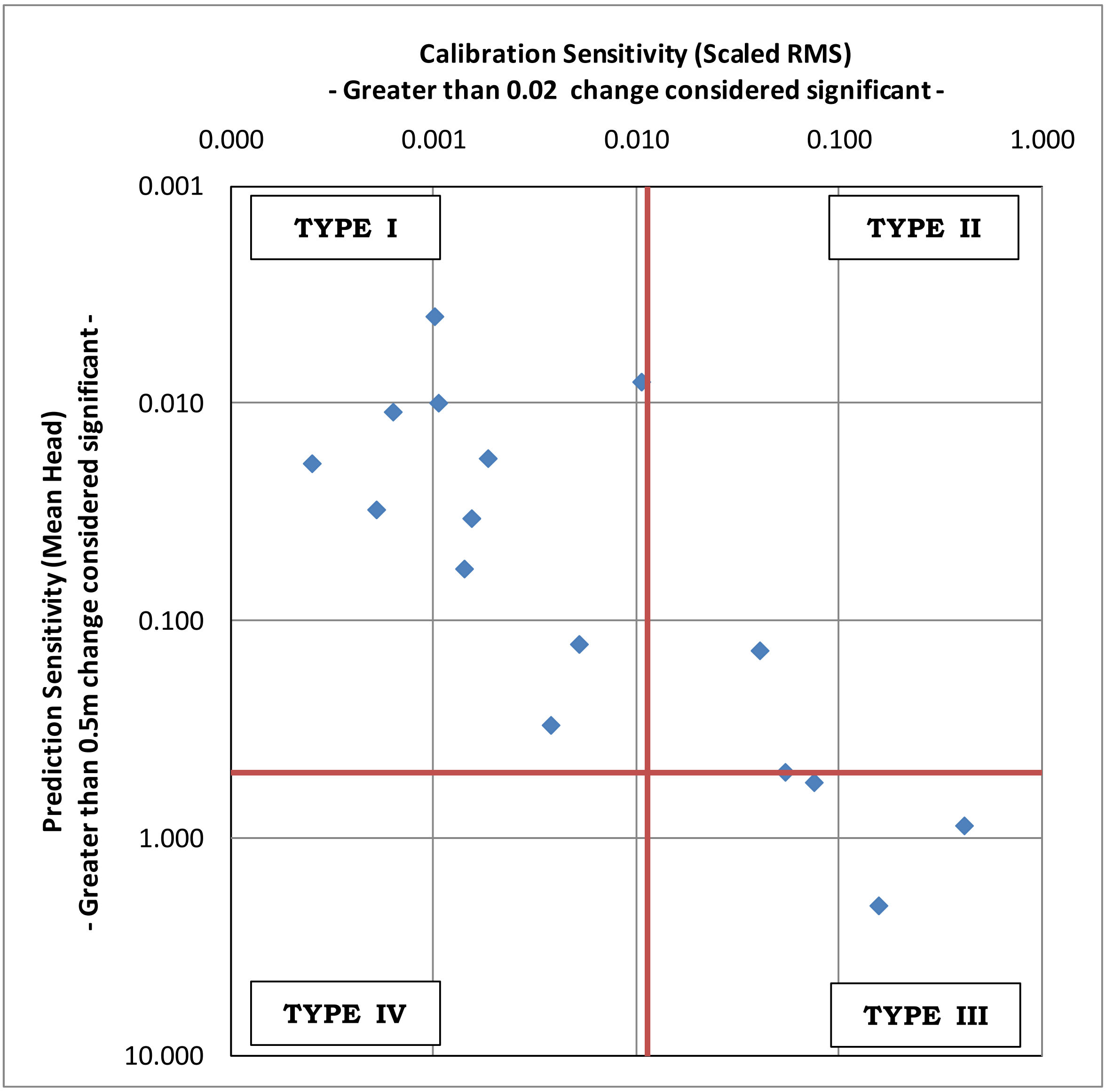
Run	Description **	Run Length	Comments on Key Bore Hydrographs	Initial Comment on Parameter Sensitivity
12	UMTA decreased from 50 to 5	2	Variable but mostly worse, probably highlights extreme heterogeneity of the Limestone	
13	Qa increased from 20 to 50	2	Negligible change	Very low sensitivity. Possibly indicative of minor proportion of total model domain
14	Qa decreased from 20 to 2	2	Negligible change	
15	Qv increased from 10 to 25	2	Variable, some improved, some worse, highlights heterogeneity	Locally sensitive, but not able to capture within regional scale model.
16	Qv decreased from 10 to 1	2	Variable, some improved, some worse, again highlights heterogeneity	
17	Removed eastern GHB	2	Falling heads, particularly in limestone aquifer	
18	Added zone for Clifton Fm, Kh = 10, Kv = 0.01	2	Improvement in Condah WSPA (Clifton formation), negligible difference elsewhere.	
19	Final Transient Model	2	Minor improvement from base case in terms of RMS but noticeable improvement in hydrographs	
19a	Final Transient Model	10	"	
20	Added new transient ET as provided by DSE	10	Significant drying evident in many hydrographs.	

*__** Aquifer Codes__*

LTA = Lower Tertiary Aquifer, PCZ = Basement Aquifer, UMT Aquitard = Upper-Mid Tertiary Aquitard, UTA = Upper Tertiary Aquifer, UMTA = Upper Mid Tertiary Aquifer, Qa = Quaternary Alluvium, Qv = Quaternary Volcanics

Table 10 Quantitative sensitivity analysis and classification of sensitivity types

Parameter/ Variable	Parameter Value	SRMS	Diff from Base	Mean Head	Diff from Base	Calib. Sens.	Pred. Sens.	Sensitivity Type
BASE CASE		4.337	-	124.0	-	-	-	-
Lower Tertiary Aquifer (Conductivity)	5	4.342	0.005	123.9	-0.1	1	1	1
	50	4.337	-	124.0	-	-	-	-
	100	4.333	-0.004	124.4	0.3	1	1	1
Pre-Cainozoic Basement (Conductivity)	0.001	4.296	-0.041	124.2	0.1	2	1	2
	0.01	4.337	-	124.0	-	-	-	-
	0.1	4.750	0.414	123.2	-0.9	2	2	3
Mid-Tertiary Aquitard (Conductivity)	0.01	4.412	0.075	123.5	-0.6	2	2	3
	0.1	4.337	-	124.0	-	-	-	-
	1	4.282	-0.054	124.5	0.5	2	2	3
Upper Tertiary Aquifer (Conductivity)	150	4.336	-0.001	124.0	0.0	1	1	1
	75	4.337	-	124.0	-	-	-	-
	7.5	4.338	0.001	124.1	0.0	1	1	1
Upper-Mid Tertiary Aquifer (Conductivity)	100	4.335	-0.002	124.1	0.0	1	1	1
	50	4.337	-	124.0	-	-	-	-
	5	4.338	0.001	124.1	0.1	1	1	1
Quaternary Alluvium (Conductivity)	50	4.337	0.000	124.0	0.0	1	1	1
	20	4.337	-	124.0	-	-	-	-
	2	4.337	0.001	124.1	0.0	1	1	1
Quaternary Volcanics (Conductivity)	25	4.336	-0.001	124.1	0.0	1	1	1
	10	4.337	-	124.0	-	-	-	-
	1	4.338	0.002	124.0	0.0	1	1	1
Eastern GHB	No	4.493	0.157	122.0	-2.1	2	2	3
	Yes	4.337	-	124.0	-	-	-	-
Discrete Clifton Formation	Yes	4.347	0.011	124.0	0.0	1	1	1
	No	4.337	-	124.0	-	-	-	-
FINAL MODEL		4.310	-0.027	124.1	0.1	-	-	-



▪ **Figure 21 Diagrammatic classification of sensitivity types**

<u>Sensitivity Type Classifications (Middlemis, 2000)</u>

Type I & II– Indicates parameters that have an insignificant impact on model predications and therefore are not a cause for concern

Type III – Indicates parameters that have a significant impact on the prediction but also have a good response during calibration therefore are considered particularly useful during calibration.

Type IV – Are parameters of most concern because it is an strong indicator of non-uniqueness (i.e. a large range of parameter values can give similar calibration statistics but have a large impact on model prediction). No 'Type IV' parameters were found during the sensitivity analysis

No 'Type IV' parameters were identified during the calibration process and most parameters fall within 'Type I' or 'Type II'. This is a positive result which suggests further refinement of parameter values (in particular conductivities) is unlikely to have any significant impact on model outcomes.

Three parameters were identified as 'Type III' suggesting that should further wrk be done on the model these would be the ones to focus on. However, two of these were variations which resulted in a significantly worse calibration. Firstly the removal of the GHB on the eastern boundary destabilised the model and had a significant negative effect on the RMS. Secondly, increasing the conductivity in the basement also caused the RMS error to increase significantly. In contrast, reducing the basement conductivity further proved to only have minimal impact.

Therefore, the major hydraulic property that was in question during calibration was the aquitard conductivity. Varying the conductivity in the aquitard proved to have a significant impact on both the model prediction and calibration. The calibration process indicated that increasing the aquitard conductivity (making it more like an aquifer) improved the overall calibration. Unfortunately, this was violating the conceptual model for the system, and references from literature which suggested lower conductivities would be more appropriate. Therefore it was decided to leave the aquitard conductivity at the upper limit deemed suitable without significantly violating the conceptual model (Kh = 0.1 m/day, Kv = 0.01 m/day).

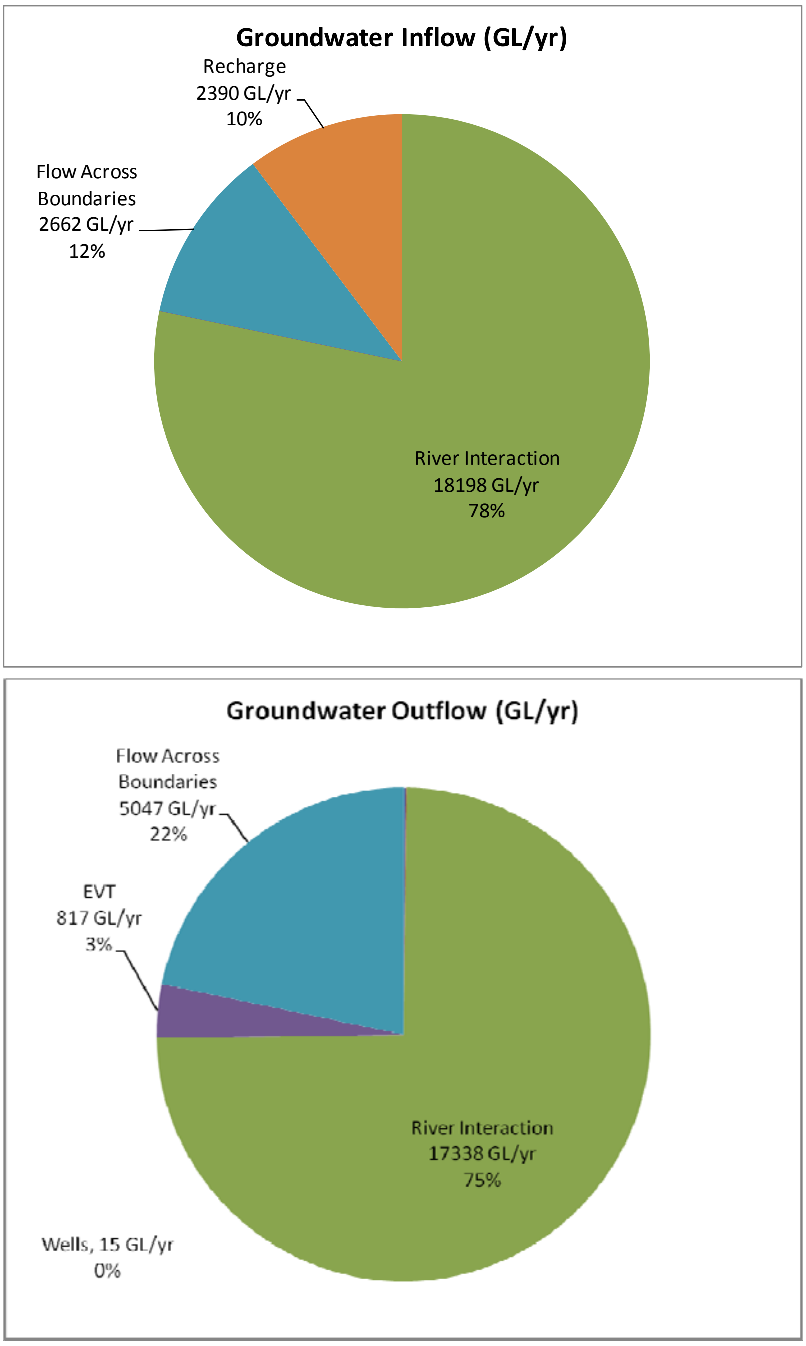
As a general conclusion the sensitivity analysis indicated that further refinement of model parameters would have limited impact on model accuracy and model predictions

4.4. Post-development Steady State Model

During the transient model calibration there were a number of model parameterisation improvements and therefore the pre-development steady state model was no longer equivalent to the transient model. To allow for this a post-development steady-state has been constructed. The post-development steady-state model has the following key structural features:

- Identical parameterisation to the transient model
- Groundwater extractions equivalent to those at 1994-95 levels
- River levels set at the long-term average (as per the transient model)
- Recharge as per the long-term average (nominally 1980-2005, as supplied by DSE).
- Evapotranspiration as per the pre-development steady state model and shown in Map 29)
- Run as a 100 year transient model with non-time varying inputs. After the 100 year period the system is considered to be in equilibrium and therefore a 'quasi' steady state is achieved. (This process was described in more detail under the pre-development steady state).

The post-development steady state model is for use as a potential base case scenario. It has not been used in any way as part of the calibration process and therefore no 'calibration' results are presented for this model. Instead the final mass-balance is presented below in Figure 22



- **Figure 22 Post-development steady state model mass balance**

5. Model Verification

Model Verification was undertaken for a five year period immediately following the calibration period as follows:

- Calibration Period – Jan 1985 to Dec 1994
- Verification Period – Jan 1995 to Dec 1999

The results of the model verification are presented below. Table 11 presents the statistics of the verification period next to the calibration period results whilst Table 12 displays the calibrations statistics by layer. Statistically there is a slight decrease in fit during the verification period, however this is still considered well within the bounds of an acceptable calibration. Figure 23 presents a scatter plot of observed versus measured values for the verification period. From this figure it can be seen that the distribution remains similar to that from the calibration period. Importantly there are no signs of 'drift' in the plot. That is, bores that drift out of calibration after the calibration period is over.

Following Figure 23, hydrographs for the combined calibration and verification period are presented. Again these hydrographs show that there is no noticeable drift after the calibration period. Therefore any model predictions can be assumed to be of comparable accuracy to that suggested by the model calibration (although model uncertainty always increases with predictions further from the calibration period).

Of particular note in the hydrographs are sites 95072 and 95073. Both of these sites exhibited rising trends in modelled water levels during the calibration period. It was inferred that the rising trend was actually the model re-equilibrating following parameter changes between the steady state and transient modelling. In the verification period this was proven to be true as both sites re-equilibrated and commenced following the observed trends with a very good level of accuracy.

Overall the verification period highlights that there is a level of confidence in model results outside of the calibration period and therefore the model can be used for predictive purposes.

Table 11 Verification period calibration statistics

Statistic	Calibration Period	Verification Period	Combined (Calibration + Verification)
No. of Observations	6564	3300	9864
Mean Sum of Residuals (MSR)	-3.36	-4.08	-3.36
Scaled Mean Sum of Residuals (SMSR)	-0.74	-0.92	-0.79
Root Mean Square (RMS)	10.24	11.13	10.55
Scaled Root Mean Square (SRMS)	2.24 %	2.49 %	2.31 %
Max Obs Head	448.3	446.04	448.3
Min Obs Head	-8.0	0	-8.0
Mean Obs Head	186.1	183.63	185.3

Table 12 Verification period calibration statistics by layer

Layer	Unit Represented	Number of Observations	Scaled RMS
1	Quaternary Alluvium	325	1.7 %
	Quaternary Basalts		
2	Upper Tertiary Aquifer	176	3.7 %
	Upper-Mid Tertiary Aquifer		
3	Upper-Mid and Lower- Mid Tertiary Aquitard	741	3.8 %
	Lower-Mid Tertiary Aquifer (Clifton Formation)		
4	Lower Tertiary Aquifer	283	3.4 %
5	Pre-Cainozoic Basalt	1775	2.3 %

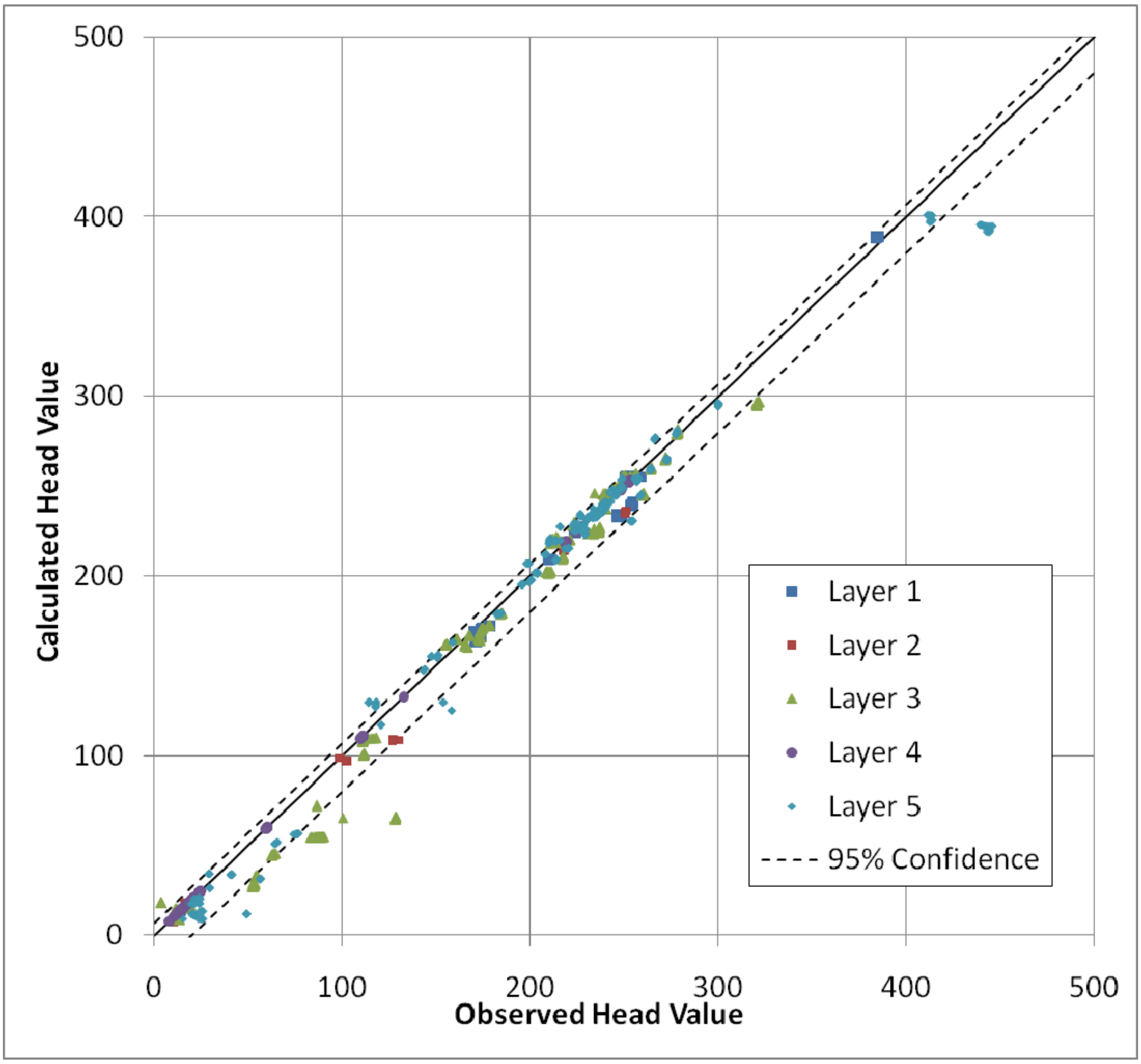
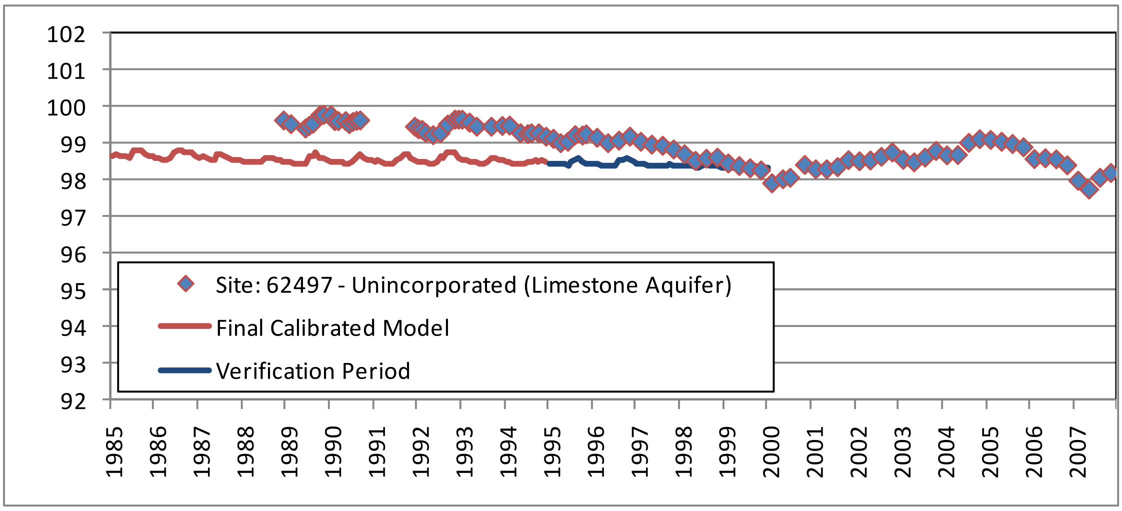
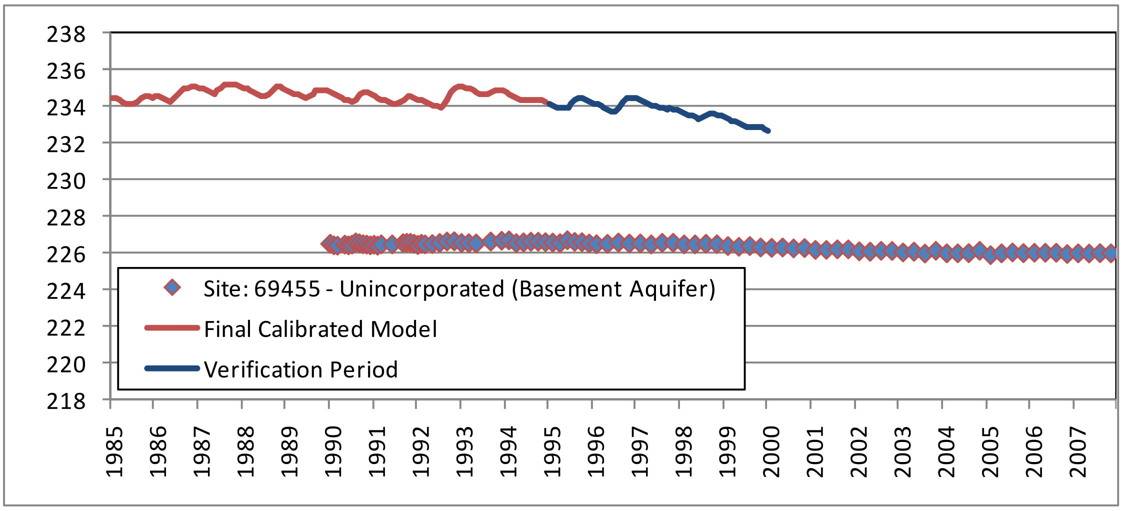


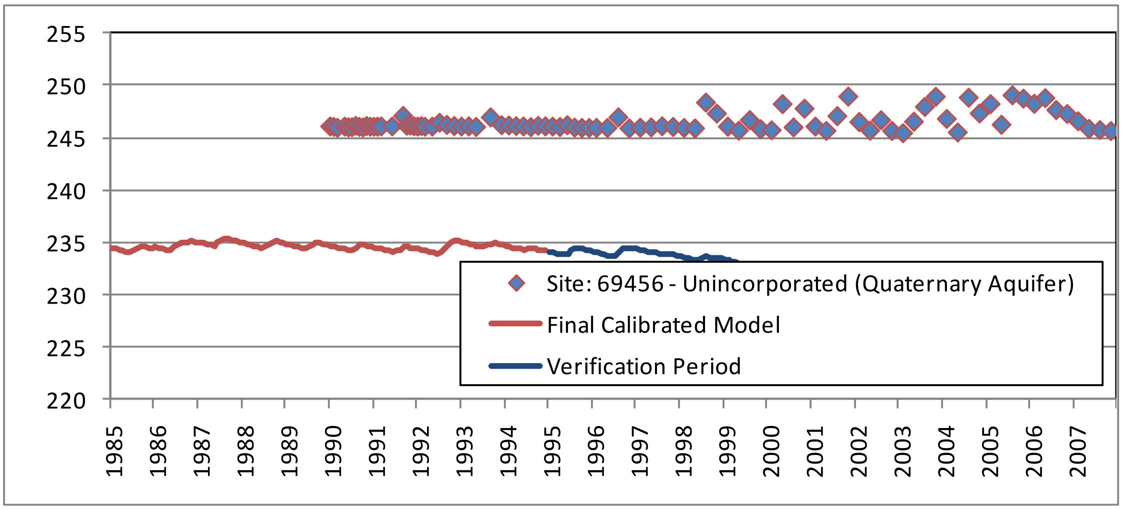
Figure 23. Verification period observed versus calculated scatter plot



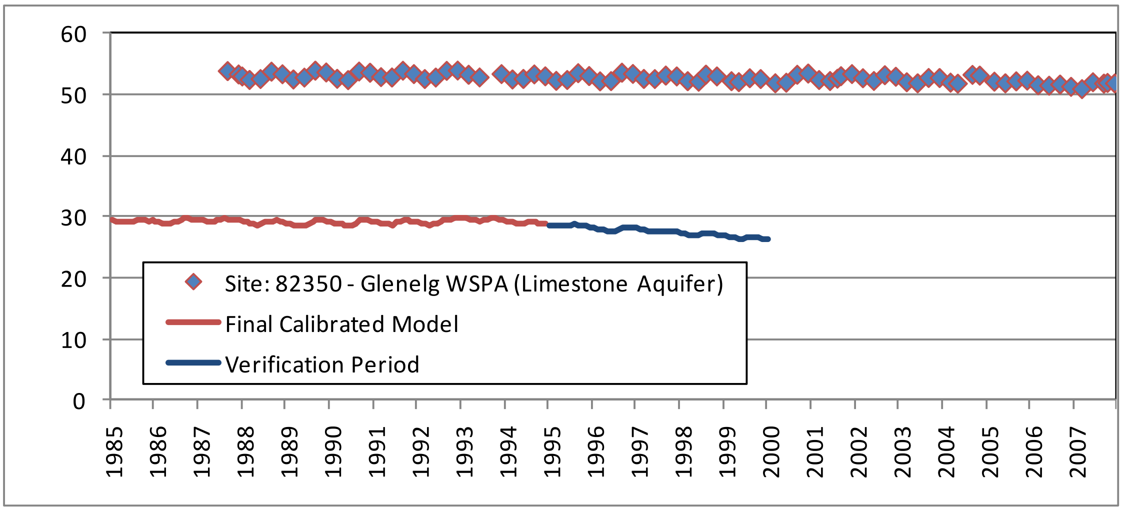
102
101
100
99
98
97
96
95
94
93
92
Site: 62497 - Unincorporated (Limestone Aquifer)
Final Calibrated Model
Verification Period
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

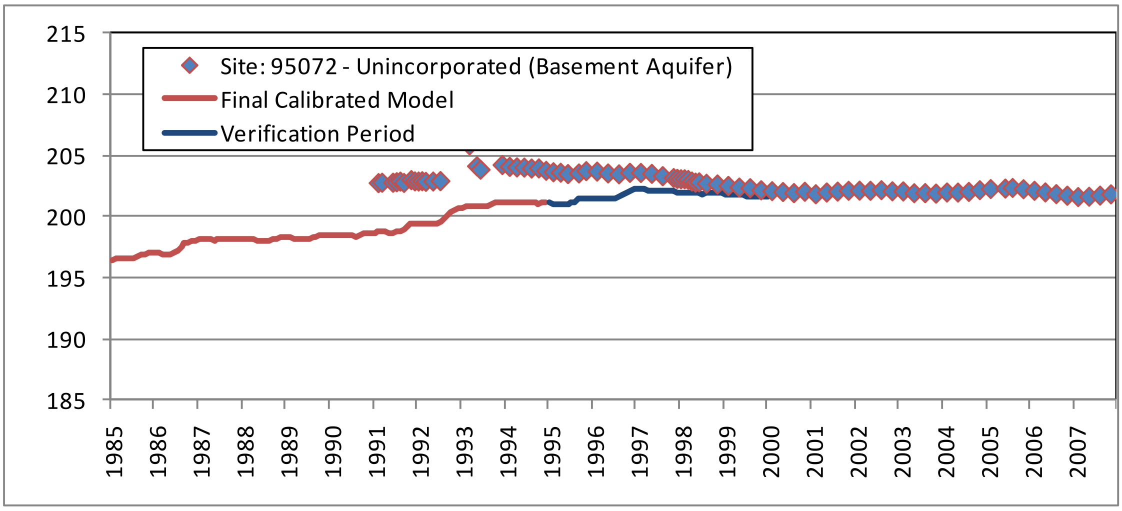


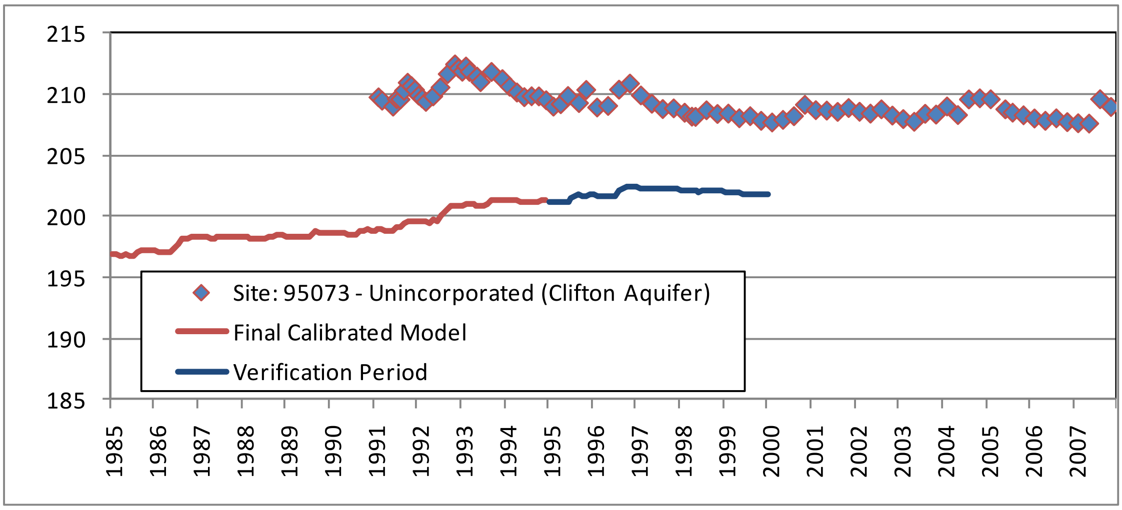
238
236
234
232
230
228
226
224
222
220
218
Site: 69455 - Unincorporated (Basement Aquifer)
Final Calibrated Model
Verification Period
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

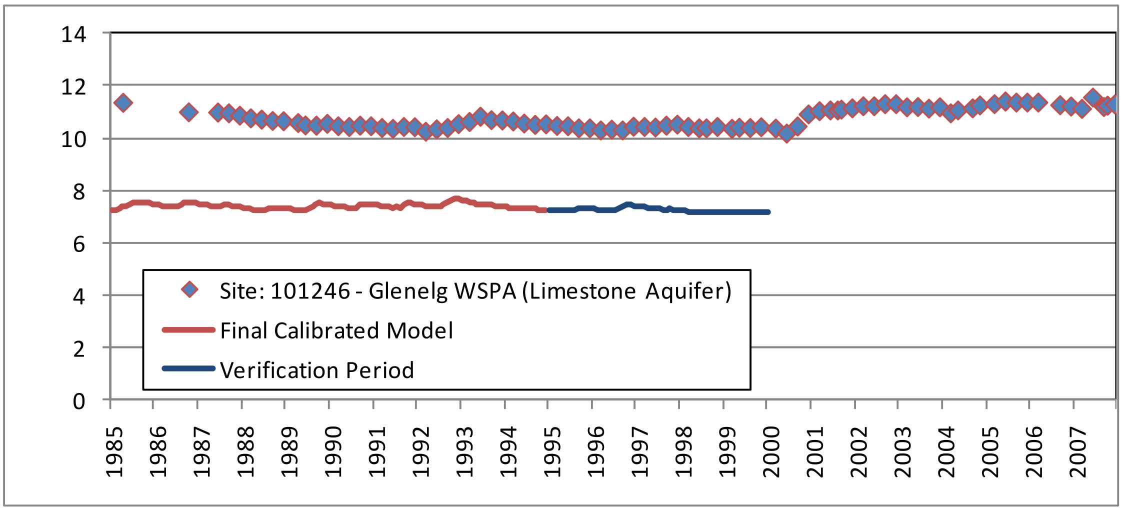


255
250
245
240
235
230
225
220
Site: 69456 - Unincorporated (Quaternary Aquifer)
Final Calibrated Model
Verification Period
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

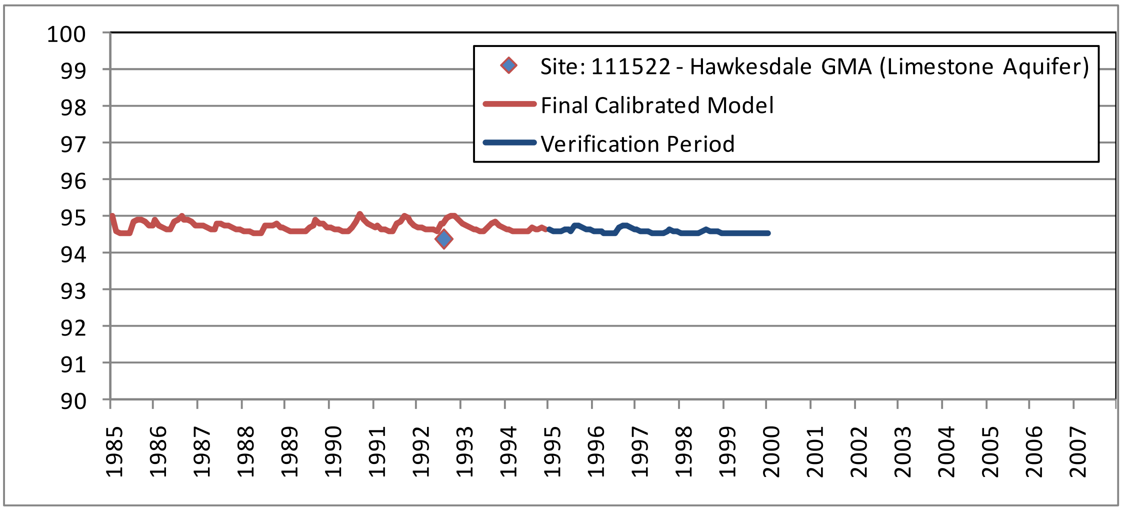

Site: 82350 - Glenelg WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
60
50
40
30
20
10
0
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007


Site: 95072 - Unincorporated (Basement Aquifer)
Final Calibrated Model
Verification Period
215
210
205
200
195
190
185
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

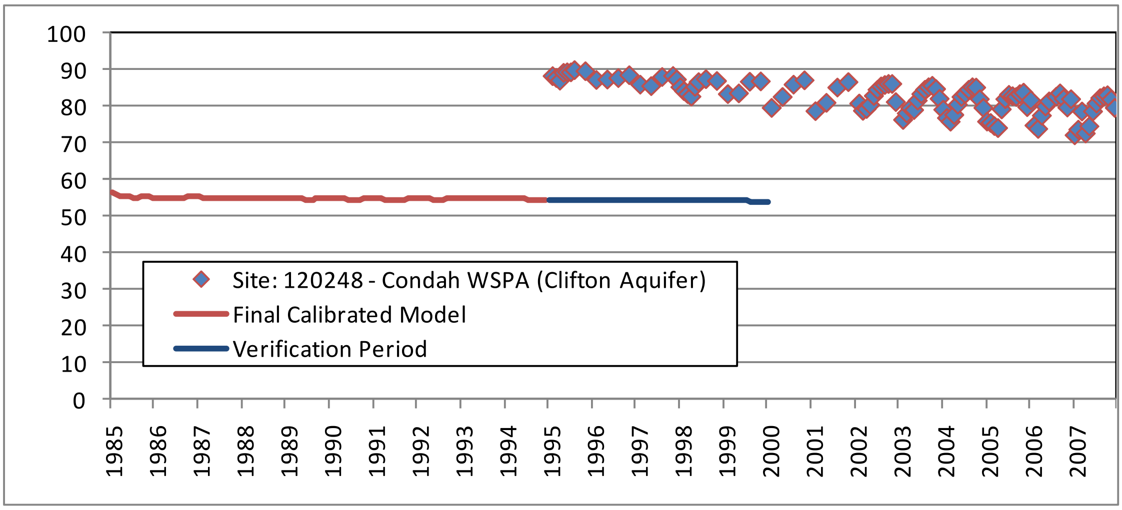

Site: 95073 - Unincorporated (Clifton Aquifer)
Final Calibrated Model
Verification Period
215
210
205
200
195
190
185
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007



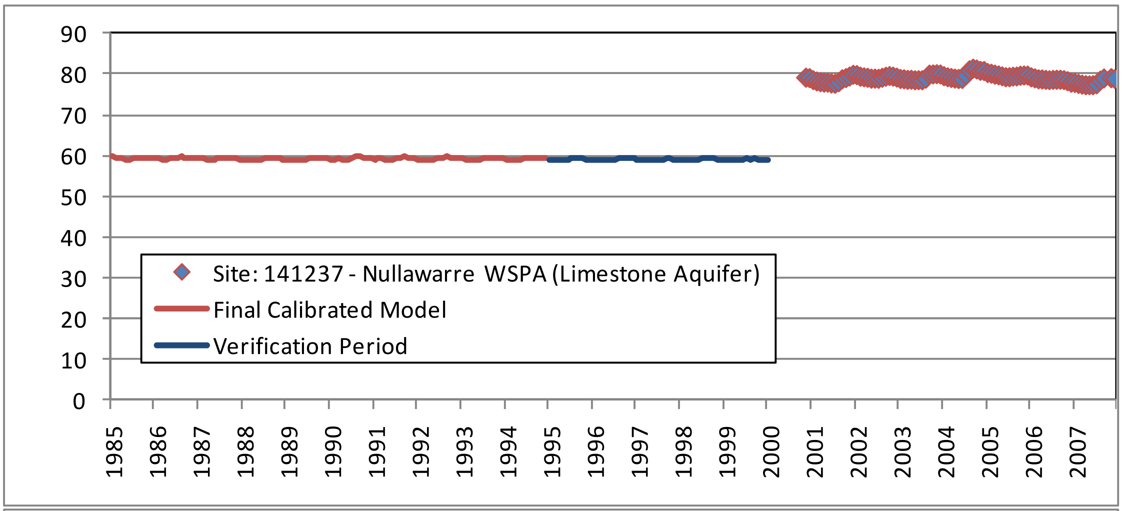
Site: 101246 - Glenelg WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
14
12
10
8
6
4
2
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

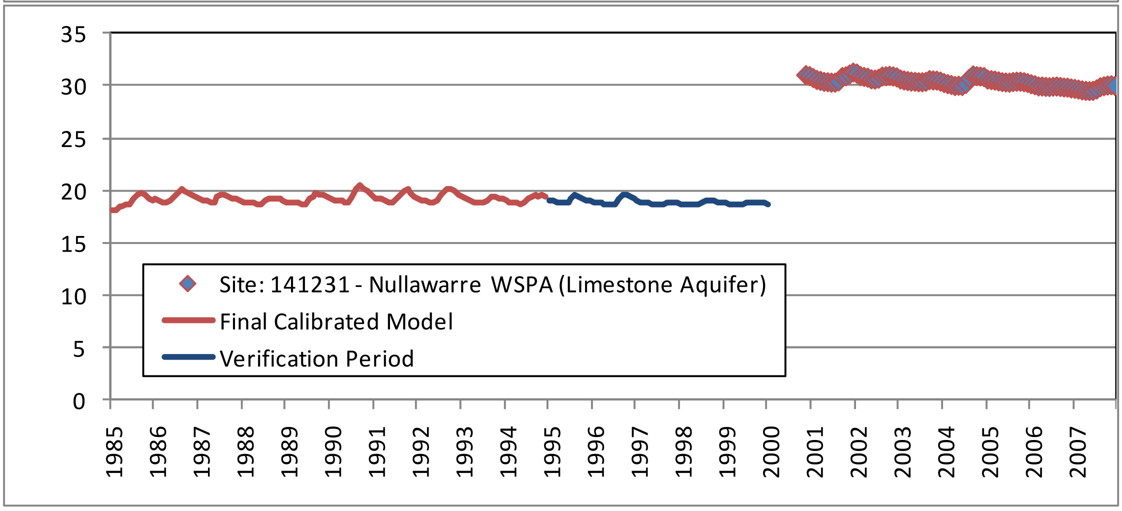


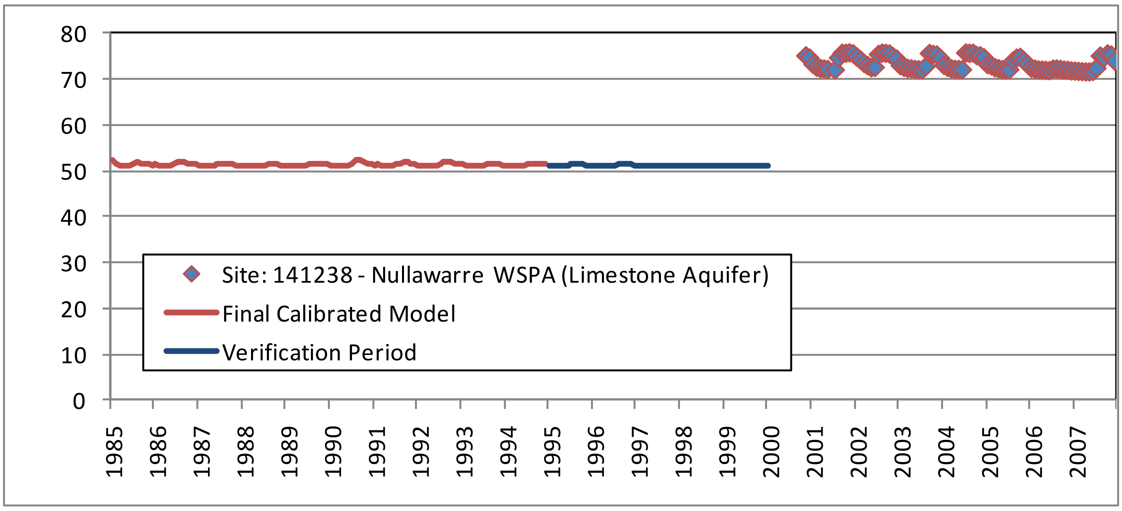
Site: 111522 - Hawkesdale GMA (Limestone Aquifer)
Final Calibrated Model
Verification Period
100
99
98
97
96
95
94
93
92
91
90
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

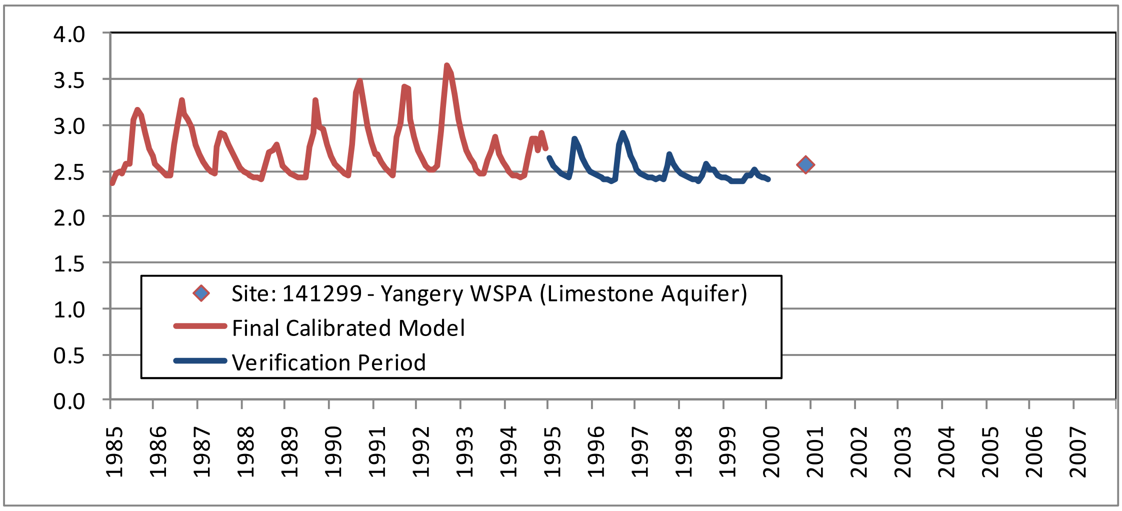


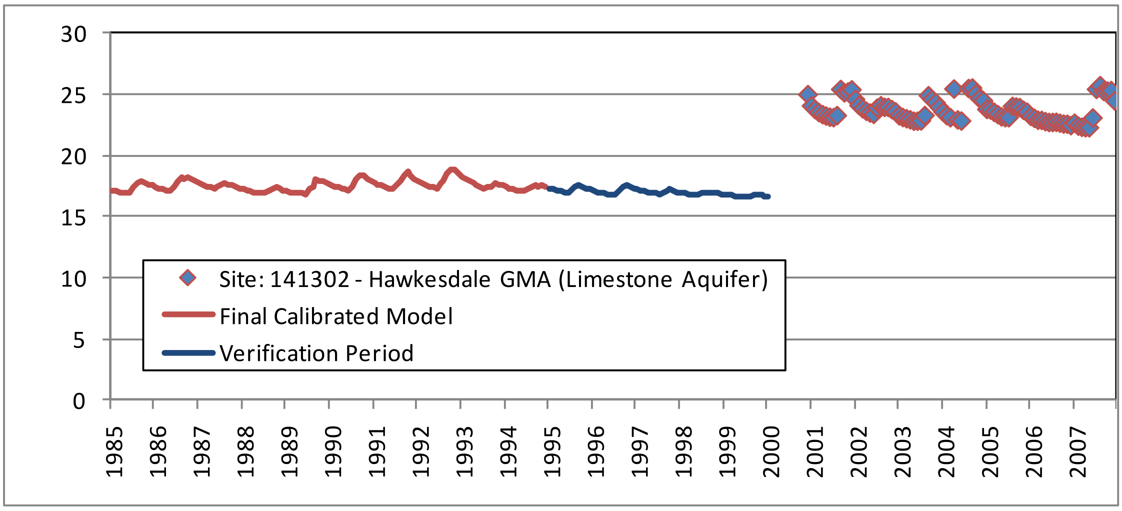
Site: 120248 - Condah WSPA (Clifton Aquifer)
Final Calibrated Model
Verification Period
100
90
80
70
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

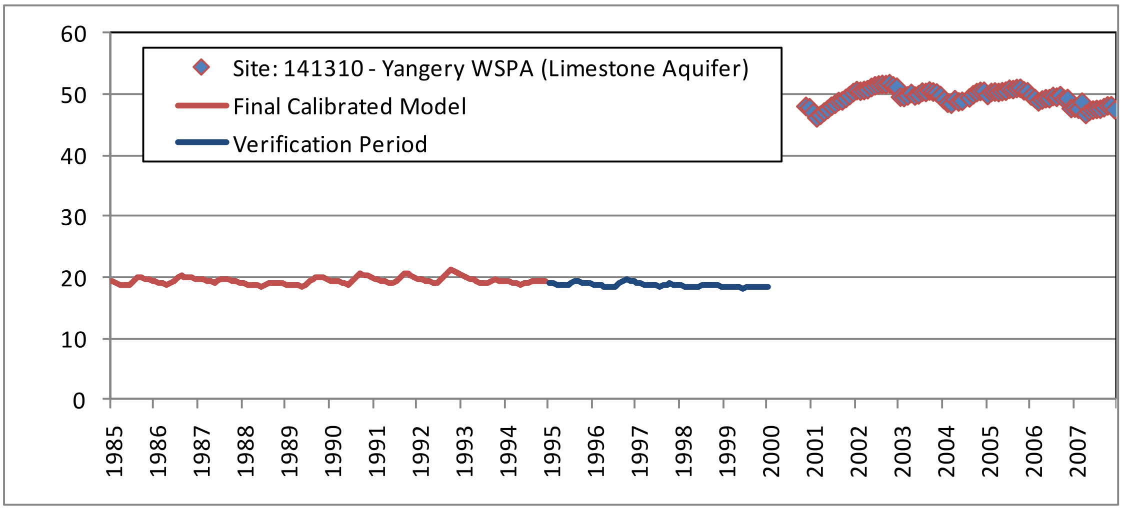

Site: 141237 - Nullawarre WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
90
80
70
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

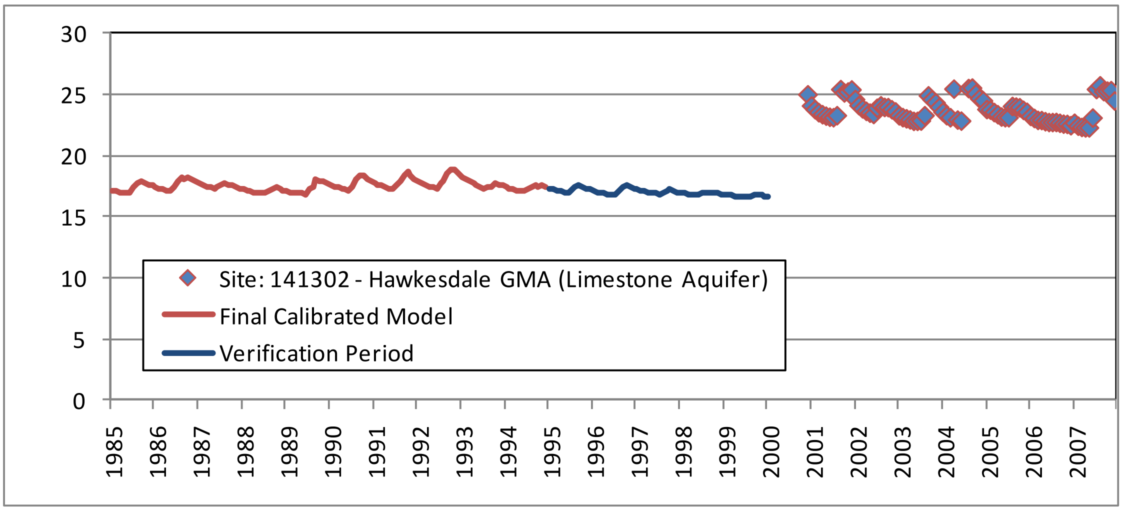

Site: 141231 - Nullawarre WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
35
30
25
20
15
10
5
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007


Site: 141238 - Nullawarre WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
80
70
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

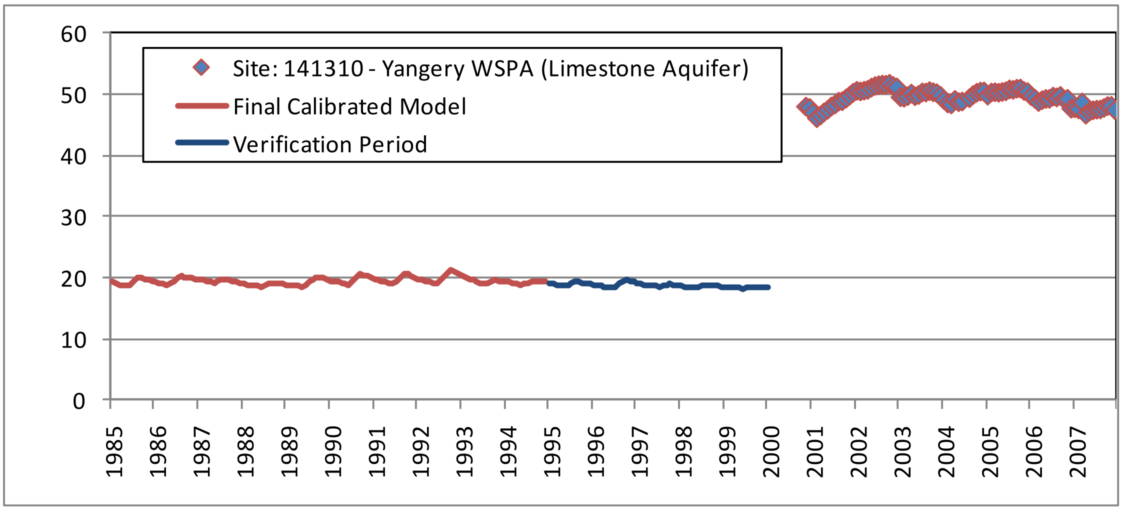

Site: 141299 - Yangery WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007


Site: 141302 - Hawkesdale GMA (Limestone Aquifer)
Final Calibrated Model
Verification Period
30
25
20
15
10
5
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

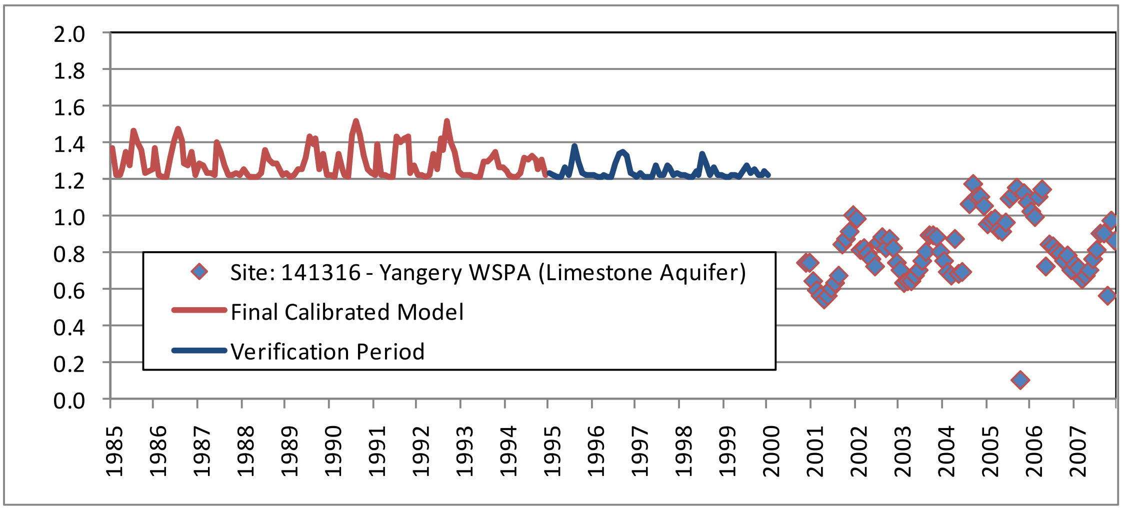

Site: 141310 - Yangery WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007



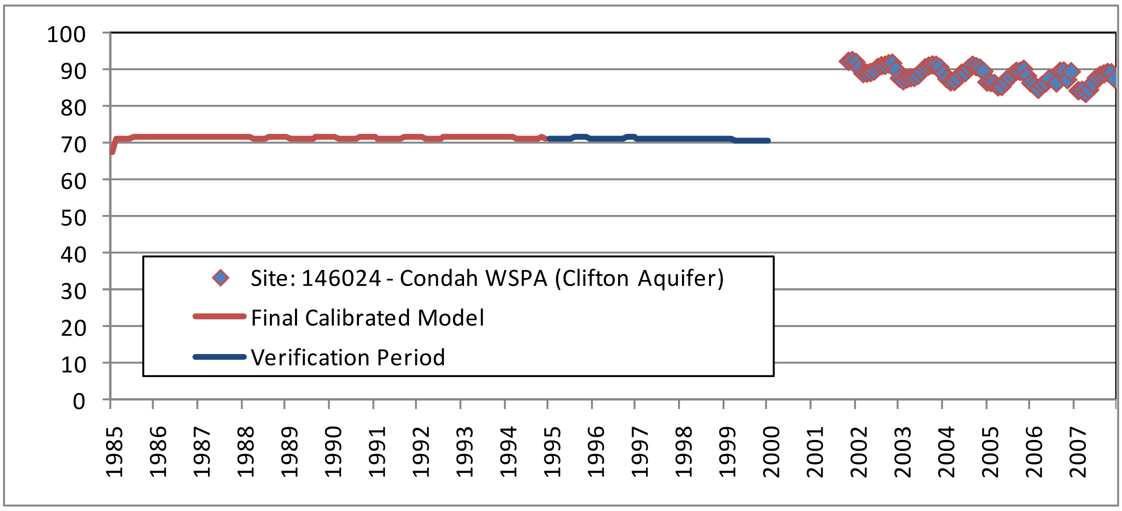
30
25
20
15
10
5
0
Site: 141302 - Hawkesdale GMA (Limestone Aquifer)
Final Calibrated Model
Verification Period
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

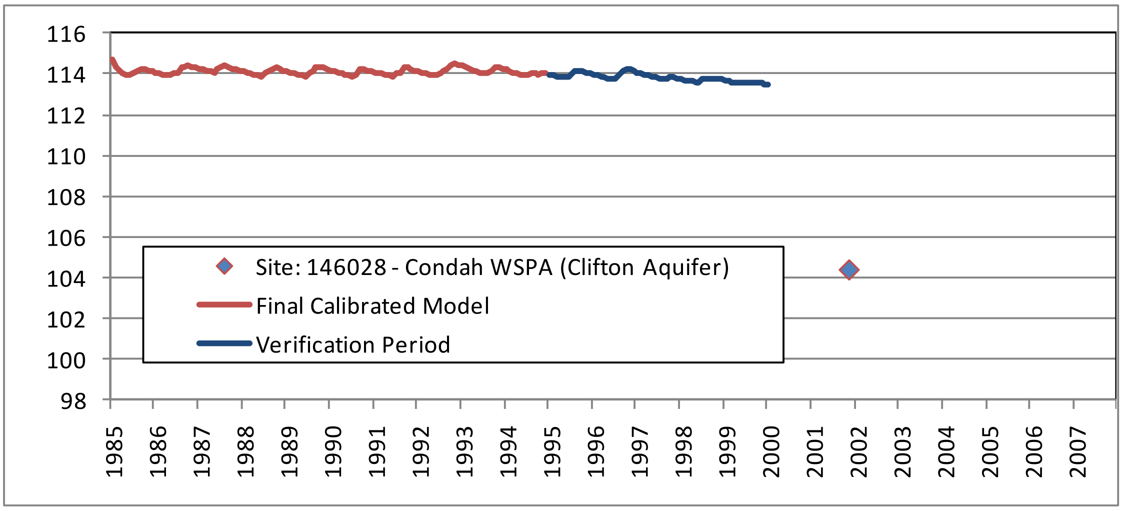


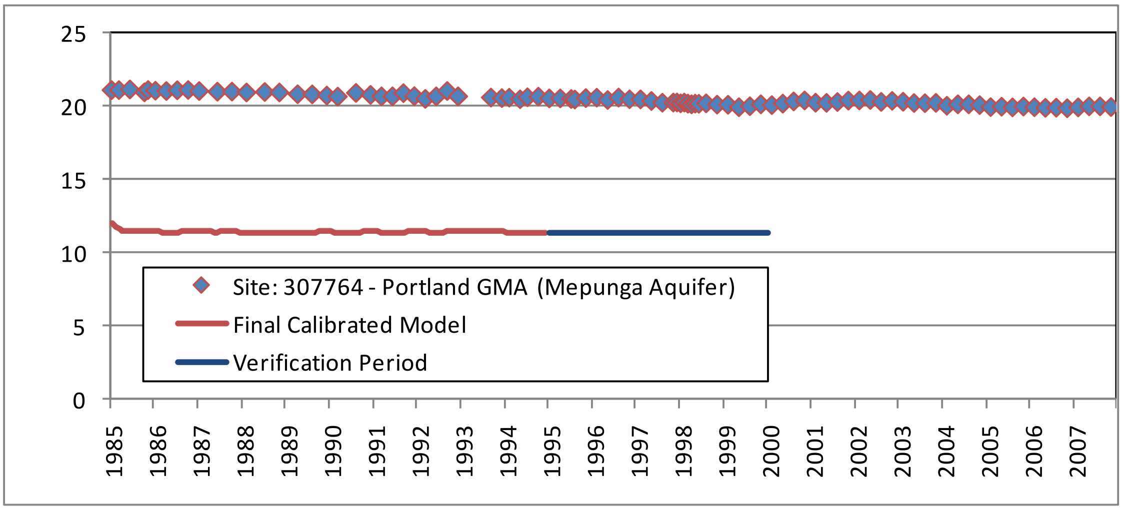
60
50
40
30
20
10
0
Site: 141310 - Yangery WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

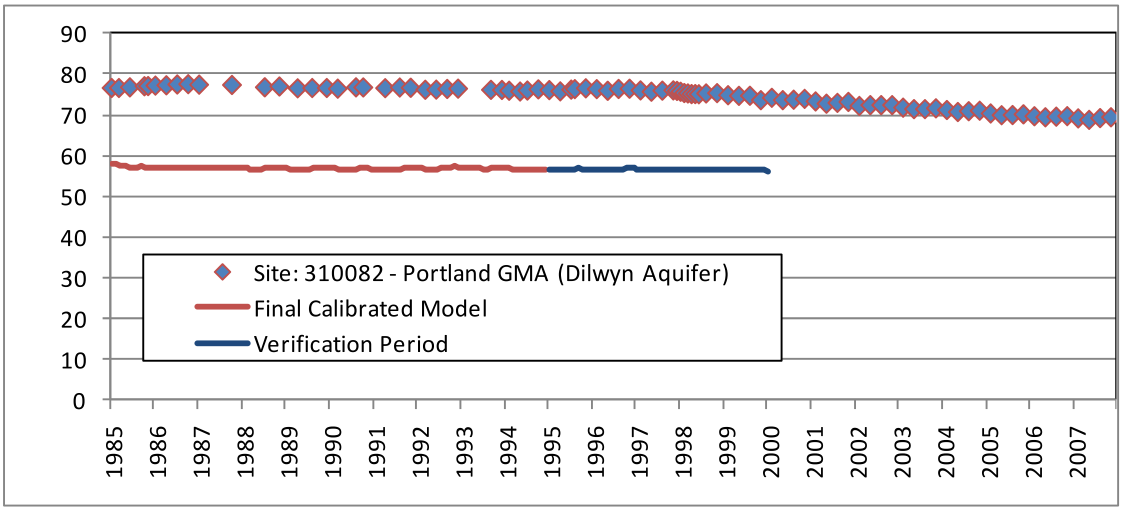


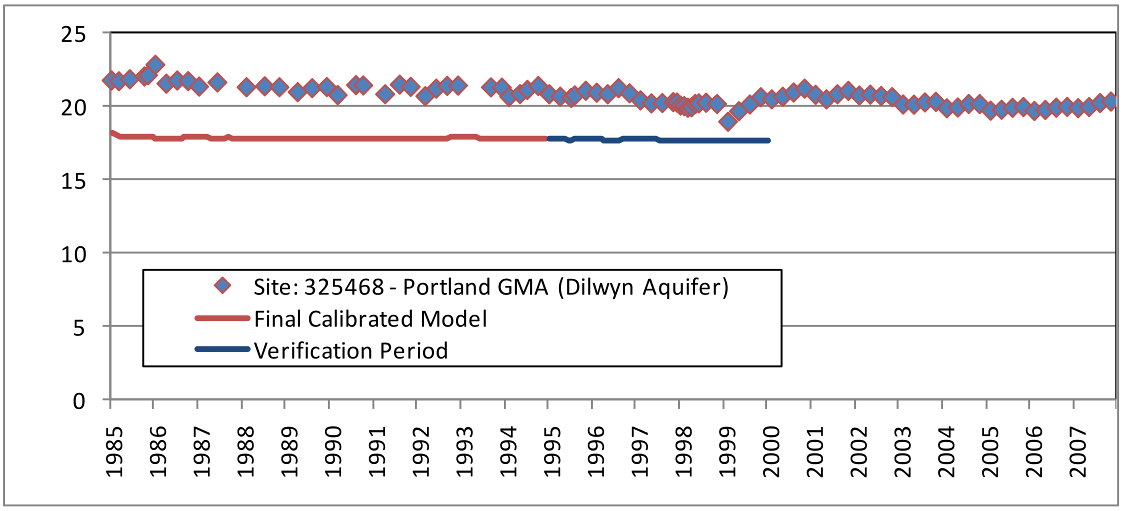
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Site: 141316 - Yangery WSPA (Limestone Aquifer)
Final Calibrated Model
Verification Period
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007


Site: 146024 - Condah WSPA (Clifton Aquifer)
Final Calibrated Model
Verification Period


Site: 146028 - Condah WSPA (Clifton Aquifer)
Final Calibrated Model
Verification Period


Site: 307764 - Portland GMA (Mepunga Aquifer)
Final Calibrated Model
Verification Period


90
80
70
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Site: 310082 - Portland GMA (Dilwyn Aquifer)
Final Calibrated Model
Verification Period


25
20
15
10
5
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Site: 325468 - Portland GMA (Dilwyn Aquifer)
Final Calibrated Model
Verification Period

6. Model Limitations/Uncertainty

The Glenelg-Hopkins groundwater model is a regional groundwater model incorporating multiple aquifers to all depths including the basement. The outputs of the model therefore need to be considered within this context (i.e. it is not suitable for local scale, fine resolution, high accuracy assessments). It is however, deemed to be suitable for use for regional investigations, looking at regional issues where broad longer-term regional trends are the required output.

Some of the key model limitations are summarised below:

- The model discretisation was specified at 200m grid cells incorporating all layers including the basement. The resulting model is highly computationally intensive. Model run times for the transient model (10 years) are in excess of 4 days.
- The second (and more important) impact of the model discretisation is that the model has low numerical stability. Therefore it was proven to be difficult to define a model for which modflow would converge to a reasonable solution. It was found that no reasonable solution was attainable using the modflow steady state setting (hence the need to run a transient model to dynamic equilibrium).
- Rivers are non time varying in both the steady state and transient versions. Therefore the model is not considered appropriate for assessing the seasonal patterns in the watertable or groundwater – surface water interaction assessments.
- The baseflow analysis highlighted that modelled baseflow volumes across the model domain are too high, however it was shown that the correct trends in baseflow (i.e. responses to various stresses) are preserved in the model. Therefore the model is not deemed suitable for estimating baseflow volumes however it is deemed suitable for analysing baseflow trends.
- The extinction depth for groundwater evapotranspiration has been set at a universal depth of 2m. This is considered appropriate within the regional context but may not be suitable for detailed investigations requiring assessments into the impacts of deep rooted vegetation. However, it is considered acceptable within the context of a regional groundwater model.
- The model parameterisation (i.e. conductivities and storage) are based on regional averages identified from literature. It is emphasised that this does not take into account any local or medium scale variability in hydrogeological properties.

- The calibration statistics for the model depict a good calibration that achieves recommended criteria for high complexity models (Scaled RMS = 2.47% for steady state). However, the good calibration is only useful when the outputs are considered within the context of the model limitations. Herein it is also important to highlight that the calibration statistics indicated that on average a water level at any point in the model may only be as accurate as ± 4.5 m.

7. References

Bennetts D. (2005). Hydrology, hydrogeology and hydrogeochemistry of groundwater flow systems within the Hamilton basalt plains, western Victoria, and their role in dryland salinisation. Unpublished PhD Thesis. La Trobe University.

Beverly, C., 2007. Technical Manual - Models of the Catchment Analysis Tool. Victoria Department of Sustainability and Environment.

Birch W.D. (Editor) (2003). Geology of Victoria. Geological Society of Australia. Special Publication 23.

Bush A.L. (2009) Physical and chemical hydrogeology of the Otway Basin, south east Australia. Unpublished PhD thesis, School of Earth Sciences, University of Melbourne.

Department of Sustainability and Environment (2003): Sustainable Diversion Limit Project – Estimation of Sustainable Diversion Limit Parameters over Winterfill Periods in Victorian Catchments, Report prepared by Sinclair Knight Merz, Final Report, January 2003.

Department of Sustainability and Environment (2006) State Water Report 2004/05. A statement of Victoriasn water resources.

Ha, J., in preparation. A Programmer's Guide for BioSym – the Biophysical Modelling Toolbox of EnSym. Victoria Department of Sustainability and Environment.

Harbaugh A. W. et al (2000) MODFLOW-2000, The U.S. Geological Survey Modular Groundwater Model – User Guide to Modularization Concepts and the Groundwater Flow Process, The U.S. Geological Survey Report 00-92 2000.

Love A.J., Herczeg A.L., Armstrong D., Stadter F. & Mazor E. (1993). Groundwater flow regime within the Gambier Embayment of the Otway Basin, Australia; evidence from hydraulics and hydrochemistry. Journal of Hydrology 143, 297–338.

Middlemis H. (2000) Murray-Darling Basin Groundwater Flow Modelling Guidelines.

SKM (2007) South Australia – Victoria Border Groundwaters Agreement Review Committee. Five year technical summary 2001-2005. Prepared for the Department of Sustainability and Environment Victoria and the Department of Water, Land and Biodiversity Conservation South Australia. February 2007.

SKM & GHD (2009) Hydrogeological Mapping of Southern Victoria. Report prepared for Southern Rural Water.

Wopfner, H., & Douglas, J.G., (editors), 1971 – The Otway Basin of southeastern Australia. Special Bulletin, Geological Surveys of South Australia and Victoria.

Appendix A Transient Equilibrium Mass Balance Results (Quasi Steady-State)

The following are extracts from the listing file. The extracts show the final volumetric budget at the end of each 10 year model run for the calibrated 'quasi' steady state model run. The extracts show how the storage volume changes reduce with each run and by the conclusion of the 10th run, storage volume changes are considered negligible (less than 0.01% of the overall mass balance) and therefore the groundwater system is considered to be in equilibrium.

Run 1 – Years 1 – 10

```
1
  VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
  ------------------------------------------------------------------------------

     CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
     ------------------                 ------------------------

           IN:                                   IN:
           ---                                   ---
             STORAGE = 10747373600.0000            STORAGE =      304255.3750
       CONSTANT HEAD =            0.0000     CONSTANT HEAD =           0.0000
       RIVER LEAKAGE =141611041000.0000      RIVER LEAKAGE =    38747968.0000
                  ET =            0.0000                ET =           0.0000
     HEAD DEP BOUNDS = 21932970000.0000    HEAD DEP BOUNDS =     5582168.0000
            RECHARGE = 28479324200.0000           RECHARGE =     7796511.0000

            TOTAL IN =202770711000.0000           TOTAL IN =    52430904.0000

          OUT:                                  OUT:
          ----                                  ----
             STORAGE =  9189458940.0000            STORAGE =      936844.4380
       CONSTANT HEAD =            0.0000     CONSTANT HEAD =           0.0000
       RIVER LEAKAGE =147722600000.0000      RIVER LEAKAGE =    39732832.0000
                  ET =  8762991620.0000                ET =     1586266.6200
     HEAD DEP BOUNDS = 37098283000.0000    HEAD DEP BOUNDS =    10174502.0000
            RECHARGE =            0.0000           RECHARGE =           0.0000

           TOTAL OUT =202773332000.0000          TOTAL OUT =    52430444.0000

            IN - OUT =     -2625536.0000          IN - OUT =         457.3125

 PERCENT DISCREPANCY =           0.00     PERCENT DISCREPANCY =          0.00
```

SKM

Run 2 – Years 11 – 20

```
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                      IN:
          ---                                      ---
            STORAGE =    477207936.0000              STORAGE =      63314.7422
      CONSTANT HEAD =           0.0000         CONSTANT HEAD =          0.0000
      RIVER LEAKAGE =141487423000.0000         RIVER LEAKAGE =    38722436.0000
                 ET =           0.0000                    ET =          0.0000
    HEAD DEP BOUNDS = 20242274300.0000       HEAD DEP BOUNDS =     5526134.0000
           RECHARGE = 28479324200.0000              RECHARGE =     7796511.0000

           TOTAL IN =190686233000.0000              TOTAL IN =    52108396.0000

         OUT:                                     OUT:
         ----                                     ----
            STORAGE =   2358913020.0000              STORAGE =      484006.5000
      CONSTANT HEAD =           0.0000         CONSTANT HEAD =          0.0000
      RIVER LEAKAGE =145236509000.0000         RIVER LEAKAGE =    39782596.0000
                 ET =   5880278530.0000                   ET =     1647027.2500
    HEAD DEP BOUNDS = 37213966300.0000       HEAD DEP BOUNDS =    10194547.0000
           RECHARGE =           0.0000              RECHARGE =          0.0000

          TOTAL OUT =190689673000.0000             TOTAL OUT =    52108176.0000

           IN - OUT =     -3436672.0000             IN - OUT =        218.9922

PERCENT DISCREPANCY =           0.00     PERCENT DISCREPANCY =          0.00
```

Run 3 – Years 21 – 30

```
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                      IN:
          ---                                      ---
            STORAGE =    136096480.0000              STORAGE =      23044.6719
      CONSTANT HEAD =           0.0000         CONSTANT HEAD =          0.0000
      RIVER LEAKAGE =141406978000.0000         RIVER LEAKAGE =    38704432.0000
                 ET =           0.0000                    ET =          0.0000
    HEAD DEP BOUNDS = 20164573200.0000       HEAD DEP BOUNDS =     5516890.0000
           RECHARGE = 28479324200.0000              RECHARGE =     7796511.0000

           TOTAL IN =190186979000.0000              TOTAL IN =    52040876.0000

         OUT:                                     OUT:
         ----                                     ----
            STORAGE =   1375051650.0000              STORAGE =      305656.4690
      CONSTANT HEAD =           0.0000         CONSTANT HEAD =          0.0000
      RIVER LEAKAGE =145405673000.0000         RIVER LEAKAGE =    39822092.0000
                 ET =   6156354560.0000                   ET =     1711976.2500
    HEAD DEP BOUNDS = 37253488600.0000       HEAD DEP BOUNDS =    10201010.0000
           RECHARGE =           0.0000              RECHARGE =          0.0000

          TOTAL OUT =190190567000.0000             TOTAL OUT =    52040736.0000

           IN - OUT =     -3596448.0000             IN - OUT =        142.9531

PERCENT DISCREPANCY =           0.00     PERCENT DISCREPANCY =          0.00
```

Run 4 – Years 31 – 40

```
VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
------------------------------------------------------------------------------

   CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
   ------------------                 ------------------------

         IN:                                   IN:
         ---                                   ---
           STORAGE =     56034992.0000           STORAGE =       10496.0586
     CONSTANT HEAD =            0.0000     CONSTANT HEAD =           0.0000
     RIVER LEAKAGE =141356155000.0000      RIVER LEAKAGE =    38693384.0000
                ET =            0.0000                ET =           0.0000
   HEAD DEP BOUNDS = 20143560700.0000    HEAD DEP BOUNDS =     5512845.5000
          RECHARGE = 28479324200.0000           RECHARGE =     7796511.0000

          TOTAL IN =190035067000.0000           TOTAL IN =    52013236.0000

        OUT:                                  OUT:
        ----                                  ----
           STORAGE =    905102080.0000           STORAGE =      206766.3750
     CONSTANT HEAD =            0.0000     CONSTANT HEAD =           0.0000
     RIVER LEAKAGE =145521164000.0000      RIVER LEAKAGE =    39848068.0000
                ET =   6342961660.0000                ET =     1754066.1200
   HEAD DEP BOUNDS = 37269504000.0000    HEAD DEP BOUNDS =    10204208.0000
          RECHARGE =            0.0000          RECHARGE =           0.0000

         TOTAL OUT =190038737000.0000          TOTAL OUT =    52013108.0000

          IN - OUT =     -3657296.0000          IN - OUT =         128.0586

PERCENT DISCREPANCY =            0.00     PERCENT DISCREPANCY =          0.00
```

Run 5 – Years 41 – 50

```
VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
------------------------------------------------------------------------------

   CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
   ------------------                 ------------------------

         IN:                                   IN:
         ---                                   ---
           STORAGE =     28119932.0000           STORAGE =        5587.0503
     CONSTANT HEAD =            0.0000     CONSTANT HEAD =           0.0000
     RIVER LEAKAGE =141324337000.0000      RIVER LEAKAGE =    38686340.0000
                ET =            0.0000                ET =           0.0000
   HEAD DEP BOUNDS = 20132018200.0000    HEAD DEP BOUNDS =     5510251.0000
          RECHARGE = 28479324200.0000           RECHARGE =     7796511.0000

          TOTAL IN =189963796000.0000           TOTAL IN =    51998688.0000

        OUT:                                  OUT:
        ----                                  ----
           STORAGE =    627123328.0000           STORAGE =      146534.2340
     CONSTANT HEAD =            0.0000     CONSTANT HEAD =           0.0000
     RIVER LEAKAGE =145597874000.0000      RIVER LEAKAGE =    39865460.0000
                ET =   6464158210.0000                ET =     1780437.2500
   HEAD DEP BOUNDS = 37278326800.0000    HEAD DEP BOUNDS =    10206110.0000
          RECHARGE =            0.0000          RECHARGE =           0.0000

         TOTAL OUT =189967483000.0000          TOTAL OUT =    51998540.0000

          IN - OUT =     -3683076.0000          IN - OUT =         147.5659

PERCENT DISCREPANCY =            0.00     PERCENT DISCREPANCY =          0.00
```

Run 6 – Years 51 – 60

```
VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
------------------------------------------------------------------------------

   CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
   ------------------                 ------------------------

         IN:                                      IN:
         ---                                      ---
           STORAGE =     15828399.0000              STORAGE =        3179.0000
     CONSTANT HEAD =            0.0000        CONSTANT HEAD =           0.0000
     RIVER LEAKAGE =141303611000.0000         RIVER LEAKAGE =     38681636.0000
                ET =            0.0000                   ET =           0.0000
    HEAD DEP BOUNDS = 20124252200.0000       HEAD DEP BOUNDS =      5508462.0000
          RECHARGE = 28479324200.0000             RECHARGE =      7796511.0000

          TOTAL IN =189923017000.0000             TOTAL IN =     51989788.0000

        OUT:                                     OUT:
        ----                                     ----
           STORAGE =    455128480.0000              STORAGE =      108380.6330
     CONSTANT HEAD =            0.0000        CONSTANT HEAD =           0.0000
     RIVER LEAKAGE =145649549000.0000         RIVER LEAKAGE =     39877296.0000
                ET =   6538435580.0000                   ET =      1796756.8800
    HEAD DEP BOUNDS = 37283614700.0000       HEAD DEP BOUNDS =     10207226.0000
          RECHARGE =            0.0000             RECHARGE =           0.0000

         TOTAL OUT =189926736000.0000            TOTAL OUT =     51989660.0000

          IN - OUT =     -3711985.0000            IN - OUT =          128.4922

PERCENT DISCREPANCY =            0.00     PERCENT DISCREPANCY =          0.00
```

Run 7 – Years 61 – 70

```
VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
------------------------------------------------------------------------------

   CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
   ------------------                 ------------------------

         IN:                                      IN:
         ---                                      ---
           STORAGE =      9642167.0000              STORAGE =        1935.1580
     CONSTANT HEAD =            0.0000        CONSTANT HEAD =           0.0000
     RIVER LEAKAGE =141289144000.0000         RIVER LEAKAGE =     38678184.0000
                ET =            0.0000                   ET =           0.0000
    HEAD DEP BOUNDS = 20118765600.0000       HEAD DEP BOUNDS =      5507158.0000
          RECHARGE = 28479324200.0000             RECHARGE =      7796511.0000

          TOTAL IN =189896884000.0000             TOTAL IN =     51983788.0000

        OUT:                                     OUT:
        ----                                     ----
           STORAGE =    342513856.0000              STORAGE =       82537.2422
     CONSTANT HEAD =            0.0000        CONSTANT HEAD =           0.0000
     RIVER LEAKAGE =145685103000.0000         RIVER LEAKAGE =     39885508.0000
                ET =   6586278400.0000                   ET =      1807738.8800
    HEAD DEP BOUNDS = 37286682600.0000       HEAD DEP BOUNDS =     10207887.0000
          RECHARGE =            0.0000             RECHARGE =           0.0000

         TOTAL OUT =189900571000.0000            TOTAL OUT =     51983672.0000

          IN - OUT =     -3701257.0000            IN - OUT =          117.0408

PERCENT DISCREPANCY =            0.00     PERCENT DISCREPANCY =          0.00
```

Run 8 – Years 71 – 80

```
'
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                      IN:
          ---                                      ---
            STORAGE =      6371897.0000            STORAGE =       1266.9576
      CONSTANT HEAD =            0.0000      CONSTANT HEAD =          0.0000
      RIVER LEAKAGE =141278888000.0000       RIVER LEAKAGE =   38675888.0000
                 ET =            0.0000                 ET =          0.0000
    HEAD DEP BOUNDS = 20114700300.0000     HEAD DEP BOUNDS =    5506189.5000
           RECHARGE = 28479324200.0000            RECHARGE =    7796511.0000

           TOTAL IN =189879288000.0000            TOTAL IN =   51979856.0000

         OUT:                                     OUT:
         ----                                     ----
            STORAGE =    264099648.0000            STORAGE =      64297.2852
      CONSTANT HEAD =            0.0000      CONSTANT HEAD =          0.0000
      RIVER LEAKAGE =145710416000.0000       RIVER LEAKAGE =   39891532.0000
                 ET =   6619886080.0000                 ET =    1815594.3800
    HEAD DEP BOUNDS = 37288587300.0000     HEAD DEP BOUNDS =   10208313.0000
           RECHARGE =            0.0000           RECHARGE =          0.0000

          TOTAL OUT =189882991000.0000           TOTAL OUT =   51979736.0000

           IN - OUT =     -3704583.0000           IN - OUT =        118.7975

PERCENT DISCREPANCY =             0.00     PERCENT DISCREPANCY =          0.00
```

Run 9 – Years 81 – 90

```
'
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD   1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                      IN:
          ---                                      ---
            STORAGE =      4478620.0000            STORAGE =        827.8513
      CONSTANT HEAD =            0.0000      CONSTANT HEAD =          0.0000
      RIVER LEAKAGE =141271941000.0000       RIVER LEAKAGE =   38674260.0000
                 ET =            0.0000                 ET =          0.0000
    HEAD DEP BOUNDS = 20111697900.0000     HEAD DEP BOUNDS =    5505483.0000
           RECHARGE = 28479324200.0000            RECHARGE =    7796511.0000

           TOTAL IN =189867442000.0000            TOTAL IN =   51977080.0000

         OUT:                                     OUT:
         ----                                     ----
            STORAGE =    207922992.0000            STORAGE =      50943.0586
      CONSTANT HEAD =            0.0000      CONSTANT HEAD =          0.0000
      RIVER LEAKAGE =145729176000.0000       RIVER LEAKAGE =   39896000.0000
                 ET =   6644215300.0000                 ET =    1821428.1300
    HEAD DEP BOUNDS = 37289836500.0000     HEAD DEP BOUNDS =   10208591.0000
           RECHARGE =            0.0000           RECHARGE =          0.0000

          TOTAL OUT =189871145000.0000           TOTAL OUT =   51976964.0000

           IN - OUT =     -3708564.0000           IN - OUT =        119.6677

PERCENT DISCREPANCY =             0.00     PERCENT DISCREPANCY =          0.00
```

Run 10 – Years 91 – 100

```
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP200 IN STRESS PERIOD    1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                      IN:
          ---                                      ---
            STORAGE =       3272893.5000             STORAGE =         579.7949
      CONSTANT HEAD =            0.0000        CONSTANT HEAD =           0.0000
      RIVER LEAKAGE =141266960000.0000         RIVER LEAKAGE =    38673076.0000
                 ET =            0.0000                   ET =           0.0000
    HEAD DEP BOUNDS = 20109561900.0000       HEAD DEP BOUNDS =     5504993.0000
           RECHARGE = 28479324200.0000              RECHARGE =     7796511.0000

           TOTAL IN =189859119000.0000              TOTAL IN =    51975160.0000

         OUT:                                     OUT:
         ----                                     ----
            STORAGE =     166776704.0000             STORAGE =       41248.5625
      CONSTANT HEAD =            0.0000        CONSTANT HEAD =           0.0000
      RIVER LEAKAGE =145743217000.0000         RIVER LEAKAGE =    39899376.0000
                 ET =   6662224900.0000                   ET =     1825655.8800
    HEAD DEP BOUNDS = 37290631200.0000       HEAD DEP BOUNDS =    10208763.0000
           RECHARGE =            0.0000             RECHARGE =           0.0000

          TOTAL OUT =189862855000.0000             TOTAL OUT =    51975044.0000

           IN - OUT =     -3730114.5000             IN - OUT =         116.3574

 PERCENT DISCREPANCY =            0.00     PERCENT DISCREPANCY =           0.00
```

Appendix B Groundwater Abstraction Wells

The following tables presents all the pumping rates used in the transient calibration and verification models. Definitions for some of the headings are as follows:

- Year – Recorded construction year for the bore.
- Depth – Total construction depth for the bore, screened intervals are not readily available for most bores
- Entitlement – Licensed entitlement volume for the bore in (ML/yr)
- 1985-2000 – Assumed pumping volume (ML/year) in the given year for the transient calibration period (1985 to 1994) and for the verification period (1995-1999).

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
46220	2153572	2404916	1970	7.9	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46223	2149801	2407676	1970	9.1	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46224	2153209	2404105	1970	8.2	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46225	2153169	2404684	1970	7.3	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46226	2153221	2404969	1970	7.6	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46227	2152955	2404529	1970	7.3	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46228	2148750	2407932	1970	9.1	BORDER	82.3	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
46229	2148672	2408200	1970	7.3	BORDER	82.3	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
46230	2148147	2408144	1970	8.2	BORDER	82.3	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
46231	2148298	2408274	1970	8.2	BORDER	82.3	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
46232	2148370	2408712	1970	7.9	BORDER	82.3	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
46233	2153738	2404219	1970	7.6	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46234	2149084	2409123	1970	8.5	BORDER	82.3	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
46235	2148012	2410005	1970	8.5	BORDER	82.3	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
46236	2148095	2407464	1970	8.5	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46237	2148345	2406902	1970	8.5	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46238	2149337	2406526	1970	7.6	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46239	2149061	2406556	1968	8.2	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
46240	2149102	2406989	1968	7.6	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46241	2149360	2407470	1966	8.5	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46242	2148591	2407443	1970	7.9	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46243	2148942	2407845	1970	7.9	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46244	2149070	2408024	1966	8.5	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46245	2149171	2407996	1970	8.2	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46246	2149257	2407623	1970	7.9	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46247	2149480	2407459	1970	7.6	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46248	2149553	2407715	1965	7.6	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46249	2150290	2407882	1968	9.1	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46250	2150013	2408268	1968	9.1	BORDER	21.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
46251	2153258	2405938	1970	9.1	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46252	2153655	2405406	1970	9.4	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46253	2153707	2406013	1970	4.8	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46254	2154322	2405245	1970	9.1	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46255	2153212	2405662	1970	9.1	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46256	2152996	2406161	1970	8.5	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46257	2154116	2404989	1970	10.6	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46258	2153736	2406214	1970	8.2	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46259	2154068	2404804	1970	9.4	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46260	2153465	2406417	1970	8.8	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46261	2154392	2404802	1970	9.7	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46262	2153470	2406761	1970	9.1	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46263	2152997	2405463	1970	8.5	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46264	2153988	2406793	1970	8.5	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46265	2152796	2405409	1970	9.1	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46266	2154110	2404091	1970	7.6	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46268	2154251	2404753	1970	7.9	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46269	2154457	2404729	1970	7.9	BORDER	3.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
46270	2147743	2409097	1967	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46271	2147035	2409104	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46272	2147303	2409333	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46273	2146869	2409414	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46274	2146928	2409575	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46275	2147382	2410035	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
46276	2147452	2410757	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46277	2146967	2410435	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46278	2146622	2410633	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46279	2145725	2410622	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46280	2145367	2410724	1970	6.1	BORDER	23.2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46392	2147037	2410826	1974	8.2	BORDER	255.0	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5
46428	2152158	2408336	1990	14.0	BORDER	72.0	0.0	0.0	0.0	0.0	0.0	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6
58596	2172354	2390746	1954	11.0	BORDER	6.0	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
58597	2169063	2396127	1970	12.8	BORDER	120.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
58753	2176411	2388981	1988	71.0	BORDER	2.2	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
65073	2149491	2376270	1970	36.6	BORDER	5.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
65126	2149877	2377441	1978	38.1	BORDER	4.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
65143	2149600	2376298	1980	32.0	BORDER	10.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
65225	2149660	2376531	1991	75.0	BORDER	4.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
68476	2145183	2420052	1964	9.0	BORDER	147.0	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1
68477	2146126	2420261	1968	9.0	BORDER	147.0	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1
68479	2151833	2418000	1970	10.0	BORDER	84.0	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
68480	2151995	2417941	1970	10.0	BORDER	84.0	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
68481	2151385	2418035	1970	10.0	BORDER	84.0	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
68482	2151394	2417779	1970	10.0	BORDER	84.0	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
68484	2145525	2421071	1970	6.0	BORDER	13.7	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
68485	2145868	2420904	1970	5.0	BORDER	13.7	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
68486	2146482	2420836	1970	13.4	BORDER	13.7	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
68487	2146735	2421282	1970	6.0	BORDER	13.7	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
68488	2145849	2421385	1970	5.0	BORDER	13.7	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
68490	2145592	2421382	1970	5.0	BORDER	13.7	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
68492	2146361	2419685	1970	10.0	BORDER	40.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
68493	2146722	2418864	1970	10.0	BORDER	40.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
68494	2147392	2419239	1970	10.0	BORDER	40.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
68495	2147055	2419098	1970	10.0	BORDER	40.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
68499	2146909	2416735	1970	17.6	BORDER	2037.8	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3	611.3
68500	2147909	2418540	1970	9.0	BORDER	723.7	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1
68522	2145184	2416254	1972	19.8	BORDER	65.5	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7
68523	2147011	2415764	1972	24.4	BORDER	65.5	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7
68525	2146446	2420623	1972	11.9	BORDER	294.0	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
68532	2147145	2419326	1972	7.6	BORDER	66.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
68537	2145399	2421457	1973	11.0	BORDER	32.0	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
68538	2144927	2420404	1973	15.2	BORDER	294.0	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2
68539	2147171	2419865	1973	7.6	BORDER	66.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
68543	2149856	2416054	1973	19.2	BORDER	1018.9	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7
68549	2154002	2417877	1976	11.0	BORDER	60.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
68553	2148860	2417123	1974	17.4	BORDER	723.7	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1	217.1
68558	2152058	2418238	1980	12.0	BORDER	112.0	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6
68565	2153956	2421671	1983	14.0	BORDER	40.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
68566	2152178	2418460	1982	12.0	BORDER	112.0	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6
68569	2148207	2423128	1985	17.5	BORDER	505.3	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6
68582	2148227	2421817	1987	14.8	BORDER	63.0	0.0	0.0	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9
68584	2146031	2418316	1987	15.0	BORDER	2160.0	0.0	0.0	648.0	648.0	648.0	648.0	648.0	648.0	648.0	648.0	648.0	648.0	648.0	648.0	648.0	648.0
68586	2147940	2423407	1988	20.0	BORDER	505.3	0.0	0.0	0.0	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6
68587	2149159	2421791	1989	18.0	BORDER	63.0	0.0	0.0	0.0	0.0	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9
68589	2148881	2422465	1989	17.5	BORDER	63.0	0.0	0.0	0.0	0.0	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9
68590	2148273	2422380	1988	16.5	BORDER	63.0	0.0	0.0	0.0	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9
68591	2146143	2418511	1984	26.0	BORDER	1018.9	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7	305.7
68629	2147919	2416295	1988	18.0	BORDER	147.0	0.0	0.0	0.0	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1
82397	2163107	2391146	1982	14.5	BORDER	32.0	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
82398	2160739	2394540	1982	14.0	BORDER	36.0	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
82405	2160385	2395198	1982	18.6	BORDER	36.0	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
82408	2159774	2395689	1982	19.0	BORDER	36.0	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
82416	2164103	2392388	1988	13.0	BORDER	32.0	0.0	0.0	0.0	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
83455	2144891	2437129	1970	7.6	BORDER	52.5	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8
83456	2145631	2437586	1970	7.6	BORDER	52.5	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8
83457	2145988	2437226	1970	12.0	BORDER	60.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
83458	2146102	2436489	1970	12.0	BORDER	60.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
83478	2152766	2431275	1978	7.0	BORDER	260.7	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2
83479	2151022	2432257	1979	7.0	BORDER	216.5	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9
83493	2151132	2431190	1985	10.0	BORDER	216.5	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9
83499	2149734	2434305	1984	22.0	BORDER	1428.0	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4	428.4
83505	2145017	2436960	1987	9.7	BORDER	52.5	0.0	0.0	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8
83506	2147300	2436255	1988	15.0	BORDER	33.0	0.0	0.0	0.0	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9
83511	2147537	2433462	1990	18.0	BORDER	22.5	0.0	0.0	0.0	0.0	0.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
83512	2146860	2433133	1990	18.0	BORDER	22.5	0.0	0.0	0.0	0.0	0.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
83513	2150674	2432442	1990	9.0	BORDER	216.5	0.0	0.0	0.0	0.0	0.0	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9
83525	2145695	2424108	1988	6.0	BORDER	180.0	0.0	0.0	0.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0
83606	2146587	2436526	1990	12.0	BORDER	40.0	0.0	0.0	0.0	0.0	0.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
83738	2166708	2428261	1989	42.0	BORDER	199.0	0.0	0.0	0.0	0.0	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7
83739	2166762	2428163	1989	42.0	BORDER	199.0	0.0	0.0	0.0	0.0	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7
96213	2144985	2443687	1991	16.5	BORDER	5.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
97043	2153812	2431186	1981	7.5	BORDER	260.7	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2
97050	2155575	2432298	1990	15.0	BORDER	36.0	0.0	0.0	0.0	0.0	0.0	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
102629	2155332	2404067	1970	7.9	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102630	2156428	2404270	1970	9.1	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102631	2155840	2404466	1970	8.5	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102632	2155855	2404646	1970	8.5	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102633	2155515	2404733	1970	8.8	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102634	2155439	2405011	1970	9.4	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102635	2155037	2404385	1970	7.6	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102636	2155473	2405241	1970	8.8	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102637	2154818	2404372	1970	9.1	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102638	2154920	2405675	1970	9.1	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102639	2154817	2404585	1970	8.8	BORDER	2.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
102640	2156997	2403797	1971	11.0	BORDER	15.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
102641	2157417	2403766	1971	11.9	BORDER	15.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
102642	2157724	2403717	1971	11.0	BORDER	15.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
102643	2155738	2403760	1972	9.4	BORDER	15.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
102644	2156060	2404123	1972	9.1	BORDER	15.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
102673	2160581	2412084	1984	22.0	BORDER	300.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
102716	2157622	2413864	1988	10.2	BORDER	60.0	0.0	0.0	0.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
111337	2146599	2433397	1997	18.0	BORDER	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	6.8	6.8	6.8
112607	2160050	2394941	1992	15.2	BORDER	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
114179	2145916	2444877	1992	16.0	BORDER	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
116131	2152875	2376286	1993	100.0	BORDER	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
123421	2152817	2387428	1994	9.0	BORDER	277.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	83.2	83.2	83.2	83.2	83.2	83.2	83.2
126284	2154407	2429616	1995	18.2	BORDER	228.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.4	68.4	68.4	68.4	68.4	68.4
126515	2151505	2430025	2005	21.5	BORDER	216.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
126535	2153430	2430946	1995	12.0	BORDER	260.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.2	78.2	78.2	78.2	78.2	78.2

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
128872	2172365	2392345	1996	66.0	BORDER	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	3.0	3.0
128937	2150230	2388230	1996	21.3	BORDER	217.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.3	65.3	65.3	65.3	65.3
128982	2153282	2396839	1995	25.0	BORDER	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	4.2	4.2	4.2	4.2	4.2
128987	2154331	2397499	1995	24.4	BORDER	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	4.2	4.2	4.2	4.2	4.2
128988	2154390	2398102	1995	24.4	BORDER	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	4.2	4.2	4.2	4.2	4.2
129878	2153945	2388697	1997	12.5	BORDER	121.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.3	36.3	36.3	36.3
130140	2172416	2392558	1997	61.0	BORDER	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	3.0
131224	2147583	2436668	1996	16.0	BORDER	55.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.5	16.5	16.5	16.5	16.5
131461	2150519	2415396	1997	18.0	BORDER	2148.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	644.4	644.4	644.4	644.4
134150	2148915	2434649	1997	18.3	BORDER	364.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	109.2	109.2	109.2	109.2
134151	2148755	2435279	1997	24.4	BORDER	364.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	109.2	109.2	109.2	109.2
134162	2145523	2424045	1997	16.8	BORDER	120.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.0	36.0	36.0	36.0
134170	2146539	2436238	1996	22.0	BORDER	960.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	288.0	288.0	288.0	288.0	288.0
135637	2151237	2430714	1998	24.0	BORDER	216.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.9	64.9	64.9
135774	2149410	2418923	1998	26.0	BORDER	112.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.6	33.6	33.6
136543	2151612	2430850	1998	20.0	BORDER	216.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.9	64.9	64.9
137780	2157837	2413291	1999	27.0	BORDER	656.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	196.8	196.8
139199	2149367	2435028	1999	21.0	BORDER	273.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.9	81.9
139200	2148439	2434734	1999	19.8	BORDER	273.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.9	81.9
139201	2145787	2434955	1999	24.4	BORDER	273.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.9	81.9
139664	2149089	2428451	1999	16.0	BORDER	56.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	16.8
140434	2152064	2414610	1999	30.0	BORDER	2148.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	644.4	644.4
140447	2152602	2431112	2000	18.0	BORDER	260.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.2
140448	2151843	2431541	1999	18.0	BORDER	260.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.2	78.2
141426	2147704	2424363	2002	33.0	BORDER	303.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
141427	2148528	2423116	2001	18.0	BORDER	303.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
143510	2152995	2428185	2000	25.3	BORDER	273.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.9
143548	2150753	2389013	2001	17.5	BORDER	145.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
143549	2151113	2387717	2001	20.0	BORDER	145.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
143550	2149837	2388053	2001	21.0	BORDER	145.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
144127	2153440	2417371	2001	53.0	BORDER	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
144128	2147712	2422156	2001	18.0	BORDER	303.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
144129	2147713	2423202	2001	18.0	BORDER	303.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
144685	2148194	2425220	2001	23.0	BORDER	303.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
144960	2145486	2423434	2001	27.0	BORDER	180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
145276	2160080	2427081	2004	30.0	BORDER	120.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
145732	2149205	2429639	2000	17.8	BORDER	56.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8
145733	2149017	2427834	2001	12.0	BORDER	56.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
126187	2224361	2384314	1990	30.0	CONDAH	60.7	0.0	0.0	0.0	0.0	0.0	42.9	42.9	42.9	42.9	42.9	42.9	42.9	42.9	42.9	42.9	42.9
136721	2260065	2359118	1991	61.0	CONDAH	195.6	0.0	0.0	0.0	0.0	0.0	0.0	167.1	167.1	167.1	167.1	167.1	167.1	167.1	167.1	167.1	167.1
61688	2202443	2374502	1992	144.0	CONDAH	38.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
122130	2304211	2328246	1995	114.0	CONDAH	34.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	14.0	14.0	14.0	14.0	14.0
124687	2304904	2334303	1995	112.0	CONDAH	94.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86220	2305083	2338414	1995	122.0	CONDAH	448.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	141.8	141.8	141.8	141.8	141.8	141.8
124665	2305111	2332960	1995	160.0	CONDAH	62.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
133611	2306188	2336350	1996	148.0	CONDAH	120.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.7	30.7	30.7	30.7	30.7
125485	2306569	2348550	1996	100.0	CONDAH	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9	1.9	1.9	1.9
116135	2307290	2336097	1997	112.0	CONDAH	240.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.8	55.8	55.8	55.8
85953	2307204	2326009	1997	117.0	CONDAH	240.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9	21.9	21.9	21.9
85952	2307271	2327232	1997	94.0	CONDAH	61.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
122885	2307448	2328875	1997	120.0	CONDAH	244.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
124658	2307775	2333885	1997	65.0	CONDAH	180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.9	36.9	36.9	36.9
135616	2307883	2336763	1997	116.0	CONDAH	393.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	195.1	195.1	195.1	195.1
86291	2307980	2340285	1997	118.0	CONDAH	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
123914	2308070	2341056	1997	188.0	CONDAH	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86215	2312891	2341338	1998	80.0	CONDAH	243.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52206	2312959	2339303	1998	100.0	CONDAH	92.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0
124688	2313235	2343419	1998	96.0	CONDAH	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	6.4	6.4
62151	2313676	2343878	1998	112.0	CONDAH	61.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	30.1	30.1
52201	2314044	2341735	1998	84.0	CONDAH	146.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.4	47.4	47.4
52202	2318177	2339866	2000	118.0	CONDAH	2187.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1582.8
124586	2322460	2367947	2000	105.0	CONDAH	171.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	162.6
72760	2263777	2348529	2001	88.0	CONDAH	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72684	2264167	2347073	2001	118.5	CONDAH	291.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72670	2264477	2352225	2001	192.0	CONDAH	125.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72730	2264393	2346922	2001	128.0	CONDAH	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77815	2278062	2357359	2002	180.0	CONDAH	552.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99864	2278040	2344202	2002	12.2	CONDAH	62.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99556	2278084	2342877	2002	112.0	CONDAH	180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99726	2278212	2345345	2002	142.0	CONDAH	240.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
99709	2278456	2345261	2002	35.1	CONDAH	48.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107238	2278578	2349638	2002	226.0	CONDAH	130.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130398	2219364	2392297	1988	17.0	GLENELG	216.0	0.0	0.0	0.0	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
125168	2219459	2394219	1988	20.4	GLENELG	120.0	0.0	0.0	0.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
102469	2225167	2390717	1990	7.6	GLENELG	96.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51393	2228602	2393068	1990	19.5	GLENELG	336.0	0.0	0.0	0.0	0.0	0.0	277.8	277.8	277.8	277.8	277.8	277.8	277.8	277.8	277.8	277.8	277.8
128871	2230116	2389089	1990	7.9	GLENELG	342.0	0.0	0.0	0.0	0.0	0.0	179.9	179.9	179.9	179.9	179.9	179.9	179.9	179.9	179.9	179.9	179.9
111492	2202917	2350926	1992	20.0	GLENELG	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
67063	2203282	2365122	1992	28.9	GLENELG	685.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	672.9	672.9	672.9	672.9	672.9	672.9	672.9	672.9	672.9
140027	2203586	2351220	1992	13.0	GLENELG	480.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
131807	2203991	2365106	1992	12.0	GLENELG	1564.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1249.3	1249.3	1249.3	1249.3	1249.3	1249.3	1249.3	1249.3	1249.3
124437	2314142	2342336	1998	16.8	GLENELG	435.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1054.4	1054.4	1054.4
51528	2369932	2445173	2000	28.0	GLENELG	240.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.6
106626	2249486	2344857	2000	7.0	GLENELG	200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	224.8
48730	2250301	2343004	2000	16.5	GLENELG	765.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	414.0
115173	2251306	2344678	2000	19.8	GLENELG	1158.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	659.1
121916	2264578	2352821	2001	24.0	GLENELG	210.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72686	2264615	2348885	2001	15.2	GLENELG	210.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72666	2264796	2350957	2001	9.0	GLENELG	588.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72677	2264786	2349797	2001	24.1	GLENELG	360.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124608	2265164	2351044	2001	10.0	GLENELG	216.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102075	2265564	2356106	2001	17.0	GLENELG	600.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72746	2265462	2347806	2001	15.0	GLENELG	168.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72675	2265662	2349485	2001	18.7	GLENELG	1516.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107045	2265855	2346794	2001	23.0	GLENELG	420.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102063	2266066	2354039	2001	13.0	GLENELG	244.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107189	2265967	2348031	2001	12.0	GLENELG	1755.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72751	2266147	2351706	2001	18.0	GLENELG	540.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72838	2266197	2349653	2001	20.0	GLENELG	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72671	2266295	2351247	2001	24.0	GLENELG	240.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72762	2266545	2350783	2001	24.0	GLENELG	662.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
122957	2266740	2354956	2001	44.0	GLENELG	380.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99732	2278563	2343934	2002	16.5	GLENELG	720.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124827	2279028	2348059	2002	20.0	GLENELG	525.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102468	2230044	2385480	1990	18.2	GLENORM	108.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
120941	2203881	2351813	1992	45.0	GLENORM	632.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	135.5	135.5	135.5	135.5	135.5	135.5	135.5	135.5	135.5
78653	2297859	2342460	1993	17.0	GLENORM	638.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	418.6	418.6	418.6	418.6	418.6	418.6	418.6	418.6
138026	2307965	2331080	1997	15.0	GLENORM	304.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	206.9	206.9	206.9	206.9
86314	2308369	2334045	1997	35.0	GLENORM	183.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124431	2314467	2342230	1998	15.8	GLENORM	250.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48586	2254462	2342571	2000	19.0	GLENORM	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54119	2231148	2390633	1990	7.6	HAWKES	196.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
122690	2235686	2381814	1990	144.0	HAWKES	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
140500	2210184	2443062	1990	35.0	HAWKES	330.4	0.0	0.0	0.0	0.0	0.0	253.8	253.8	253.8	253.8	253.8	253.8	253.8	253.8	253.8	253.8	253.8
96179	2209954	2444716	1990	34.0	HAWKES	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72862	2259986	2351307	1991	47.2	HAWKES	244.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102079	2260758	2361670	1991	31.7	HAWKES	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
114855	2204416	2365484	1992	33.0	HAWKES	37.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
139487	2204623	2361998	1992	31.1	HAWKES	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
116466	2298172	2352948	1993	43.9	HAWKES	451.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	395.4	395.4	395.4	395.4	395.4	395.4	395.4	395.4
92967	2298341	2345584	1993	32.0	HAWKES	678.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	326.3	326.3	326.3	326.3	326.3	326.3	326.3	326.3
92985	2298434	2346436	1993	32.3	HAWKES	186.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	137.6	137.6	137.6	137.6	137.6	137.6	137.6	137.6
114039	2301348	2334812	1994	13.7	HAWKES	294.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85956	2301626	2332761	1994	7.6	HAWKES	654.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124614	2308862	2349239	1997	10.7	HAWKES	854.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	665.6	665.6	665.6	665.6
141456	2315915	2342091	1998	5.4	HAWKES	142.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52242	2316673	2343085	1998	54.9	HAWKES	496.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	348.1	348.1	348.1
72754	2266288	2350281	1998	37.8	HAWKES	75.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7
107063	2266875	2347302	2001	22.9	HAWKES	222.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72707	2267021	2353415	2001	5.4	HAWKES	155.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107386	2267212	2348312	2001	26.2	HAWKES	31.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107053	2267246	2346529	2001	30.0	HAWKES	485.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
125475	2267374	2349696	2001	36.5	HAWKES	408.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72743	2267662	2351916	2001	18.3	HAWKES	608.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102072	2267762	2354505	2001	68.6	HAWKES	360.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99549	2278929	2343681	2002	8.5	HAWKES	73.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111577	2279080	2342824	2002	53.3	HAWKES	935.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77749	2280051	2352644	2002	9.1	HAWKES	352.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
144618	2208662	2435285	1990	12.2	HEYWOOD	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
122920	2208554	2436018	1990	132.0	HEYWOOD	79.9	0.0	0.0	0.0	0.0	0.0	86.9	86.9	86.9	86.9	86.9	86.9	86.9	86.9	86.9	86.9	86.9

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
88405	2204863	2342642	1992	54.0	HEYWOOD	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
144517	2301719	2336720	1994	57.0	HEYWOOD	72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.1	36.1	36.1	36.1	36.1	36.1	36.1
86203	2301841	2335146	1994	24.4	HEYWOOD	31.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.7	10.7	10.7	10.7	10.7	10.7	10.7
124747	2302240	2344411	1994	18.3	HEYWOOD	183.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
86228	2309011	2341161	1997	15.2	HEYWOOD	69.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	5.7	5.7	5.7
77839	2206627	2480889	1998	9.8	HEYWOOD	114.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	8.2	8.2
48588	2256374	2343264	2000	24.4	HEYWOOD	200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.2
48590	2257847	2344832	2000	54.9	HEYWOOD	38.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.4
48577	2258204	2344515	2000	7.6	HEYWOOD	235.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7
140342	2258378	2344605	2000	18.3	HEYWOOD	102.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.2
48826	2259020	2345526	2000	7.6	HEYWOOD	33.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2
48584	2259276	2345304	2000	38.1	HEYWOOD	1431.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1298.9
72667	2267735	2350903	2001	32.0	HEYWOOD	170.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107367	2267663	2347386	2001	12.0	HEYWOOD	122.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72721	2267814	2352852	2001	66.4	HEYWOOD	102.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72761	2267762	2350469	2001	50.9	HEYWOOD	57.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72917	2268055	2352989	2001	36.0	HEYWOOD	261.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107187	2267992	2348331	2001	24.4	HEYWOOD	161.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107098	2268047	2347561	2001	15.2	HEYWOOD	246.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99952	2280412	2347328	2002	70.0	HEYWOOD	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103493	2385466	2443906	1987	60.9	NULLAW	98.1	0.0	0.0	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9
77283	2330146	2361418	1987	89.0	NULLAW	172.3	0.0	0.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
131499	2198698	2391072	1987	82.8	NULLAW	247.2	0.0	0.0	225.3	225.3	225.3	225.3	225.3	225.3	225.3	225.3	225.3	225.3	225.3	225.3	225.3	225.3
66240	2219531	2389992	1988	30.0	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
132275	2220011	2387563	1988	81.0	NULLAW	528.0	0.0	0.0	0.0	1044.1	1044.1	1044.1	1044.1	1044.1	1044.1	1044.1	1044.1	1044.1	1044.1	1044.1	1044.1	1044.1
102465	2221201	2390382	1989	21.3	NULLAW	68.0	0.0	0.0	0.0	0.0	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1
128923	2221635	2392584	1989	15.0	NULLAW	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
115735	2222166	2391135	1989	9.1	NULLAW	104.0	0.0	0.0	0.0	0.0	103.6	103.6	103.6	103.6	103.6	103.6	103.6	103.6	103.6	103.6	103.6	103.6
102467	2222649	2387991	1989	88.4	NULLAW	145.2	0.0	0.0	0.0	0.0	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4
68472	2208077	2419369	1990	22.8	NULLAW	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
143543	2208331	2432309	1990	13.7	NULLAW	52.0	0.0	0.0	0.0	0.0	0.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0
68483	2207615	2419337	1990	44.2	NULLAW	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46281	2206272	2406599	1990	0.0	NULLAW	334.5	0.0	0.0	0.0	0.0	0.0	405.0	405.0	405.0	405.0	405.0	405.0	405.0	405.0	405.0	405.0	405.0
128793	2206358	2422291	1990	15.0	NULLAW	220.0	0.0	0.0	0.0	0.0	0.0	243.1	243.1	243.1	243.1	243.1	243.1	243.1	243.1	243.1	243.1	243.1
130320	2206436	2429987	1990	9.1	NULLAW	397.2	0.0	0.0	0.0	0.0	0.0	377.1	377.1	377.1	377.1	377.1	377.1	377.1	377.1	377.1	377.1	377.1

