Department of
Sustainability and
Environment

ecoMarkets
VALUING OUR ENVIRONMENT

North Central CMA Groundwater Model

Transient model development report

HYDRO GEO ENVIRONMENTAL SERVICES
HOCKING ET AL PTY LTD

A Victorian Government initiative

Victoria
The Place To Be

Produced by Hocking et al on behalf of the Victorian Government Department of Sustainability and Environment Melbourne, 2010.

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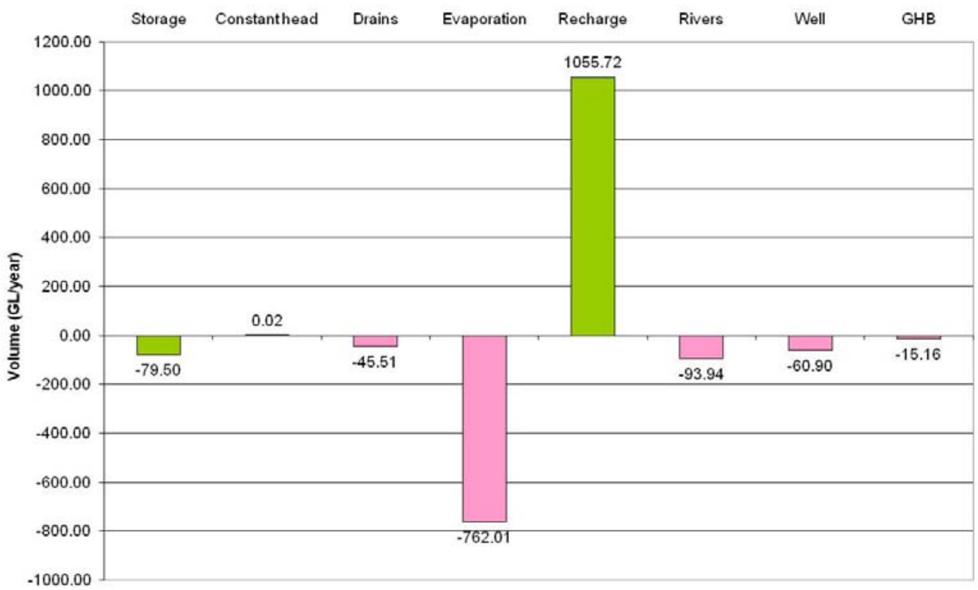
Summary

The groundwater model described in this report has been developed within the context of DSE requirements consistent with the ecoTender approach. That is, it provides a tool for assessing the impacts of land use change on catchment water balances. The model predicts changes in the volume of base flow, areas of land subject to a shallow watertable and, by inference, areas subject to land salinity.

This report describes the second stage of a two-part project; the first stage was a multilayer steady-state groundwater model, and this stage presents a simulated multilayer transient groundwater model of the North Central Catchment Management Authority (CMA) region.

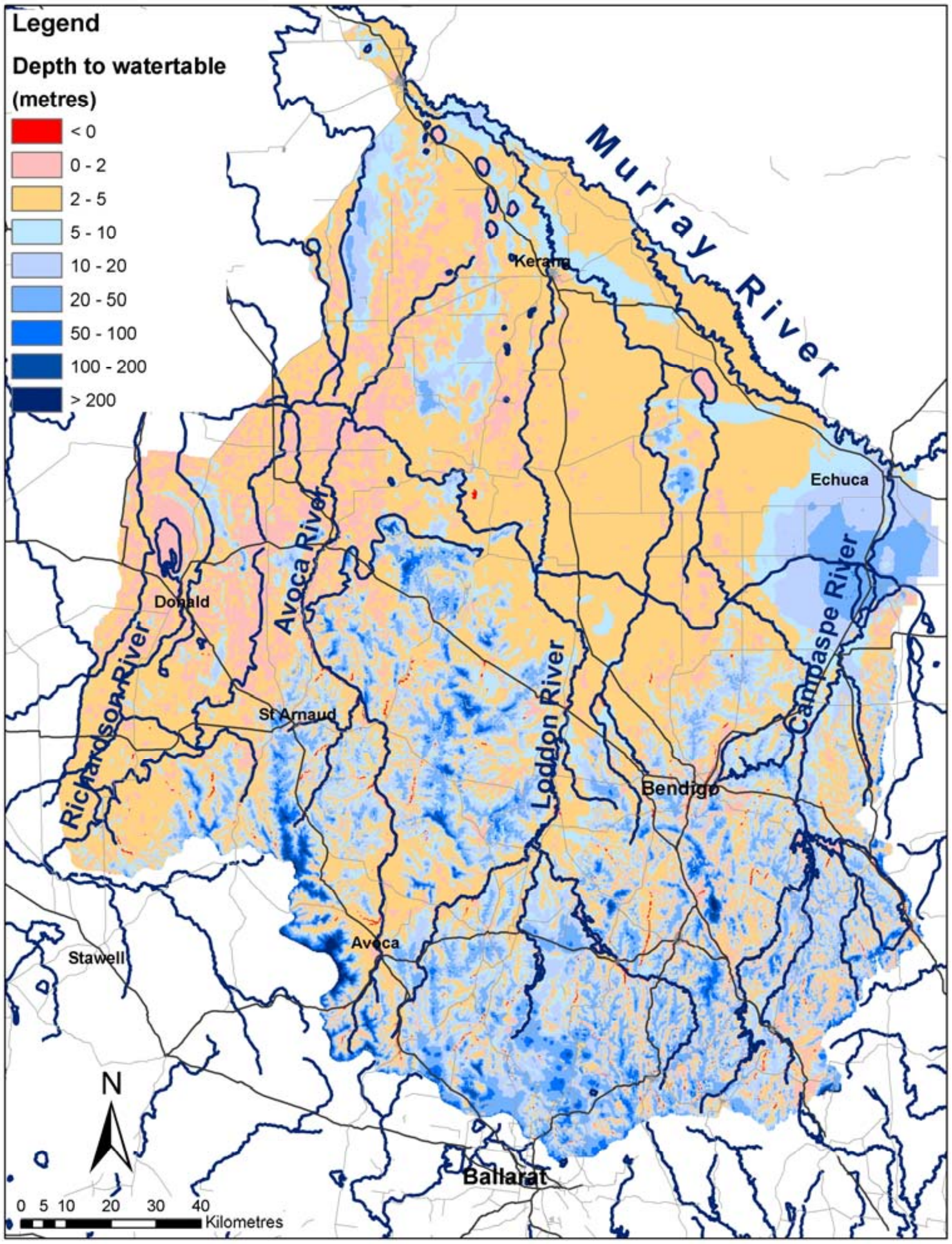
The North Central CMA region model attempts to simulate groundwater movement within each of the principal aquifers of the region. The following model layers and geology groups have been aligned in a ten-layer framework. The model has been developed in finite difference format (regular gridding). It features a cell size of 200 m, totalling 740 768 solution points occupying 1272 rows and 980 columns, and comprises of ten layers and 7 407 680 active cells.

Annual average calibrated time-varying water balance between1990 and 1999 is presented below. Results suggest the main export of groundwater from the catchment is evaporation, groundwater base flow, groundwater pumping and groundwater outflow respectively.



Model calibration was achieved by attempting to match observed groundwater level with simulated groundwater level over monthly time steps over the calibration period between 1990 and 1999. The transient calibration follows-on from a calibrated steady-state simulation (Hocking et al. 2010).

Simulated versus observed groundwater level data statistics found a scaled Root Mean Square (RMS) over time generally remained less than 2 % across the calibration (1990–1999) and validation (2000–2005) periods. The simulated depth to watertable (below) is considered a reasonable representation of the region when considering the scale, assumptions and time limitations of the project


Legend
Depth to watertable
(metres)
< 0
0 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
> 200
Murray River
Kerang
Echuca
Avoca River
Donald
Richardson River
St Arnaud
Loddon River
Campaspe River
Bendigo
Stawell
Avoca
Ballarat
N
0 5 10 20 30 40
Kilometres

The model developer considers the application of the North Central CMA region groundwater model has the capacity to predict changes in the water balance, however there are a number of potential limitations which should be kept in mind, they are;

- There should be some caution in long-term scenario prediction of the transient model (e.g. > 15 years), as no data validation has been undertaken beyond this period. Also, underlying groundwater trends may impact model prediction capacity beyond this period.
- Only relative water balance changes should be considered, not absolute changes. That is, due to scale, complexity, availability of calibration data and project time limitations, model calibration is not at sufficient detail to warrant absolute values.
- The application of the North Central CMA region steady-state groundwater model should not be used for assessment of impacts of land use change as calibrated recharge rates provided appeared higher than considered reasonable, and therefore may redistribute the groundwater balance disproportionately.
- In areas of high intensity groundwater pumping (e.g. Lower Campaspe) the simulation error is likely to be significantly greater. This error is likely to reduce the capacity to reasonably predict land use change.
- When considering land use change scenarios, the area of change should be no less than 10 hectares, as scale generalisations and solver tolerance is unlikely to accurately identify changes in the catchment groundwater balance.

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1 Introduction

This report has been prepared by Hocking et al. Pty Ltd in conjunction with Phil Dyson and Associates on behalf of the Department of Sustainability and Environment (DSE) and describes the conceptualisation, attribution and calibration of the multi-layer spatial groundwater model for the entire North Central Catchment Management Authority (CMA) region.

1.1 ecoMarkets project background

The North Central CMA groundwater model represents part of a statewide program aimed at producing groundwater models for each of Victoria's eight CMA regions. The groundwater models for each CMA region will be used to assess the impacts of land use change on the water balance, and in particular the influence on depth to watertable and base flow volume. This information is intended to inform DSE market-based approaches to land management that are designed to reward landholders for environmental improvements in their properties. This DSE program is generally known as 'ecoTender'

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 (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 simplified 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 time step thus processes that occur on a smaller time step 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 prep.)

1.2 Model objectives and context

The groundwater model described in this report has been developed within the context of DSE requirements consistent with the Ensym approach. That is, it provides a tool for assessing the impacts of land use change on catchment water balances. The model predicts changes in the volume of base flow, areas of land subject to a shallow watertable and, by inference, areas subject to land salinity.

The groundwater modelling project has been undertaken in two parts: the first phase involved the calibration of a multi-layer steady-state groundwater model. This work was be independently reviewed before stage two (this stage) was commissioned. The second stage aimed at further refinement and expansion of the phase 1 outputs. It builds on the conceptualisation and the datasets and lead to the construction of a calibrated multi-layer transient groundwater model for the North Central CMA region.

1.3 Model specifications

Specifications for this modelling exercise are:

- finite difference/element gridding at 200 metre cell size
- multi-layer groundwater model (representing major geological units) consistent with existing models
- common boundary conditions and relatively consistent aquifer parameters with adjacent models

- a scaled (normalised) RMS of less than 10% for the transient model based upon time-series observation data
- a transient calibration/validation period of 10 years
- a sensitivity analysis to assess the variability of modelled outputs to variations in key model input parameters
- catchment water balance error of less than 2%
- all catchment water balance features to be considered and reported
- the source and statement of quality of all input datasets to be reported
- at least 500 groundwater observation bores used for calibration (if more than 500 present)
- the model domain represents at least the entire extent of the North Central CMA region
- groundwater recharge layers to be developed by DSE and be incorporated into the groundwater model, unless demonstrated to be erroneous.

1.4 External review and workshops

An independent external review of the key project outputs forms an integral part of the project. This was achieved through five workshops, held at key stages during the project, and through regular informal communication with the reviewers. The following workshops were conducted:

- ✓ Informal review workshop – to be held following the collation of all the relevant datasets and the development of the preliminary aquifer conceptualisation.
- ✓ Statewide groundwater modelling workshop – was conducted following the preliminary conceptualisation. The workshop ensured the biophysical processes being considered are consistent across each CMA region.
- ✓ Formal Phase 1 model review workshop – formal presentation of final aquifer conceptualisation and a calibrated multi-layer, steady-state groundwater model for review.
- ✓ Final model workshop – formal presentation of a calibrated multi-layer transient groundwater model and report for review.
- ✓ Final audit workshop – formal audit of the final groundwater model including handover and review of the model input and output data files.

Alan Wade and Brian Rask (of Parsons Brinckerhoff Pty Ltd) and Phillip Macumber (of Phillip Macumber Consulting Services Pty Ltd) was appointed as the external reviewers for the North Central CMA region model.

2 Hydrogeological setting

2.1 Study area

This investigation covers the North Central Catchment Management Authority (CMA) region in Victoria (Figure 1). The region encompasses almost three million hectares of land and the major population centres of Bendigo, Swan Hill, Maryborough, Kyneton, St Arnaud, Castlemaine, Creswick and Kerang.

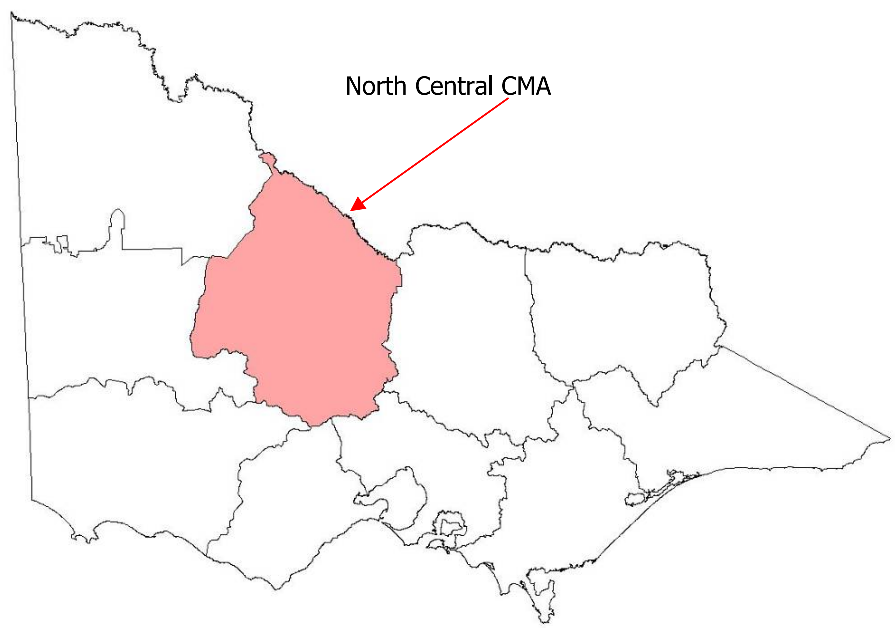


Figure 1 Location of North Central CMA region

2.2 Climate

Climate plays an important role in the hydrologic processes that drive the catchment water balance. The mean annual rainfall distribution over the North Central CMA region varies, ranging from more than 1230 mm/year near Trentham to 330 mm/year at Swan Hill (Figure 2).

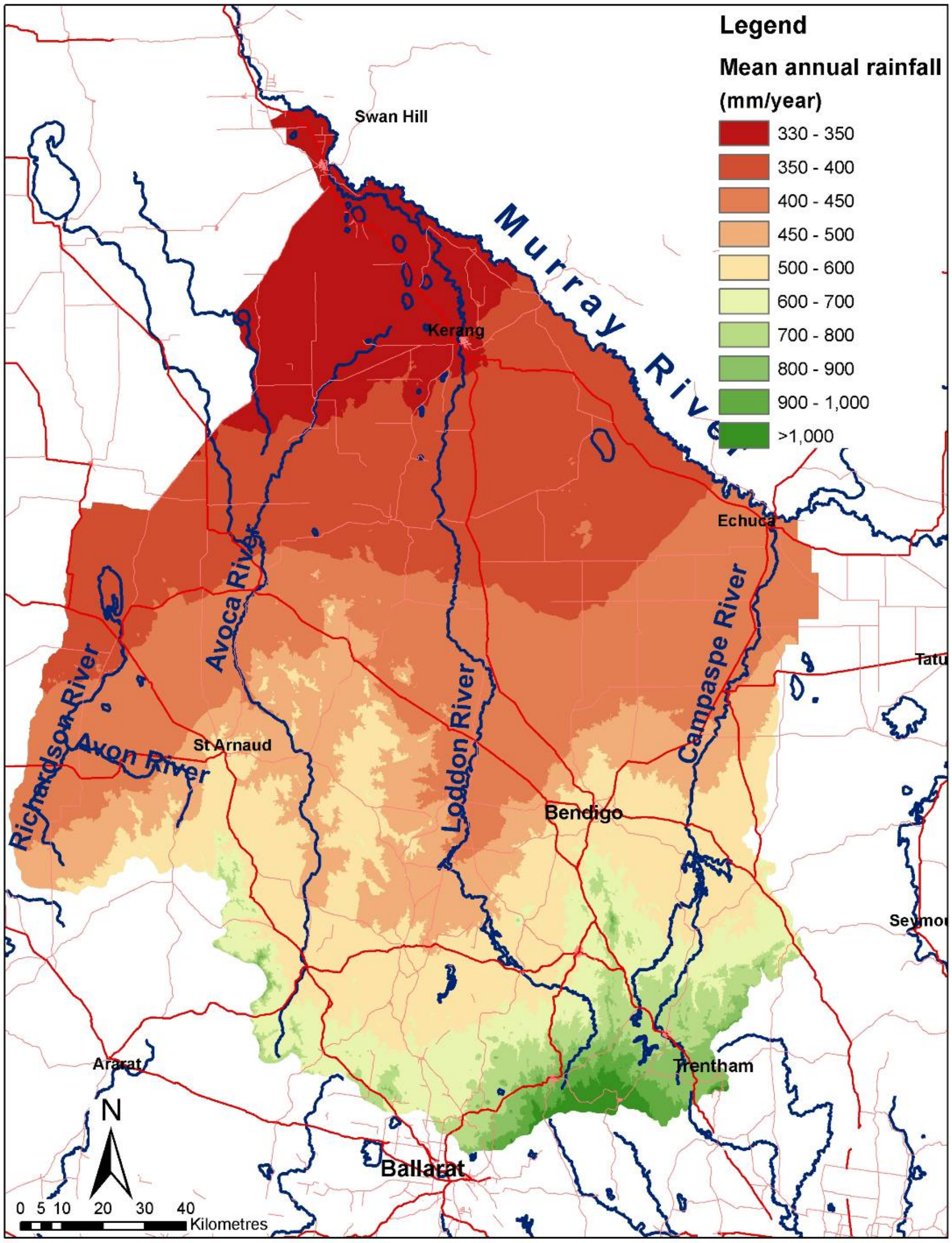


Figure 2 Distribution of mean annual rainfall across the North Central CMA region

Over the past ten years there has been a major change in monthly rainfall volume. Figure 3 presents the cumulative residual rainfall for the Bendigo BOM climate station. It demonstrates a strong decline in mean monthly rainfall since 1996.

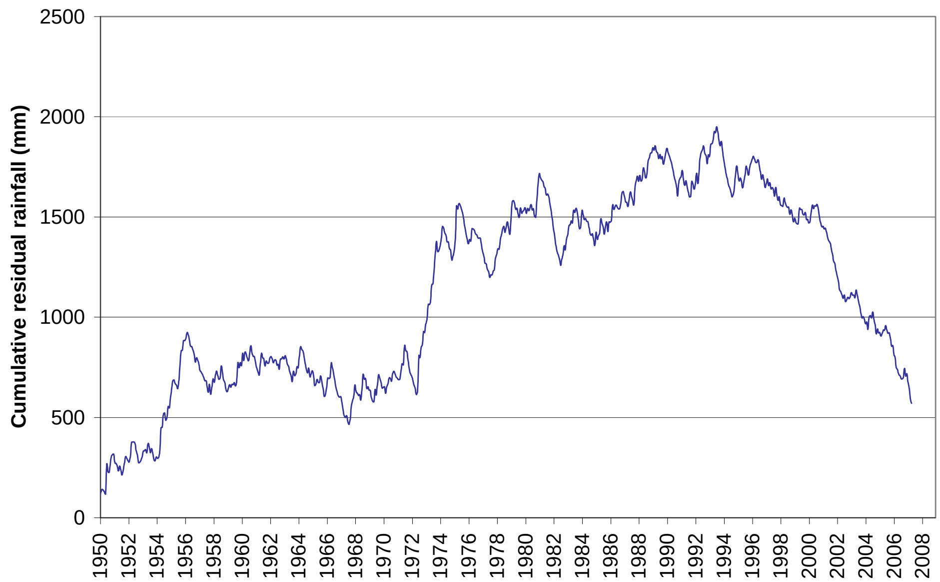


Figure 3 Cumulative residual rainfall at Bendigo

2.2.2 Regional groundwater trends

Groundwater recharge in southern Australia is strongly correlated with annual rainfall. This is particularly true when the seasonal rainfall pattern follows that established by the long-term trend. In this condition most rainfall occurs during cold wet winters and least in hot dry summers.

Hekmeijer et al (2008) selected 68 bores in the DPI groundwater trend review across Northern Victoria (including the North Central region), only 7 bores recorded a rising groundwater trend. Eighteen (18) were relatively stable (especially in recent years), and 43 have a falling trend. Of the latter group, 32 are presently recording their lowest water levels. Many of the selected bores are currently recording their lowest groundwater level (Reid, et al 2009). The declines in levels have mostly occurred since 1996 or 1997 but there are examples of declines occurring since 1994 and also only as recently as from 2002. Upper landscape bores show the most significant change in level, with declines most commonly being 4 to 8 metres (e.g. Bore 163 on the Wimmera – North Central catchment divide) (Reid, et al 2009).

Average rainfall trend should be used to select a representative year for recharge as individual groundwater monitoring bore have site specific factors which obscure an average annual climate sequence.

2.3 Topography

The North Central CMA region can be considered to comprise two major geomorphic zones; the uplands and the plains. The uplands terrain ranges from gentle undulating lands in the mid reaches through to steep hills in the headwaters and along the catchment margins. The river valleys of the uplands are narrow compared with the much broader and less defined valleys in the lowland plains. Significant topographic features in the region include the Great Dividing Range, Mount Camel Range, Pyrenees Range, Terrick Terrick Range and Murray, Loddon, and Campaspe Valleys.

Digital elevation data for the North Central CMA region was sourced via the DSE corporate geospatial library at 20 m cell size. The Digital Elevation Model (DEM) was re-

sampled to 200 m using bilinear interpolation (Figure 4). It is acknowledged re-sampling the landscape into 200m cells causes elevation generalisations, and is likely to produce an underlying error which may distort model calibration data statistics. In attempt to quantify the likely error, a comparison of available surveyed bore elevation with the DEM used for this modelling exercise was undertaken. Results show the mean sum of residuals is 3.84 m (Figure 4), this underlying elevation variation should be kept in mind when reviewing measured versus simulated groundwater level data.

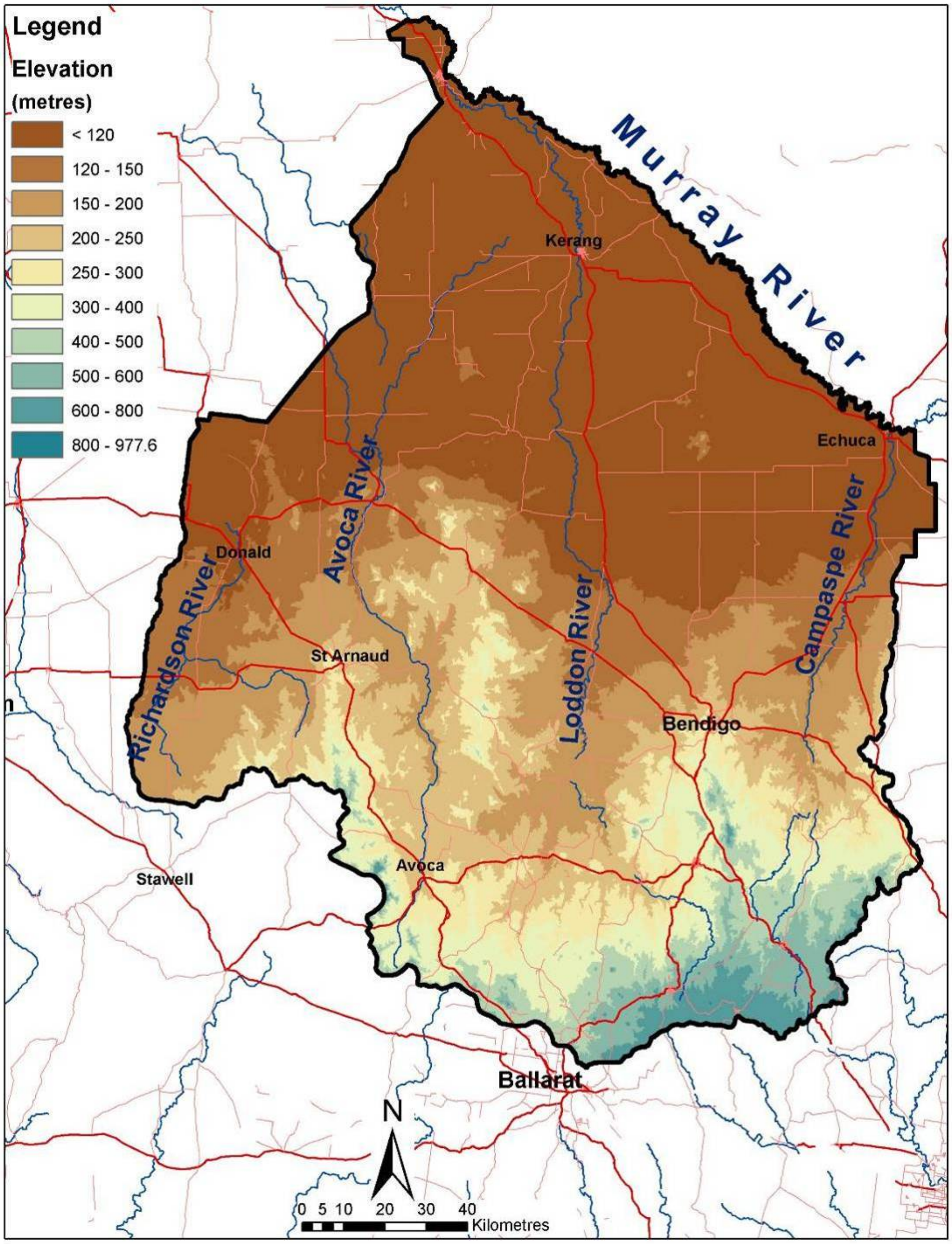


Figure 4 Topography and topographic features of the North Central CMA region

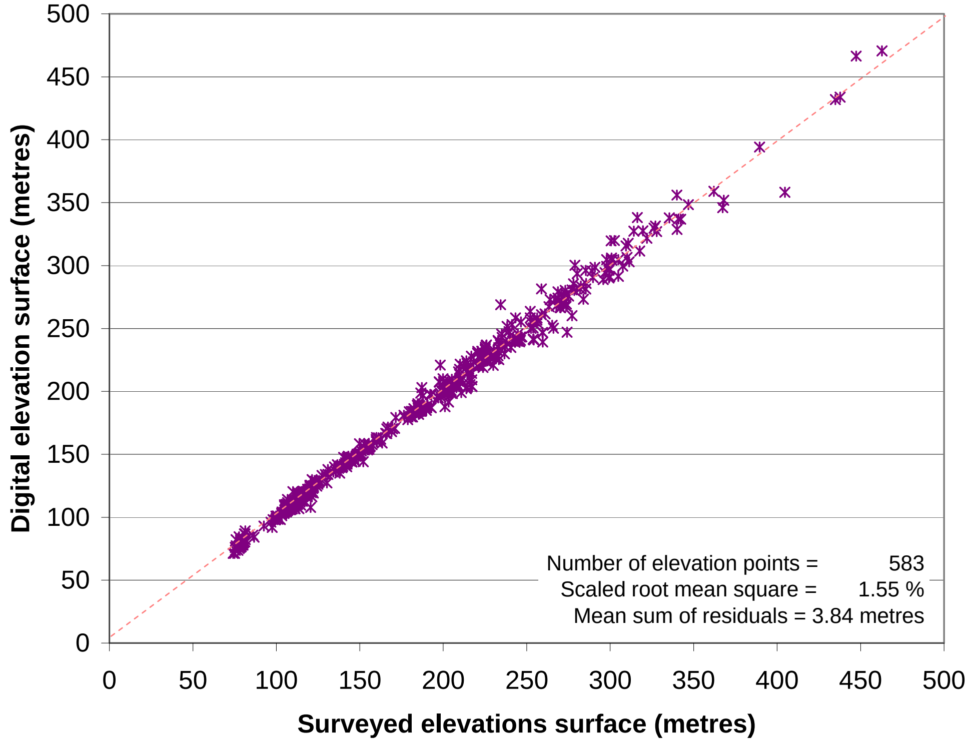


Figure 5 Surveyed versus digital elevation data

2.4 Land use

The North Central CMA region comprises the land extending from the Murray River in the north and the Great Dividing Range to the south. In the west the Wimmera Plains separate it from the Wimmera, and to the east the Mount Camel Range adjoins the Goulburn Broken catchment.

The landscapes of north central Victoria are diverse. In the south the land is hilly to mountainous, but in the north the ranges give way to gentler foothills and Riverine Plains.

Figure 6 presents the distribution of broad land use classes in the North Central CMA region. The dominant land uses are grazing (43%), cropping (25%), irrigation (11%), native vegetation (8%) and forestry (5%).

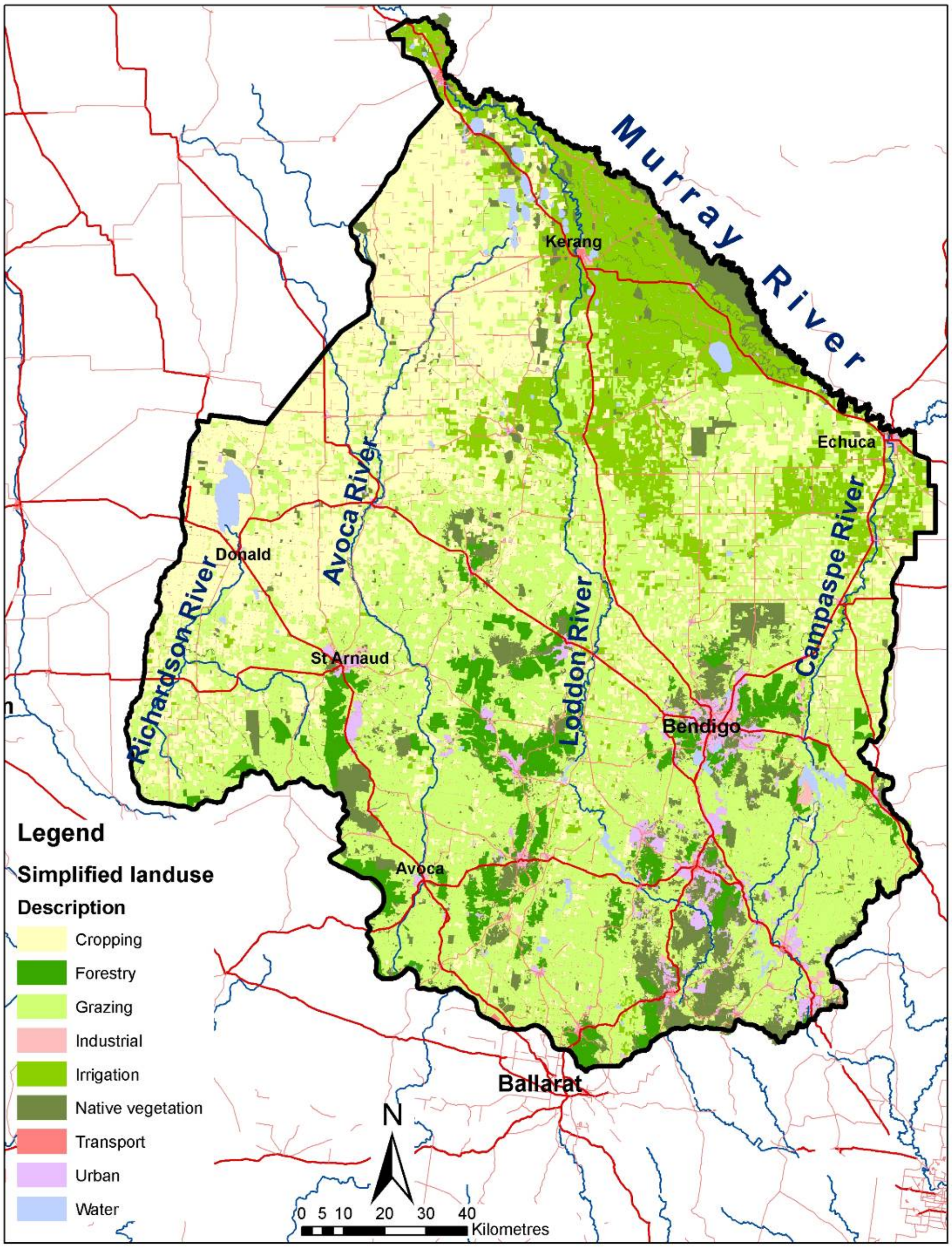


Figure 6 Land use classes of the North Central CMA region

2.5 Hydrology

Natural surface hydrology of the North Central CMA region includes the major drainage networks (Figure 7) of the Avon-Richardson, Avoca, Loddon and Campaspe rivers. All surface waters export the catchment (in theory) via the Murray River.

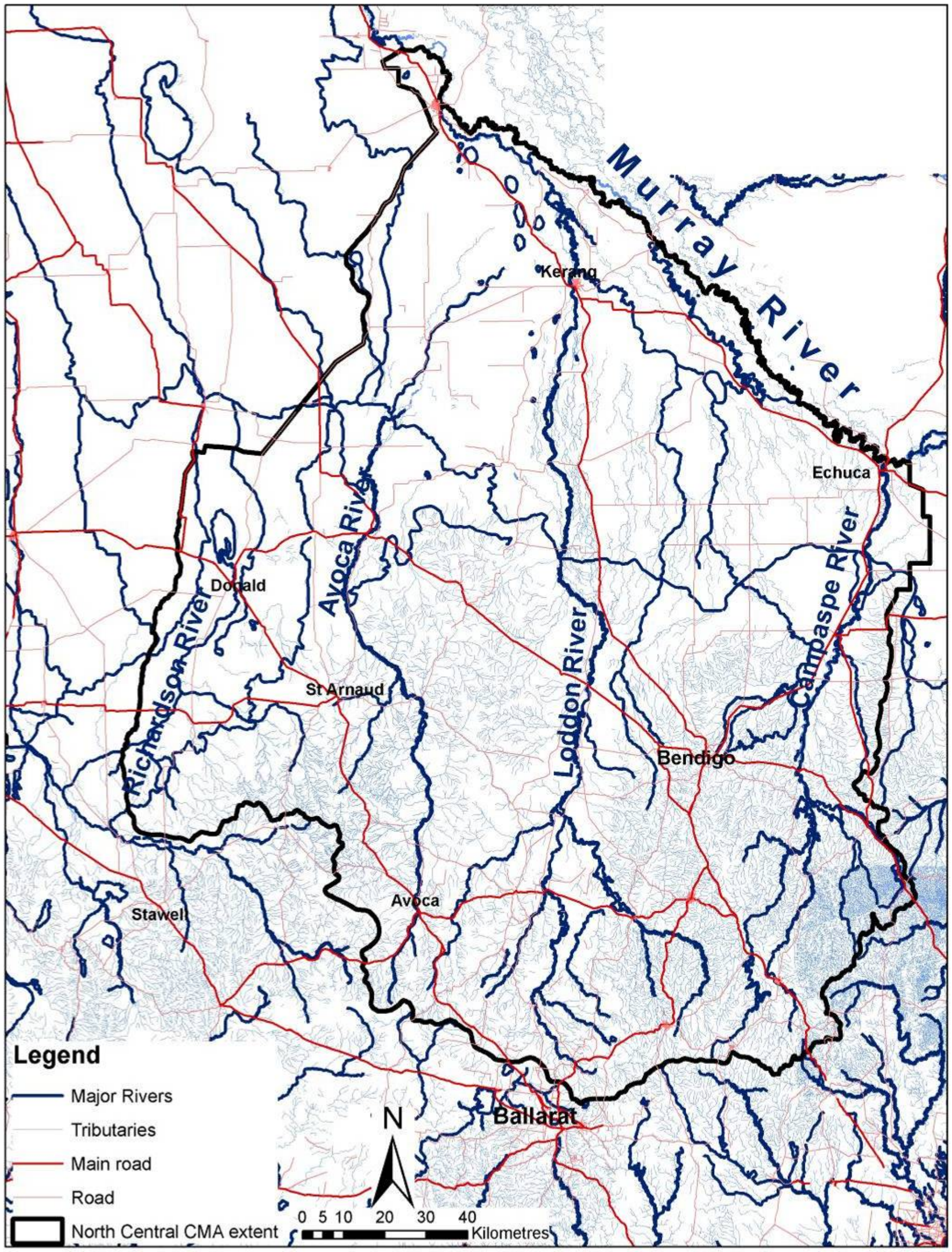


Figure 7 Drainage networks of the North Central CMA region

2.6 Surface water and groundwater interactions

This section provides insight into of the various surface water and groundwater interactions known to occur within the North Central CMA region.

2.6.1 Recharge

Spatially varying groundwater recharge was provided by DSE via 'Ensym' (Figure 8). The Ensym framework is underpinned by the Catchment Assessment Tool (CAT) (DSE 2007) and utilises a number of one-dimensional farming system models to estimate the impact of variations in soil, water and vegetation on certain components of the water balance, including estimates of groundwater recharge and surface runoff.

Spatially varying groundwater recharge over 30.4 day time steps supplied for the 1990 – 2005 period. Appendix 3 presents monthly groundwater recharge rates over the model calibration (0-120 time steps) and validation (121-192 time step) periods

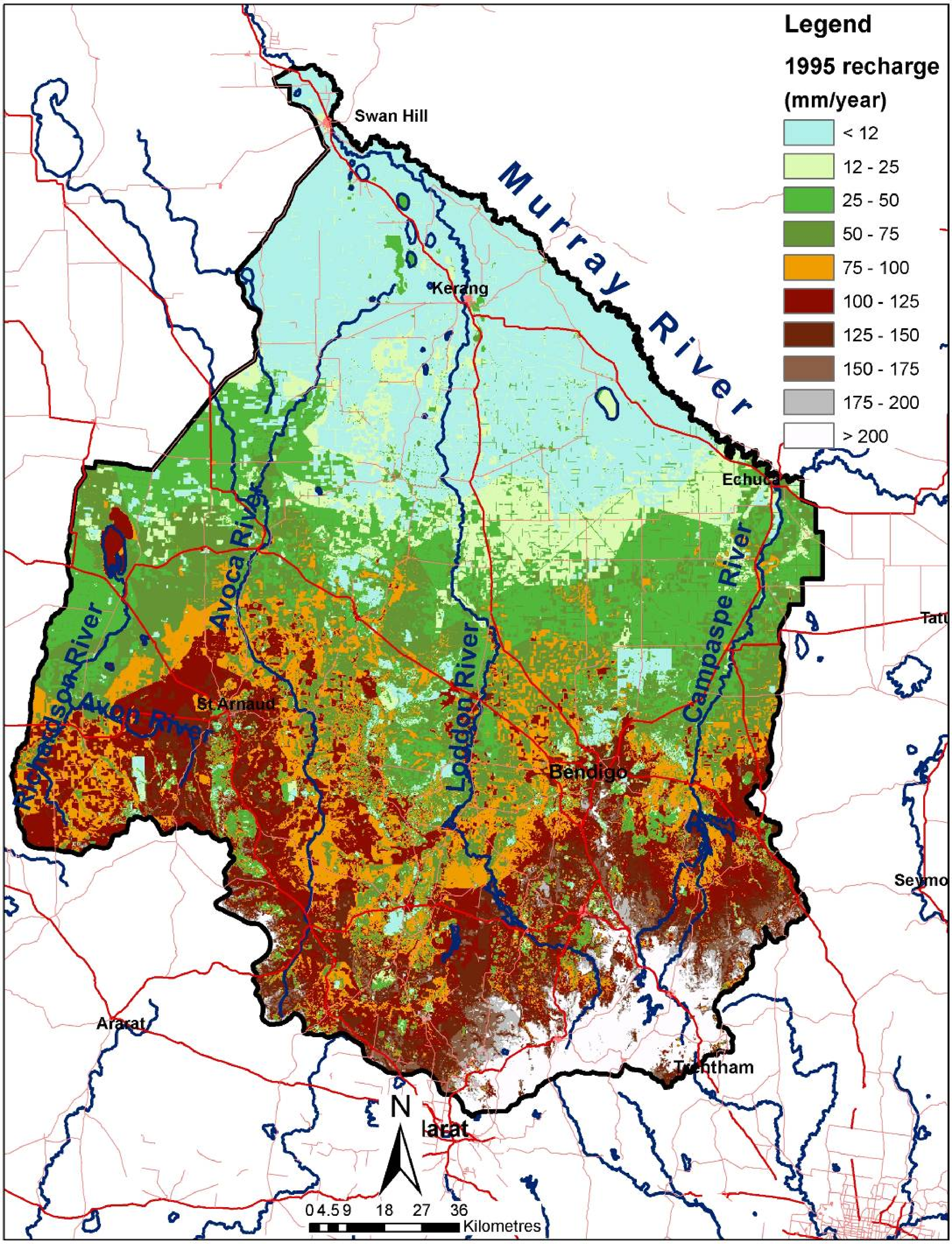


Figure 8 DSE provided Ensym groundwater recharge layer

2.6.2 River interaction

Base flow

Groundwater–surface water interaction calculations have were made in regulated catchments via selected stream gauge base flow estimates.

Figure 9 presents stream gauges and contributing catchment areas analysed for base flow contribution. Stream base flow contribution was estimated using a first pass recursive digital filtering method described by Arnold and Allen (1999).

The equation for the filter is:

$$q_t = \beta\, q_{t-1} + (1 + \beta)/2 * (Q_t - Q_{t-1})$$

Where;

q_t = filtered surface run off

t = time step

Qt = original stream flow data

β = filter parameter (0.95)

The recursive digital filter technique is described by Nathan and McMahon (1990). The technique has no real physical basis, however it is objective and repeatable (Arnold, et, al., 1995). The digital base flow filtering can be passed up to three times, where each pass effectively reduces base flow percentage. Nathan and McMahon (1990) compared a manual and the recursive digital filtering base flow analysis and found the automated filtering method was comparable in accuracy to that of manual base flow separation. Arnold, et. al., (1995) recommend in the absence of on-site conditions that the one filter pass (first pass) be the default value used.

Figure 9 presents stream gauges and contributing catchment areas analysed for baseflow. Baseflow was estimated using the automated analysis technique described by Arnold and Allen (1999). Appendix 1 presents individual baseflow data for each stream gauge and this information is summarised in Table 1 for 1995. In locations where gauged sub-catchment can not be calibrated steady state baseflow calibration setting for the river model was used.

Table 1 Base flow estimates of selected catchments in 1995

Stream gauge	Catchment recharge (mm)	Base flow calculation (ML)	Baseflow % of recharge
406208	199.9	2 817	43
406214	104.2	4 938	32
406235	135.9	10 535	36
407217	222.5	27 313	42
407220	101.6	5 079	15
407290	77	5 379	13
408202	139.7	1 791	16
408206	120	10 307	11
415220	108.5	4 489	8
			Average = 24%

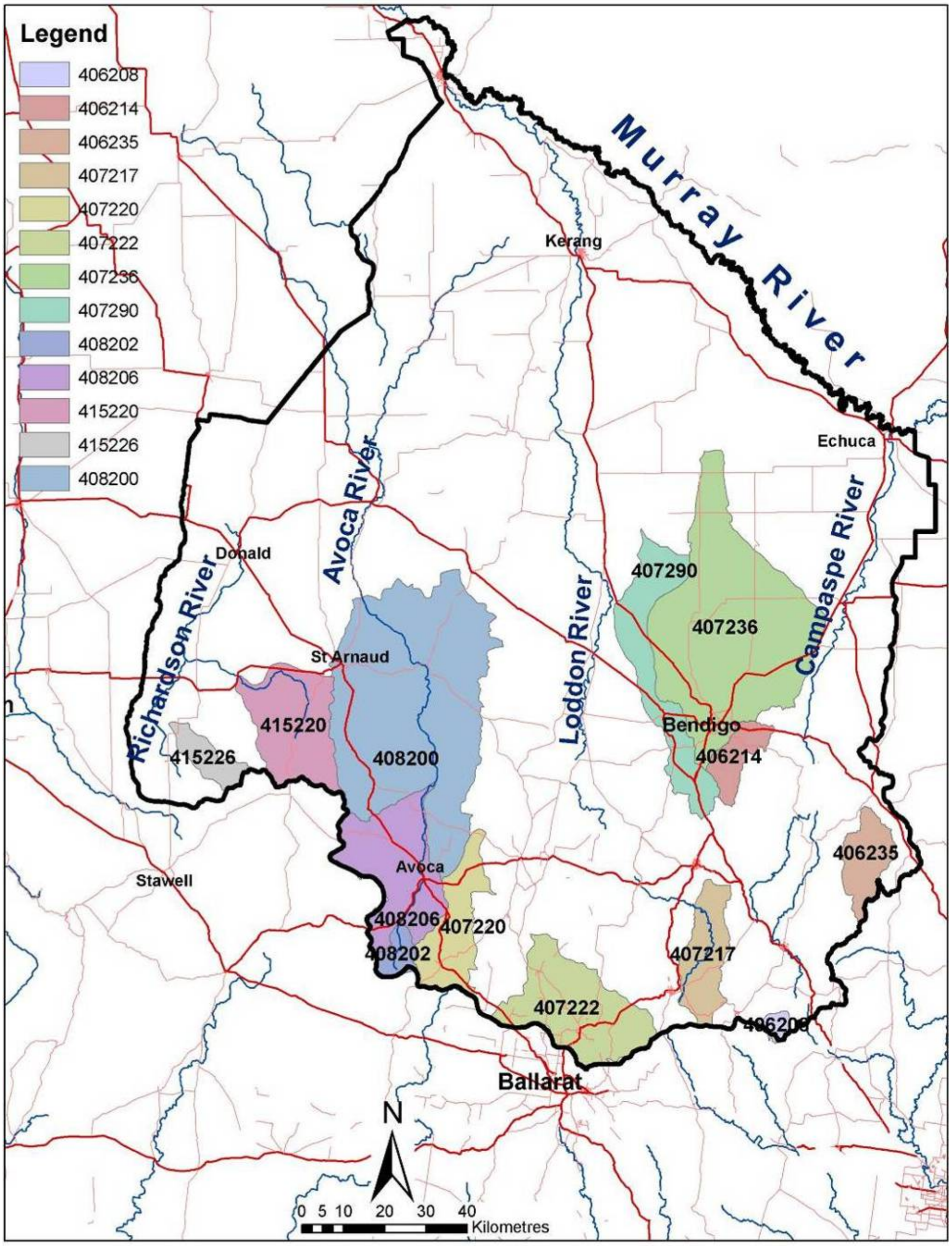


Figure 9 Gauged catchments considered for base flow analysis

Surface water – groundwater interaction

Investigation of groundwater – surface water interaction, specifically along the Murray River was undertaken to determine if groundwater level is controlled, or controls surface water level. . Figure 10 presents the location of stream gauges considered for surface water –groundwater interaction. Appendix 1 presents surface water versus groundwater level data along the Murray River. Time-series data suggests along the Murray River there is some groundwater – surface water interaction from 1990 to 2000. At Echuca (upstream of Torrumbarry weir), it is clear the Murray River contributes to the Shepparton Formation groundwater level, but not to the deeper Renmark Group aquifer. Overall, there is some surface water – groundwater interaction in the Shepparton Formation (in average climate years), but negligible direct connection with the deeper Calivil Formation or Renmark Group aquifers in the region.

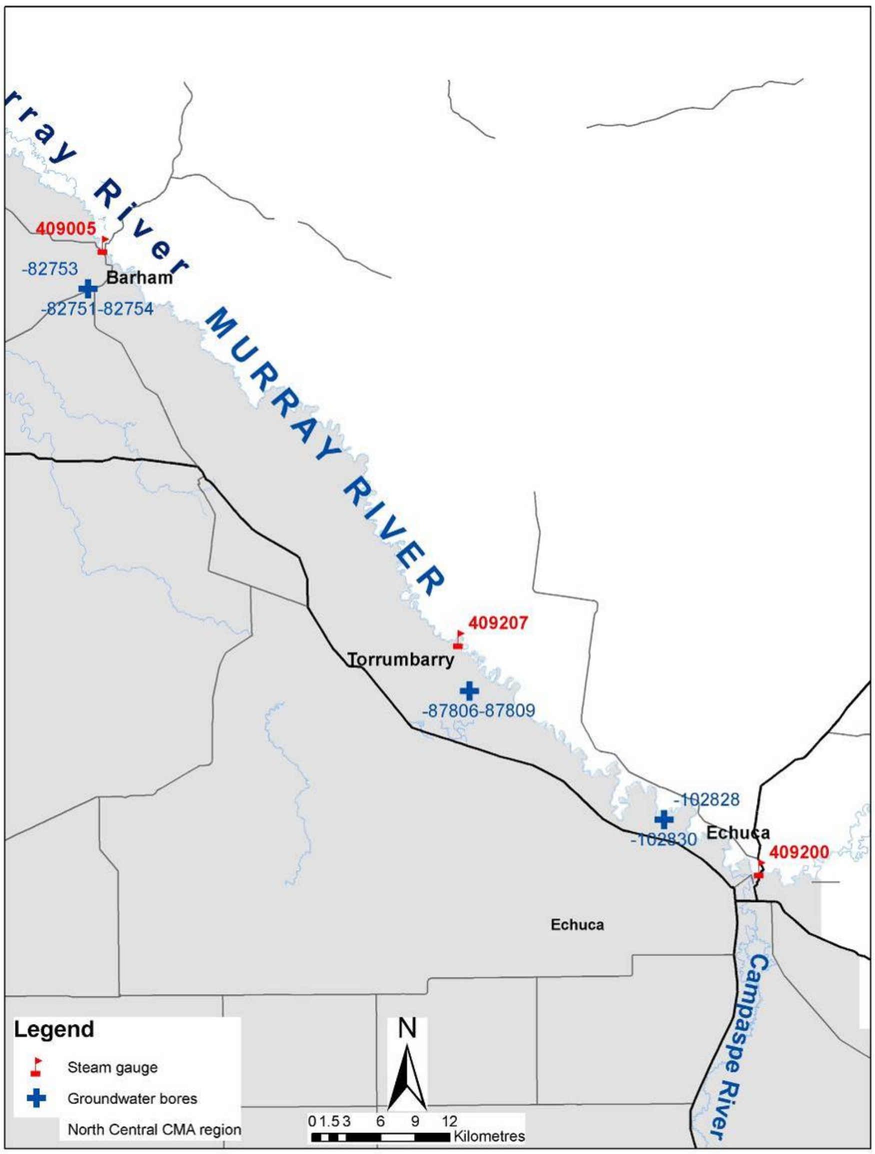


Figure 10 River gauges considered for groundwater - surface water interactions along the Murray River

2.6.3 Evapotransporation

Potential mean annual evaporation increases by more than double from south to north across the region.

Potential groundwater evapotranspiration is expected to be low in areas of dense vegetation cover (e.g. trees), as the vegetation is likely to evaporate near pan evaporation. Conversely, in areas of sparse vegetation evapotranspiration rates are low, thus allowing for a larger potential for water to evapotranspire

Spatially varying groundwater evapotranspiration at 30.4 day time steps in MODFLOW format was supplied via Ensym (Figure 11). Steady state spatially varying groundwater evapotranspiration depth was also used for this transient simulation on 30.4 day time steps at a constant rate.

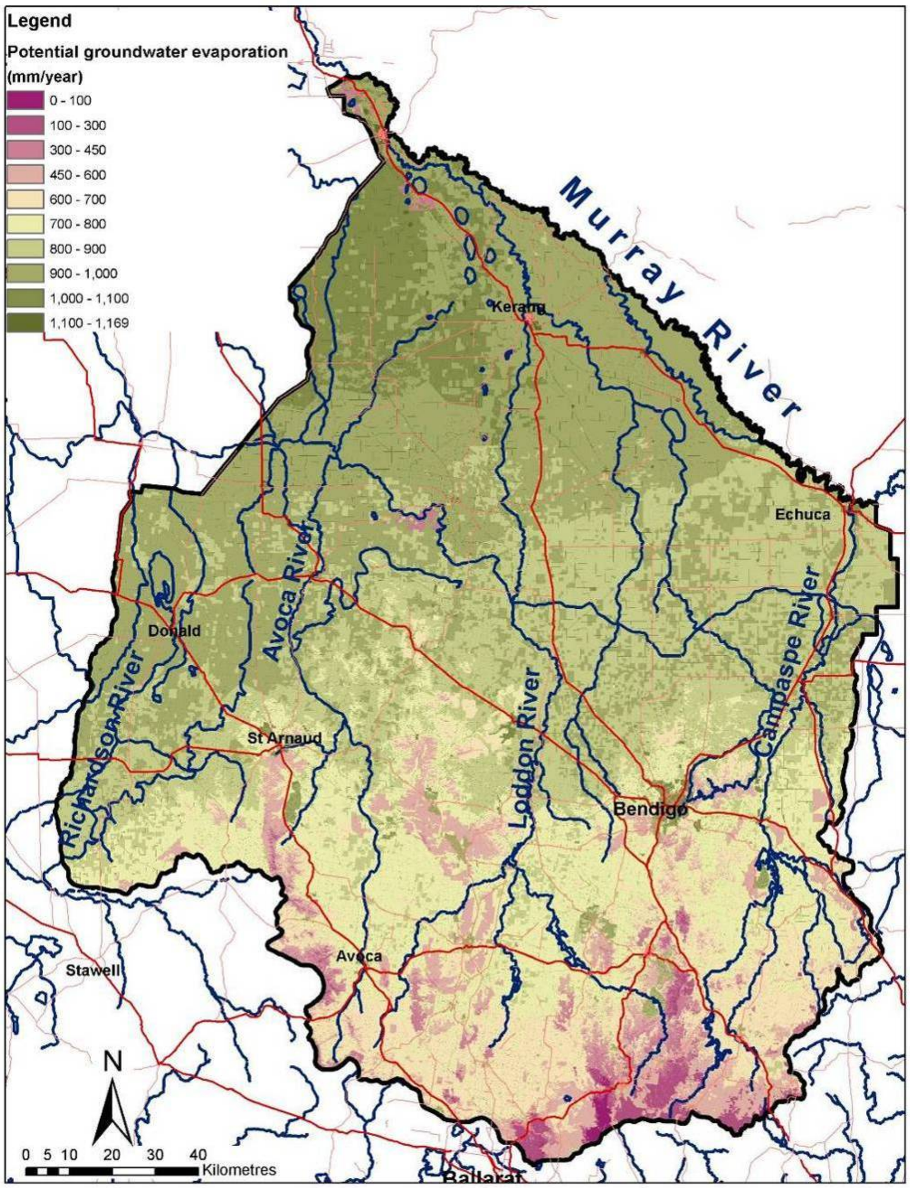


Figure 11 Ensym groundwater evaporation across the North Central CMA region

2.6.4 Groundwater usage

Within the North Central CMA region groundwater is sourced via a number of aquifers in various locations, with most pumping occurring within the Loddon and Campaspe river valleys (Figure 12). The region also spans two water management authorities—Grampians Wimmera Mallee Water to the west and Goulburn Murray Water to the east.

In the eastern region 60% of the licensed groundwater pumping volume was considered a reasonable estimation of mean annual groundwater pumping volume (pers. comm.[1]). Across the eastern region 1198 pumping wells, extracting a total of approximately 67 GL/year (60% of licensed volume) was considered (Table 2).

A groundwater pumping season was assumed to occur between December – April annually and was incorporated into the model groundwater pumping simulation in equally distributed monthly time step intervals.

Table 2 Goulburn Murray Water and Grampians Wimmera Mallee Water mean annual groundwater pumping volumes

Aquifer	Mean annual volume (ML/year)
Shepparton Formation	15 723
Quaternary basalt	7 720
Calivil Formation	32 883
Renmark Group	259
Palaeozoic basement	11 001
TOTAL	67 586

2.6.5 Surface water bodies

A number of natural and artificially filled water bodies exist in the region. To date, there has been little quantification of any surface water and groundwater interactions at these locations. It is considered the magnitude of any interaction is insignificant relative to the scale and magnitude of the overall catchment water balance and is considered a fixed feature in the landscape for the purpose of this project.

Water features such as lakes and reservoirs are not enforced in the groundwater model. That is, a shallow watertable was not enforced in the groundwater model by setting fixed head conditions. Fixed heads boundaries can enforce an artificially high zone of shallow watertable expanding well beyond the extent of the water body, producing an unrealistic potentiometric surface and water balance at each location.

[1] Brendan Cossens (Water Resources Officer, Goulburn Murray Water) April 2008.

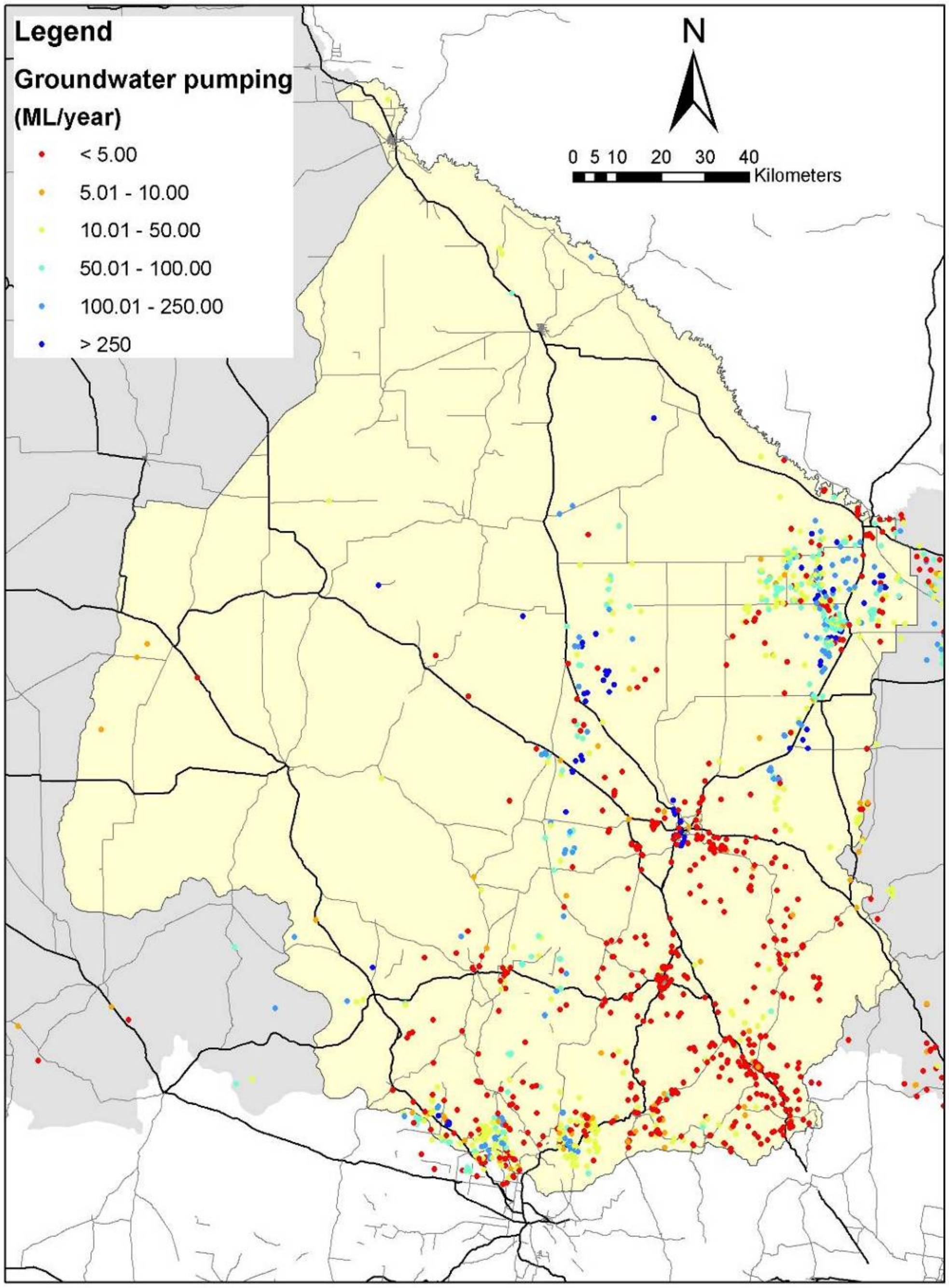


Figure 12 Groundwater pumping of the North Central CMA region (source: Grampians Wimmera Mallee Water & Goulburn Murray Water)

2.6.6 Groundwater in/outflow

Groundwater flows out of the North Central CMA region. In each instance where groundwater flow crosses the model margins, boundary conditions were established and fluxes estimated for the purpose of model calibration.

Table 3 provides a summary of total groundwater flow from the dominant aquifers in the region. Appendix 2 presents cross-section flow estimates, transect locations and groundwater bores considered.

Table 3 Groundwater flow calculations for dominant aquifers

Aquifer	Total groundwater outflow (ML/year)
Shepparton Formation	2 263
Parilla Sand	3 305
Calivil Formation	15 856
Renmark Group	6 566
Palaeozoic basement	493
	TOTAL = 28 483

2.7 Hydrogeology

2.7.1 Regional setting

The North Central CMA region of Victoria comprises the catchment of the Campaspe River basin in the east and the Loddon, Avoca, Avon and Richardson river basins further west.

The Murray River forms the northern limit of the region and the apex of the Great Dividing Range defines the southern boundary. In the east the boundary is for the most part the prominent fault controlled bedrock ridge known as the Heathcote Axis or the Mount Camel Range. In the west the boundary is less well defined by the western extremities of the Richardson River catchment on the plains of the eastern Wimmera.

The catchment's headwaters lie within the dissected Western Uplands and their rivers flow northward through the foothills and beyond to the northern plains. In the east the rivers pass through the alluvial sediments of the Riverine Plains whilst further west they pass into unconsolidated marine sediments common to the Wimmera.

2.7.2 North Central Victoria

The surface and subsurface geology of the North Central CMA region is diverse (Figure 13), ranging from the Palaeozoic metasediments and Devonian granites in the uplands through to recent geological formations of the Murray Basin along the Murray River.

The North Central CMA region of Victoria comprises at least 20 different groundwater systems. Each functions at different scales and in different geological circumstances. Fractured rock aquifers are common within the bedrock uplands, as are localised flow systems within colluvium and alluvium. Much larger aquifers comprising alluvial sands and gravels are found within the main upland valleys and further and within the northern plains. In the north and west sediment deposited during the last marine incursion forms a sheet-like body of fine sands that function as an unconfined aquifer.

The large alluvial aquifers that provide a substantive resource and groundwater abstraction are commonplace, particularly in the northern plains. Groundwater is used to supplement surface water for the purposes of irrigation and stock and domestic supplies.

Groundwater is not only a resource in the North Central CMA region: in many areas where it is saline and lies close to the land surface it can cause substantial salinity problems. Saline groundwater discharge and salinity issues are widespread throughout the region, and extend from the smaller groundwater flow systems common to the uplands through to the regional aquifers of the northern plains.

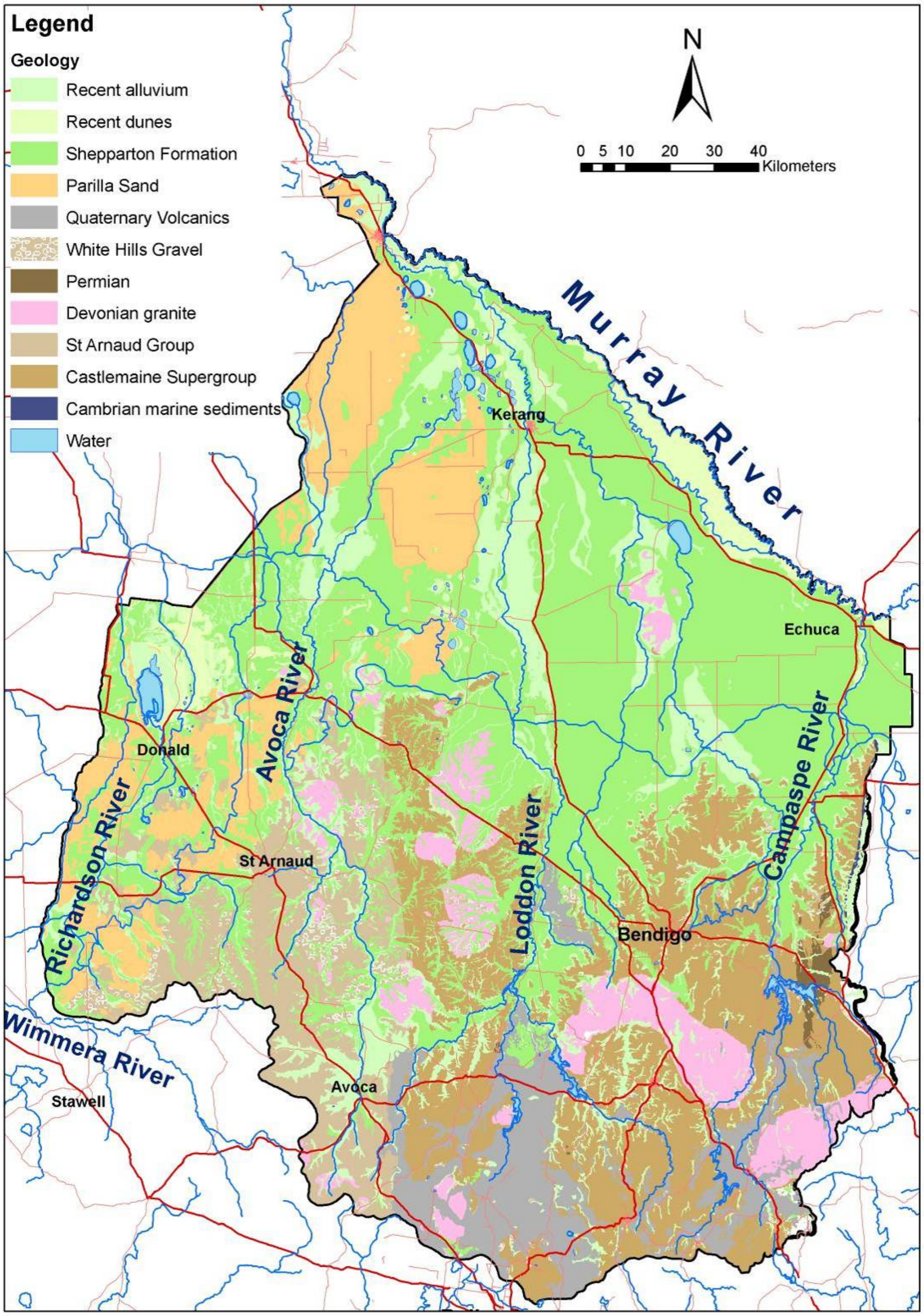


Figure 13 Surface geology of the North Central CMA region

Fractured rock aquifers of the uplands

The Quaternary basaltic rocks and Palaeozoic metasediments that comprise large areas of the bedrock uplands function as fractured rock aquifers. Localised shear zones sometimes bestow limited aquifer capacity within the granitic rocks, but fractured granite aquifers are for the most part very poor fractured aquifers.

Quaternary basalts

The Quaternary basaltic plains and scoria cones of the upper Campaspe and Loddon catchments are quite variable in their capacity as a fractured rock aquifer. In some instances fracture density is high realising substantial groundwater yields, whilst in other areas limited fracturing affords very low yields.

This variation in fracture density is problematic from the perspective of assigning hydraulic conductivity/transmissivity values to the aquifer; however, the range is probably of the order of one to 10 metres per day, and perhaps a little higher where there is intense fracturing.

In most instances the basaltic flows have filled much older bedrock valleys and, accordingly, the depth of the basalt varies laterally from as much as 50 metres near the centre of the ancient valleys, to only a few metres along the margins. The rock is commonly (but not always) in immediate hydraulic connection with underlying alluvial aquifers (deep leads).

The salinity of groundwater in the fractured basalt aquifers is usually quite low and generally less than 1000 mg/L, but in some instances it can be high and as great as 5000 mg/L. The latter usually occurs where palaeosols and weathered zones are present between successive layers in areas where multiple flows have occurred, or where the fractured rock receives groundwater from more saline aquifers.

Low salinity groundwater in basalt sustains a mineral water industry in several areas of the upper Campaspe and Loddon catchments, and most notably in the Kyneton and Daylesford regions.

Fractured metasediments

Palaeozoic metasediments comprise most of the bedrock within the Western Uplands. The rocks are tightly folded, and faults, fractures and joints bestow aquifer capacity and are ubiquitous but quite variable in extent throughout the rock mass. Open fractures in the rock are responsible for groundwater transmission as the rock has very low primary porosity.

The depth to which fracturing, and hence groundwater transmission, occurs varies with lithology and is limited by overburden pressures. Groundwater yields are normally greater 30 to 50 metres below the land surface, with yields generally falling below that depth. Very little groundwater is found at depths greater than 100 metres. There are however, exceptions, particularly in the region of large faults and shear zones. For example a groundwater observation bore drilled on the Whitelaw Fault south-east of Bendigo intersected a major fracture set at 72 metres, and the consequent yield of the bore was approximately 30 L/sec.

The fractured metasediment aquifers are typically heterogeneous and strongly anisotropic. Transmissivity along north-south fold trending axes is usually much higher than it is across the strike. Equally, local faulting and fracturing within immediate fold axes often afford zones of preferential groundwater flow.

Where local relief is steep, perhaps greater than 50 metres, groundwater flow paths within the metasediments are largely confined to the immediate surface catchment. Recharge occurs on the slopes and discharge occurs within the adjacent valley floor. Where relief is lower, however, there is opportunity for flow to occur over much larger distances and flow paths extend over distances of 30 to 50 kilometres or more. In such instances the aquifer is described as ‘sub-regional’ in scale.

Sub-regional groundwater flows in metasediments are in some instances aided by the presence of extensive fracture zones that occur in the immediate region of the larger faults. This phenomenon has been observed on the Whitelaw Fault near Bendigo, south of Marnoo in the Avon-Richardson catchment, at Moonambel in the Avoca catchment, and at Toolleen in the Campaspe catchment.

As with the fractured basalts it is difficult to assign hydraulic conductivity and transmissivity values to the fractured metasediments. The results from pump tests are generally a poor indicator because of the extreme variability from site to site. It is also difficult to assign a hydraulic conductivity on the basis of a pump test from a bore that typically intersects only one or two fracture sets, and to then extrapolate that result over the entire depth. It is perhaps even more problematic to multiply the same value by an aquifer thickness in order to derive a transmissivity. Hydraulic conductivity values of the broader rock mass, however, are generally thought to be in the range of one to two metres per day.

The extent of the fractured rock aquifer beyond the uplands remains the subject of conjecture. The metasediments form the basement rock present beneath the northern plains, but there remains considerable uncertainty regarding its capacity as an aquifer in this region. Overburden pressures together with the extensive weathering may severely limit transmissivity.

Deeply weathered fractured metasediments

Deeply weathered land surfaces dating from Early Tertiary times are present as remnant landforms throughout the northern foothills in all catchments within the North Central CMA region.

The imposition of saprolite over otherwise fractured rock reduces the transmissivity of the aquifer. It also realises a regolith that has capacity as a sink for salts introduced through rainfall and concentrated during vegetative transpiration. As a consequence, flow paths are generally shorter than in the less weathered rock and groundwater salinity is much higher. Landscapes comprising deeply weathered metasediments are, thus, normally considered to salt prone.

Saline groundwater discharges to cause severe dryland salinity issues at along the foot slopes of the Mt Camel Ranges in the Campaspe catchment, at Kamarooka in the Loddon catchment, at Burkes Flat in the Avoca catchment, and at Marnoo in the Avoca catchment.

The salinity of groundwater in deeply weathered sediments is typically of the order of 15 000 mg/L through to 25 000 mg/L. Hydraulic conductivity of the saprolite is usually of the order of 0.1 through to 0.9 m/day. Transmissivity of the underlying rock is, thus, markedly reduced depending upon the thickness of the saprolite. The latter can vary from a few metres in upper landscape positions through 30 to 60 metres in lower landscapes. This variation is attributable to the extent of dissection and removal of the remnant land surface. In some places (White Hills within the City of Greater Bendigo) the surface has been preserved by the presence of Tertiary gravels. In other areas a laterite surface has been instrumental in preserving the landform (e.g. Paradise).

Regional alluvial aquifers – deep leads

Most of the larger tributary valleys found within river basins of the uplands comprise expansive floodplains built from thick sequences of alluvial sediments. The sediments partially infill ancient valleys cut into the bedrock by the ancestral streams of the modern day rivers. Extensive coarse sand and gravel deposits are common at the base of the unconsolidated sediments and lie within trenches that were the main tracts of the ancient rivers, These ancient buried stream deposits were important sources of alluvial gold in the early mining days and, accordingly, they are known as ‘deep leads’.

The deep leads form the largest and most economically important aquifers within the North Central CMA region. In many areas of the uplands, particularly in the upper Loddon and Campaspe catchments they are buried beneath Quaternary basalt flows. In the east they are of upper Miocene to Pliocene age and comprise the Calivil Formation, whist in the far west (Avon-Richardson) they are older and appear as channel deposits within the basal Renmark Formation sediments of early Tertiary times.

The deep leads comprise an expansive and continuous interconnected network of alluvial aquifers that have the capacity to transport groundwater from the upland valleys into the Riverine Plains of the southern Murray Basin. The aquifers are large, typically buried within 30 to 50 metres below the land surface and extending to depths of more than 100 metres. In the uplands they are often less than 100 metres in width, becoming progressively more expansive as they move from the confines of the narrower uplands valleys into the northern plains.

The character of the deep leads within each of the upland valleys reflects local geological circumstances. For example, a series of east-west oriented faults appear to have influenced deposition of the deep lead in the upper Loddon. The stratigraphic data suggests the ancient river was forced to negotiate a series of horsts and graben structures that invoked stream flow environments that alternated between narrow high-energy ravines and lower energy troughs. The geographic extent of the regional aquifer appears to vary in sympathy with such structural controls.

The deep lead in the upper Campaspe Valley also appears to be influenced by recent faulting. Vertical displacement along the north-south trending Meadow Valley Fault, (or similar), interrupts the easterly passage of the Huntly Deep Lead south of Goornong. This in turn appears to sustain elevated groundwater in the region of Crabhole Creek.

Deep leads in the Riverine Plains

In moving from the uplands to the immediate Riverine Plains deep leads escape the confines of the narrow upland valleys and fan out reflecting a network of anatomising streams across the floor of the basin. In these areas expansive areas of Calivil Formation extend laterally for more than 10 kilometres and form an extensive aquifer in the region of Goornong in the Campaspe Valley (Macumber 2008), and at Barkly north of Leichardt in the Loddon Valley (Macumber 2007).

As the deep leads pass further northward into the Riverine Plains the valleys containing them are incised into the alluvial and paludal sediments of the Renmark Group. These strata form the basal sediments of the southern Murray Basin. Two units are recognised. The lowermost is the Warina Sand, a sheet-like body of coarse sand and minor gravels distributed over the bedrock floor of the basin. This varies considerably in thickness and texture in sympathy with bedrock topography.

The high energy streams responsible for the deposition of the Warina Sand in Eocene times were replaced by much lesser streams of lower energy during the late Eocene through Early Miocene times. These quieter environments of shallow lakes, low energy streams and breaks in deposition allowed for the formation of thick sequences of clay sediments rich in lignite and organic matter. These are the Olney Formation.

Stratigraphic boundaries defining the exact spatial relationships between Olney Formation and Warina Sand are not particularly well defined in the eastern part of the Murray Basin in Victoria, and it is not always clear from drilling logs which unit is being intersected.

The Calivil Formation of the lower Loddon and Campaspe valley plains is deposited within trenches cut within the upper surface of the Olney Clay. It is it is not clear whether groundwater in the Calivil Formation is in hydraulic connection with the underlying Warina Sands. The Olney Formation is known to be a confining layer to the Warina Sand beneath the marine sediments of the Wimmera, but the relationship between the two units is less clear in the eastern sector of the Riverine Plains.

Marine sediments in the north-west sector

A marine transgression in the western sector of the Murray Basin during the Early Oligocene saw shallow seas persist until the Mid Miocene regression. A further brief transgression occurred in the Late Miocene/Early Pliocene and the Murray Sea finally retreated from the basin at the end of the Pliocene.

In northern Victoria the Early Oligocene transgression resulted in the deposition of the Geer Clay and a local variant, the Torrumbarry Silt. These fine-grained clay-rich strata were established under the shallow water marine conditions that prevailed along the coastal margins extending westerly from Cohuna/Kerang along the highland front through to Wycheproof and Donald.

The Geera Clay forms a significant aquitard varying in thickness from about 50 metres to the west of Kerang through to less than 20 metres west of Donald. The Geera Clay separates groundwater within the basal Renmark Group from that in the overlying marine (Parilla) sands and, accordingly, it is referred to herein as the 'Lower Tertiary Aquitard'.

A continuous thick layer of fine-grained sand and stranded beach ridges formed as the sea retreated from the Murray Basin during the final regression. A blanket of this semi-consolidated sand, the 'Parilla Sand', up to 50 metres thick now rests over the Mologa Surface above the Geera Clay. It is the uppermost stratigraphic unit and outcrops over large areas of northern Victoria where it forms a continuous unconfined aquifer. In the North Central CMA region it is found between Cohuna/Kerang in the east and stretches to Donald in the west. It extends both northward and westward into the Victorian Mallee.

Groundwater within the Parilla Sand aquifer is saline with total dissolved salts ranging in concentration from about 20 000 through to about 30 000 mg/L. In some areas, saline groundwater discharges to landscape depressions forming salinas. Some of these are natural (primary), whilst others are relicts of past episodes of salinity reactivated by contemporary land use (secondary).

The Late Miocene/Early Pliocene regression drowned the deep lead channels that had cut into the Upper Renmark Group, and subsequent deposition of Parilla Sand backfilled and buried them beneath the sandy aquifer. The deep leads, thus, extend below the Parilla Sand. In regions distant from the highlands, the channels diminish and ultimately terminate. Here the deep leads discharge to the overlying unconfined Parilla Sand and the consequent dramatic reduction in transmissivity promotes regional saline groundwater discharge, and the characteristic salina/lunette complexes. These phenomena are particularly evident where the Loddon deep lead terminates in the Kerang/Cohuna region and where the Avon-Richardson deep lead terminates below the Parilla Sand west of Donald.

2.7.3 Dominant aquifers of the North Central CMA region

The dominant aquifers of the North Central CMA region are summarised as:

- Coonambidgal Formation. This formation represents the most recent phases of alluvial sedimentation in the region, generally within proximity to major river systems. The permeability of the aquifer varies both spatially and vertically.
- Newer Volcanics. Moderate permeability aquifer differs both spatially and vertically.
- Shepparton Formation alluvial sediments. Textural variation both spatially and vertically can be significant. Permeability ranges from low to highly permeable.
- Parilla Sand. Low to moderate permeability aquifer, the dominant unconfined aquifer occurring west of Boort.
- Calivil Formation. High permeability aquifer restricted to the ancestral tributaries of the Murray Plains.
- Renmark Group. Generally confined aquifer beneath the Riverine Plain. Moderate variability permeability depending on the inter-bedding of the Warina Sand and Olney Clay.
- Deeply weathered Palaeozoic metasediments. Acts as a low hydraulic conductivity aquifer generally composed of kaolinite.
- Palaeozoic metasediments. Fractured rock aquifers in fresh rock with variable permeability depending on the density of fracturing.

There are a number of well defined aquitards in the region, they are:

- Bookpurnong beds
- Geera Clay
- Winnambool beds
- Boga silt/clay

Within the context of this project and the relative stratigraphic location of these aquitards have been considered as a single aquitard unit, the 'Tertiary aquitard'.

2.8 Proposed layering system

It is important that the North Central CMA groundwater model attempts to simulate groundwater movement of all dominant aquifers in the region. The following model layers and geology groups have been aligned in a ten layer framework (Appendix 2).

The ten geology groups provide a convenient basis for the ten layers adopted in the numerical model. Table 4 presents the layers modelled in this exercise.

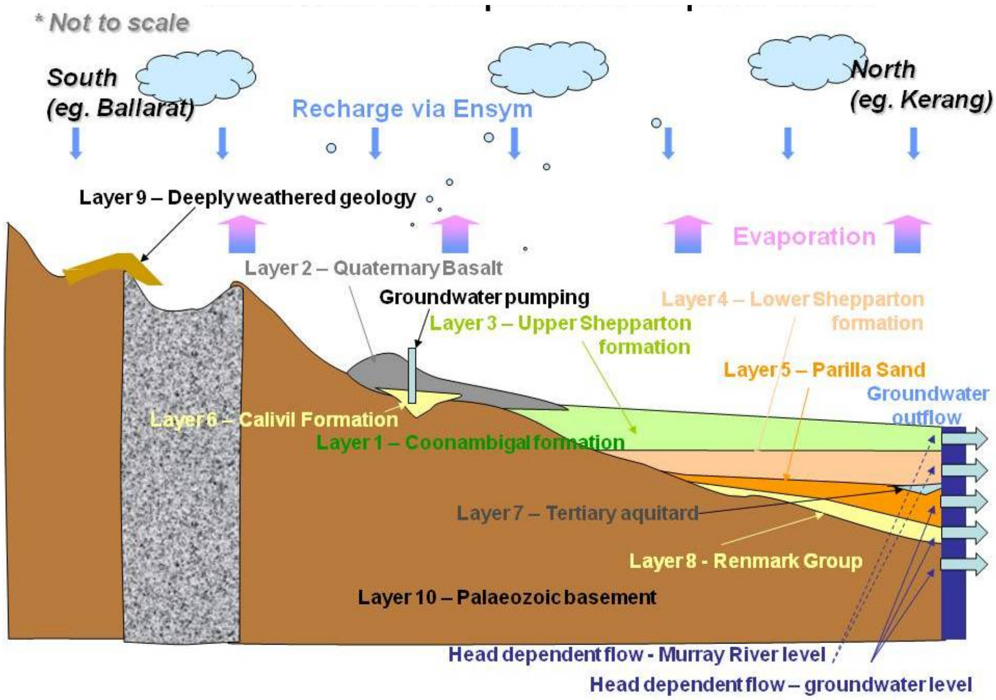
Table 4 Model layers and associated geology groups

Model layer	Geology group
Layer 1 – Recent alluvium	Coonambidgal Formation
Layer 2 – Basalt	Quaternary basalt
Layer 3 – Upper Shepparton Formation	Shepparton Formation (Shepparton Formation thickness up to 25 metres thick)
Layer 4 – Lower Shepparton Formation	Shepparton Formation (Shepparton Formation more than 25 metres thick)
Layer 5 – Parilla Sand	Parilla Sand and western Shepparton Formation
Layer 6 – Calivil Formation	Calivil Formation
Layer 7 – Tertiary aquitard	Bookpurnong beds, Geera Clay, Winnambool beds, Boga silt/clay
Layer 8 – Renmark Group	Olney Formation and Warina Sand
Layer 9 – Deeply weathered geology	Deeply weathered granite, deeply weathered Palaeozoic basement
Layer 10 – Palaeozoic basement	Palaeozoic metasediments, Devonian granite, Devonian volcanics, Cambrian metasediments, Silurian-Devonian metasediments, Older volcanics

2.9 Schematic conceptual model

A schematic conceptual understanding of the water balance and hydrogeology within the North Central CMA region is presented in Figure 14. The important water balance features considered within the model include:

- Groundwater recharge
- Groundwater inflow and outflow
- Groundwater abstraction
- Groundwater evaporation
- Groundwater – surface water interaction.



*Note: Layer structure does not illustrate the minimum thickness approach used

Figure 14 Schematic conceptualisation of hydrogeology and model layers

Table 5 presents ranges and mean of hydraulic conductivity values of model layers, this information will be used as 'reasonable' ranges of hydraulic conductivity during model calibration. These values are based upon field experience of the model developers in the region as published data is generally spatially specific.

Table 5 Expected range of hydraulic conductivity values of aquifers

Aquifer	Hydraulic conductivity range (m/day)	Mean hydraulic conductivity (m/day)
Coonambidgal Formation	0.1 – 1.0	0.5
Quaternary basalt	2.0 – 7.0	5.0
Shepparton Formation	0.5 – 7.0	4.0
Parilla Sand	0.2 – 2.0	1.0
Calivil Formation	30.0 – 120.0	60.0
Renmark Group	3.0 – 10.0	5.0
Deeply weathered metasediments	0.1 – 0.4	0.2
Palaeozoic metasediments	0.3 – 1.0	0.7

3 Numerical model design

3.1 Groundwater modelling software

Groundwater flow through the North Central CMA region was simulated using MODFLOW-96, a widely used modular finite-difference groundwater flow code written by USGS (Harbaugh and McDonald, 1996). This code was selected because of;

- its documented capabilities to simulate regional scale groundwater processes,
- its documentation and wide use (McDonald and Harbaugh, 1998; Anderson and Woessner, 1992),
- the availability of a number of third-party pre- and post-processors,
- its easily available public domain software.

This model was developed and run on a Hewlett Packard ProLiant ML350 with an Intel Xeon 2.50 GHz processors with 24.0 GB of RAM running Windows XP 64 bit software.

All model development was undertaken by Mark Hocking of Hocking et. al. MODFLOW used in this exercise has been benchmarked with MODFLOW96 provided by DSE.

3.2 Groundwater model complexity

The complexity of the North Central CMA groundwater model is consistent with the 'Impact Assessment' class described by MDBC (2000). It has moderate complexity and is suitable for predicting the impacts of proposed developments or management policies.

The model has been developed in finite difference format (regular gridding). It features a cell size of 200 metres, totalling 740 768 solution points occupying 1272 rows and 980 columns, and comprises of 10 layers and 7 407 680 active cells.

3.3 Model boundary conditions

The spatial extent of the North Central CMA region model aligns with the CMA extent. The Murray River has been specified as the northern model boundary for the purposes of this exercise. In most instances is more than 600m of native vegetation buffers the Murray River, where for the purposes of this project, is a fixed landuse and not considered for landuse change scenarios. This buffer is considered an adequate distance from the model boundary bearing in mind the hydrogeolgical complexity associated with Murray River anabranch topography and hydraulic conductivity.

The groundwater model has been developed with head dependant flow boundary conditions (third type) to simulate lateral groundwater outflow to the north and west. These conditions are consistent with hydrogeological conceptualisation previously mentioned.

All model layers with boundary conditions are set to head dependent flow (type 3). Model layer 3 and 4 (upper and lower Shepparton Formations) have been allocated to reflect groundwater flow boundary conditions resulting from water levels in the Murray River (discussed previously), where stream gauge data is used to reflect oscillating groundwater levels.

Below model layer 4 groundwater levels have been shown not to be connected to the Murray River. Lateral groundwater flow conditions in the 'deeper aquifers' have been allocated to reflect levels according to nearby groundwater observation bores.

An underlying assumption of assigning the outflow boundary conditions in this model is that any groundwater outflow from the model domain ultimately discharges into the Murray River. That is, while upper aquifers have boundary conditions linked with the Murray River water level, the deeper aquifer groundwater outflow is considered to also

discharge into the Murray River down catchment within the Murray Basin, albeit 10's – 100's down stream of the North Central region.

3.4 Model layers: Spatial extent and parameterisation

The layered approach for model layers has been used. The layered approach uses a minimum thickness of 5 meters. In locations where a model layer is not present, a minimum thickness of 5 metres and aquifer attributes of the next active layer at the location is used, where the thickness of the next active layer is 5 metres less than the total thickness (or more if more than one layer is not present). Likewise, hydraulic conductivity and storage is assigned from the underlying active layer and the Vcont is set to 1 (e.g. fully connected to underlying active layer). Figure 15 presents the layered approach for model layers graphically.

All model layers were assigned as confined/unconfined layer type, allowing MODFLOW to calculate transmissivity and storativity from simulated saturated thickness and assigned hydraulic conductivity and specific storage values.

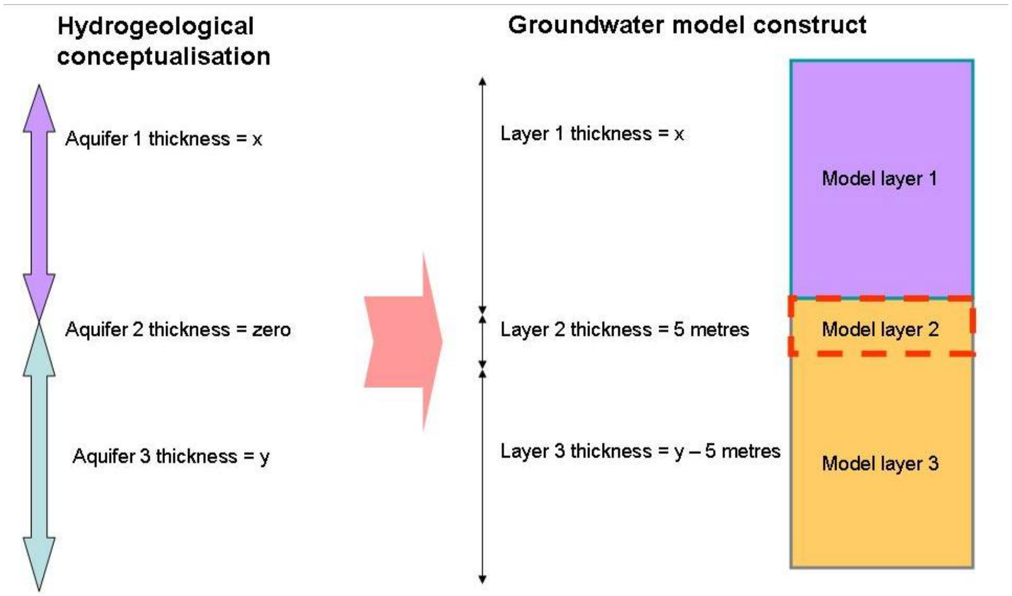


Figure 15 Layered approach used for model build

3.5 Model layer's spatial extent and parameterisation

3.5.1 Layer 1 (Coonambidgal Formation)

Model layer 1 is bounded by the Murray River (Figure 16). Layer 1 is unconfined and bounded by river stage levels, and no lateral flow boundaries due to the local natural of the aquifer.

3.5.2 Layer 2 (Quaternary basalt)

Model layer 2 has no lateral flow boundary conditions assigned (Figure 17).

3.5.3 Layer 3 (upper Shepparton Formation)

Model layer 3 is bounded by surface water levels at the interface of the Murray River (Figure 18). Layer 3 is variably confined/unconfined with head dependent flow boundaries associated with the Murray River and in other locations determined based upon groundwater observation bore levels.

3.5.4 Layer 4 (lower Shepparton Formation)

Model layer 4 is bounded by surface water levels at the interface of the Murray River (Figure 19). Layer 4 is variably confined/unconfined with head dependent flow boundaries allocated in locations where groundwater outflow occurs.

3.5.5 Layer 5 (Parilla Sand)

Model layer 5 is bounded by groundwater levels at the interface of the Murray River and along the western model extent (Figure 20). Layer 5 is variably confined/unconfined with head dependent flow boundaries allocated in locations where groundwater outflow occurs.

3.5.6 Layer 6 (Calivil Formation)

Model layer 6 is bounded by groundwater levels at the interface of the Murray River (Figure 21). Layer 6 is variably confined/unconfined with head dependant flow boundaries allocated in locations where groundwater outflow occurs.

3.5.7 Layer 7 (Tertiary aquitard)

Model layer 7 has no head dependent boundary assigned (Figure 22).

3.5.8 Layer 8 (Renmark Group)

Model layer 8 is bounded by groundwater levels at the interface of the Murray River and along the western model extent (Figure 23). Layer 8 is variably confined/unconfined with head dependent flow boundaries allocated in locations where groundwater outflow occurs.

3.5.9 Layer 9 (deeply weathered Palaeozoic geology)

Model layer 9 has no boundary conditions (Figure 24).

3.5.10 Layer 10 (Palaeozoic basement)

Model layer 10 is bounded by groundwater levels at the interface of the Murray River and along the western model extent (Figure 25). Layer 10 is variably confined/unconfined with head dependent flow boundaries allocated in locations where groundwater outflow occurs.

3.5.11 Uppermost active layers

Figure 26 presents the uppermost active layers for the North Central groundwater model.