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
68491	2206031	2417030	1990	30.4	NULLAW	193.2	0.0	0.0	0.0	0.0	0.0	311.0	311.0	311.0	311.0	311.0	311.0	311.0	311.0	311.0	311.0	311.0
143752	2206245	2428440	1990	25.9	NULLAW	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
83468	2206019	2429257	1990	18.3	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
140454	2205616	2430121	1990	13.7	NULLAW	167.0	0.0	0.0	0.0	0.0	0.0	212.0	212.0	212.0	212.0	212.0	212.0	212.0	212.0	212.0	212.0	212.0
134149	2204783	2434222	1990	9.1	NULLAW	92.0	0.0	0.0	0.0	0.0	0.0	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6
131806	2204245	2414405	1990	20.0	NULLAW	198.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
134148	2204480	2427647	1990	45.0	NULLAW	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
68568	2204196	2421663	1990	33.0	NULLAW	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46221	2203856	2406373	1990	30.5	NULLAW	246.0	0.0	0.0	0.0	0.0	0.0	362.5	362.5	362.5	362.5	362.5	362.5	362.5	362.5	362.5	362.5	362.5
115890	2203033	2420895	1990	21.5	NULLAW	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96177	2203122	2435486	1990	30.4	NULLAW	31.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
120442	2202607	2430651	1990	13.0	NULLAW	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
143727	2202247	2426694	1990	6.0	NULLAW	105.0	0.0	0.0	0.0	0.0	0.0	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
46290	2201875	2412259	1990	30.0	NULLAW	76.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46423	2201224	2407533	1990	10.0	NULLAW	80.0	0.0	0.0	0.0	0.0	0.0	131.4	131.4	131.4	131.4	131.4	131.4	131.4	131.4	131.4	131.4	131.4
122887	2201325	2429988	1990	35.0	NULLAW	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128936	2200184	2387237	1990	73.2	NULLAW	105.5	0.0	0.0	0.0	0.0	0.0	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
138033	2199002	2396624	1990	24.3	NULLAW	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
143551	2198952	2397442	1990	9.1	NULLAW	139.6	0.0	0.0	0.0	0.0	0.0	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
140893	2199014	2416244	1990	92.0	NULLAW	319.1	0.0	0.0	0.0	0.0	0.0	143.2	143.2	143.2	143.2	143.2	143.2	143.2	143.2	143.2	143.2	143.2
143678	2194729	2396583	1990	10.6	NULLAW	130.0	0.0	0.0	0.0	0.0	0.0	124.8	124.8	124.8	124.8	124.8	124.8	124.8	124.8	124.8	124.8	124.8
103114	2191969	2413843	1990	20.3	NULLAW	96.0	0.0	0.0	0.0	0.0	0.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0
65458	2317671	2370598	1990	44.0	NULLAW	98.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
116470	2319017	2365108	1990	10.0	NULLAW	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
133359	2319307	2364650	1990	10.7	NULLAW	75.0	0.0	0.0	0.0	0.0	0.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0
65485	2320098	2365114	1990	15.0	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130115	2320102	2362644	1990	60.0	NULLAW	450.0	0.0	0.0	0.0	0.0	0.0	481.4	481.4	481.4	481.4	481.4	481.4	481.4	481.4	481.4	481.4	481.4
111193	2321294	2365946	1990	11.0	NULLAW	130.0	0.0	0.0	0.0	0.0	0.0	130.6	130.6	130.6	130.6	130.6	130.6	130.6	130.6	130.6	130.6	130.6
65451	2321580	2368127	1990	18.3	NULLAW	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103333	2261729	2363794	1991	18.0	NULLAW	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72692	2262044	2354062	1991	0.0	NULLAW	68.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103232	2262983	2370115	1991	21.3	NULLAW	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72718	2264071	2352300	1991	10.0	NULLAW	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
143786	2275001	2358176	1991	8.0	NULLAW	302.2	0.0	0.0	0.0	0.0	0.0	0.0	89.8	89.8	89.8	89.8	89.8	89.8	89.8	89.8	89.8	89.8
134686	2196979	2372310	1991	83.8	NULLAW	54.0	0.0	0.0	0.0	0.0	0.0	0.0	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
116292	2196594	2349843	1991	23.2	NULLAW	304.2	0.0	0.0	0.0	0.0	0.0	0.0	220.4	220.4	220.4	220.4	220.4	220.4	220.4	220.4	220.4	220.4
88459	2205424	2340754	1992	20.0	NULLAW	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50452	2206899	2355750	1992	23.0	NULLAW	12.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
84397	2207440	2366423	1992	20.0	NULLAW	82.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
121462	2210548	2370820	1992	30.0	NULLAW	25.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
143174	2210323	2354934	1992	36.6	NULLAW	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130513	2210614	2365485	1992	40.0	NULLAW	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
84390	2215329	2356788	1992	10.0	NULLAW	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130500	2224180	2357227	1992	45.7	NULLAW	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99777	2285134	2342945	1992	9.0	NULLAW	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78633	2287461	2341008	1992	12.0	NULLAW	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78632	2287584	2340547	1992	44.8	NULLAW	12.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124777	2287831	2344218	1992	10.0	NULLAW	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99870	2288524	2343246	1992	36.0	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130752	2288568	2339786	1992	12.2	NULLAW	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78640	2288682	2340598	1992	42.1	NULLAW	121.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8
78651	2288853	2341859	1992	33.0	NULLAW	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124502	2289350	2343362	1992	9.0	NULLAW	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99553	2289701	2345699	1992	10.6	NULLAW	8.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78619	2289711	2342517	1992	10.0	NULLAW	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
99530	2290026	2347038	1992	13.0	NULLAW	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
137618	2289944	2339292	1992	30.0	NULLAW	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
93001	2290580	2346443	1992	42.7	NULLAW	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78579	2291293	2342637	1992	48.6	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
93070	2291446	2345328	1992	76.8	NULLAW	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78637	2291395	2340946	1992	12.2	NULLAW	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130109	2291696	2343276	1992	40.0	NULLAW	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78784	2291638	2338299	1992	10.0	NULLAW	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92949	2292073	2347890	1992	9.1	NULLAW	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78645	2292228	2339762	1992	36.6	NULLAW	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92951	2292502	2346191	1992	13.0	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78623	2292498	2342583	1992	15.2	NULLAW	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92948	2292740	2349414	1992	21.3	NULLAW	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78610	2292638	2341061	1992	43.0	NULLAW	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92954	2293337	2343017	1992	28.0	NULLAW	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
93024	2293430	2346691	1992	10.0	NULLAW	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
129942	2293399	2338548	1992	35.0	NULLAW	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
92958	2293618	2344850	1992	60.0	NULLAW	362.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	265.2	265.2	265.2	265.2	265.2	265.2	265.2	265.2	265.2
92950	2293751	2349055	1992	15.0	NULLAW	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
131511	2293636	2336996	1992	18.0	NULLAW	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124639	2297303	2332237	1992	20.0	NULLAW	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92943	2297904	2344557	1992	15.0	NULLAW	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
129840	2298482	2341448	1993	20.0	NULLAW	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92969	2299029	2347703	1993	62.0	NULLAW	95.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78612	2299257	2334047	1993	71.0	NULLAW	131.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.4	60.4	60.4	60.4	60.4	60.4	60.4	60.4
92983	2299679	2343722	1993	10.0	NULLAW	541.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	229.5	229.5	229.5	229.5	229.5	229.5	229.5	229.5
92979	2299727	2342800	1993	12.0	NULLAW	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64057	2300012	2354418	1993	39.6	NULLAW	721.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	741.3	741.3	741.3	741.3	741.3	741.3	741.3	741.3
124632	2299783	2333474	1993	47.0	NULLAW	173.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124633	2300163	2334431	1993	15.0	NULLAW	198.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	160.9	160.9	160.9	160.9	160.9	160.9	160.9	160.9
85974	2302158	2334319	1994	18.2	NULLAW	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64055	2302586	2352184	1994	24.0	NULLAW	227.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	117.4	117.4	117.4	117.4	117.4	117.4	117.4
85967	2302184	2332853	1994	19.5	NULLAW	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64053	2302905	2351513	1994	41.5	NULLAW	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73719	2302826	2345437	1994	28.0	NULLAW	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73799	2302821	2344887	1994	40.0	NULLAW	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124686	2303011	2342292	1994	120.0	NULLAW	453.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	559.7	559.7	559.7	559.7	559.7	559.7	559.7
86206	2303033	2336396	1994	28.5	NULLAW	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85960	2302874	2328831	1994	14.0	NULLAW	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124664	2305320	2331367	1995	33.5	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124619	2305687	2347161	1995	36.0	NULLAW	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124695	2305781	2338856	1995	16.3	NULLAW	191.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124696	2306522	2334162	1996	60.9	NULLAW	568.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	559.2	559.2	559.2	559.2	559.2
123088	2306546	2331029	1996	93.0	NULLAW	92.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.5	41.5	41.5	41.5	41.5
124622	2307103	2350125	1996	16.0	NULLAW	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86301	2309048	2339092	1997	45.7	NULLAW	48.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.2	36.2	36.2	36.2
73728	2309284	2345355	1997	35.0	NULLAW	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124697	2309120	2335915	1997	15.3	NULLAW	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73781	2309497	2345622	1997	28.0	NULLAW	12.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	27.0	27.0	27.0
73768	2309608	2348035	1997	30.4	NULLAW	103.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.0	71.0	71.0	71.0

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
124612	2309697	2347035	1997	140.0	NULLAW	180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
131517	2309638	2338089	1997	0.0	NULLAW	48.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
76920	2198131	2465519	1998	15.5	NULLAW	322.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.7	61.7	61.7
54527	2270553	2389217	1998	30.0	NULLAW	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
104700	2274406	2365633	1998	48.8	NULLAW	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128886	2282131	2353968	1998	64.0	NULLAW	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99548	2287269	2348502	1998	16.8	NULLAW	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88904	2287856	2353185	1998	61.0	NULLAW	44.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
81890	2306996	2378613	1998	85.5	NULLAW	278.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	194.6	194.6	194.6
127906	2306936	2350989	1999	54.3	NULLAW	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.8	23.8
62112	2313706	2345719	1999	16.3	NULLAW	191.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
115576	2260204	2346168	2000	6.0	NULLAW	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124476	2260382	2347887	2000	22.9	NULLAW	8.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72804	2260535	2346706	2000	13.7	NULLAW	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128568	2260945	2346880	2000	100.0	NULLAW	430.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	277.7
72736	2261155	2349857	2000	21.3	NULLAW	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102066	2268272	2354009	2001	24.3	NULLAW	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72747	2268370	2353052	2001	78.0	NULLAW	223.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107104	2268320	2348949	2001	27.4	NULLAW	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107090	2268392	2347967	2001	70.0	NULLAW	139.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128564	2268629	2357869	2001	10.0	NULLAW	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107082	2268446	2348024	2001	42.6	NULLAW	8.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72665	2269346	2352935	2001	74.5	NULLAW	455.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107274	2269556	2347527	2001	19.8	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107241	2269726	2352855	2001	71.5	NULLAW	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107008	2269885	2353045	2001	24.0	NULLAW	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107396	2269867	2348741	2001	36.0	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107330	2270056	2348742	2001	10.0	NULLAW	469.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107288	2270296	2352163	2001	40.0	NULLAW	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107242	2270366	2352326	2001	24.0	NULLAW	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107858	2270789	2355338	2001	12.1	NULLAW	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107395	2270732	2352192	2001	21.3	NULLAW	78.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107787	2270865	2354435	2001	15.0	NULLAW	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107050	2270784	2348415	2001	12.0	NULLAW	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107324	2270882	2348904	2001	22.8	NULLAW	177.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
107070	2271313	2352529	2001	33.0	NULLAW	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124825	2271513	2350312	2001	123.0	NULLAW	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107206	2271920	2347694	2001	9.1	NULLAW	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107069	2272115	2351763	2001	90.0	NULLAW	408.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107790	2272213	2353581	2001	16.3	NULLAW	227.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107057	2272107	2348266	2001	57.9	NULLAW	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124780	2280737	2348832	2002	12.0	NULLAW	262.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77684	2280930	2353476	2002	18.0	NULLAW	303.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99677	2280897	2344026	2002	10.0	NULLAW	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130009	2199986	2390449	1987	30.4	UC	71.2	0.0	0.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
83028	2207678	2387830	1987	51.8	UC	107.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
135859	2220725	2390048	1988	30.4	UC	49.0	0.0	0.0	0.0	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
49741	2224982	2364188	1990	30.5	UC	96.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51987	2233920	2368643	1990	33.0	UC	109.0	0.0	0.0	0.0	0.0	0.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
124468	2237956	2375242	1990	87.0	UC	105.0	0.0	0.0	0.0	0.0	0.0	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
78631	2293970	2342710	1992	28.0	UC	62.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78627	2293995	2337520	1992	33.0	UC	152.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
120502	2294266	2346284	1992	36.0	UC	56.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
137613	2294311	2338997	1992	57.0	UC	74.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
128989	2302949	2330135	1994	29.0	UC	120.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1
120443	2303660	2353262	1994	15.2	UC	96.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8	10.8	10.8	10.8	10.8	10.8	10.8
47151	2288983	2370117	1998	24.0	UC	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0
72737	2261713	2350099	2000	30.0	UC	61.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72703	2262028	2347647	2000	43.6	UC	27.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107204	2272432	2351056	2001	33.5	UC	732.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107076	2272519	2348565	2001	67.1	UC	130.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107223	2272743	2351324	2001	35.6	UC	107.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
119846	2208444	2386413	1987	24.3	YANGERY	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
144138	2216264	2384017	1987	32.0	YANGERY	56.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128922	2216985	2387922	1987	26.5	YANGERY	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
141387	2217347	2394415	1987	38.4	YANGERY	99.0	0.0	0.0	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6
130112	2218235	2388421	1987	41.1	YANGERY	72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
134592	2218794	2390737	1987	55.0	YANGERY	95.0	0.0	0.0	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
127104	2218757	2388676	1987	46.9	YANGERY	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
137633	2218914	2387820	1987	36.5	YANGERY	25.0	0.0	0.0	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
66267	2219215	2387504	1987	36.5	YANGERY	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
132248	2220704	2386353	1988	32.3	YANGERY	524.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
135870	2221083	2393289	1988	41.1	YANGERY	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128521	2221141	2393775	1988	4.8	YANGERY	96.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
125388	2222917	2384916	1989	62.2	YANGERY	9.0	0.0	0.0	0.0	0.0	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
135954	2223099	2392338	1989	42.7	YANGERY	132.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
146709	2223152	2389114	1989	12.2	YANGERY	38.0	0.0	0.0	0.0	0.0	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
55946	2240482	2351048	1990	9.1	YANGERY	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52192	2241283	2366192	1990	18.2	YANGERY	67.0	0.0	0.0	0.0	0.0	0.0	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1
106589	2242671	2349685	1990	28.9	YANGERY	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130778	2243224	2352797	1990	24.3	YANGERY	107.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
106610	2244201	2349063	1990	26.2	YANGERY	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
106588	2244241	2347836	1990	25.9	YANGERY	48.0	0.0	0.0	0.0	0.0	0.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
106584	2244549	2349682	1990	10.0	YANGERY	12.0	0.0	0.0	0.0	0.0	0.0	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
135051	2248411	2361718	1990	17.0	YANGERY	70.0	0.0	0.0	0.0	0.0	0.0	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6
48809	2253122	2345777	1990	3.1	YANGERY	45.0	0.0	0.0	0.0	0.0	0.0	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
131773	2254459	2344702	1990	12.2	YANGERY	30.0	0.0	0.0	0.0	0.0	0.0	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5
48753	2255792	2343800	1990	29.3	YANGERY	204.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48780	2256164	2350542	1990	54.8	YANGERY	124.0	0.0	0.0	0.0	0.0	0.0	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6
72719	2257971	2351974	1990	53.3	YANGERY	180.0	0.0	0.0	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
72702	2257972	2350505	1990	18.3	YANGERY	65.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72733	2258315	2350813	1990	42.6	YANGERY	78.0	0.0	0.0	0.0	0.0	0.0	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8
130126	2259725	2354388	1990	43.0	YANGERY	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
134139	2199400	2363560	1991	18.3	YANGERY	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
67047	2201527	2367860	1991	41.7	YANGERY	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
131348	2202186	2367533	1991	26.0	YANGERY	73.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78617	2294357	2336323	1992	25.6	YANGERY	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92982	2294830	2344657	1992	23.0	YANGERY	10.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111868	2295052	2345822	1992	33.0	YANGERY	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78833	2295074	2339200	1992	25.0	YANGERY	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124636	2295213	2342510	1992	21.3	YANGERY	13.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92971	2295967	2344705	1992	61.0	YANGERY	245.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
131801	2295724	2333400	1992	65.0	YANGERY	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78719	2295949	2342564	1992	20.1	YANGERY	176.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	155.0	155.0	155.0	155.0	155.0	155.0	155.0	155.0	155.0
92981	2295995	2344552	1992	48.7	YANGERY	126.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	134.7	134.7	134.7	134.7	134.7	134.7	134.7	134.7	134.7

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
78605	2295960	2339912	1992	15.0	YANGERY	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
92953	2296109	2346319	1992	18.0	YANGERY	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
140746	2296369	2348753	1992	30.0	YANGERY	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92980	2296360	2348039	1992	30.0	YANGERY	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78657	2296228	2339605	1992	31.0	YANGERY	309.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
78599	2296635	2341983	1992	10.0	YANGERY	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
121978	2296922	2344235	1992	25.0	YANGERY	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
131856	2296714	2335015	1992	45.0	YANGERY	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
78649	2297066	2337688	1992	10.0	YANGERY	12.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
64058	2300687	2350562	1993	40.2	YANGERY	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124685	2300597	2335511	1993	45.7	YANGERY	180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.6	72.6	72.6	72.6	72.6	72.6	72.6	72.6
78655	2300882	2342039	1993	48.4	YANGERY	251.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	150.8	150.8	150.8	150.8	150.8	150.8	150.8	150.8
124849	2300998	2345360	1993	15.8	YANGERY	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86311	2300900	2338082	1993	6.0	YANGERY	177.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
87598	2301123	2347377	1993	54.8	YANGERY	492.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86208	2301071	2337350	1993	37.0	YANGERY	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
85965	2301159	2332182	1993	75.0	YANGERY	750.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124692	2303368	2335819	1994	27.4	YANGERY	483.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	148.9	148.9	148.9	148.9	148.9	148.9	148.9
86230	2303553	2337153	1994	22.0	YANGERY	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
132551	2303747	2334894	1994	36.5	YANGERY	125.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.1	72.1	72.1	72.1	72.1	72.1	72.1
73720	2304242	2350063	1994	27.4	YANGERY	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.5	15.5	15.5	15.5	15.5	15.5	15.5
86202	2304107	2342485	1994	27.4	YANGERY	329.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	291.7	291.7	291.7	291.7	291.7	291.7	291.7
124690	2303987	2337027	1994	7.0	YANGERY	97.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	127.1	127.1	127.1	127.1	127.1	127.1	127.1
122077	2304218	2344516	1994	15.0	YANGERY	439.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8
86198	2304038	2335570	1994	18.0	YANGERY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85948	2304044	2334072	1994	24.4	YANGERY	124.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
129841	2304136	2337985	1994	36.5	YANGERY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86316	2304190	2336603	1994	24.3	YANGERY	239.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0
120505	2304322	2340435	1994	25.0	YANGERY	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5
124615	2304592	2350538	1994	33.0	YANGERY	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124656	2304175	2329556	1994	36.0	YANGERY	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73773	2306138	2344577	1995	17.0	YANGERY	17.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	2.3	2.3	2.3	2.3	2.3
86217	2305996	2337938	1995	60.1	YANGERY	150.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.7	94.7	94.7	94.7	94.7	94.7
64050	2306346	2350954	1995	66.0	YANGERY	216.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	110.1	110.1	110.1	110.1	110.1	110.1
124616	2306322	2349871	1995	30.5	YANGERY	9.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
131347	2305951	2331124	1995	10.5	YANGERY	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73801	2306363	2346329	1995	30.0	YANGERY	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86284	2306793	2336340	1996	39.0	YANGERY	72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	37.1	37.1	37.1	37.1
124663	2306894	2333897	1996	18.2	YANGERY	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124662	2306914	2333898	1996	48.7	YANGERY	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86205	2307035	2335285	1996	50.9	YANGERY	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86307	2307149	2340185	1996	42.7	YANGERY	38.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
116135	2307290	2336097	1996	13.4	YANGERY	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
116170	2310589	2340673	1997	45.0	YANGERY	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124441	2311323	2339893	1997	40.2	YANGERY	101.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.7	31.7	31.7	31.7
135771	2311470	2340440	1997	38.1	YANGERY	120.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124618	2311929	2344935	1997	57.9	YANGERY	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
134603	2290502	2355104	1998	33.5	YANGERY	218.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	74.2	74.2	74.2
81860	2306890	2379347	1998	45.7	YANGERY	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
121470	2315487	2345076	1999	21.3	YANGERY	127.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.4	48.4
137673	2315972	2349887	1999	88.4	YANGERY	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.2
94976	2316547	2359657	1999	20.4	YANGERY	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72731	2262546	2346785	2000	38.1	YANGERY	12.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72694	2262808	2350220	2000	38.4	YANGERY	58.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.3
72906	2262853	2350045	2000	61.0	YANGERY	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	96.8
72722	2262907	2346671	2000	35.0	YANGERY	264.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.5
72712	2263099	2350013	2000	48.7	YANGERY	34.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128981	2263225	2346573	2000	61.0	YANGERY	526.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	195.8
107377	2272852	2349447	2001	67.1	YANGERY	212.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107784	2273128	2354616	2001	12.2	YANGERY	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107344	2273056	2350791	2001	18.3	YANGERY	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107235	2273071	2350516	2001	22.8	YANGERY	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107052	2273043	2348950	2001	24.4	YANGERY	57.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107830	2273281	2353759	2001	38.4	YANGERY	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107054	2273200	2348490	2001	32.0	YANGERY	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107236	2273469	2351370	2001	19.8	YANGERY	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
114709	2273548	2353072	2001	15.8	YANGERY	47.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107059	2273454	2348175	2001	9.1	YANGERY	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107068	2273519	2348711	2001	24.4	YANGERY	76.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107157	2273661	2348073	2001	21.3	YANGERY	127.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Site ID	Easting	Northing	Year	Depth	WSPA GMA	Entitle-ment	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
107182	2273964	2352713	2001	18.3	YANGERY	51.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107089	2274040	2348950	2001	13.7	YANGERY	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107080	2274109	2351840	2001	24.4	YANGERY	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107074	2274034	2347426	2001	8.8	YANGERY	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107058	2274107	2348314	2001	12.1	YANGERY	68.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
116474	2274094	2346577	2001	24.3	YANGERY	137.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107101	2274335	2348772	2001	10.6	YANGERY	37.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107077	2274380	2347973	2001	17.0	YANGERY	102.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107151	2274586	2348521	2001	24.4	YANGERY	122.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128938	2274616	2346329	2001	25.9	YANGERY	25.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107087	2274748	2346724	2001	45.7	YANGERY	194.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107056	2274886	2350657	2001	21.3	YANGERY	114.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107434	2275003	2351121	2001	24.3	YANGERY	37.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
122679	2274935	2346463	2001	39.6	YANGERY	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124826	2275259	2352624	2001	24.3	YANGERY	151.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124828	2275304	2351575	2001	12.8	YANGERY	70.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107083	2275405	2346373	2001	38.1	YANGERY	181.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107215	2275499	2350541	2001	41.2	YANGERY	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124499	2275647	2344441	2001	27.4	YANGERY	97.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107084	2275700	2345554	2001	41.1	YANGERY	234.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107055	2275813	2346932	2001	27.4	YANGERY	106.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99542	2275919	2347250	2001	36.5	YANGERY	120.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99539	2275913	2346429	2001	27.3	YANGERY	295.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124846	2276570	2352410	2001	9.1	YANGERY	151.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99980	2276428	2345054	2001	7.3	YANGERY	56.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107781	2276605	2352531	2001	40.5	YANGERY	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107441	2276715	2348291	2001	9.1	YANGERY	1200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124782	2277029	2347493	2001	103.8	YANGERY	66.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124832	2277212	2353788	2001	52.0	YANGERY	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99801	2277578	2345925	2001	39.6	YANGERY	72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124631	2277822	2353584	2001	53.0	YANGERY	43.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99923	2281503	2343518	2002	24.3	YANGERY	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
133290	2281982	2345912	2002	33.6	YANGERY	38.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99507	2282146	2343806	2002	22.0	YANGERY	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99519	2282624	2344639	2002	27.4	YANGERY	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix C Model Hydrographs

The table below lists all monitoring sites used as part of the calibration process, with location details and assumed elevation data and model layer screened.

Calibration hydrographs for each of the sites can be found following the table. Note that in a few cases no “calculatd” hydrograph is shown. This occurs when the relevant model cell dries out and thus no model hydrograph can be extracted.

Note model hydrographs include both the transient calibration and verification periods.

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
45806	2274099	2427769	69	260	191.58	3
45807	2273368	2423734	87	290	203.74	1
45808	2273368	2423734	101	290	188.91	3
45815	2274330	2429411	77	247	170.37	5
45816	2274327	2429411	40	247	207.41	1
46217	2145263	2406119	1501	66	-1434.54	5
46489	2393055	2449908	150	437	287.00	5
46853	2341607	2420719	85	253	167.90	4
46854	2341407	2420760	36	253	216.90	3
47356	2331471	2445206	62	322	260.38	4
47357	2331473	2445208	45	322	277.11	4
48560	2256345	2342742	1683	6	-1677.17	5
48567	2250801	2344879	1484	18	-1465.48	5
51213	2263414	2474214	76	212	135.70	5
51214	2264075	2473410	62	211	148.50	5
51215	2264203	2472944	32	215	183.20	5
53514	2283408	2434869	20	263	242.80	5
53515	2285135	2436644	20	249	228.90	5
53517	2296397	2433066	13	252	238.90	5
53518	2275006	2435916	72	249	177.37	5
53519	2275009	2435916	56	249	193.31	3
53974	2390561	2450342	75	415	340.03	5
54274	2154693	2442559	23	82	59.07	3
54474	2331243	2425583	120	252	131.71	5
54475	2331243	2425583	15	252	236.70	1
55475	2185277	2373238	45	121	75.66	1

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
55506	2302280	2396145	85	192	107.10	5
55507	2297449	2397577	16	153	136.88	5
57685	2246107	2412672	110	233	123.05	1
58587	2171628	2392023	19	36	17.22	3
60988	2174179	2383801	110	40	-70.22	4
61879	2335366	2399187	76	203	127.00	5
61881	2335366	2399187	84	203	118.50	5
61922	2168564	2474578	65	166	100.81	5
61923	2168564	2474578	57	166	108.89	5
62084	2313658	2344810	912	105	-807.46	5
62085	2313658	2344810	47	105	57.88	2
62497	2297572	2369453	30	104	73.37	2
62733	2348485	2433219	84	343	259.27	3
62734	2348483	2433219	127	343	216.25	5
62792	2374512	2458187	101	480	379.68	3
62832	2379097	2454990	90	558	468.29	3
64139	2335216	2387420	104	167	62.32	3
65058	2157216	2375432	140	52	-88.27	3
66950	2312332	2449133	31	251	220.10	1
66985	2296652	2386882	152	127	-25.63	5
67006	2195356	2366142	1842	53	-1789.32	5
67872	2266676	2462695	24	256	232.10	5
67873	2266218	2462789	23	259	236.10	5
69022	2240150	2423332	87	227	140.19	5
69023	2240150	2423332	18	227	209.38	3
69120	2151515	2457442	59	119	60.18	3
69186	2261842	2374393	26	103	77.00	2
69455	2249403	2429429	77	261	184.06	5
69456	2249403	2429429	30	261	231.04	1
69835	2261345	2407409	128	214	86.30	5
69836	2267729	2412685	102	263	161.82	2
69961	2171334	2374974	26	33	7.34	2
69962	2174433	2368885	1733	43	-1689.90	5
69963	2174541	2364697	404	133	-270.68	3
70920	2300961	2443478	72	251	179.08	4
70921	2300957	2443478	40	251	211.11	3
72649	2329976	2408266	175	217	42.15	5
72650	2329976	2408266	54	217	163.15	1
72659	2264774	2346363	1499	3	-1495.96	5

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
74021	2292921	2434771	20	242	221.80	5
74022	2290925	2432284	20	248	228.20	5
74023	2290738	2434328	7	245	237.26	5
74030	2291423	2434707	4	240	235.90	5
74031	2291231	2434499	10	245	234.70	5
74032	2291231	2434501	23	245	221.80	5
74033	2291240	2434299	13	245	231.22	5
74034	2291240	2434301	24	245	220.95	5
74035	2287814	2432453	37	251	214.00	5
74036	2296098	2434204	25	248	222.84	5
74037	2291159	2433846	13	243	230.04	5
74038	2291041	2433090	16	246	229.55	5
74039	2290758	2431476	9	250	240.59	5
74041	2290808	2431479	10	246	235.45	5
75635	2317194	2389907	120	161	41.21	5
75743	2255502	2410666	116	206	89.55	5
76914	2156758	2466073	24	124	99.41	5
76977	2147140	2397187	1719	59	-1660.08	5
76986	2150627	2397852	23	60	37.20	3
78528	2310541	2432313	152	268	116.42	4
78529	2310541	2432313	48	268	220.42	1
78550	2293167	2343182	49	29	-20.12	2
78553	2292323	2342186	47	21	-26.58	2
78556	2298031	2337986	1152	38	-1114.56	5
79557	2323050	2432344	117	279	162.14	5
79558	2323050	2432342	69	279	210.14	3
81949	2263839	2428937	101	223	122.25	5
81956	2255604	2420081	78	234	156.15	3
81957	2255604	2420081	42	234	192.15	3
81998	2189425	2357232	1948	75	-1873.06	5
82344	2166140	2402637	1132	58	-1074.40	5
82347	2154989	2402076	1228	65	-1163.40	5
82350	2155090	2393818	201	55	-146.43	3
83446	2153111	2432581	252	68	-184.25	4
83447	2153111	2432581	24	68	43.66	3
83676	2289325	2420405	38	275	237.04	5
83726	2166900	2427927	31	78	46.72	3
83729	2172142	2435934	32	137	105.10	3
85602	2325045	2413611	98	237	138.65	4

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
85937	2303177	2334701	1686	49	-1636.19	5
85942	2302990	2329687	1281	43	-1237.85	4
86197	2304089	2339146	1128	58	-1070.46	5
87527	2146079	2384326	1461	25	-1435.55	5
87529	2145802	2383764	25	21	-3.65	3
87530	2151383	2393911	41	56	14.67	3
87708	2260671	2436512	45	221	175.98	5
87709	2260666	2436511	15	221	205.96	3
87750	2272217	2440782	55	262	206.94	5
87751	2286160	2444014	26	264	237.73	1
87752	2285192	2437653	12	253	241.20	3
87753	2284132	2437824	10	254	243.70	3
87754	2283361	2437940	16	256	239.70	3
87755	2282991	2437991	18	260	242.26	3
87756	2285711	2440772	25	261	235.55	3
87757	2288051	2440501	28	251	222.87	5
87762	2318210	2421379	145	237	92.79	4
87763	2318211	2421378	54	237	183.29	1
87781	2309770	2420971	90	226	135.51	5
88247	2279158	2407563	53	254	201.07	3
88257	2278463	2407433	80	254	174.01	3
88370	2203377	2341089	1384	39	-1345.27	4
88372	2203600	2340488	1595	38	-1557.45	4
89851	2156905	2453064	45	132	86.84	5
93541	2323724	2421161	144	238	93.75	5
93542	2323726	2421161	57	238	180.76	3
93794	2190178	2343442	1729	30	-1698.30	4
94910	2313833	2443262	60	256	196.35	4
94911	2313831	2443261	109	256	147.35	5
95056	2330211	2398017	63	187	124.10	3
95057	2330213	2398017	39	187	147.60	1
95072	2324033	2403259	104	223	119.10	5
95073	2324035	2403259	42	223	181.07	3
95074	2329341	2400832	6	179	172.58	1
95075	2329341	2400834	40	179	138.50	3
95076	2329824	2402504	42	189	147.18	3
95077	2329822	2402504	25	189	164.61	1
95078	2329820	2402504	17	189	172.16	1
95079	2327811	2402769	42	186	143.52	5

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
95080	2327809	2402769	22	186	163.62	5
95081	2327807	2402769	7	186	178.67	3
100533	2154944	2383332	43	24	-18.33	3
101238	2159264	2375156	29	35	5.62	1
101239	2158733	2375443	1787	33	-1753.10	5
101246	2166298	2370207	32	25	-6.90	2
102411	2281590	2446357	28	268	240.05	5
102412	2289729	2445142	18	260	242.38	1
102621	2155569	2413411	103	67	-36.27	3
103096	2305020	2423224	56	234	178.35	5
103097	2305021	2423222	17	234	217.35	5
103113	2161024	2419397	26	67	40.68	3
103182	2280715	2465484	64	421	357.44	5
103183	2280261	2465565	155	457	301.91	5
103341	2290601	2435224	22	240	217.8	5
103342	2290600	2435223	4	240	235.73	3
103343	2290846	2435334	7	244	236.9	3
103344	2291439	2435509	4	240	235.9	5
103345	2291747	2435322	6	241	235.1	5
103346	2291749	2435322	22	241	219	5
103348	2289619	2441858	19	261	242.67	3
103349	2293775	2438030	4	256	252.01	1
103350	2296624	2437630	4	259	255.51	1
104928	2304141	2399112	85	204	118.19	5
104929	2302862	2408021	63	197	134.24	5
104930	2302862	2408016	15	197	182.24	5
110097	2334719	2414422	304	221	-82.9	5
110098	2334719	2414424	69	221	152.3	2
110099	2334719	2414426	90	221	131.22	4
110104	2287597	2396208	101	176	74.64	5
110105	2283774	2391943	80	154	74.12	3
110106	2283774	2391942	23	154	131.15	2
110107	2283093	2380851	70	137	67.06	2
110108	2283094	2380851	14	137	123.06	1
110109	2285621	2367994	44	119	75.06	2
110110	2329822	2400202	47	174	127.25	3
110111	2329820	2400202	23	174	151.25	1
110112	2329818	2400202	14	174	160.25	1
110113	2330688	2399739	13	174	161.43	1

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
110114	2330688	2399741	49	174	125.43	3
110115	2330688	2399743	19	174	155.43	1
110515	2289112	2442017	6	253	246.91	1
110516	2288137	2435469	24	250	226.53	5
110517	2287754	2432701	16	249	233.5	5
110736	2317481	2416143	111	223	112.4	5
110745	2171586	2392031	1101	37	-1063.79	5
110746	2152971	2418823	1000	67	-932.9	5
110747	2165733	2442020	23	130	107.04	3
110748	2163957	2381824	1853	35	-1817.64	5
111322	2296212	2435060	51	241	189.95	5
111522	2250366	2370448	36	96	59.85	2
111523	2250366	2370448	17	96	78.85	1
111524	2252146	2374902	57	134	76.76	1
111525	2252146	2374902	24	134	109.92	1
111526	2252146	2374902	8	134	125.96	1
111527	2251541	2380525	8	160	152.38	1
111528	2251541	2380525	58	160	102.47	2
111529	2317299	2439484	64	293	228.73	4
111530	2312289	2443489	52	250	197.86	5
111531	2312289	2443487	11	250	238.87	5
111689	2298307	2449214	60	258	198.12	5
111690	2298307	2449211	45	258	213.2	3
111691	2290509	2451589	53	284	230.87	5
111692	2290510	2451585	23	284	260.68	3
111695	2283991	2445954	43	280	237.48	5
111696	2306567	2437753	79	235	155.71	5
111697	2306567	2437755	36	235	198.78	3
111698	2306567	2437757	8	235	226.76	1
111699	2309465	2441503	44	254	210.45	5
111700	2309465	2441501	20	255	234.52	3
111701	2320683	2438743	59	283	224.01	4
112226	2320682	2438740	24	283	259.04	1
112227	2314941	2439412	92	296	203.98	5
112228	2314941	2439410	41	296	255.02	4
112229	2319646	2442439	80	281	201.41	5
112230	2319644	2442439	34	281	247.43	3
112231	2318026	2442683	60	274	213.68	5
112232	2318023	2442683	18	274	255.71	3

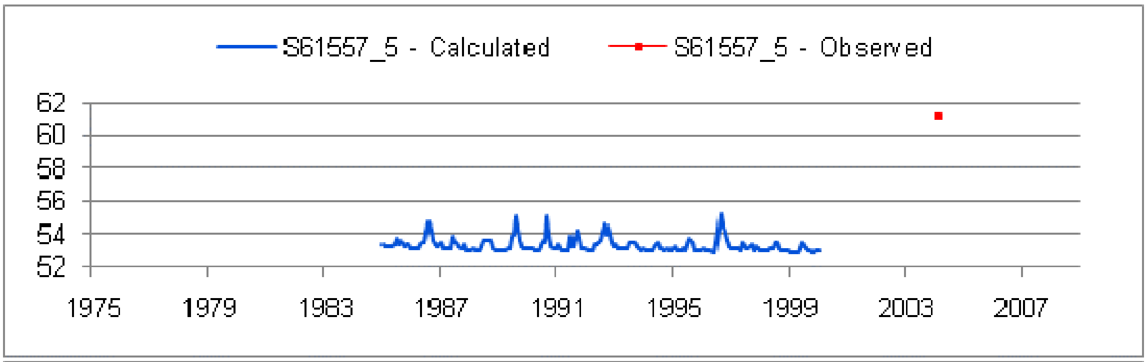
ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
112233	2315465	2443056	33	260	226.97	3
112234	2311336	2443651	34	248	213.61	5
112235	2311290	2454217	31	262	230.66	5
112236	2311289	2454218	14	262	247.66	5
112237	2311894	2452422	34	256	222.13	5
112242	2335371	2376717	226	147	-79.48	5
112243	2336274	2381360	167	159	-7.58	5
112255	2227125	2481096	5	165	160.06	1
112256	2226873	2481135	6	158	152.13	5
112257	2227676	2484172	5	159	154.03	5
112258	2228778	2484158	6	166	160.25	3
112259	2228771	2484318	5	167	162.37	3
112281	2228296	2484899	9	168	158.88	3
112282	2228246	2484897	9	168	158.57	3
112283	2225978	2482899	9	155	146.21	5
112289	2227677	2484162	6	159	153.02	5
112290	2228683	2484024	7	166	158.91	3
112292	2229067	2484431	6	168	162.19	3
112373	2313711	2450544	87	264	176.62	5
112826	2308546	2375525	199	125	-73.2	3
113149	2300241	2433279	0	221	221.07	5
113150	2300491	2433289	0	220	219.73	5
113151	2301740	2433342	0	222	222.45	5
113152	2301867	2432697	0	221	220.47	3
113153	2299438	2433345	0	222	222.45	5
113154	2299325	2433640	0	224	223.89	5
113155	2296133	2434556	0	230	229.81	5
113156	2293617	2434900	0	233	233.19	5
113157	2291277	2434601	0	230	229.99	5
113158	2290910	2431433	0	239	239.34	5
113159	2289112	2434910	5	233	228.24	5
113160	2286233	2434338	5	241	235.53	5
113161	2284927	2435634	5	242	236.79	5
113162	2285053	2437391	5	240	234.6	3
113163	2285824	2436923	6	237	231.29	5
113164	2286820	2438216	5	239	233.35	3
113165	2285011	2438390	5	238	233.12	3
113166	2288446	2442389	6	248	241.62	3
113167	2330648	2399737	0	170	170	1

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
113169	2328928	2401115	0	170	170	1
113170	2329816	2400252	0	170	170	1
113717	2200035	2449444	31	299	268.38	5
113718	2200035	2449442	3	299	295.64	1
113719	2200034	2449440	1	299	297.68	1
113720	2200173	2449234	17	284	267.21	5
113721	2200173	2449233	6	284	278.91	5
113722	2200173	2449231	2	284	282.9	5
113723	2200316	2449428	29	298	268.69	5
113724	2200316	2449427	4	298	293.76	1
113725	2200317	2449426	1	298	296.82	1
114152	2307672	2379592	214	167	-47.21	5
114474	2200046	2449982	3	299	296.3	1
114475	2200050	2449983	3	299	296.3	1
114476	2200065	2449981	3	299	296.39	1
114477	2200080	2449980	3	299	296.36	1
114478	2200084	2449980	3	299	296.36	1
114479	2231791	2450506	5	242	236.87	3
114480	2231806	2450497	3	242	239.46	3
114481	2231802	2450499	3	242	239.41	3
114482	2231790	2450502	3	242	239.41	3
114483	2231778	2450506	3	242	239.32	3
114484	2231774	2450507	3	242	239.28	3
114485	2231650	2450517	5	239	233.23	5
114486	2231651	2450520	3	239	235.79	3
114487	2231538	2450488	3	236	233.19	5
114488	2231534	2450489	3	236	233.08	5
114489	2231523	2450493	3	236	232.71	5
114490	2231511	2450498	3	235	232.43	5
114491	2231507	2450499	3	235	232.16	5
114492	2231522	2450490	5	236	230.16	5
114493	2231308	2450503	5	230	224.23	5
114494	2231311	2450505	3	230	226.73	5
114495	2231753	2449939	5	231	225.4	5
114496	2231756	2449939	3	231	227.94	5
114497	2231722	2450064	5	234	229.03	5
114498	2231725	2450063	3	234	231.61	5
114499	2231676	2450218	5	240	235.12	3
114500	2231679	2450219	3	241	237.7	3

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
114501	2231792	2450508	20	242	222.28	5
114502	2231520	2450487	10	236	225.34	5
114503	2231306	2450500	7	230	222.94	5
114504	2231649	2450514	6	239	233.11	5
114505	2231673	2450217	19	240	221.37	5
114506	2231719	2450064	14	234	220.69	5
114507	2231750	2449939	15	231	216	5
114508	2200065	2449982	24	299	275.16	5
114509	2200180	2449927	16	299	282.9	5
114510	2200322	2450131	19	300	280.55	5
114511	2200413	2449575	25	300	274.77	5
114512	2200204	2449811	15	295	280.42	5
114513	2200297	2449592	13	297	284.14	5
114514	2200298	2447814	25	293	268.05	5
114515	2200065	2449980	5	299	294.06	1
114516	2200180	2449930	5	299	293.54	1
114517	2200181	2449933	5	299	293.96	1
114518	2200322	2450133	5	300	294.64	3
114519	2200412	2449569	5	300	295	3
114520	2200413	2449572	5	300	295.54	3
114521	2200207	2449811	5	295	290.07	3
114522	2200210	2449812	3	295	292.68	2
114523	2200316	2449426	3	297	294.2	1
114524	2200296	2449588	5	297	291.86	3
114525	2200223	2449606	3	293	289.91	3
114526	2200222	2449609	3	293	290.01	3
114527	2200303	2450132	10	300	289.62	3
114528	2200307	2450133	10	300	289.59	3
114529	2200323	2450133	5	300	294.61	3
114530	2200338	2450132	5	300	294.55	3
114531	2200342	2450132	3	300	296.82	1
120248	2218625	2387783	142	77	-64.57	3
121019	2375424	2451050	84	390	306.49	1
121777	2206752	2441396	20	317	296.96	5
121778	2204172	2442038	20	308	288.41	5
121779	2202995	2440286	17	306	288.48	1
121780	2205691	2440450	20	297	276.5	5
121781	2205184	2441780	23	295	272.45	5
121782	2204460	2441149	20	283	262.74	5

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
121783	2204870	2440916	20	291	271.19	5
121784	2205844	2440857	19	294	275.15	5
121785	2205998	2441484	20	312	292.07	5
122670	2211610	2384363	379	132	-246.53	4
122674	2213686	2391530	168	124	-43.64	3
122675	2227995	2406050	150	176	25.83	4
122676	2208532	2394906	112	97	-14.62	3
122677	2206549	2396465	74	97	23.08	3
124323	2204982	2440641	10	306	295.28	5
124324	2204974	2440821	16	305	289.51	5
124325	2204789	2440712	5	294	288.91	5
124326	2204789	2440713	18	293	275.88	5
124327	2204675	2440808	9	280	271.72	5
124328	2204675	2440808	18	280	262.52	5
141230	2290837	2338686	20	6	-14.12	2
141231	2298122	2337970	85	37	-47.71	2
141232	2298122	2337970	35	37	2.29	2
141233	2299915	2351332	60	94	33.53	2
141234	2301557	2344043	30	41	10.9	2
141235	2306498	2348384	20	92	72.12	2
141237	2306498	2348384	58	92	34.12	2
141238	2308943	2338011	35	76	41	2
141239	2303039	2329734	35	43	8.06	2
141240	2303039	2329734	75	43	-31.64	2
141242	2313590	2344767	18	105	86.85	2
141243	2315949	2340402	25	102	77.22	2
141298	2254093	2342986	15	7	-8.14	1
141299	2254093	2342986	36	7	-29.14	2
141300	2259759	2345840	14	3	-11.06	2
141301	2259759	2345840	36	3	-33.06	2
141302	2262989	2351144	26	26	0.21	2
141303	2264701	2347832	20	7	-12.87	2
141304	2264701	2347832	54	7	-46.87	2
141305	2267508	2350815	50	37	-12.7	2
141306	2267555	2355362	56	59	2.82	2
141307	2271315	2355722	30	80	50.26	1
141308	2271315	2355722	48	80	32.26	2
141309	2272884	2352965	26	73	46.9	1
141310	2272884	2352965	60	73	12.9	2

ID	East	North	Depth	RLNS (mAHD)	Scr Elev (mAHD)	Model Layer
141311	2277468	2355123	48	75	27	2
141312	2271927	2349791	73	40	-33.16	2
141313	2268904	2347660	54	4	-49.67	2
141314	2274960	2347467	37	14	-23.37	2
141315	2278189	2347584	39	32	-6.57	2
141316	2278358	2344548	35	25	-9.77	2
141911	2287421	2340978	14	12	-2.12	2
146023	2222304	2394066	98	82	-16.25	3
146024	2227868	2388925	153	84	-68.3	3
146025	2199207	2393101	90	88	-1.53	3
146026	2211641	2384344	35	132	97	1
146027	2211641	2384344	191	132	-59	3
146028	2220811	2402163	90	142	52.1	3
146029	2218716	2387747	32	77	45.43	3
146030	2213686	2391530	40	124	84.36	2
146031	2222304	2394066	40	82	41.75	3
146032	2212293	2398299	98	102	3.87	3
146033	2203777	2387757	125	91	-34.25	3
307764	2195939	2354734	1799	80	-1719.11	4
310064	2212164	2367142	1670	25	-1644.03	5
310082	2199183	2393079	1350	89	-1261.2	5
325468	2209831	2364250	1670	69	-1600.76	5
GMS-188	2373223	2460287	100	458	358.43	3
S61556/1	2313312	2342942	12	90	78.66	2
S61556/2	2301642	2344720	15	35	20.26	2
S61556/3	2301622	2344567	15	41	25.69	2
S61556/4	2301661	2345011	32	54	22.66	2
S61556/5	2294734	2348065	19	20	1.18	2
S61557/1	2145272	2433886	18	69	51.18	3
S61557/2	2158747	2427378	22	68	45.94	3
S61557/3	2167073	2414060	19	62	43.19	1
S61557/4	2154478	2401962	20	65	44.83	1
S61557/5	2145253	2405399	24	66	42.22	3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S61557_5 - Observed
62
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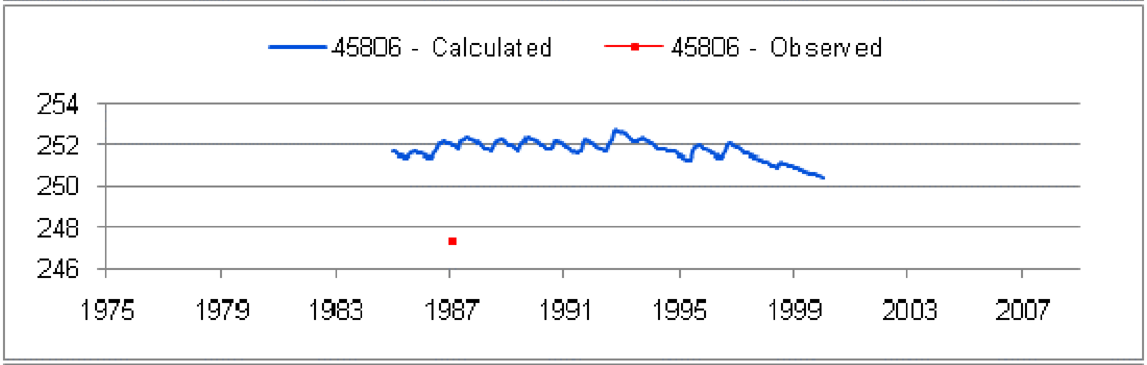
45806 - Calculated
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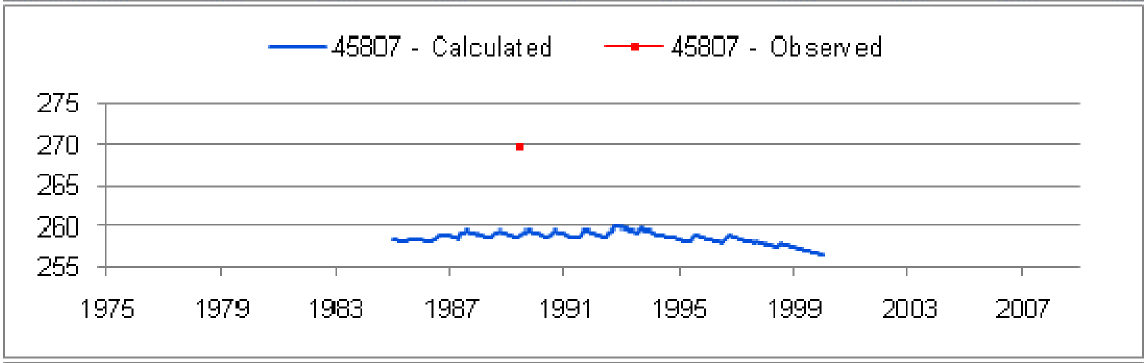
45807 - Calculated
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255
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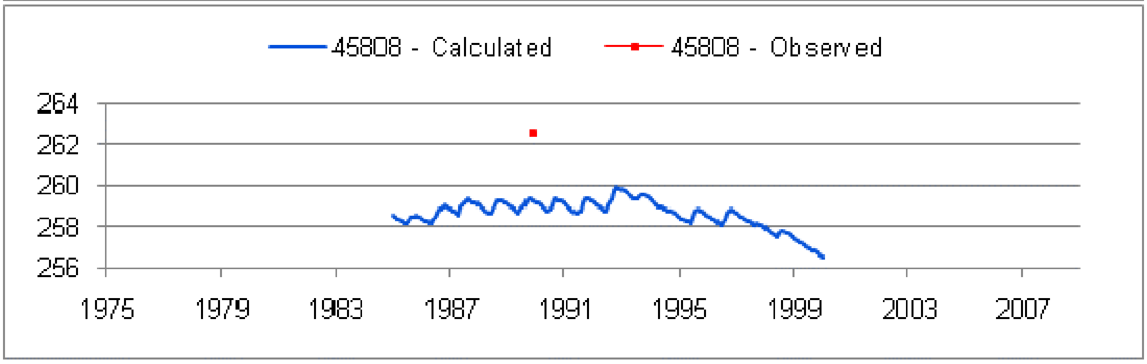
45808 - Calculated
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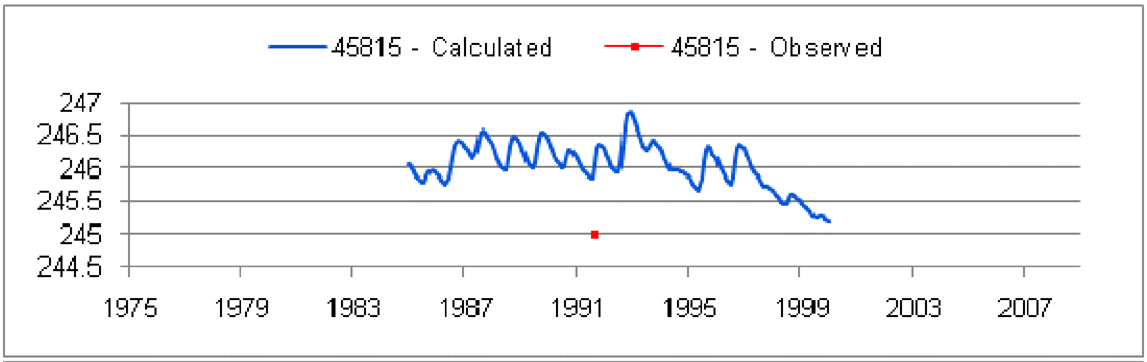

45815 - Calculated
45815 - Observed
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245.5
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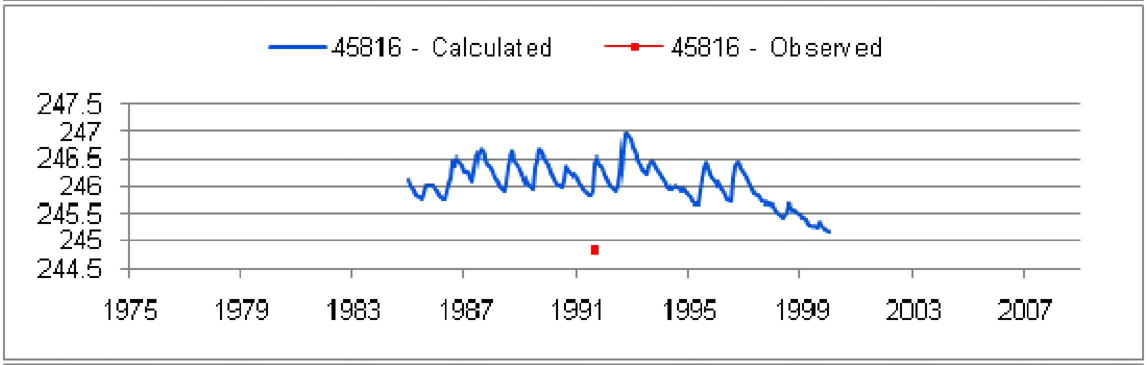

45816 - Calculated
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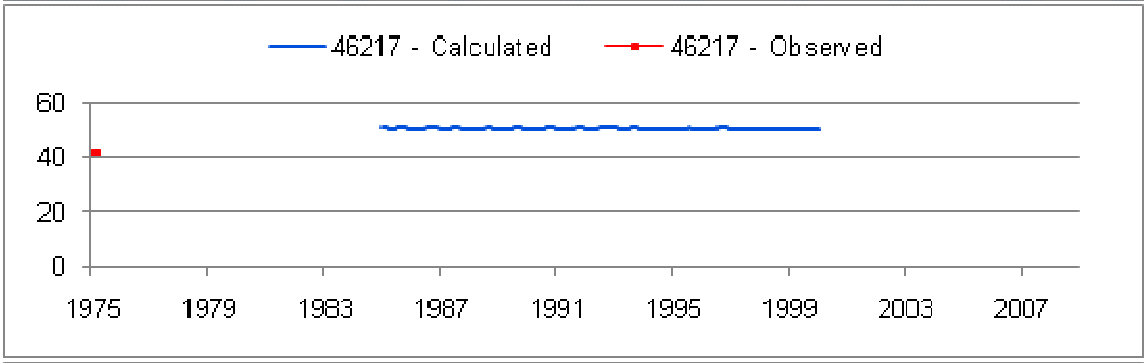

46217 - Calculated
46217 - Observed
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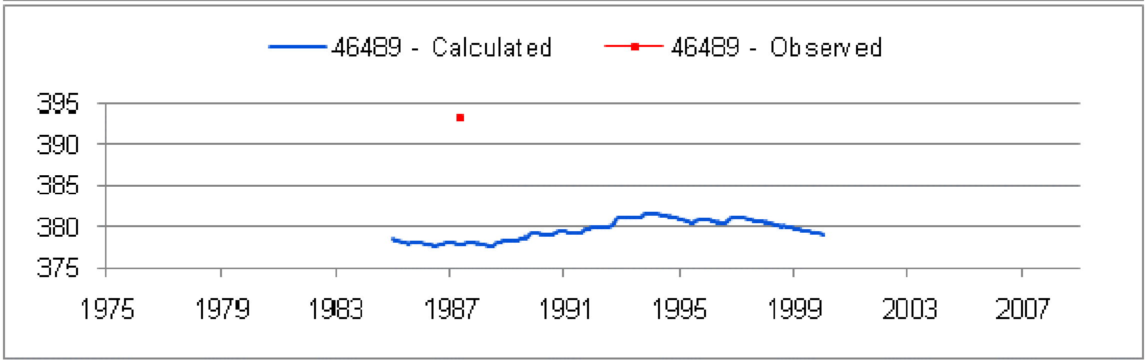

46489 - Calculated
46489 - Observed
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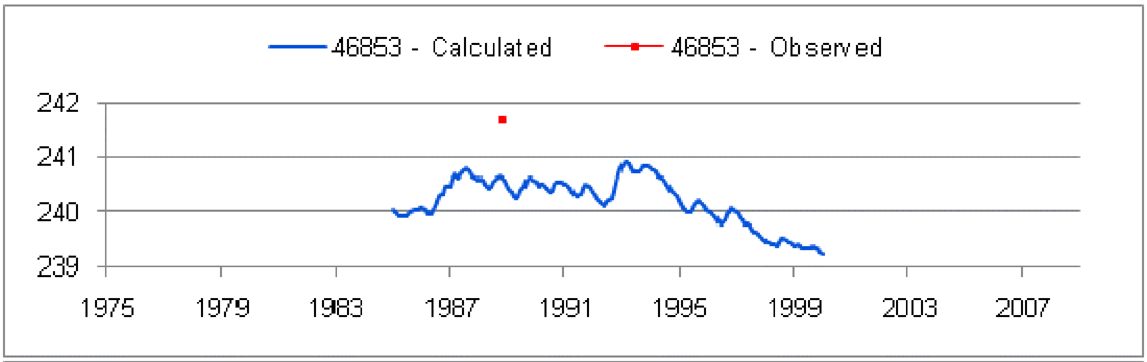
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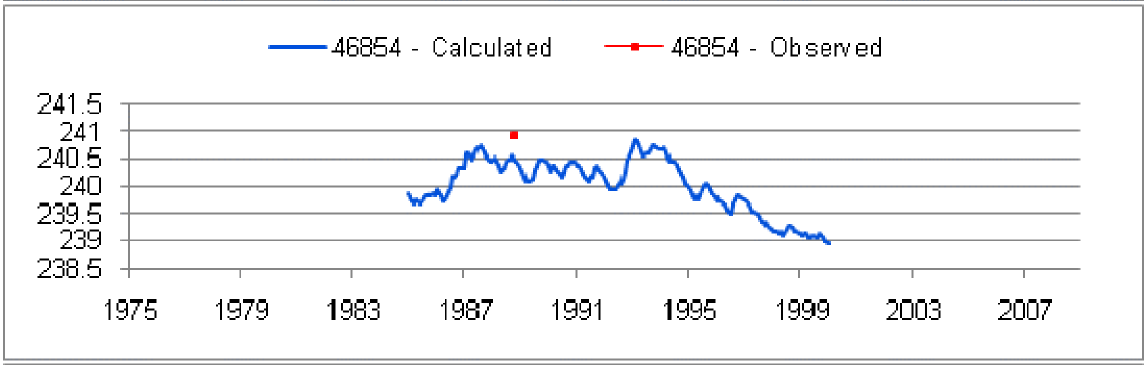
46854 - Calculated
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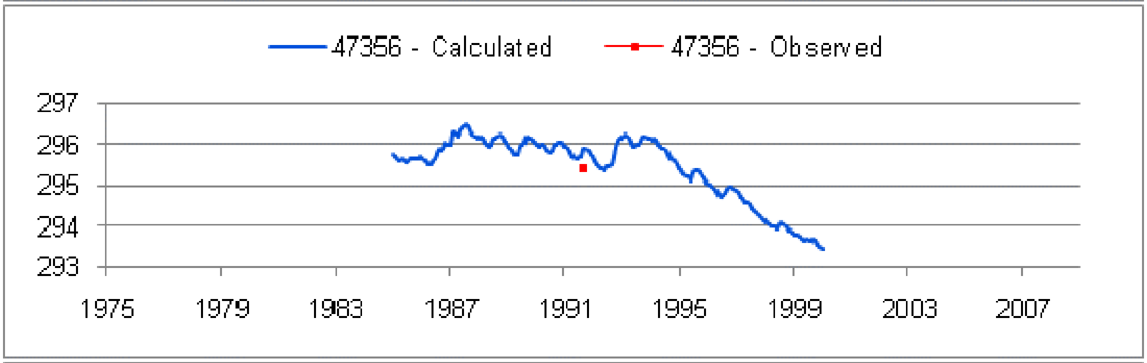
47356 - Calculated
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293
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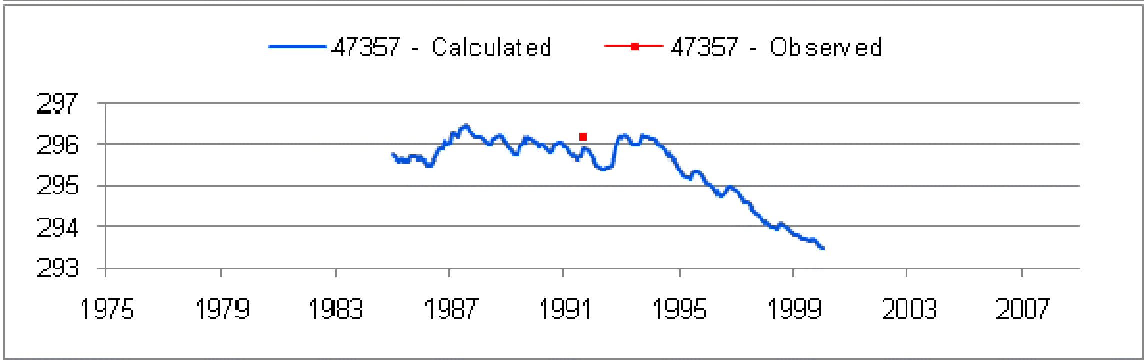
47357 - Calculated
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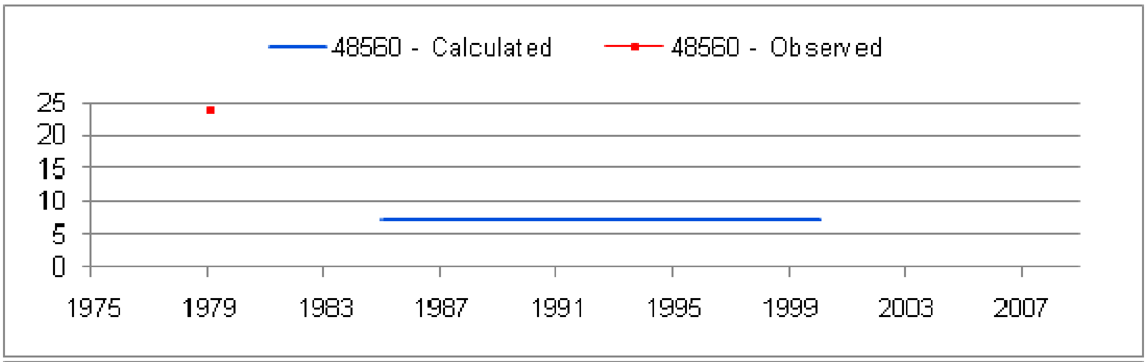

48560 - Calculated
48560 - Observed
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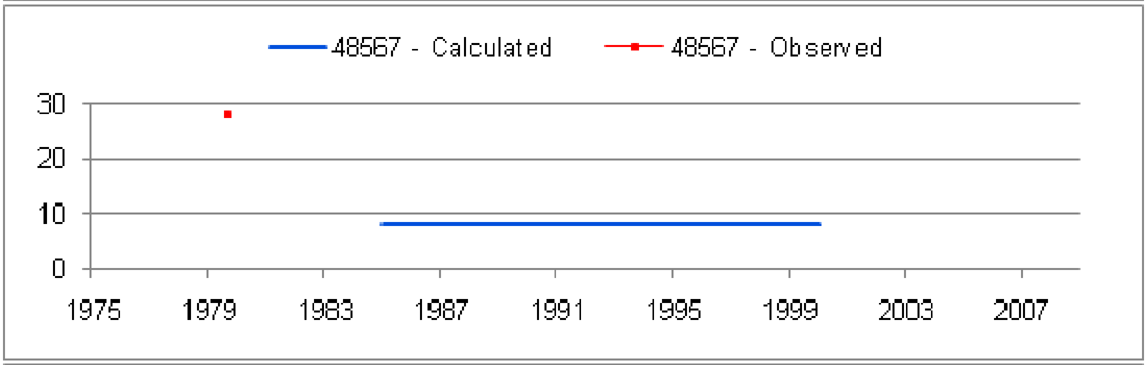

48567 - Calculated
48567 - Observed
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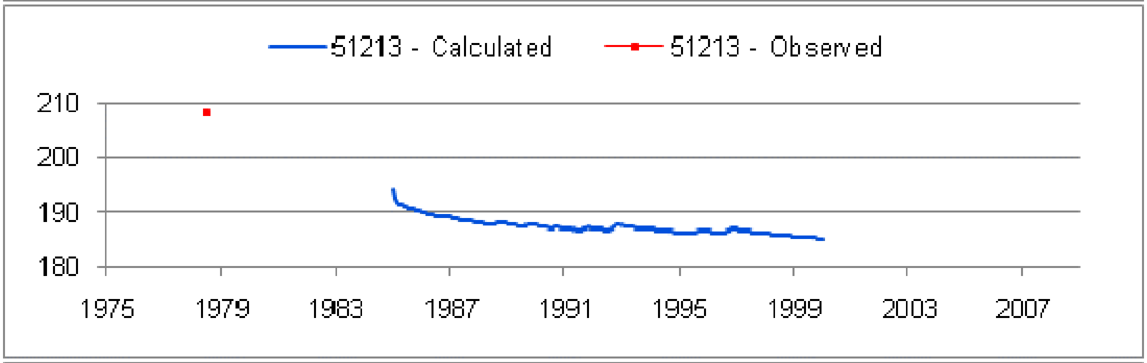

51213 - Calculated
51213 - Observed
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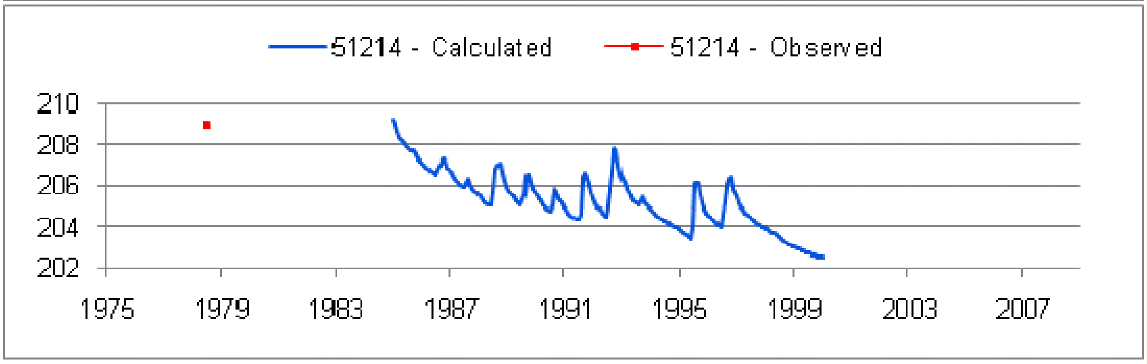
2003
2007



51214 - Calculated
51214 - Observed
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202
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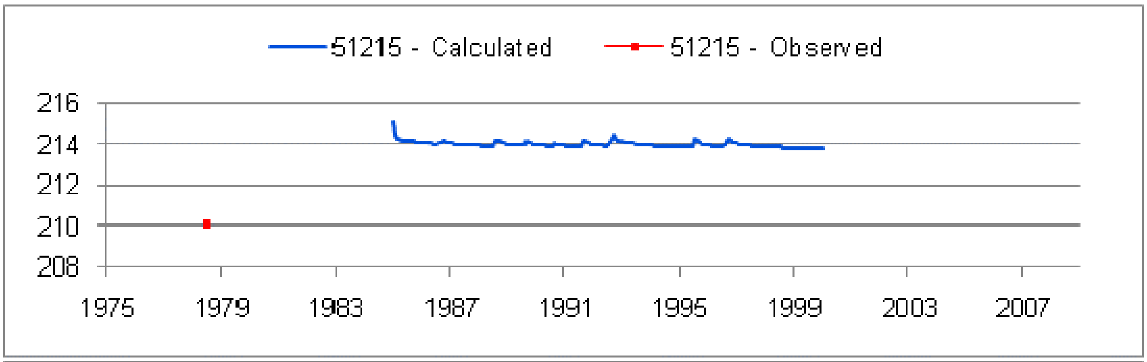

51215 - Calculated
51215 - Observed
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208
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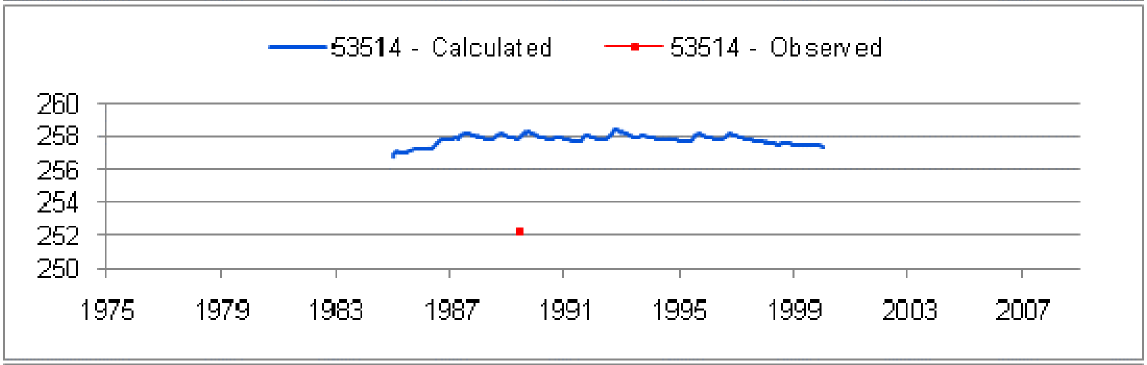

53514 - Calculated
53514 - Observed
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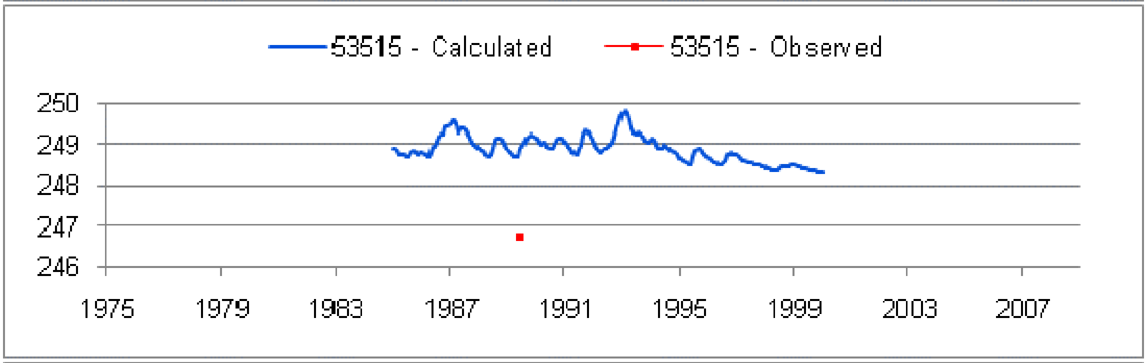

53515 - Calculated
53515 - Observed
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246
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1979
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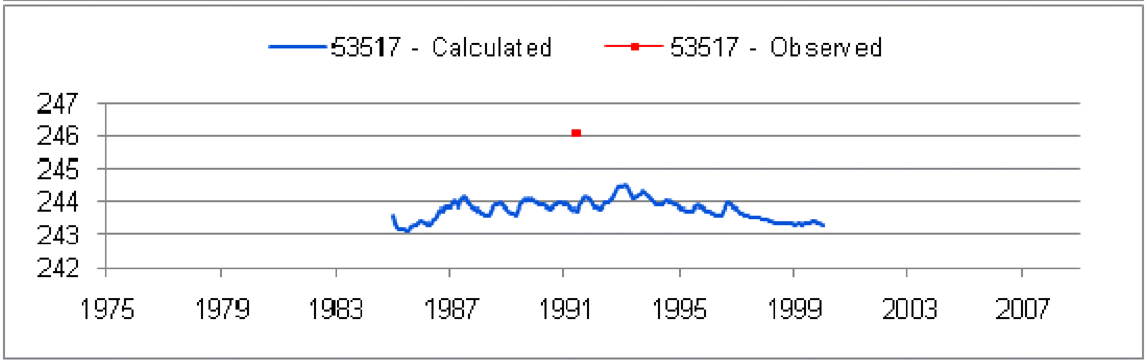

53517 - Calculated
53517 - Observed
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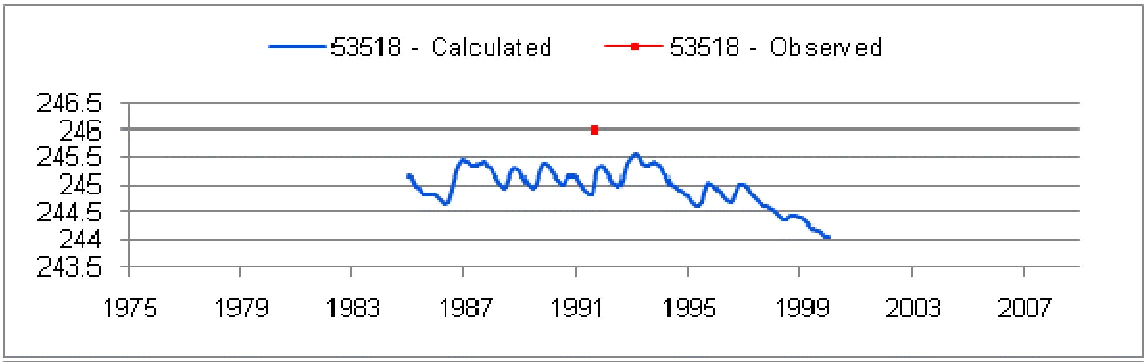
53518 - Calculated
53518 - Observed
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245.5
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243.5
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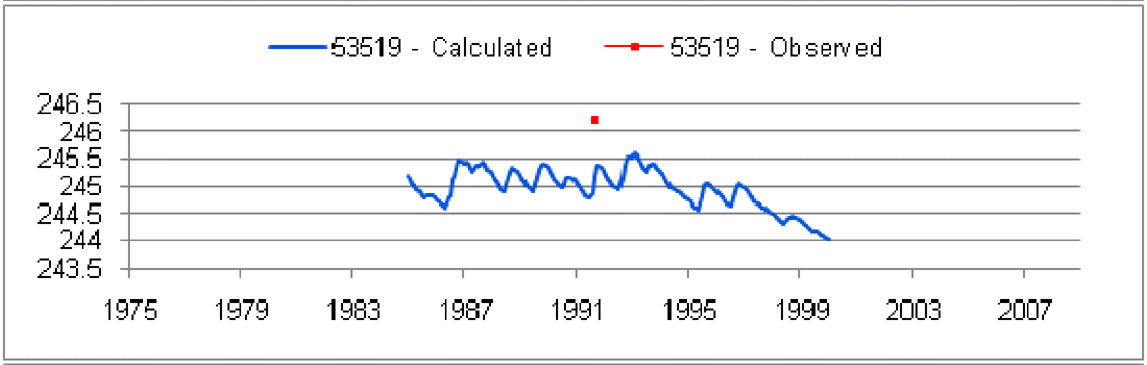
53519 - Calculated
53519 - Observed
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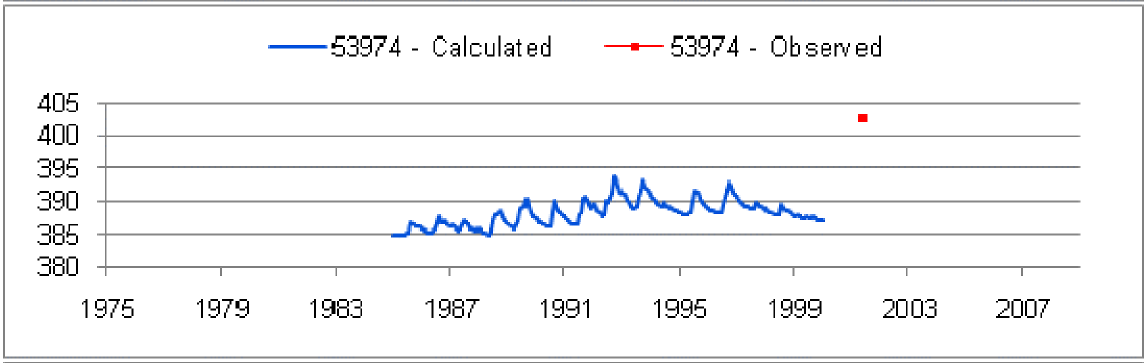
53974 - Calculated
53974 - Observed
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380
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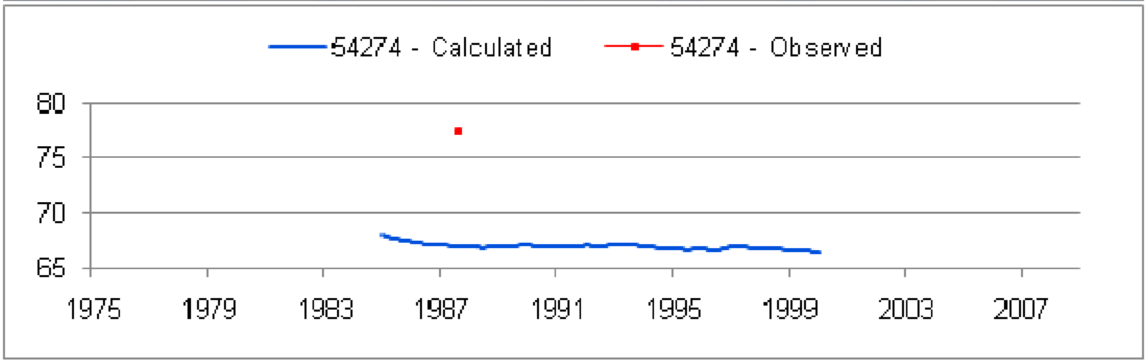
54274 - Calculated
54274 - Observed
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65
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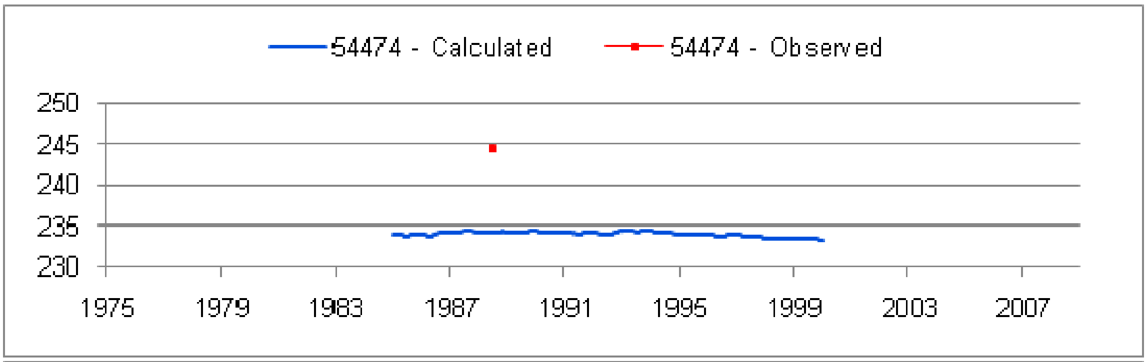
54474 - Calculated
54474 - Observed
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235
230
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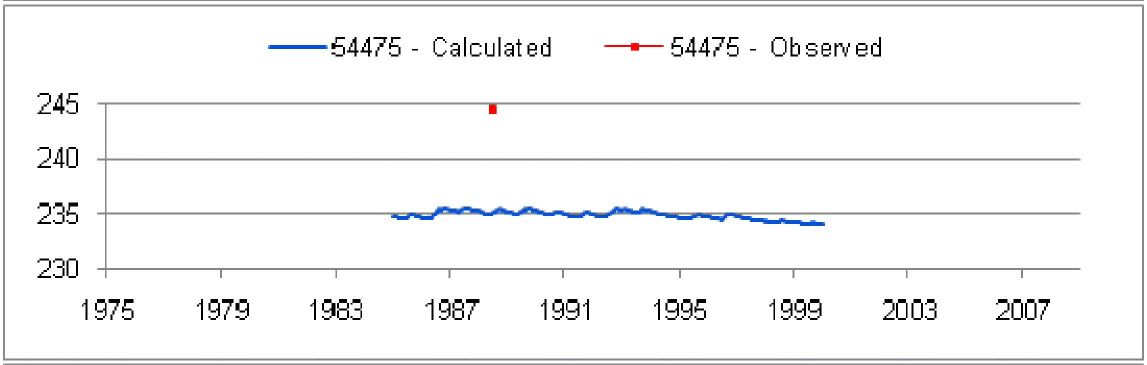
2003
2007


54475 - Calculated
54475 - Observed
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230
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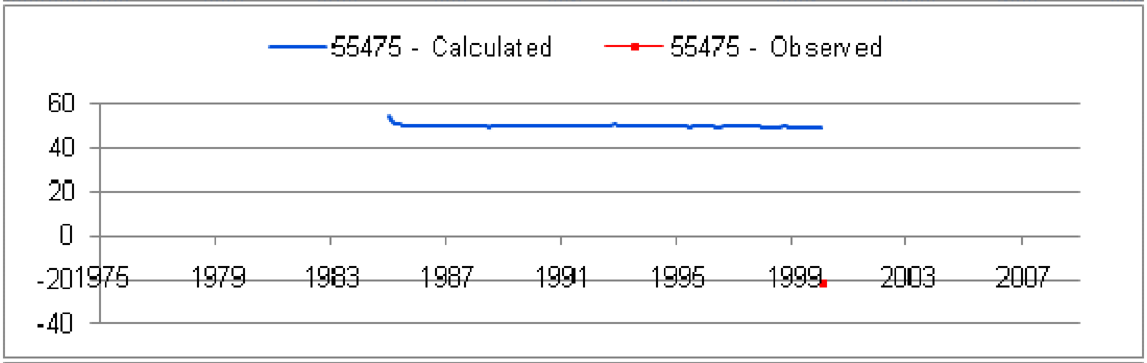
55475 - Calculated
55475 - Observed
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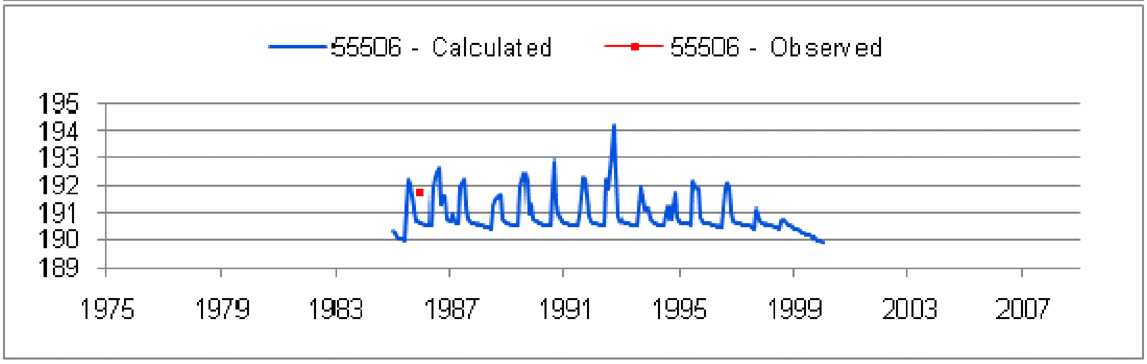
55506 - Calculated
55506 - Observed
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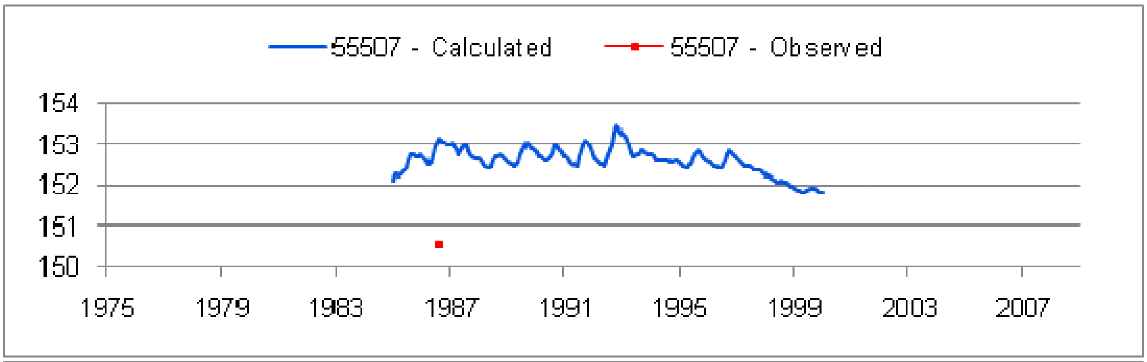
55507 - Calculated
55507 - Observed
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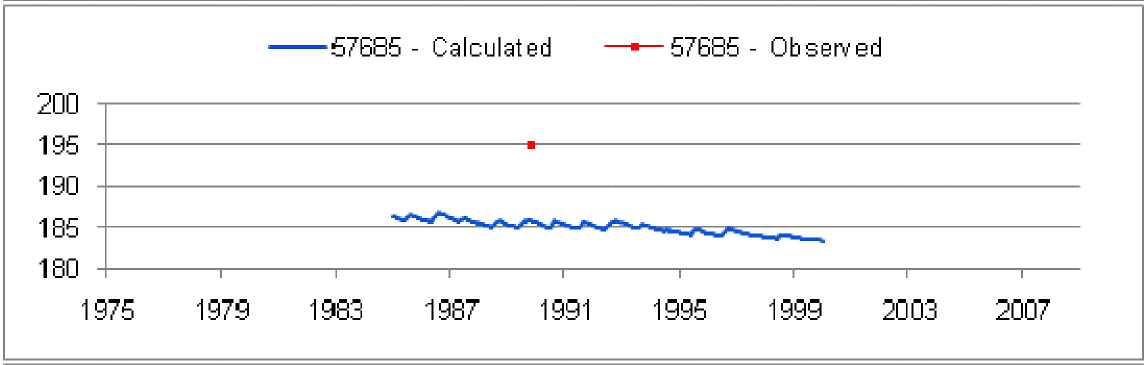
57685 - Calculated
57685 - Observed
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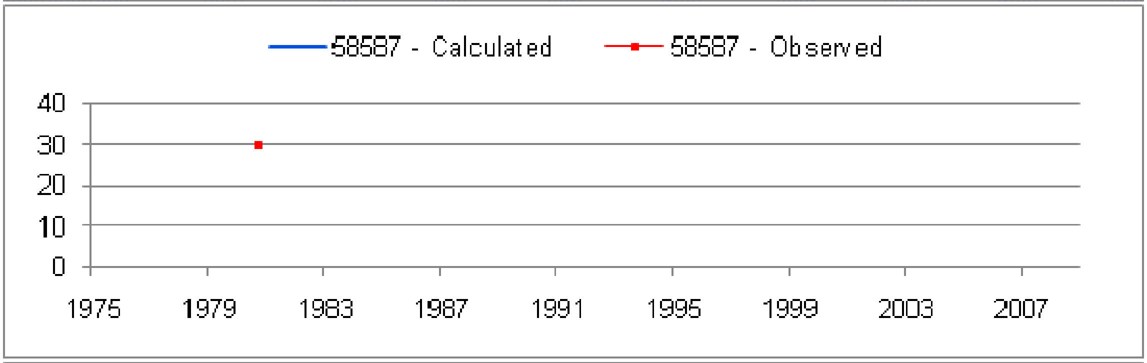
58587 - Calculated
58587 - Observed
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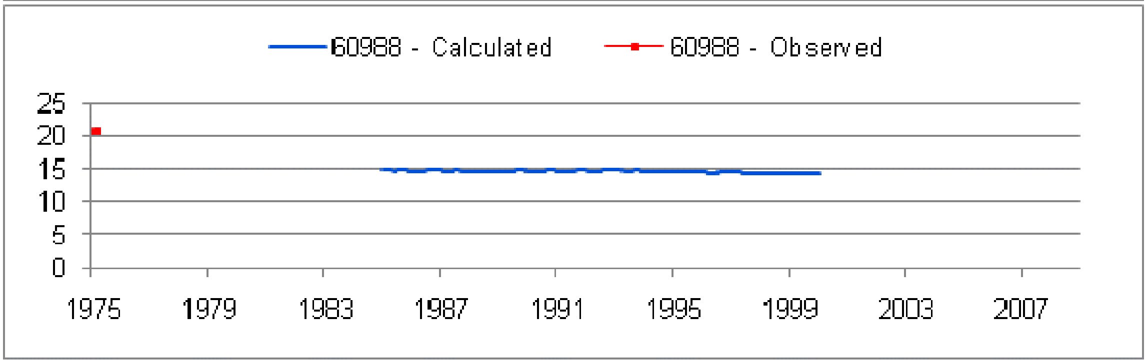
60988 - Calculated
60988 - Observed
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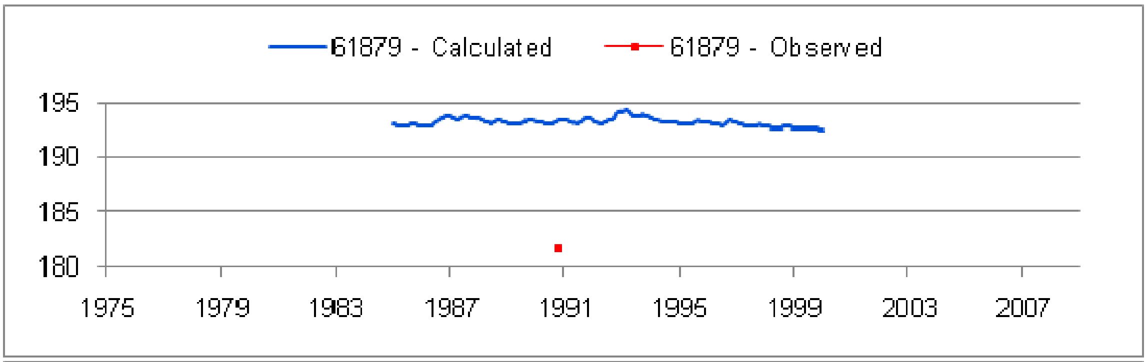
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61879 - Observed
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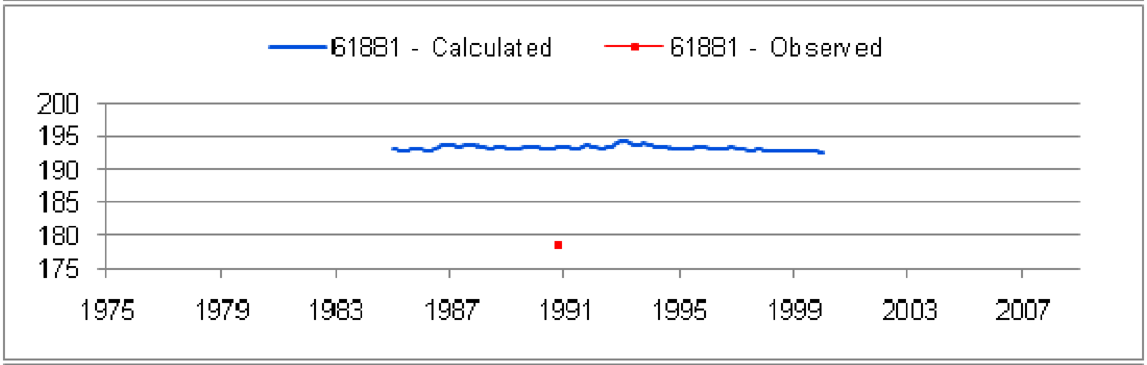
2003
2007


61881 - Calculated
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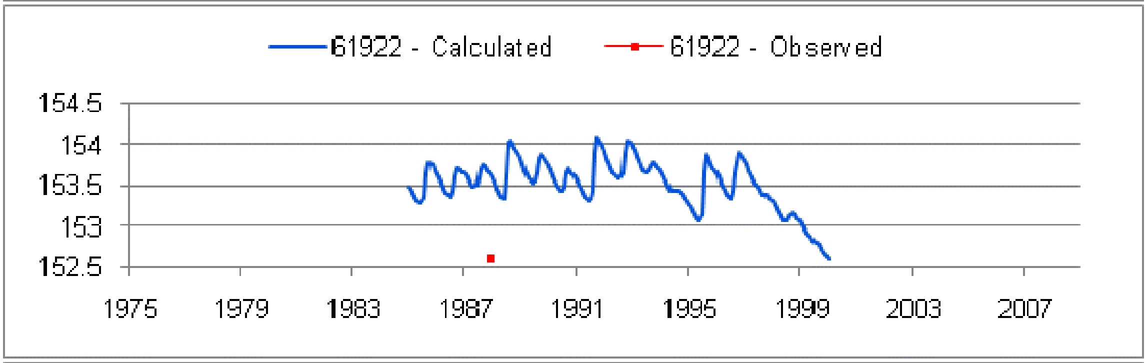
61922 - Calculated
61922 - Observed
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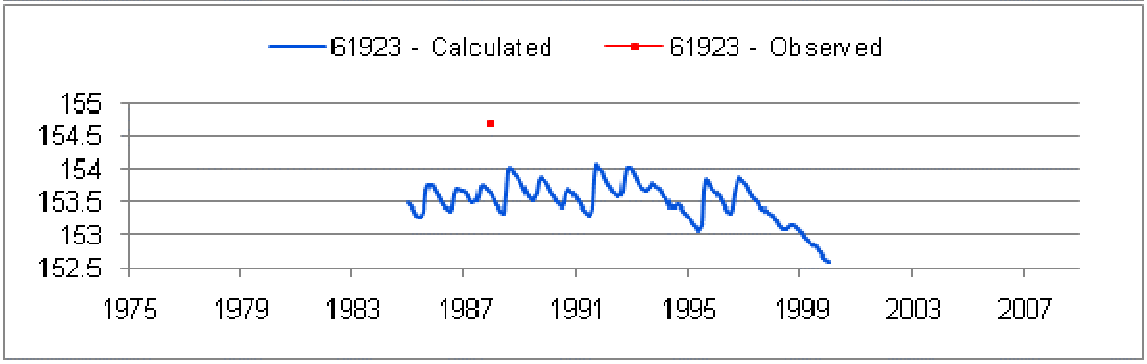
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61923 - Observed
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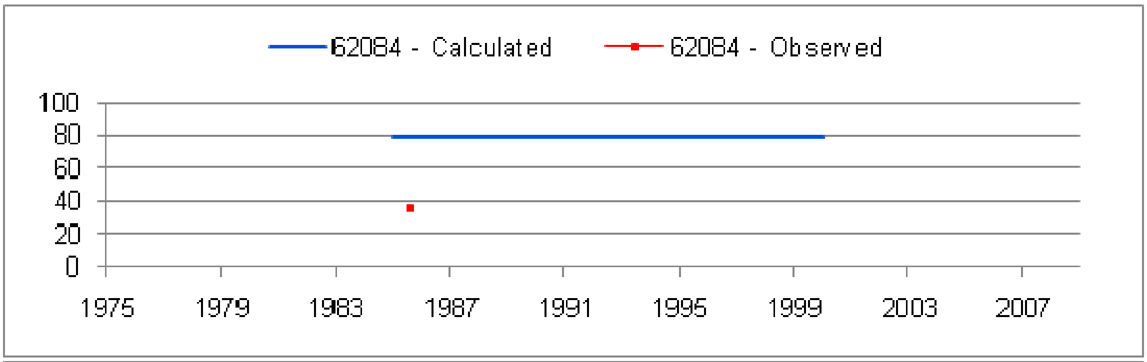
62084 - Calculated
62084 - Observed
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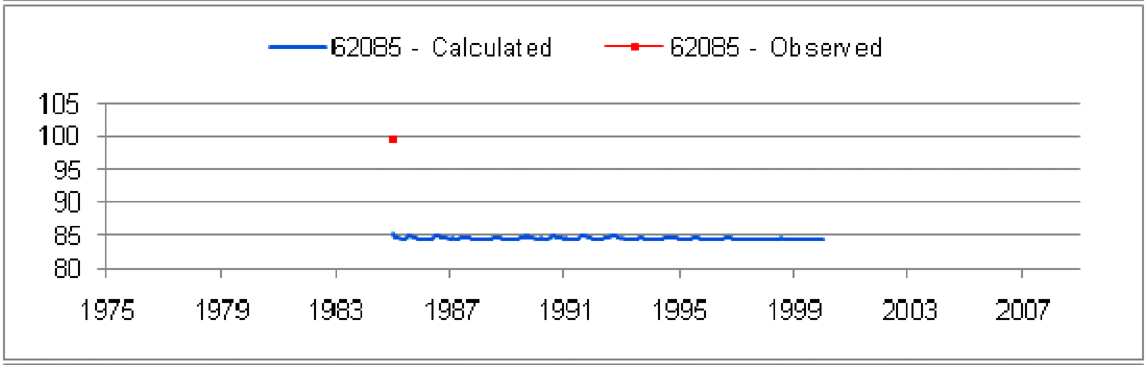
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62085 - Observed
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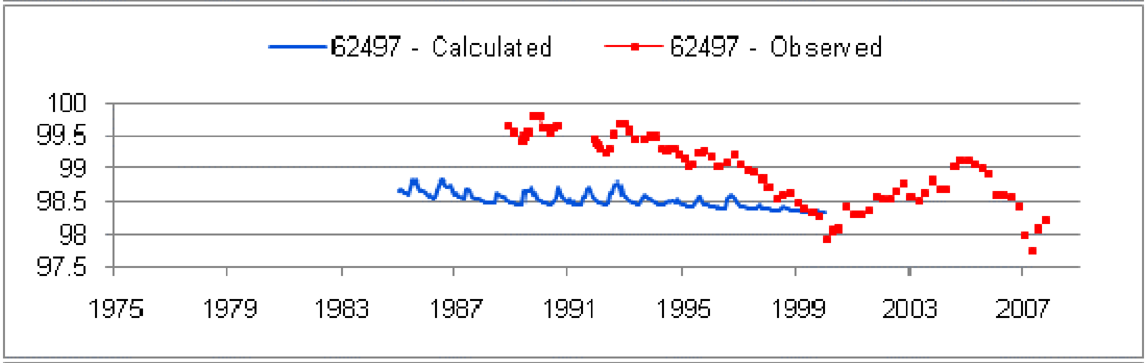
62497 - Calculated
62497 - Observed
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97.5
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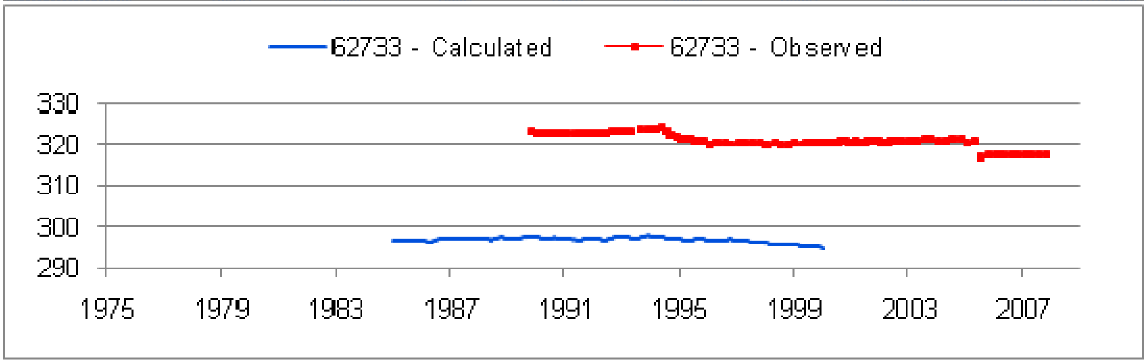
62733 - Calculated
62733 - Observed
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290
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1979
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1995
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2003
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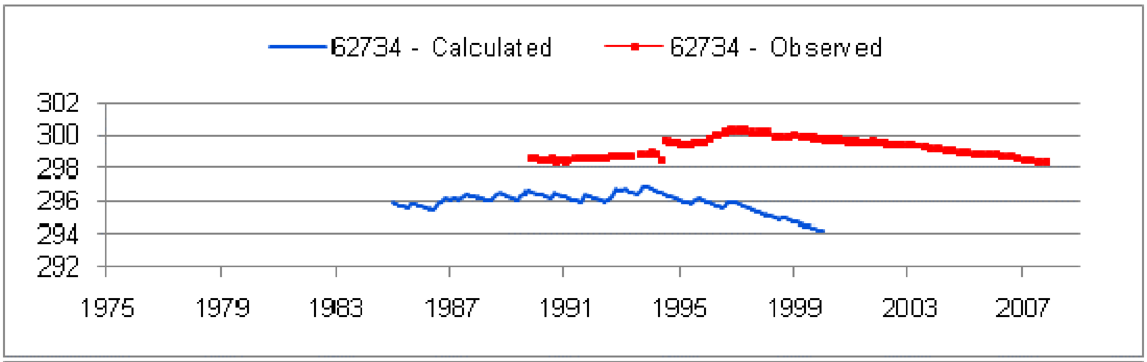
62734 - Calculated
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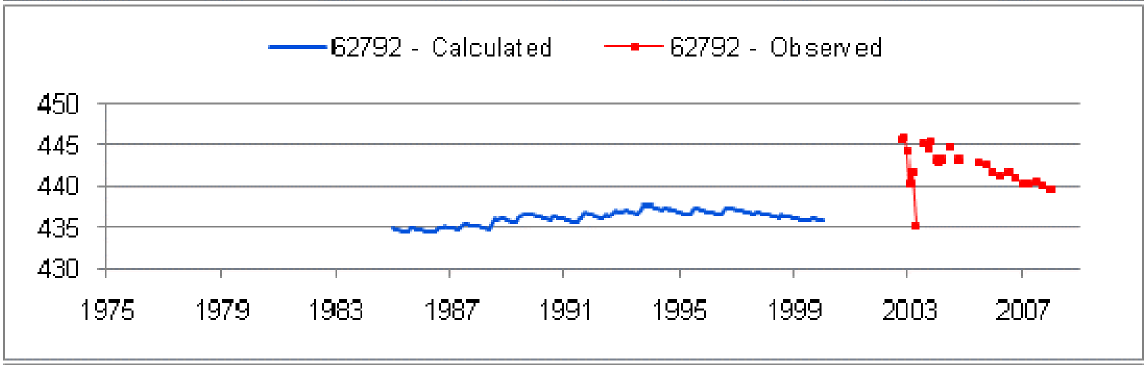
62792 - Calculated
62792 - Observed
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430
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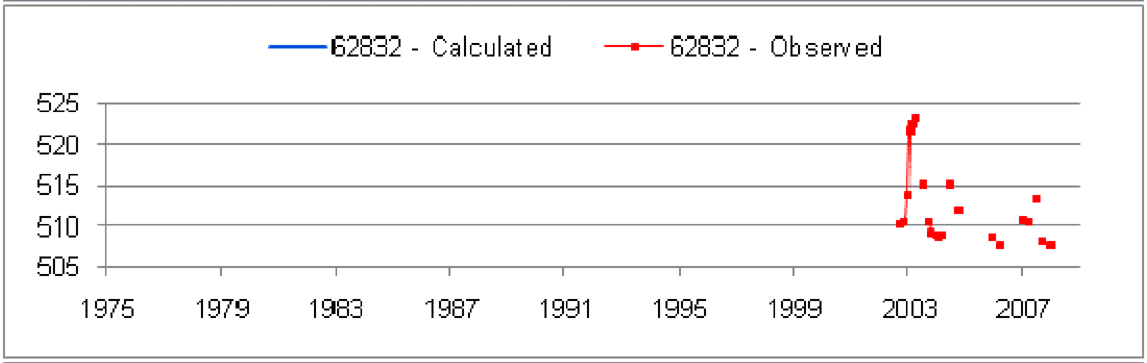
62832 - Calculated
62832 - Observed
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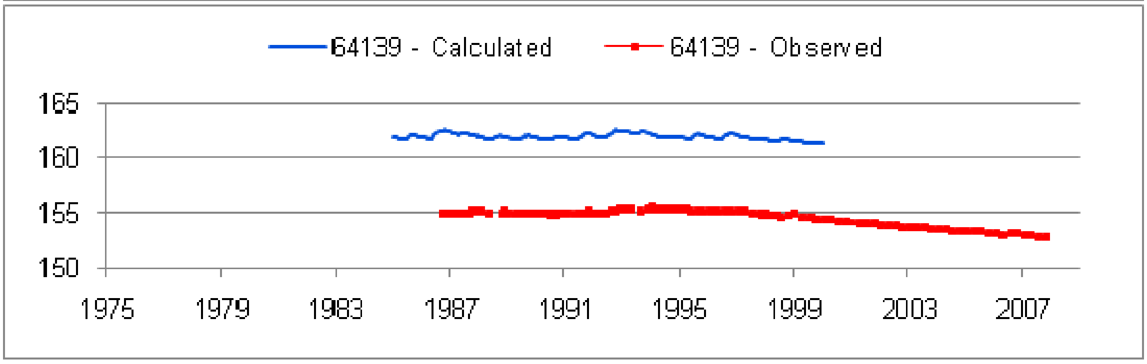
64139 - Calculated
64139 - Observed
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1979
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2003
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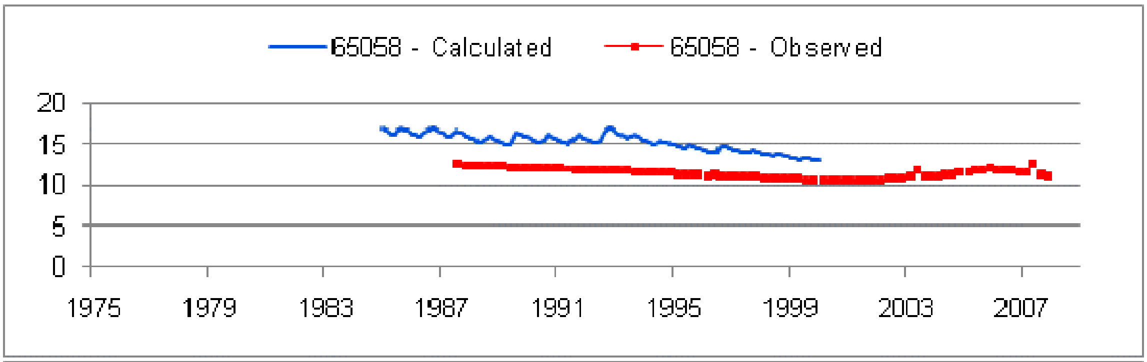
65058 - Calculated
65058 - Observed
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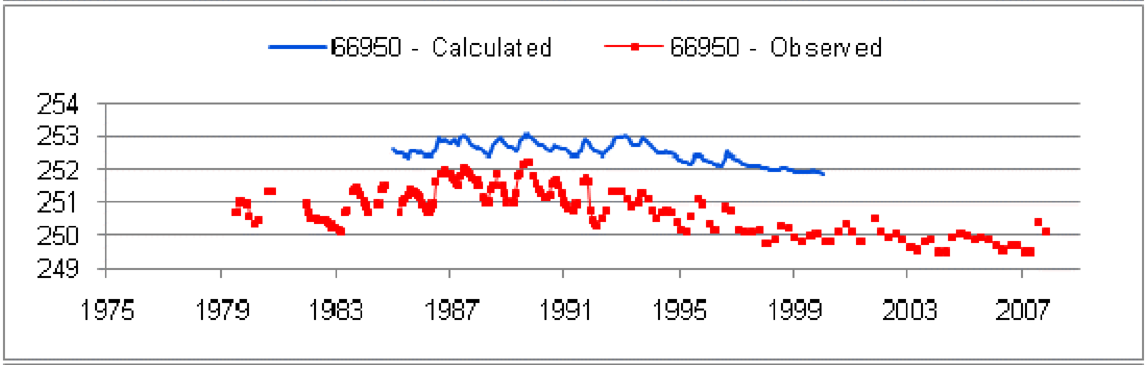
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66950 - Observed
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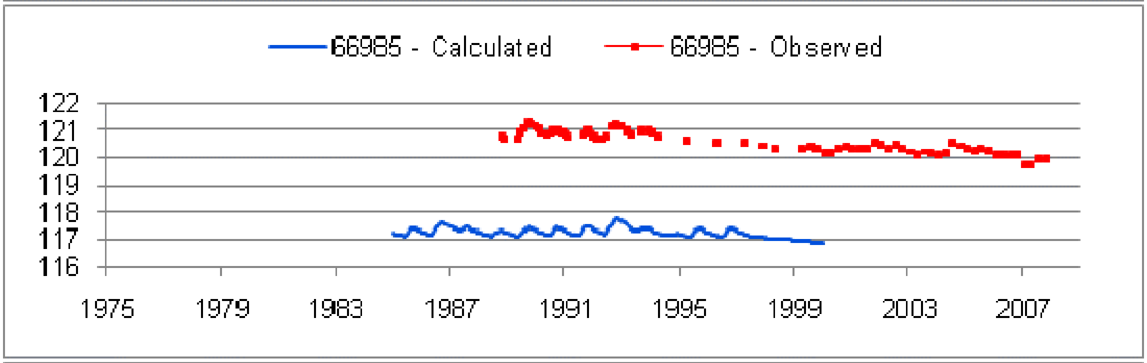
1975 1979 1983 1987 1991 1995 1999 2003 2007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66985 - Observed
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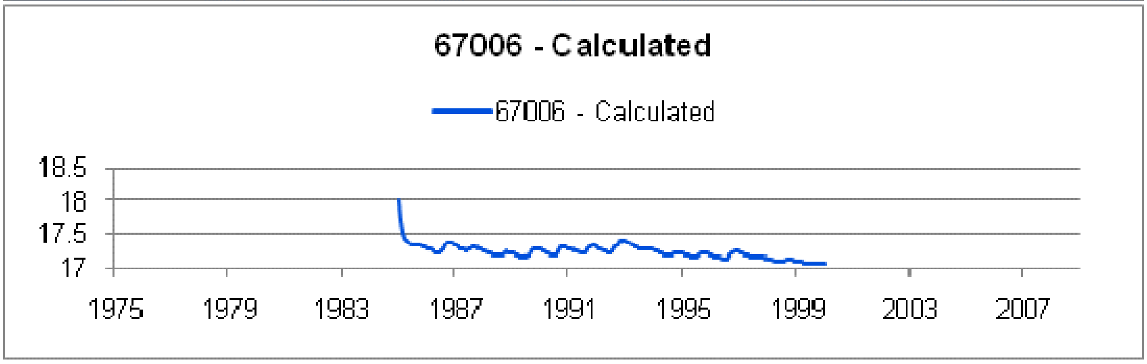
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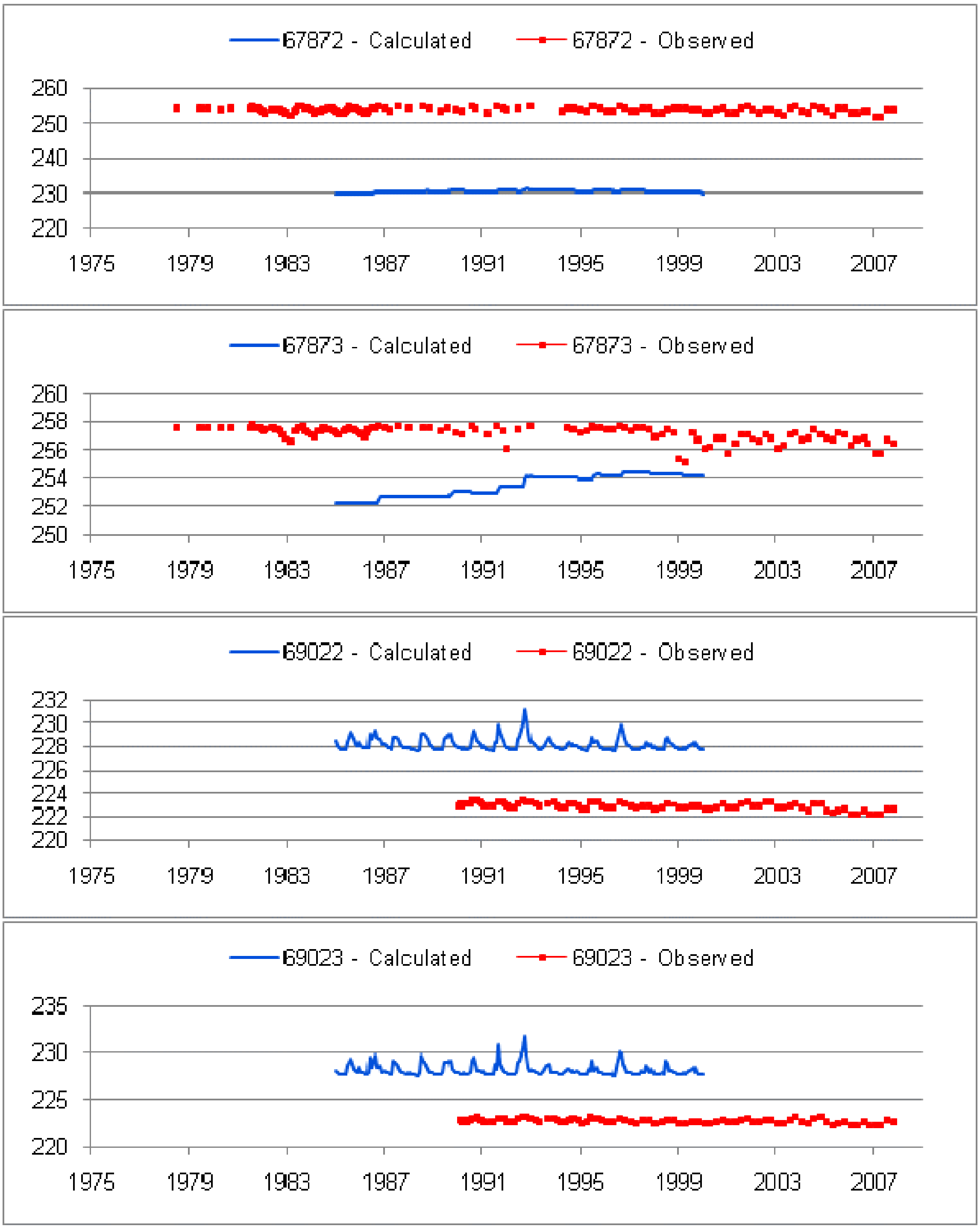
67872 - Calculated
67872 - Observed
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220
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1979
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1987
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1995
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2003
2007
67873 - Calculated
67873 - Observed
260
258
256
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252
250
69022 - Calculated
69022 - Observed
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69023 - Calculated
69023 - Observed
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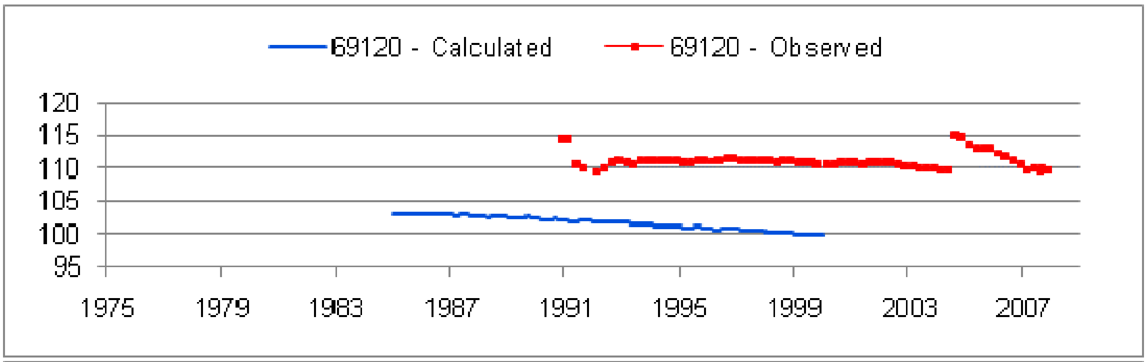
220


69120 - Calculated
69120 - Observed
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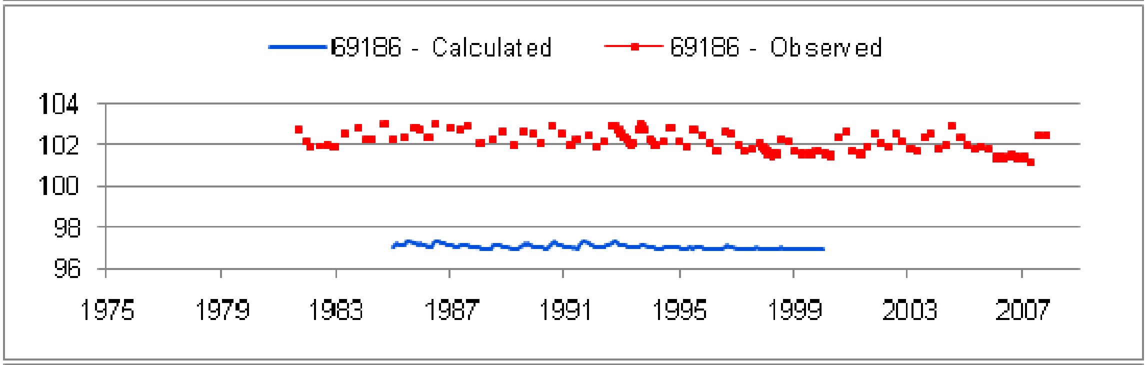
69186 - Calculated
69186 - Observed
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2003
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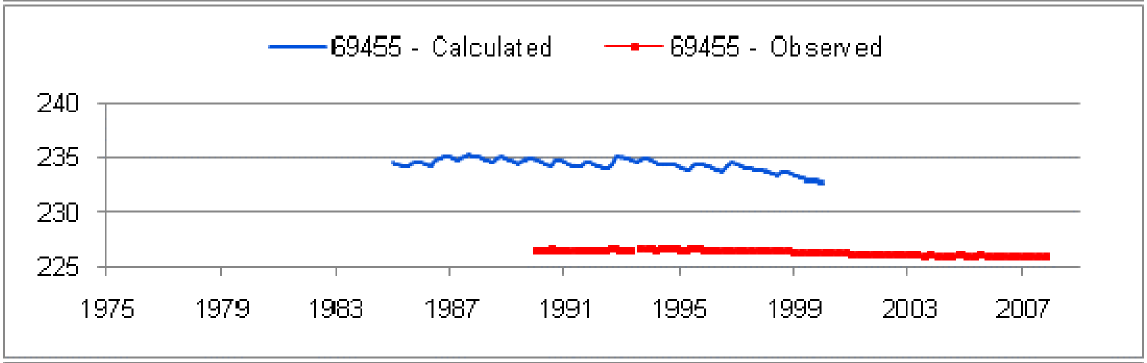
69455 - Calculated
69455 - Observed
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225
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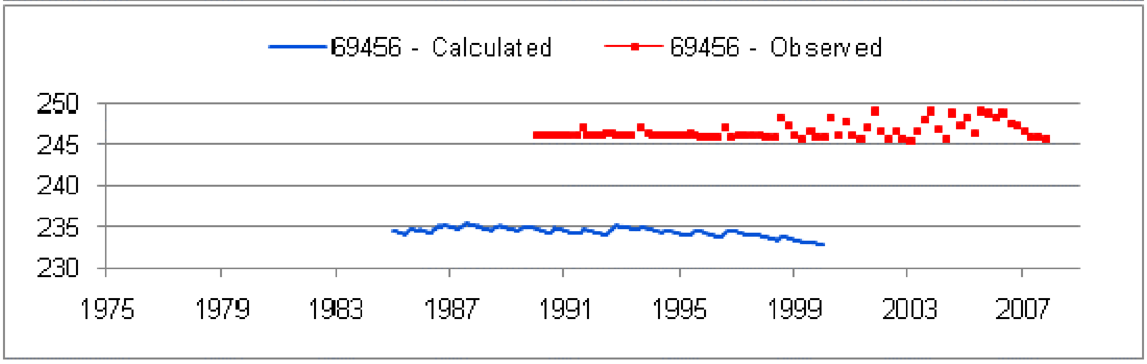
69456 - Calculated
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2003
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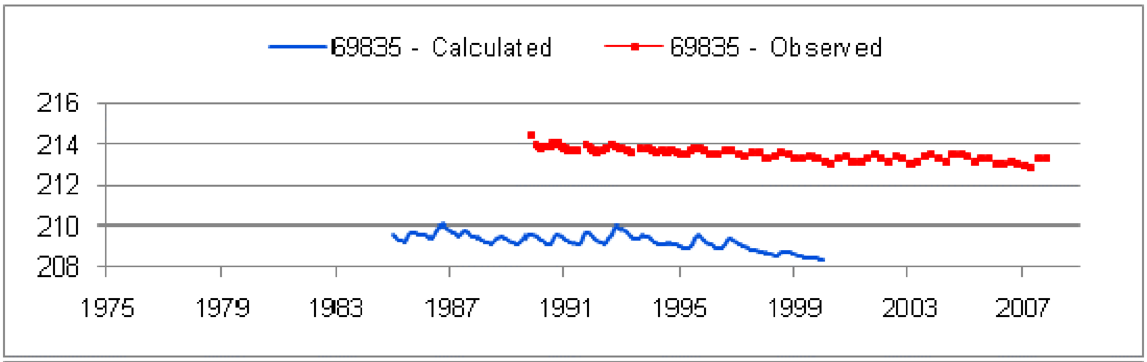
69835 - Calculated
69835 - Observed
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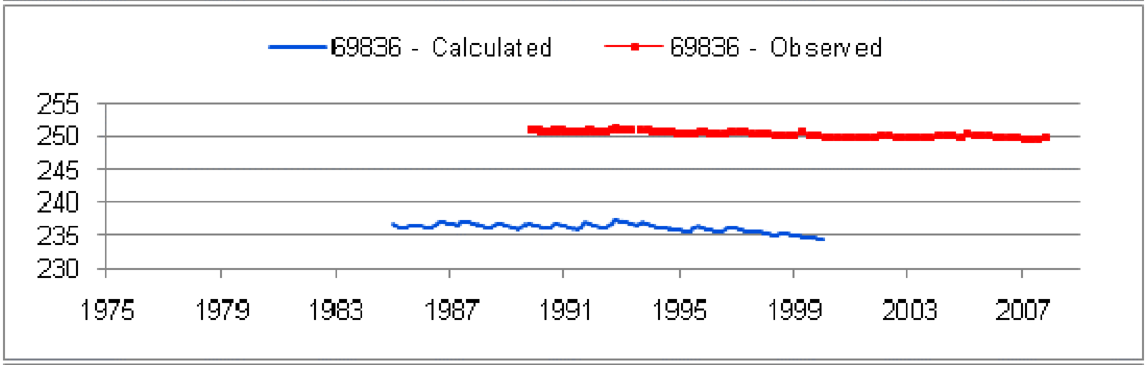
69836 - Calculated
69836 - Observed
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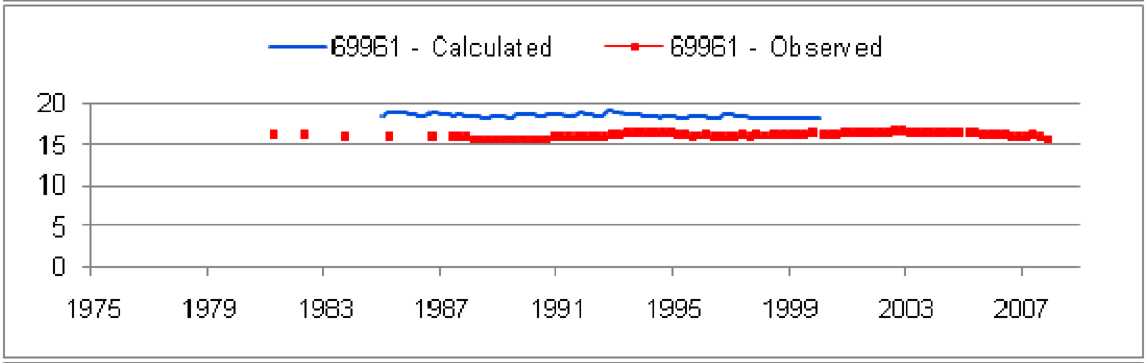
69961 - Calculated
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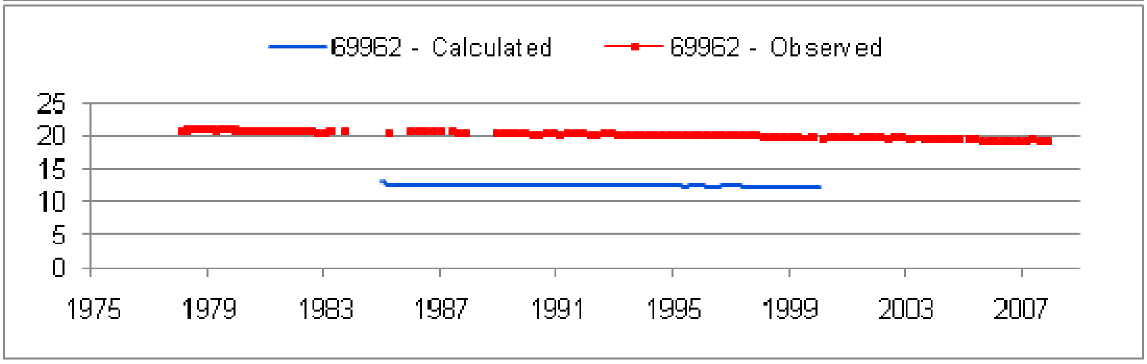
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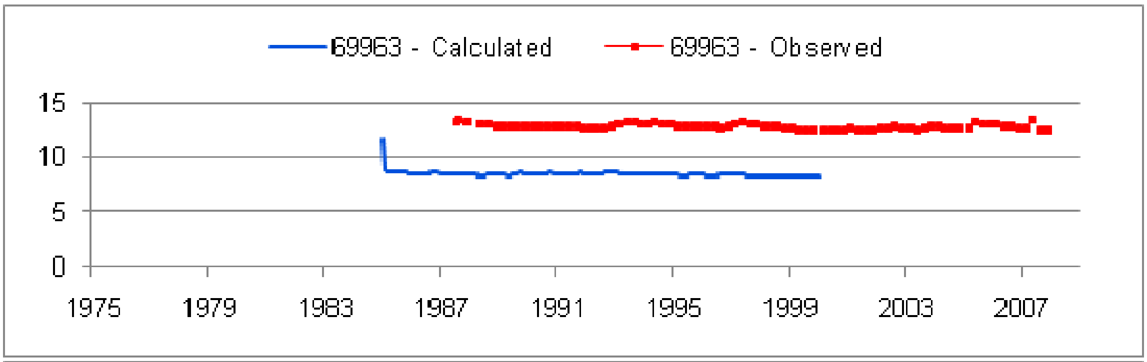
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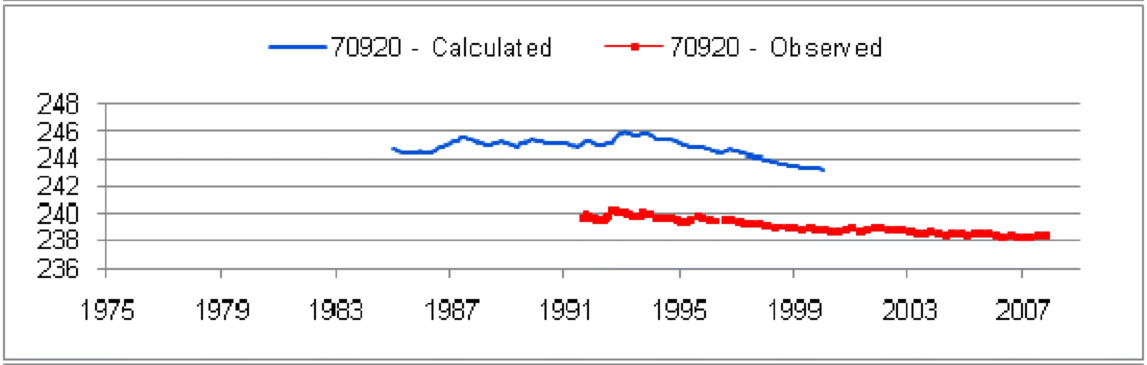
70920 - Calculated
70920 - Observed
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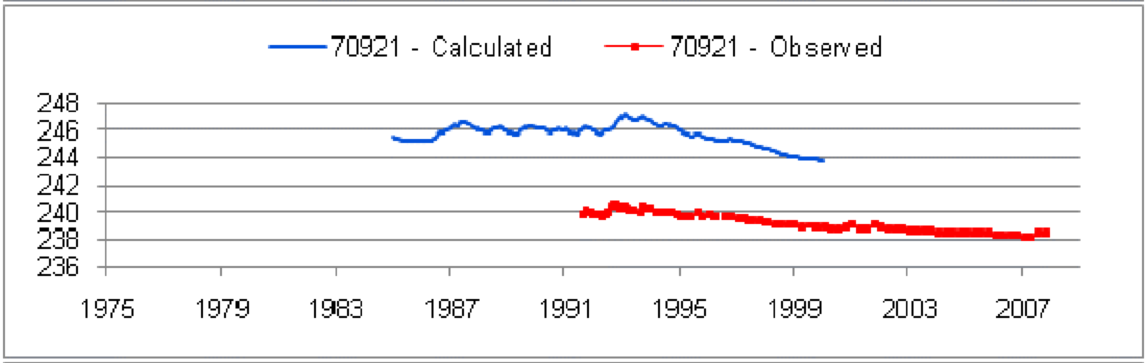
70921 - Calculated
70921 - Observed
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236
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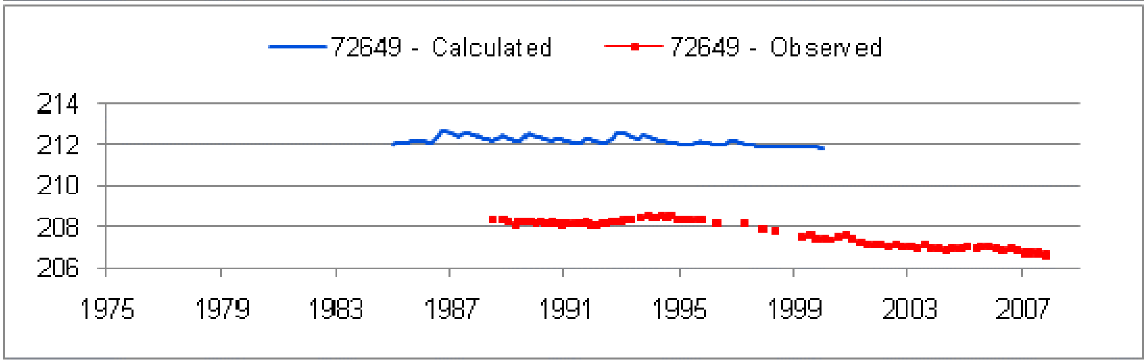
72649 - Calculated
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214
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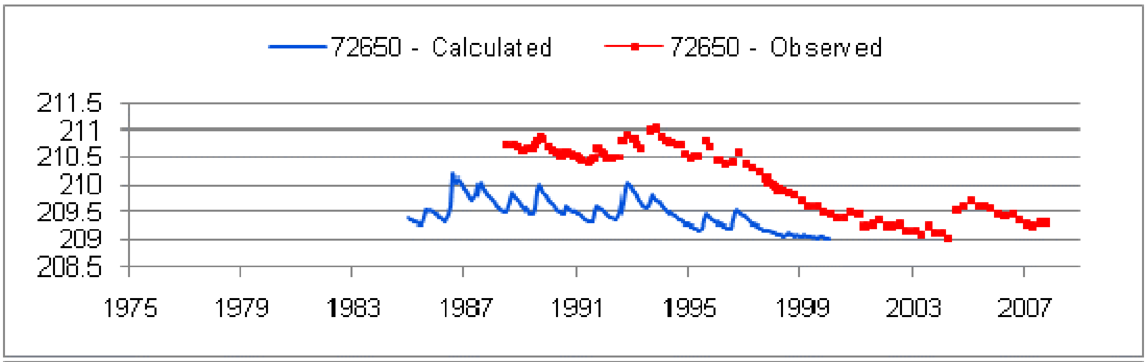
2007

SKM



72650 - Calculated
72650 - Observed
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210.5
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208.5
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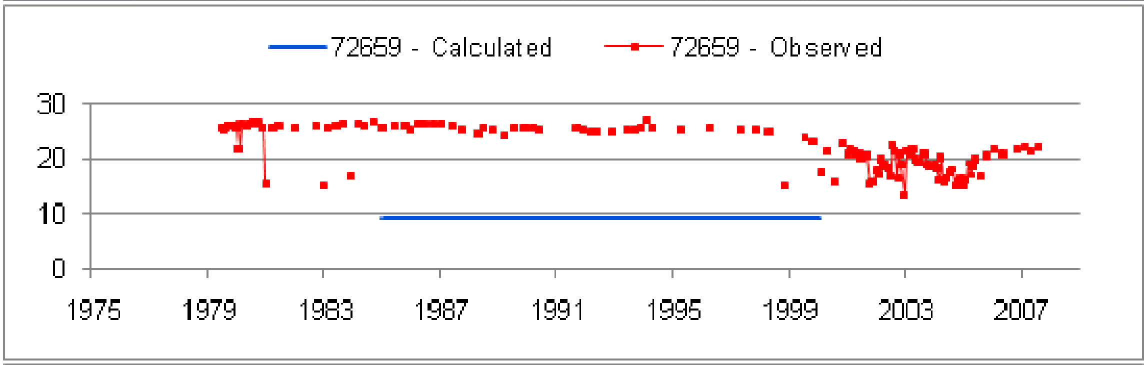

72659 - Calculated
72659 - Observed
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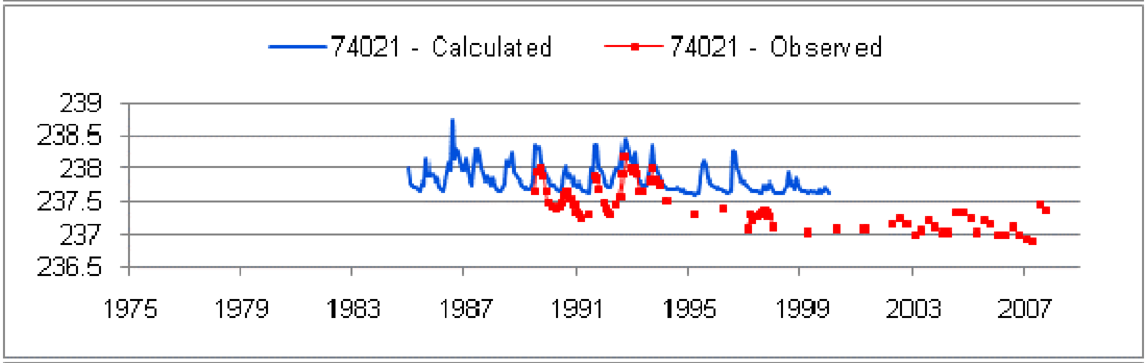
2003
2007



74021 - Calculated
74021 - Observed
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238.5
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237.5
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236.5
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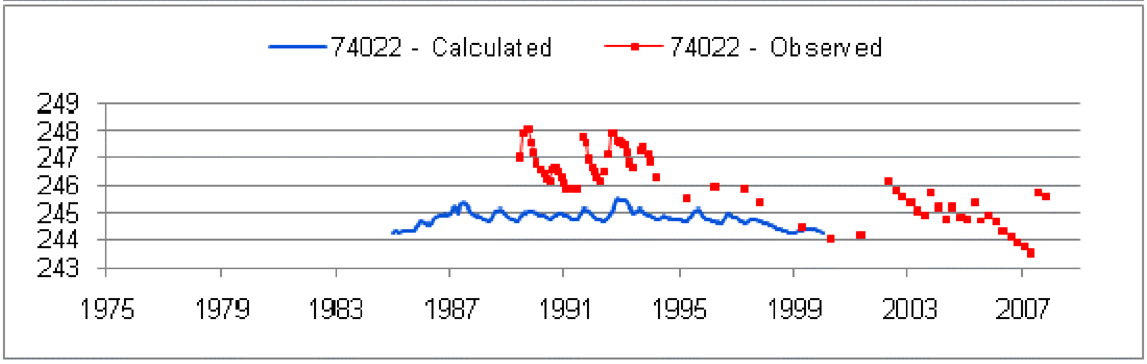

74022 - Calculated
74022 - Observed
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248
247
246
245
244
243
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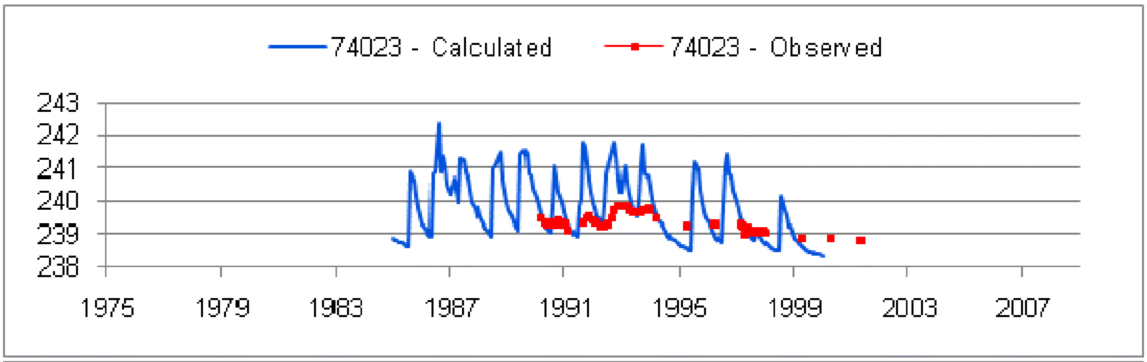
2003
2007


74023 - Calculated
74023 - Observed
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240
239
238
1975
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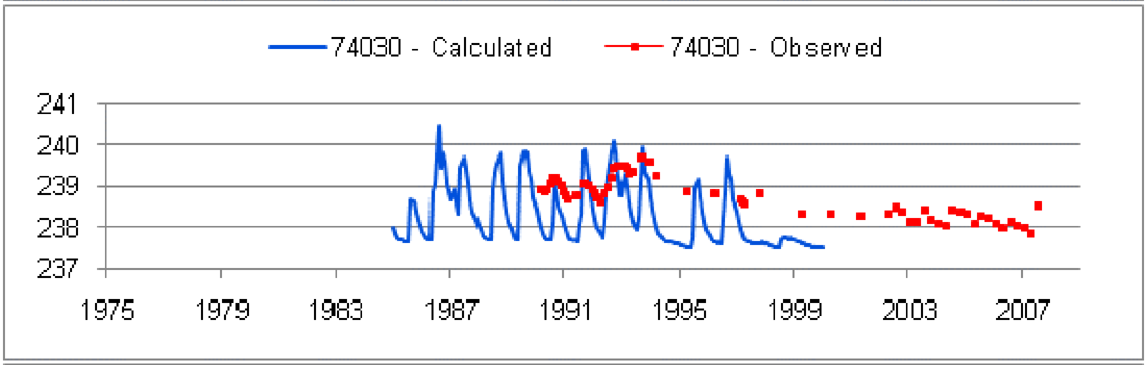
2003
2007


74030 - Calculated
74030 - Observed
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237
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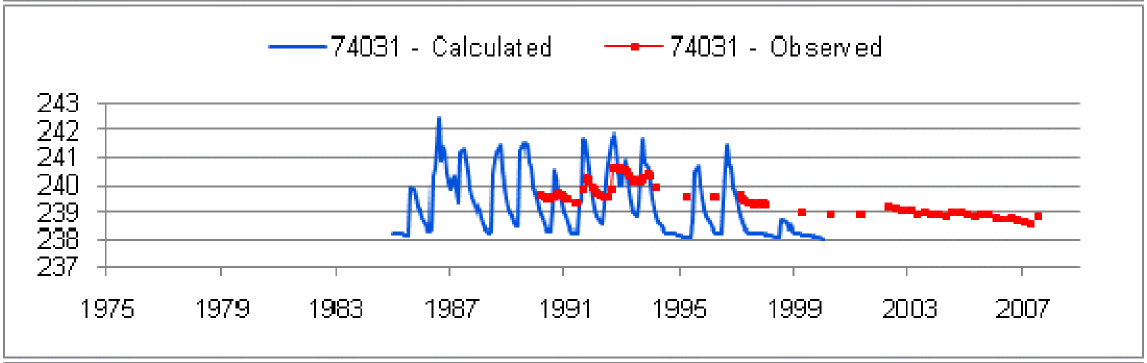
2003
2007


74031 - Calculated
74031 - Observed
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237
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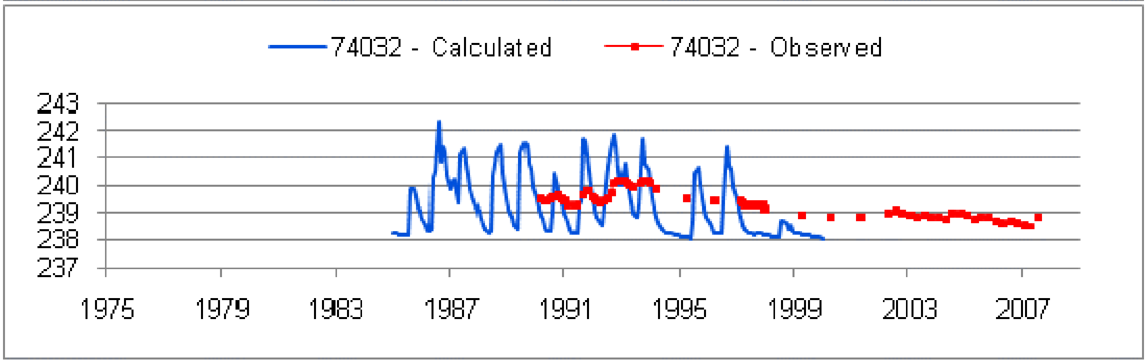
2003
2007


74032 - Calculated
74032 - Observed
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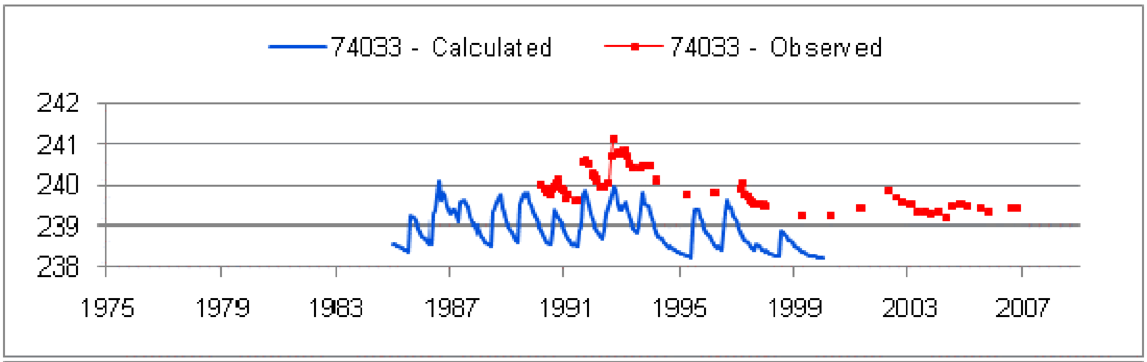
74033 - Calculated
74033 - Observed
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239
238
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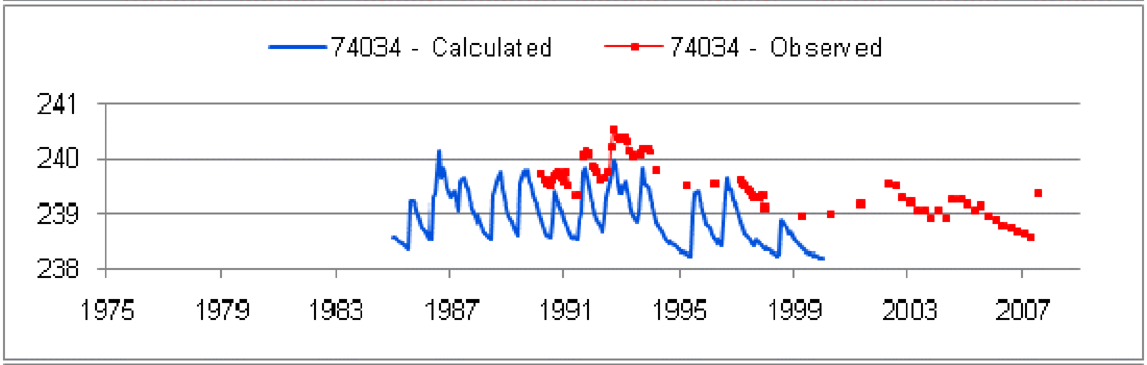
2003
2007


74034 - Calculated
74034 - Observed
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238
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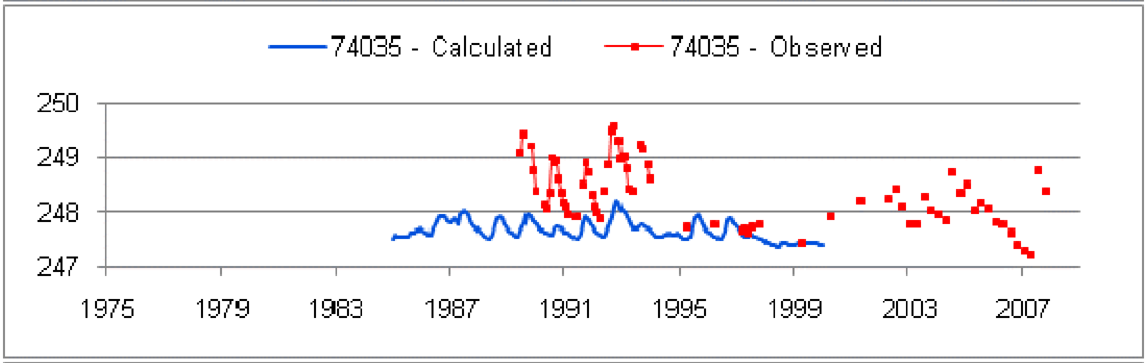
2003
2007


74035 - Calculated
74035 - Observed
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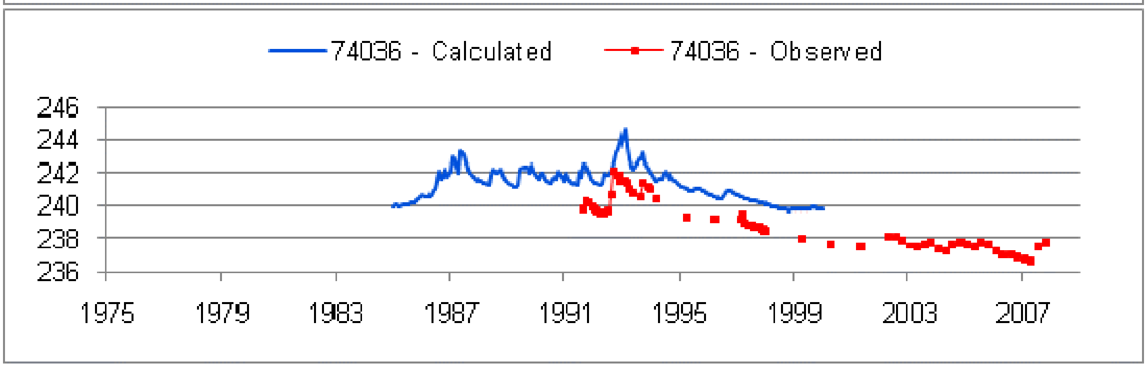
2007


74036 - Calculated
74036 - Observed
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238
236
1975
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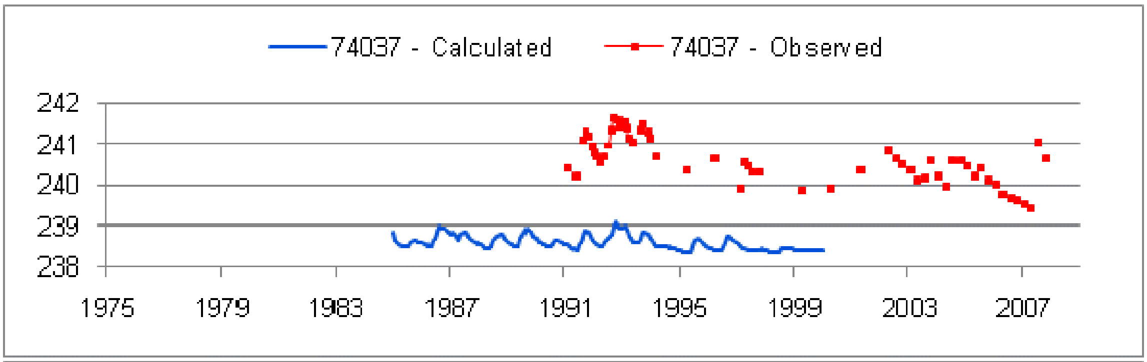
2003
2007



74037 - Calculated
74037 - Observed
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240
239
238
1975
1979
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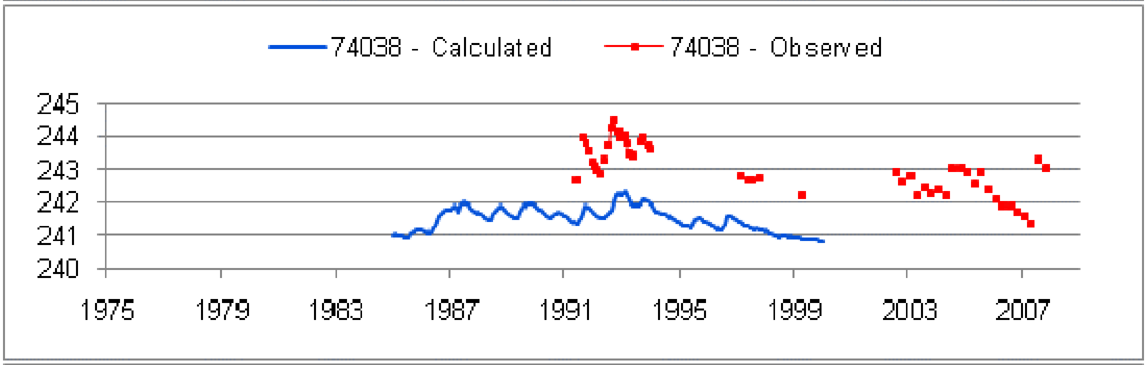
1991
1995
1999
2003
2007



74038 - Calculated
74038 - Observed
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244
243
242
241
240
1975
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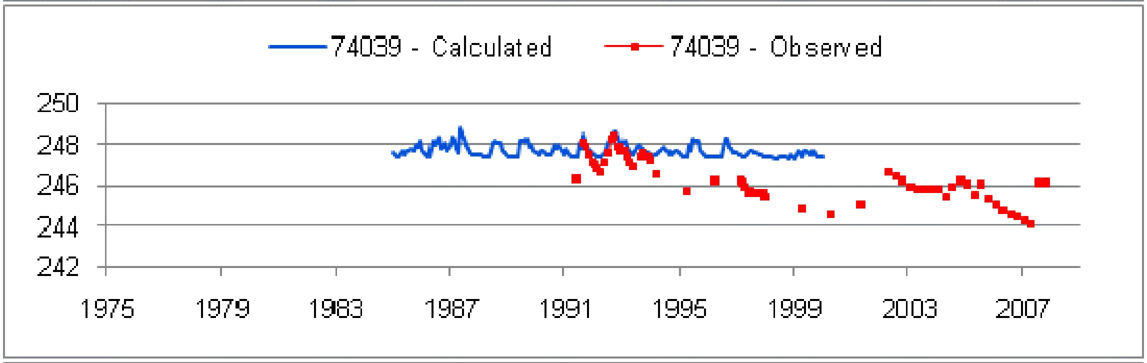
1983
1987
1991
1995
1999
2003
2007



74039 - Calculated
74039 - Observed
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248
246
244
242
1975
1979
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1987
1991
1995
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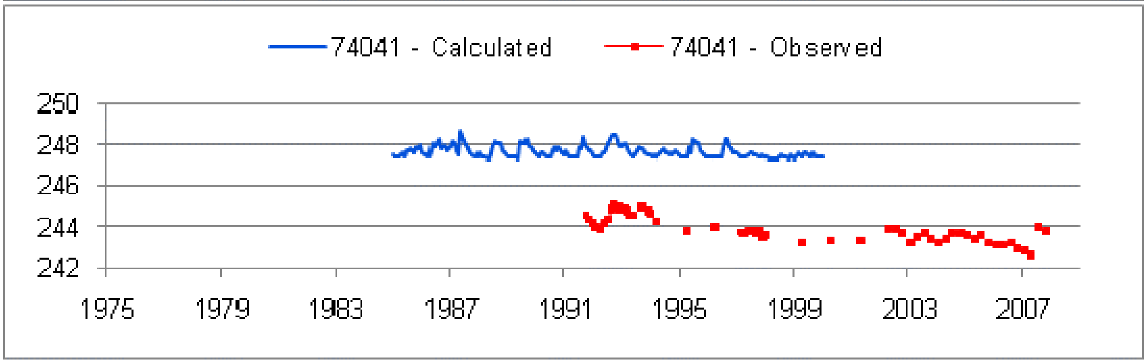
2003
2007



74041 - Calculated
74041 - Observed
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248
246
244
242
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1979
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1987
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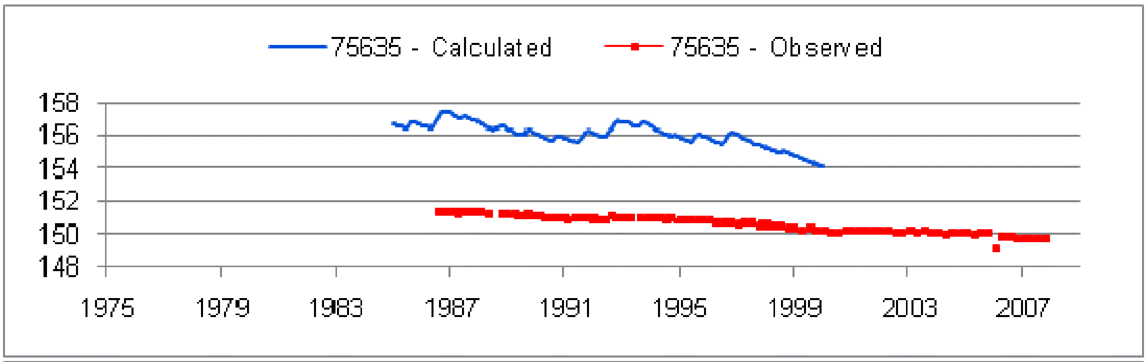
1995
1999
2003
2007



75635 - Calculated
75635 - Observed
158
156
154
152
150
148
1975
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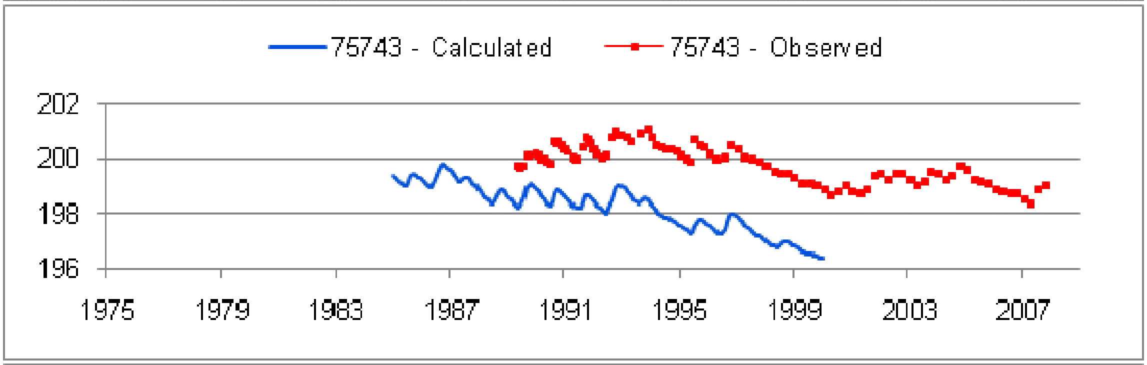
1999
2003
2007



75743 - Calculated
75743 - Observed
202
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198
196
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1995
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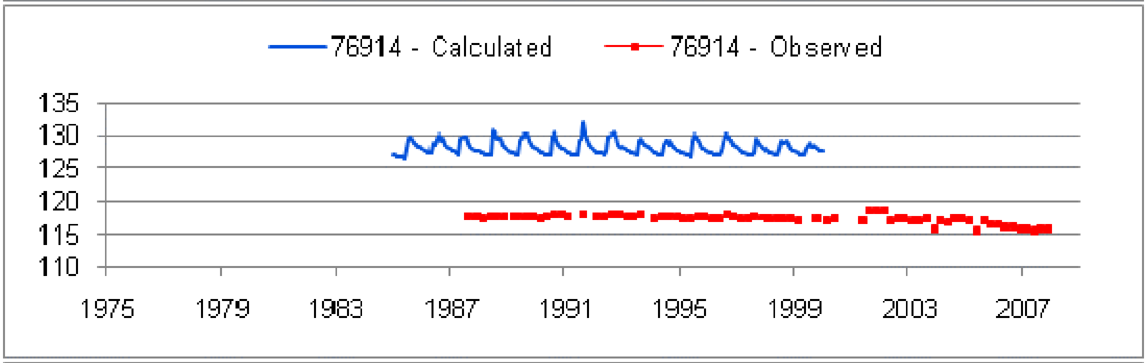
2003
2007



76914 - Calculated
76914 - Observed
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115
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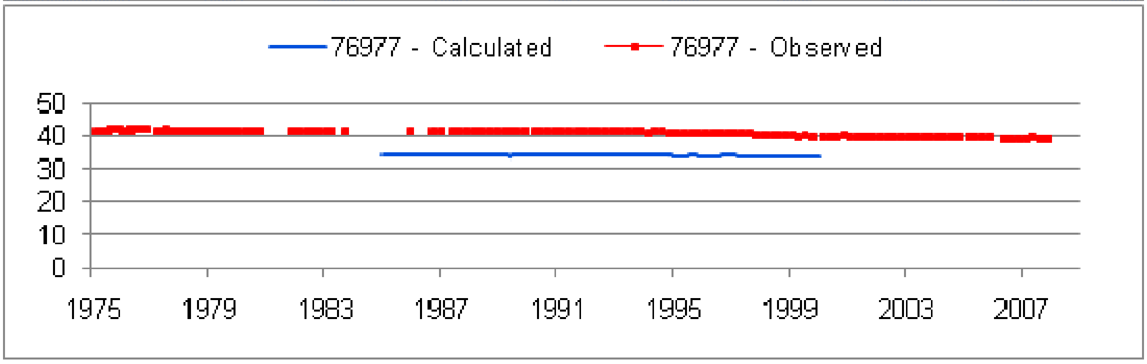
2003
2007



76977 - Calculated
76977 - Observed
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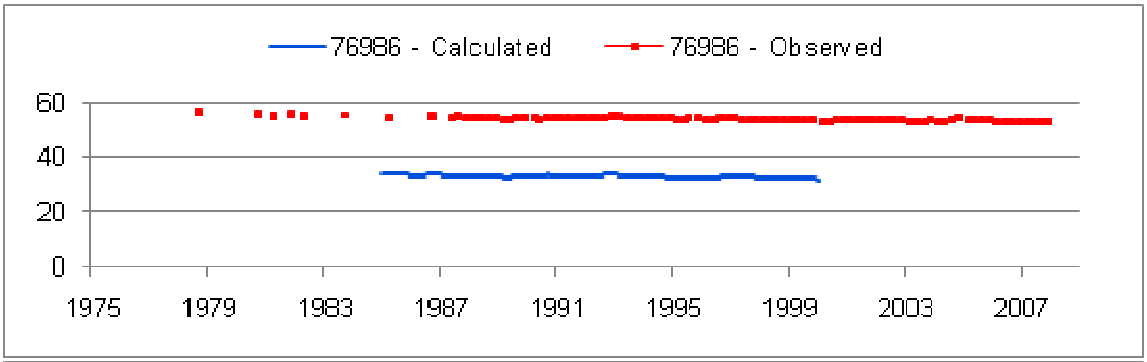
2003
2007


76986 - Calculated
76986 - Observed
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2003
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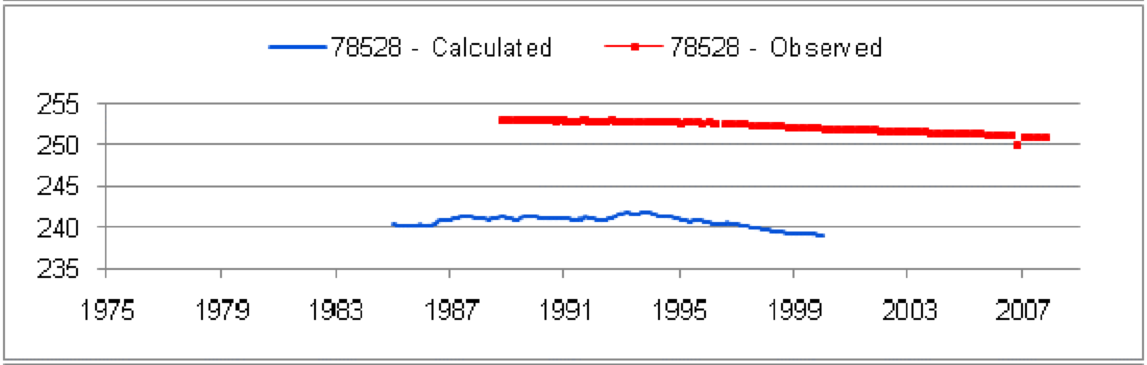
78528 - Calculated
78528 - Observed
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2003
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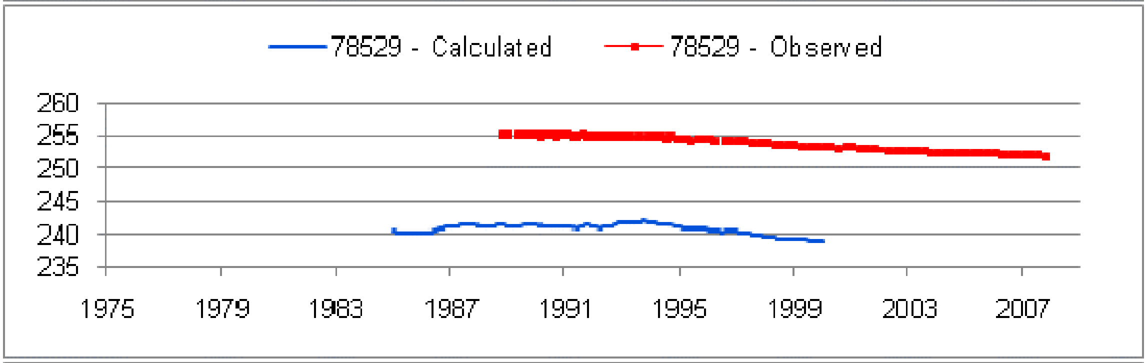
78529 - Calculated
78529 - Observed
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240
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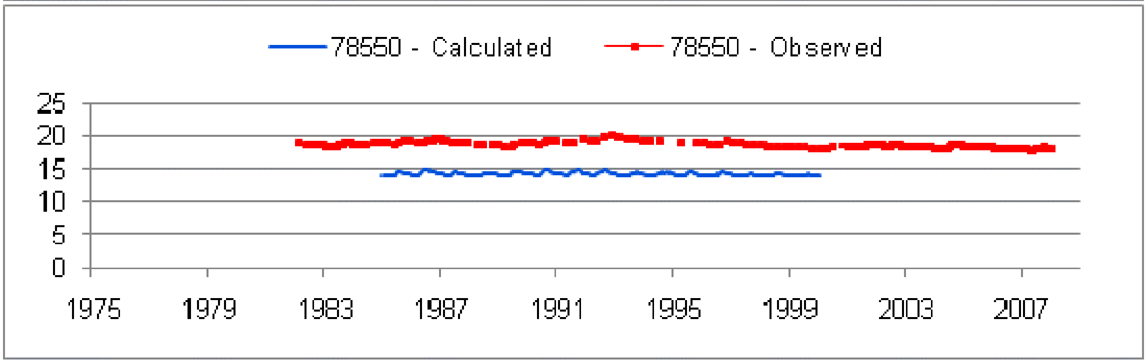
78550 - Calculated
78550 - Observed
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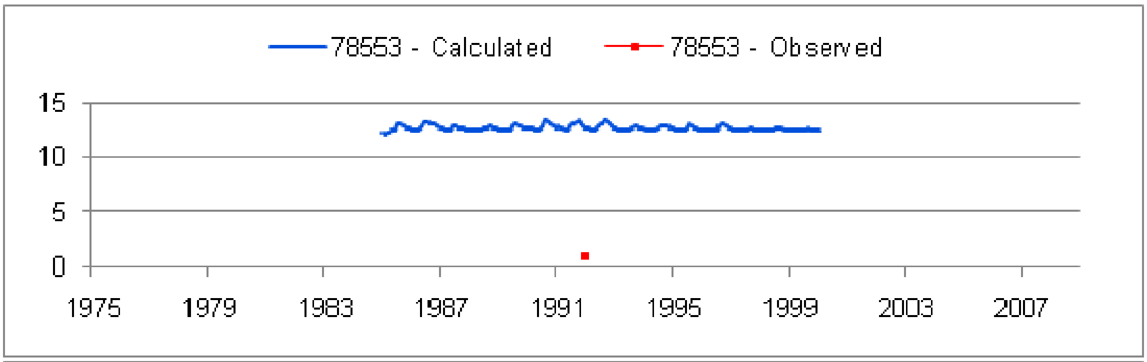
2003
2007


78553 - Calculated
78553 - Observed
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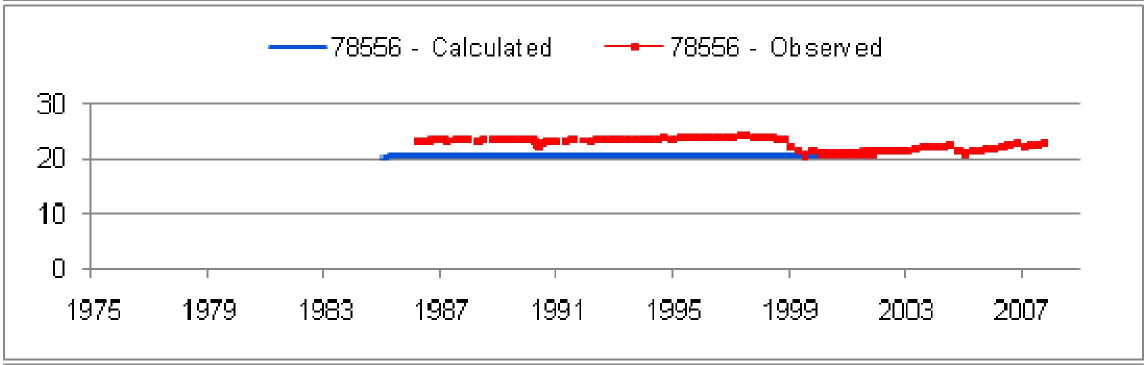
2003
2007


78556 - Calculated
78556 - Observed
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1995
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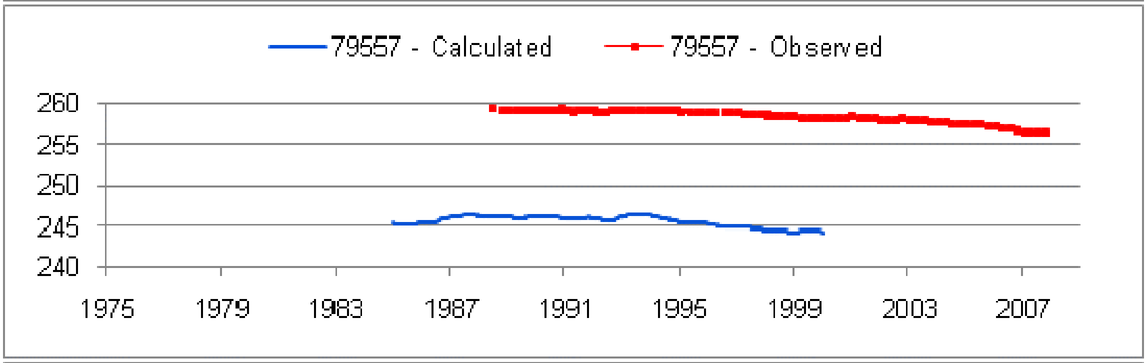
2003
2007


79557 - Calculated
79557 - Observed
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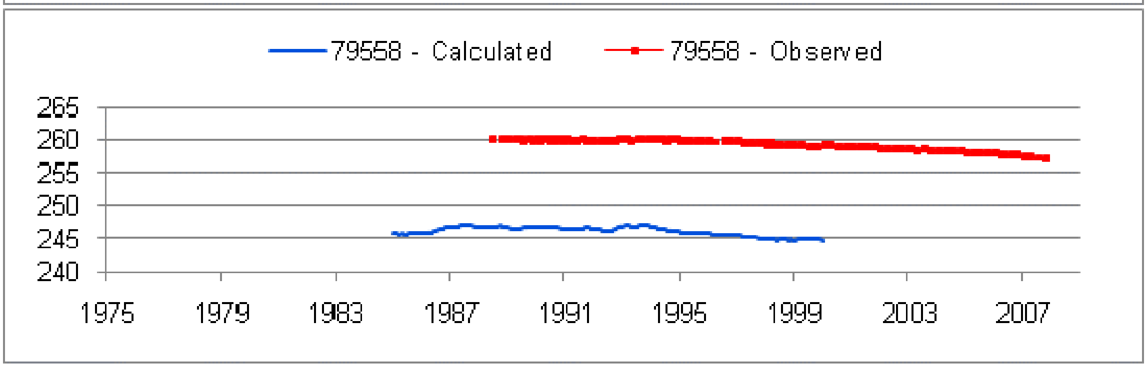
1995
1999
2003
2007


79558 - Calculated
79558 - Observed
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250
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240
1975
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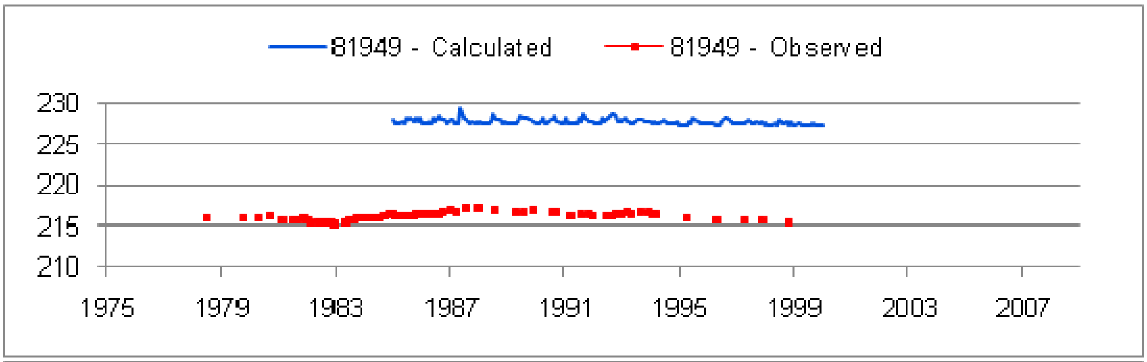
1983
1987
1991
1995
1999
2003
2007

SKM



81949 - Calculated
81949 - Observed
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215
210
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1979
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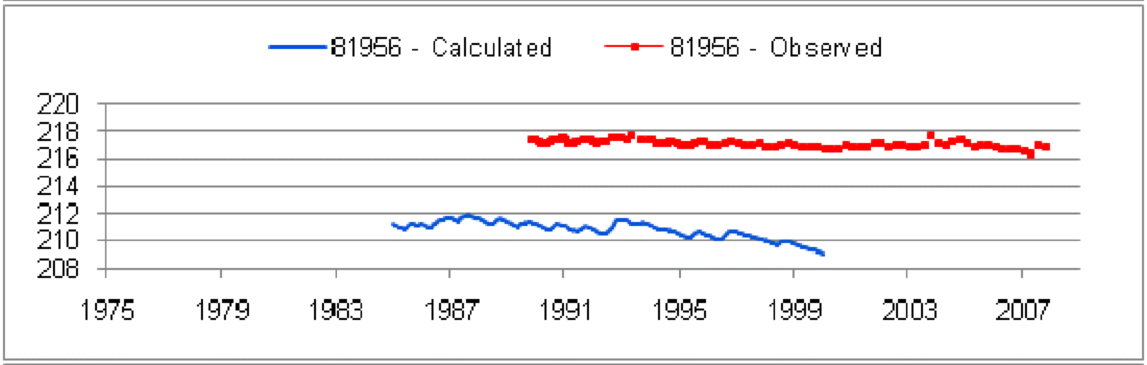
1991
1995
1999
2003
2007



81956 - Calculated
81956 - Observed
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212
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208
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1979
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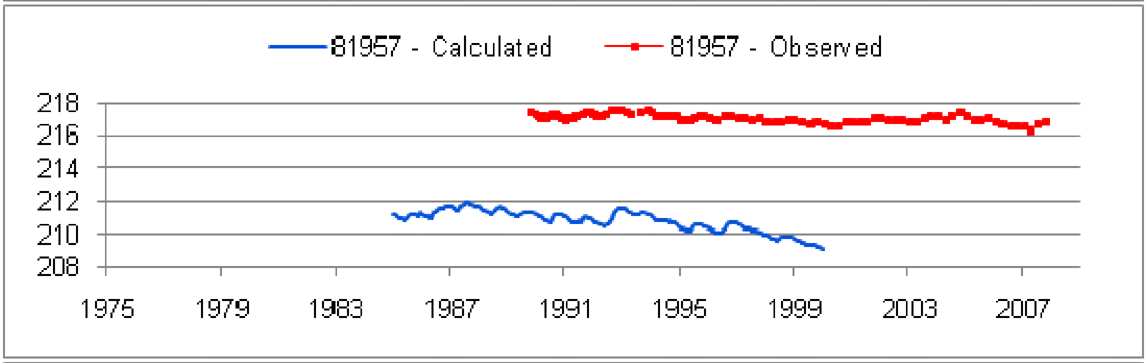
1987
1991
1995
1999
2003
2007



81957 - Calculated
81957 - Observed
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216
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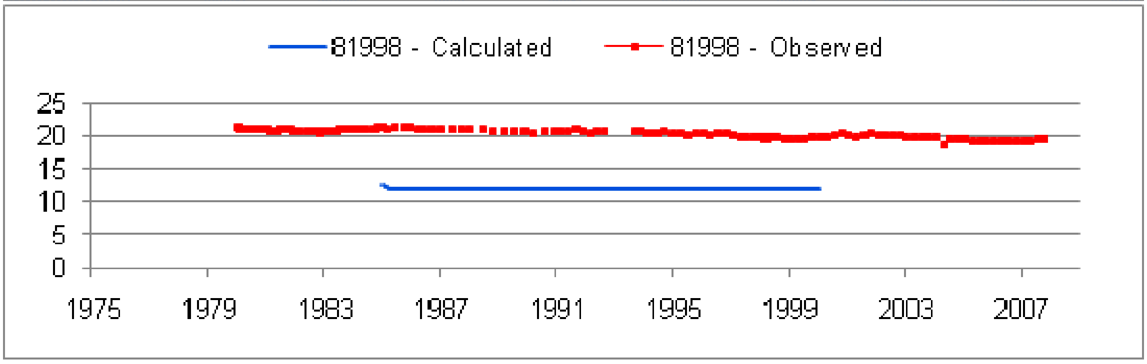
212
210
208
1975
1979
1983
1987
1991
1995
1999
2003
2007



81998 - Calculated
81998 - Observed
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10
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1983
1987
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2003
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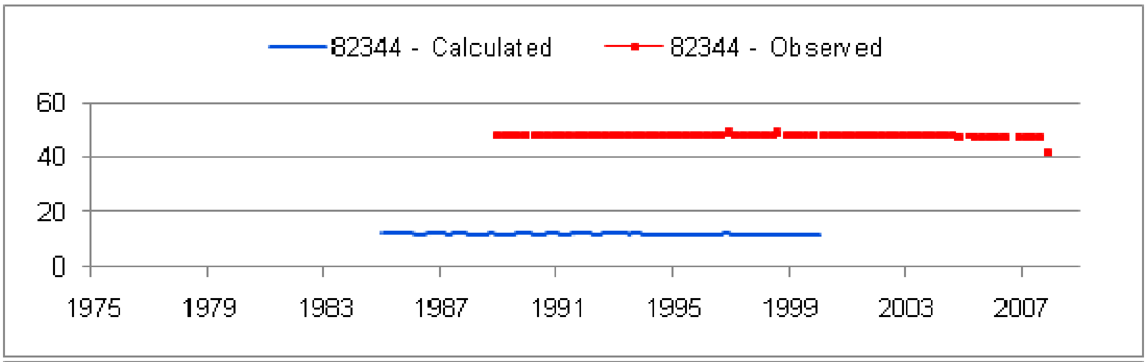
82344 - Calculated
82344 - Observed
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1979
1983
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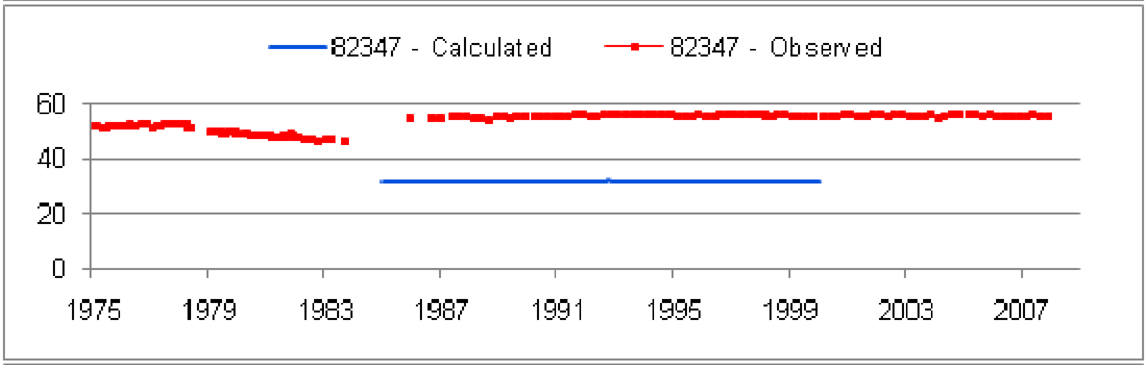
1991
1995
1999
2003
2007


82347 - Calculated
82347 - Observed
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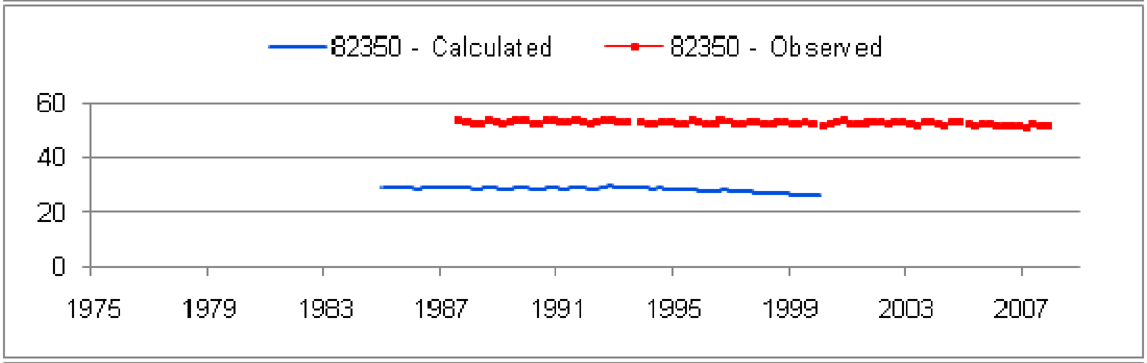
0
1975
1979
1983
1987
1991
1995
1999
2003
2007


82350 - Calculated
82350 - Observed
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0
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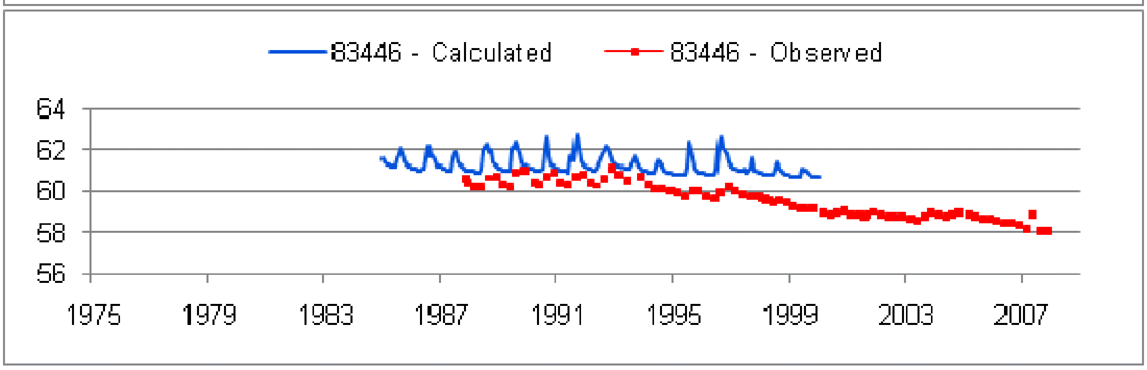
1979
1983
1987
1991
1995
1999
2003
2007


83446 - Calculated
83446 - Observed
64
62
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58
56
1975
1979
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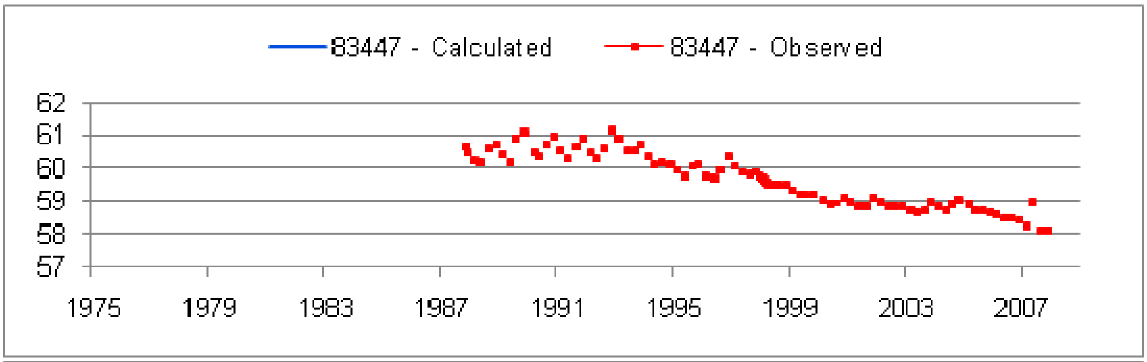
1987
1991
1995
1999
2003
2007


83447 - Calculated
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59
58
57
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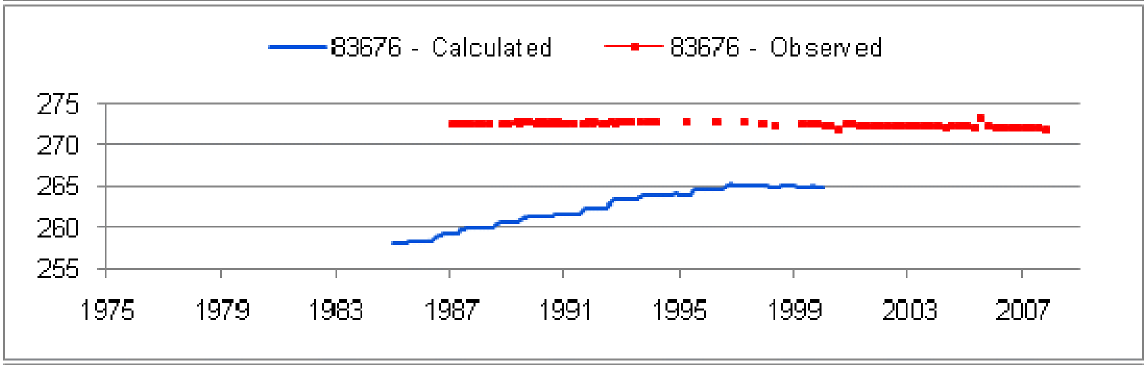
2003
2007


83676 - Calculated
83676 - Observed
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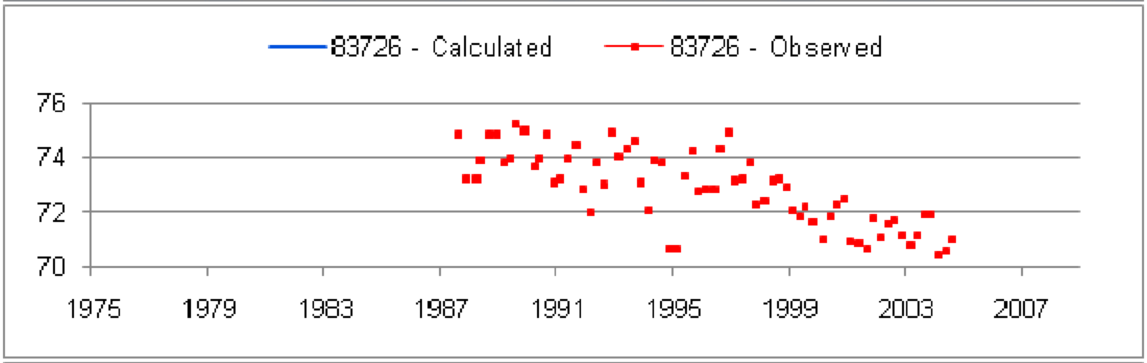
270
265
260
255
1975
1979
1983
1987
1991
1995
1999
2003
2007


83726 - Calculated
83726 - Observed
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74
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70
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1995
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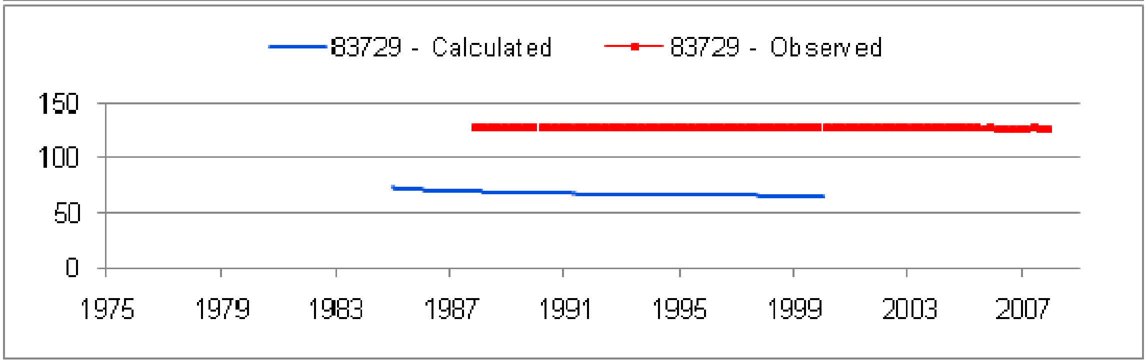
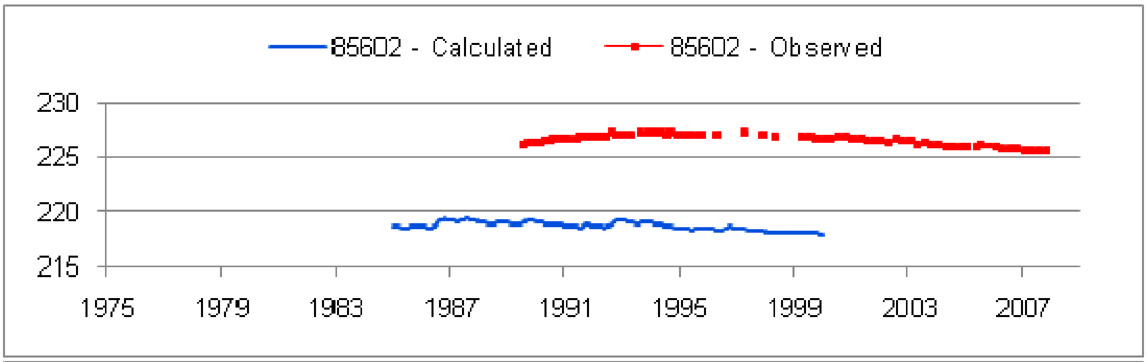
2003
2007


83729 - Calculated
83729 - Observed
150
100
50
0
1975
1979
1983
1987
1991
1995
1999
2003
2007



85602 - Calculated
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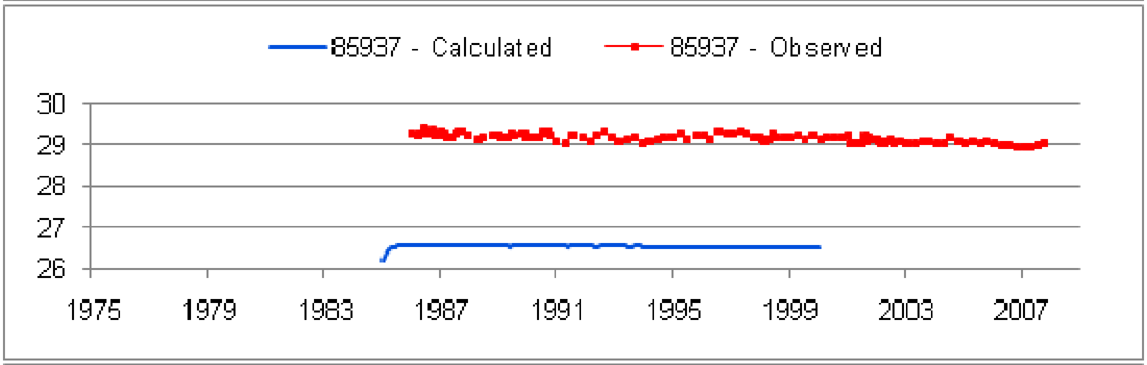

85937 - Calculated
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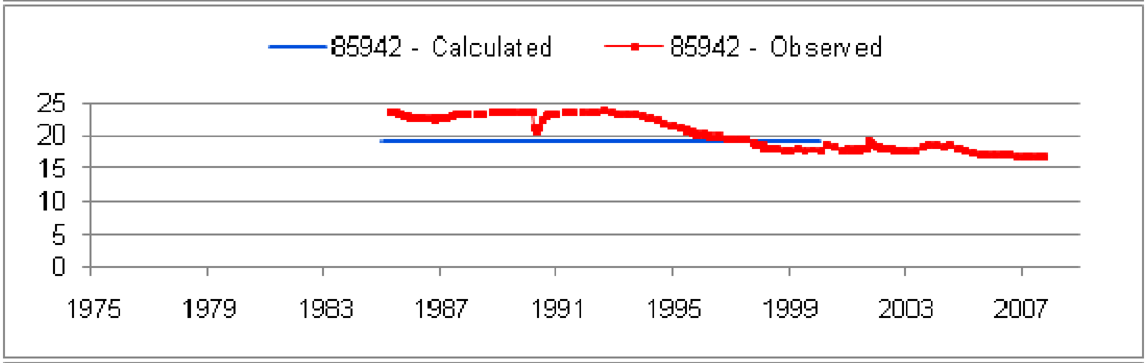

85942 - Calculated
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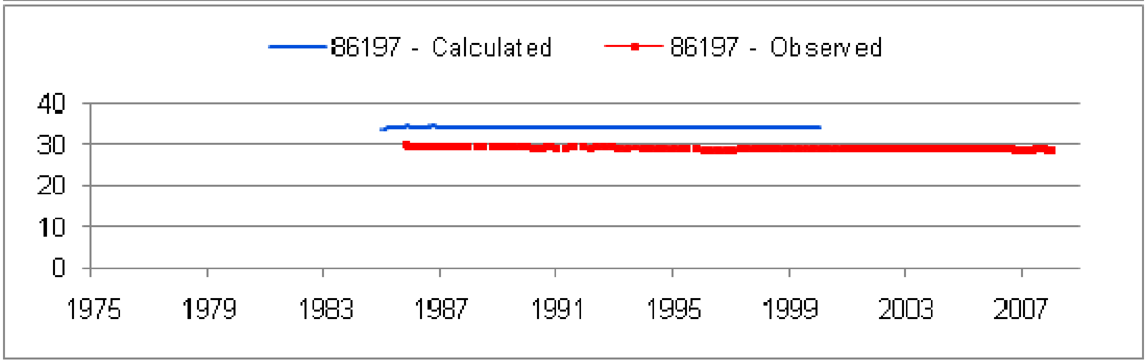

86197 - Calculated
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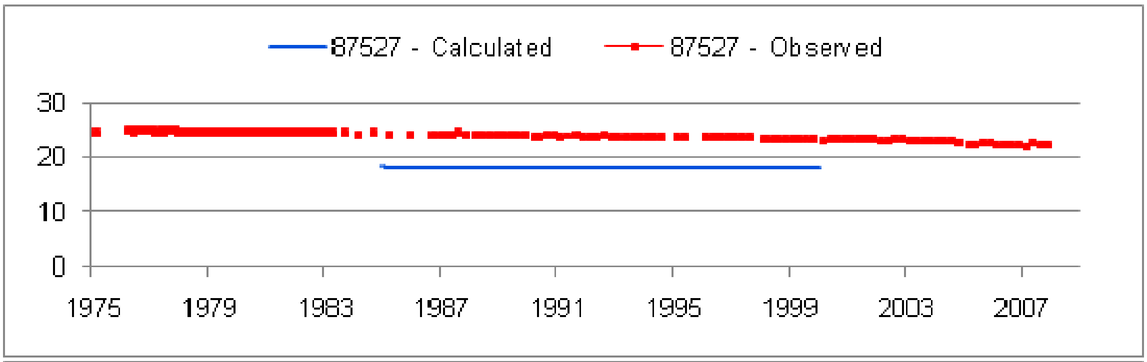
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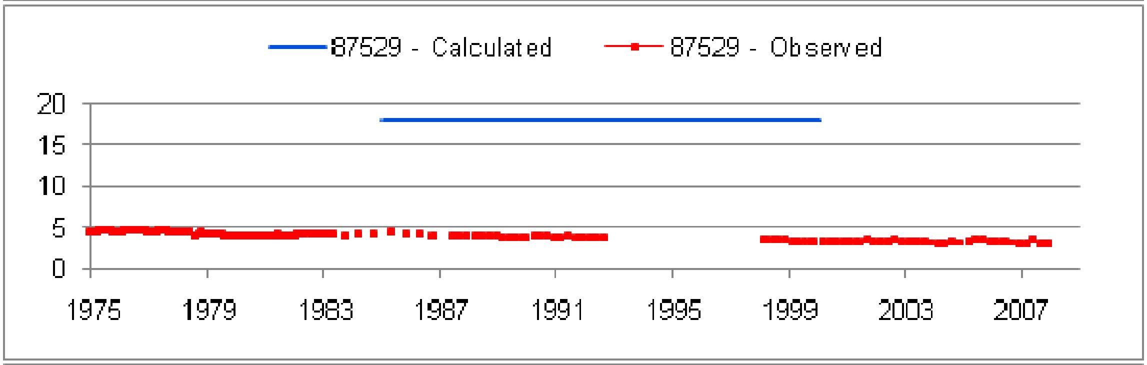
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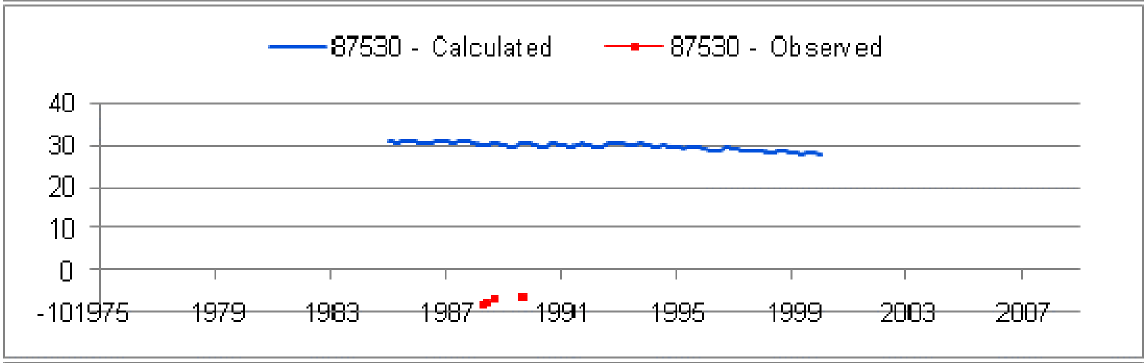
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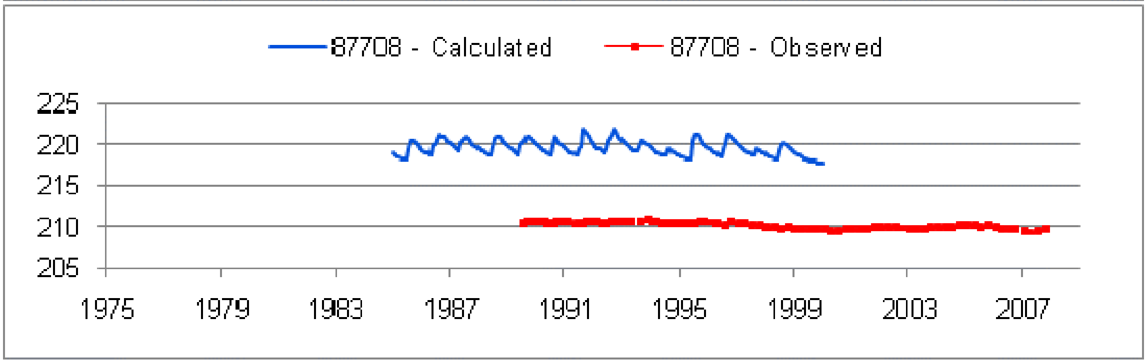
87708 - Calculated
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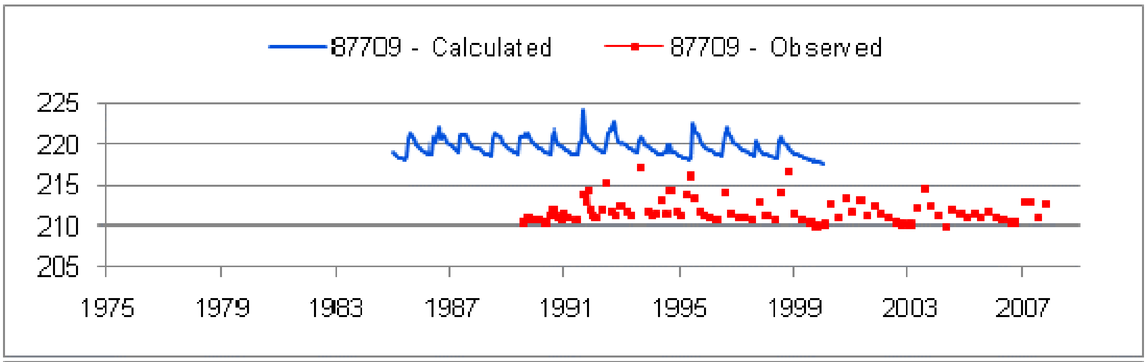
87709 - Calculated
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2003
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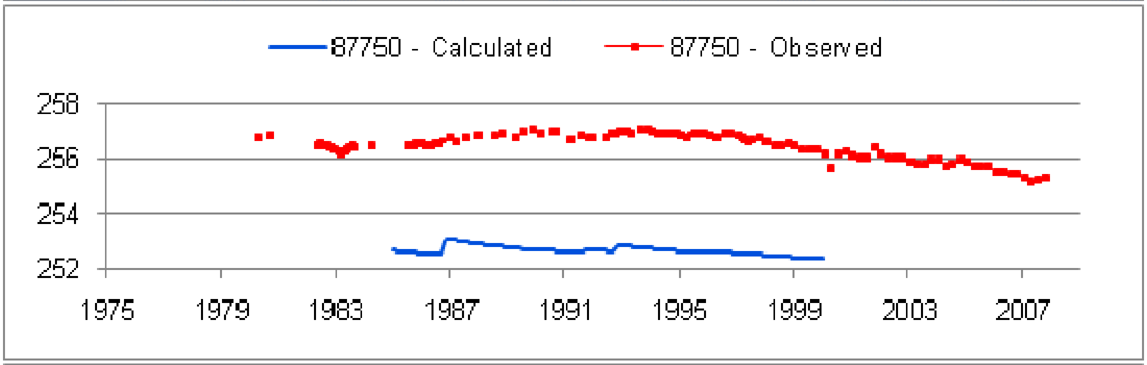
87750 - Calculated
87750 - Observed
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2003
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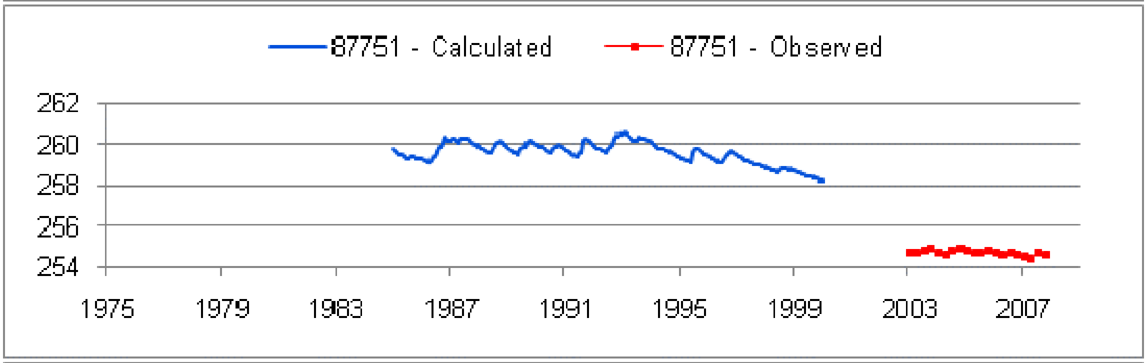
87751 - Calculated
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254
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1979
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2003
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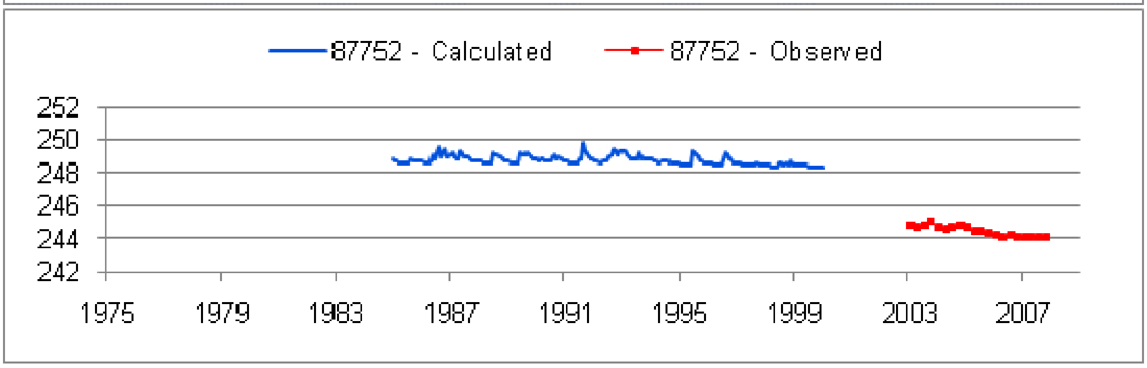
87752 - Calculated
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244
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2003
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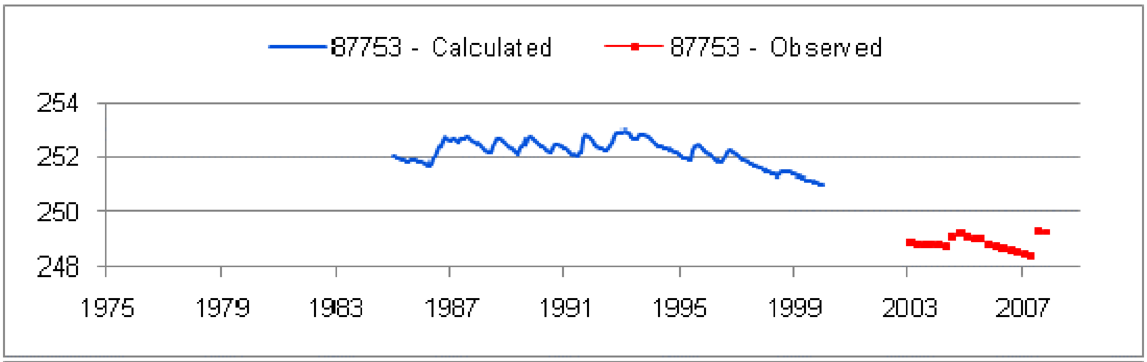
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254
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248
1975
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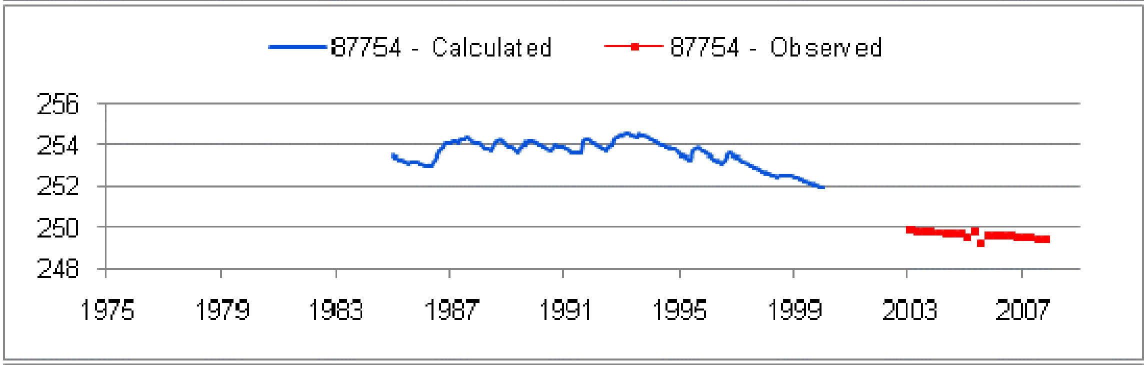
87754 - Calculated
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2003
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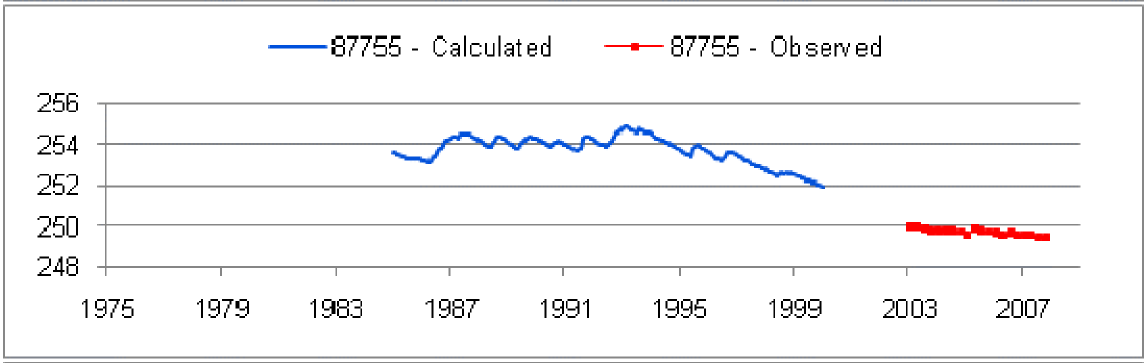
87755 - Calculated
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1979
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1995
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2003
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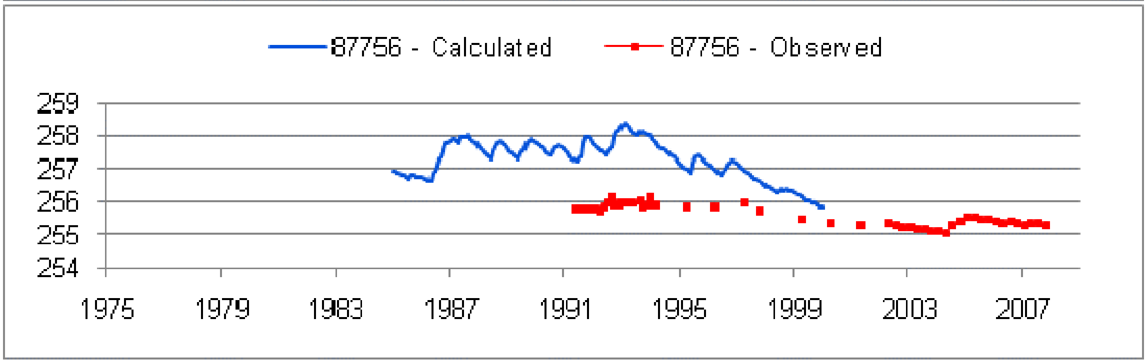
87756 - Calculated
87756 - Observed
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1975
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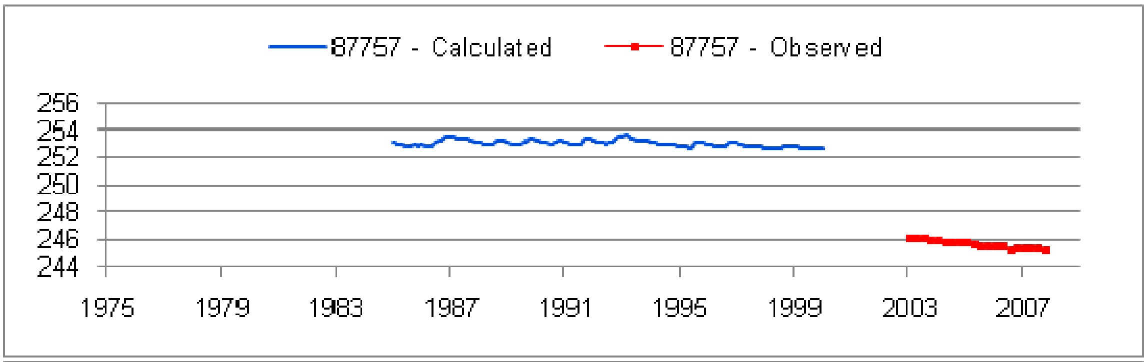
87757 - Calculated
87757 - Observed
256
254
252
250
248
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244
1975
1979
1983
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1995
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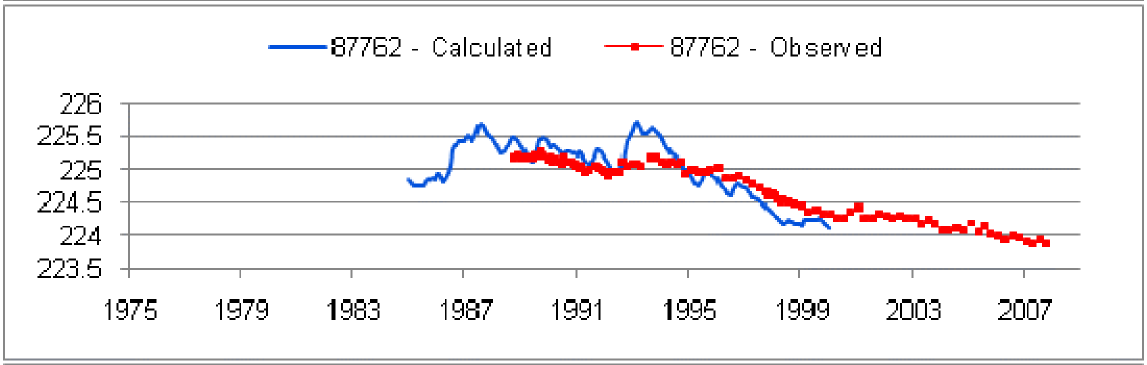
2003
2007


87762 - Calculated
87762 - Observed
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225.5
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224.5
224
223.5
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1979
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1995
1999
2003
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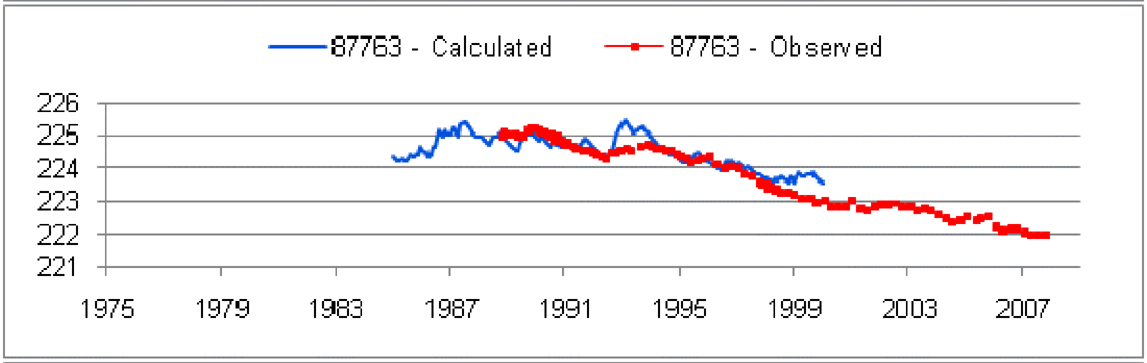
87763 - Calculated
87763 - Observed
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224
223
222
221
1975
1979
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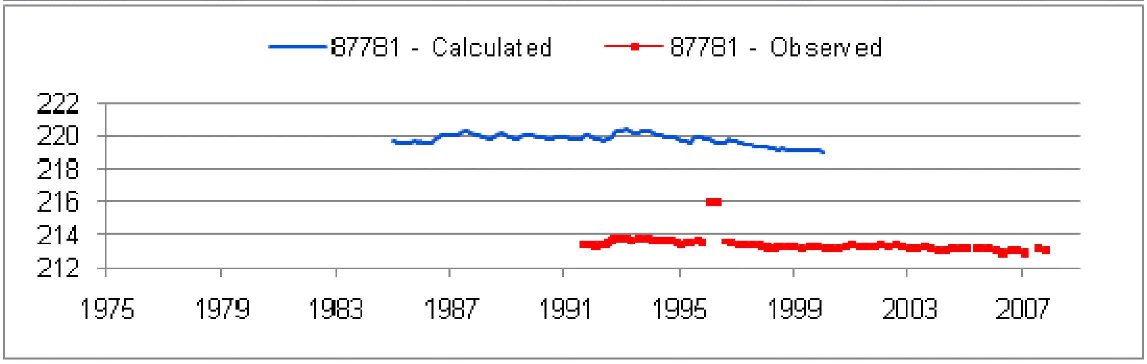
2003
2007


87781 - Calculated
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222
220
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216
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212
1975
1979
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1987
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1995
1999
2003
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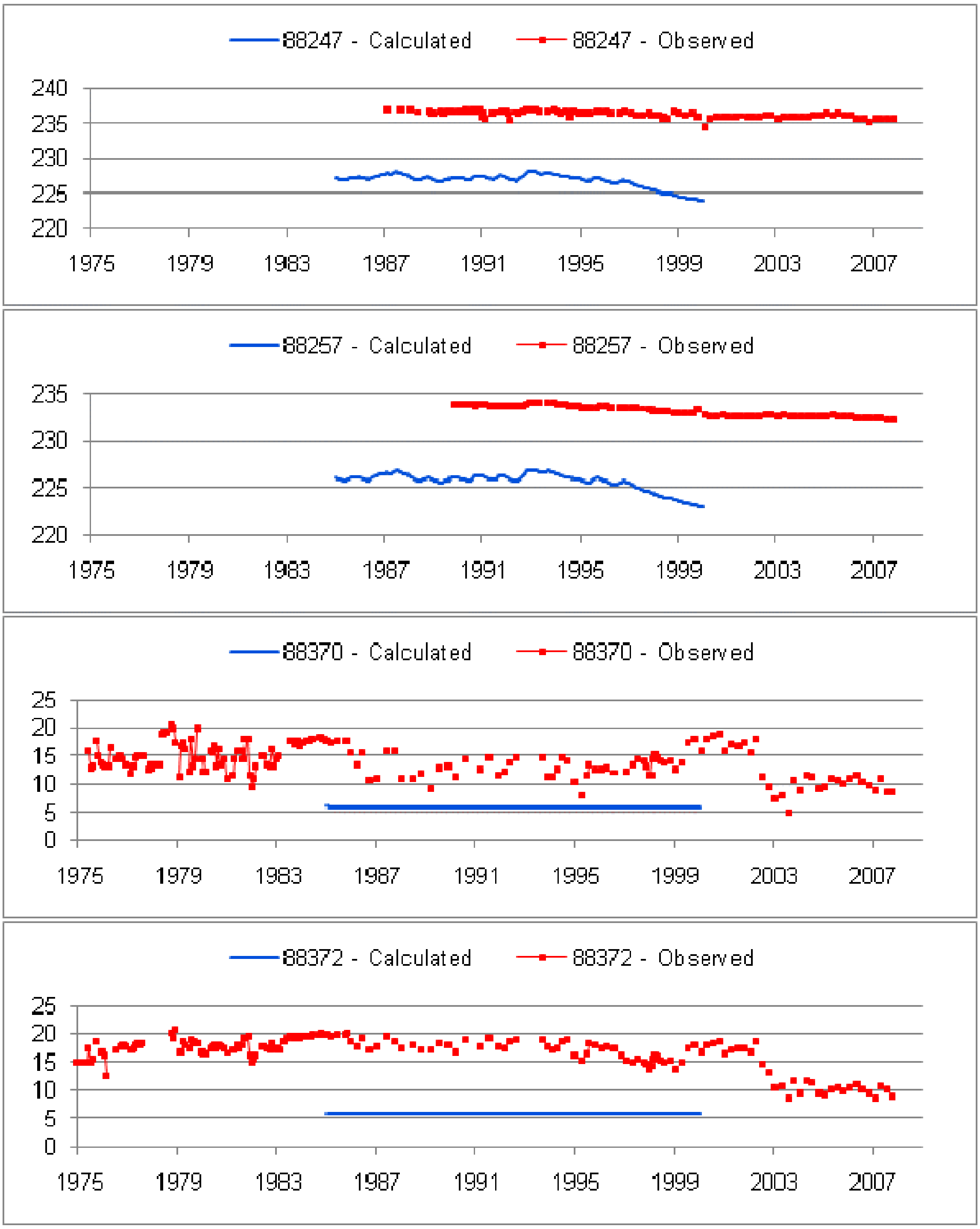

88247 - Calculated
88247 - Observed
240
235
230
225
220
1975
1979
1983
1987
1991
1995
1999
2003
2007
88257 - Calculated
88257 - Observed
235
230
225
220
1975
1979
1983
1987
1991
1995
1999
2003
2007
88370 - Calculated
88370 - Observed
25
20
15
10
5
0
1975
1979
1983
1987
1991
1995
1999
2003
2007
88372 - Calculated
88372 - Observed
25
20
15
10
5
0
1975
1979
1983
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1991
1995
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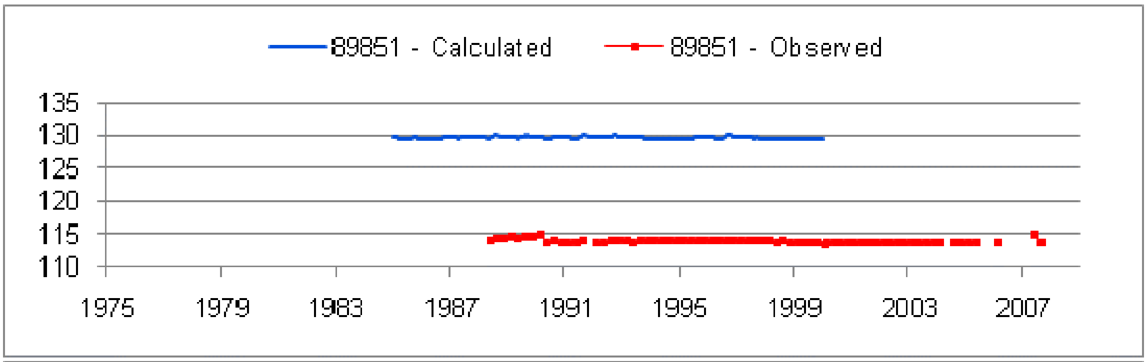
2003
2007


89851 - Calculated
89851 - Observed
135
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125
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115
110
1975
1979
1983
1987
1991
1995
1999
2003
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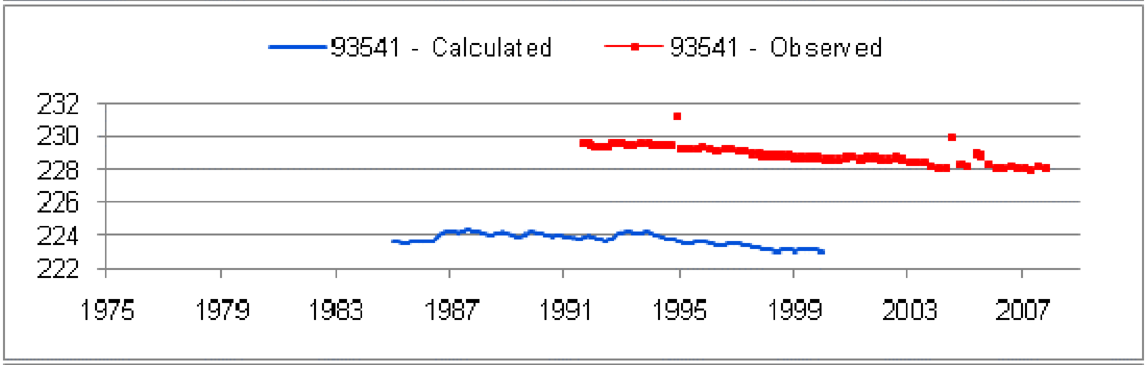
93541 - Calculated
93541 - Observed
232
230
228
226
224
222
1975
1979
1983
1987
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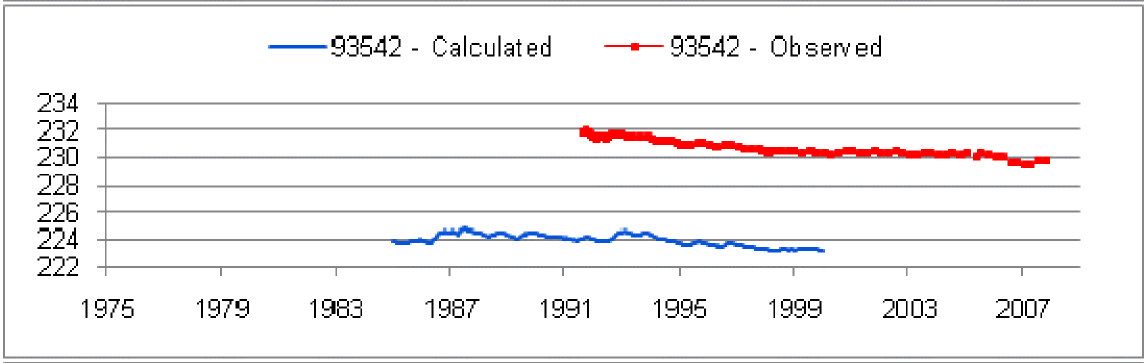
1995
1999
2003
2007


93542 - Calculated
93542 - Observed
234
232
230
228
226
224
222
1975
1979
1983
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2003
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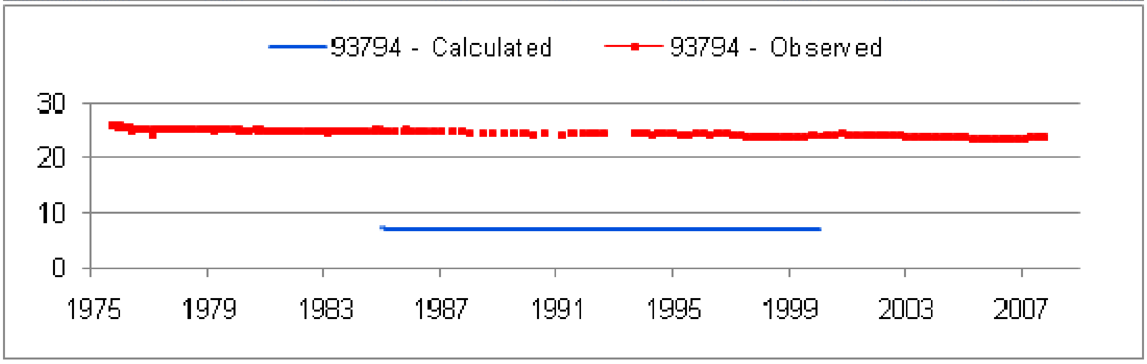
93794 - Calculated
93794 - Observed
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1979
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1995
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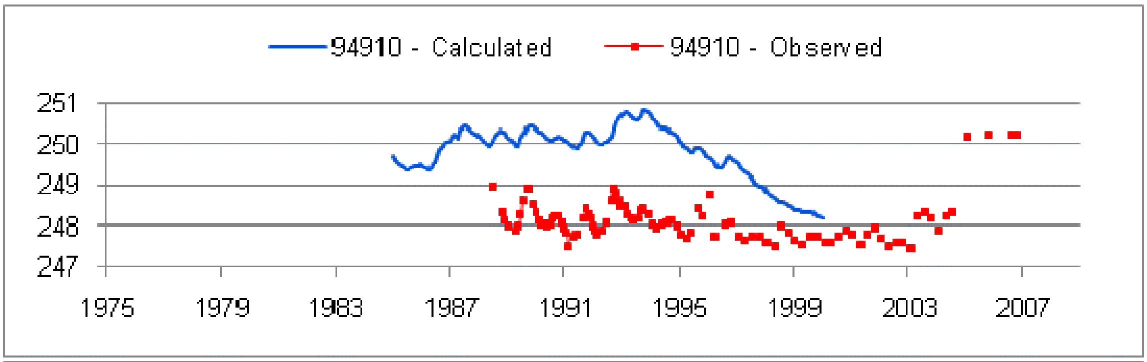
2003
2007