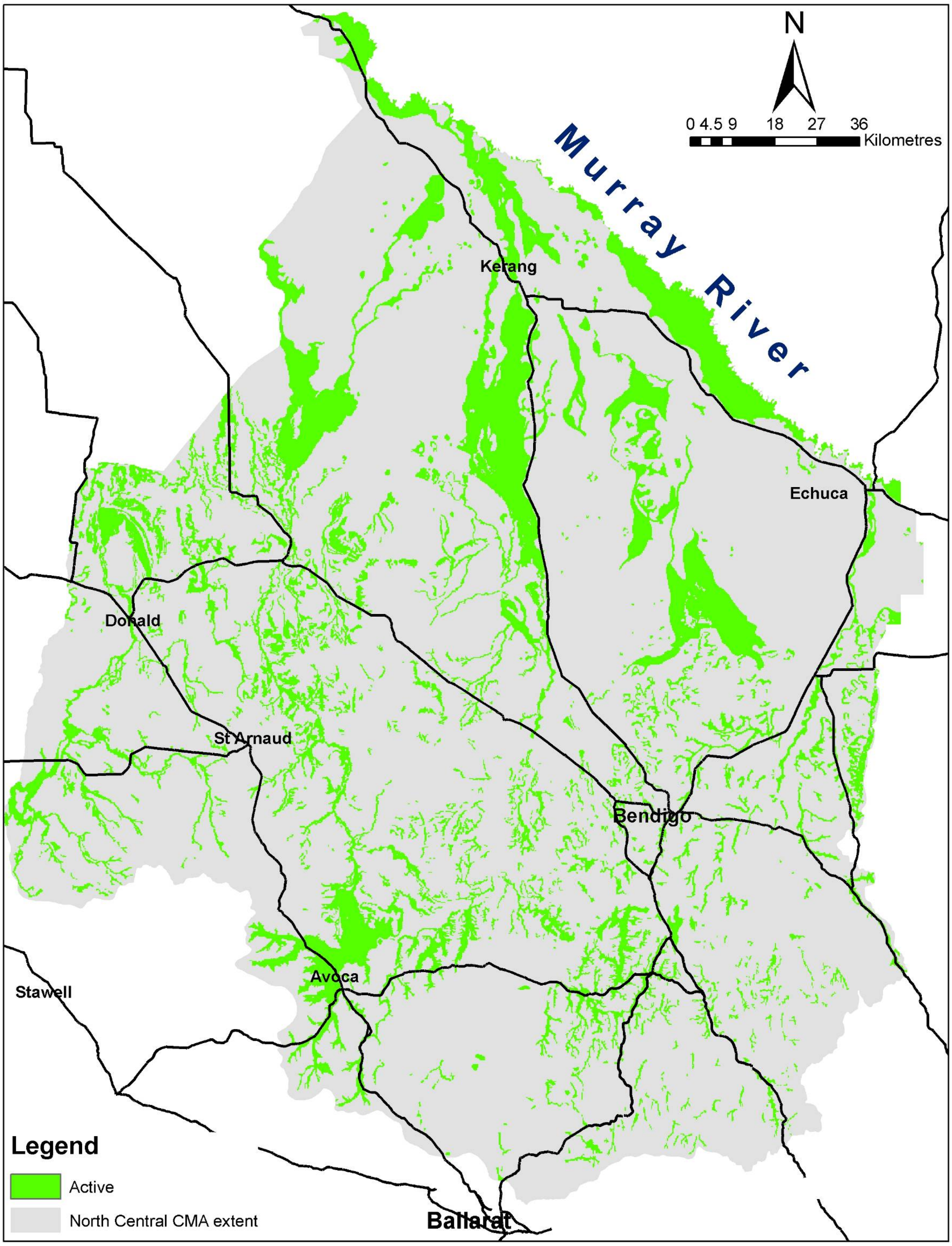


Figure 16 Layer 1 extent and flow boundary conditions

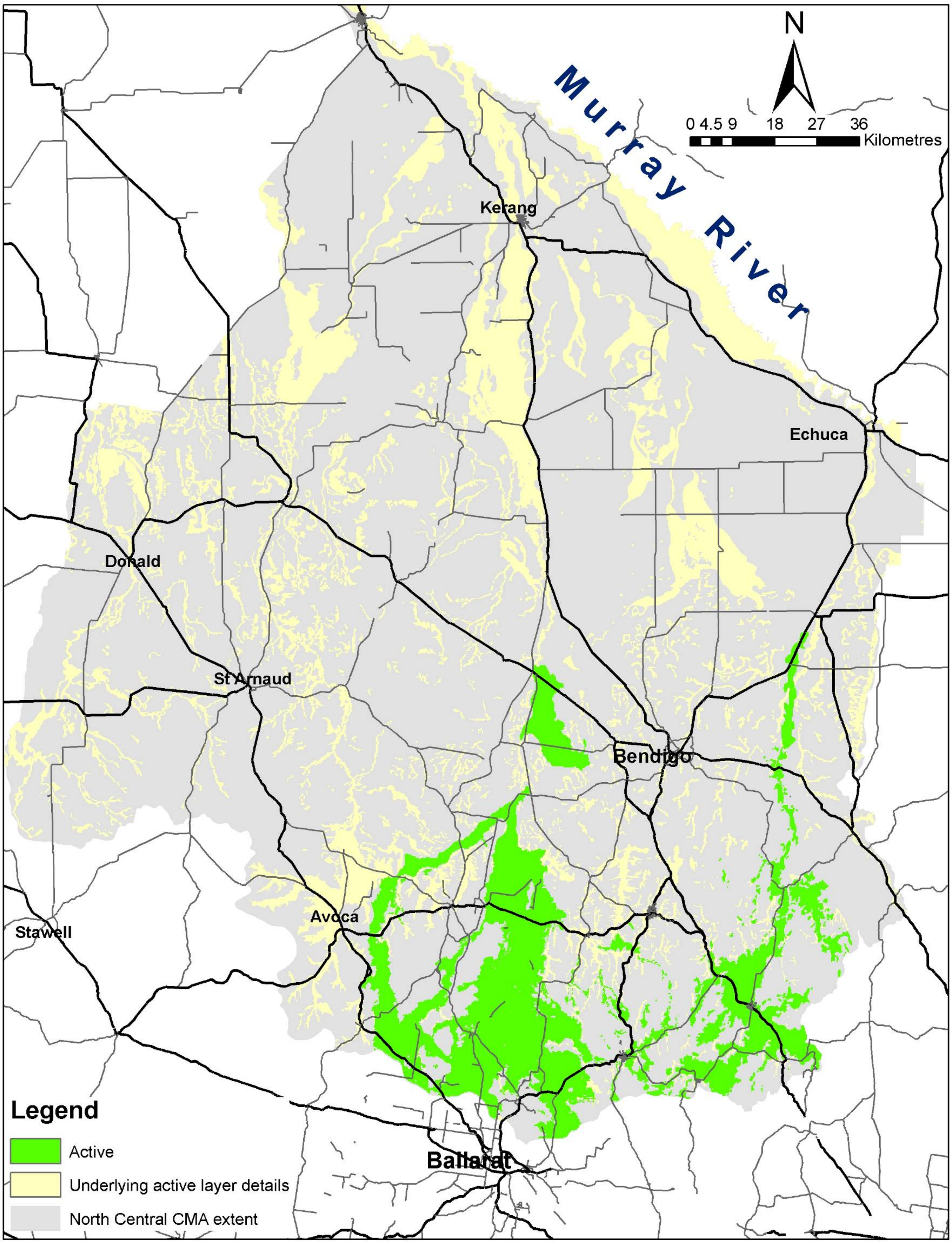


Figure 17 Layer 2 extent and no boundary conditions

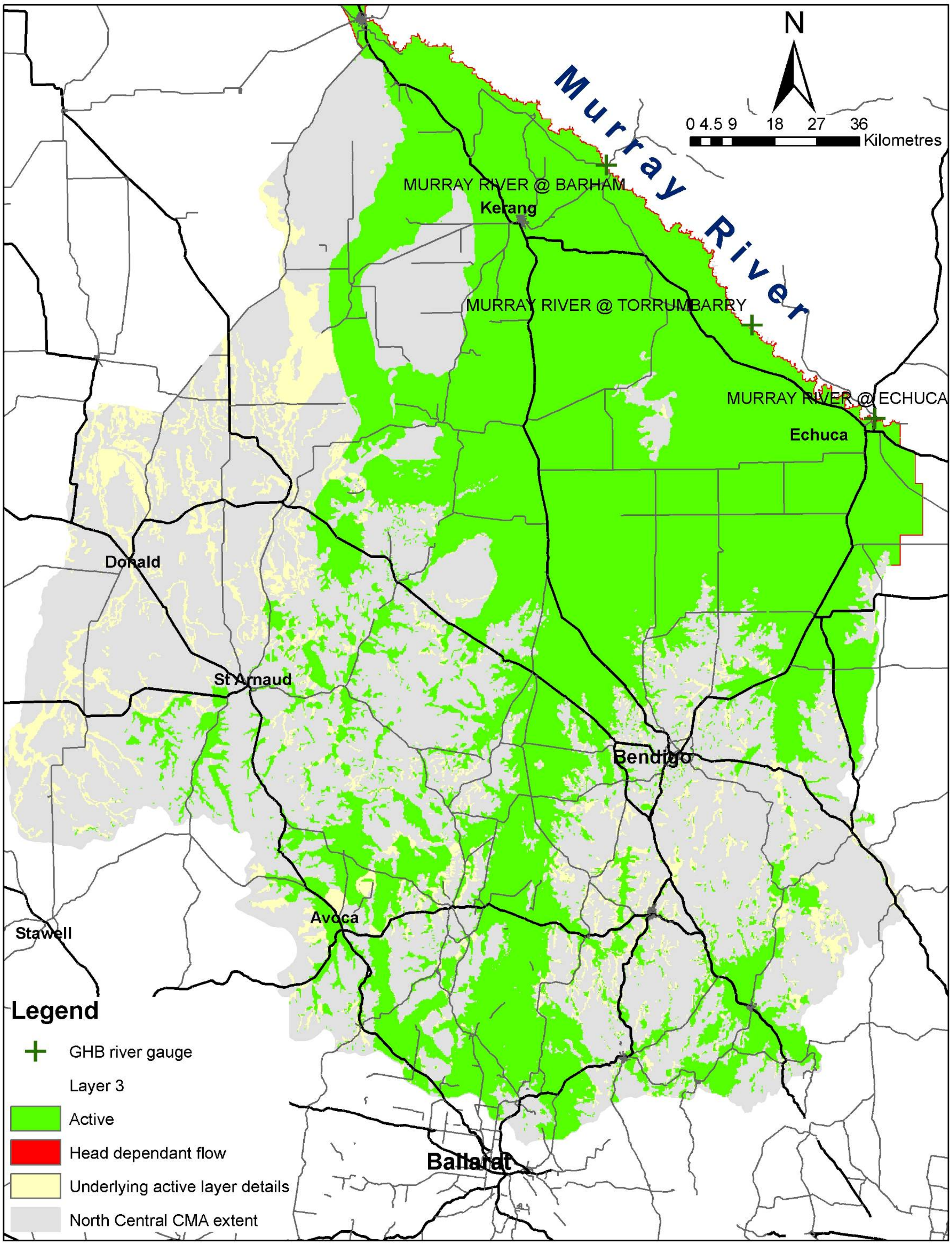


Figure 18 Layer 3 extent and outflow boundary conditions

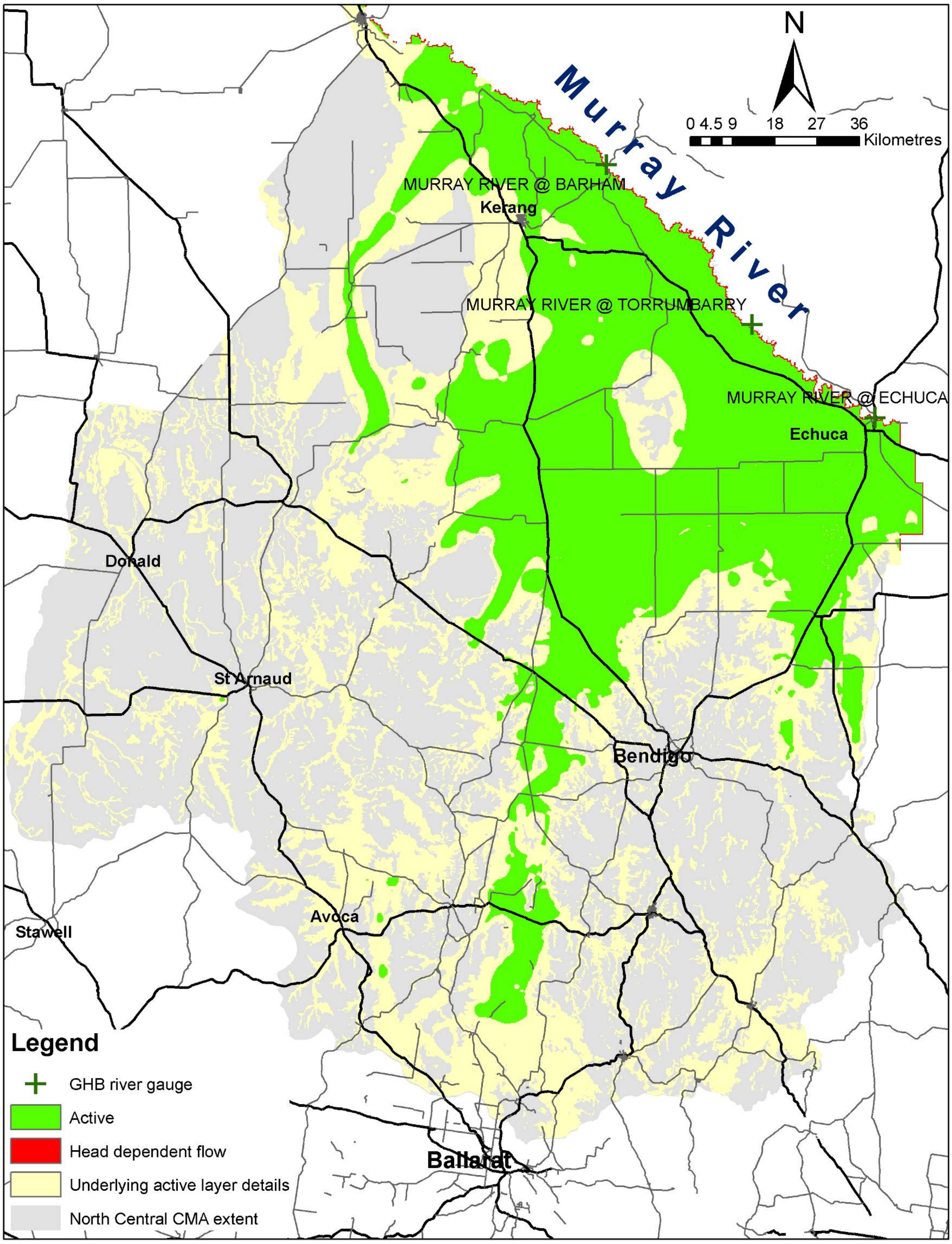


Figure 19 Layer 4 extent and outflow boundary conditions

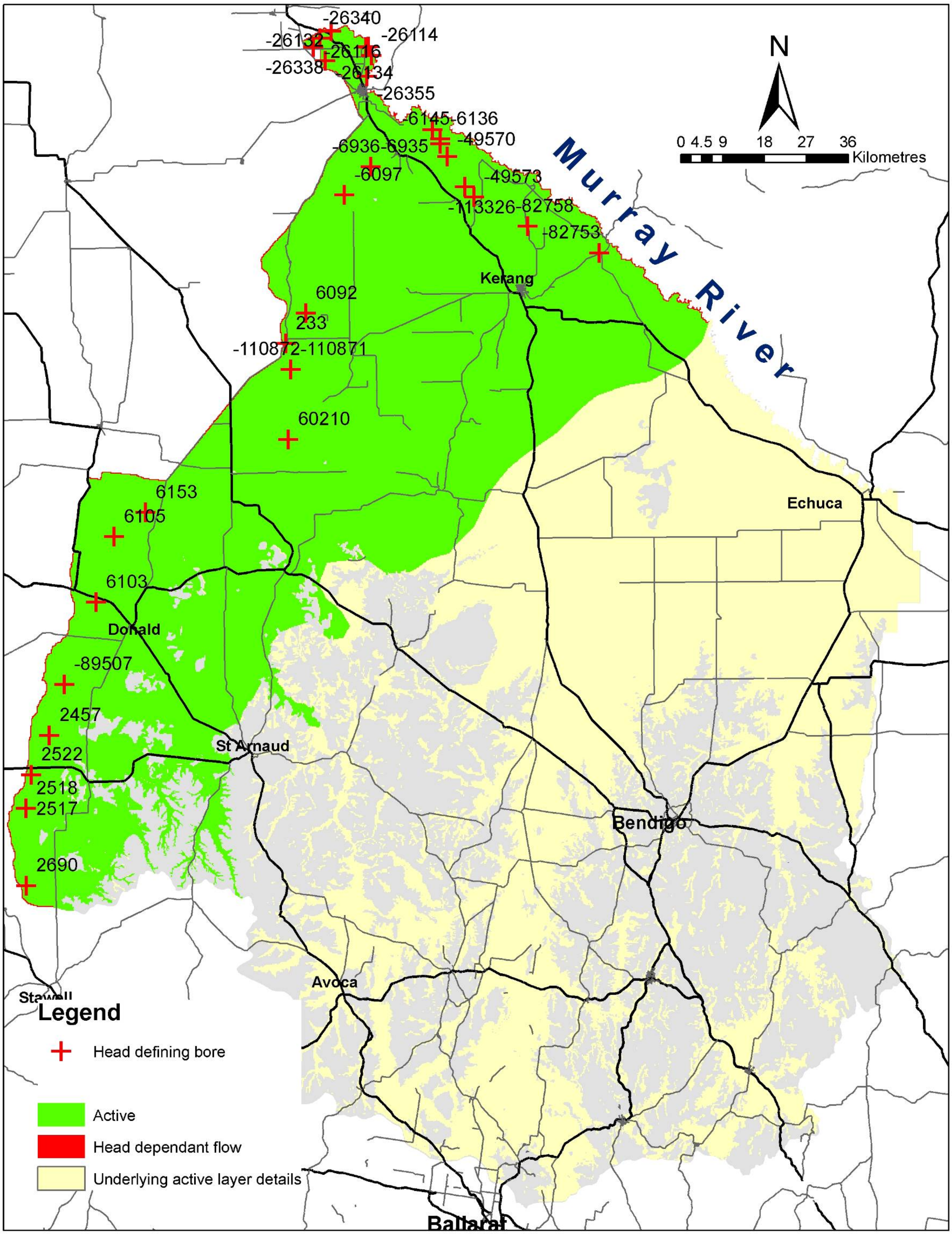


Figure 20 Layer 5 extent and outflow boundary conditions

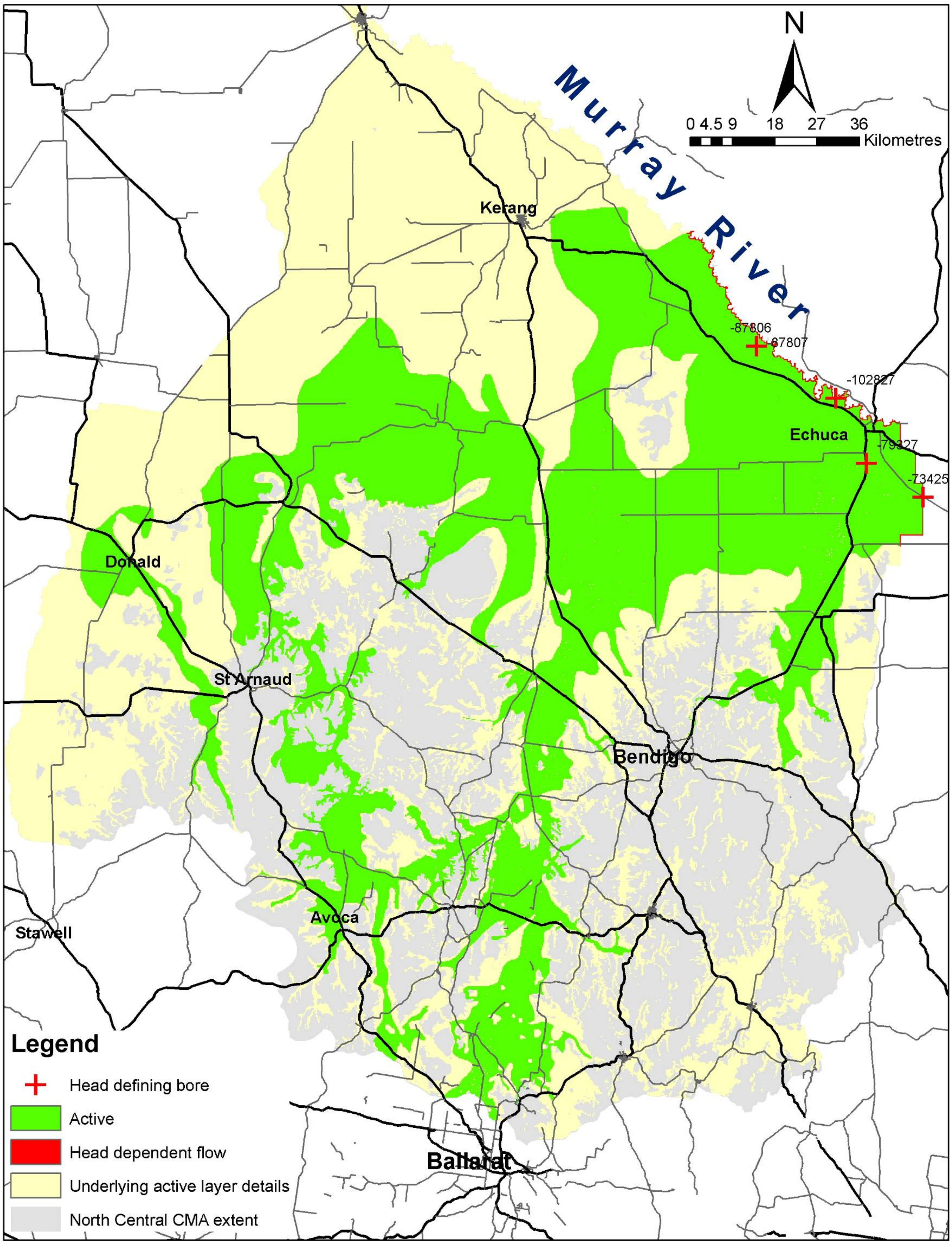


Figure 21 Layer 6 extent and outflow boundary conditions

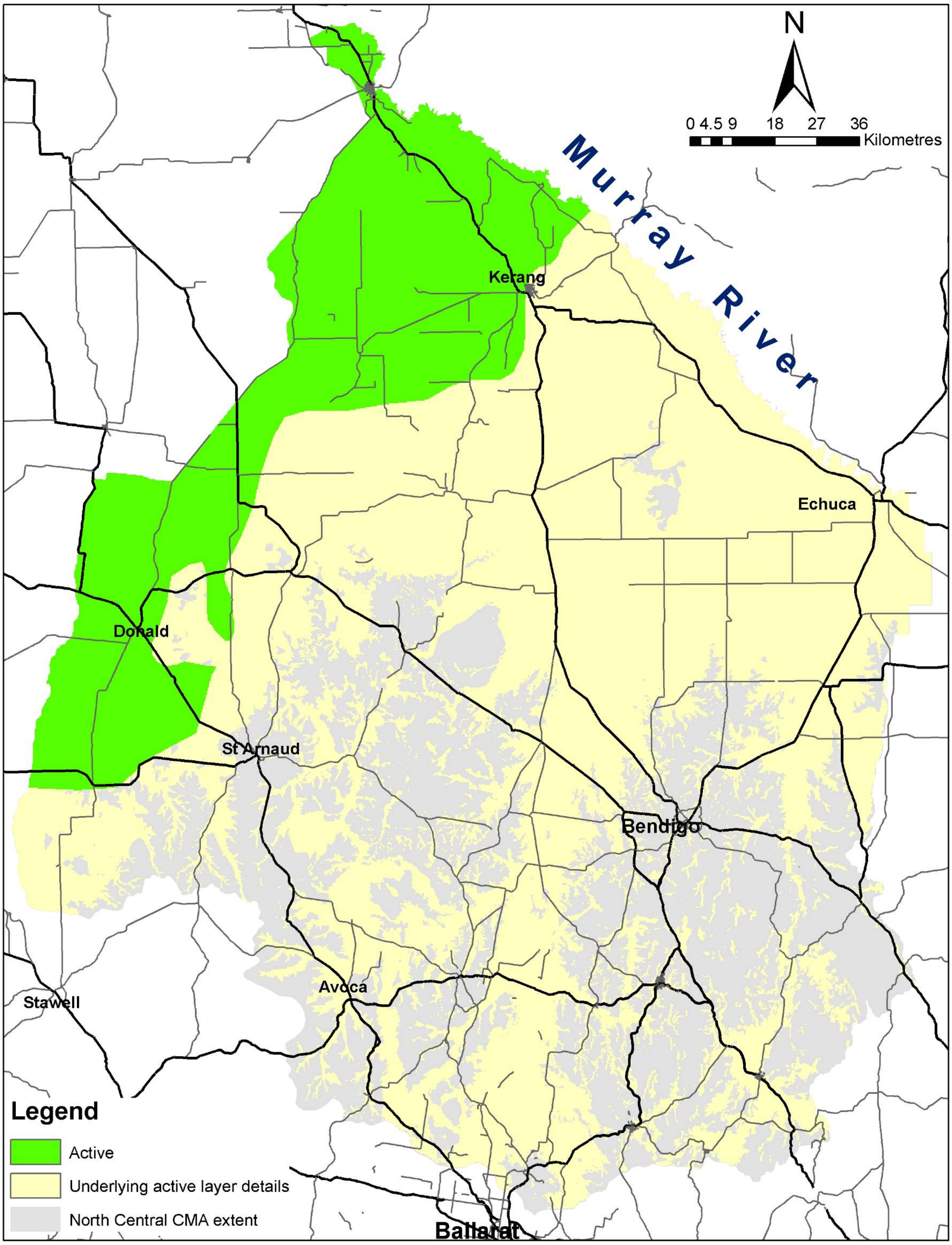


Figure 22 Layer 7 extent and no boundary conditions

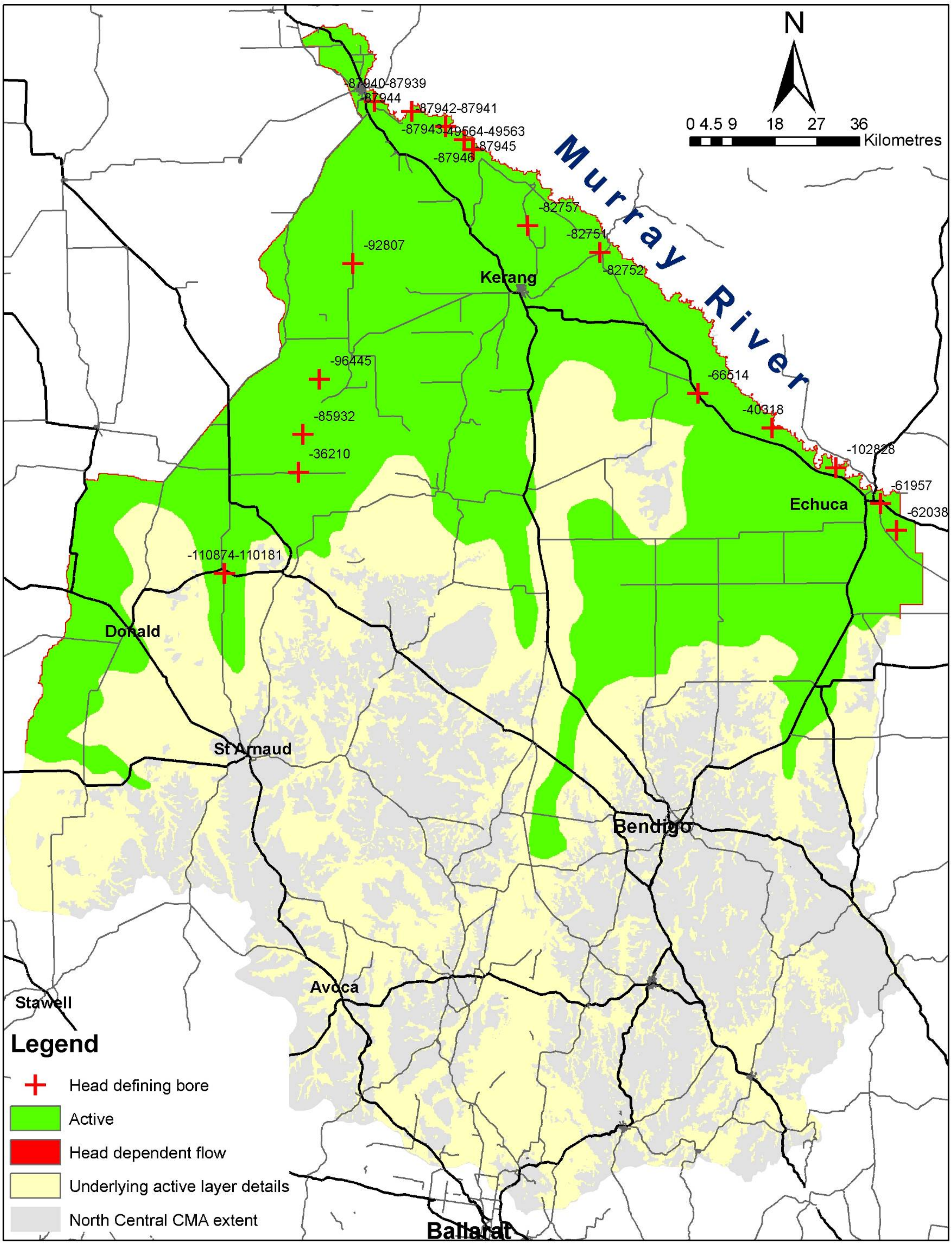


Figure 23 Layer 8 extent and boundary conditions

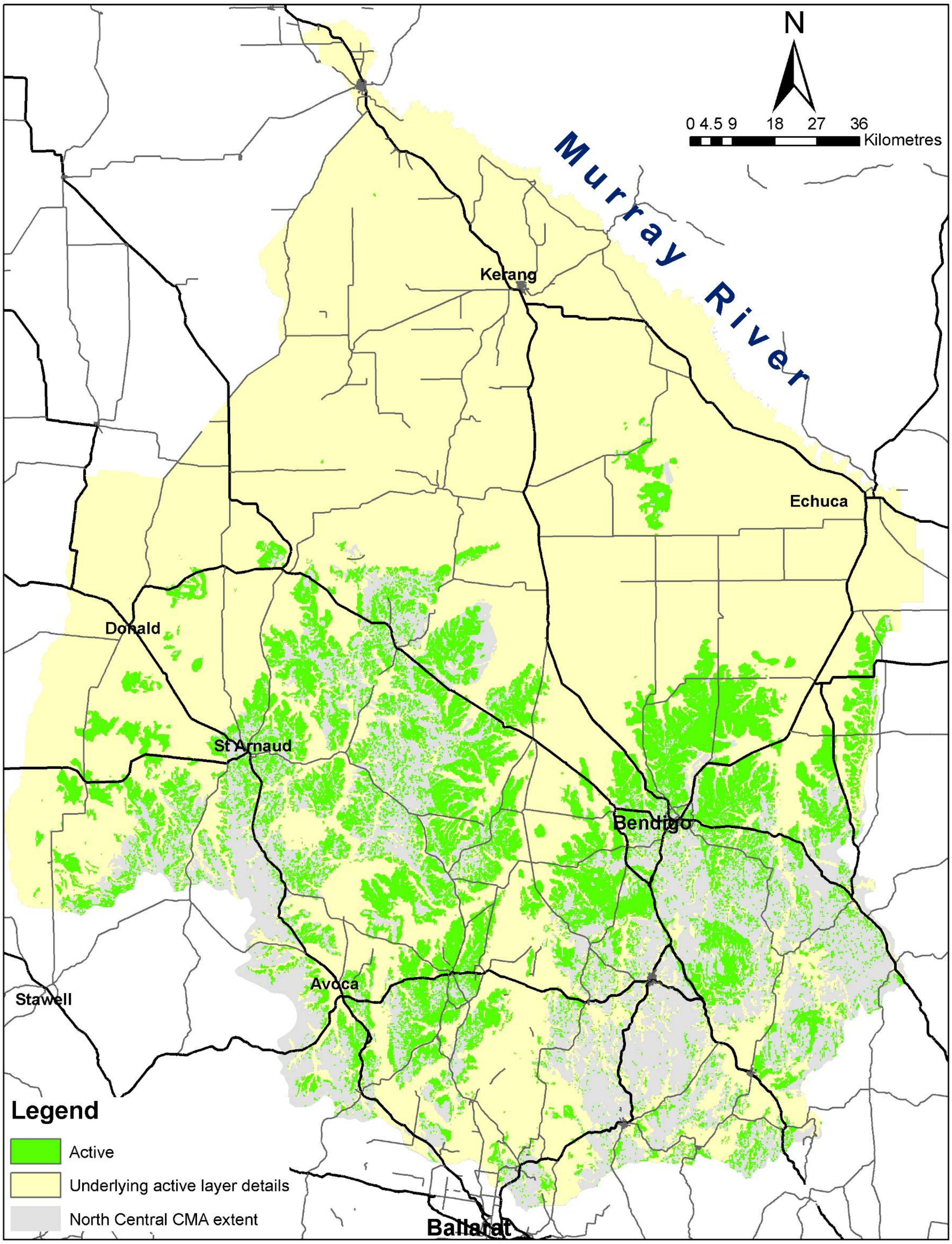


Figure 24 Layer 9 extent

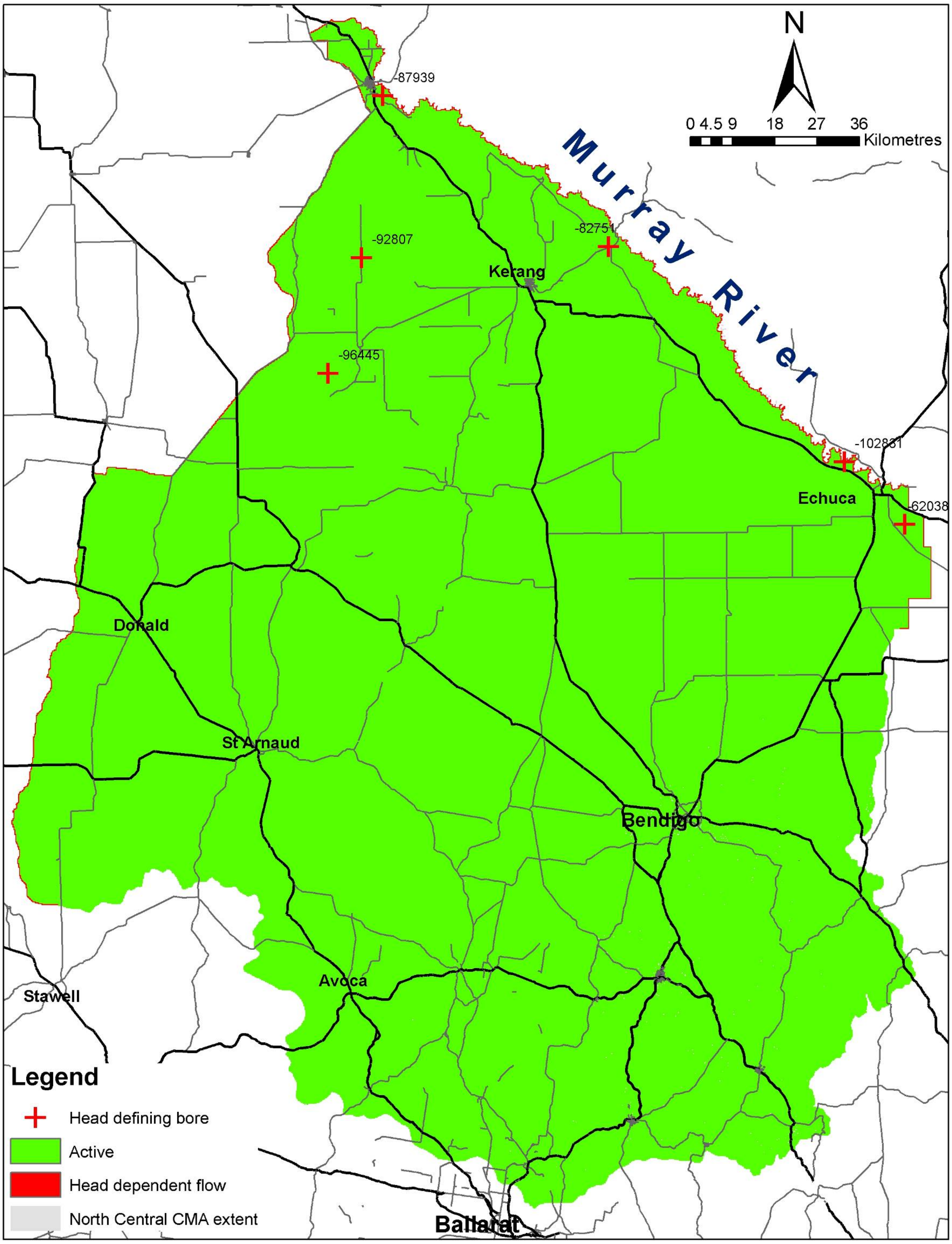


Figure 25 Layer 10 extent and boundary conditions

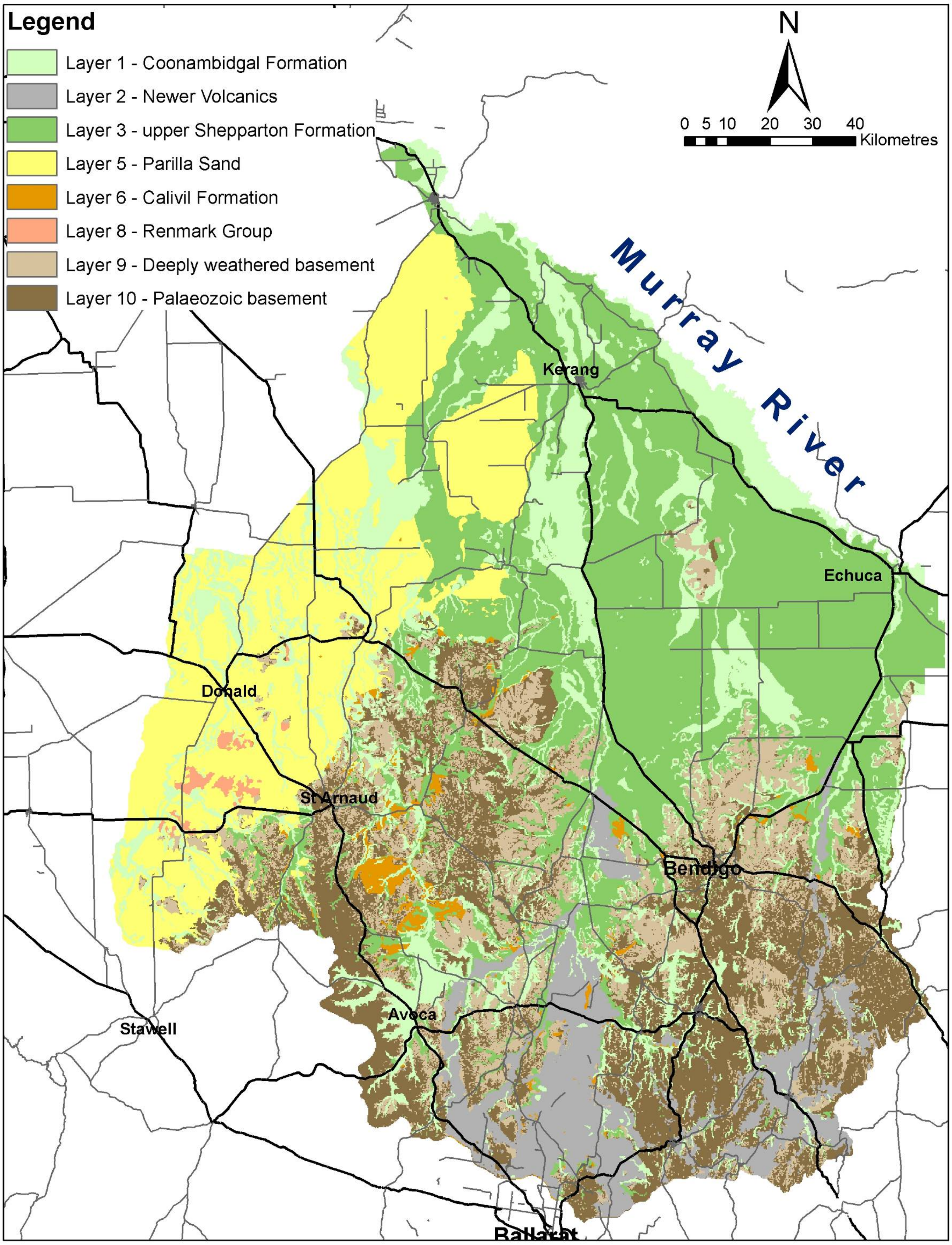


Figure 26 Uppermost active model layers

3.6 Model recharge and discharge features

The following section describes the input and output features of the North Central CMA groundwater model.

3.6.1 Groundwater abstraction

Described previously, the annual licensed volume of each groundwater pumping bore was supplied by Goulburn-Murray Water (October 2008), where 60% of the licensed annual abstraction volume was considered as a reasonable mean annual extraction volume.

Groundwater pumping volumes in the Grampians Wimmera Mallee Water service area were supplied as a five-year average at individual bore extraction sites.

3.6.2 River features

Three hydrological settings were considered in accounting for surface water and groundwater interactions. These are average river width, the depth of incision below the natural surface and an estimate of the depth of water in the river. The classification was limited by the attribution assigned to the 1:25 000 hydrology network on the DSE geospatial database. Hydrology varies between gaining and losing streams. Table 6 summaries the generalised properties from each stream 'type' considered in the model.

Table 6 Groundwater-surface water dynamics settings

	Average river width (m)	Incised river bed depth below surface (m)	Default river stage (m) above river bed
Major waterway	20	12	3.0
Tributary	5	5	0

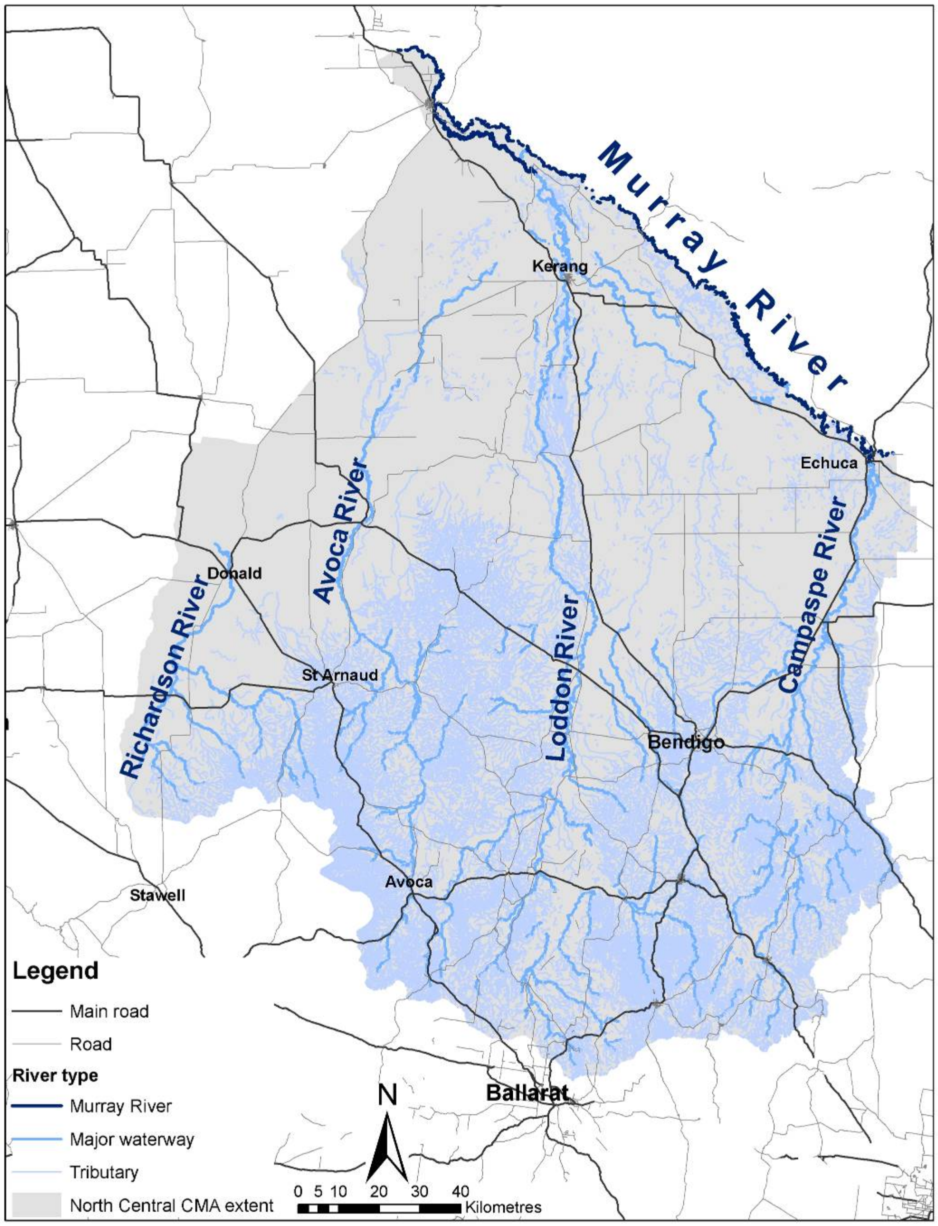


Figure 27 River types and locations considered in the North Central CMA model

3.6.3 Drainage

Drainage was allocated over the entire model domain (e.g. every uppermost active cell). Drainage elevation was set at ground surface, with a uniform calibratable conductance rate (presented in Appendix 3). This ensured any artesian water (e.g. above ground surface) was removed from the groundwater model and rerouted for baseflow accounting.

3.6.4 Surface water bodies

Water features such as lakes and reservoirs were not enforced in the groundwater model. That is, a shallow watertable was not enforced by setting fixed head conditions. Rather, it was considered (but not endorsed by DSE) recharge rates supplied by Ensym were sufficient to raise groundwater levels in the vicinity of water bodies.

3.6.5 DSE supplied recharge

Spatially and time varying simulated groundwater recharge was supplied between 1990 to 2005 by DSE. Spatially varying groundwater recharge was set as a non-calibration parameter as required by DSE.

3.6.6 Evapotranspiration

Spatially and time varying groundwater evapotranspiration data between 1990 to 2005 was used. Steady-state model groundwater evaporation depth and rates were applied to the transient model. Evaporation rate and depth were used as calibratable features (unlike the steady state phase).

Figure 28 presents groundwater evaporation depth information provided by Ensym and suggested the groundwater evaporation depth ranged from 0 - ≈ 5 metres. Evaporation rate were initially provided by ENSYM, and then calibrated. Constant evaporation rates were used, ideally, time varying evaporation rates would have been applied to the temporal groundwater model if suitable information could be provided.

3.6.7 Irrigation

No irrigation was applied to the groundwater model directly. Irrigated land use was accounted for as recharge supplied by Ensym.

3.7 Model time frames

This transient groundwater model was calibrated over a 10 year period between 1st January 1990 to 31st December 1999, with a 5 year blind validation period between 1st January 2000 to 1st January 2005.

3.7.1 Stress periods

A constant stress period of 30.4 days was applied to the groundwater model throughout the duration of the model. The stress period duration was based upon available calibration data (eg. most bores are monitored monthly, at best), computational power (eg. size of files) and project objectives (eg. determined DSE).

3.7.2 BAS summary

Table 7 summaries the information used in the transient Basic (BAS) package.

Table 7 Summary of Basic package

Size of first time-step	30.4
Number of time steps	3
Time step multiplier	1.2
Starting heads	Modified from steady state head file

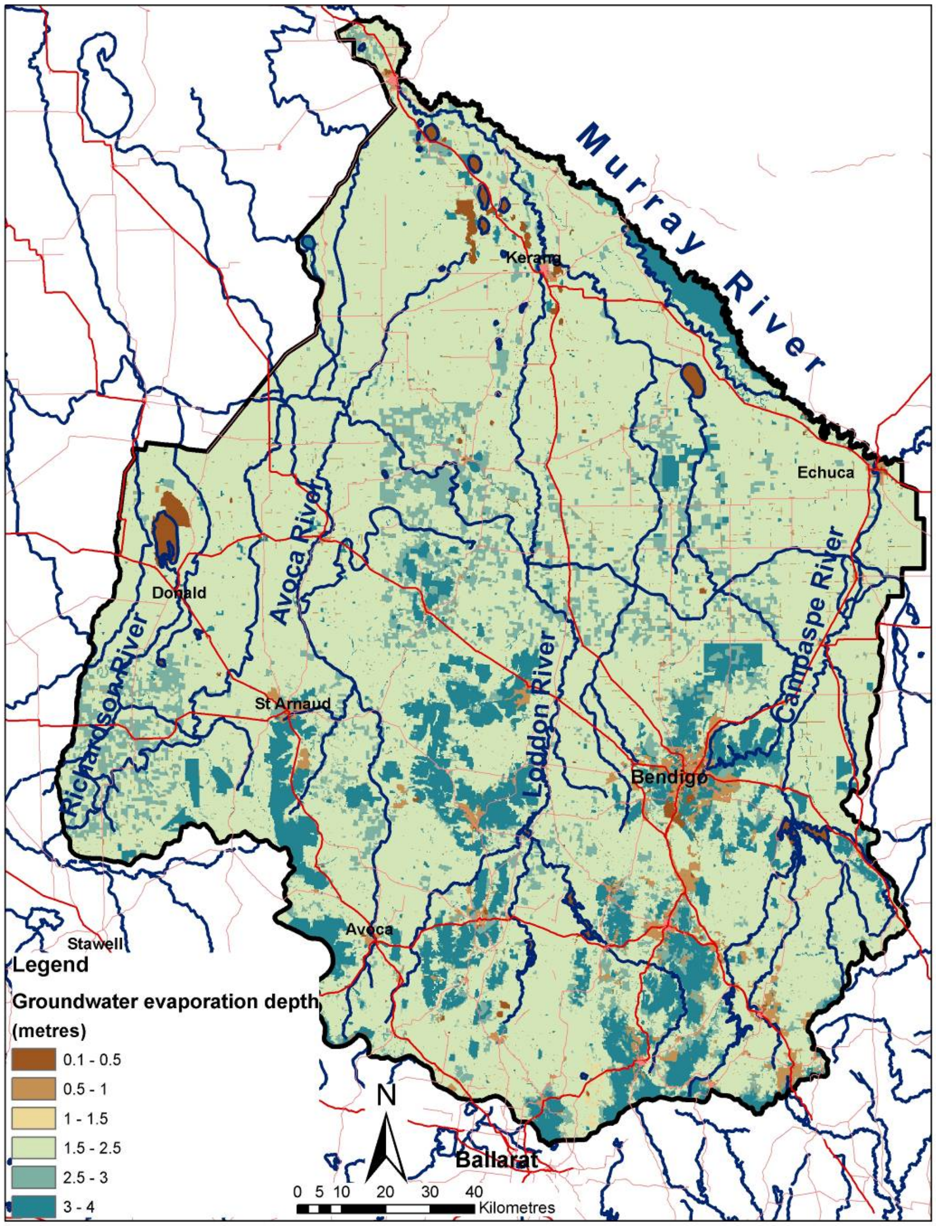


Figure 28 Ensym groundwater evaporation depth layer

3.7.3 Solver and tolerance

The SIP (Strongly Implicit Procedure) solver (Stone, 1968) was used as the MODFLOW solver. The SIP is an accepted algorithm for solving a sparse linear system of equations and was found to converge relatively fast.

A solver tolerance of 0.1 m was set, which was considered appropriate for the scale and underlying assumptions for this modelling exercise.

To ensure the model would not dry and become inactive, the MODFLOW rewetting option was used. The rewetting option allows for cells to dry and wet over-time depending on the flux at the stress period.

3.8 Assumptions and limitations

All numerical groundwater flow models have limitations. These limitations are usually associated with

- The extent of the hydrogeological understanding of the aquifer,
- Availability and accuracy of input data,
- Assumptions and simplifications used in developing the numerical model.

These limitations determine the spatial and temporal variation of uncertainties in the model, as calibration uncertainty generally decreases with increased availability of input data.

Specifically, the following assumptions have been made in developing the North Central CMA region groundwater model:

- a strongly implicit procedure solver tolerance of 0.10 m adequately addresses the scale objectives of the project
- all aquifers and model layers are considered vertically uniform
- there is limited dual porosity (eg. equivalent porous medium flow system)
- groundwater concentration gradients have negligible impact on head pressures
- bores used in the model are representative of all modelled aquifers in the region
- bores used in the model have correct aquifers attributed
- the digital elevation model (DEM) has adequate vertical resolution to allow reasonable calibration of the model and represents the land surface topology over the entire domain.

These assumptions provide a foundation for the development of the model; while there is always some level of uncertainty the best *available* data has been used to limit associated errors.

It is likely that in some areas detailed hydrogeological processes have not been fully captured in the conceptualisation because further sub-catchment investigations would be required to achieve this end.

3.9 Model calibration targets

Model calibration was undertaken by automated and manual methods to ensure aquifer parameters and calibration targets remain within acceptable ranges. Specifically, the primary calibration targets were;

- Observed versus simulated groundwater level,
- Depth to watertable of the region, and
- Groundwater baseflow volume.

4 Steady-state model solution and calibration

The first stage of the Ecomarkets project (prior to this the second stage) was to develop and calibrate a steady state groundwater model of the North Central (Hocking et al. 2010). The steady state model calibration was developed first to facilitate easier calibration because some parameters, such as aquifer storage and water level variations over time, do not need to be taken into consideration and secondly as a proof of concept.

Summary results for the steady state simulation are presented below and address all calibration targets as required for the steady state solution. The calibrated MODFLOW model for the region produced the following water balance (Figure 29). Steady-state model calibration was achieved by considering observed groundwater levels (Figure 30 & Table 8), groundwater outflow and river baseflow estimates where 1995 was considered as an 'average' and 'representative' year for steady state simulation.

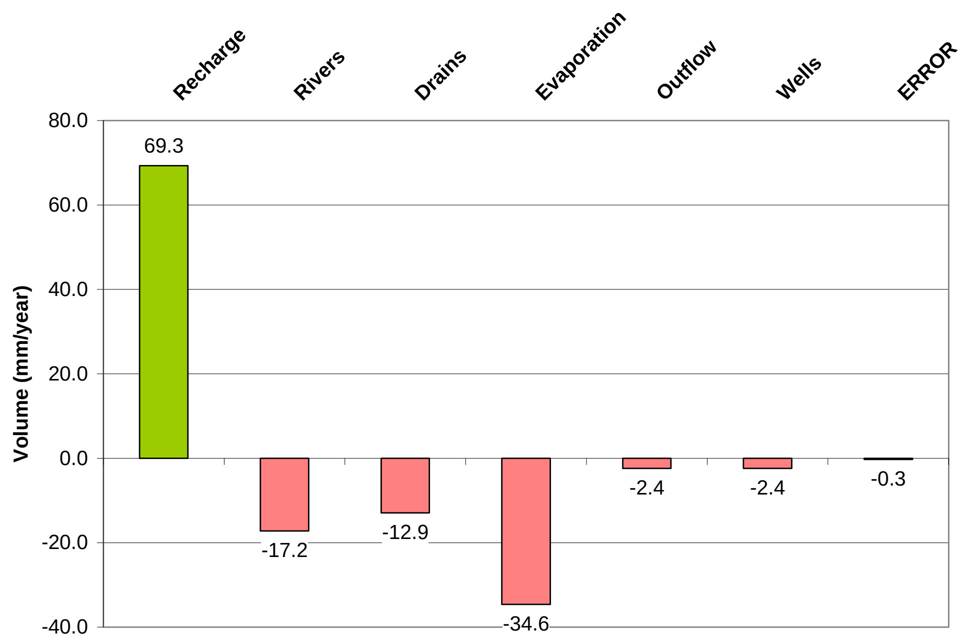


Figure 29 Calibrated steady state water balance

Steady state simulated depth to watertable (Figure 31) was considered to be generally shallower than which those occur in reality, which was a result of higher groundwater recharge rates than those which occur.

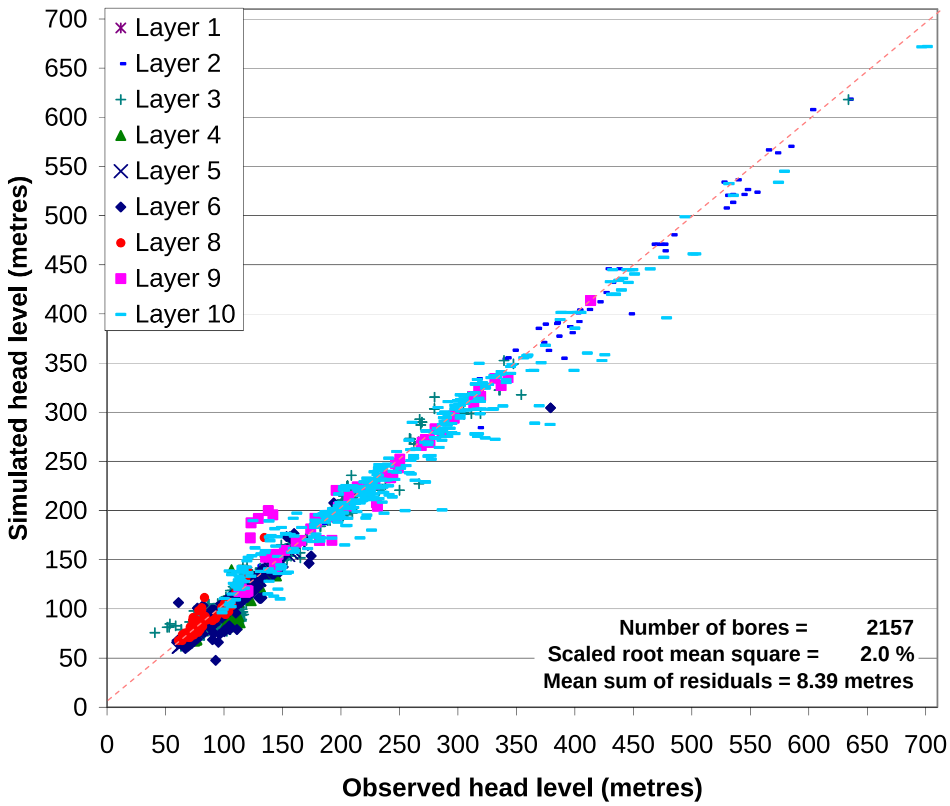


Figure 30 Simulated versus observed water level data

Table 8 Descriptive simulated versus observed water level data

Statistic	Value
Number	2157
Maximum residual	91.2 m
Minimum residual	−65.0 m
Average residual	1.7 m
Median residual	0.2 m
Mean sum of residuals	8.39 m
Scaled mean sum of residuals	1.3%
Root mean square	13.10 m
Scale root mean square (RMS)	2.0%

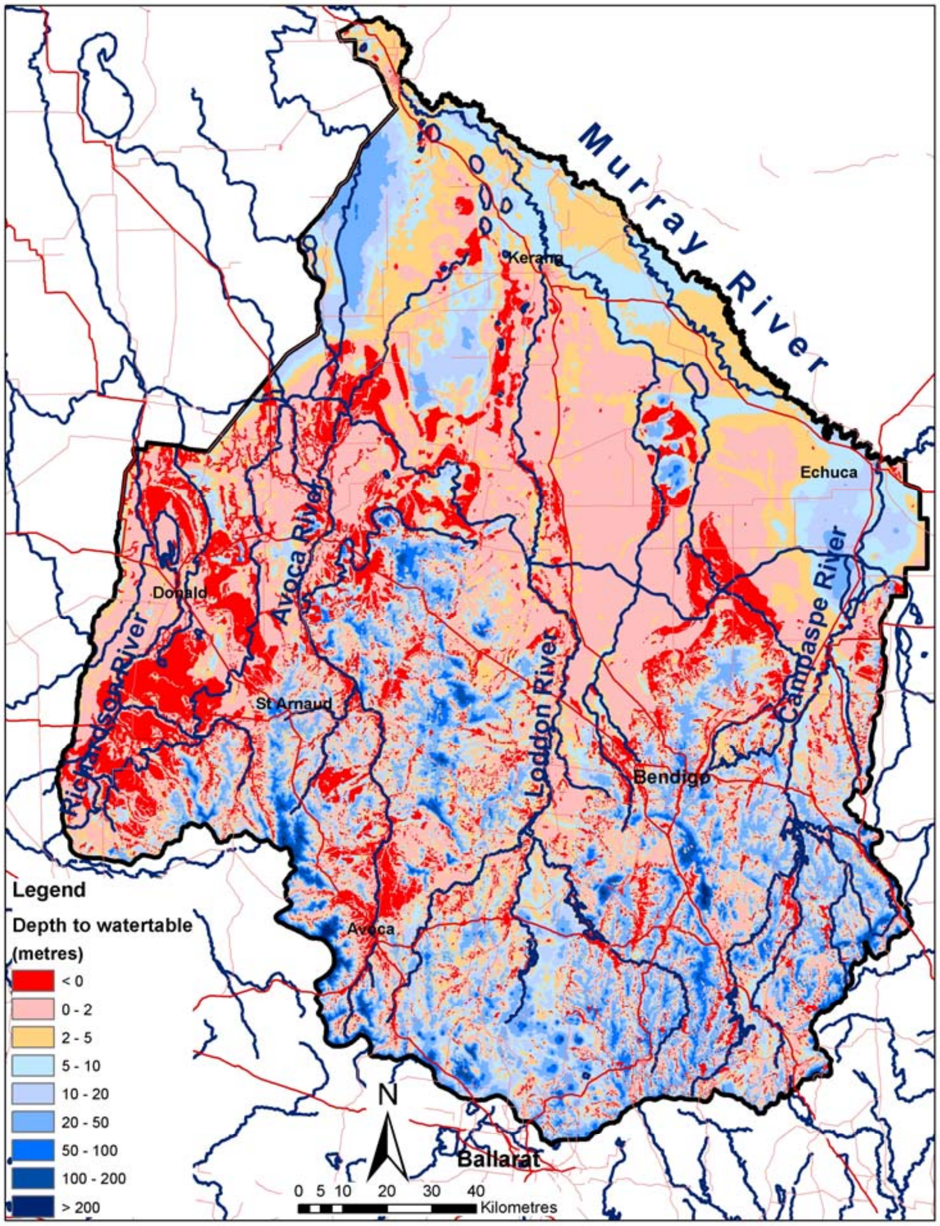


Figure 31 Steady state simulated depth to watertable

5 Transient model solution and calibration

Following calibration of the steady-state model, the model was then calibrated to simulate transient conditions during the period 1990 to 1999. Transient model calibration was achieved by considering observed groundwater levels and depth to watertable (visual analysis), the results of which are discussed in the following sections. Individual calibrated model layer attributes are presented in Appendix 4.

5.1 Observed groundwater level

Comparison of simulated with observed groundwater level for each model layer was undertaken over time. To ensure no bias of statistical data would occur during model calibration all available groundwater modelling bores were considered.

One of the project objectives relates to simulating change in shallow watertable level, for this reason calibration plots relative to depth to watertable have been made. This information provides a better indication of the likely accuracy of the groundwater model to simulate groundwater relative to depth to watertable.

A total of 3815 groundwater observation bores were selected for calibration (all in catchment) for calibration (excluding the 115 GHB bores). However, 3480 were used for statistical analysis as the remainder identified the monitored layer as being either inactive at these locations, or had less than three data points for calibration purposes.

Figure 32 presents residual frequency distribution data between 1990 - 2005 period. Results generally show a normalised distribution, with the exception of a few sites which under predict the water level in the Lower Campaspe region.

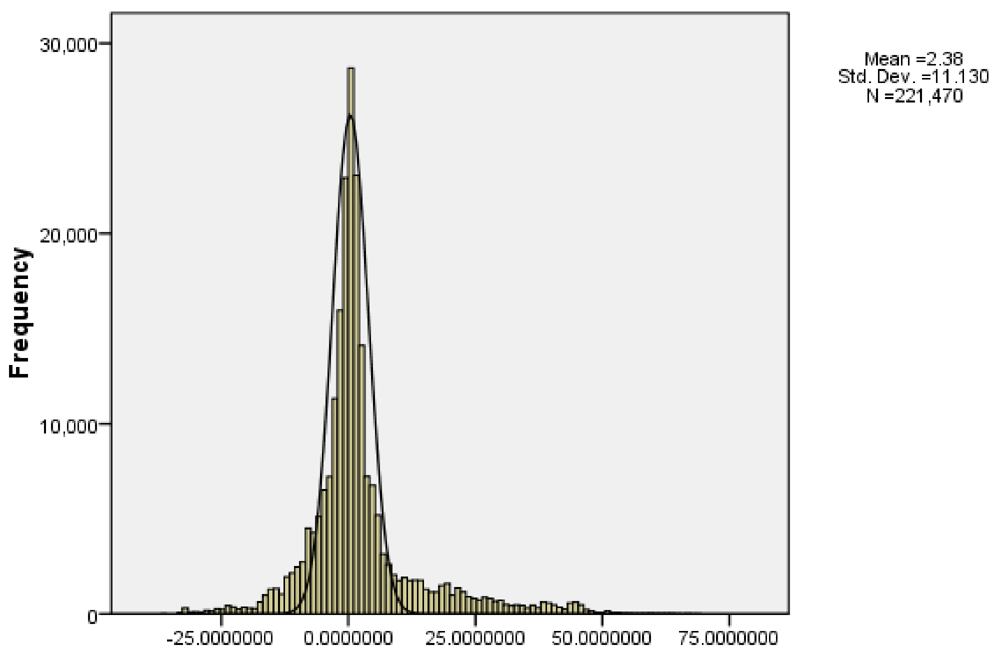


Figure 32 Frequency distribution of residual water level data

Time-series calibration plots are presented in Appendix 8. Figure 33 presents the scaled RMS and mean absolute residual 1990 to 1999. Results show the scale RMS over time remains below 2 % and mean absolute residual generally remains below 8m

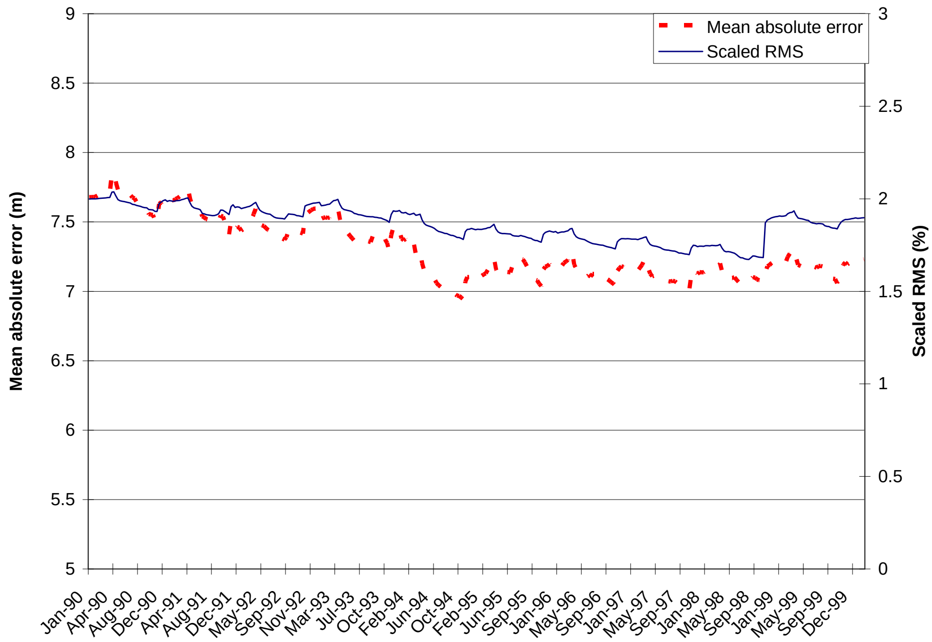


Figure 33 Calibrated scaled RMS and mean absolute error over time

5.2 Groundwater abstraction

Analysis of assigned versus simulated groundwater pumping volume was undertaken to determine if the groundwater model extracted the simular volumes. Figure 34 presents the cumulative assigned versus simulated groundwater pumping volumes over the calibration period, results show over the 10 year calibration period there is a deficiency of 120 GL (≈12 GL/year). This volume deficiency is not ideal, where well optimisation would resolve this issue. Individual aquifer pumping rates are presented in Table 9.

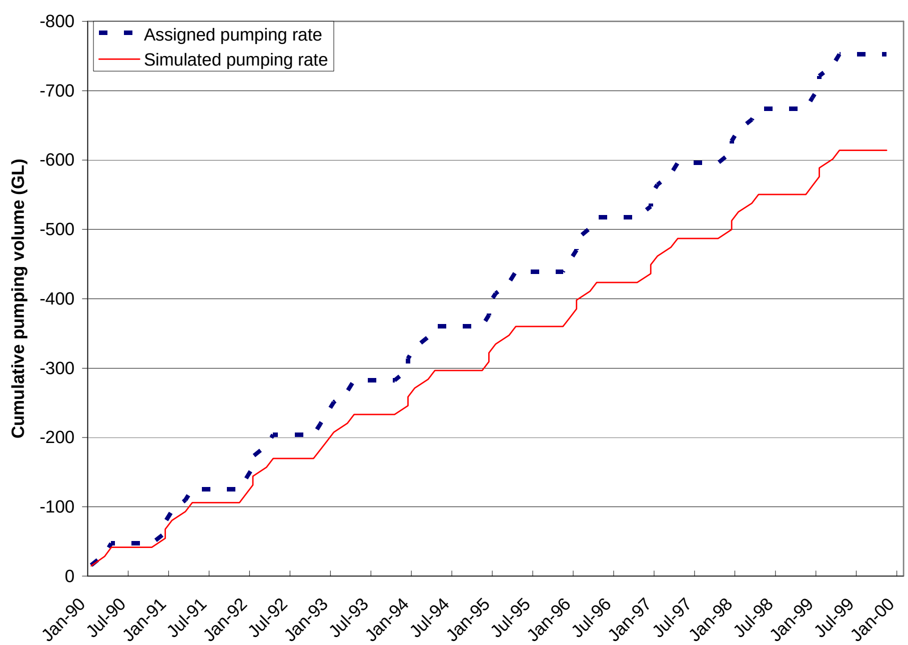


Figure 34 Cumulative observed versus simulated pumping volumes

Table 9 Assigned versus simulated pumping rates

Layer	Assigned pumping (GL)	Simulated pumping (GL)
1	0.00	0.00
2	-124.28	-120.64
3	-152.05	-152.05
4	-233.78	-229.85
5	0.00	0.00
6	-575.57	-575.57
7	0.00	0.00
8	-4.15	-4.15
9	0.00	0.00
10	-175.92	-175.92
Totals	**-1265.75**	**-1258.19**

5.3 Groundwater balance

Monthly time step water balance between 1990-1999 is presented below (Figure 35). Simulation data show oscillations in the waterbalance as a result of differing stress on the groundwater system.

In attempt to summarise the catchment groundwater balance Figure 36 presents the 1990 – 1999 mean annual groundwater balance. Results show groundwater recharge is the dominant source of water for the waterbalance, where a small source of water also comes from groundwater storage. The small volume of groundwater derived from storage reflects a slight overall fall in groundwater level from 1990 to 1999. This slight fall also matches cumulative residual rainfall trends over the same period. Overall, the 10 year water balance suggests the groundwater model is relatively stable.

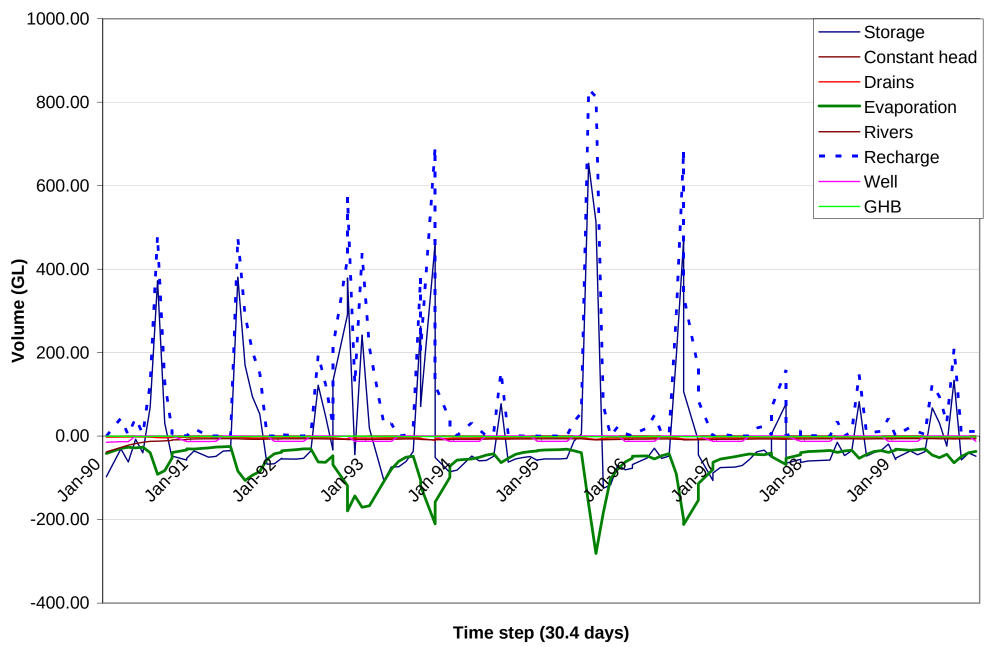


Figure 35 Simulated monthly 1990 – 1999 groundwater balance

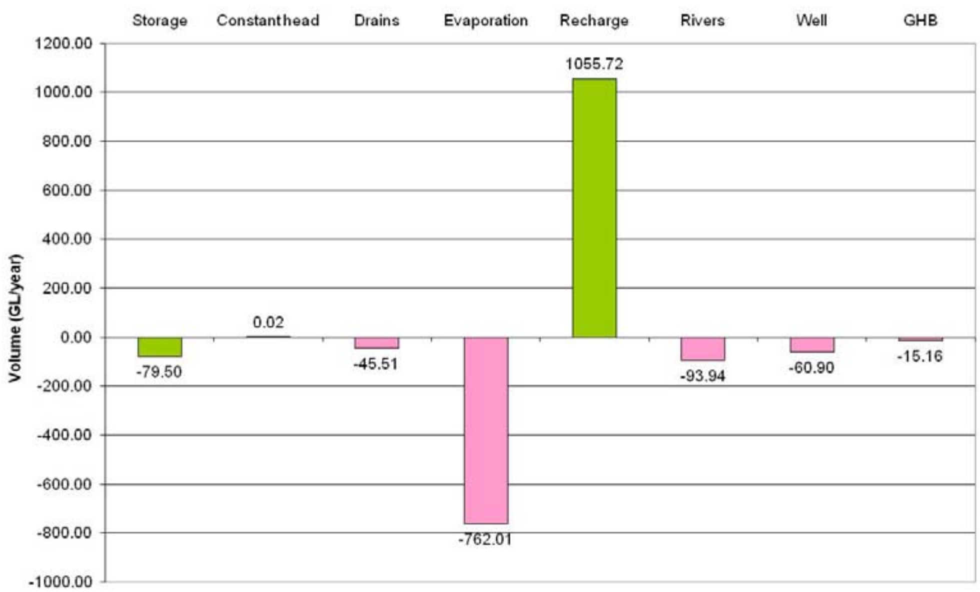


Figure 36 Simulated mean annual 1990-1999 groundwater balance

5.4 Water balance error versus shallow watertable area over time

Figure 37 presents the shallow watertable (e.g. < 2m) area on a monthly basis over the duration of the calibration period. Results show the shallow watertable area varies considerably over time which is closely related to variations in groundwater recharge fluxes. Changes in water balance error over time generally oscillate by less than 1%, well within the 2% model target.

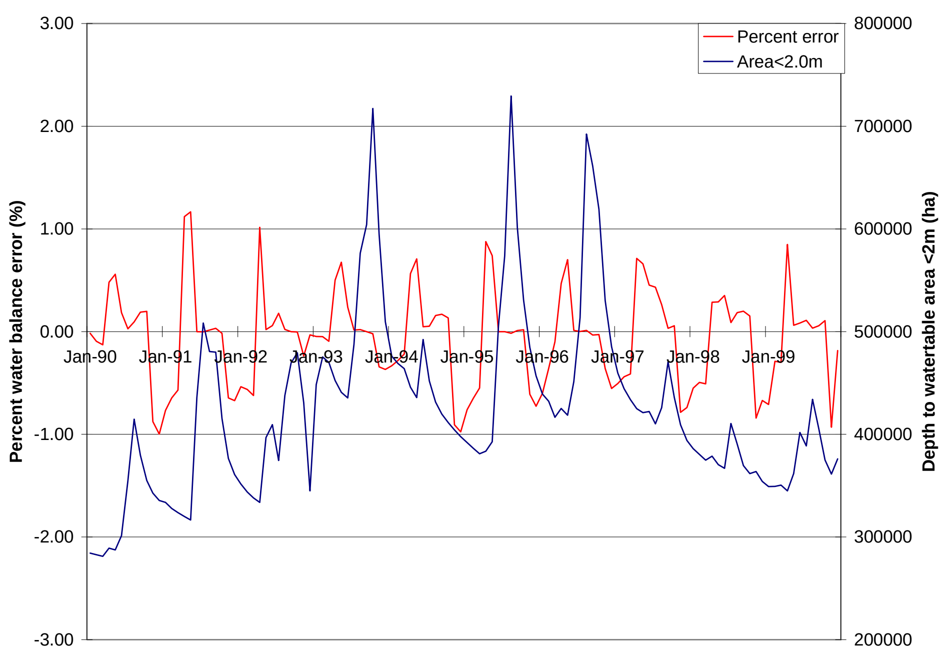


Figure 37 Calibration period water balance error and shallow watertable area

5.5 Depth to watertable

Transient calibrated simulated depth to watertable for 1995 is presented below (Figure 38). The depth to watertable is generally shallow and follows the landscape topography in the lower parts of the catchment and is much deeper in the upper parts of the catchment. Overall, the simulated depth to watertable is a good reflection of the watertable. The Lower Campaspe is considered to have the poorest watertable correlation, which is considered to be associated with high intensity groundwater pumping and a consequently broad depression in water level. Initial analysis suggests low groundwater recharge and hydraulic conductivity rates have caused this poor result.

5.6 Watertable level

Simulated 1995 watertable level (potentiometric surface) is presented in Figure 31. The gradient of the potentiometric surface is generally a subdued reflection of the landscape surface and generally follows surface water catchment boundaries. Direction of groundwater flow is north to north-west, which is consistent with regional hydrogeological understanding as previously mentioned. Appendix 5 presents individual model layer water level elevation data.

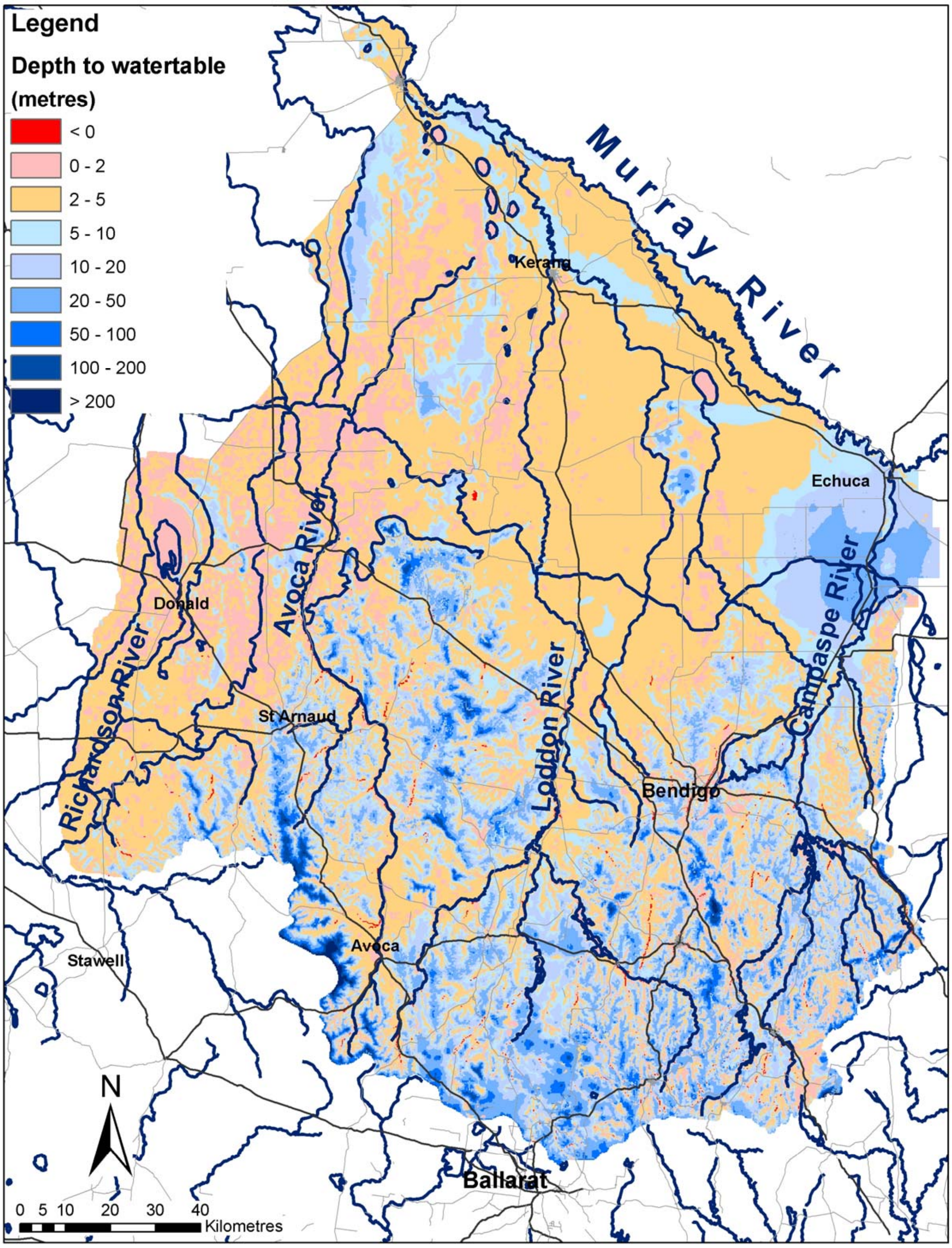


Figure 38 Simulated transient 2000 depth to waterable

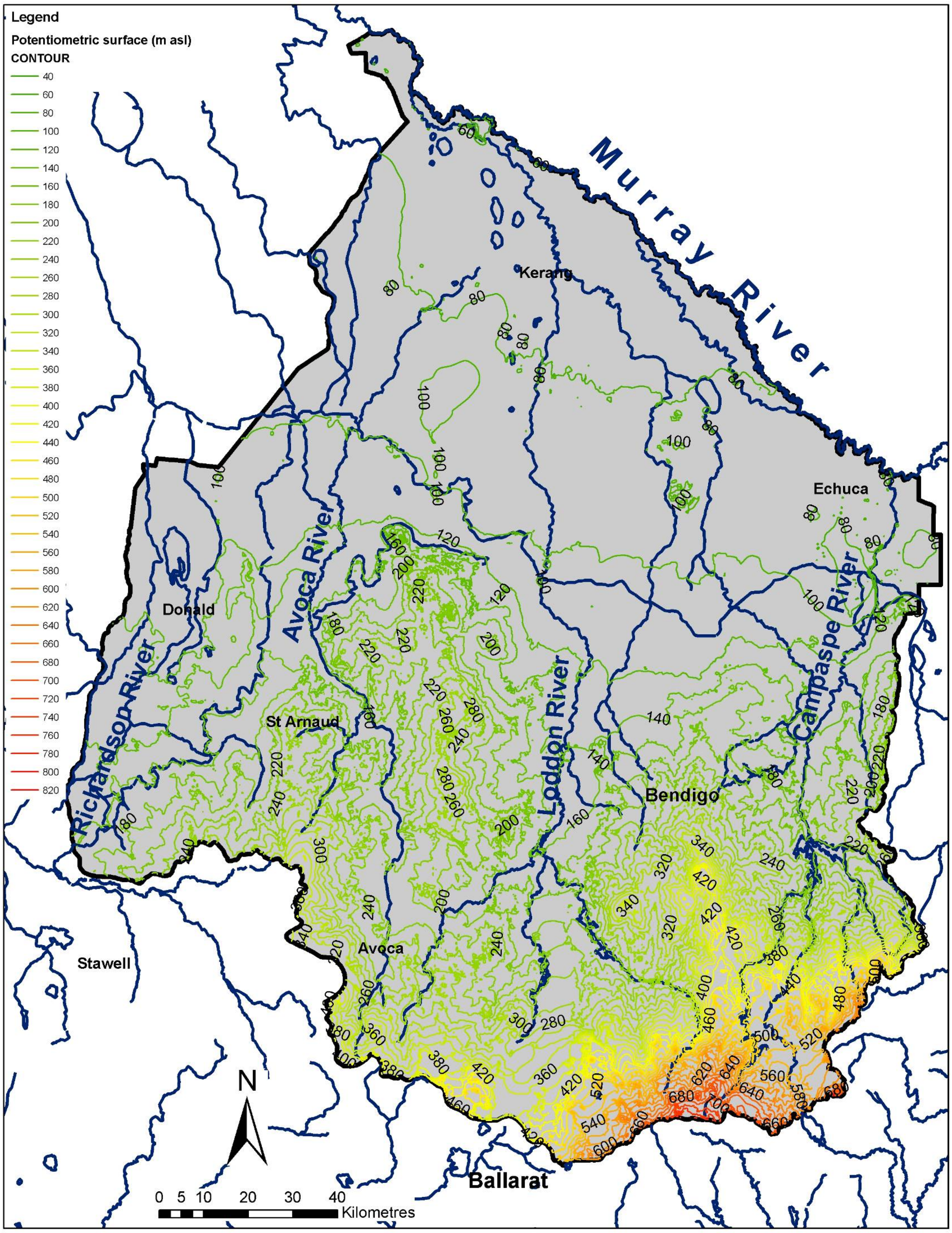


Figure 39 Simulated transient 2000 watertable level of the North Central CMA region

6 Model validation

Model validation process can be considered as an additional filter for independent model evaluation to assess the suitability of a model for its given purpose. Although there is a general agreement on the goal of model validation, no agreement exists on a uniform methodology for executing model validation (Duan et al., 2003).

For the purpose of this project, a five-year validation period (2000–2005) was selected to assess the projective capacity of the groundwater model. Scaled RMS of observed versus simulated groundwater levels was considered the most appropriate (and only consistent) dataset which could be used in this analysis. Also time-series groundwater balance information is presented to identify any underlying water balance trends.

6.1 Observed groundwater levels

Figure 40 shows the scaled RMS over the five-year validation period remains well below the calibration target of less than 10% (at 2%). The mean absolute error over the validation period appears to be slightly increasing with time, however generally remains less than 8 m.

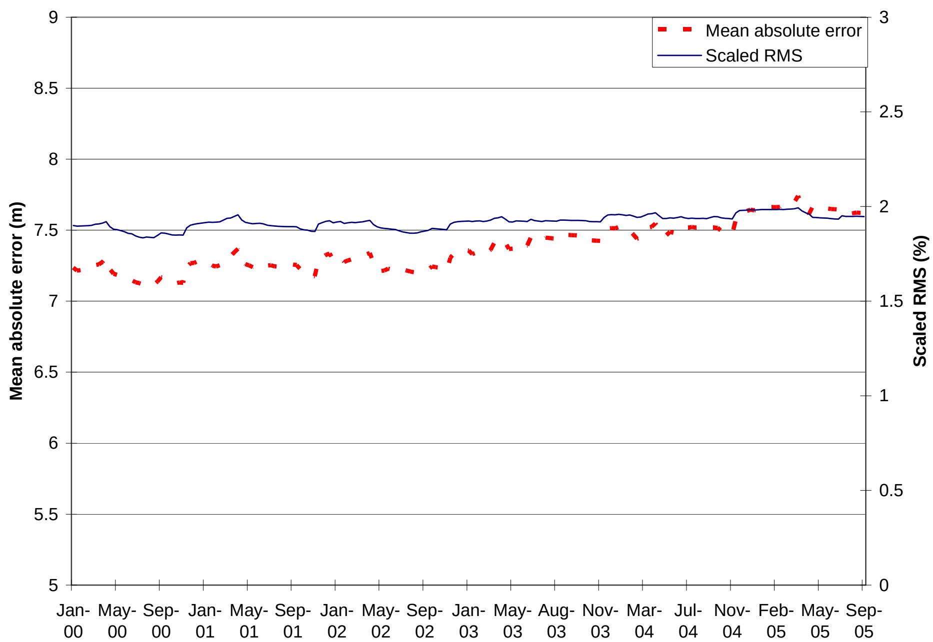


Figure 40 Scaled RMS and mean absolute error over the validation period

6.2 Groundwater balance

Figure 41 presents the simulated groundwater balance between 2000 and 2005. Data shows the water balance fluctuates comparable to that of the calibration period, with groundwater storage mirrors. Reduction in rainfall over the validation period has seen lower groundwater recharge rates and lower fluctuations in groundwater storage.

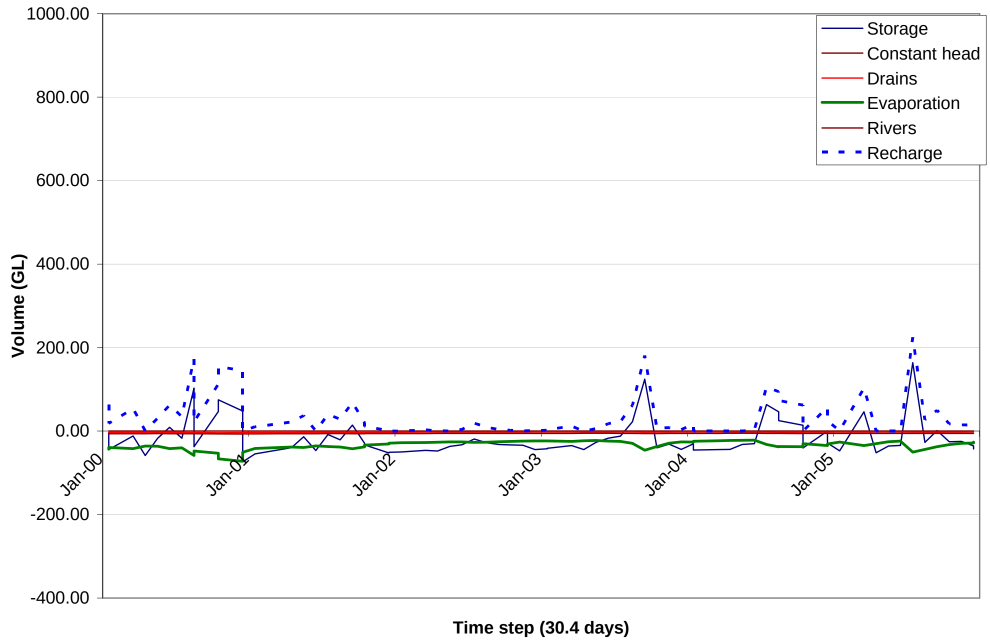


Figure 41 2000-2005 monthly water balance

The average annual groundwater balance over the validation period shows comparable relative proportions of the distribution of the water balance (Figure 42). The exception is groundwater storage where there is a net loss of groundwater storage in the validation period. The loss in groundwater storage is expected, as lower groundwater recharge rates over the validation period compared to the calibration period has caused a lowering of the watertable. The lowering of the watertable can also be seen in time-series groundwater level data presented in Appendix 6.

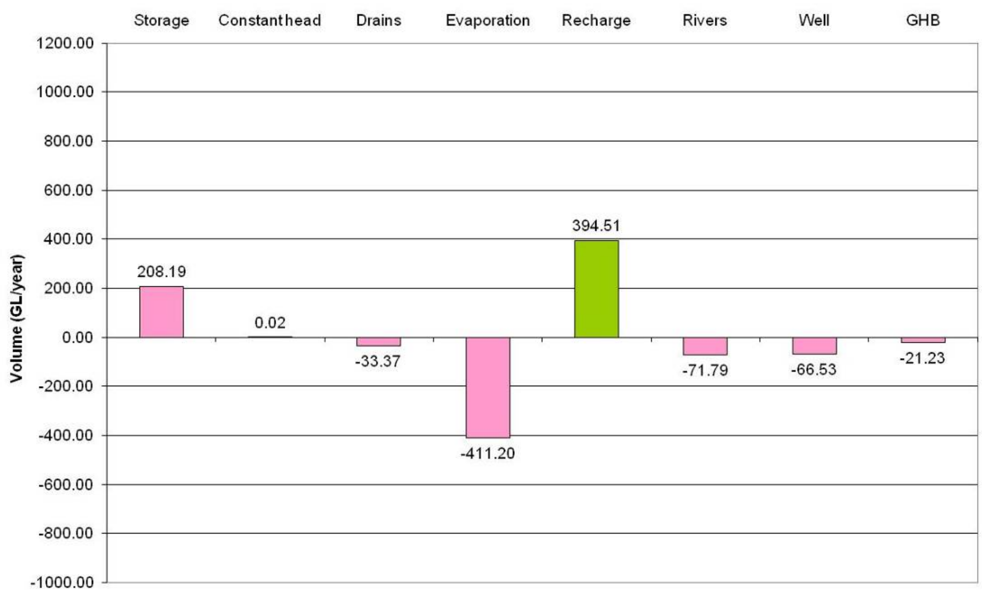


Figure 42 Mean annual validation groundwater balance

6.3 Mass balance error versus shallow watertable area over time

Analysis of water balance error percentage over time during validation (Figure 43) shows the error generally fluctuates around 1%. Shallow watertable area of the validation period is slowly decreasing, the decrease is associated with a falling rainfall trend and subsequent groundwater recharge.

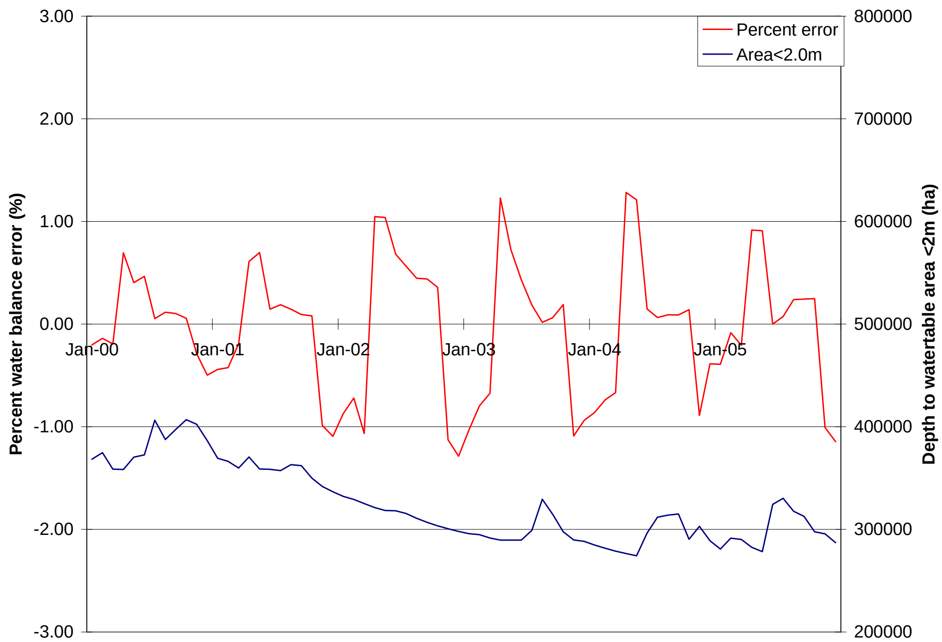


Figure 43 Validation mass balance and shallow depth to watertable area

7 Conversion of transient to steady state

The calibrated transient model was run in a steady state solution to provide an end-point comparison n for the transient simulation. Average groundwater recharge between 1990 – 2005 was used for this comparison, despite acknowledging temporal flux variations in groundwater recharge are likely to provide a different result.

No steady state solution could be solved when using MODFLOW96. The solution would not solve due to excessive dry cells in the model.

A modified version of MODFLOW96 which oversteps the dry cell issue was used for sensitivity analysis.

8 Model sensitivity

After calibration of the steady state model input parameters were analysed to assess the sensitivity of model results to respective input parameters, that is, hydraulic conductivity (vertical and lateral), groundwater recharge rate, evapotranspiration rate and depth and river stage and conductance. Sensitivity analysis is a method of quantifying uncertainty of the calibrated model related to uncertainty in the estimates of aquifer parameters (Anderson and Woessner, 1992). Determining the sensitivity of the model to specific parameters offers insights into the uniqueness of the calibrated model. Due to long time requirement to undertake transient sensitivity runs and short project time limitations, it was not possible to undertaken sensitivity analysis of specific yield and specific storage.

MDBC (2000) refer to four 'types' of parameter sensitivities. Type I and II are of no concern as the impacts of the predictions are insignificant. Type III is of concern for un-calibrated low complexity models. Type IV is of concern as model non-uniqueness in the model input may cause a range of valid calibrations, but the results may vary significantly on prediction. Each model parameter was considered for model sensitivity by applying a percentage difference from the calibrated parameter. In many instances model convergence failed during sensitivity analysis, these values were not plotted. A model is considered sensitive to an input parameter if relatively small changes in that parameter results in relatively large changes in simulated water level or the catchment water balance. That is, calibration is possible only over a narrow range of values and, as a result, model uncertainty is relatively low. A model is insensitive if relatively if relatively large changes of a parameter produces a relatively small change in water level or water balance. Insensitivity results in higher uncertainties because the model will calibrate over a range of input parameter values.

Detailed sensitivity results are presented in Appendix 7. Figure 10 summarises the sensitivity types of the North Central CMA region model compared with the area of depth to watertable of less than two metres and change in groundwater base flow in the model domain. Results suggest the majority of attribute variations result in Type I sensitivity, whereas groundwater recharge and hydraulic conductivity of layers 5 and 10 were Type II sensitivity.

Table 10 Sensitivity types (described in MDBC 2000)

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">CHANGE IN sRMS CALIBRATION</td></tr>
<tr><td>Insignificant (e.g. < 50%)</td><td>Significant (e.g. > 50%)</td></tr>
<tr><td rowspan="2">CHANGE IN PREDICTION</td><td>Insignificant
(e.g. < 50%)</td><td>Evaporation rate (baseflow)
HY (layer 1,2,3,4,6,7,8,9)
Evaporation depth
Vcont (all other)
Vcont (layer 7) #
Vcont (layer 8) *
River conductance #
Evaporation rate (watertable)
TYPE I</td><td>Recharge #
HY (layers 5,10)
TYPE II</td></tr>
<tr><td>Significant (e.g. > 50%)</td><td>TYPE III</td><td>TYPE IV</td></tr>
</table>

HY = Hydraulic conductivity
* - would not converge with 50% increase
# - would not converge with 50% decrease

Sensitivity results suggest river bed conductance, recharge and layer 7 & 8 are limiting features which reduce model 'robustness'. Likewise, information suggests groundwater

evaporation rate and depth and recharge have the greatest impact on baseflow and shallow watertable area.

Additionally, changes in model parameters were considered on the impact of scaled RMS (Appendix 7). Results show model parameters within a 100% range of the calibrated value do not vary the scaled RMS by more than 2% in most instances. It was apparent groundwater recharge and hydraulic conductivity of layer 10 caused the greatest variation in scaled RMS. The impact of this sensitivity indicates groundwater recharge is the most sensitive on scaled RMS and layer 10 has the majority of groundwater observation bores, thus impacting scaled RMS to such order.

9 Model uncertainty and assumptions

A number of challenges have been faced when developing this groundwater model and many generalisations have been made in an attempt to best represent the groundwater conditions. The following section describes some of the generalisations, assumptions and areas of concern identified when developing the groundwater model.

9.1 Ensym evapotranspiration data

The provision of an Ensym-derived evapo transpiration module was assumed to represent physically reasonable estimates of groundwater evapo transpiration depth and rate. Upon further investigation, it was found the Ensym data prohibited developing a perceived reasonable depth to watertable layer (despite scale RMS and catchment water balance results being reasonable).

The range of evapo transpiration rates were heavily weighted under specific native vegetation species (e.g. skewed) causing model stability issues when attempting to uniformly adjust rates. It was decided the mean annual steady-state groundwater recharge layer would be used in the transient model. This assumed there is little temporal deference in evaporation rate from month to month, which is clearly not the case.

9.2 Groundwater base flow calibration

Calibration of groundwater base flow to calculated gauge flow data was not undertaken due to project time limitations and limited calibration data. Instead, calibrated steady-state base flow attributes (river and drainage modules) were used in the transient model. It is acknowledged the limited level of base flow calibration provides uncertainty and perhaps some error, but it is considered appropriate for the amount of calibration data available.

9.3 Hydraulic conductivity comparison

Broad generalisations associated with calibrating model layers with predominantly uniform values cause some uncertainty with expected calibrated values. Comparison of estimated hydraulic conductivity with calibrated transient hydraulic conductivity (Table 11) suggests the calibrated values are generally within a reasonable and expected range.

Table 11 Expected and calibrated transient hydraulic conductivity values

Model layer	Expected (m/day)	Transient (metres/day)
1	0.5	0.3
2	5	3.4
3	≈4	0.7
4	≈4	1.7
5	1	0.55
6	60	39.3
7	Unknown (<0.1)	0.004
8	5	1.6
9	0.2	0.1
10	0.7	0.05

9.4 Groundwater abstraction

Groundwater pumping data in the model domain was found, in many instances, to require modification to correct for dry wells. In particular, model layers 2, 4, 5 and 10

required significant expansion of the groundwater pumping capture zone (e.g. area of extraction) to reduce the wells going dry. The issue of under extraction of groundwater rates confirm the issue of using near uniform aquifer parameters in attempting to simulate an aquifer and/or the aquifer maybe verging towards its' sustainable extraction limit. To overcome this issue well pumping optimization may have assisted if project time permitted.

9.5 Areas of conceptual uncertainty

During the period of model calibration it was clear there were locations where model simulations did not match reality. There are a number of potential causes of this variability; one of which is the use of uniform values to represent entire model attributes. That is, the generalisation of a single value (such as conductivity) accurately representing an entire model layer is clearly with flaw. Regardless this generalisation was considered a reasonable initial assumption whereby zoning of differing values could be undertaken at a later time. However, the relatively short time between the delivery of Ensym groundwater recharge and required project completion (approximately nine weeks) prohibited zonal calibration. Despite having a number of uniform model attributes, results suggest the use of uniform values is adequate within the calibration targets of this project.

Such areas which would benefit include:

- The lower Campaspe region, where there is significant pressure on groundwater pumping. The groundwater model suggests a large area of watertable draw down, whereas in reality the watertable aquifer has not lowered to the same rate as the underlying aquifer.
- In locations of Quaternary basalt spatial variability in hydraulic conductivity has not need able to be attributed. As a result many groundwater pumping bores have not been able to extract all licensed volumes.
- Basement hydraulic conductivity – variability in confined, unconfined and faulting locations. Applying spatial variability would enhance model calibration accuracy.

9.6 Groundwater recharge

Despite groundwater recharge being provided as a non-calibration feature it is likely there is some variability with groundwater recharge rates and timing. Some areas of low confidence include:

- the time delay between a rainfall events and groundwater recharge
- deep drainage partitioning (recharge – lateral flow relationship)
- area-specific land use factors which may impact on recharge rate
- overland flow contributing recharge in low points of the landscape
- accuracy of soil hydraulic data, and
- groundwater usage in irrigation districts (both over time and aquifers)

9.7 Elevation variation

Mentioned previously, there is likely to be an inherent error in the comparison of simulated versus observed data. Scatter plot data of surveyed versus DEM point data suggests the greatest error occurs in the steeper more undulating parts of the catchment, where an average elevation error of 3.84m occurs. While there is little which can be done with this elevation error, the information should be kept in mind when reviewing individual simulated versus observed data and overall calibration statistics. The current cell size and inherent elevation error of the model is considered reasonable within the specifications and underlying assumptions of this project.

9.8 Depth to watertable

There is no definitive information set which defines the current depth to watertable of the North Central CMA region. For the purpose of this project, it was considered on-ground knowledge of the depth to watertable in the region was an adequate means to determine if the simulated depth to watertable was "reasonable". With this qualitative assessment there is no measure of determining the true accuracy of the simulated depth to watertable in the region.

9.9 Temporal water balance

With any temporal simulation of groundwater levels it is difficult to history match underlying groundwater trends. Underlying trends have attempted to be matched; however, it is more than likely that these trends will differ from simulated groundwater trending. This difference, in some locations, may impact on changes in the catchment water balance both temporally and spatially.

9.10 Groundwater extraction rates

During model construction it became apparent there was little information available regarding the relevant pumping aquifer. To overcome tis problem, pumping aquifers were assumed based upon the most productive aquifer at those locations.

During the model calibration phase a number of groundwater pumping bores became "dry" (e.g. inactive). That is, the pumping bores were unable to extract the allocated volume from the aquifer, resulting in lower overall volumes of groundwater pumping in the catchment groundwater balance. Despite the modification of a number pumping bores to allow the allocated volume to be extracted (e.g. expanding the pumping area) a number of groundwater pumping bores run dry during the simulation. Ideally, well optimisation would have been undertaken as part of this project, however large computational time requirements and a short project timeline prohibited this to be undertaken.

10 Conclusion

This report describes a hydrogeological model assembled for the entire North Central CMA region. The size of the model and the complexity of the processes simulated reaffirm many of the challenges faced in assembling large hydrogeological simulations in both steady and transient states.

The application of MODFLOW allowed for the simulation of regional hydrogeological flow processes. Whilst it is likely there are some areas where the simulated depth to watertable does not correlate well with known values, every effort has been made within the scope of this project to make the model reflect reality. The absolute accuracy of the depth to watertable map is difficult to quantify, particularly with an underlying elevation error with a mean sum of residuals of 3.84 m existing within the catchment. Despite this 'residual' elevation variation, a scaled RMS of less than 10% was able to be achieved throughout the duration of the model calibration and validation period.

It has become apparent that despite reaching all required calibration targets there is considerable scope for improving the accuracy of this groundwater model in specific locations. Most of these enhancements centre on the ability to incorporate spatially varying data (such as vertical and lateral hydraulic conductivity, full base flow calibration, temporal groundwater pumping rates, etc.) into the existing groundwater. These enhancements are anticipated to provide better spatial and temporal calibration.

Limited data analysis of model validation data suggests overall the North Central CMA region groundwater model has adequate predictive capacity to simulate groundwater levels beyond the 1990–1999 calibration period of the model and at least into the validation period.

10.1 Model fit for purpose

The purpose of the North Central CMA region groundwater model is to assess the impacts of land use change on the water balance, and in particular the influence on depth to watertable and base flow volume. In previous chapters a number of assumptions and generalisations have been discussed in an attempt to contextualise the scale and limitations of the groundwater model.

The model developer considers the application of the North Central CMA region groundwater model has the capacity to predict changes to the water balance; however there are a number of potential limitations which should be kept in mind:

- The long-term prediction of the transient model (e.g. > 15 years) has not been validated. Also, underlying groundwater trends may impact model prediction capacity beyond this period.
- Only relative water balance changes should be considered, not absolute changes. That is, due to scale, complexity, availability of calibration data and time limitations model calibration is not at sufficient detail to warrant absolute values.
- The application of the initial North Central steady-state groundwater model should not be used for assessment of impacts of land use change as calibrated recharge rates provided appeared higher than considered reasonable and therefore may redistribute the groundwater balance disproportionately.
- Likewise, the application of the North Central transient converted to steady state groundwater model should not be used for assessment of impacts of land use change as steady state convergence could not be achieved due to excessive dry cells.

11 Recommendations

Whilst the development of a useful transient regional groundwater model was possible for the North Central, the capacity to simulate the water balance over time was limited in some areas by a general lack of information and knowledge. The following recommendations propose actions that would improve the results of the simulation and the usefulness of the modelling framework.

The specific recommendations are as follows:

- There is a need to improve the knowledge of groundwater abstraction across the region. This should extend to a better appreciation of the location of pumped wells, the volumes removed on a monthly basis and the aquifers involved.
- Further sub-catchment hydrogeological investigations should be undertaken to improve the knowledge of groundwater processes in areas where there is a poor correlation between simulated and observed depth to watertable.
- Groundwater level monitoring should continue in the region to support the development of temporal catchment simulations.
- In its' current form, this catchment water balance should be applied in further considering relative land management and groundwater allocations in the North Central CMA region.
- Time series groundwater data retained within the Victorian groundwater database be inspected and filtered for spurious data.
- Further review and calibration of groundwater recharge and run-off estimates determined by Ensym should be undertaken to ensure the full catchment water balance is considered.
- Undertaking well optimisation would enable simulated groundwater pumping volumes to closer match observed groundwater pumping rates.
- Refinement of this groundwater model in areas of significant error (e.g. Lower Campaspe). This would provide other potential applications of the model, such as groundwater availability modelling.
- Recalibration of the transient converted steady state groundwater model should be undertaken to achieve a working steady state groundwater model for the region.