94910 - Calculated
94910 - Observed
251
250
249
248
247
1975
1979
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1987
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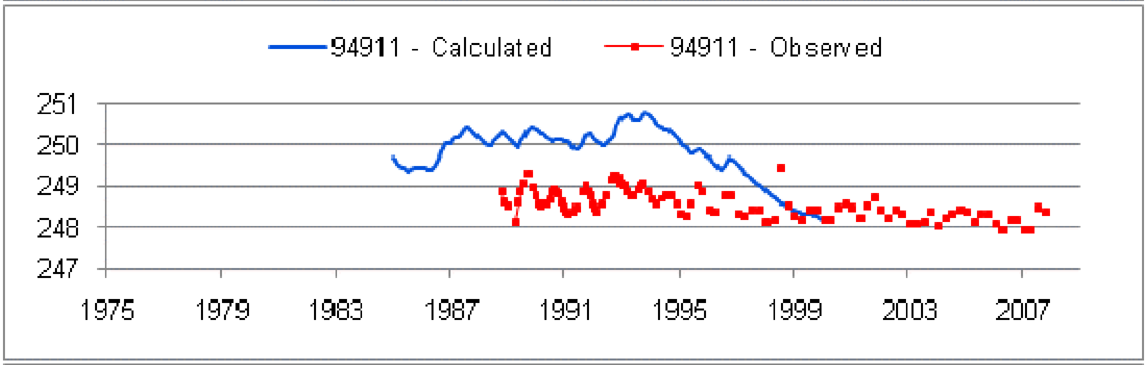
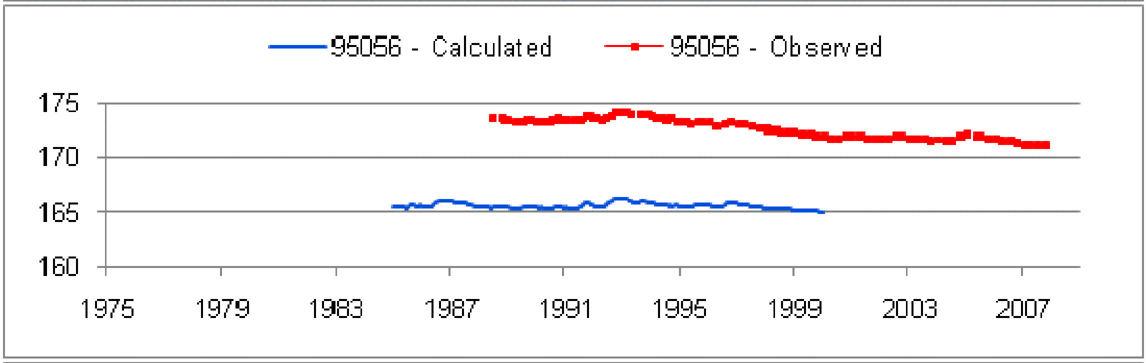
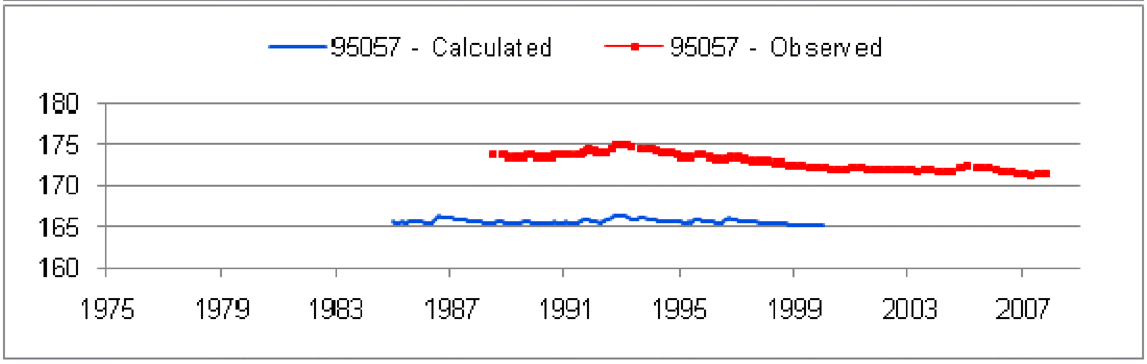
1995
1999
2003
2007



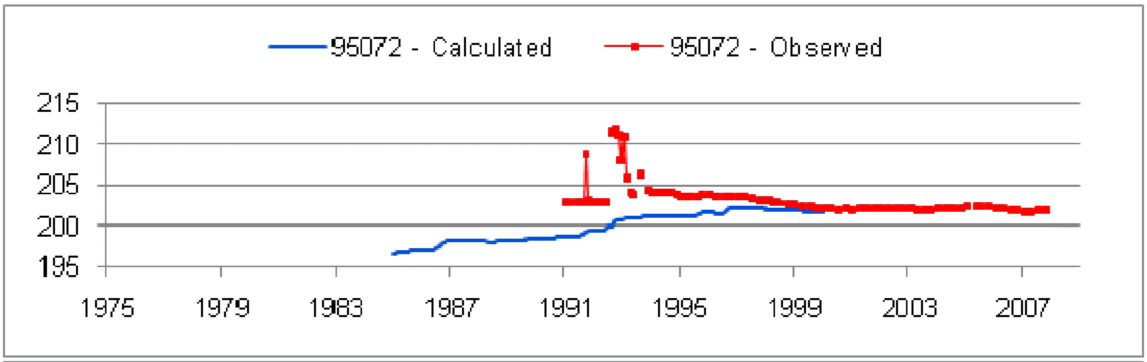
94911 - Calculated
94911 - Observed
251
250
249
248
247
1975
1979
1983
1987
1991
1995
1999
2003
2007



95056 - Calculated
95056 - Observed
175
170
165
160
1975
1979
1983
1987
1991
1995
1999
2003
2007



95057 - Calculated
95057 - Observed
180
175
170
165
160
1975
1979
1983
1987
1991
1995
1999
2003
2007



95072 - Calculated
95072 - Observed
215
210
205
200
195
1975
1979
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1987
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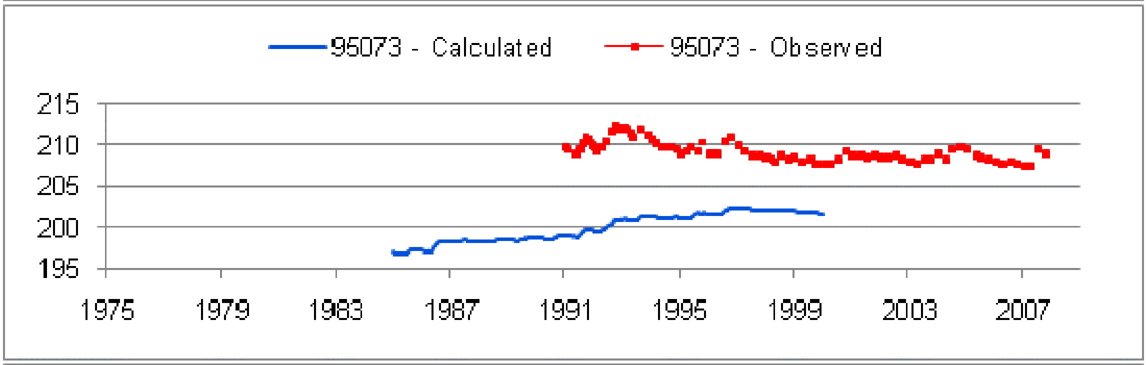
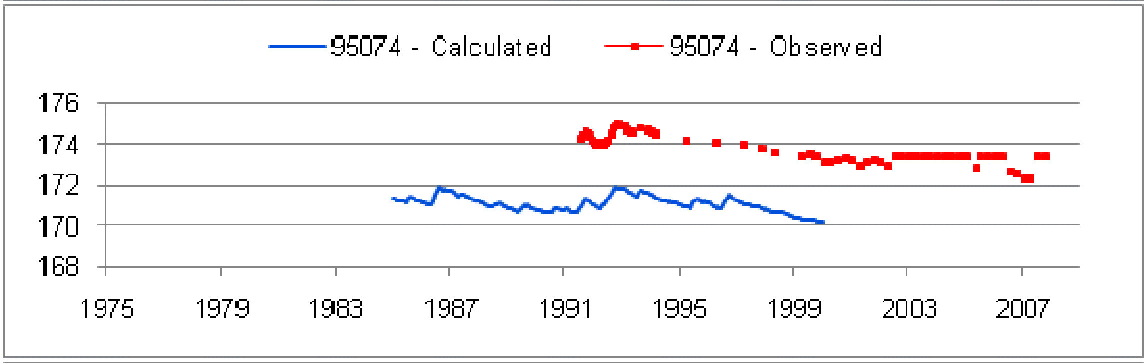
2003
2007



95073 - Calculated
95073 - Observed
215
210
205
200
195
1975
1979
1983
1987
1991
1995
1999
2003
2007



95074 - Calculated
95074 - Observed
176
174
172
170
168
1975
1979
1983
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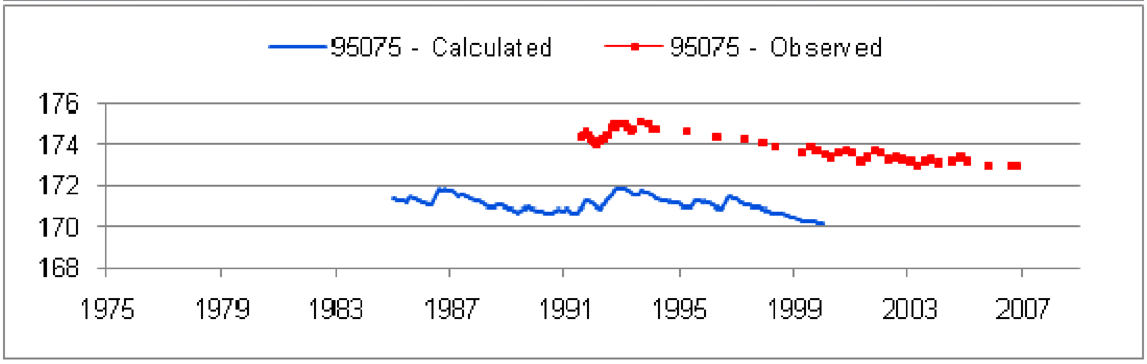
2003
2007



95075 - Calculated
95075 - Observed
176
174
172
170
168
1975
1979
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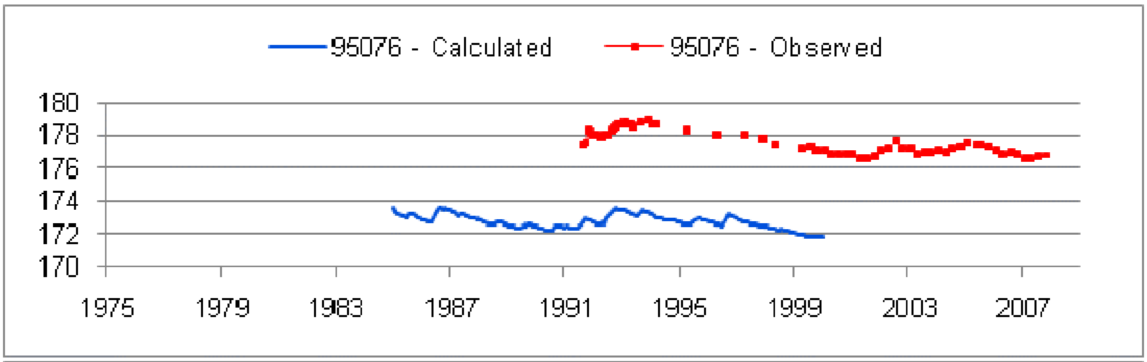
1995
1999
2003
2007



95076 - Calculated
95076 - Observed
180
178
176
174
172
170
1975
1979
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1995
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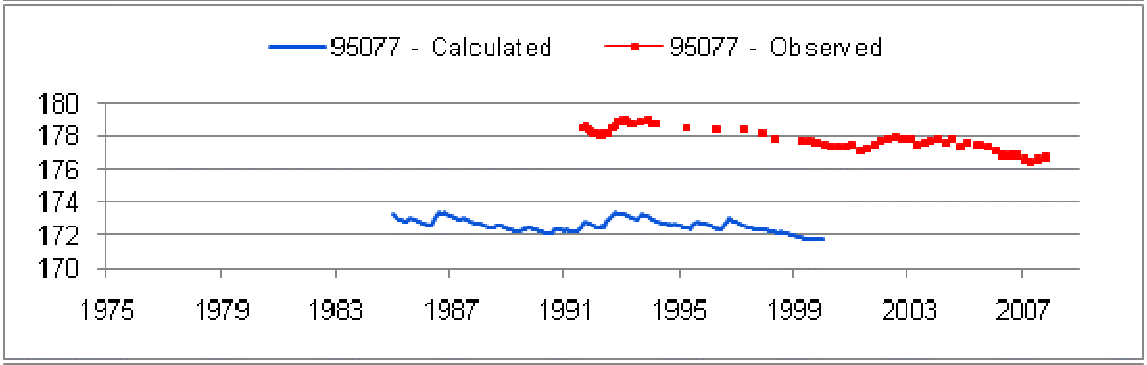
2003
2007



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95077 - Observed
180
178
176
174
172
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1975
1979
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2003
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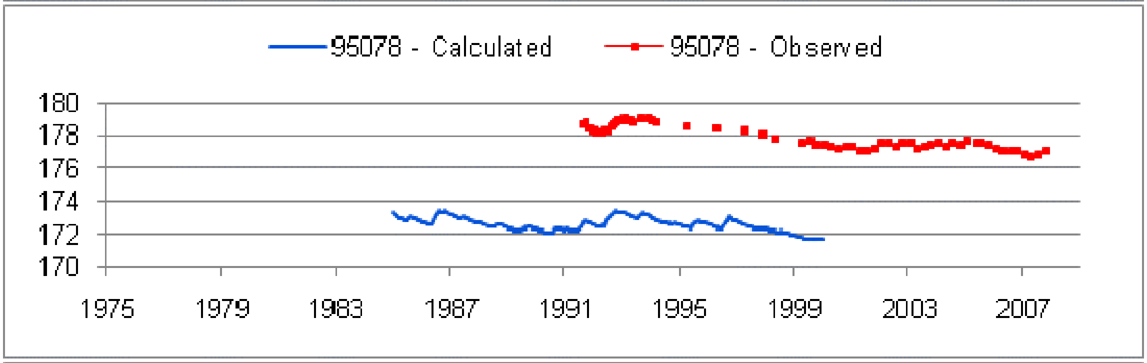
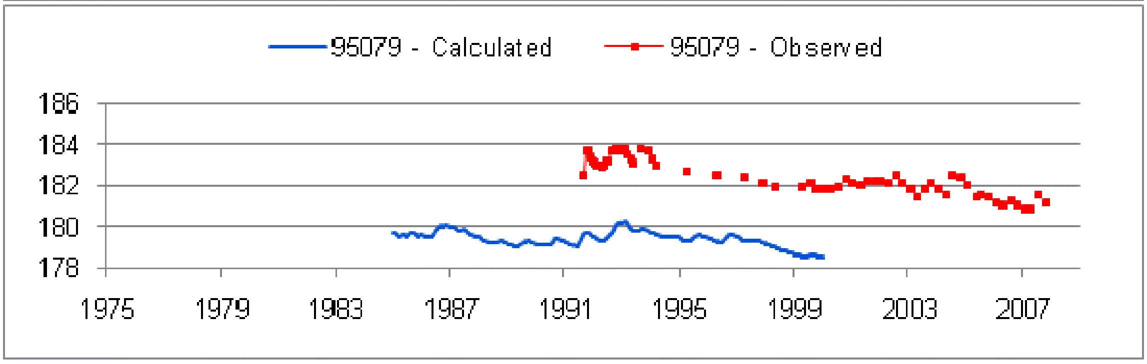
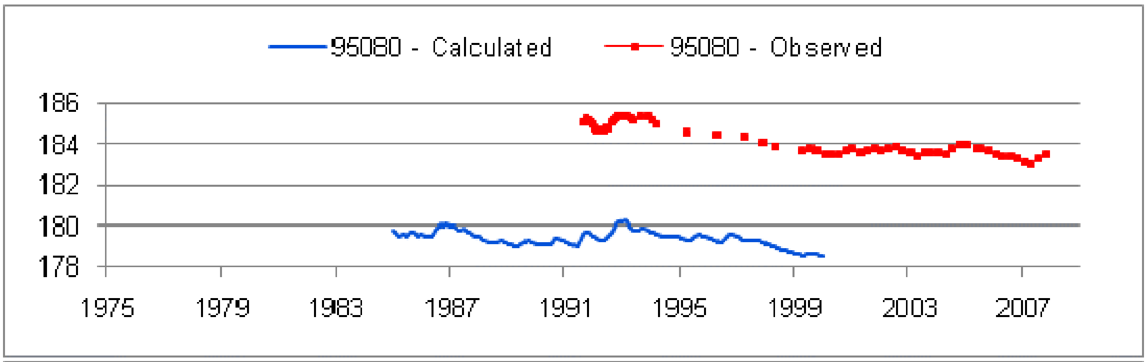


95078 - Calculated
95078 - Observed
180
178
176
174
172
170
1975
1979
1983
1987
1991
1995
1999
2003
2007



95079 - Calculated
95079 - Observed
186
184
182
180
178
1975
1979
1983
1987
1991
1995
1999
2003
2007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95080 - Observed
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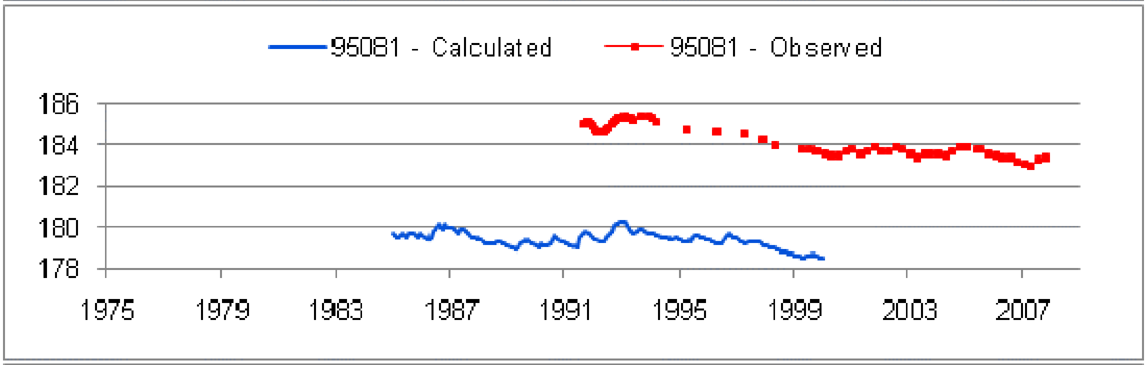
182
180
178
1975
1979
1983
1987
1991
1995
1999
2003
2007


95081 - Calculated
95081 - Observed
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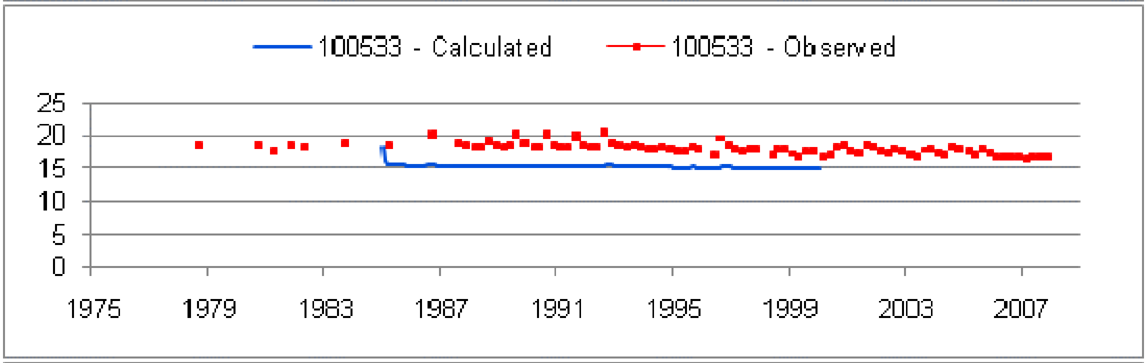
182
180
178
1975
1979
1983
1987
1991
1995
1999
2003
2007


100533 - Calculated
100533 - Observed
25
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10
5
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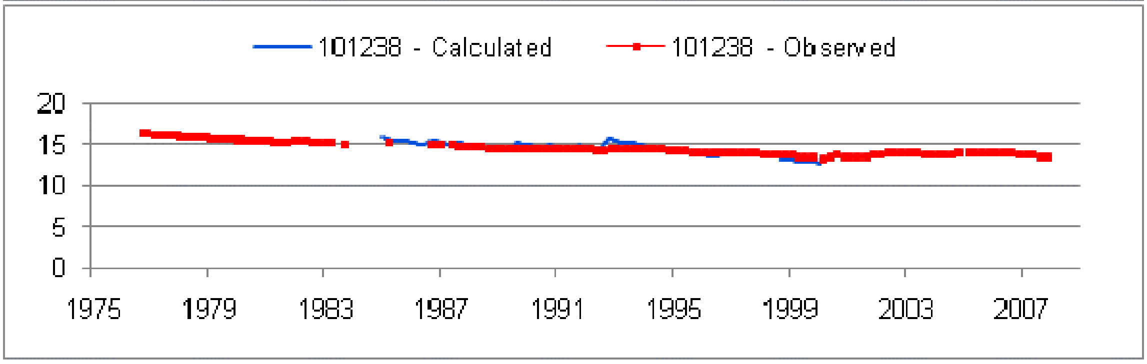
1975
1979
1983
1987
1991
1995
1999
2003
2007


101238 - Calculated
101238 - Observed
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0
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1979
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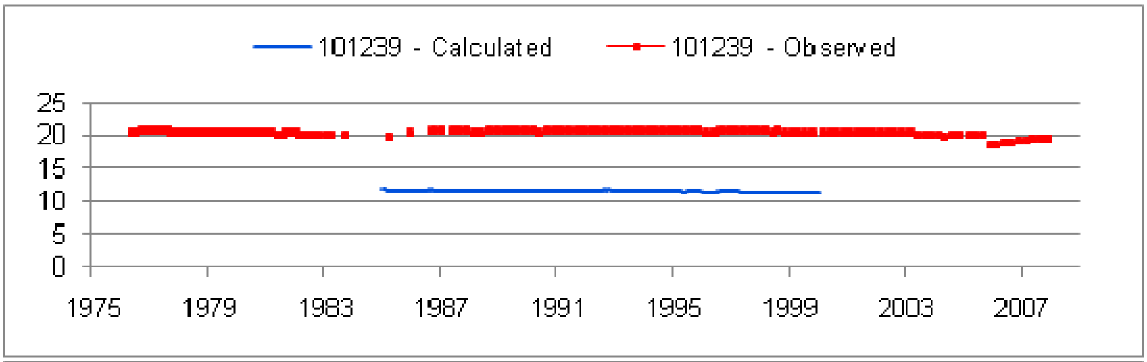
1987
1991
1995
1999
2003
2007


101239 - Calculated
101239 - Observed
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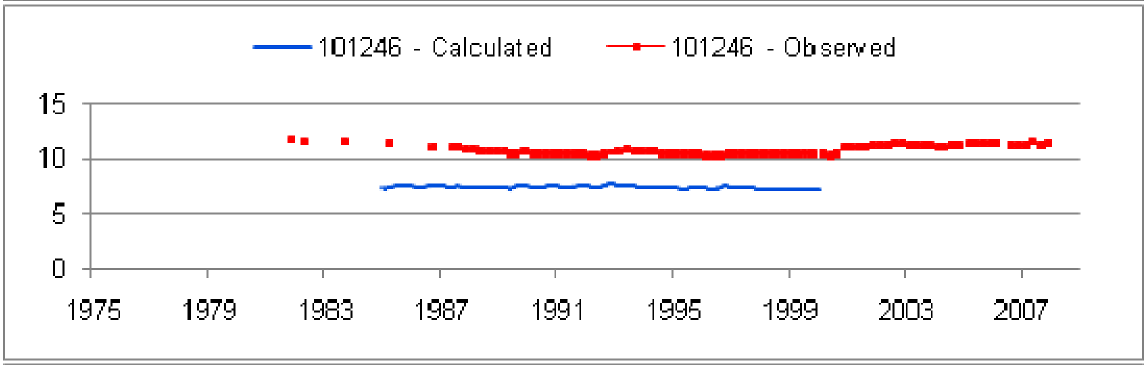
1975
1979
1983
1987
1991
1995
1999
2003
2007


101246 - Calculated
101246 - Observed
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0
1975
1979
1983
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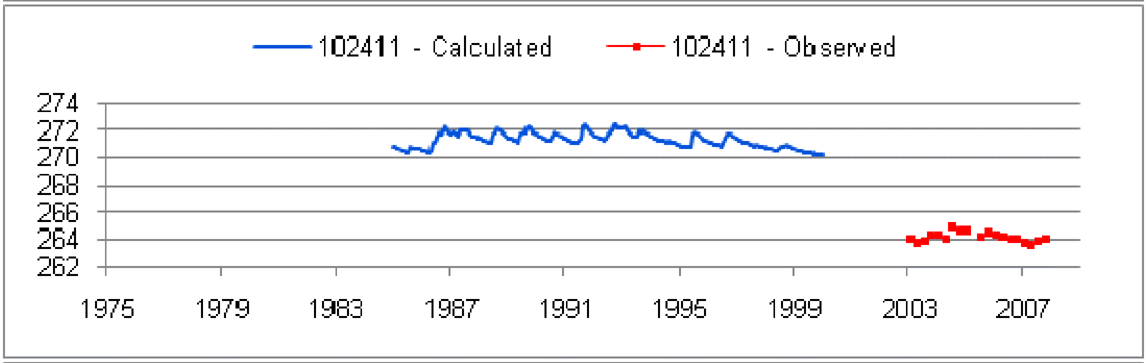
1991
1995
1999
2003
2007


102411 - Calculated
102411 - Observed
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272
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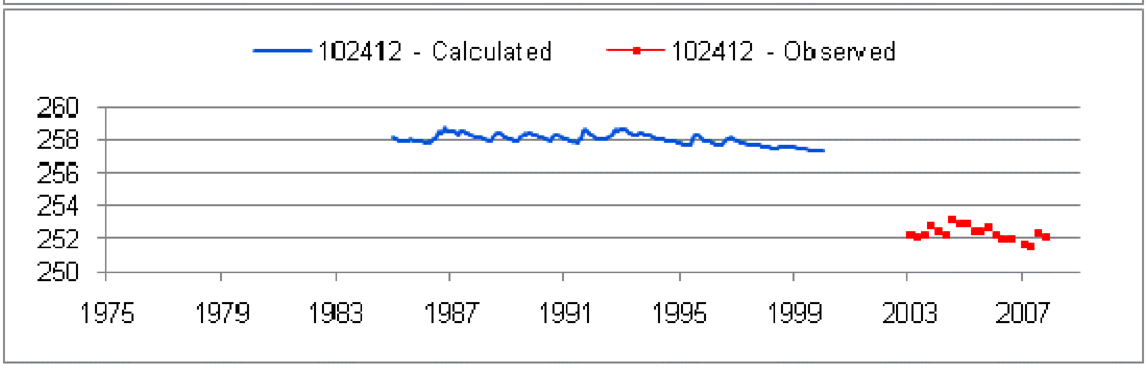
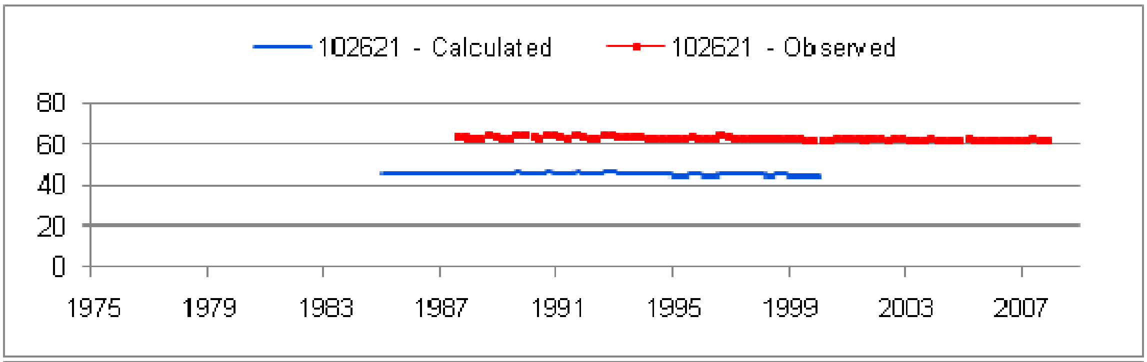
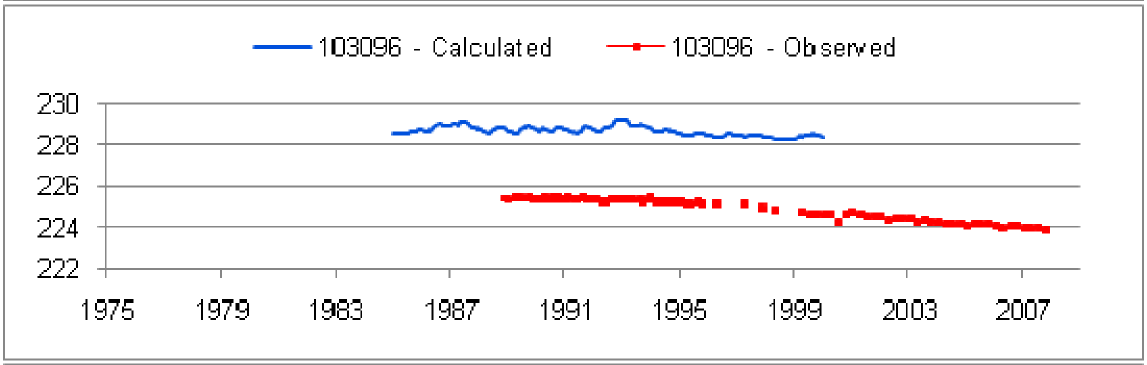
268
266
264
262
1975
1979
1983
1987
1991
1995
1999
2003
2007

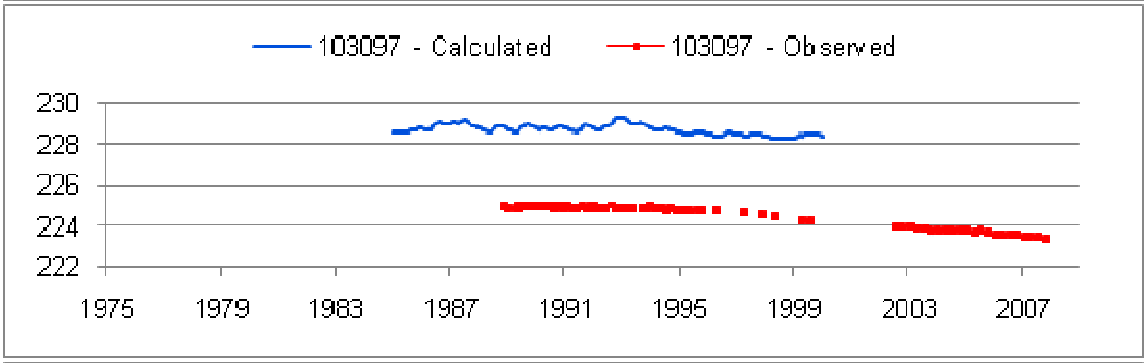

102412 - Calculated
102412 - Observed
260
258
256
254
252
250
1975
1979
1983
1987
1991
1995
1999
2003
2007



102621 - Calculated
102621 - Observed
80
60
40
20
0
1975
1979
1983
1987
1991
1995
1999
2003
2007



103096 - Calculated
103096 - Observed
230
228
226
224
222
1975
1979
1983
1987
1991
1995
1999
2003
2007



103097 - Calculated
103097 - Observed
230
228
226
224
222
1975
1979
1983
1987
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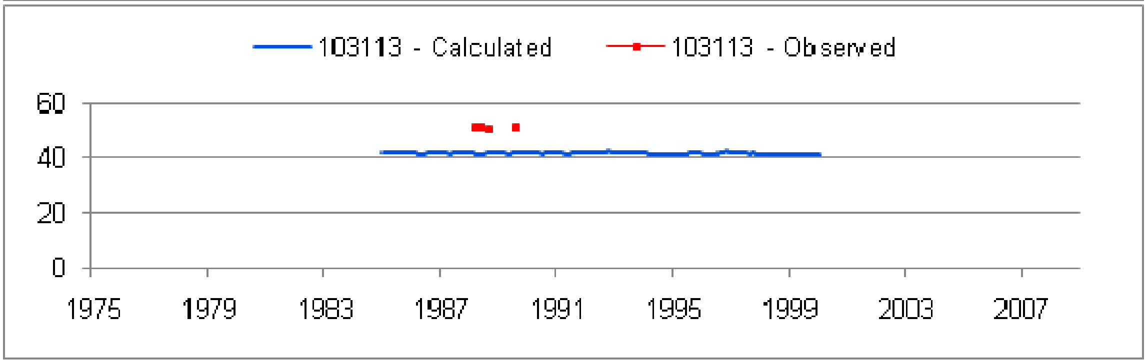
1995
1999
2003
2007



103113 - Calculated
103113 - Observed
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40
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0
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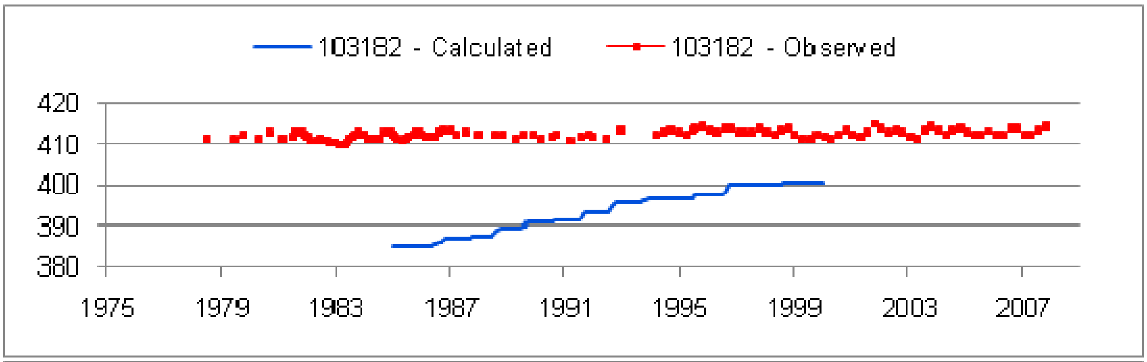
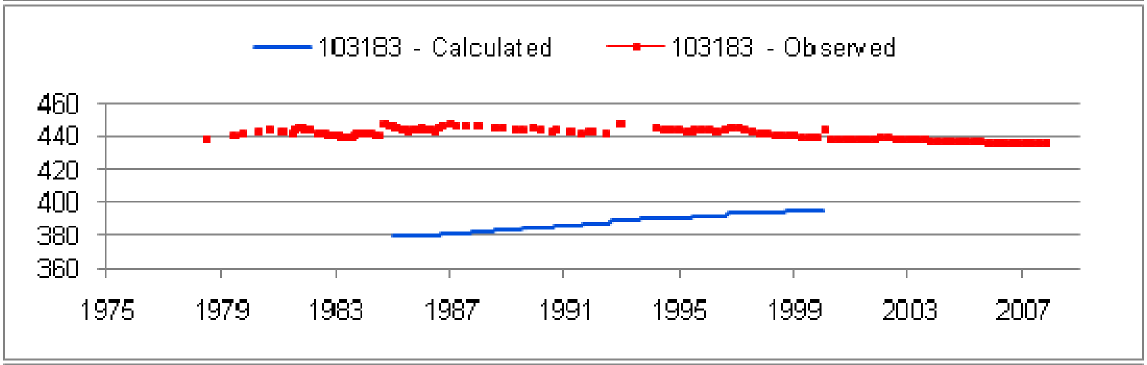
1979
1983
1987
1991
1995
1999
2003
2007


103182 - Calculated
103182 - Observed
420
410
400
390
380
1975
1979
1983
1987
1991
1995
1999
2003
2007


103183 - Calculated
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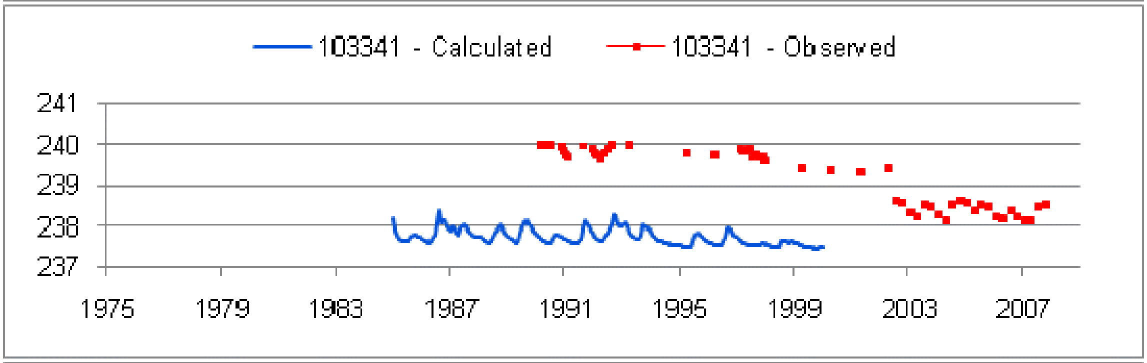
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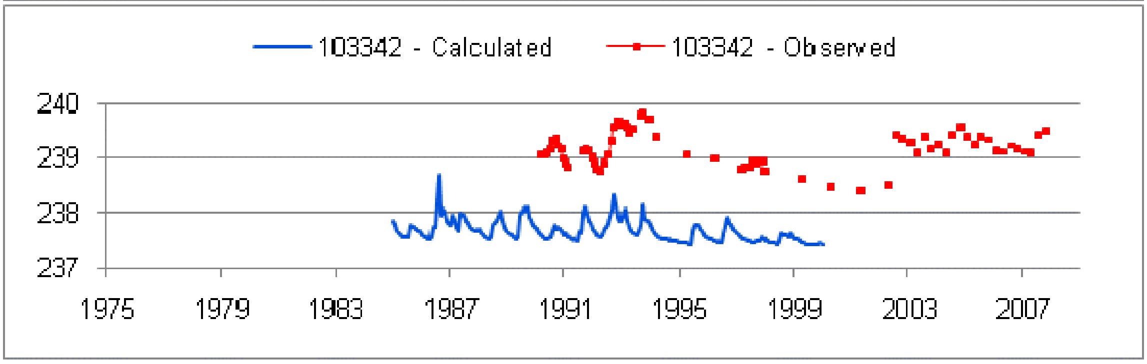
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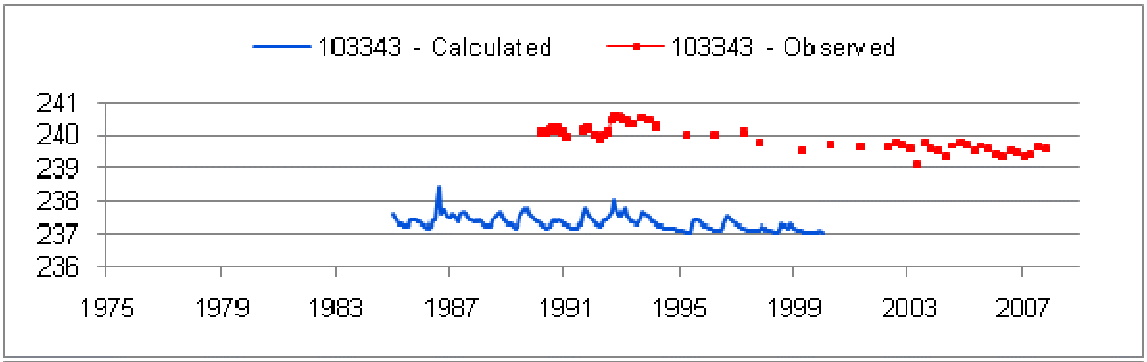
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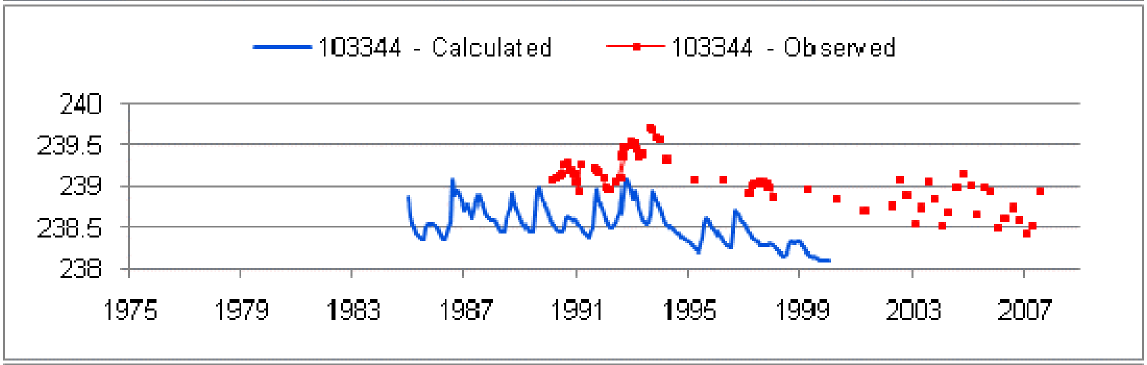
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238.5
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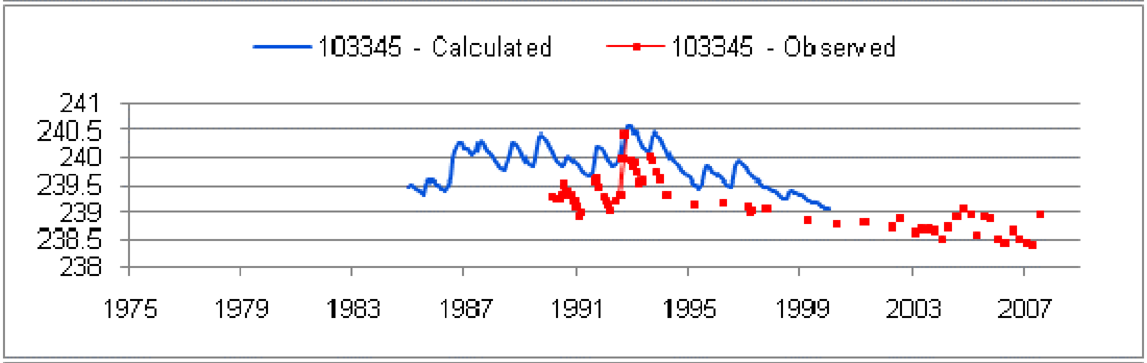
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238.5
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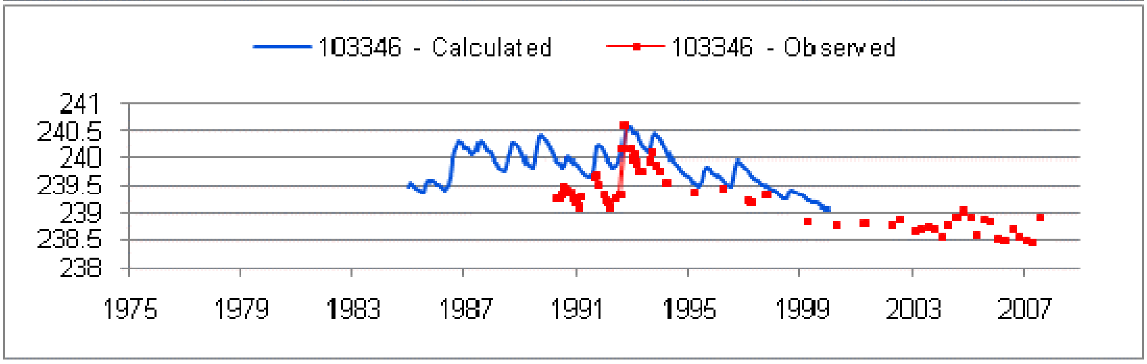
103346 - Calculated
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238.5
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2003
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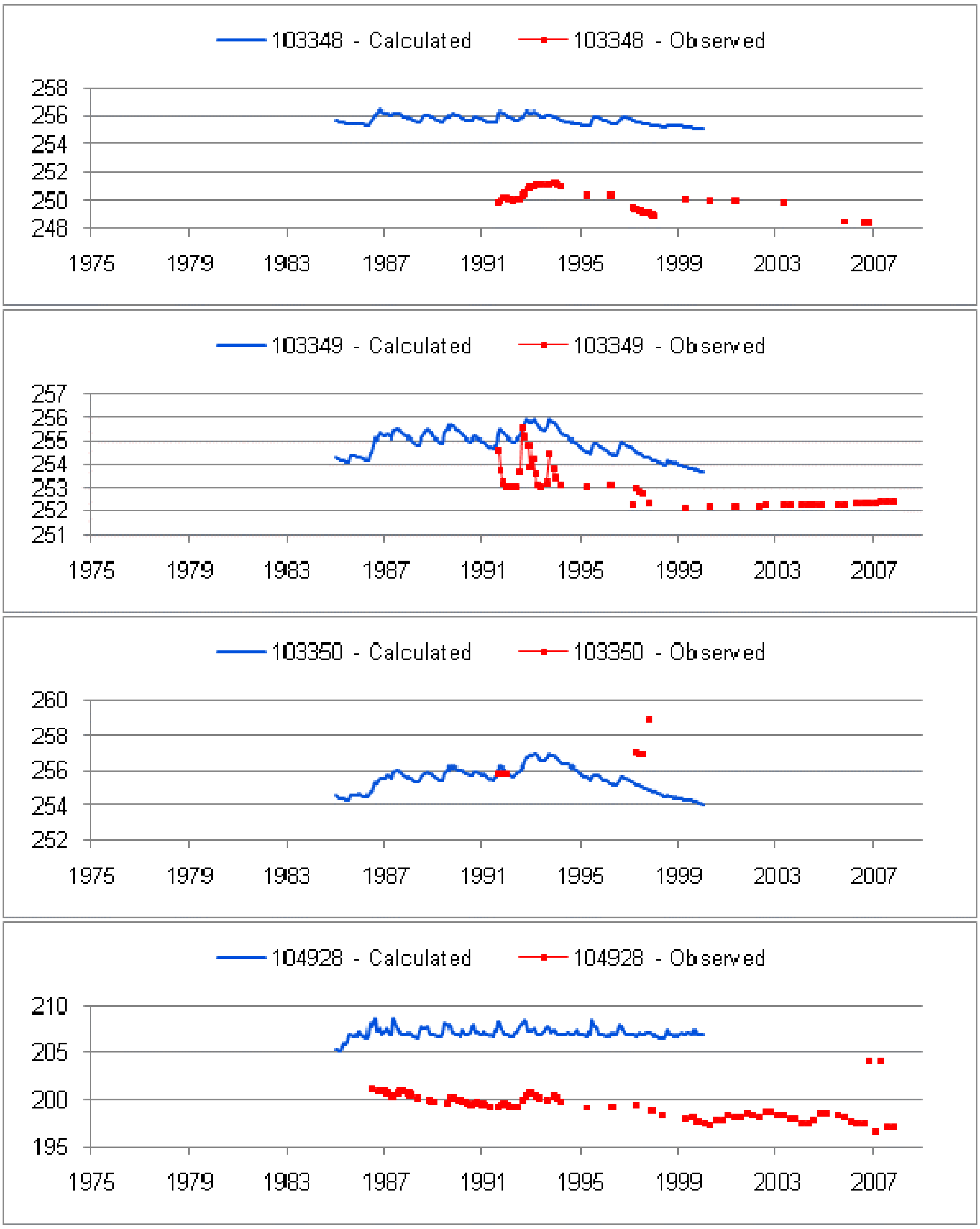
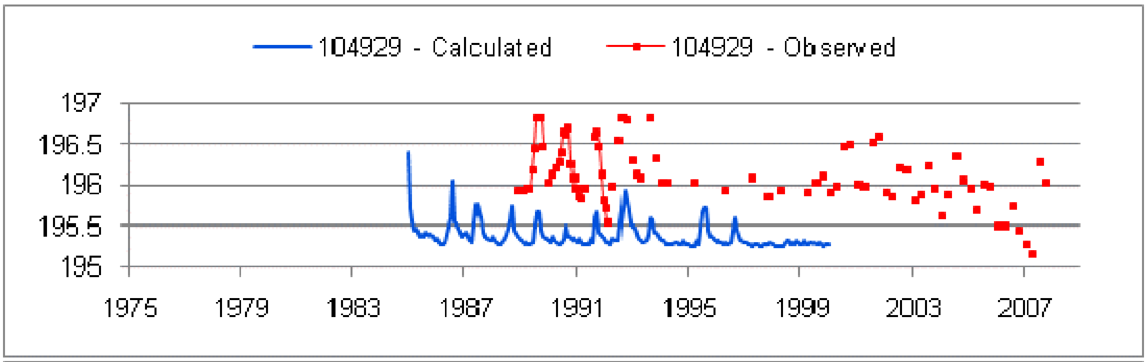


SINCLAIR KNIGHT MERZ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195.5
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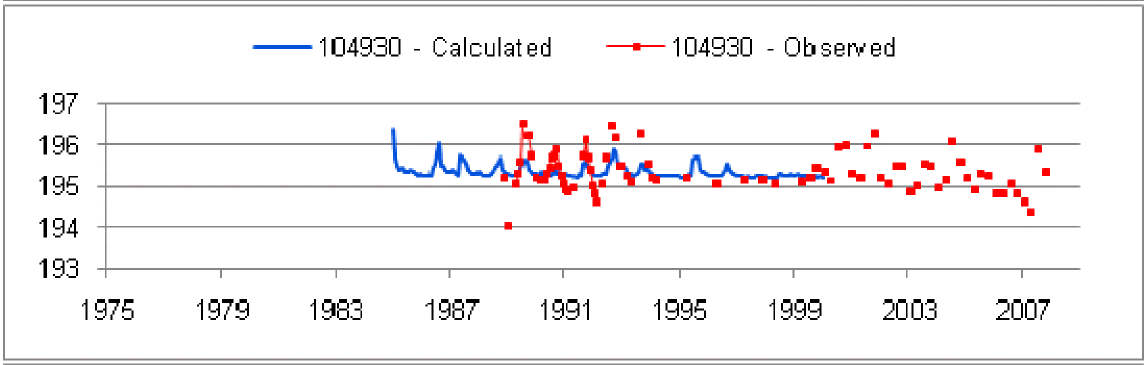
104930 - Calculated
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193
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2003
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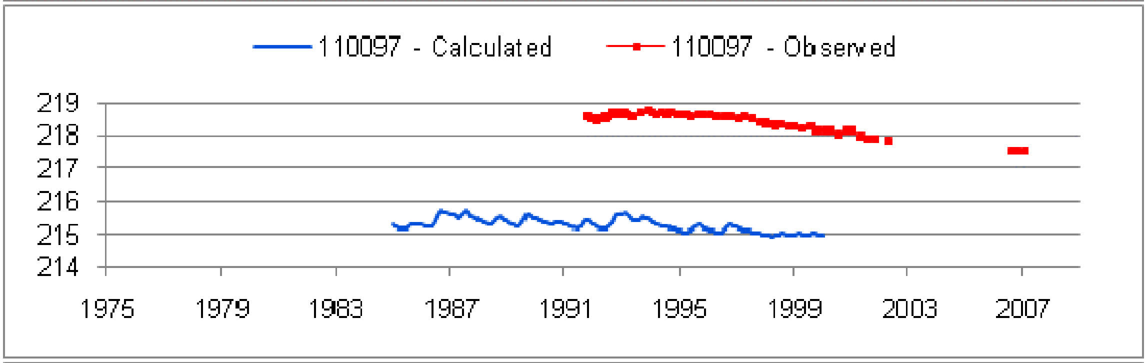
110097 - Calculated
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219
218
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215
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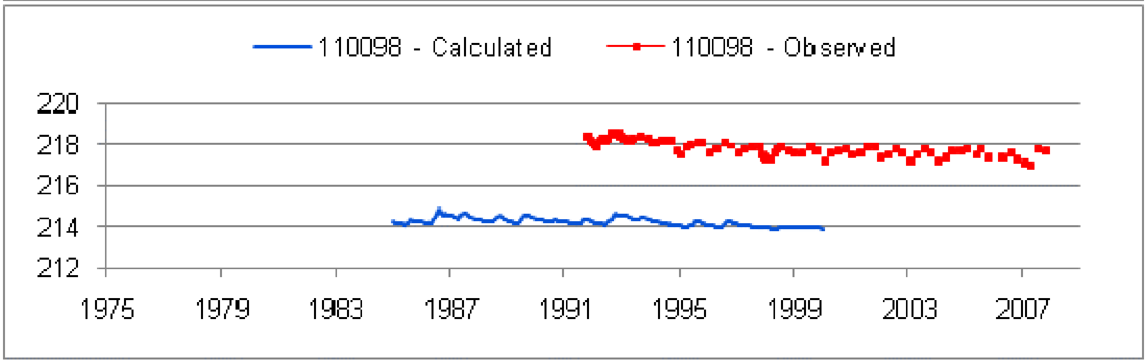
110098 - Calculated
110098 - Observed
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212
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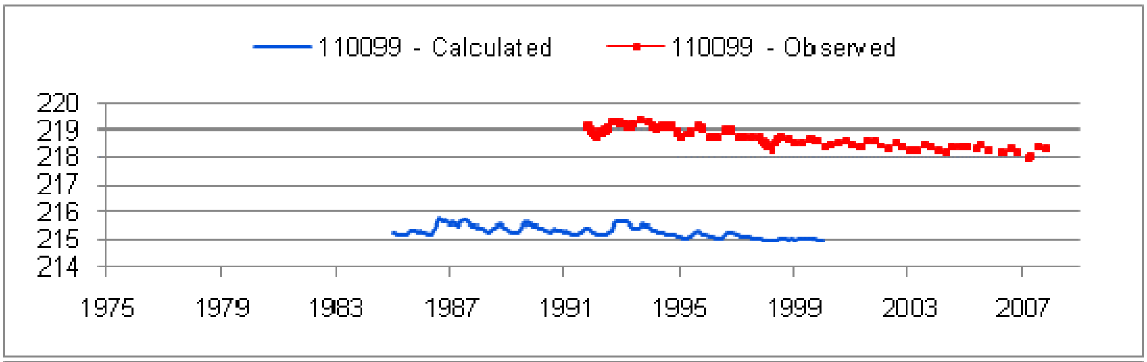
110099 - Calculated
110099 - Observed
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219
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216
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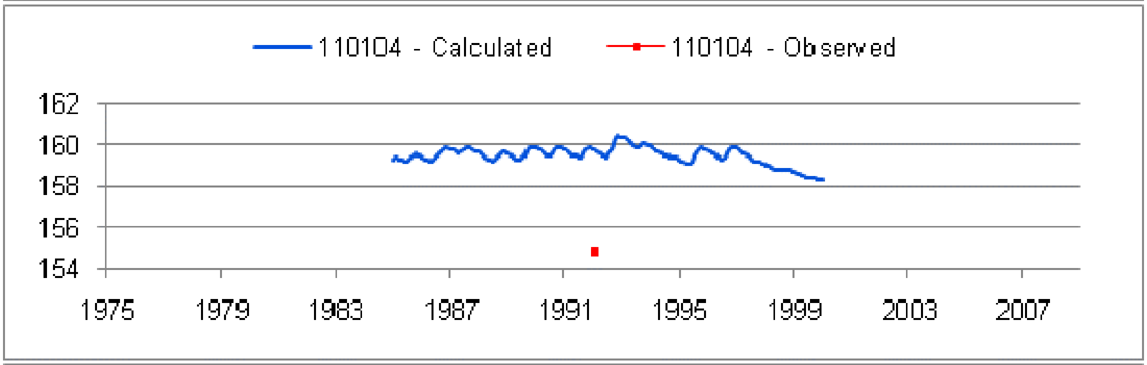
110104 - Calculated
110104 - Observed
162
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154
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2003
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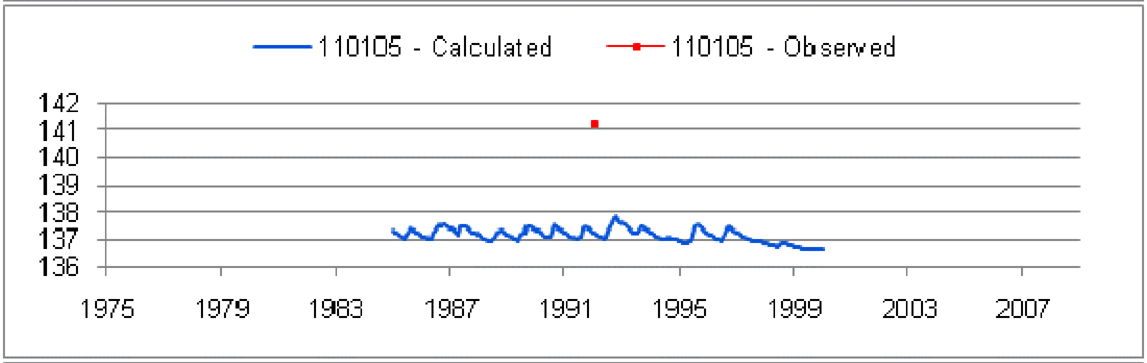
110105 - Calculated
110105 - Observed
142
141
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139
138
137
136
1975
1979
1983
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1991
1995
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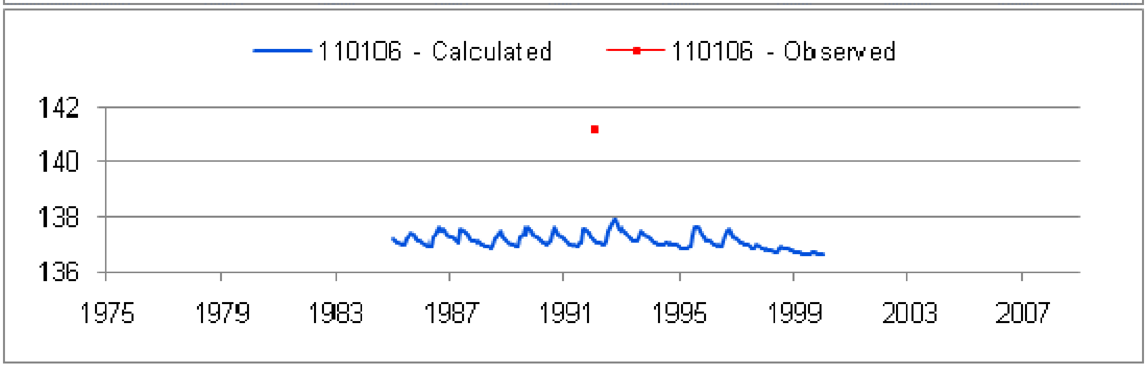
2003
2007


110106 - Calculated
110106 - Observed
142
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138
136
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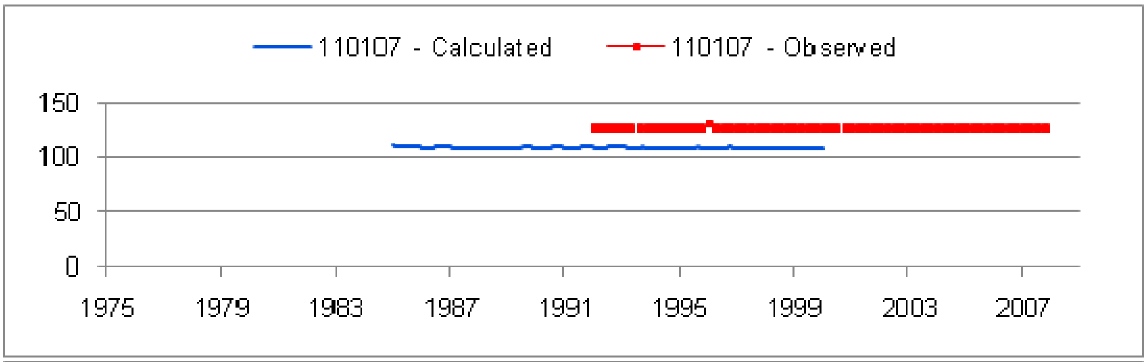
2003
2007


110107 - Calculated
110107 - Observed
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100
50
0
1975
1979
1983
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1995
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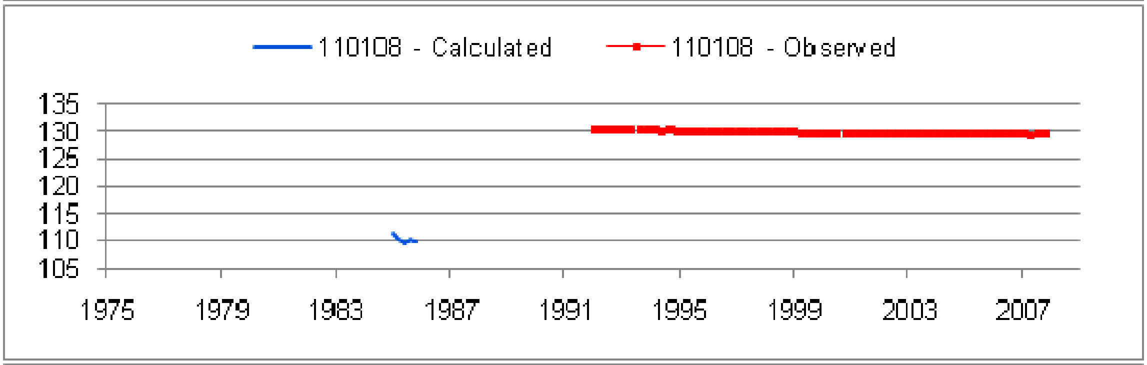
2003
2007


110108 - Calculated
110108 - Observed
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130
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120
115
110
105
1975
1979
1983
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1999
2003
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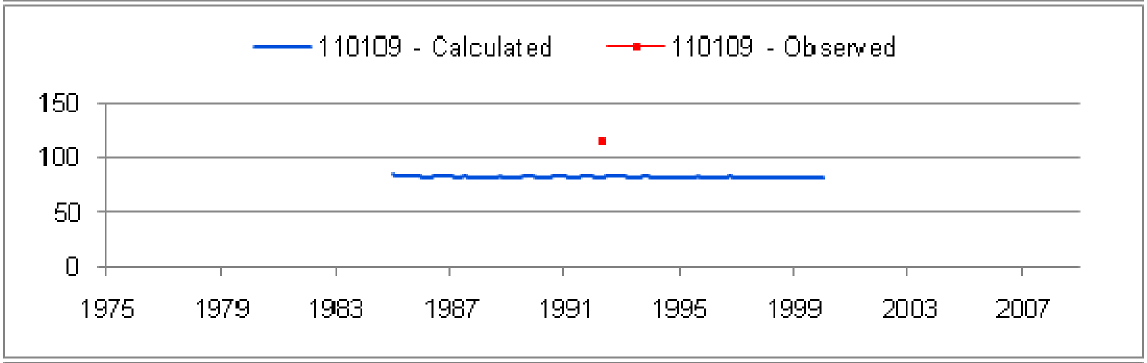
110109 - Calculated
110109 - Observed
150
100
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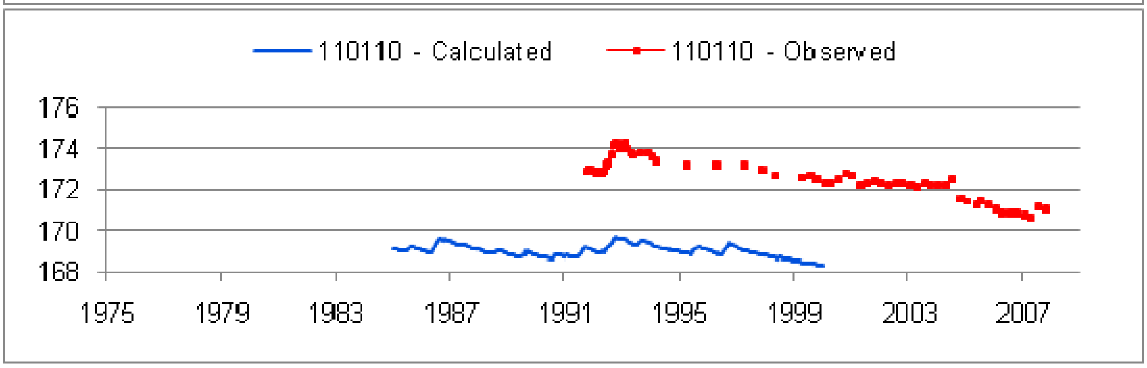
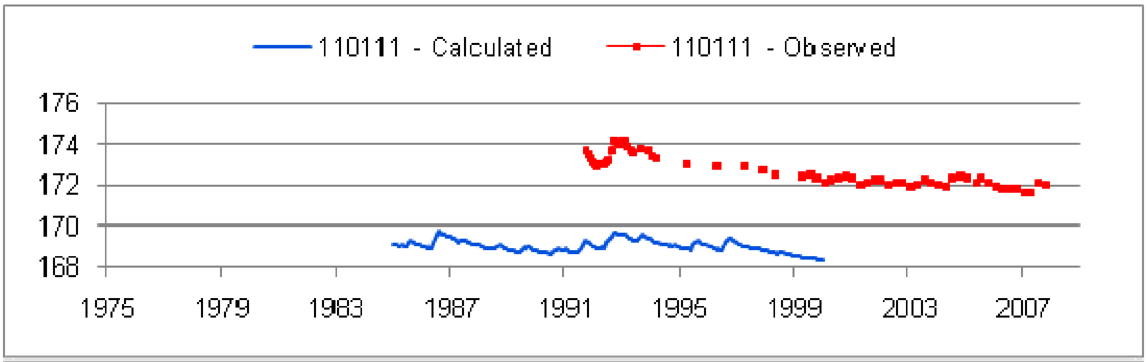
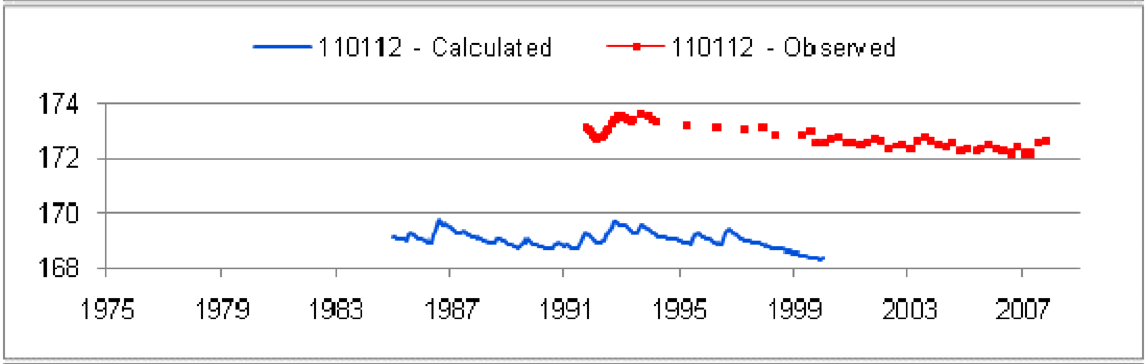
0
1975
1979
1983
1987
1991
1995
1999
2003
2007

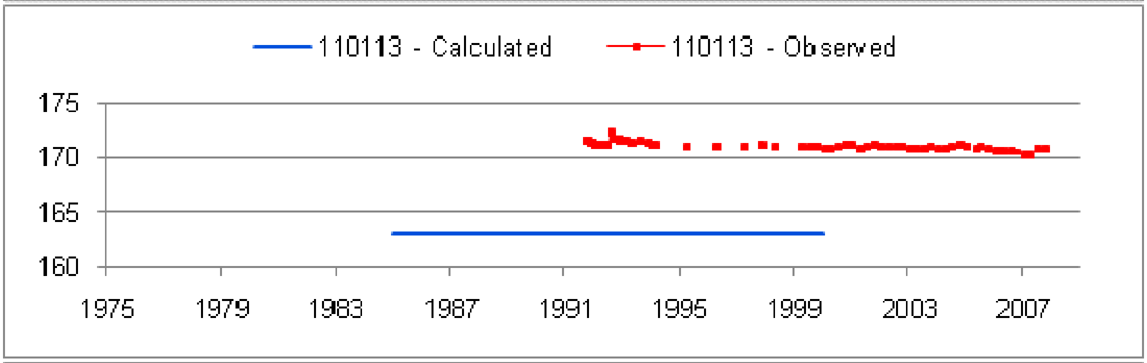

110110 - Calculated
110110 - Observed
176
174
172
170
168
1975
1979
1983
1987
1991
1995
1999
2003
2007



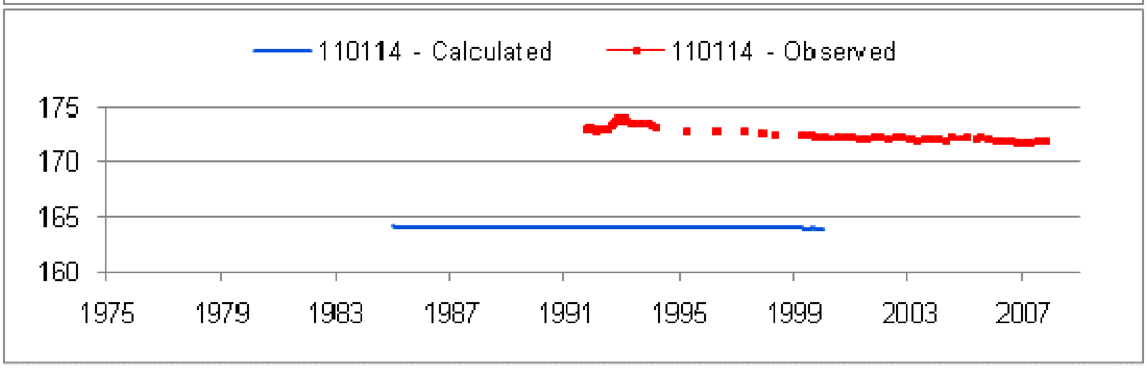
110111 - Calculated
110111 - Observed
176
174
172
170
168
1975
1979
1983
1987
1991
1995
1999
2003
2007



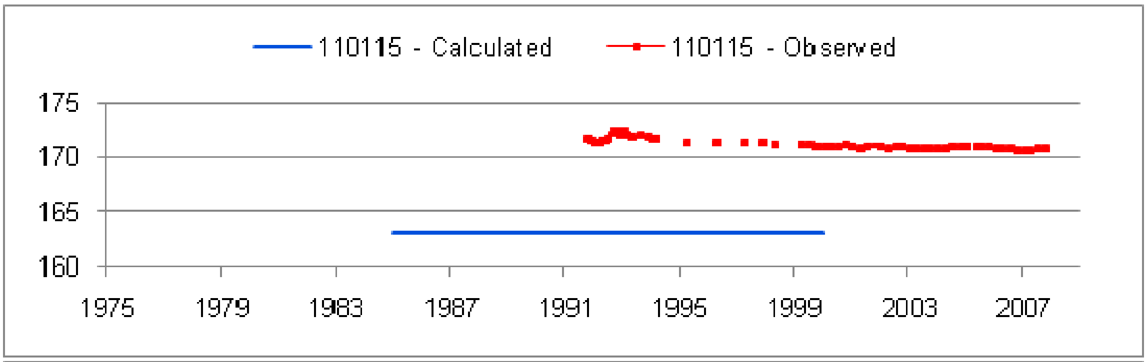
110112 - Calculated
110112 - Observed
174
172
170
168
1975
1979
1983
1987
1991
1995
1999
2003
2007



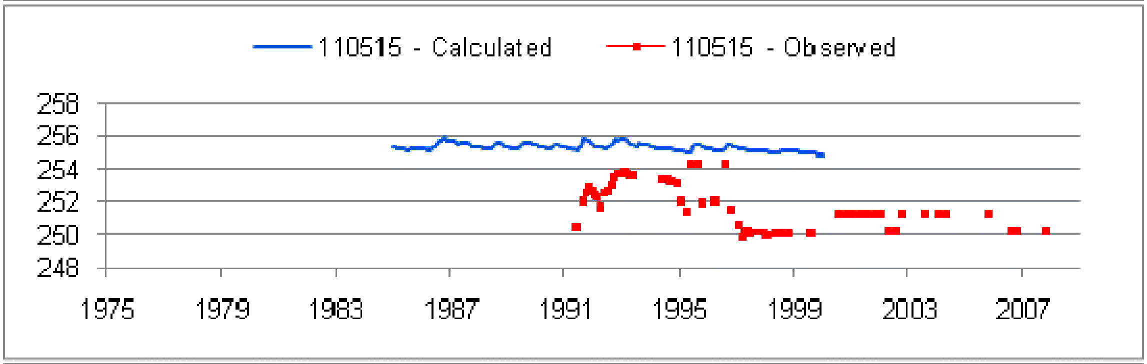
110113 - Calculated
110113 - Observed
175
170
165
160
1975
1979
1983
1987
1991
1995
1999
2003
2007



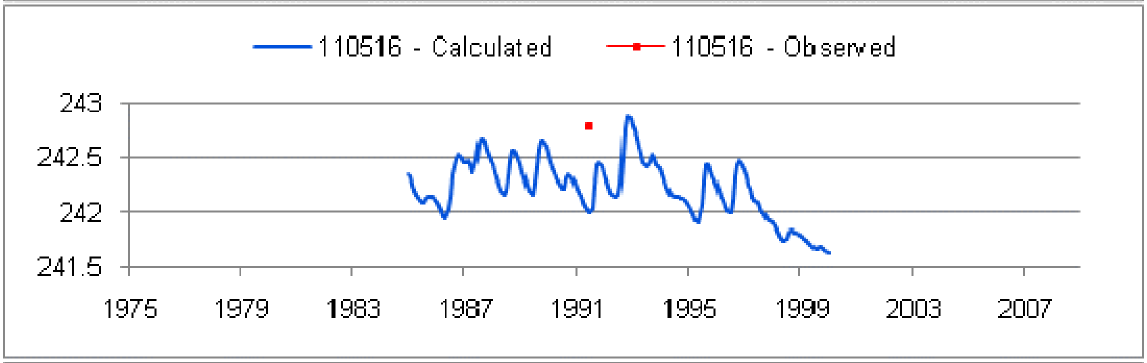
110114 - Calculated
110114 - Observed
175
170
165
160
1975
1979
1983
1987
1991
1995
1999
2003
2007



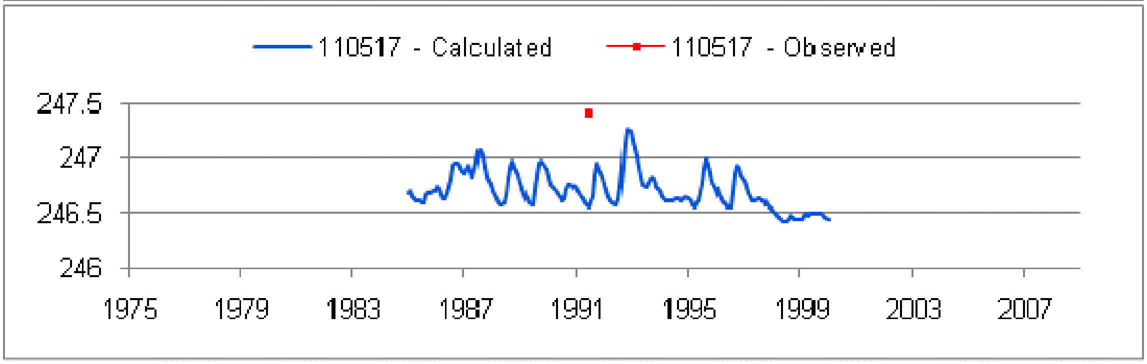
110115 - Calculated
110115 - Observed
175
170
165
160
1975
1979
1983
1987
1991
1995
1999
2003
2007



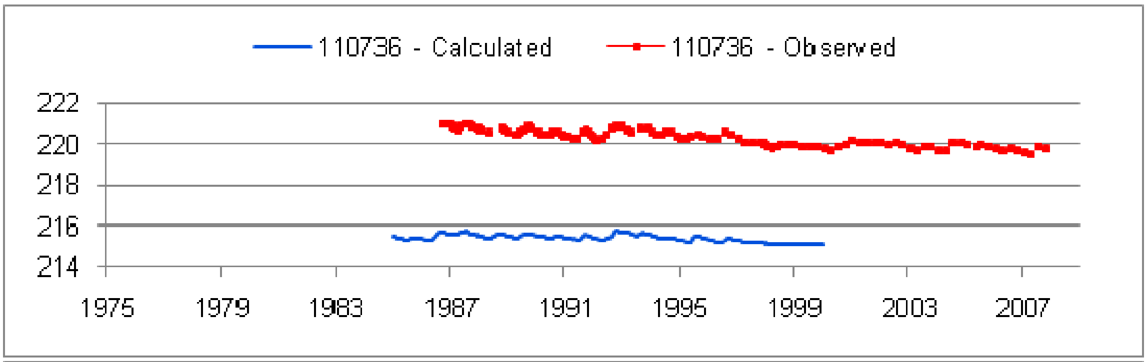
110515 - Calculated
110515 - Observed
258
256
254
252
250
248
1975
1979
1983
1987
1991
1995
1999
2003
2007



110516 - Calculated
110516 - Observed
243
242.5
242
241.5
1975
1979
1983
1987
1991
1995
1999
2003
2007



110517 - Calculated
110517 - Observed
247.5
247
246.5
246
1975
1979
1983
1987
1991
1995
1999
2003
2007


110736 - Calculated
110736 - Observed
222
220
218
216
214
1975
1979
1983
1987
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1995
1999
2003
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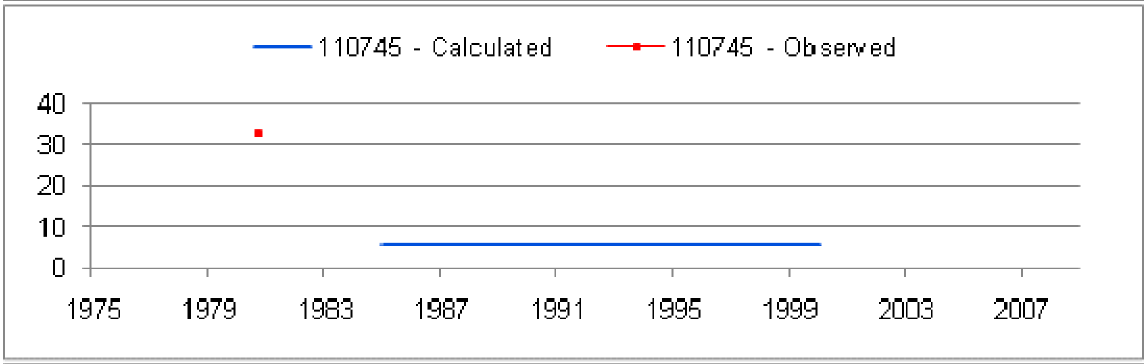
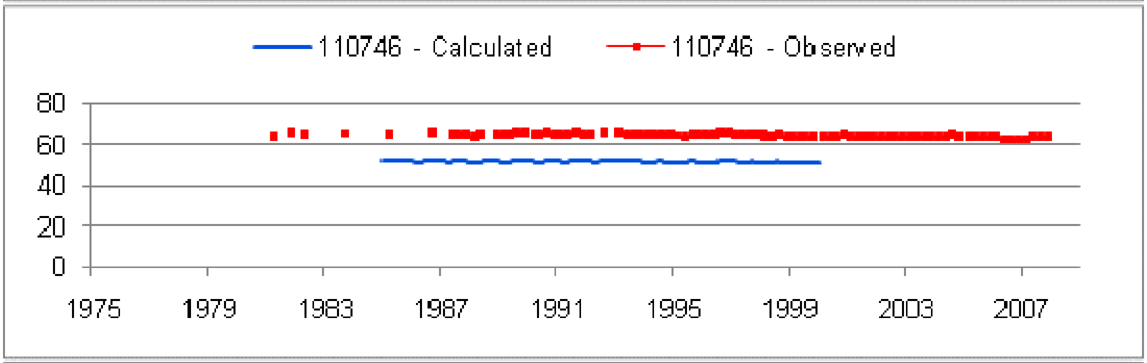

110745 - Calculated
110745 - Observed
40
30
20
10
0
1975
1979
1983
1987
1991
1995
1999
2003
2007


110746 - Calculated
110746 - Observed
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60
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20
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1975
1979
1983
1987
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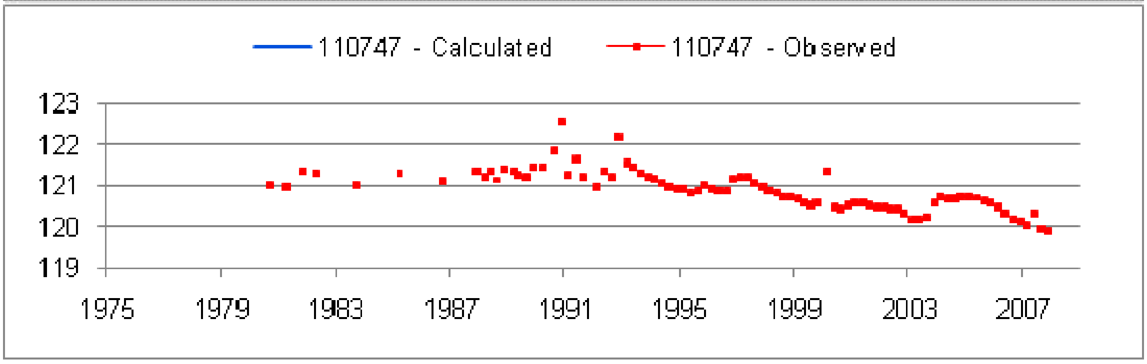
1995
1999
2003
2007


110747 - Calculated
110747 - Observed
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119
1975
1979
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1987
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1995
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2003
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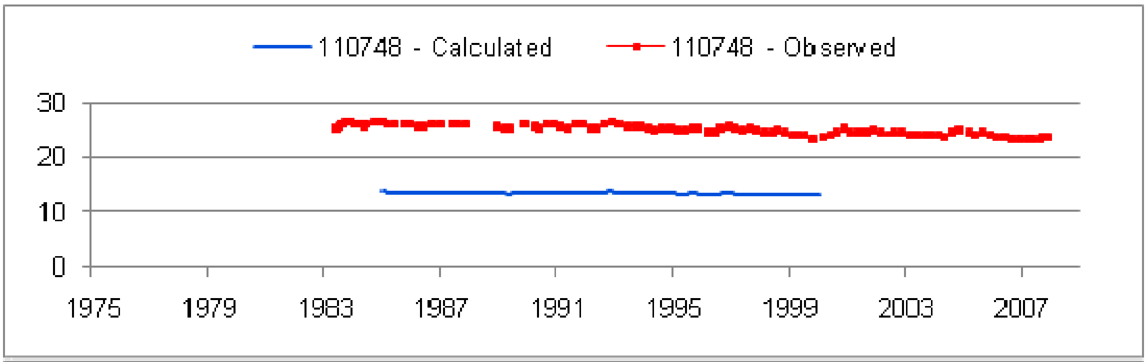
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110748 - Observed
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20
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1979
1983
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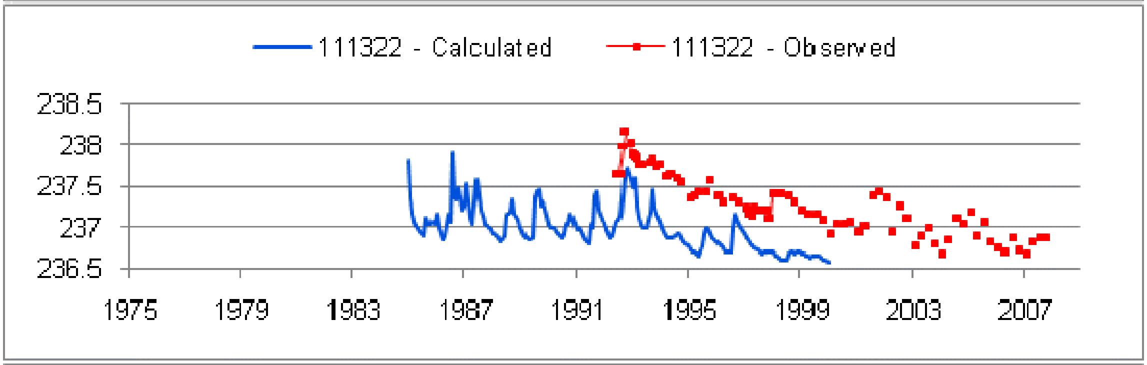
1995
1999
2003
2007


111322 - Calculated
111322 - Observed
238.5
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237.5
237
236.5
1975
1979
1983
1987
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1995
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2003
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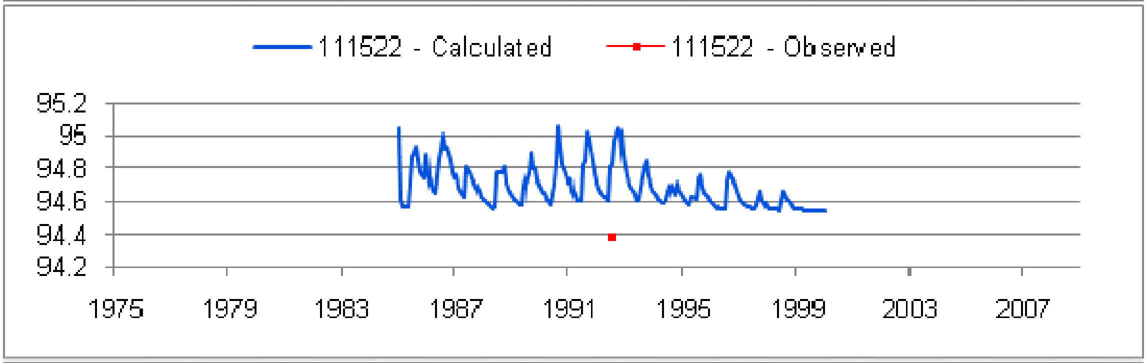
111522 - Calculated
111522 - Observed
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95
94.8
94.6
94.4
94.2
1975
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1995
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2003
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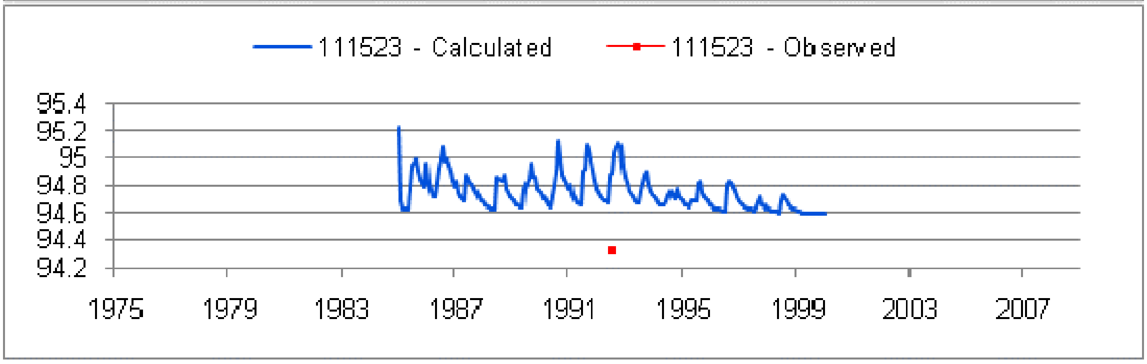
111523 - Calculated
111523 - Observed
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95.2
95
94.8
94.6
94.4
94.2
1975
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1995
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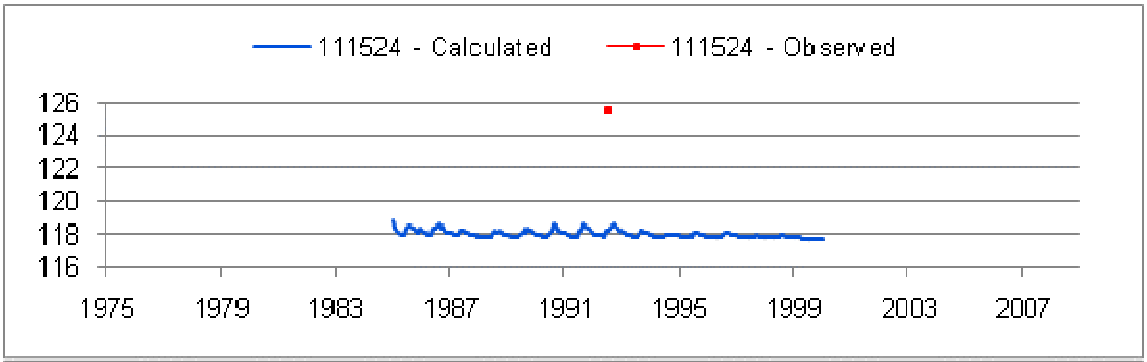
2003
2007



111524 - Calculated
111524 - Observed
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124
122
120
118
116
1975
1979
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1987
1991
1995
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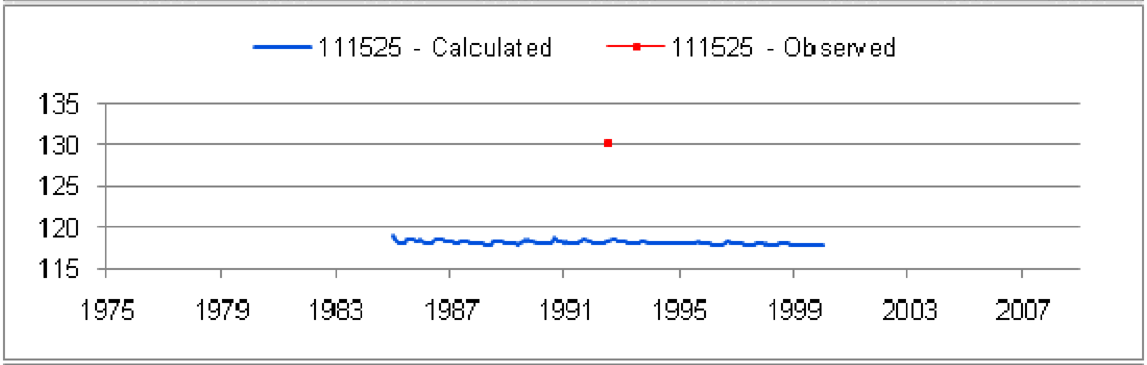
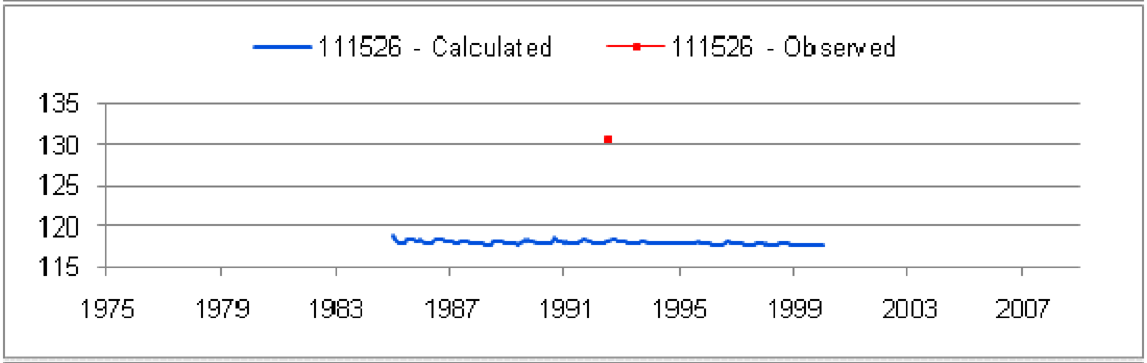
2003
2007



111525 - Calculated
111525 - Observed
135
130
125
120
115
1975
1979
1983
1987
1991
1995
1999
2003
2007



111526 - Calculated
111526 - Observed
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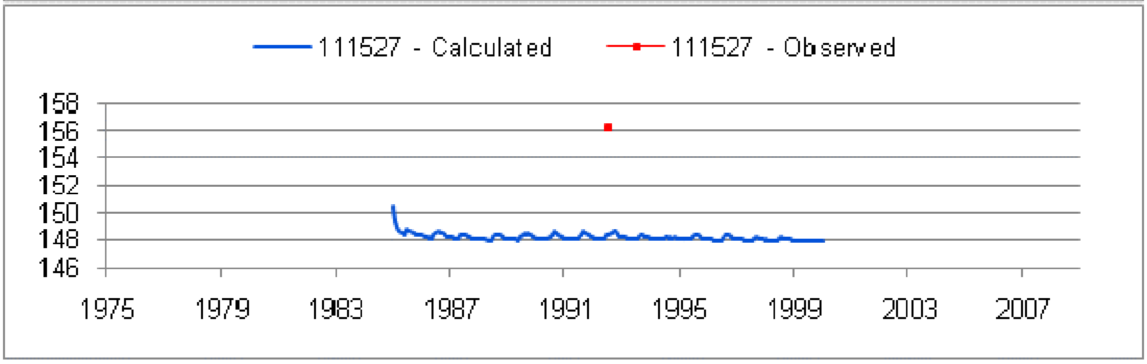
130
125
120
115
1975
1979
1983
1987
1991
1995
1999
2003
2007



111527 - Calculated
111527 - Observed
158
156
154
152
150
148
146
1975
1979
1983
1987
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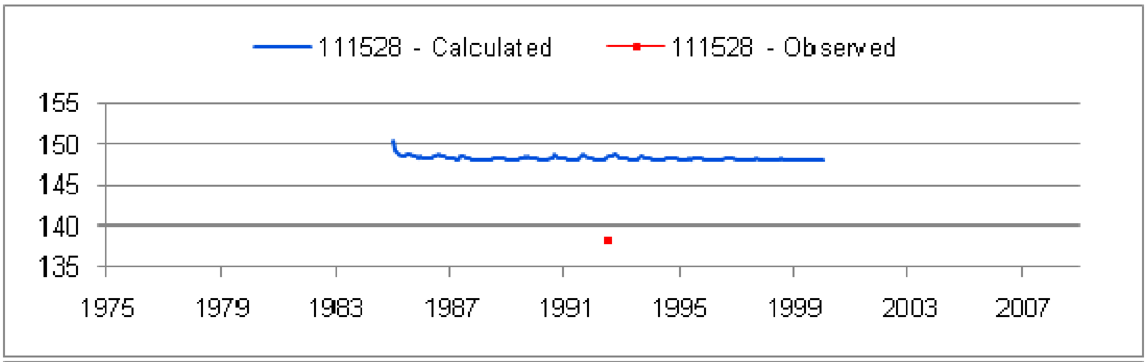
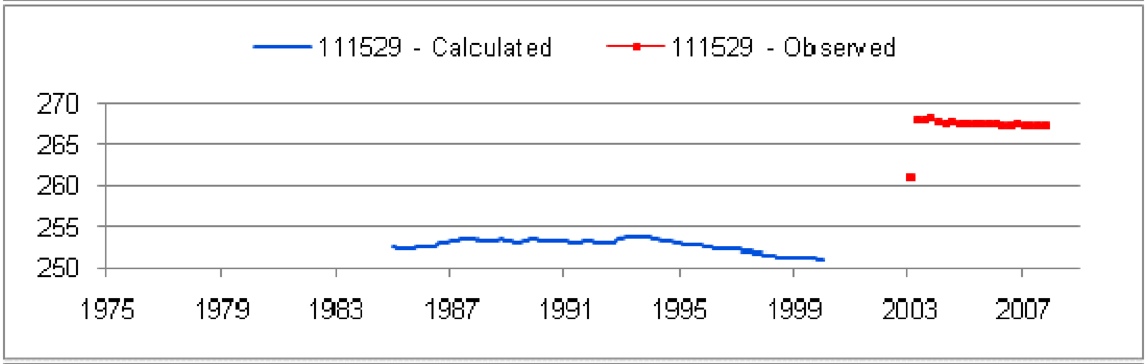
1995
1999
2003
2007



111528 - Calculated
111528 - Observed
155
150
145
140
135
1975
1979
1983
1987
1991
1995
1999
2003
2007



111529 - Calculated
111529 - Observed
270
265
260
255
250
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1979
1983
1987
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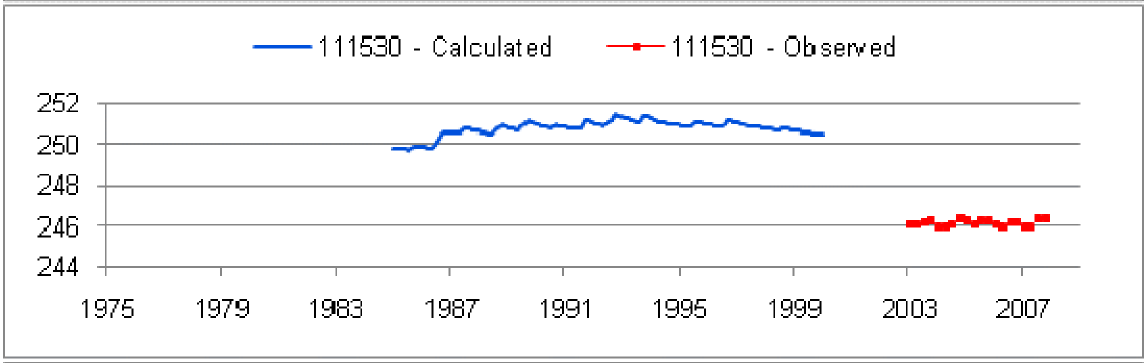
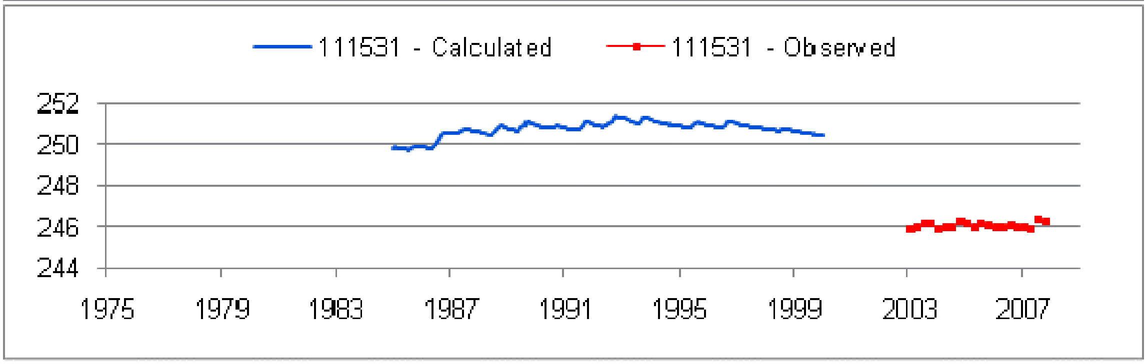
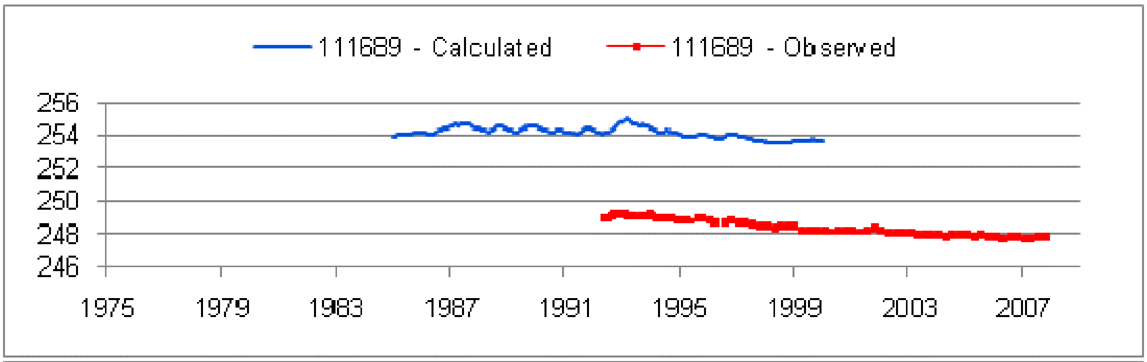
1995
1999
2003
2007

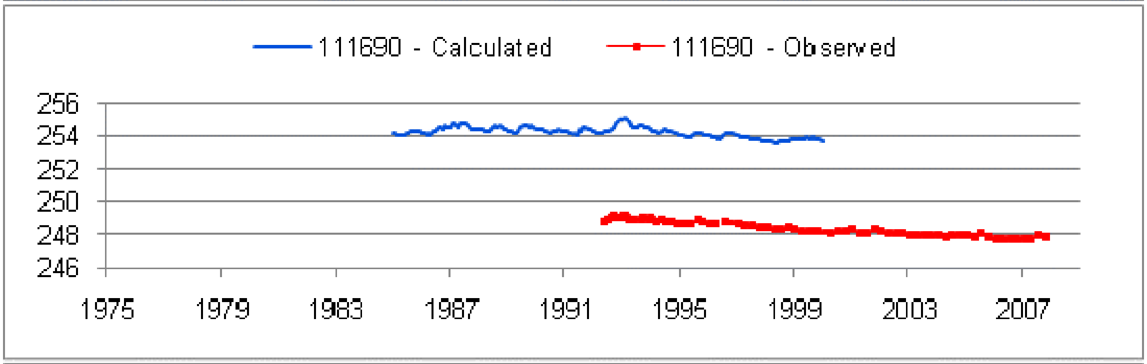


111530 - Calculated
111530 - Observed
252
250
248
246
244
1975
1979
1983
1987
1991
1995
1999
2003
2007



111531 - Calculated
111531 - Observed
252
250
248
246
244
1975
1979
1983
1987
1991
1995
1999
2003
2007


111689 - Calculated
111689 - Observed
256
254
252
250
248
246
1975
1979
1983
1987
1991
1995
1999
2003
2007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111690 - Observed
256
254
252
250
248
246
1975
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1987
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1995
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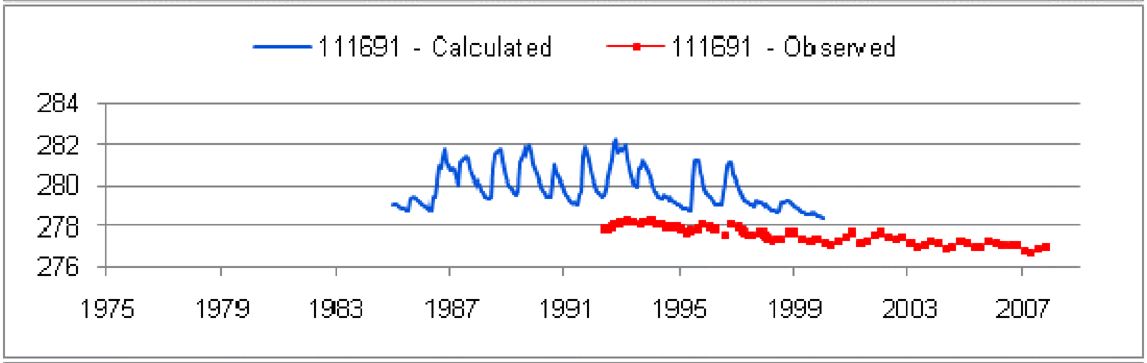
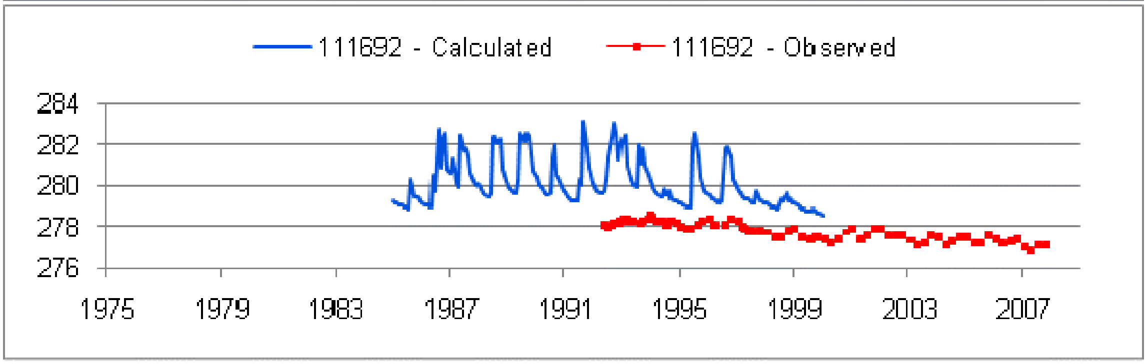
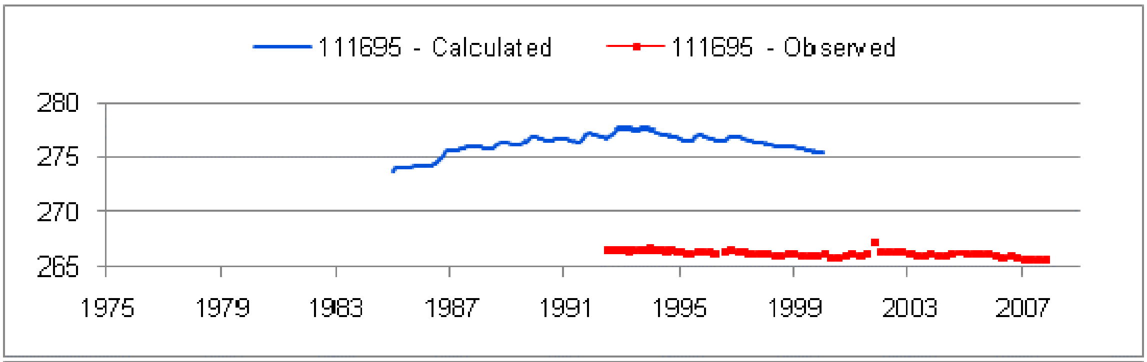
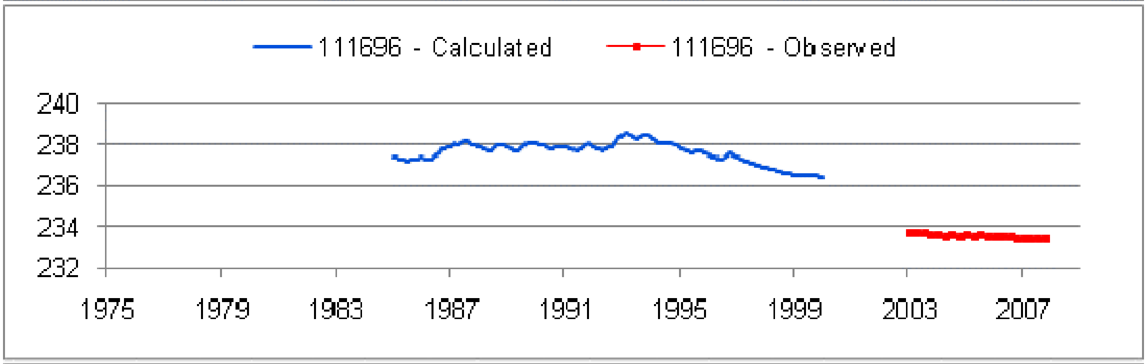
2003
2007


111691 - Calculated
111691 - Observed
284
282
280
278
276
1975
1979
1983
1987
1991
1995
1999
2003
2007


111692 - Calculated
111692 - Observed
284
282
280
278
276
1975
1979
1983
1987
1991
1995
1999
2003
2007


111695 - Calculated
111695 - Observed
280
275
270
265
1975
1979
1983
1987
1991
1995
1999
2003
2007


111696 - Calculated
111696 - Observed
240
238
236
234
232
1975
1979
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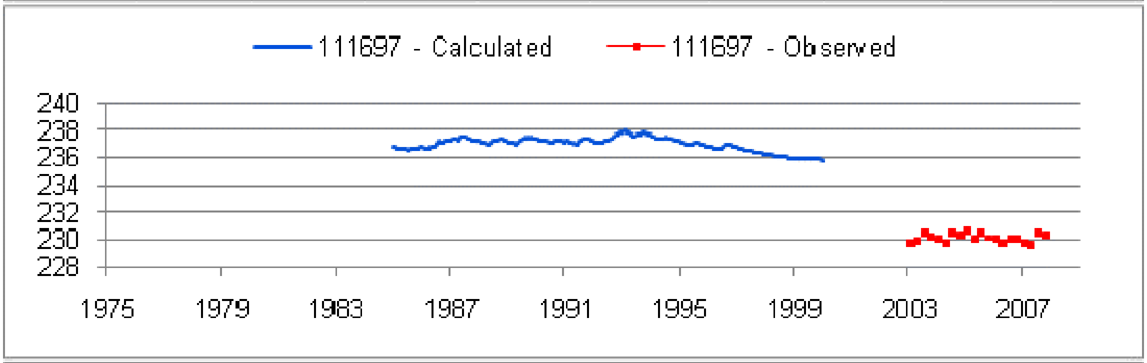
1995
1999
2003
2007


111697 - Calculated
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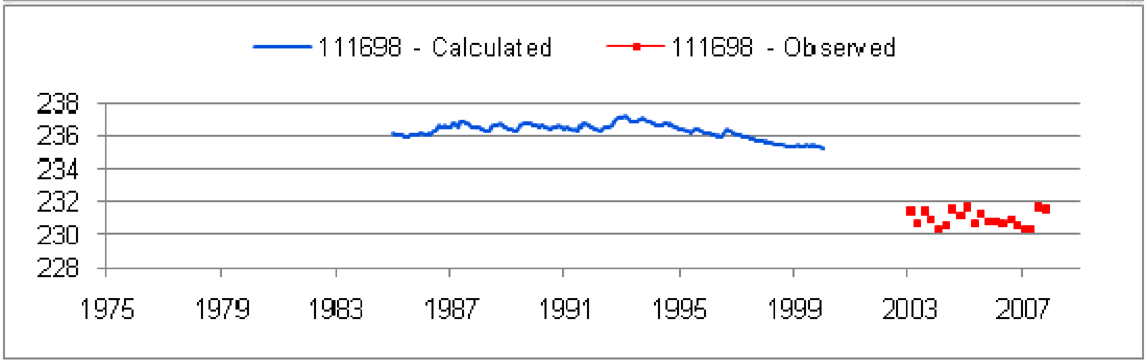
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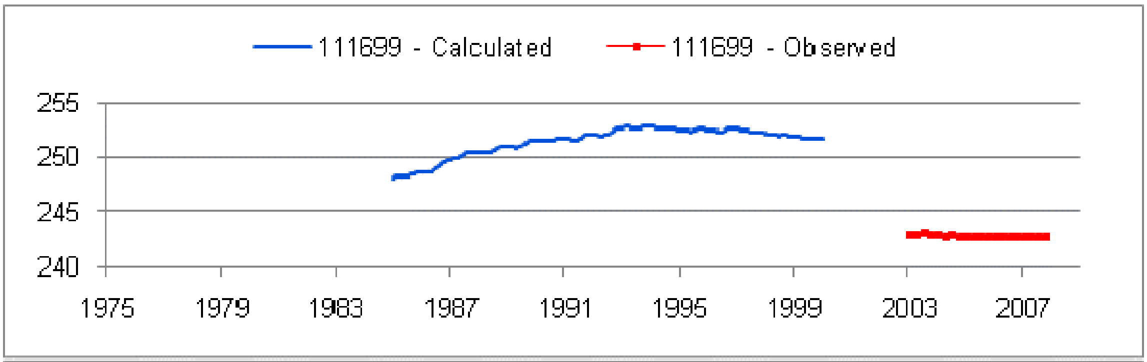

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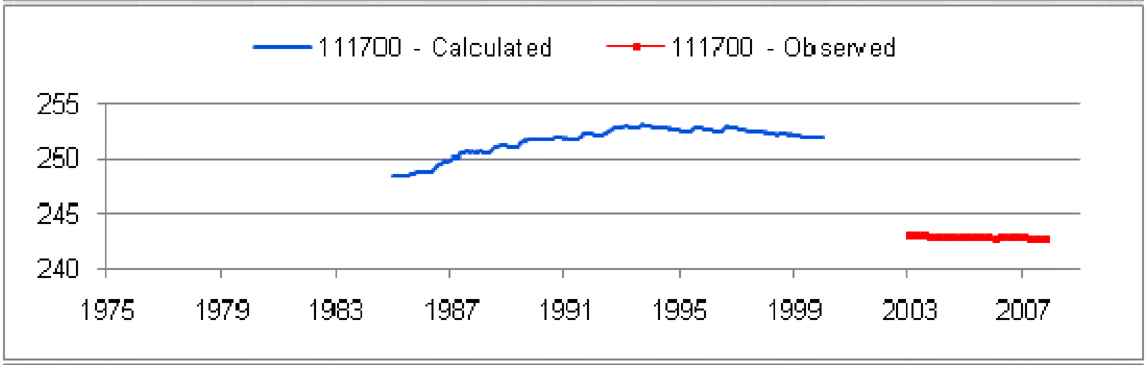