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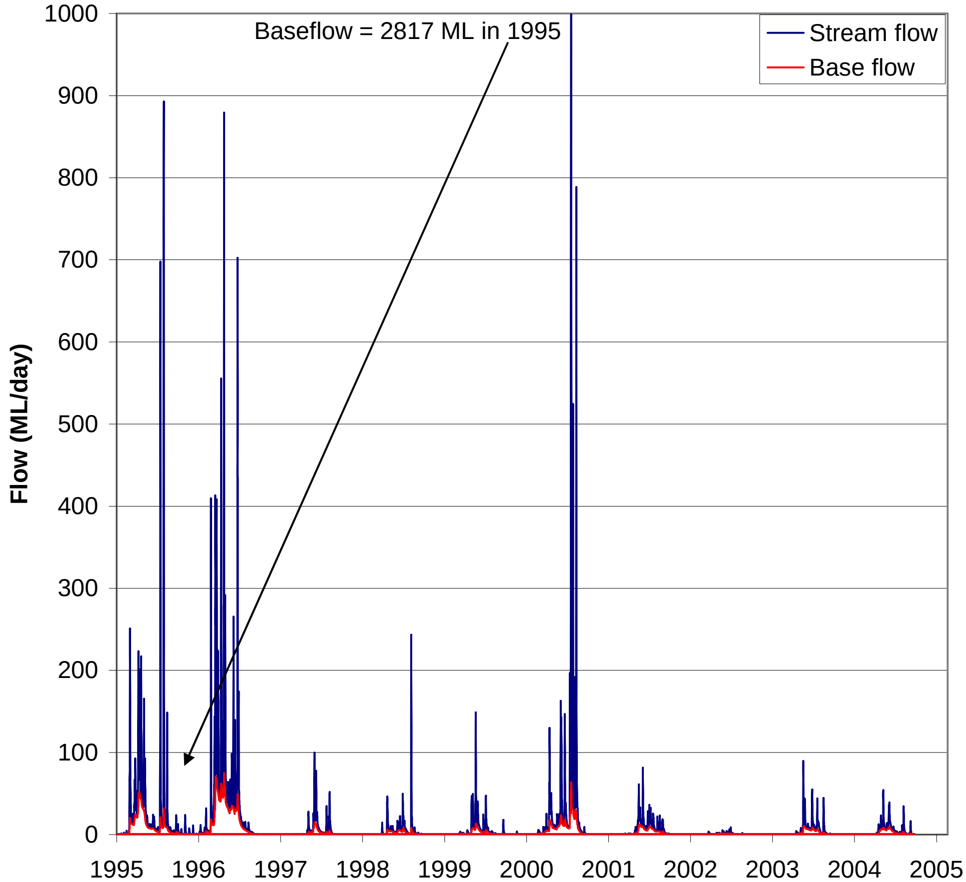
Appendix 1: Automated base flow calculations for selected sub-catchments

406208



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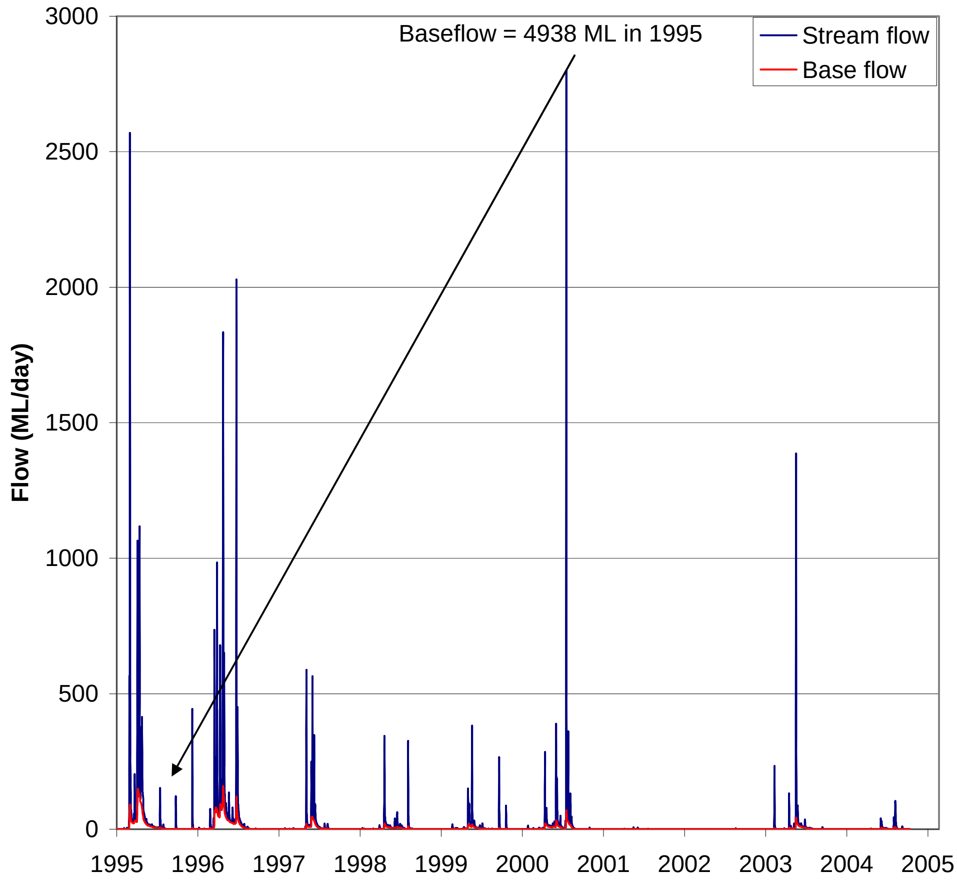
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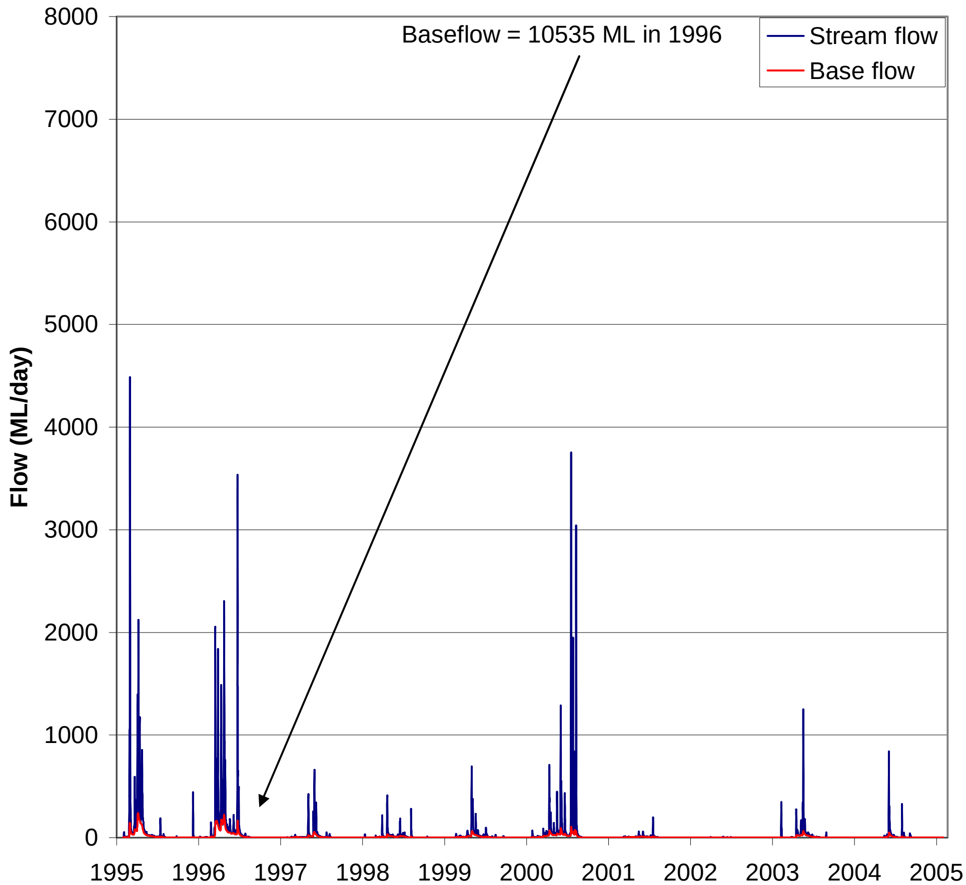
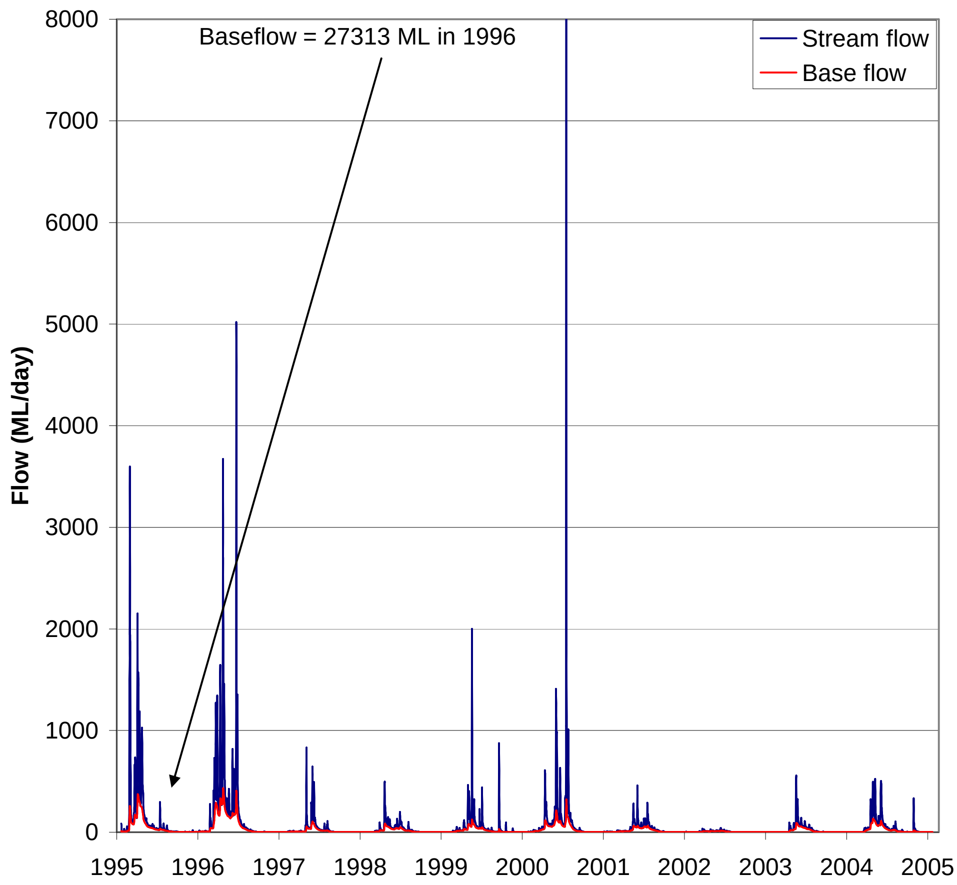
Stream flow
Base flow
Flow (ML/day)
3000
2500
2000
1500
1000
500
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

406235

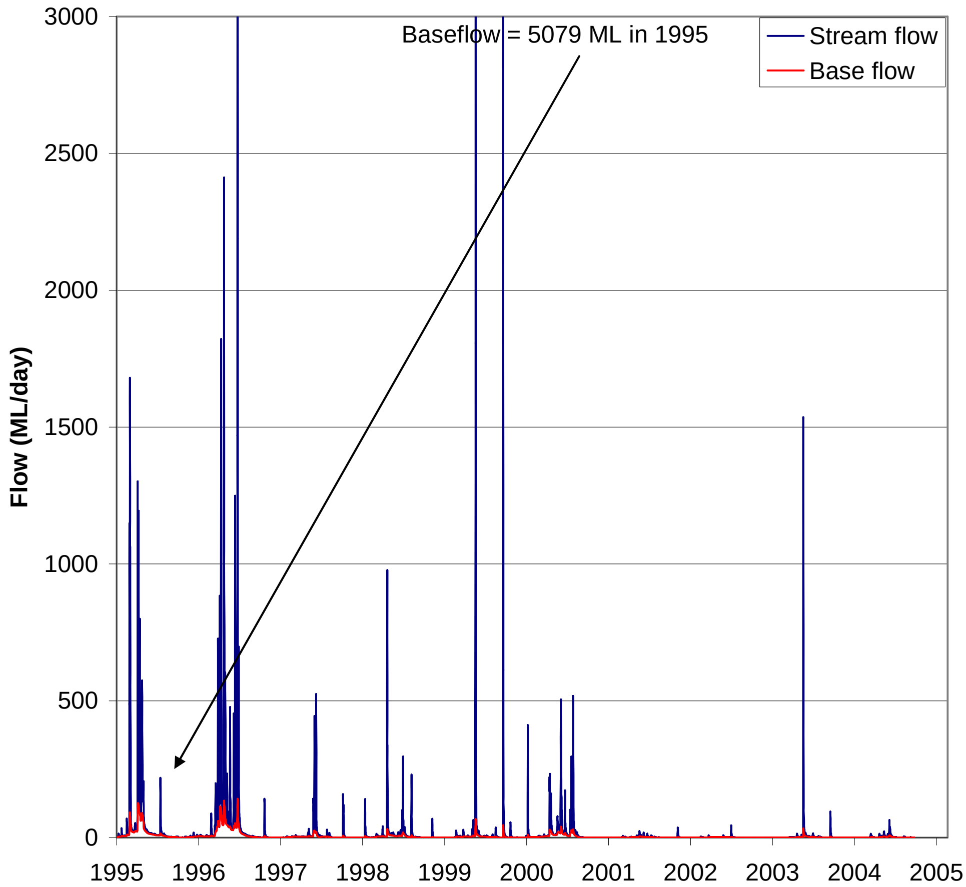

Baseflow = 10535 ML in 1996
Stream flow
Base flow
Flow (ML/day)
8000
7000
6000
5000
4000
3000
2000
1000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

407217



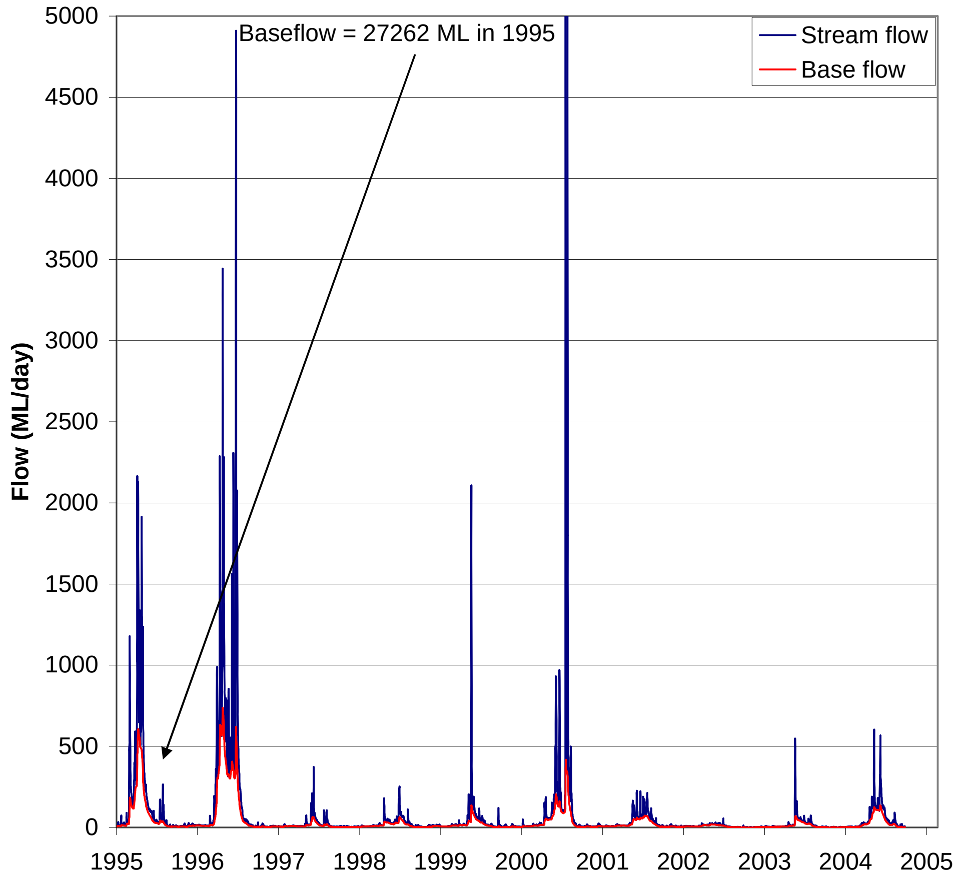
Baseflow = 27313 ML in 1996
Stream flow
Base flow
Flow (ML/day)
0
1000
2000
3000
4000
5000
6000
7000
8000
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

407220



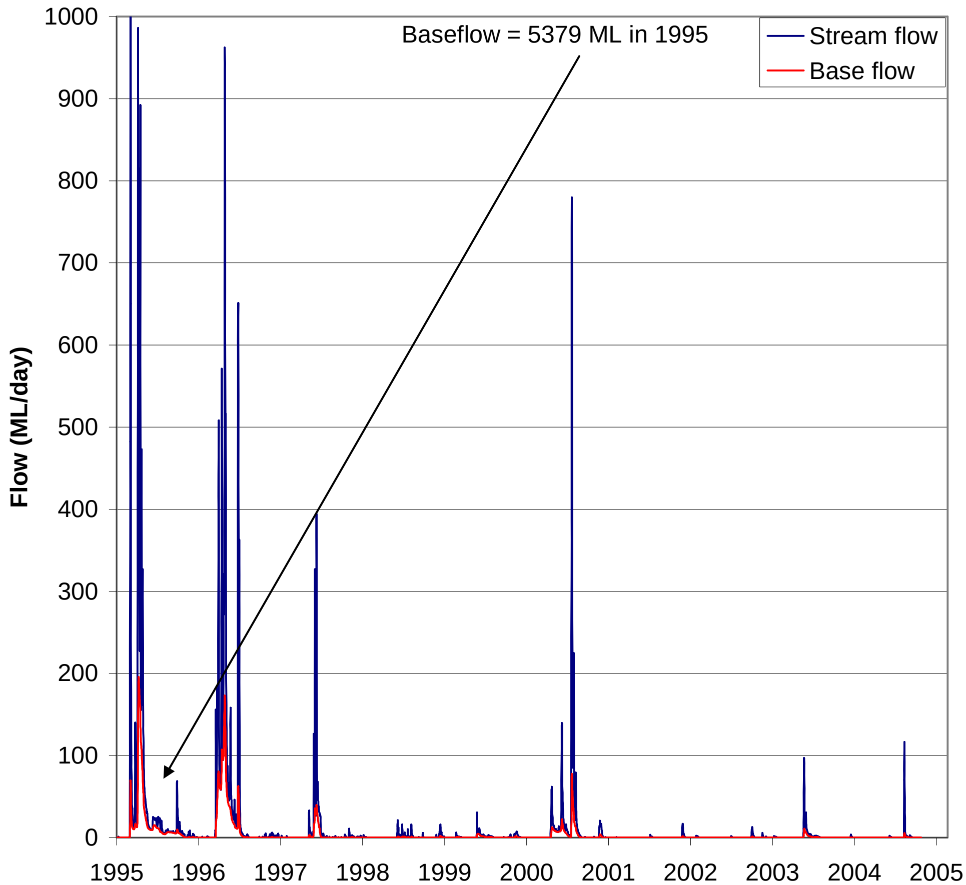
Flow (ML/day)
3000
2500
2000
1500
1000
500
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Baseflow = 5079 ML in 1995
Stream flow
Base flow

407222



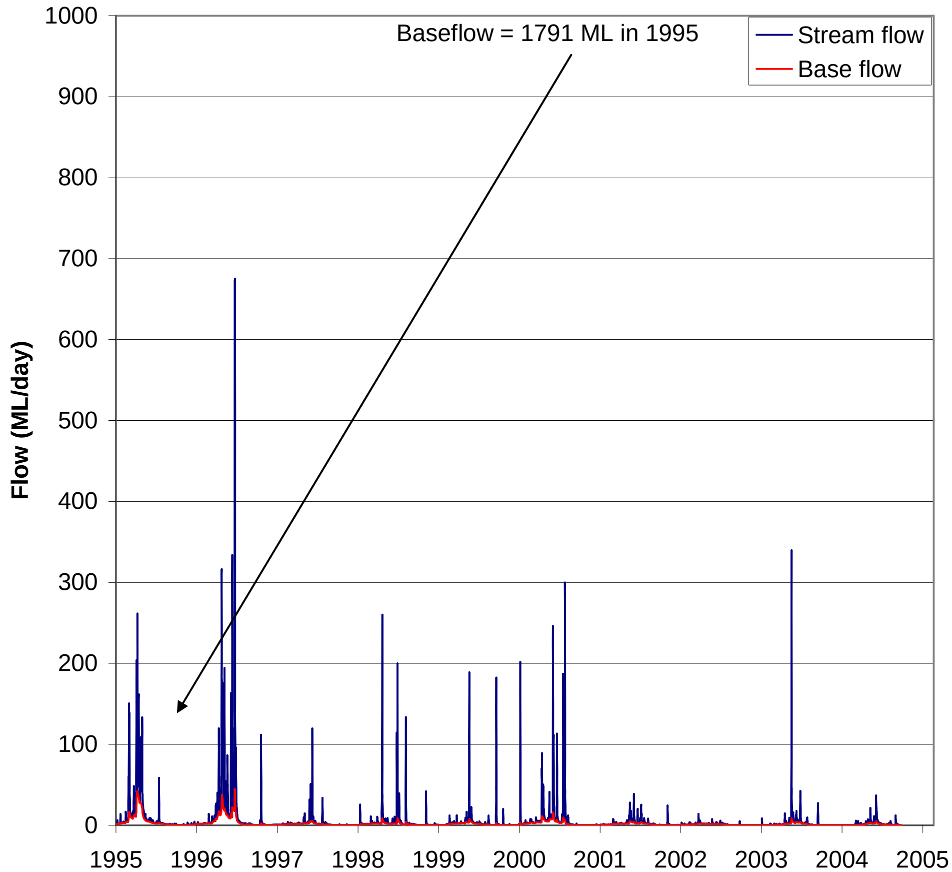
Baseflow = 27262 ML in 1995
Stream flow
Base flow
Flow (ML/day)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

407290



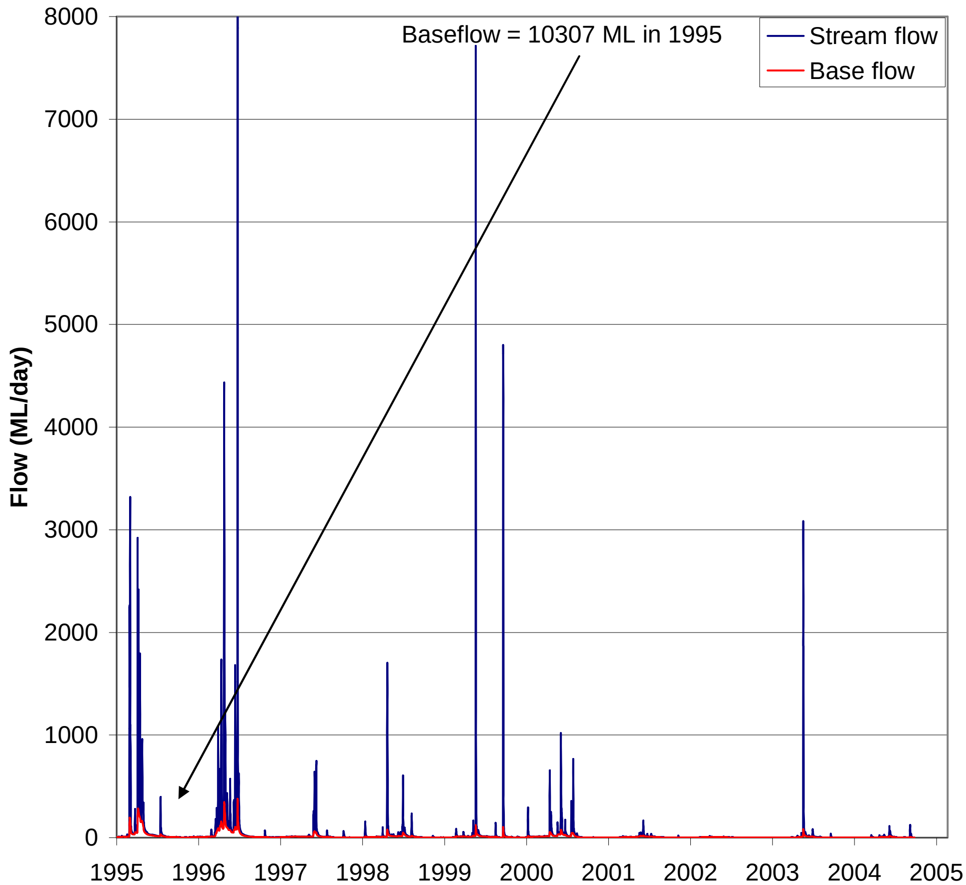
Baseflow = 5379 ML in 1995
Stream flow
Base flow
Flow (ML/day)
1000
900
800
700
600
500
400
300
200
100
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

408202



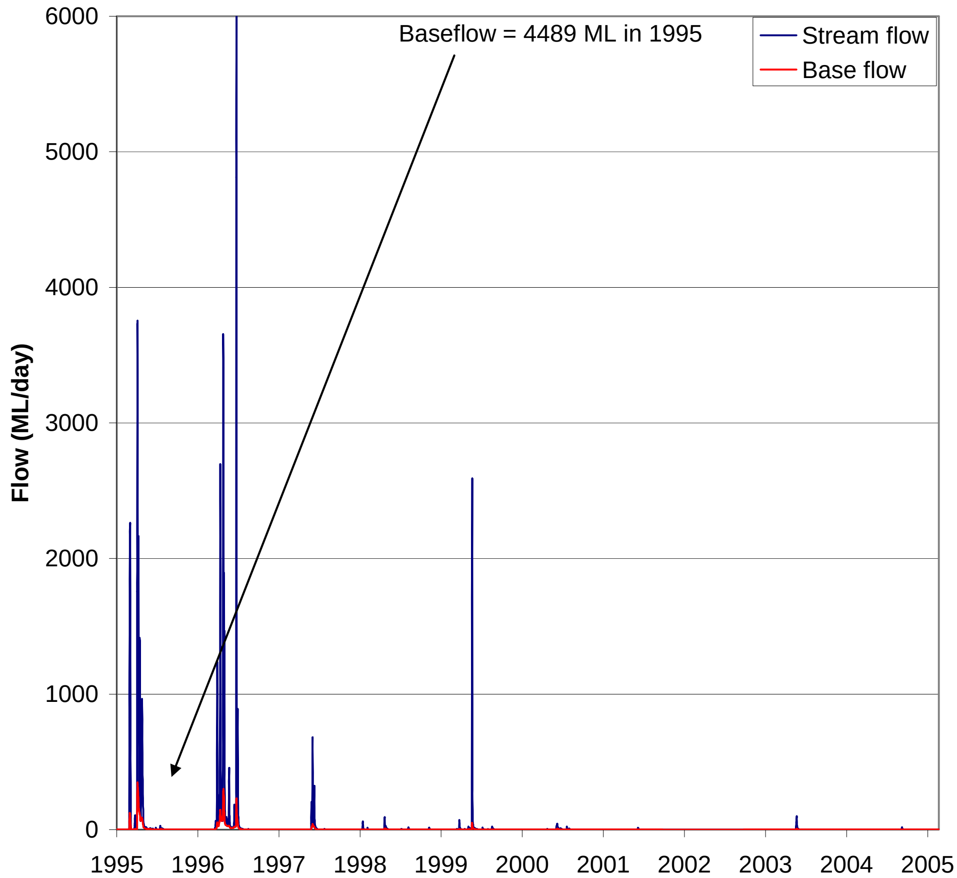
Baseflow = 1791 ML in 1995
Stream flow
Base flow
Flow (ML/day)
1000
900
800
700
600
500
400
300
200
100
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

408206

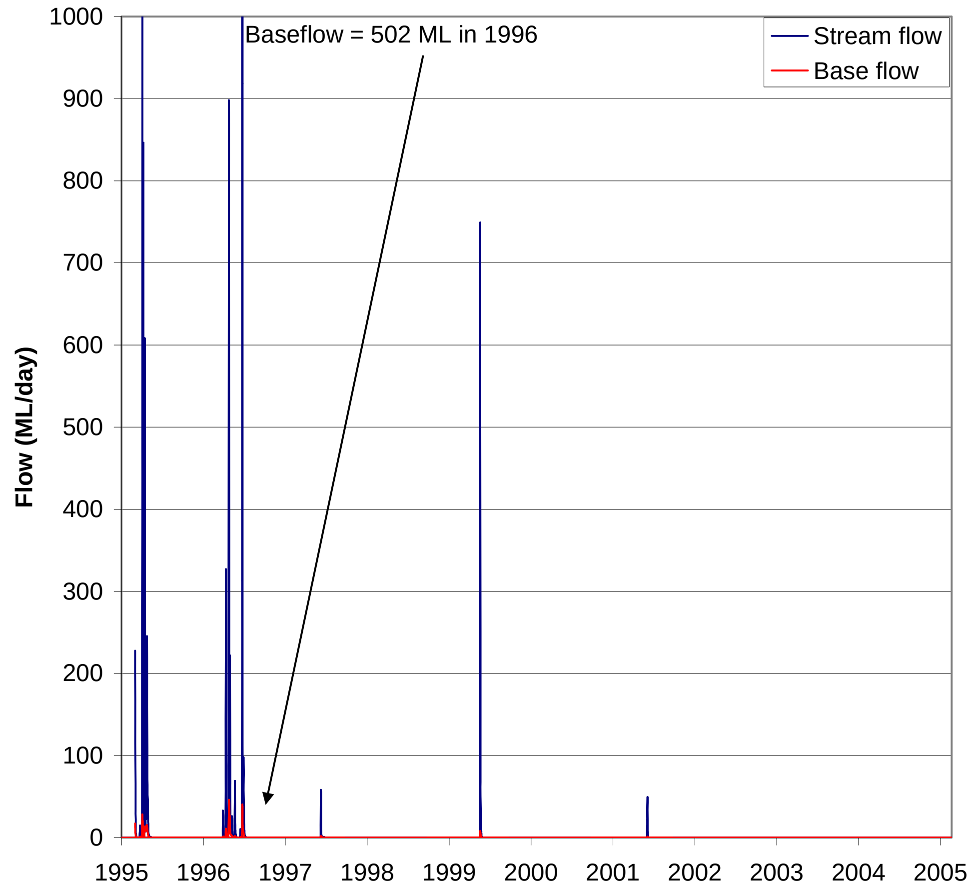


Flow (ML/day)
8000
7000
6000
5000
4000
3000
2000
1000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Baseflow = 10307 ML in 1995
Stream flow
Base flow

415220

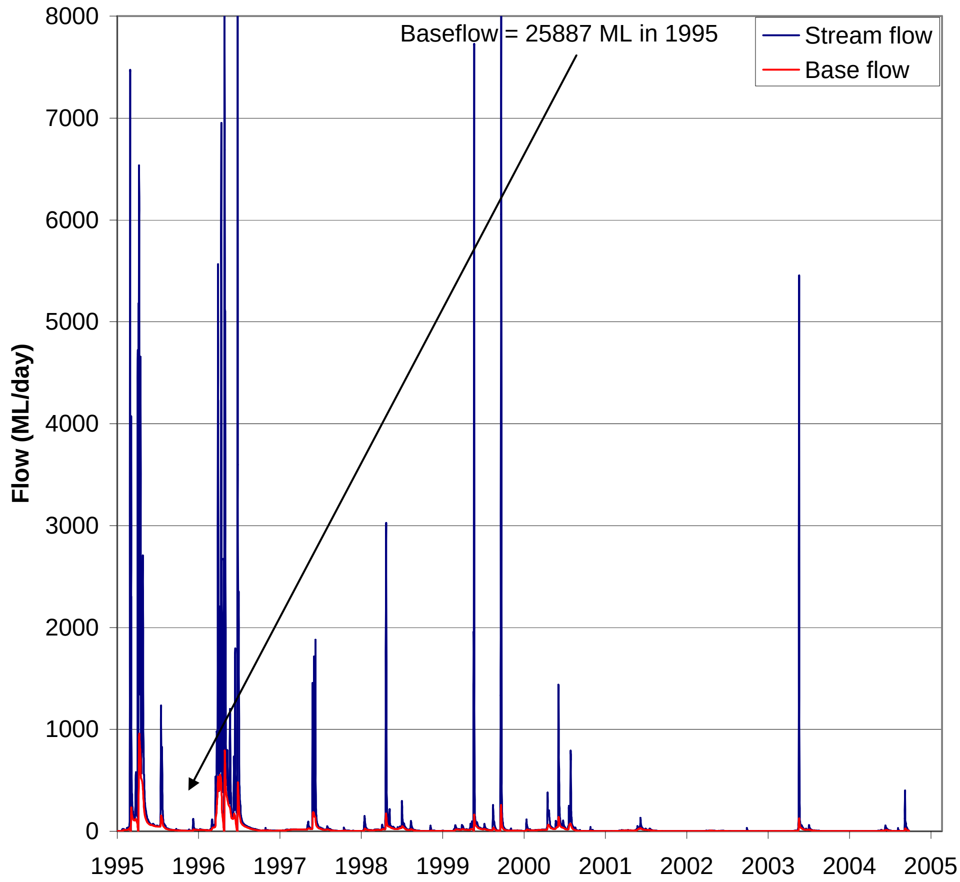

Baseflow = 4489 ML in 1995
Stream flow
Base flow
Flow (ML/day)
6000
5000
4000
3000
2000
1000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

415226



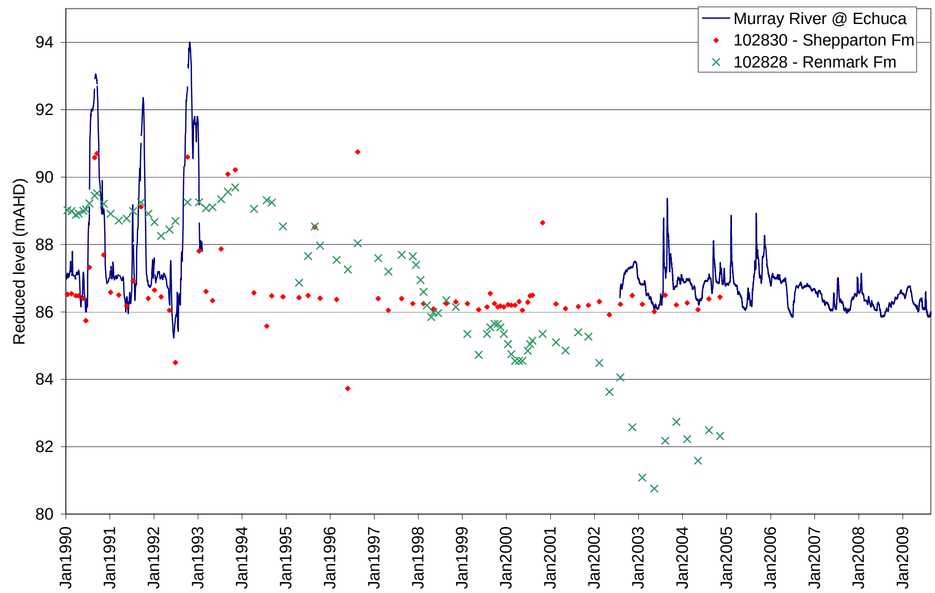
Baseflow = 502 ML in 1996
Stream flow
Base flow
Flow (ML/day)
1000
900
800
700
600
500
400
300
200
100
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

408200

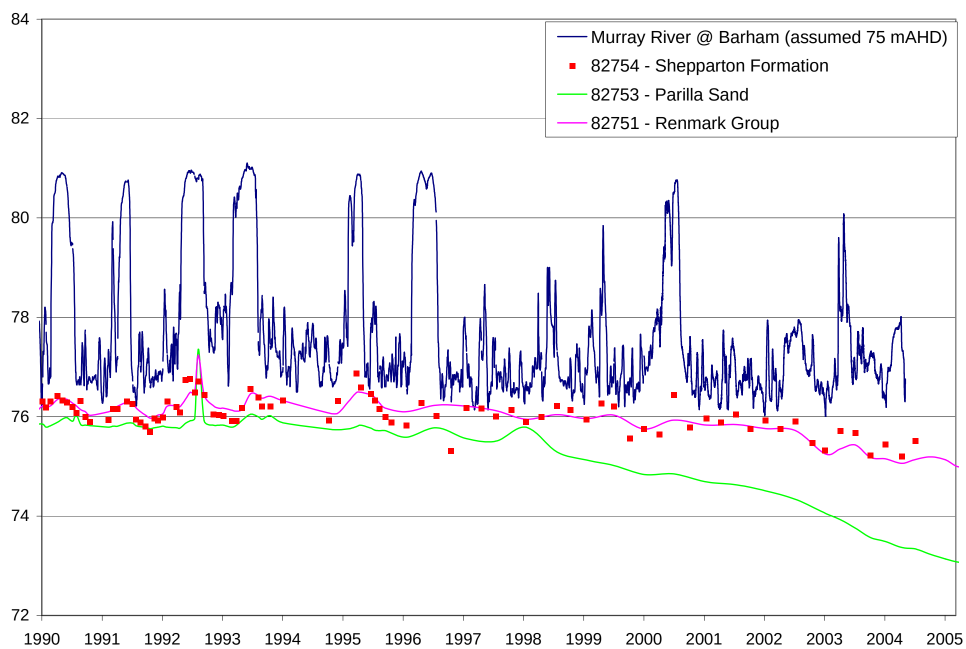


Baseflow = 25887 ML in 1995
Stream flow
Base flow
Flow (ML/day)
8000
7000
6000
5000
4000
3000
2000
1000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

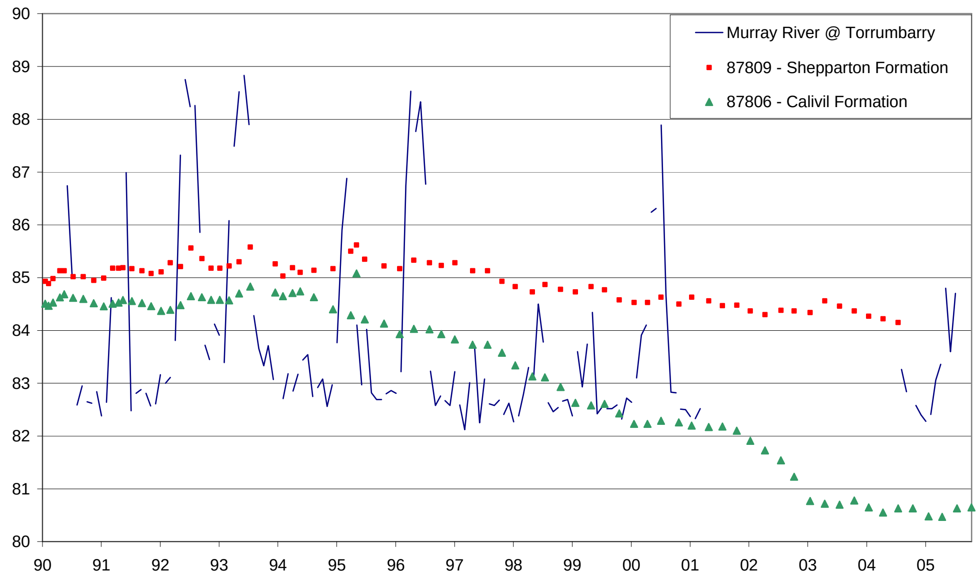
Groundwater – surface water interaction Echuca



Groundwater – surface water interaction Barham



Groundwater – surface water interaction Torrumbarry



Appendix 2: Model layer development

The objective of the following section is to describe the process and origin of data used in the assembly of the various data sets for each model layer.

Model layer 1

Described previously, model layer 1 is composed primarily of Coonambidgal Formation.

The extent of layer 1 was defined by 1:250 000 geology mapping (DPI, 2003) of the Coonambidgal Formation.

Isopachs

Layer 1 was considered by assuming a uniform thickness of 7 m.

Hydraulic conductivity

Uniform hydraulic conductivity of 0.8 m/day was assigned in layer 1 prior to calibration.

Model layer 2

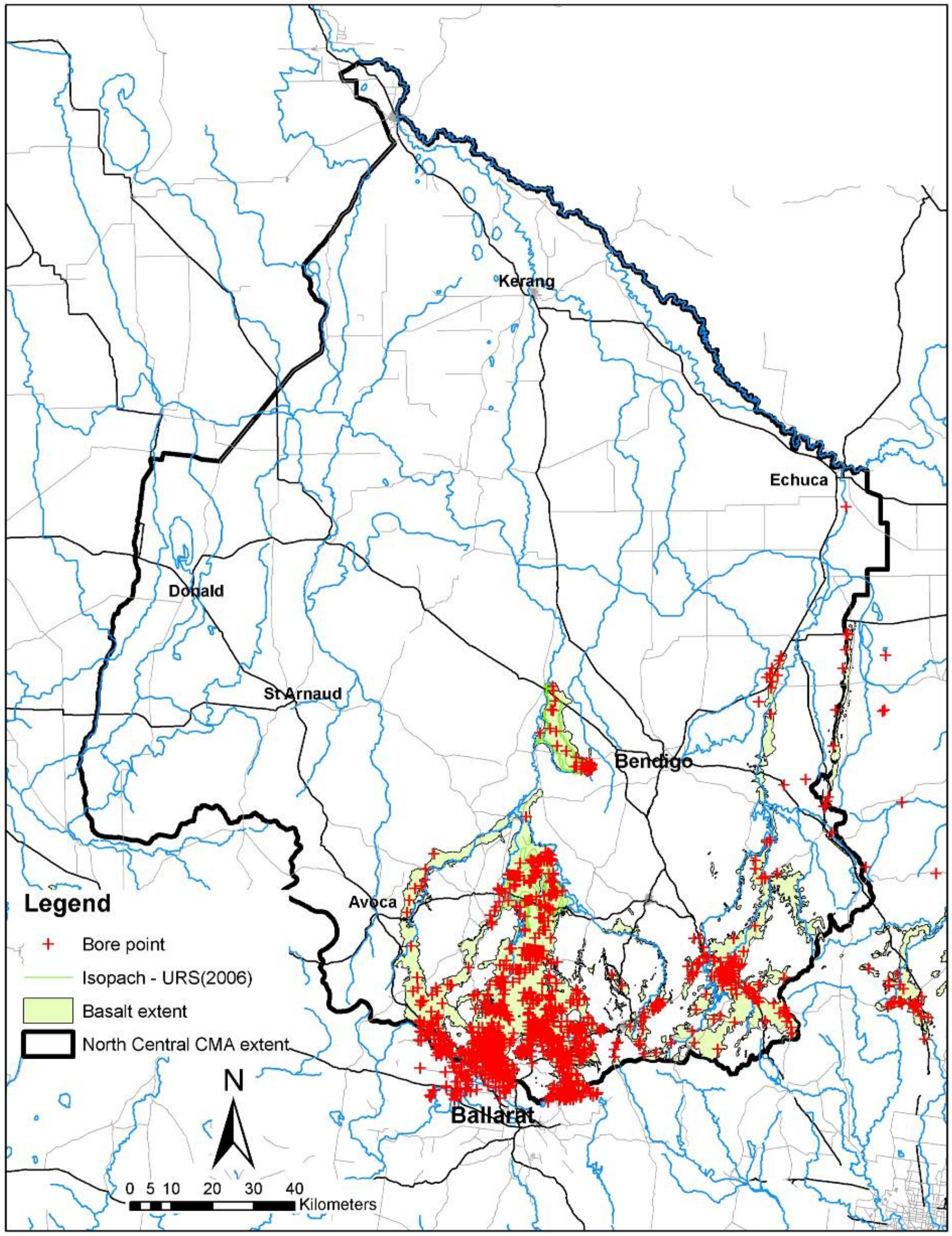
Extent

The extent of Quaternary basalt was made by selecting 'Newer Volcanics' geology mapping of 1:250 000 geology mapping, then updated with basalt mapping by Wilford, James and Halas (2007) in the Loddon Catchment.

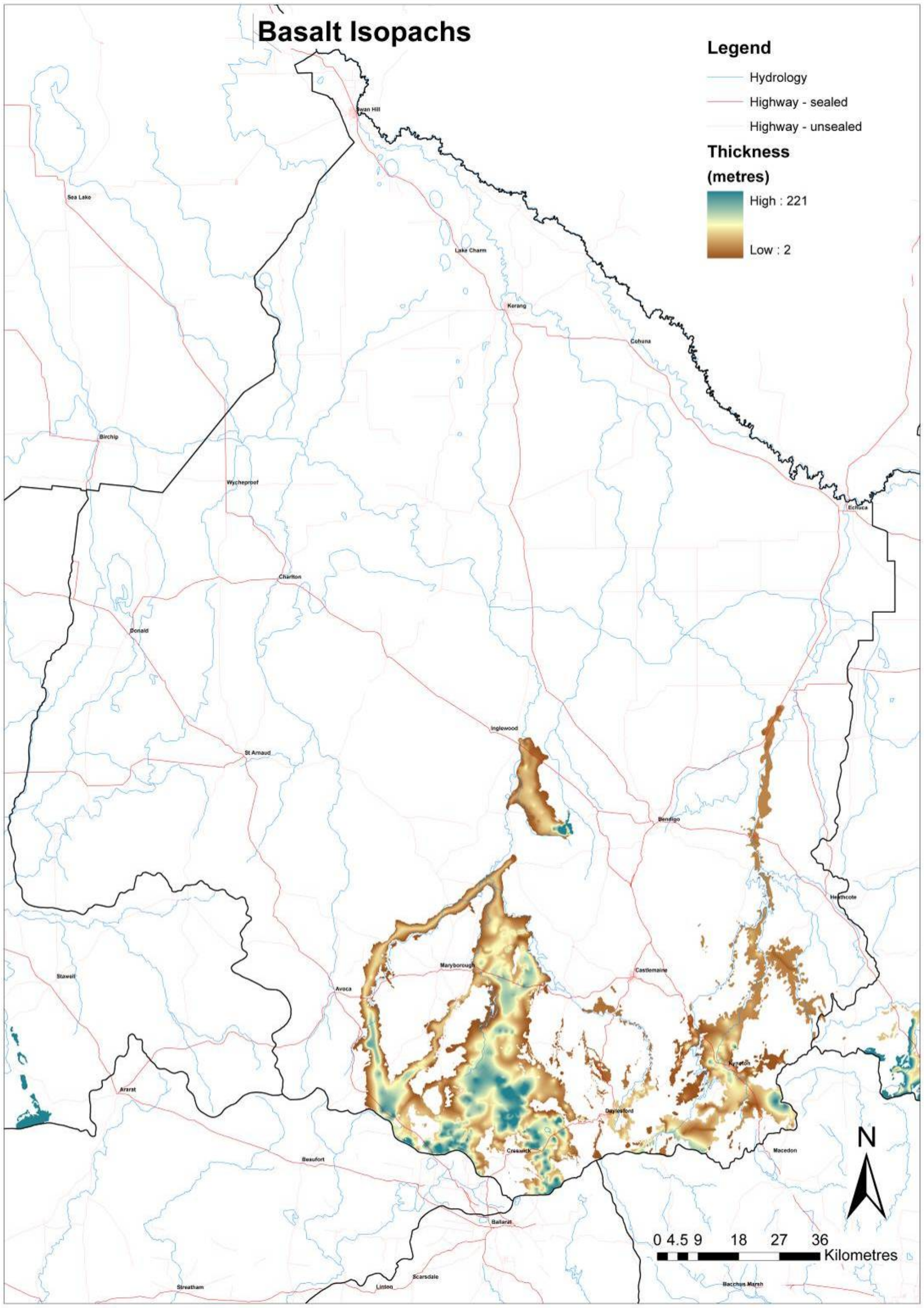
Thickness

Thickness of the geological unit was defined by data presented below, then incorporated in TOPOGRIDTOOL (module of ArcGIS©). Boundary enforcement was made to ensure pinching of aquifer occurred.

Source	Data type
URS (2006)	Isopach contours
Wilford, James & Halas (2007)	Extent of geology
Fawcett (2004)	Bore logs
DSE (2009)	Interpreted stratigraphy
DPI (2003)	Geology mapping



Kerang
Echuca
Donald
St Arnaud
Bendigo
Avoca
Ballarat
Legend
Bore point
Isopach - URS(2006)
Basalt extent
North Central CMA extent
N
0 5 10 20 30 40
Kilometers



Hydraulic conductivity

Uniform hydraulic conductivity value of 5 metres/day was assigned prior to calibration.

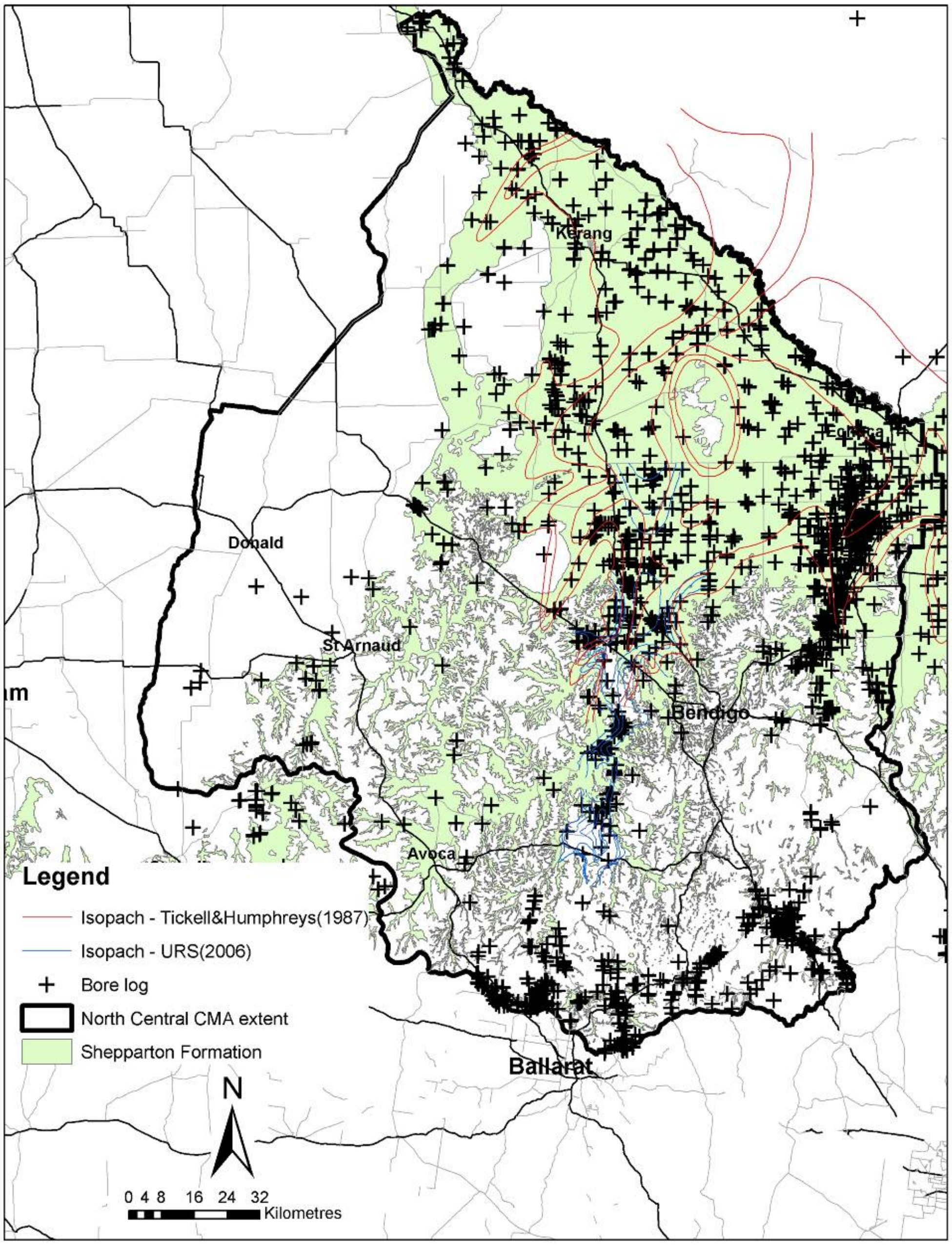
Model layers 3 and 4

The primary extent of the Shepparton Formation was defined by 1:250 000 geology mapping (DPI 2003). Recent Quaternary deposits have been placed with the Shepparton Formation due to their relatively minor thickness.

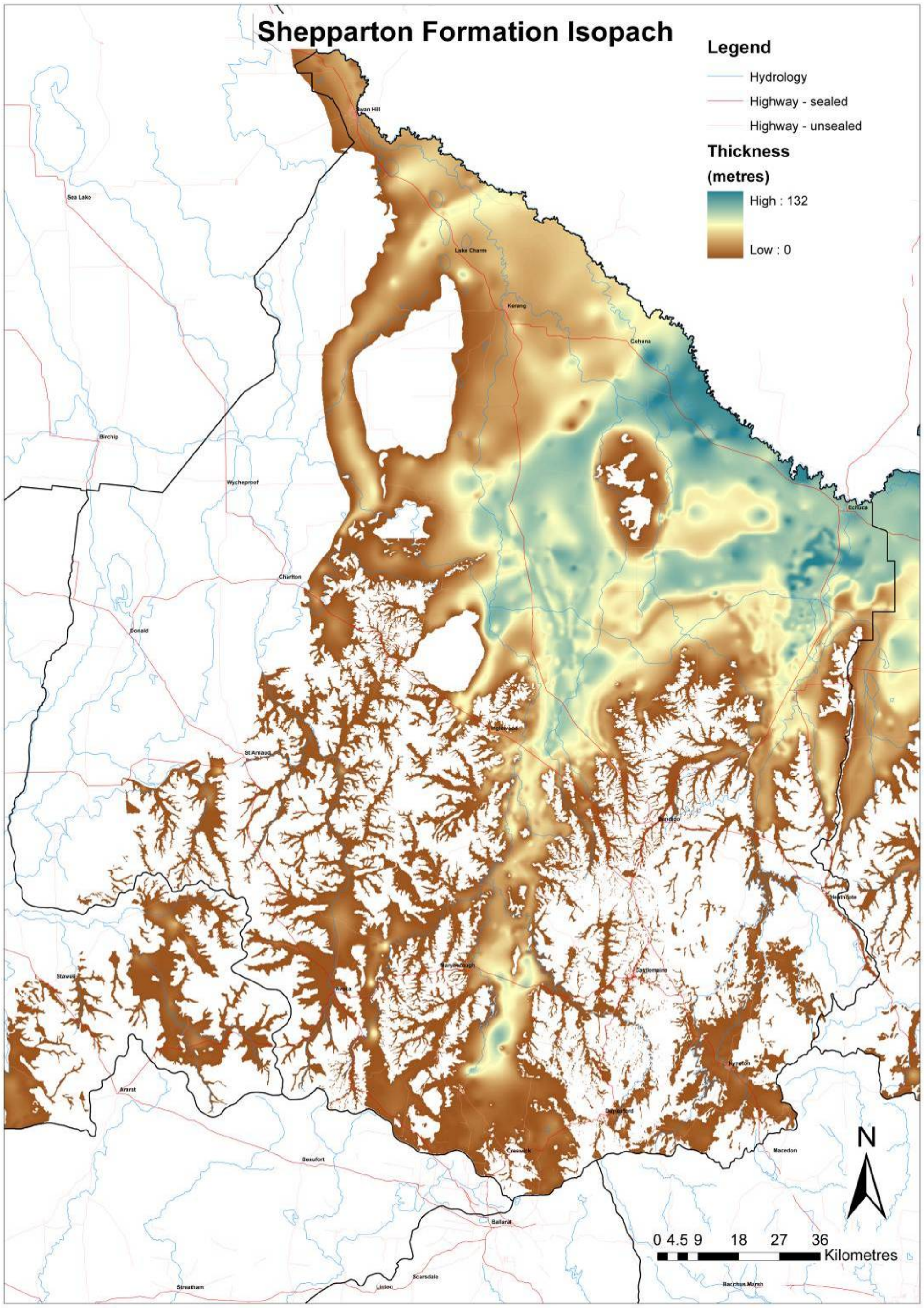
In the north-west of the North Central CMA region it was considered that the Shepparton Formation thins and becomes unsaturated, here the underlying Parilla Sand aquifer becomes the primary unconfined aquifer. To simulate the thinning of the Shepparton Formation, layer 3 pinches out above the elevation contour of 210 m west of Charlton, where between Charlton and Swan Hill an approximate boundary was used based upon mapping by Tickell and Humphreys (1987).

The thickness of the Shepparton Formation was derived by utilising isopach maps of previous studies, published bore logs and interpreted stratigraphic information from the DSE statewide groundwater database. Information from the following published reports was used.

Source	Data type
Tickell & Humphrys (1987)	Isopach contours & bore logs
URS (2006)	Isopach contours
Potts (1988)	Bore logs
Brinkley, Bartley & Reid (1988)	Bore logs
Lawrence (1975)	Bore logs
Nolan_ITU (2006)	Bore logs
Dyson (2008)	Bore logs
Lakey (1986)	Isopach contours
Pratt et al. (1988)	Bore logs
Brinkley & Reid (1993)	Bore logs
CRA (1994)	Bore logs
DSE (2009)	Interpreted stratigraphy



Kerang
Echuca
Donald
St Arnaud
Bendigo
Avoca
Ballarat
Legend
Isopach - Tickell&Humphreys(1987)
Isopach - URS(2006)
Bore log
North Central CMA extent
Shepparton Formation
N
0 4 8 16 24 32
Kilometres


Shepparton Formation Isopach
Legend
Hydrology
Highway - sealed
Highway - unsealed
Thickness
(metres)
High : 132
Low : 0
N
0 4.5 9 18 27 36
Kilometres
Lake Charm
Kerang
Cohuna
Echuca
Sea Lake
Birchip
Wycheproof
Charlton
Donald
St Arnaud
Maryborough
Castlemaine
Heathcote
Stawell
Ararat
Beaufort
Macedon
Ballarat
Scarsdale
Linton
Streatham
Bacchus Marsh

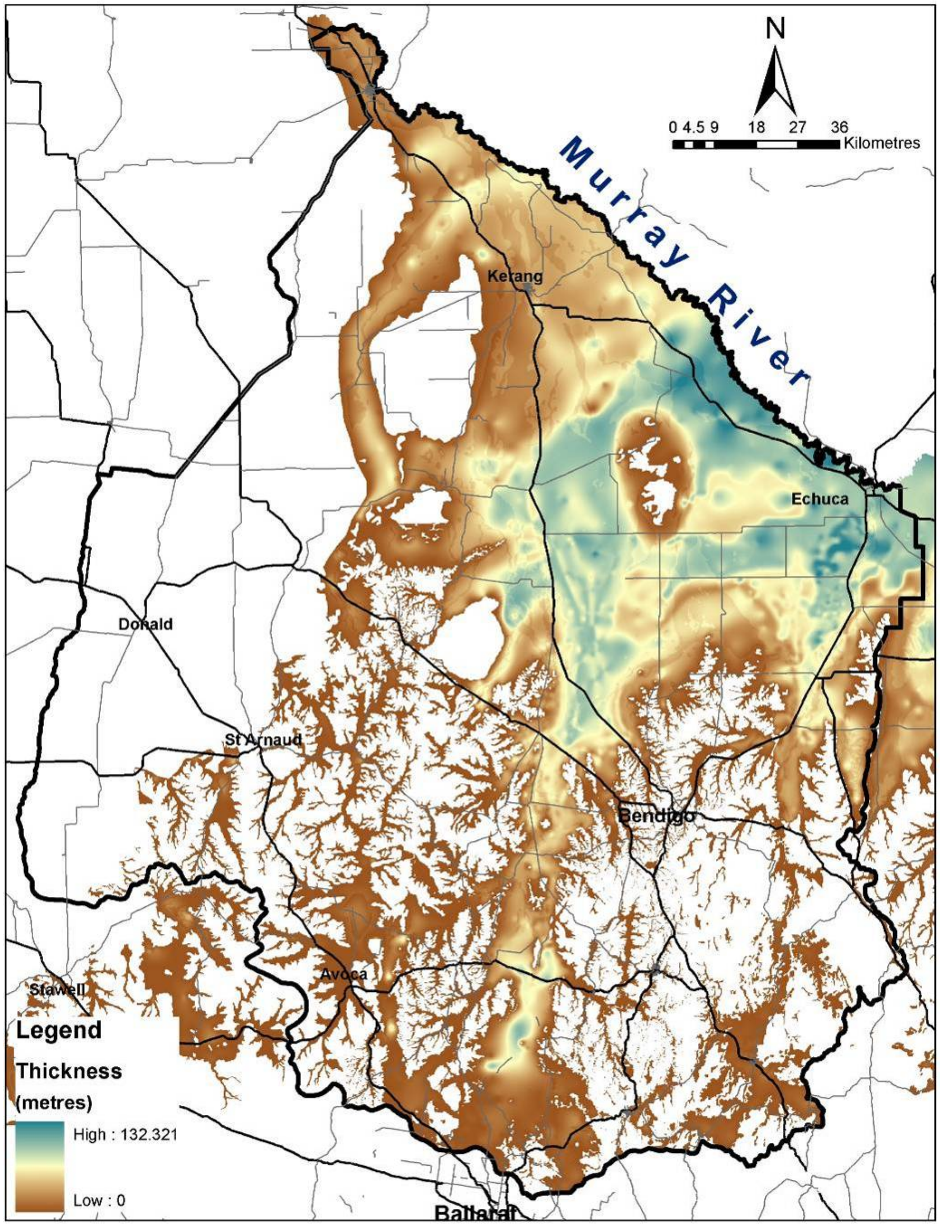
Model layer 3

Extent

The upper Shepparton Formation described by Ife (1988) was noted to be the primary aquifer to have groundwater extracted in the Shepparton region (top 20 metres of the profile). Spatial mapping of the upper Shepparton Formation thickness is difficult due to the high variability in the Shepparton Formation and the presence and absence of sand lenses. Projects such as Tickell & Humphreys 1987 and Ivkovic et al. 2001 consider an approximate the boundary between the upper and lower Shepparton Formation to be in the range of 25 metres from ground surface in a modelling context. The extent of the upper Shepparton Formation was assigned the same extent as the entire Shepparton Formation.

Thickness

The upper Shepparton Formation was assigned the same thickness as the Shepparton Formation, unless the thickness was greater than 25 m, then it was set to 25 m.



N
0 4.5 9 18 27 36
Kilometres
Murray River
Kerang
Echuca
Donald
St Arnaud
Bendigo
Avoca
Stawell
Ballarat
Legend
Thickness
(metres)
High : 132.321
Low : 0

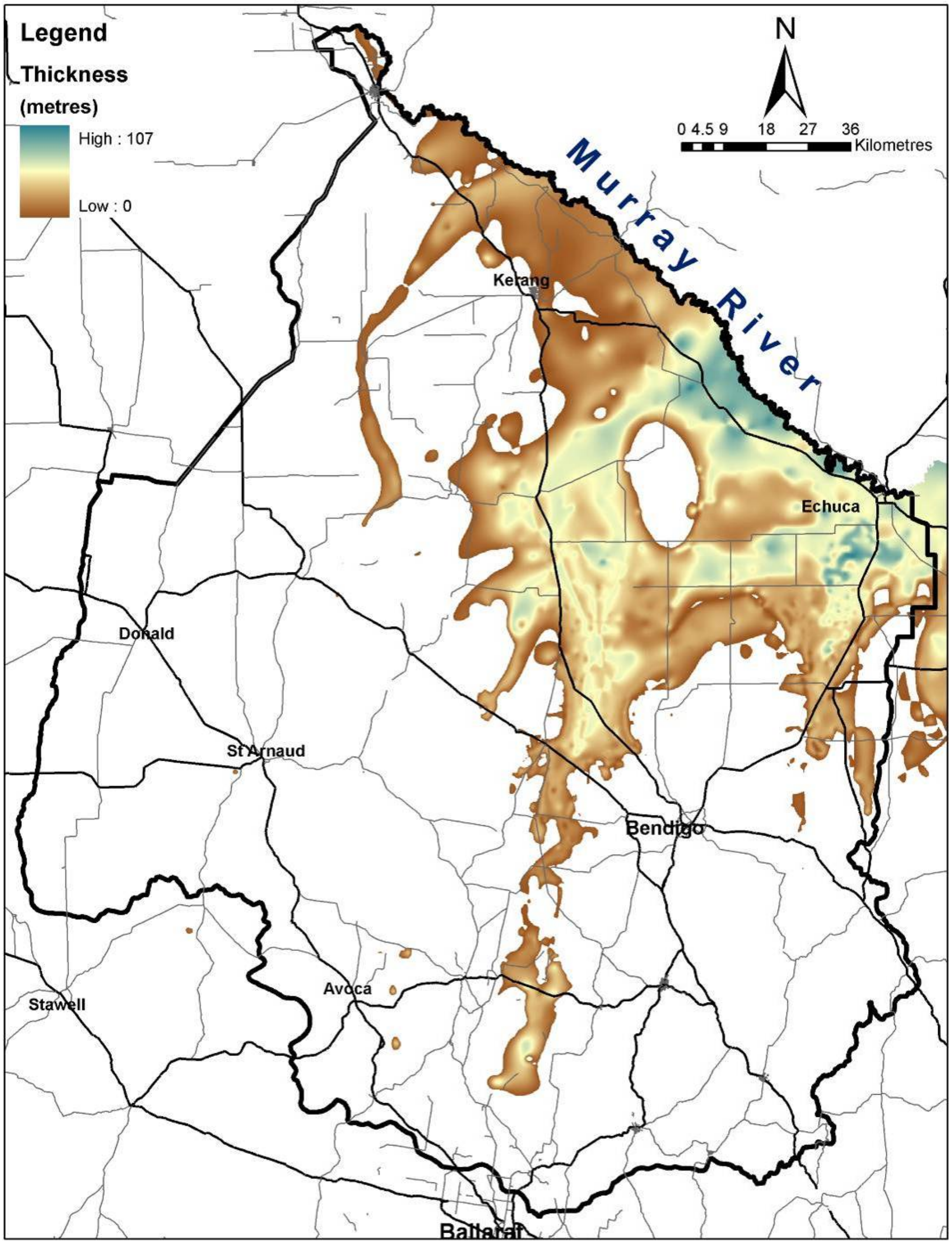
Model layer 4

Extent

The delineation of the spatial extent of the lower Shepparton Formation selected the locations where the thickness of the Shepparton Formation was greater than 25 metres.

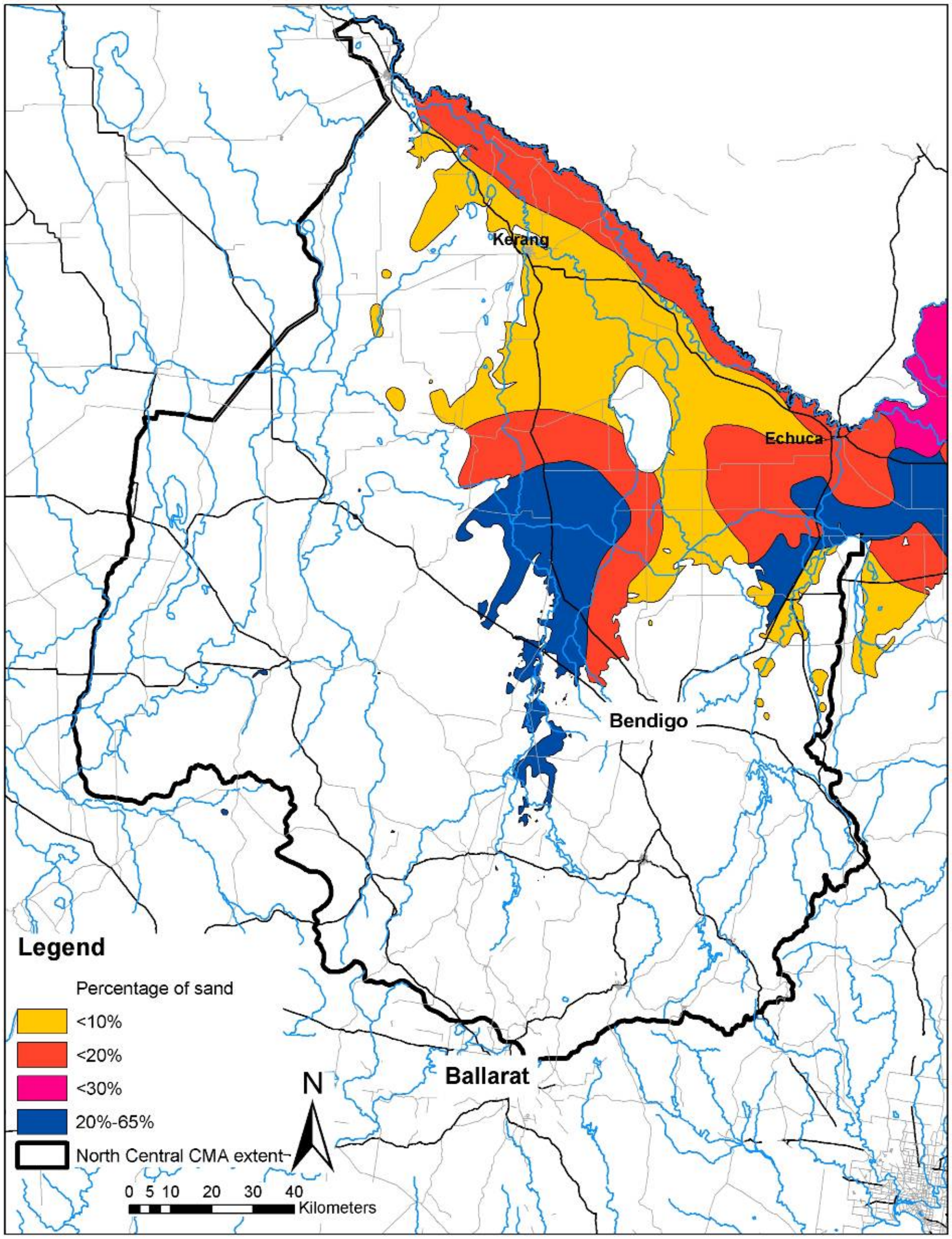
Thickness

The thickness of the lower Shepparton Formation was allocated as the thickness of the Shepparton Formation minus 25 metres.



Hydraulic conductivity

Spatial attribution of hydraulic conductivity was allocated using percentage sand mapping by Tickell and Humphreys (1987). Sand percentage estimates of the Shepparton Formation are presented below.

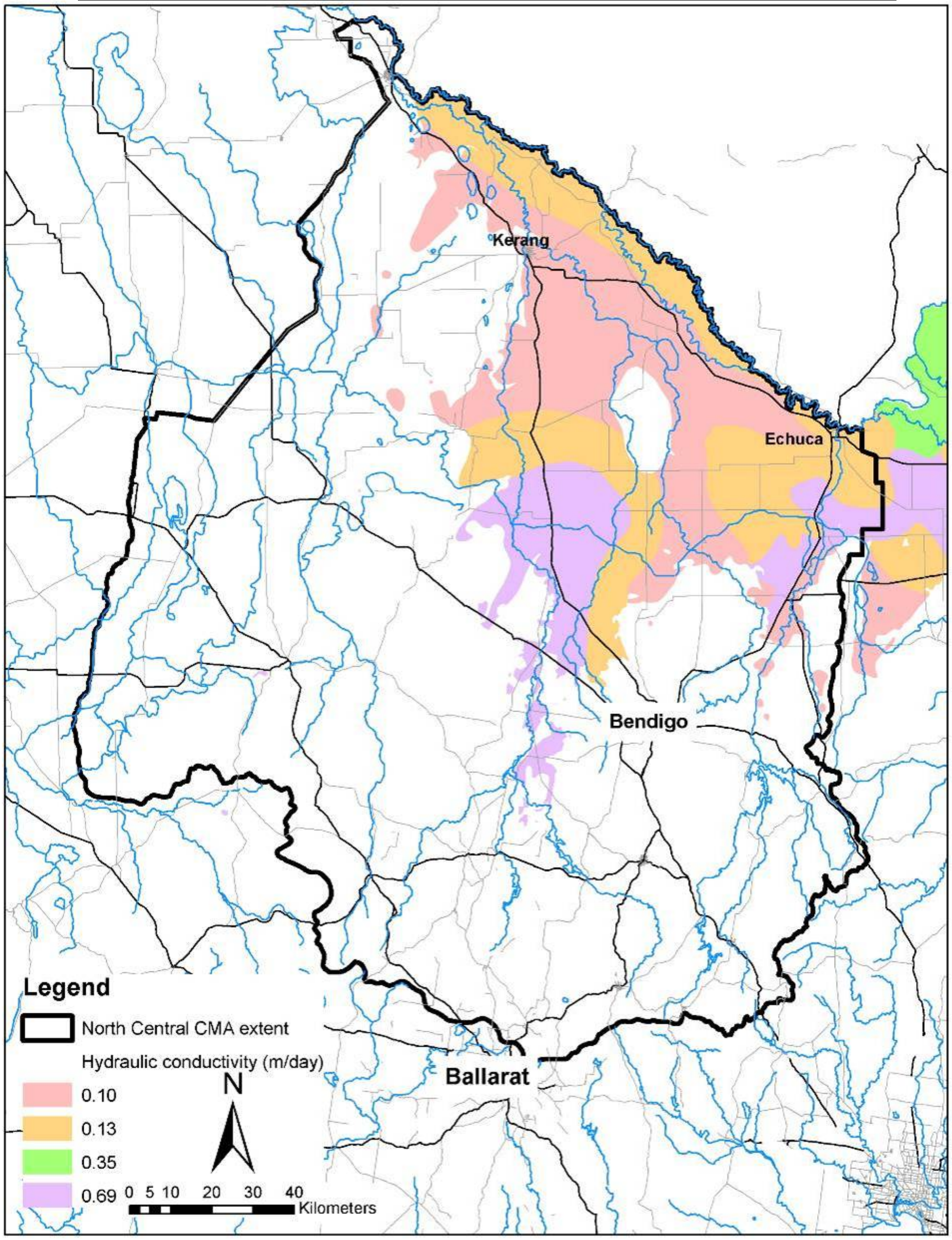


(Source: Tickell & Humphrys 1987 p. 24)

The below table presents the conversion of percentage sand to hydraulic conductivity.

Percentage sand	Hydraulic conductivity (metres/day)
< 10	0.10
< 20	0.13
< 30	0.35

20 – 65	0.69



Kerang
Echuca
Bendigo
Ballarat
Legend
North Central CMA extent
Hydraulic conductivity (m/day)
0.10
0.13
0.35
0.69
N
0 5 10 20 30 40
Kilometers

Model layer 5

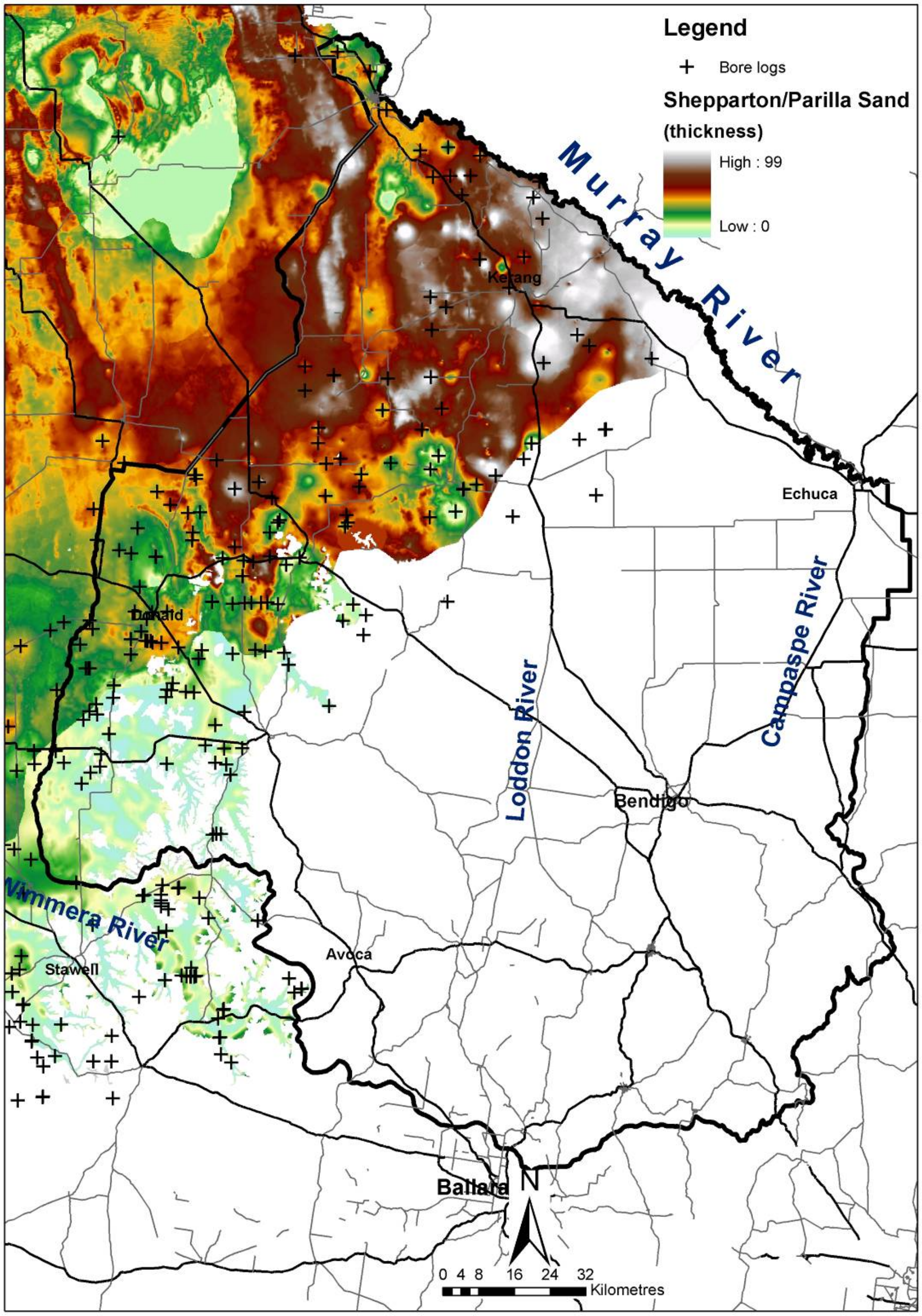
Extent

Macumber (1976) identified the eastern extent of Parilla Sand in the vicinity of Cohuna to Charlton, which was later updated in Macumber (1978). South of Charlton, the extent of the marine transgression was approximated to equal the 210 metre ahd contour, based upon the investigations in the Wimmera (Hughes, Carey, and Kotsonis, 1999, Cayley & Taylor, 1997, Hocking, 2005).

Source	Data type
Macumber (1976)	Isopach contours
Hughes, Carey, and Kotsonis (1999)	Extent of geology
DSE (2009)	Interpreted stratigraphy
DPI (2003)	Geology mapping

Thickness

The thickness of the Parilla Sand aquifer was defined entirely by interpretation of bore log data, then incorporated in TOPOGRIDTOOL (module of ArcGIS©) Boundary enforcement was made to ensure pinching of aquifer occurred.



Hydraulic conductivity

Uniform hydraulic conductivity value of 1.3 metres/day was set prior to calibration.

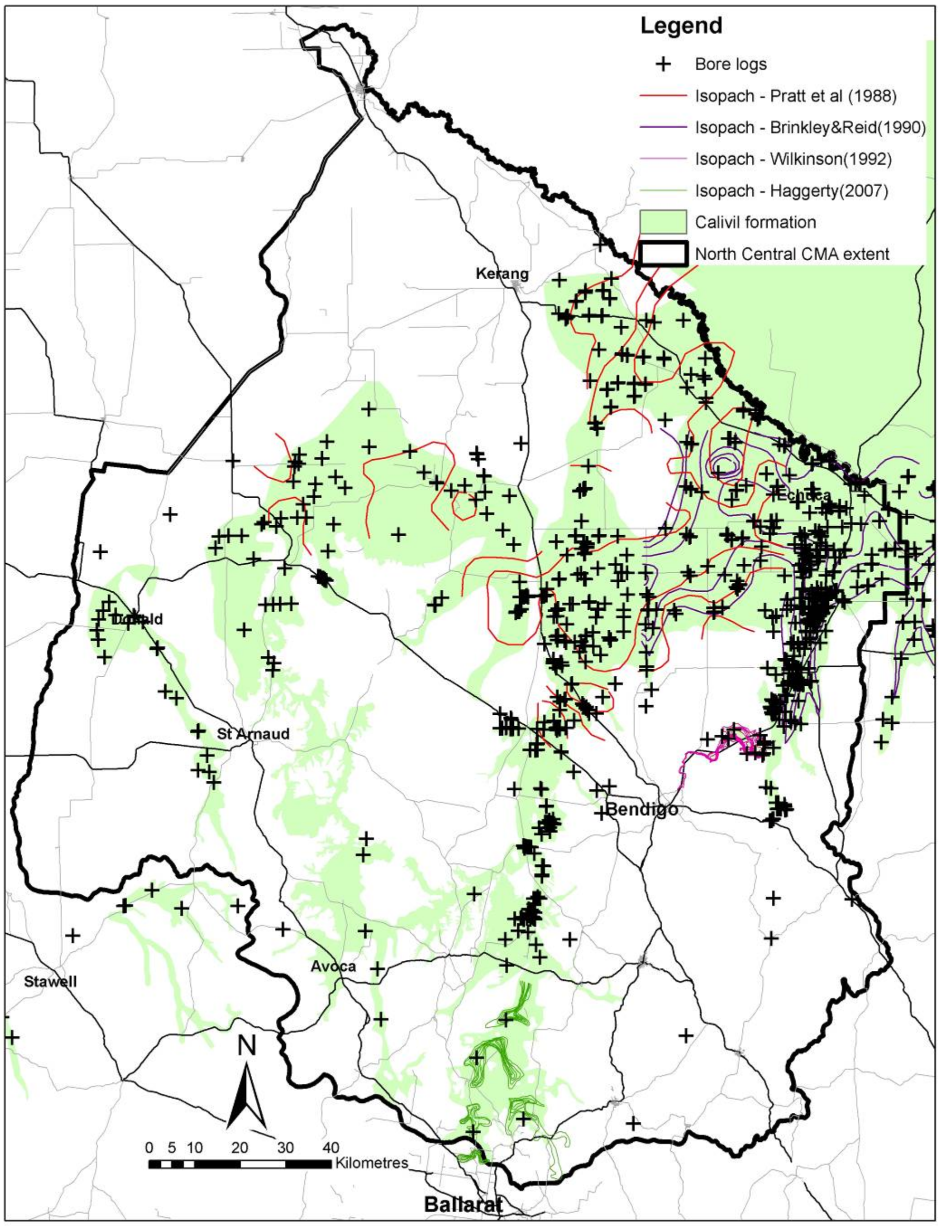
Model layer 6

Model layer 6 describes the Calivil Formation.

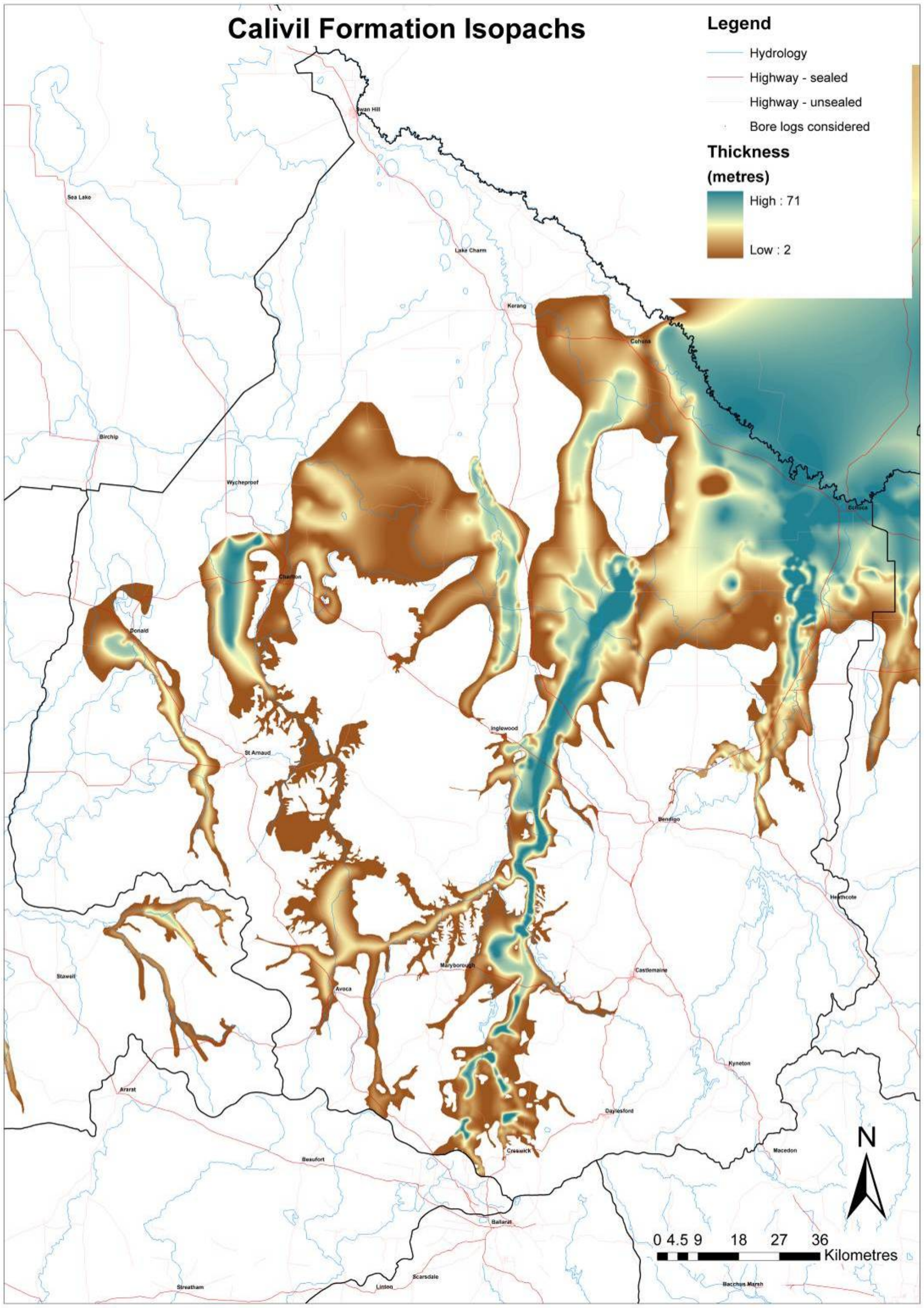
The primary extent of layer 6 was defined by 1:250 000 hydrogeology mapping (MDBA 2009) plus site specific projects (various authors). Detailed analysis of the 1:250 000 hydrogeology mapping with bore log data found a number of locations where aquifer extents differed. In these locations bore log data was considered to be the more accurate dataset and the extent modified accordingly.

Thickness

The thickness of layer 6 was derived by utilising published bore logs, interpreted stratigraphic information from the DSE statewide groundwater database and project mapping. Hydrogeological map series isopachs were not used as discrepancies with bore log data were apparent. Information from the following published reports was used.



Source	Data type
Pratt et al. (1988)	Bore logs
Brinkley & Reid (1993)	Bore logs
Bartley & Reid (1987)	Bore logs
Lawrence (1975)	Bore logs
Brinkley, Bartley & Reid (1988)	Bore logs
CRA (1994)	Bore logs
Tickell & Humphrys (1987)	Bore logs
Lakey (1986)	Isopach contours
Wilkinson (1993)	Isopach contours
Nolan ITU (2006)	Isopach contours
Ryan (1991)	Isopach contours
Haggerty (2007)	Isopach contours
DSE (2009)	Interpreted stratigraphy



Hydraulic conductivity

Uniform hydraulic conductivity of 50 metres/day was assigned prior to calibration.

Model layer 7

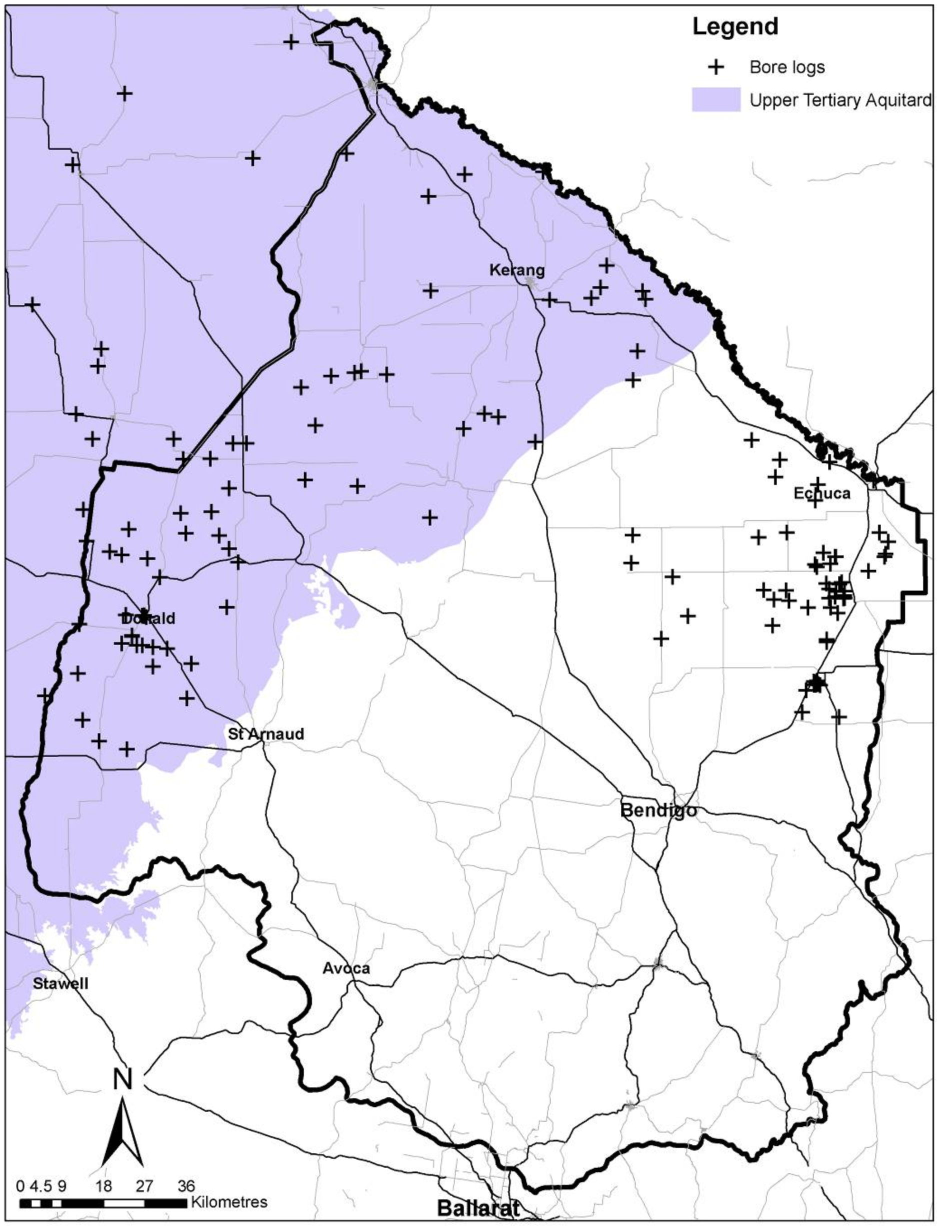
Extent and thickness

The extent of the Tertiary aquitard was considered to have a maximum inland extent simular as the Parilla Sand boundary based upon bore log interpretation and the lack of any other clear geological boundary in the area.

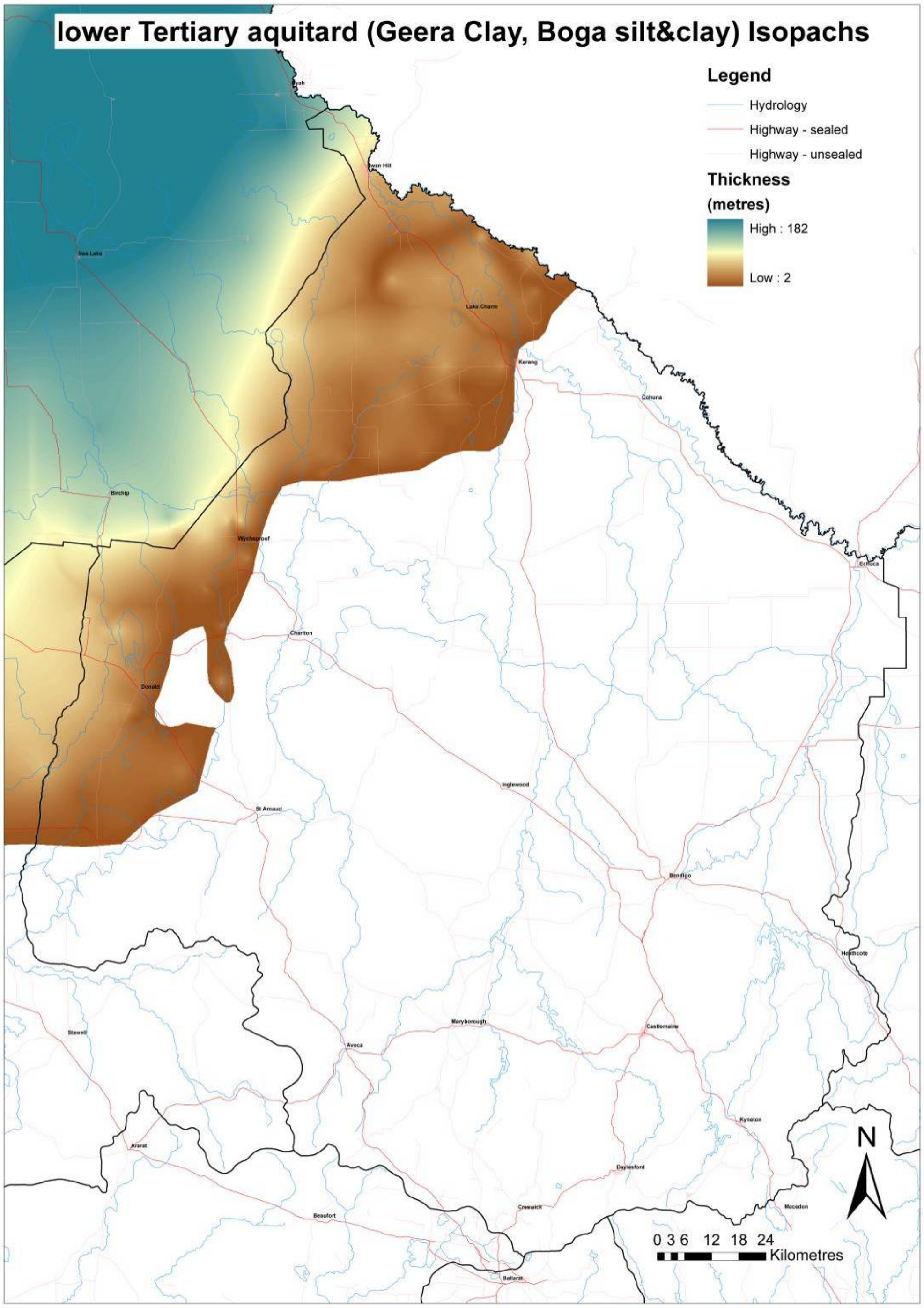
The geological units were amalgamated for the purposes of this exercise due to their low water bearing nature and difficulty in distinguishing individual units when interpreting bore logs (also noted by Lakey et al. 1986).

The thickness of the Tertiary aquitard was determined by data presented below, then incorporated in TOPOGRIDTOOL (module of ArcGIS©). Boundary enforcement was made to ensure pinching of aquifer occurred.

Source	Data type
Pratt et al. (1988)	Bore logs
Brinkley & Reid (1993)	Bore logs
Bartley & Reid (1987)	Bore logs
Lawrence (1975)	Bore logs
Brinkley, Bartley & Reid (1988)	Bore logs
CRA (1994)	Bore logs
Tickell & Humphrys (1987)	Bore logs
DSE (2009)	Interpreted stratigraphy



Legend
Bore logs
Upper Tertiary Aquitard
Kerang
Echuca
Donald
St Arnaud
Bendigo
Stawell
Avoca
Ballarat
N
0 4.5 9 18 27 36
Kilometres



Hydraulic conductivity

A uniform hydraulic conductivity of 0.01 metres/day was assigned prior to model calibration.

Model layer 8

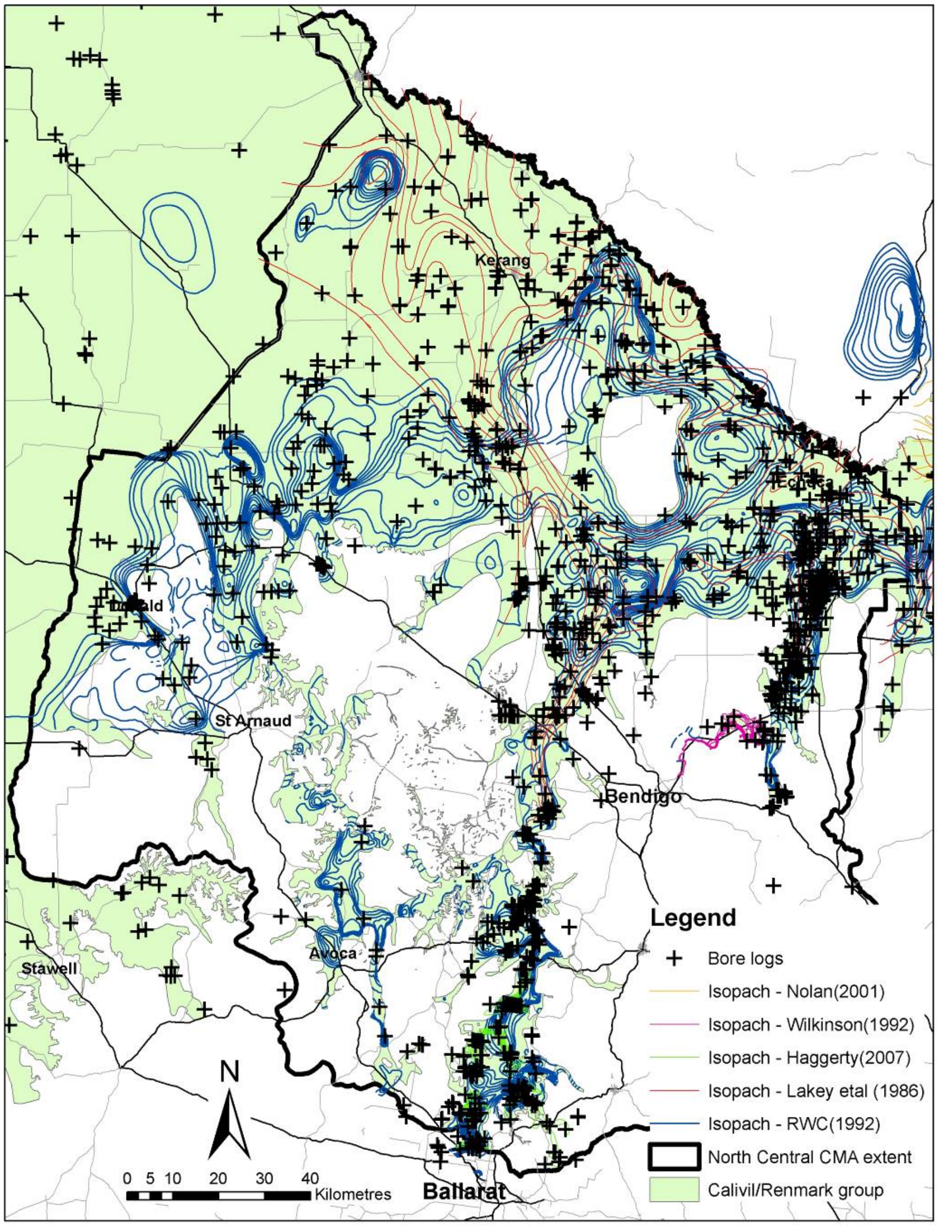
Model layer 8 describes the Renmark Group.

The primary extent of layer 8 was defined by 1:250 000 hydrogeology mapping (various authors).

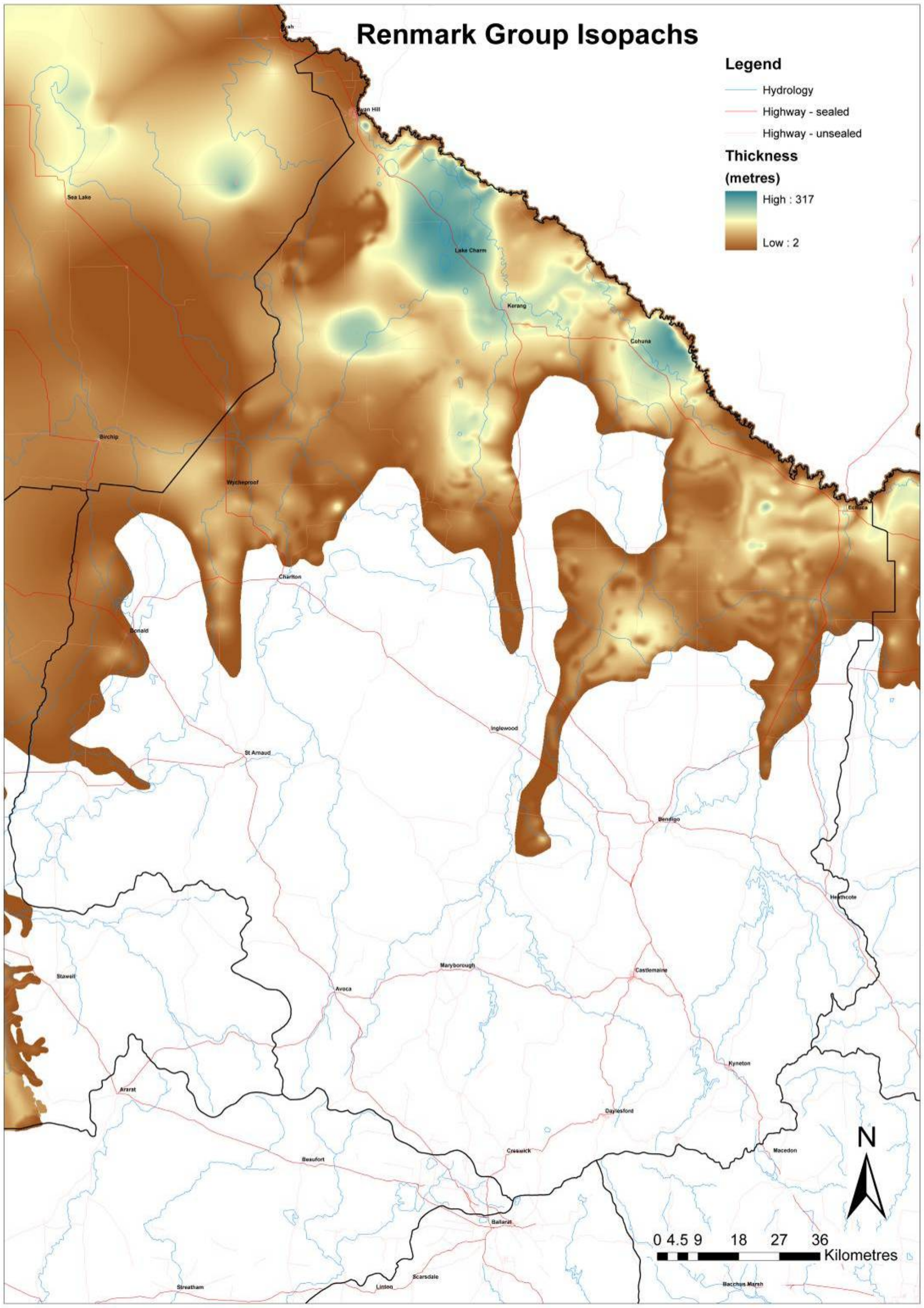
Isopachs

The thickness of layer 8 was derived by utilising published bore logs and interpreted stratigraphic information from the DSE statewide groundwater database. Hydrogeological map series isopachs were not used as discrepancies with bore logs were apparent. Information from the following published reports was used.