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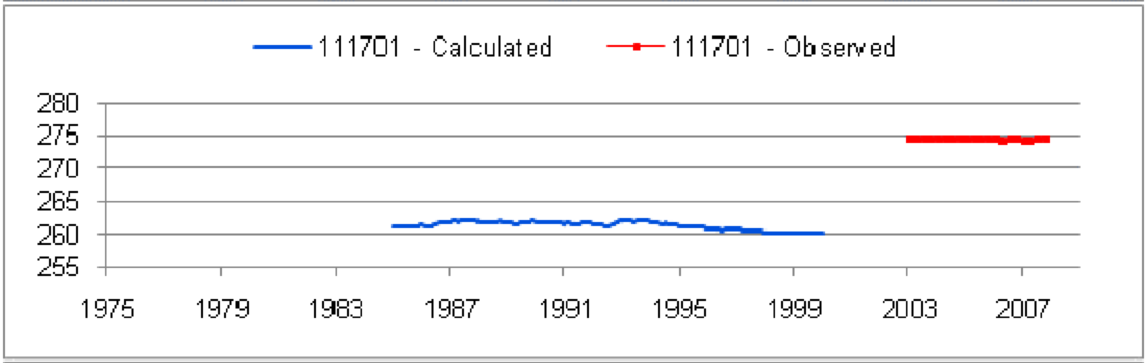

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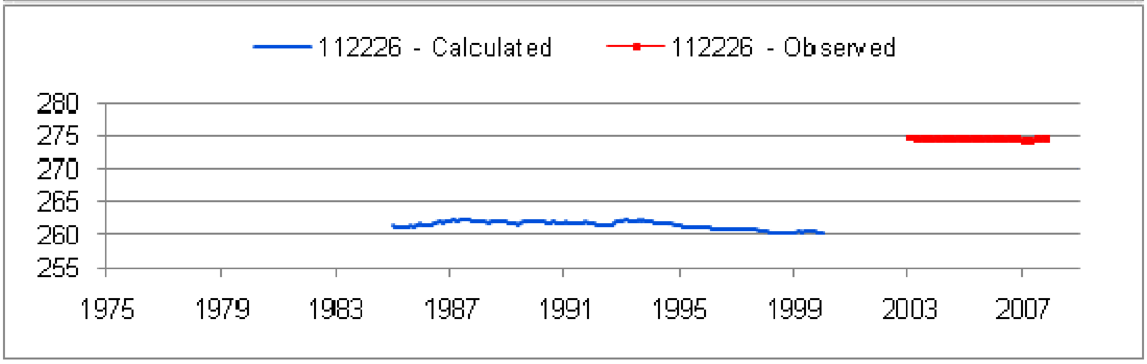

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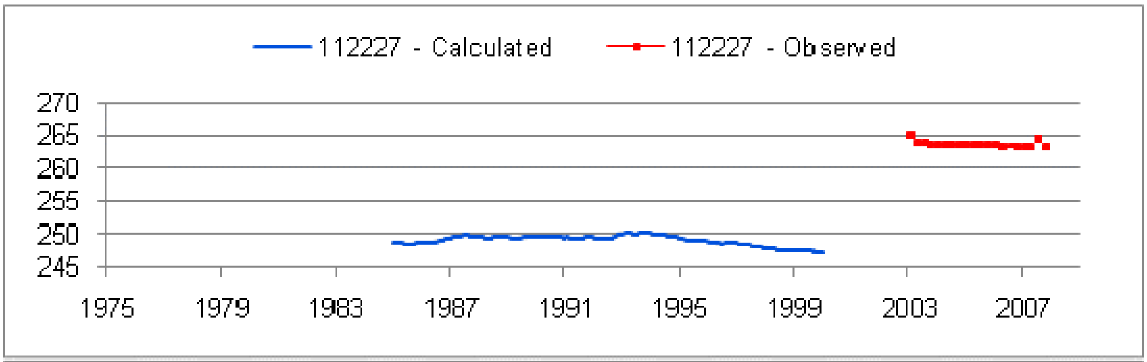
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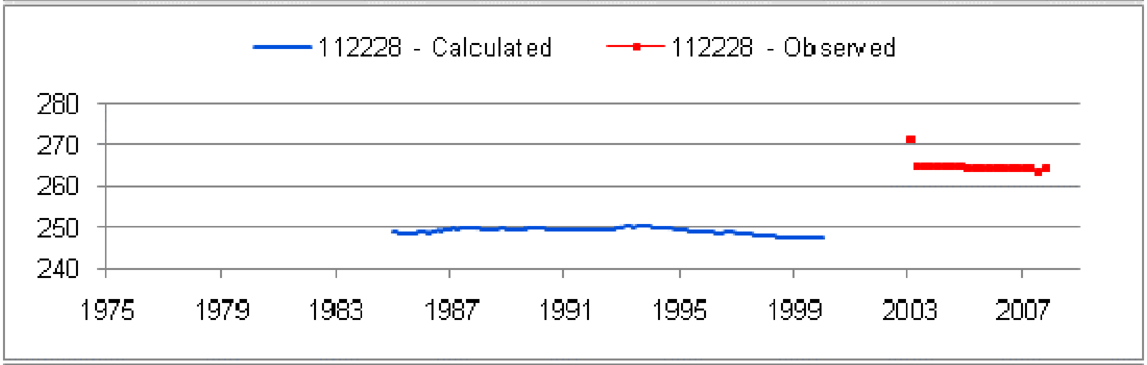
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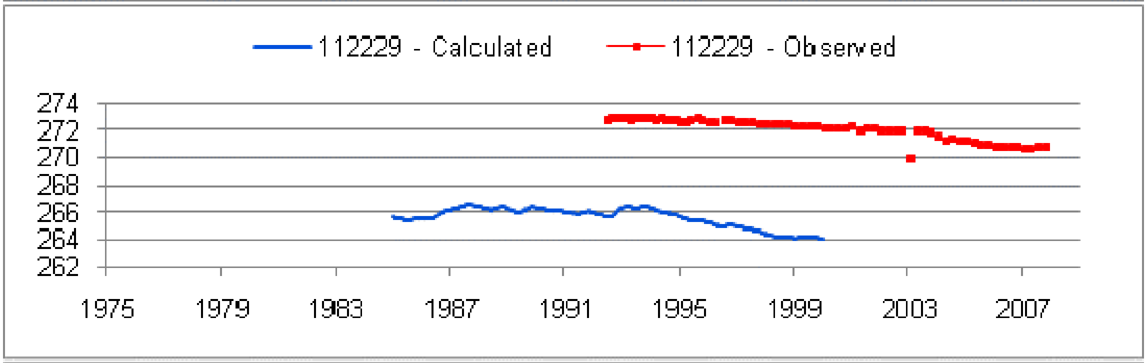
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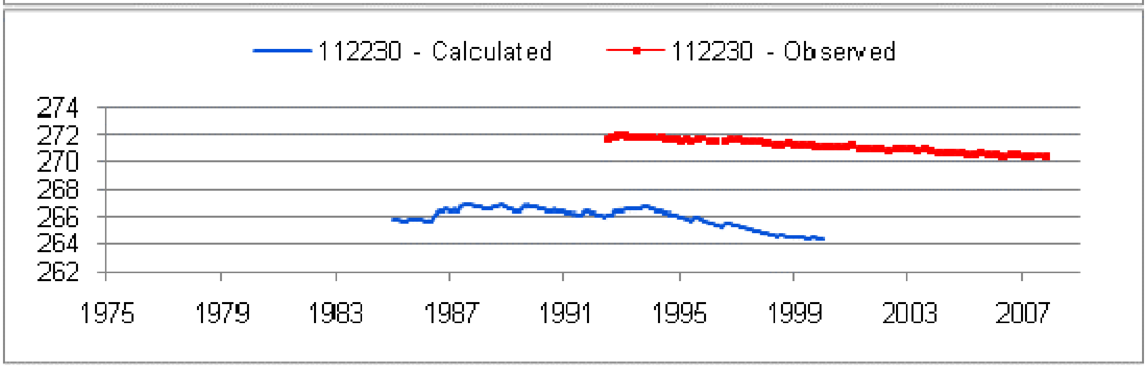
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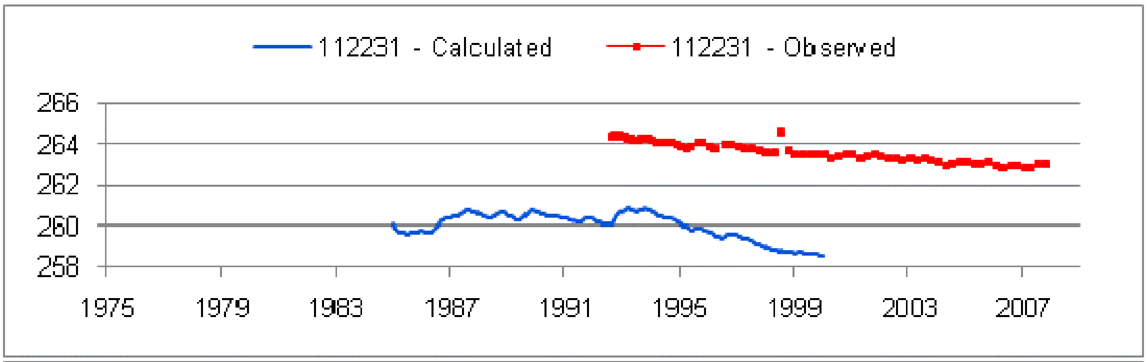
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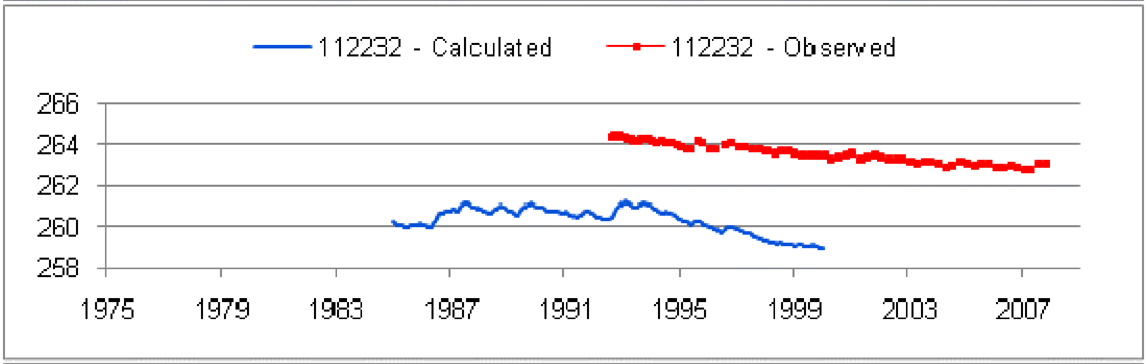
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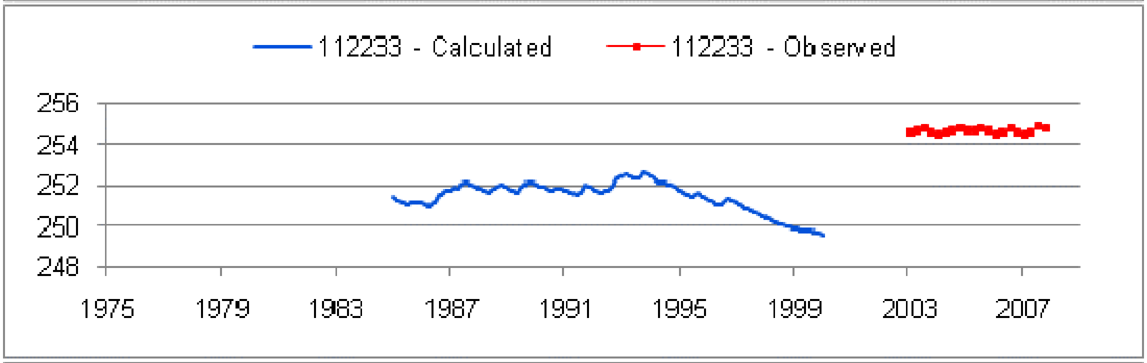
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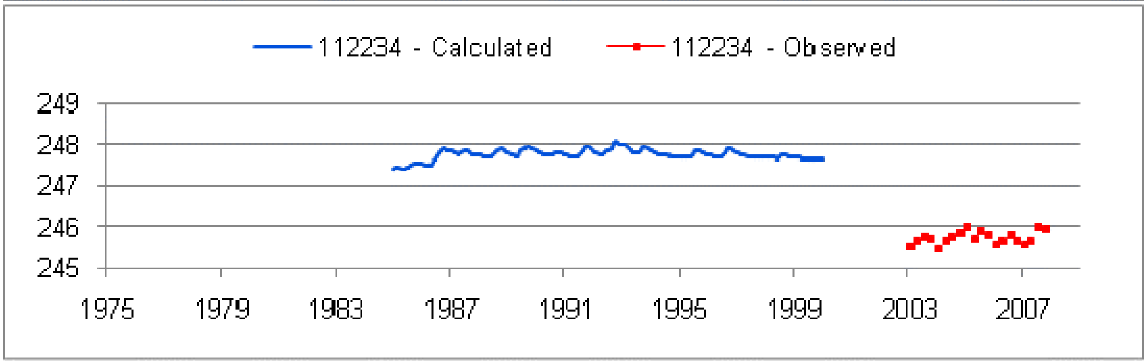
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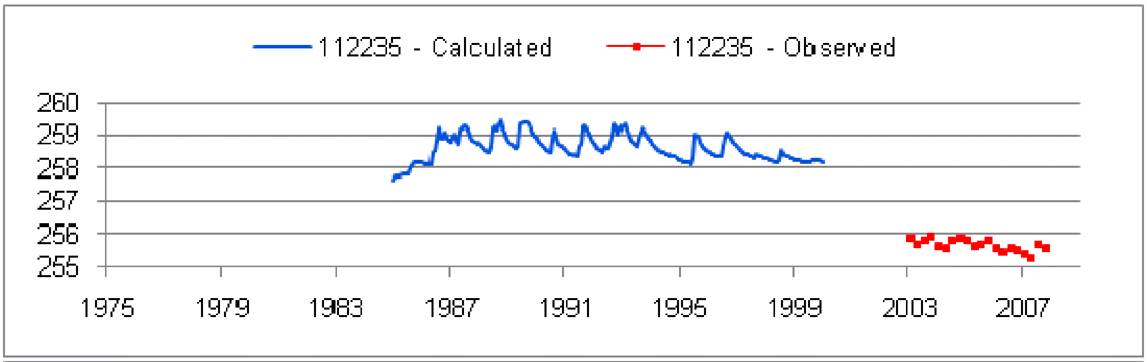
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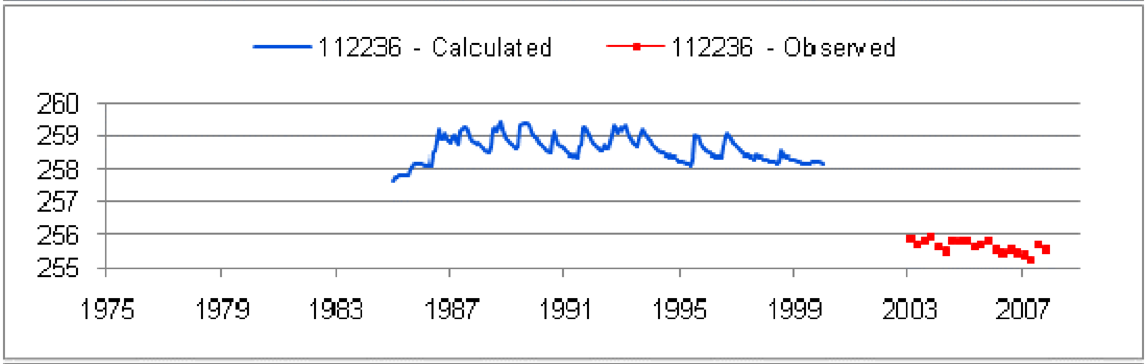
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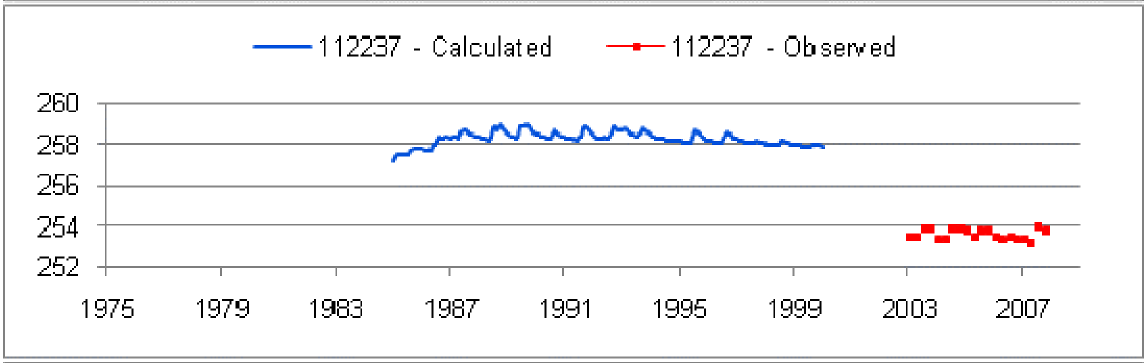
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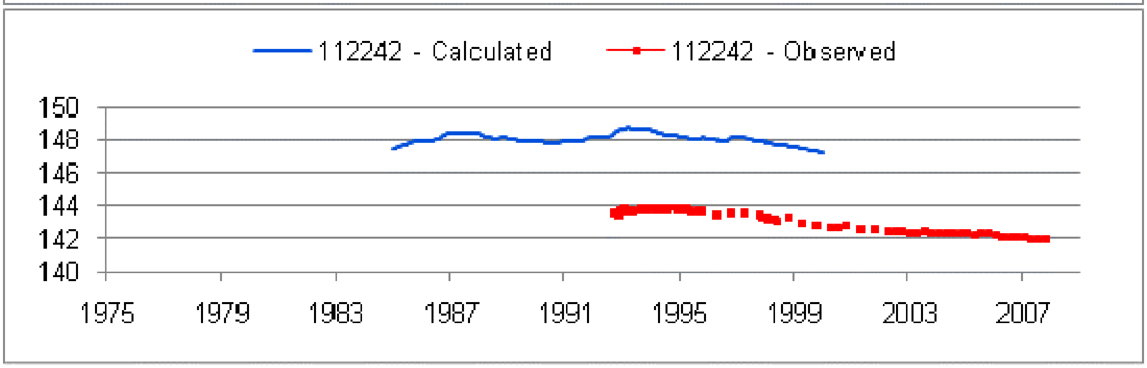
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142
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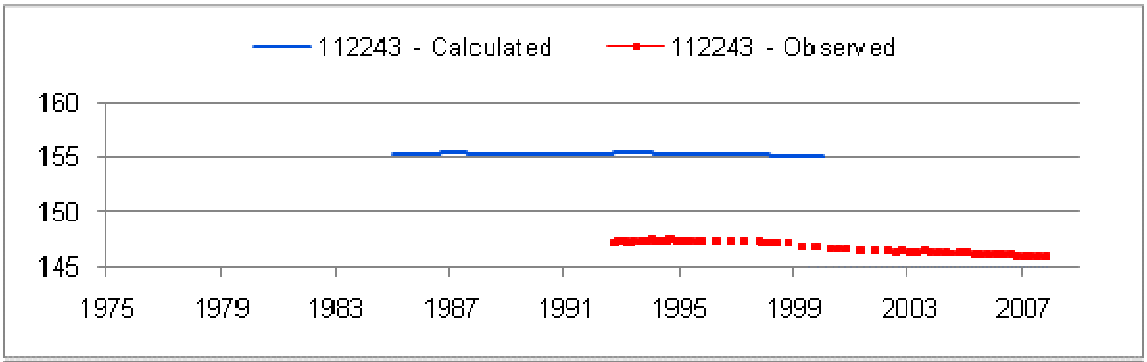

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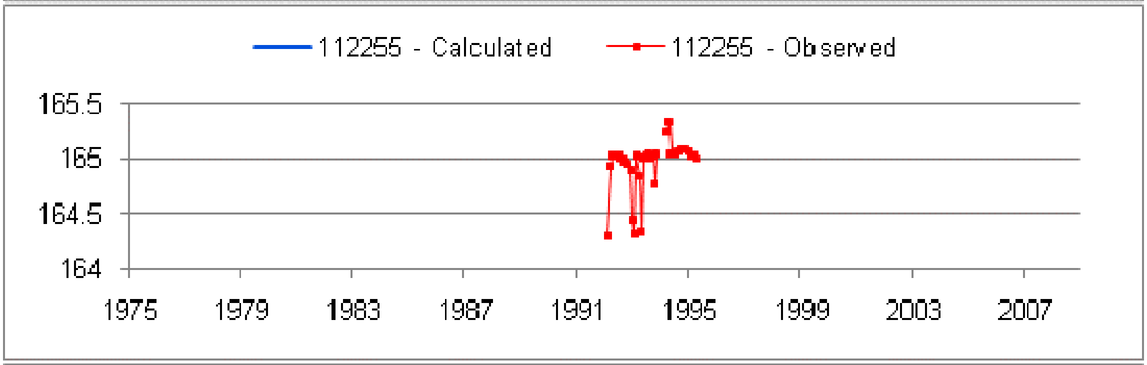

112255 - Calculated
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164
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1979
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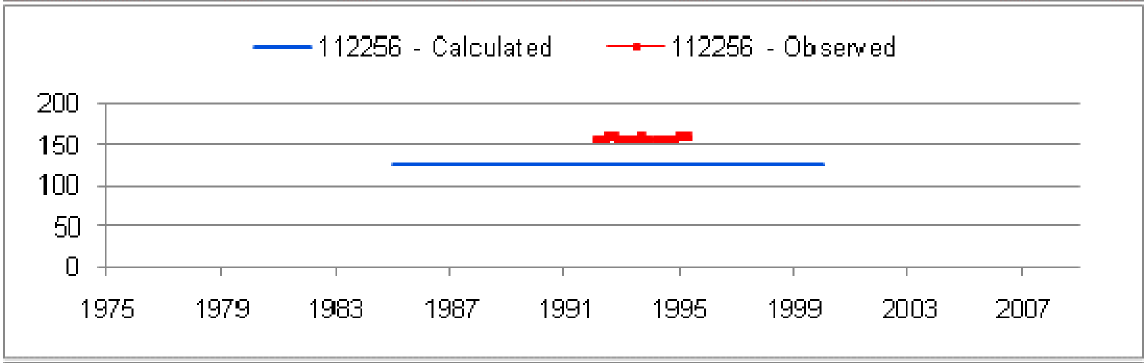

112256 - Calculated
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0
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1979
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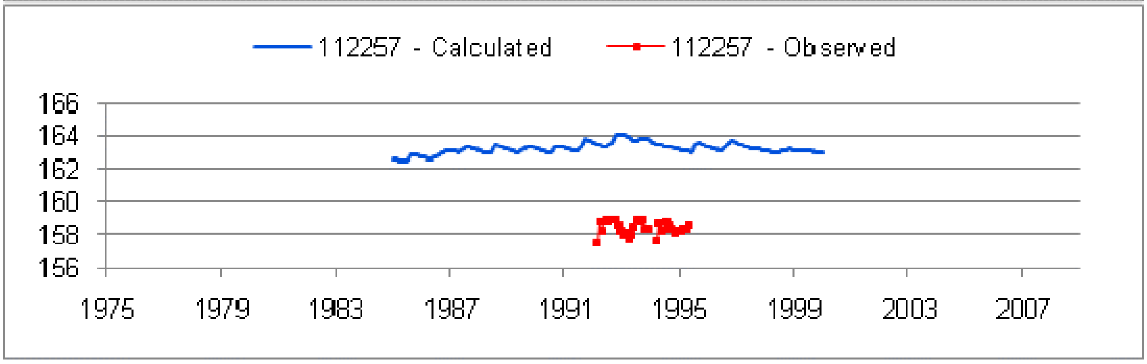

112257 - Calculated
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158
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1975
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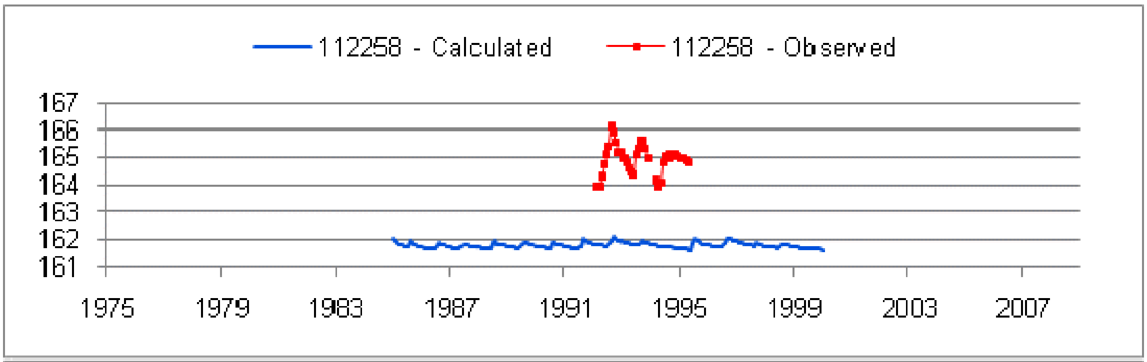

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1975
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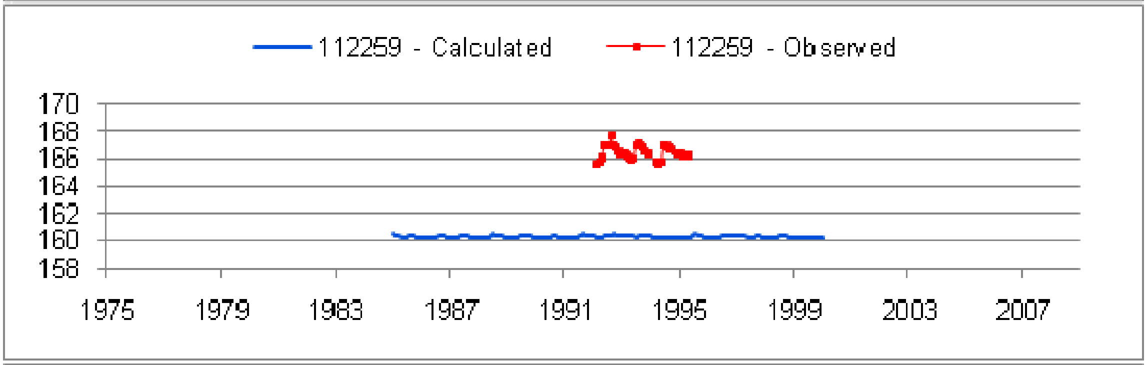

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162
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158
1975
1979
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2003
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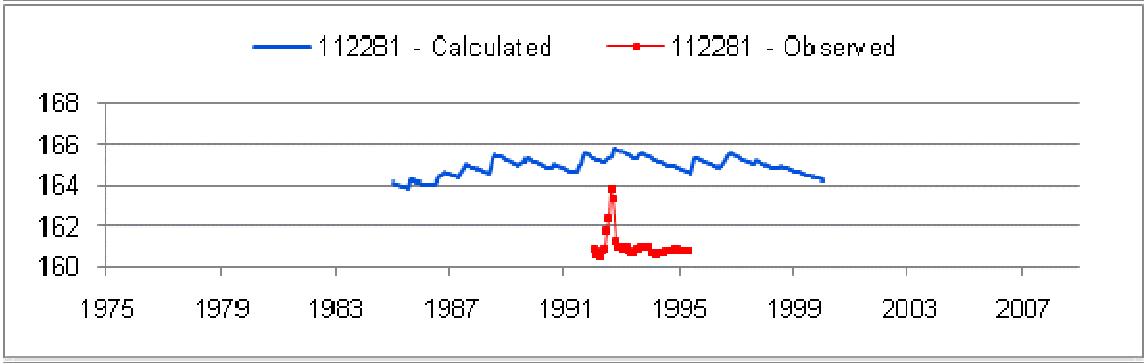

112281 - Calculated
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1975
1979
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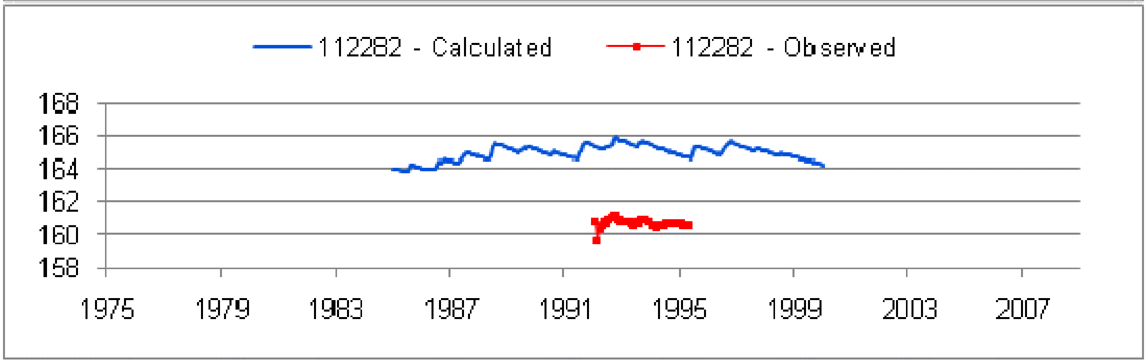

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164
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160
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1975
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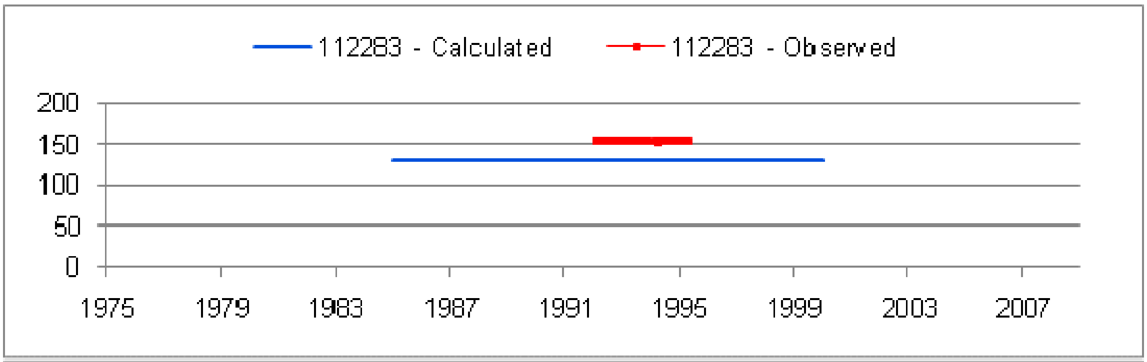
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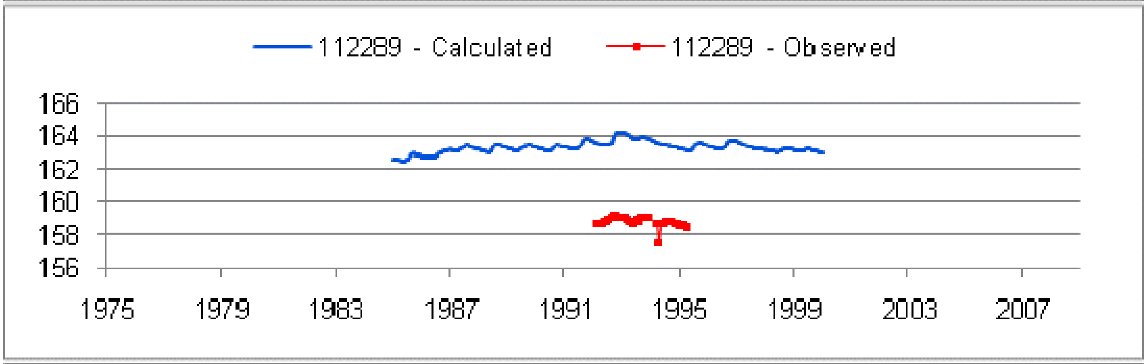
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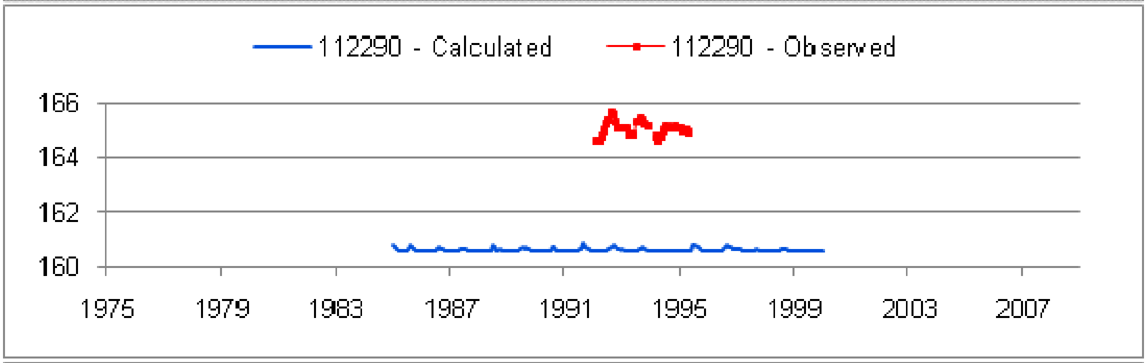
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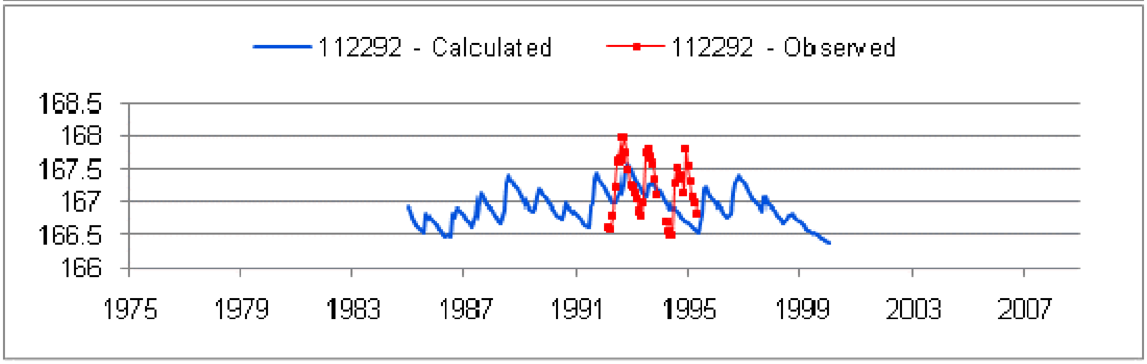
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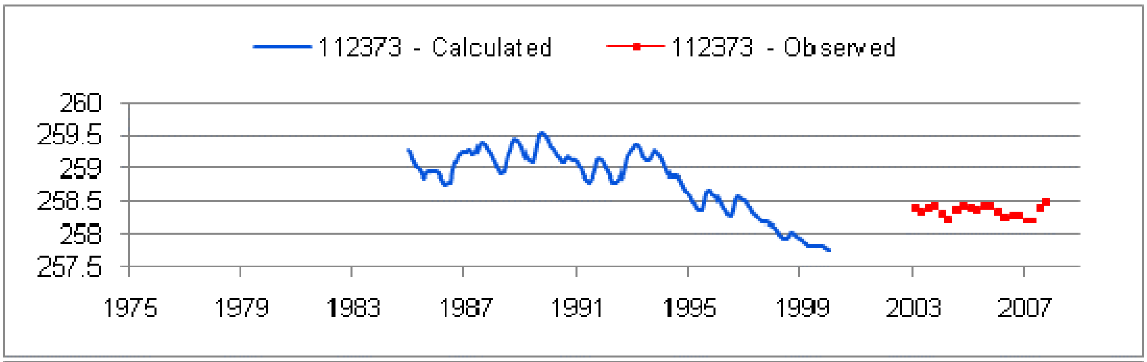
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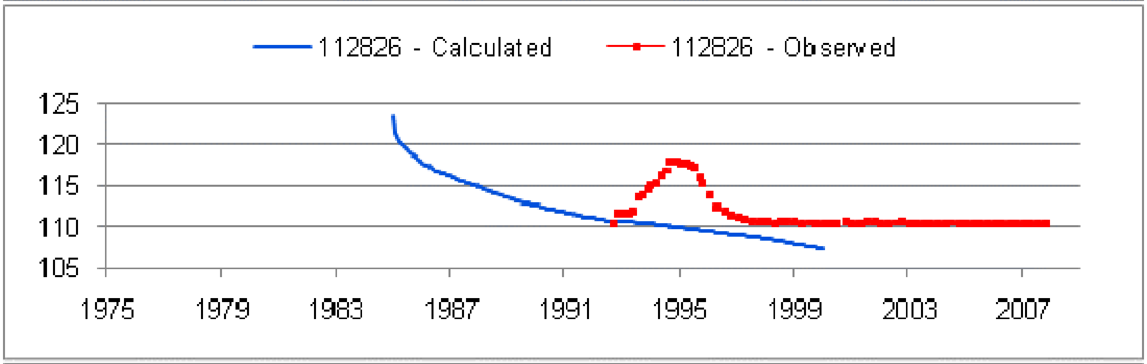
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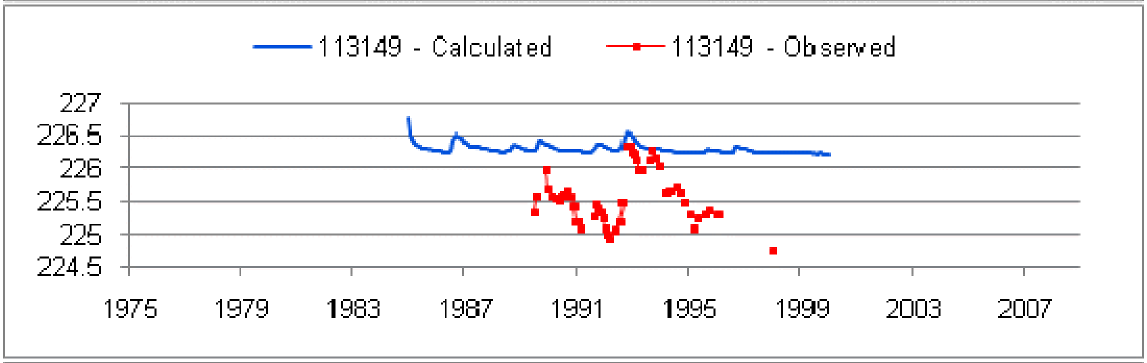
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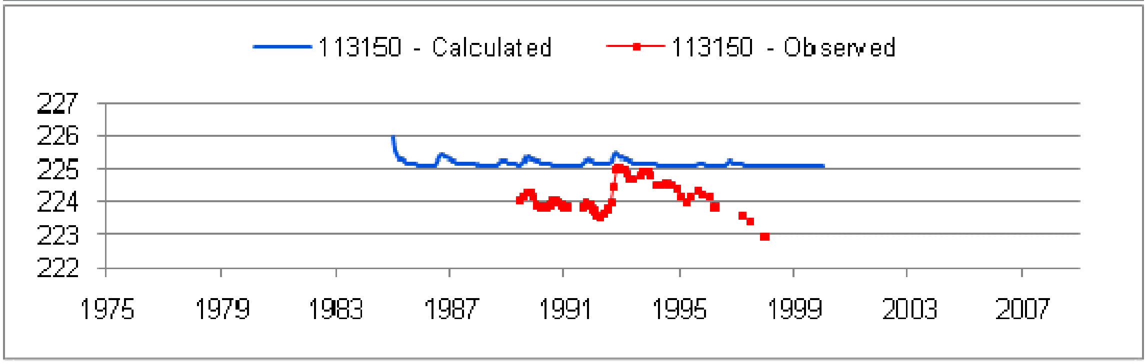
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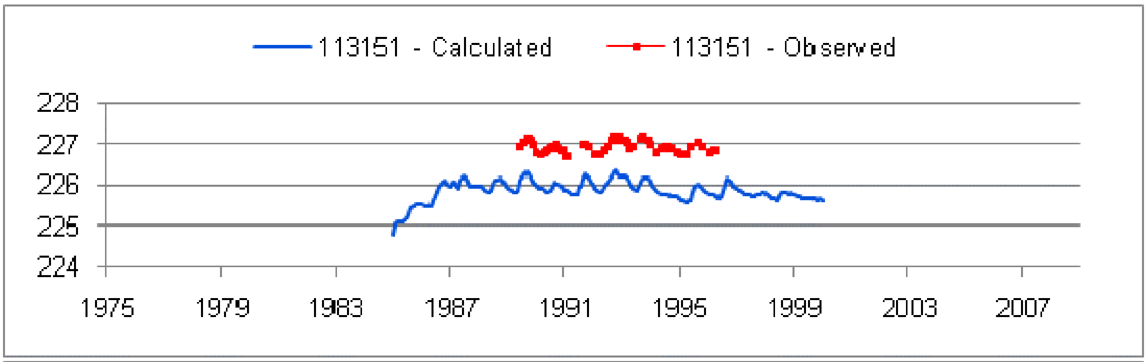
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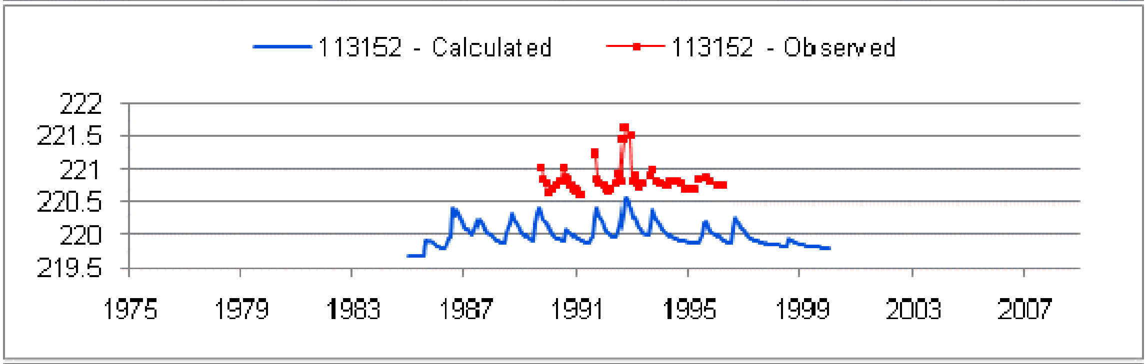
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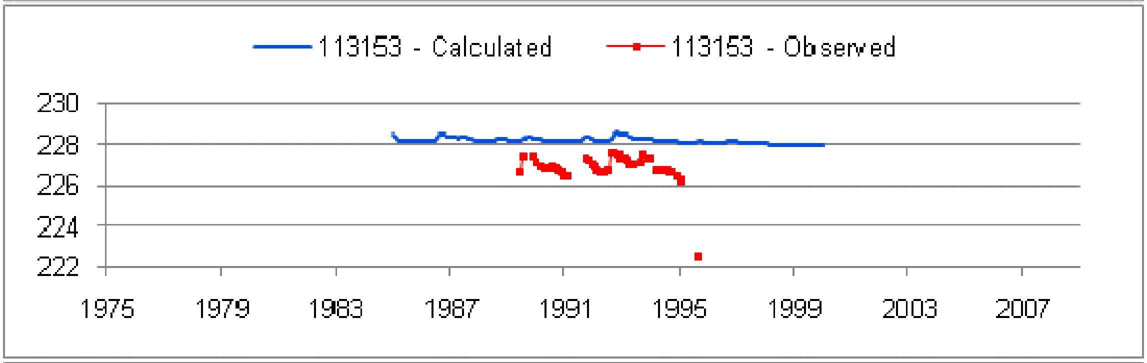
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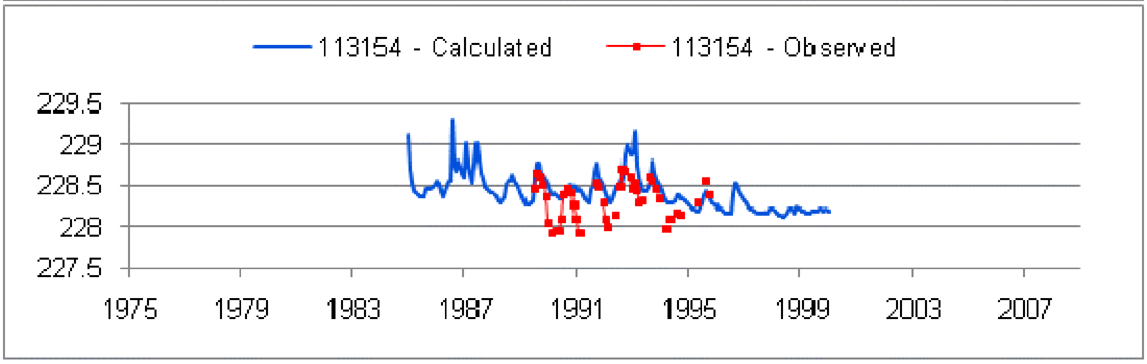
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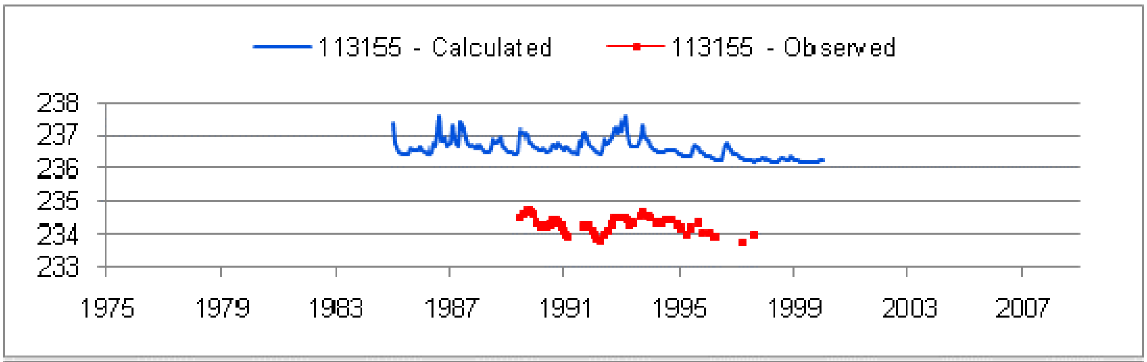

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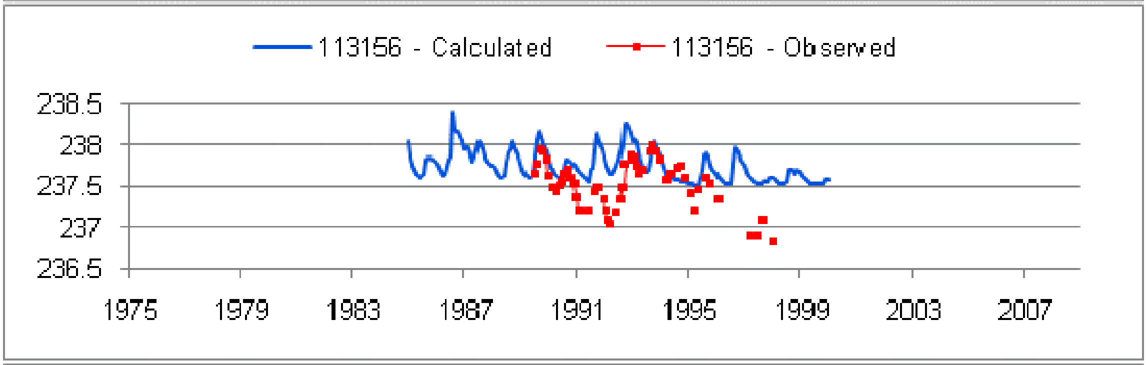

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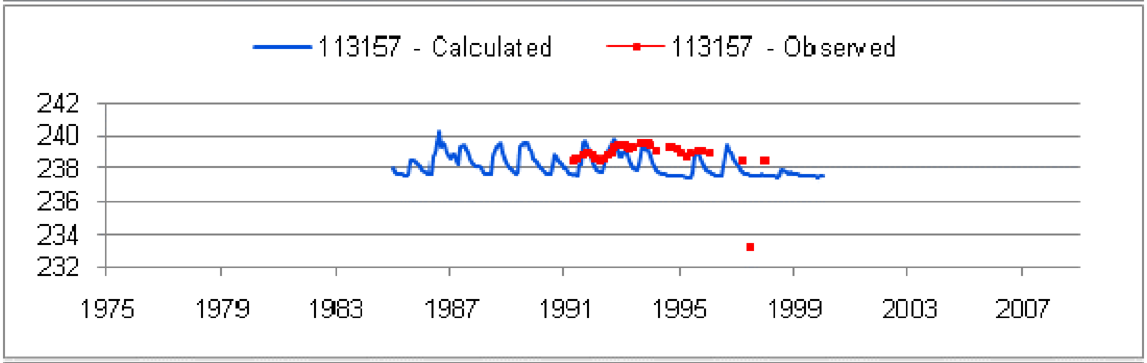

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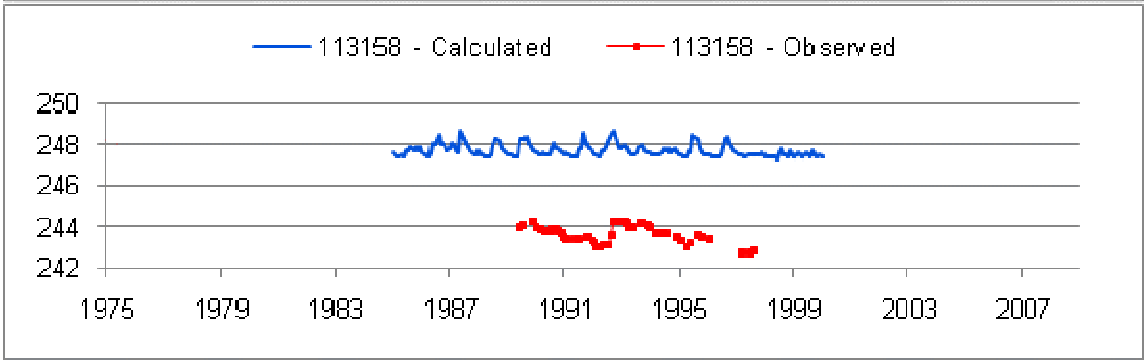

113158 - Calculated
113158 - Observed
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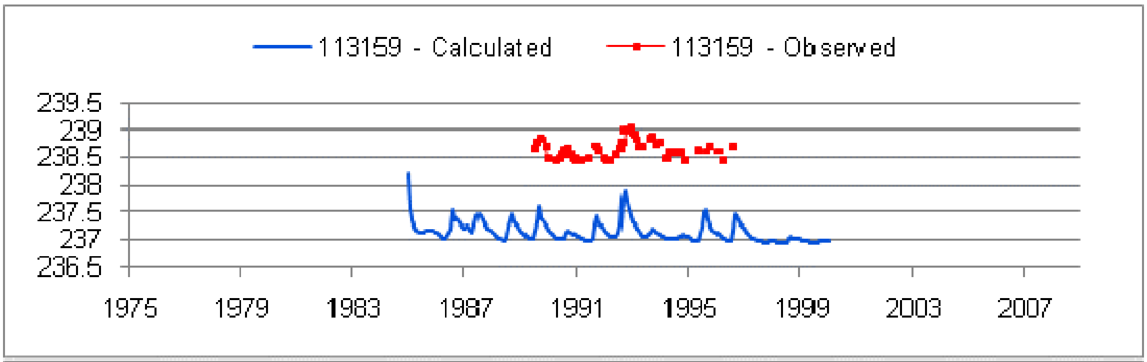
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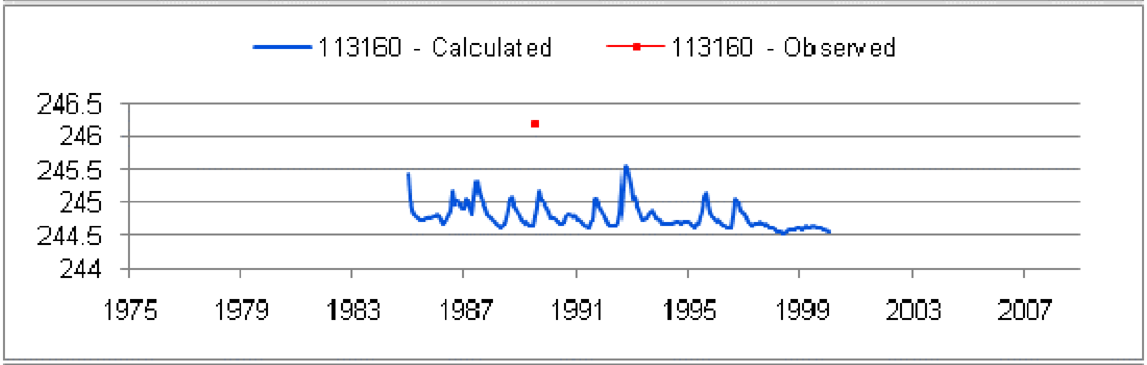
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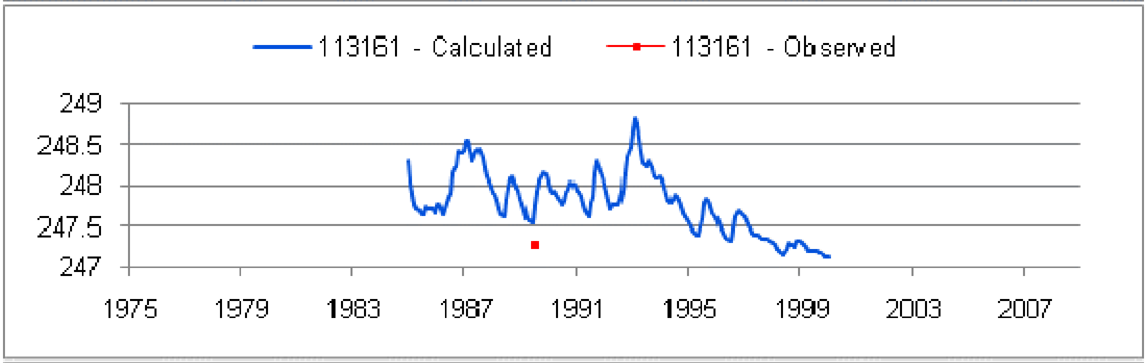
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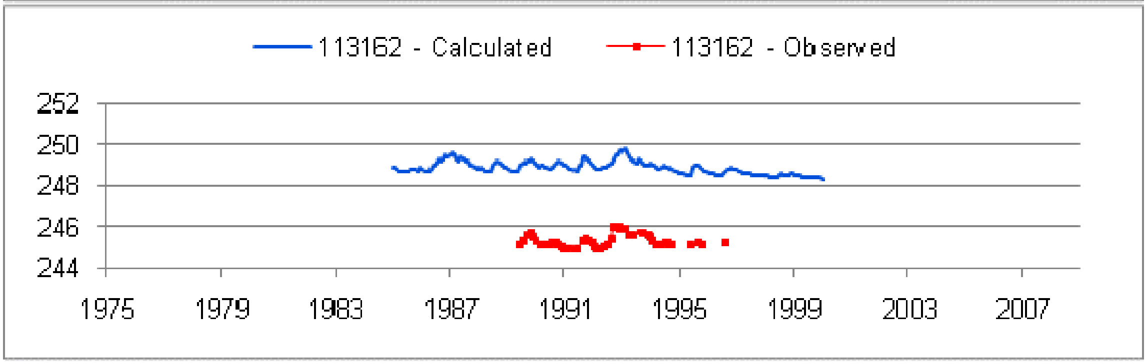
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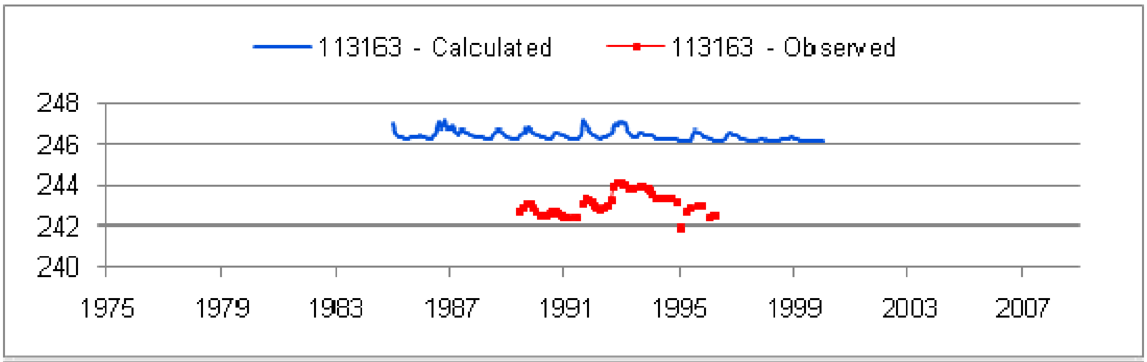
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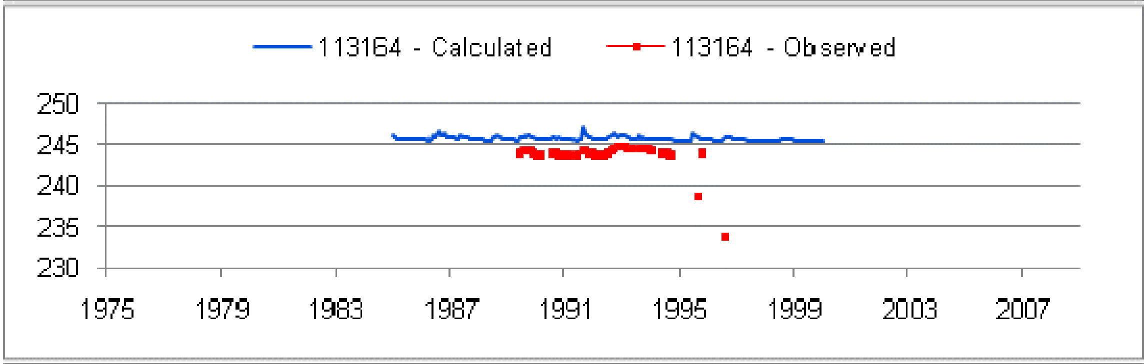
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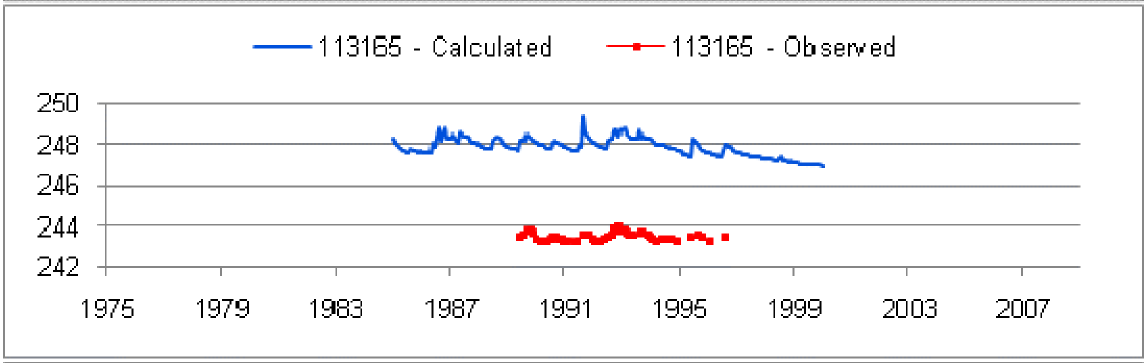
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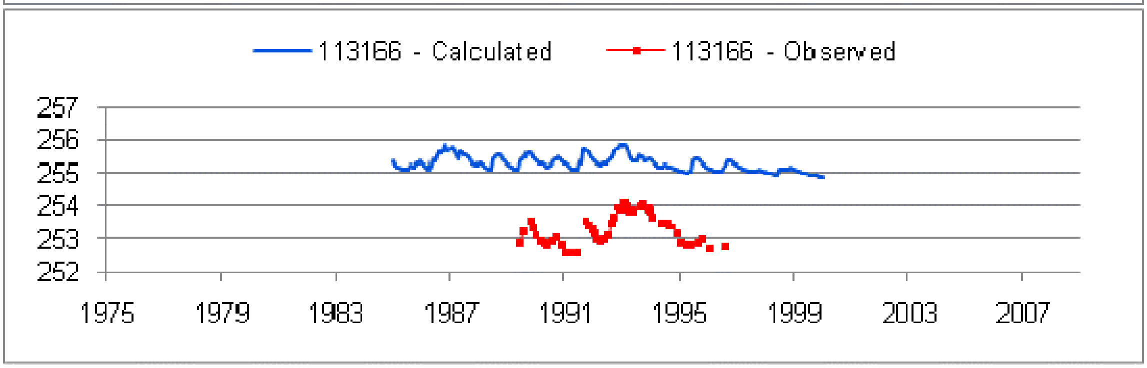
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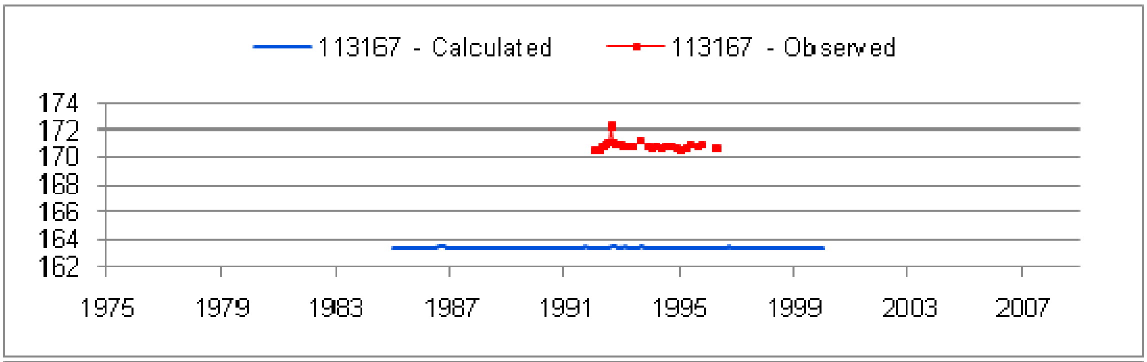
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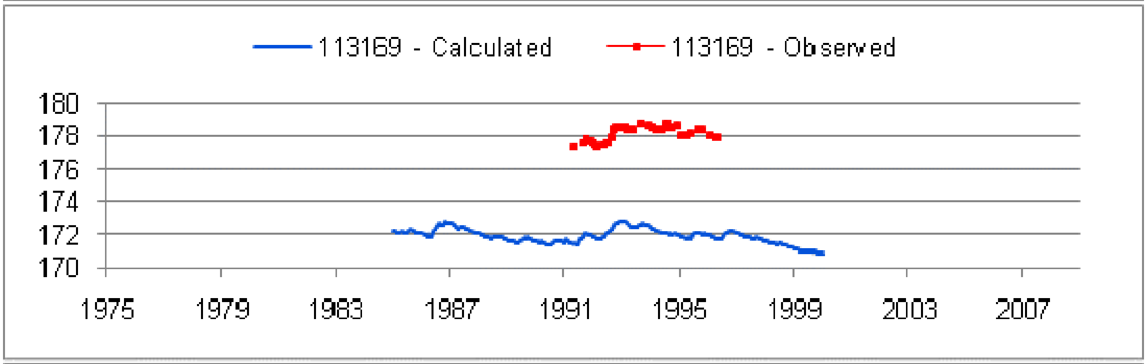
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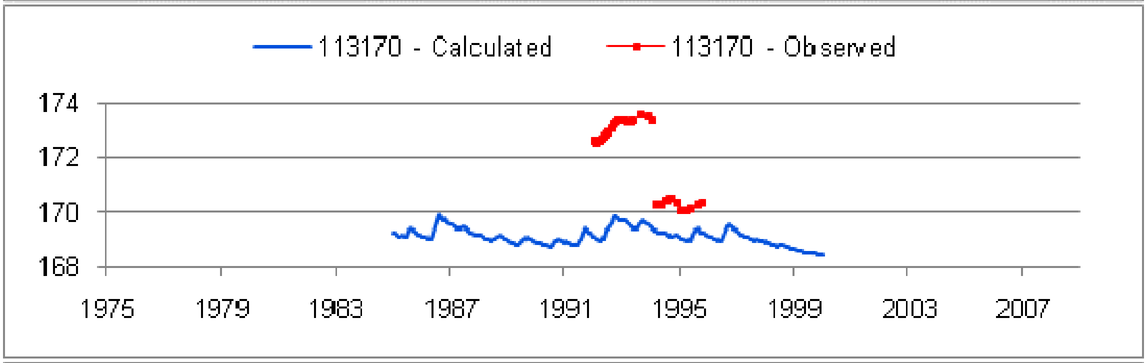
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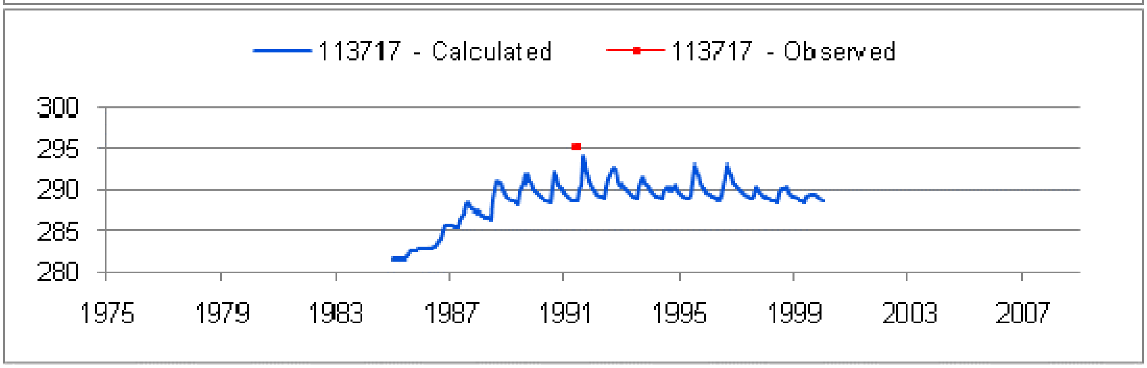
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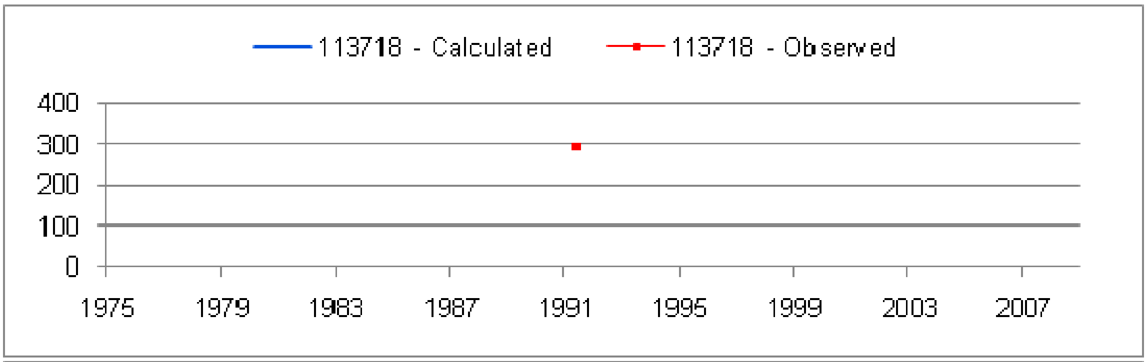
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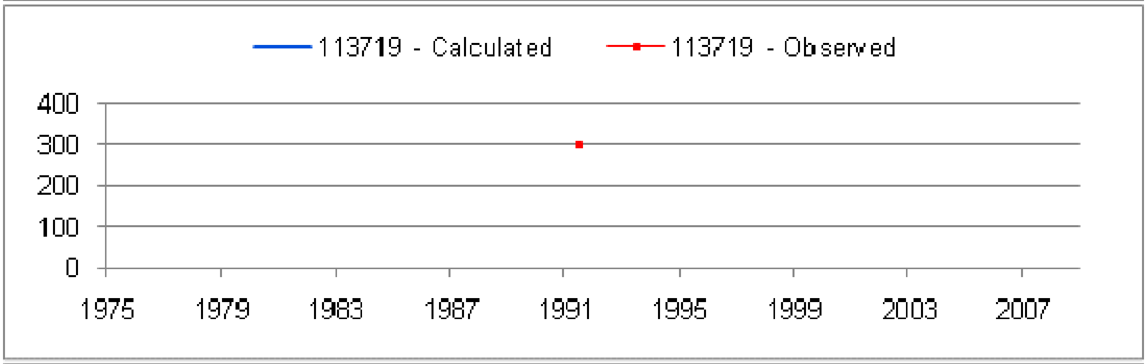
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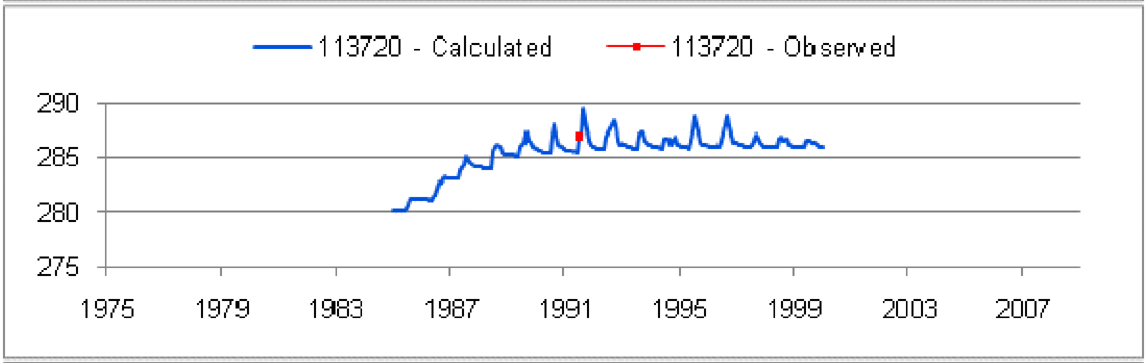
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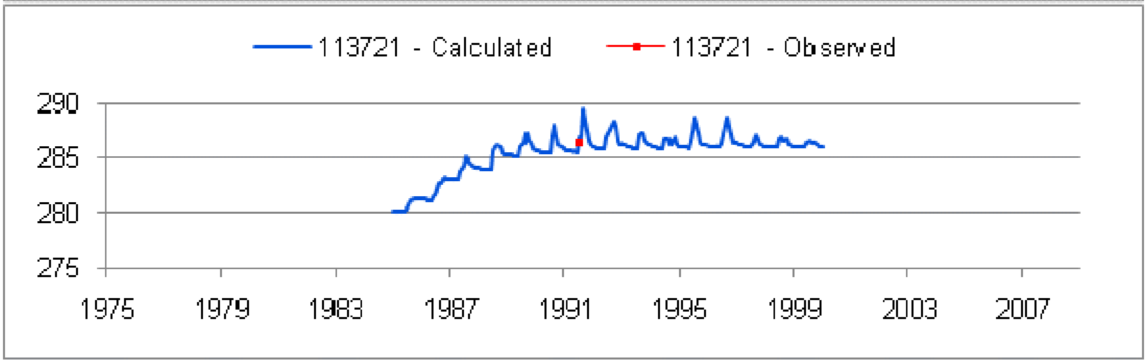
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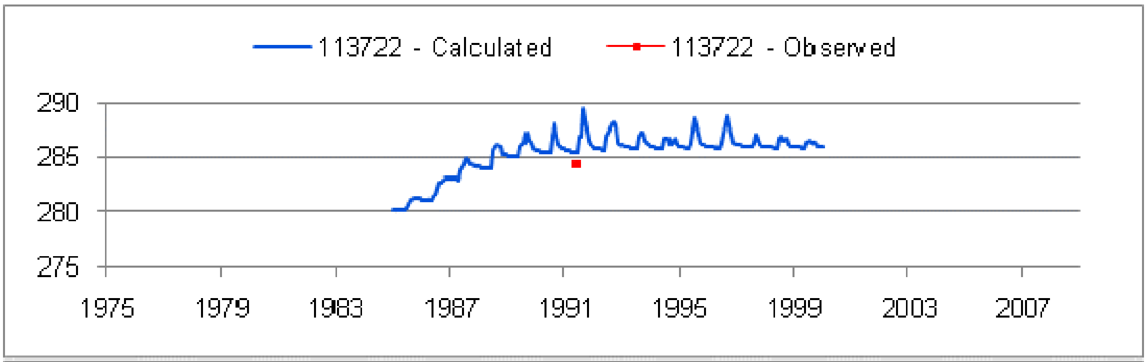

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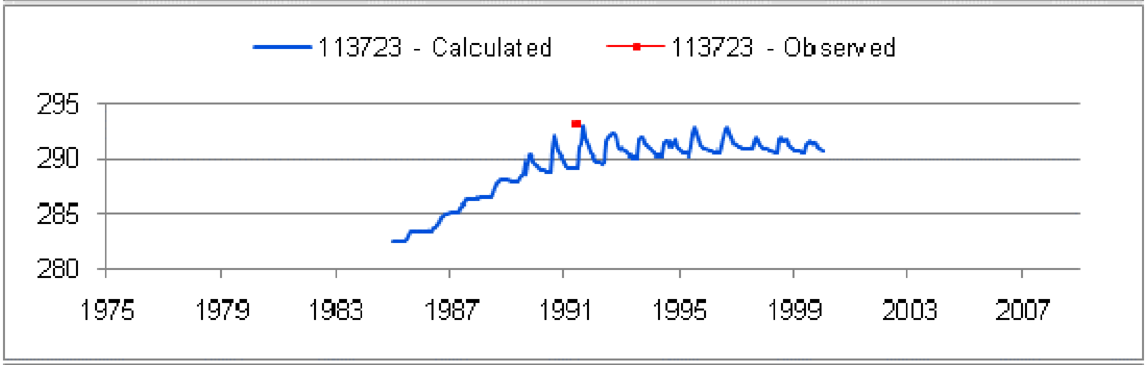

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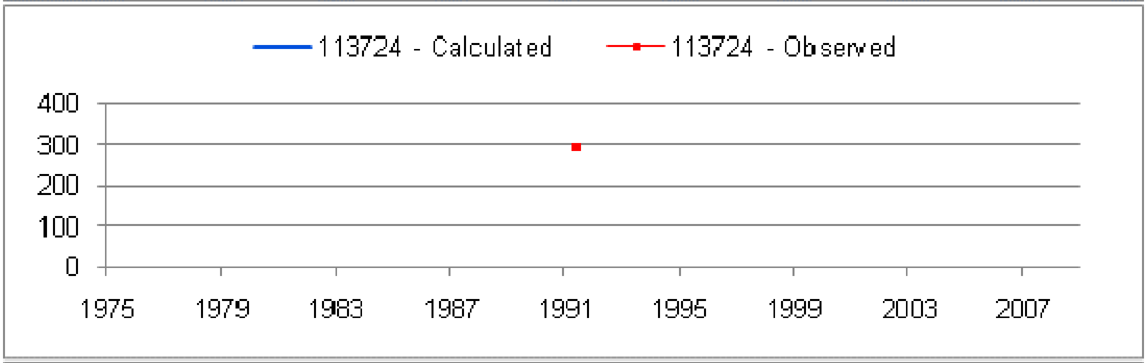

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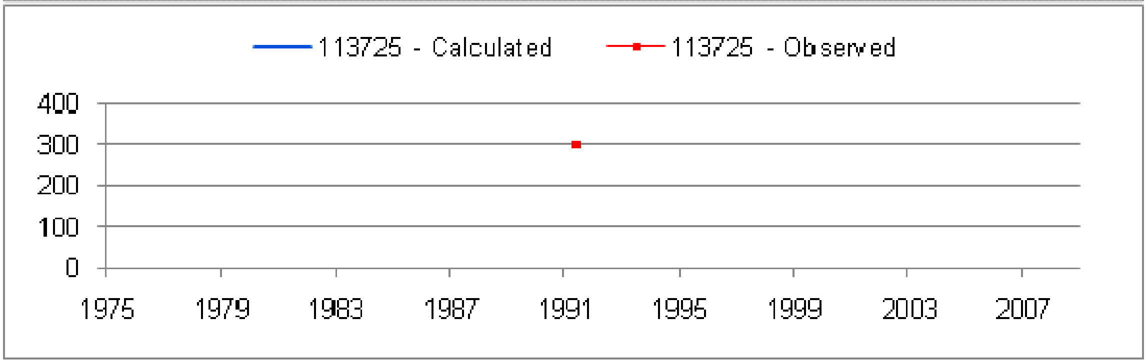

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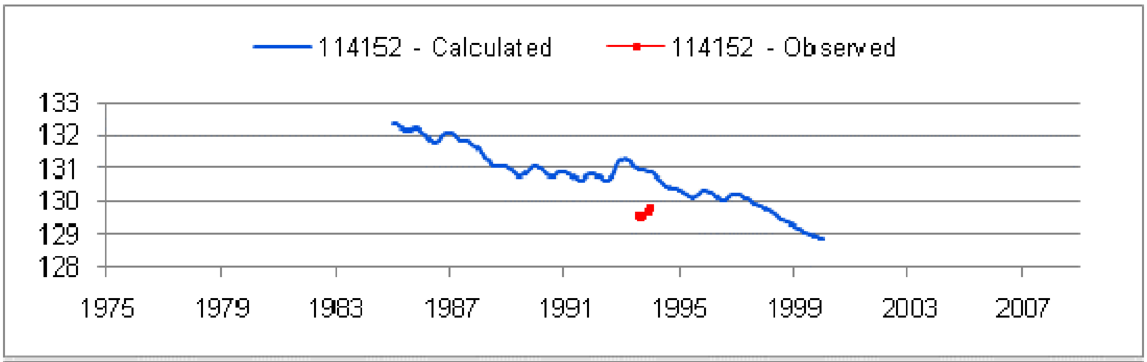
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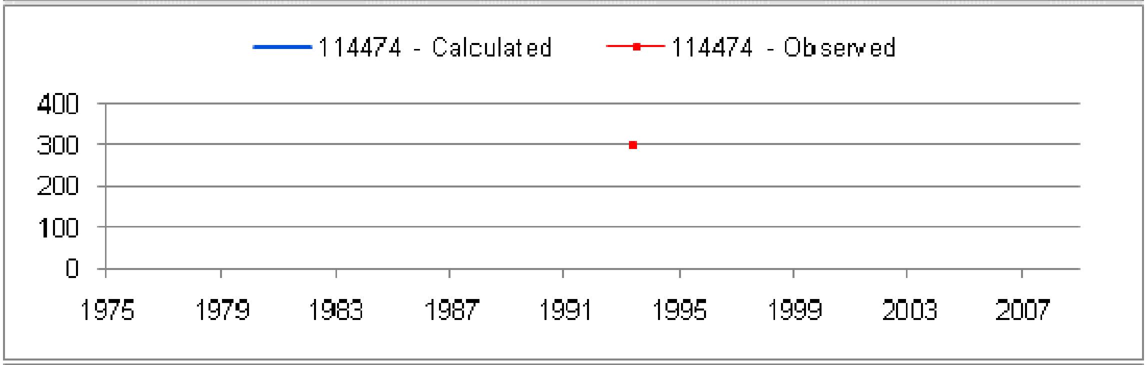
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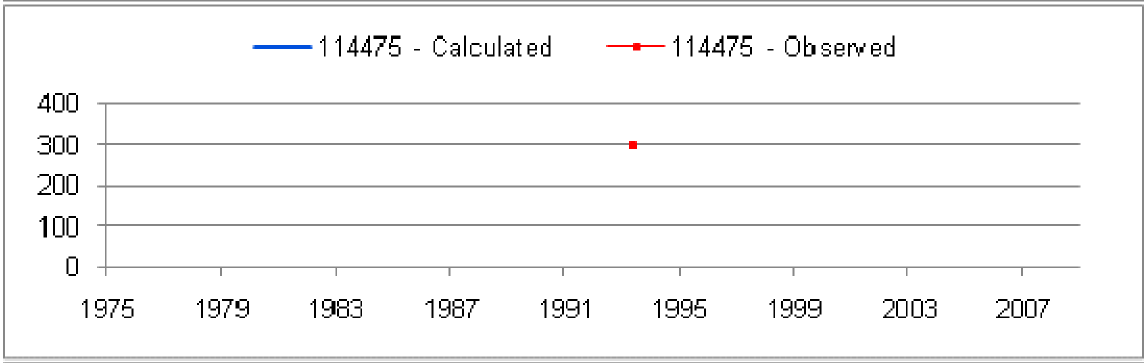
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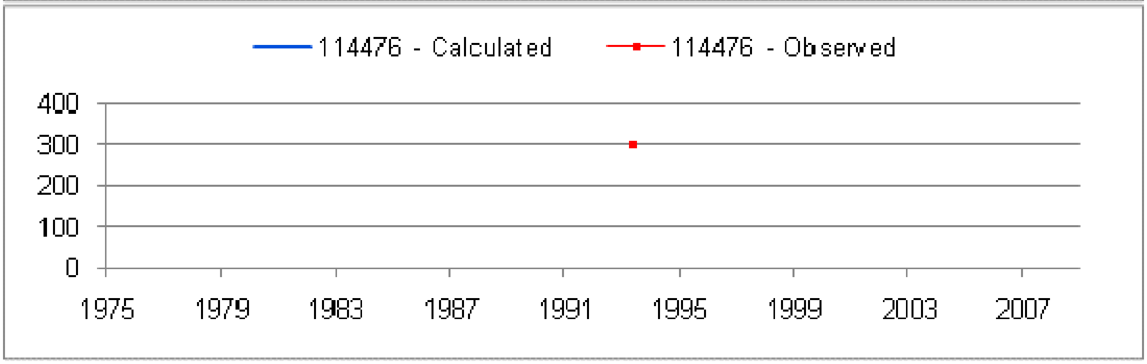
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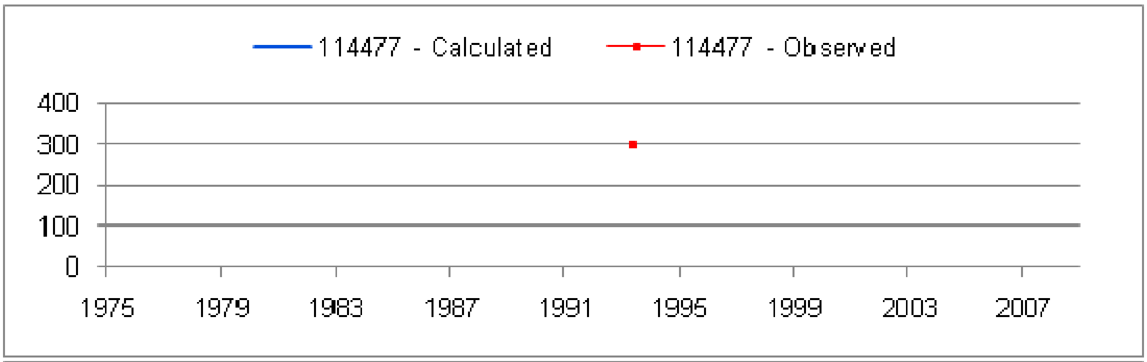
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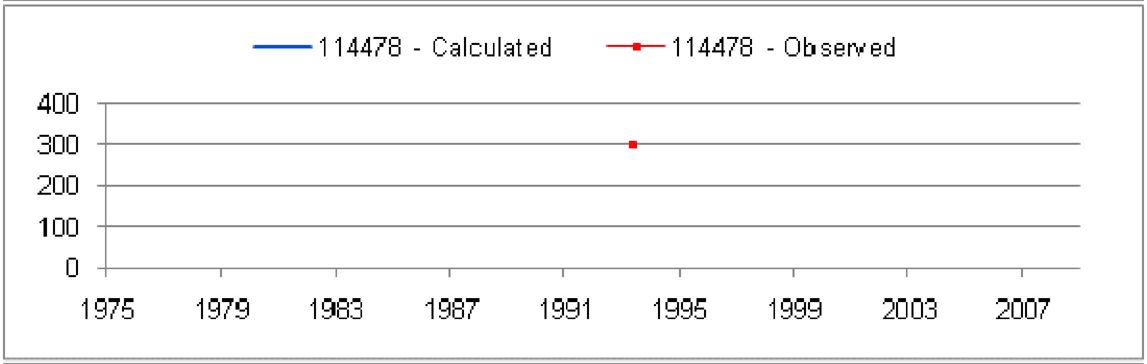
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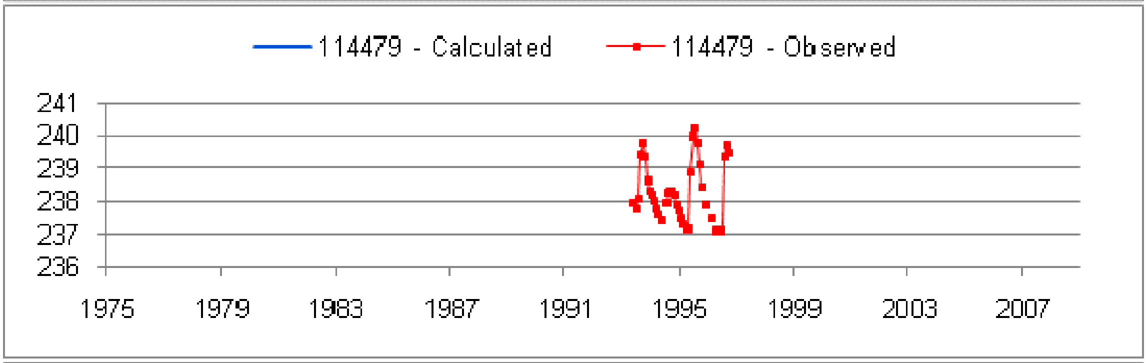
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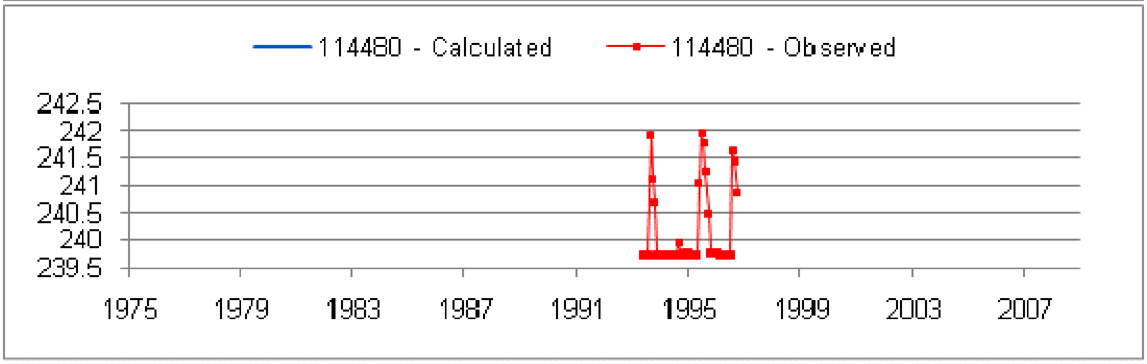
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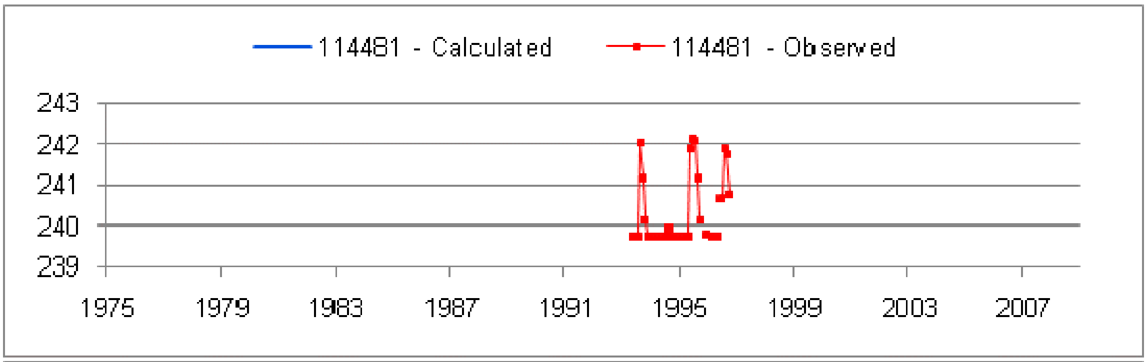
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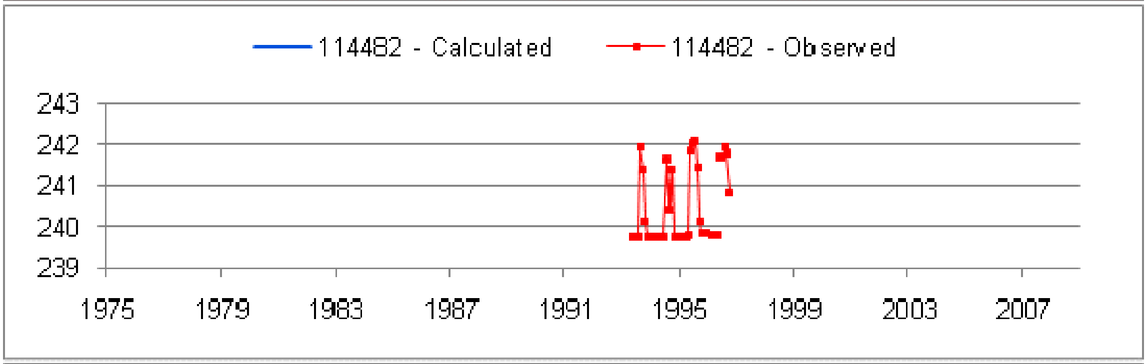
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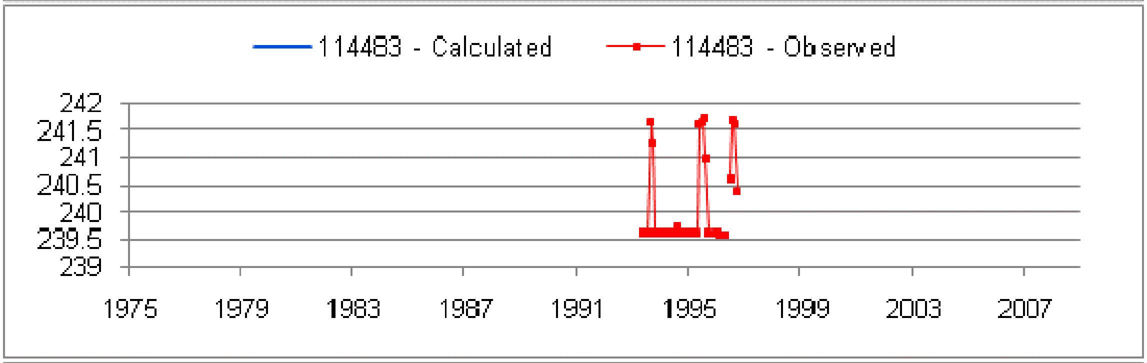
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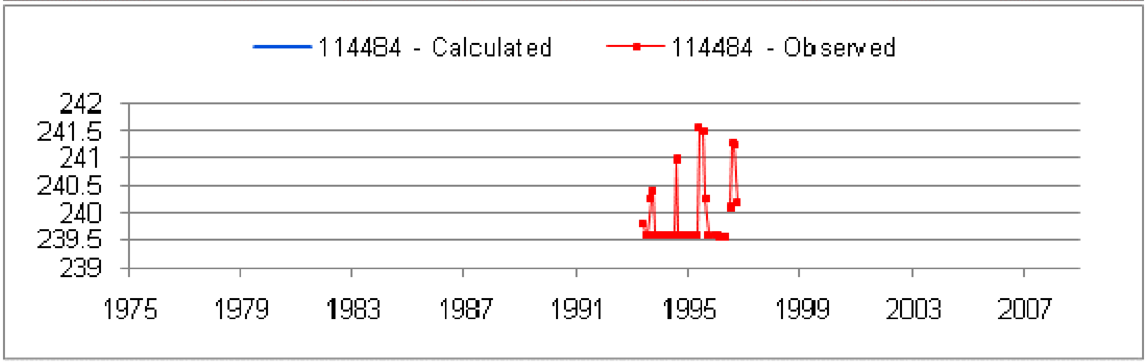
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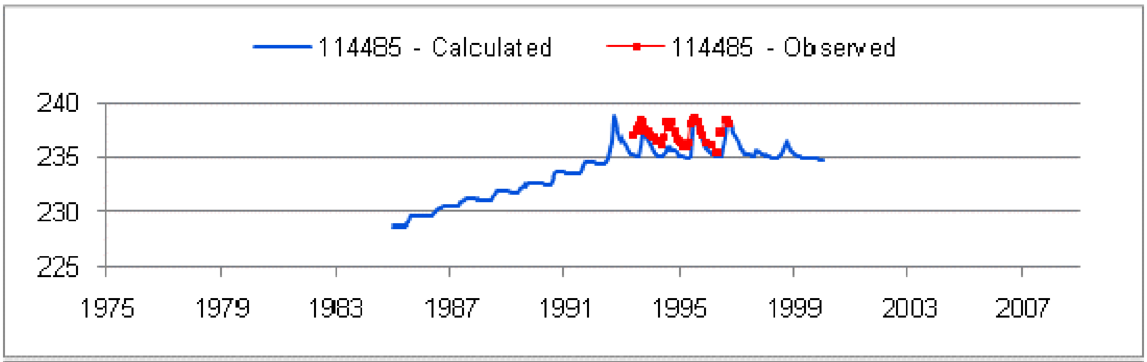
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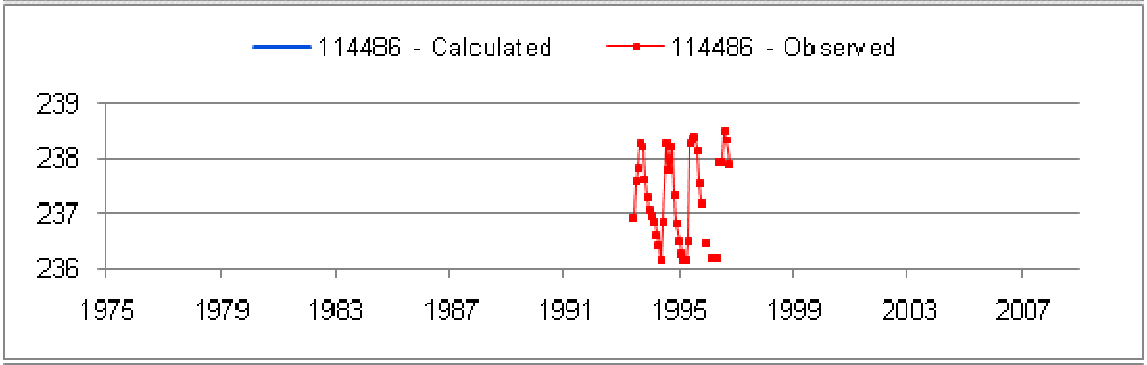
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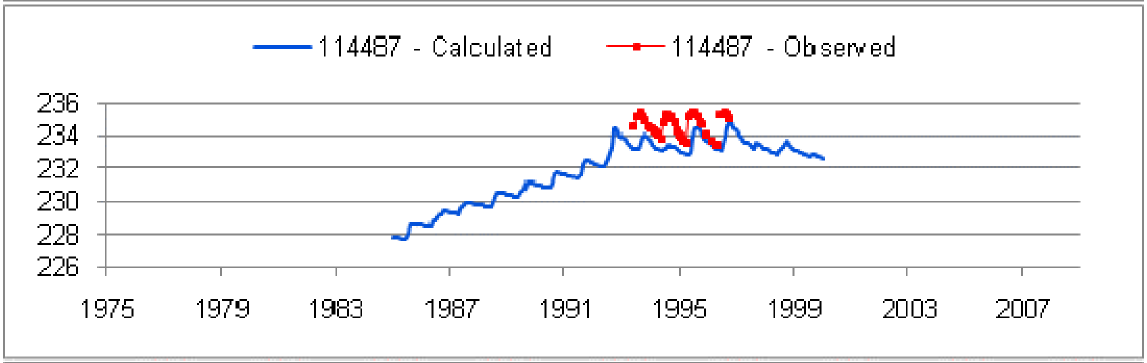
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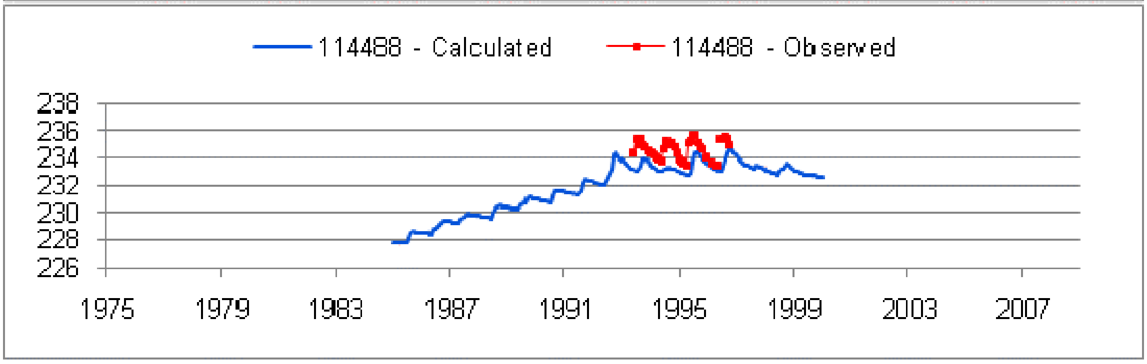
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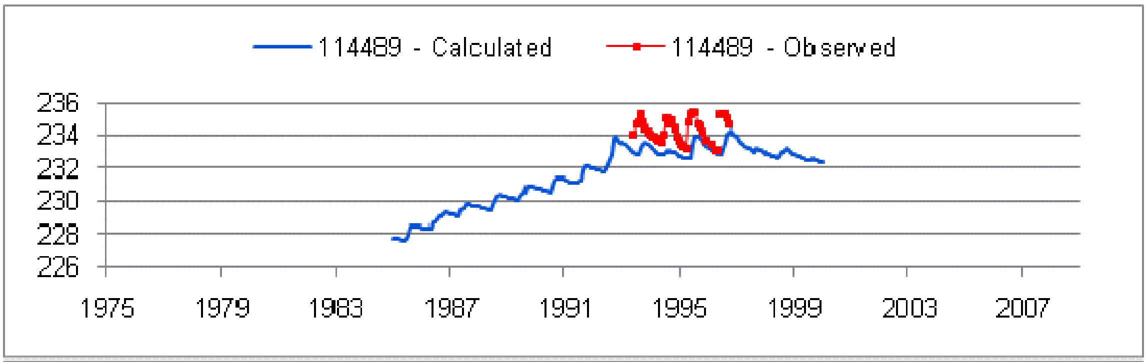
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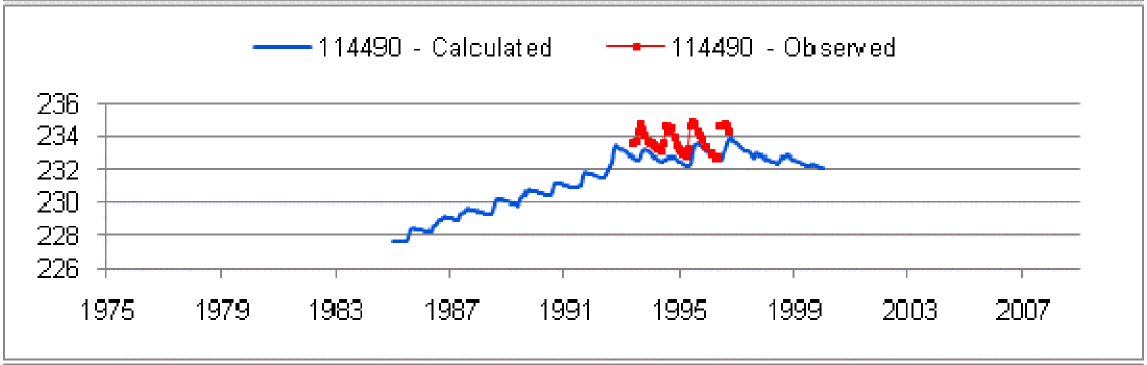
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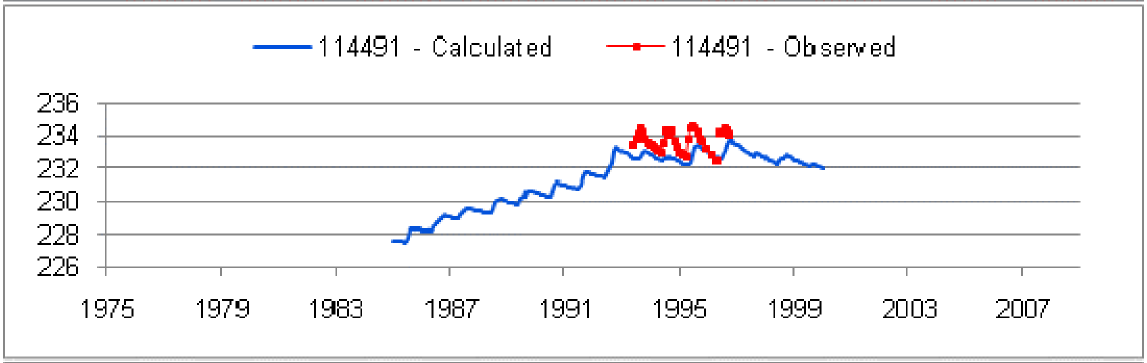
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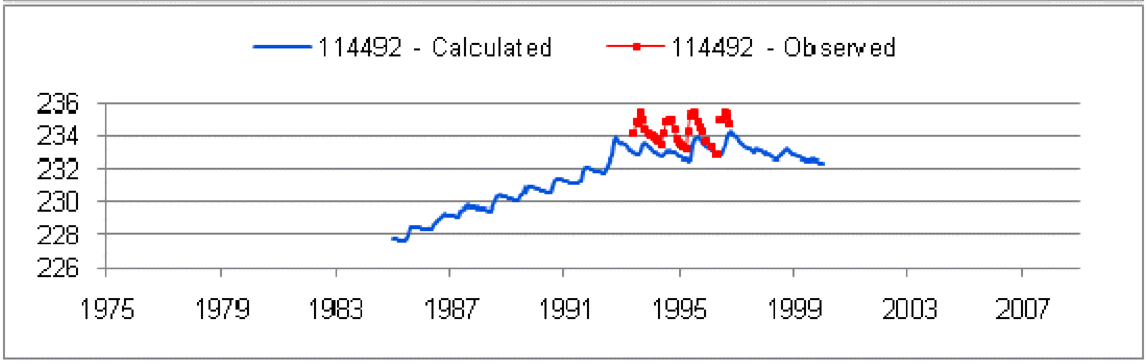
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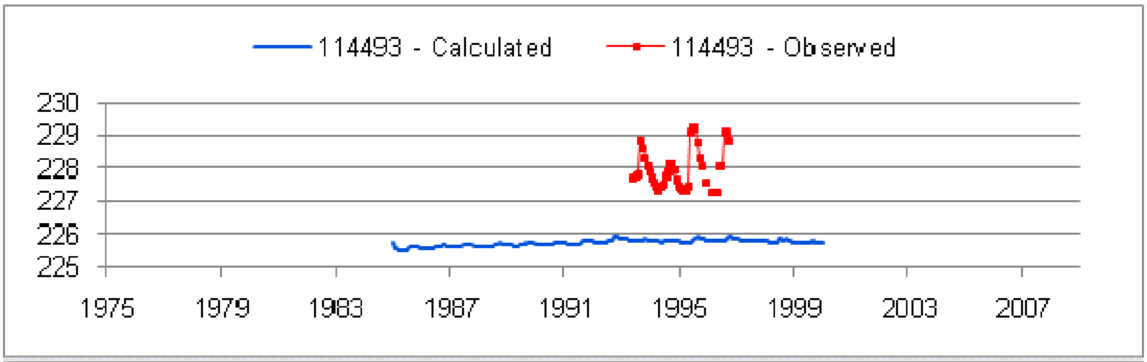

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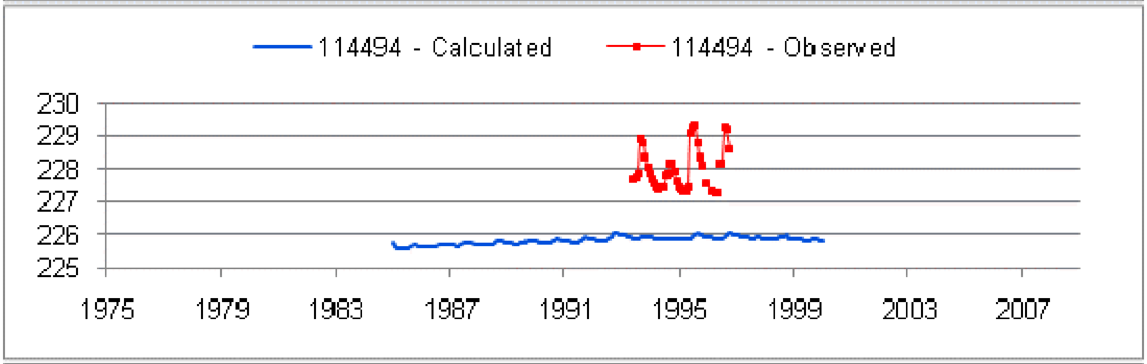

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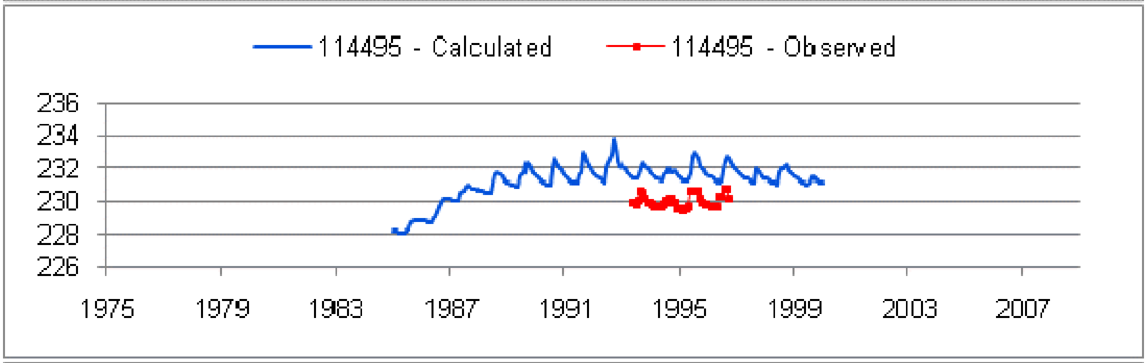

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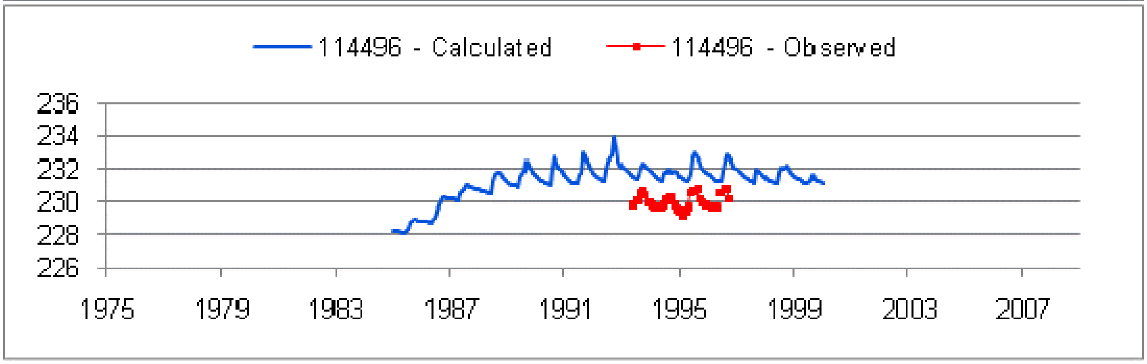

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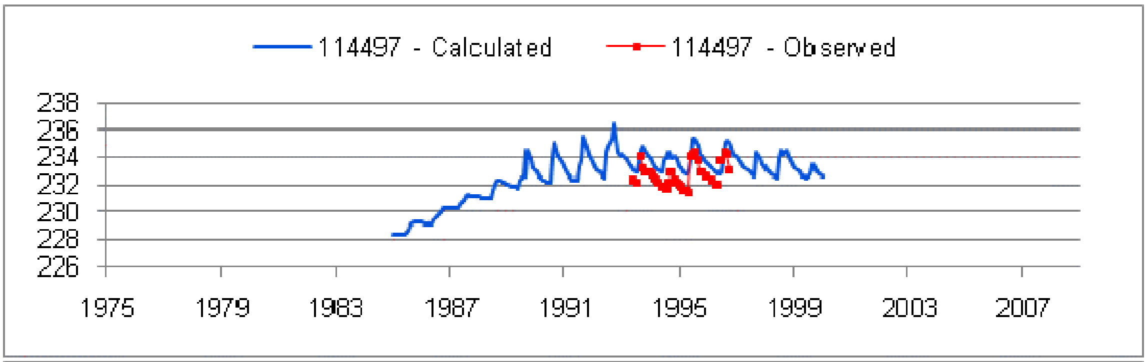
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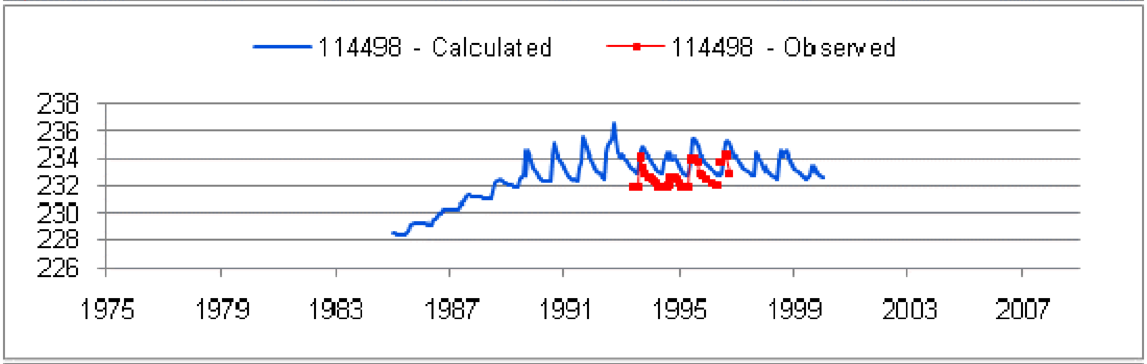
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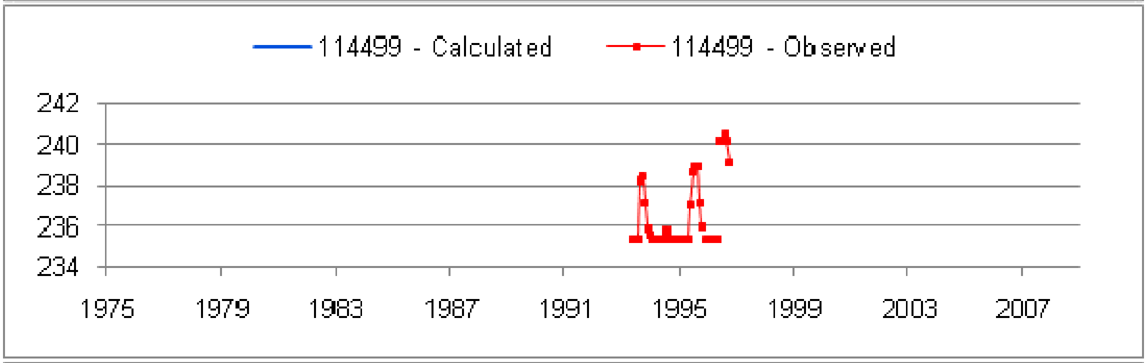
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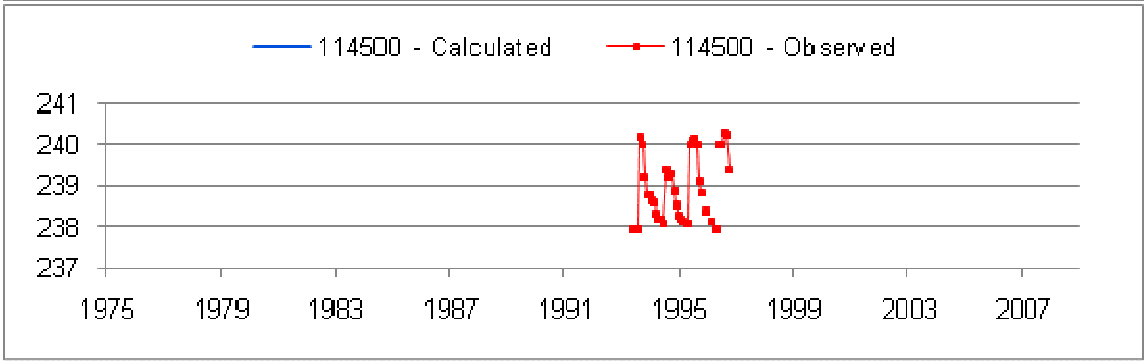
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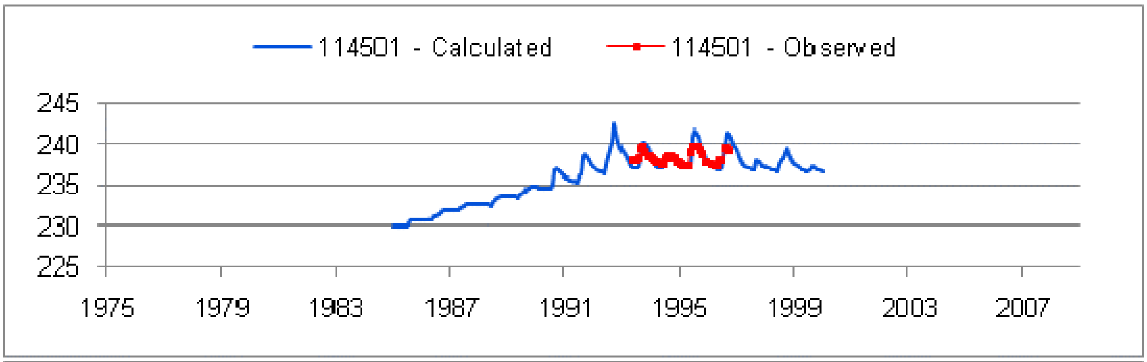