Source	Data type
CRA (1994)	Bore logs
DSE (2009)	Interpreted stratigraphy
DPI (2003)	Interpreted stratigraphy
GSV (2008)	Bore logs
MDBA (2009)	Aquifer extents
Pratt et al. (1988)	Bore logs
Brinkley & Reid (1993)	Bore logs
Bartley & Reid (1987)	Bore logs
Lawrence (1975)	Bore logs
Brinkley, Bartley & Reid (1988)	Bore logs
CRA (1994)	Bore logs
Tickell & Humphrys (1987)	Bore logs
Lakey (1986)	Isopach contours
Nolan ITU (2006)	Isopach contours
Hyder (2006)	Isopach contours
SKM (2006)	Transects



Kerang
Echuca
Donald
St Arnaud
Bendigo
Stawell
Avoca
Ballarat
N
0 5 10 20 30 40
Kilometres
Legend
Bore logs
Isopach - Nolan(2001)
Isopach - Wilkinson(1992)
Isopach - Haggerty(2007)
Isopach - Lakey etal (1986)
Isopach - RWC(1992)
North Central CMA extent
Calivil/Renmark group



Hydraulic conductivity

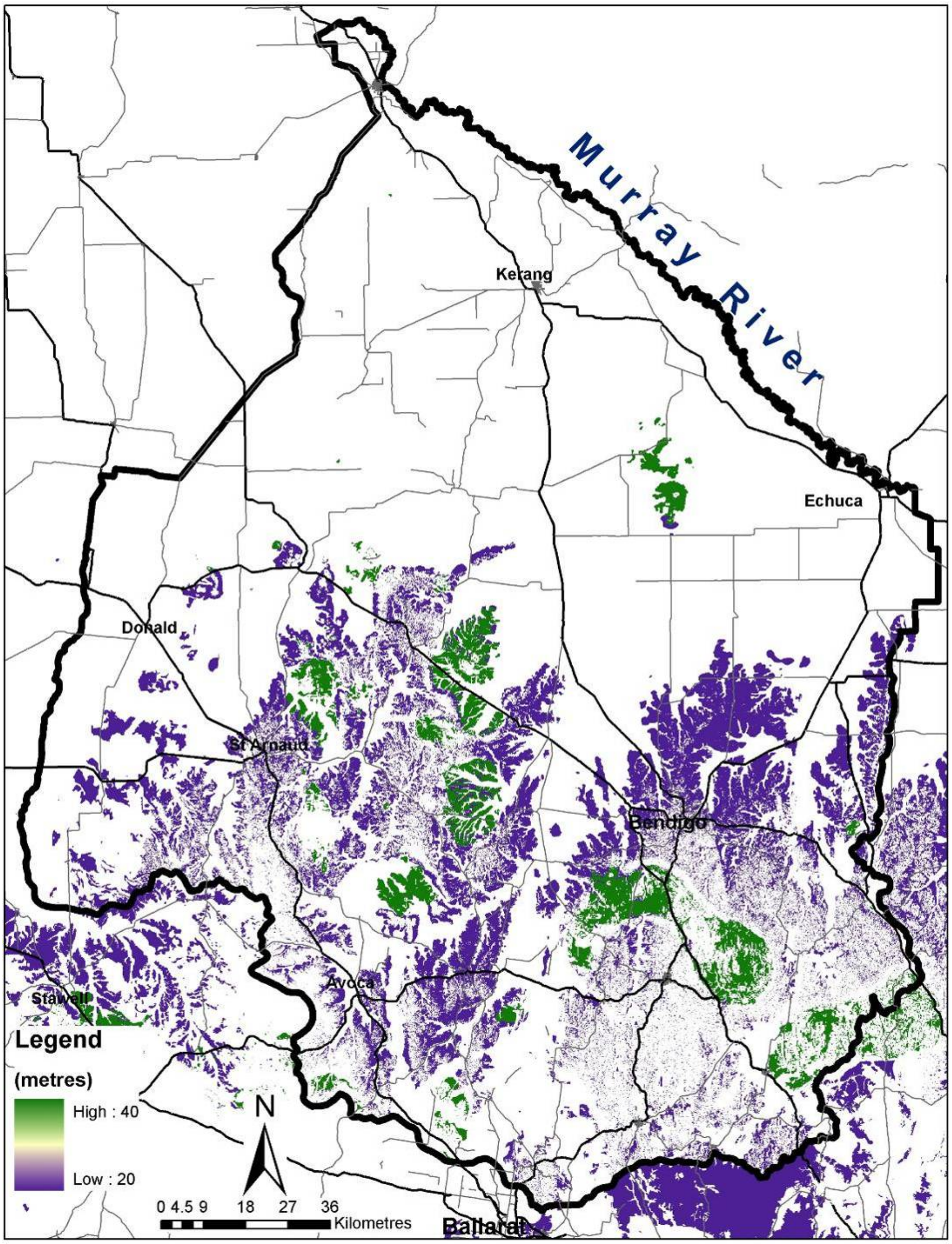
Uniform hydraulic conductivity of 5 metres/day was assigned in layer 8 prior to calibration.

Model layer 9

Described previously, model layer 9 is composed of deeply weathered geology. The primary extent of layer 9 was defined by 1:250 000 GFS mapping.

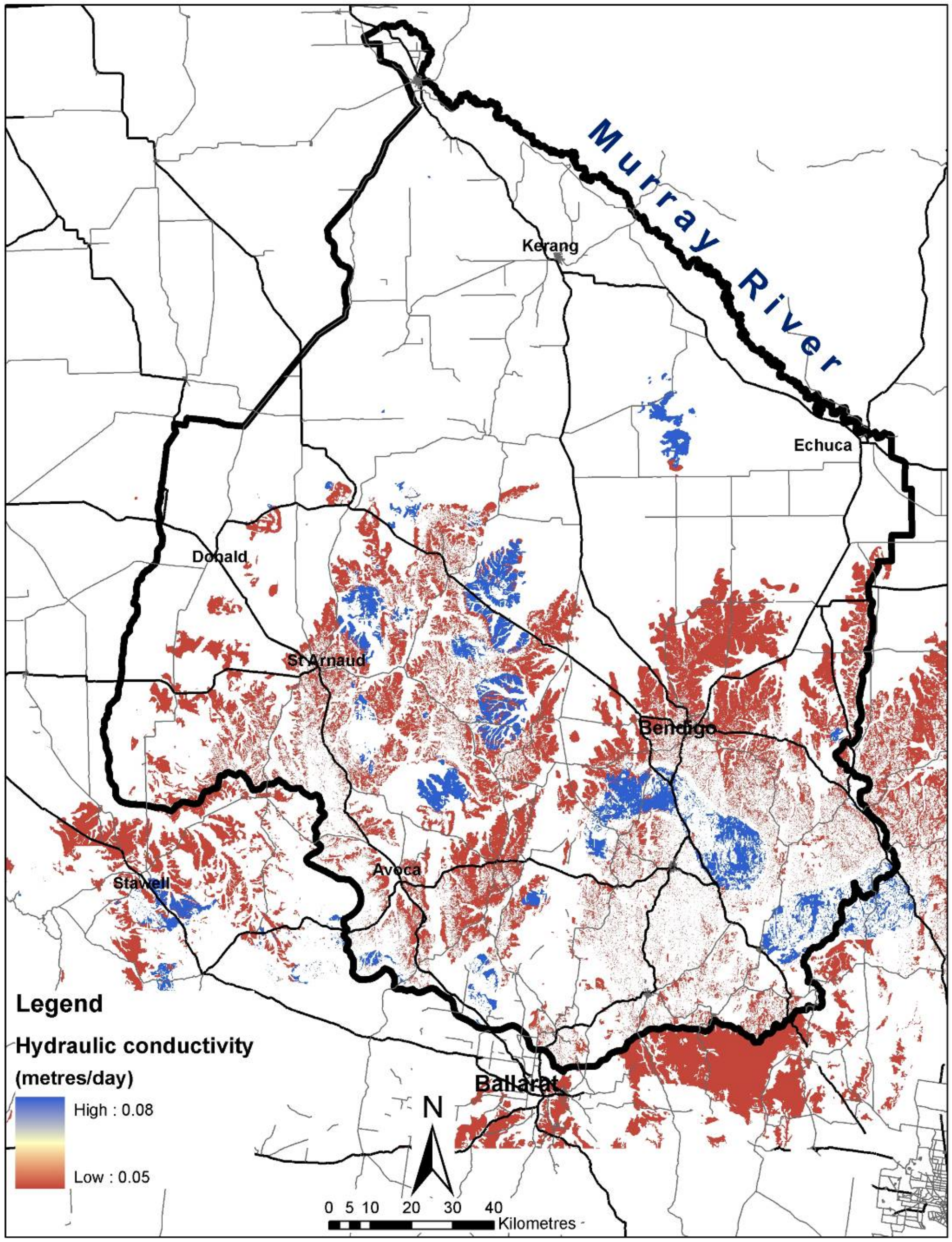
Isopachs

The thickness of layer 9 was determined based upon geology. For Palaeozoic sediments an effective thickness was assumed at 20 metres, and for Devonian granite an effective thickness was assumed at 40 metres. A smoothing algorithm was then applied to ensure a smooth transition on and off the aquifer.



Hydraulic conductivity

Variable hydraulic conductivity was assigned in layer 9 depending on geology, That is, Devonian granite was set at 0.8 m/day and Palaeozoic metasediments at 0.5 metres/day.



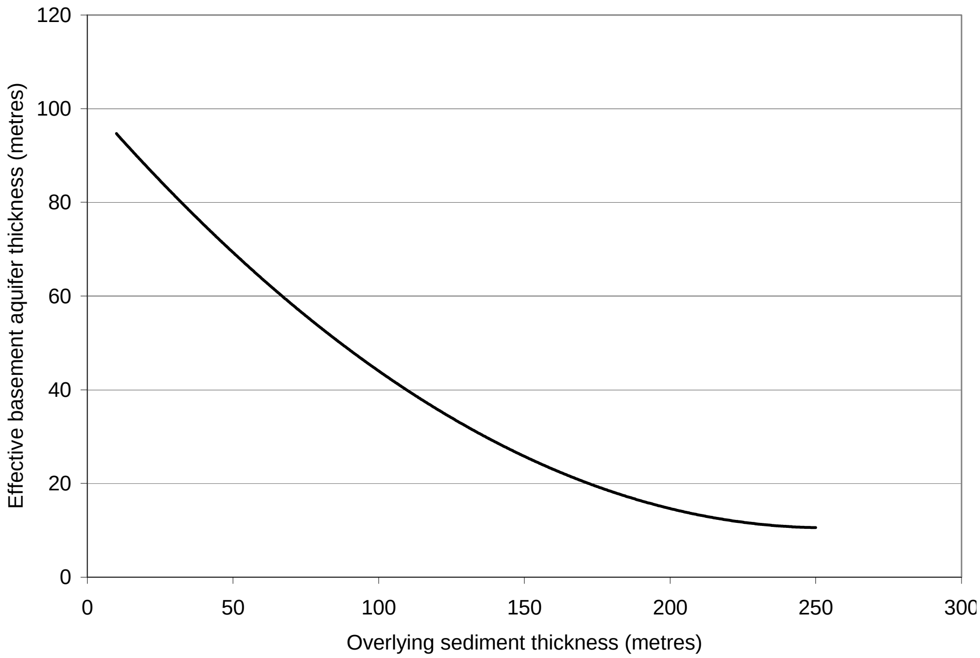
Model layer 10

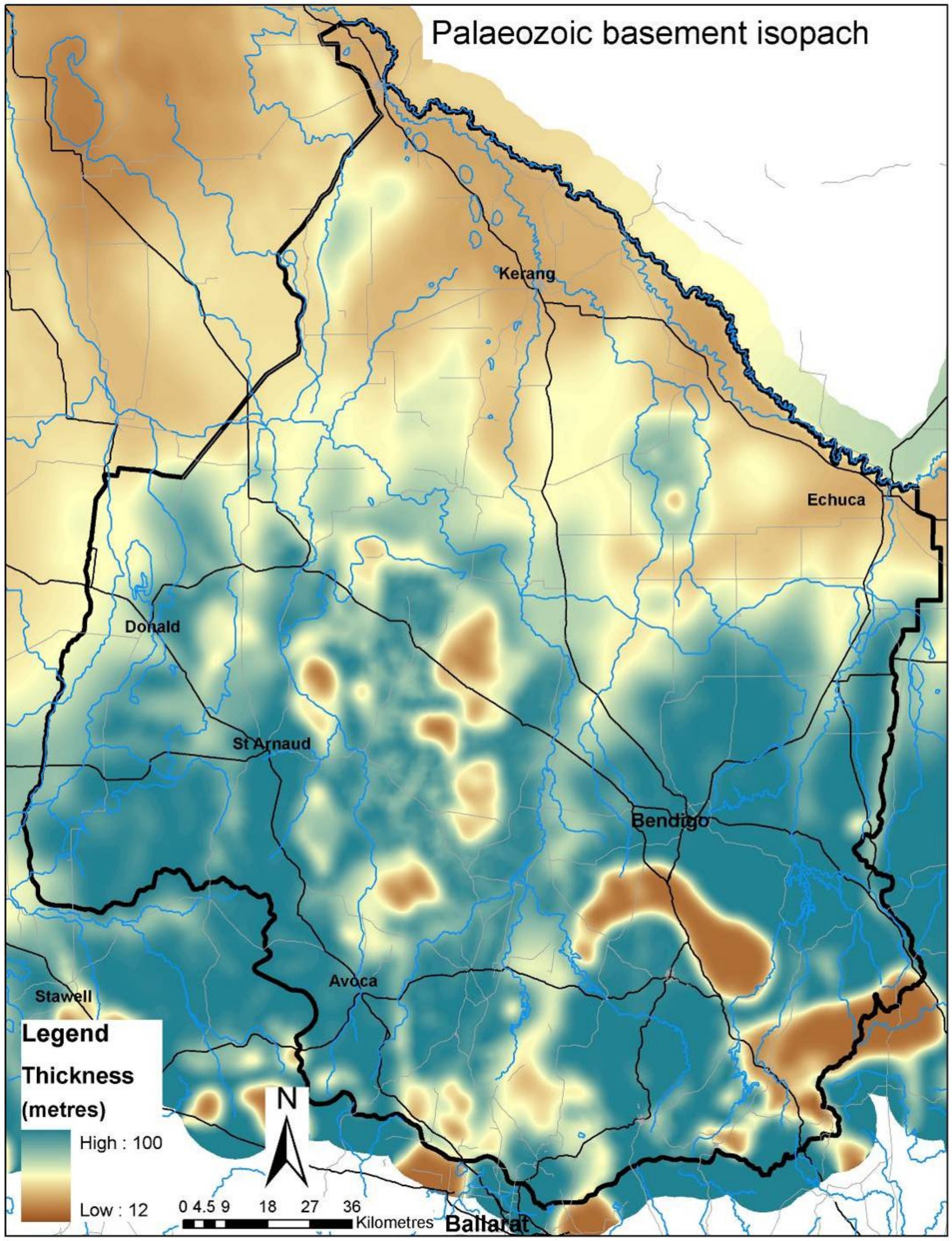
Described previously, model layer 10 is composed of Palaeozoic basement. The extent of layer 10 was set as the entire model domain as confined/unconfined.

Isopachs

The basement behaves as an aquifer where fractures in the rock are sufficiently open to allow for groundwater transmission. Overburden pressures are believed to moderate/reduce the effective hydraulic conductivity.

The effective thickness of layer 10 when confined was based upon overlying sediment thickness. That is, when unconfined it was assumed the aquifer thickness was 100 metres and when overlying sediment thickness was greater than 250 metres aquifer thickness was 10 metres (refer to below).





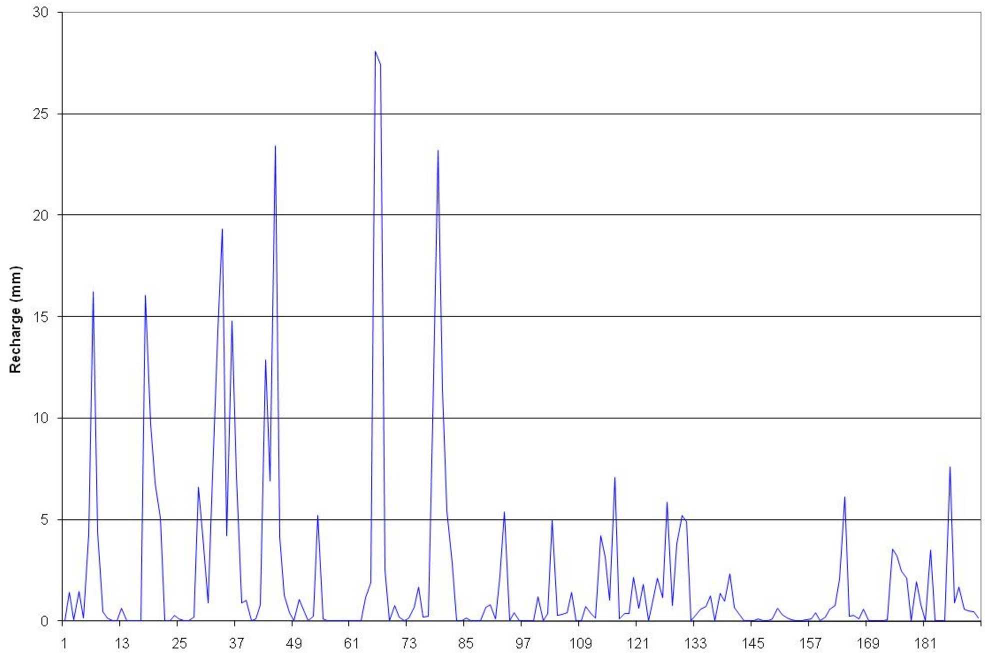
Hydraulic conductivity

Uniform hydraulic conductivity of 0.5 metres/day was assigned in layer 10 prior to calibration.

Appendix 3: Model Attributes

Groundwater recharge

Spatially and time varying recharge was applied to the groundwater model as a non-calibratable feature.



Time step	GL	mm	days
1	24.2871	0.0008	30.4
2	42586.91	1.4373	30.4
3	2427.984	0.0819	30.4
4	42867.59	1.4467	30.4
5	5034.939	0.1699	30.4
6	126614.2	4.2731	30.4
7	480285.2	16.2091	30.4
8	129791	4.3803	30.4
9	13133.4	0.4432	30.4
10	4845.298	0.1635	30.4
11	419.7318	0.0142	30.4
12	530.0695	0.0179	30.4
13	18080.91	0.6102	30.4
14	23.9562	0.0008	30.4
15	90.5228	0.0031	30.4
16	341.6314	0.0115	30.4
17	792.6066	0.0267	30.4
18	476166.8	16.0701	30.4
19	287648.7	9.7078	30.4

20	201719	6.8078	30.4
21	150512.4	5.0796	30.4
22	45.4656	0.0015	30.4
23	63.7165	0.0022	30.4
24	8669.289	0.2926	30.4
25	3639.921	0.1228	30.4
26	81.4995	0.0028	30.4
27	58.457	0.002	30.4
28	6033.076	0.2036	30.4
29	195042.7	6.5825	30.4
30	123384.6	4.1641	30.4
31	25920.74	0.8748	30.4
32	213121	7.1926	30.4
33	424538.3	14.3277	30.4
34	572980.6	19.3374	30.4
35	124118.3	4.1888	30.4
36	437859.8	14.7772	30.4
37	211447.6	7.1361	30.4
38	27044.95	0.9127	30.4
39	30177.31	1.0184	30.4
40	108.9291	0.0037	30.4
41	2611.443	0.0881	30.4
42	23787.69	0.8028	30.4
43	381744.6	12.8834	30.4
44	204815.2	6.9123	30.4
45	693639	23.4095	30.4
46	122002.5	4.1174	30.4
47	38534.63	1.3005	30.4
48	12271.19	0.4141	30.4
49	1270.28	0.0429	30.4
50	32127.52	1.0843	30.4
51	16170.58	0.5457	30.4
52	109.1592	0.0037	30.4
53	7521.837	0.2539	30.4
54	154496.4	5.2141	30.4
55	3313.604	0.1118	30.4
56	1233.811	0.0416	30.4
57	90.9942	0.0031	30.4
58	242.1004	0.0082	30.4
59	16.9955	0.0006	30.4
60	15.9032	0.0005	30.4
61	1055.983	0.0356	30.4
62	319.2393	0.0108	30.4
63	288.658	0.0097	30.4
64	34839.55	1.1758	30.4

65	56144.55	1.8948	30.4
66	831699.7	28.0689	30.4
67	812860	27.4331	30.4
68	74441.3	2.5123	30.4
69	125.7501	0.0042	30.4
70	22787.3	0.769	30.4
71	6198.694	0.2092	30.4
72	420.1921	0.0142	30.4
73	4149.966	0.1401	30.4
74	19368.4	0.6537	30.4
75	50026.58	1.6883	30.4
76	6119.949	0.2065	30.4
77	6951.605	0.2346	30.4
78	294498.3	9.939	30.4
79	686638	23.1732	30.4
80	335932	11.3373	30.4
81	160415.1	5.4138	30.4
82	84904.35	2.8654	30.4
83	184.4678	0.0062	30.4
84	36.2601	0.0012	30.4
85	4883.897	0.1648	30.4
86	227.7101	0.0077	30.4
87	22.4116	0.0008	30.4
88	15.9973	0.0005	30.4
89	19419.83	0.6554	30.4
90	24146.6	0.8149	30.4
91	2673.634	0.0902	30.4
92	67102.39	2.2646	30.4
93	158931.3	5.3637	30.4
94	854.5574	0.0288	30.4
95	12844.03	0.4335	30.4
96	15.9504	0.0005	30.4
97	1172.12	0.0396	30.4
98	807.7343	0.0273	30.4
99	15.9949	0.0005	30.4
100	35559	1.2001	30.4
101	256.701	0.0087	30.4
102	10957.28	0.3698	30.4
103	148053	4.9966	30.4
104	8143.44	0.2748	30.4
105	9108.676	0.3074	30.4
106	11774.28	0.3974	30.4
107	42392.87	1.4307	30.4
108	129.981	0.0044	30.4

109	1162.678	0.0392	30.4
110	21391.09	0.7219	30.4
111	10449.57	0.3527	30.4
112	4246.408	0.1433	30.4
113	124274.5	4.1941	30.4
114	93996.34	3.1723	30.4
115	30921.55	1.0436	30.4
116	210352.8	7.0992	30.4
117	3871.105	0.1306	30.4
118	10990.03	0.3709	30.4
119	11308.96	0.3817	30.4
120	63516.29	2.1436	30.4
121	18113.76	0.6113	30.4
122	53893.41	1.8188	30.4
123	548.0339	0.0185	30.4
124	30134.54	1.017	30.4
125	62160.78	2.0979	30.4
126	34382.32	1.1604	30.4
127	173471.3	5.8545	30.4
128	21951.8	0.7408	30.4
129	112338.4	3.7913	30.4
130	154364	5.2096	30.4
131	144724.7	4.8843	30.4
132	900.6415	0.0304	30.4
133	10291.17	0.3473	30.4
134	17712.75	0.5978	30.4
135	21730.78	0.7334	30.4
136	37038.12	1.25	30.4
137	254.174	0.0086	30.4
138	40058.28	1.3519	30.4
139	28538.24	0.9631	30.4
140	68697.72	2.3185	30.4
141	19932.15	0.6727	30.4
142	11562.24	0.3902	30.4
143	925.6434	0.0312	30.4
144	160.6502	0.0054	30.4
145	17.0521	0.0006	30.4
146	3181.616	0.1074	30.4
147	642.6648	0.0217	30.4
148	426.3617	0.0144	30.4
149	3819.043	0.1289	30.4
150	19024.72	0.6421	30.4
151	9473.358	0.3197	30.4
152	3917.577	0.1322	30.4
153	1826.321	0.0616	30.4

154	510.9061	0.0172	30.4
155	849.9603	0.0287	30.4
156	2173.242	0.0733	30.4
157	3673.542	0.124	30.4
158	11668.31	0.3938	30.4
159	31.1176	0.0011	30.4
160	5901.933	0.1992	30.4
161	17500.18	0.5906	30.4
162	22866.66	0.7717	30.4
163	61929.83	2.0901	30.4
164	181145.8	6.1135	30.4
165	6997.805	0.2362	30.4
166	8021.03	0.2707	30.4
167	3325.162	0.1122	30.4
168	17215.09	0.581	30.4
169	69.0203	0.0023	30.4
170	15.9579	0.0005	30.4
171	16.0573	0.0005	30.4
172	313.0114	0.0106	30.4
173	2069.159	0.0698	30.4
174	105386.6	3.5567	30.4
175	94463.53	3.188	30.4
176	73053.15	2.4655	30.4
177	62303.91	2.1027	30.4
178	27.0726	0.0009	30.4
179	56840.59	1.9183	30.4
180	24312.98	0.8205	30.4
181	825.2543	0.0279	30.4
182	103307.6	3.4865	30.4
183	17.2952	0.0006	30.4
184	28.914	0.001	30.4
185	21.3348	0.0007	30.4
186	224721.9	7.5841	30.4
187	27055.3	0.9131	30.4
188	49785.22	1.6802	30.4
189	17442.06	0.5886	30.4
190	14767.84	0.4984	30.4
191	14115.93	0.4764	30.4
192	4330.17	0.1461	30.4
TOTAL	**13046000**	**440.2869**	

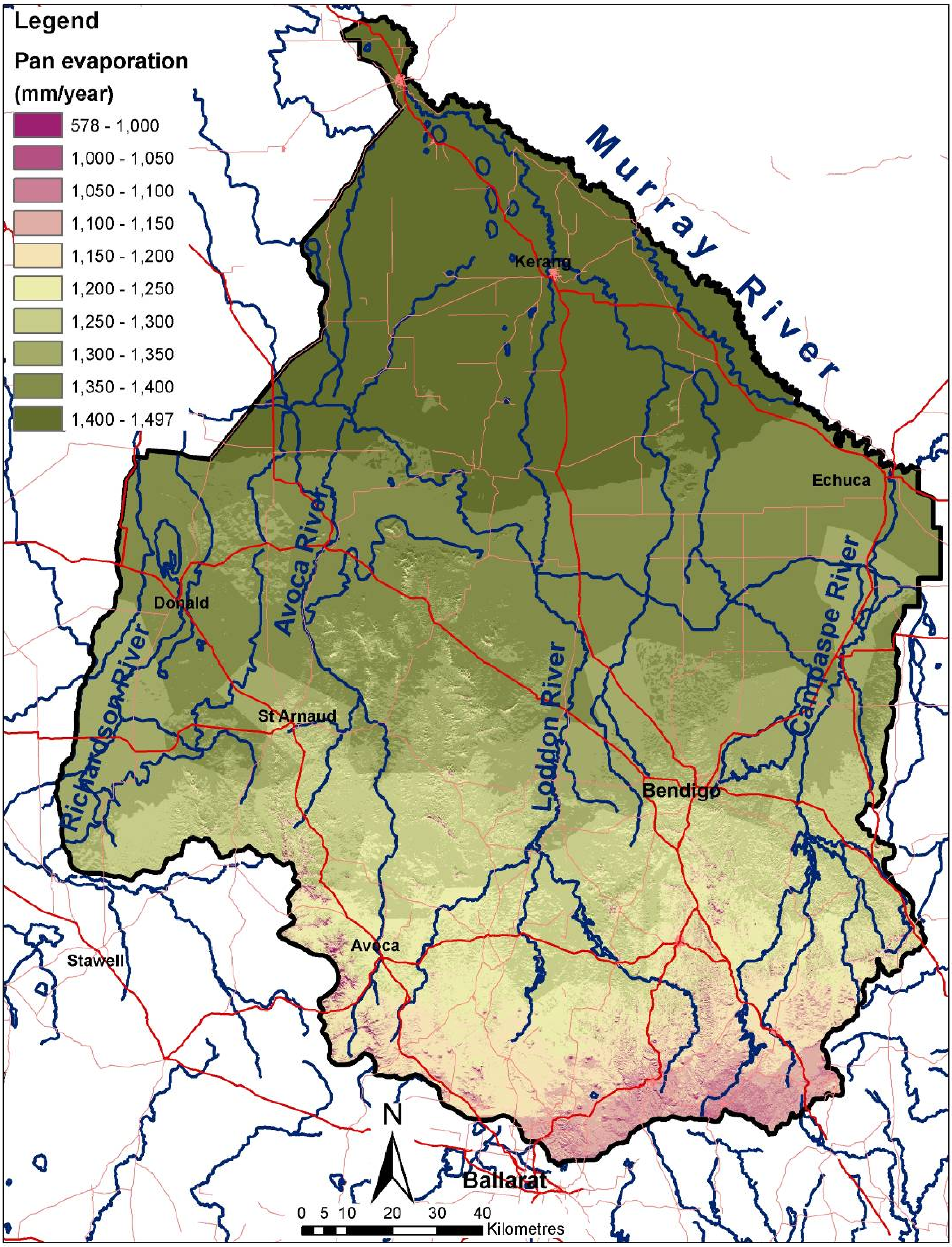
Drainage conductance

Uniform at 40 000 m^2/day

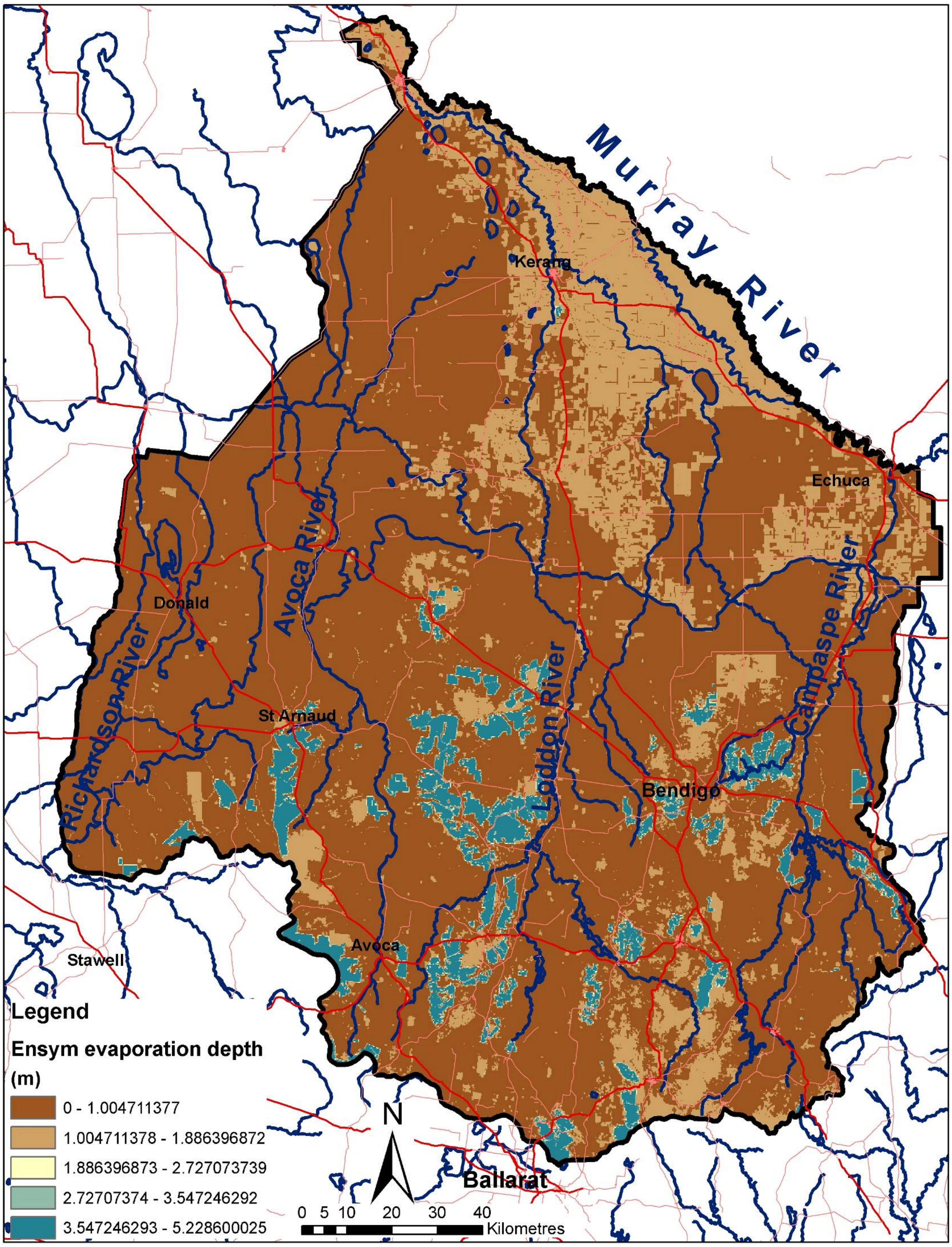
Drainage depth

Set at DEM surface

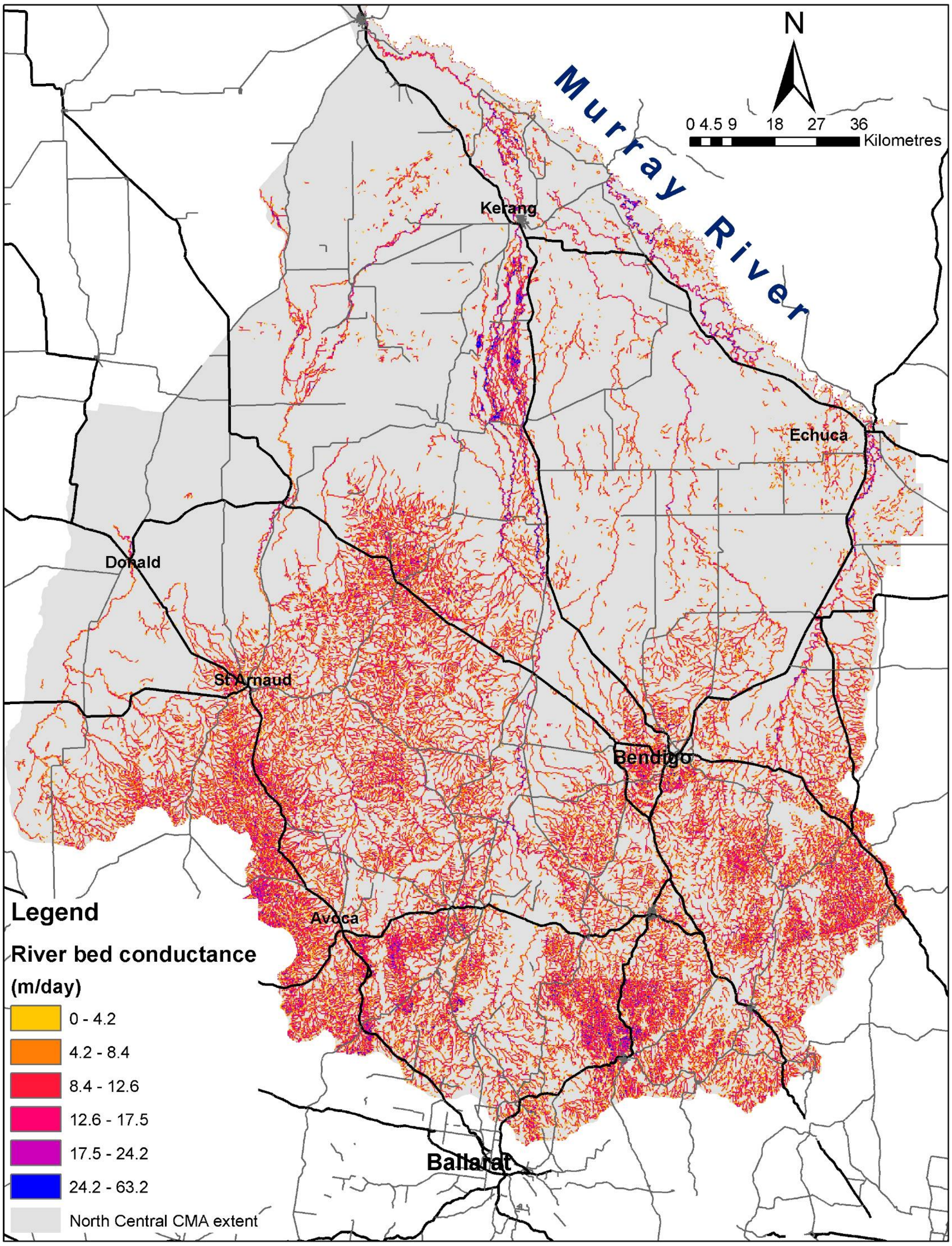
Evaporation rate



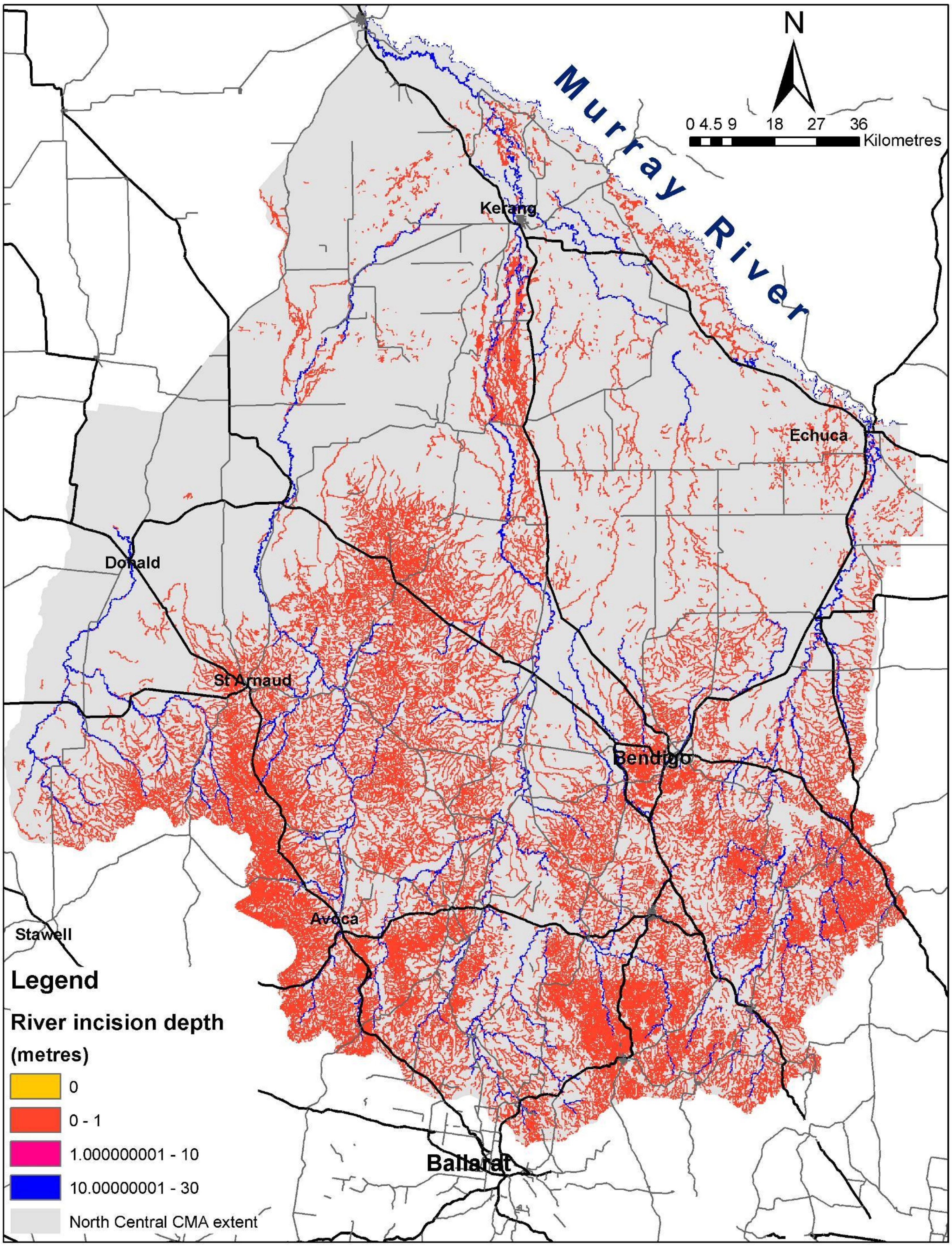
Evaporation depth



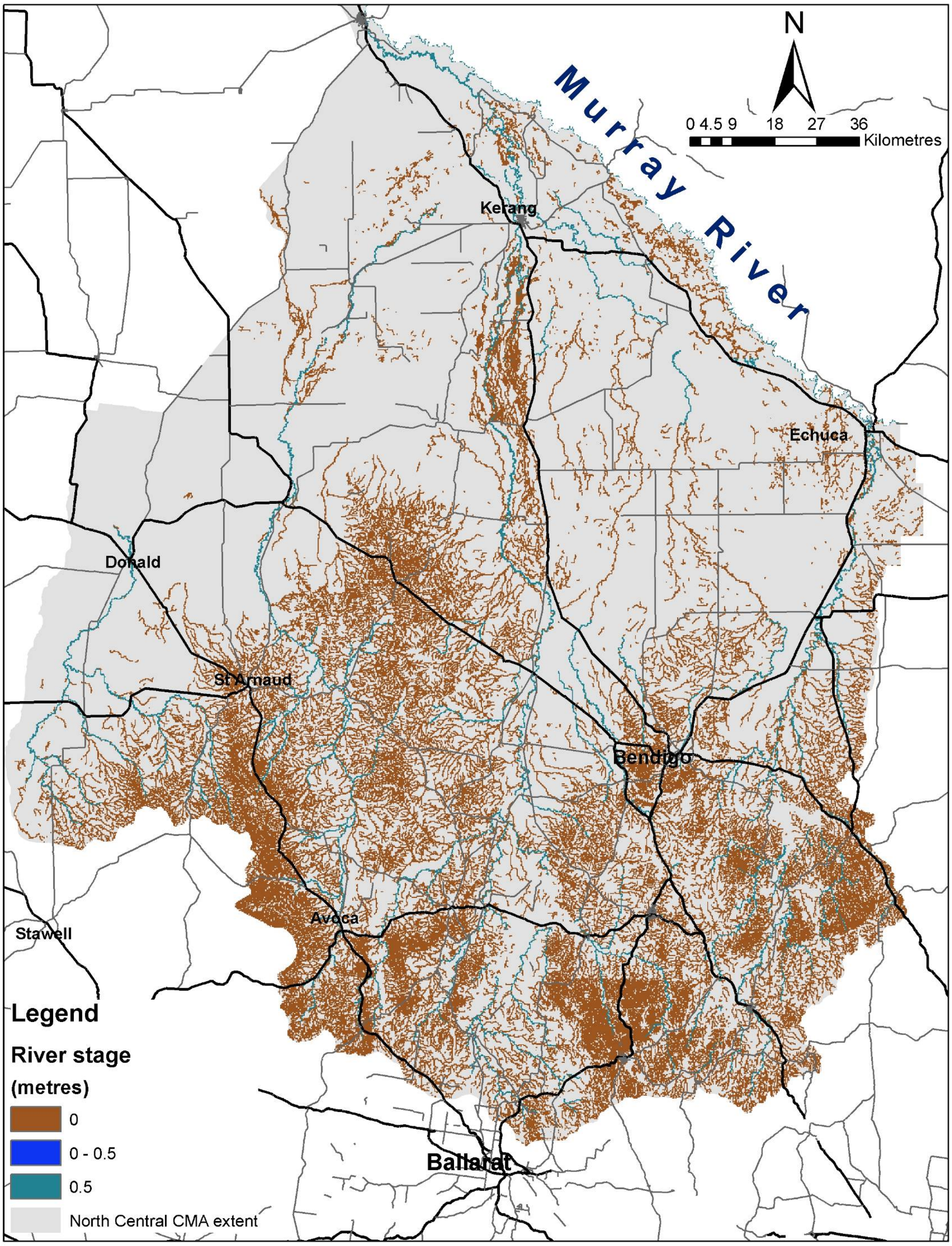
River conductance



River incision depth



River stage



N
0 4.5 9 18 27 36
Kilometres
Murray River
Kerang
Echuca
Donald
St Arnaud
Bendigo
Avoca
Stawell
Ballarat
Legend
River stage
(metres)
0
0 - 0.5
0.5
North Central CMA extent

Groundwater abstraction

Provided annual groundwater pumping rates were further subdivided into seasonal monthly rates. Irrigation seasonality was assumed to occur between November – March each year. Groundwater pumping rates were held as a non-calibratable attribute.

Time step	Lay er 1	Layer 2	Laye r 3	Layer 4	Lay er 5	Layer 6	Laye r 7	Layer 8	Layer 9	Layer 10
1	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
2	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
3	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
12	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
13	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
14	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
15	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
24	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
25	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
26	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
27	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
36	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
37	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
38	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
39	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0

44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
48	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
49	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
50	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
51	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
52	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0
59	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
60	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
61	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
62	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
63	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
71	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
72	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
73	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
74	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
75	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
76	0	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0	0
83	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
84	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
85	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
86	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
87	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
88	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0
91	0	0	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0
94	0	0	0	0	0	0	0	0	0	0

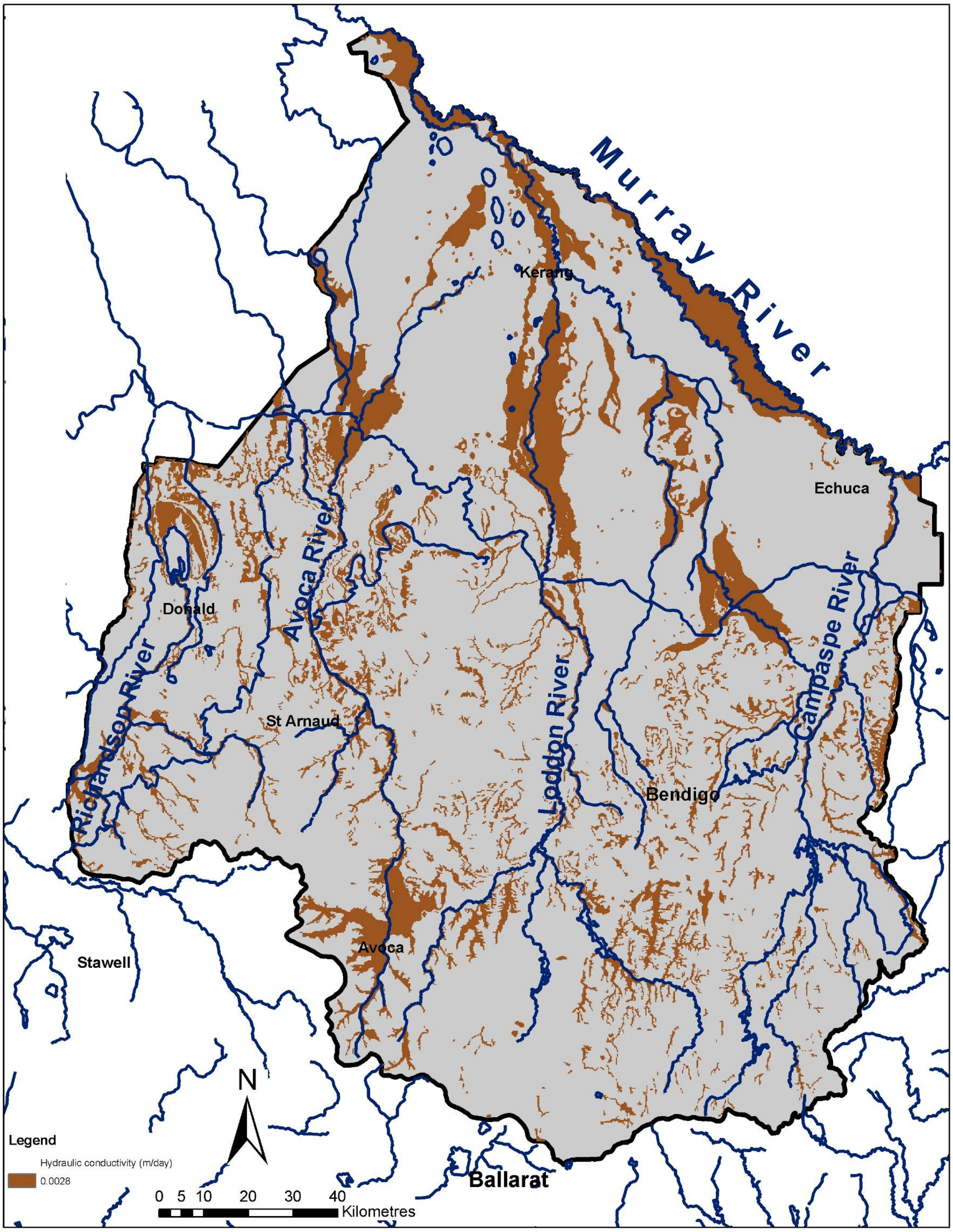
95	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
96	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
97	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
98	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
99	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
100	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0
104	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0	0
106	0	0	0	0	0	0	0	0	0	0
107	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
108	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
109	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
110	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
111	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
112	0	0	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0	0	0
117	0	0	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0	0	0
119	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
120	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
121	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
122	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
123	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
124	0	0	0	0	0	0	0	0	0	0
125	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0	0
128	0	0	0	0	0	0	0	0	0	0
129	0	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0
131	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
132	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
133	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
134	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
135	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
136	0	0	0	0	0	0	0	0	0	0
137	0	0	0	0	0	0	0	0	0	0
138	0	0	0	0	0	0	0	0	0	0
139	0	0	0	0	0	0	0	0	0	0
140	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0
142	0	0	0	0	0	0	0	0	0	0
143	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
144	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
145	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
146	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2

147	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
148	0	0	0	0	0	0	0	0	0	0
149	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0
152	0	0	0	0	0	0	0	0	0	0
153	0	0	0	0	0	0	0	0	0	0
154	0	0	0	0	0	0	0	0	0	0
155	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
156	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
157	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
158	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
159	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
160	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0
162	0	0	0	0	0	0	0	0	0	0
163	0	0	0	0	0	0	0	0	0	0
164	0	0	0	0	0	0	0	0	0	0
165	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0
167	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
168	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
169	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
170	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
171	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
172	0	0	0	0	0	0	0	0	0	0
173	0	0	0	0	0	0	0	0	0	0
174	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0
177	0	0	0	0	0	0	0	0	0	0
178	0	0	0	0	0	0	0	0	0	0
179	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
180	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
181	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
182	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
183	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
184	0	0	0	0	0	0	0	0	0	0
185	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0
187	0	0	0	0	0	0	0	0	0	0
188	0	0	0	0	0	0	0	0	0	0
189	0	0	0	0	0	0	0	0	0	0
190	0	0	0	0	0	0	0	0	0	0
191	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
192	0	-1.47	-1.9	-2.87	0	-7.19	0	-0.05	0	-2.2
TOTAL	**0**	**-117.6**	**-152**	**-229.6**	**0**	**-575.2**	**0**	**-4**	**0**	**-176**

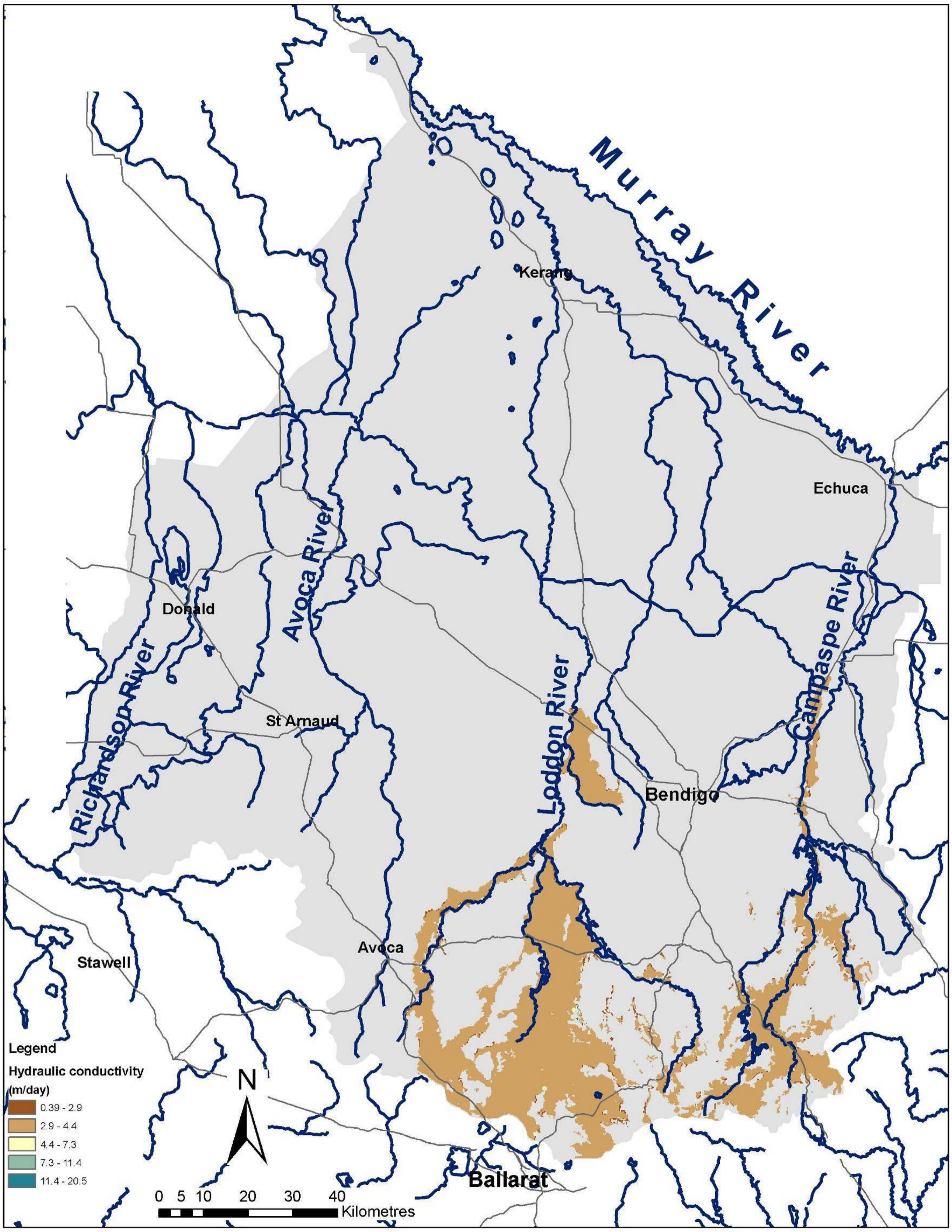
Appendix 4 Calibrated aquifer parameters

Hydraulic conductivity (m/day)

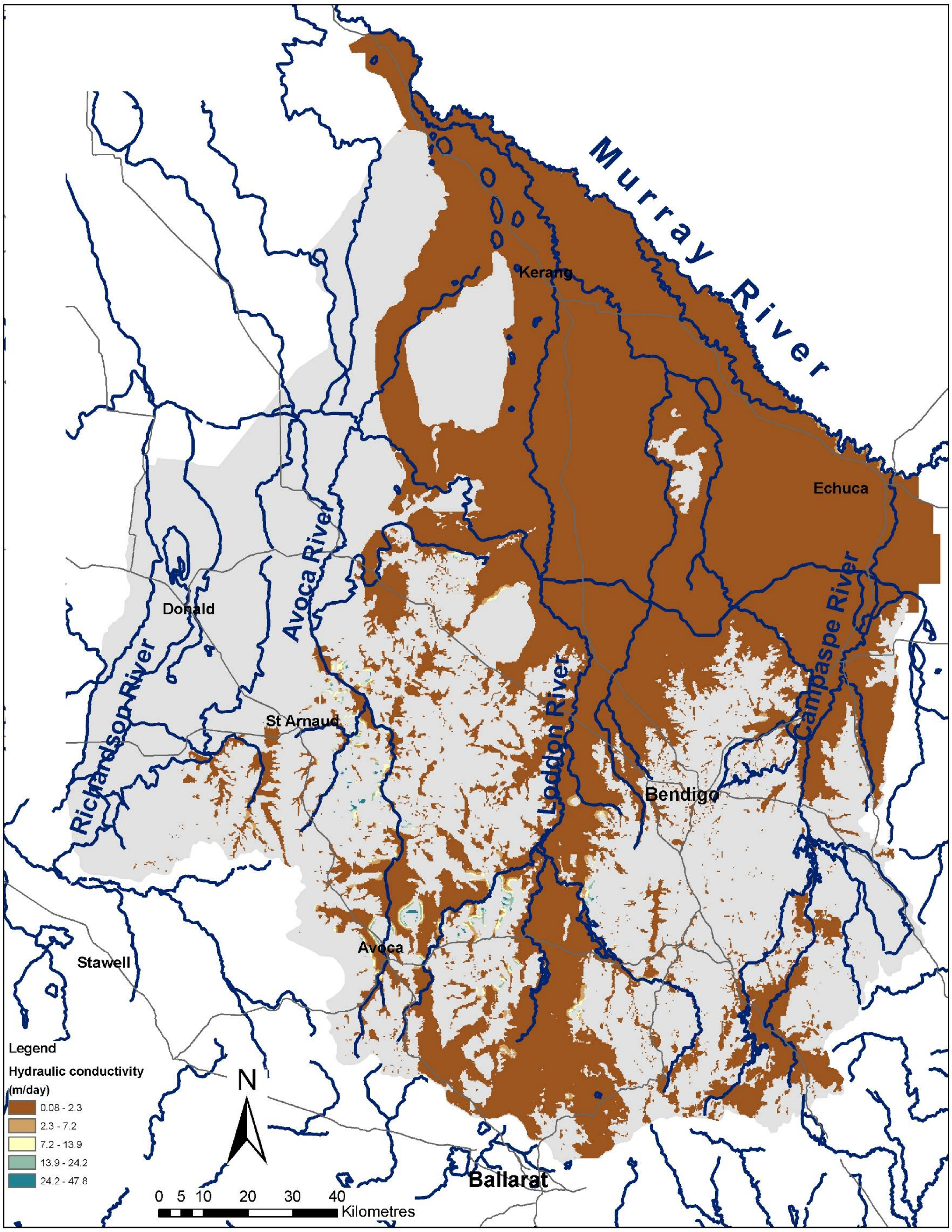
Layer 1 (Coonambidgal Formation)



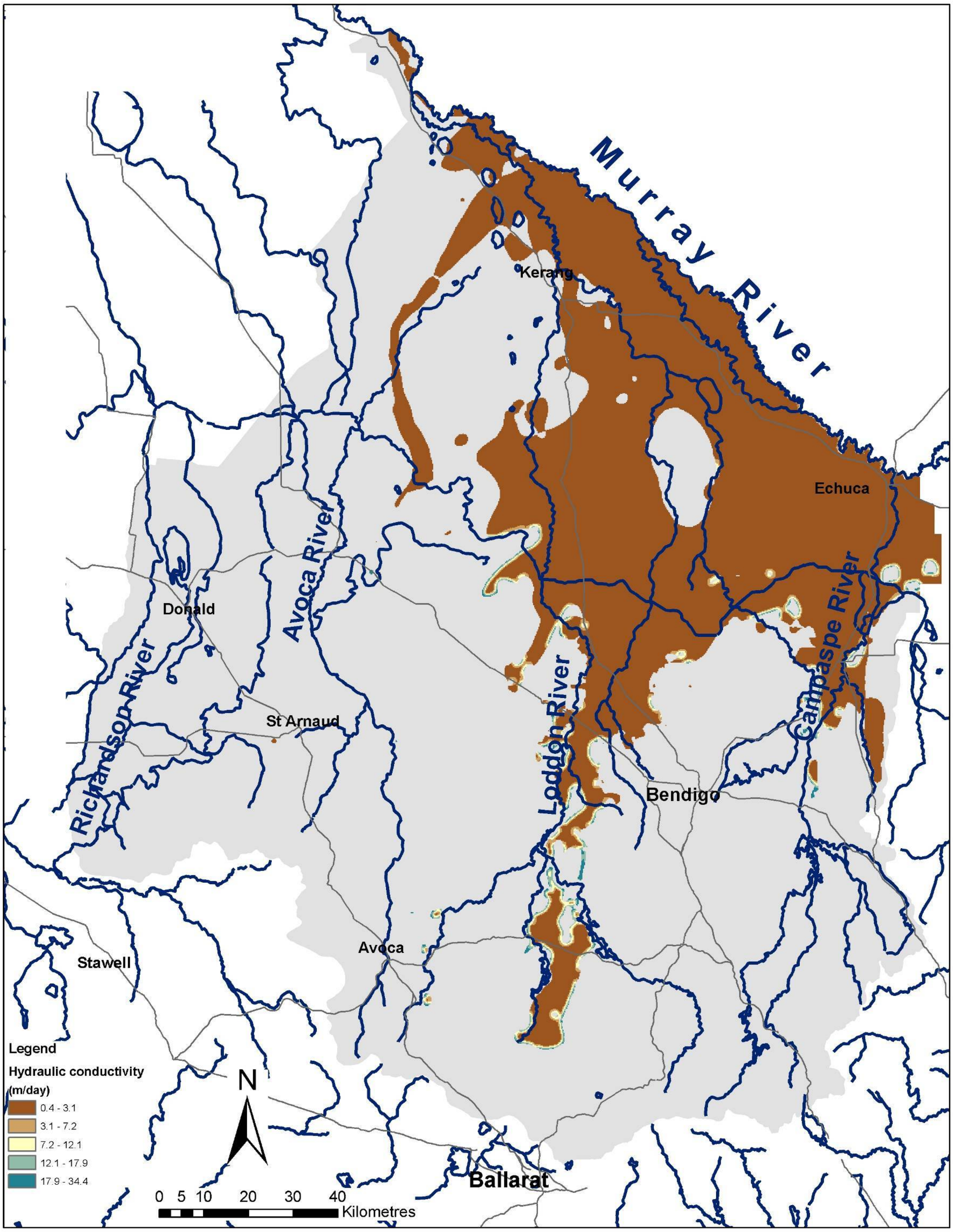
Hydraulic conductivity (m/day) Layer 2 (Newer Volcanics)



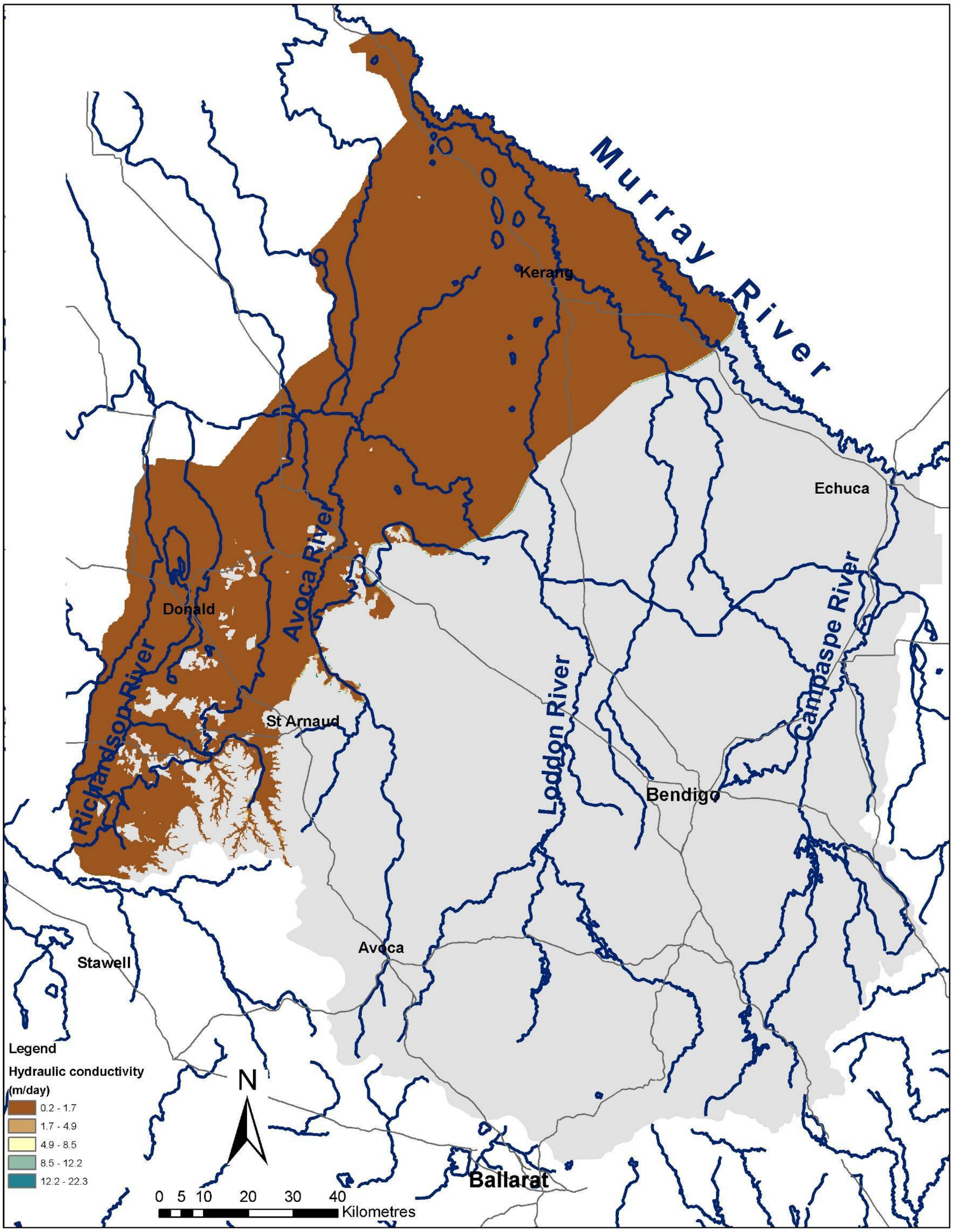
Hydraulic conductivity (m/day) Layer 3 (upper Shepparton Formation – thickness < 25m)



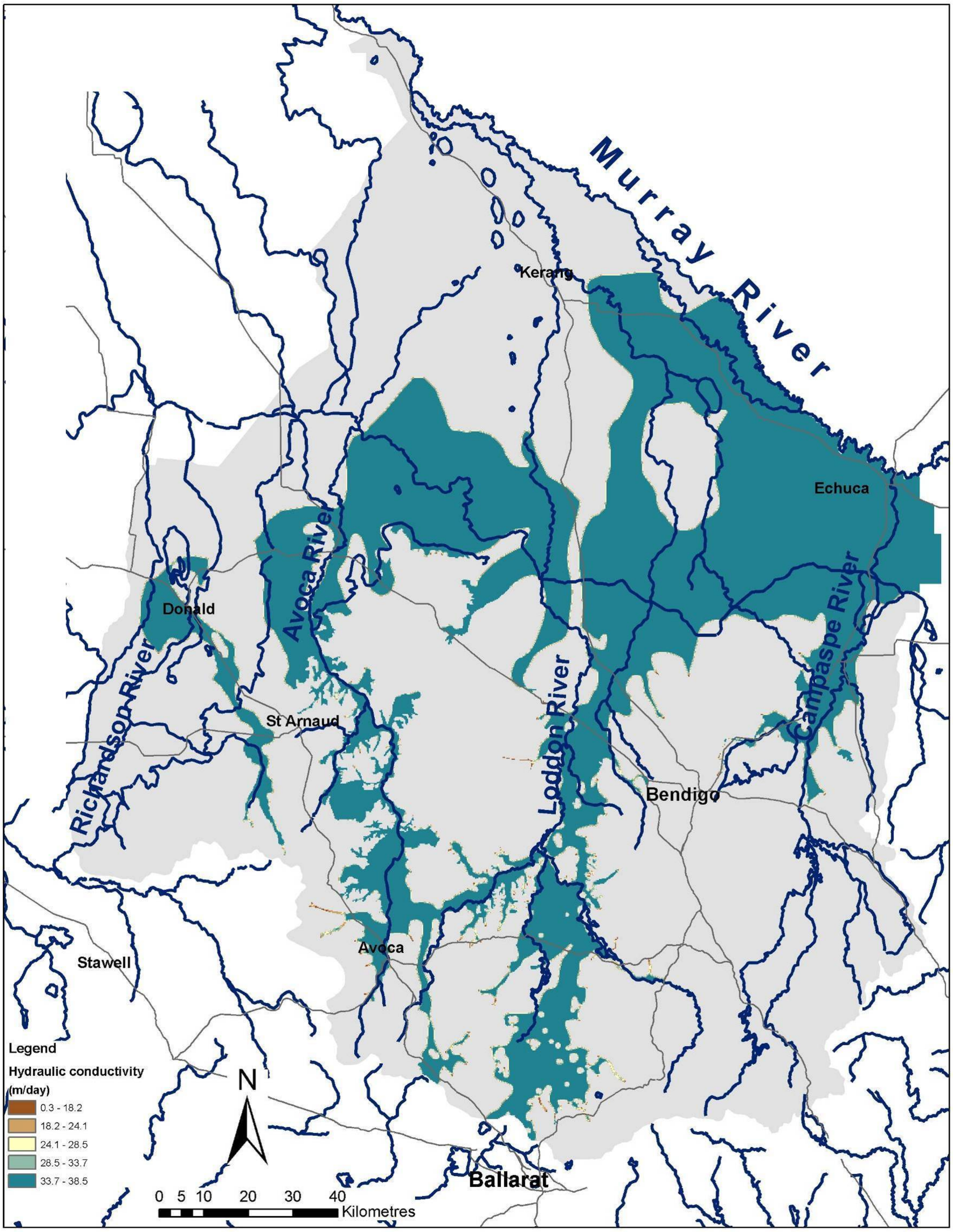
Hydraulic conductivity (m/day) Layer 4 (lower Shepparton Formation – thickness > 25m)



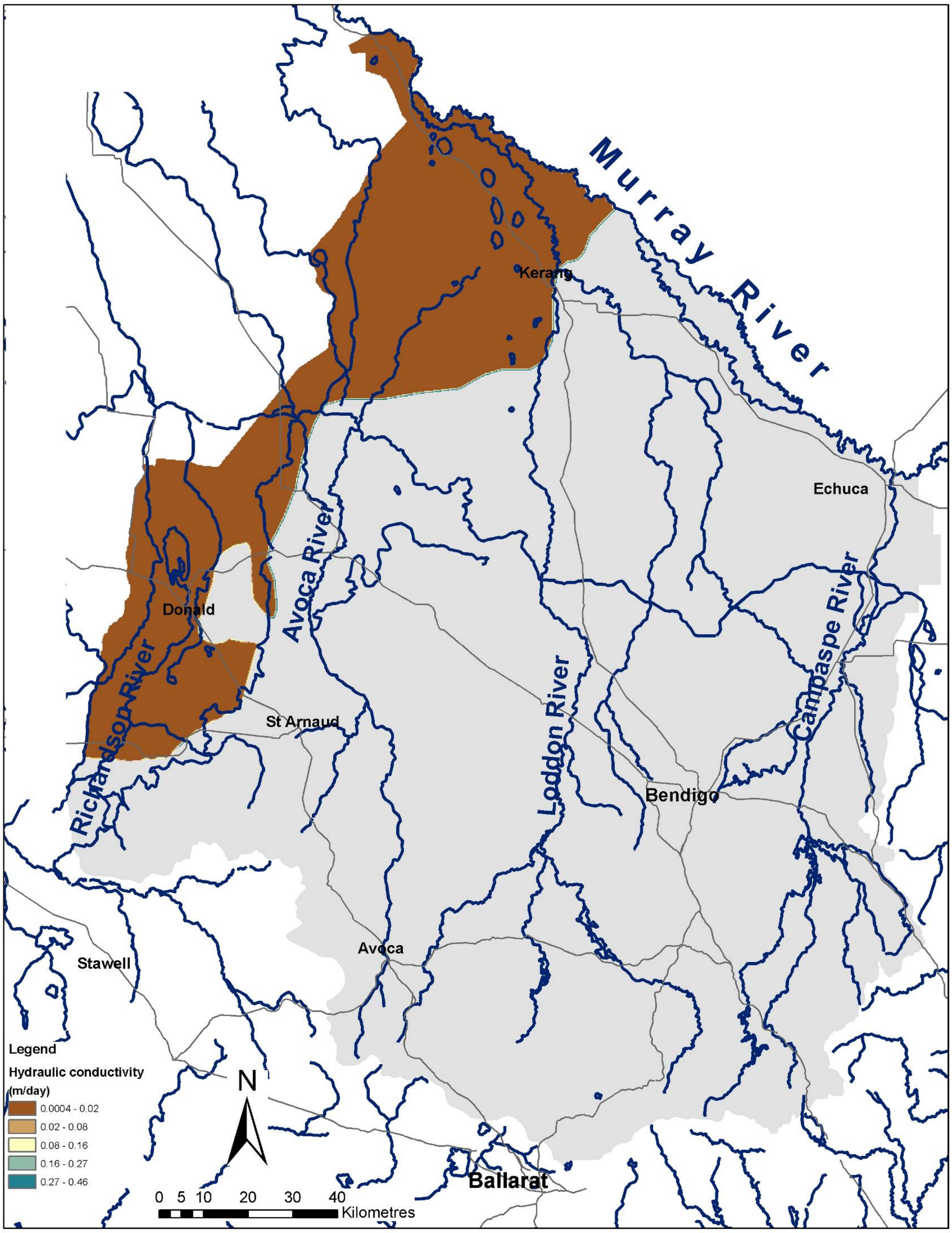
Hydraulic conductivity (m/day) Layer 5 (Parilla Sand)



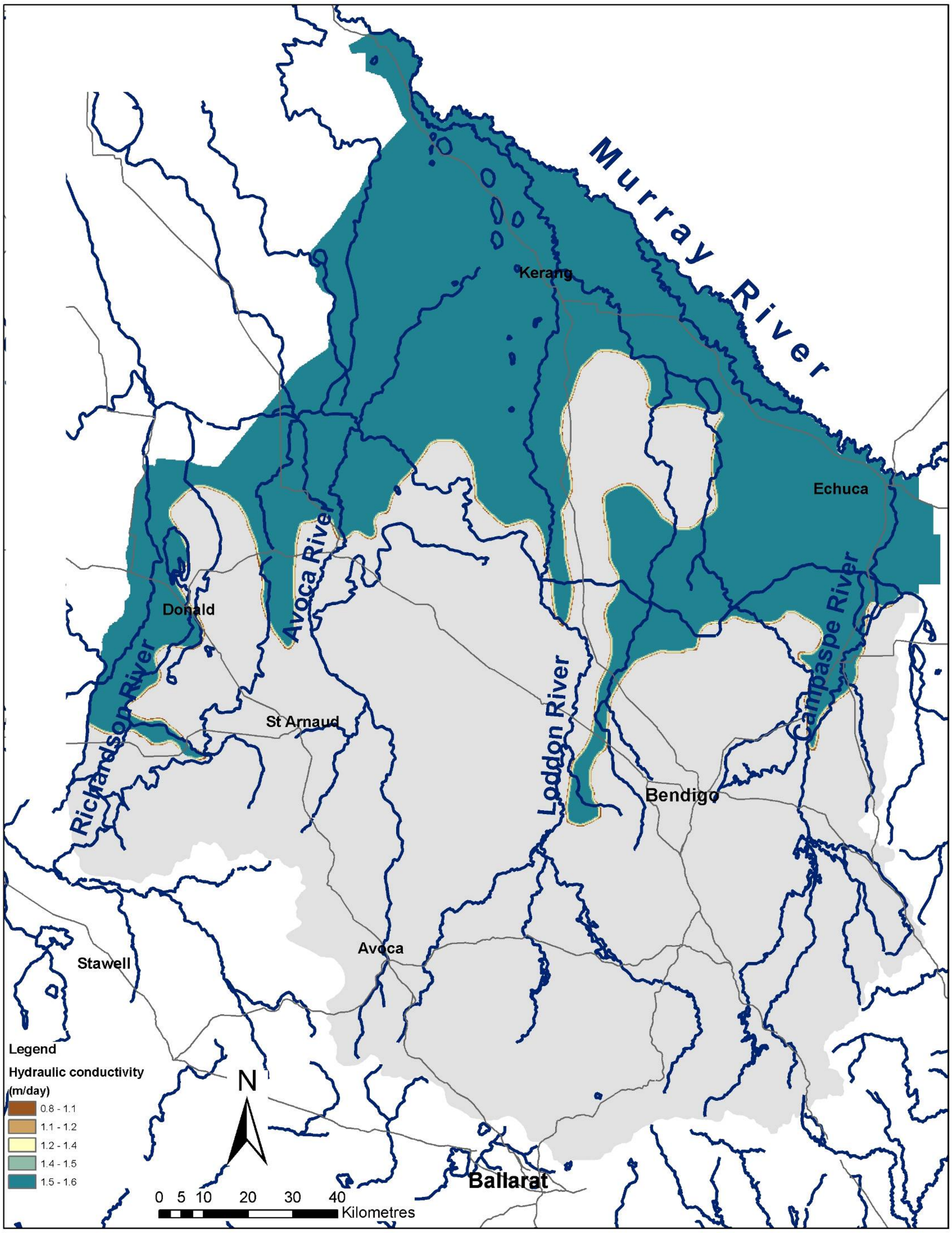
Hydraulic conductivity (m/day) Layer 6 (Calivil Formation)



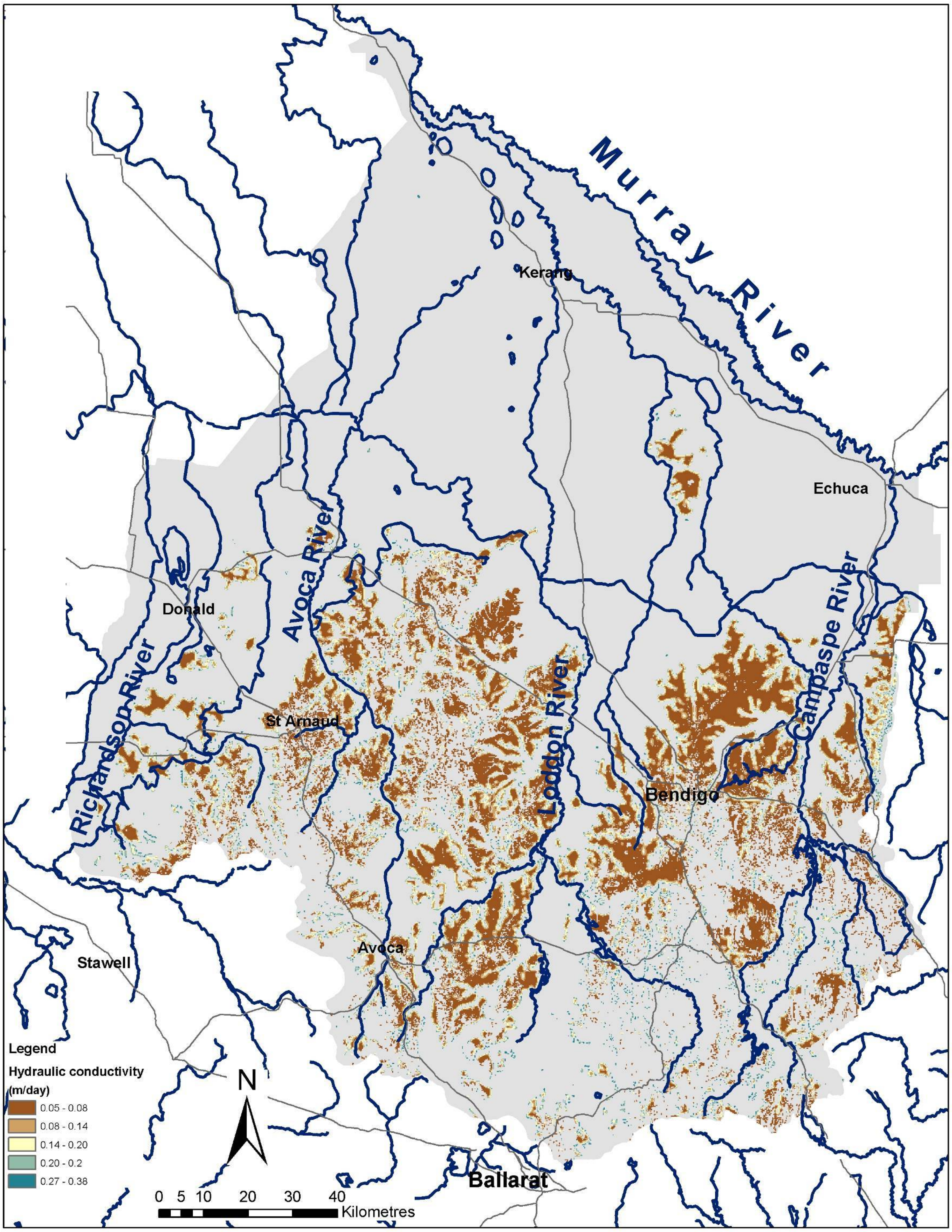
Hydraulic conductivity (m/day) Layer 7 (lower Tertiary aquitard)



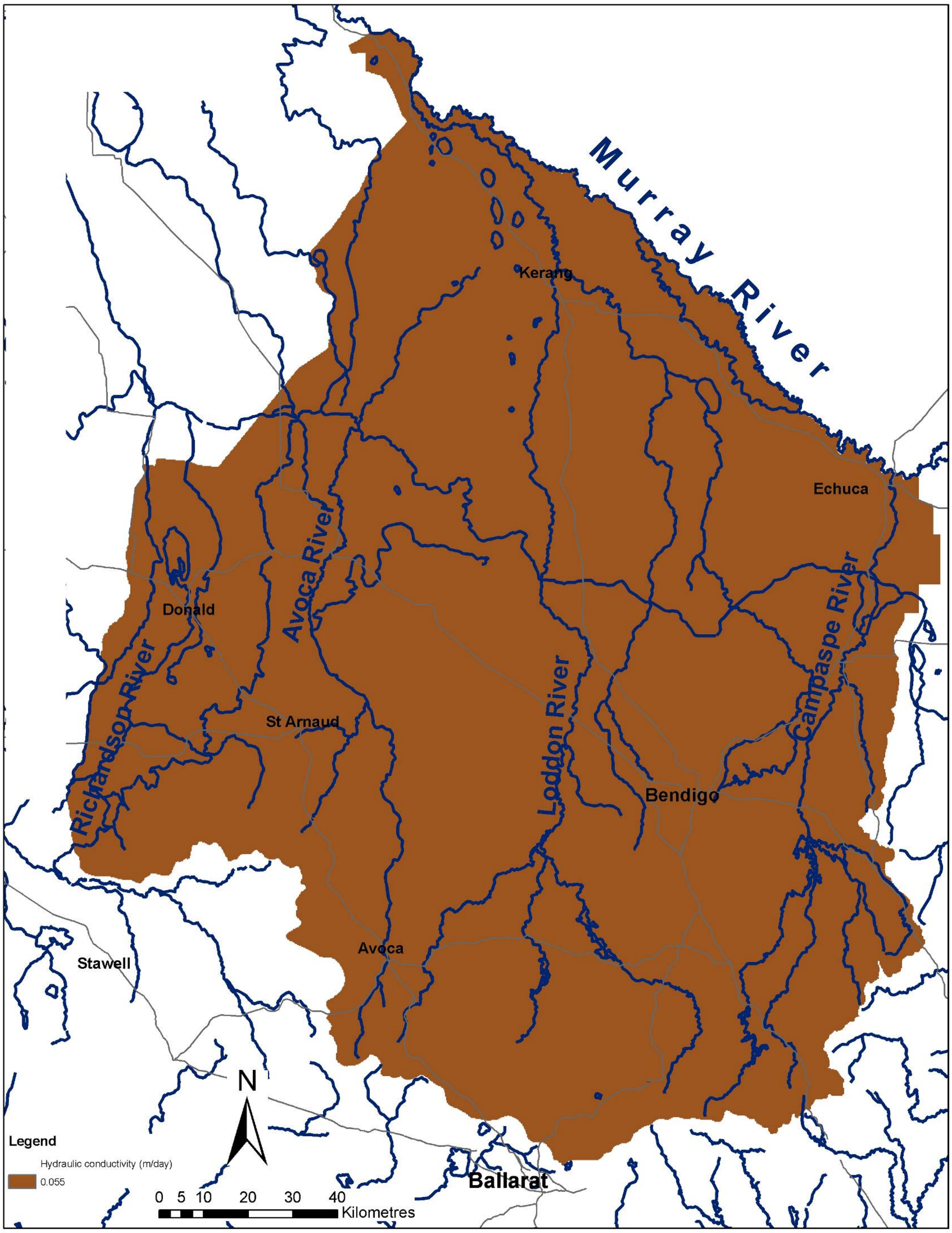
Hydraulic conductivity (m/day) Layer 8 (Renmark Group)



Hydraulic conductivity (m/day) Layer 9 (deeply weathered geology)

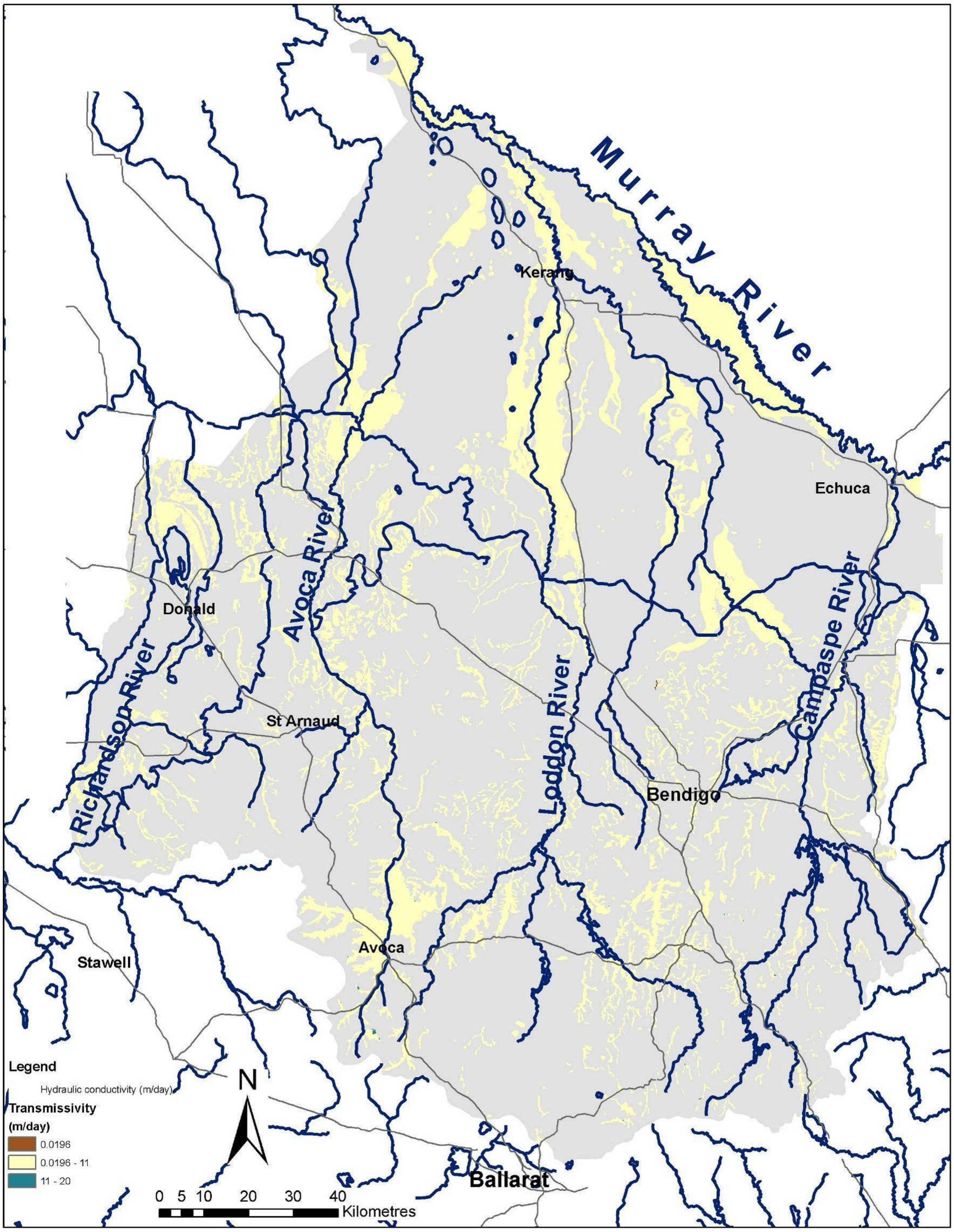


Hydraulic conductivity (m/day) Layer 10 (Palaeozoic basement)

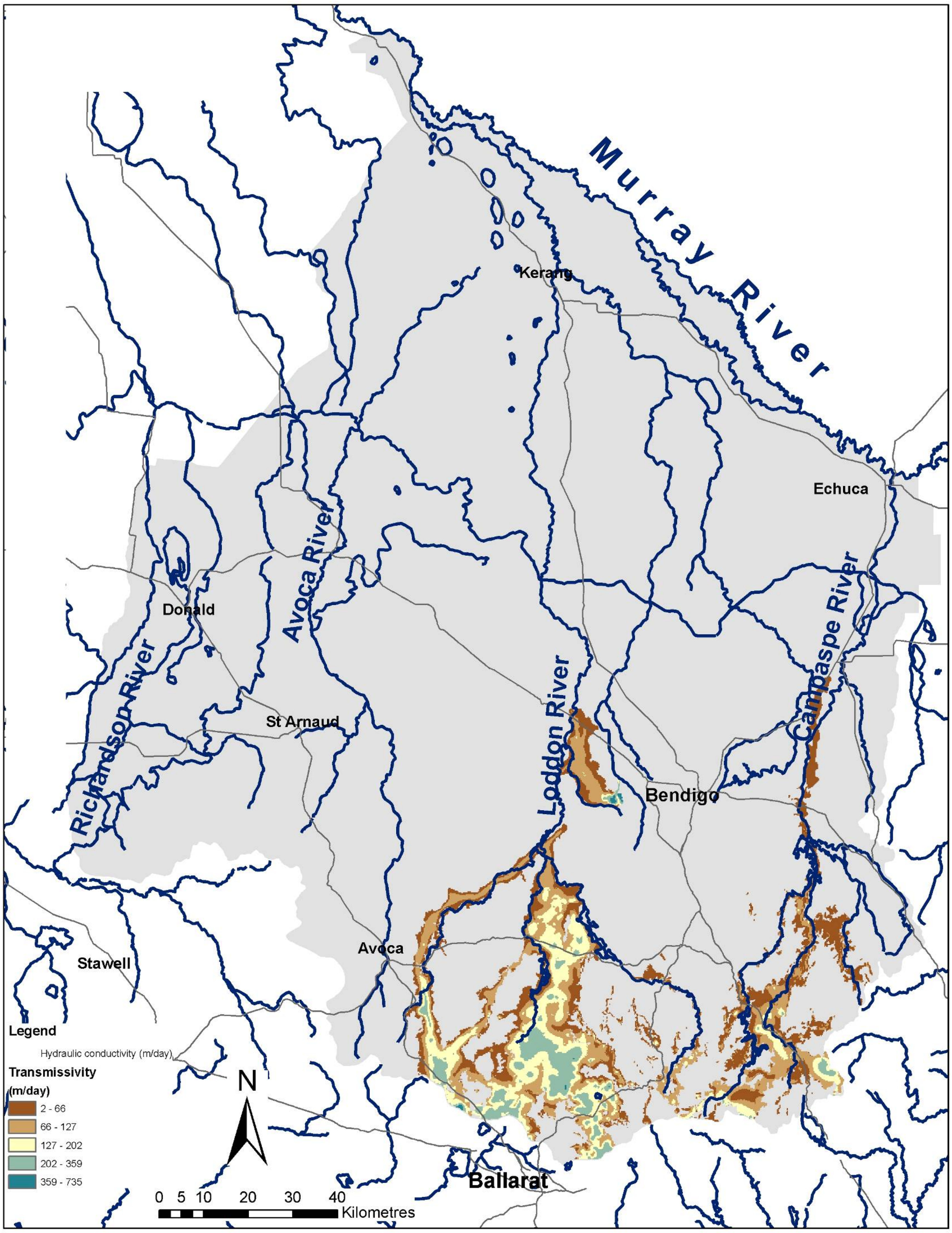


Transmissivity

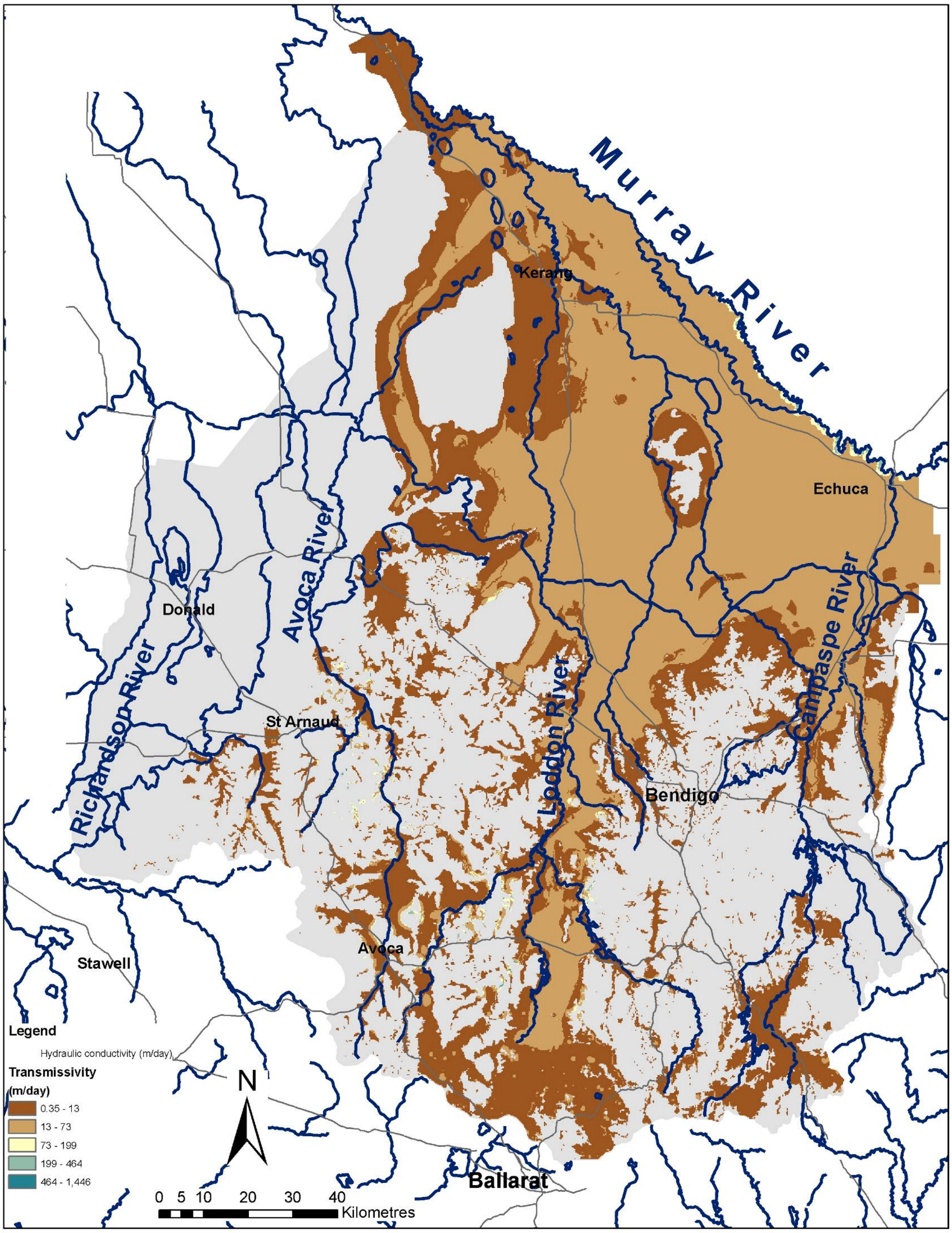
Transmissivity (m2/day) Layer 1 (Coonambidgal Formation)



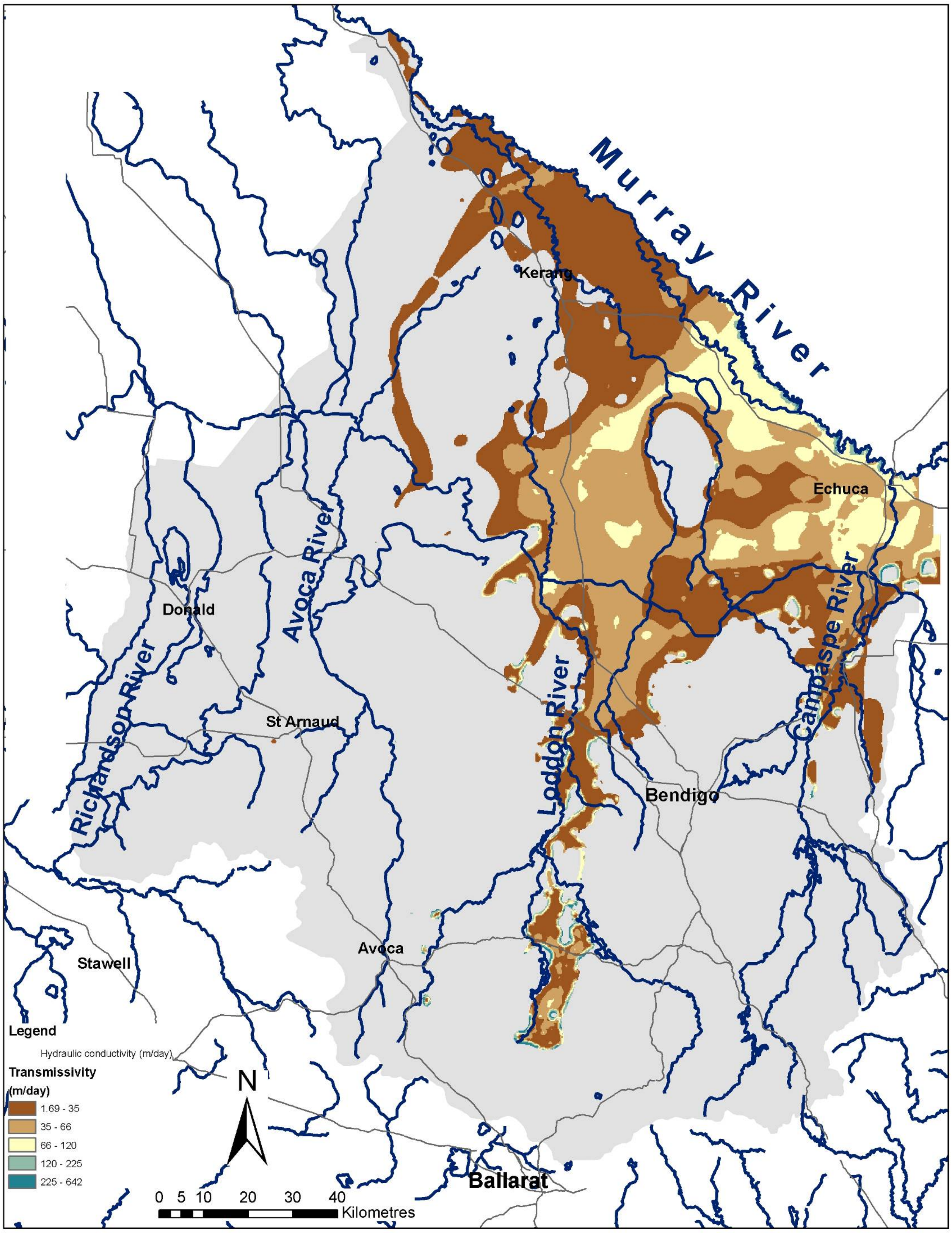
Transmissivity (m2/day) Layer 2 (Newer Volcanics)



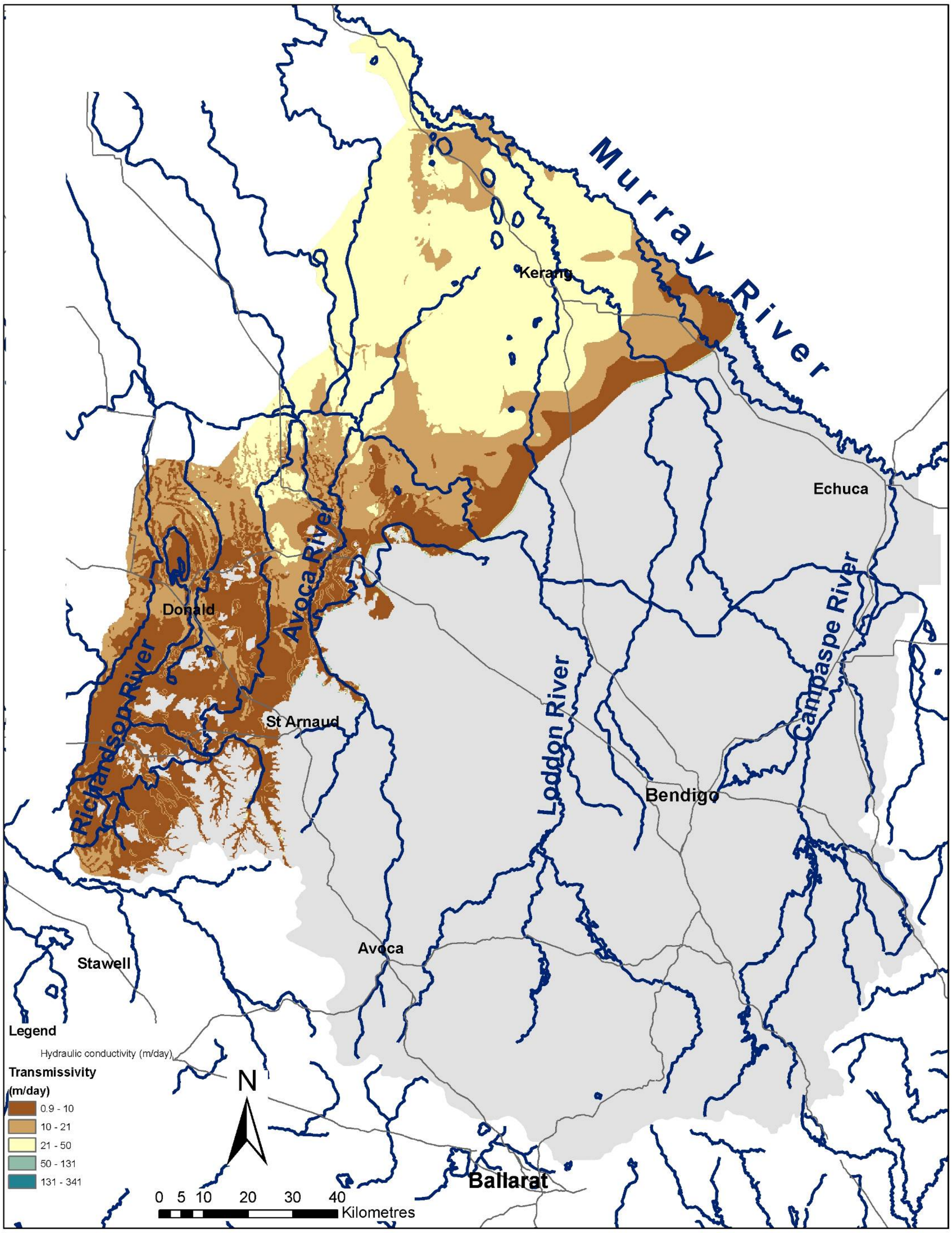
Transmissivity (m2/day) Layer 3 (upper Shepparton Formation)