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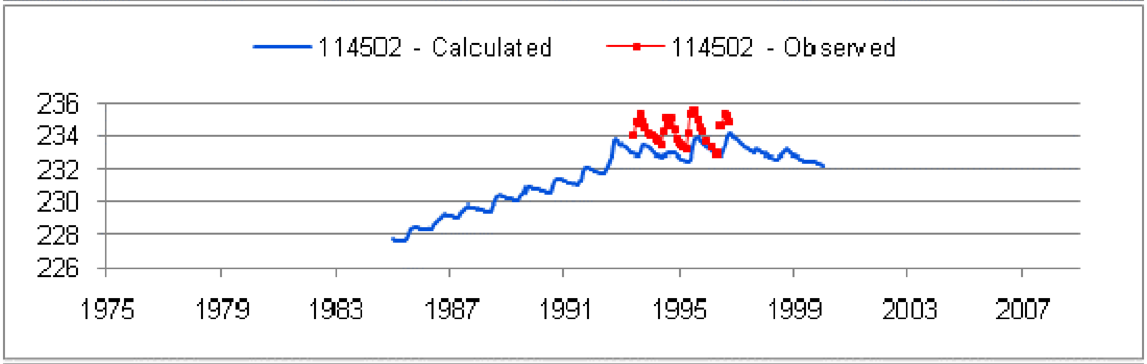

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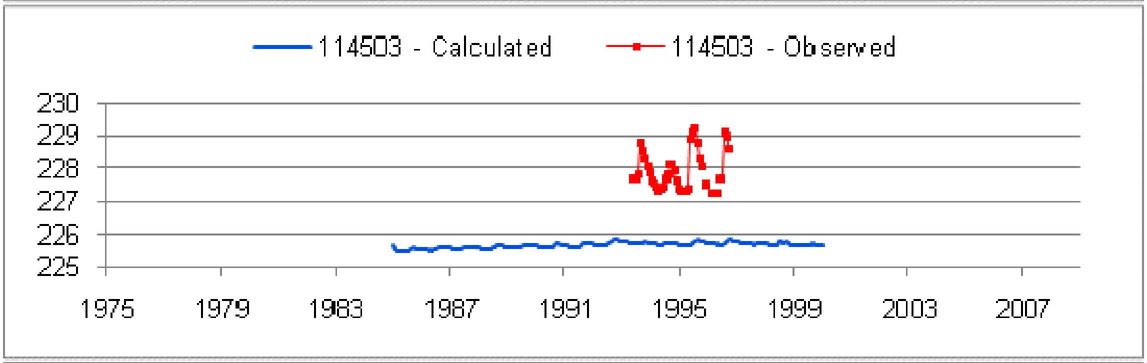

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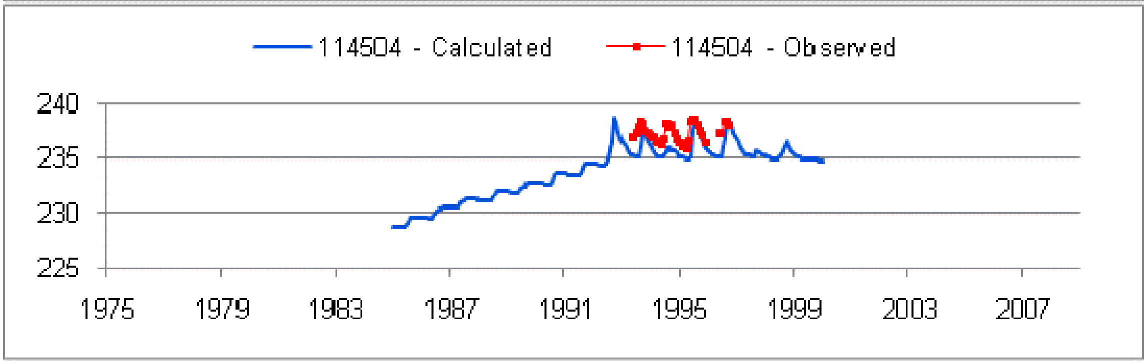

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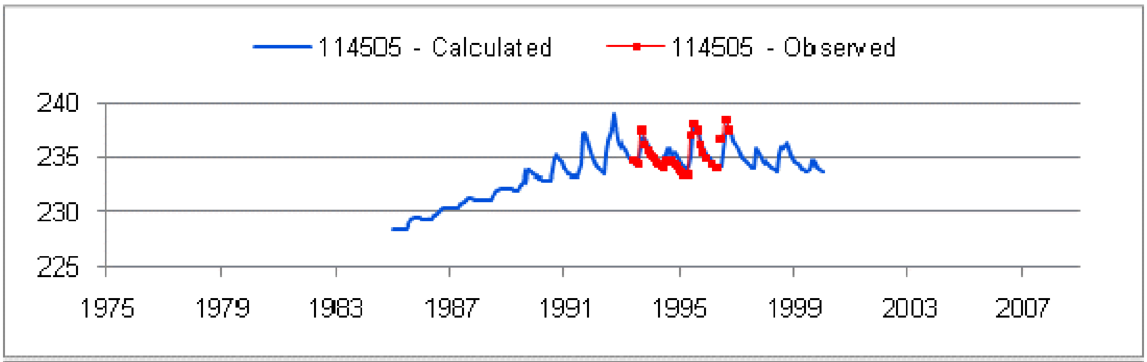
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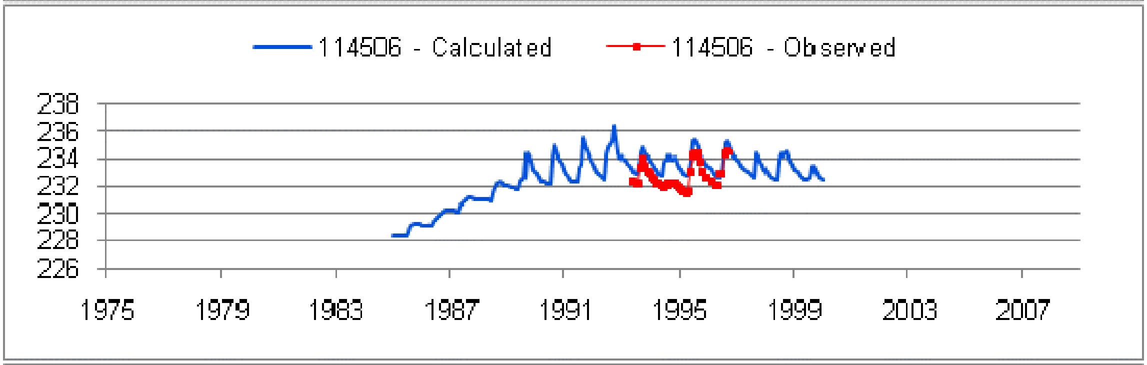
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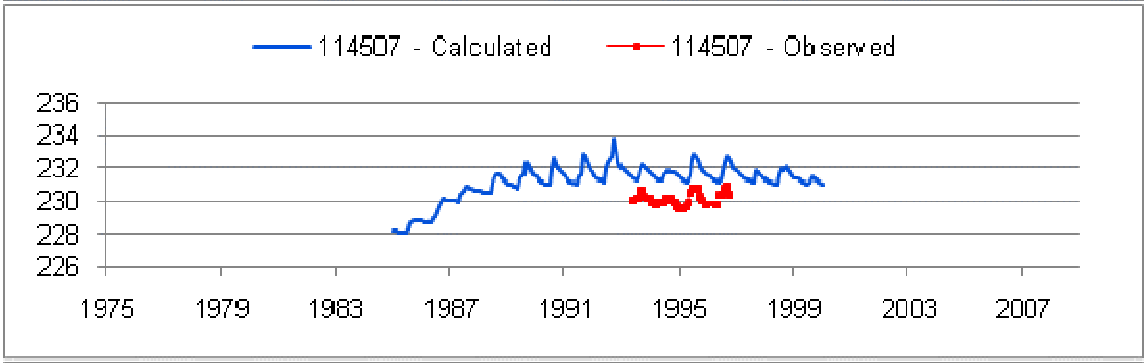
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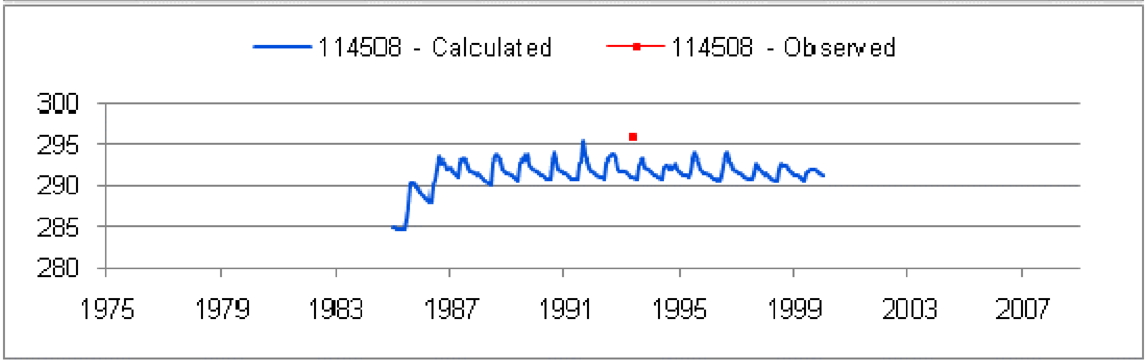
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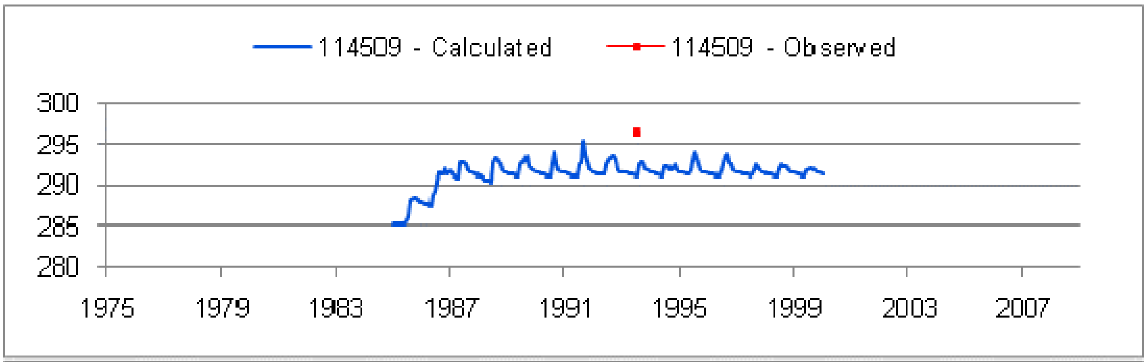
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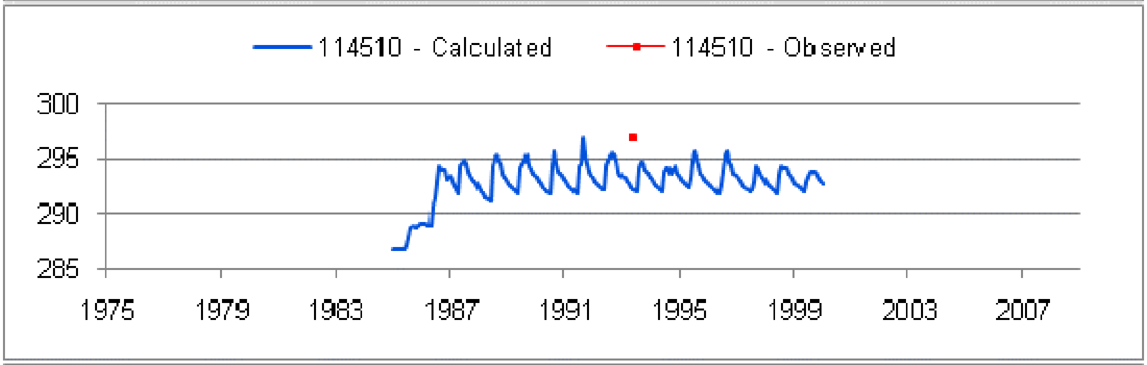
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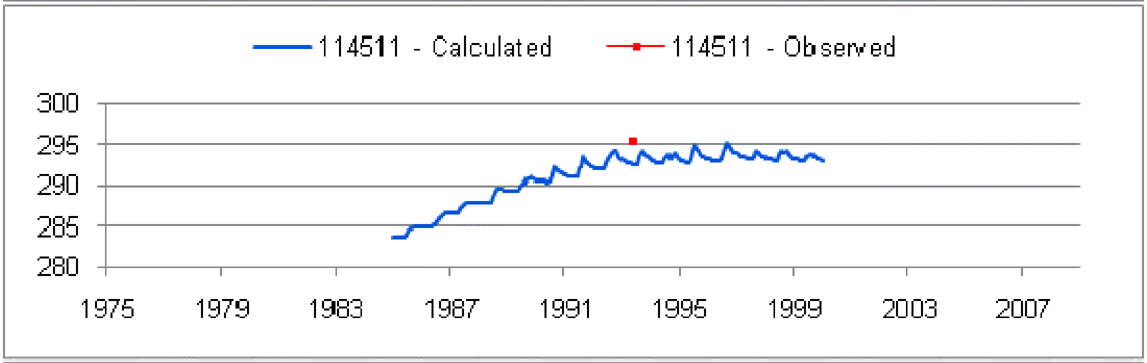
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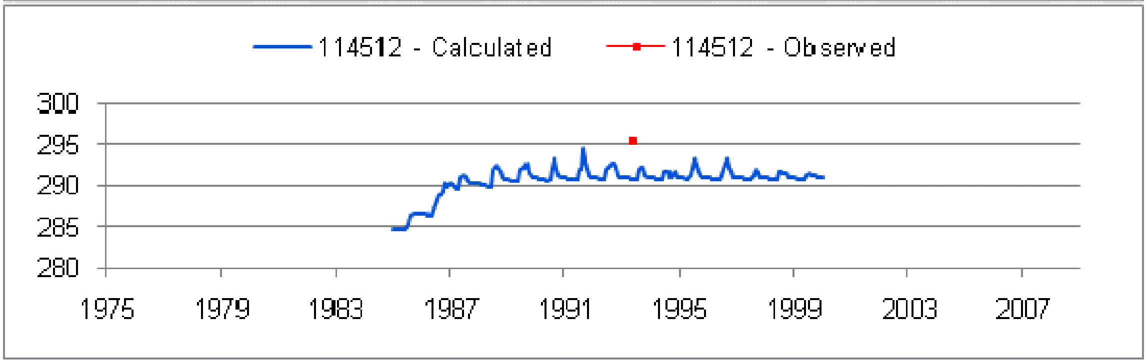
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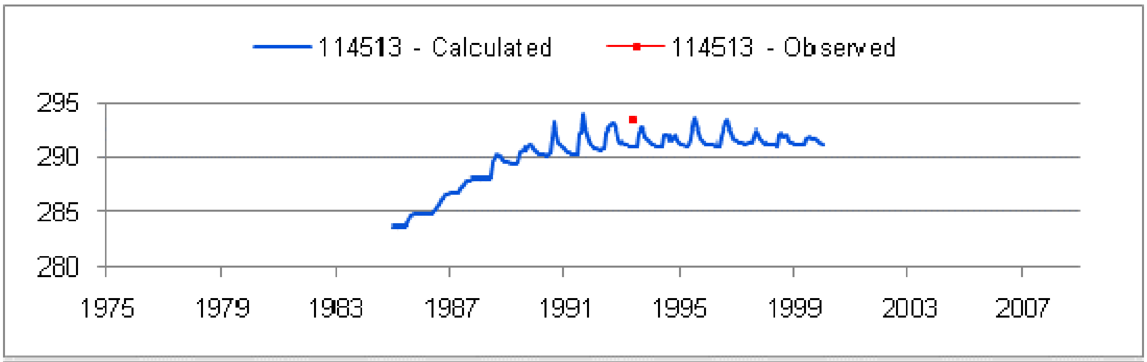
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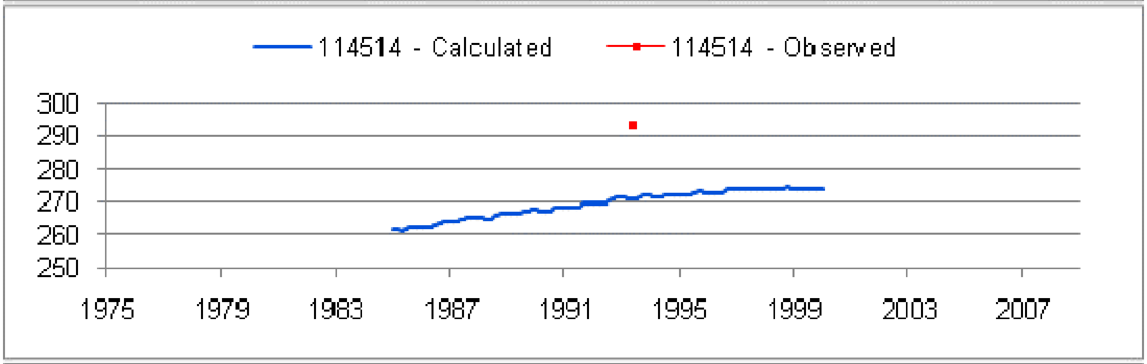
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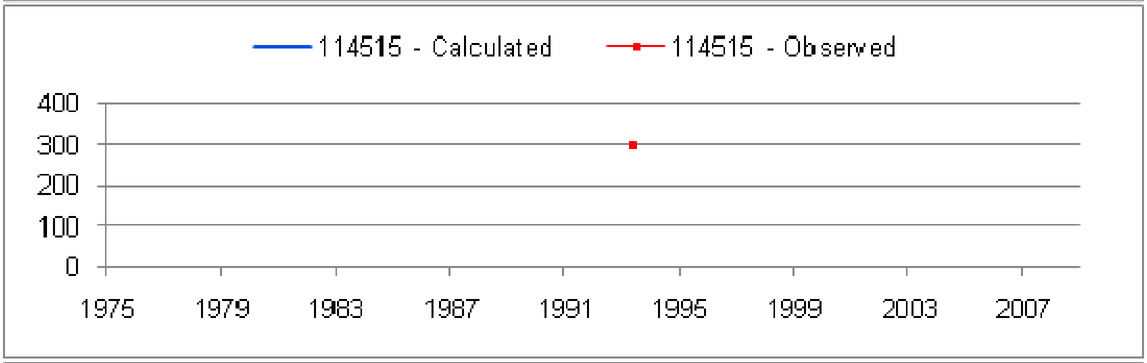
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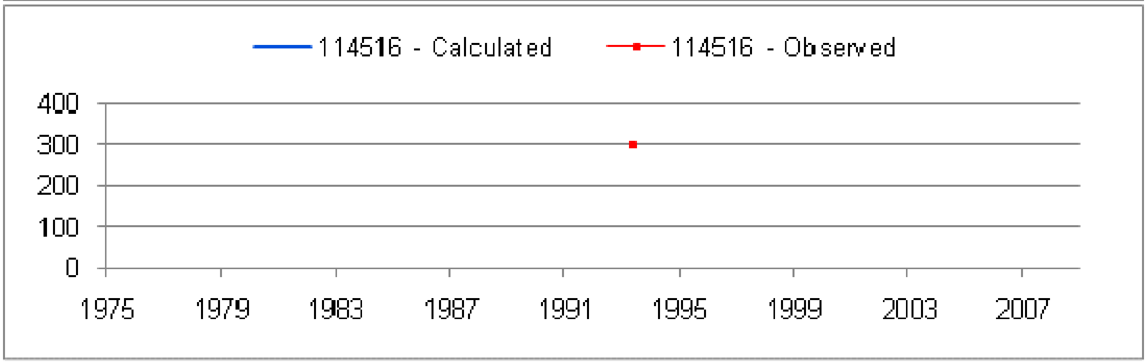
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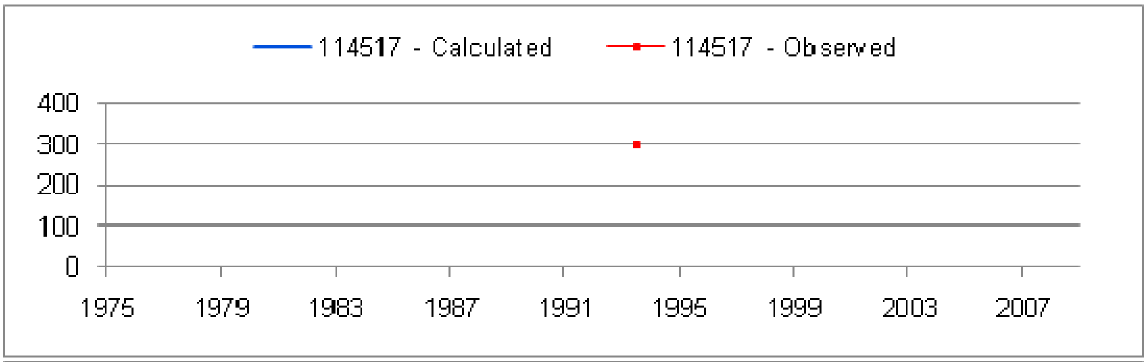
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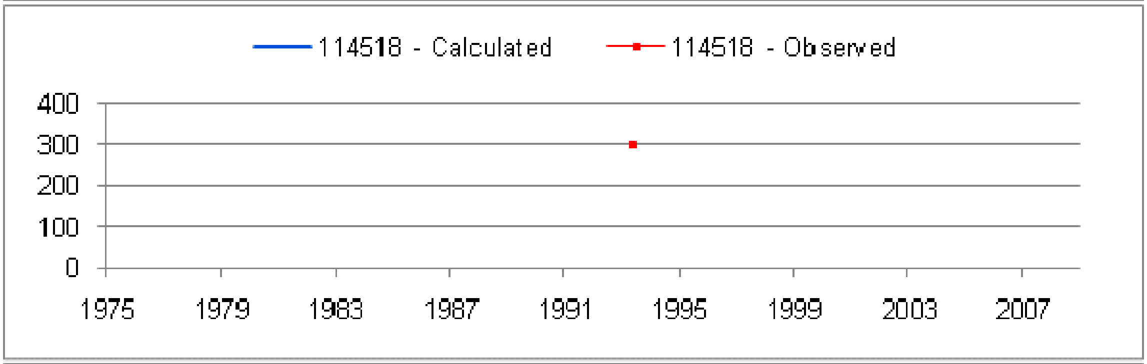
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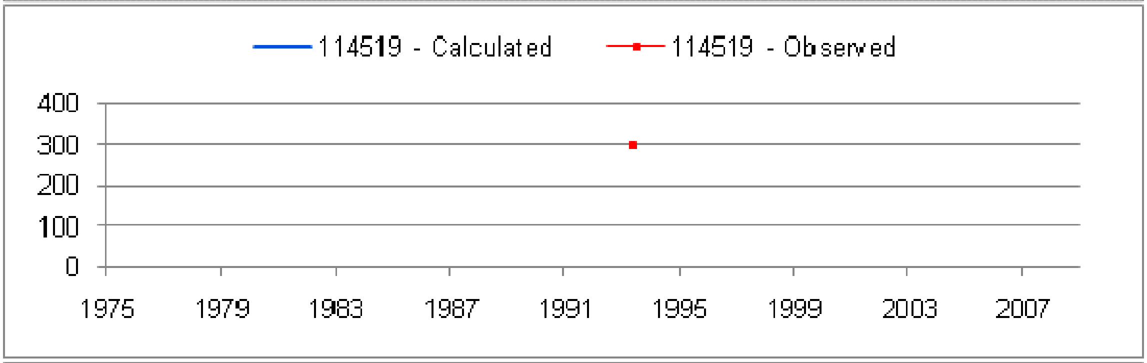
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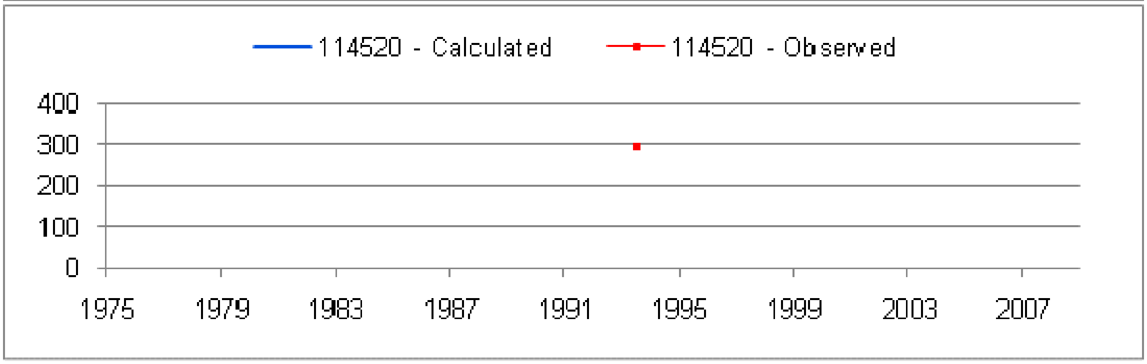
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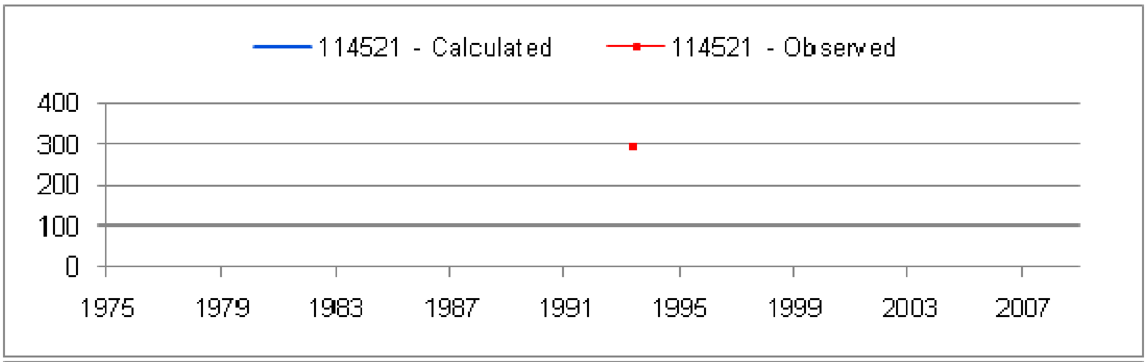

114521 - Calculated
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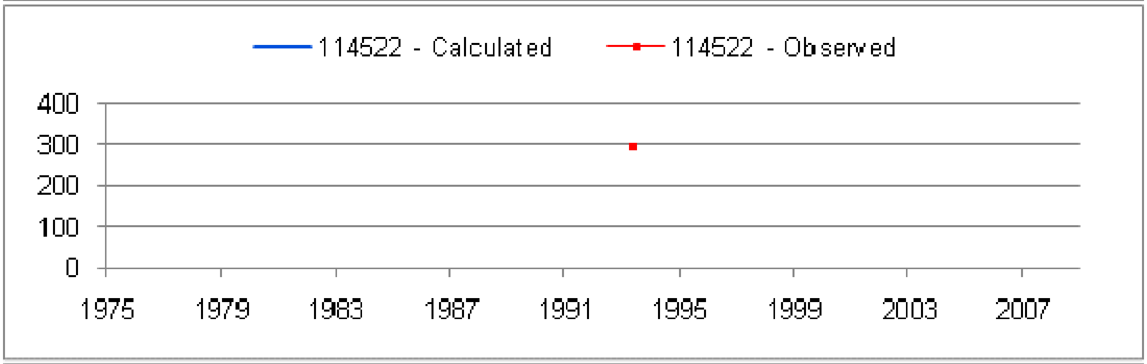

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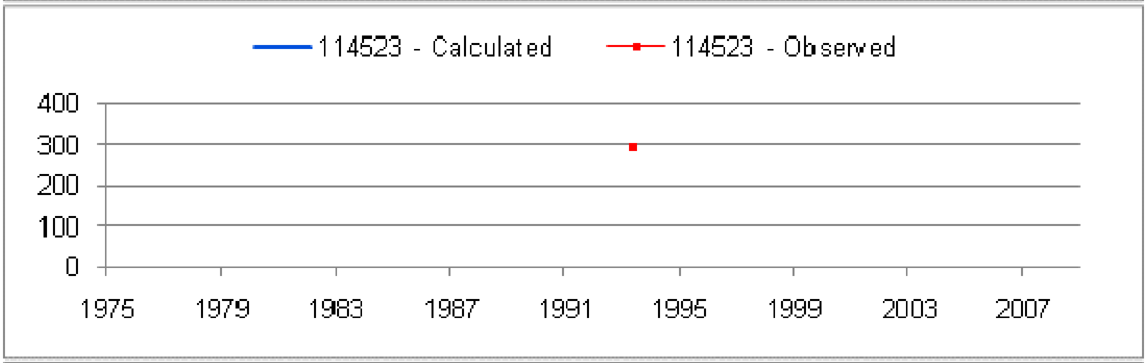

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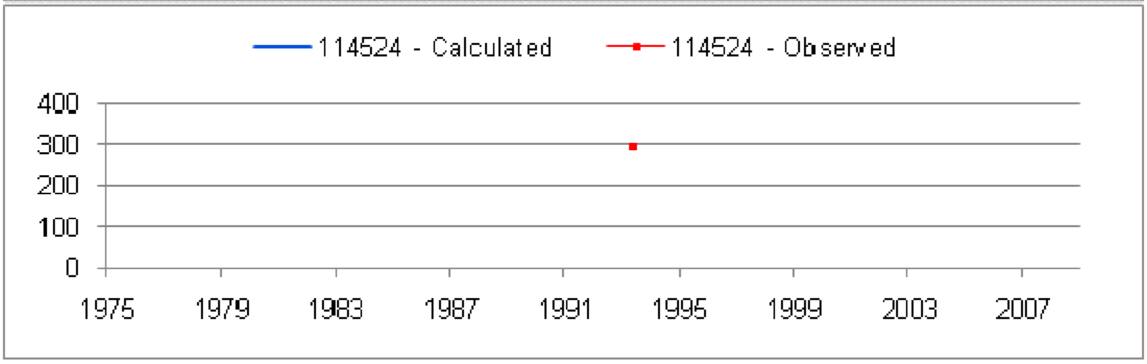

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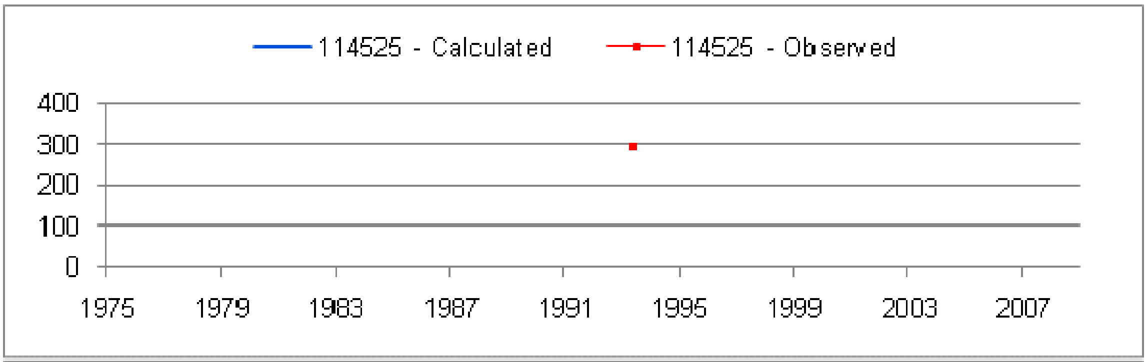

114525 - Calculated
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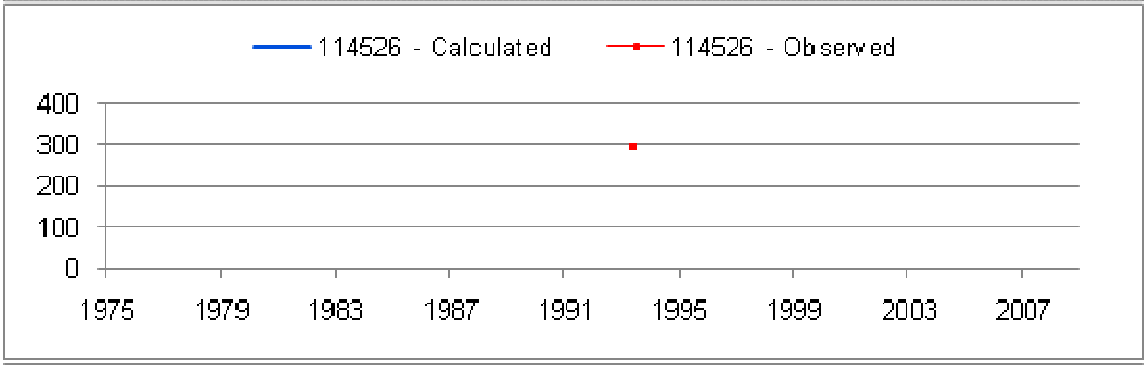

114526 - Calculated
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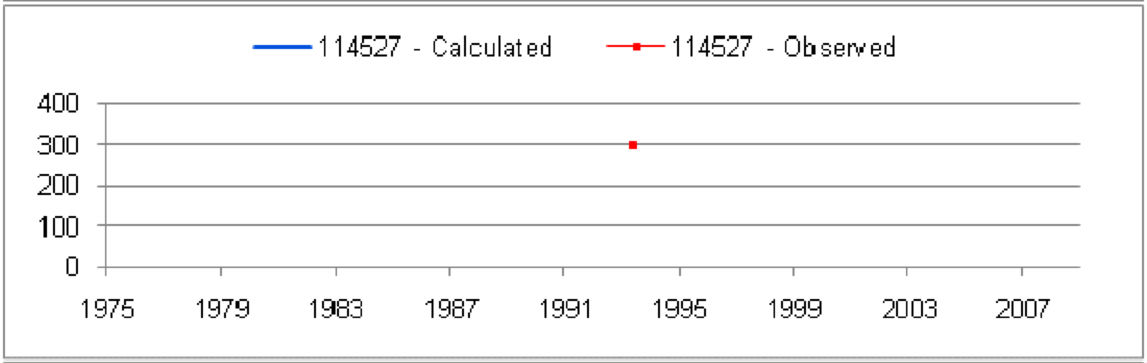

114527 - Calculated
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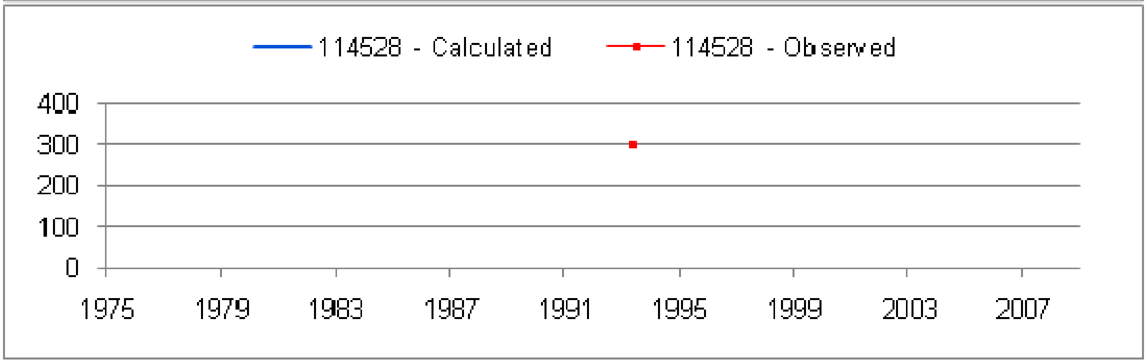

114528 - Calculated
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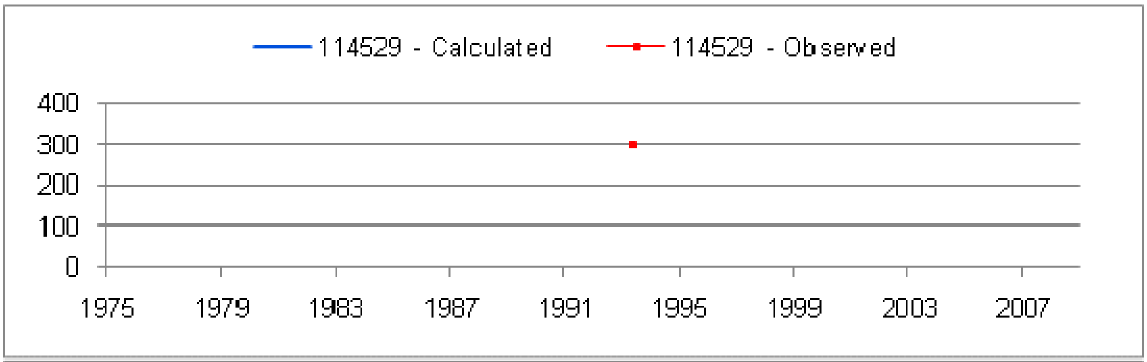
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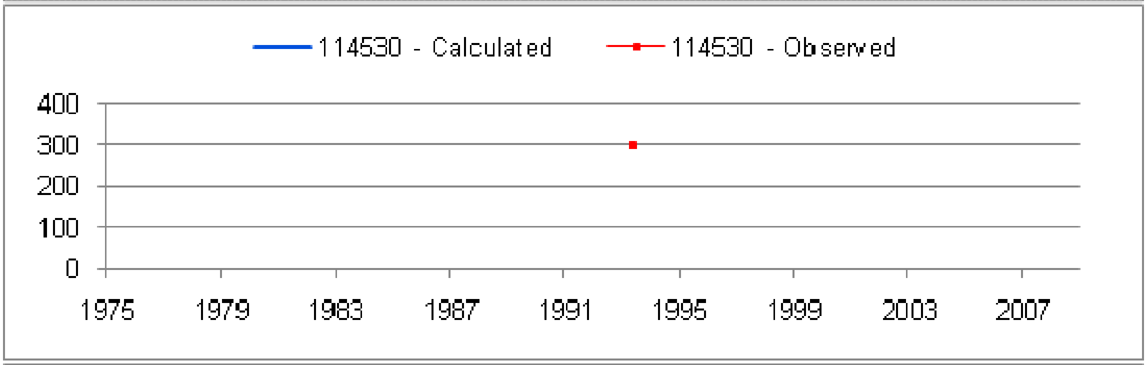
114530 - Calculated
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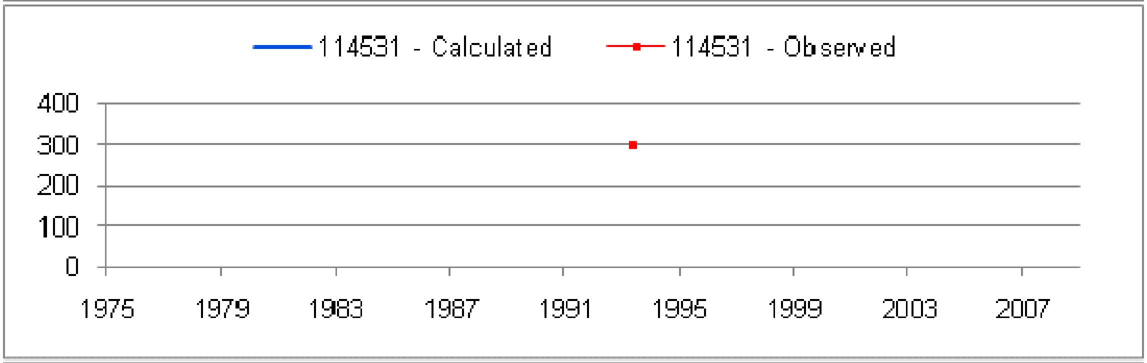
114531 - Calculated
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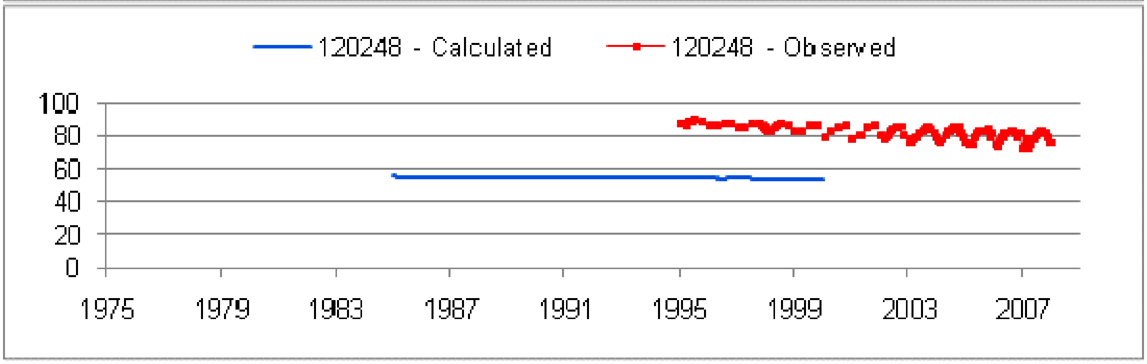
120248 - Calculated
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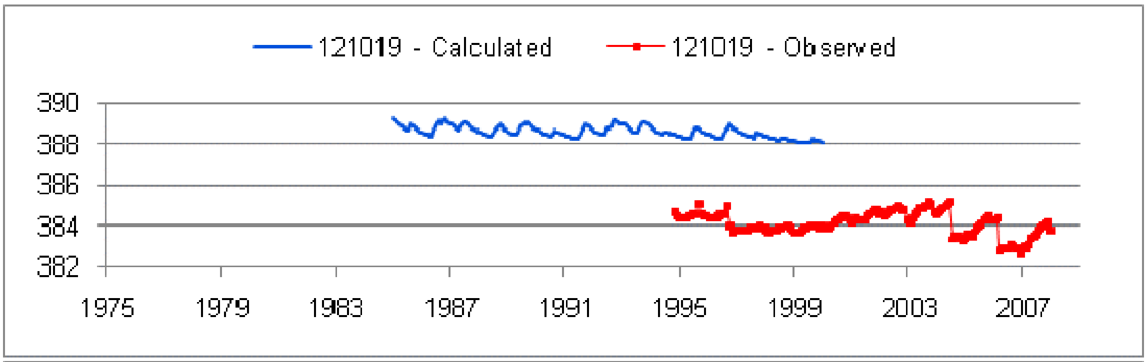
121019 - Calculated
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386
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382
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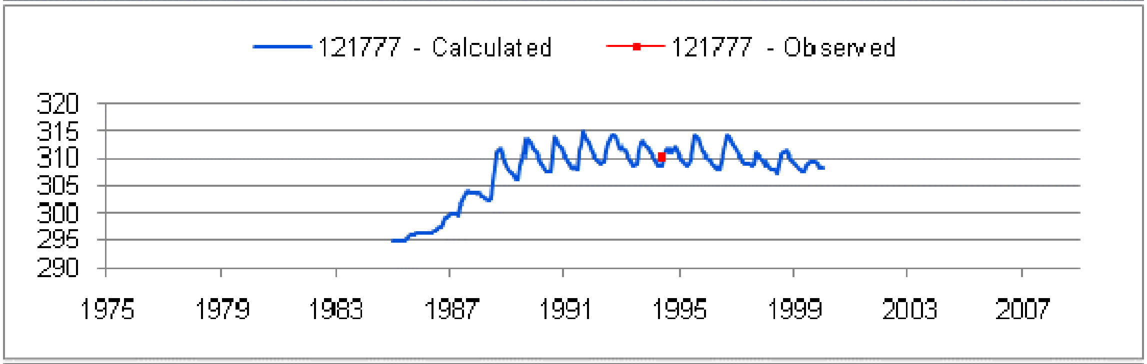
121777 - Calculated
121777 - Observed
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290
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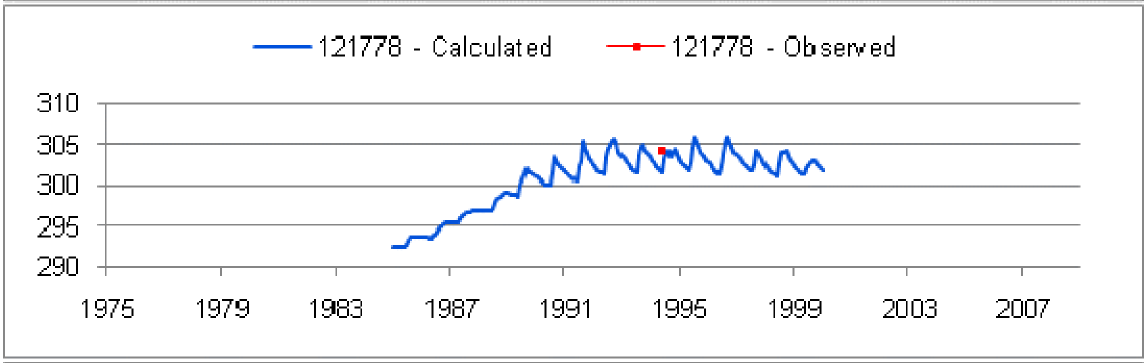
121778 - Calculated
121778 - Observed
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290
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2003
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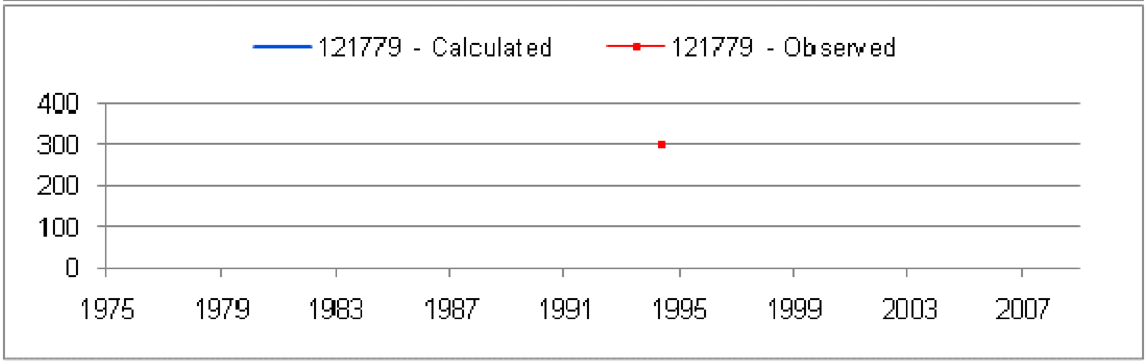
121779 - Calculated
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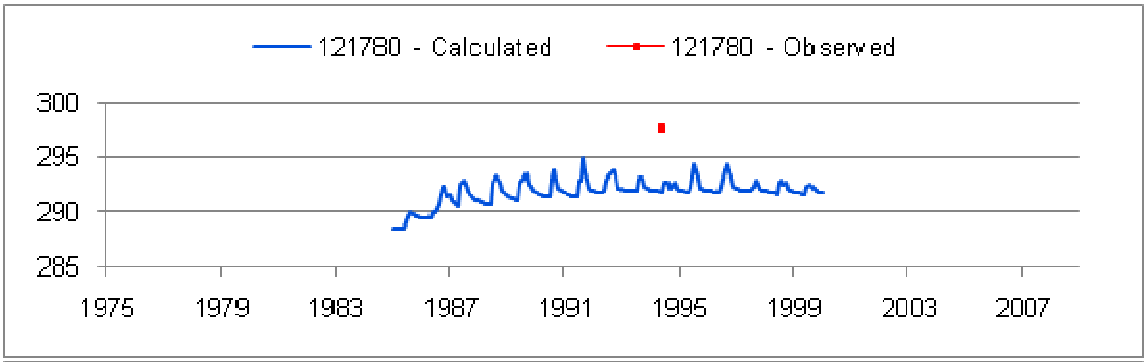
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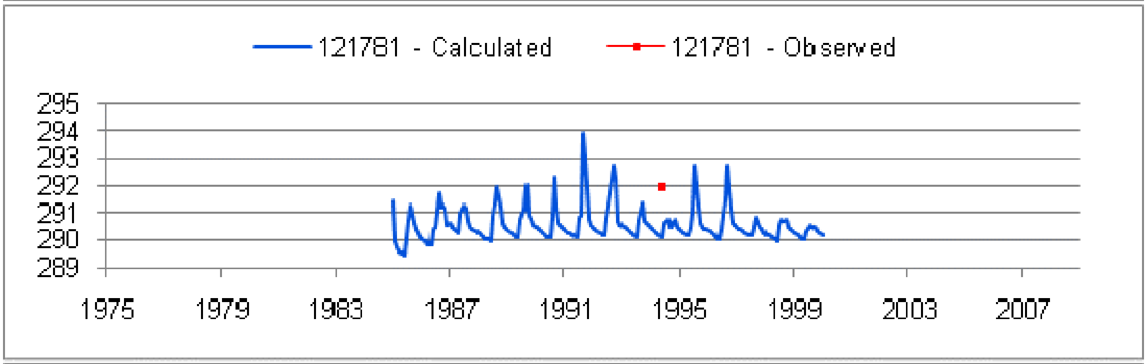
121781 - Calculated
121781 - Observed
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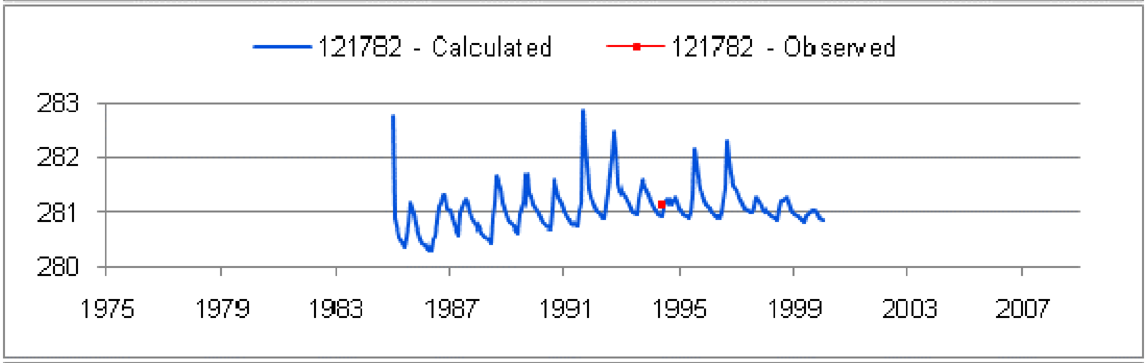
121782 - Calculated
121782 - Observed
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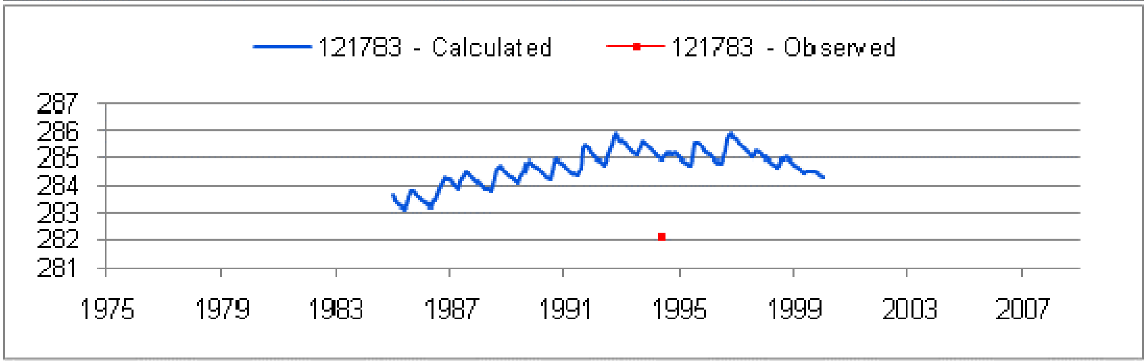
121783 - Calculated
121783 - Observed
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281
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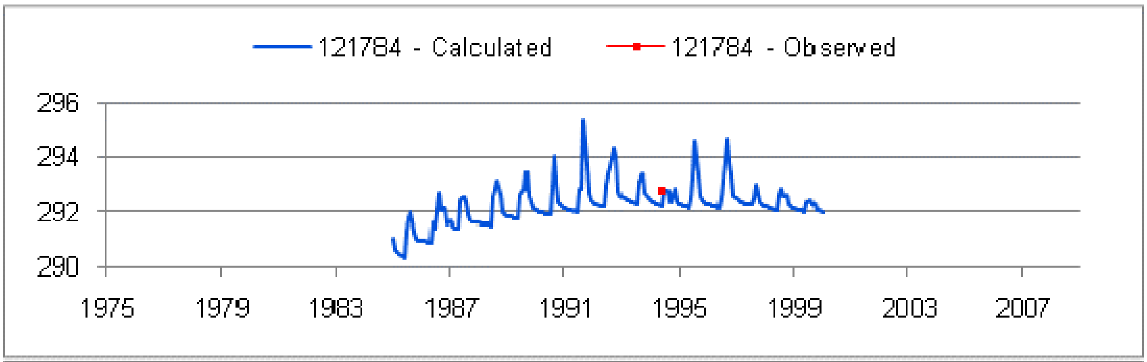
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121784 - Observed
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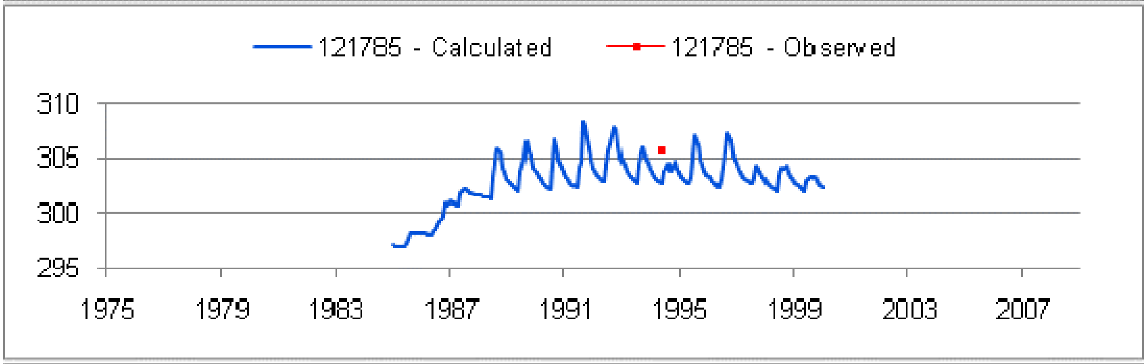
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121785 - Observed
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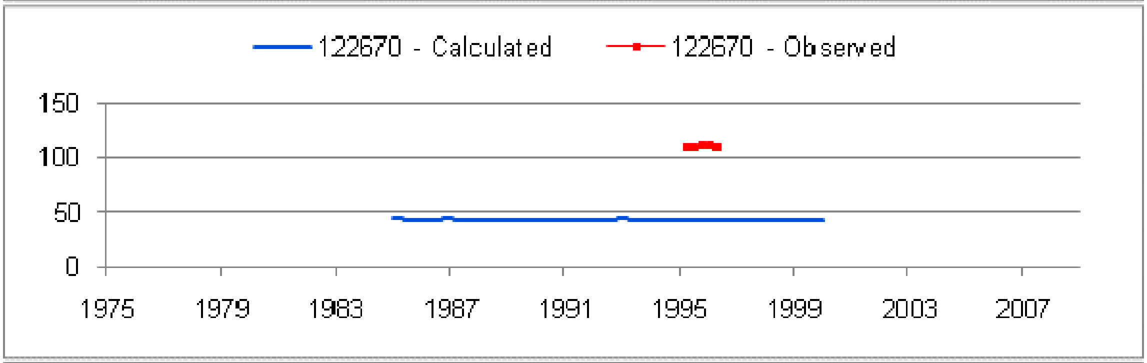
122670 - Calculated
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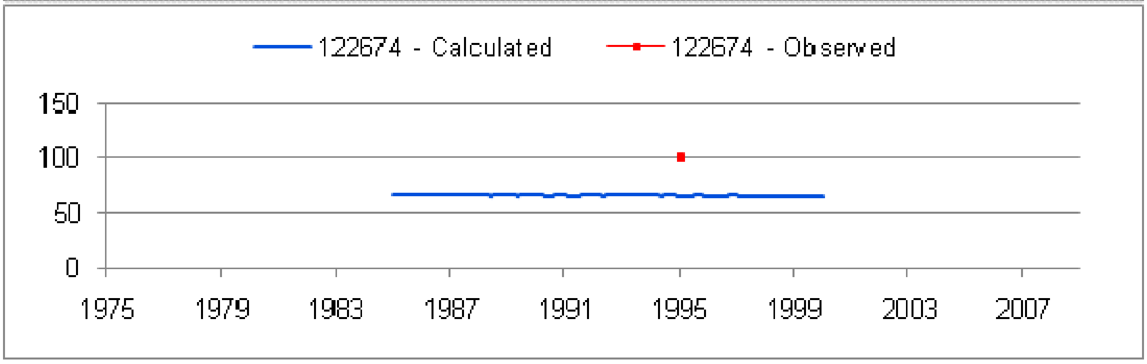
122674 - Calculated
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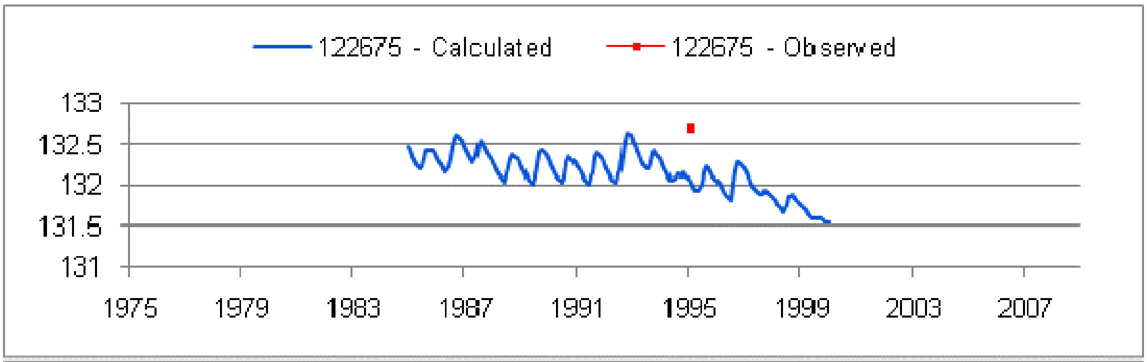
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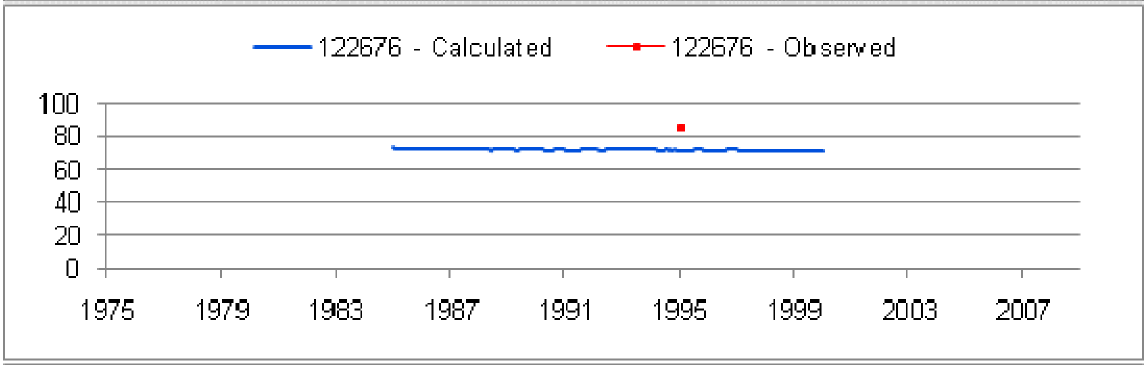
122676 - Calculated
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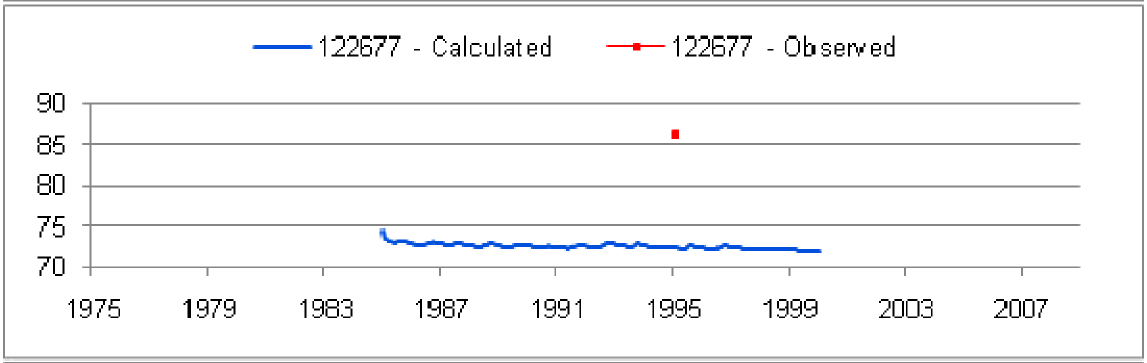
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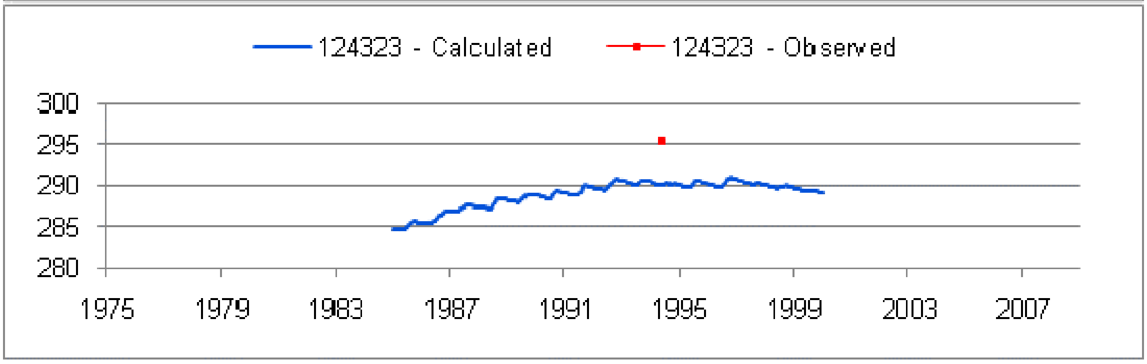
124323 - Calculated
124323 - Observed
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2003
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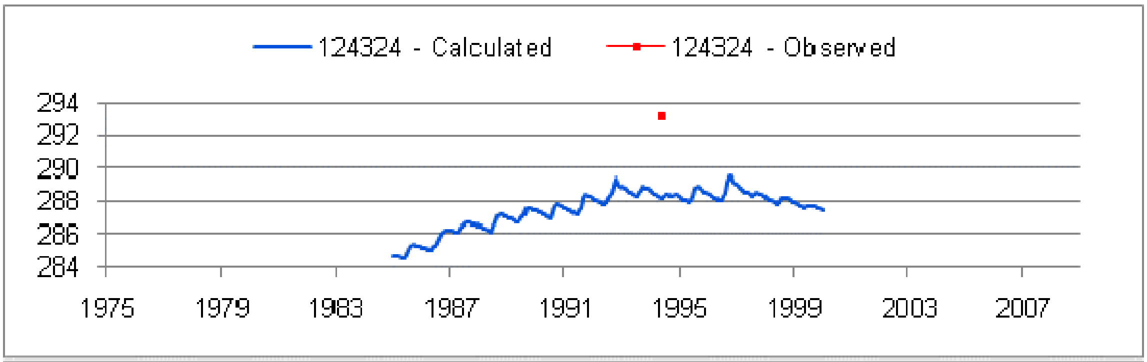
124324 - Calculated
124324 - Observed
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2003
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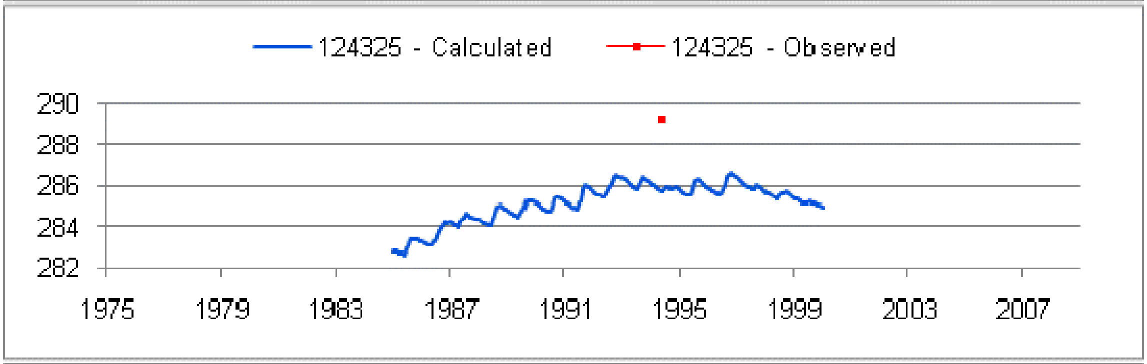
124325 - Calculated
124325 - Observed
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282
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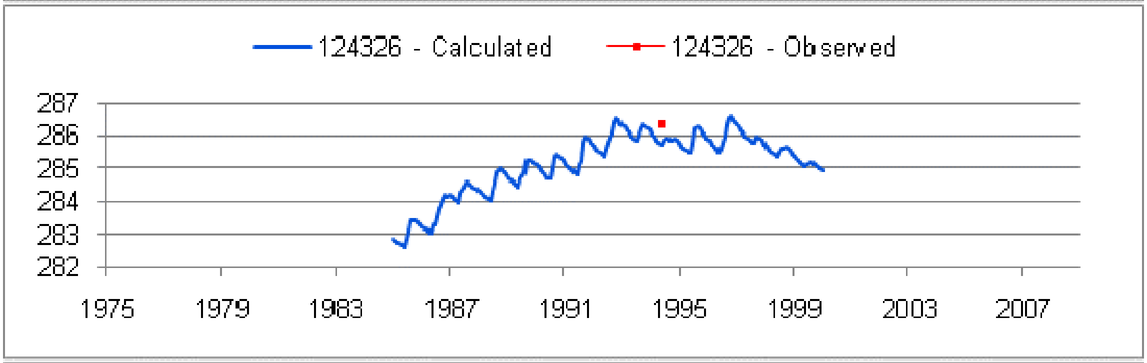
124326 - Calculated
124326 - Observed
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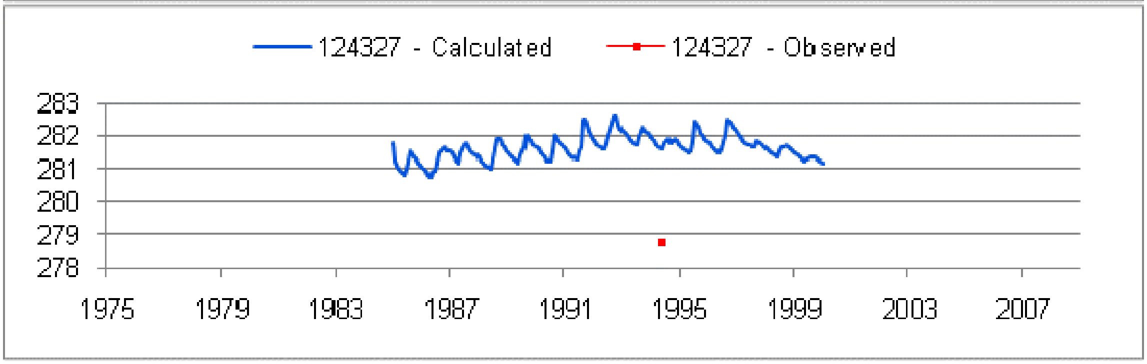
124327 - Calculated
124327 - Observed
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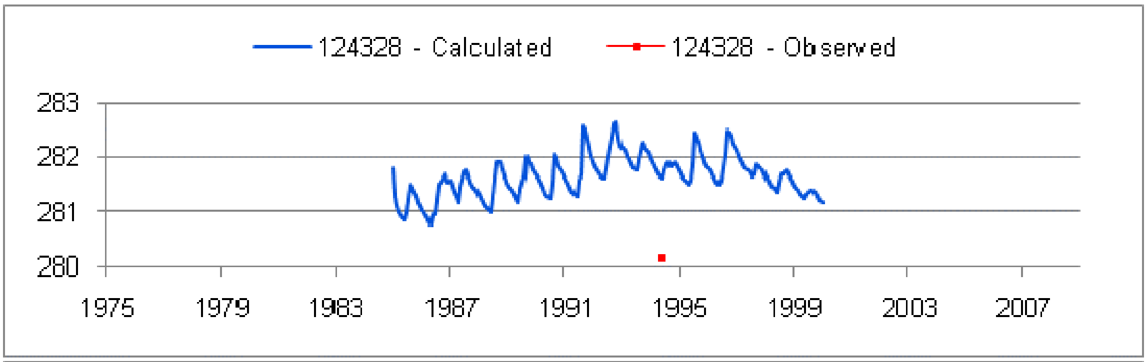
124328 - Calculated
124328 - Observed
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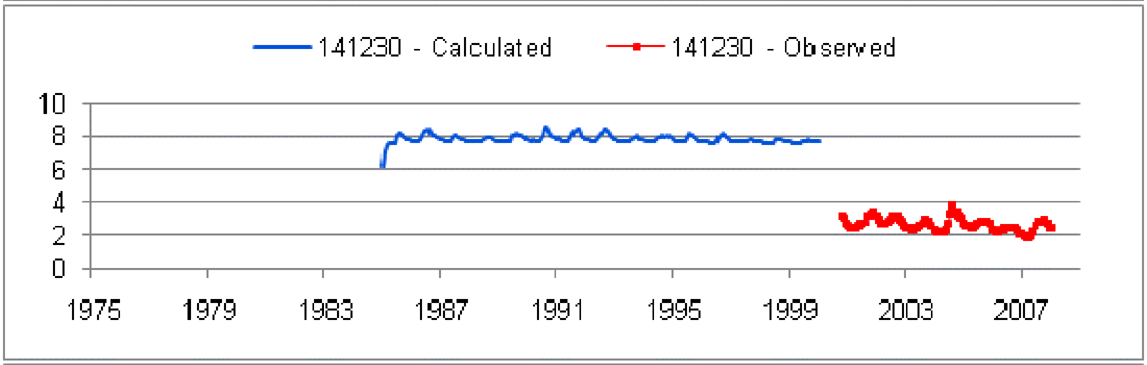
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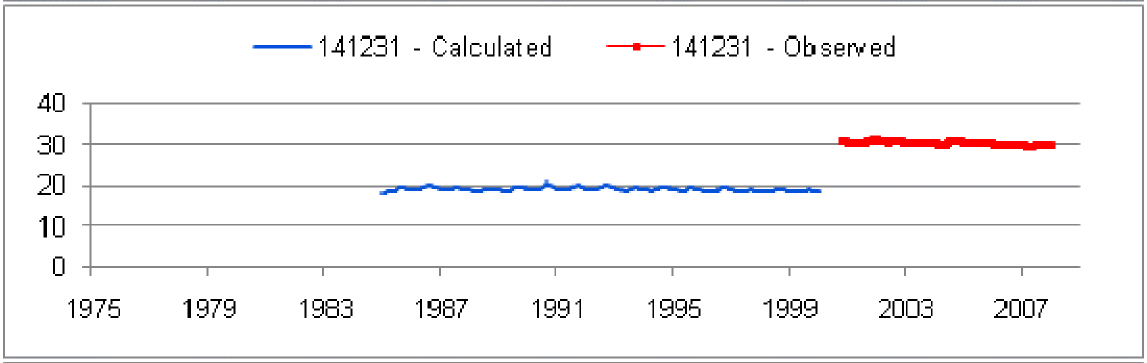
141231 - Calculated
141231 - Observed
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1995
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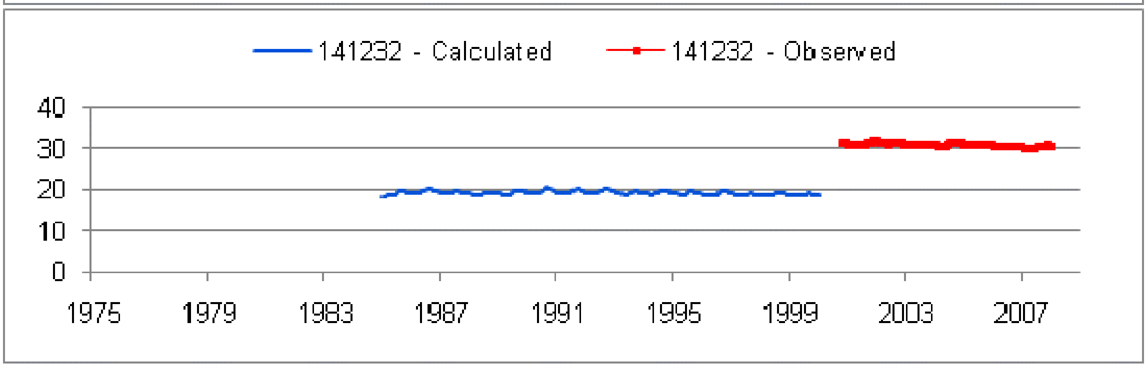
2003
2007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141232 - Observed
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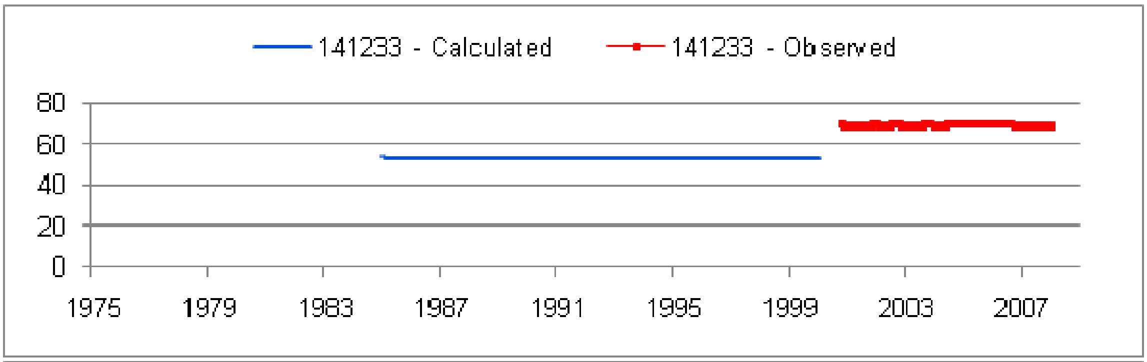
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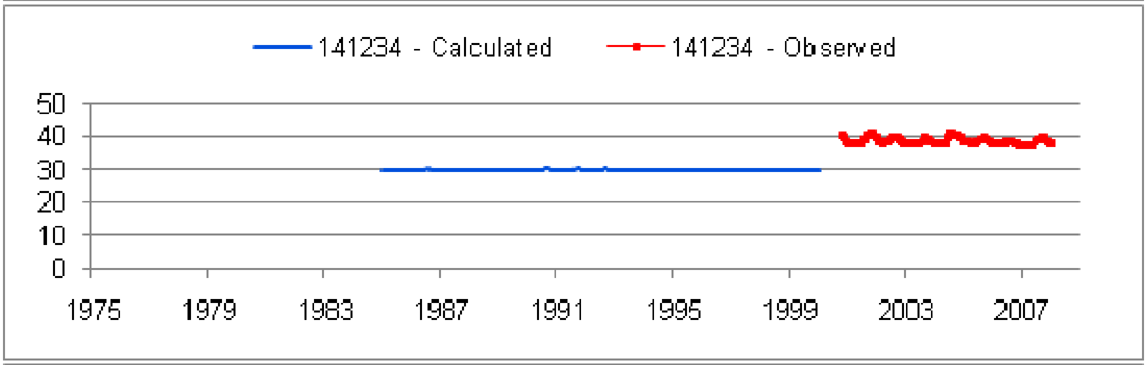
141234 - Calculated
141234 - Observed
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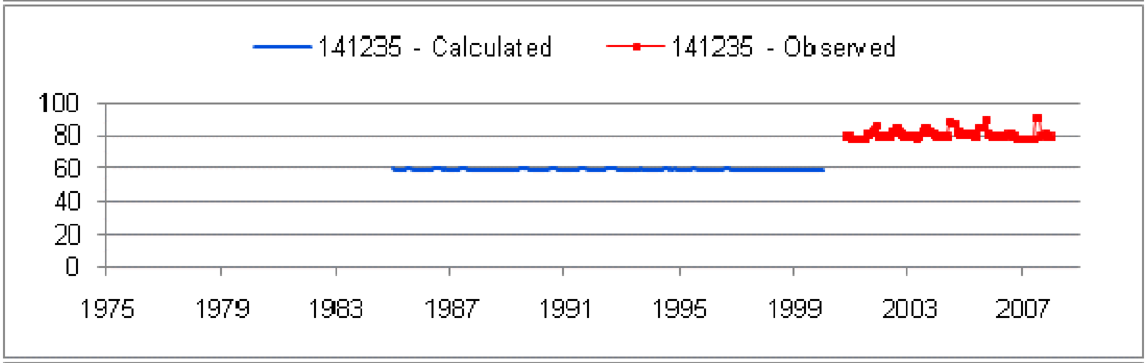
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141235 - Observed
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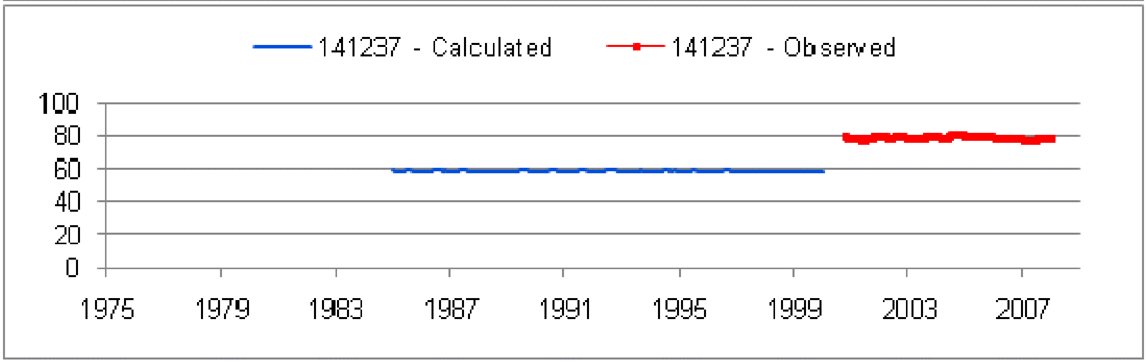
141237 - Calculated
141237 - Observed
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40
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0
1975
1979
1983
1987
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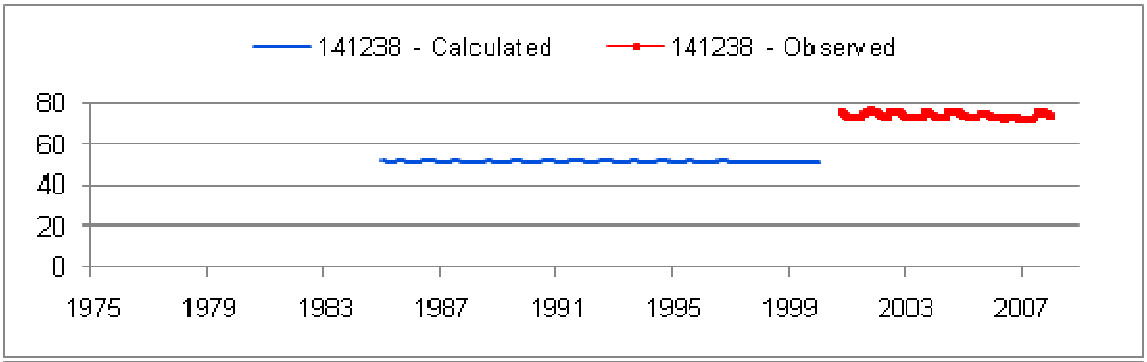
2007

SKM


141238 - Calculated
141238 - Observed
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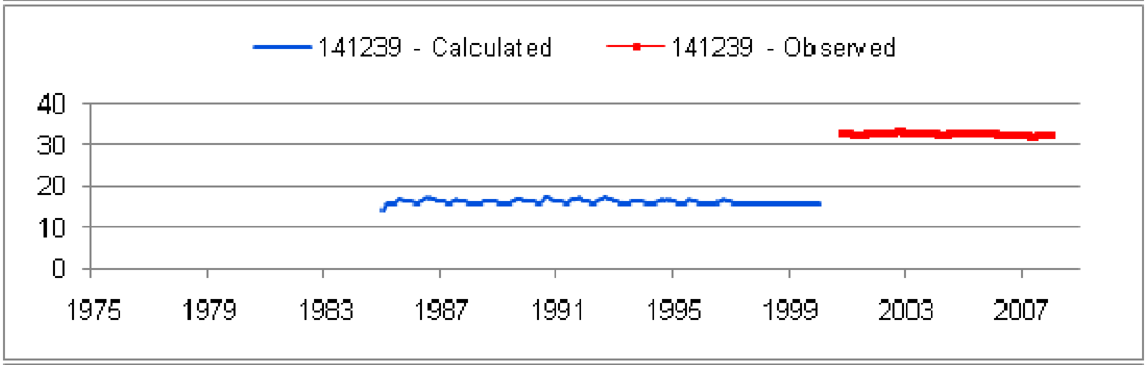
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2003
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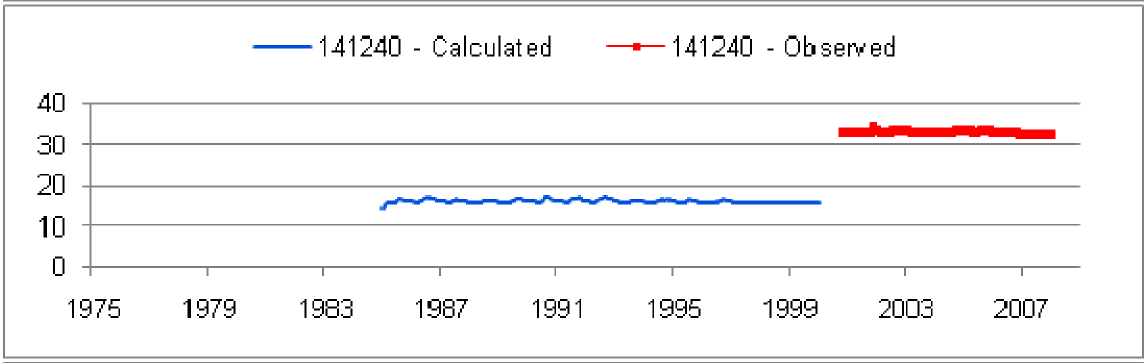
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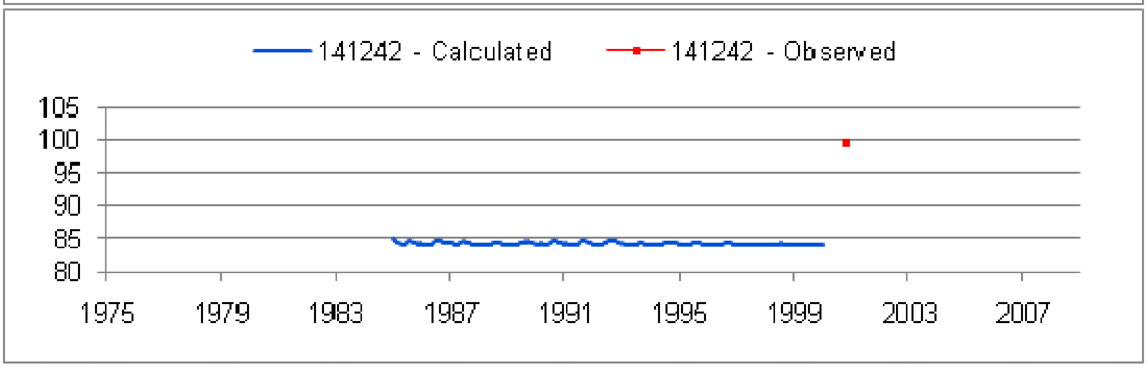
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2003
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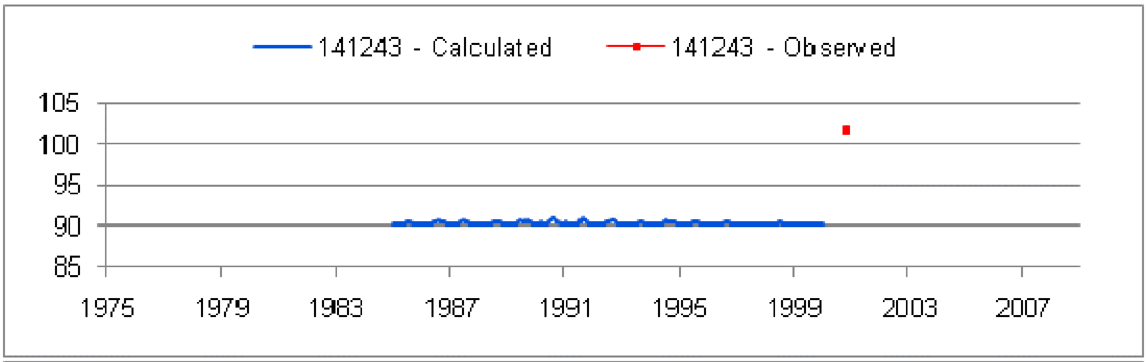
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1979
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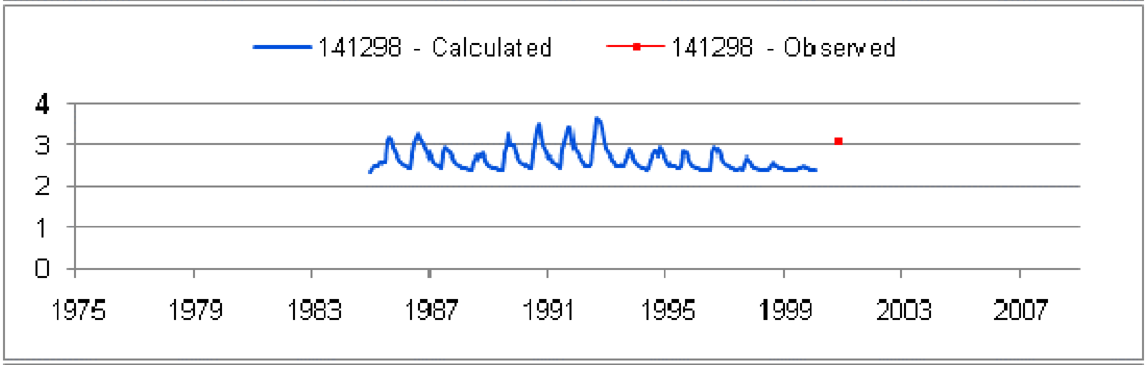
1999
2003
2007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0
1975
1979
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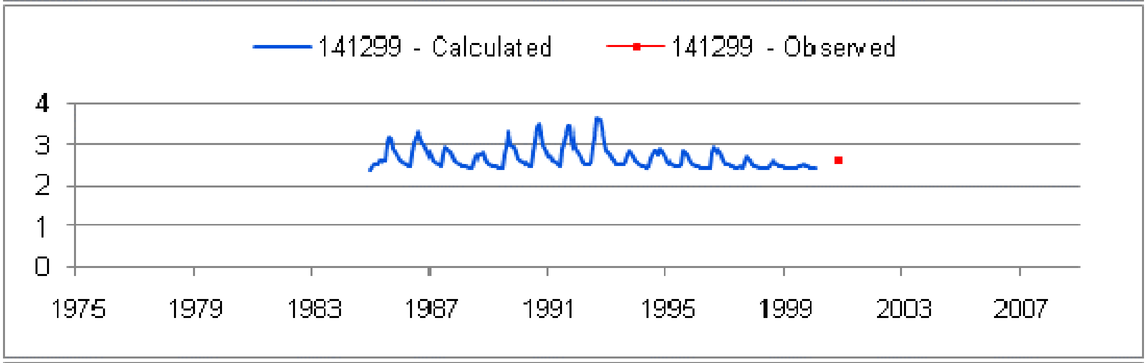
2003
2007


141299 - Calculated
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3
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1979
1983
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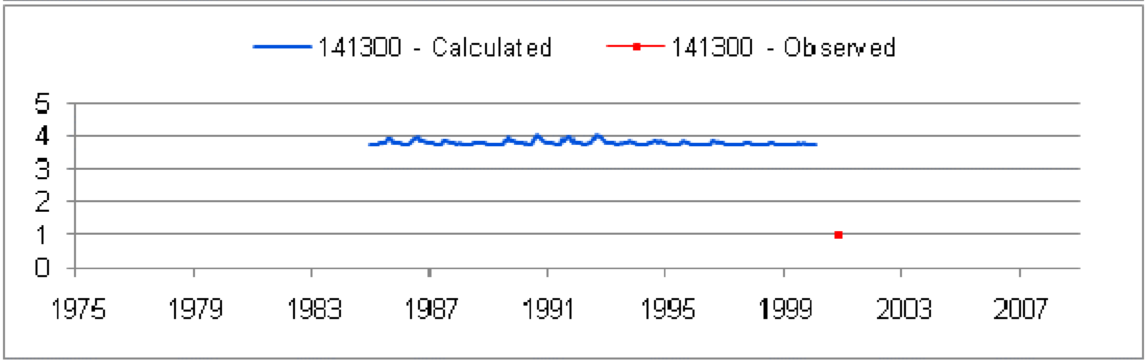
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1979
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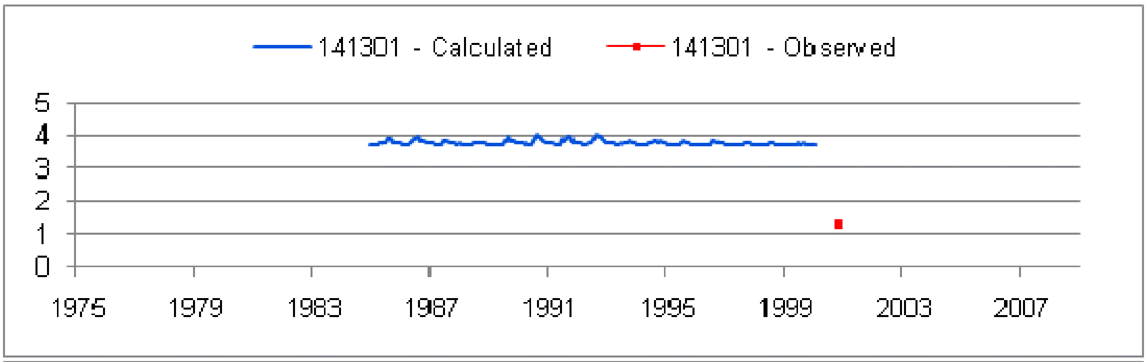
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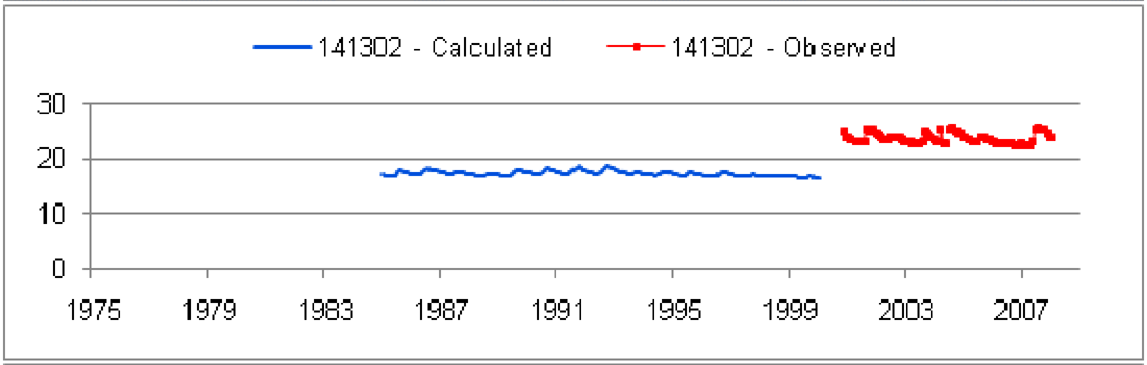
141302 - Calculated
141302 - Observed
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1975
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1983
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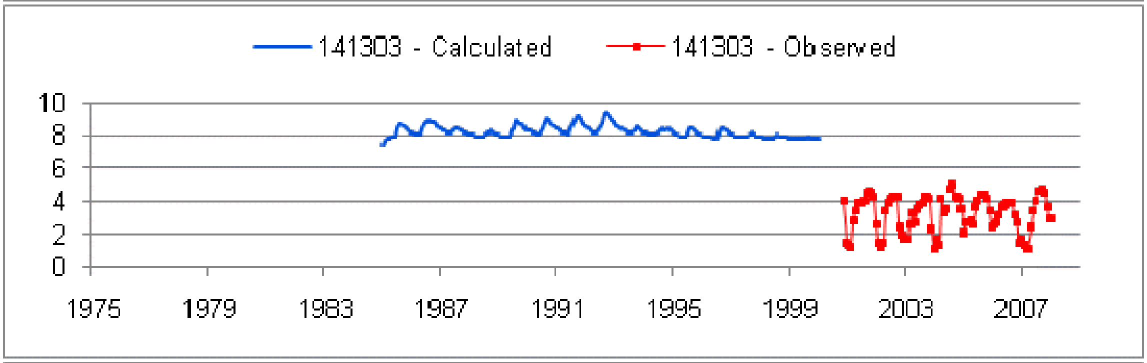
2007


141303 - Calculated
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4
2
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1979
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1999
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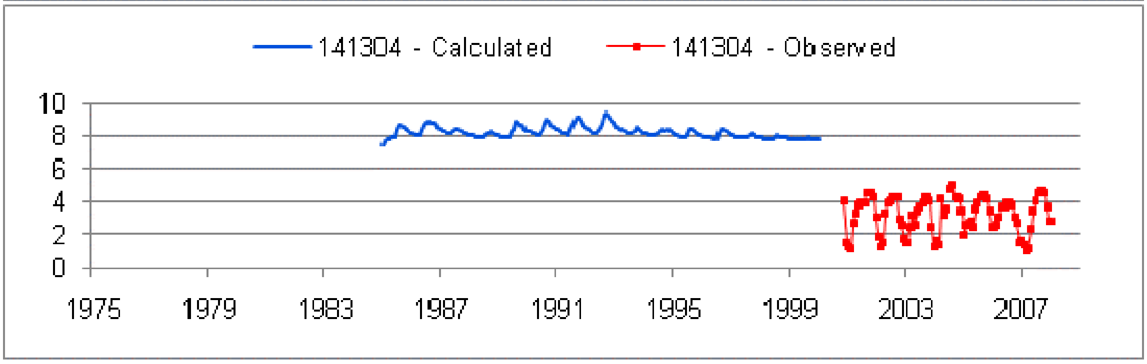
141304 - Calculated
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6
4
2
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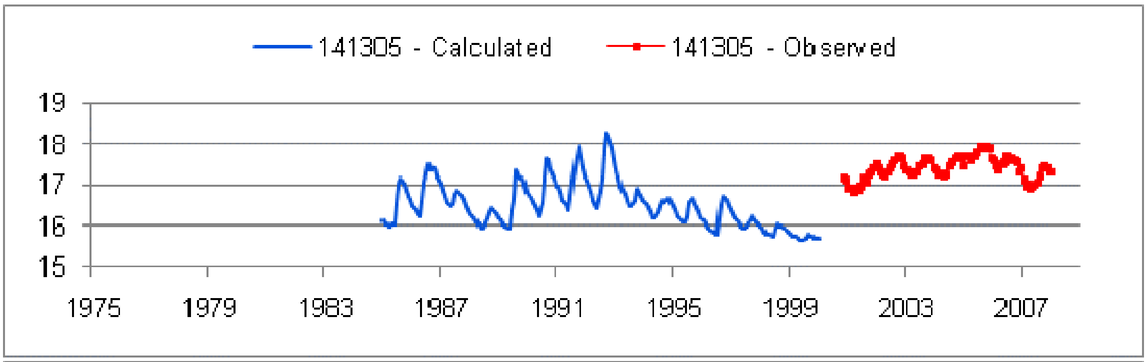
141305 - Calculated
141305 - Observed
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17
16
15
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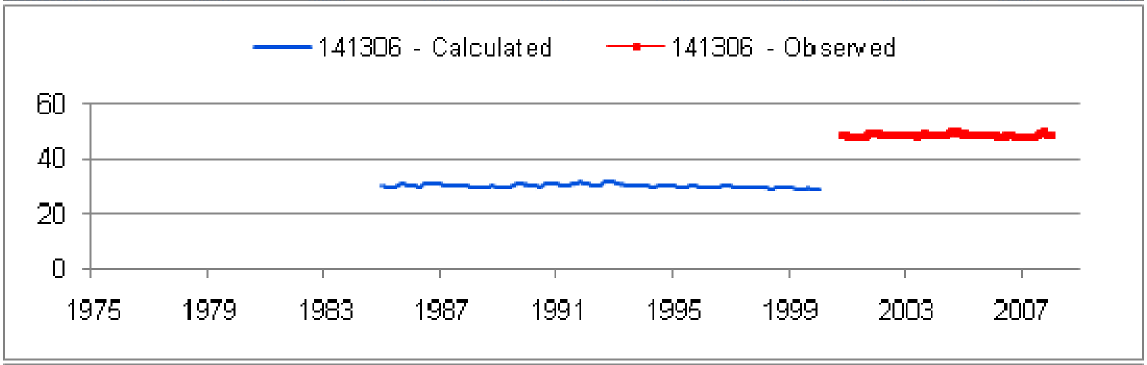
141306 - Calculated
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40
20
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1983
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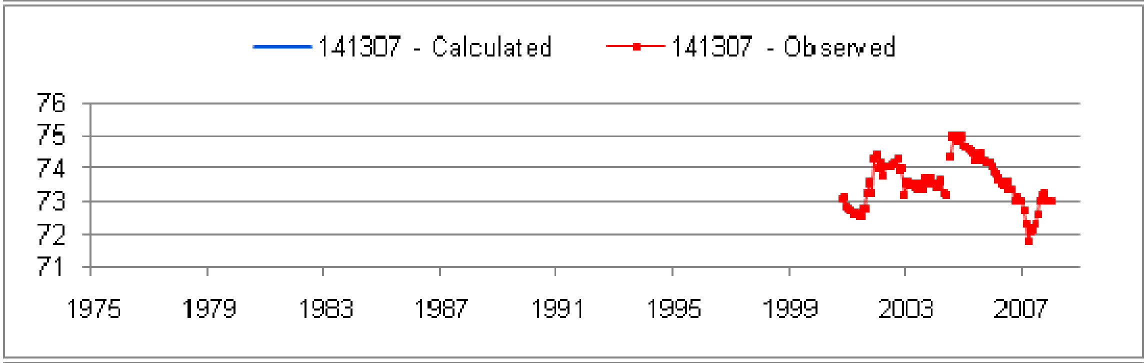
1991
1995
1999
2003
2007


141307 - Calculated
141307 - Observed
76
75
74
73
72
71
1975
1979
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1987
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1995
1999
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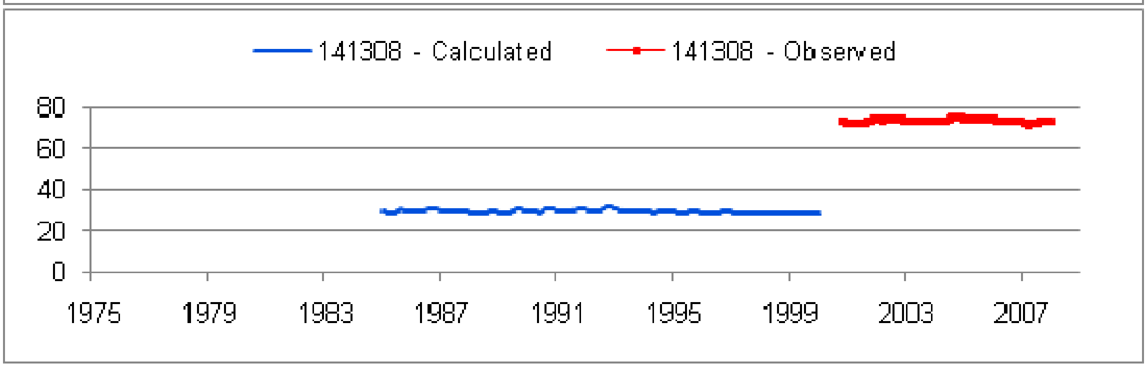
141308 - Calculated
141308 - Observed
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1979
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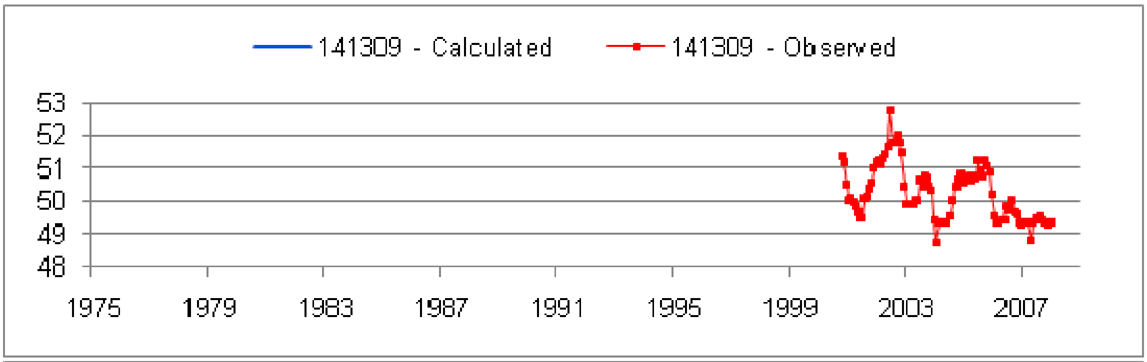
1995
1999
2003
2007


141309 - Calculated
141309 - Observed
53
52
51
50
49
48
1975
1979
1983
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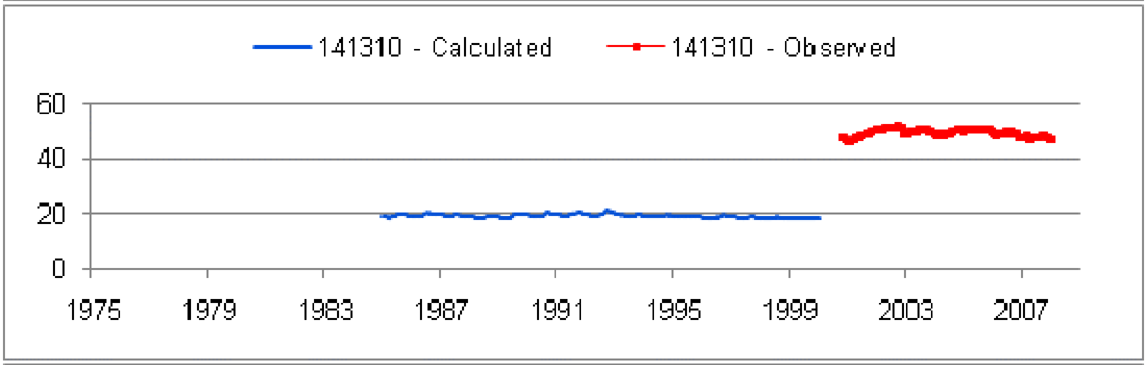
1995
1999
2003
2007


141310 - Calculated
141310 - Observed
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40
20
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1975
1979
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1991
1995
1999
2003
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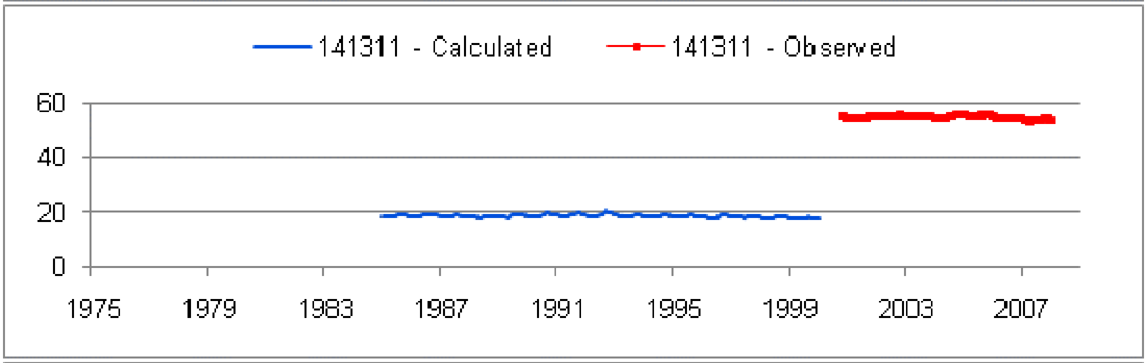
141311 - Calculated
141311 - Observed
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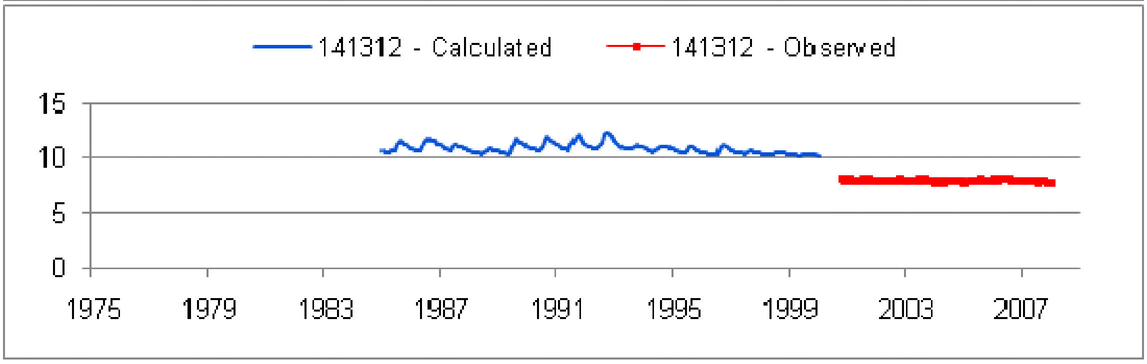
40
20
0
1975
1979
1983
1987
1991
1995
1999
2003
2007


141312 - Calculated
141312 - Observed
15
10
5
0
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1979
1983
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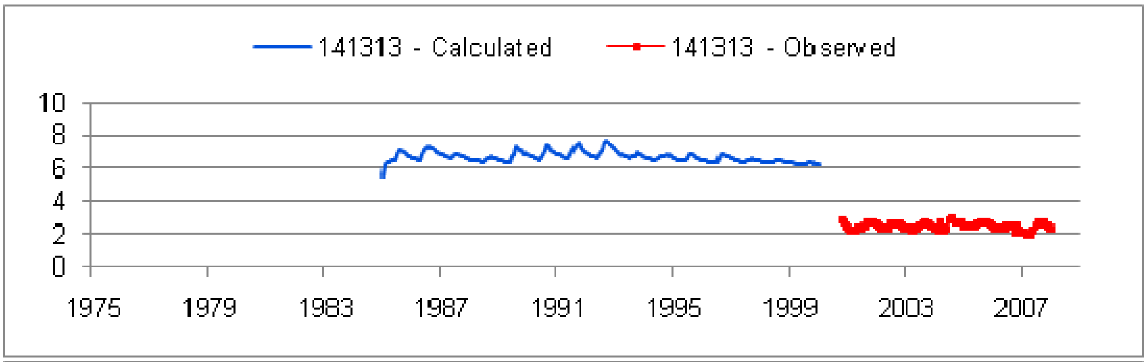
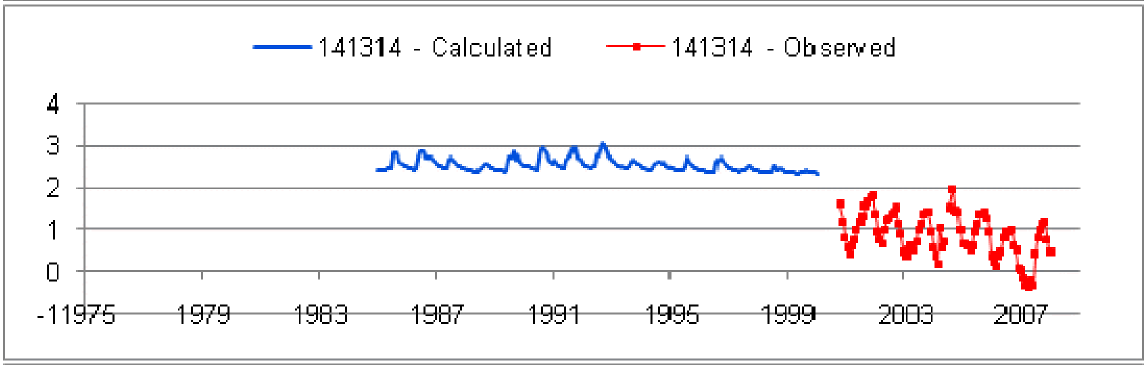
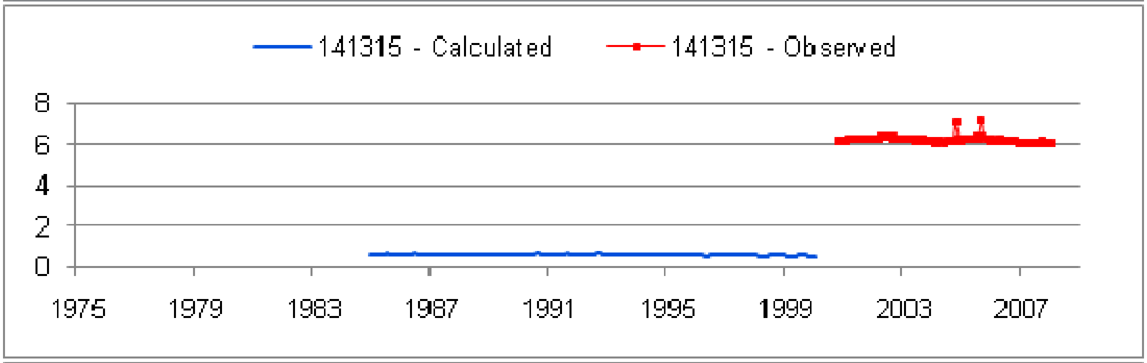
1991
1995
1999
2003
2007



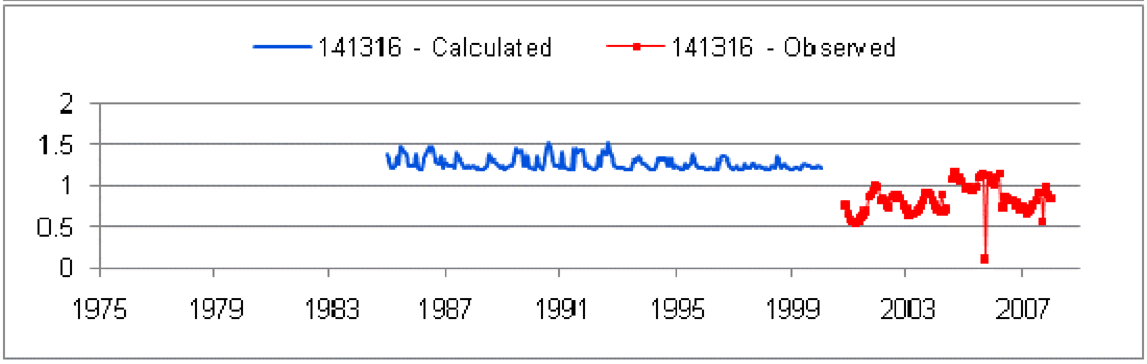
141313 - Calculated
141313 - Observed
10
8
6
4
2
0
1975
1979
1983
1987
1991
1995
1999
2003
2007