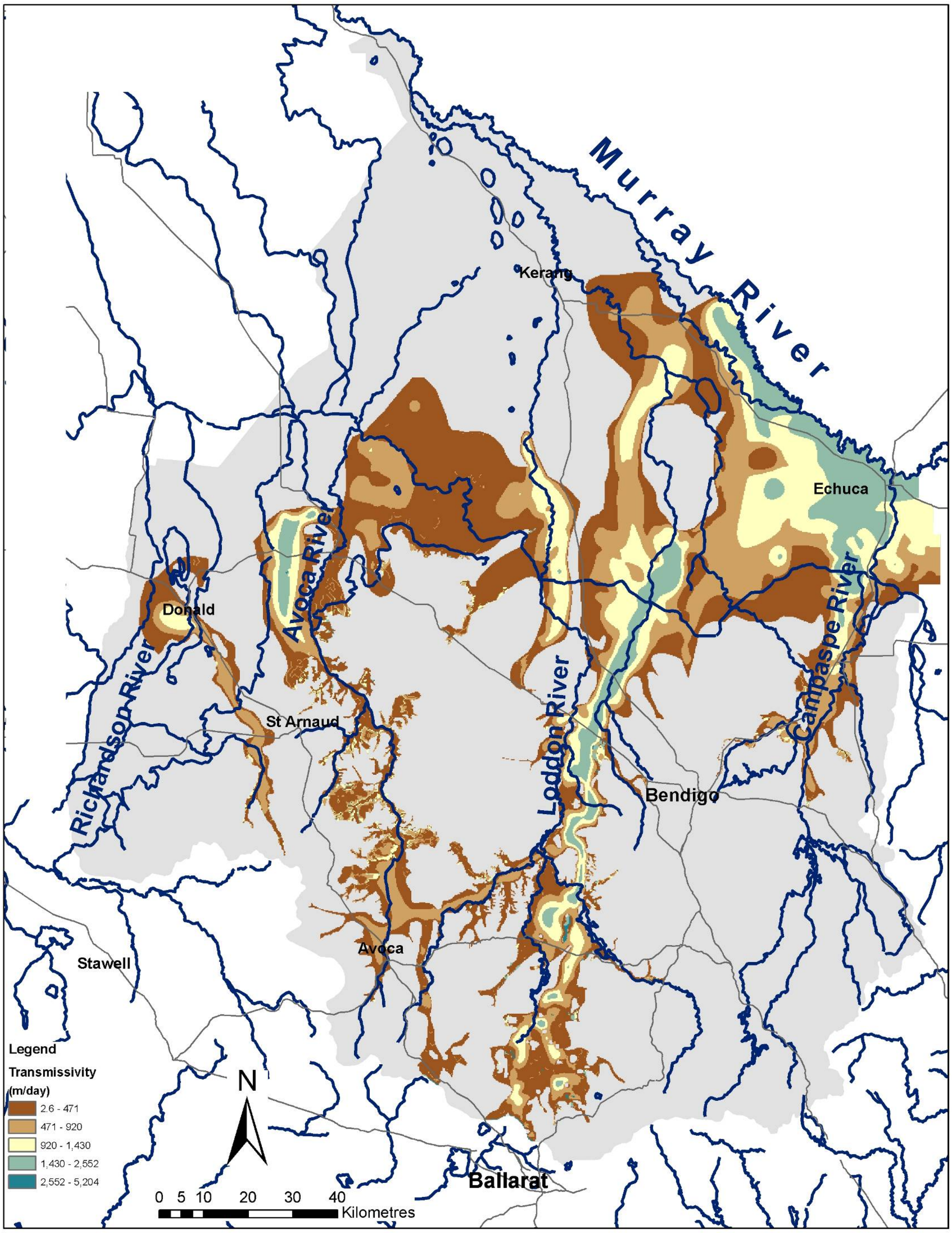
Transmissivity (m2/day) Layer 4 (lower Shepparton Formation)



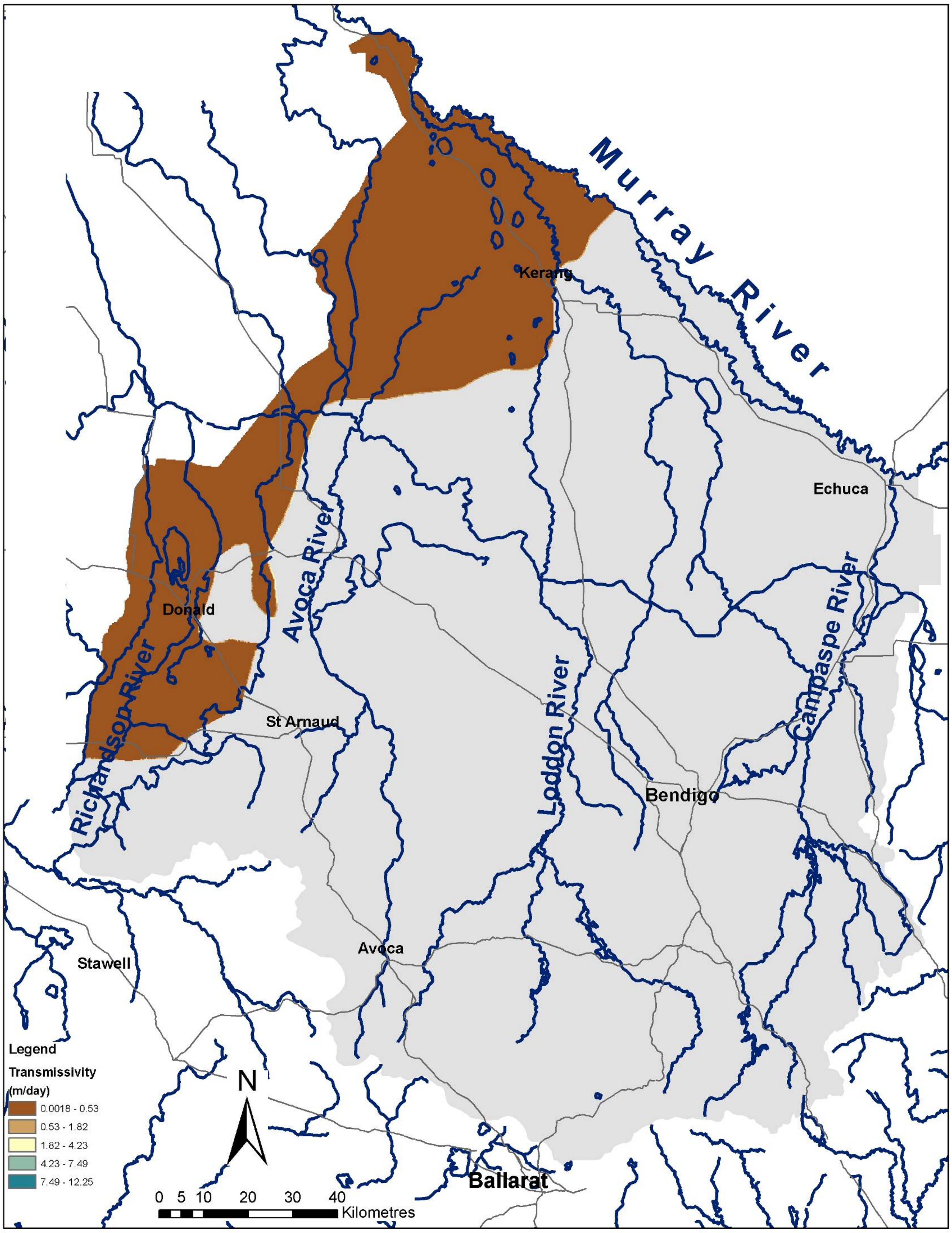
Transmissivity (m2/day) Layer 5 (Parilla Sand)



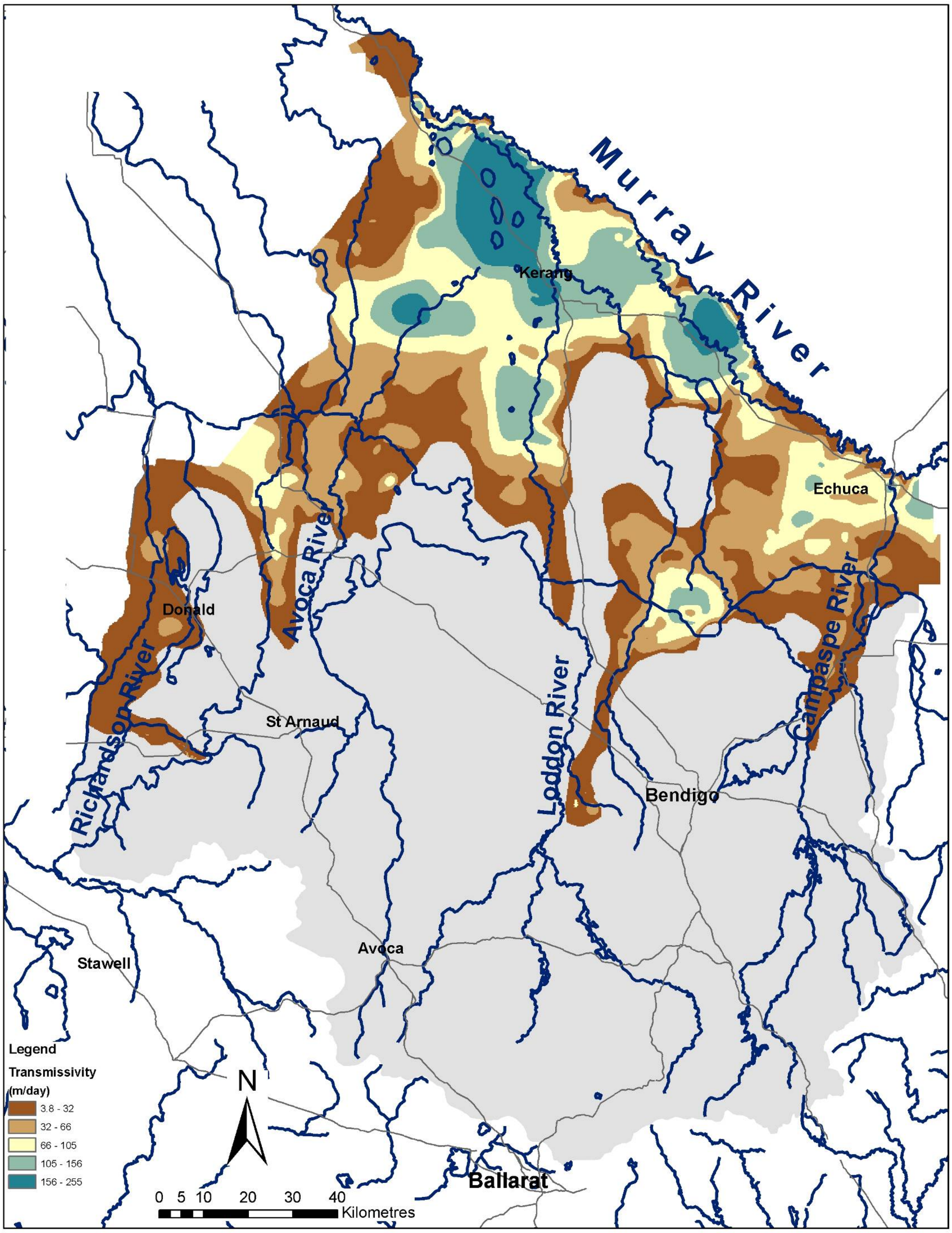
Transmissivity (m2/day) Layer 6 (Calivil Formation)



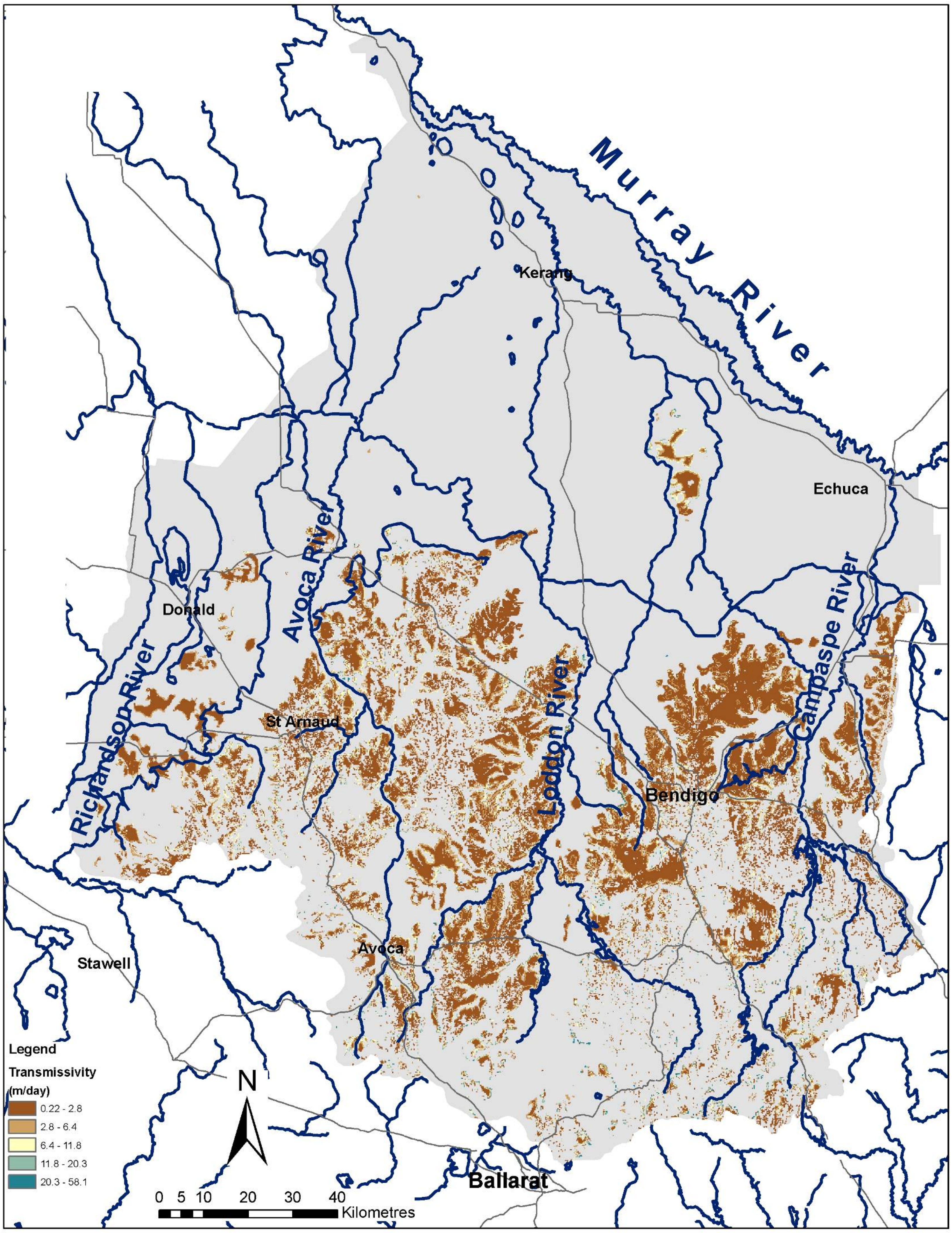
Transmissivity (m2/day) Layer 7 (lower Tertiary aquitard)



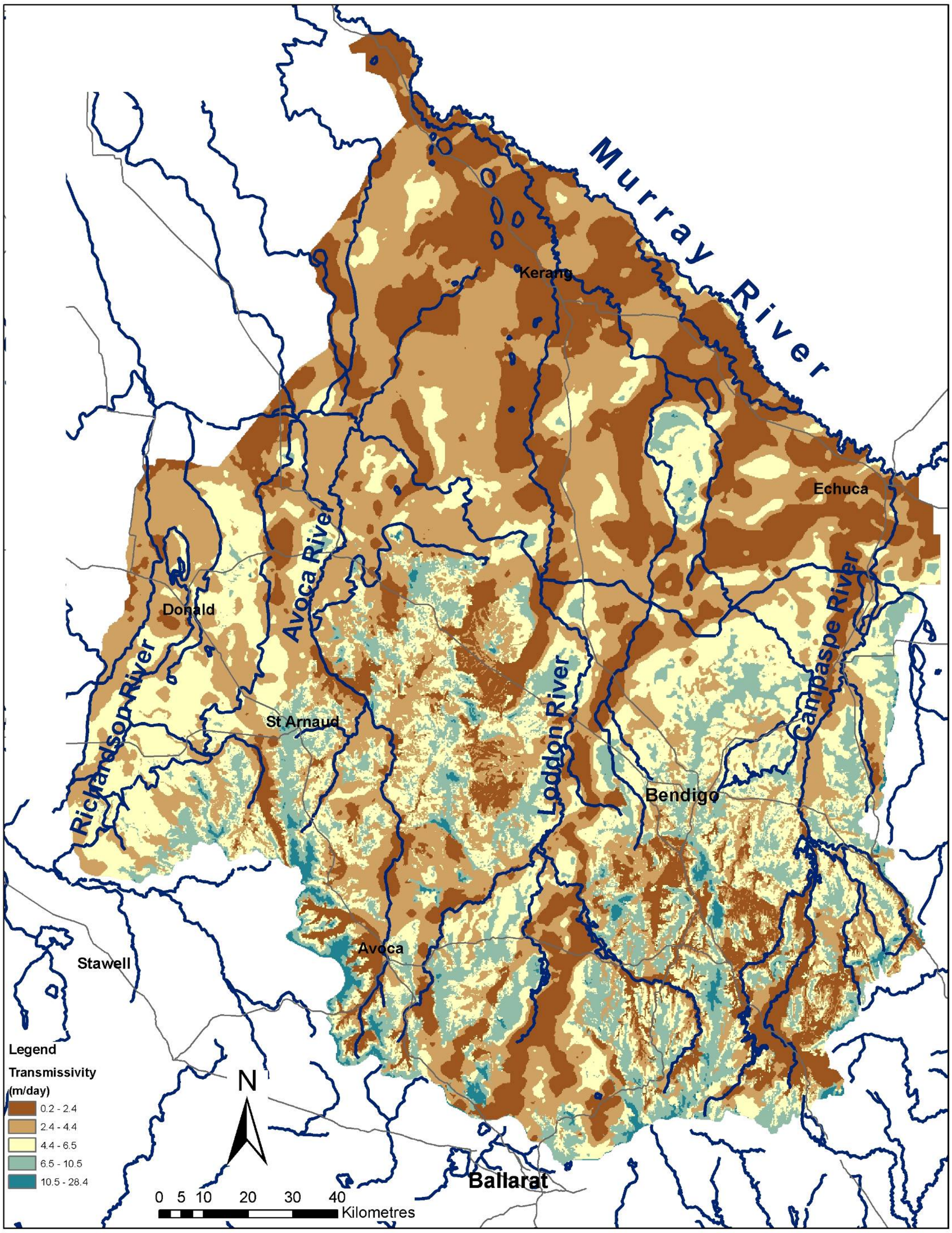
Transmissivity (m2/day) Layer 8 (Renmark Group)



Transmissivity (m2/day) Layer 9 (deeply weathered Palaeozoic)



Transmissivity (m2/day) Layer 8 (Palaeozoic basement)



Vertical conductance

Vcont (1/day) Layer 1 (Coonambidgal Formation)

Uniform value of 1.08 x 10^{-3} 1/day

Vcont (1/day) Layer 2 (Newer volcanics)

Uniform value of 1.24 x 10^{-3} 1/day

Vcont (1/day) Layer 3 (upper Shepparton Formation)

Uniform value of 1.23 x 10^{-3} 1/day

Vcont (1/day) Layer 4 (lower Shepparton Formation)

Uniform value of 1.24 x 10^{-3} 1/day

Vcont (1/day) Layer 5 (Parilla Sand)

Uniform value of 6.56 x 10^{-4} 1/day

Vcont (1/day) Layer 6 (Calivil Formation)

Uniform value of 8.92 x 10^{-5} 1/day

Vcont (1/day) Layer 7 (lower Tertiary aquitard)

Uniform value of 1.4 x 10^{-3} 1/day

Vcont (1/day) Layer 8 (Renmark Group)

Uniform value of 9.83 x 10^{-4} 1/day

Vcont (1/day) Layer 9 (deeply weathered Palaeozoic basement)

Uniform value of 6.9 x 10^{-4} 1/day

Specific yield

Specific yield (unit less) Layer 1 (Coonambidgal Formation)

Uniform value of 0.052

Specific yield (unit less) Layer 2 (Newer volcanics)

Uniform value of 0.072

Specific yield (unit less) Layer 3 (upper Shepparton Formation)

Uniform value of 0.101

Specific yield (unit less) Layer 4 (lower Shepparton Formation)

Uniform value of 0.104

Specific yield (unit less) Layer 5 (Parilla Sand)

Uniform value of 0.21

Specific yield (unit less) Layer 6 (Calivil Formation)

Uniform value of 0.104

Specific yield (unit less) Layer 7 (lower Tertiary aquitard)

Uniform value of 0.01

Specific yield (unit less) Layer 8 (Renmark Group)

Uniform value of 0.156

Specific yield (unit less) Layer 9 (deeply weathered geology)

Uniform value of 0.021

Specific yield (unit less) Layer 10 (Palaeozoic basement)

Uniform value of 0.027

Confined storage

Confined storage (unit less) Layer 2 (Newer Volcanics)

Uniform value of 1.04×10^{-3}

Confined storage (unit less) Layer 3 (upper Shepparton Formation)

Uniform value of 9.64×10^{-3}

Confined storage (unit less) Layer 4 (lower Shepparton Formation)

Uniform value of 1.04×10^{-2}

Confined storage (unit less) Layer 5 (Parilla Sand)

Uniform value of 1.04×10^{-1}

Confined storage (unit less) Layer 6 (Calivil Formation)

Uniform value of 1.04×10^{-2}

Confined storage (unit less) Layer 7 (lower Tertiary aquitard)

Uniform value of 1.04×10^{-4}

Confined storage (unit less) Layer 8 (Renmark Group)

Uniform value of 5.2×10^{-2}

Confined storage (unit less) Layer 7 (deeply weathered basement)

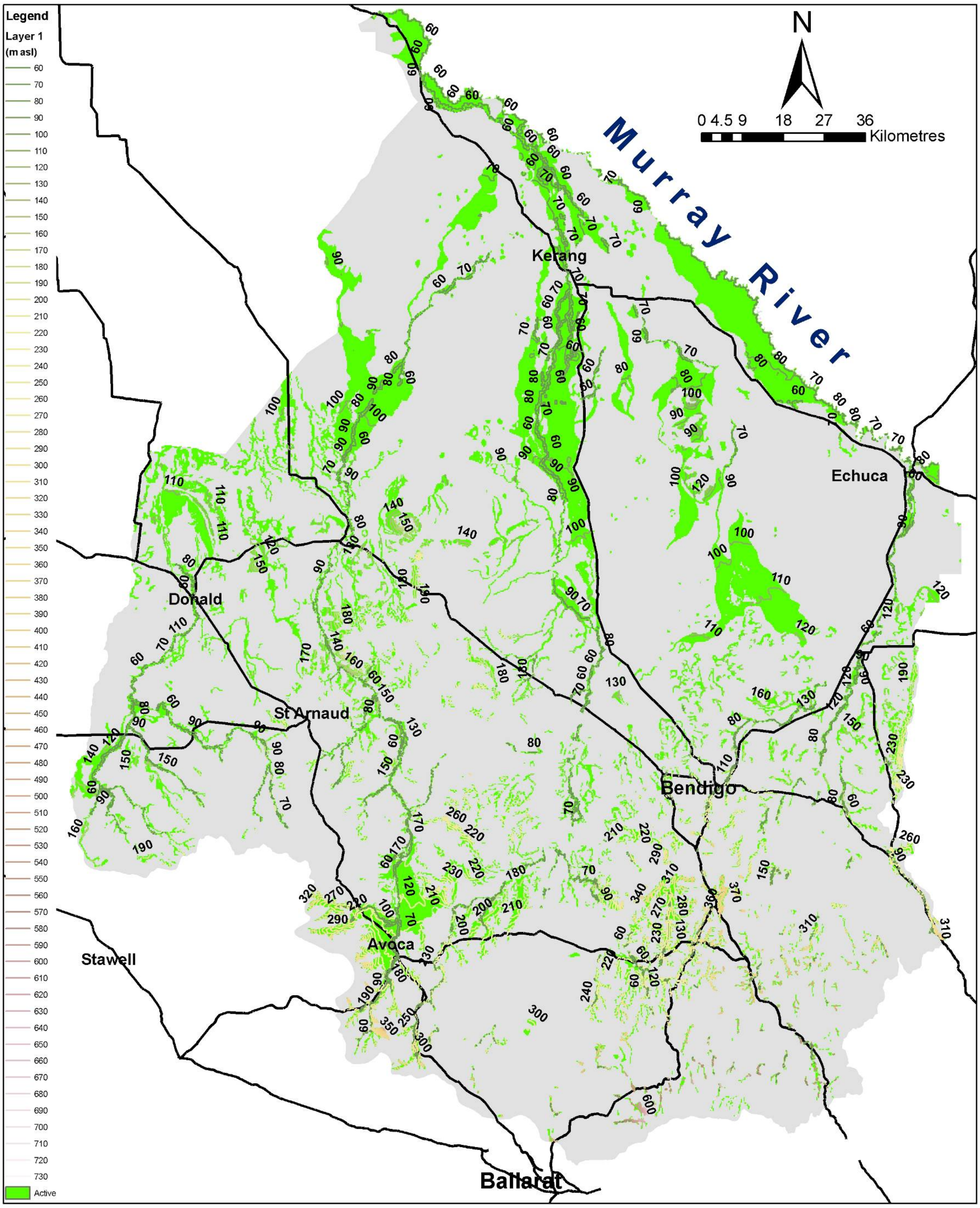
Uniform value of 1.04×10^{-3}

Confined storage (unit less) Layer 8 (Palaeozoic basement)

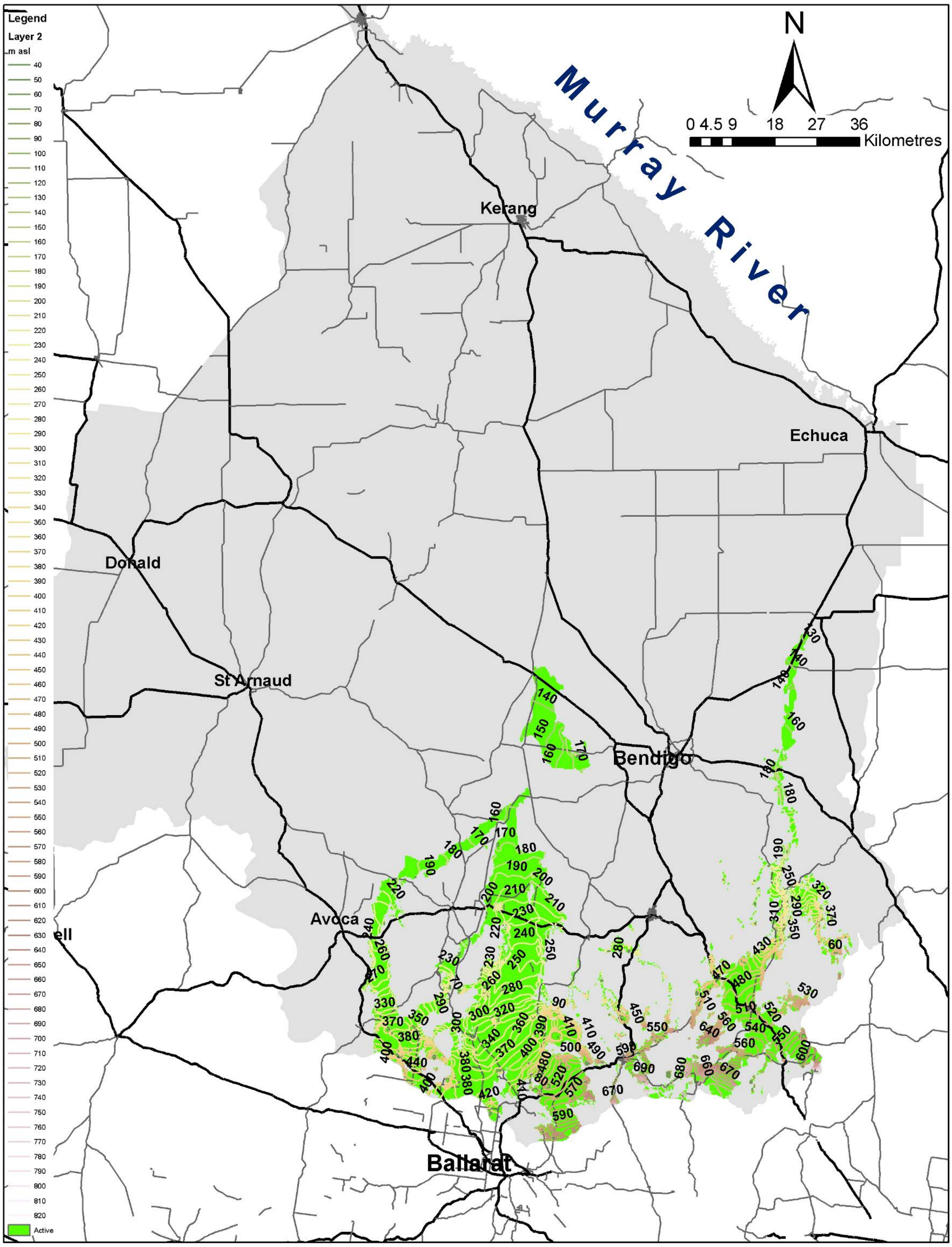
Uniform value of 1.04×10^{-3}

Appendix 5 Simulated water levels

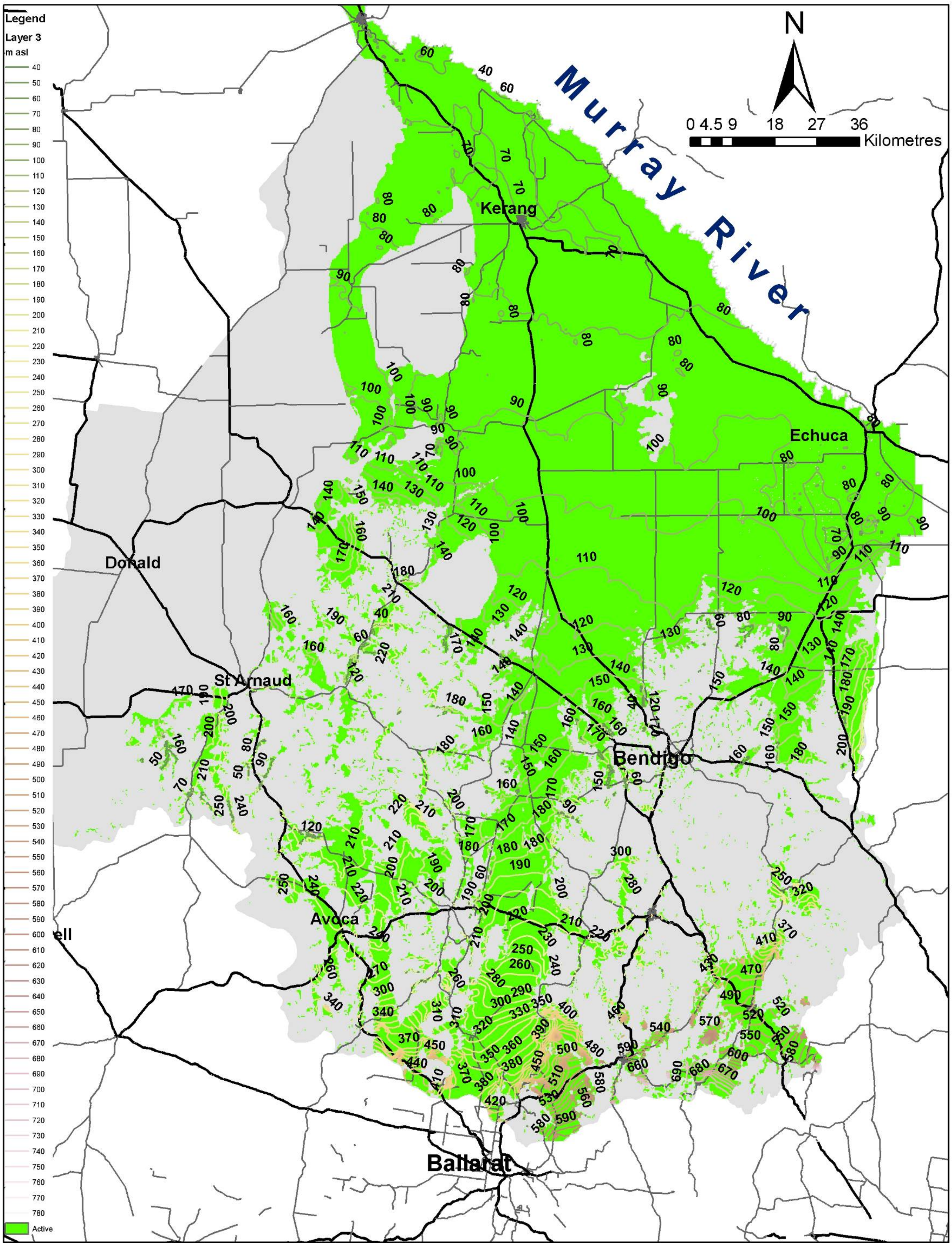
Model layer 1



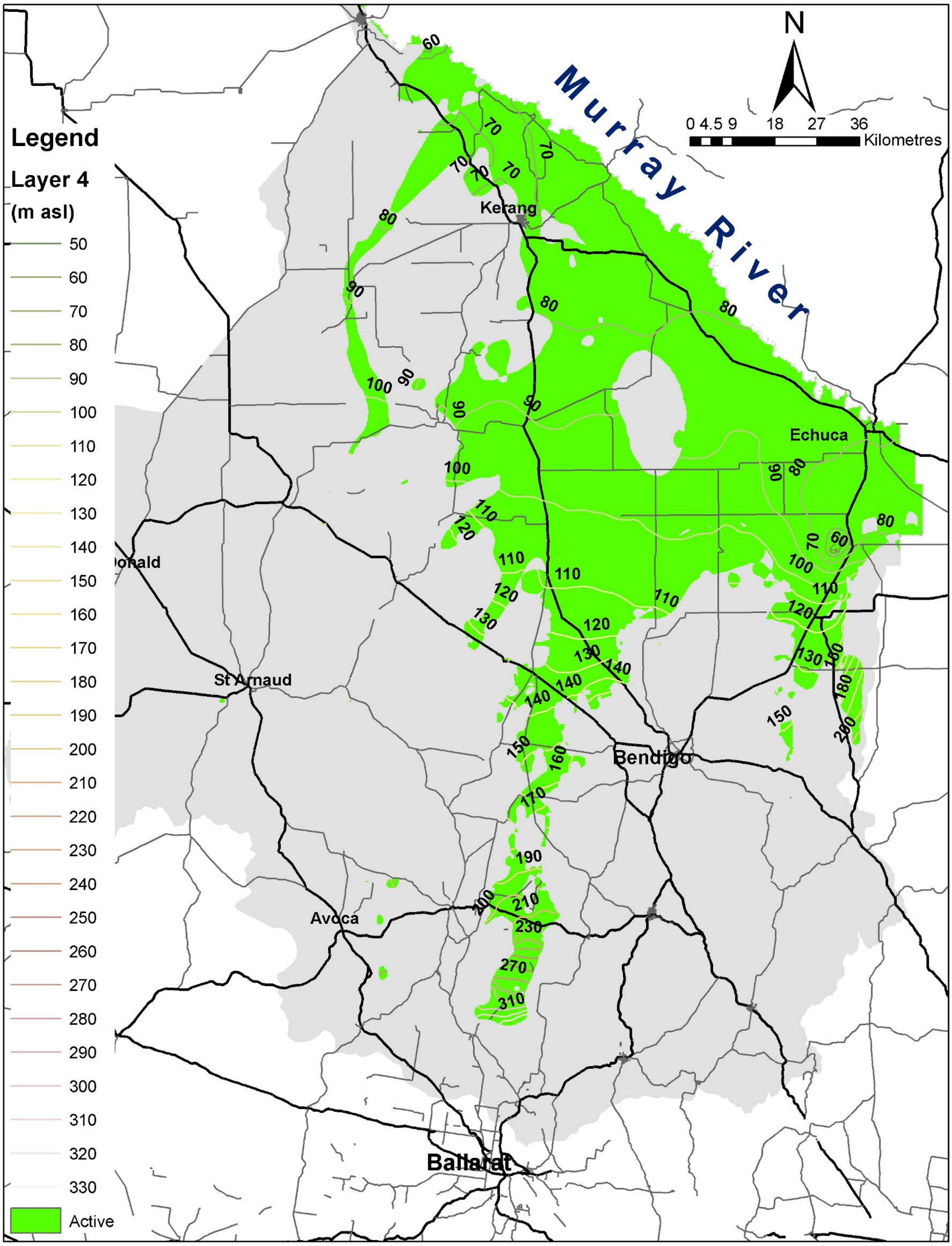
Model layer 2



Model layer 3

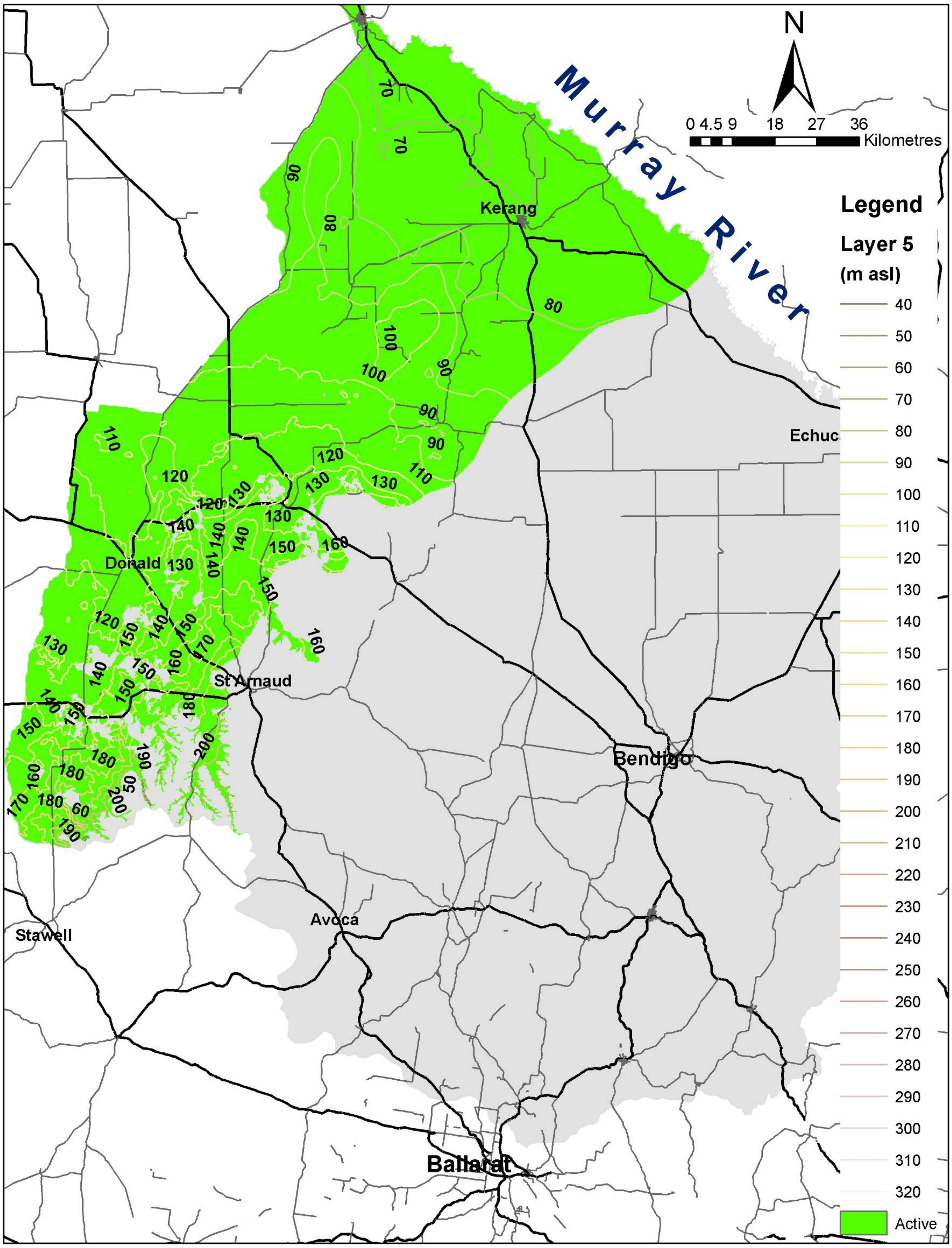


Model layer 4

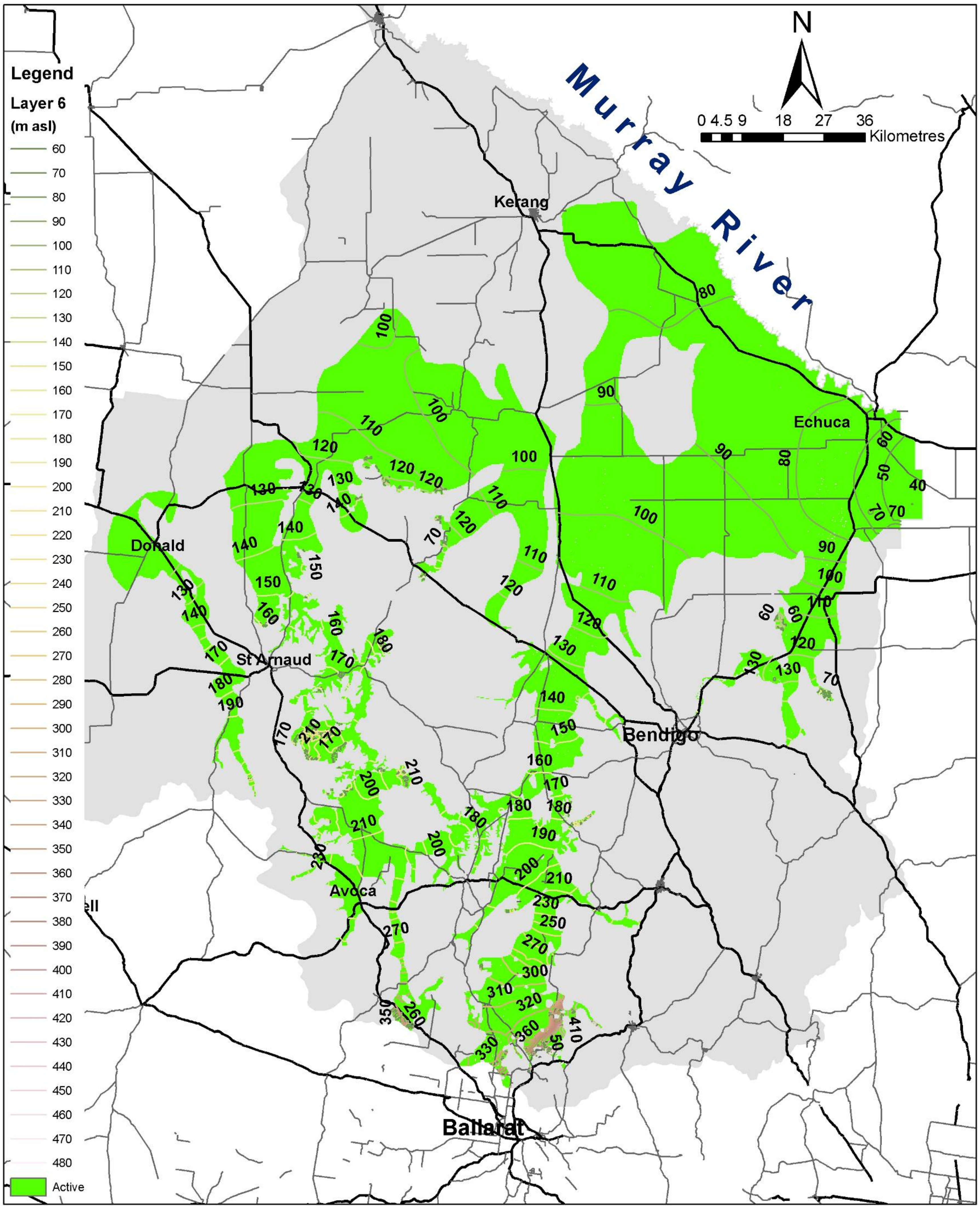


Job	Document	Status	Version	Date	Page
DSE_Ecomarkets_NC	NC_trans5.doc	DRAFT	1.1	25 May 2010	153

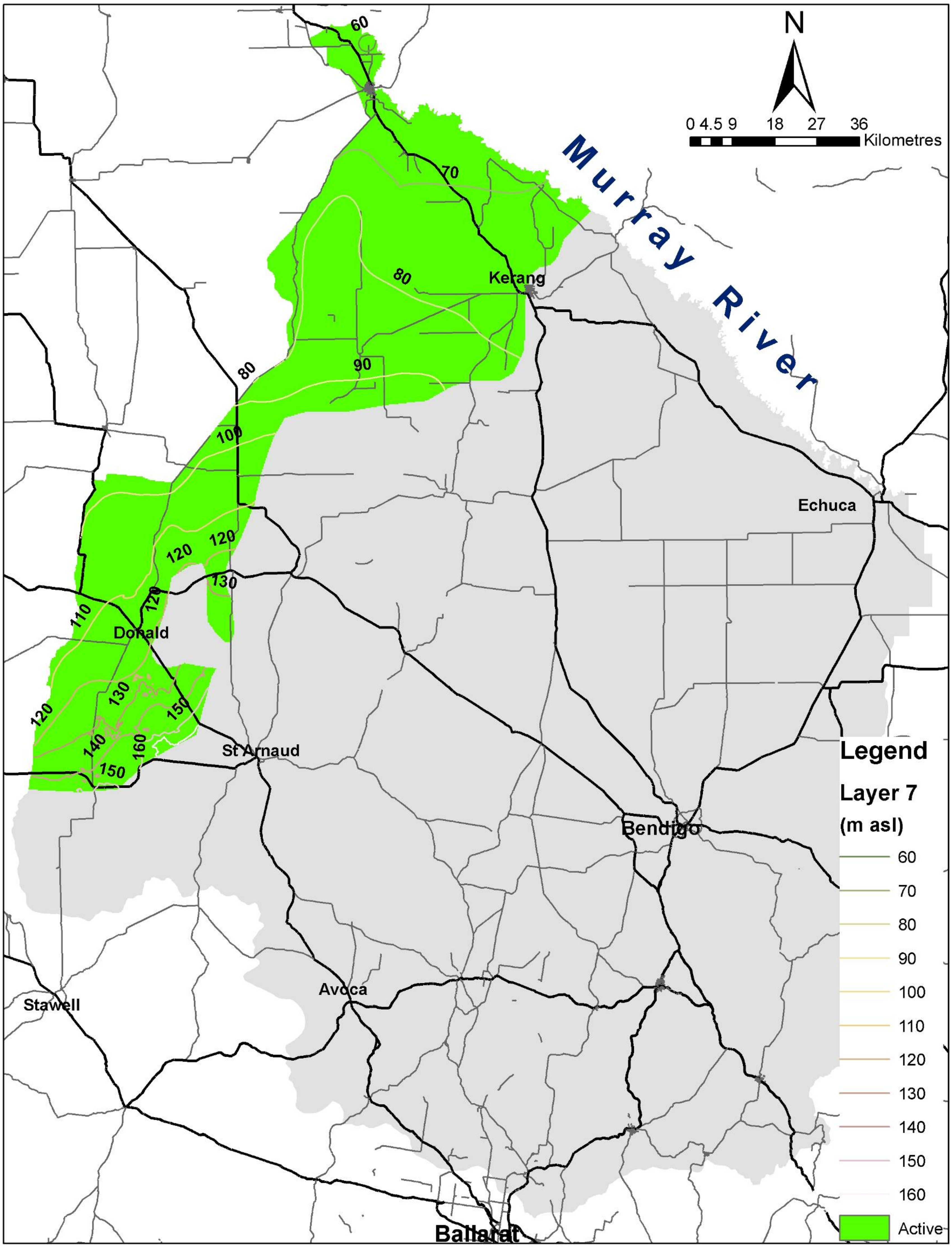
Model layer 5



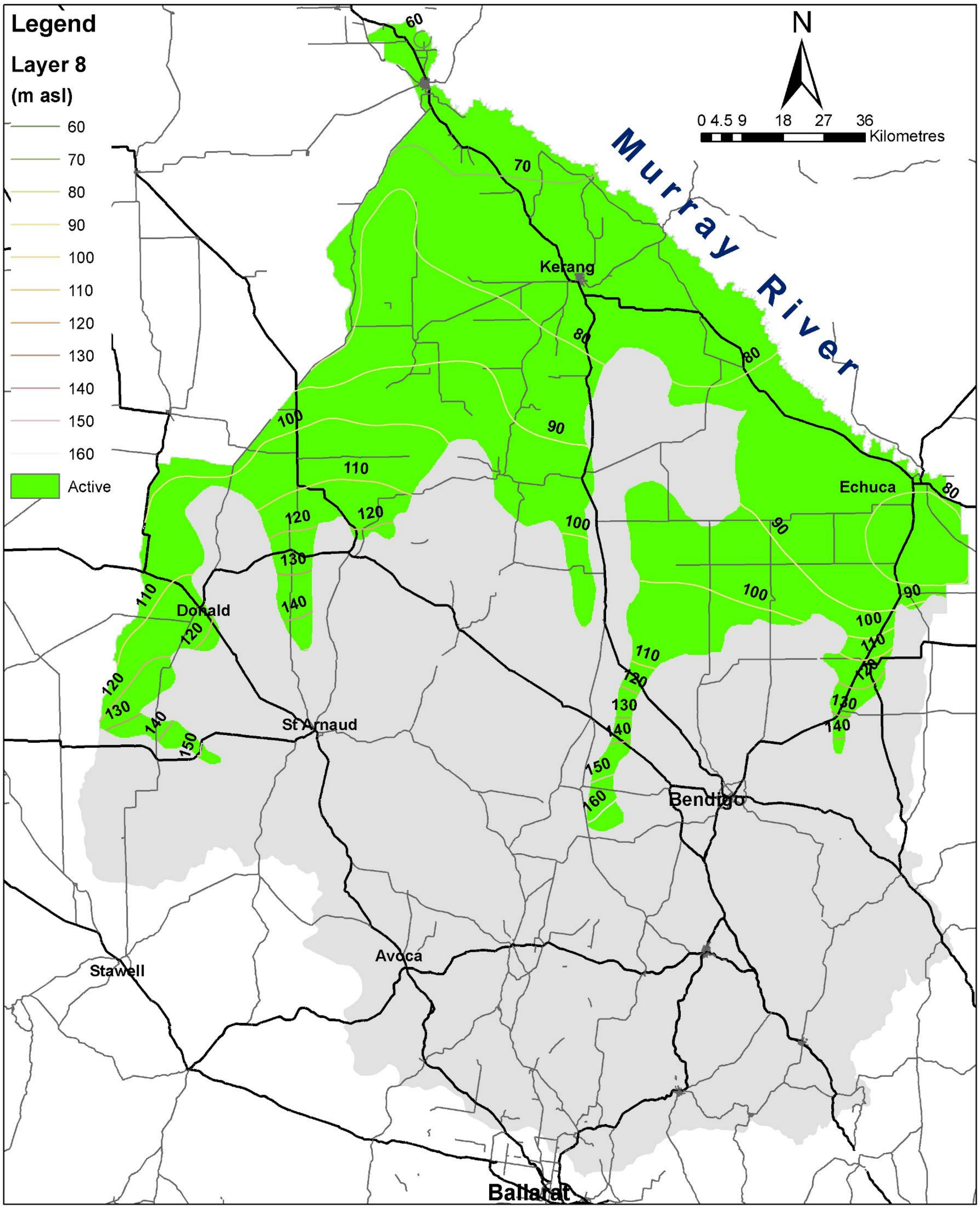
Model layer 6



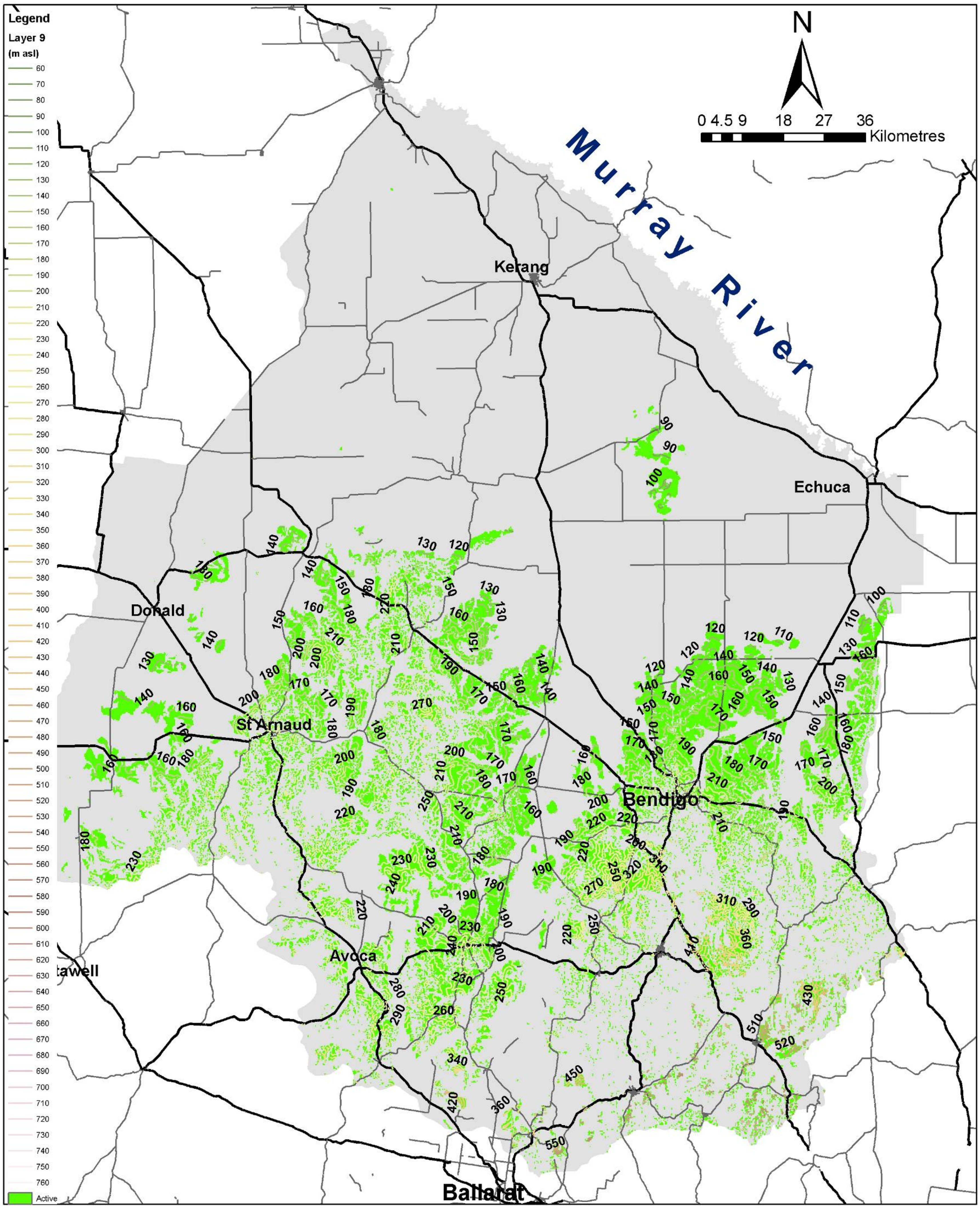
Model layer 7



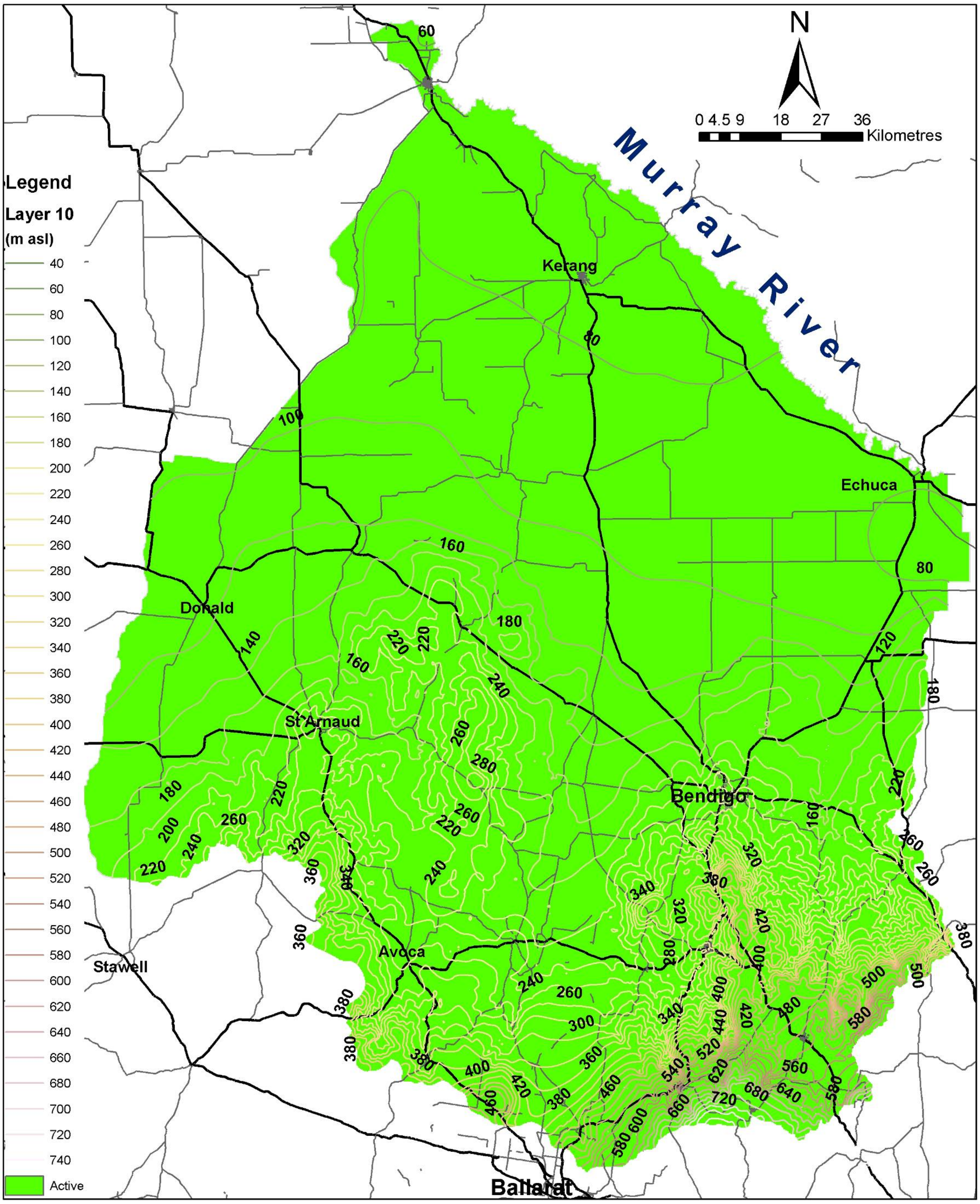
Model layer 8



Model layer 9



Model layer 10

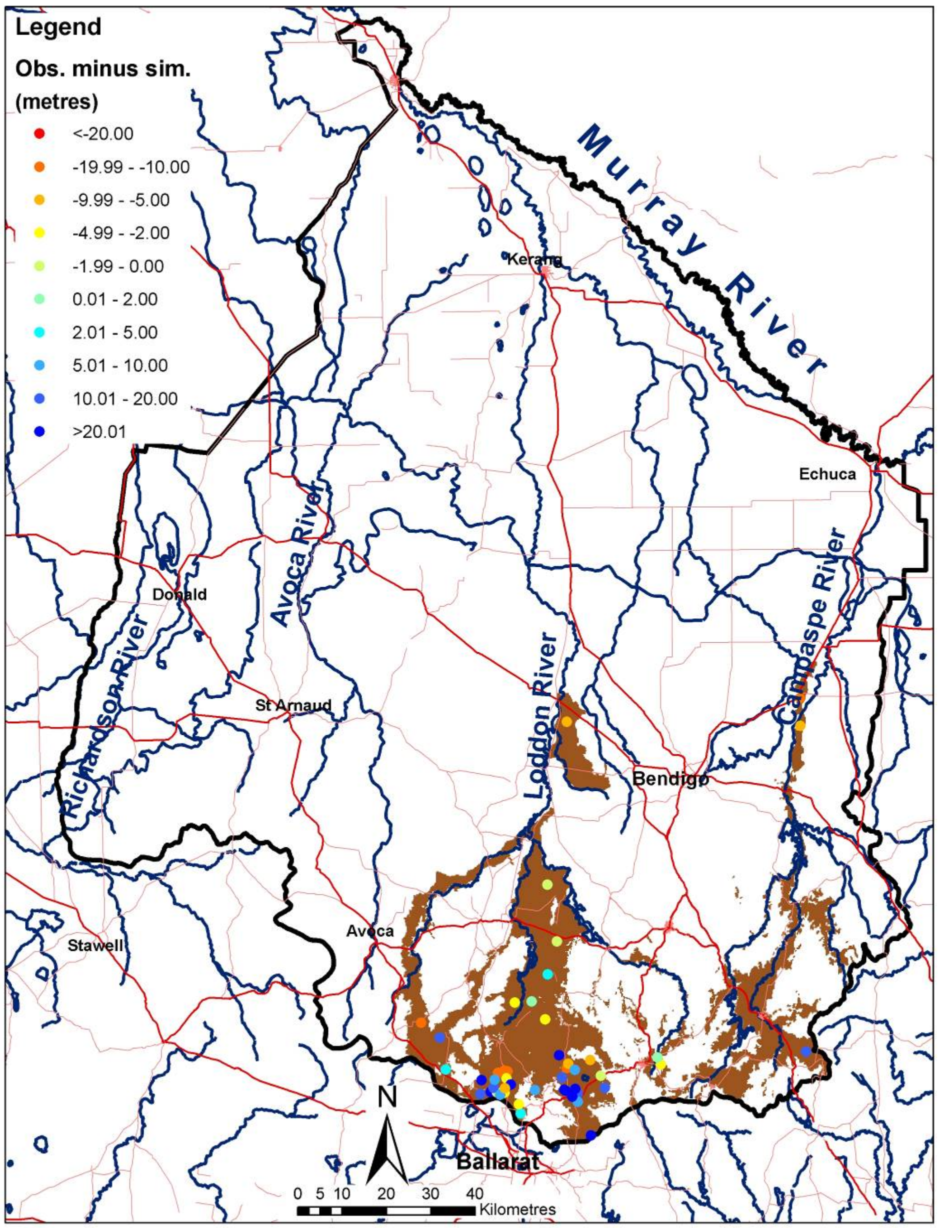


Appendix 6 Simulated minus observed residual water level

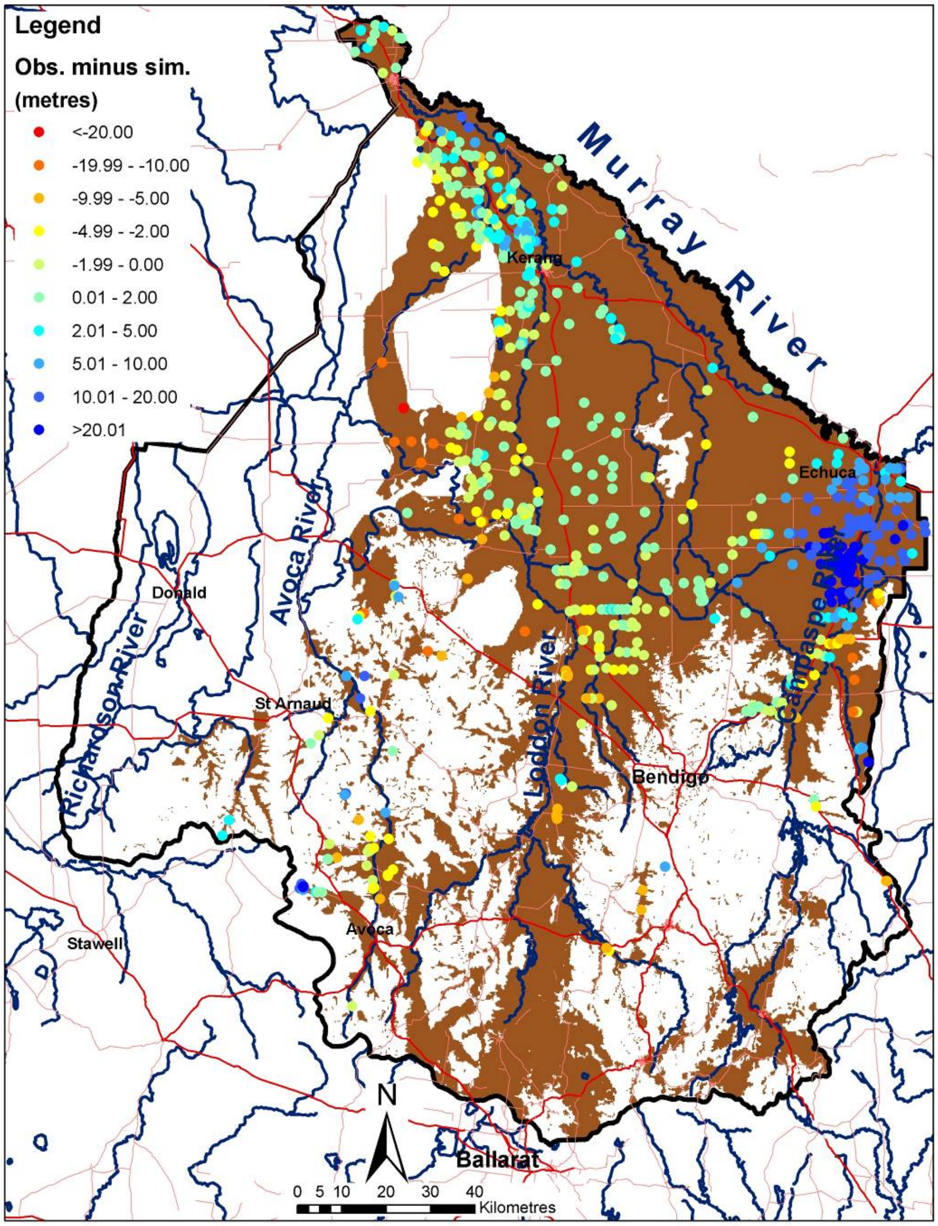
Layer 1

No data

Layer 2

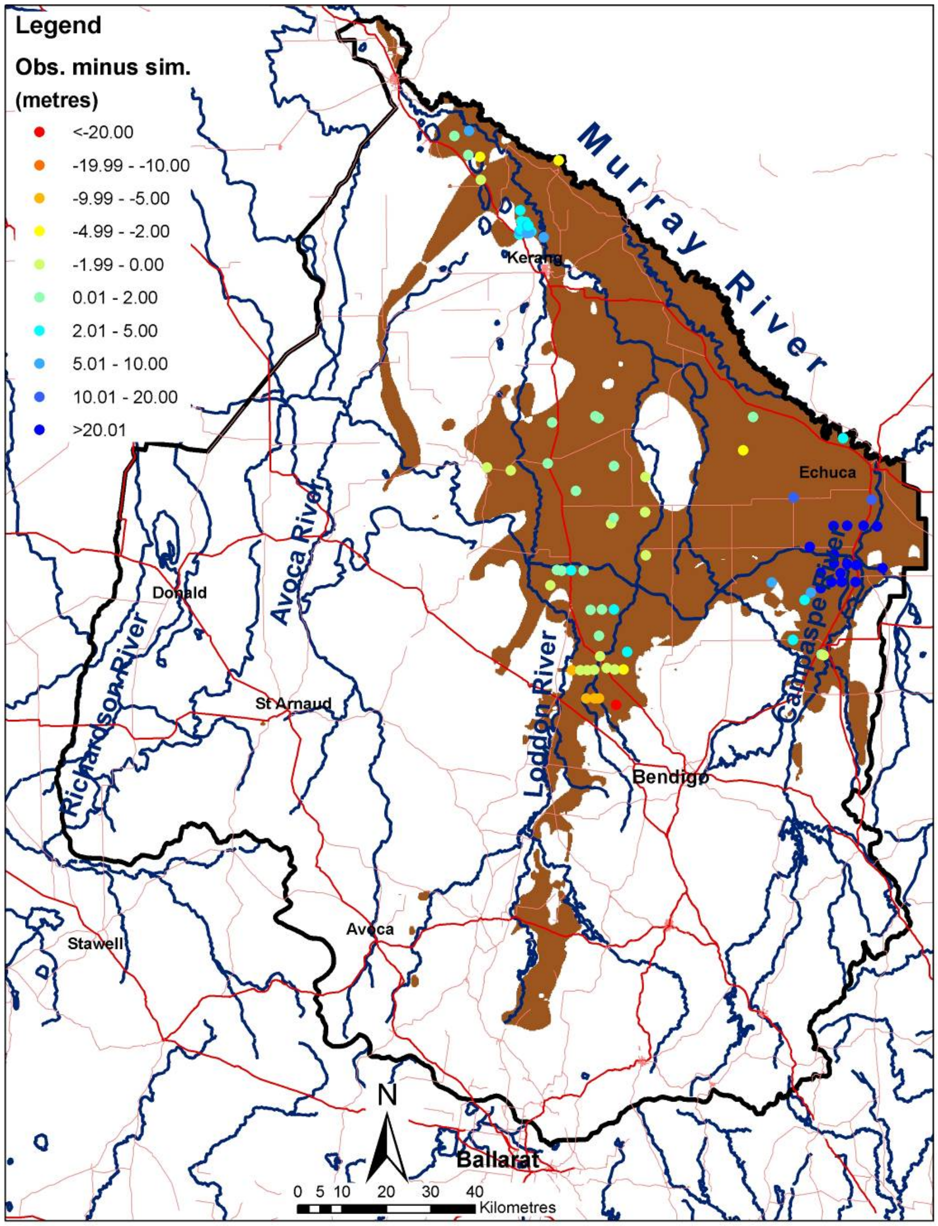


Layer 3



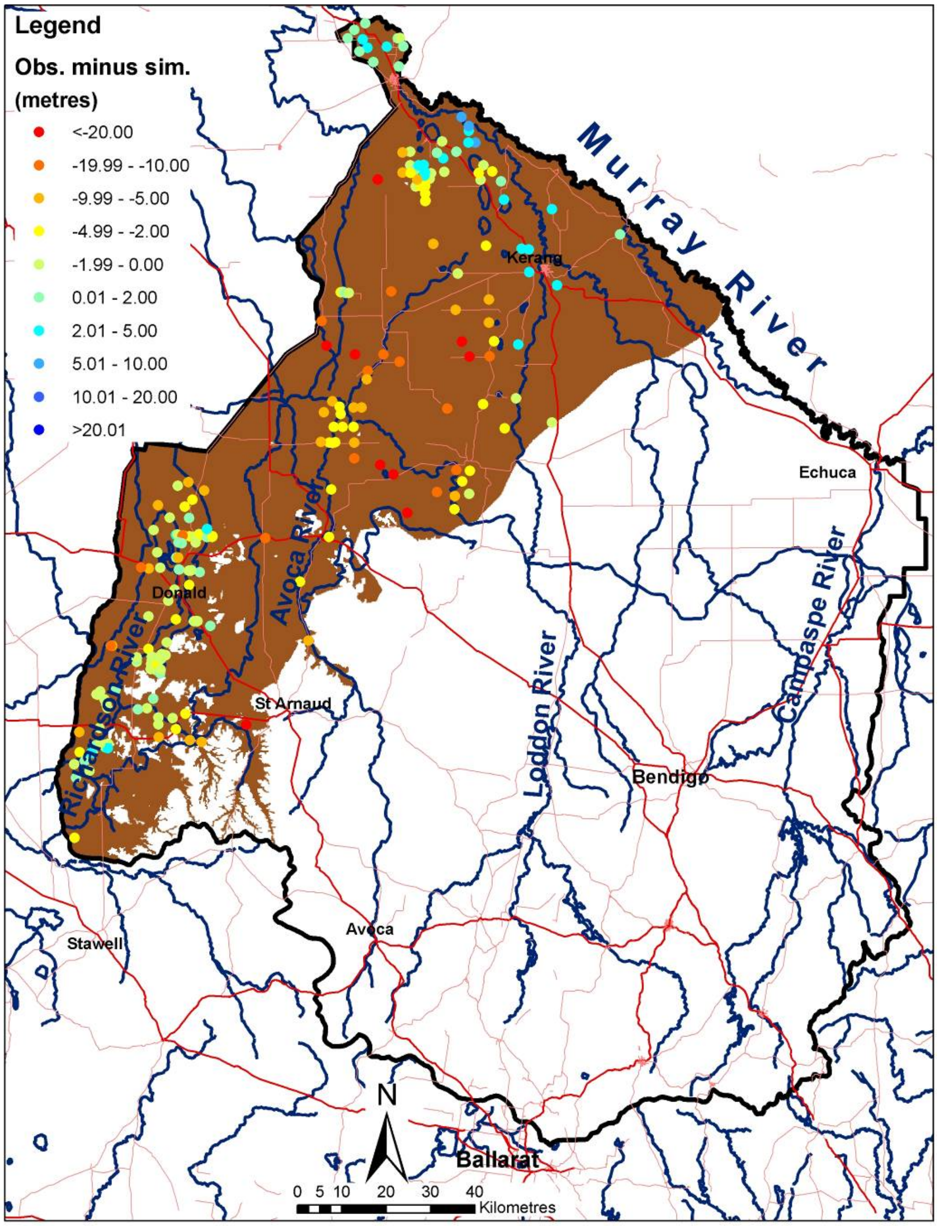
Legend
Obs. minus sim.
(metres)
<-20.00
-19.99 - -10.00
-9.99 - -5.00
-4.99 - -2.00
-1.99 - 0.00
0.01 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 20.00
>20.01
Murray River
Kerang
Echuca
Avoca River
Donald
Richardson River
St Arnaud
Loddon River
Campaspe River
Bendigo
Avoca
Stawell
Ballarat
N
0 5 10 20 30 40
Kilometres

Layer 4



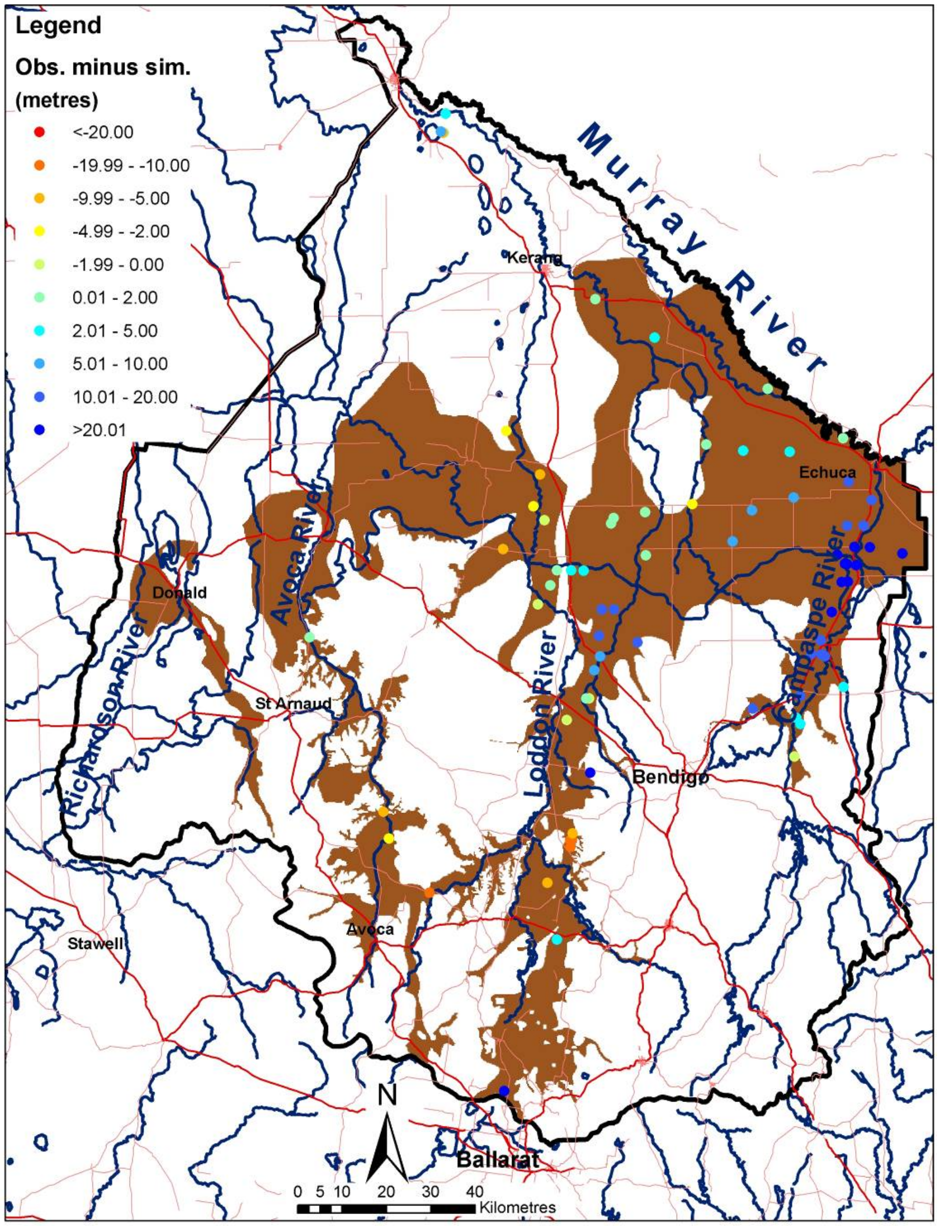
Legend
Obs. minus sim.
(metres)
<-20.00
-19.99 - -10.00
-9.99 - -5.00
-4.99 - -2.00
-1.99 - 0.00
0.01 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 20.00
>20.01
Murray River
Kerang
Echuca
Avoca River
Donald
Richardson River
Loddon River
Campaspe River
St Arnaud
Bendigo
Avoca
Stawell
Ballarat
N
0 5 10 20 30 40
Kilometres

Layer 5



Legend
Obs. minus sim.
(metres)
<-20.00
-19.99 - -10.00
-9.99 - -5.00
-4.99 - -2.00
-1.99 - 0.00
0.01 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 20.00
>20.01
Murray River
Kerang
Echuca
Avoca River
Donald
Richardson River
St Arnaud
Loddon River
Campaspe River
Bendigo
Stawell
Avoca
Ballarat
N
0 5 10 20 30 40
Kilometres

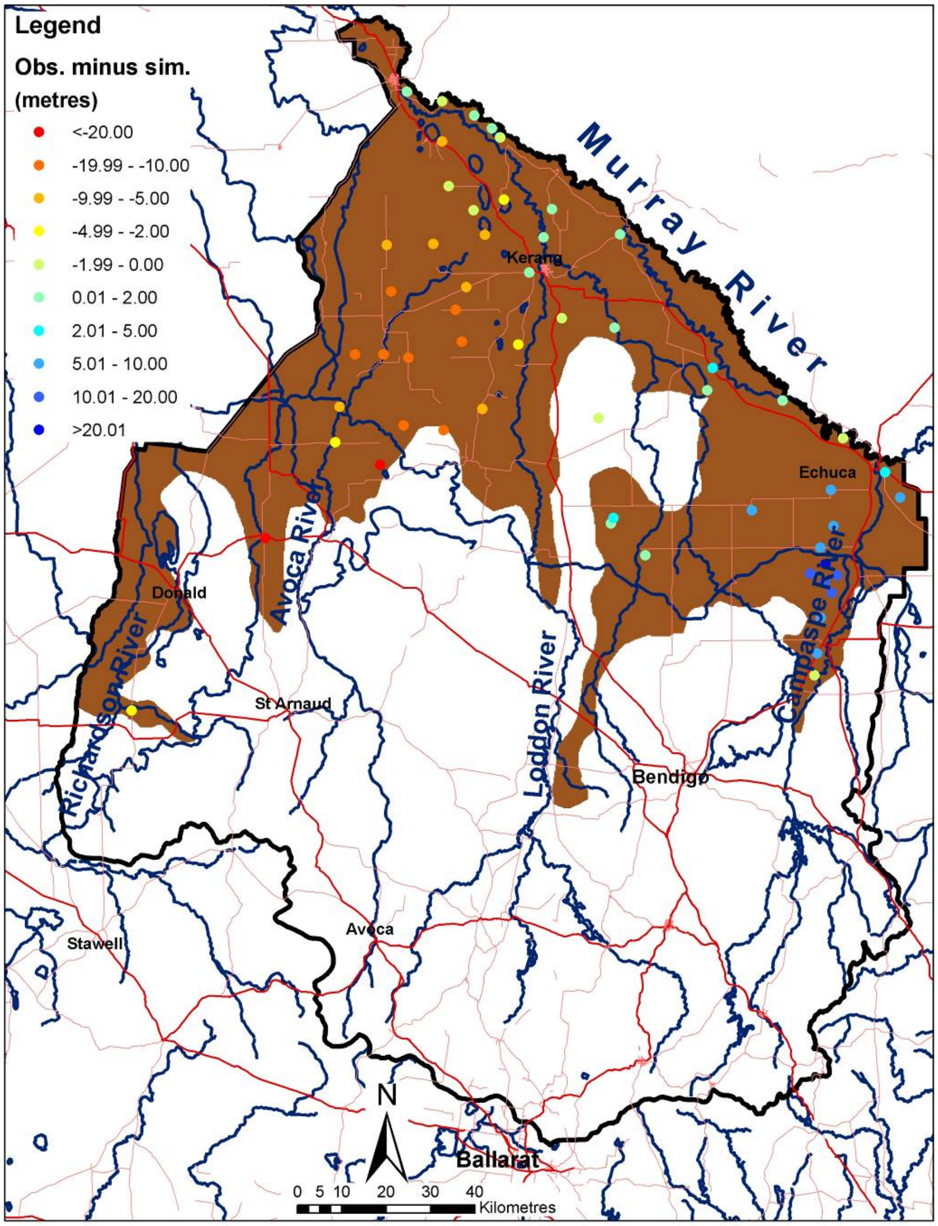
Layer 6



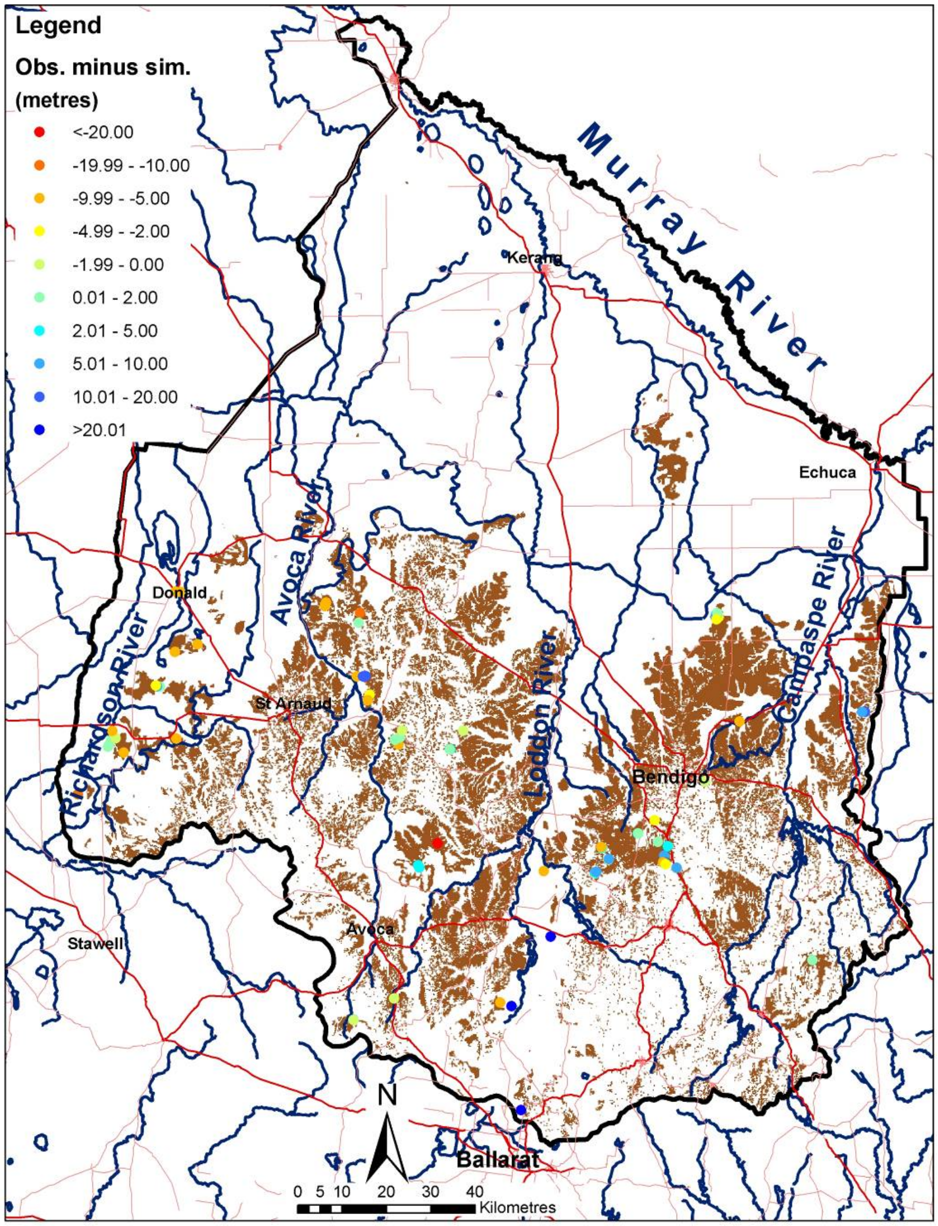
Layer 7

No data

Layer 8

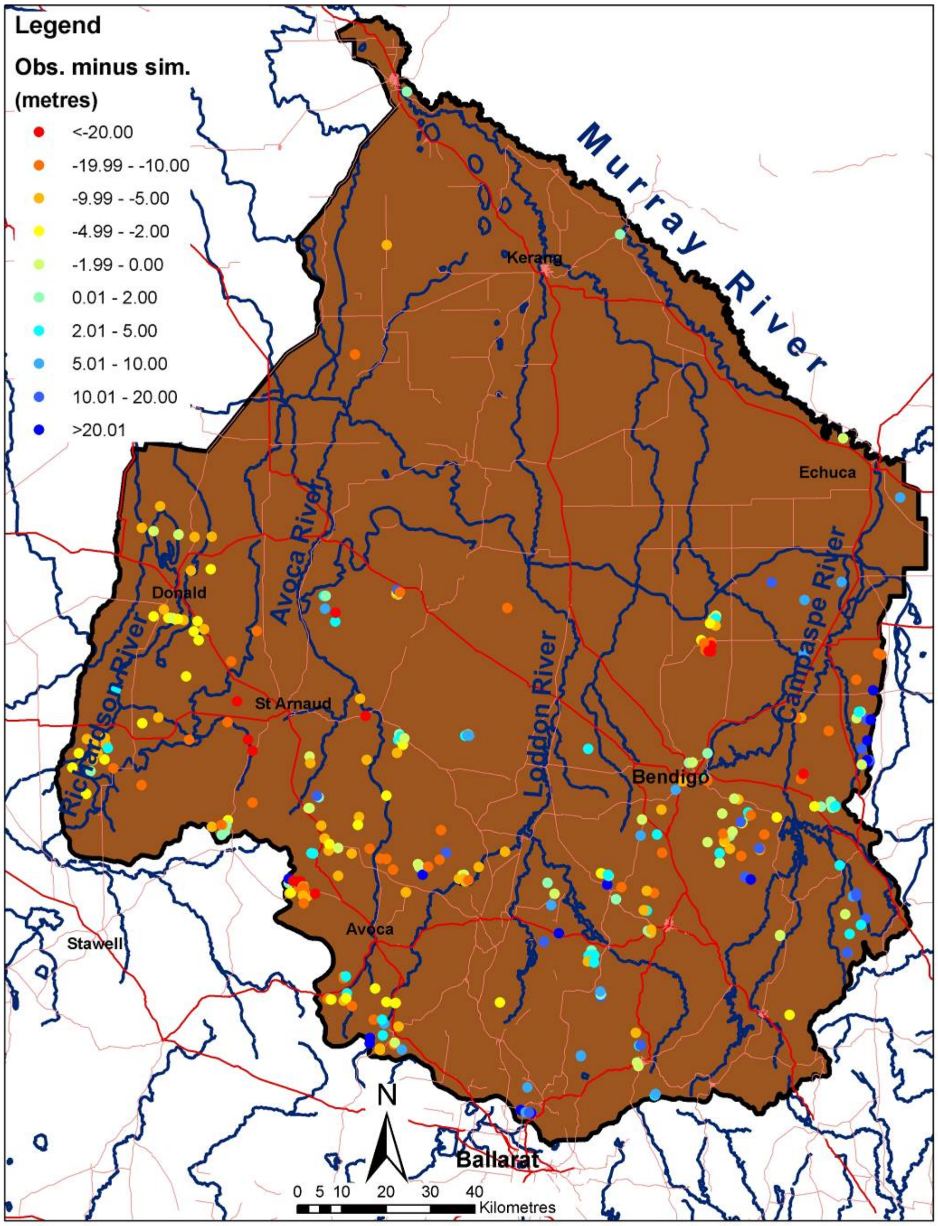

Legend
Obs. minus sim.
(metres)
<-20.00
-19.99 - -10.00
-9.99 - -5.00
-4.99 - -2.00
-1.99 - 0.00
0.01 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 20.00
>20.01
Murray River
Kerang
Echuca
Avoca River
Donald
Richardson River
St Arnaud
Loddon River
Campaspe River
Bendigo
Stawell
Avoca
Ballarat
N
0 5 10 20 30 40
Kilometres

Layer 9



Legend
Obs. minus sim.
(metres)
<-20.00
-19.99 - -10.00
-9.99 - -5.00
-4.99 - -2.00
-1.99 - 0.00
0.01 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 20.00
>20.01
Murray River
Kerang
Echuca
Avoca River
Campaspe River
Donald
Richardson River
St Arnaud
Loddon River
Bendigo
Avoca
Stawell
Ballarat
N
0 5 10 20 30 40
Kilometres

Layer 10



Legend
Obs. minus sim.
(metres)
<-20.00
-19.99 - -10.00
-9.99 - -5.00
-4.99 - -2.00
-1.99 - 0.00
0.01 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 20.00
>20.01
Murray River
Kerang
Echuca
Avoca River
Campaspe River
Donald
Loddon River
St Arnaud
Richardson River
Bendigo
Avoca
Stawell
Ballarat
N
0 5 10 20 30 40
Kilometres

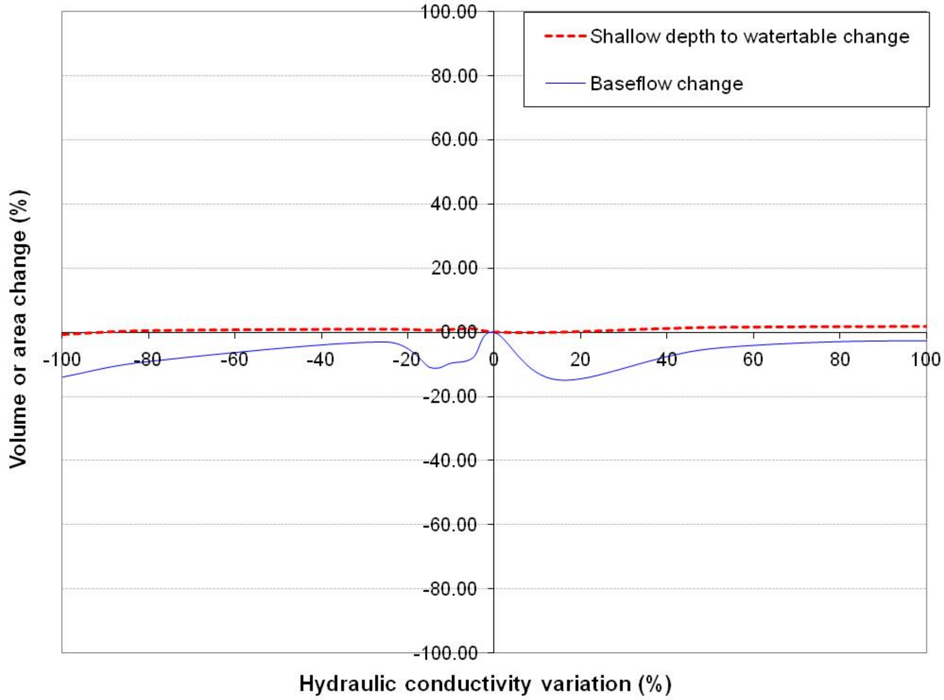
Appendix 7 Model sensitivity analysis

Model sensitivity analysis was undertaken to demonstrate the implications varying model parameters have relative to the model result. The area of depth to watertable less than 2 m, groundwater base flow and scale RMS have been used as the reference for model sensitivity and multiplied by values presented below.

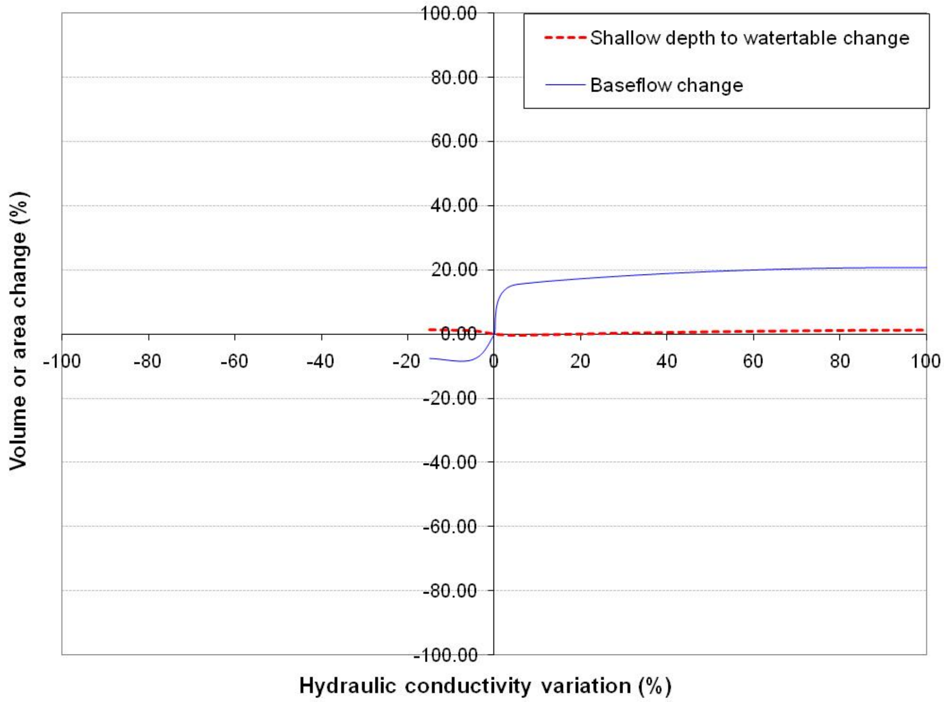
Model attribute difference (%)
−100
−95
−90
−80
−50
−25
−20
−15
−10
−5
−2
−1
1
2
5
10
15
20
25
50
80
90
95
100

Hydraulic conductivity – shallow depth to watertable and baseflow

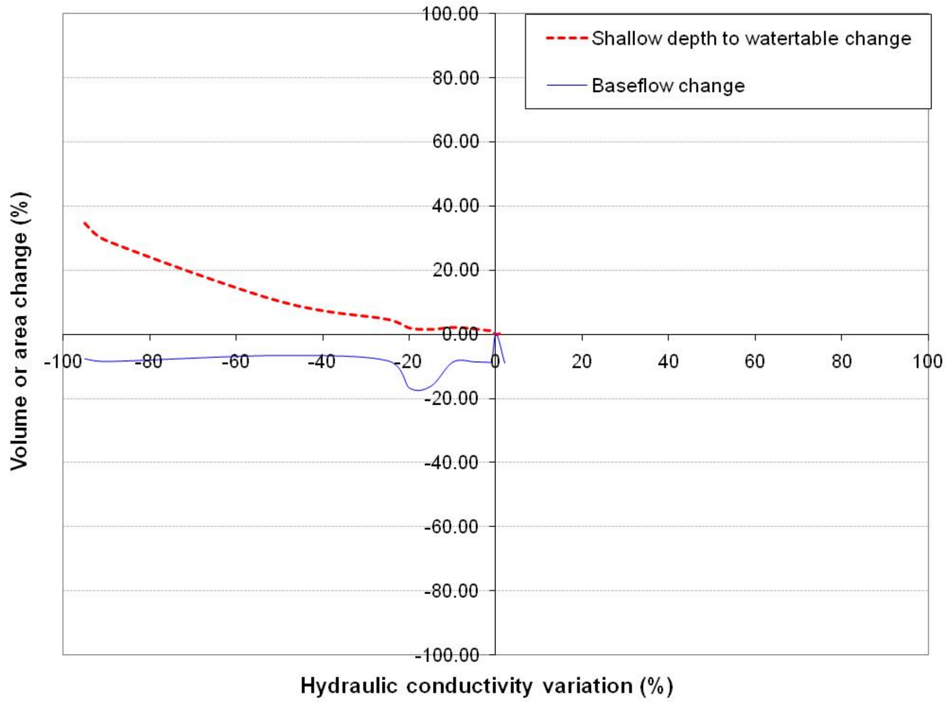
Hydraulic conductivity – Layer 1



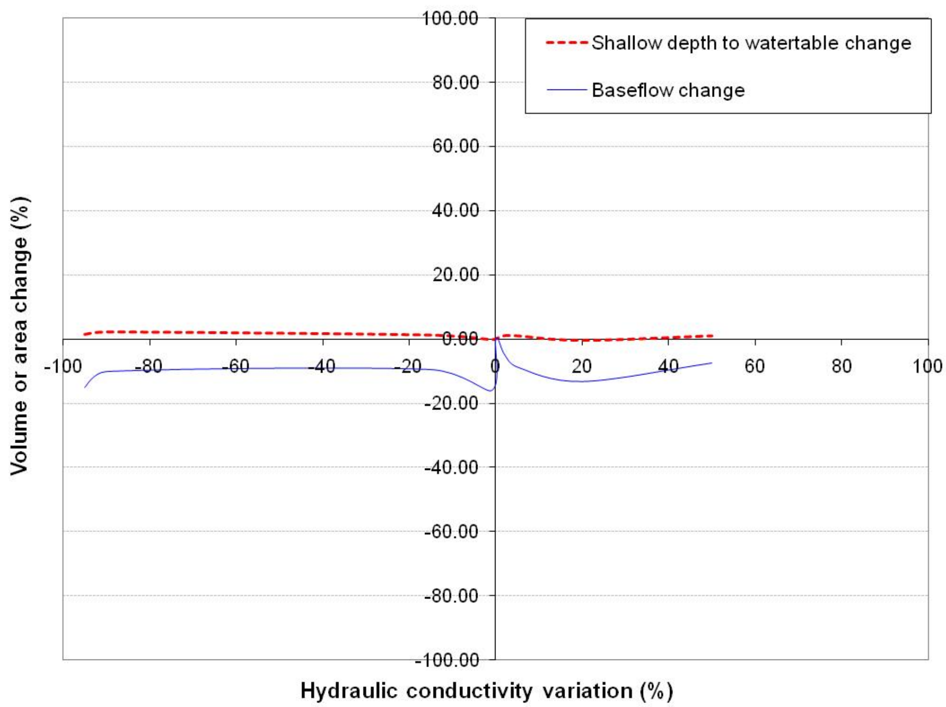
Hydraulic conductivity – Layer 2



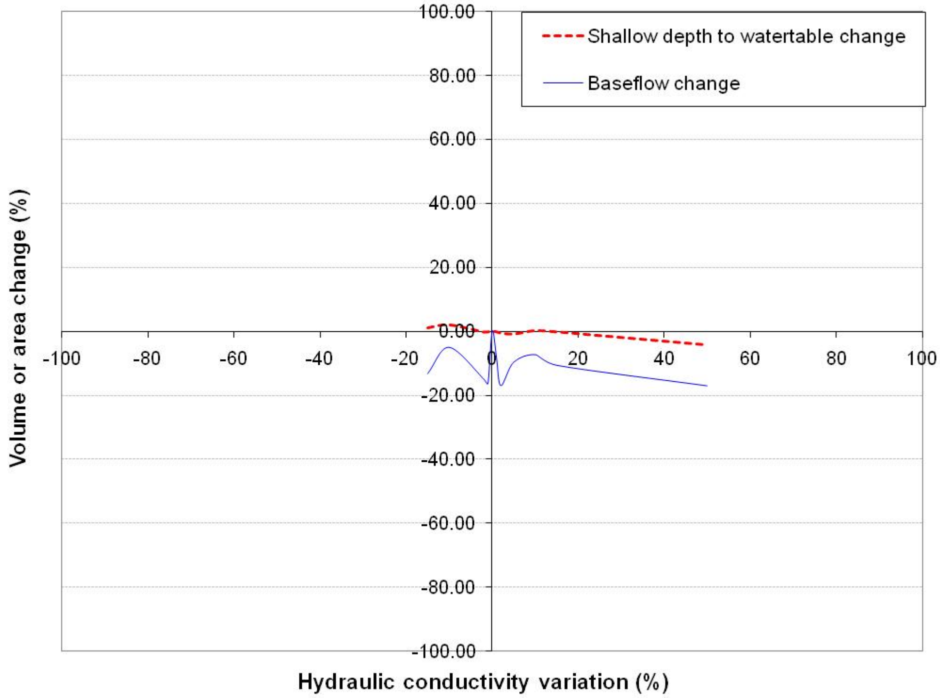
Hydraulic conductivity – Layer 3



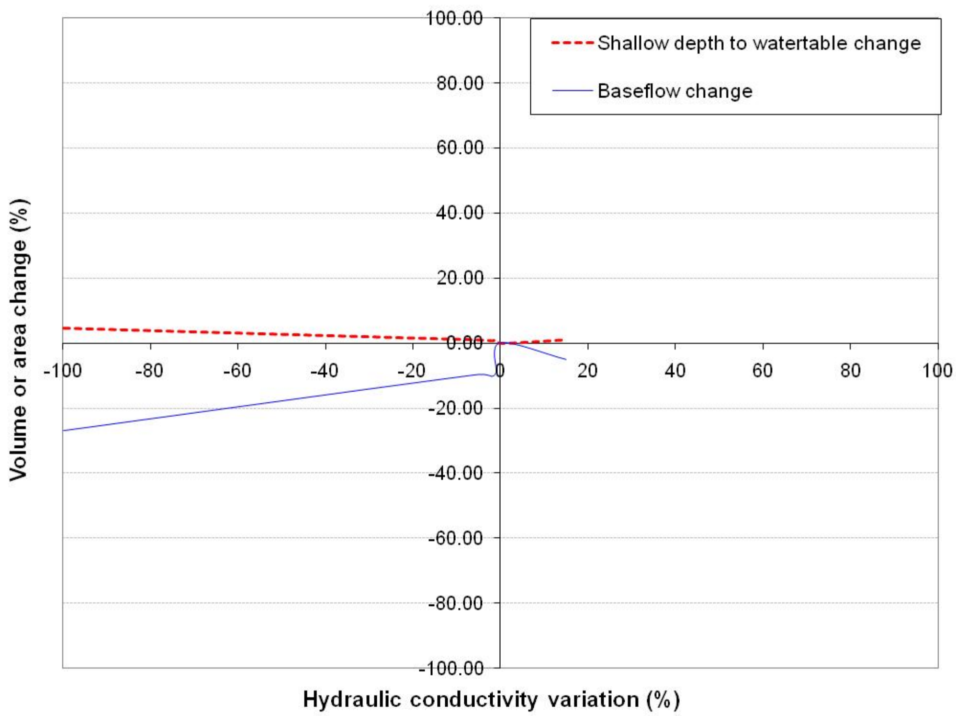
Hydraulic conductivity – Layer 4



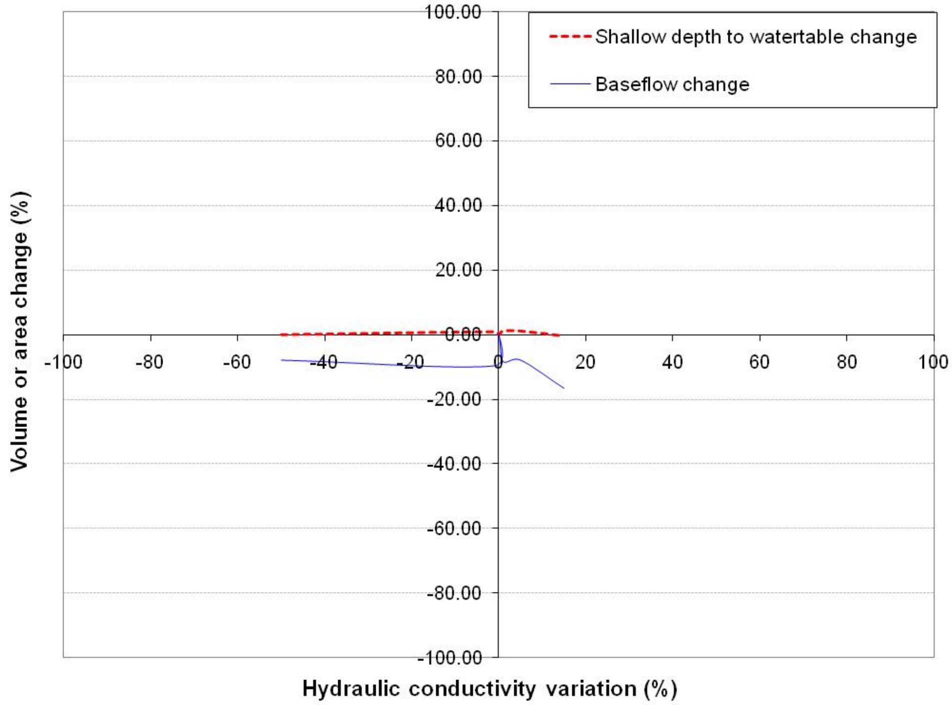
Hydraulic conductivity – Layer 5



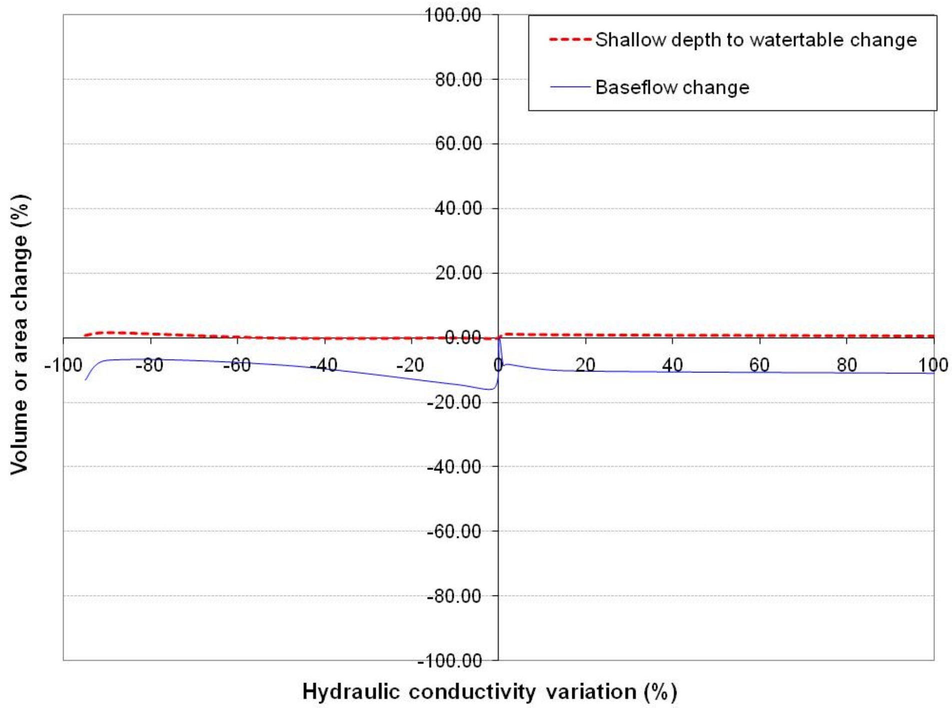
Hydraulic conductivity – Layer 6



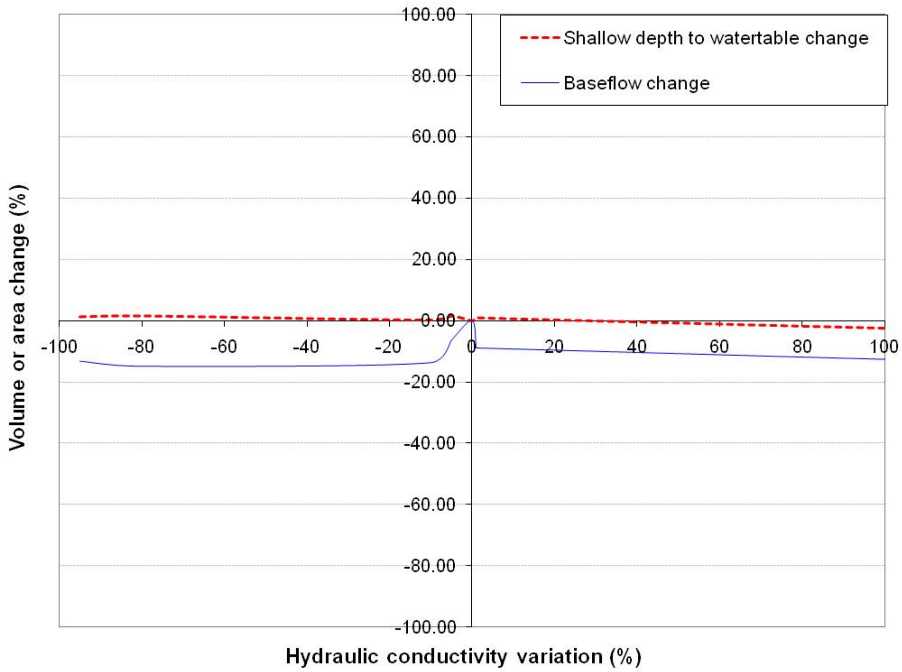
Hydraulic conductivity – Layer 7



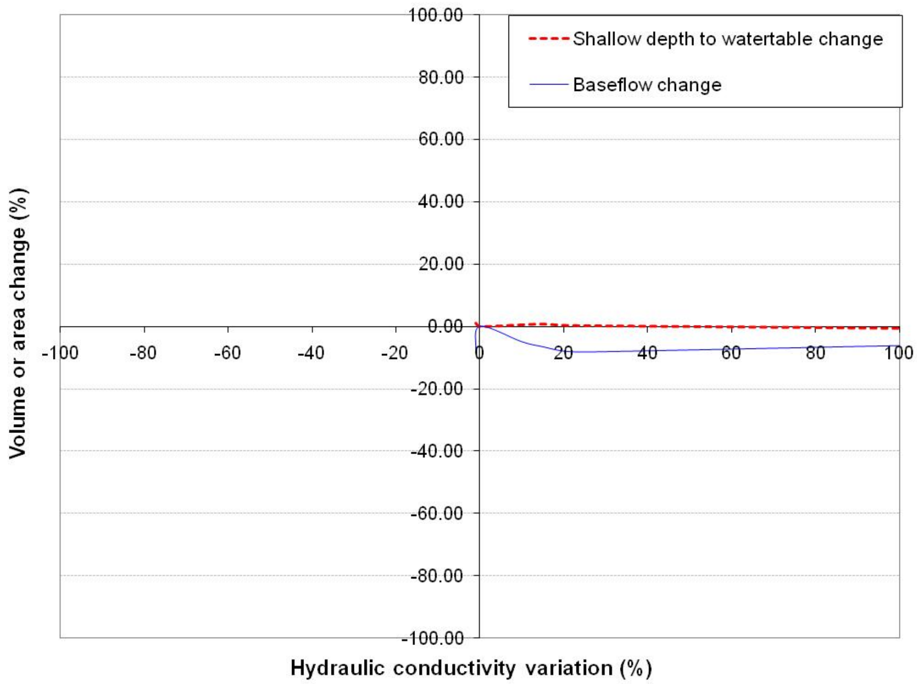
Hydraulic conductivity – Layer 8



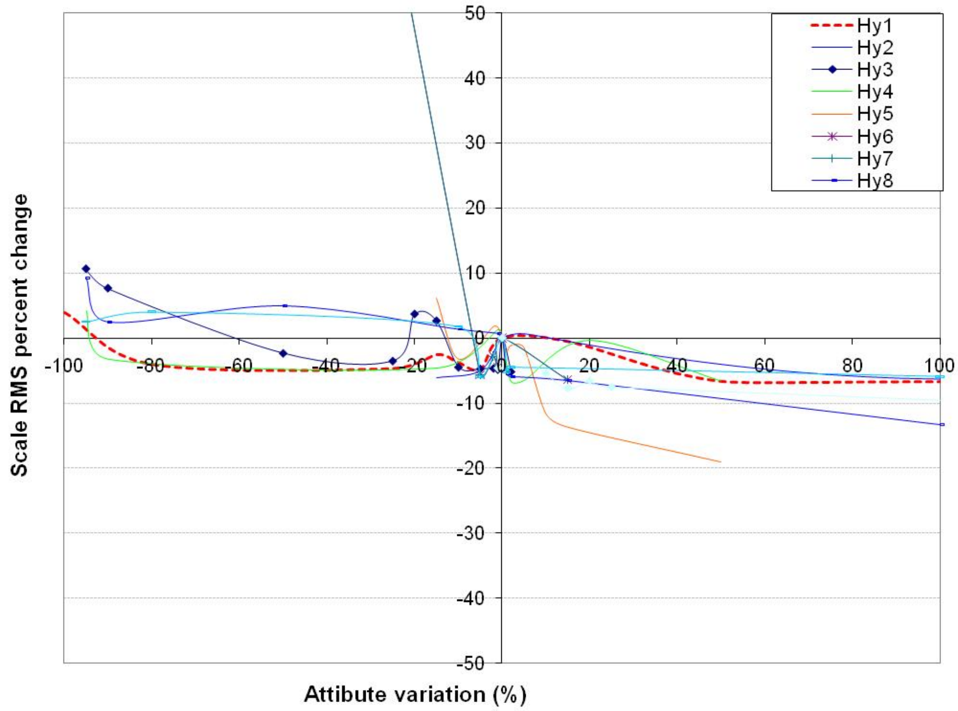
Hydraulic conductivity – Layer 9



Hydraulic conductivity – Layer 10

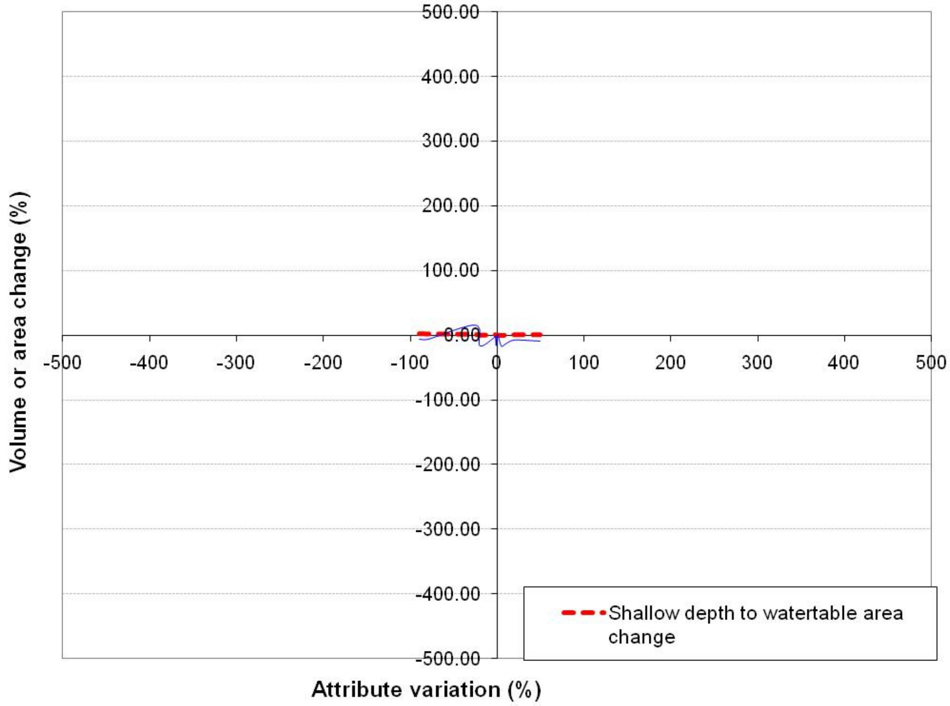


Hydraulic conductivity – scale root mean squared

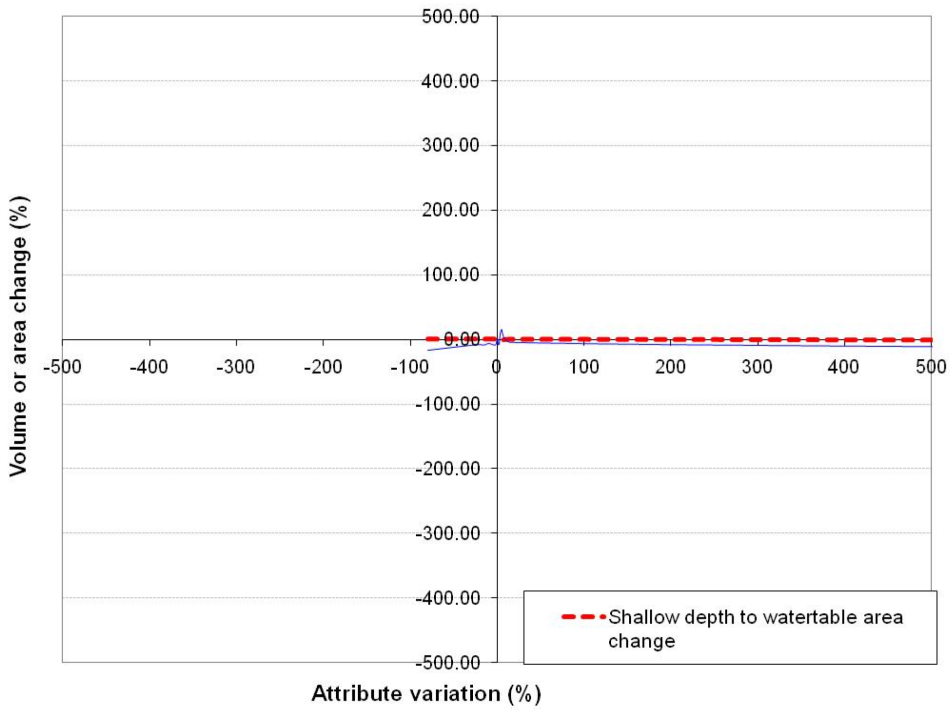


Vcont – shallow depth to watertable and baseflow

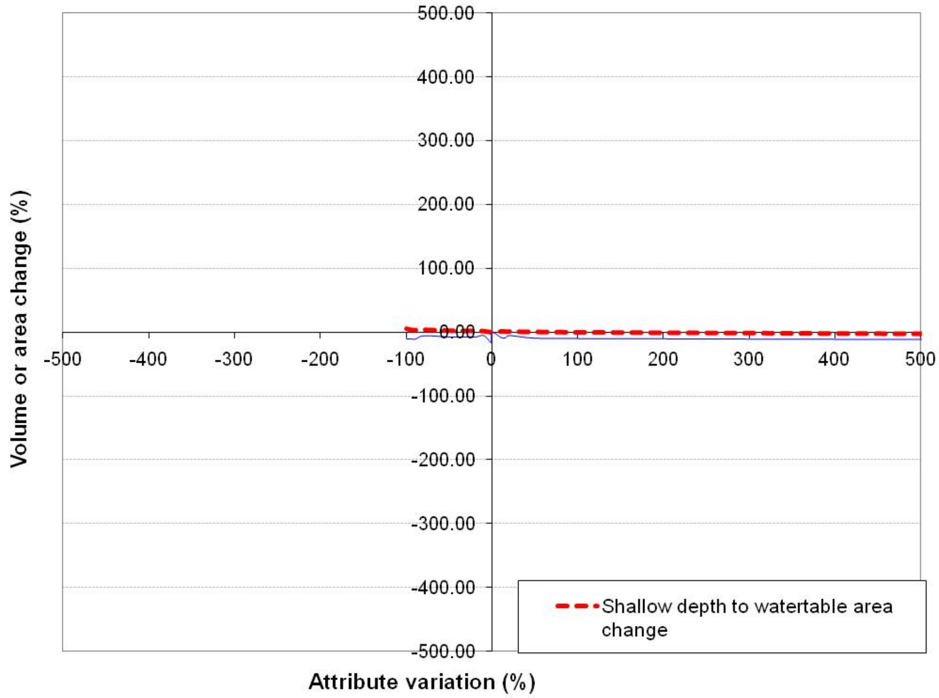
Vcont – layer1



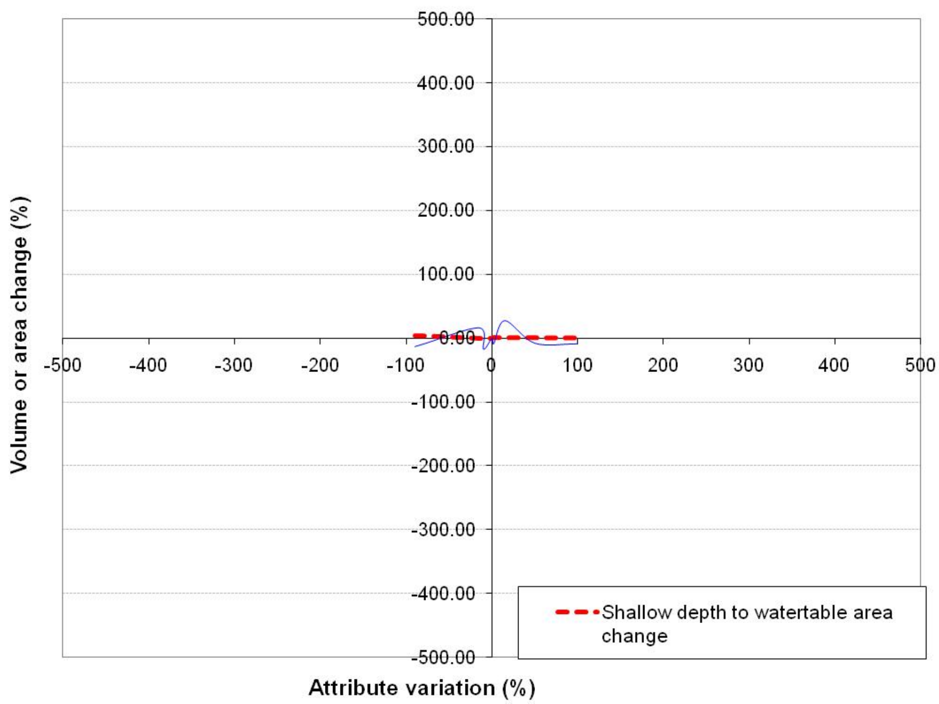
Vcont – layer2



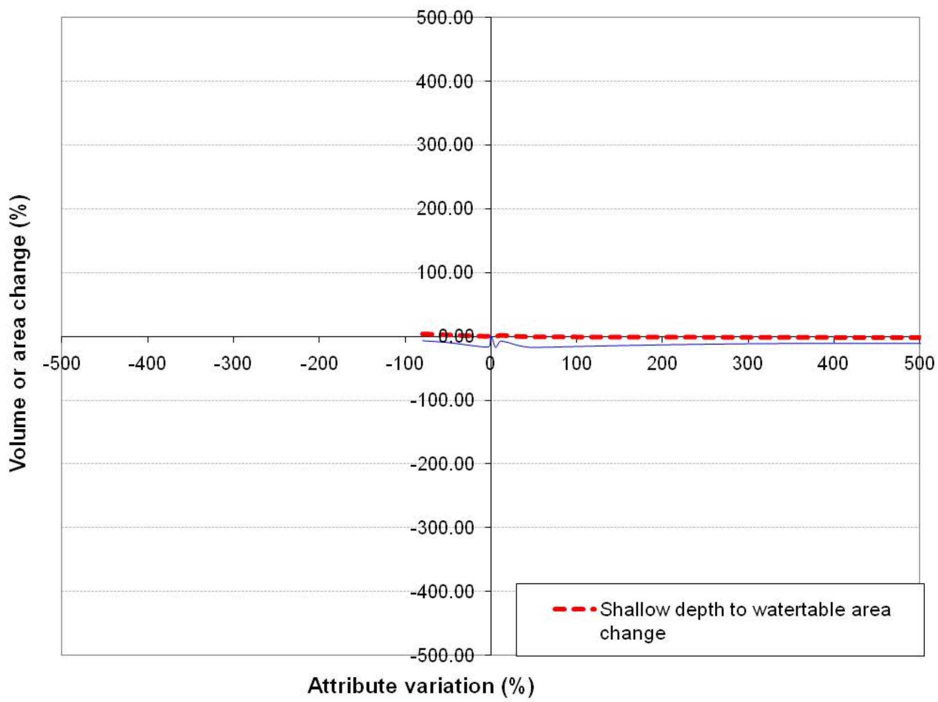
Vcont – layer3



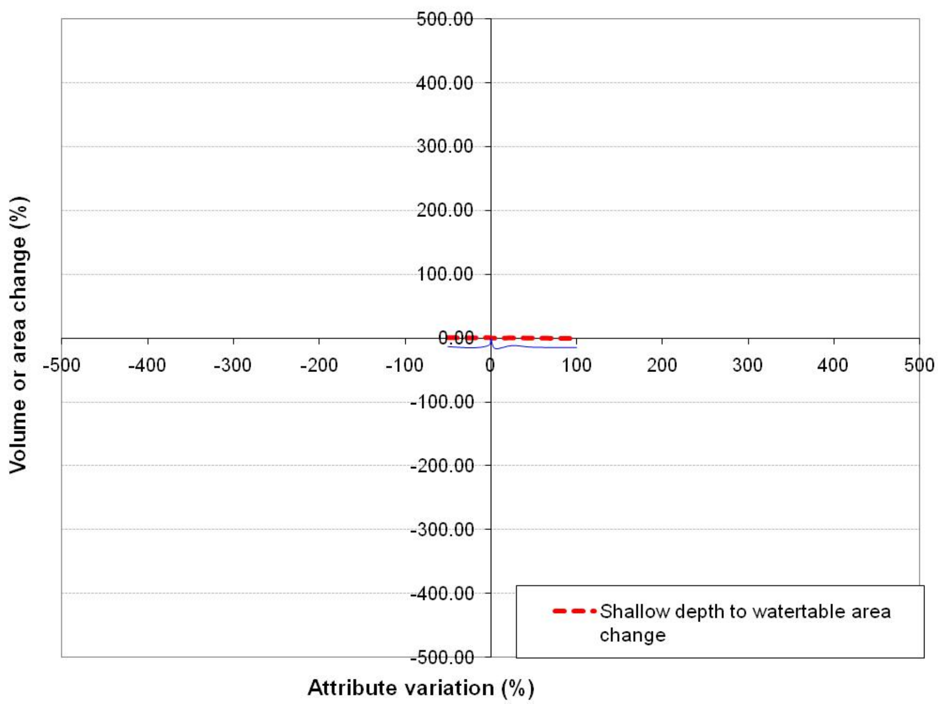
Vcont – layer4



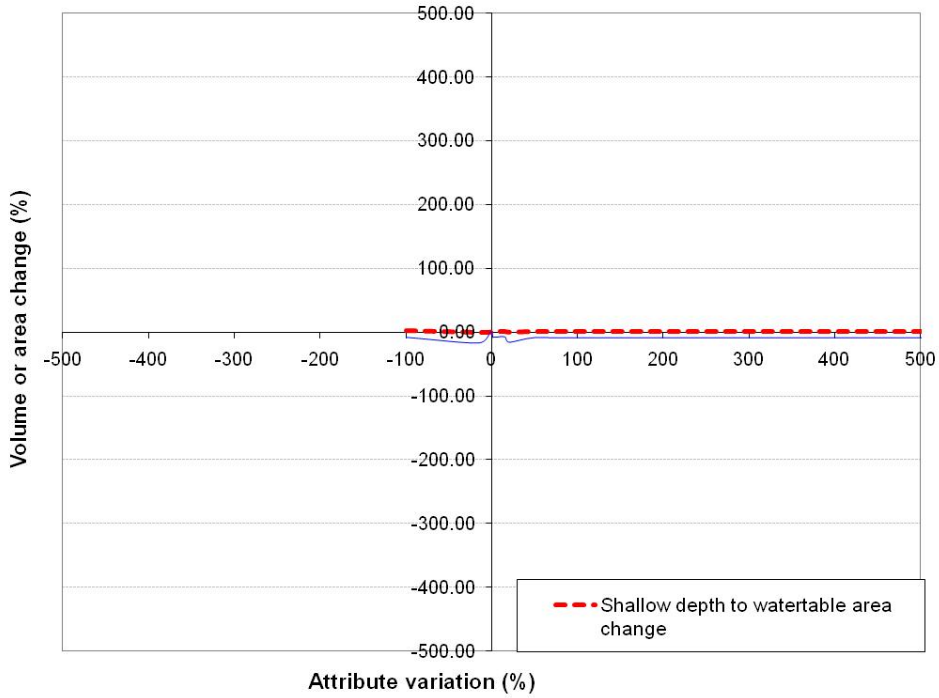
Vcont – layer5



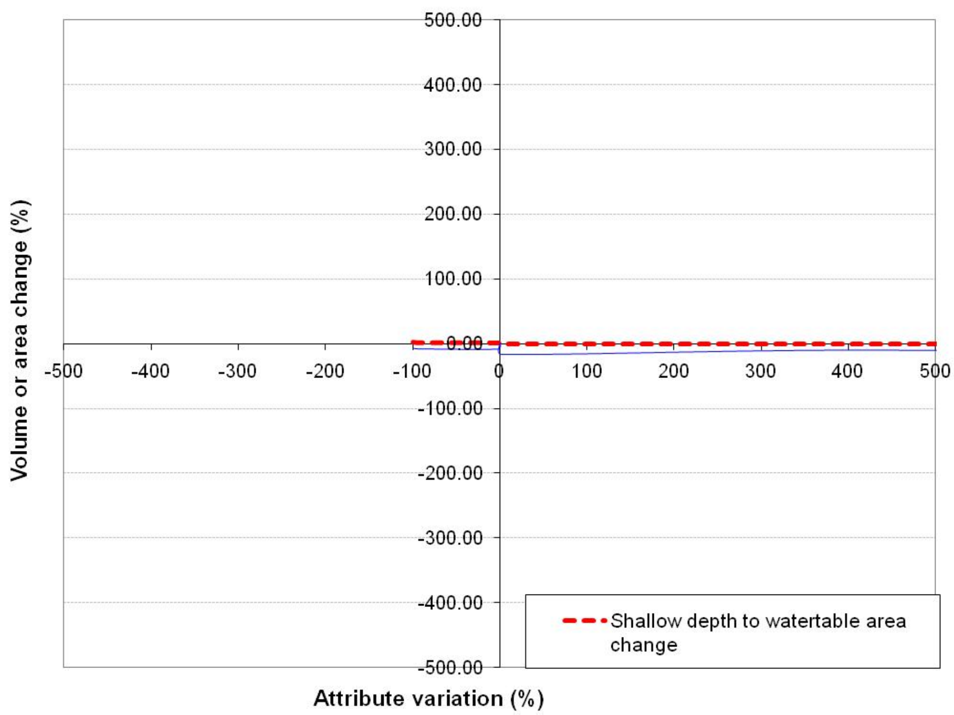
Vcont – layer6



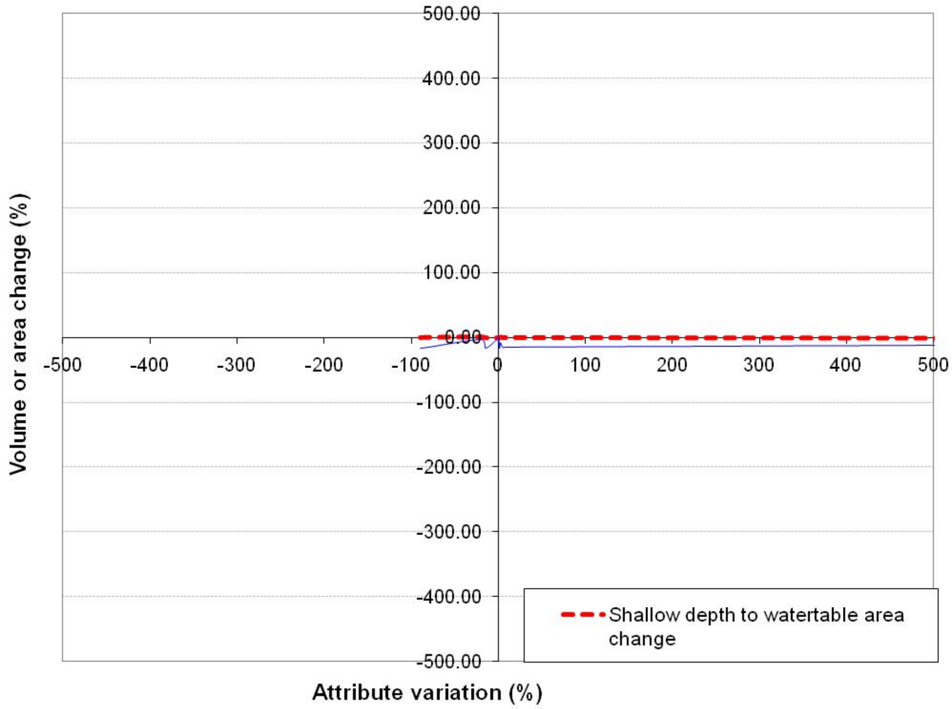
Vcont – layer7



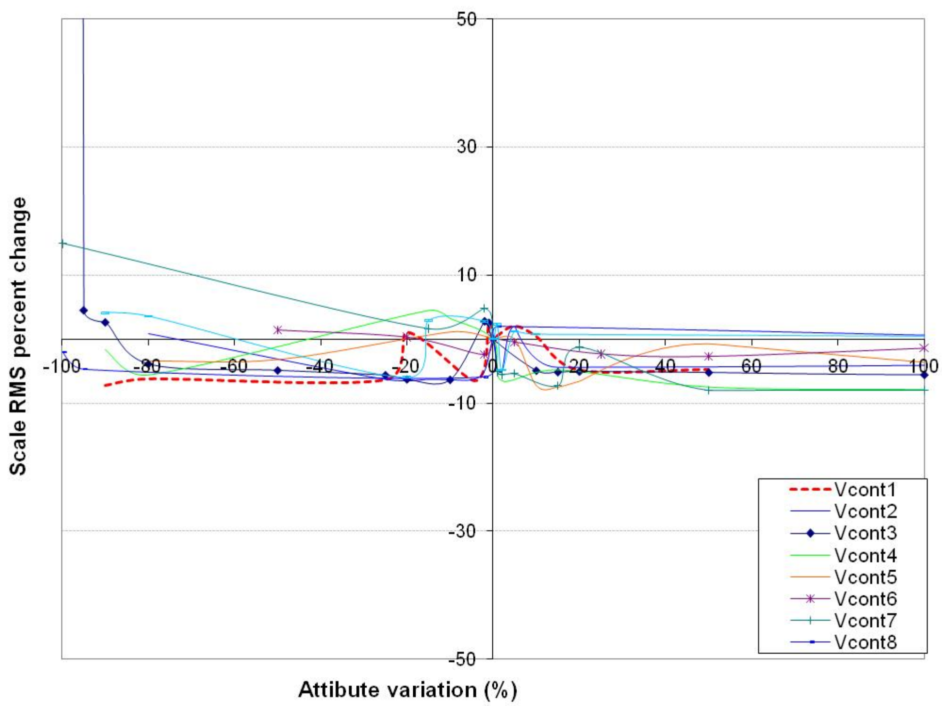
Vcont – layer 8



Vcont – layer9

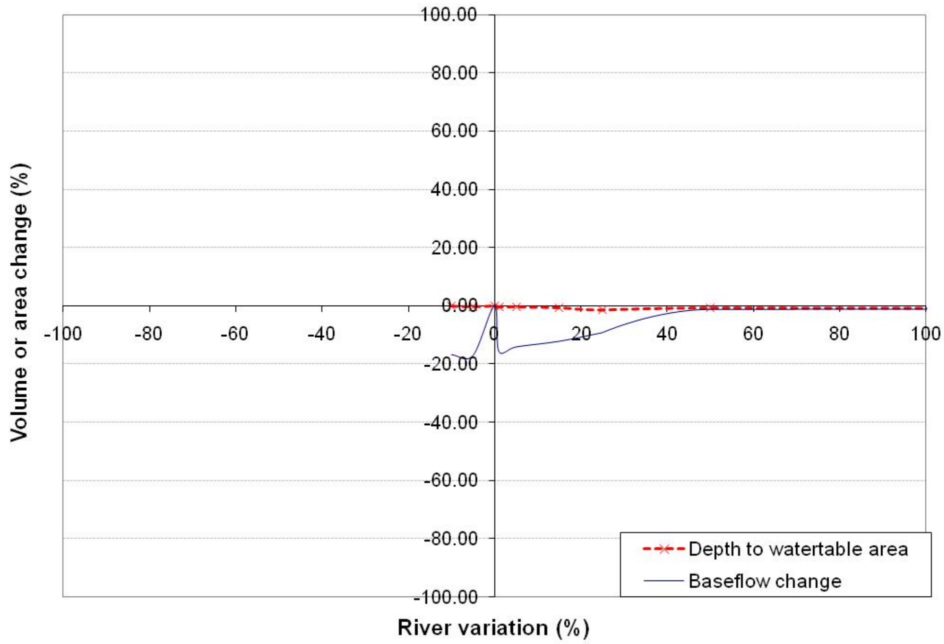


Vcont – scale root mean square

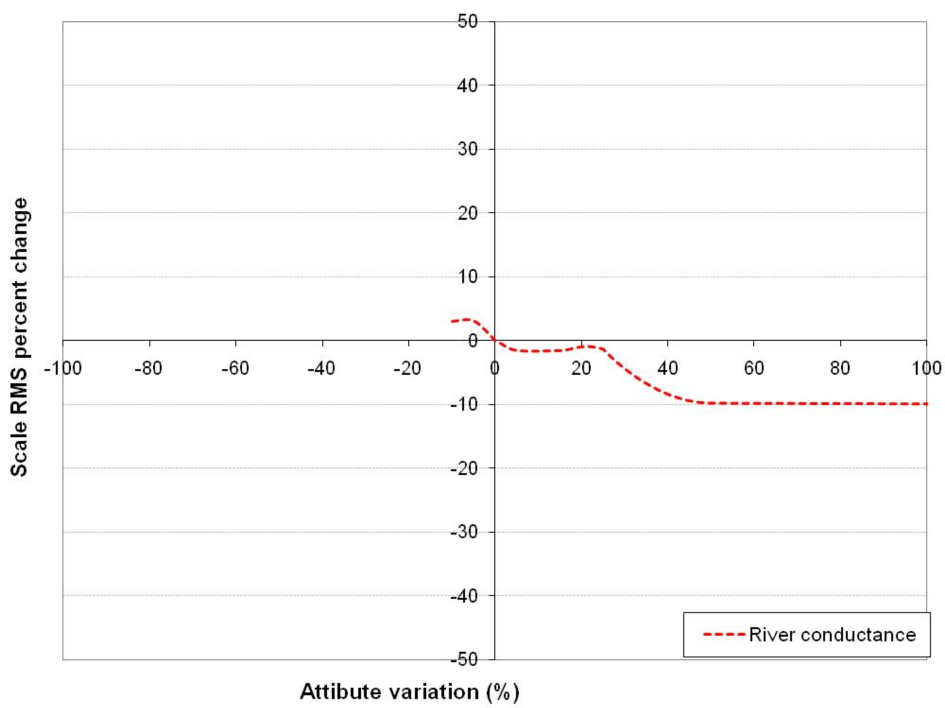


River bed conductance

Depth to watertable and base flow

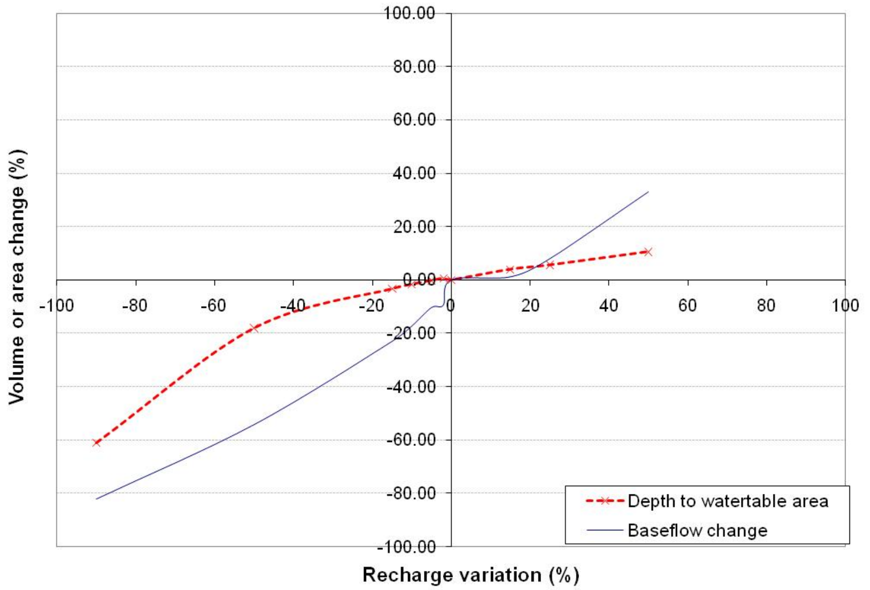


Scale root mean square

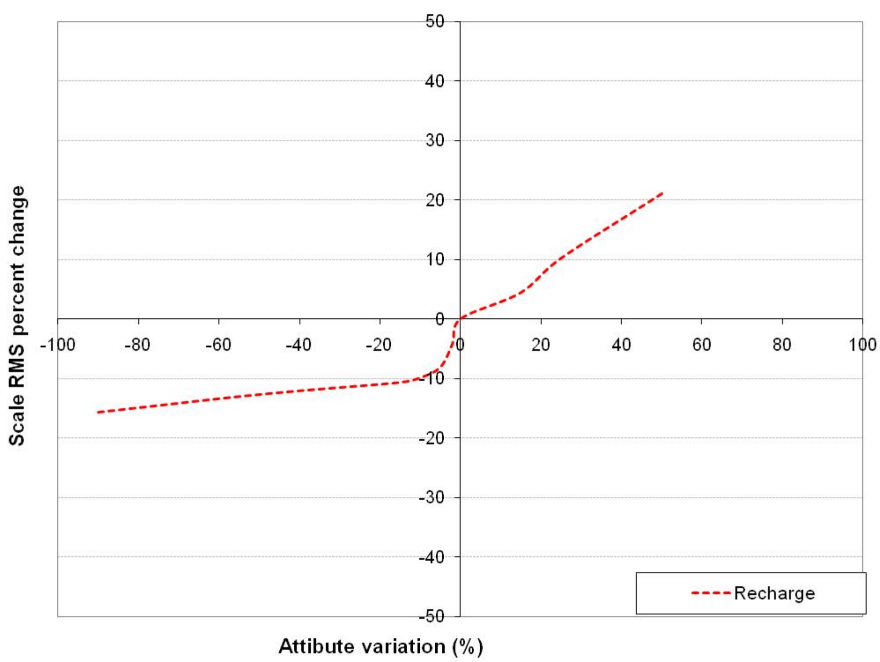


Recharge

Shallow watertable and groundwater baseflow

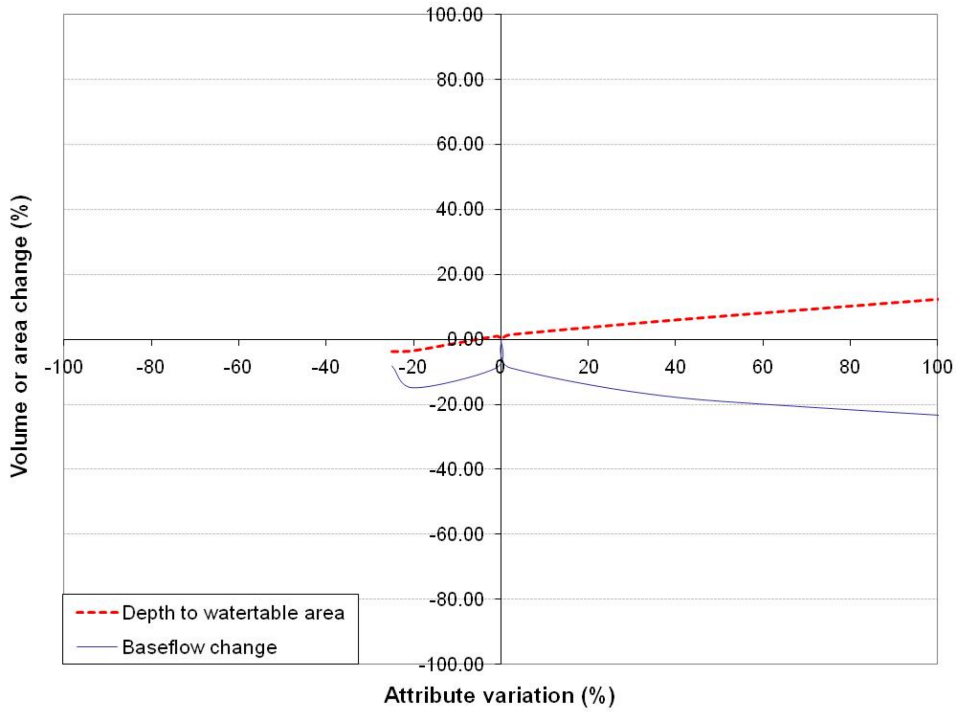


Scale root mean square

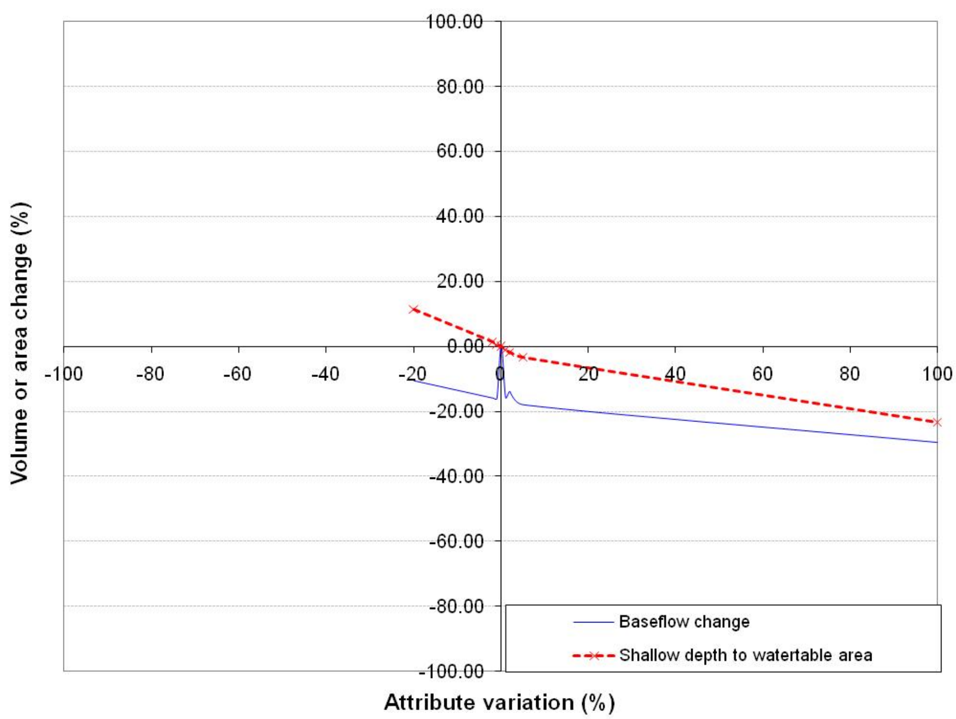


Evaporation features

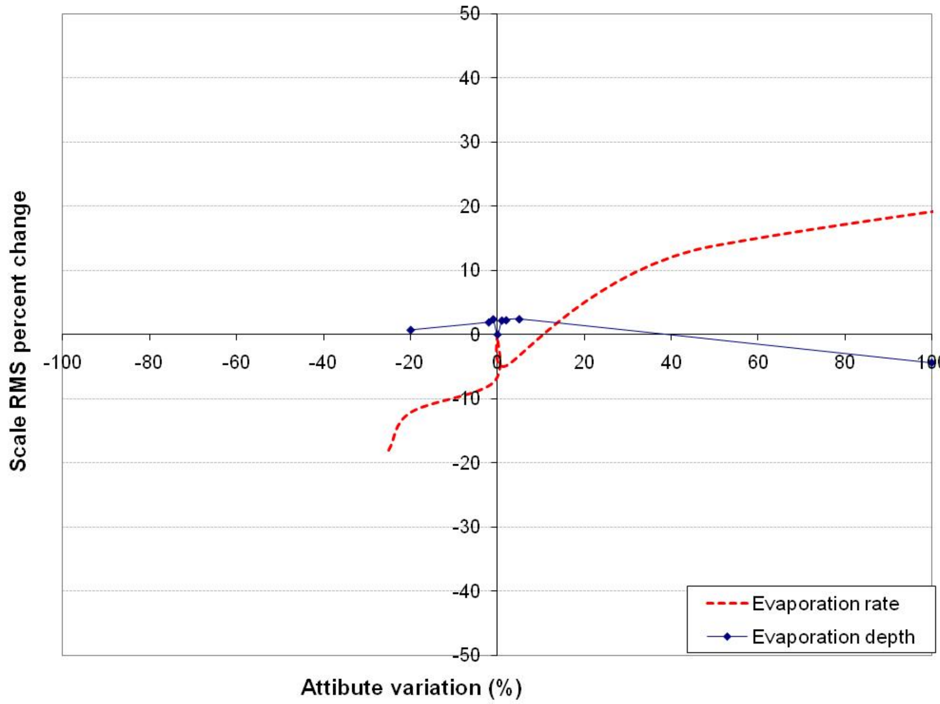
Evaporation rate



Evaporation depth



Scale root mean square

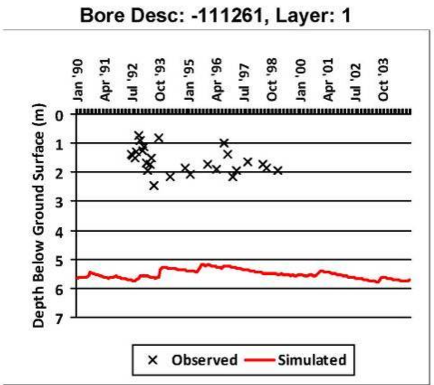


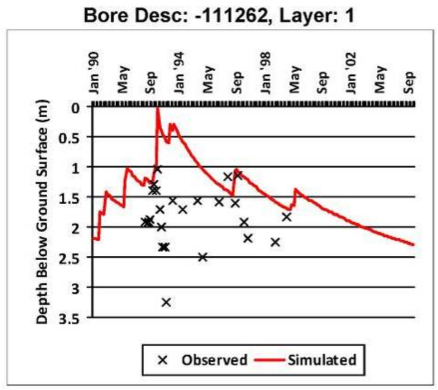
Appendix 8 Time series simulated versus observed depth to watertable data

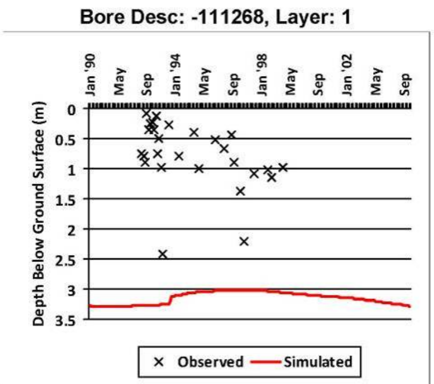
GHB bores

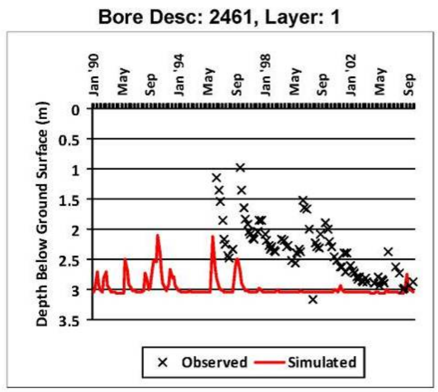
Bore_id	Layer	Bore_id	Layer	Bore_id	Layer	Bore_id	Layer
-113330	5	-102827	6	-110874	8	-102831	10
-113329	5	-87807	6	-110181	8	-96445	10
-113328	5	-87806	6	-102828	8	-92807	10
-113327	5	-79327	6	-96445	8	-87939	10
-113326	5	-73425	6	-92807	8	-82751	10
-110872	5			-87947	8	-62038	10
-110871	5			-87946	8		
-89507	5			-87945	8		
-82758	5			-87944	8		
-82753	5			-87943	8		
-50321	5			-87942	8		
-50318	5			-87941	8		
-49573	5			-87940	8		
-49570	5			-87939	8		
-26432	5			-85932	8		
-26430	5			-82757	8		
-26355	5			-82752	8		
-26340	5			-82751	8		
-26338	5			-66514	8		
-26134	5			-62038	8		
-26132	5			-61957	8		
-26116	5			-49564	8		
-26114	5			-49563	8		
-6936	5			-40318	8		
-6935	5			-36210	8		
-6145	5						
-6136	5						
-6097	5						
233	5						
2457	5						
2517	5						
2518	5						
2522	5						
2690	5						
6092	5						
6103	5						
6105	5						
6153	5						
60210	5						

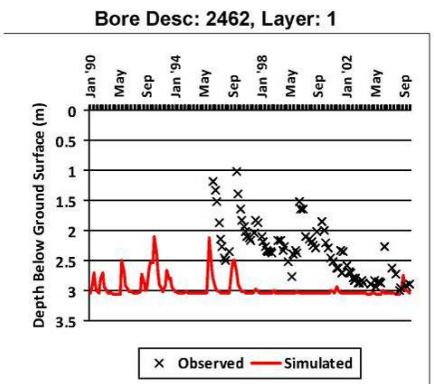
Layer 1 (Coonambidgal Formation)

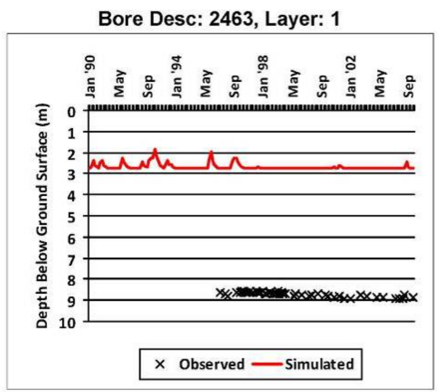




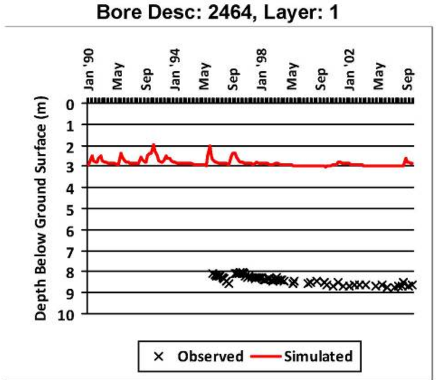




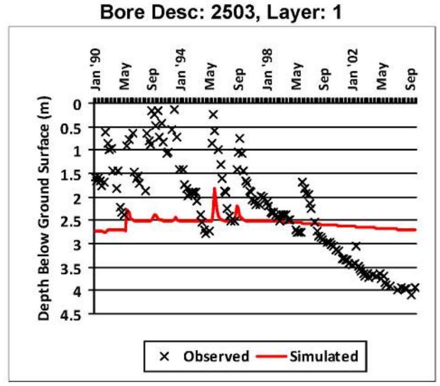




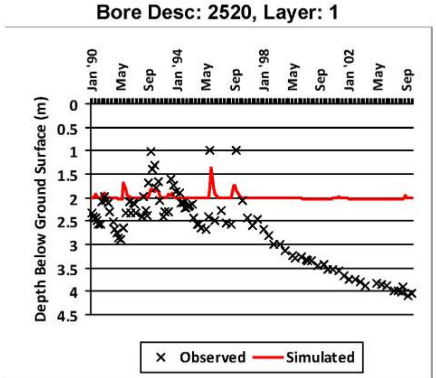
Bore Desc: 2464, Layer: 1



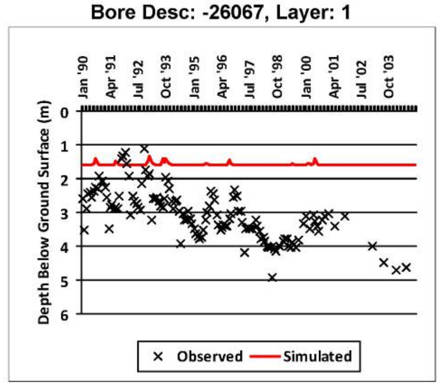
Bore Desc: 2503, Layer: 1



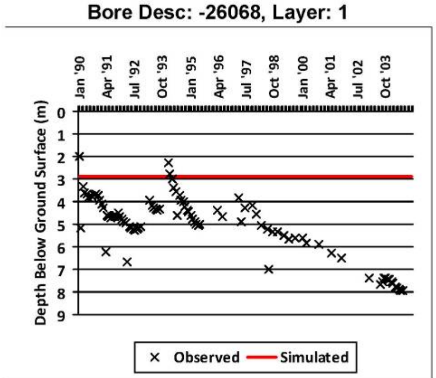
Bore Desc: 2520, Layer: 1



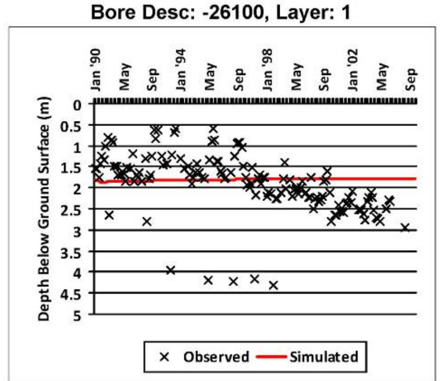
Bore Desc: -26067, Layer: 1



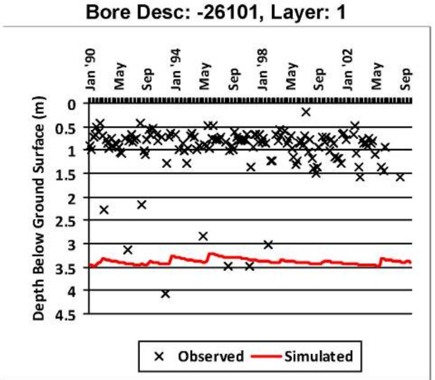
Bore Desc: -26068, Layer: 1



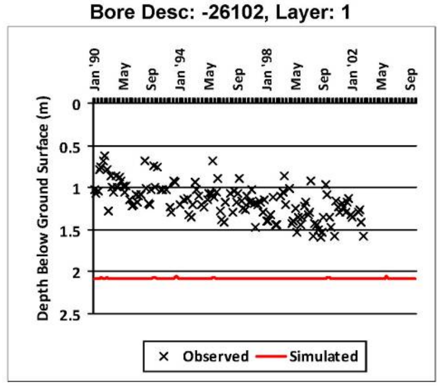
Bore Desc: -26100, Layer: 1



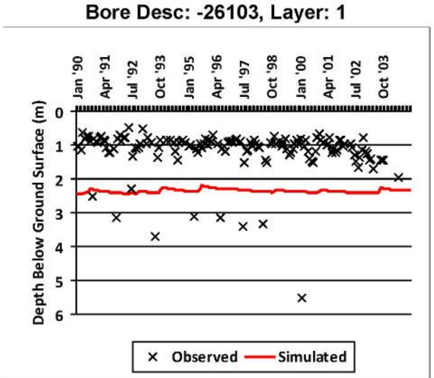
Bore Desc: -26101, Layer: 1



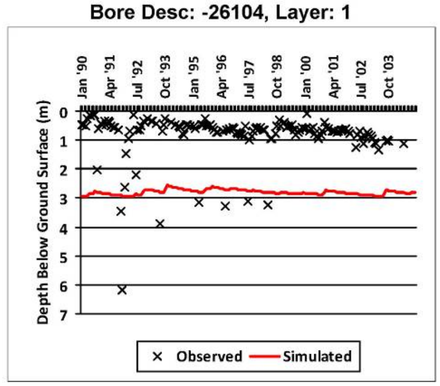
Bore Desc: -26102, Layer: 1



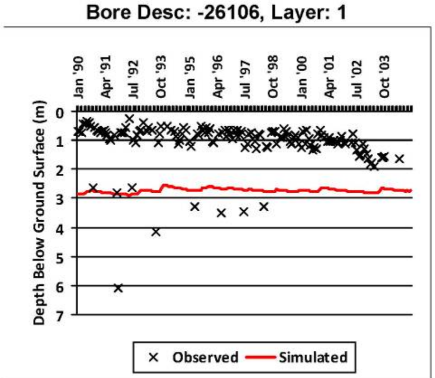
Bore Desc: -26103, Layer: 1



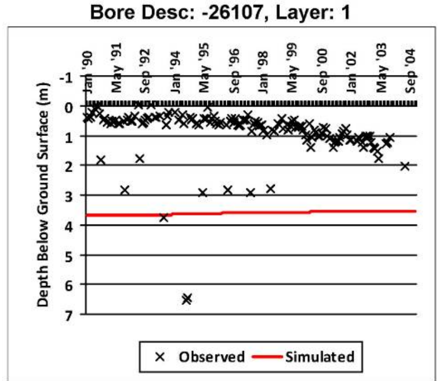
Bore Desc: -26104, Layer: 1

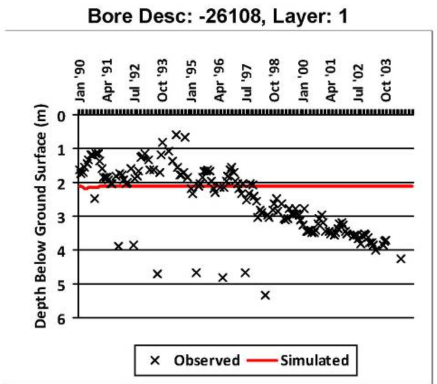


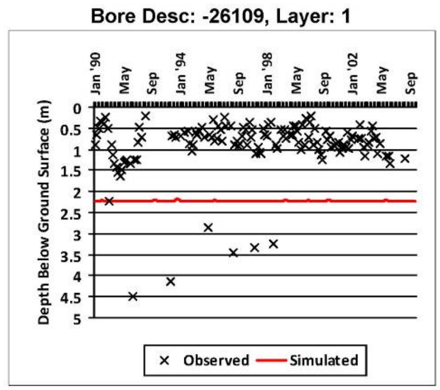
Bore Desc: -26106, Layer: 1

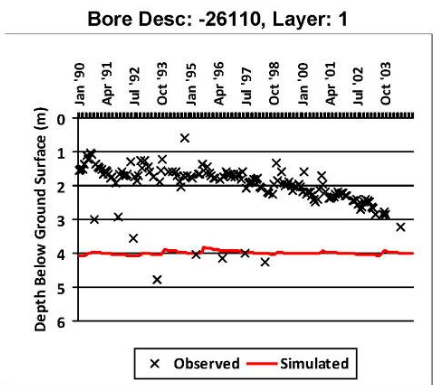


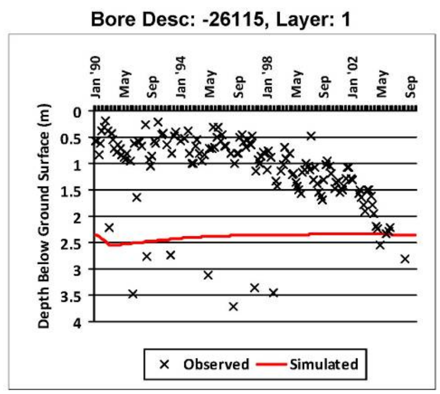
Bore Desc: -26107, Layer: 1

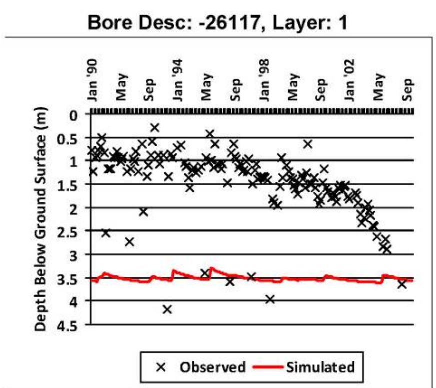


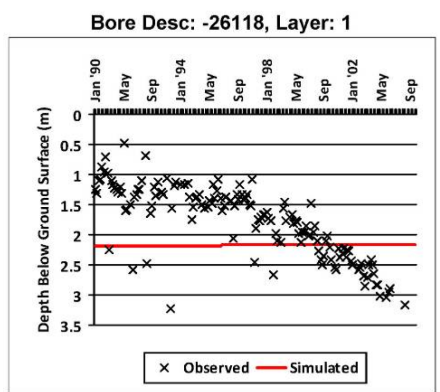

Bore Desc: -26108, Layer: 1
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed
Simulated


Bore Desc: -26109, Layer: 1
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed
Simulated

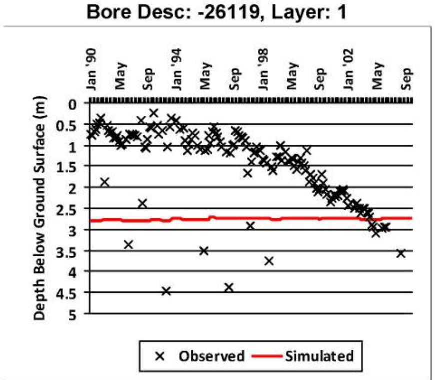

Bore Desc: -26110, Layer: 1
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed
Simulated


Bore Desc: -26115, Layer: 1
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed
Simulated

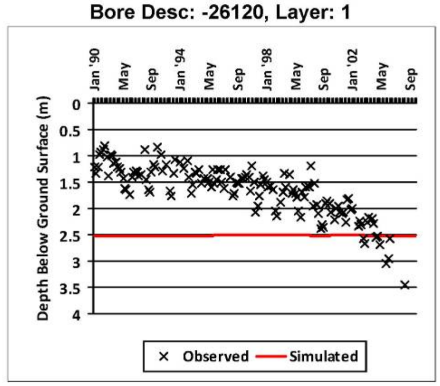

Bore Desc: -26117, Layer: 1
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed
Simulated


Bore Desc: -26118, Layer: 1
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed
Simulated

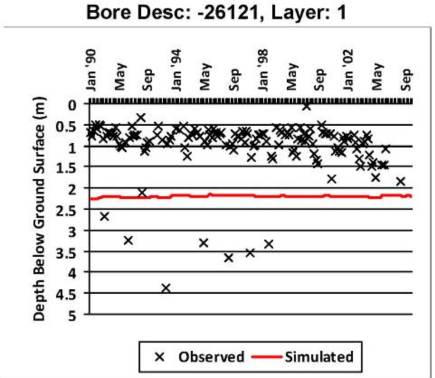
Bore Desc: -26119, Layer: 1



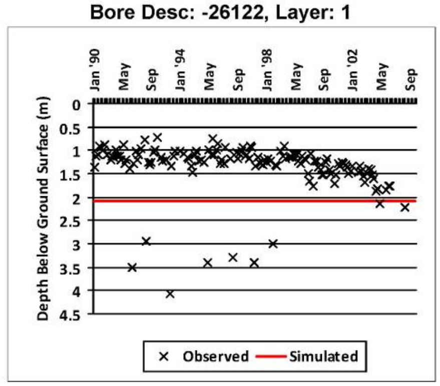
Bore Desc: -26120, Layer: 1



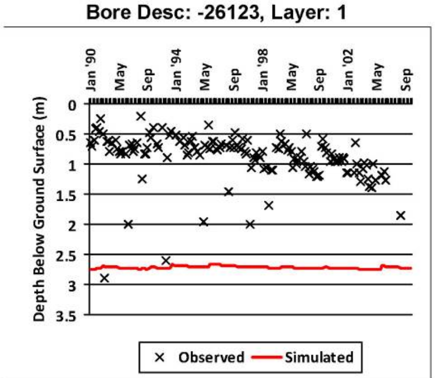
Bore Desc: -26121, Layer: 1



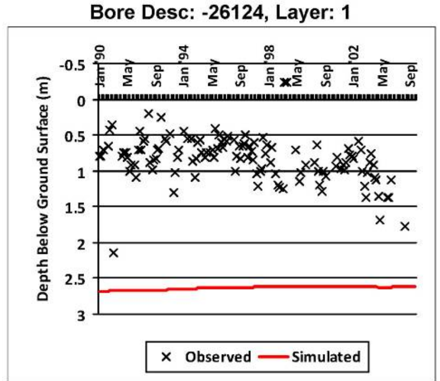
Bore Desc: -26122, Layer: 1

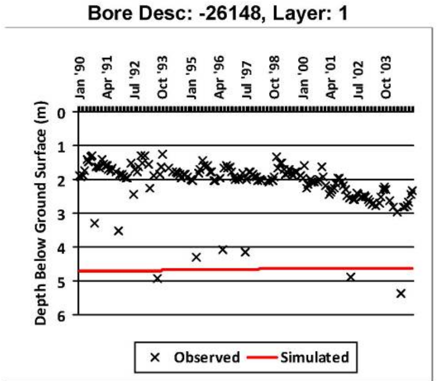


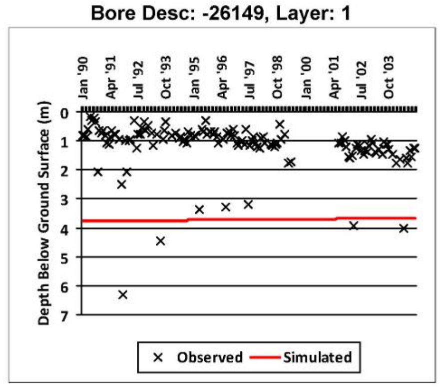
Bore Desc: -26123, Layer: 1

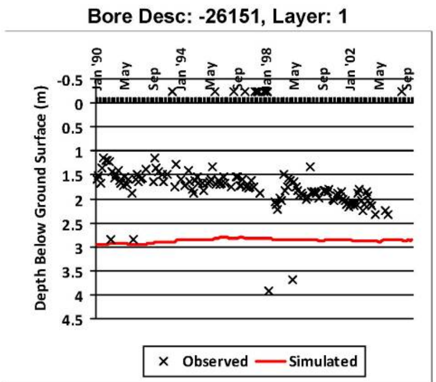


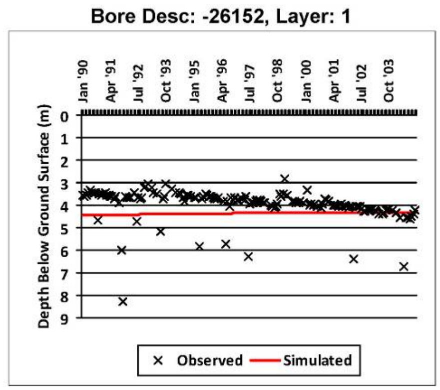
Bore Desc: -26124, Layer: 1

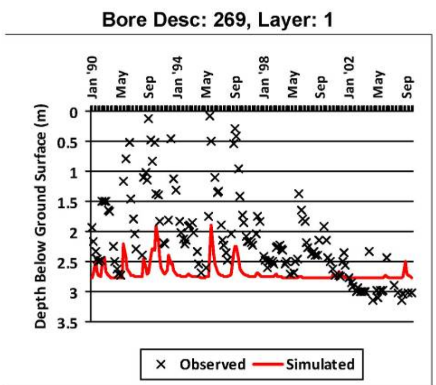


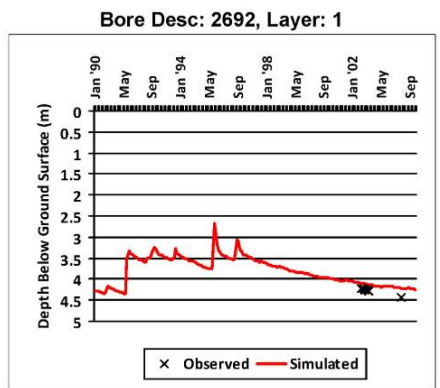

Bore Desc: -26148, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

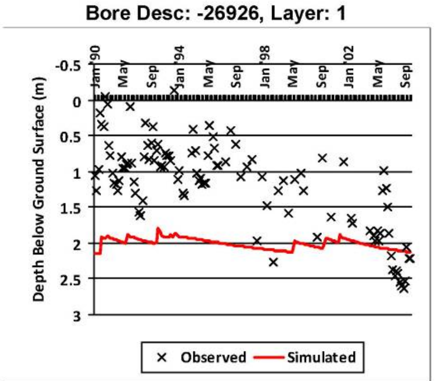

Bore Desc: -26149, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

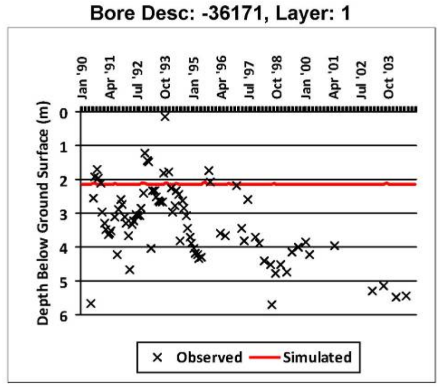

Bore Desc: -26151, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

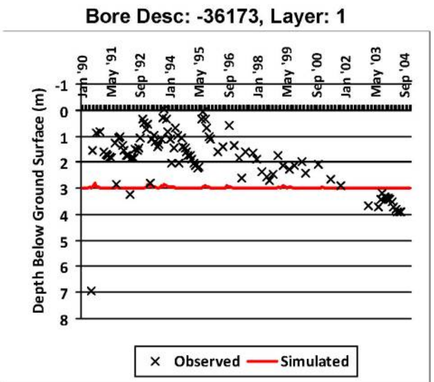

Bore Desc: -26152, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

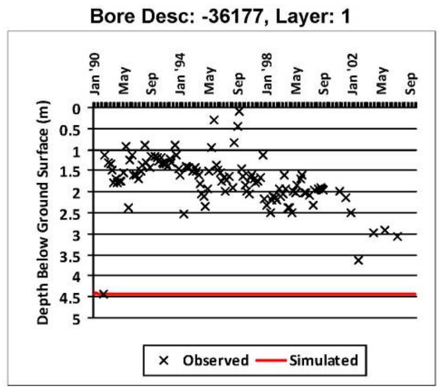

Bore Desc: 269, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

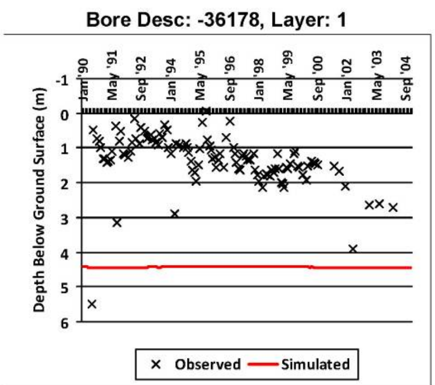

Bore Desc: 2692, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

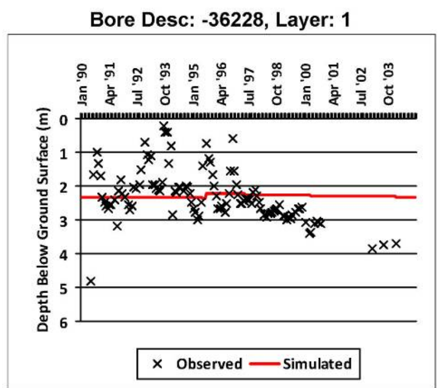

Bore Desc: -26926, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

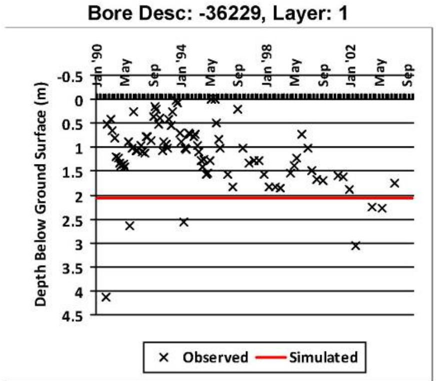

Bore Desc: -36171, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

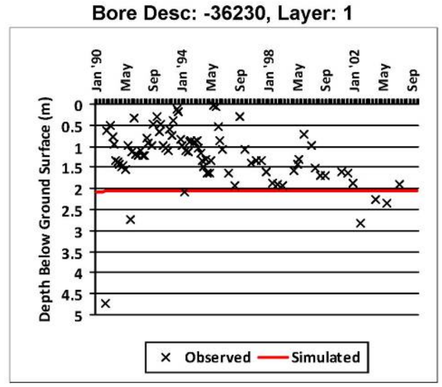

Bore Desc: -36173, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

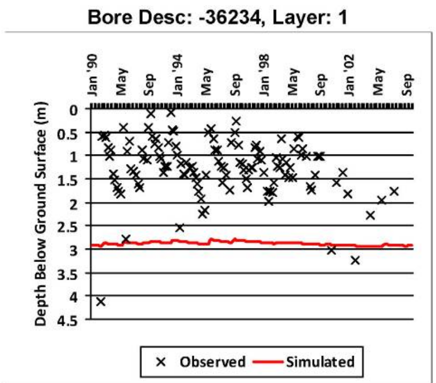

Bore Desc: -36177, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

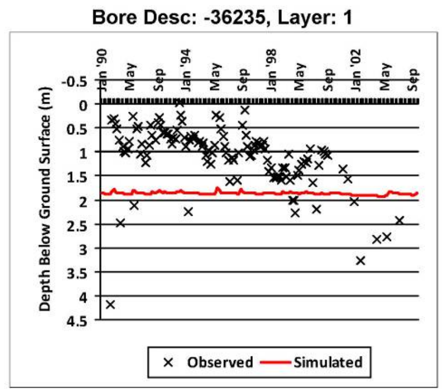

Bore Desc: -36178, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

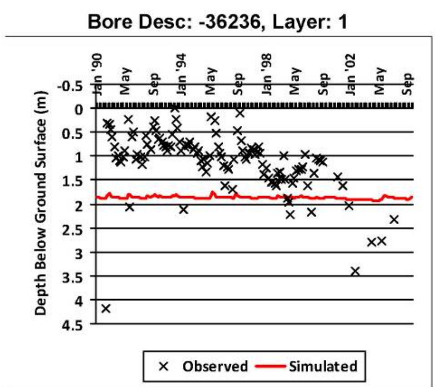

Bore Desc: -36228, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

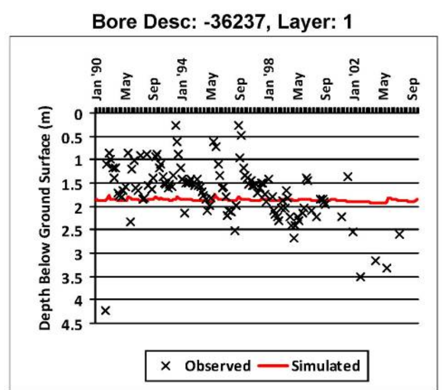

Bore Desc: -36229, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -36230, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

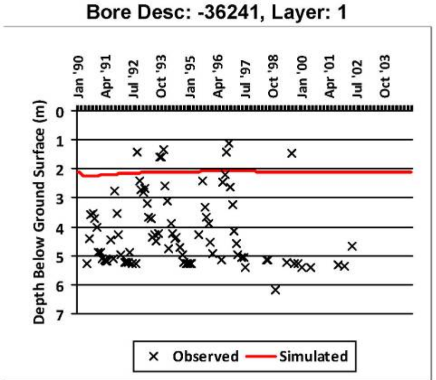

Bore Desc: -36234, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -36235, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

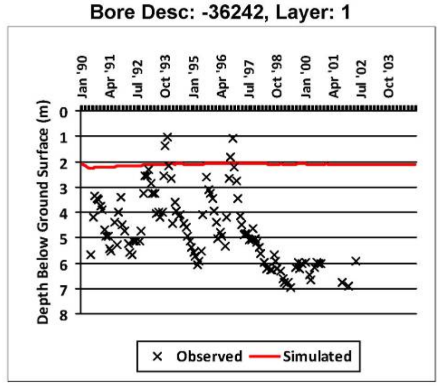

Bore Desc: -36236, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -36237, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

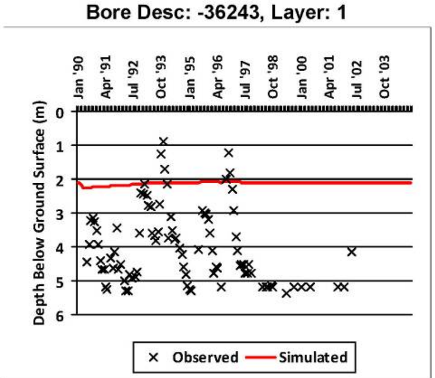
Bore Desc: -36241, Layer: 1



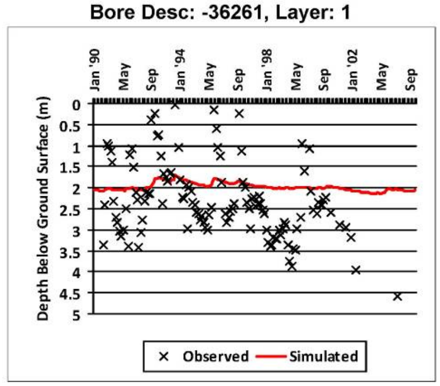
Bore Desc: -36242, Layer: 1



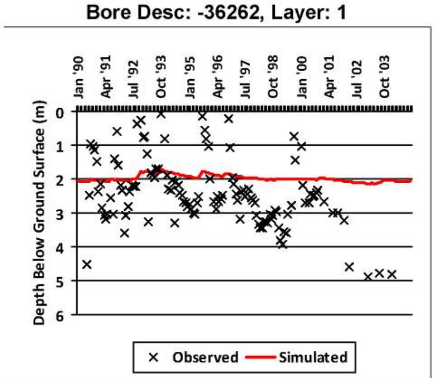
Bore Desc: -36243, Layer: 1



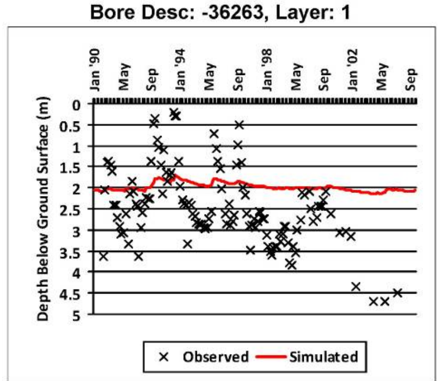
Bore Desc: -36261, Layer: 1



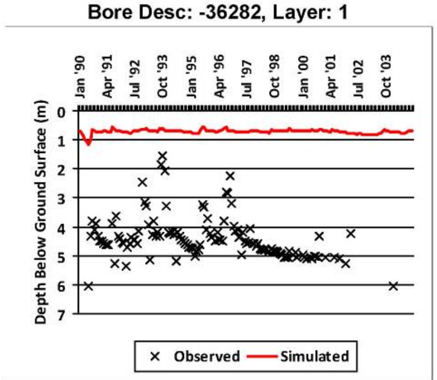
Bore Desc: -36262, Layer: 1



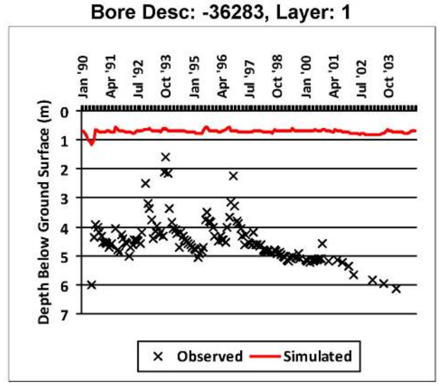
Bore Desc: -36263, Layer: 1



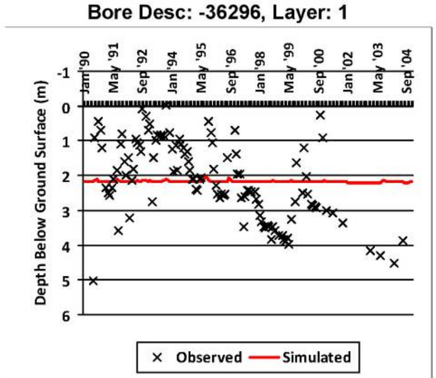
Bore Desc: -36282, Layer: 1



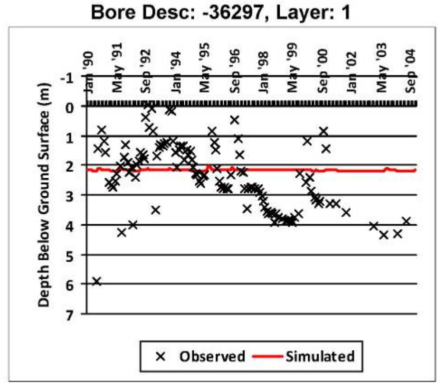
Bore Desc: -36283, Layer: 1



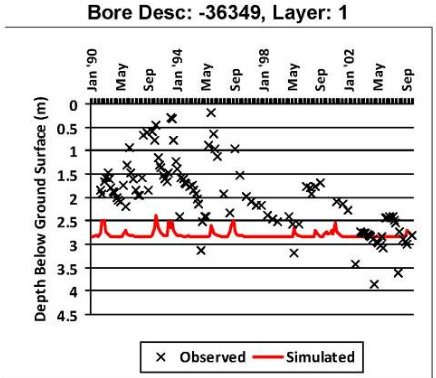
Bore Desc: -36296, Layer: 1



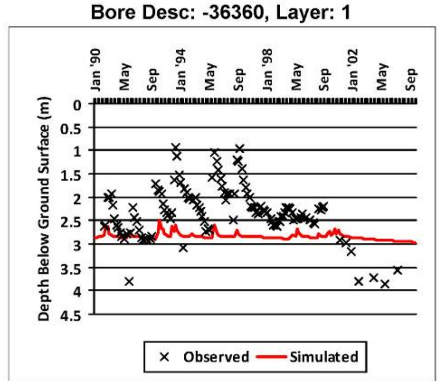
Bore Desc: -36297, Layer: 1



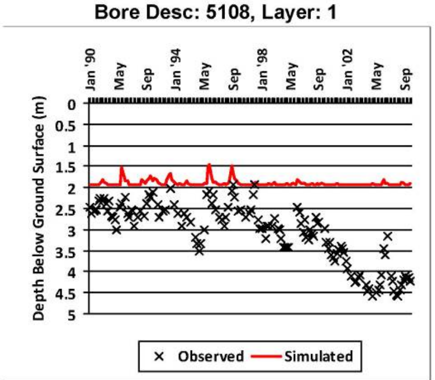
Bore Desc: -36349, Layer: 1



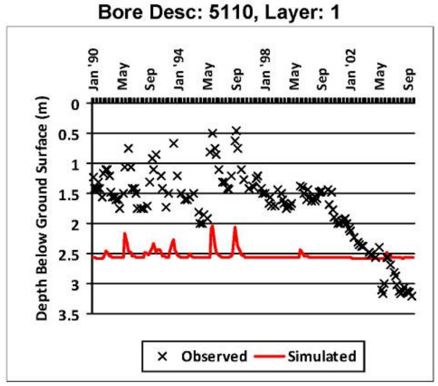
Bore Desc: -36360, Layer: 1



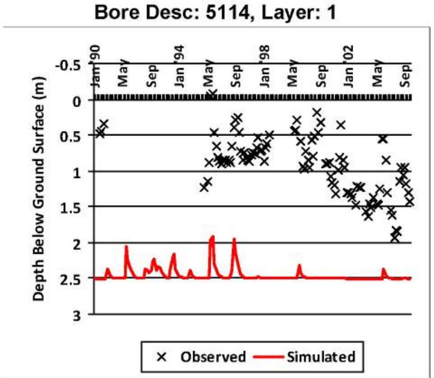
Bore Desc: 5108, Layer: 1



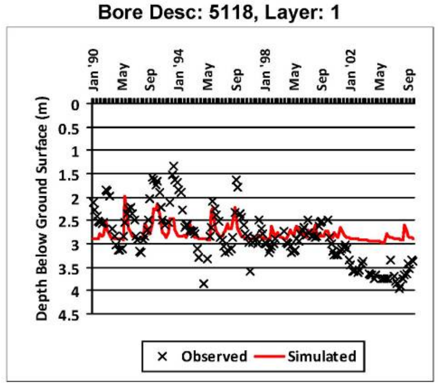
Bore Desc: 5110, Layer: 1



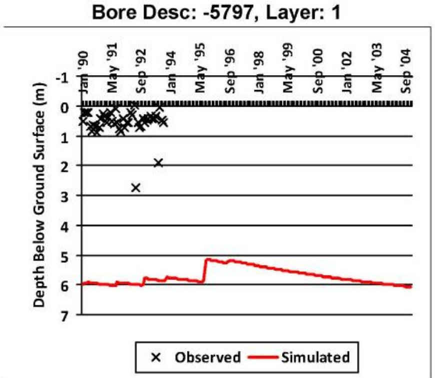
Bore Desc: 5114, Layer: 1



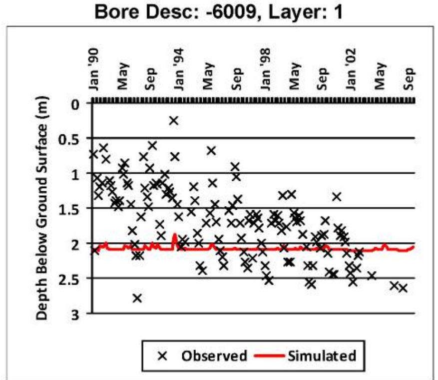
Bore Desc: 5118, Layer: 1



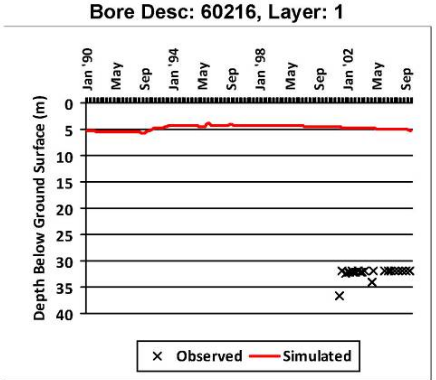
Bore Desc: -5797, Layer: 1



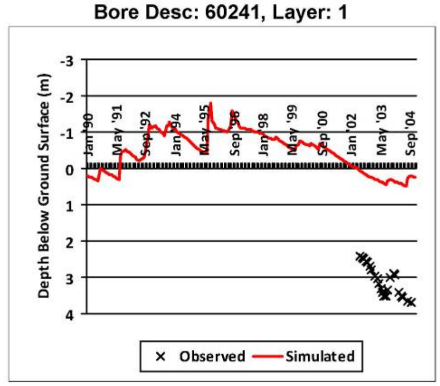
Bore Desc: -6009, Layer: 1



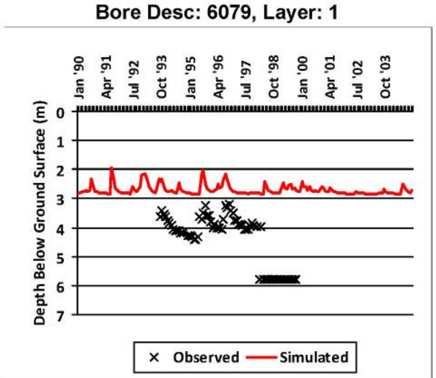
Bore Desc: 60216, Layer: 1



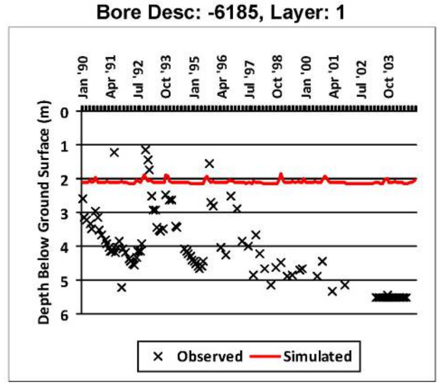
Bore Desc: 60241, Layer: 1



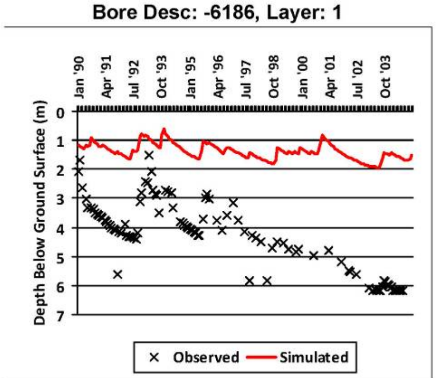
Bore Desc: 6079, Layer: 1



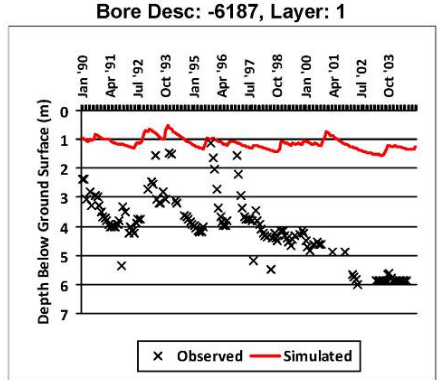
Bore Desc: -6185, Layer: 1

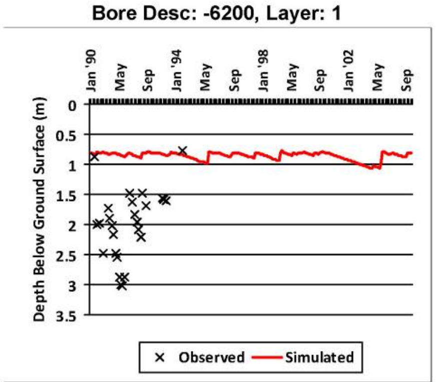


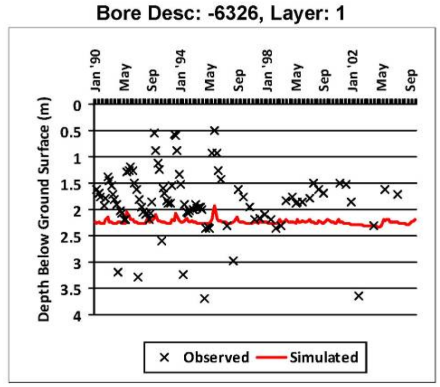
Bore Desc: -6186, Layer: 1

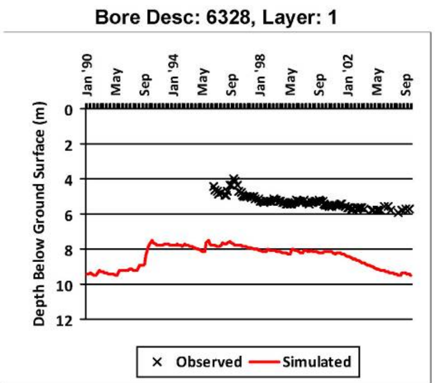


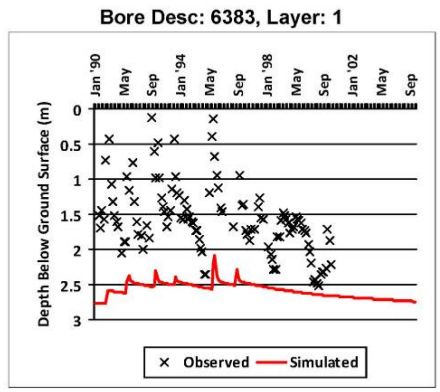
Bore Desc: -6187, Layer: 1

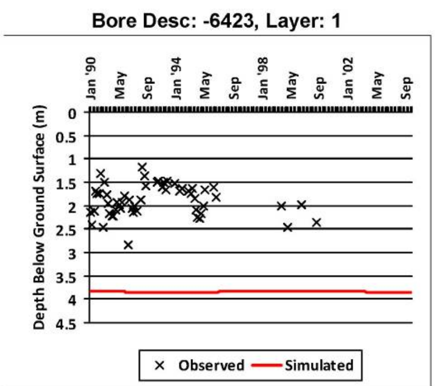


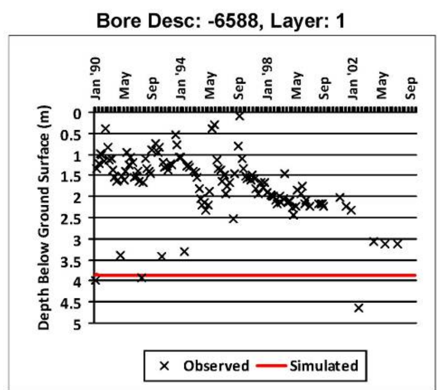

Bore Desc: -6200, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

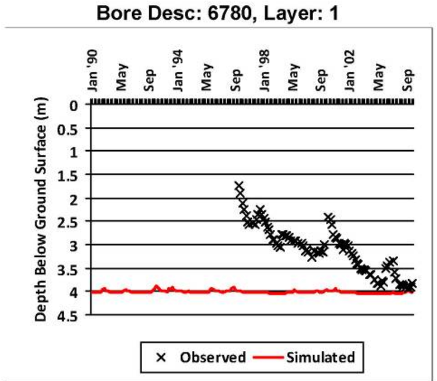

Bore Desc: -6326, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

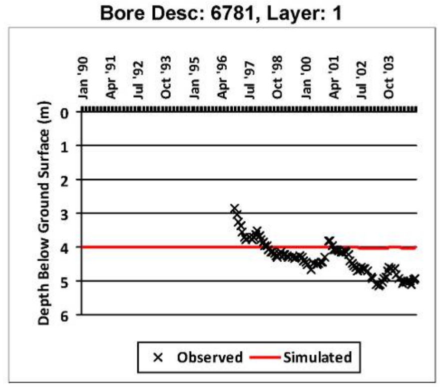

Bore Desc: 6328, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

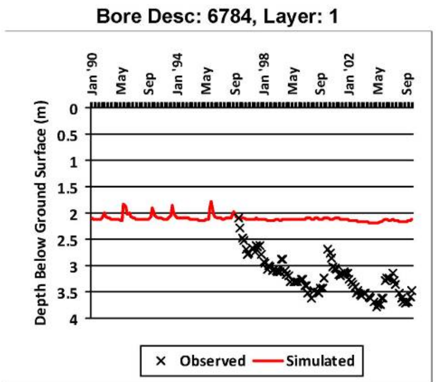

Bore Desc: 6383, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

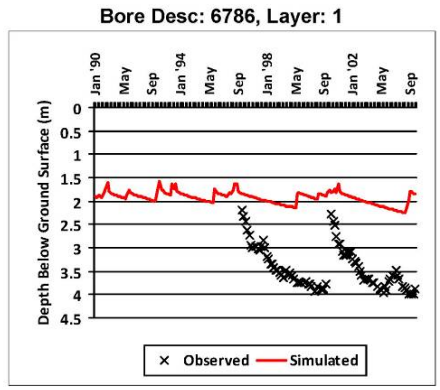

Bore Desc: -6423, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

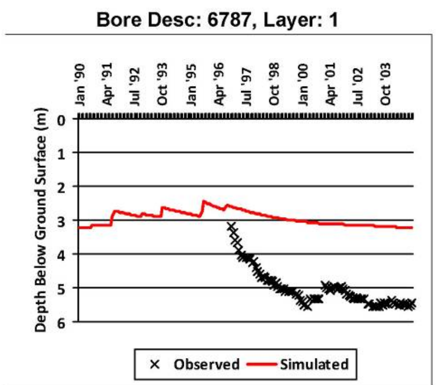

Bore Desc: -6588, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

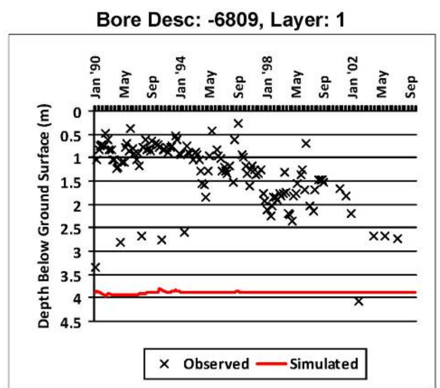

Bore Desc: 6780, Layer: 1
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Simulated

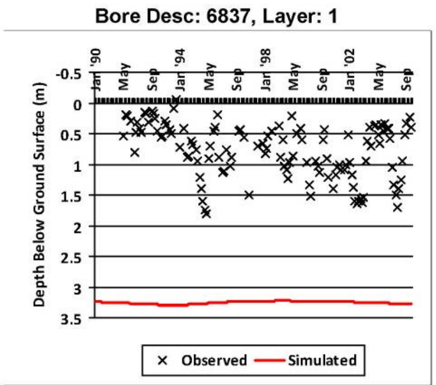

Bore Desc: 6781, Layer: 1
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Depth Below Ground Surface (m)
0
1
2
3
4
5
6
Observed
Simulated

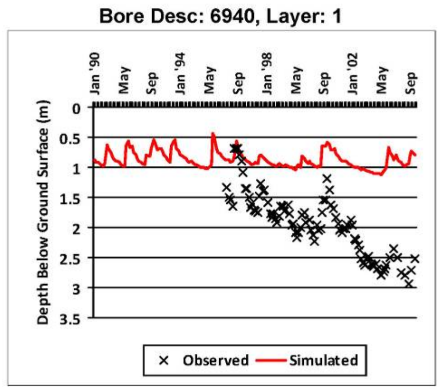

Bore Desc: 6784, Layer: 1
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
Observed
Simulated

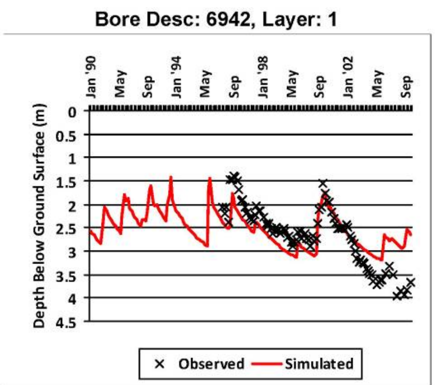

Bore Desc: 6786, Layer: 1
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Simulated