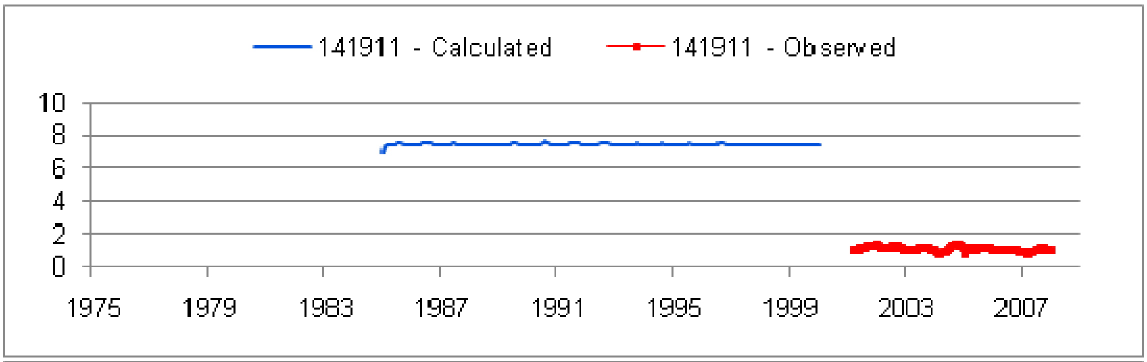
141314 - Calculated
141314 - Observed
4
3
2
1
0
-1
1975
1979
1983
1987
1991
1995
1999
2003
2007

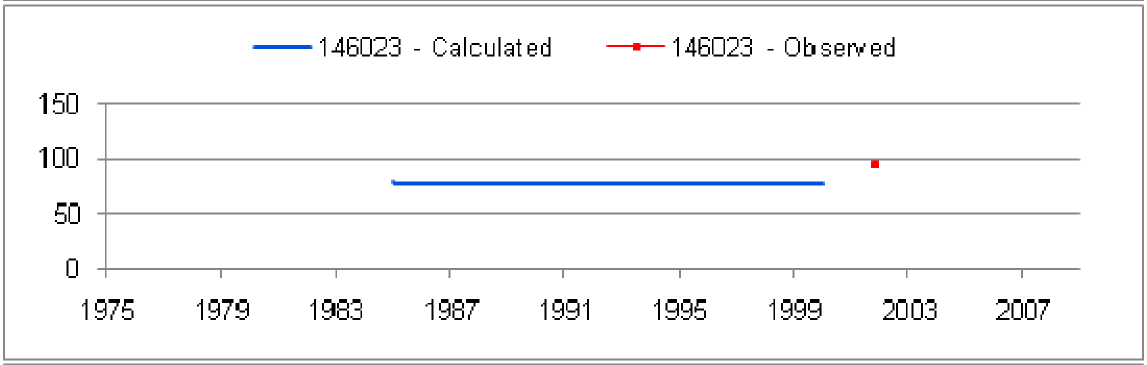


141315 - Calculated
141315 - Observed
8
6
4
2
0
1975
1979
1983
1987
1991
1995
1999
2003
2007



141316 - Calculated
141316 - Observed
2
1.5
1
0.5
0
1975
1979
1983
1987
1991
1995
1999
2003
2007


141911 - Calculated
141911 - Observed
10
8
6
4
2
0
1975
1979
1983
1987
1991
1995
1999
2003
2007


146023 - Calculated
146023 - Observed
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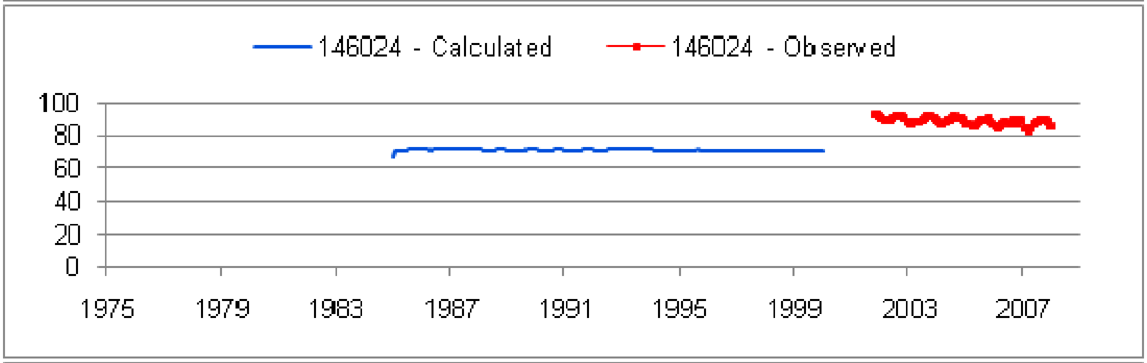
100
50
0
1975
1979
1983
1987
1991
1995
1999
2003
2007


146024 - Calculated
146024 - Observed
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80
60
40
20
0
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1995
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2003
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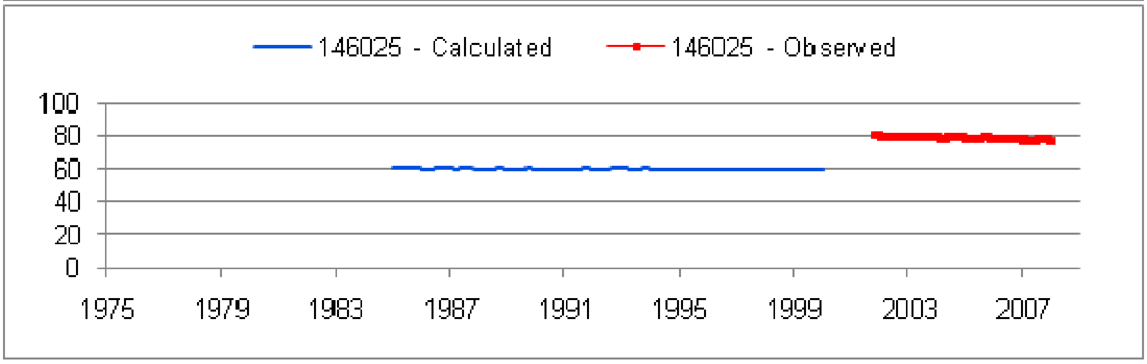
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146025 - Observed
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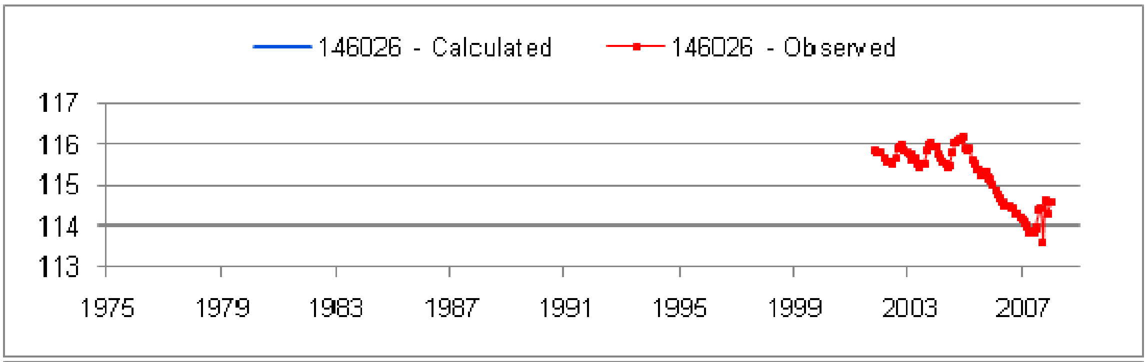
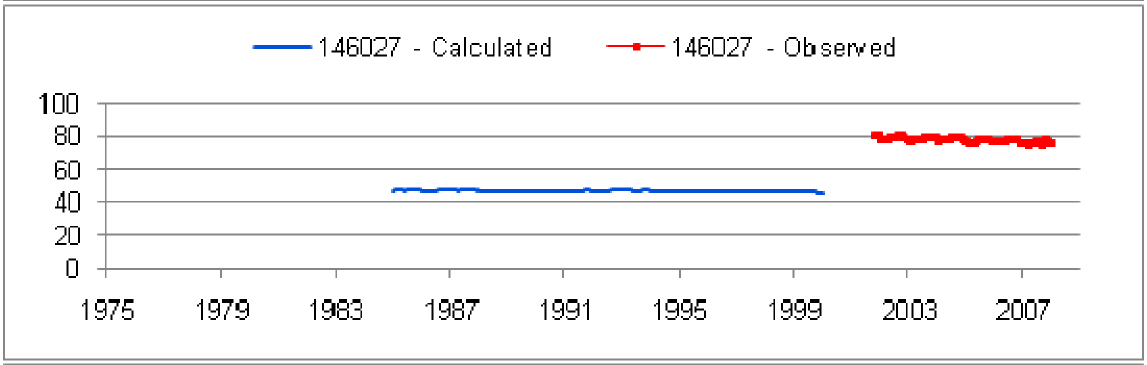
80
60
40
20
0
1975
1979
1983
1987
1991
1995
1999
2003
2007


146026 - Calculated
146026 - Observed
117
116
115
114
113
1975
1979
1983
1987
1991
1995
1999
2003
2007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146027 - Observed
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60
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0
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1979
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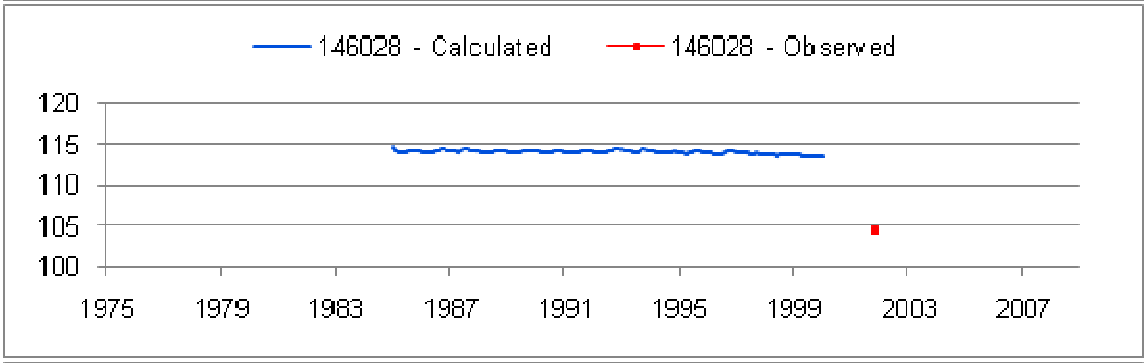
1995
1999
2003
2007


146028 - Calculated
146028 - Observed
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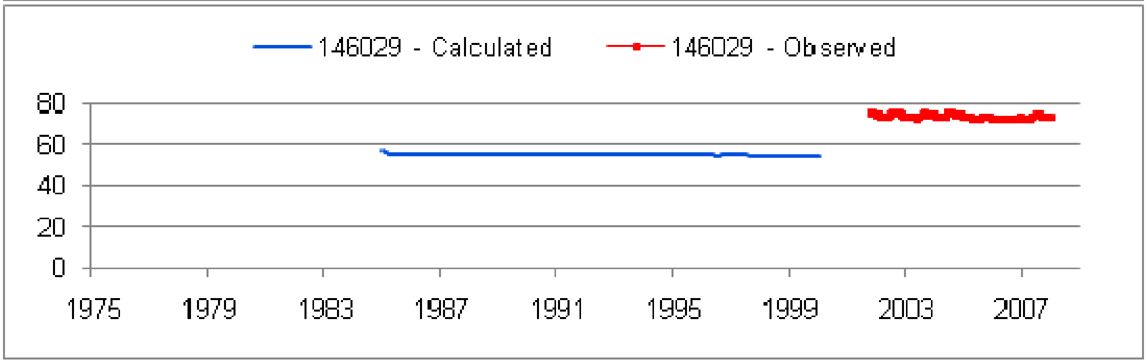
115
110
105
100
1975
1979
1983
1987
1991
1995
1999
2003
2007


146029 - Calculated
146029 - Observed
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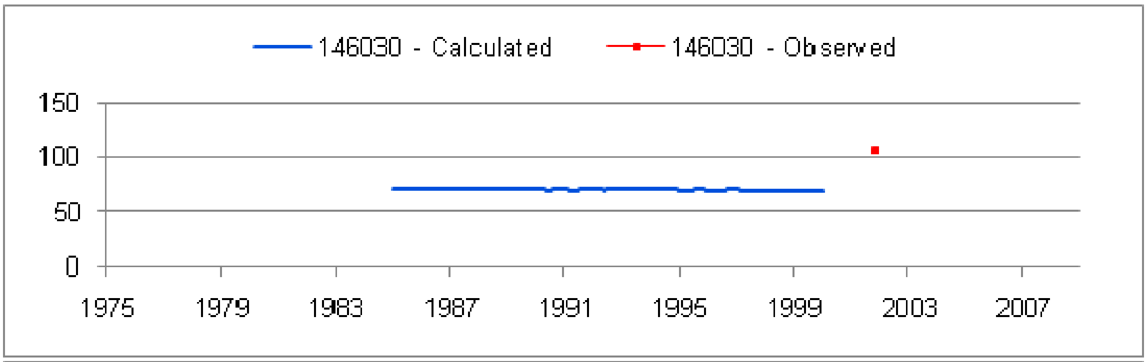
1979
1983
1987
1991
1995
1999
2003
2007


146030 - Calculated
146030 - Observed
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100
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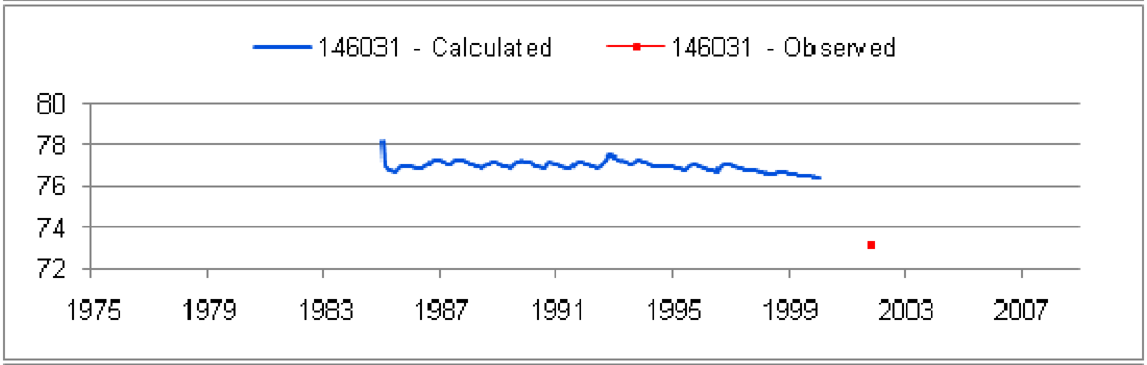
0
1975
1979
1983
1987
1991
1995
1999
2003
2007


146031 - Calculated
146031 - Observed
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78
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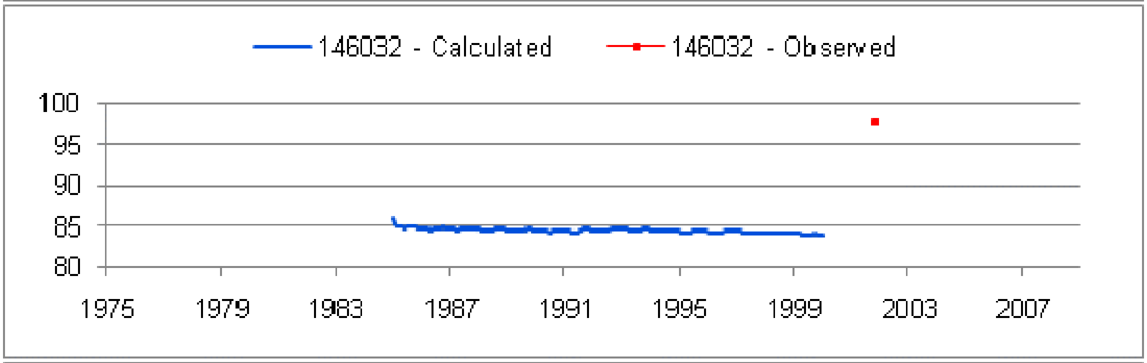
1995
1999
2003
2007


146032 - Calculated
146032 - Observed
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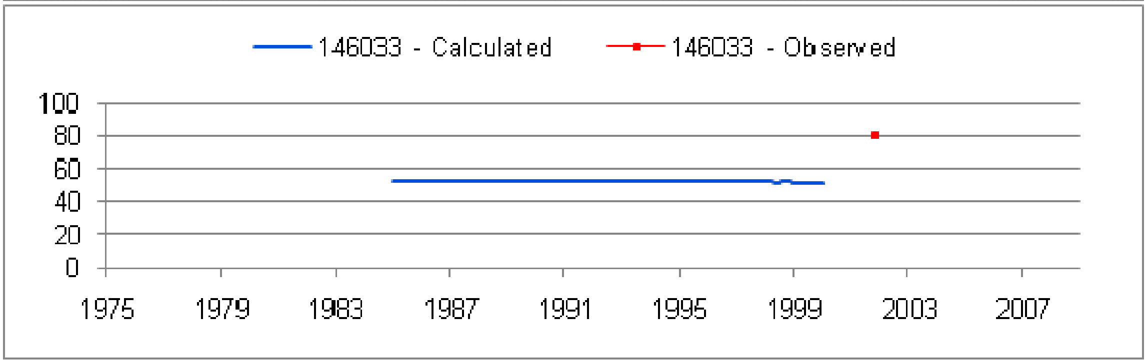
1979
1983
1987
1991
1995
1999
2003
2007


146033 - Calculated
146033 - Observed
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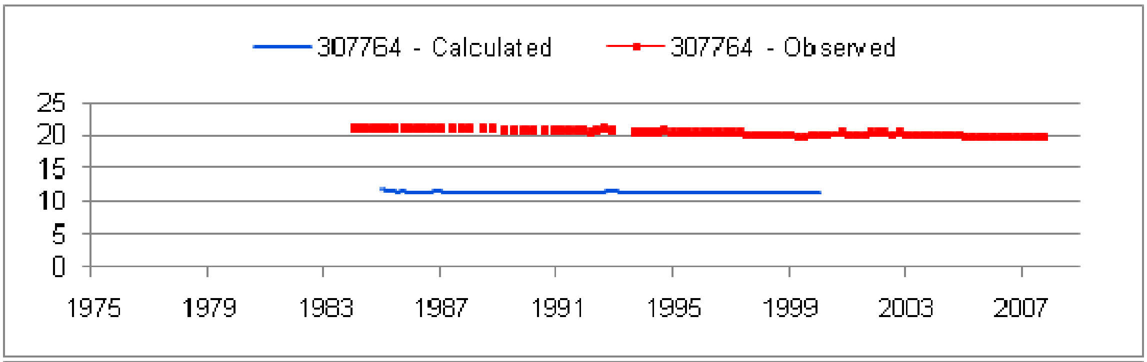
1975
1979
1983
1987
1991
1995
1999
2003
2007


307764 - Calculated
307764 - Observed
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1975
1979
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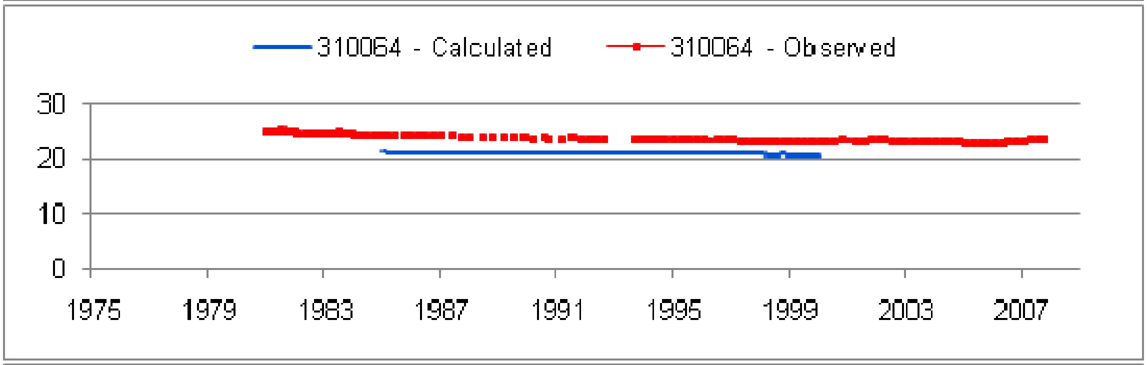
1995
1999
2003
2007


310064 - Calculated
310064 - Observed
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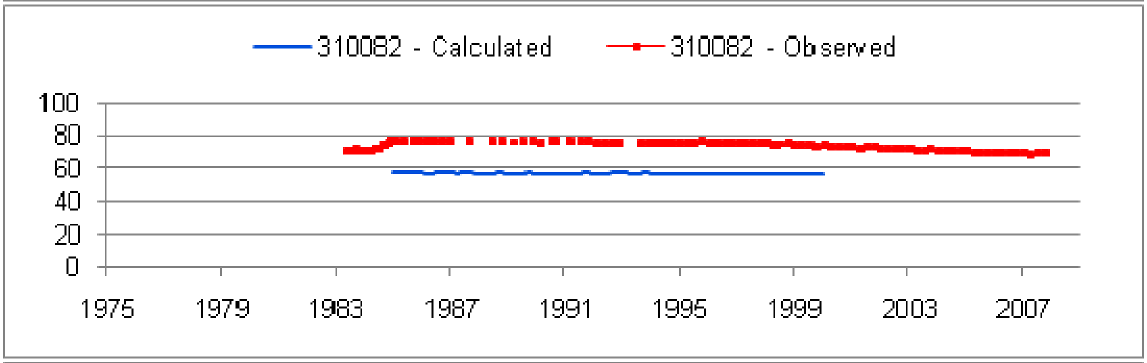
1975
1979
1983
1987
1991
1995
1999
2003
2007


310082 - Calculated
310082 - Observed
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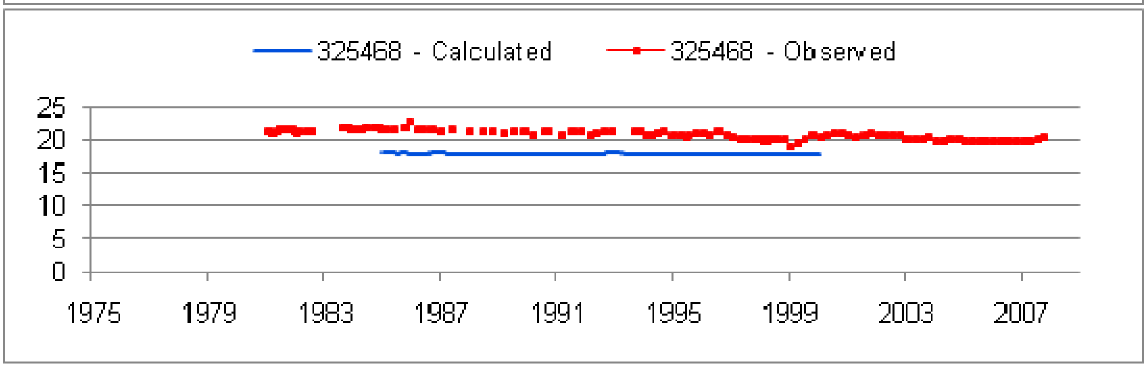
1979
1983
1987
1991
1995
1999
2003
2007


325468 - Calculated
325468 - Observed
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10
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1987
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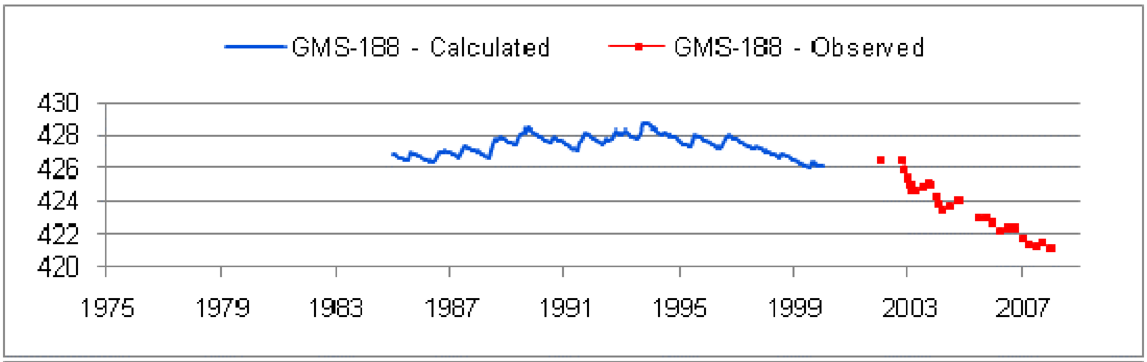
1995
1999
2003
2007


GMS-188 - Calculated
GMS-188 - Observed
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428
426
424
422
420
1975
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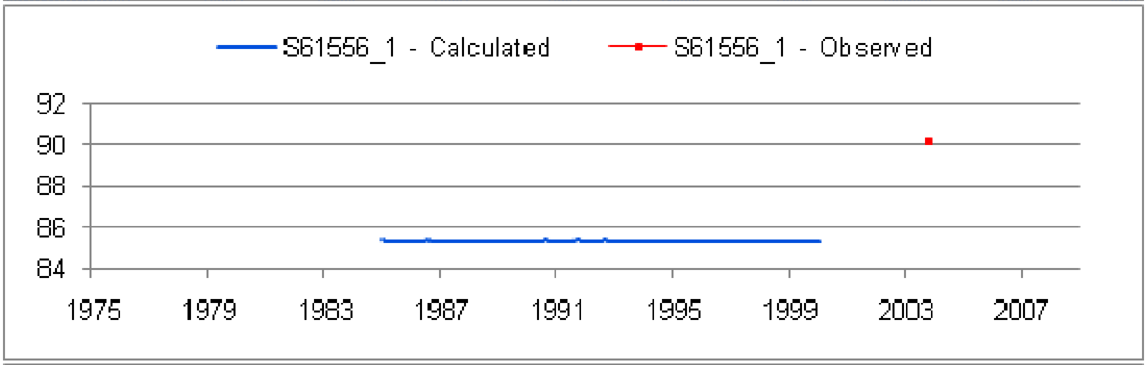
1991
1995
1999
2003
2007


S61556_1 - Calculated
S61556_1 - Observed
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90
88
86
84
1975
1979
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1991
1995
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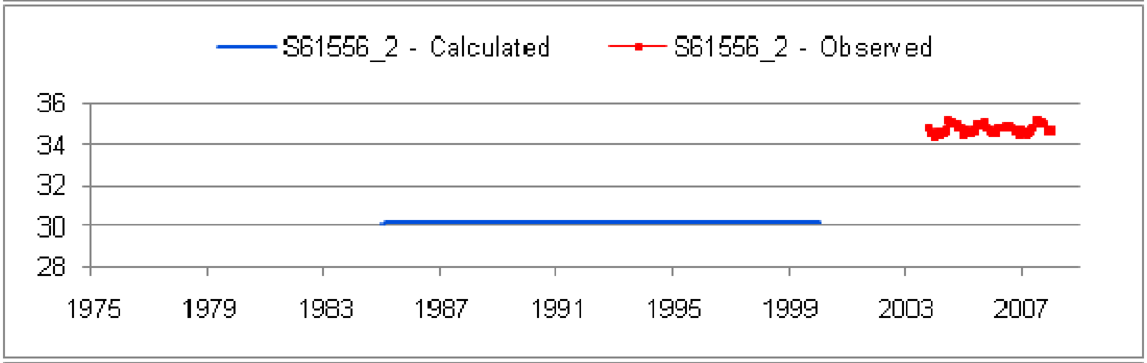
2003
2007


S61556_2 - Calculated
S61556_2 - Observed
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28
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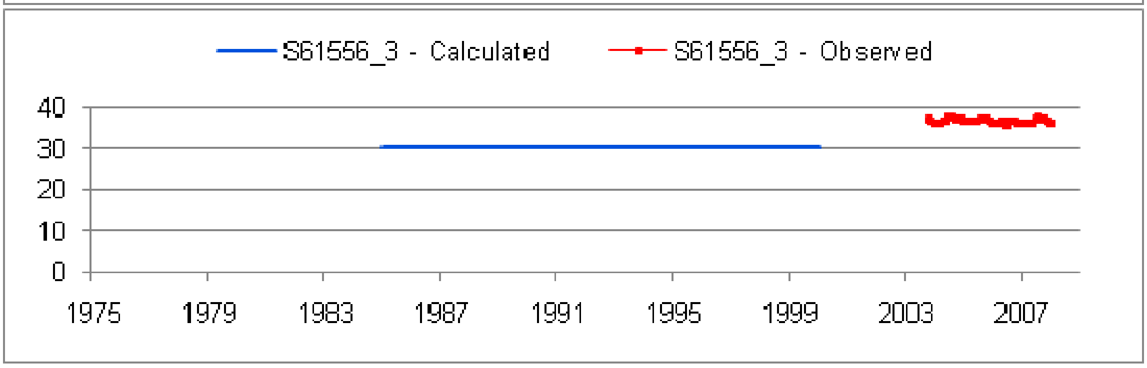
1995
1999
2003
2007


S61556_3 - Calculated
S61556_3 - Observed
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1975
1979
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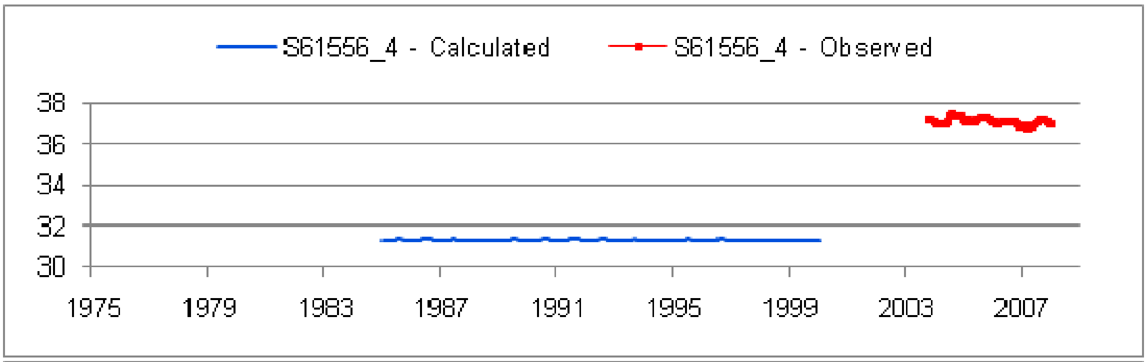
1991
1995
1999
2003
2007


S61556_4 - Calculated
S61556_4 - Observed
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36
34
32
30
1975
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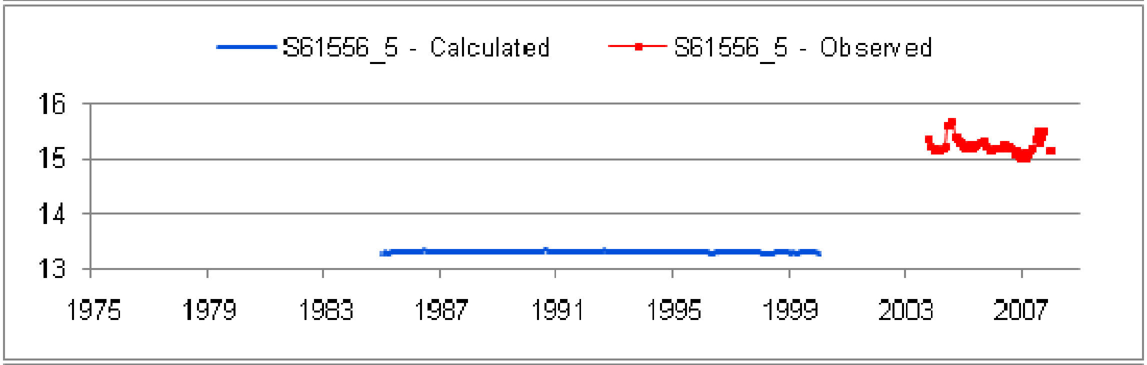
1991
1995
1999
2003
2007


S61556_5 - Calculated
S61556_5 - Observed
16
15
14
13
1975
1979
1983
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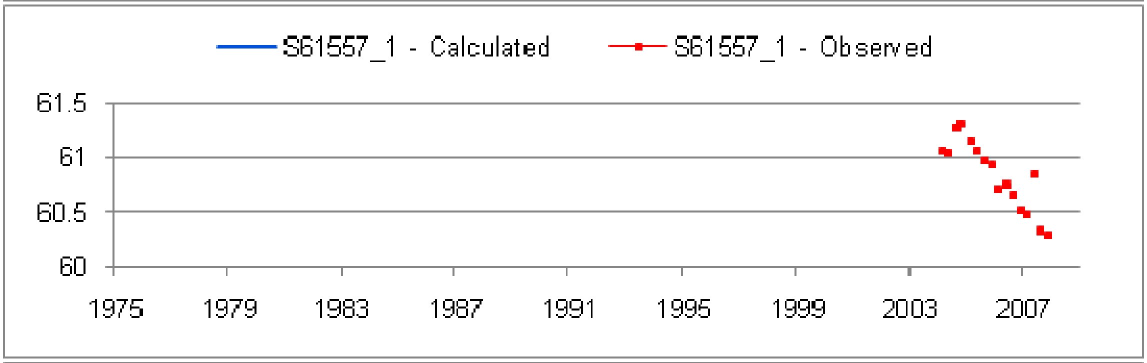
1995
1999
2003
2007


S61557_1 - Calculated
S61557_1 - Observed
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61
60.5
60
1975
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1987
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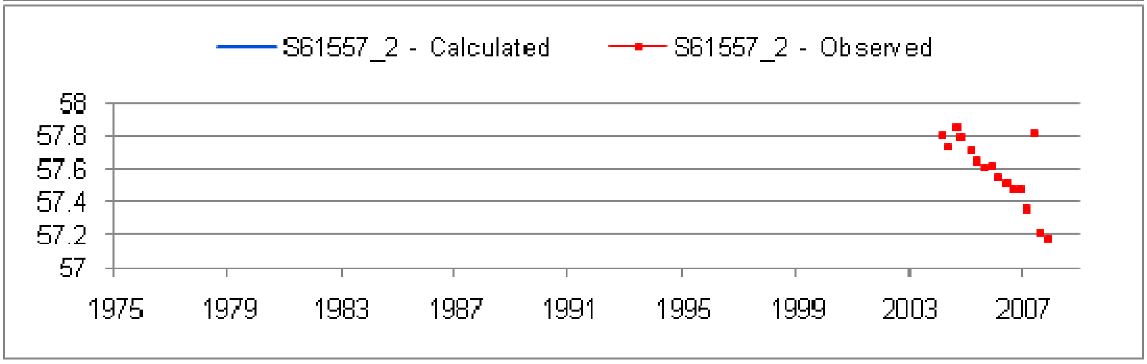
1995
1999
2003
2007


S61557_2 - Calculated
S61557_2 - Observed
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57.8
57.6
57.4
57.2
57
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1995
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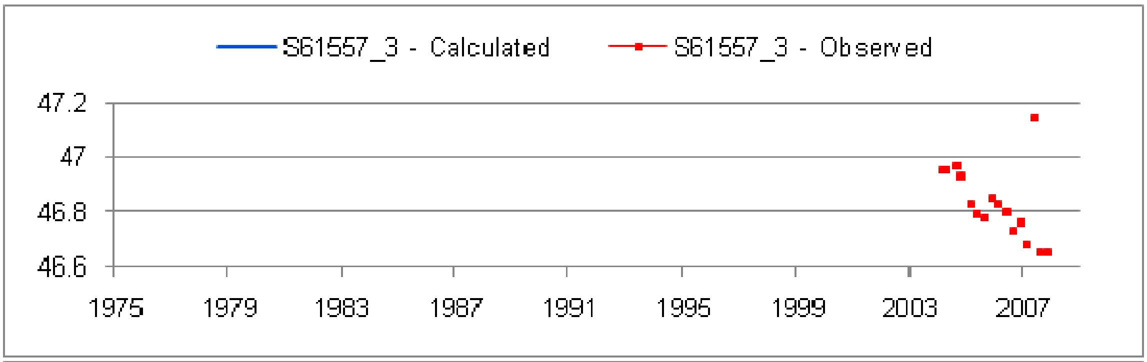
2003
2007


S61557_3 - Calculated
S61557_3 - Observed
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47
46.8
46.6
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1979
1983
1987
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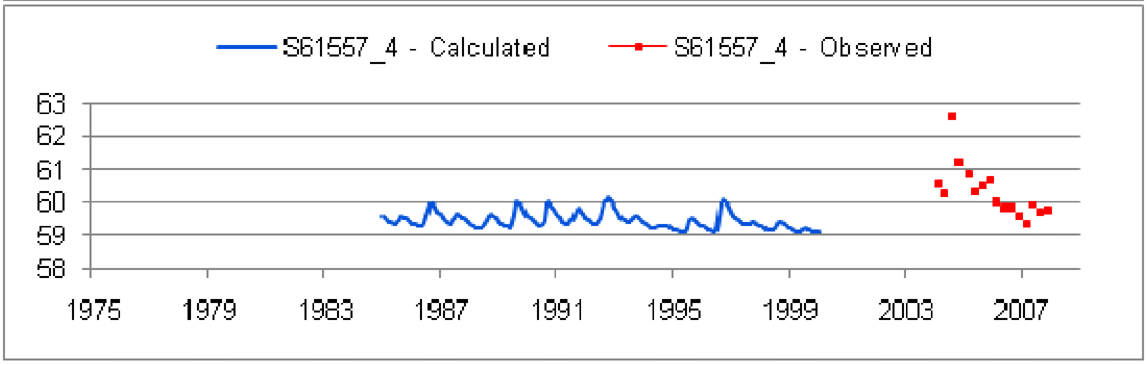
1995
1999
2003
2007


S61557_4 - Calculated
S61557_4 - Observed
63
62
61
60
59
58
1975
1979
1983
1987
1991
1995
1999
2003
2007

Appendix D Mapping

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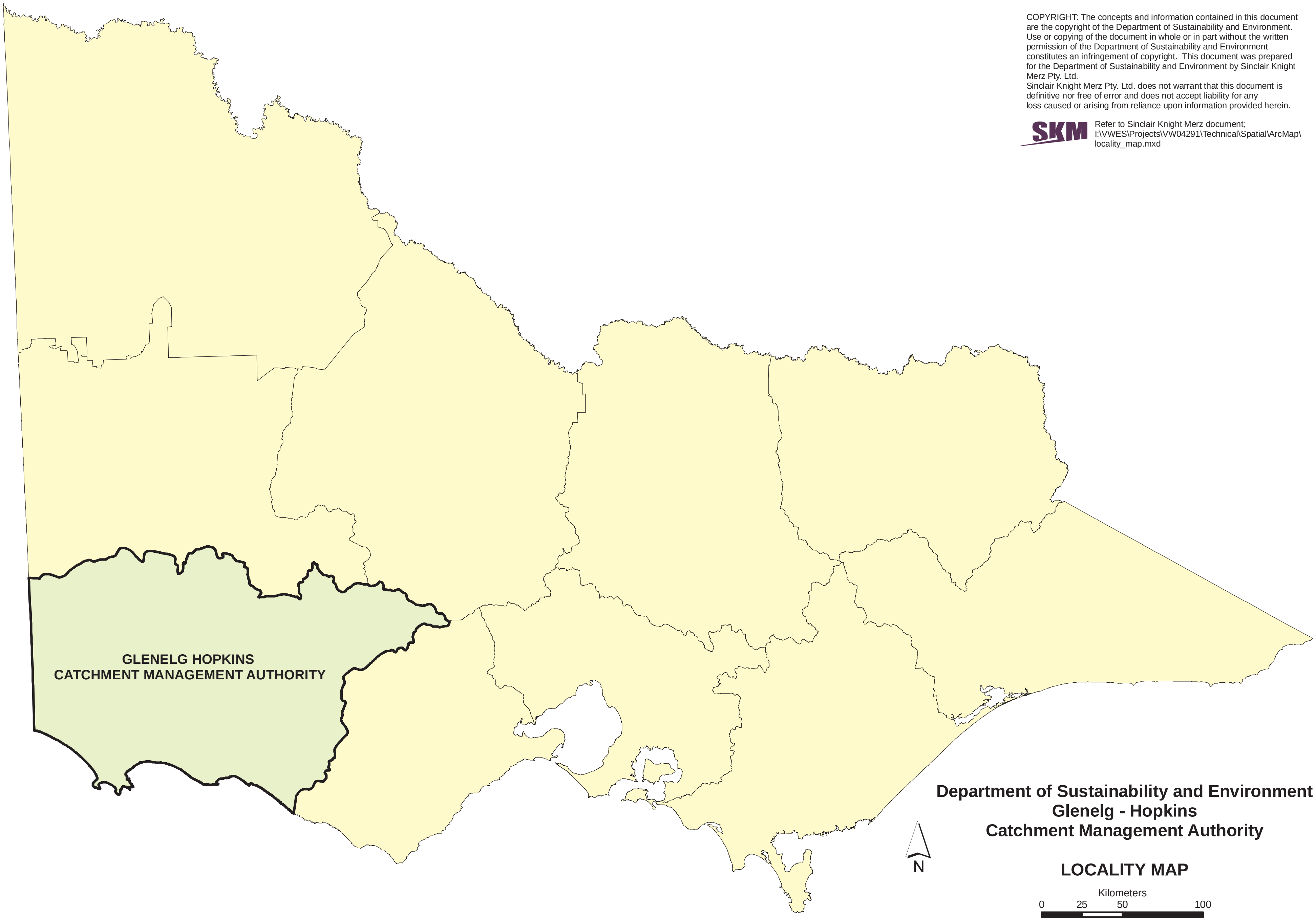
Map 1



SKM Refer to Sinclair Knight Merz document;
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LOCALITY MAP

Map 2

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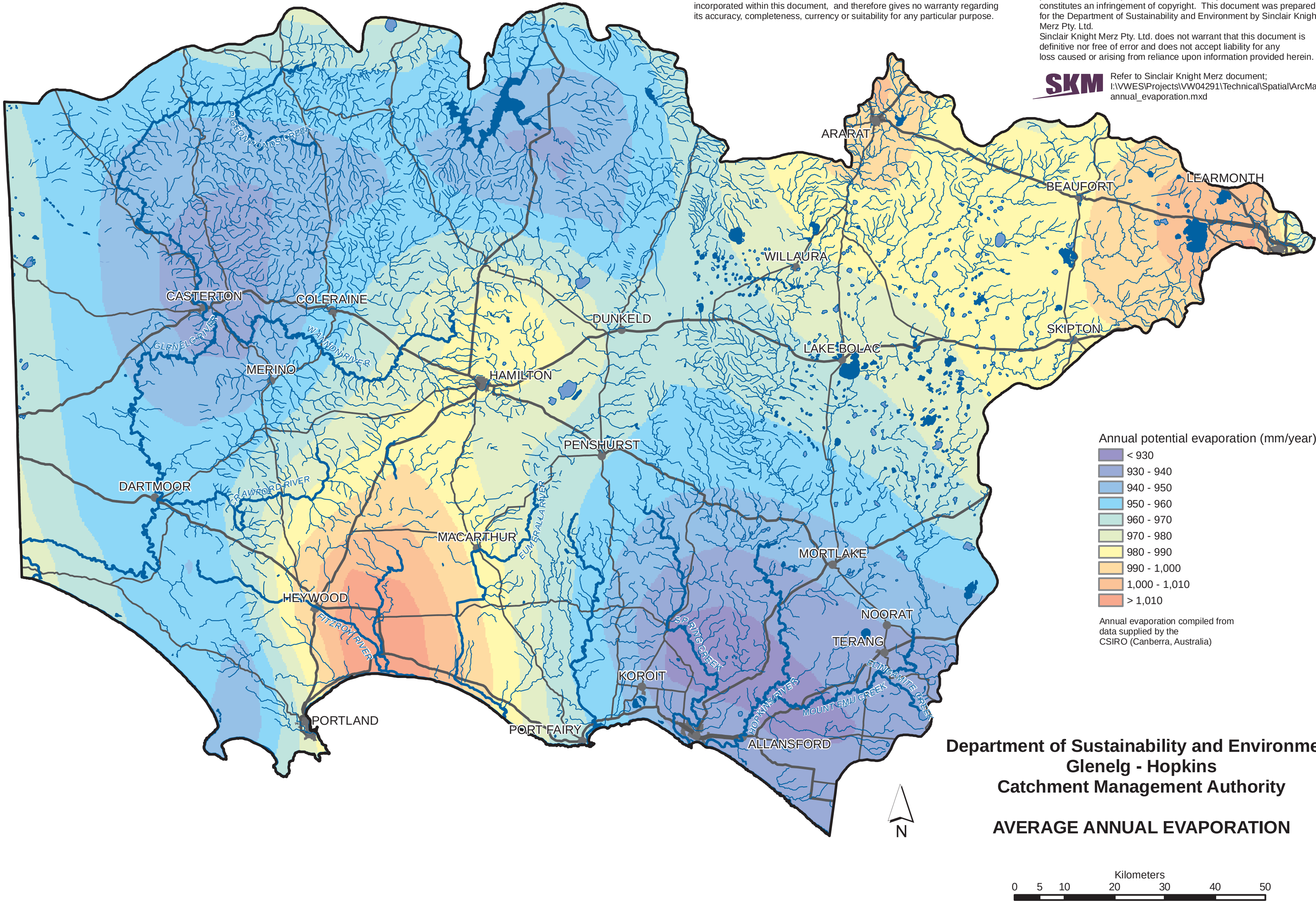

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AVERAGE ANNUAL EVAPORATION

Map 3

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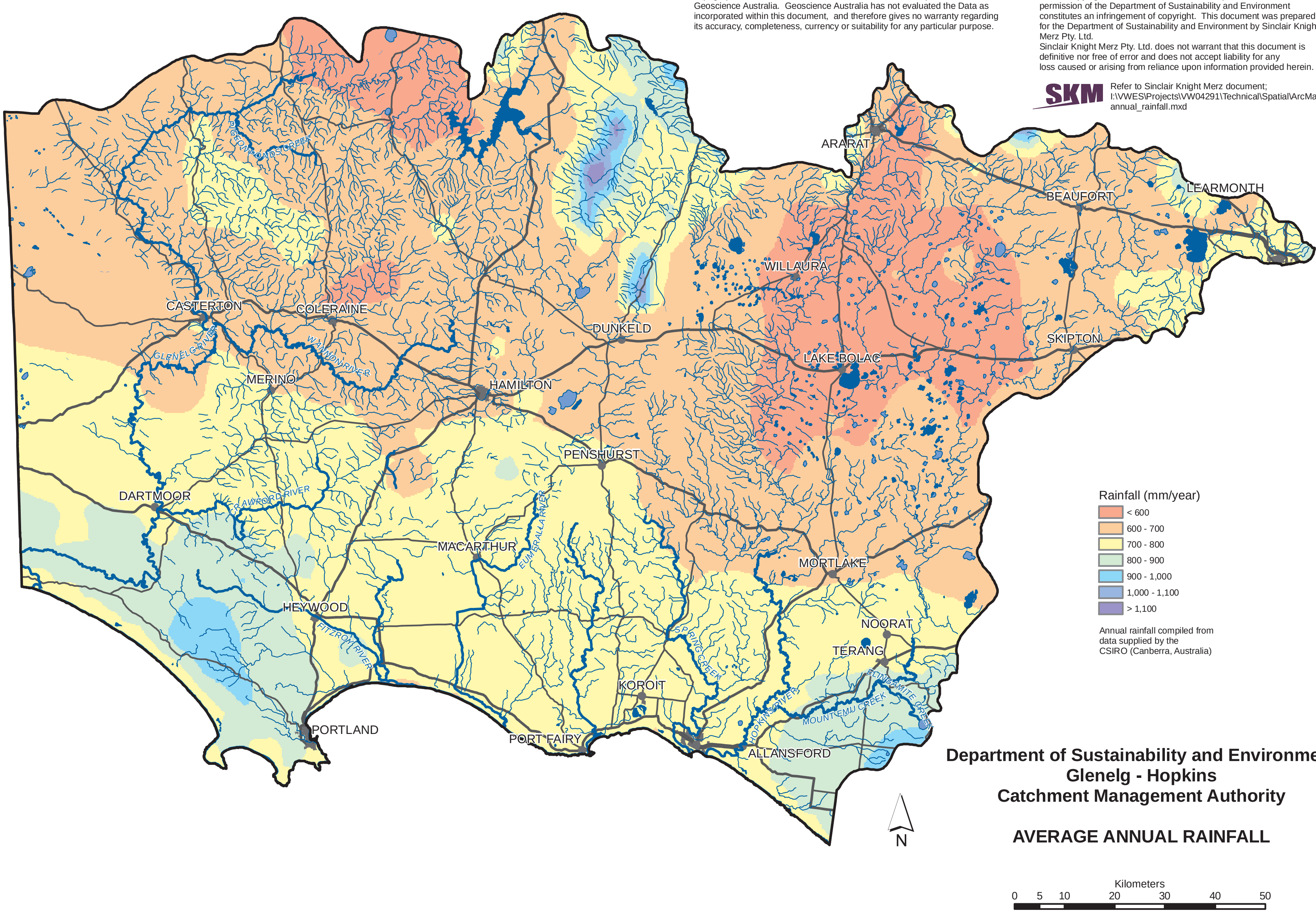

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AVERAGE ANNUAL RAINFALL

Map 4

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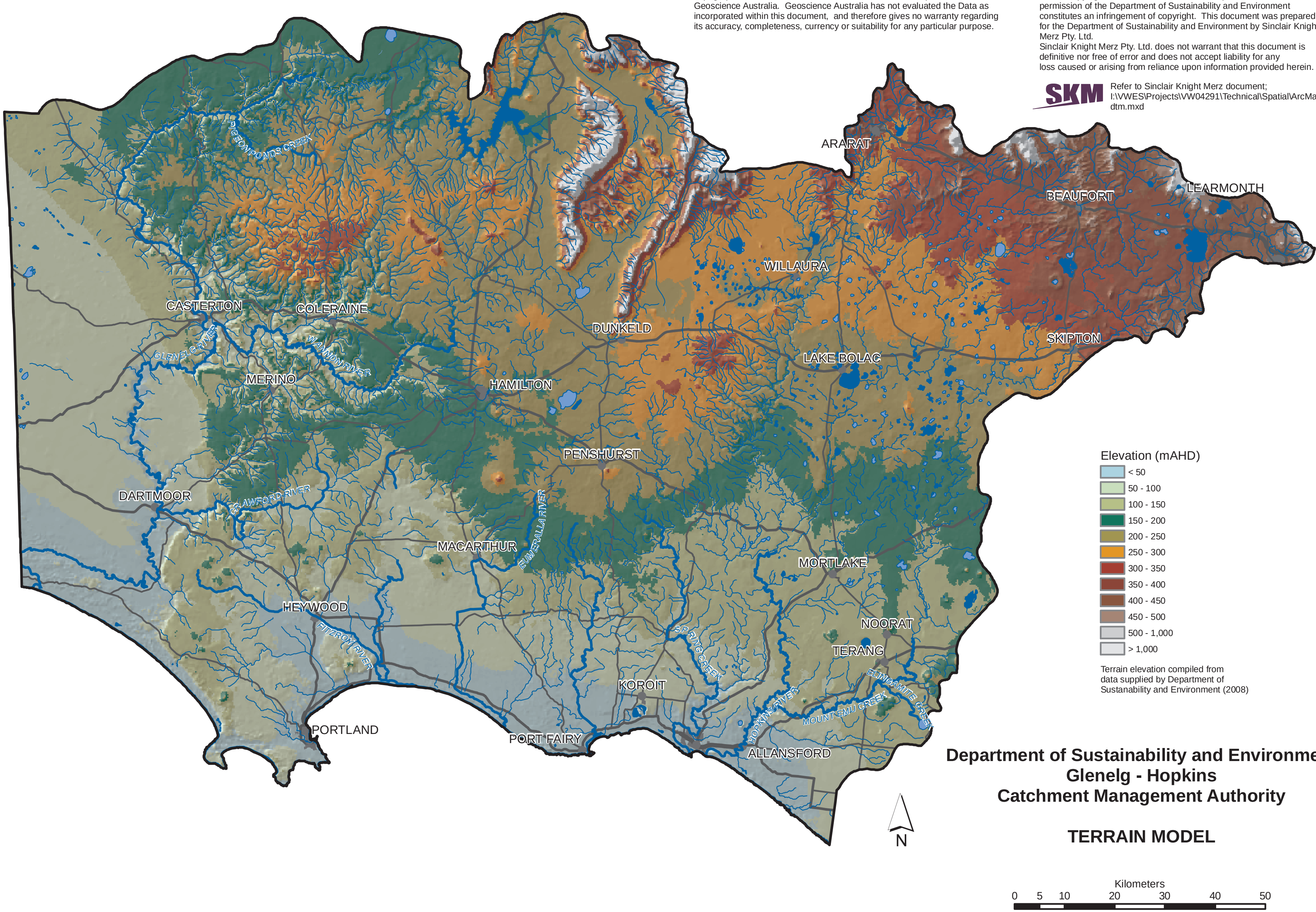

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TERRAIN MODEL

Map 5

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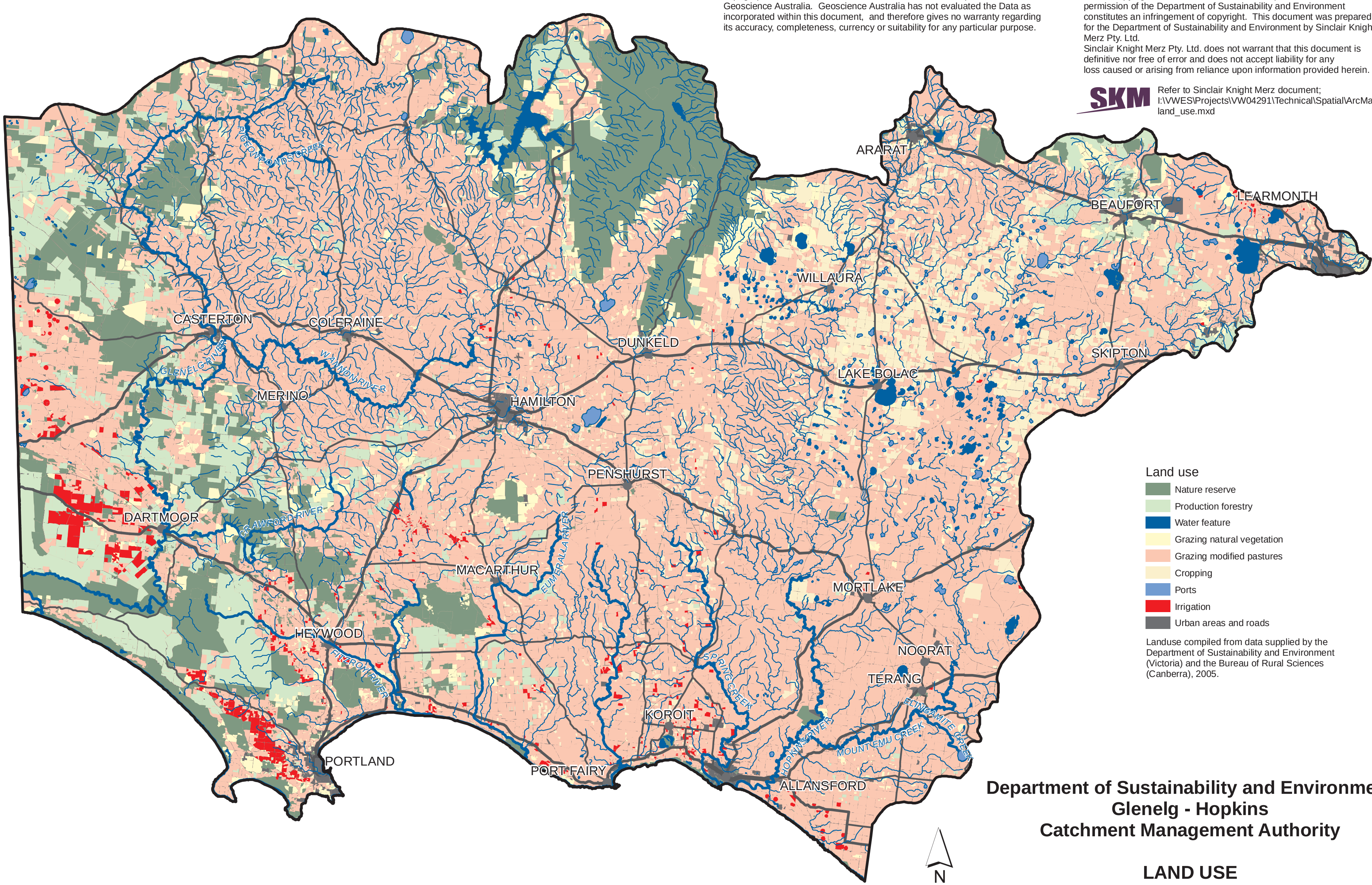

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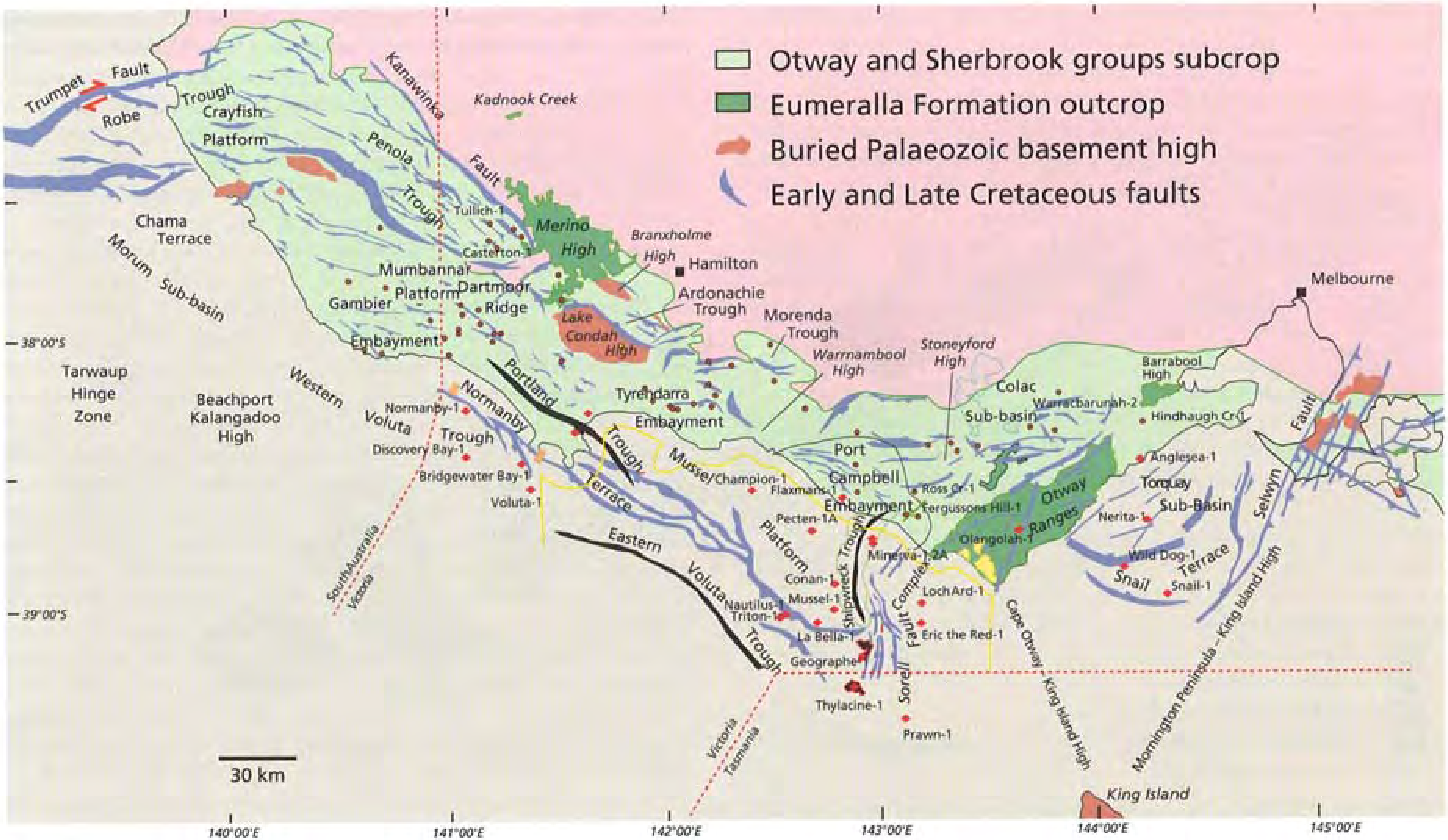
LAND USE

Kilometers
0 5 10 20 30 40 50

Map 6



Otway and Sherbrook groups subcrop
Eumeralla Formation outcrop
Buried Palaeozoic basement high
Early and Late Cretaceous faults
Trumpet Fault
Robe Trough
Crayfish Platform
Kanawinka Fault
Penola Trough
Kadnook Creek
Chama Terrace
Morum Sub-basin
Merino High
Branxholme High
Hamilton
Tullich-1
Casterton-1
Mumbannar Platform
Dartmoor Ridge
Gambier Embayment
Lake Condah High
Ardonachie Trough
Morenda Trough
Warrnambool High
Stoneyford High
Melbourne
Tarwaup Hinge Zone
Beachport Kalangadoo High
Western Voluta Trough
Normanby-1
Normanby Trough
Portland Trough
Discovery Bay-1
Bridgewater Bay-1
Voluta-1
Tyrendarra Embayment
Mussel/Champion-1
Terrace
Flaxmans-1
Port Campbell Embayment
Colac Sub-basin
Barrabool High
Warracbarunah-2
Hindhaugh Cr-1
Fault
Anglesea-1
Torquay Sub-Basin
Ross Cr-1
Fergussons Hill-1
Otway Ranges
Olangolah-1
Nerita-1
Selwyn
Pecten-1A
Eastern Voluta Trough
Platform
Shipwreck Trough
Minerva-1,2A
Wild Dog-1
Terrace
Snail
Snail-1
Conan-1
Mussel-1
Nautilus-1
Triton-1
La Bella-1
Geographe-1
Thylacine-1
Sorell Fault Complex
Loch Ard-1
Eric the Red-1
Cape Otway – King Island High
Mornington Peninsula – King Island High
Prawn-1
South Australia
Victoria
Victoria
Tasmania
King Island
30 km
38°00'S
39°00'S
140°00'E
141°00'E
142°00'E
143°00'E
144°00'E
145°00'E

Map 7

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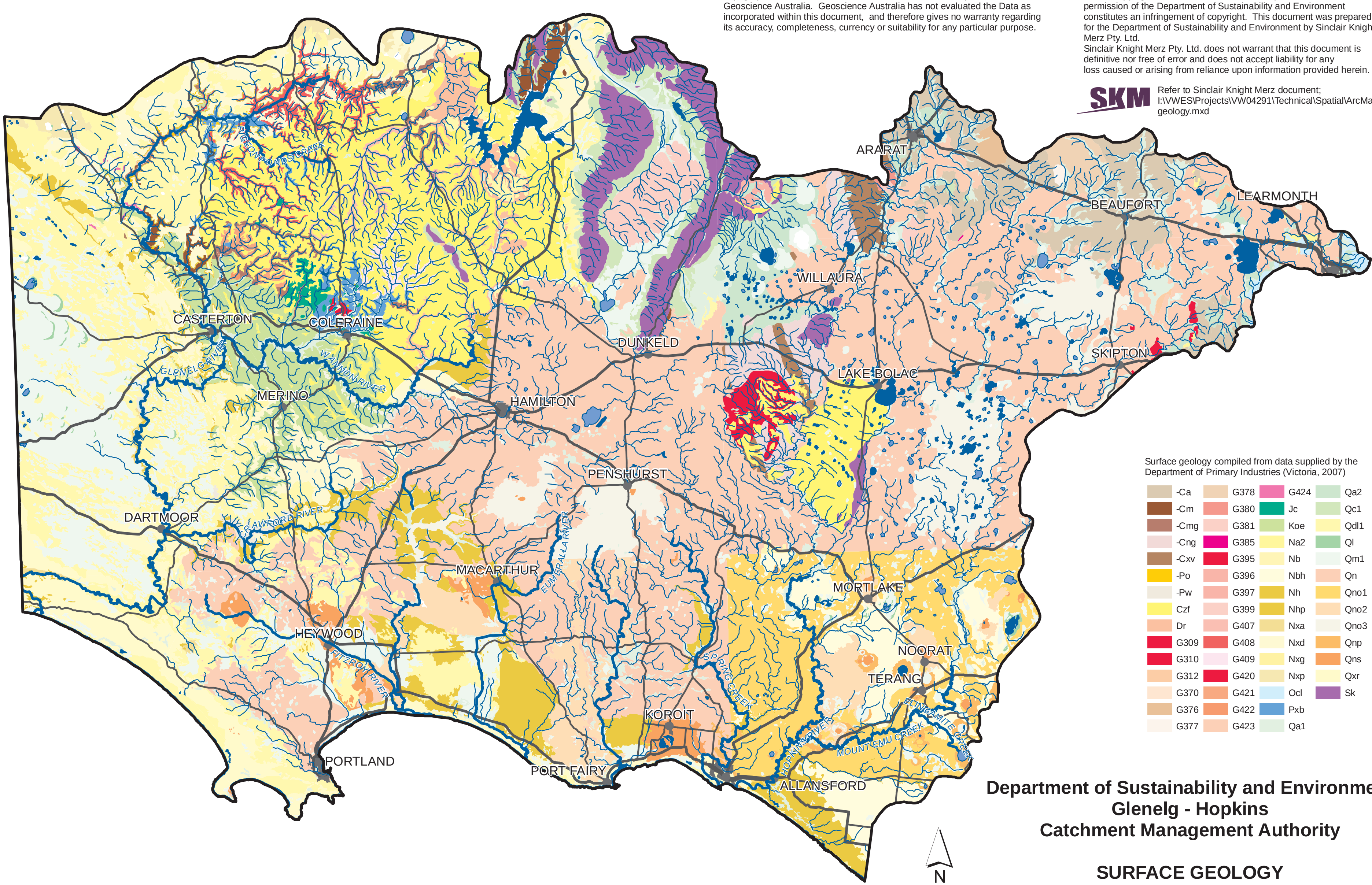

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SURFACE GEOLOGY

Map 8

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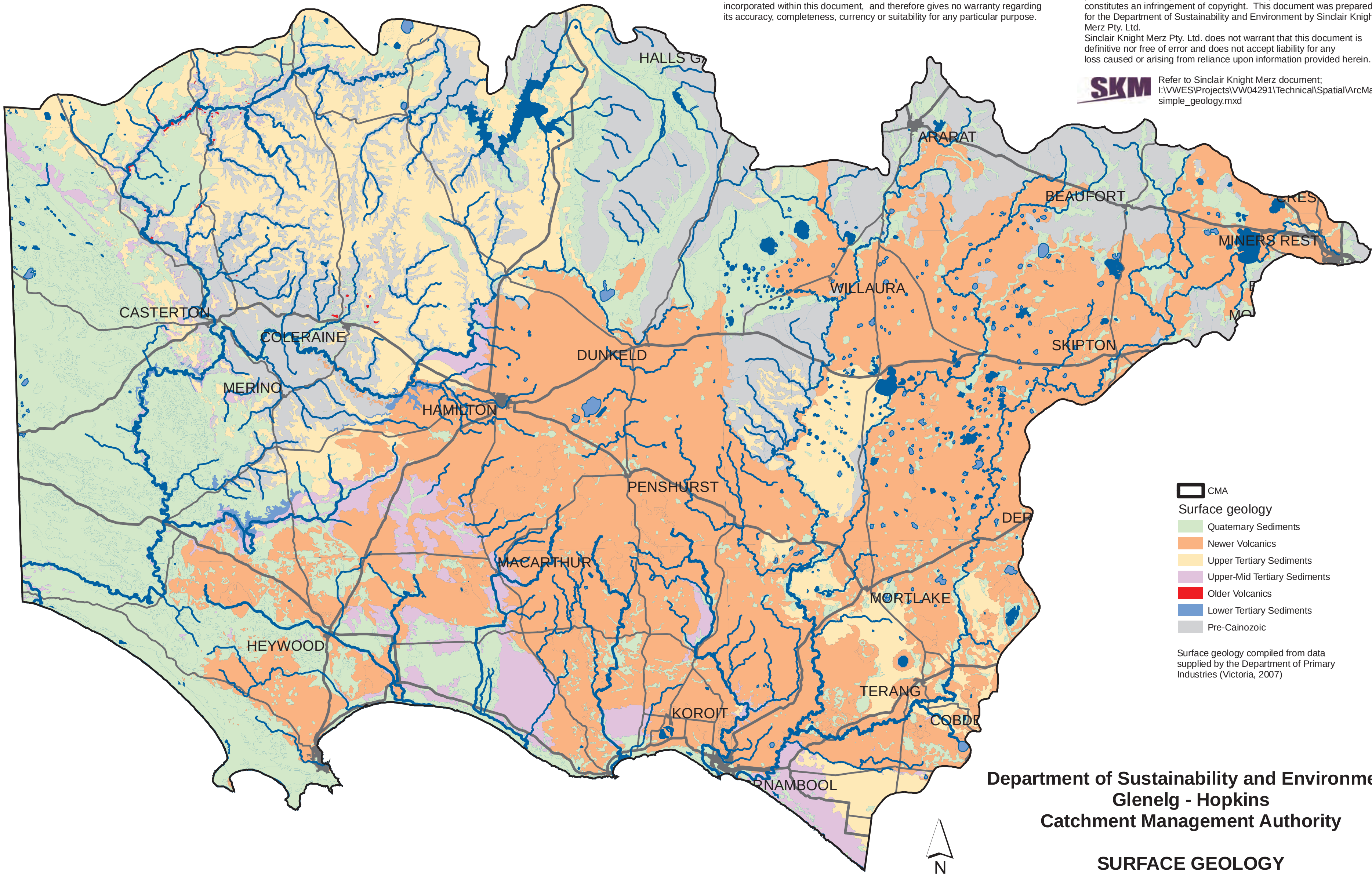

Surface geology compiled from data supplied by the Department of Primary Industries (Victoria, 2007)

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SURFACE GEOLOGY

Kilometers
0 5 10 20 30 40 50

Map 9

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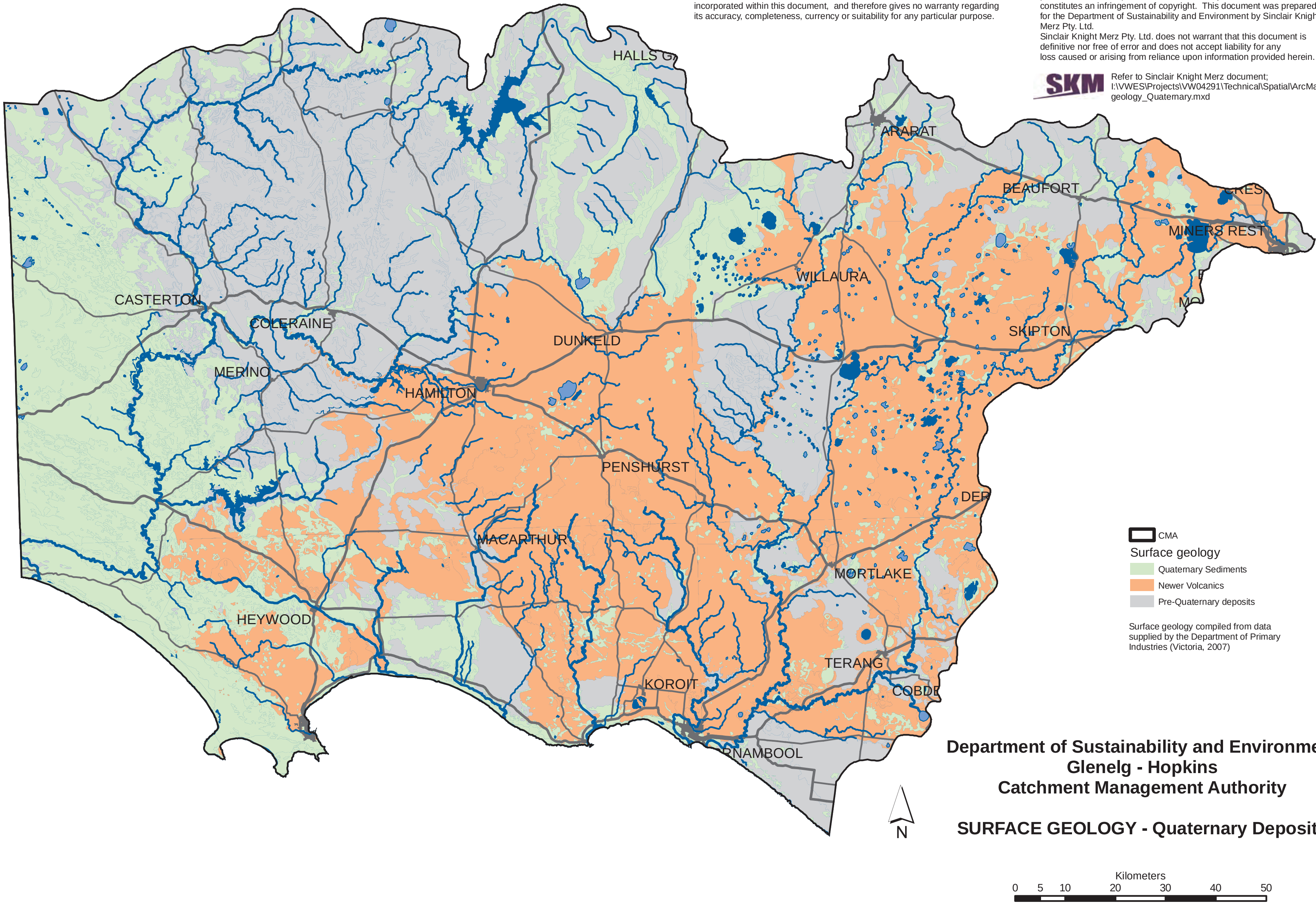

Surface geology compiled from data supplied by the Department of Primary Industries (Victoria, 2007)

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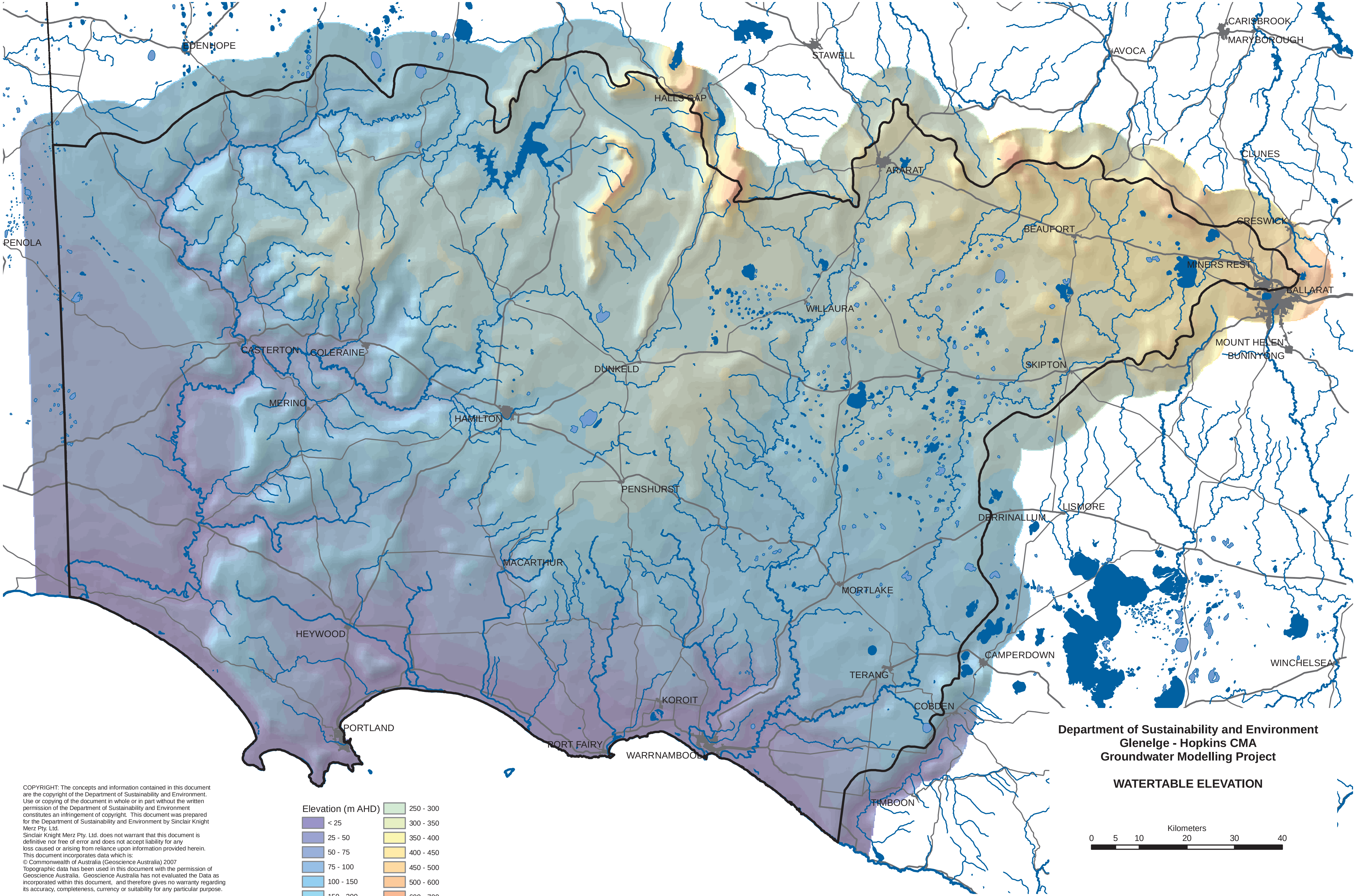
SURFACE GEOLOGY - Quaternary Deposits



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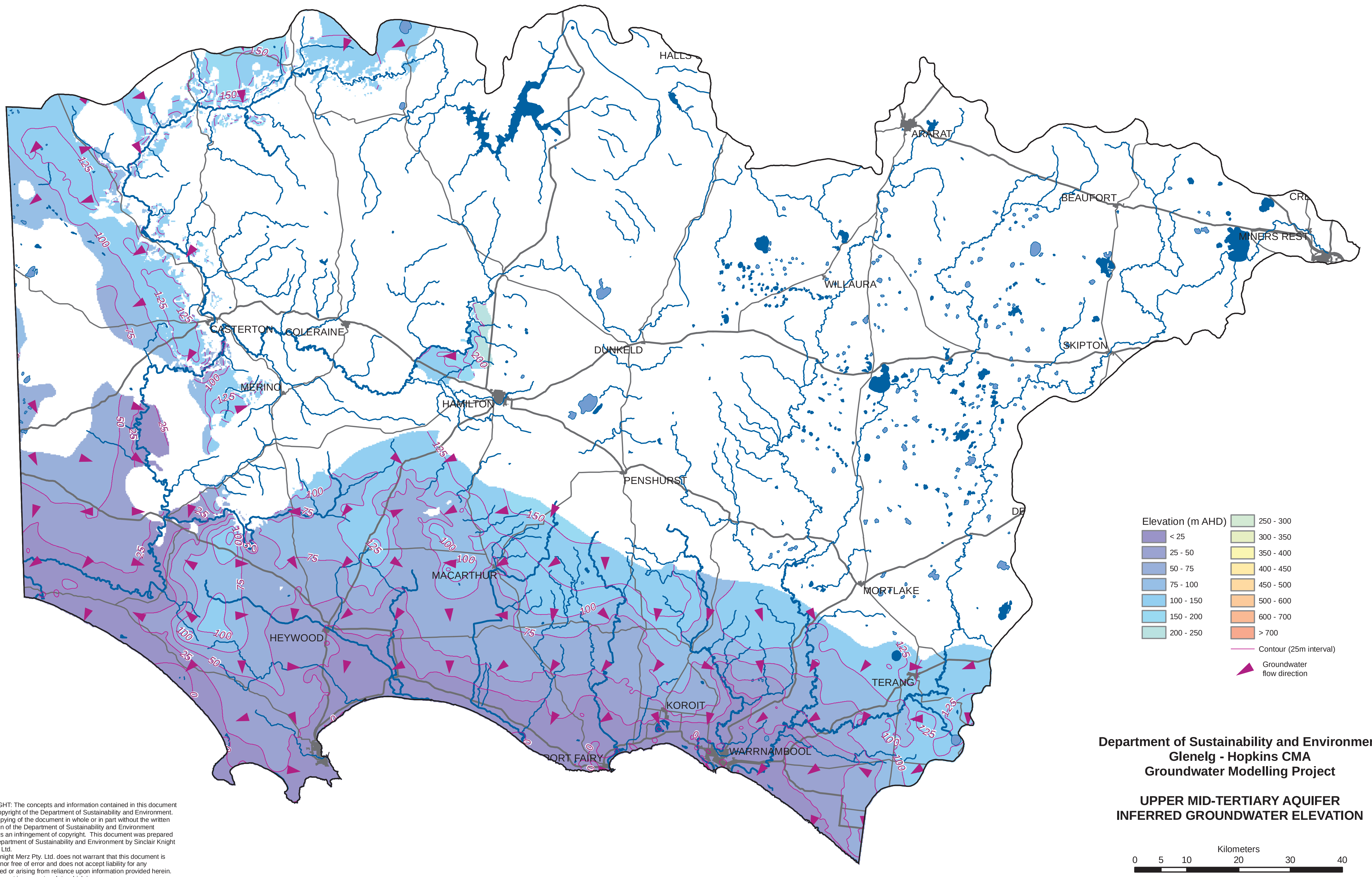
WATERTABLE ELEVATION

Elevation (m AHD)	
< 25	250 - 300
25 - 50	300 - 350
50 - 75	350 - 400
75 - 100	400 - 450
100 - 150	450 - 500
150 - 200	500 - 600
200 - 250	600 - 700
	> 700

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\watertable_elevation.mxd



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UPPER MID-TERTIARY AQUIFER
INFERRED GROUNDWATER ELEVATION

Refer toSinclair Knight Merz document
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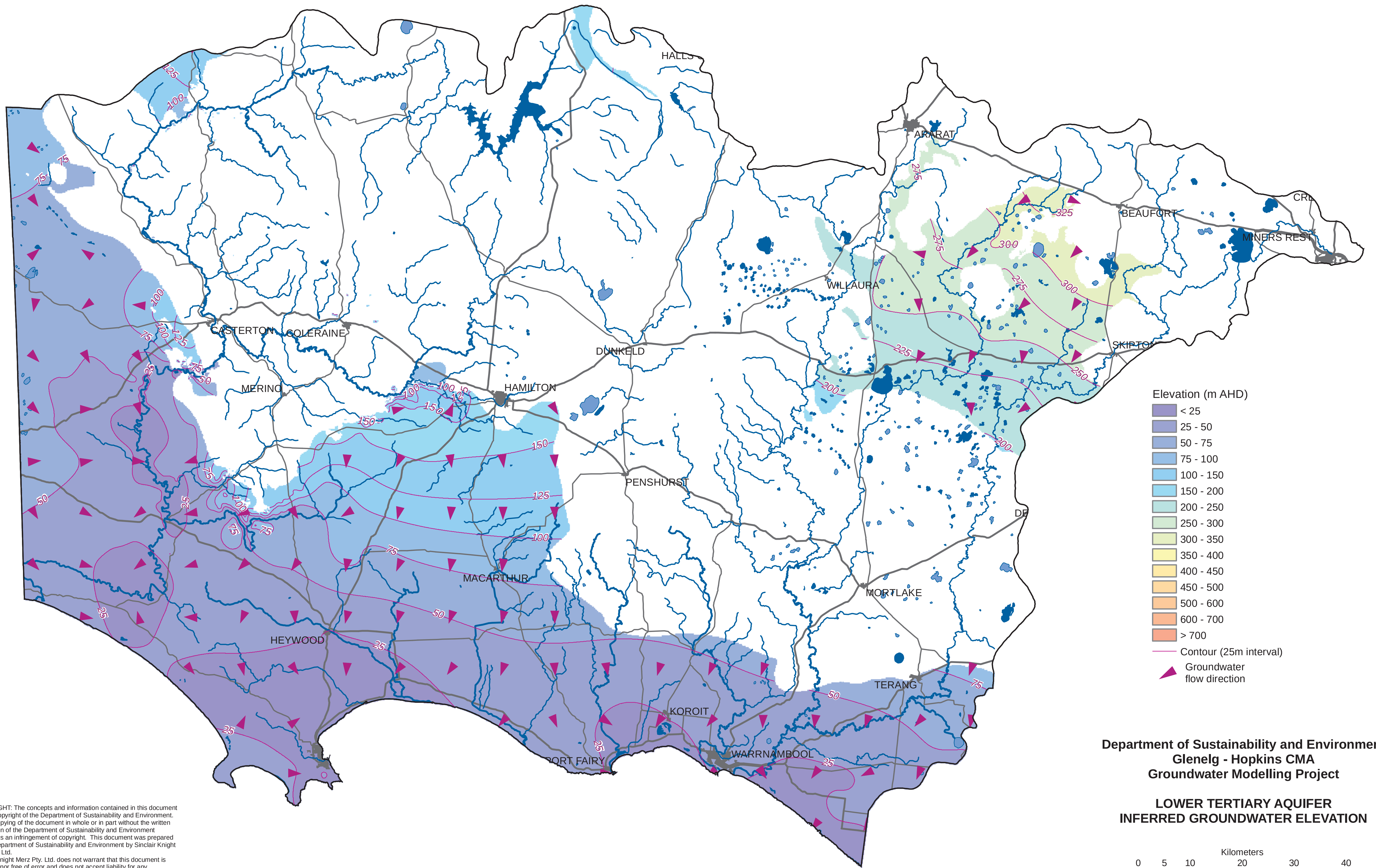
umta_rwl.mxd



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LOWER TERTIARY AQUIFER
INFERRED GROUNDWATER ELEVATION

SKM

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lta_rwl.mxd

Map 13

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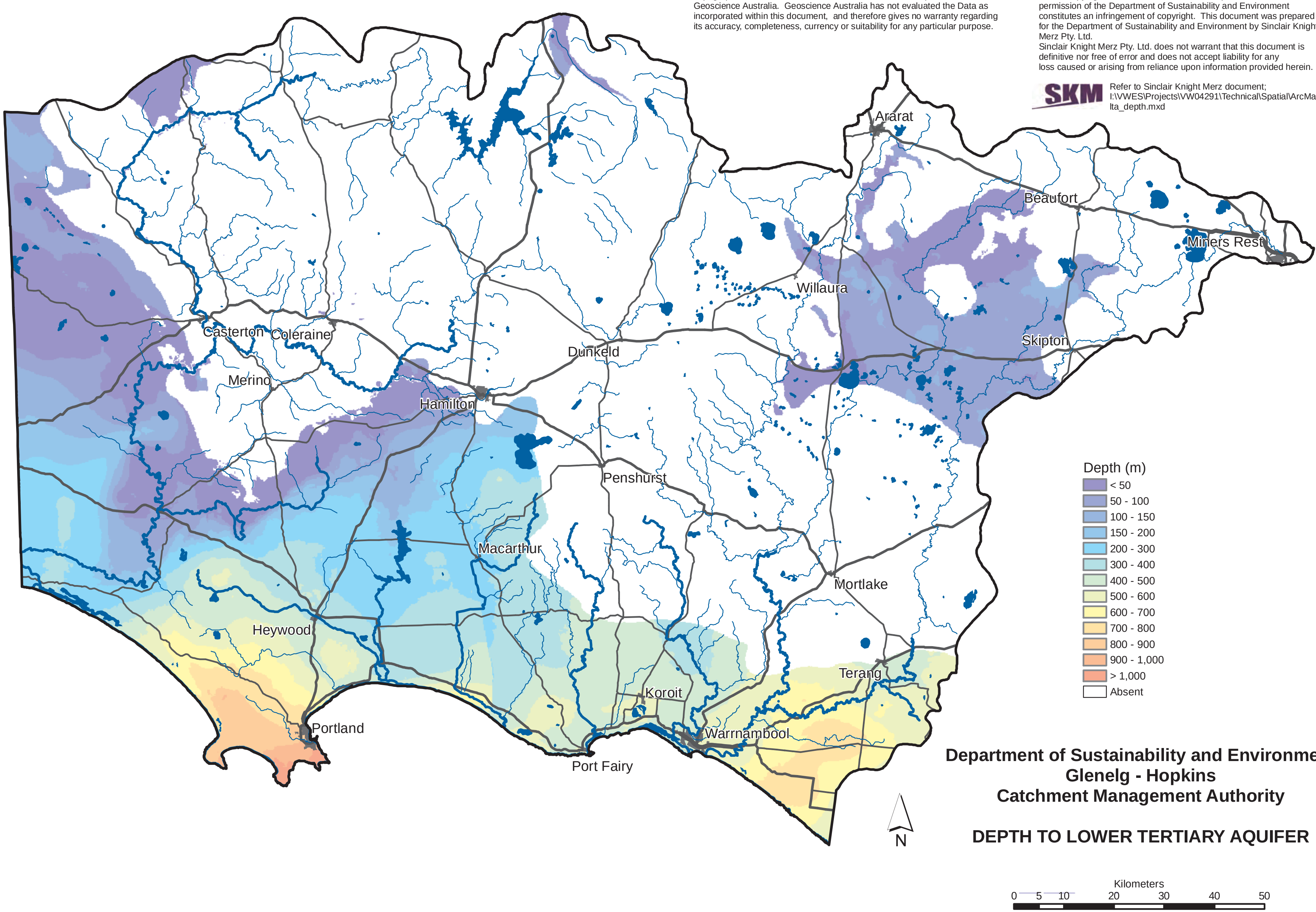

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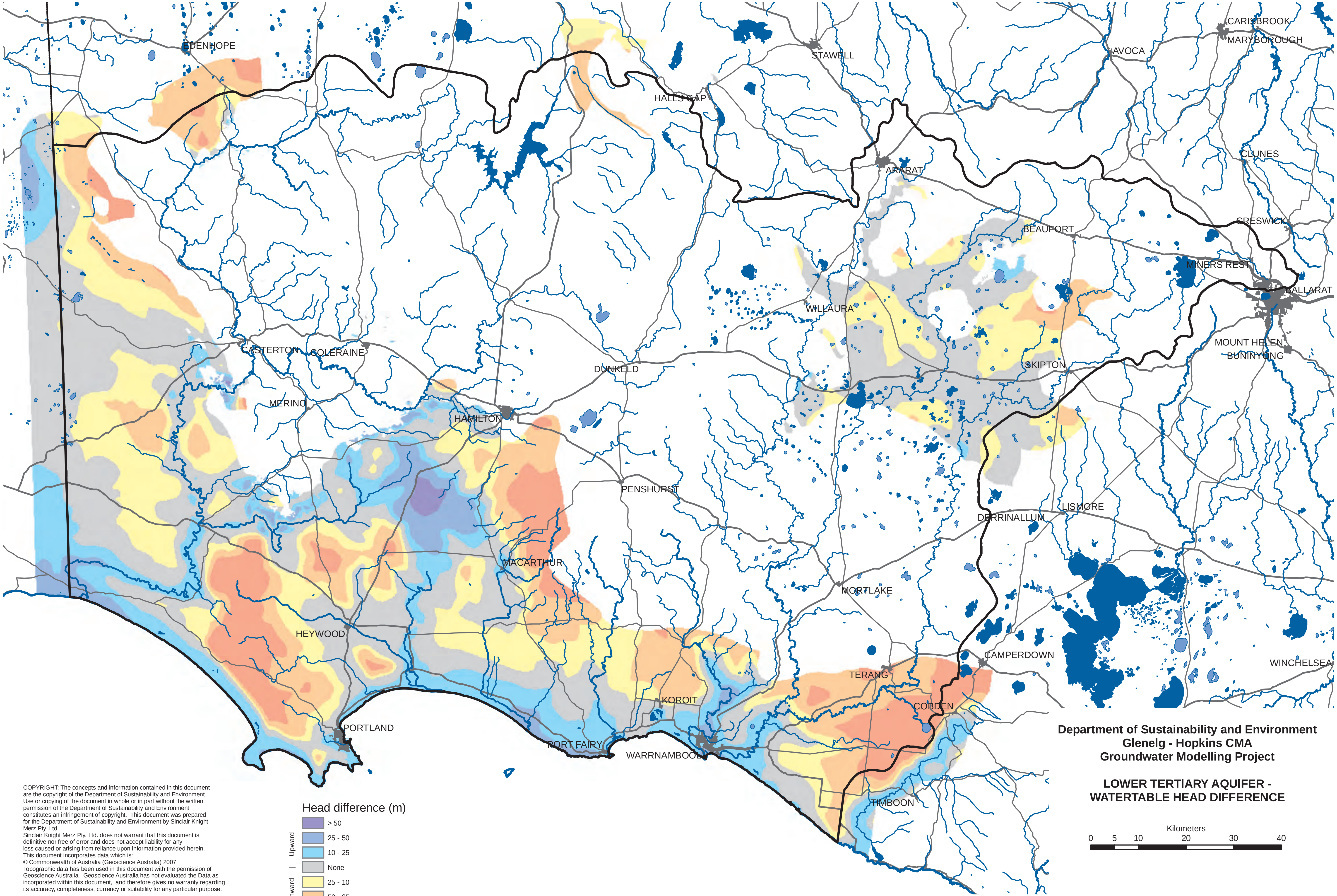
DEPTH TO LOWER TERTIARY AQUIFER

Map 14



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LOWER TERTIARY AQUIFER - WATERTABLE HEAD DIFFERENCE

Kilometers
0 5 10 20 30 40

Head difference (m)

Upward	> 50	
	25 - 50	
	10 - 25	
	None	
Downward	25 - 10	
	50 - 25	
	> 50	

Refer toSinclair Knight Merz document I:\VWES\Projects\VW04237\Technical\spatial\arcmap\lta_wt_head_diff.mxd

Map 15

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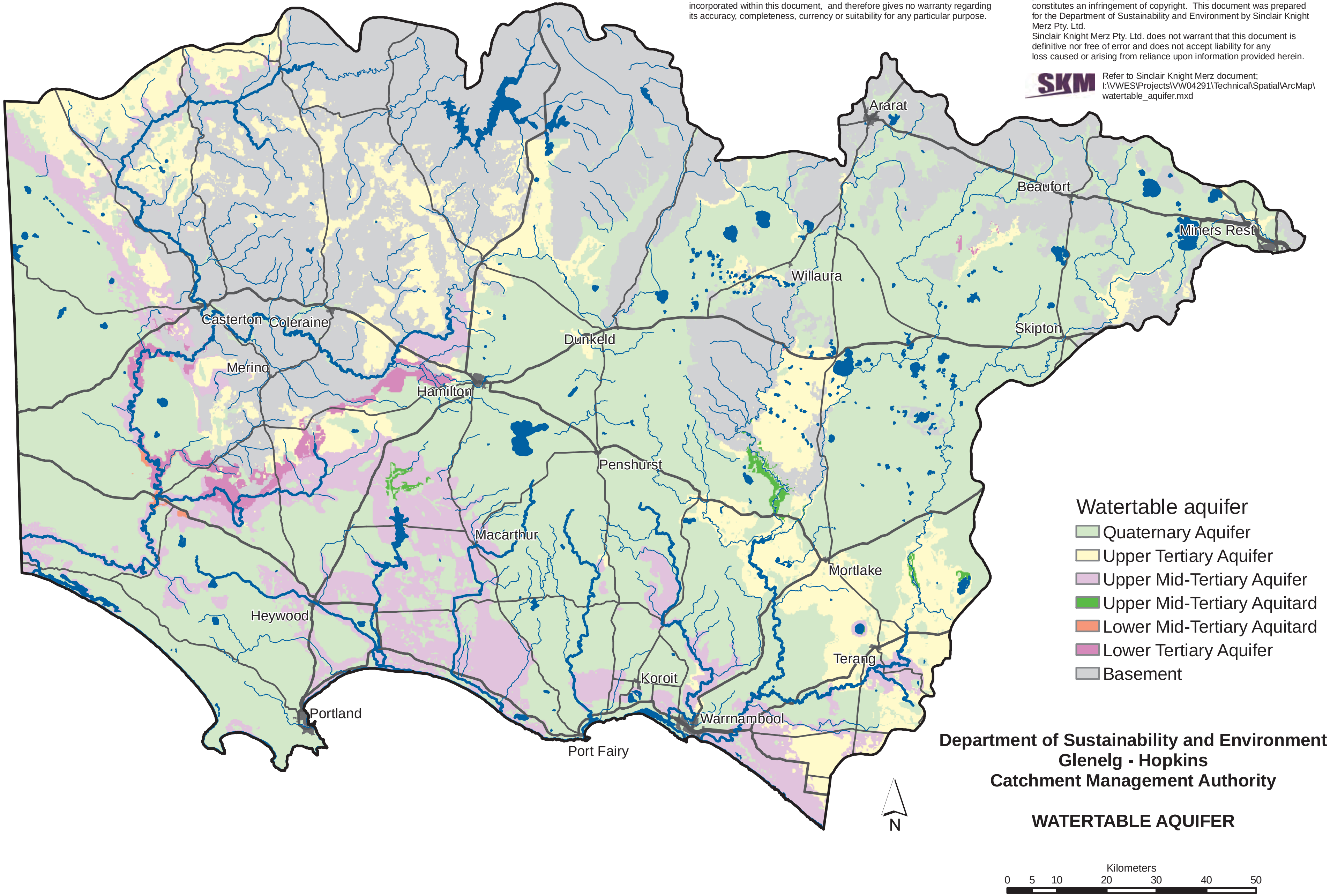

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WATERTABLE AQUIFER

Map 16

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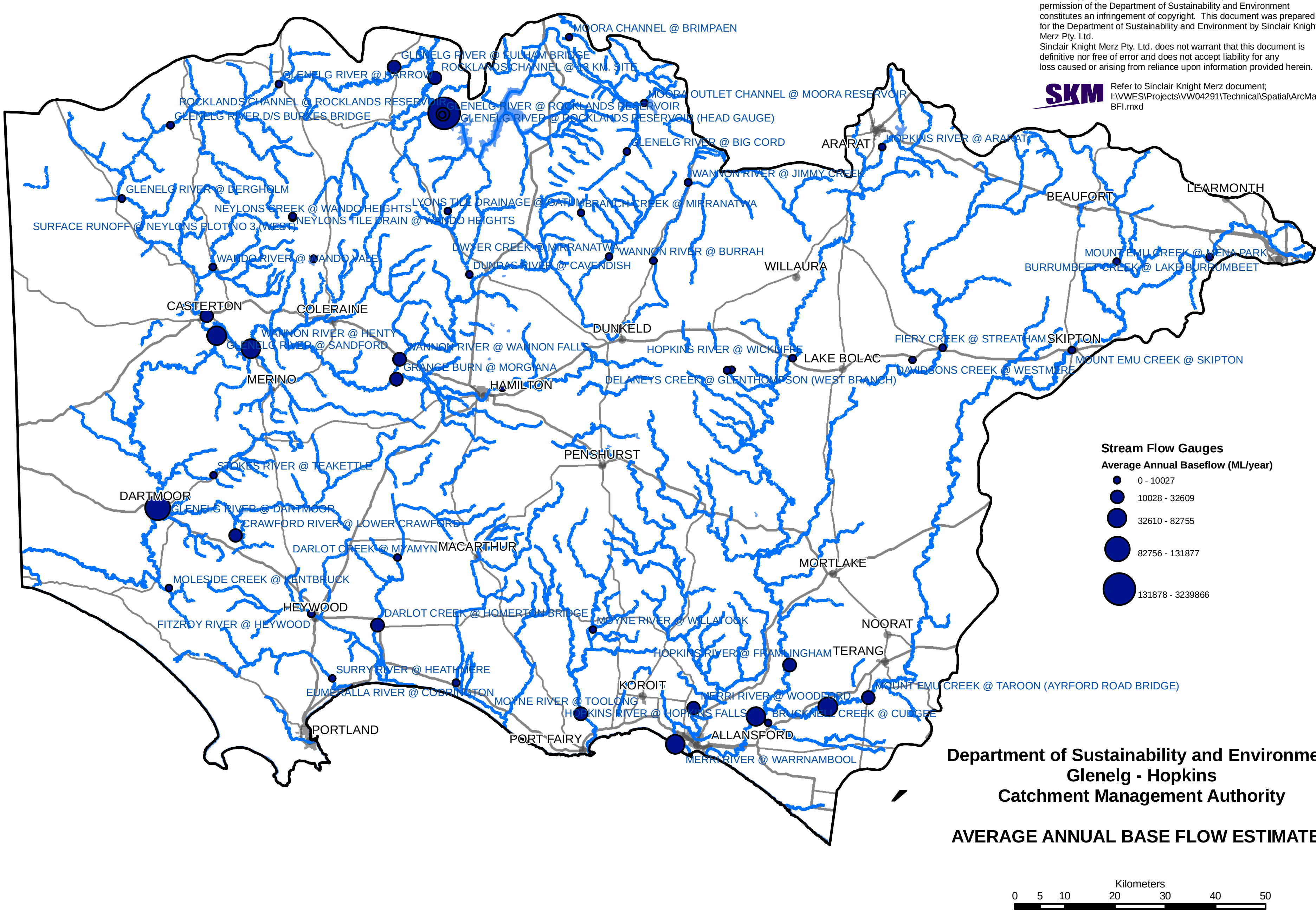

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AVERAGE ANNUAL BASE FLOW ESTIMATES

Map 17

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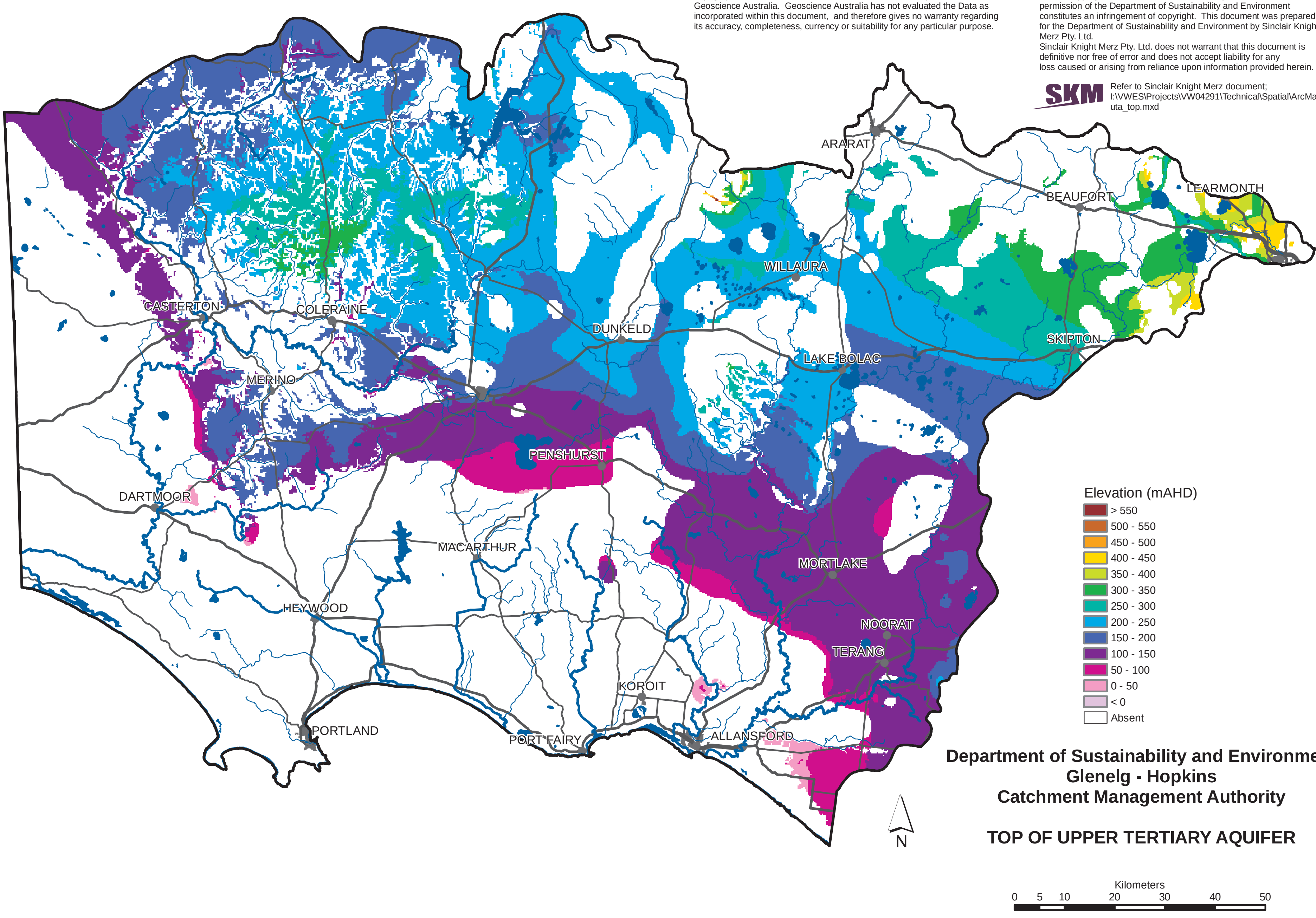

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TOP OF UPPER TERTIARY AQUIFER

Map 18

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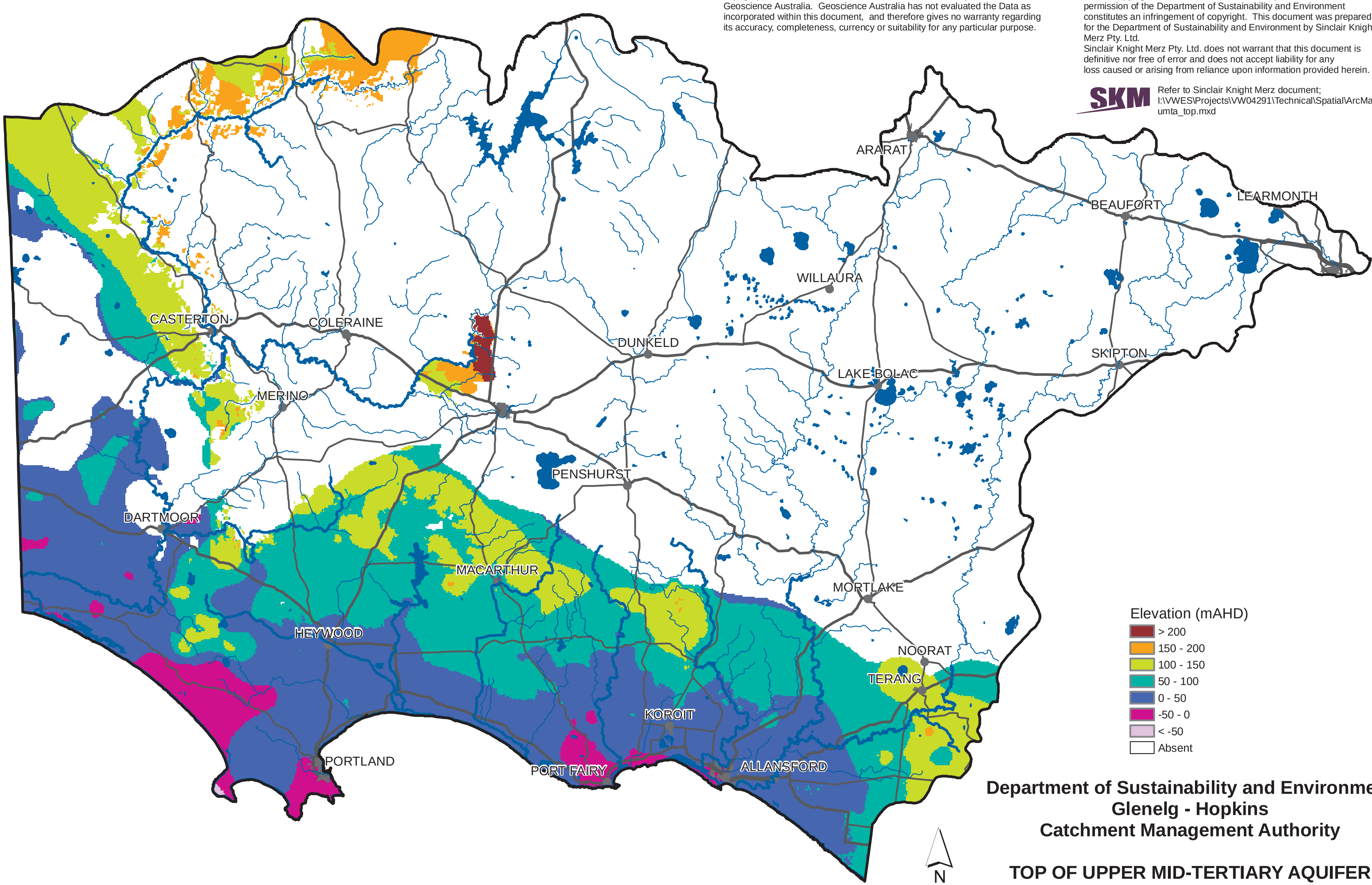

Elevation (mAHD)
- > 200
- 150 - 200
- 100 - 150
- 50 - 100
- 0 - 50
- -50 - 0
- < -50
- Absent

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TOP OF UPPER MID-TERTIARY AQUIFER

Kilometers
0 5 10 20 30 40 50

Map 19

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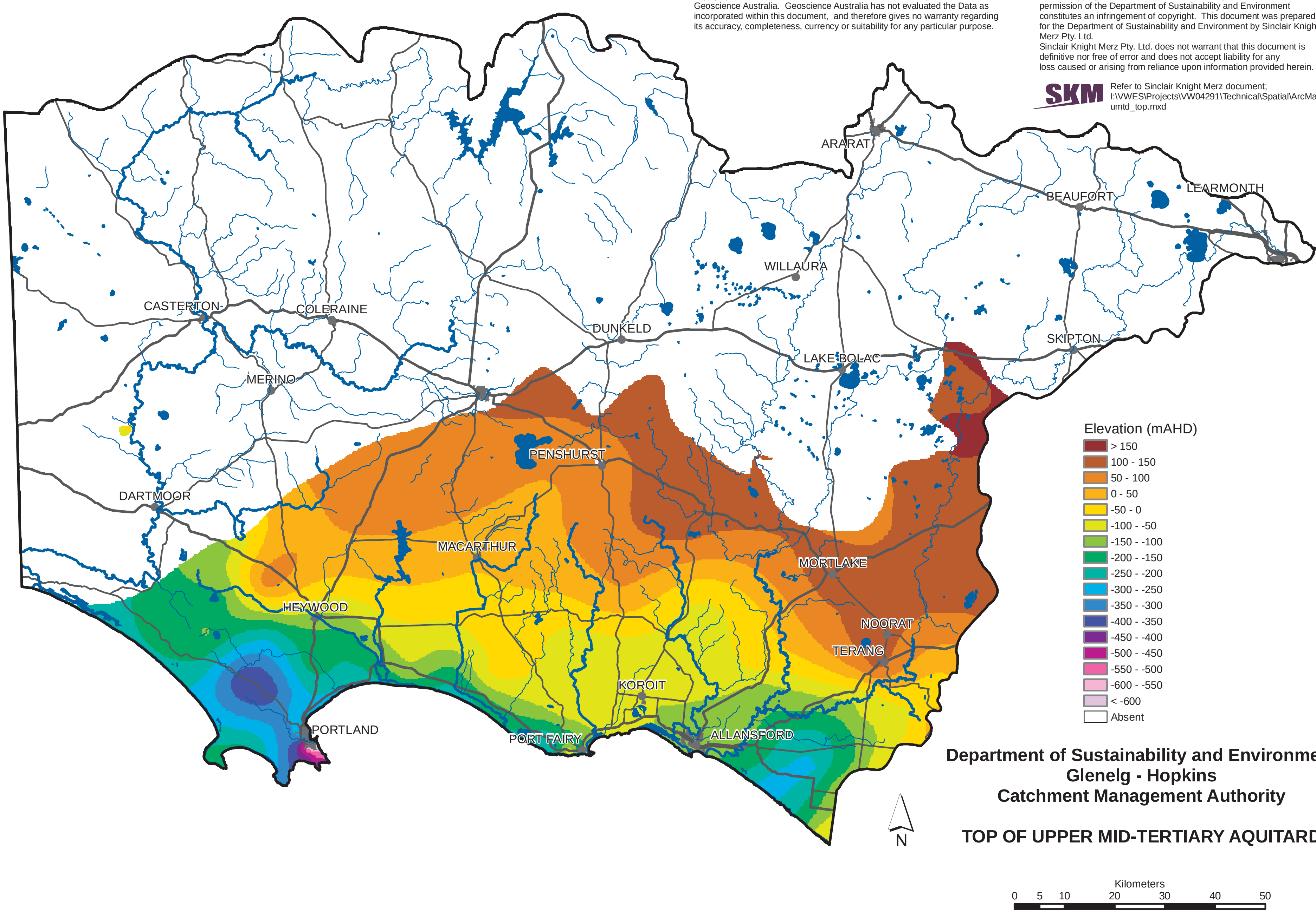