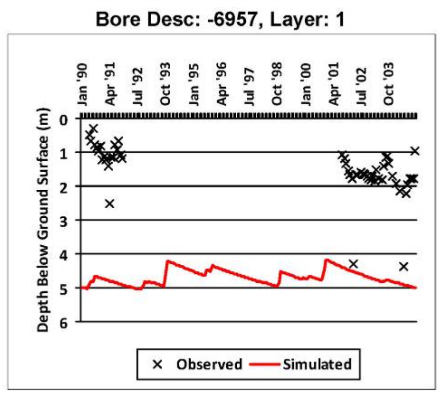

Bore Desc: 6787, Layer: 1
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Depth Below Ground Surface (m)
0
1
2
3
4
5
6
Observed
Simulated


Bore Desc: -6809, Layer: 1
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Simulated


Bore Desc: 6837, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

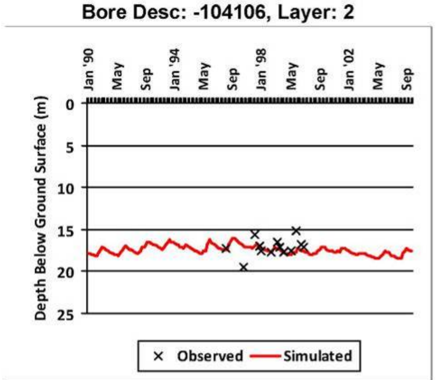

Bore Desc: 6940, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6942, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

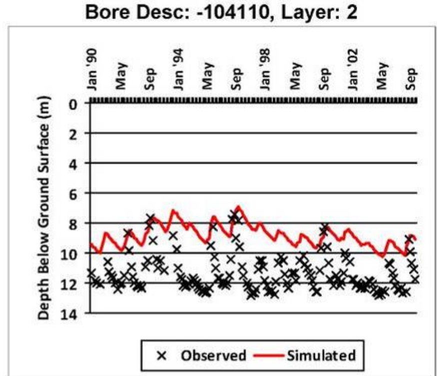

Bore Desc: -6957, Layer: 1
Depth Below Ground Surface (m)
Observed
Simulated

Layer 2 (Quaternary basalt)

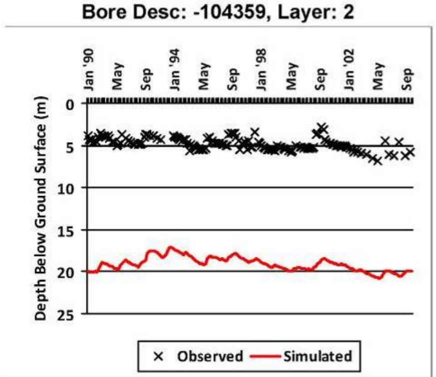
Bore Desc: -104106, Layer: 2



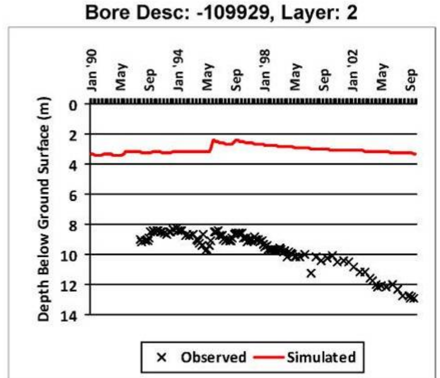
Bore Desc: -104110, Layer: 2



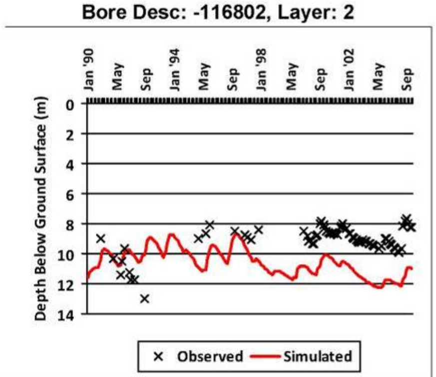
Bore Desc: -104359, Layer: 2



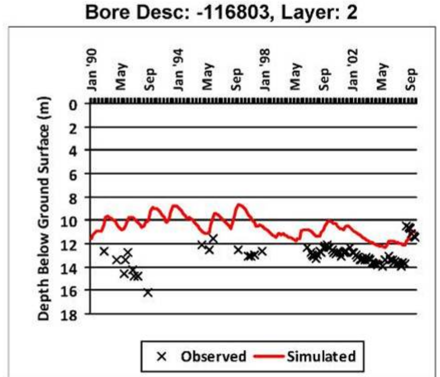
Bore Desc: -109929, Layer: 2



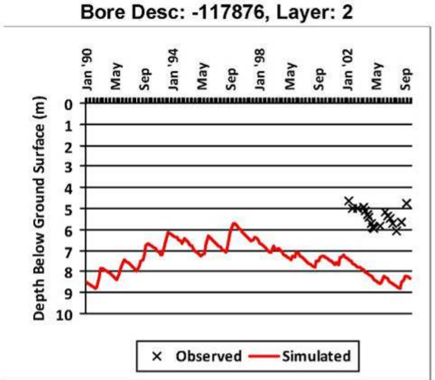
Bore Desc: -116802, Layer: 2



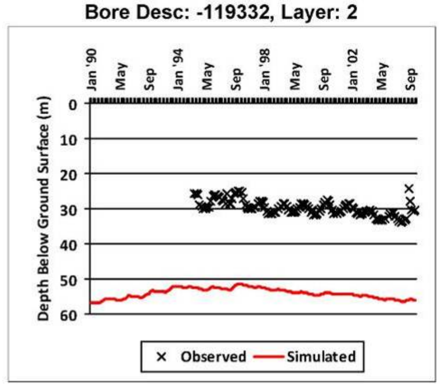
Bore Desc: -116803, Layer: 2



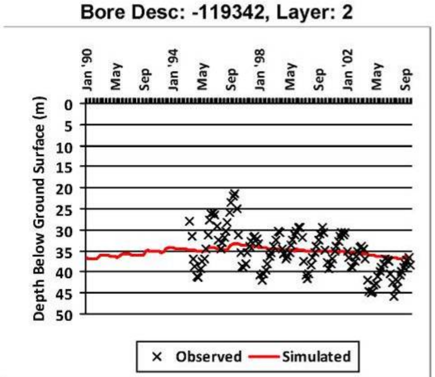
Bore Desc: -117876, Layer: 2



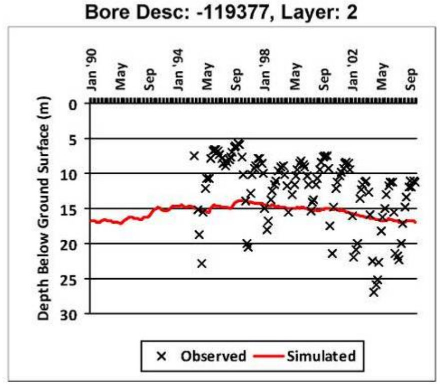
Bore Desc: -119332, Layer: 2



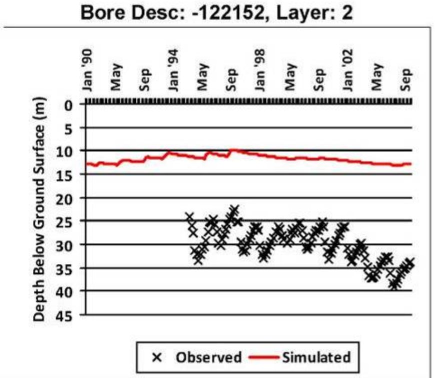
Bore Desc: -119342, Layer: 2



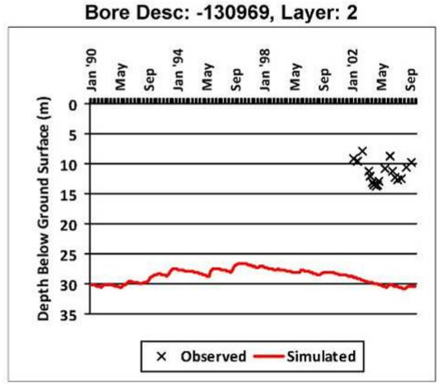
Bore Desc: -119377, Layer: 2



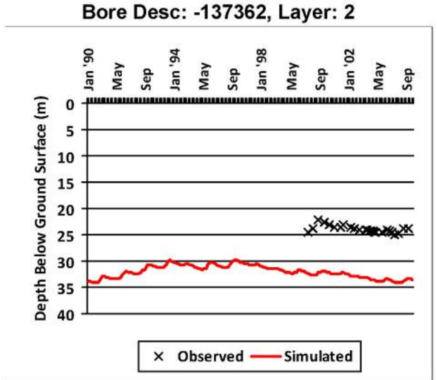
Bore Desc: -122152, Layer: 2



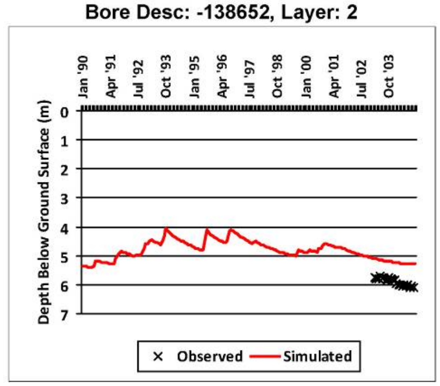
Bore Desc: -130969, Layer: 2



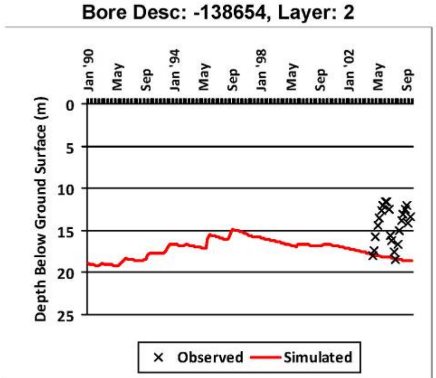
Bore Desc: -137362, Layer: 2



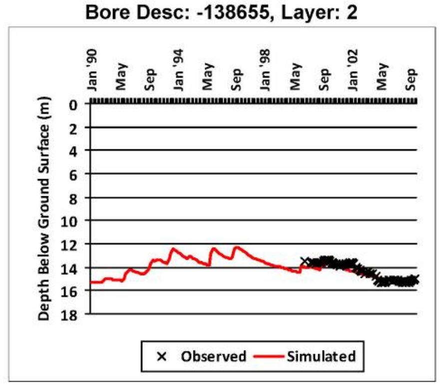
Bore Desc: -138652, Layer: 2



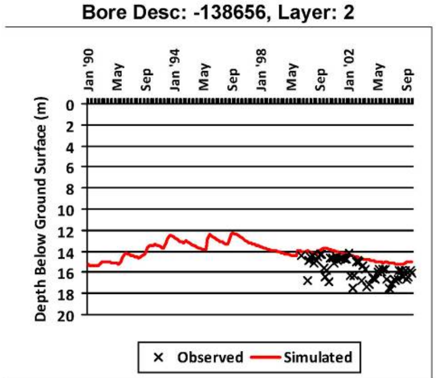
Bore Desc: -138654, Layer: 2



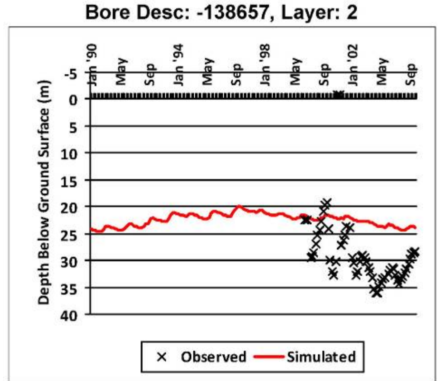
Bore Desc: -138655, Layer: 2



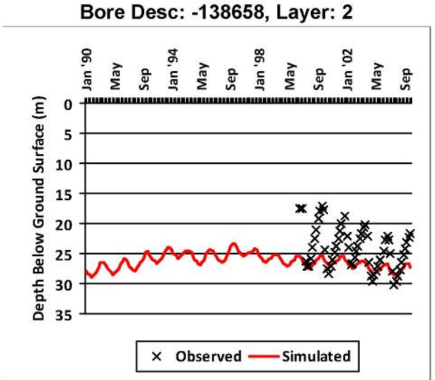
Bore Desc: -138656, Layer: 2



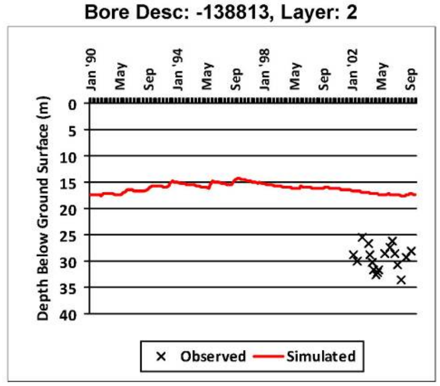
Bore Desc: -138657, Layer: 2



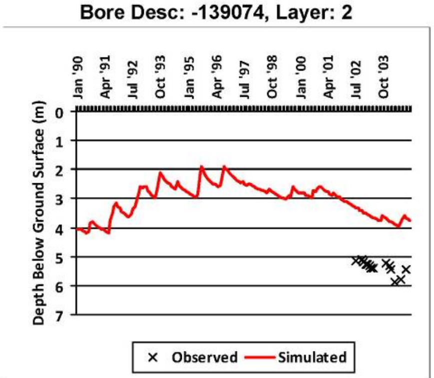
Bore Desc: -138658, Layer: 2



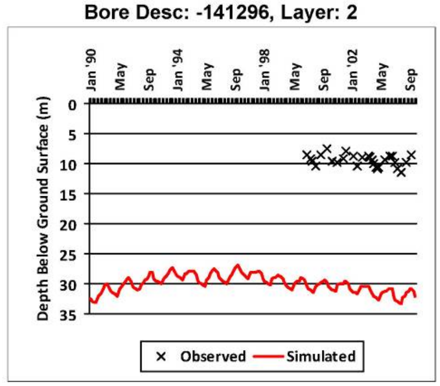
Bore Desc: -138813, Layer: 2



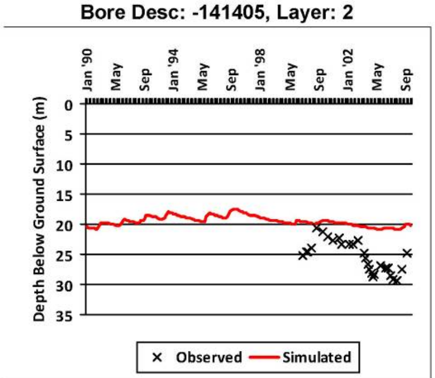
Bore Desc: -139074, Layer: 2



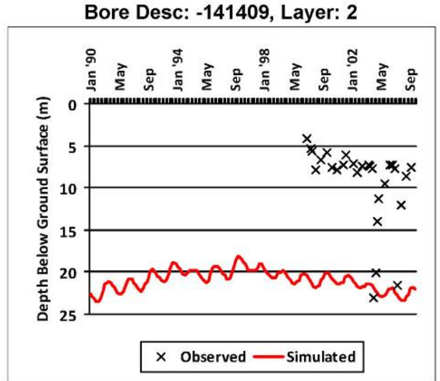
Bore Desc: -141296, Layer: 2

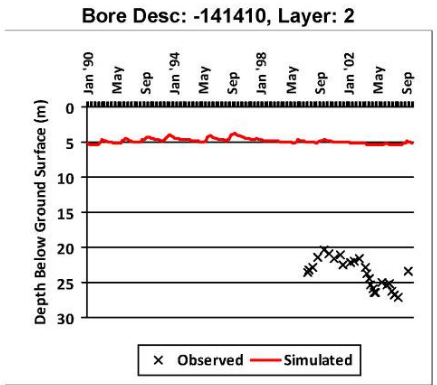


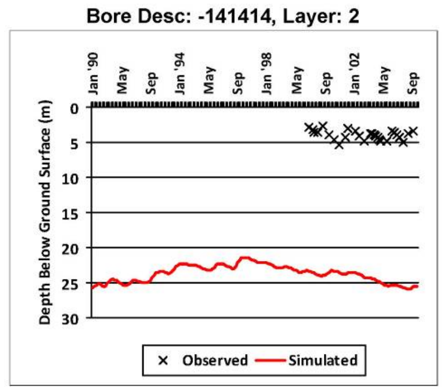
Bore Desc: -141405, Layer: 2

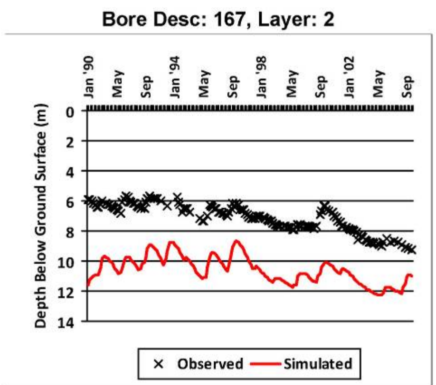


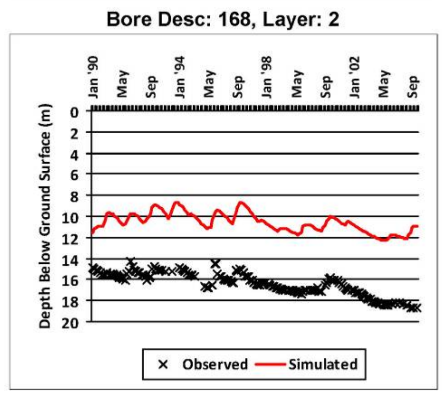
Bore Desc: -141409, Layer: 2

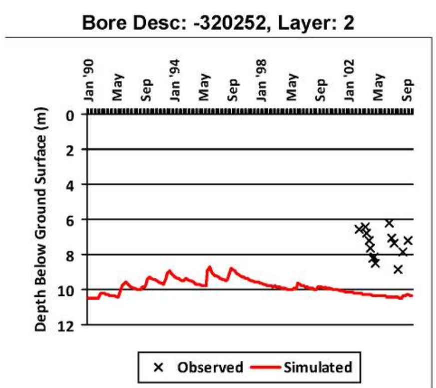


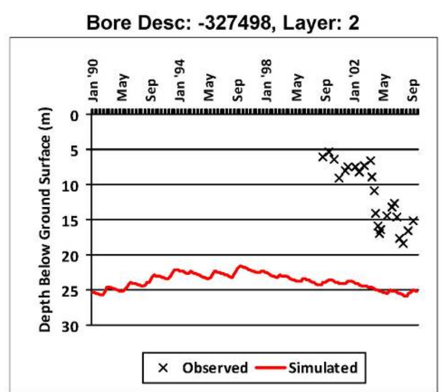

Bore Desc: -141410, Layer: 2
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
0
5
10
15
20
25
30
Observed
Simulated


Bore Desc: -141414, Layer: 2
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
0
5
10
15
20
25
30
Observed
Simulated

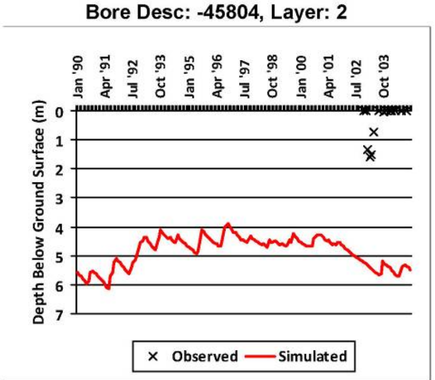

Bore Desc: 167, Layer: 2
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
0
2
4
6
8
10
12
14
Observed
Simulated


Bore Desc: 168, Layer: 2
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
0
2
4
6
8
10
12
14
16
18
20
Observed
Simulated

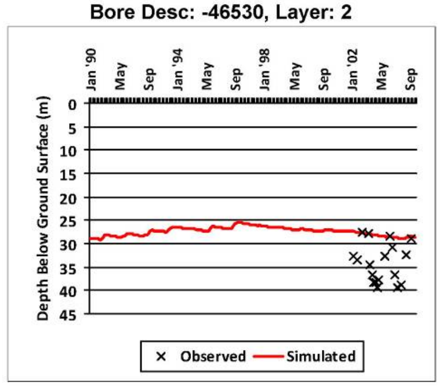

Bore Desc: -320252, Layer: 2
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
0
2
4
6
8
10
12
Observed
Simulated


Bore Desc: -327498, Layer: 2
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
0
5
10
15
20
25
30
Observed
Simulated

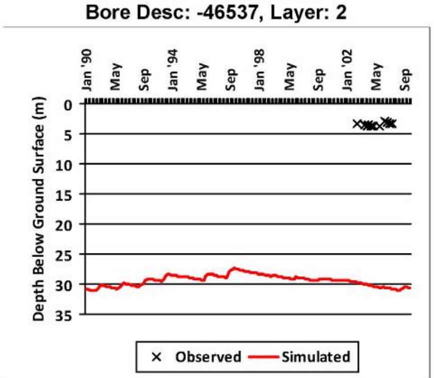
Bore Desc: -45804, Layer: 2



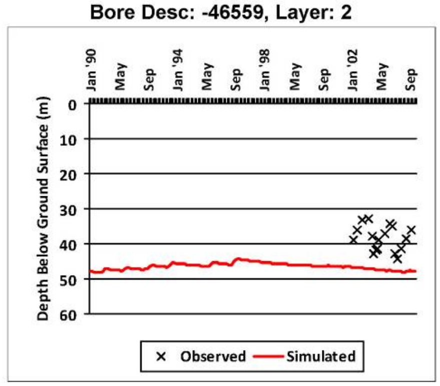
Bore Desc: -46530, Layer: 2



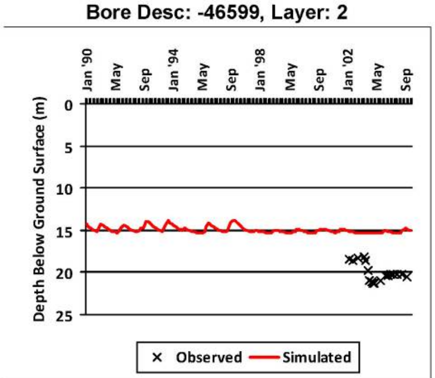
Bore Desc: -46537, Layer: 2



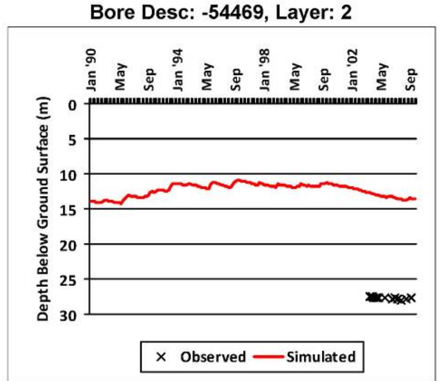
Bore Desc: -46559, Layer: 2

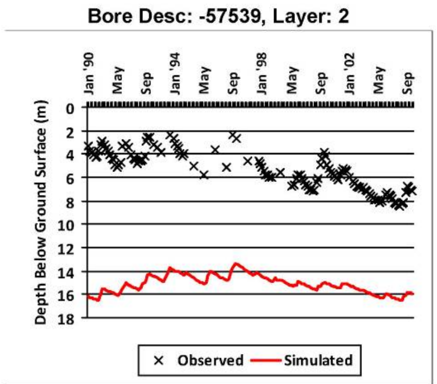


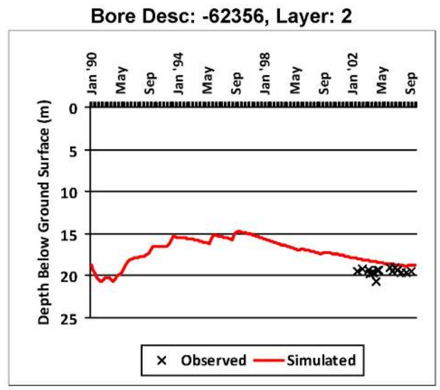
Bore Desc: -46599, Layer: 2

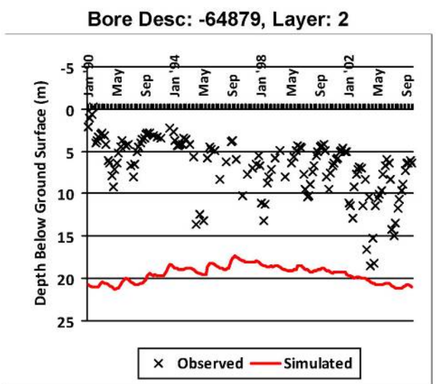


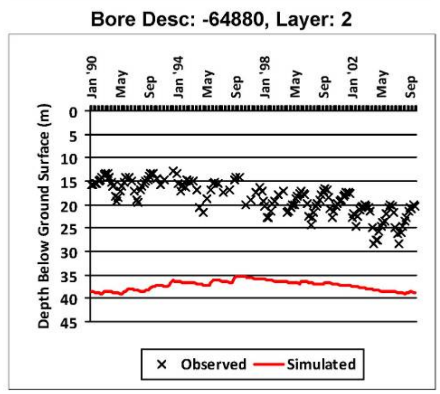
Bore Desc: -54469, Layer: 2

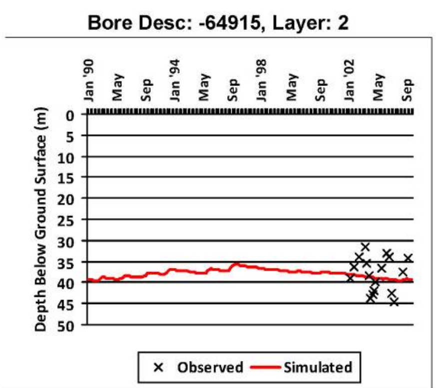


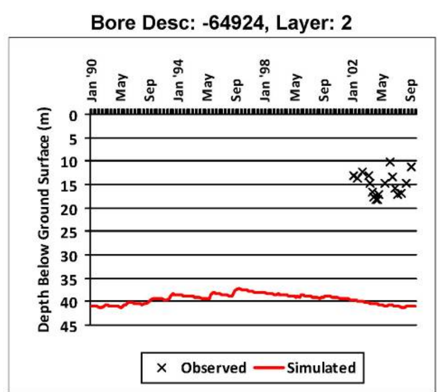

Bore Desc: -57539, Layer: 2
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
× Observed
Simulated


Bore Desc: -62356, Layer: 2
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
× Observed
Simulated

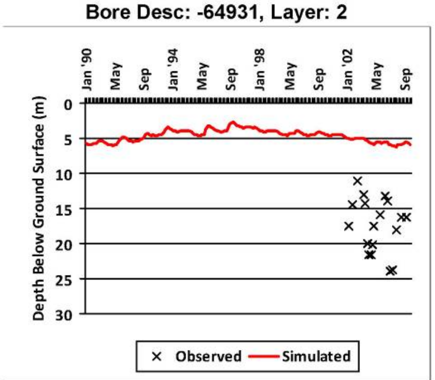

Bore Desc: -64879, Layer: 2
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
× Observed
Simulated


Bore Desc: -64880, Layer: 2
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
× Observed
Simulated

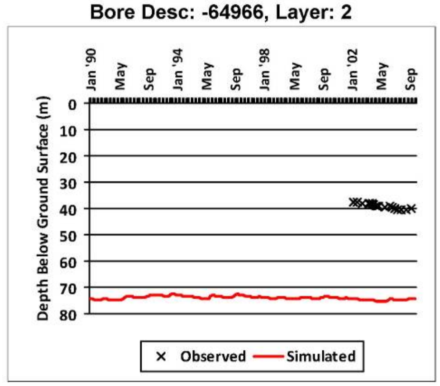

Bore Desc: -64915, Layer: 2
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
× Observed
Simulated


Bore Desc: -64924, Layer: 2
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
× Observed
Simulated

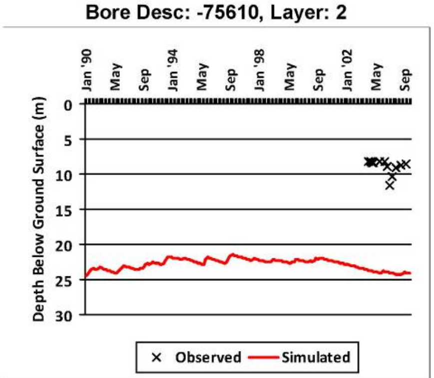
Bore Desc: -64931, Layer: 2



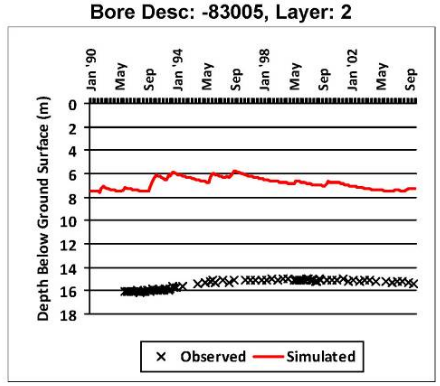
Bore Desc: -64966, Layer: 2



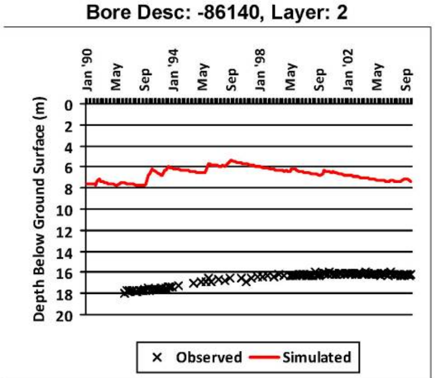
Bore Desc: -75610, Layer: 2



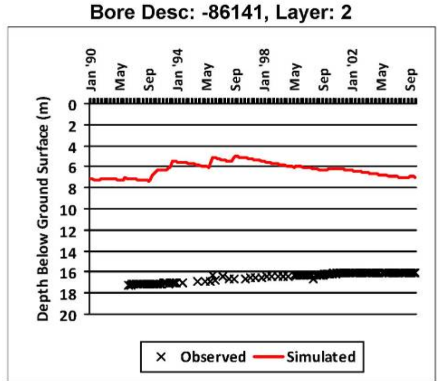
Bore Desc: -83005, Layer: 2



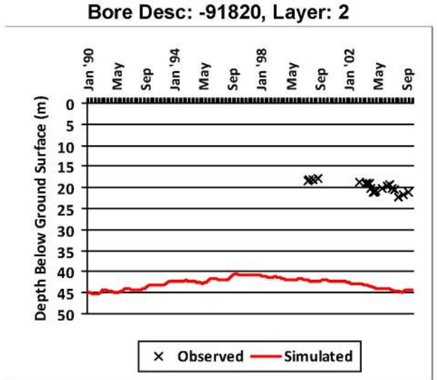
Bore Desc: -86140, Layer: 2



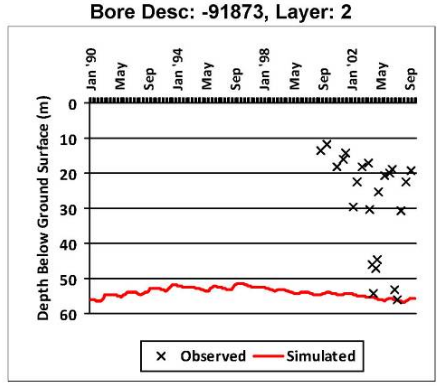
Bore Desc: -86141, Layer: 2



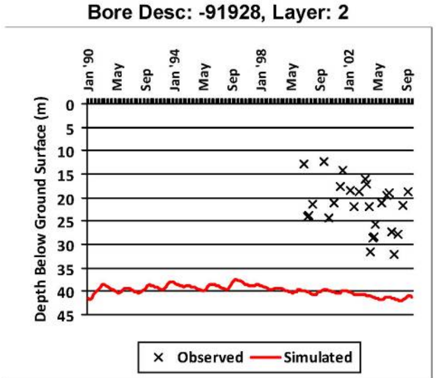
Bore Desc: -91820, Layer: 2



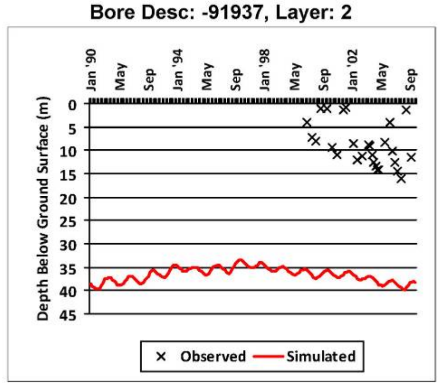
Bore Desc: -91873, Layer: 2



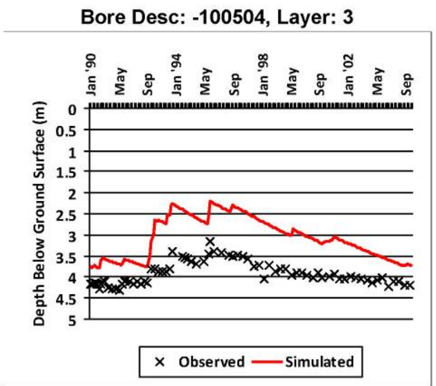
Bore Desc: -91928, Layer: 2

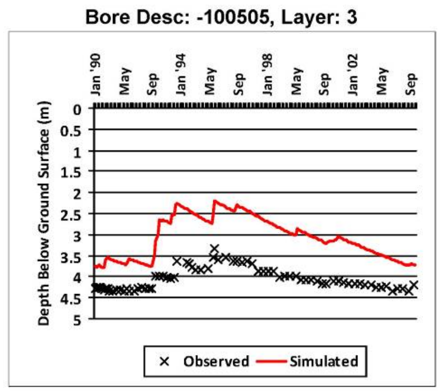


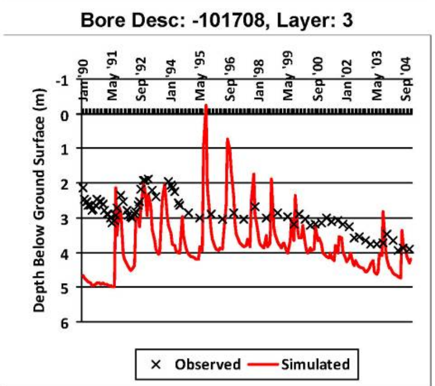
Bore Desc: -91937, Layer: 2

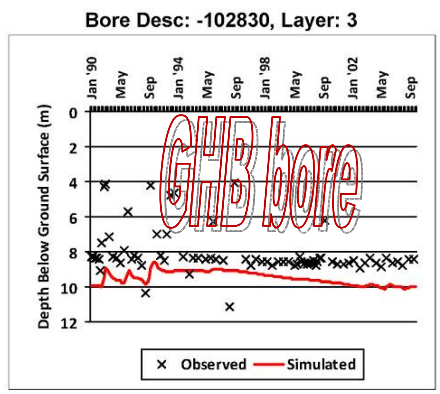


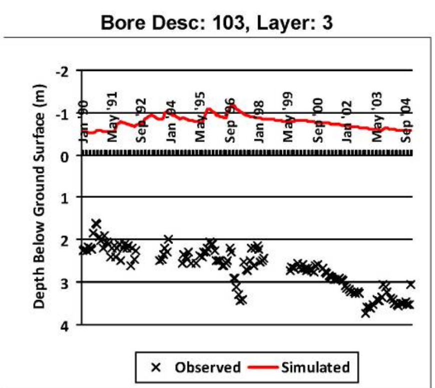
Layer 3 (upper Shepparton Formation)

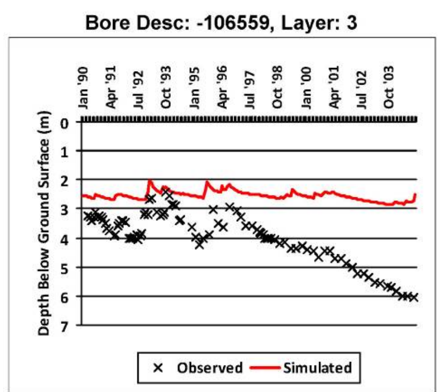












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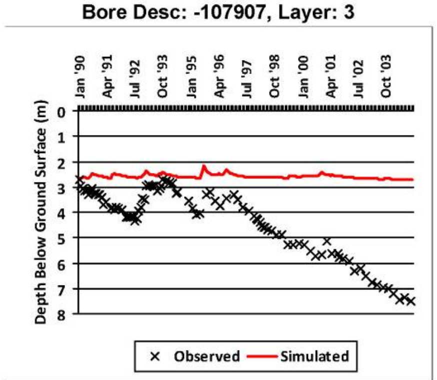

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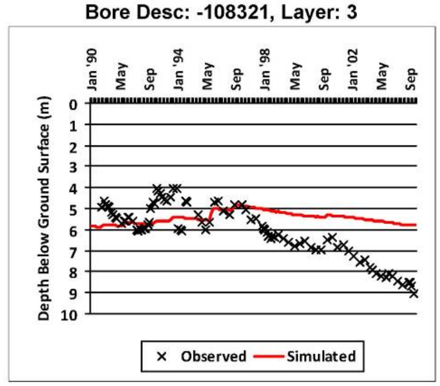
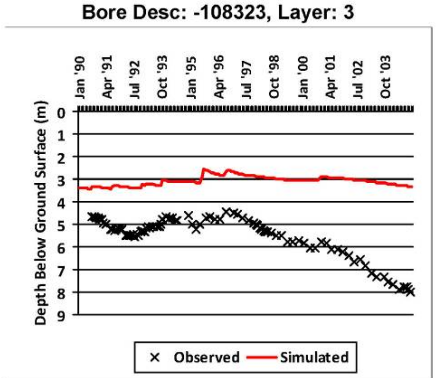


Bore Desc: -108323, Layer: 3



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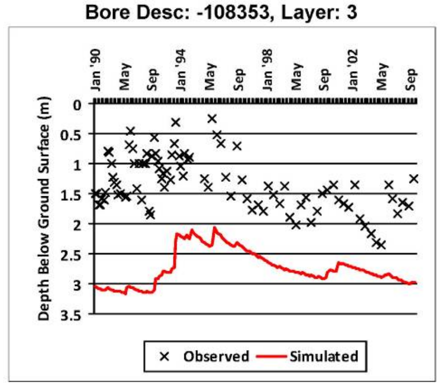

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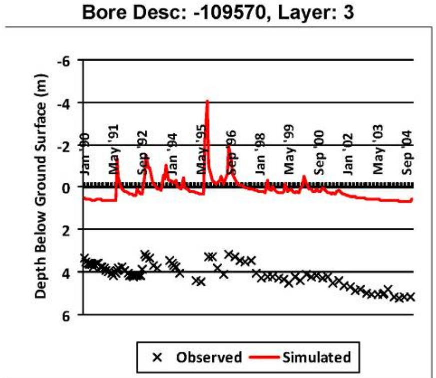

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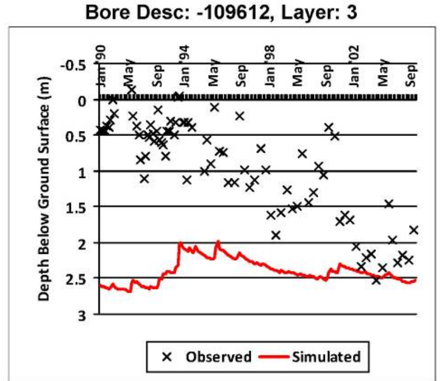

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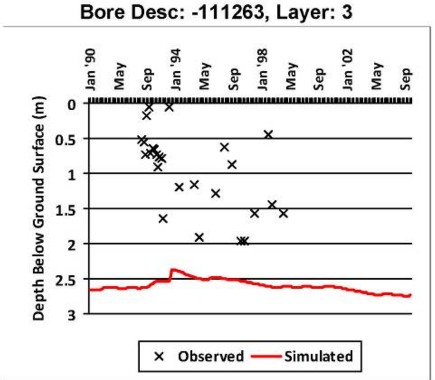

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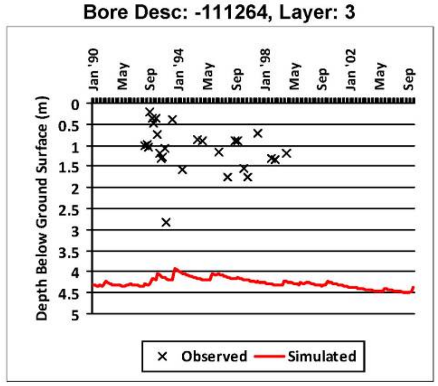

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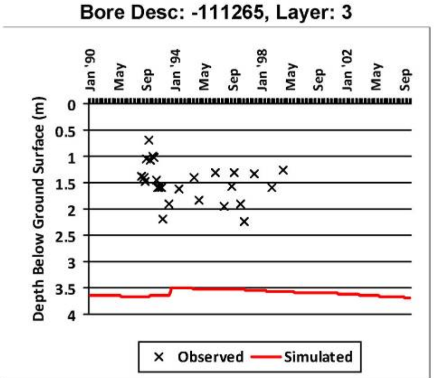

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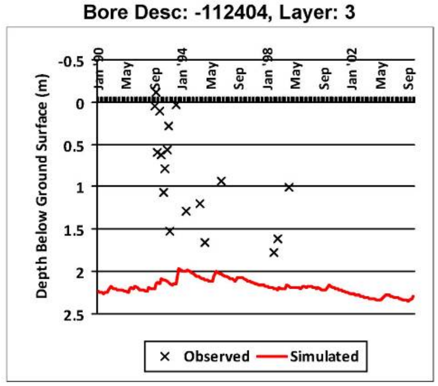

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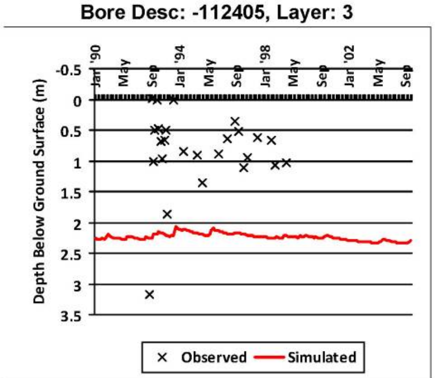

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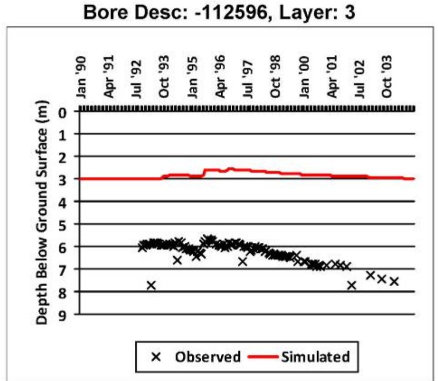

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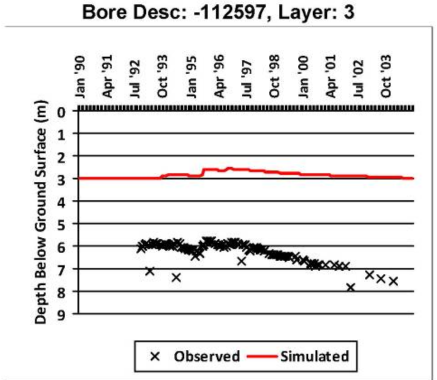

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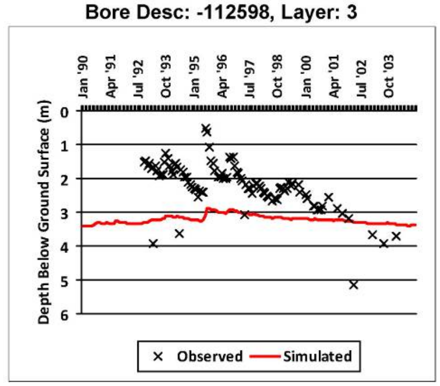
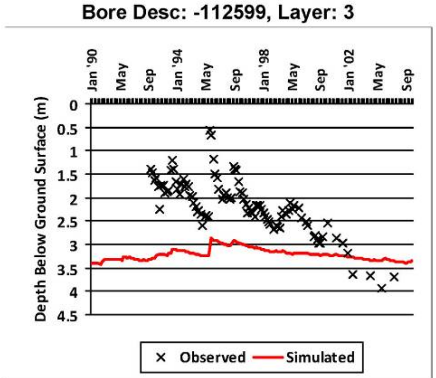
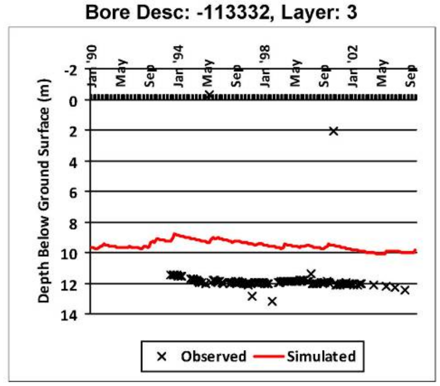


Bore Desc: -112599, Layer: 3



Bore Desc: -113332, Layer: 3



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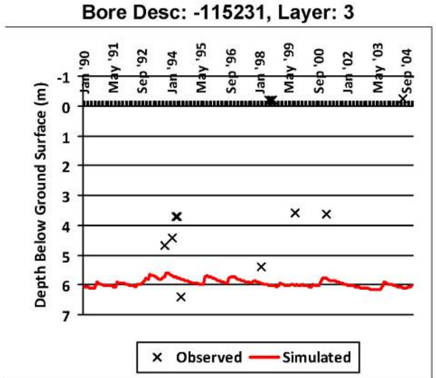

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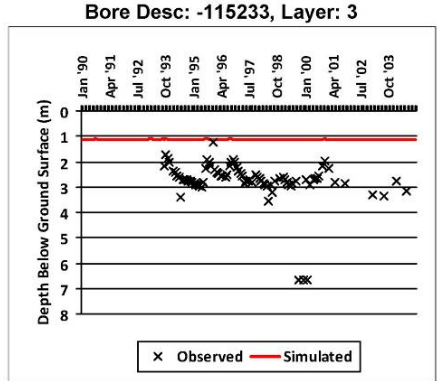

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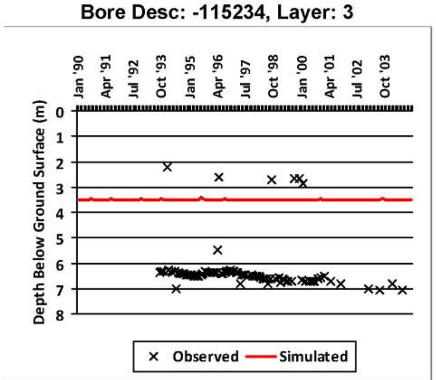

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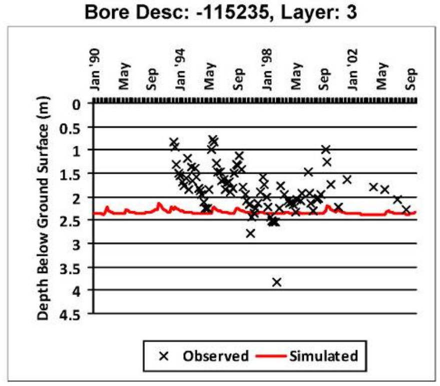

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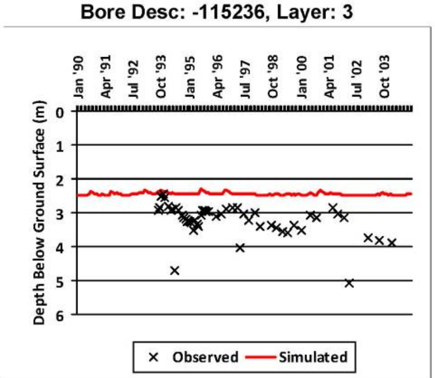

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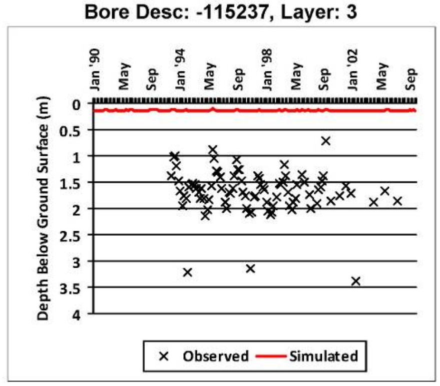

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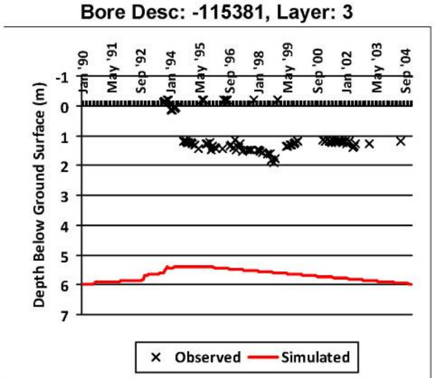

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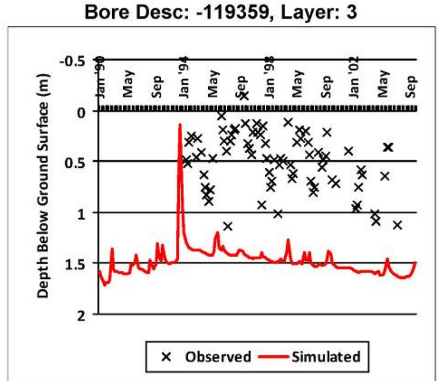

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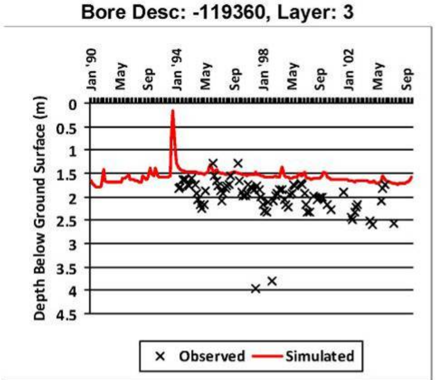
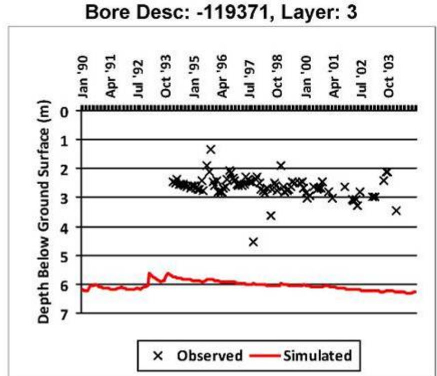
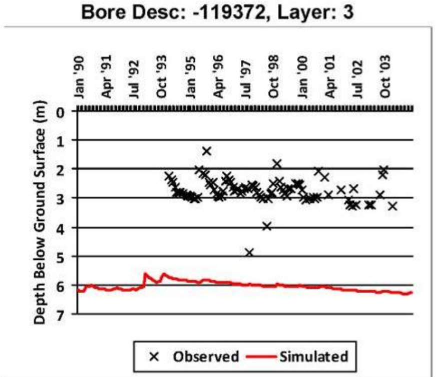


Bore Desc: -119371, Layer: 3



Bore Desc: -119372, Layer: 3



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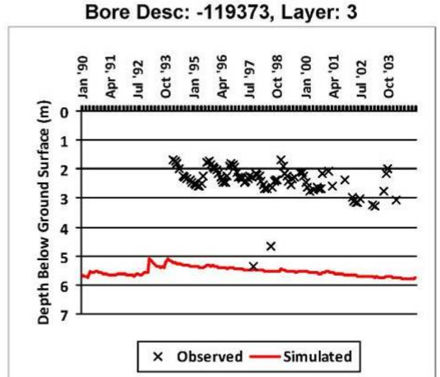

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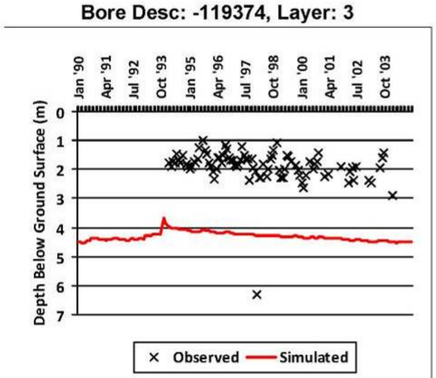

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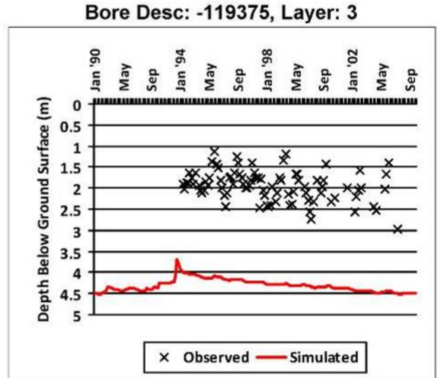
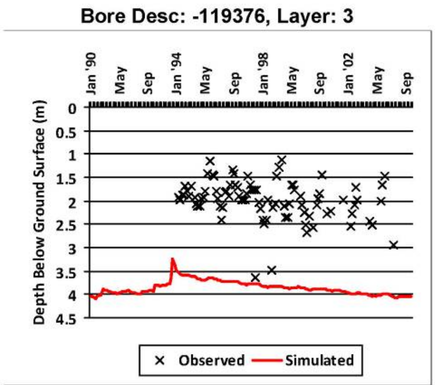
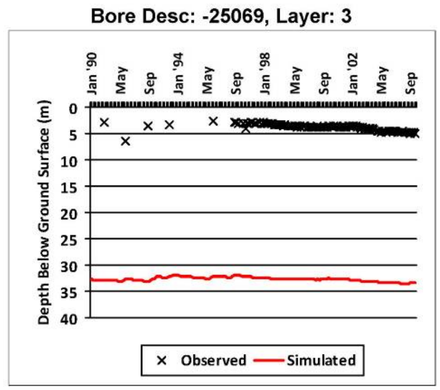
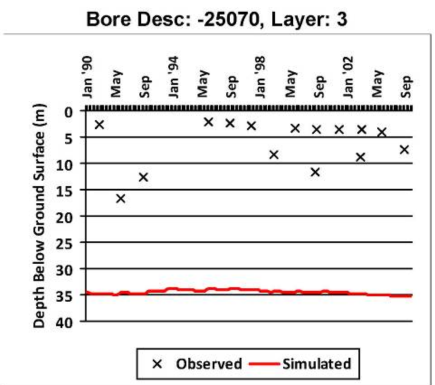
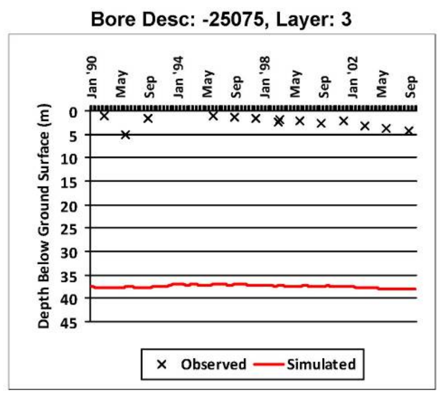
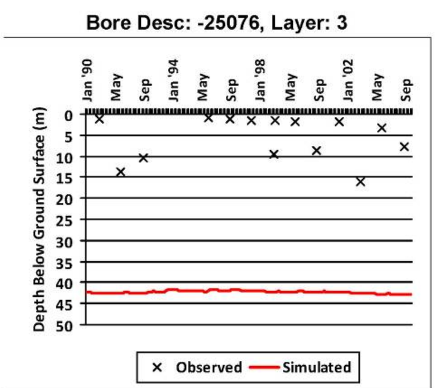


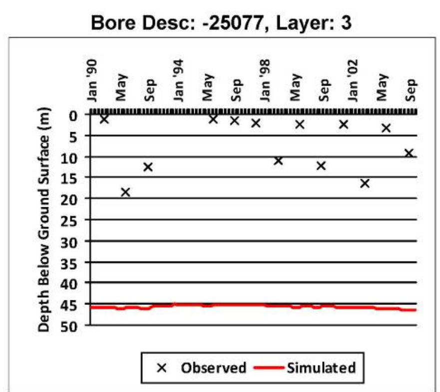

Bore Desc: -119376, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -25069, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40
Depth Below Ground Surface (m)
Observed
Simulated

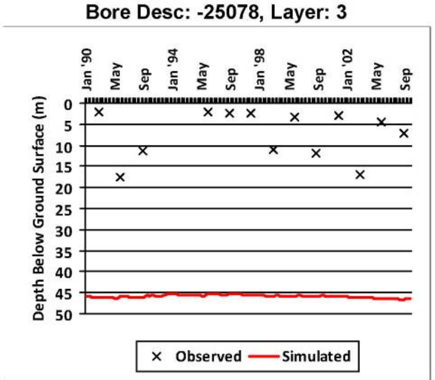

Bore Desc: -25070, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -25075, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40 45
Depth Below Ground Surface (m)
Observed
Simulated

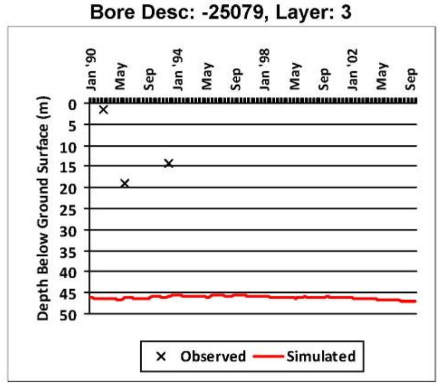

Bore Desc: -25076, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40 45 50
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -25077, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40 45 50
Depth Below Ground Surface (m)
Observed
Simulated

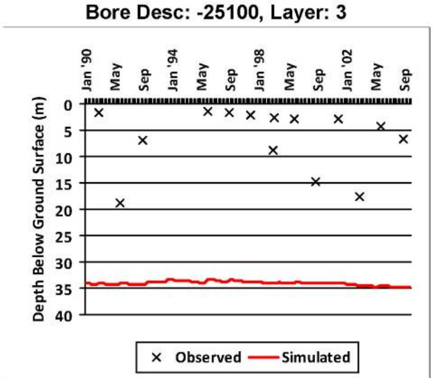
Bore Desc: -25078, Layer: 3



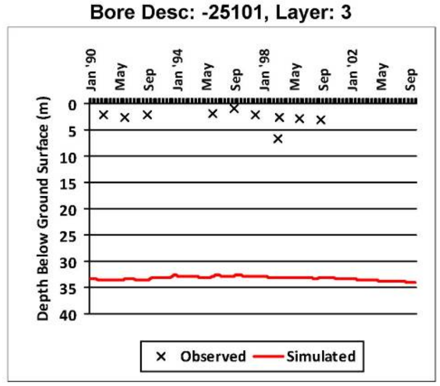
Bore Desc: -25079, Layer: 3



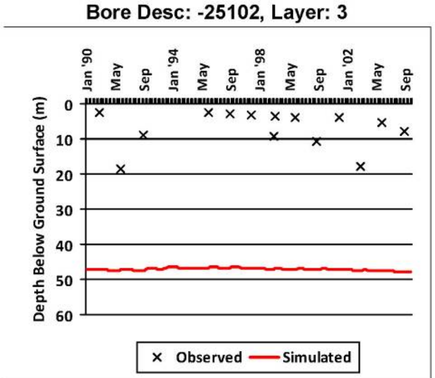
Bore Desc: -25100, Layer: 3



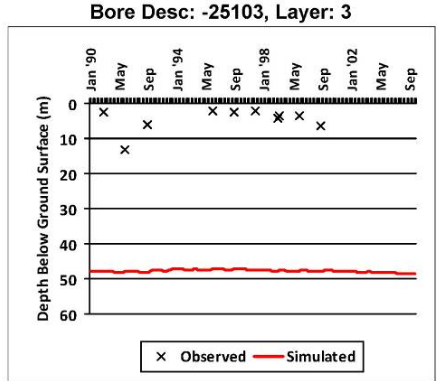
Bore Desc: -25101, Layer: 3

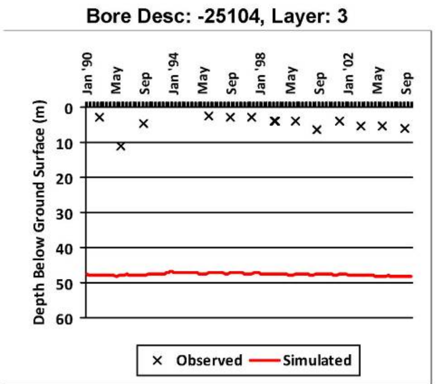


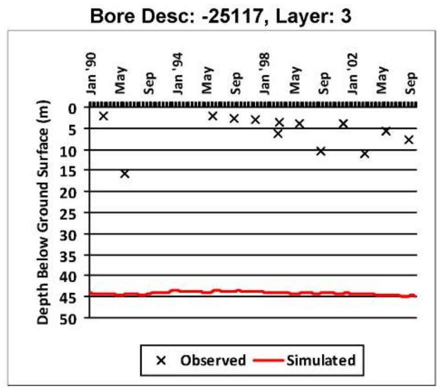
Bore Desc: -25102, Layer: 3

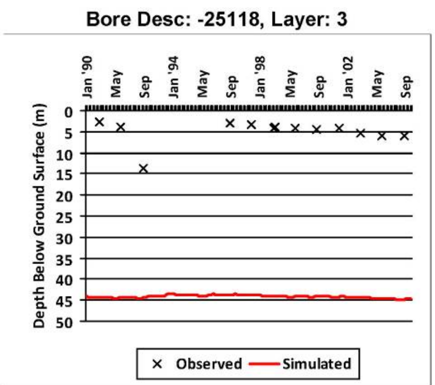


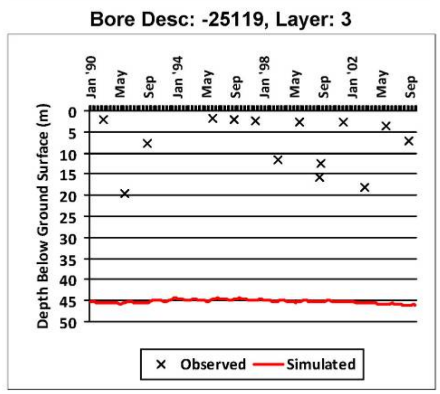
Bore Desc: -25103, Layer: 3

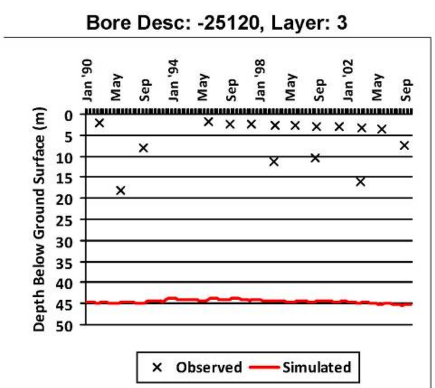


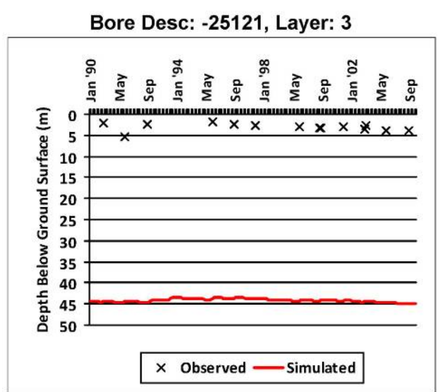

Bore Desc: -25104, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 10 20 30 40 50 60
Observed
Simulated


Bore Desc: -25117, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40 45 50
Observed
Simulated

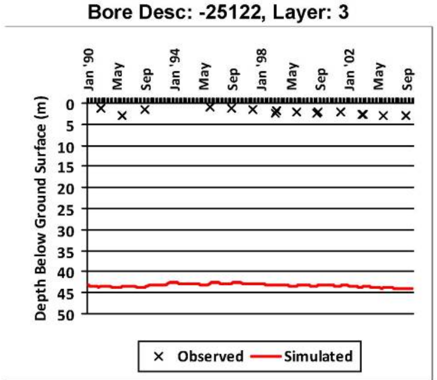

Bore Desc: -25118, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40 45 50
Observed
Simulated


Bore Desc: -25119, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40 45 50
Observed
Simulated


Bore Desc: -25120, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40 45 50
Observed
Simulated


Bore Desc: -25121, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40 45 50
Observed
Simulated

Bore Desc: -25122, Layer: 3



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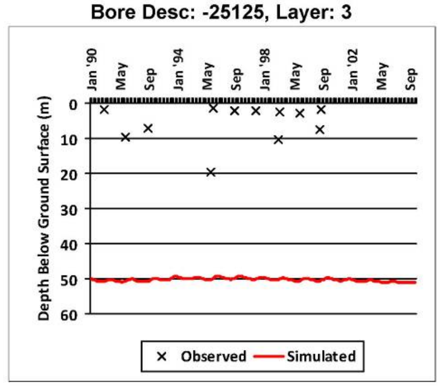

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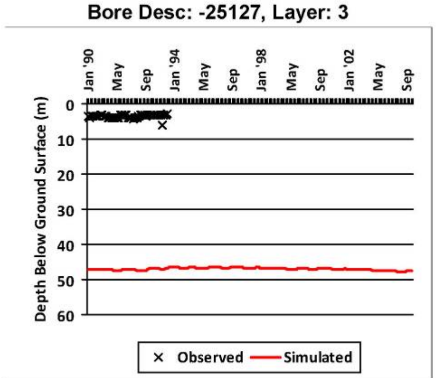
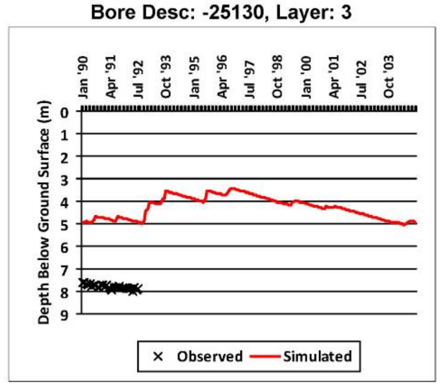
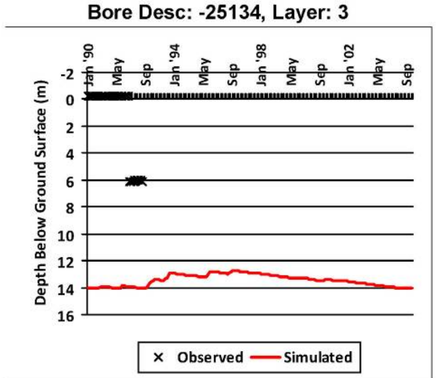


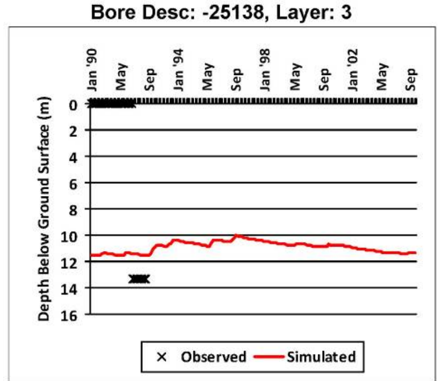
Bore Desc: -25130, Layer: 3



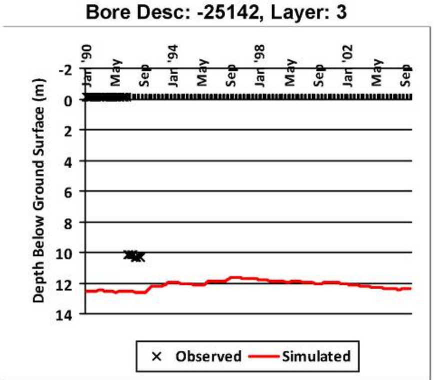
Bore Desc: -25134, Layer: 3



Bore Desc: -25138, Layer: 3



Bore Desc: -25142, Layer: 3



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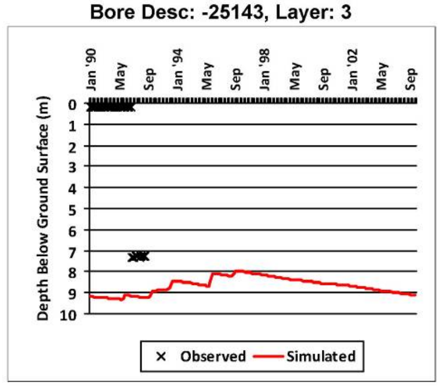

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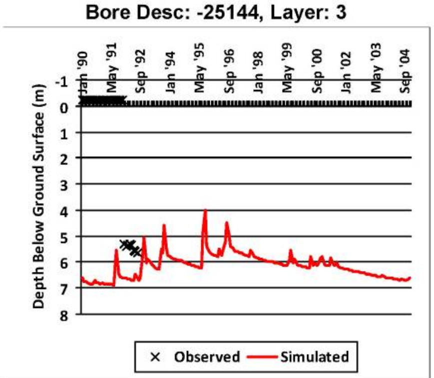

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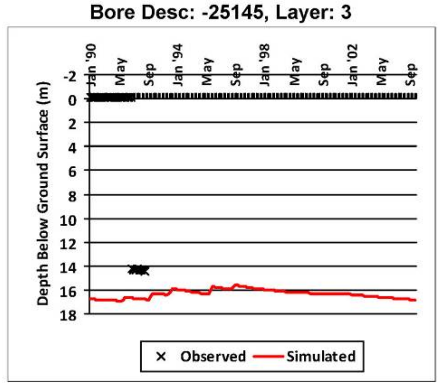

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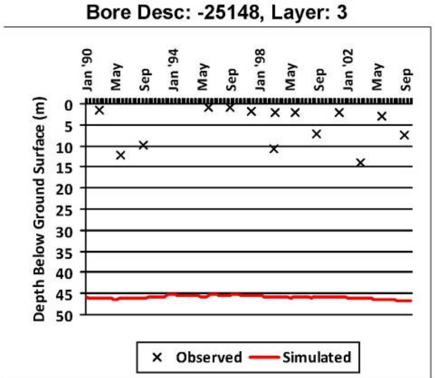

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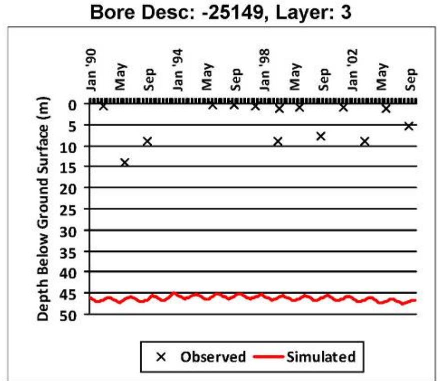

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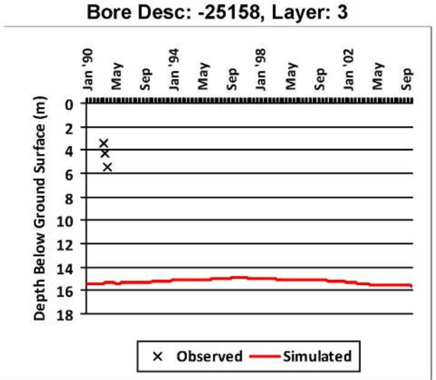
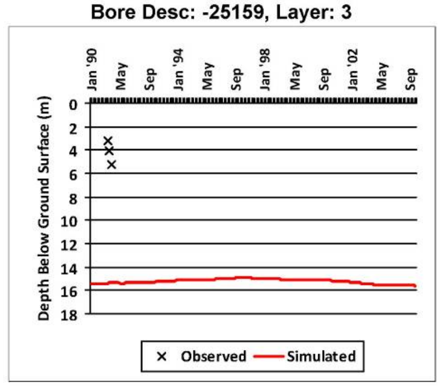


Bore Desc: -25159, Layer: 3



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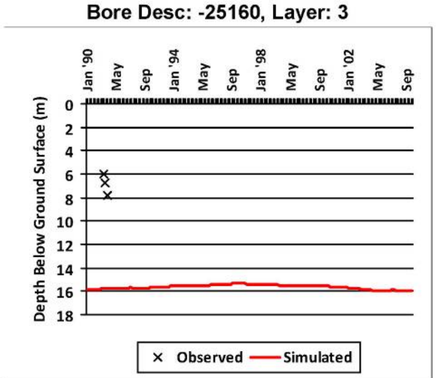

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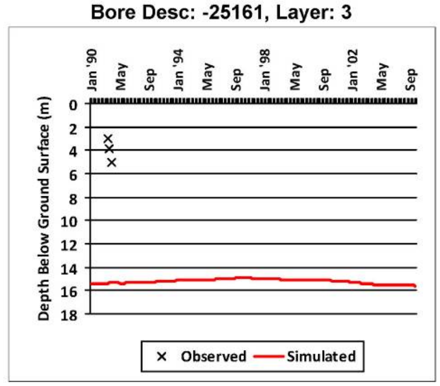

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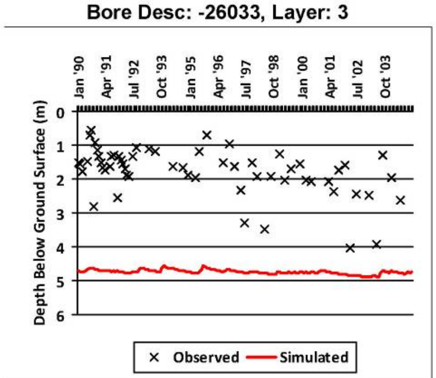

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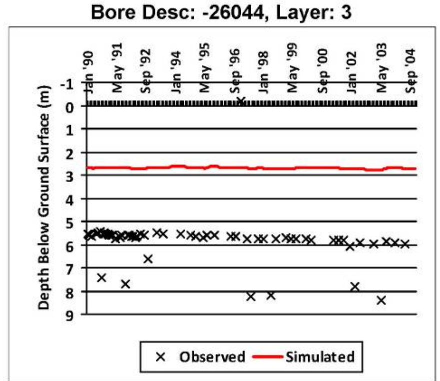

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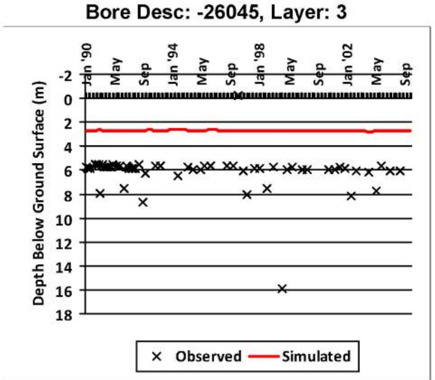

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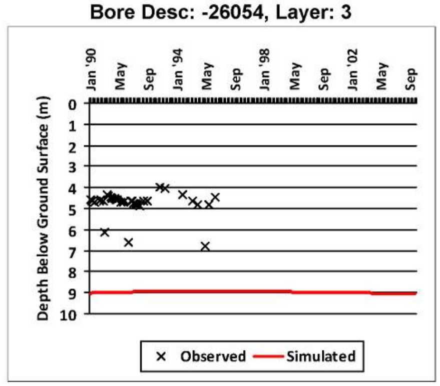

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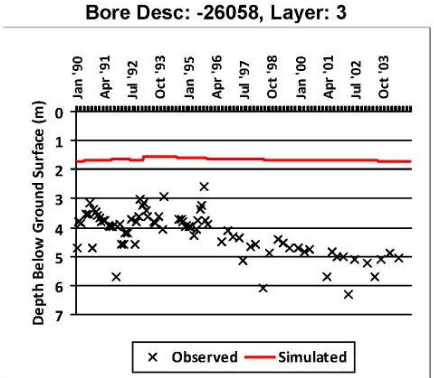

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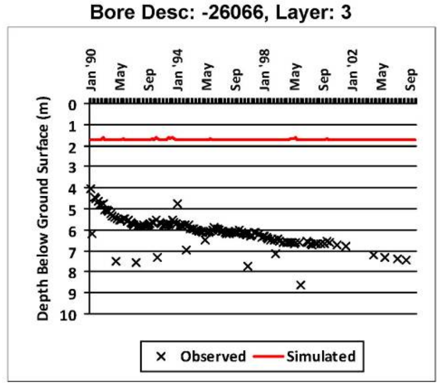

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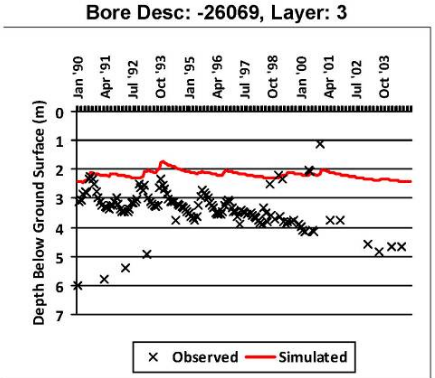

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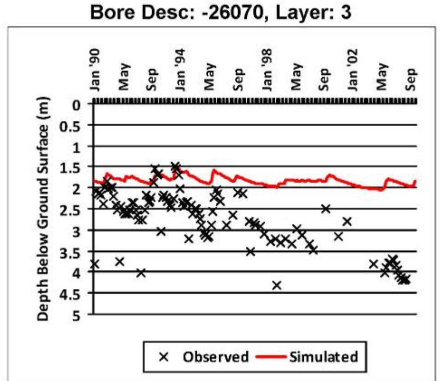

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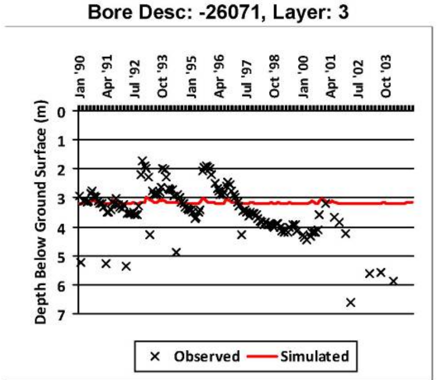

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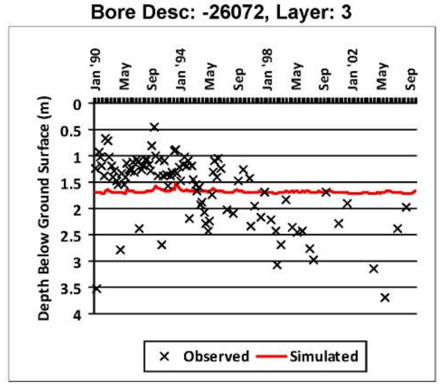

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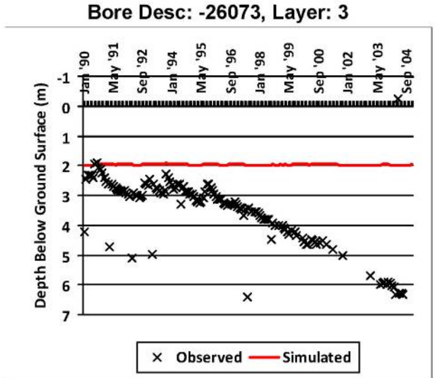

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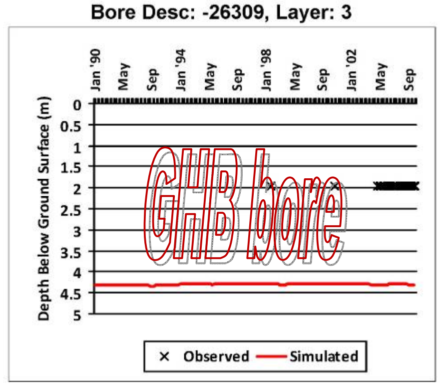

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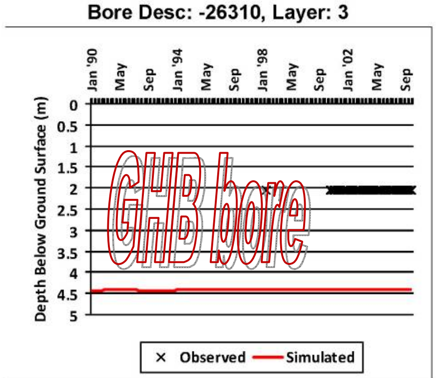

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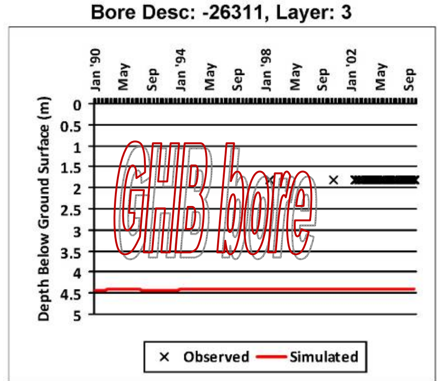

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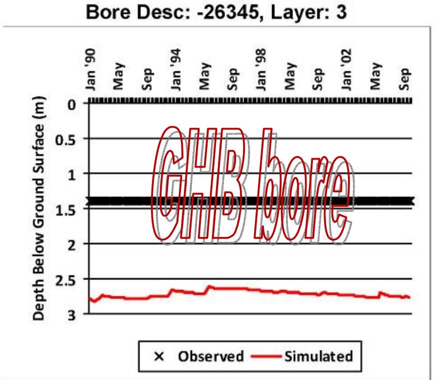

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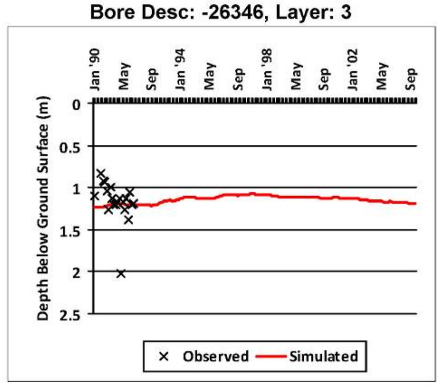

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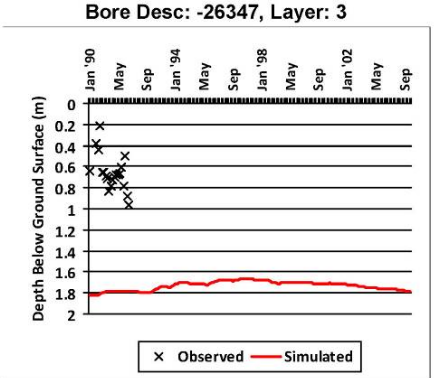

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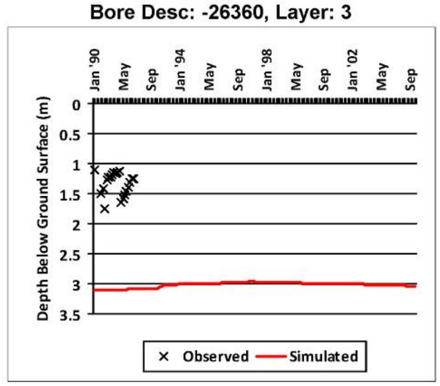

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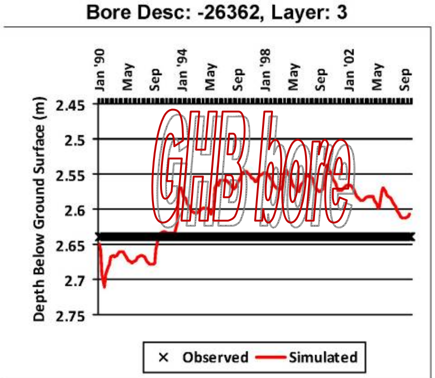

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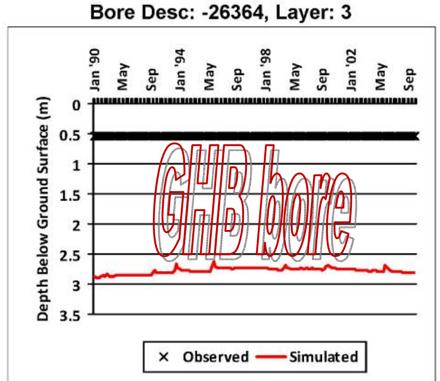
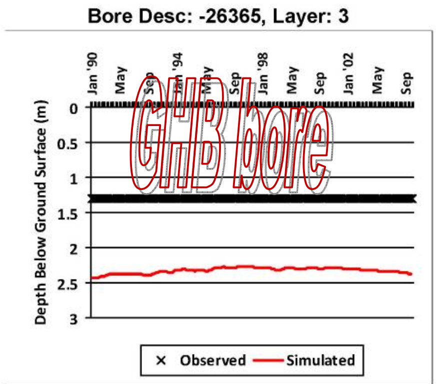
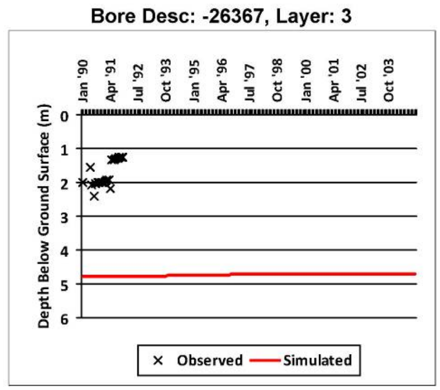
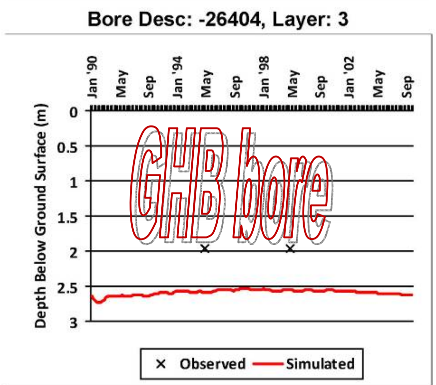
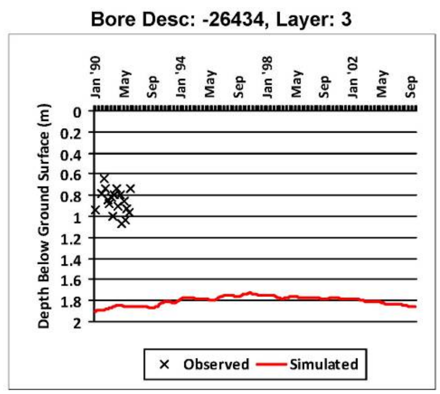
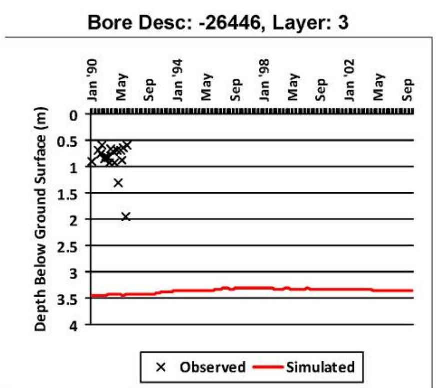


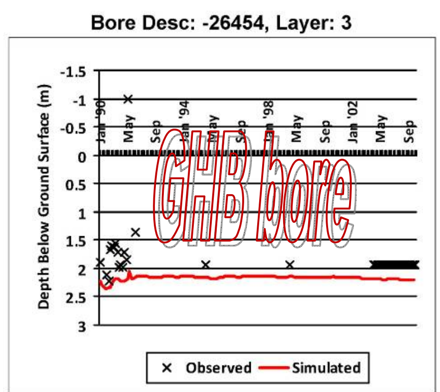

Bore Desc: -26365, Layer: 3
Depth Below Ground Surface (m)
GHB bore
Observed
Simulated

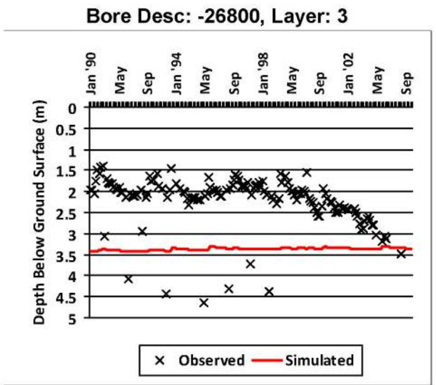

Bore Desc: -26367, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

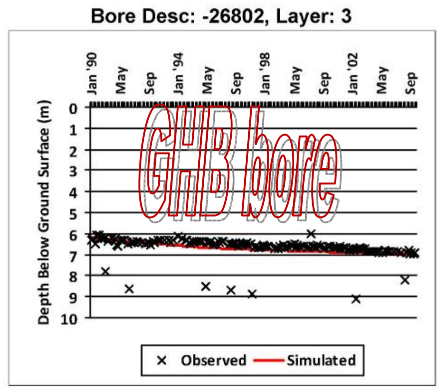

Bore Desc: -26404, Layer: 3
Depth Below Ground Surface (m)
GHB bore
Observed
Simulated

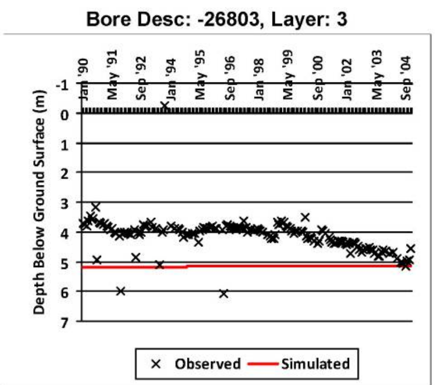

Bore Desc: -26434, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -26446, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -26454, Layer: 3
Depth Below Ground Surface (m)
GHB bore
Observed
Simulated


Bore Desc: -26800, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -26802, Layer: 3
GHB bore
Depth Below Ground Surface (m)
Observed
Simulated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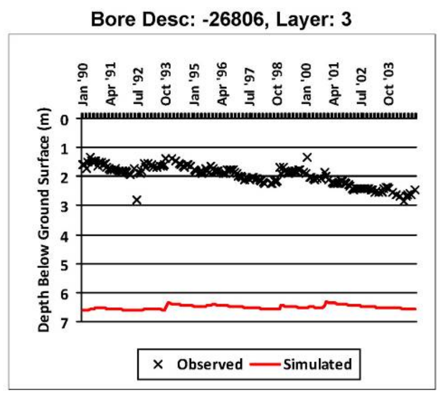
Depth Below Ground Surface (m)
Observed
Simulated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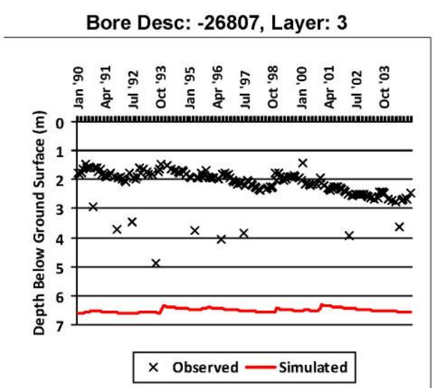
Depth Below Ground Surface (m)
Observed
Simulated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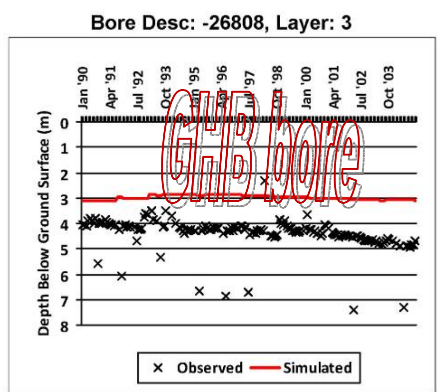
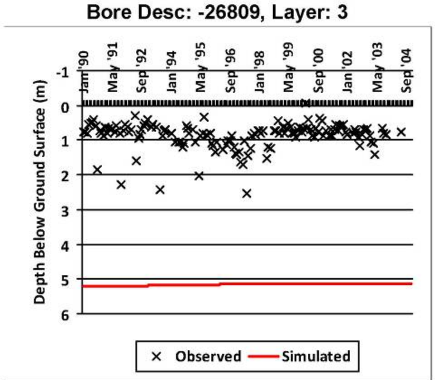
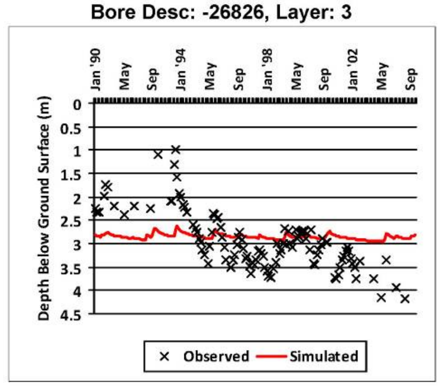
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -26808, Layer: 3
GHB bore
Depth Below Ground Surface (m)
Observed
Simulated

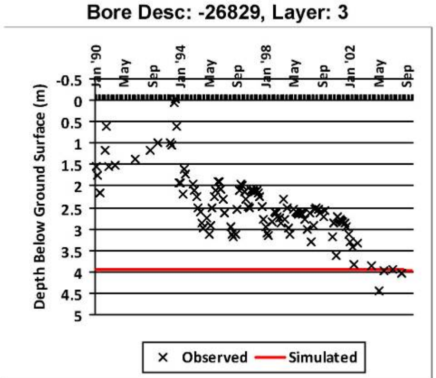
Bore Desc: -26809, Layer: 3



Bore Desc: -26826, Layer: 3



Bore Desc: -26829, Layer: 3



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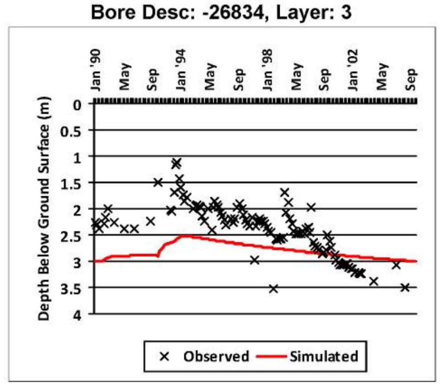

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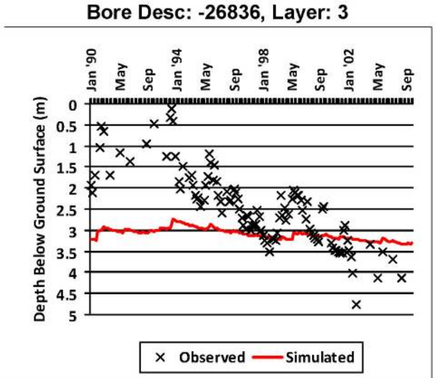

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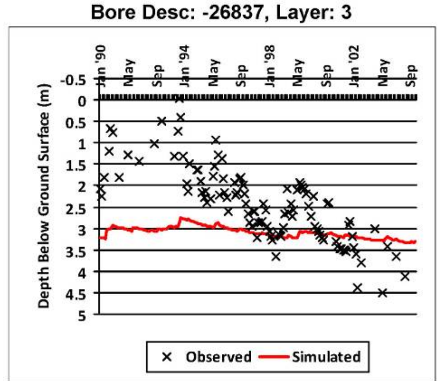

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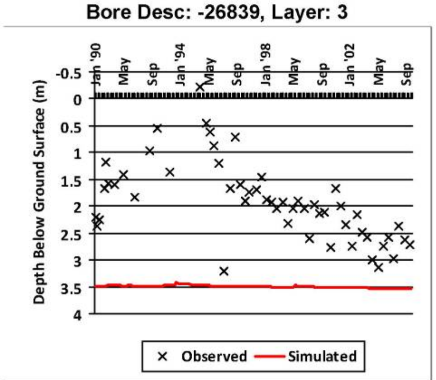

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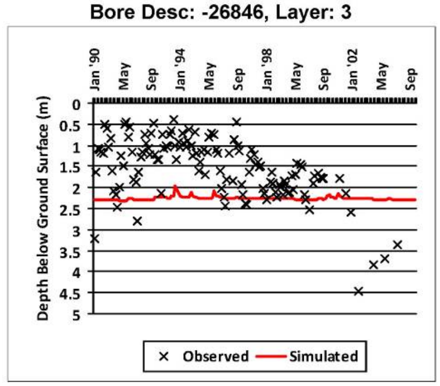

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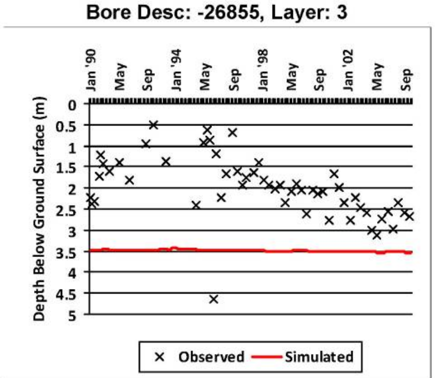

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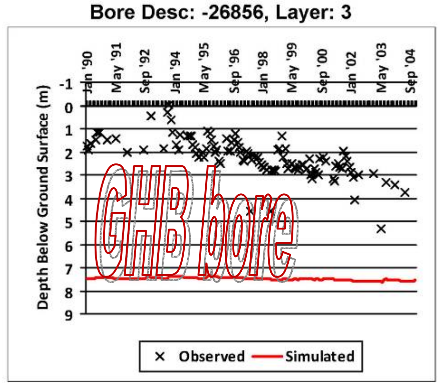

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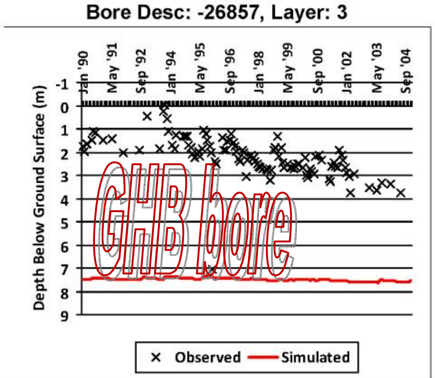

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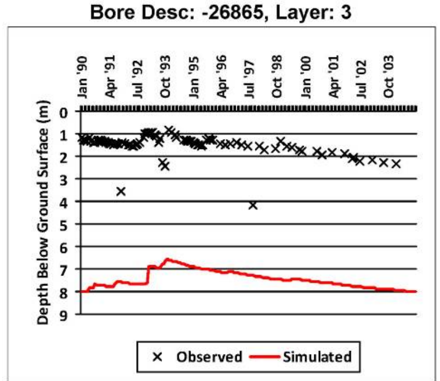

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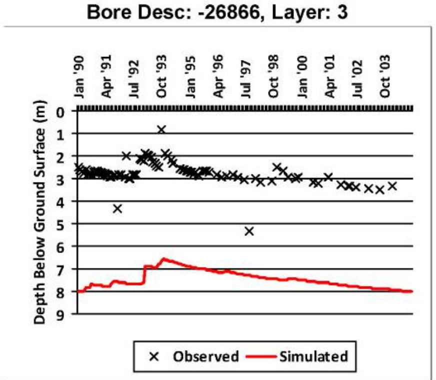

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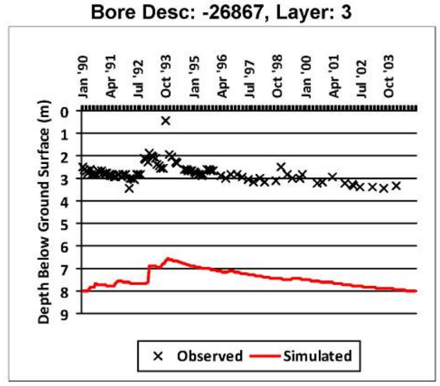

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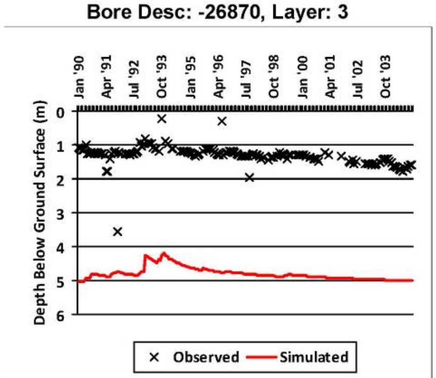

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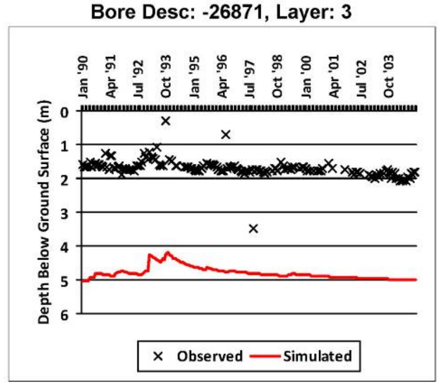

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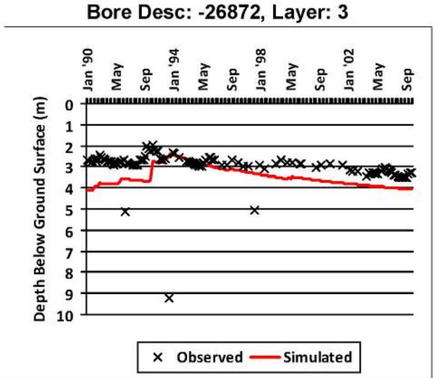

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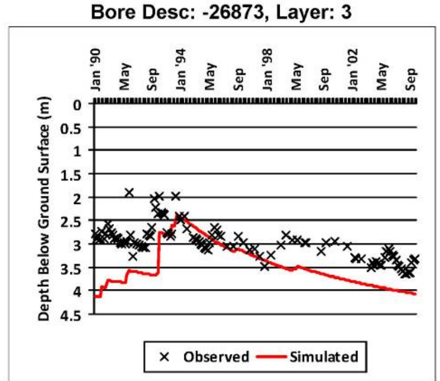

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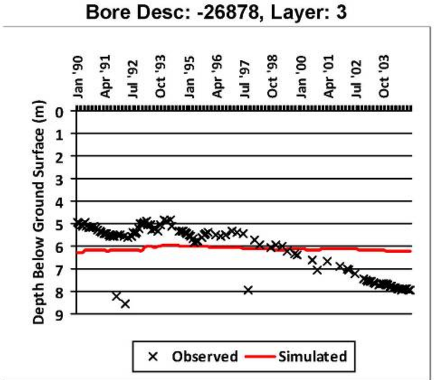

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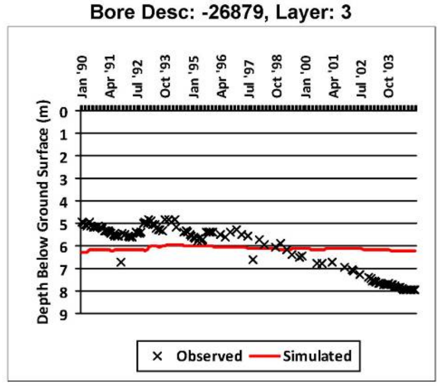

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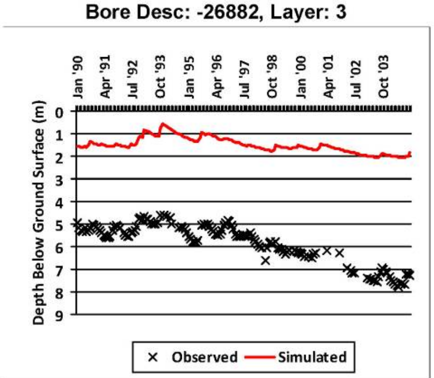