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TOP OF UPPER MID-TERTIARY AQUITARD

Map 20

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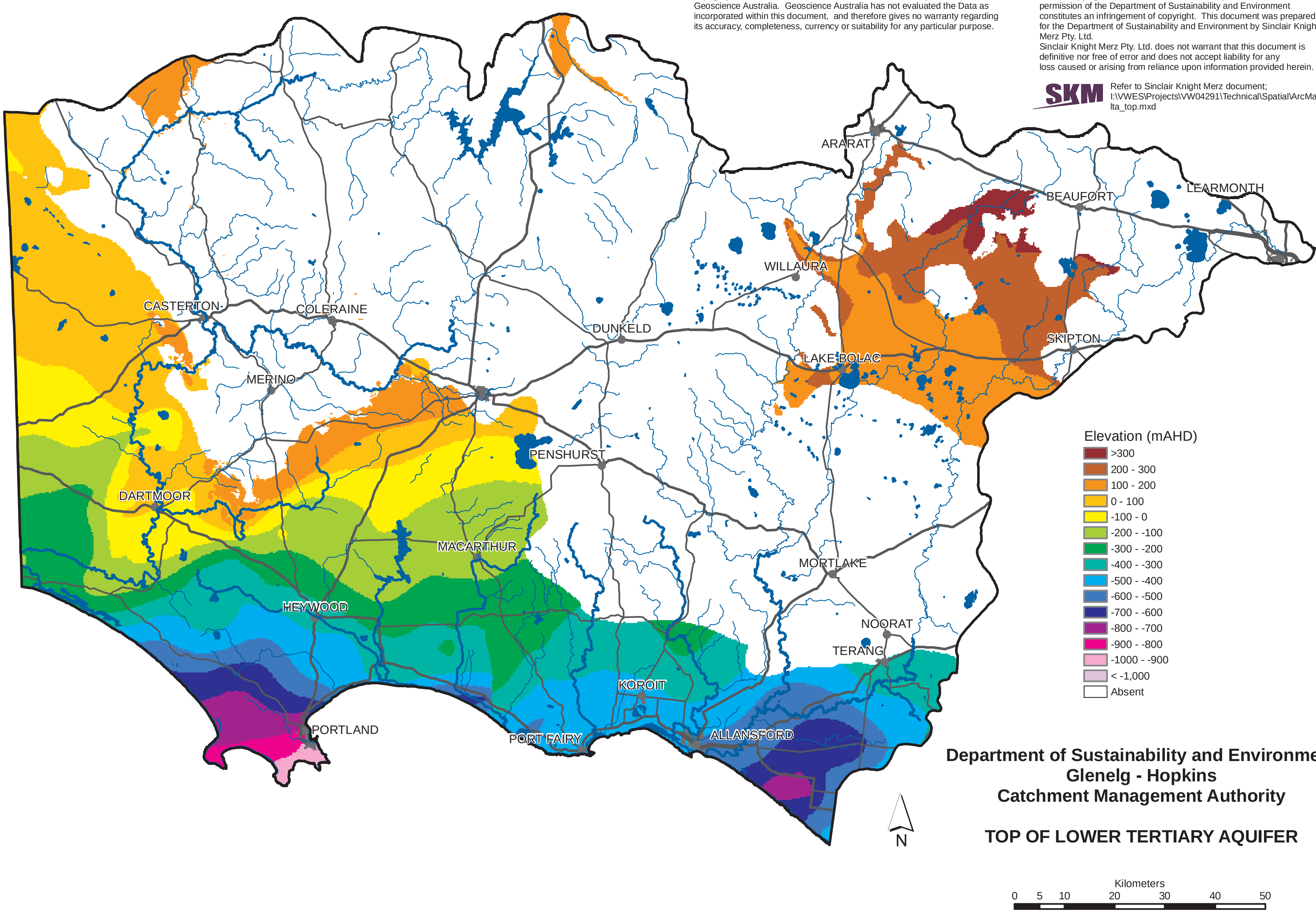

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TOP OF LOWER TERTIARY AQUIFER

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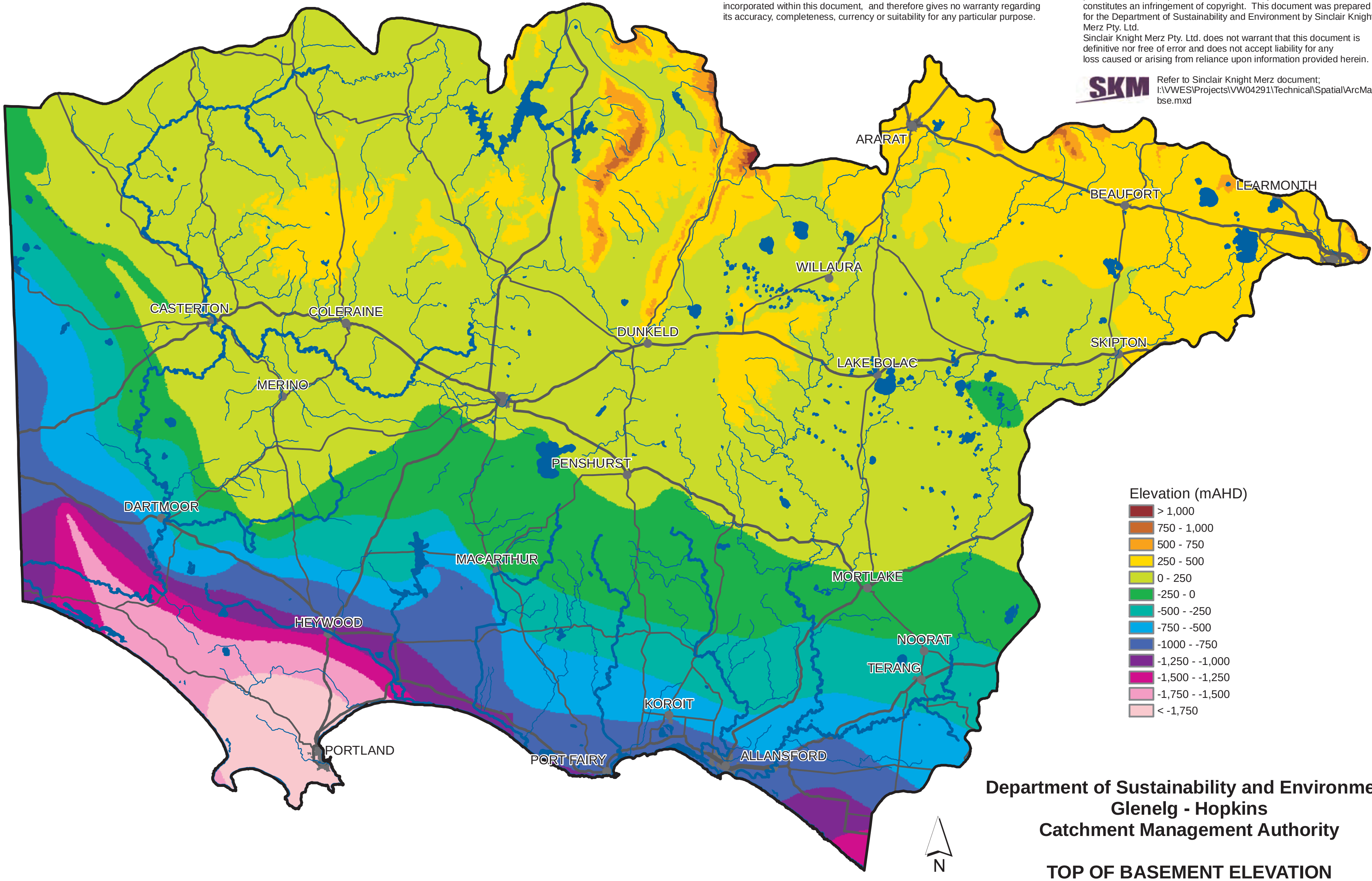

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TOP OF BASEMENT ELEVATION

Kilometers
0 5 10 20 30 40 50

Map 22

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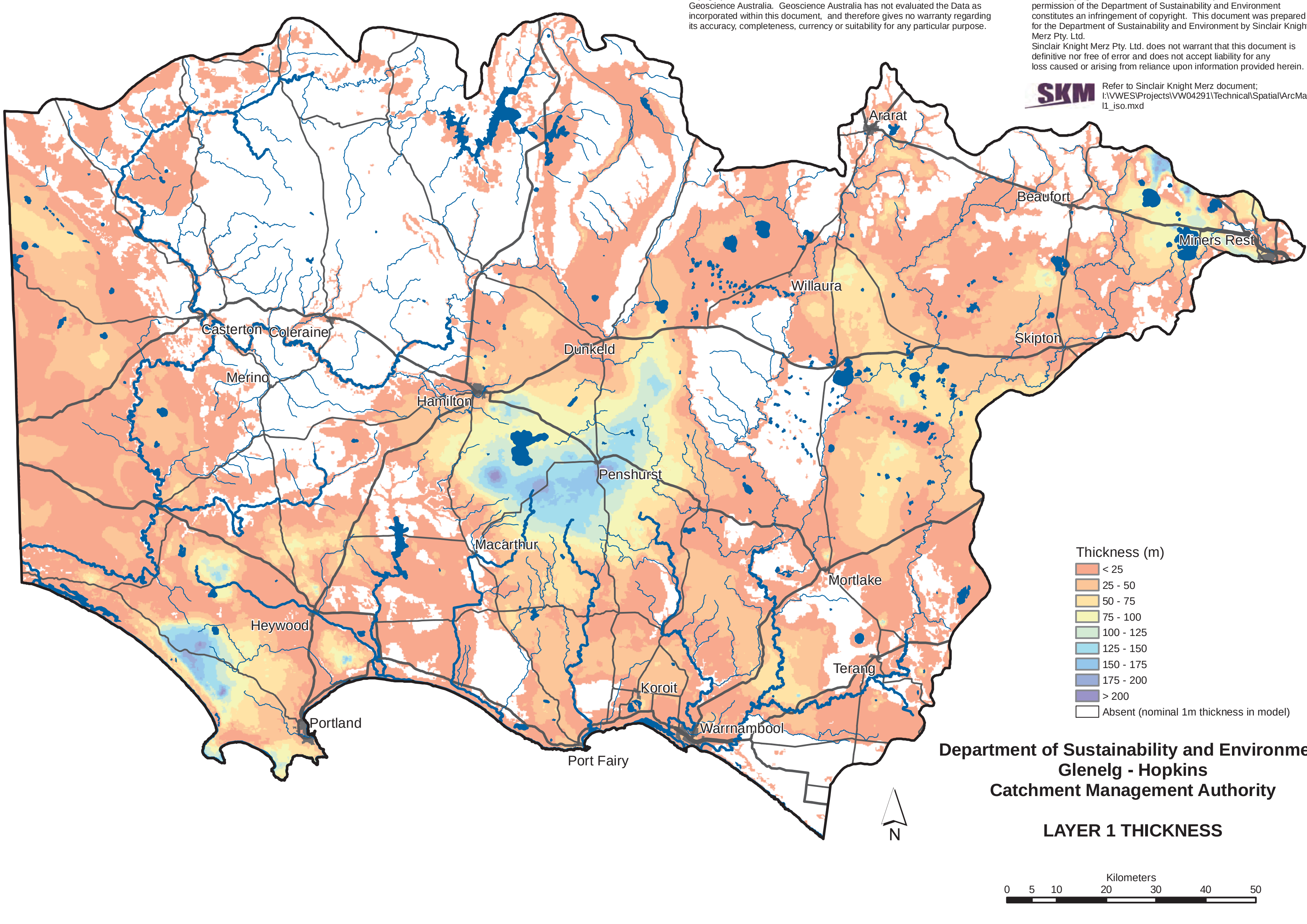

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LAYER 1 THICKNESS

Map 23

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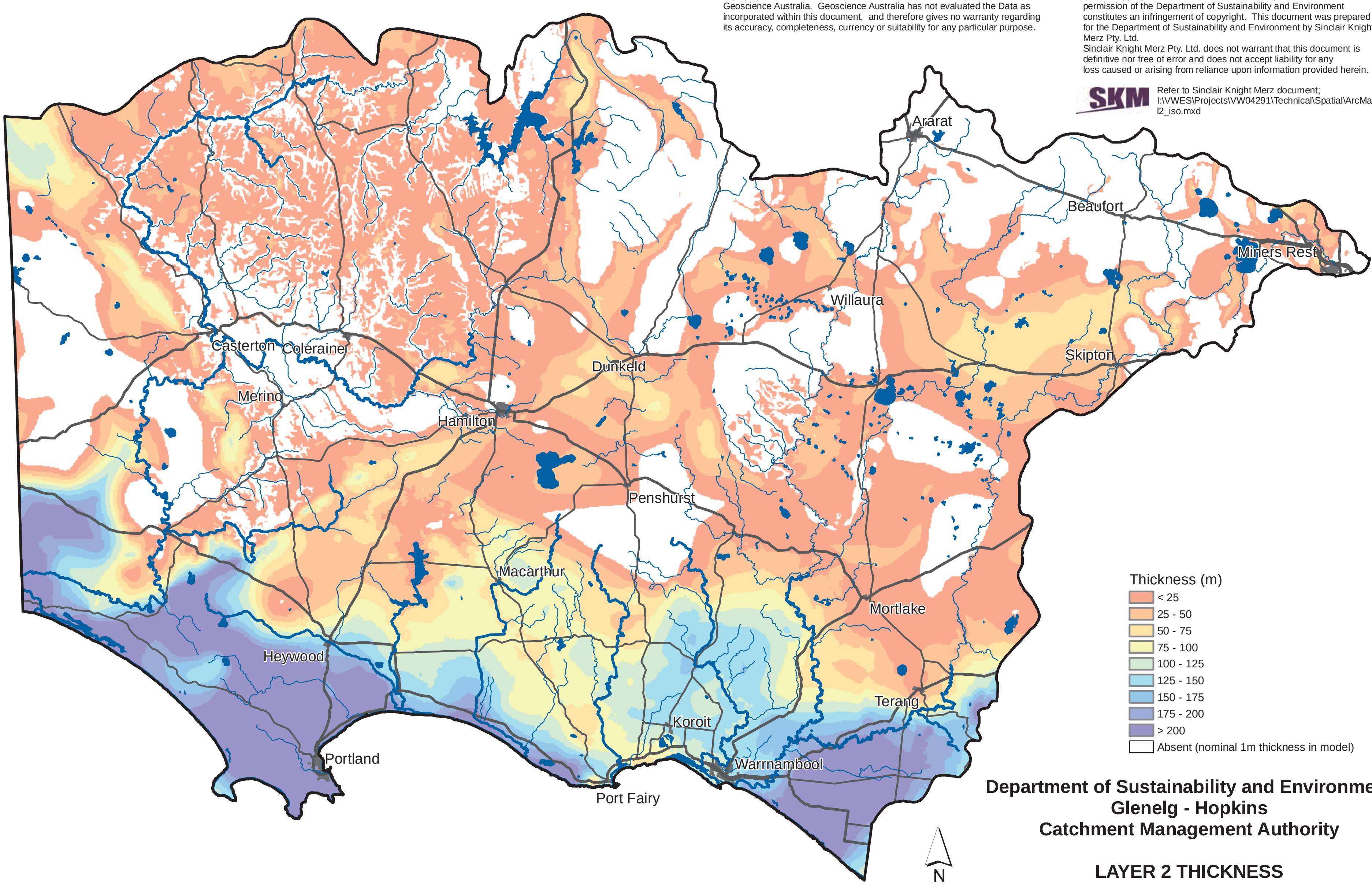

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LAYER 2 THICKNESS

Map 24

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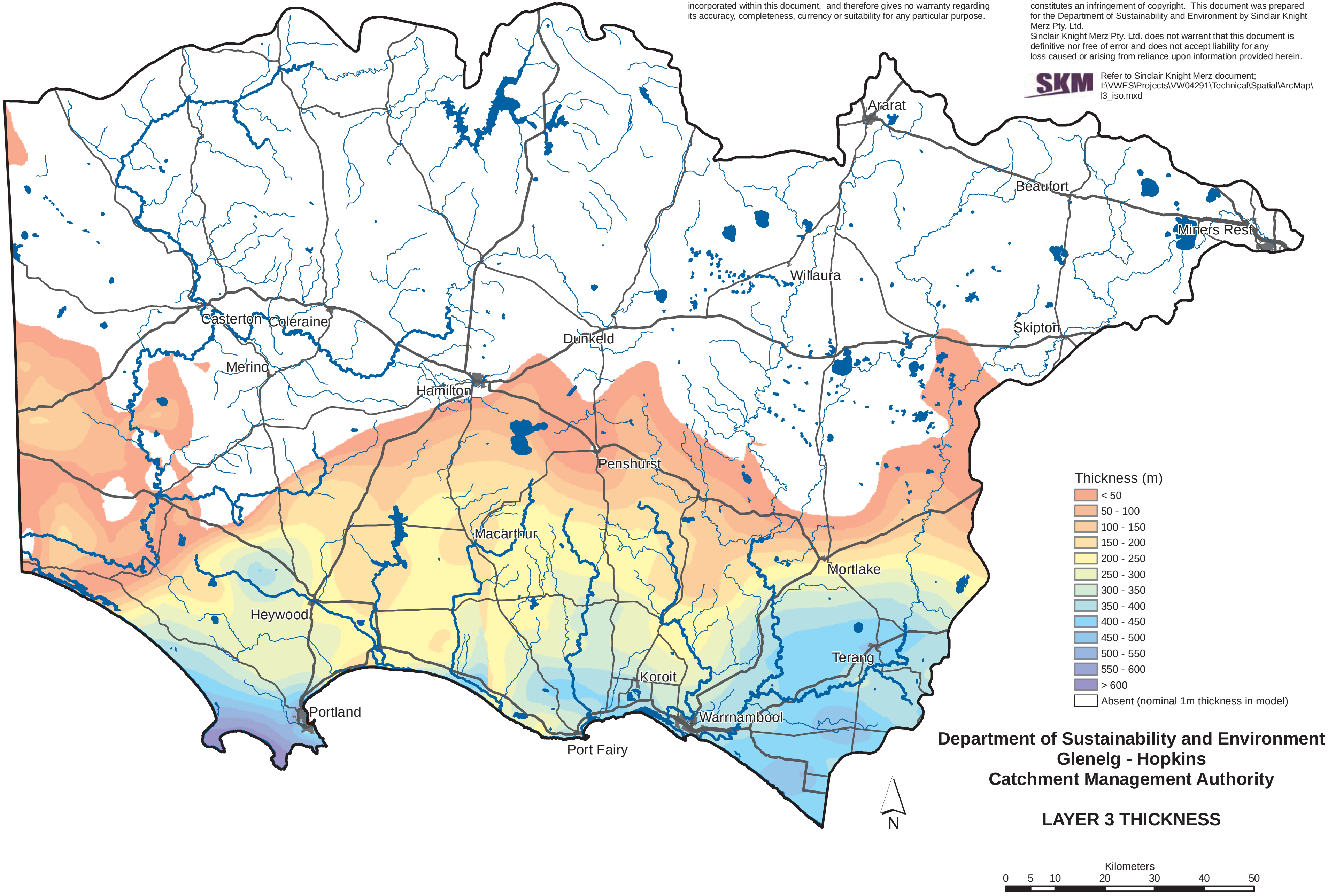

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LAYER 3 THICKNESS

Map 25

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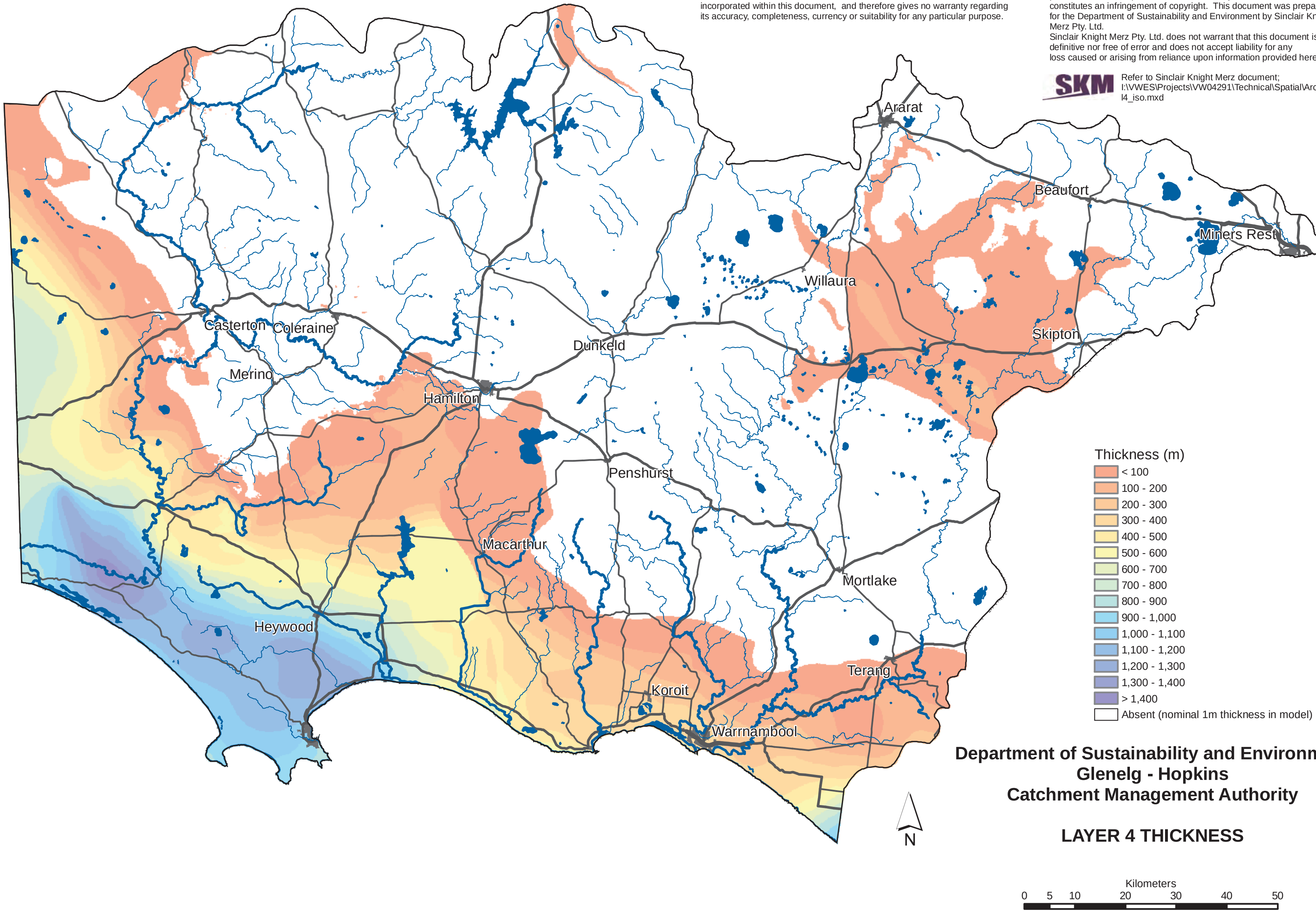

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LAYER 4 THICKNESS

Map 26

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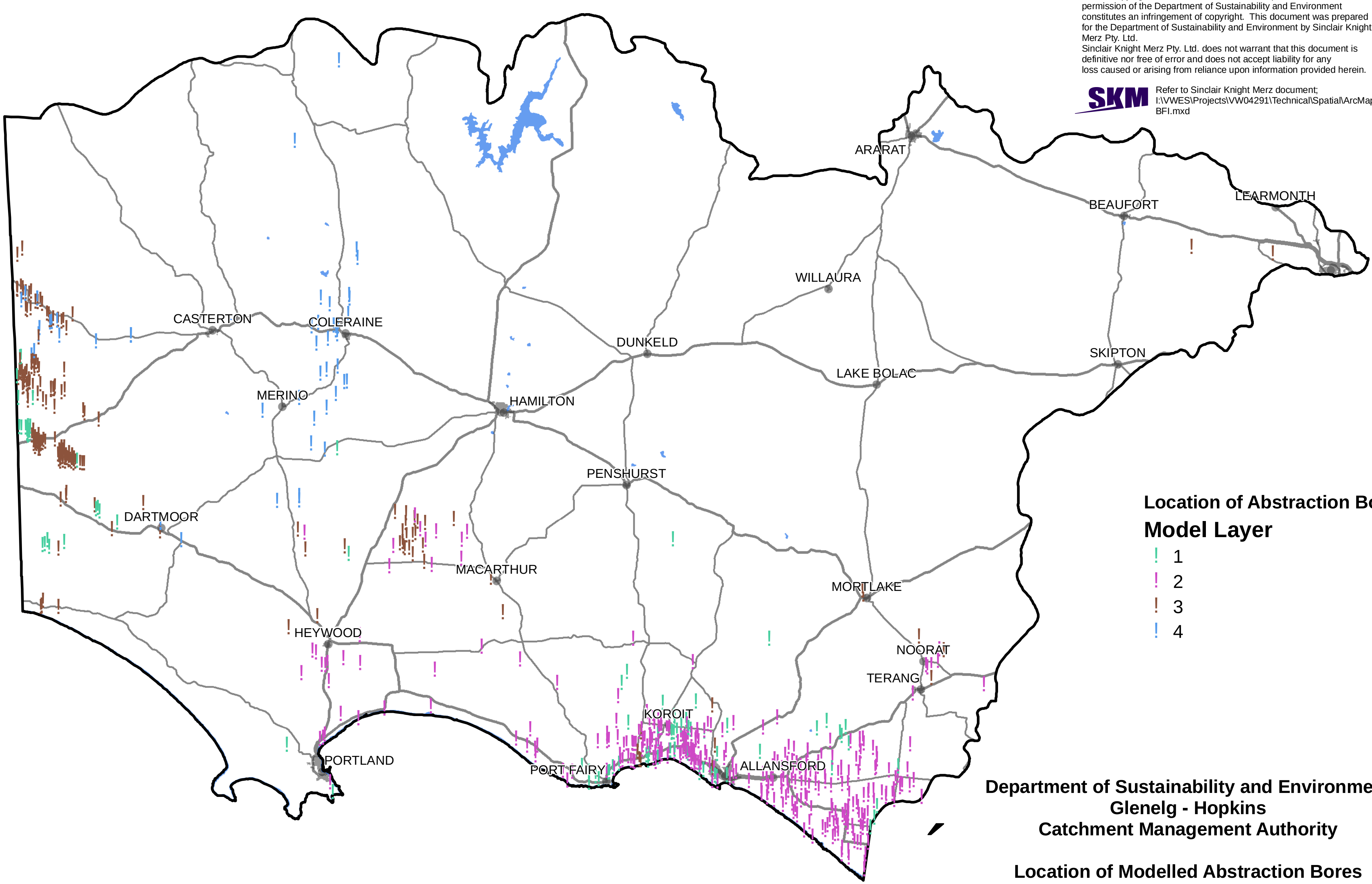

Location of Abstraction Bores

Model Layer

- 1
- 2
- 3
- 4

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Location of Modelled Abstraction Bores

Kilometers
0 5 10 20 30 40 50

Map 27

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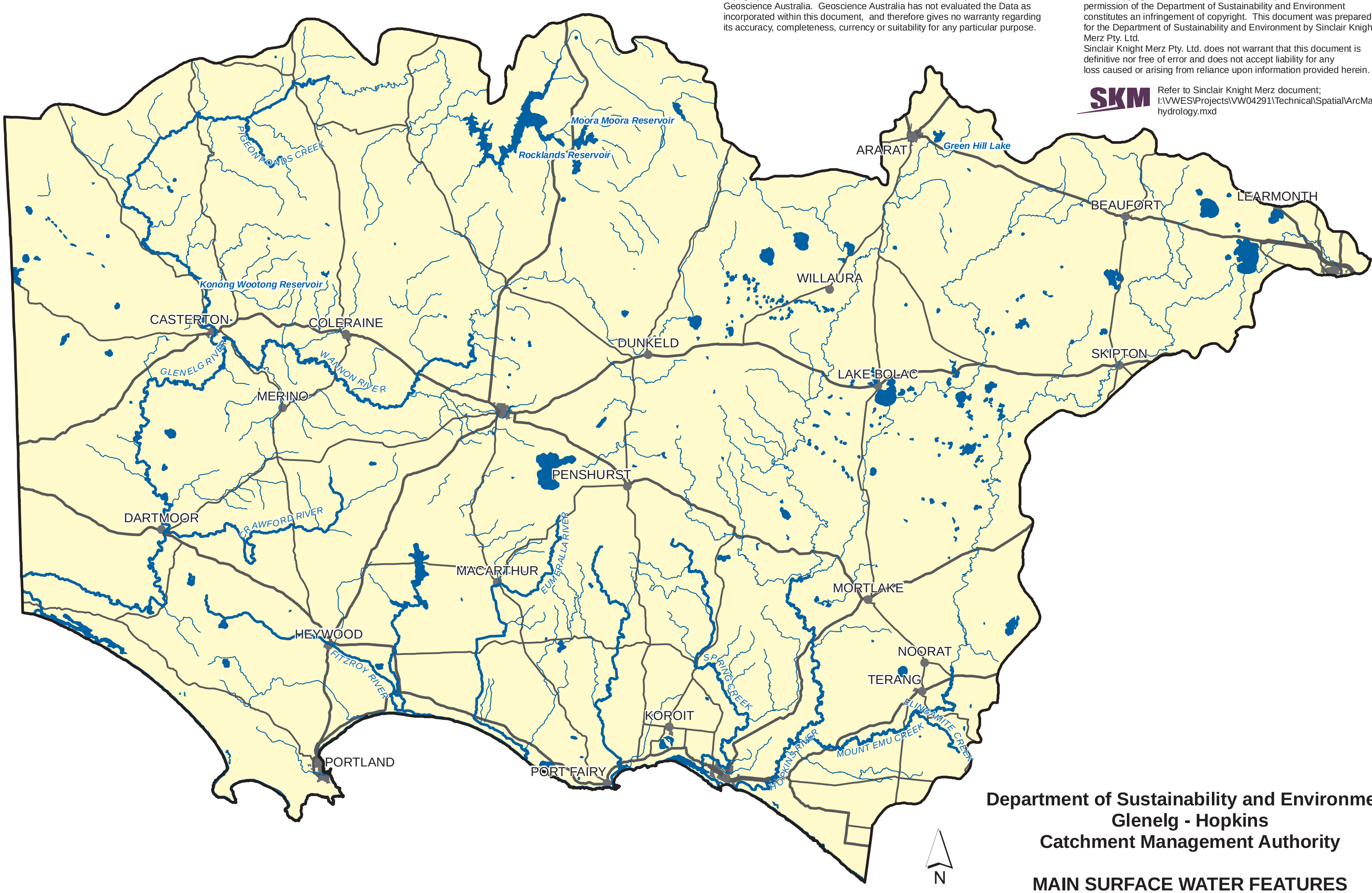

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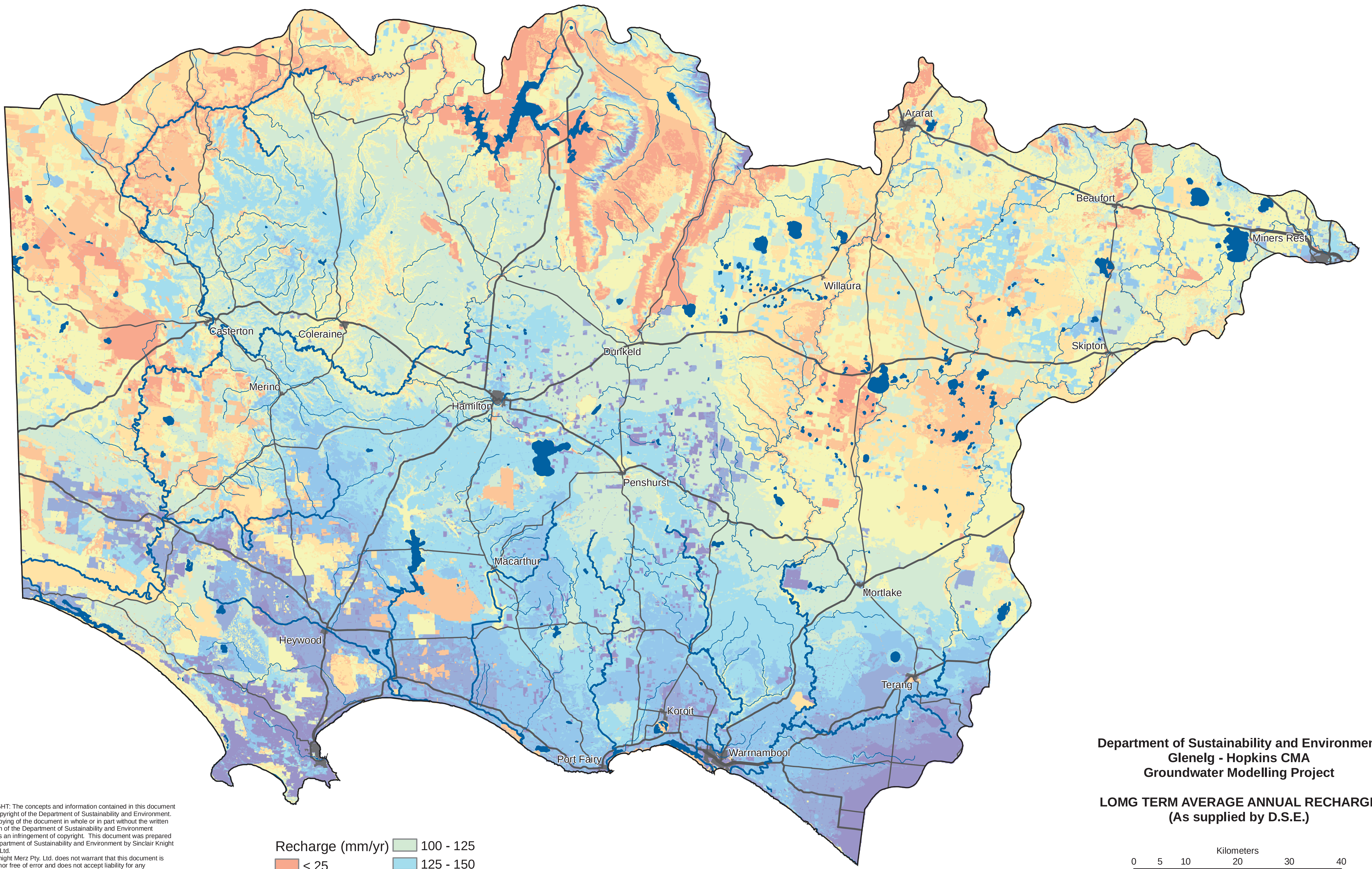
MAIN SURFACE WATER FEATURES

Map 28



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LOMG TERM AVERAGE ANNUAL RECHARGE
(As supplied by D.S.E.)

Kilometers
0 5 10 20 30 40

Recharge (mm/yr)

- < 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 125
- 125 - 150
- 150 - 175
- 175 - 200
- > 200

Recharge data supplied by Department of Sustainability and Environment (DSE).

Refer toSinclair Knight Merz document
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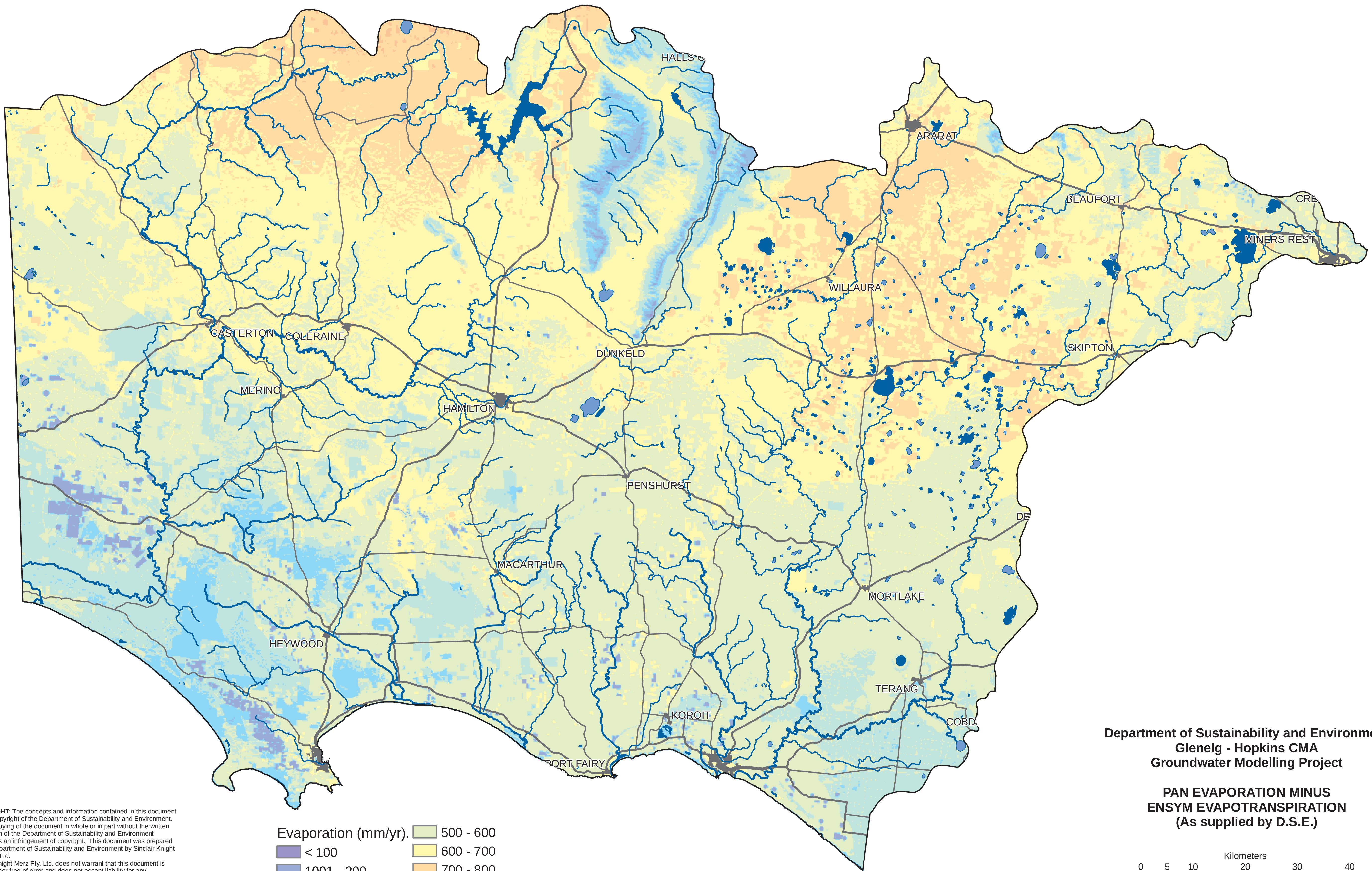
Recharge.mxd



Evaporation (mm/yr).

- < 100
- 1001 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- > 900

Evaporation data supplied Department of Sustainability and Environment (DSE).

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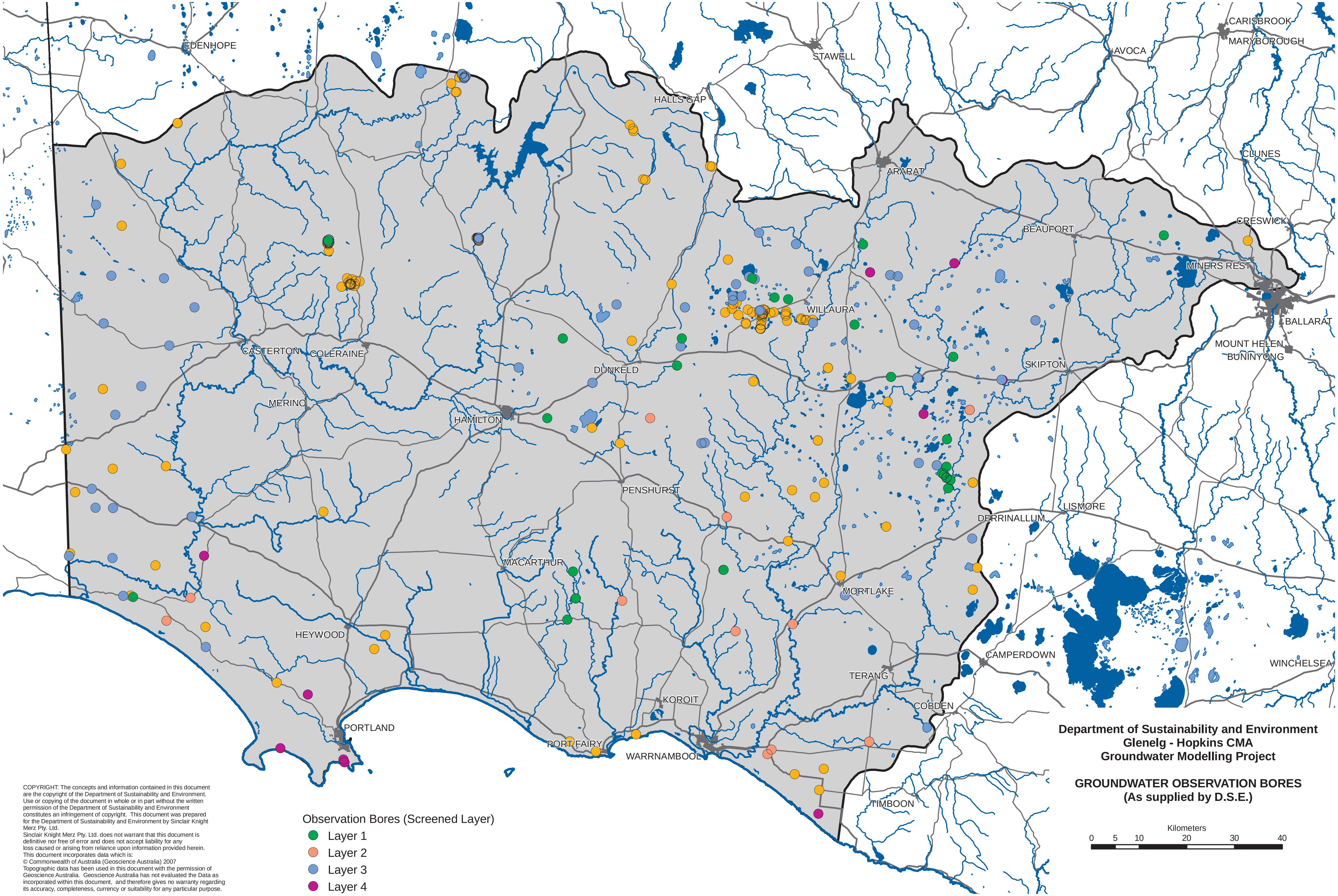
PAN EVAPORATION MINUS
ENSYM EVAPOTRANSPIRATION
(As supplied by D.S.E.)

Kilometers
0 5 10 20 30 40

Refer toSinclair Knight Merz document I:\VWES\Projects\VW04291\Technical\Spatial\ArcMap Evap.mxd

Map 30



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Groundwater Modelling Project

GROUNDWATER OBSERVATION BORES
(As supplied by D.S.E.)

Observation Bores (Screened Layer)
- Layer 1
- Layer 2
- Layer 3
- Layer 4
- Layer 5

Bore data supplied Department of Sustainability and Environment (DSE).

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\Observation_bores.mxd

Map 31

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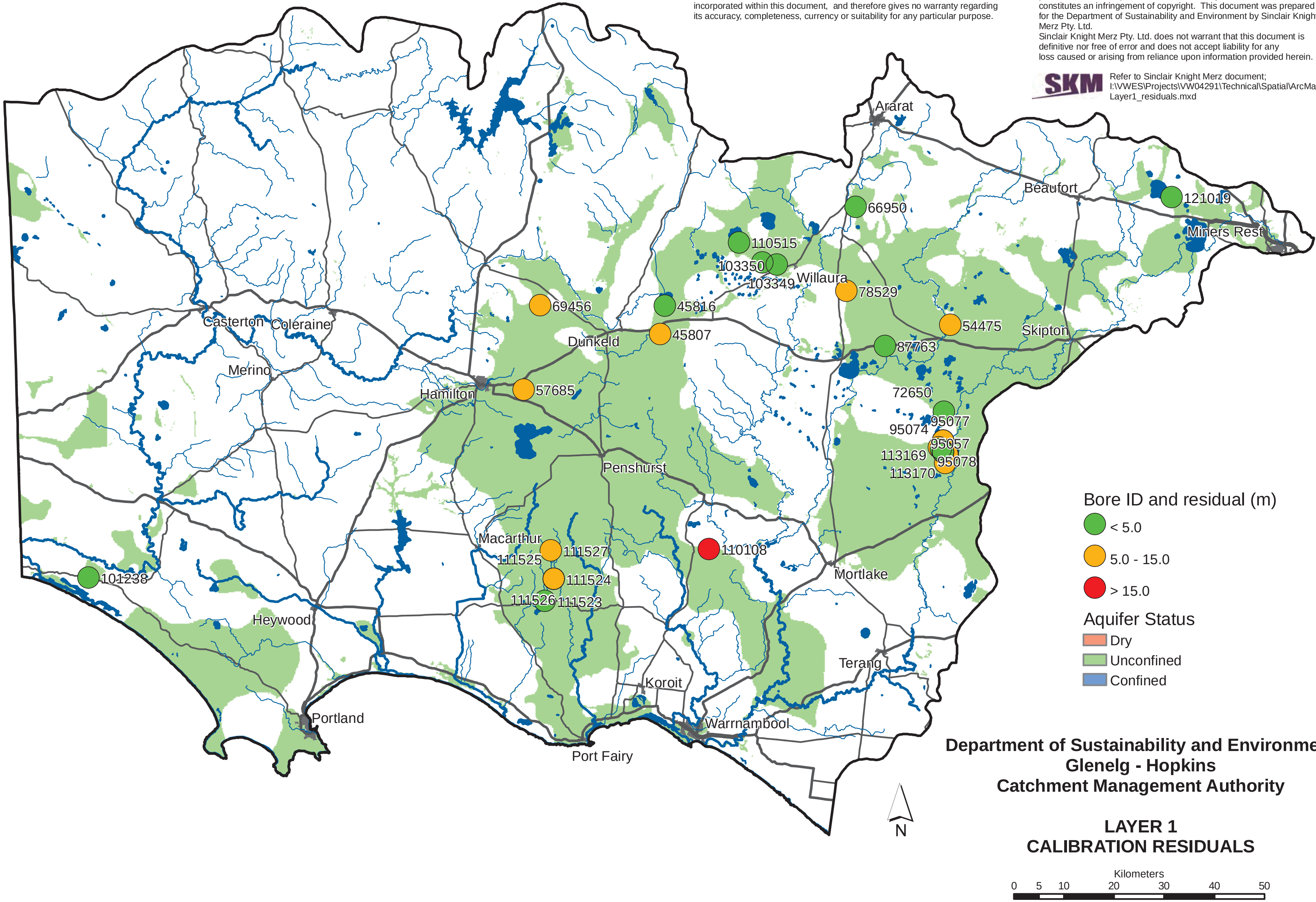
Refer to Sinclair Knight Merz document;
I:\VWES\Projects\VW04291\Technical\Spatial\ArcMap\Layer1_residuals.mxd



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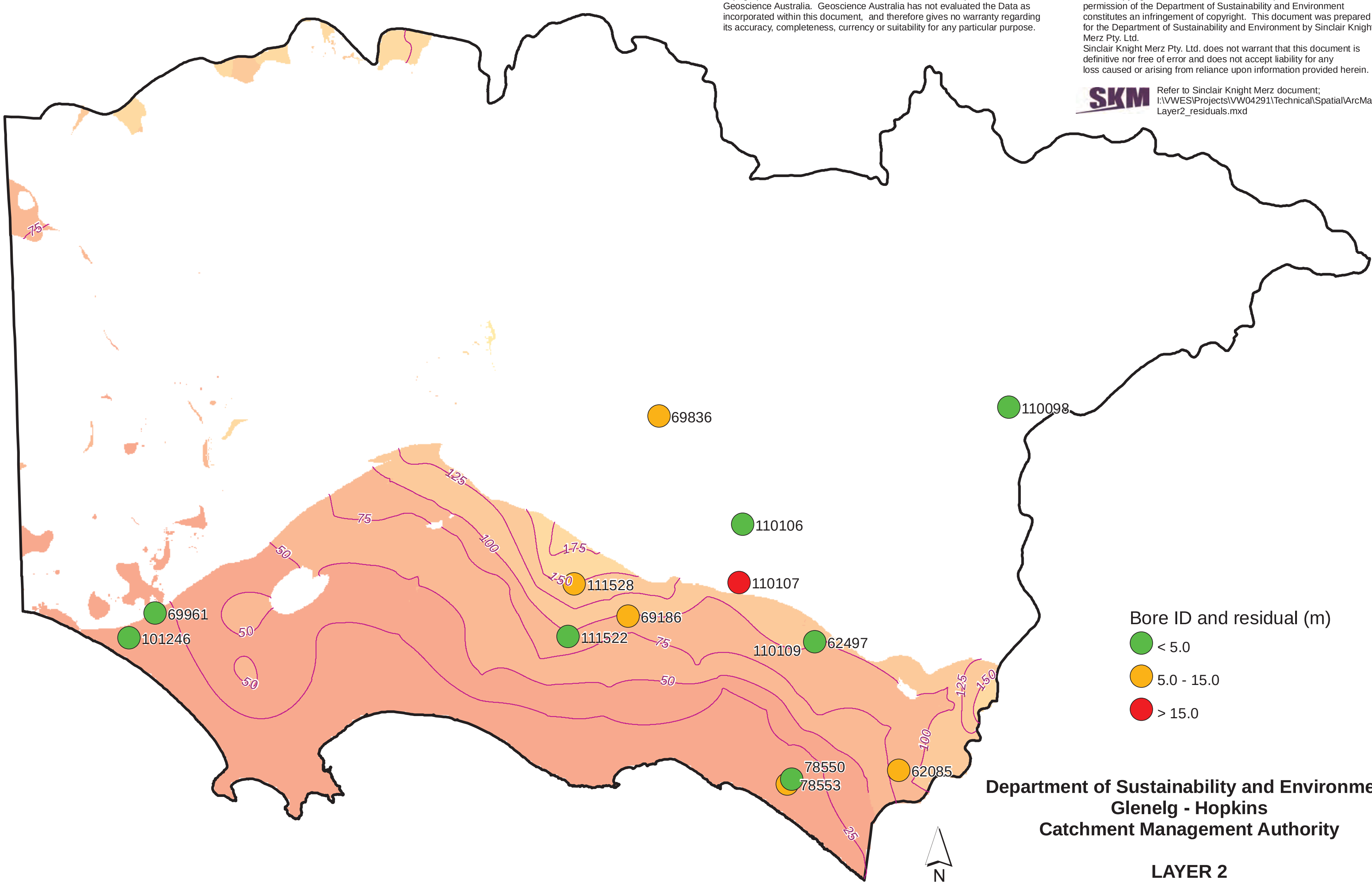
Catchment Management Authority

LAYER 1
CALIBRATION RESIDUALS

Map 32

Refer to Sinclair Knight Merz document;
I:\VWES\Projects\VW04291\Technical\Spatial\ArcMap\Layer2_residuals.mxd



Bore ID and residual (m)
- < 5.0
- 5.0 - 15.0
- > 15.0

N

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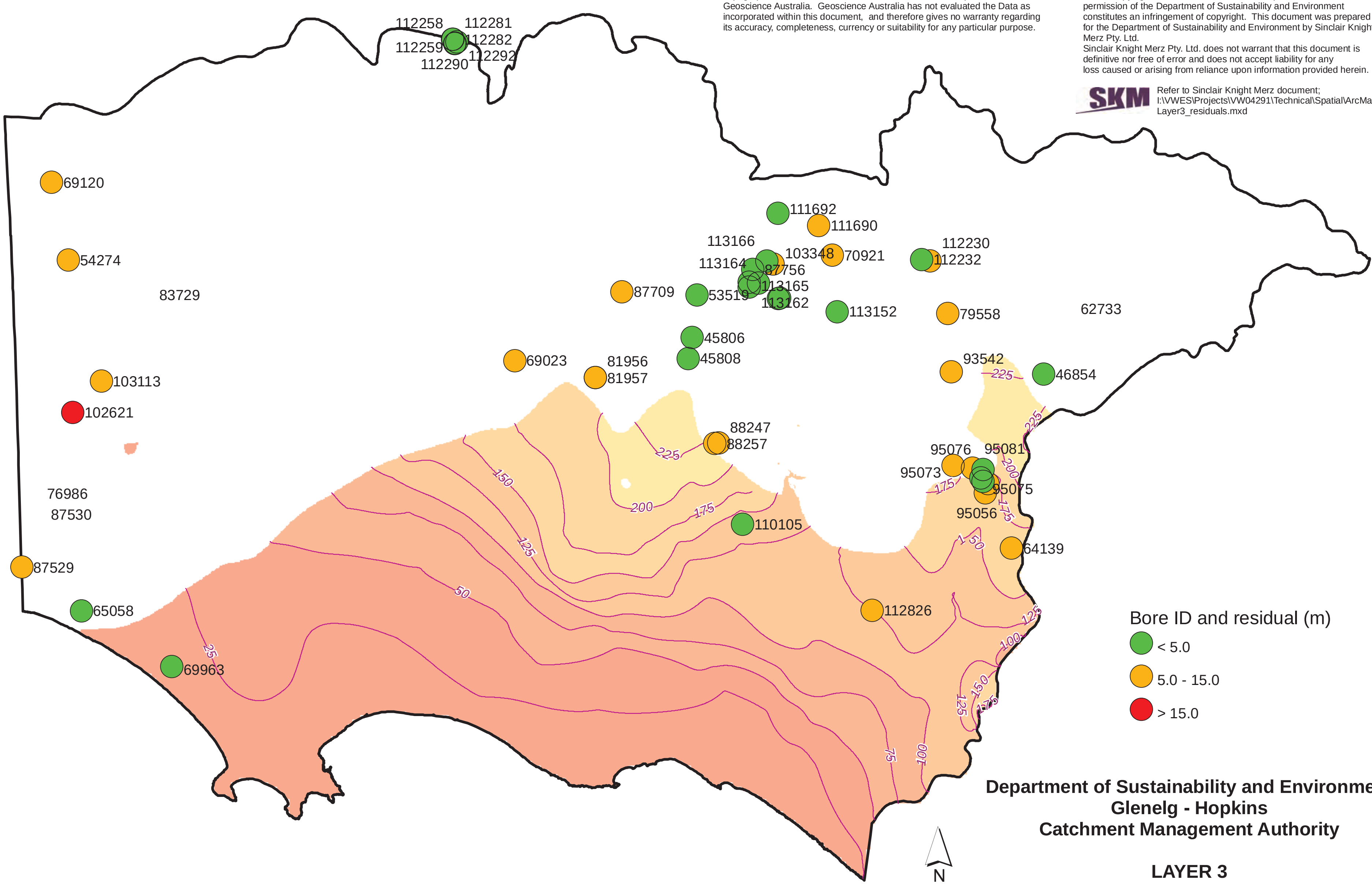
Catchment Management Authority

LAYER 2
CALIBRATION RESIDUALS

Kilometers
0 5 10 20 30 40 50

Map 33

Refer to Sinclair Knight Merz document;
I:\VWES\Projects\VW04291\Technical\Spatial\ArcMap\Layer3_residuals.mxd



Bore ID and residual (m)

- < 5.0
- 5.0 - 15.0
- > 15.0

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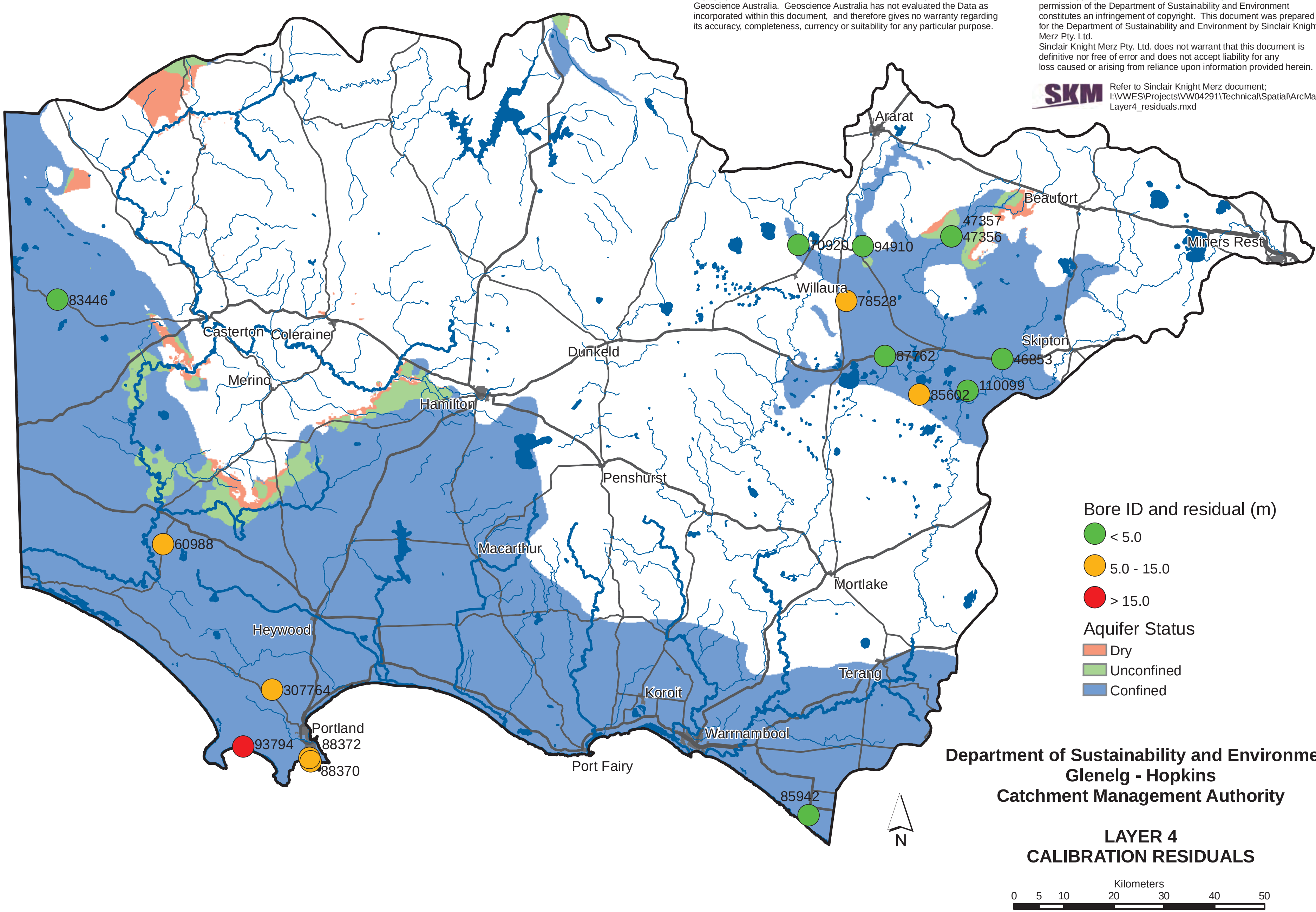
Glenelg - Hopkins
Catchment Management Authority

LAYER 3
CALIBRATION RESIDUALS

Kilometers
0 5 10 20 30 40 50

Map 34

Refer to Sinclair Knight Merz document;
I:\VWES\Projects\VW04291\Technical\Spatial\ArcMap\Layer4_residuals.mxd



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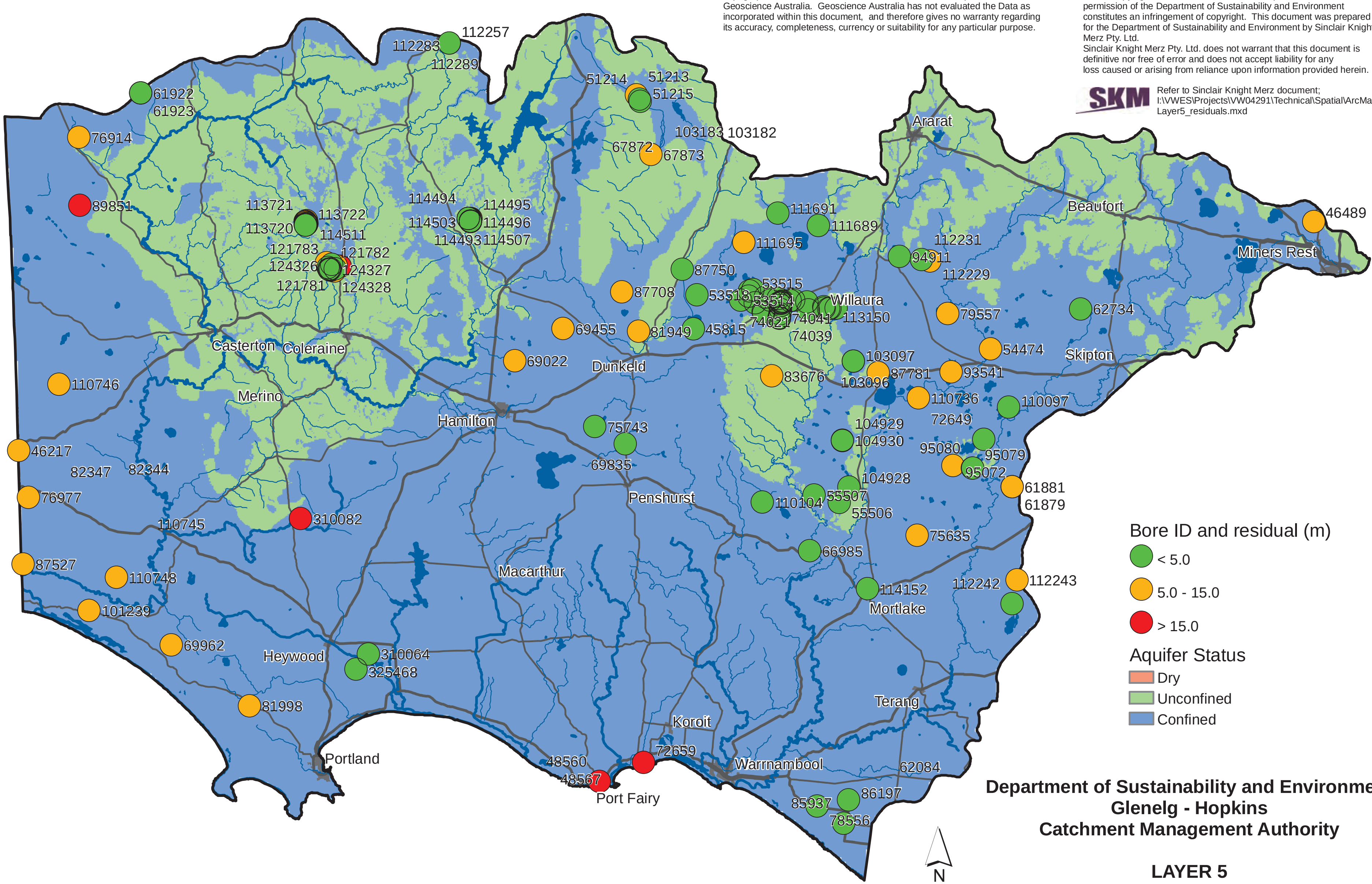
LAYER 4
CALIBRATION RESIDUALS

Map 35

Refer to Sinclair Knight Merz document;
I:\VWES\Projects\VW04291\Technical\Spatial\ArcMap\Layer5_residuals.mxd



Bore ID and residual (m)

- < 5.0
- 5.0 - 15.0
- > 15.0

Aquifer Status

- Dry
- Unconfined
- Confined

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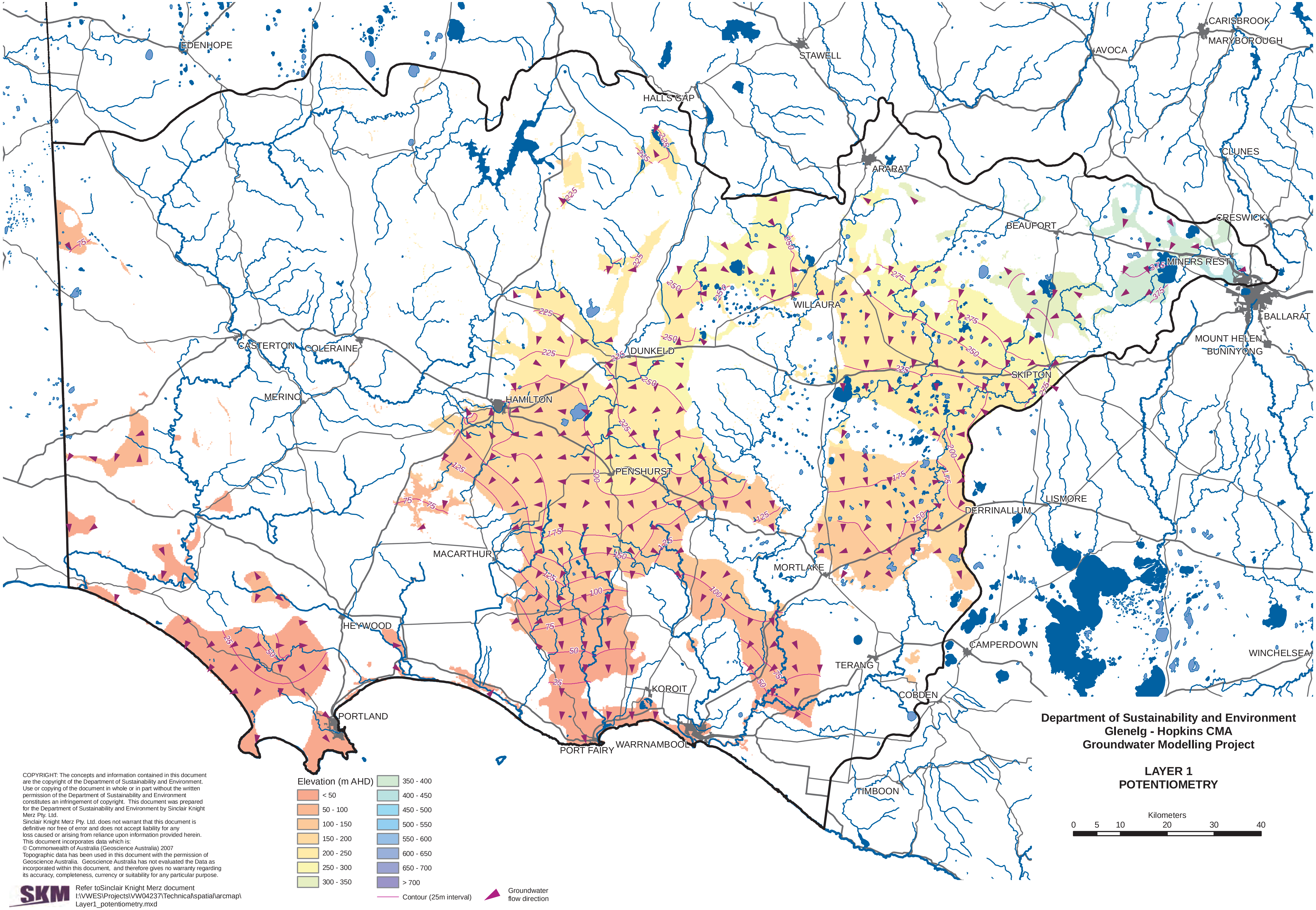
LAYER 5
CALIBRATION RESIDUALS

Kilometers
0 5 10 20 30 40 50

Map 36



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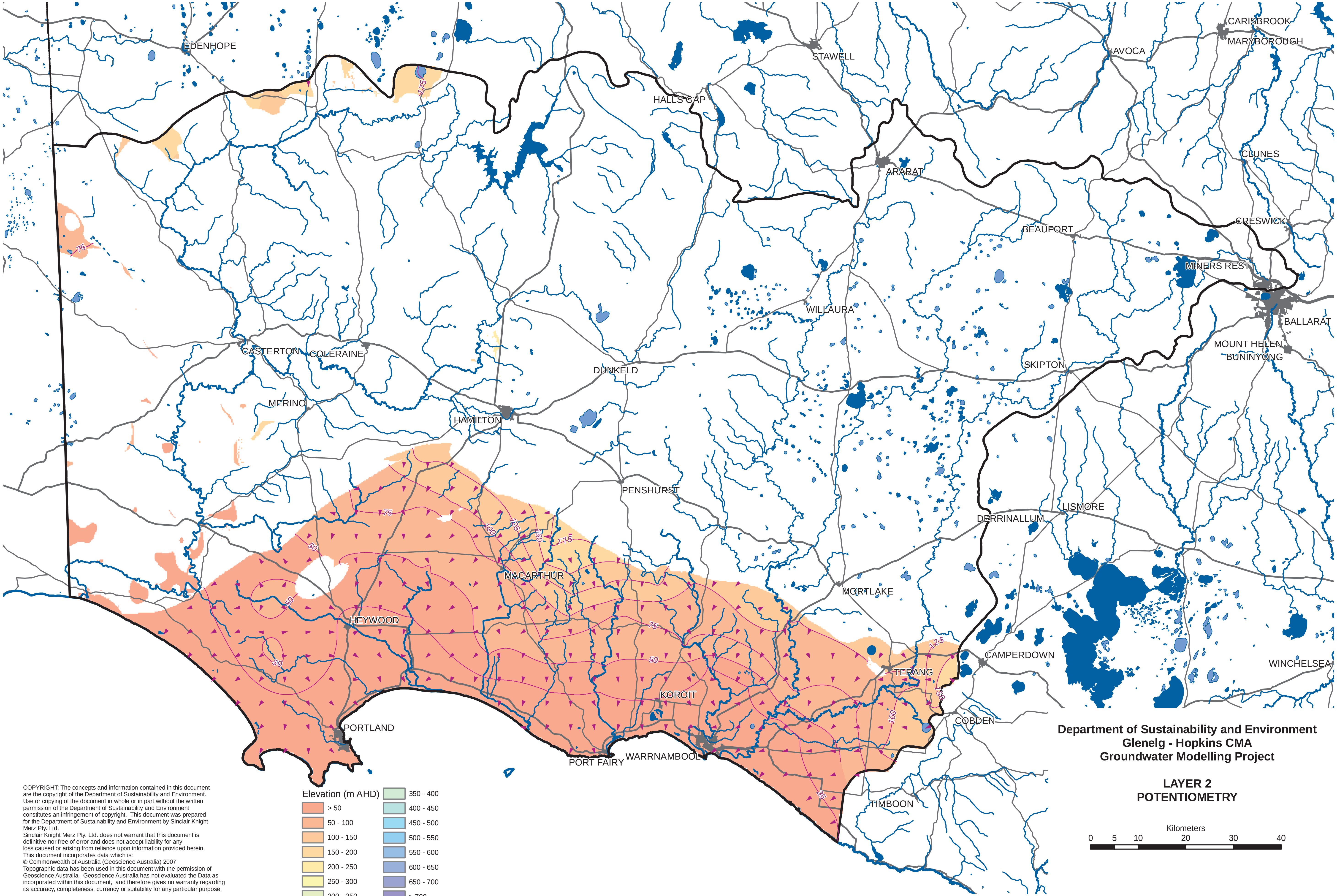
LAYER 1
POTENTIOMETRY

Refer toSinclair Knight Merz document I:\VWES\Projects\VW04237\Technical\spatial\arcmap\Layer1_potentiometry.mxd

Map 37



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LAYER 2
POTENTIOMETRY

Elevation (m AHD)

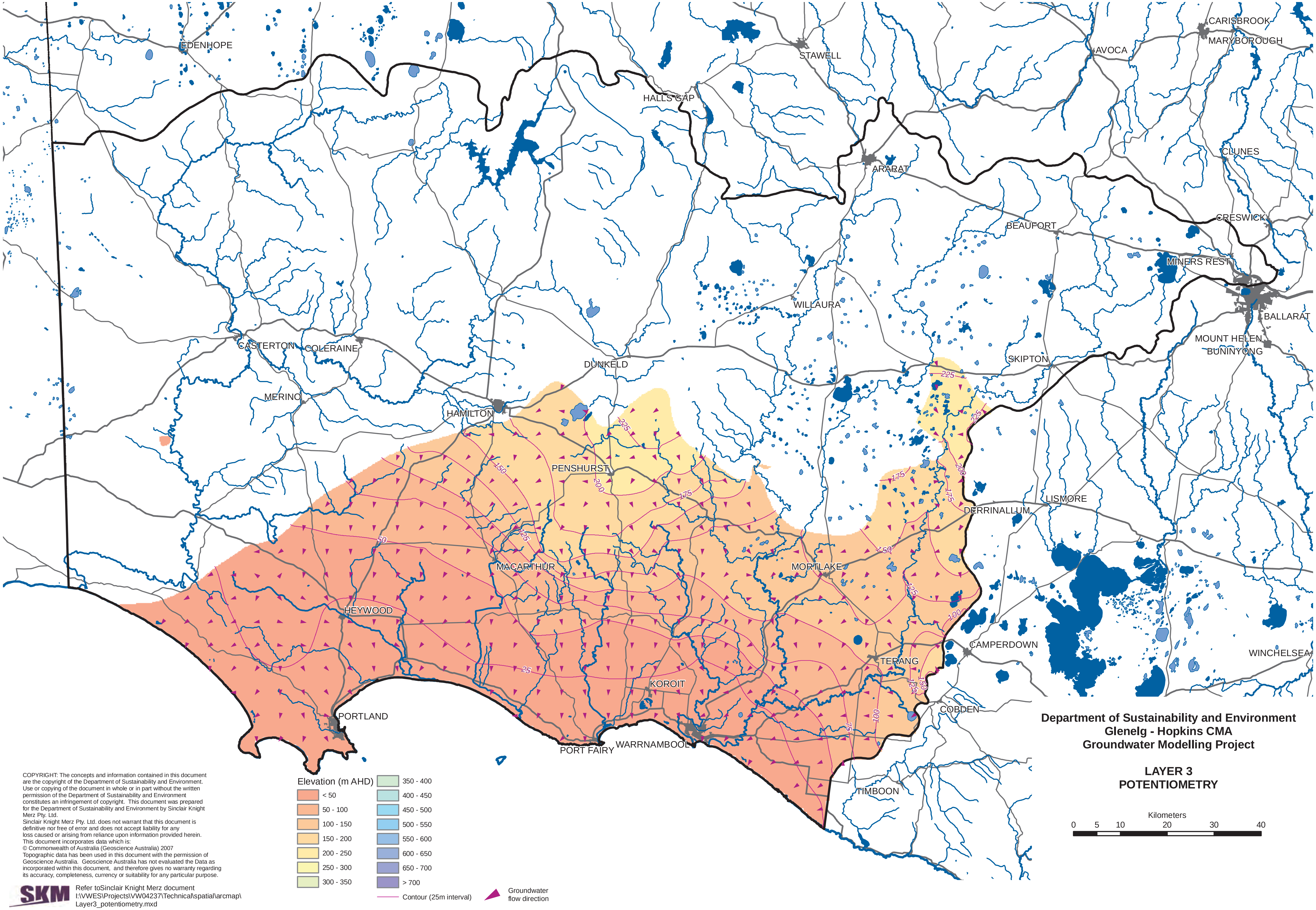
> 50	350 - 400
50 - 100	400 - 450
100 - 150	450 - 500
150 - 200	500 - 550
200 - 250	550 - 600
250 - 300	600 - 650
300 - 350	650 - 700
	> 700

Contour (25m interval)

Groundwater flow direction

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\
Layer2_potentiometry.mxd

Map 38



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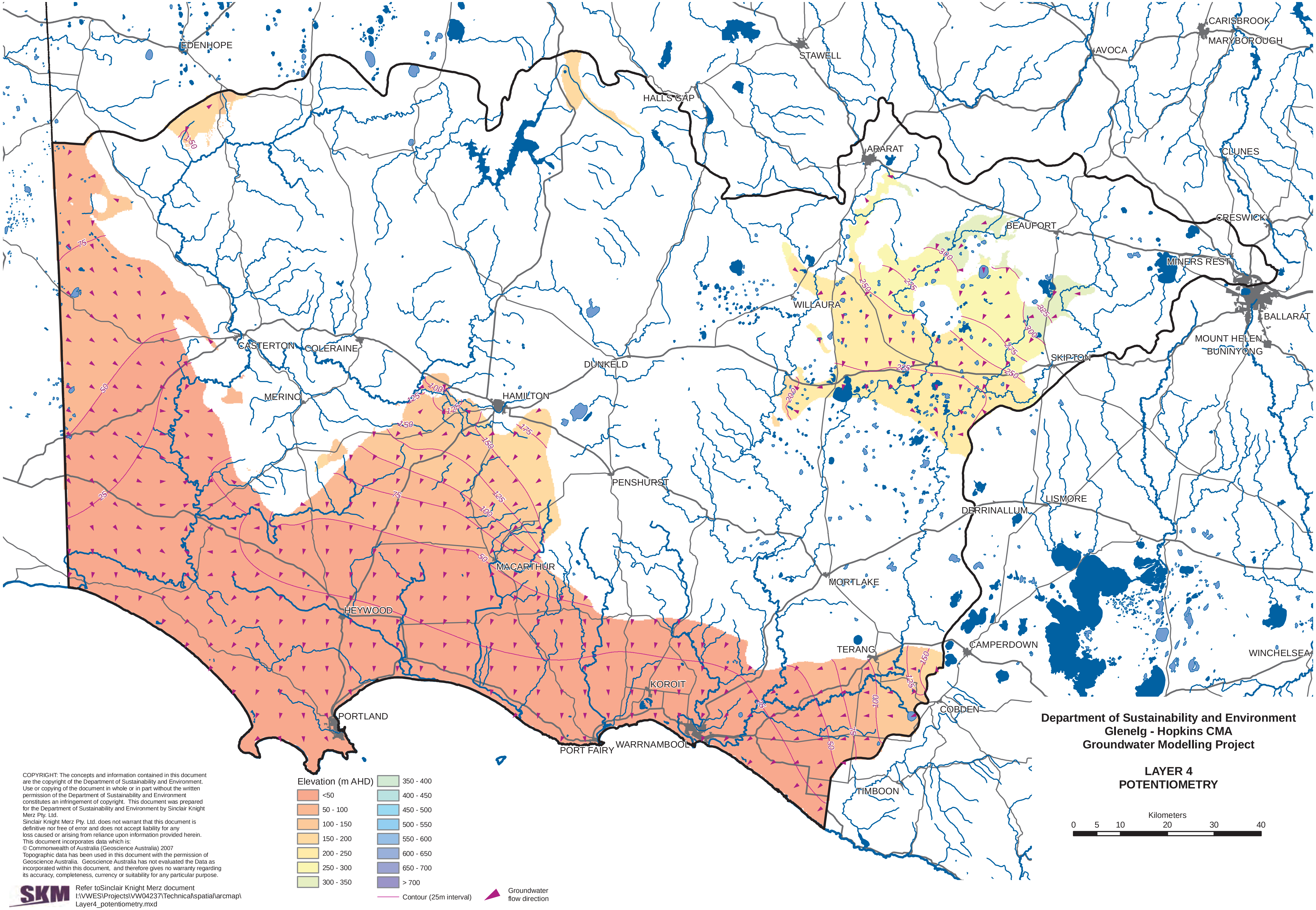
LAYER 3
POTENTIOMETRY

Refer toSinclair Knight Merz document I:\VWES\Projects\VW04237\Technical\spatial\arcmap\Layer3_potentiometry.mxd



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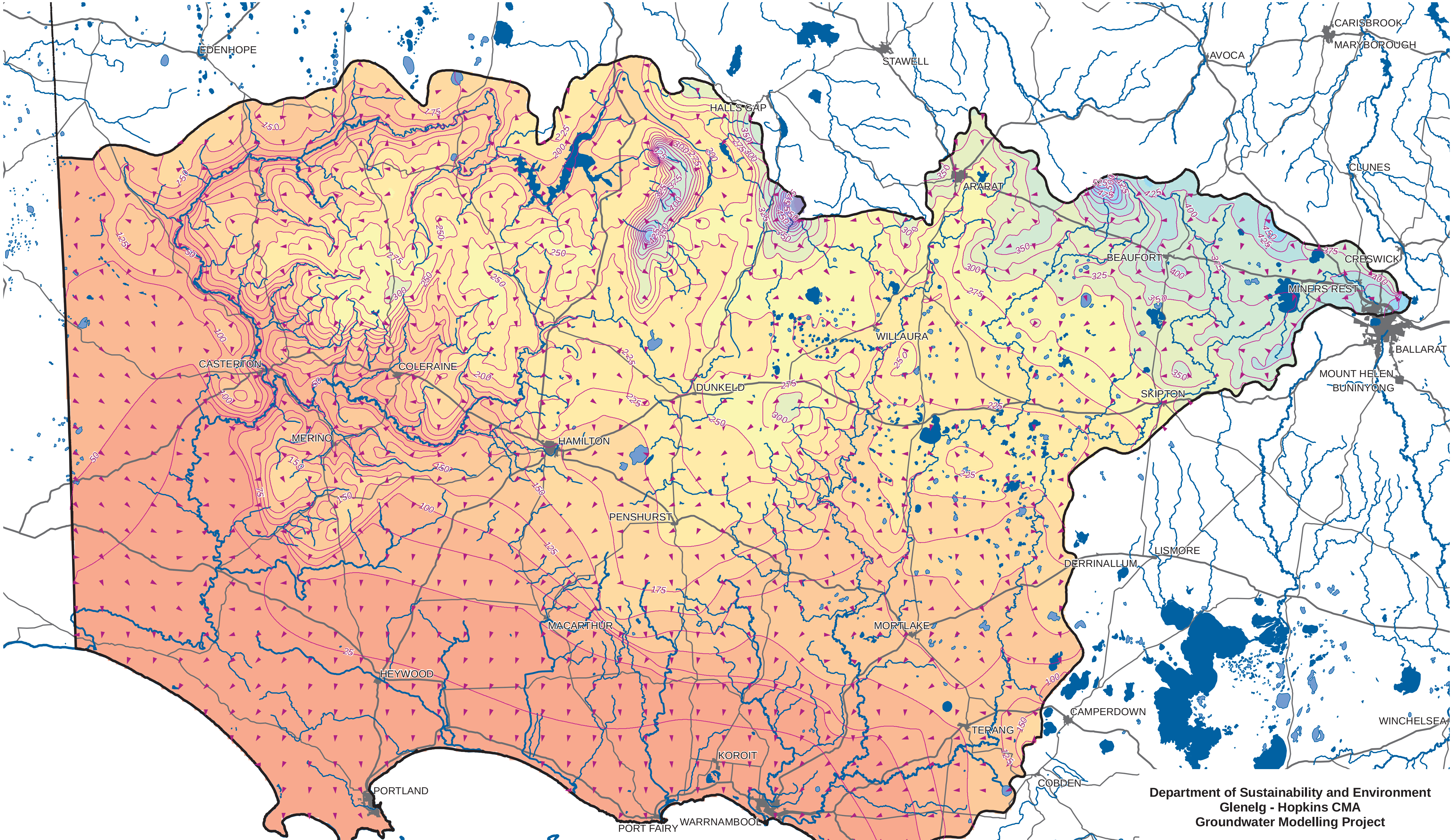
LAYER 4
POTENTIOMETRY

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\
Layer4_potentiometry.mxd



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LAYER 5
POTENTIOMETRY

Kilometers
0 5 10 20 30 40

Elevation (m AHD)

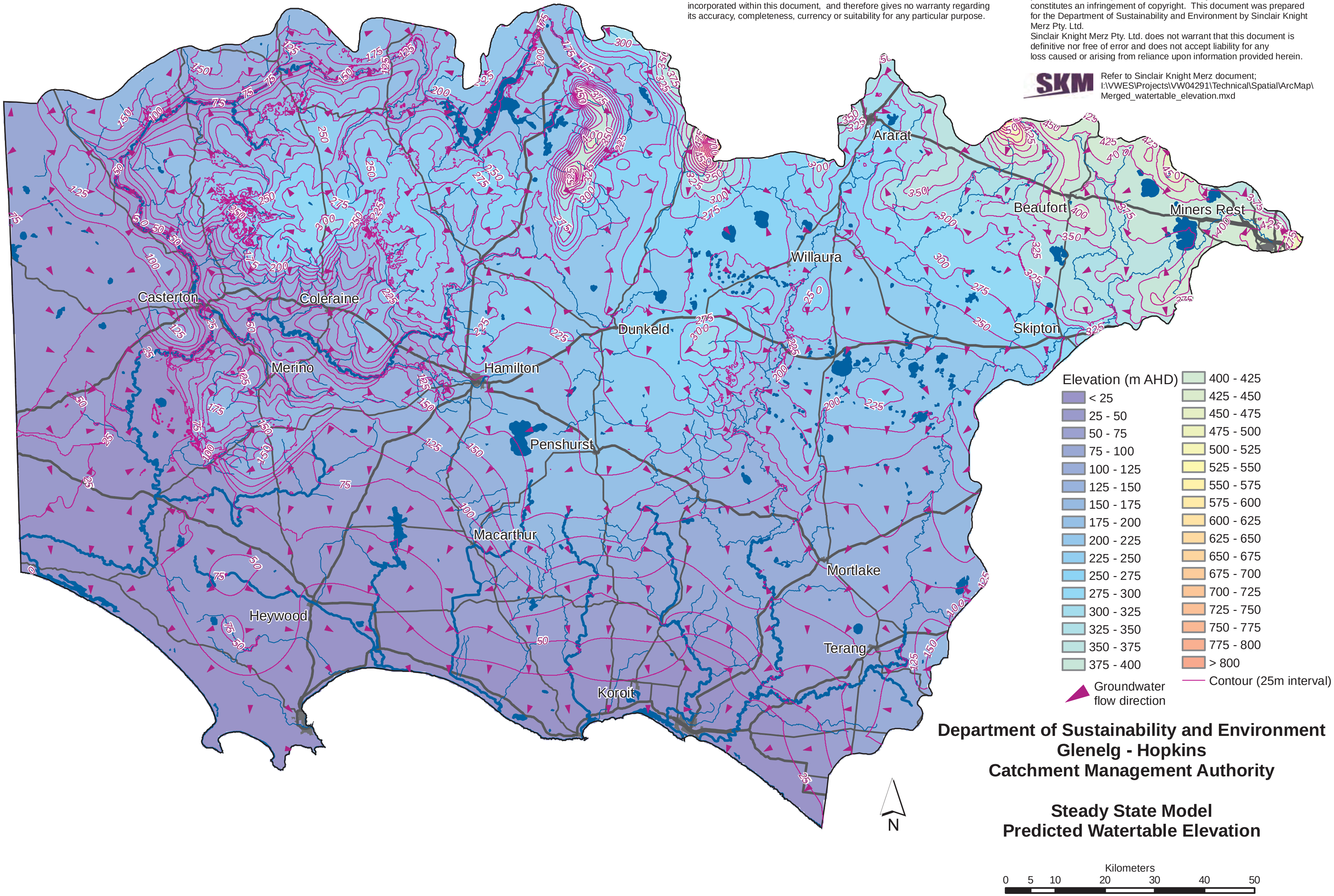
< 50	350 - 400
50 - 100	400 - 450
100 - 150	450 - 500
150 - 200	500 - 550
200 - 250	550 - 600
250 - 300	600 - 650
300 - 350	650 - 700
	> 700

Contour (25m interval)
Groundwater flow direction

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\Layer5_potentiometry.mxd

Map 41

Refer to Sinclair Knight Merz document;
I:\VWES\Projects\VW04291\Technical\Spatial\ArcMap\Merged_watertable_elevation.mxd



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Steady State Model
Predicted Watertable Elevation

Map 42

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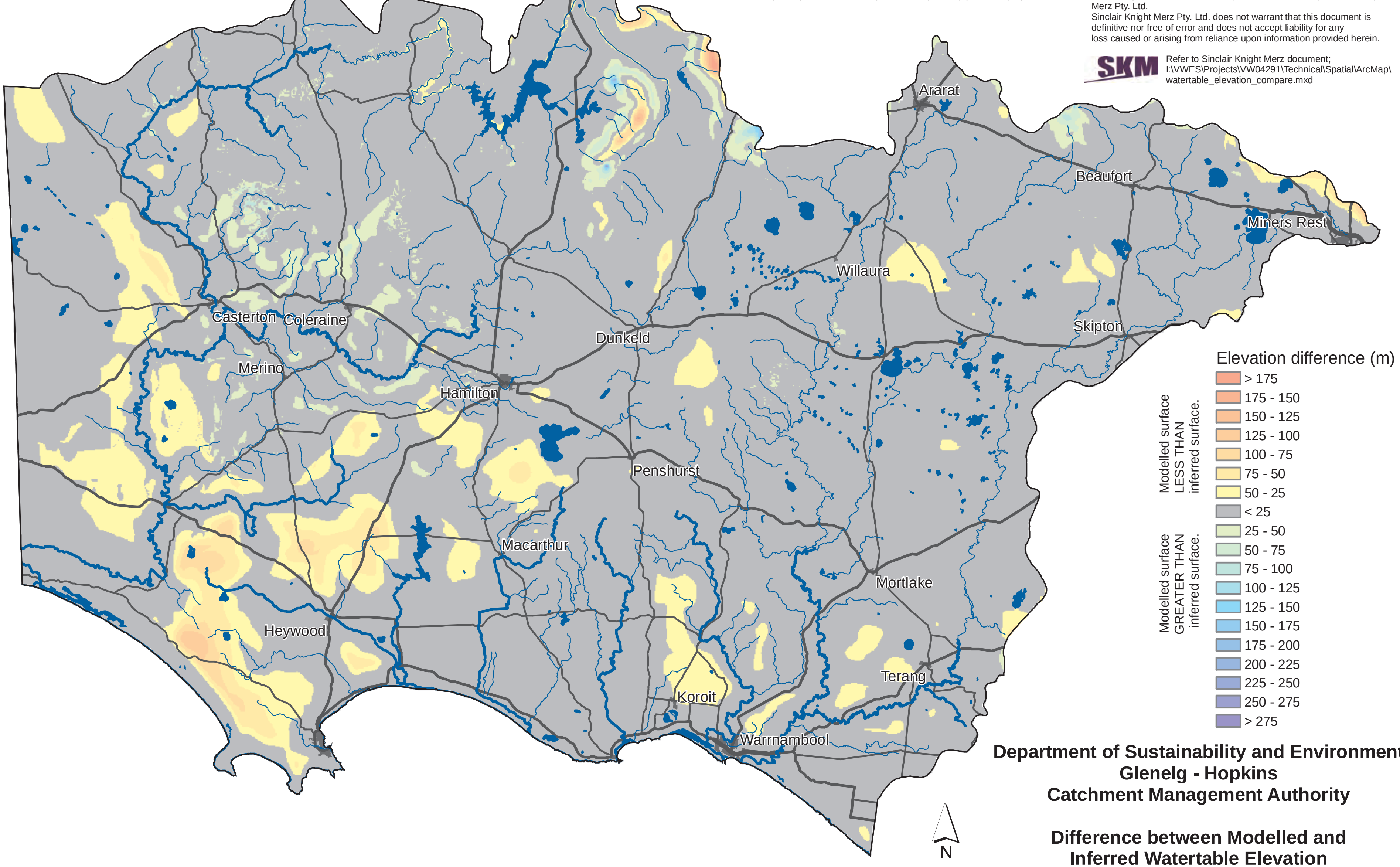
SKM

Refer to Sinclair Knight Merz document;
I:\VWES\Projects\VW04291\Technical\Spatial\ArcMap\watertable_elevation_compare.mxd



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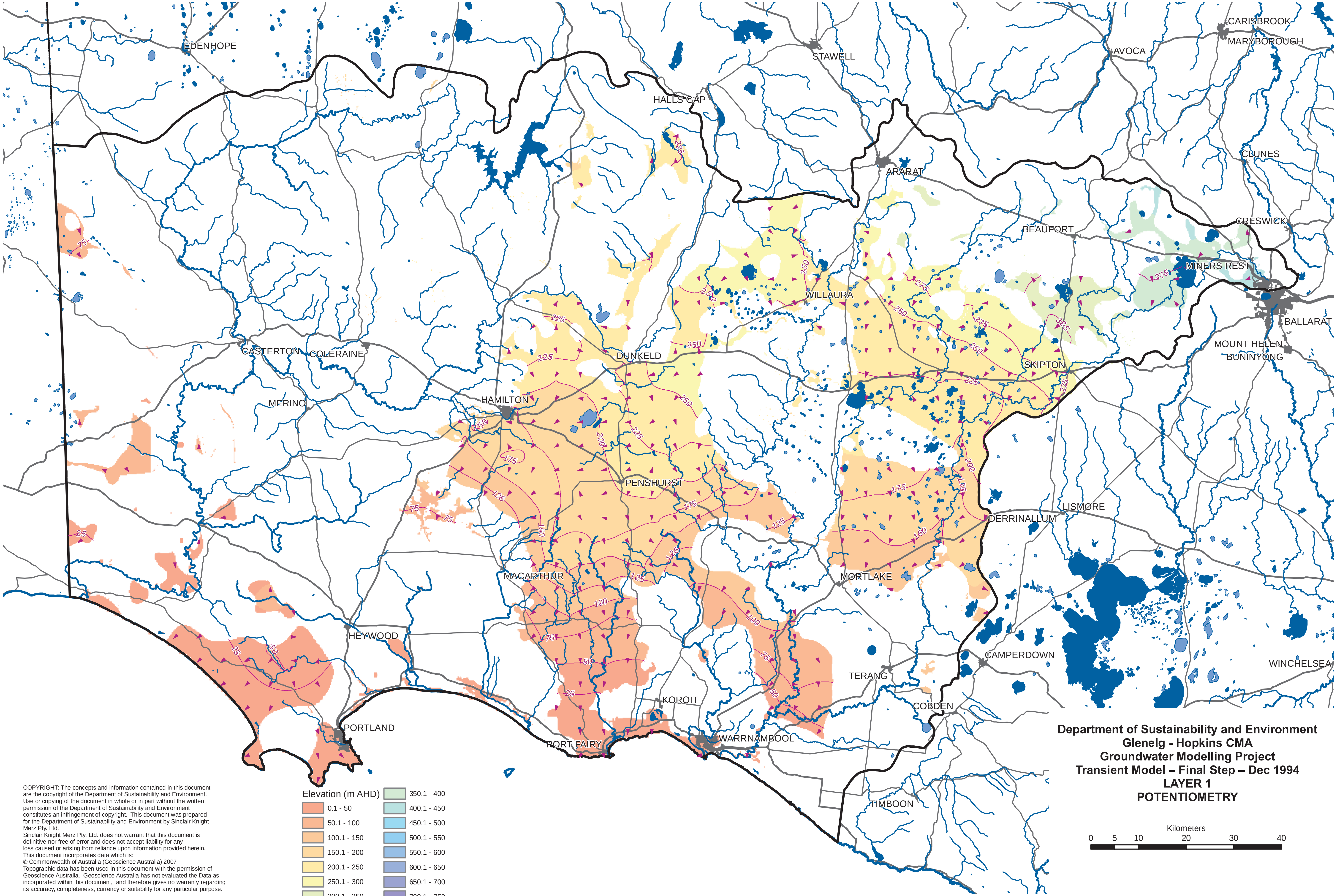
Difference between Modelled and Inferred Watertable Elevation

Kilometers
0 5 10 20 30 40 50



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Groundwater Modelling Project
Transient Model – Final Step – Dec 1994
LAYER 1
POTENTIOMETRY

Kilometers
0 5 10 20 30 40

Elevation (m AHD)

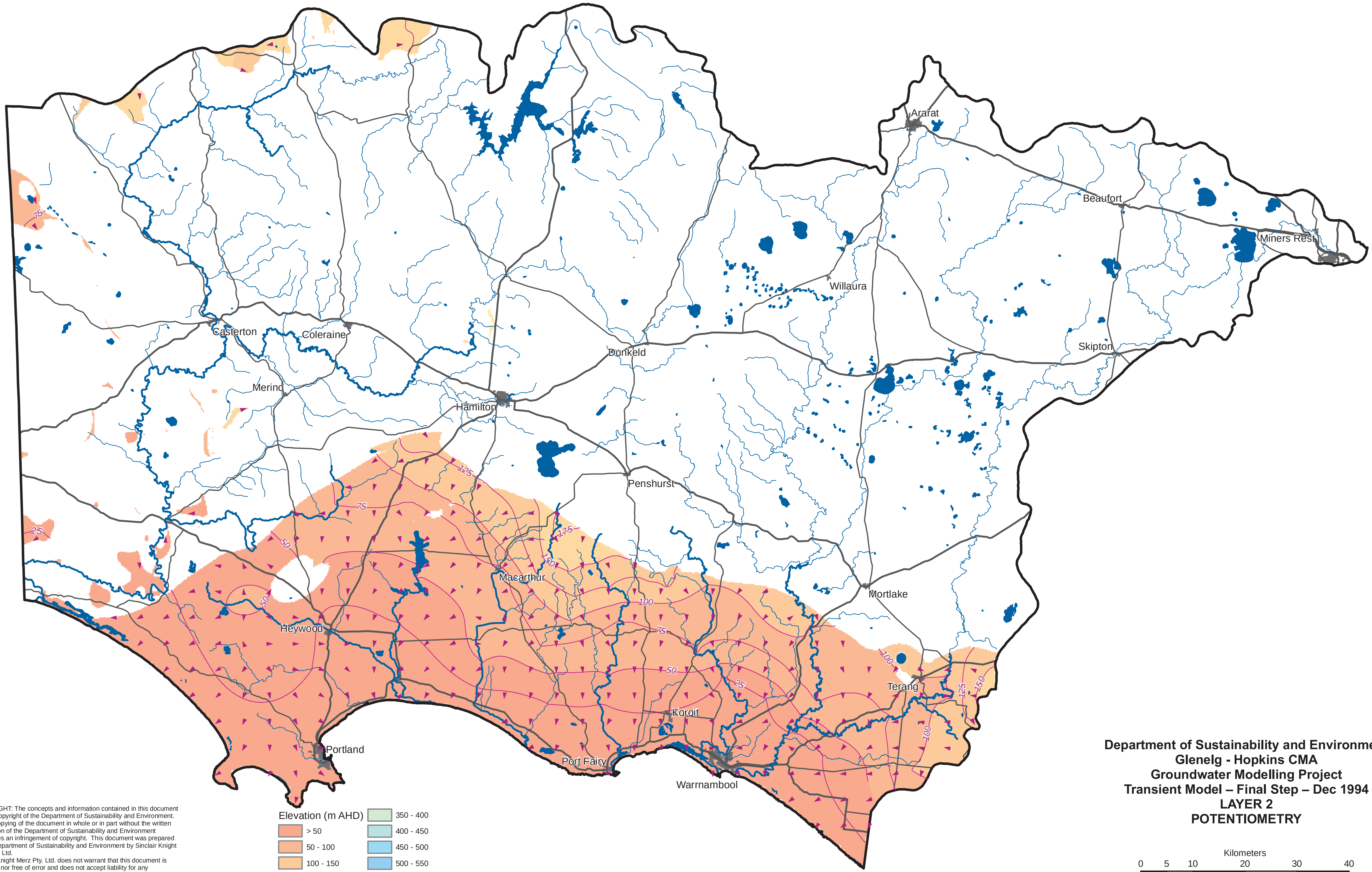
0.1 - 50	350.1 - 400
50.1 - 100	400.1 - 450
100.1 - 150	450.1 - 500
150.1 - 200	500.1 - 550
200.1 - 250	550.1 - 600
250.1 - 300	600.1 - 650
300.1 - 350	650.1 - 700
	700.1 - 750

Contour (25m interval)

Groundwater flow direction

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\Layer1_Transient_potentiometry.mxd

Map 44



Elevation (m AHD)

- > 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500
- 500 - 550
- 550 - 600
- 600 - 650
- 650 - 700
- > 700

Contour (25m interval)

Groundwater flow direction

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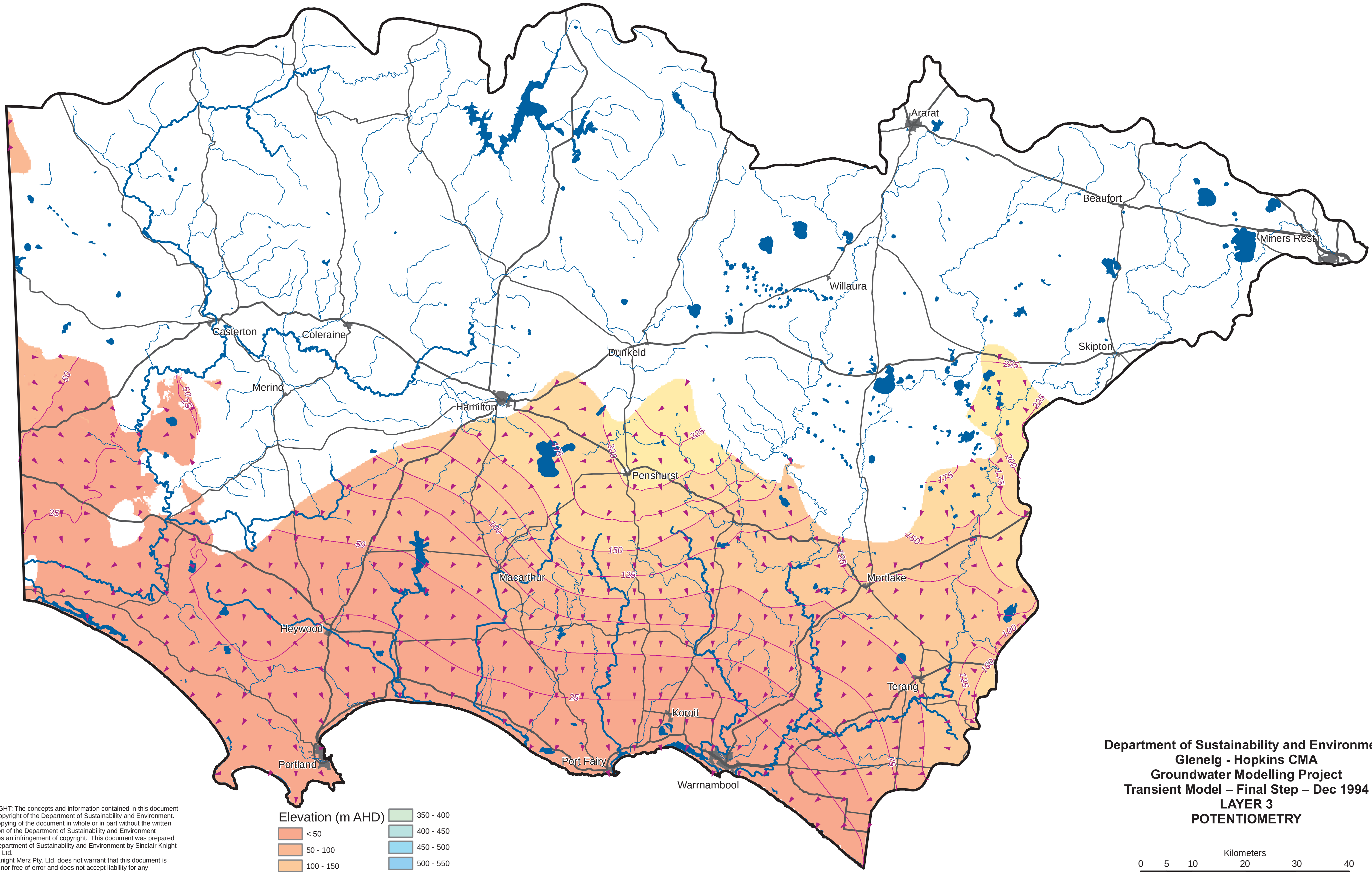
Groundwater Modelling Project
Transient Model – Final Step – Dec 1994
LAYER 2
POTENTIOMETRY

Kilometers
0 5 10 20 30 40

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\
Layer2_Transient_potentiometry.mxd



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Transient Model – Final Step – Dec 1994
LAYER 3
POTENTIOMETRY

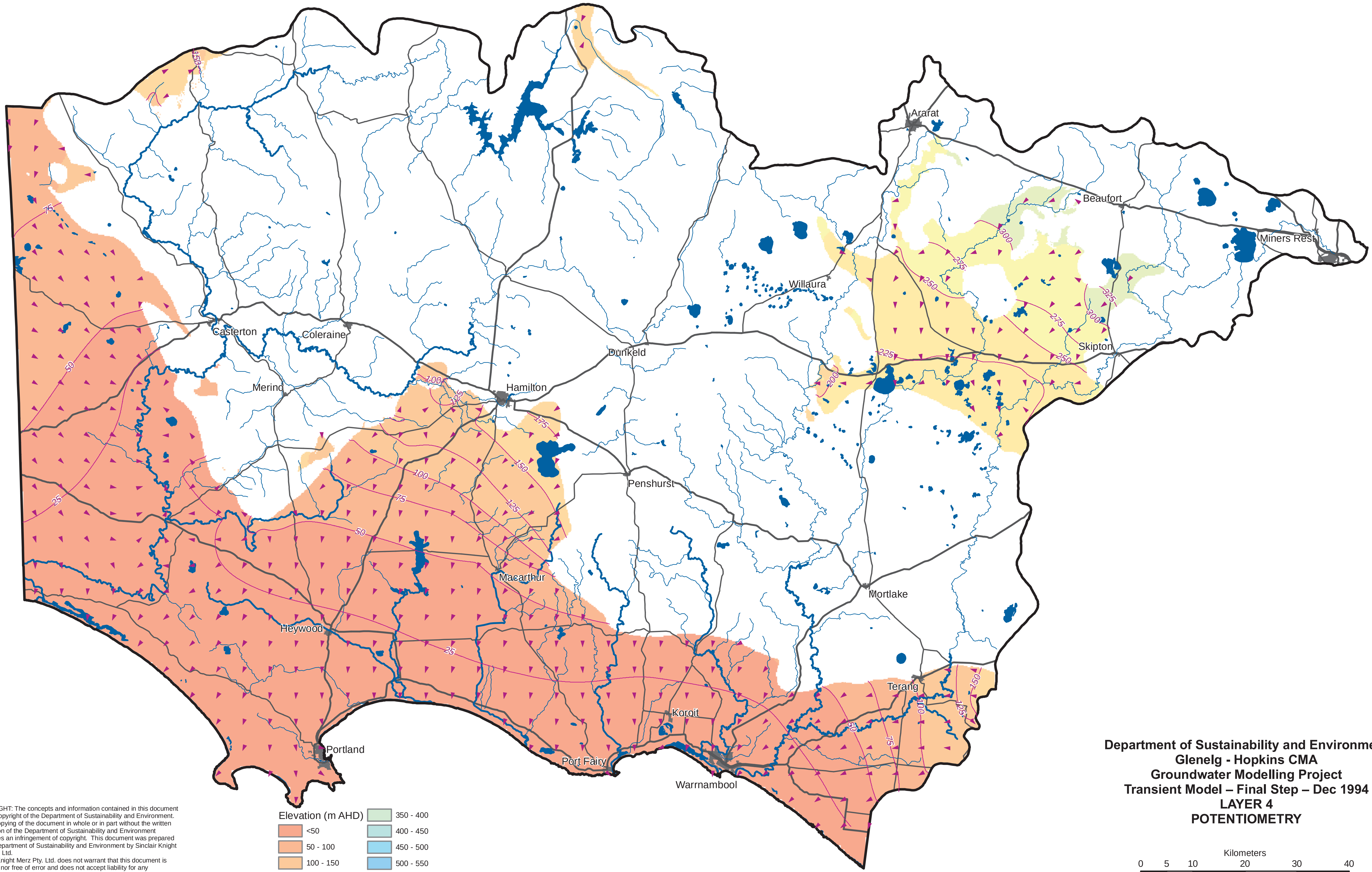
Elevation (m AHD)

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500
- 500 - 550
- 550 - 600
- 600 - 650
- 650 - 700
- > 700
- Contour (25m interval)
- Groundwater flow direction

Kilometers
0 5 10 20 30 40

SKM

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\Layer3_Transient_potentiometry.mxd



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Groundwater Modelling Project
Transient Model – Final Step – Dec 1994
LAYER 4
POTENTIOMETRY

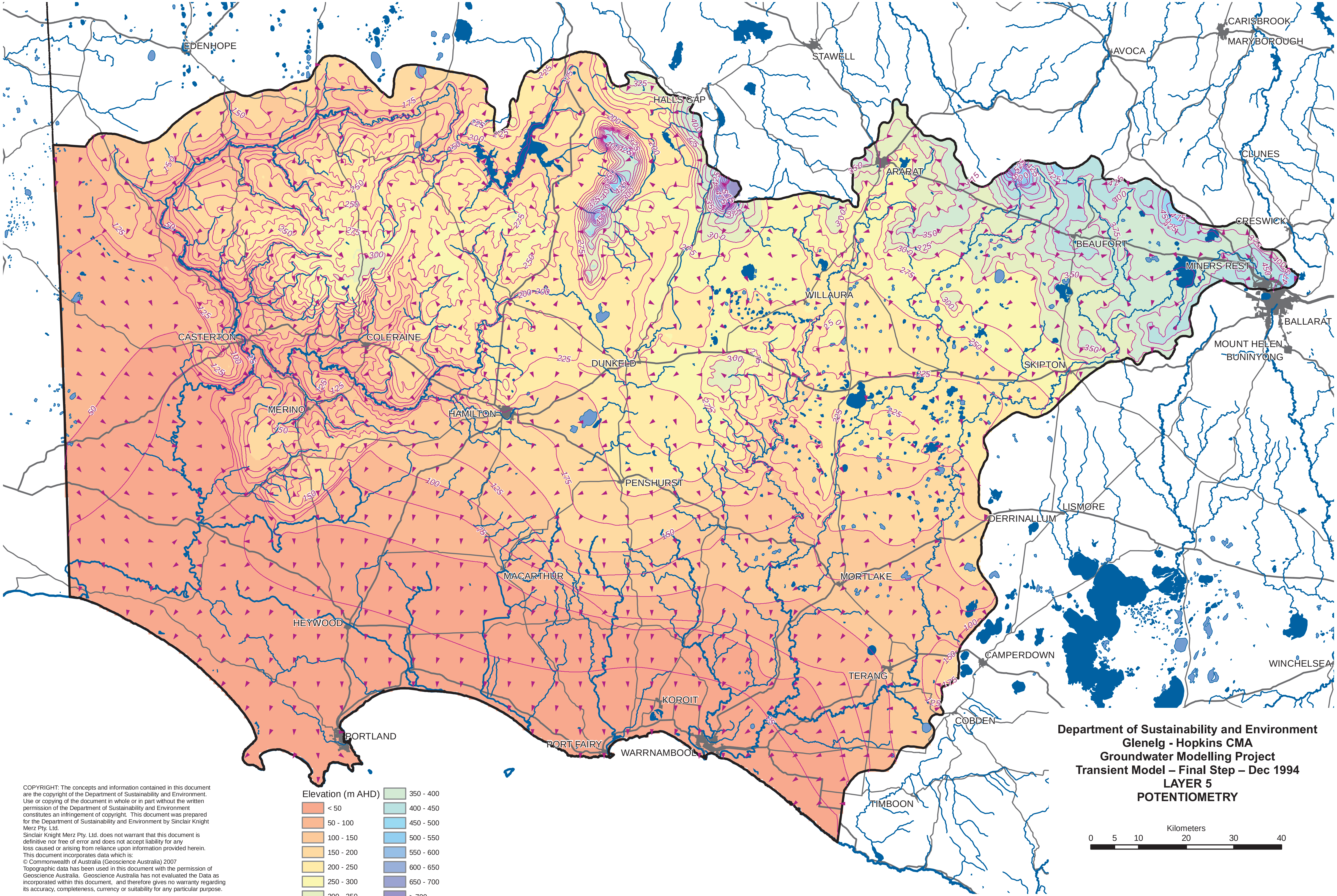
Kilometers
0 5 10 20 30 40

Elevation (m AHD)

<50	350 - 400
50 - 100	400 - 450
100 - 150	450 - 500
150 - 200	500 - 550
200 - 250	550 - 600
250 - 300	600 - 650
300 - 350	650 - 700
	> 700

Contour (25m interval)
Groundwater flow direction

Refer toSinclair Knight Merz document
I:\VWES\Projects\VW04237\Technical\spatial\arcmap\Layer4_Transient_potentiometry.mxd



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Groundwater Modelling Project
Transient Model – Final Step – Dec 1994
LAYER 5
POTENTIOMETRY

Kilometers
0 5 10 20 30 40

Elevation (m AHD)
- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500
- 500 - 550
- 550 - 600
- 600 - 650
- 650 - 700
- > 700
- Contour (25m interval)
- Groundwater flow direction

Refer toSinclair Knight Merz document I:\VWES\Projects\VW04237\Technical\spatial\arcmap\Layer5_Transient_potentiometry.mxd