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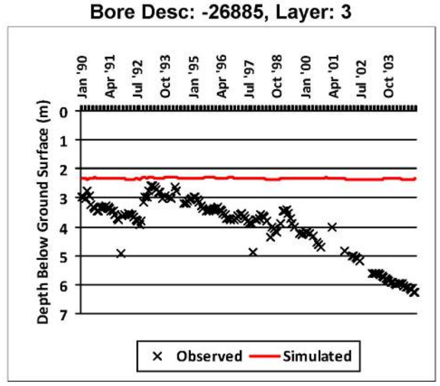

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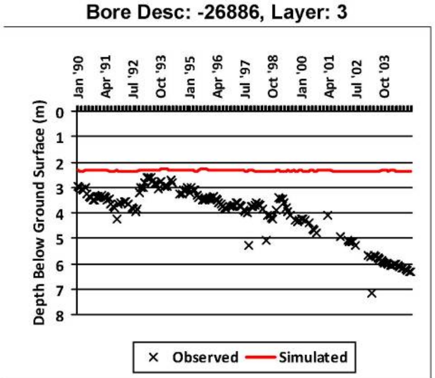

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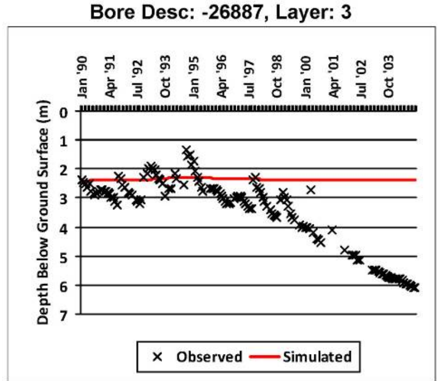

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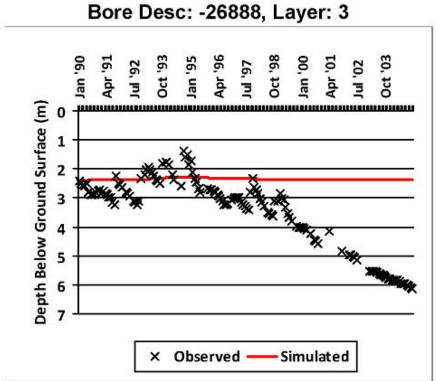

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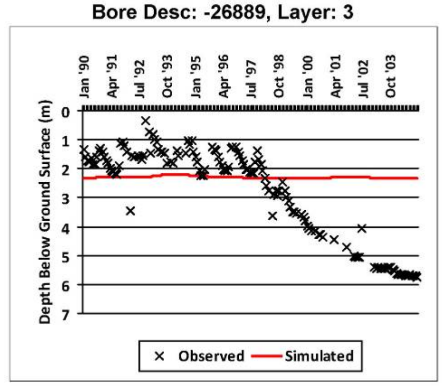

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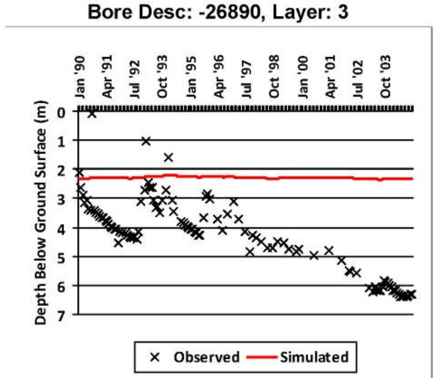

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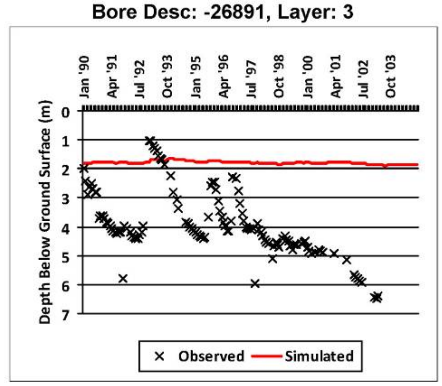

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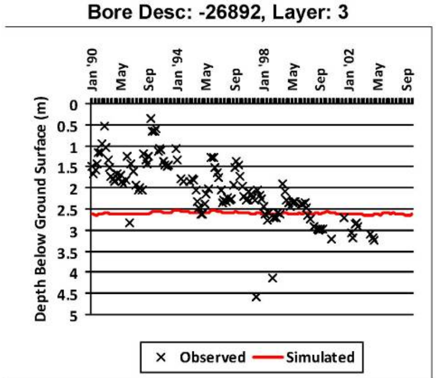

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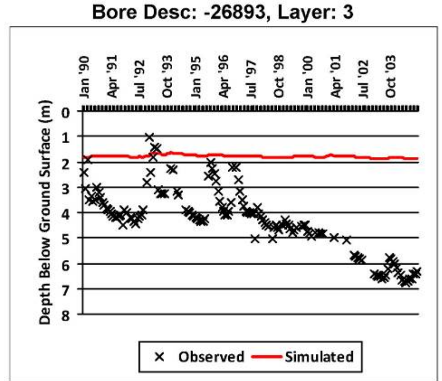

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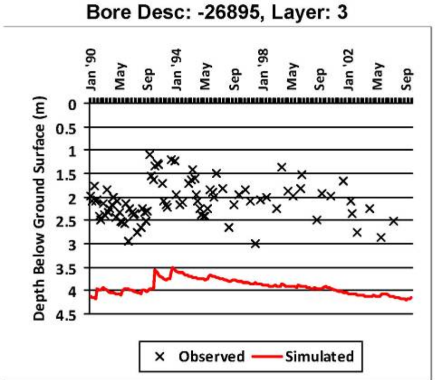

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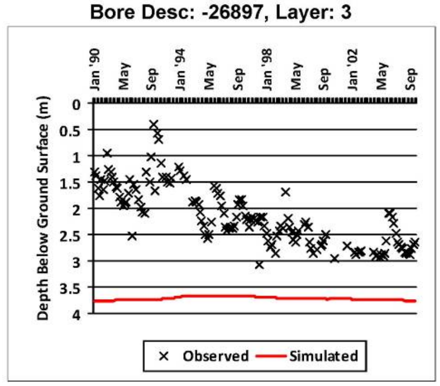

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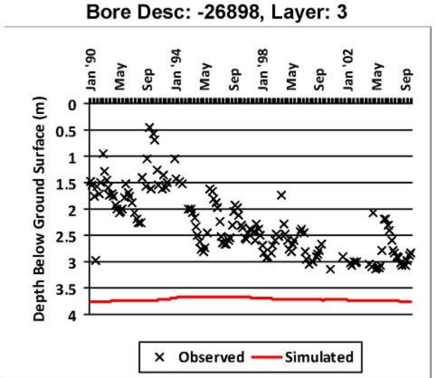

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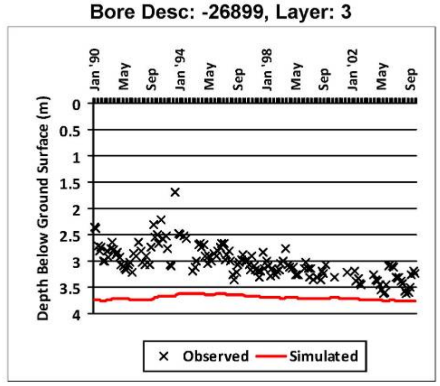

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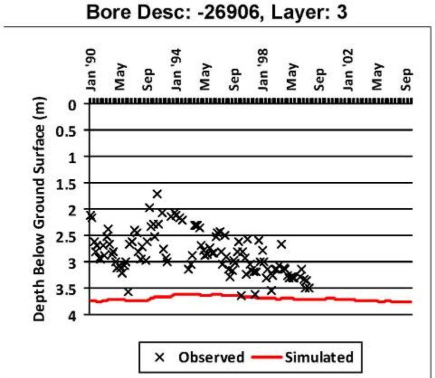

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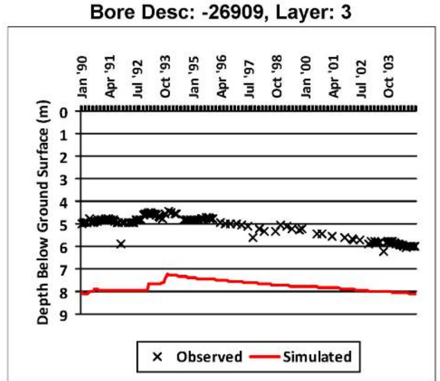

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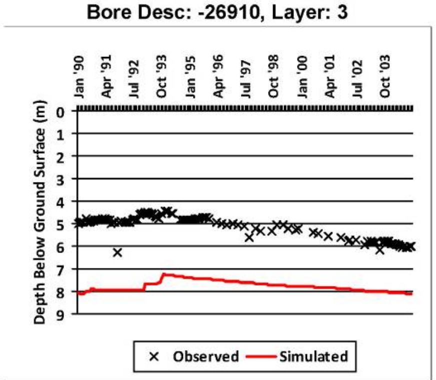

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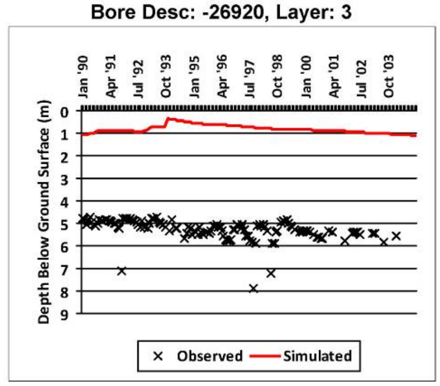

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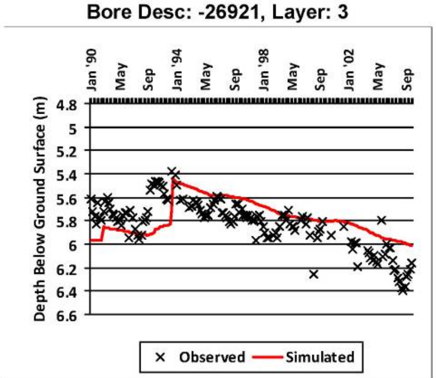

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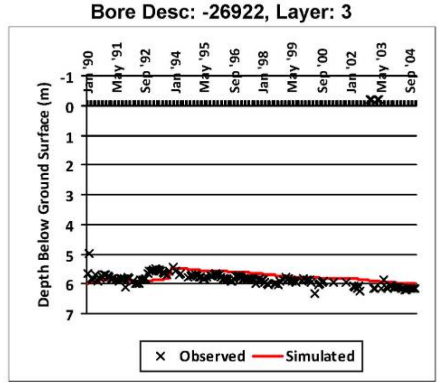

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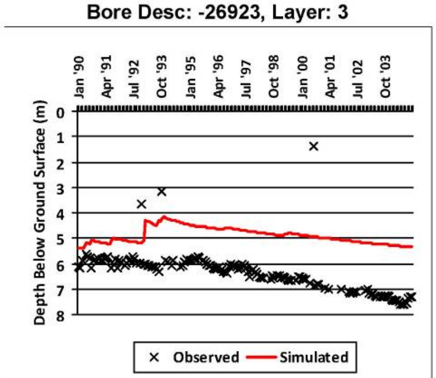

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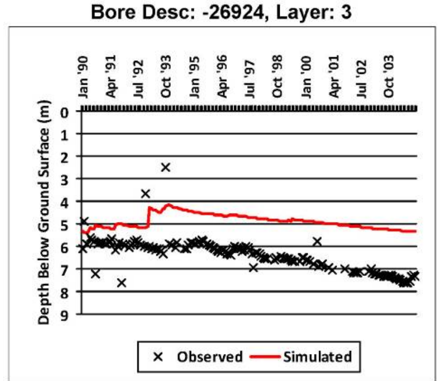

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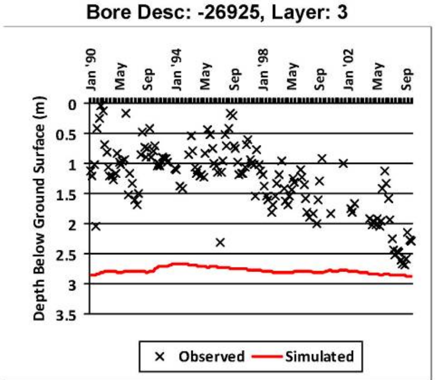

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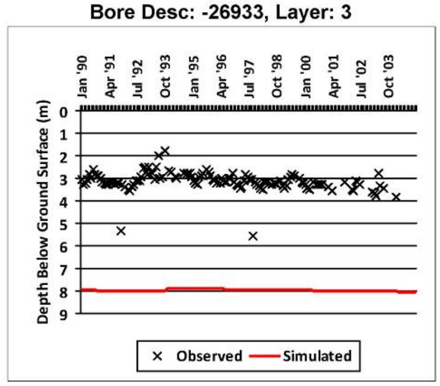

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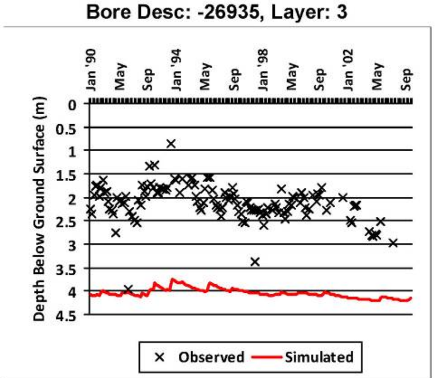

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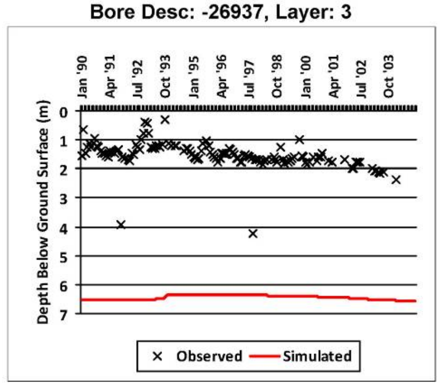

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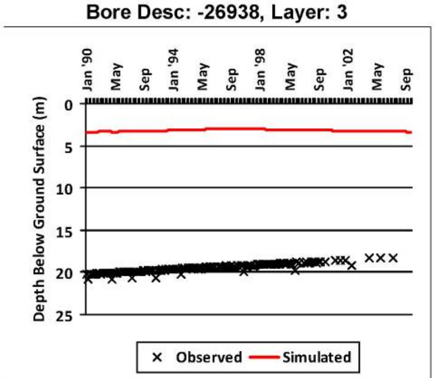

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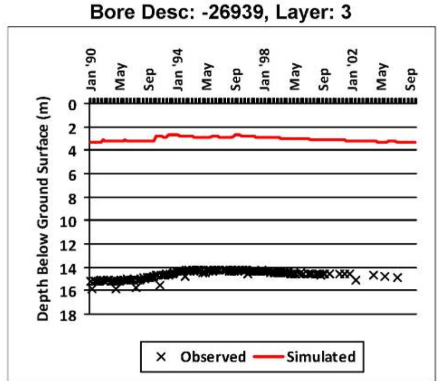

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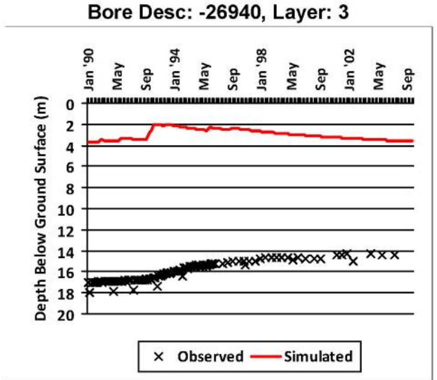

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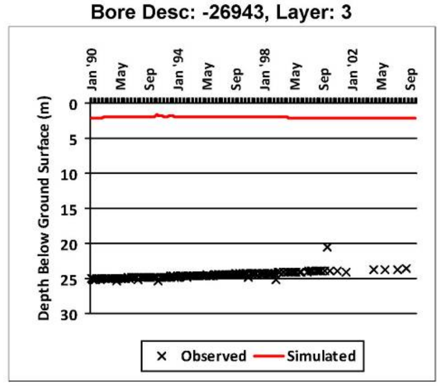

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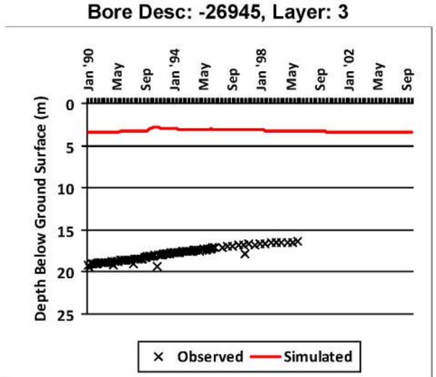

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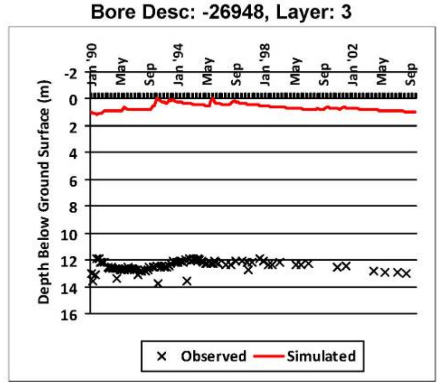

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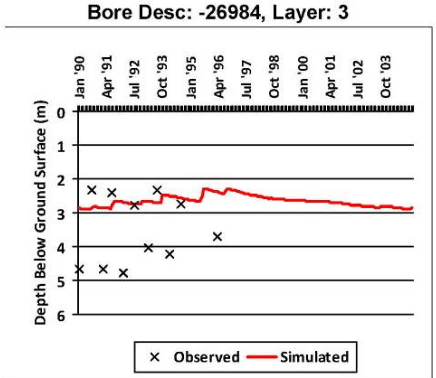

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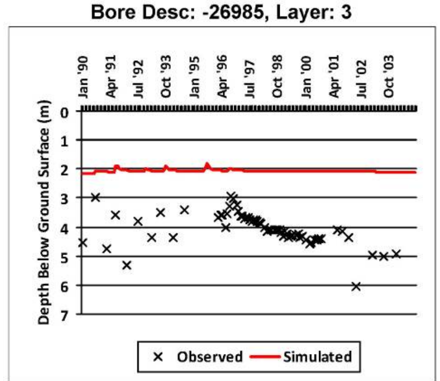

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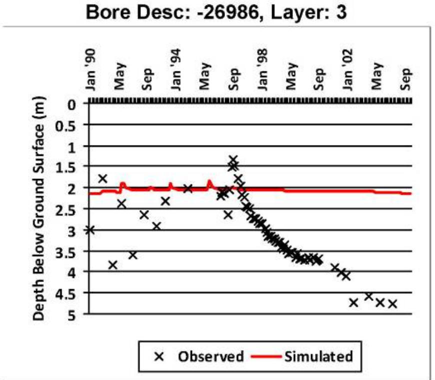

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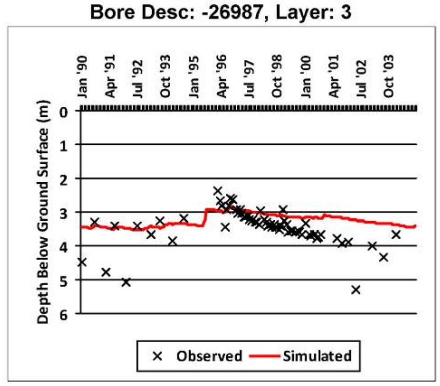

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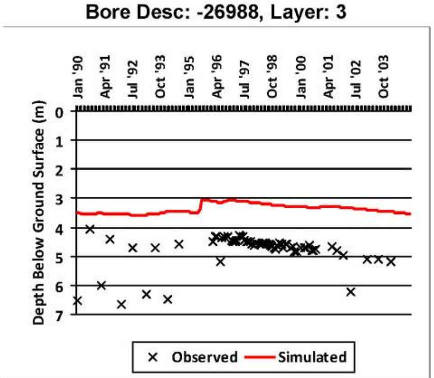

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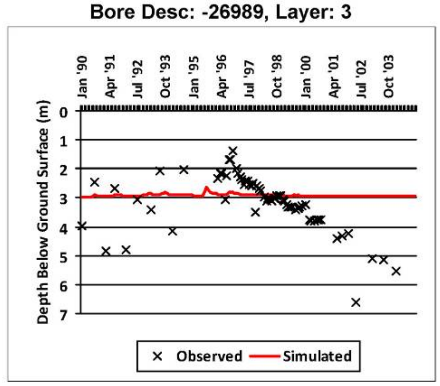

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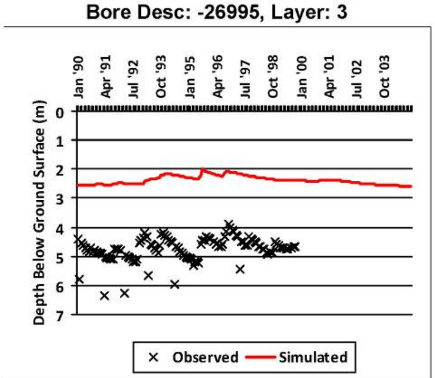

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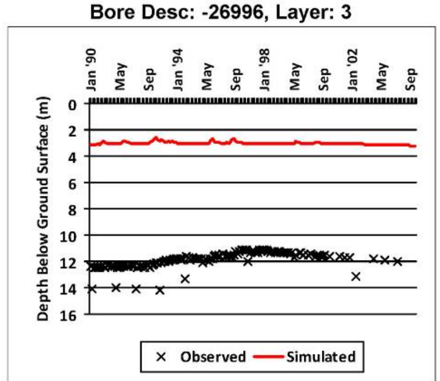

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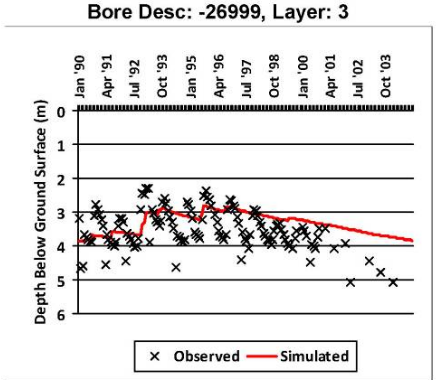

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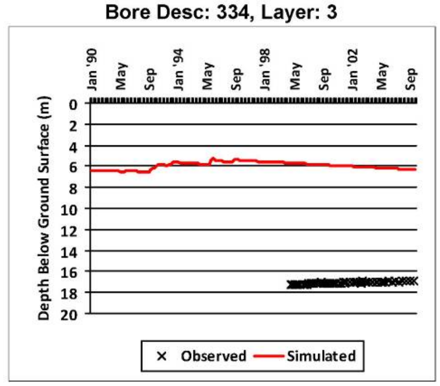

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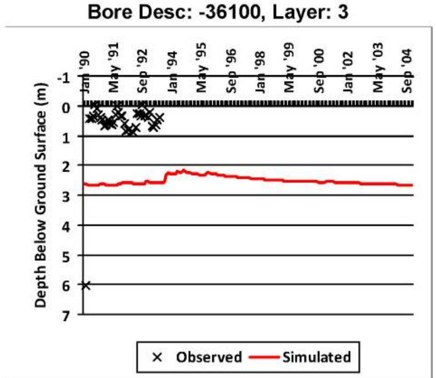

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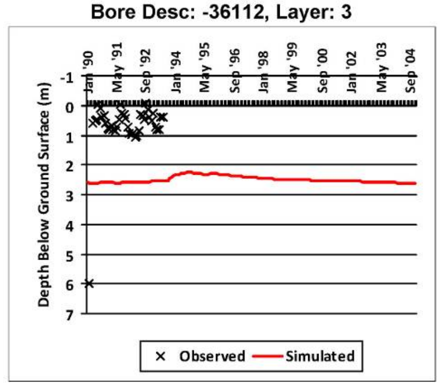

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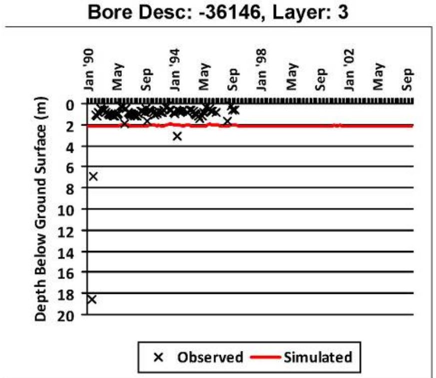

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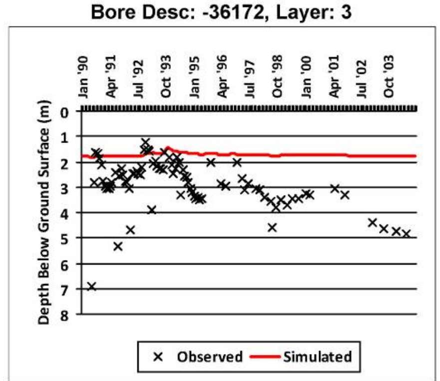

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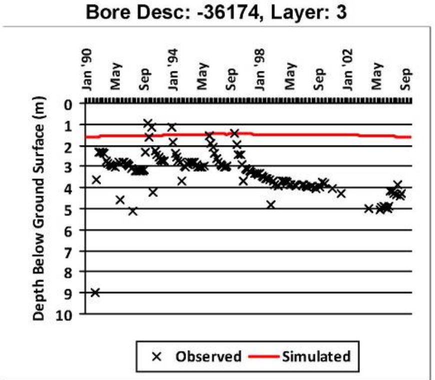

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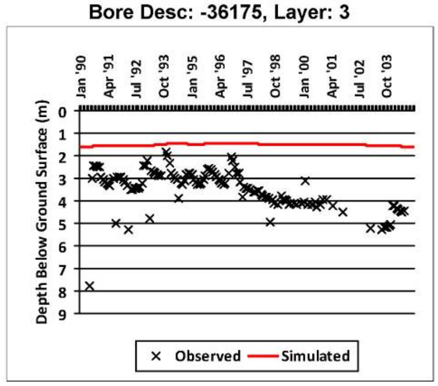

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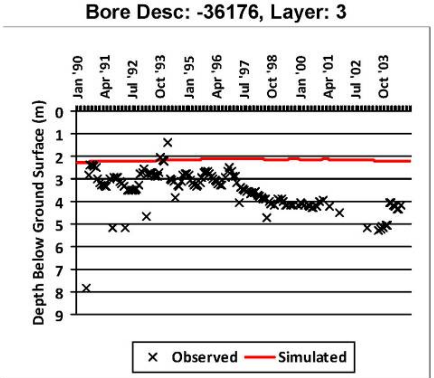

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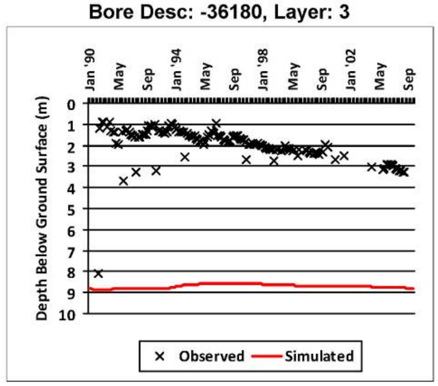

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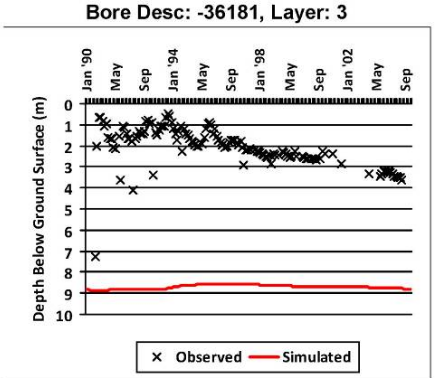

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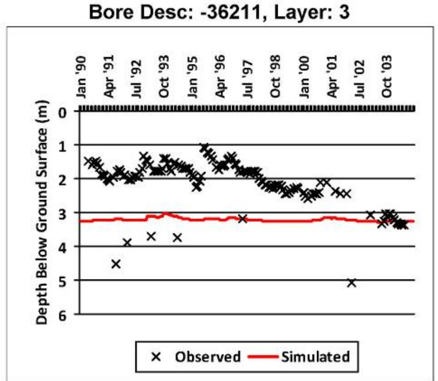

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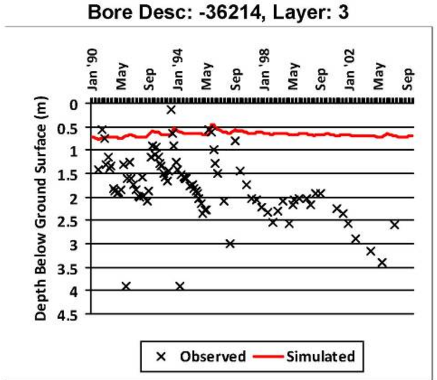

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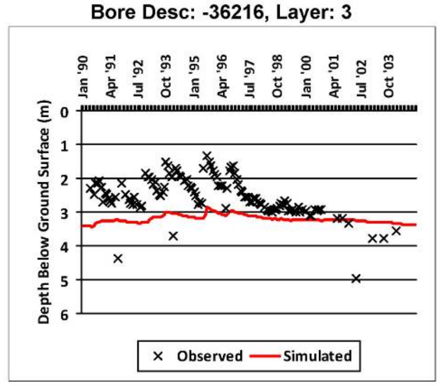

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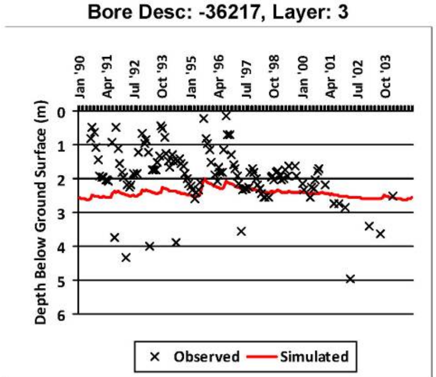

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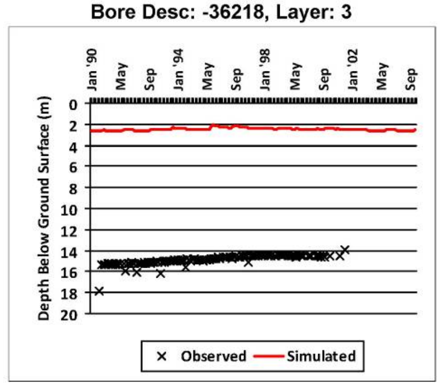

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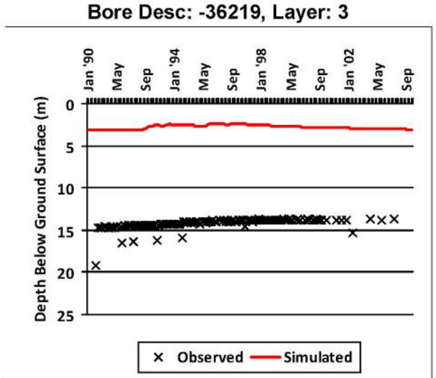

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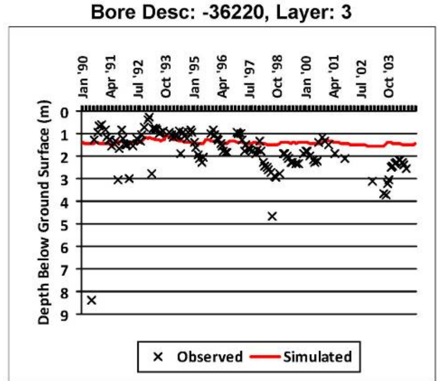

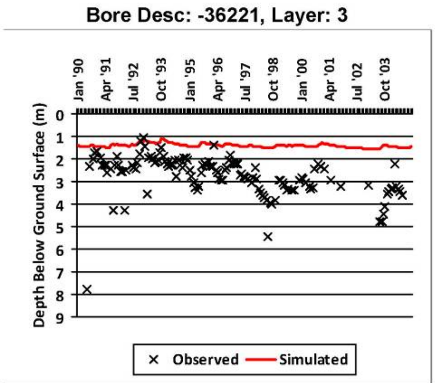
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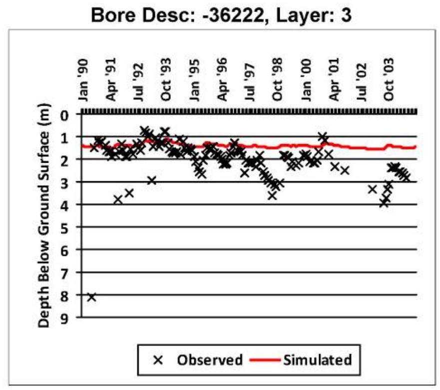
Depth Below Ground Surface (m)
Observed
Simulated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Observed
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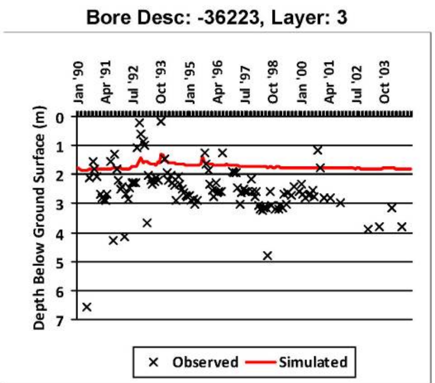
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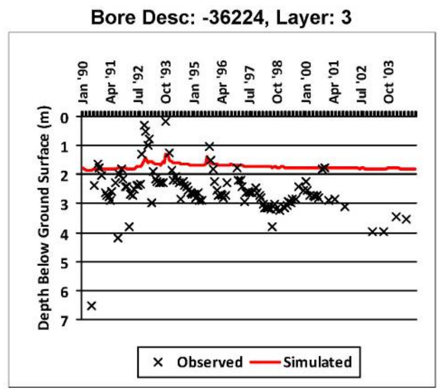
Observed
Simulated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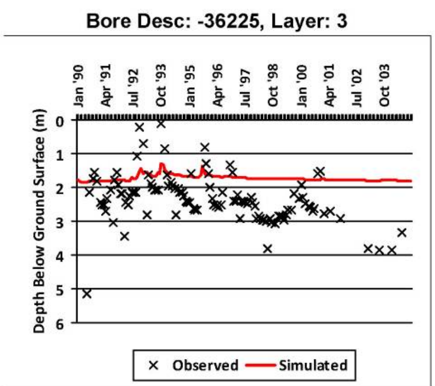
Observed
Simulated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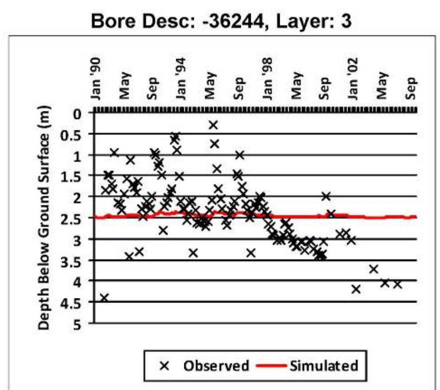
Depth Below Ground Surface (m)
Observed
Simulated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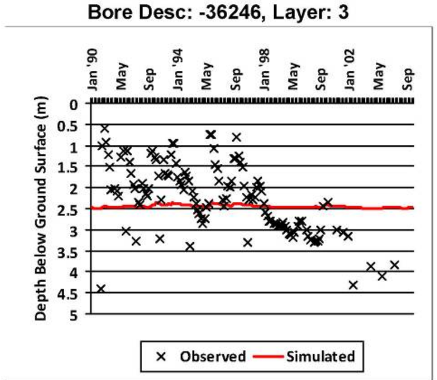
Depth Below Ground Surface (m)
Observed
Simulated

Bore Desc: -36246, Layer: 3



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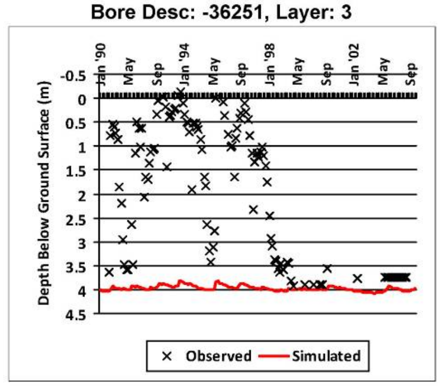

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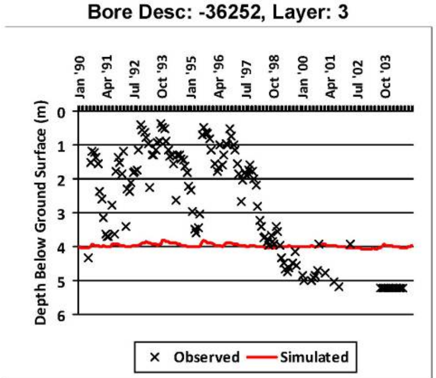

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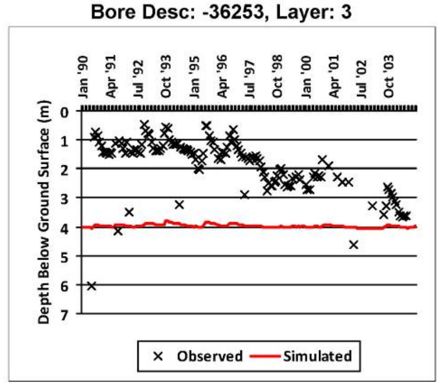

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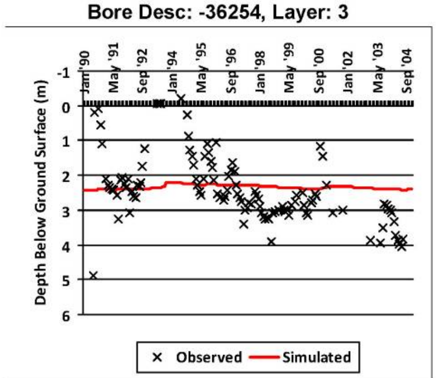

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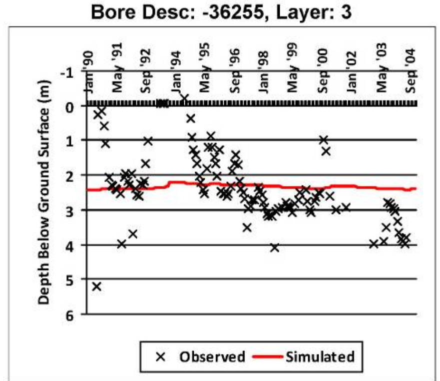

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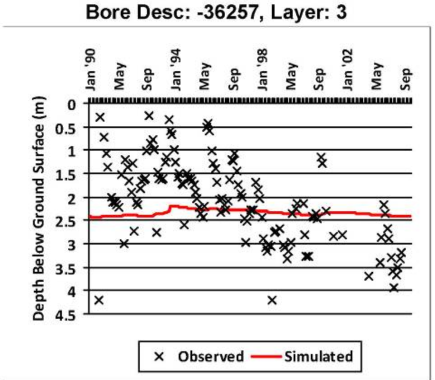

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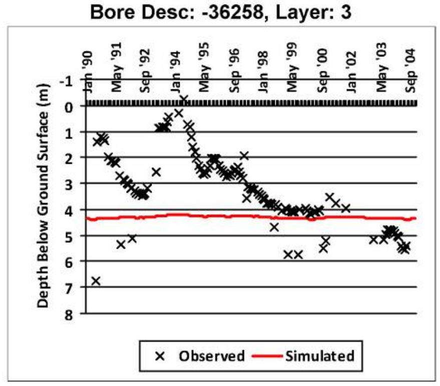

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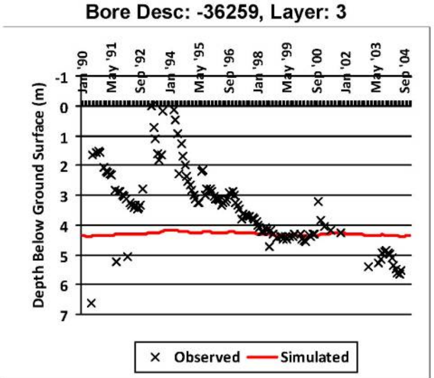

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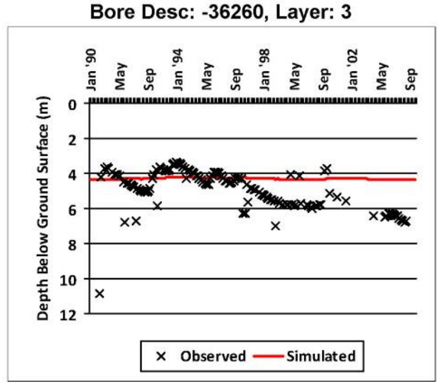

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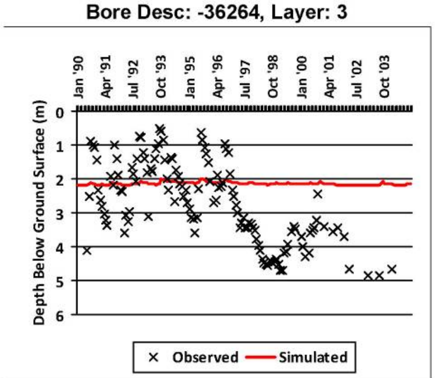

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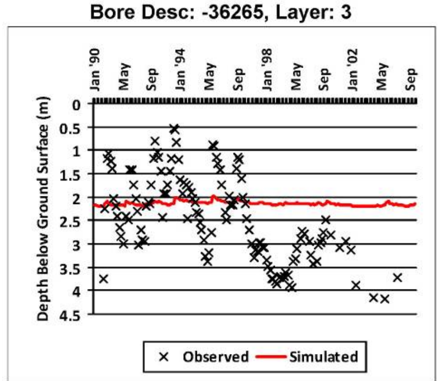

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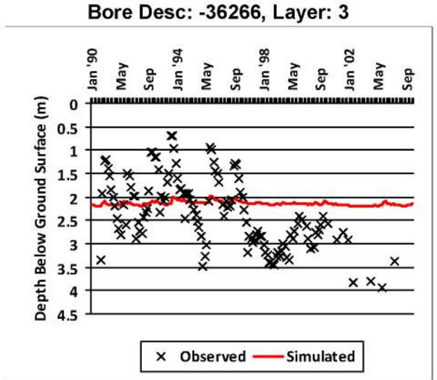

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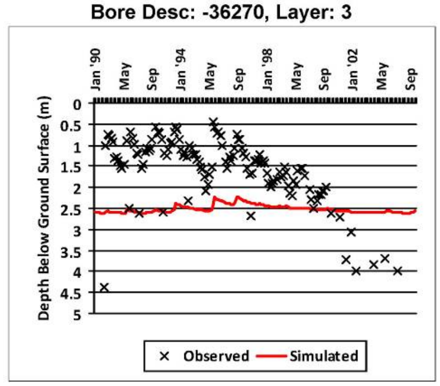

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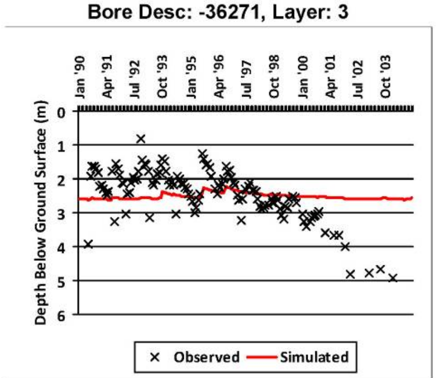

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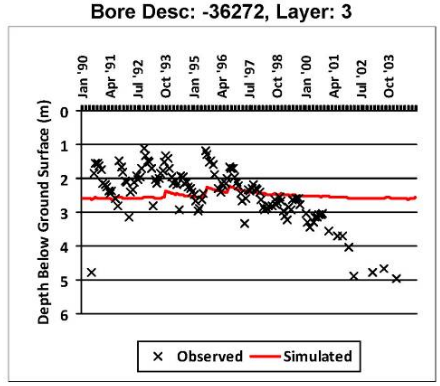

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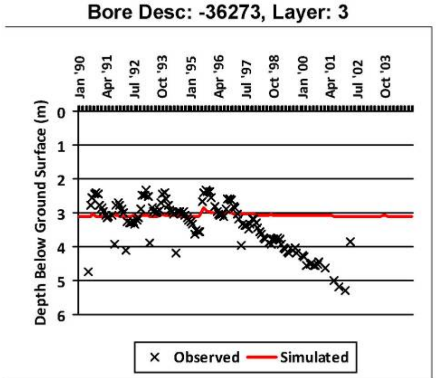

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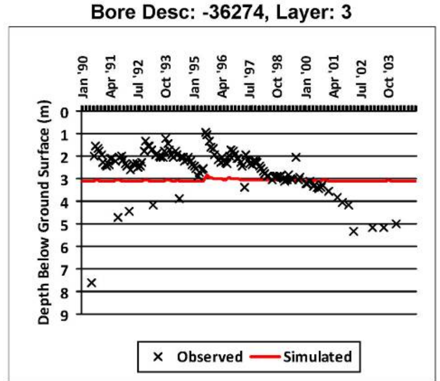

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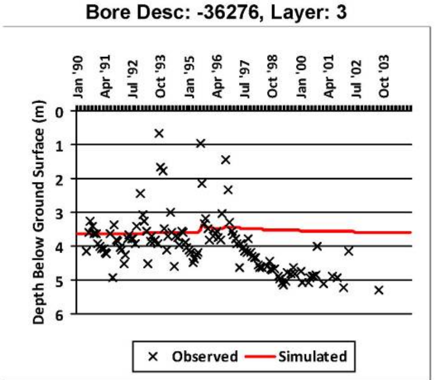

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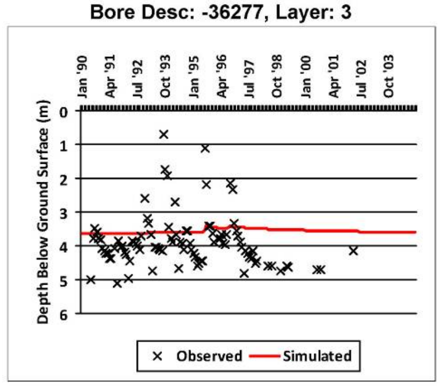

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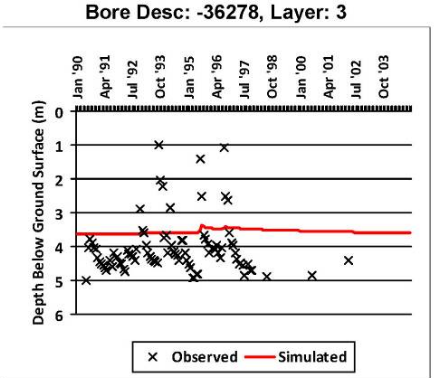

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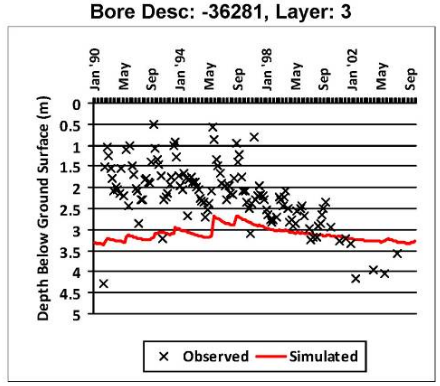

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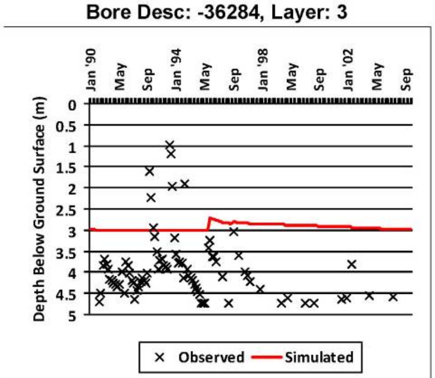

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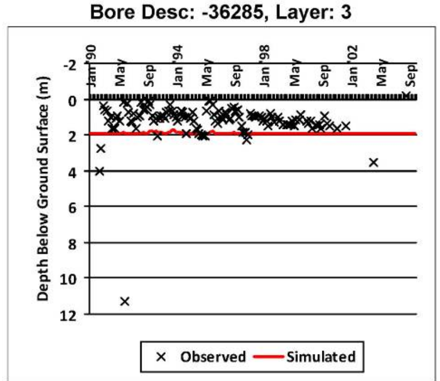

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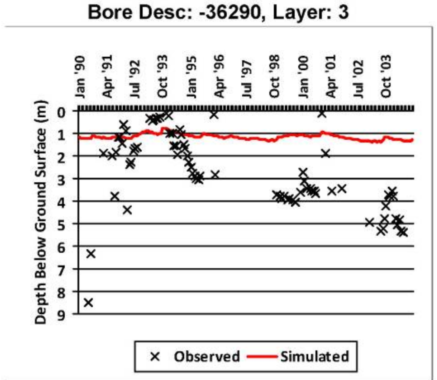

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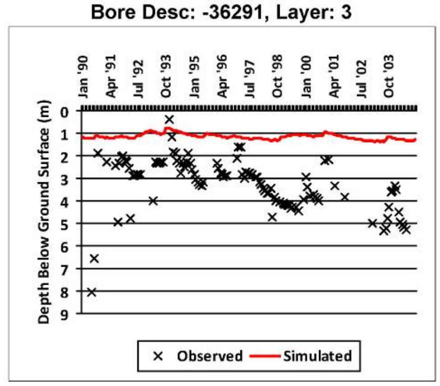

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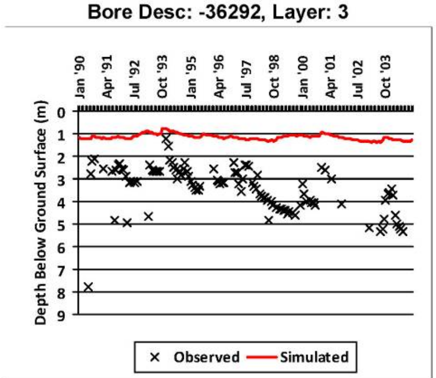

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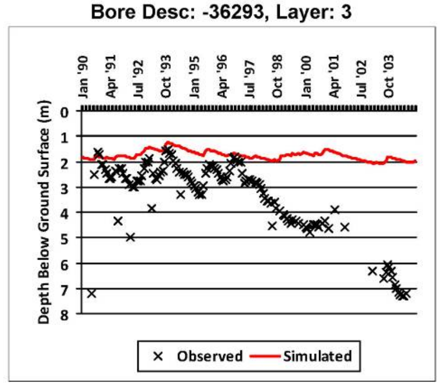

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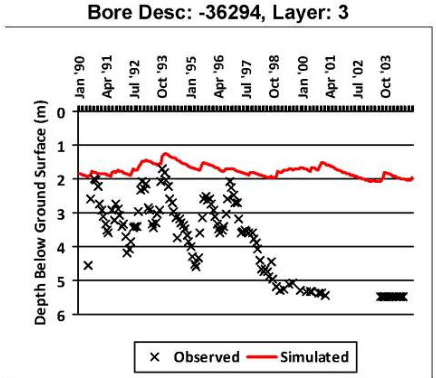

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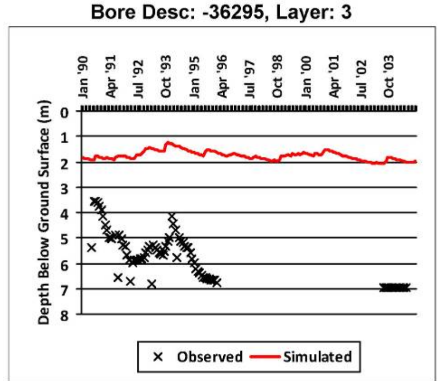

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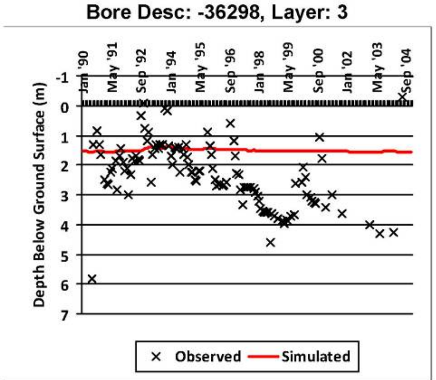

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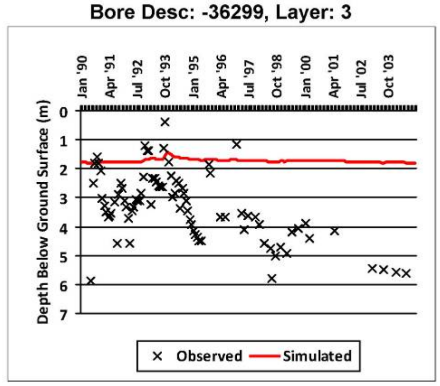

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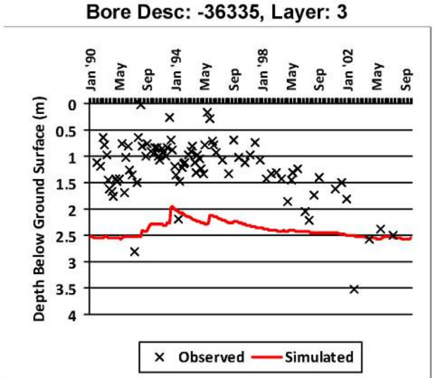

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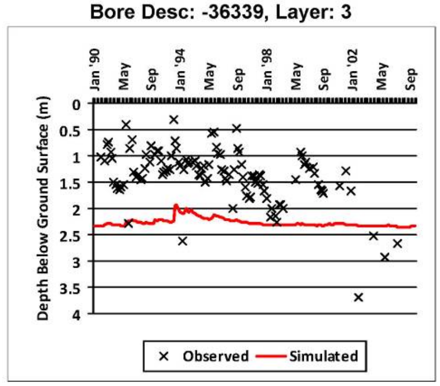

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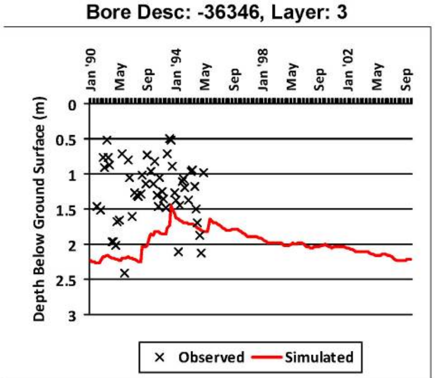

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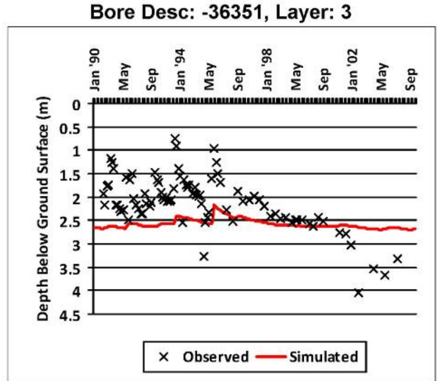
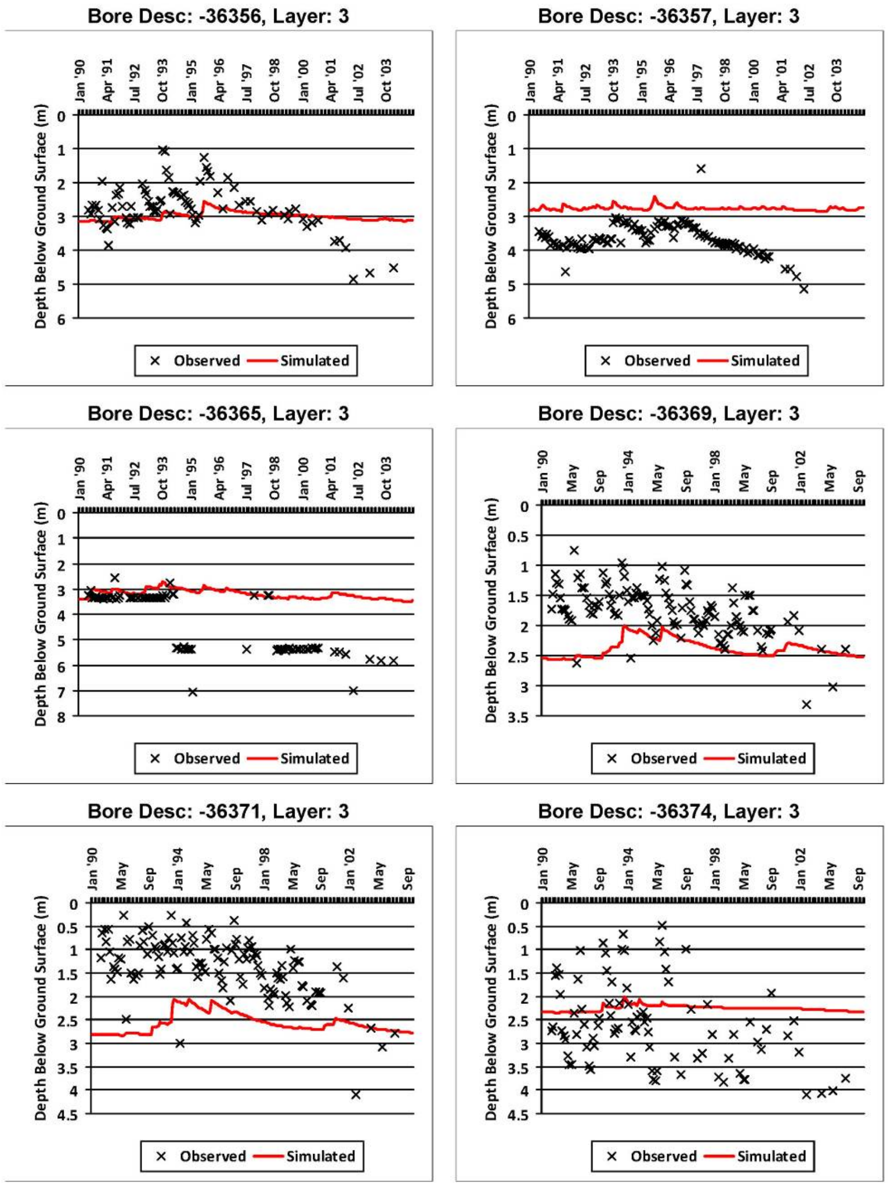
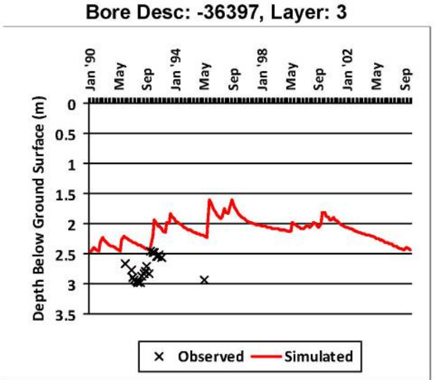



Bore Desc: -36356, Layer: 3
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed
Simulated
Bore Desc: -36357, Layer: 3
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed
Simulated
Bore Desc: -36365, Layer: 3
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed
Simulated
Bore Desc: -36369, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed
Simulated
Bore Desc: -36371, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed
Simulated
Bore Desc: -36374, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed
Simulated

Bore Desc: -36397, Layer: 3



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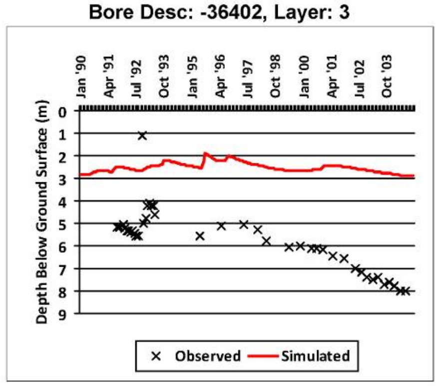

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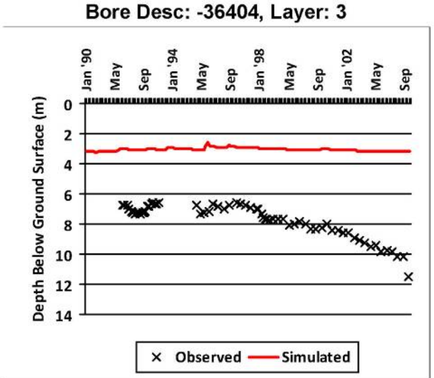

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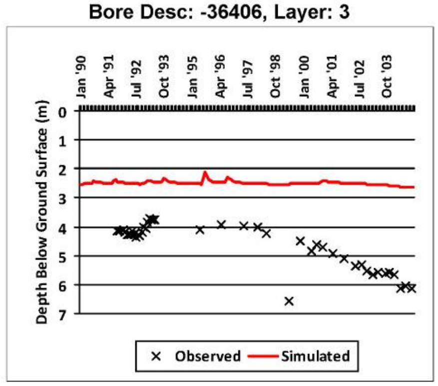

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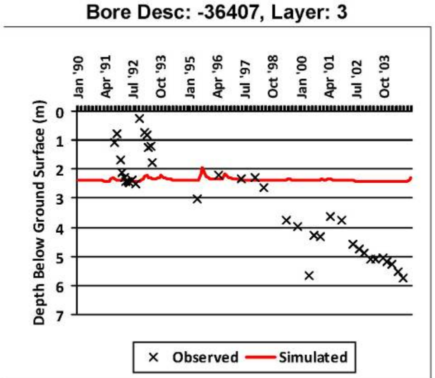

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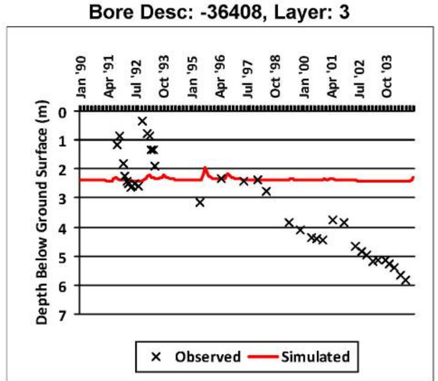

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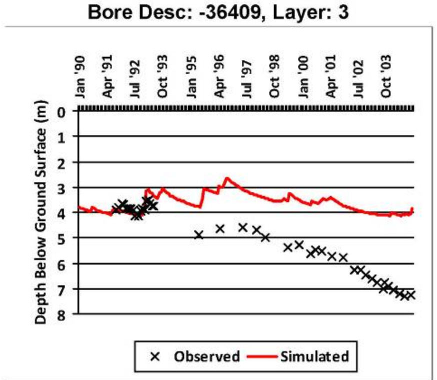

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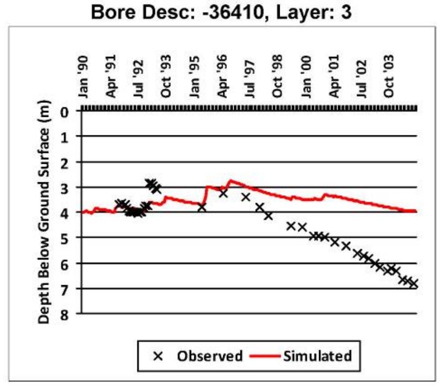

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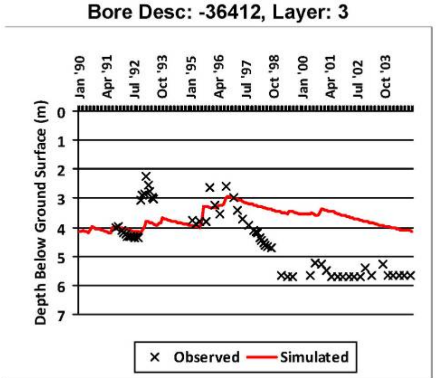

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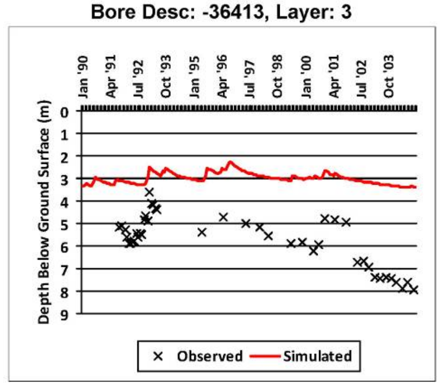

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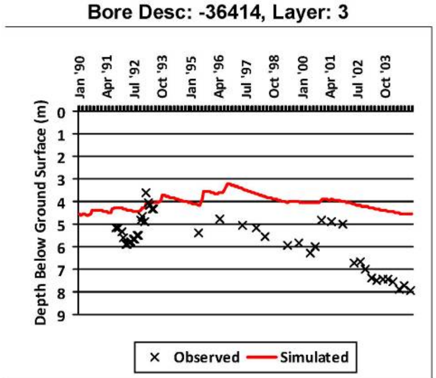

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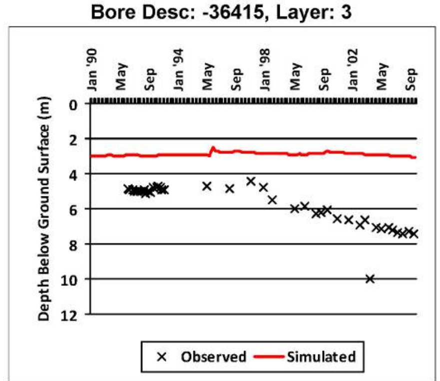

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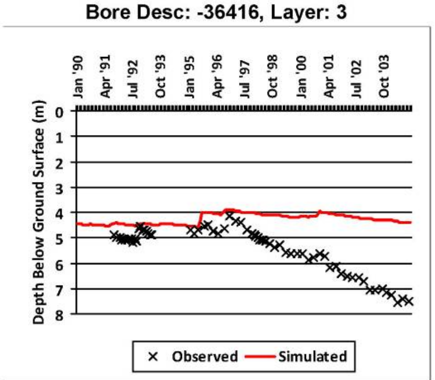

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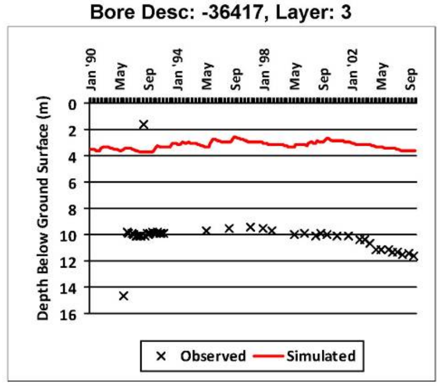

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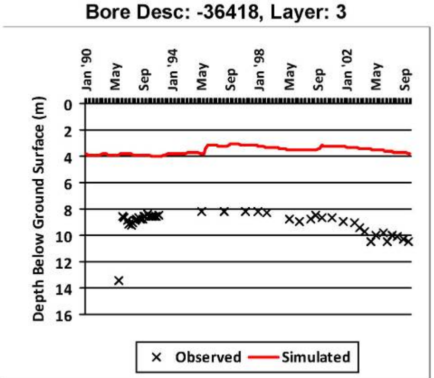

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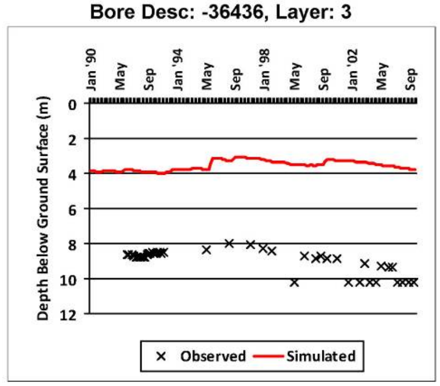

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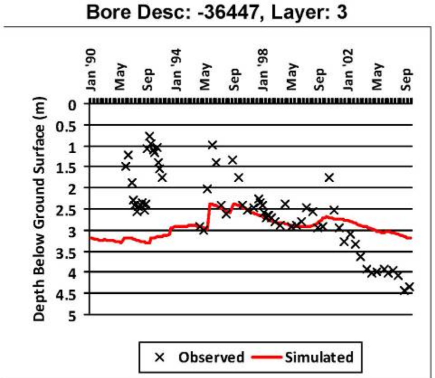

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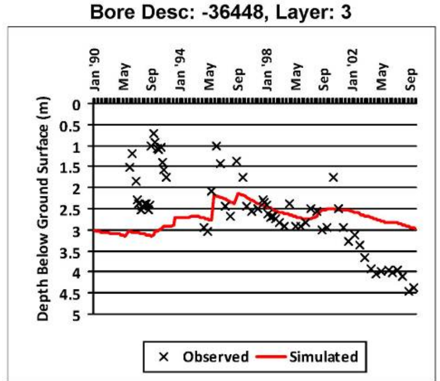

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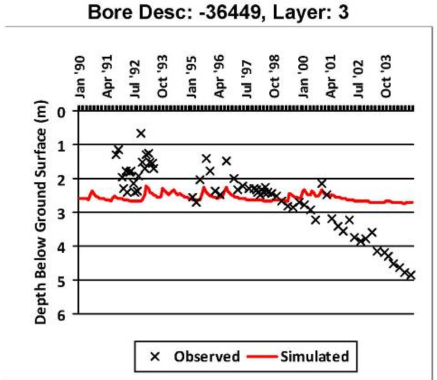

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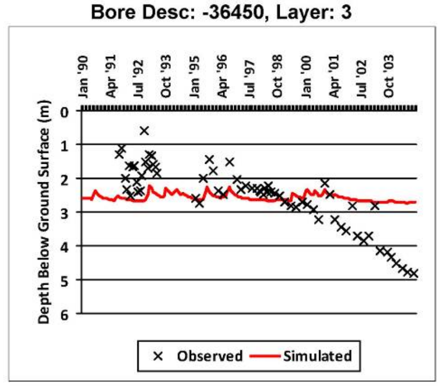

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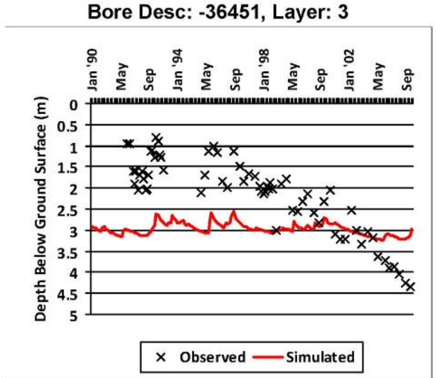

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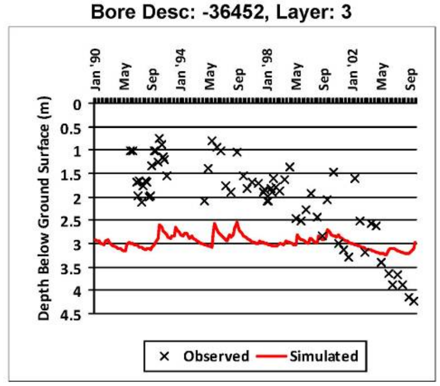

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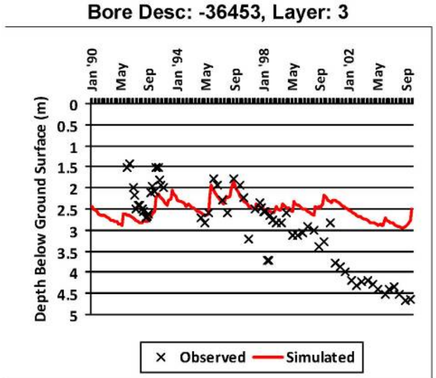

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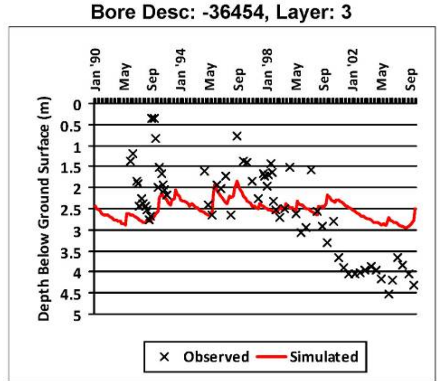

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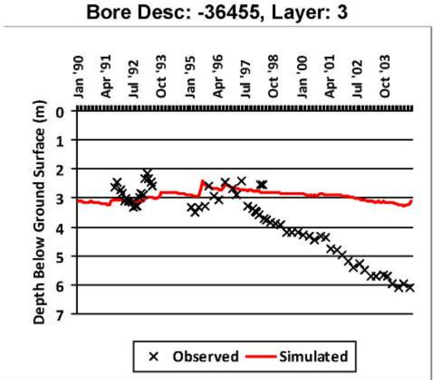

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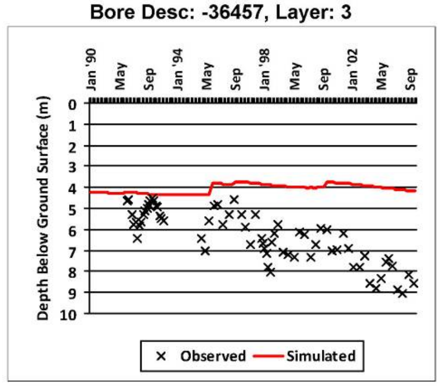

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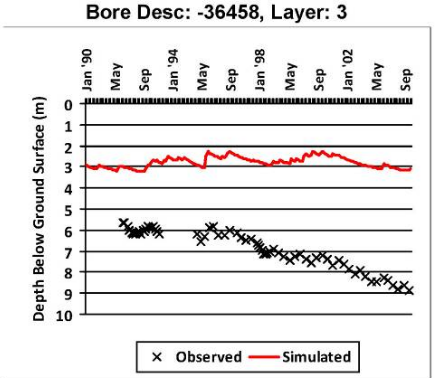

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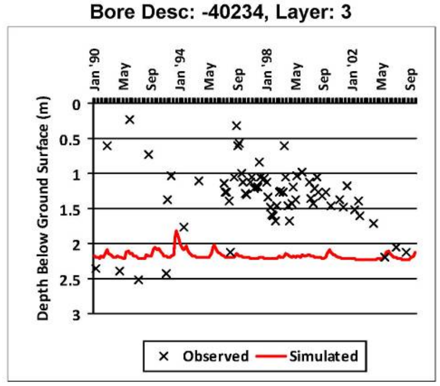

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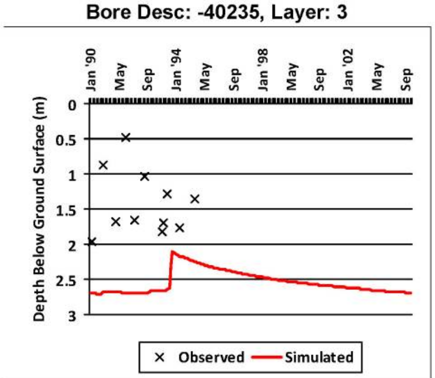

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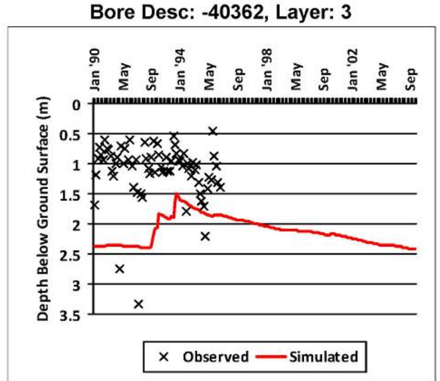

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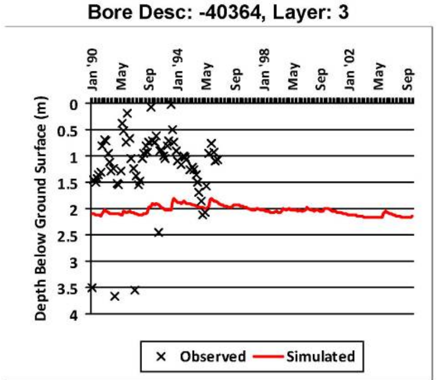

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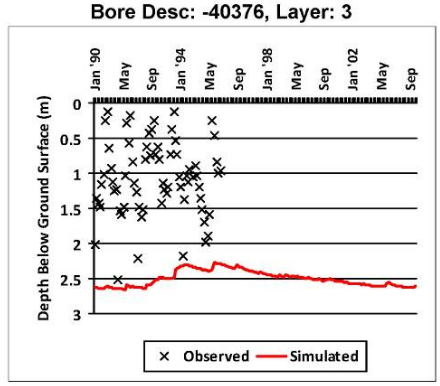

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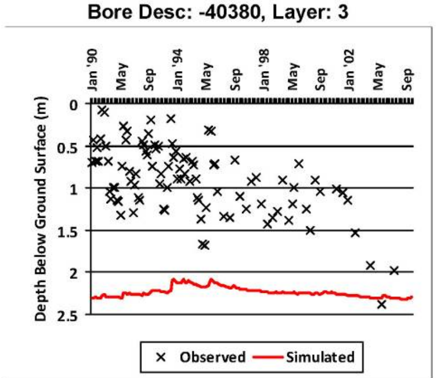

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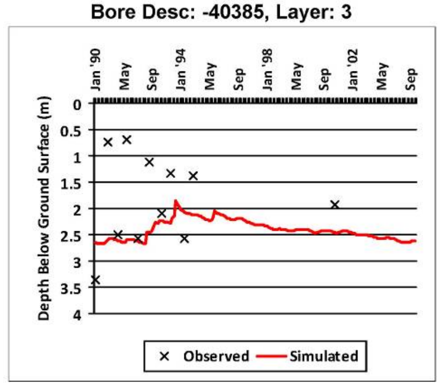

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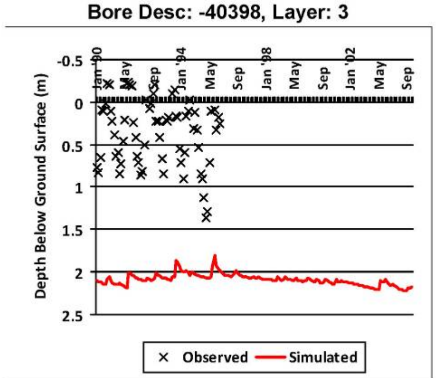

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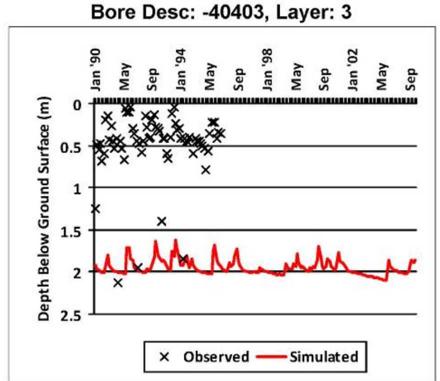

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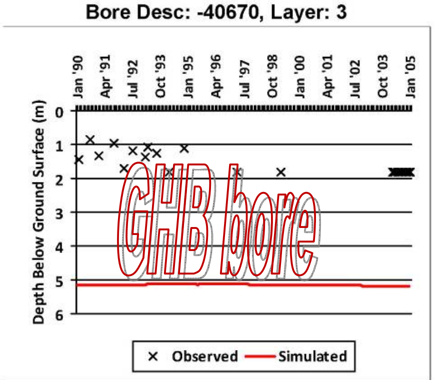

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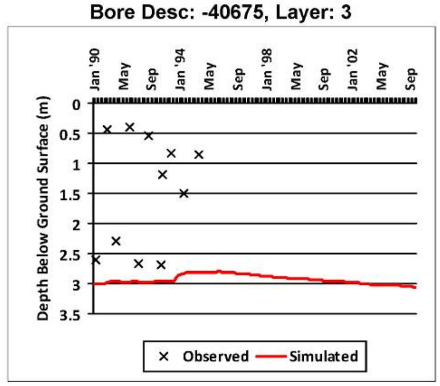

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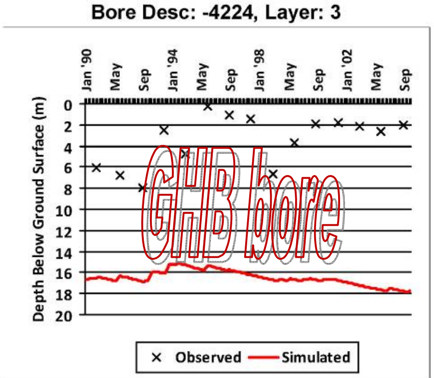

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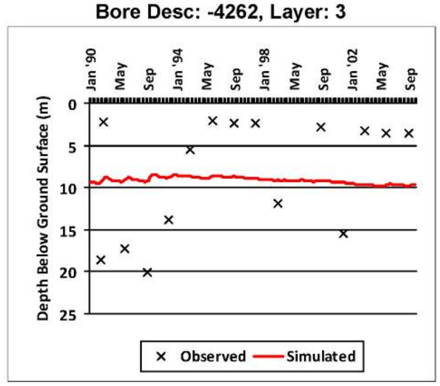

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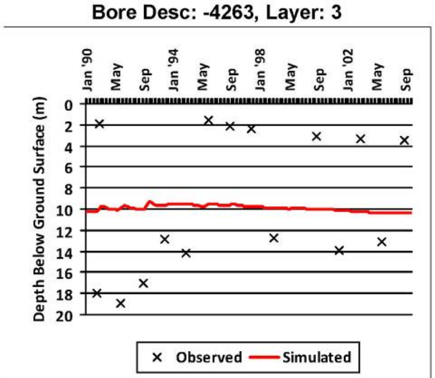

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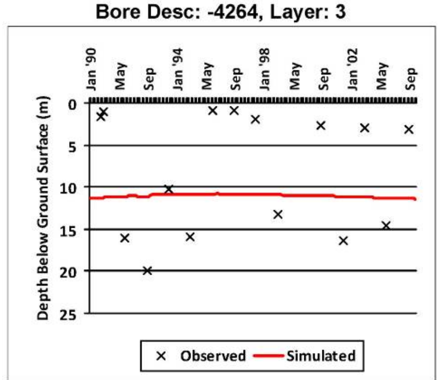
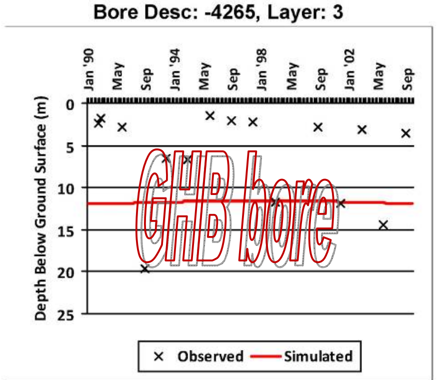
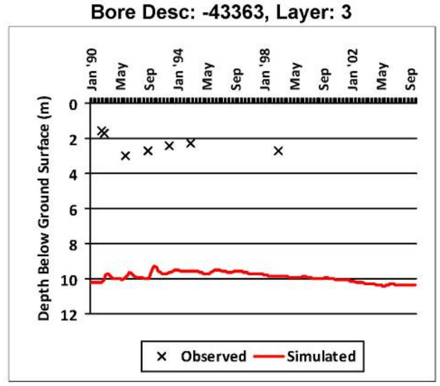


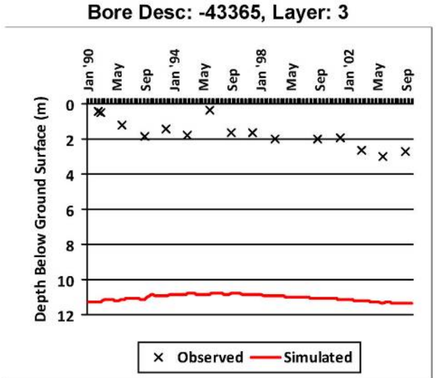
Bore Desc: -4265, Layer: 3



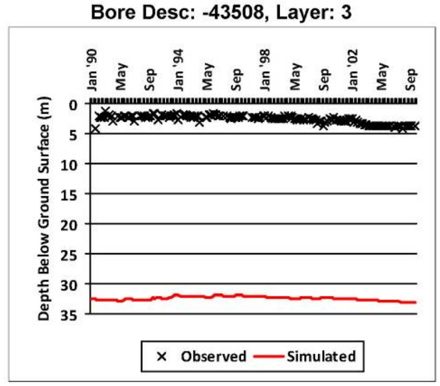
Bore Desc: -43363, Layer: 3



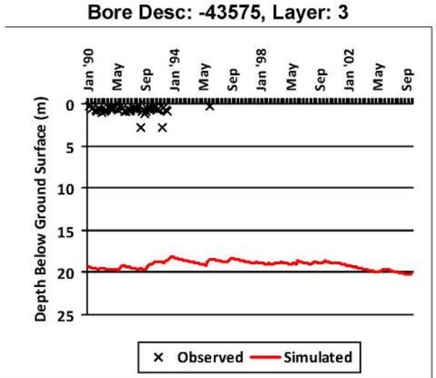
Bore Desc: -43365, Layer: 3



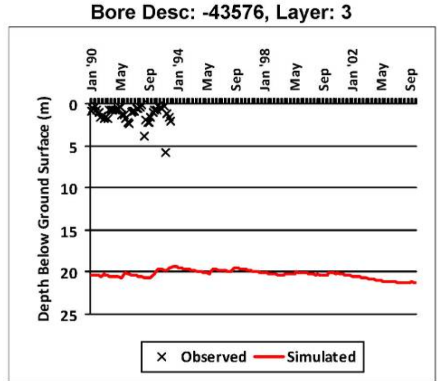
Bore Desc: -43508, Layer: 3

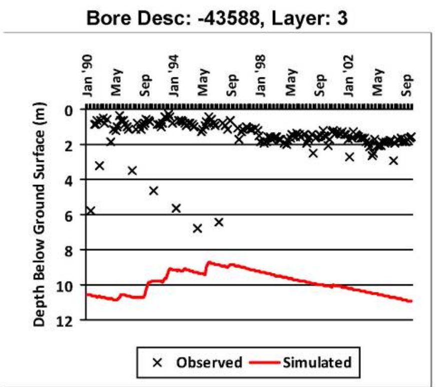


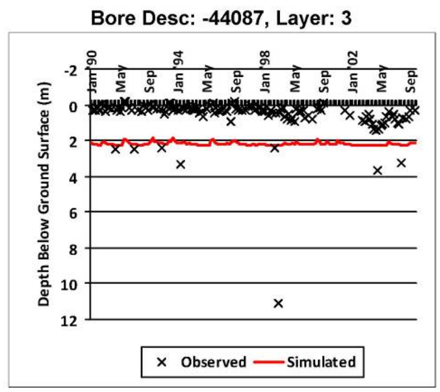
Bore Desc: -43575, Layer: 3

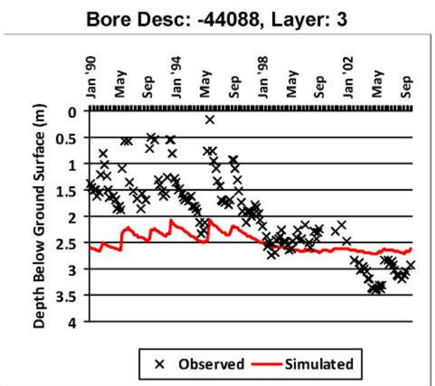


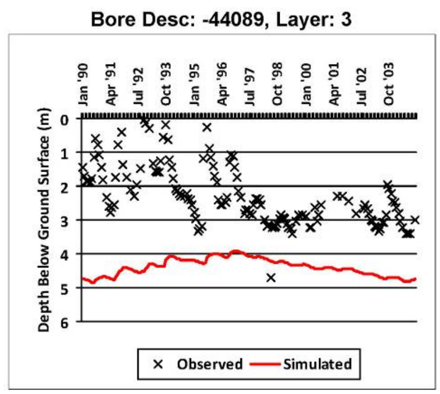
Bore Desc: -43576, Layer: 3

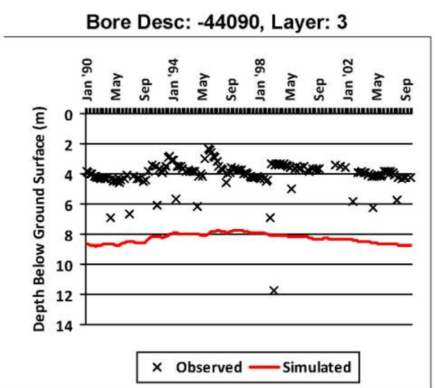


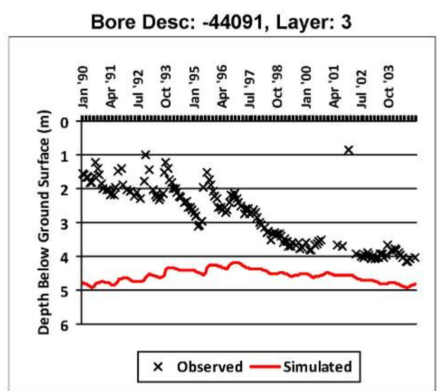

Bore Desc: -43588, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -44087, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

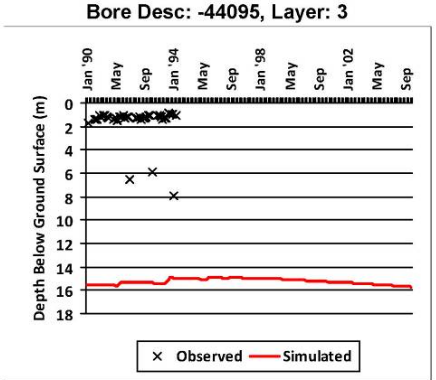

Bore Desc: -44088, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -44089, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

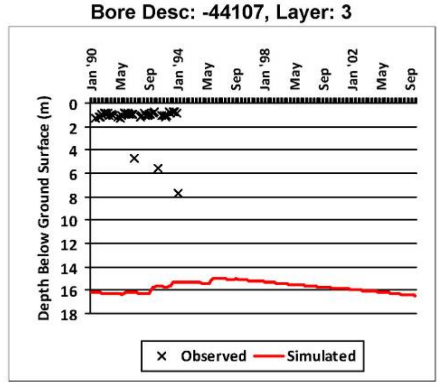

Bore Desc: -44090, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -44091, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

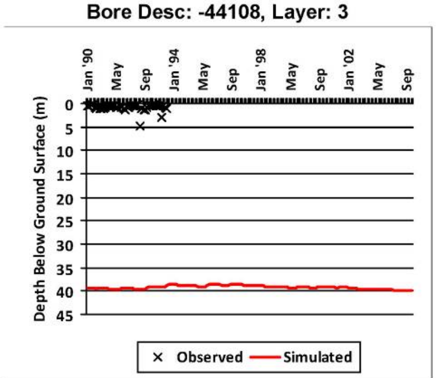
Bore Desc: -44095, Layer: 3



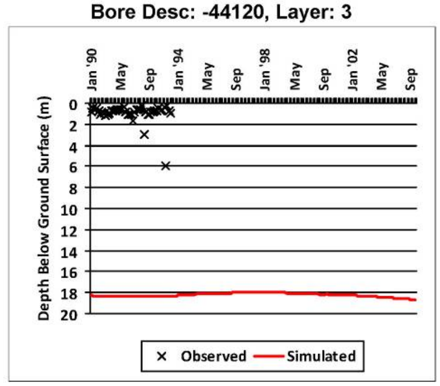
Bore Desc: -44107, Layer: 3



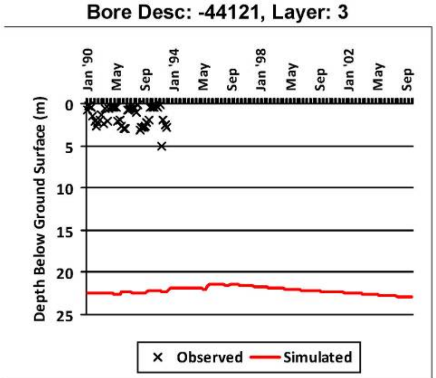
Bore Desc: -44108, Layer: 3



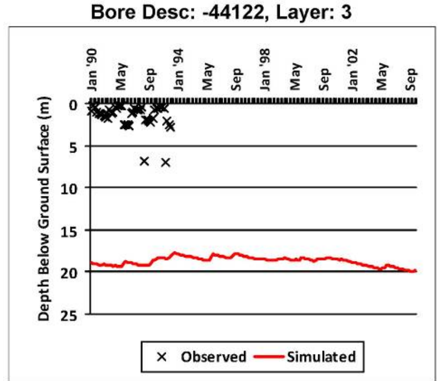
Bore Desc: -44120, Layer: 3



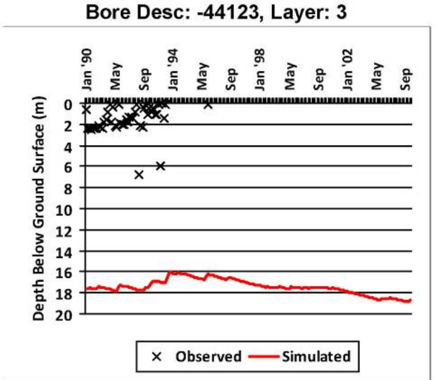
Bore Desc: -44121, Layer: 3



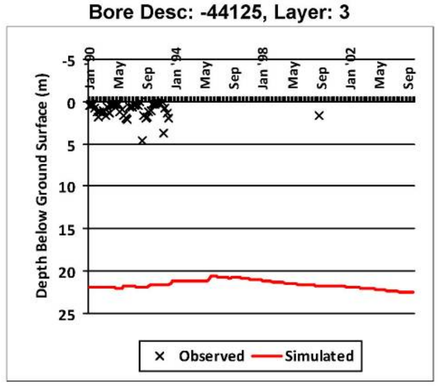
Bore Desc: -44122, Layer: 3



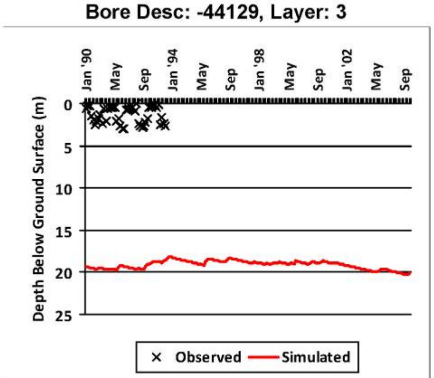
Bore Desc: -44123, Layer: 3



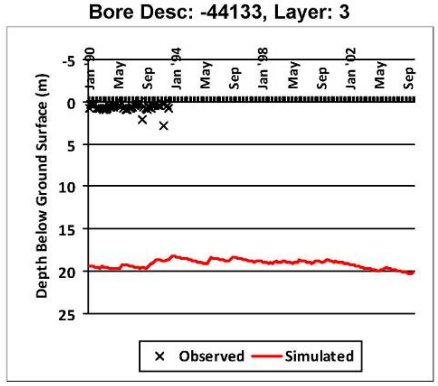
Bore Desc: -44125, Layer: 3



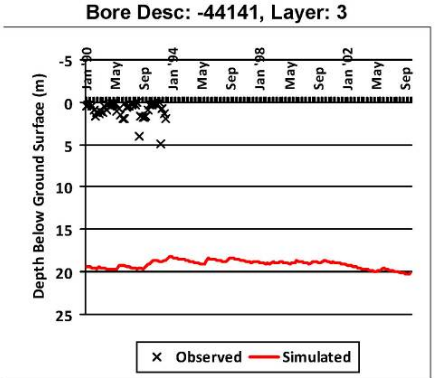
Bore Desc: -44129, Layer: 3



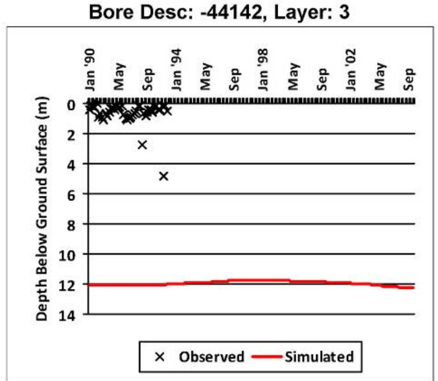
Bore Desc: -44133, Layer: 3



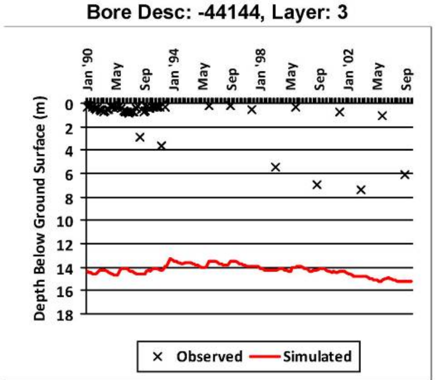
Bore Desc: -44141, Layer: 3



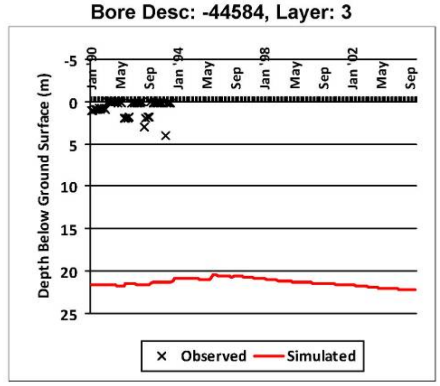
Bore Desc: -44142, Layer: 3



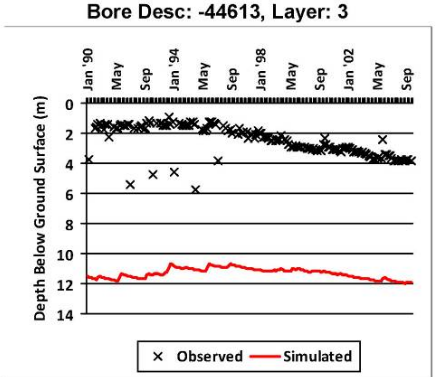
Bore Desc: -44144, Layer: 3



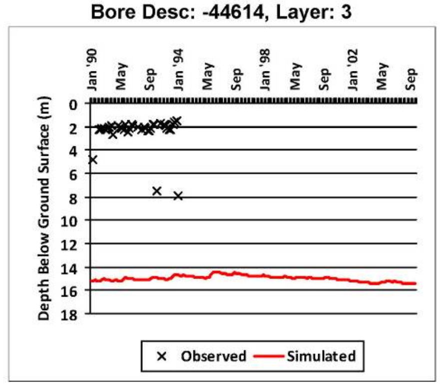
Bore Desc: -44584, Layer: 3



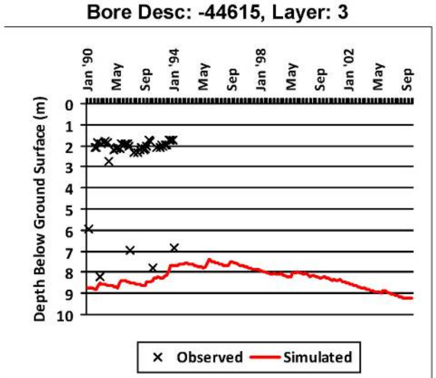
Bore Desc: -44613, Layer: 3



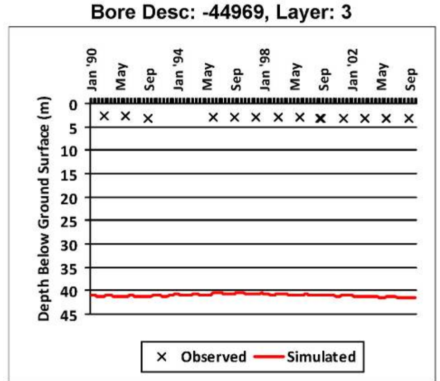
Bore Desc: -44614, Layer: 3



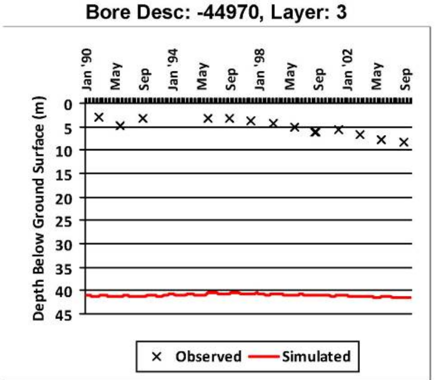
Bore Desc: -44615, Layer: 3



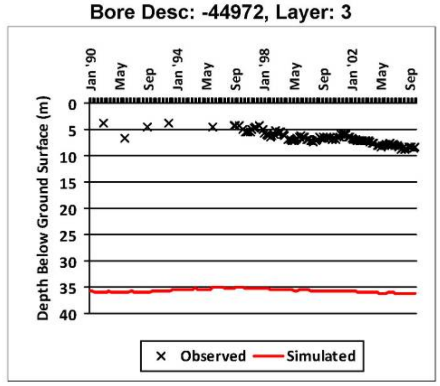
Bore Desc: -44969, Layer: 3



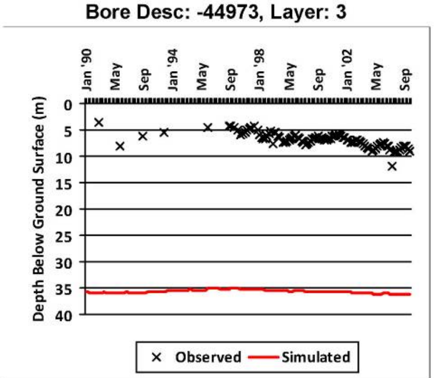
Bore Desc: -44970, Layer: 3



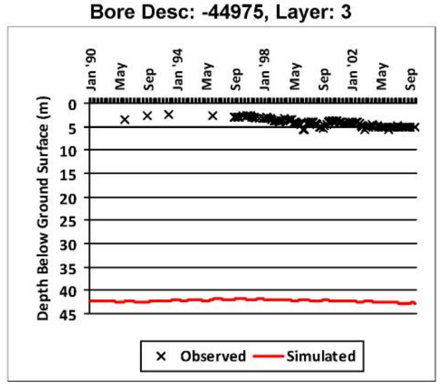
Bore Desc: -44972, Layer: 3



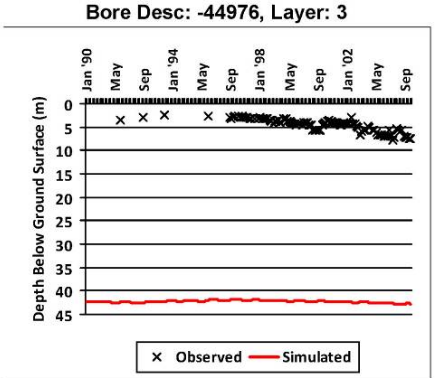
Bore Desc: -44973, Layer: 3



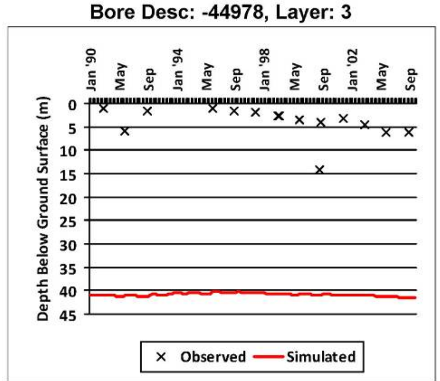
Bore Desc: -44975, Layer: 3



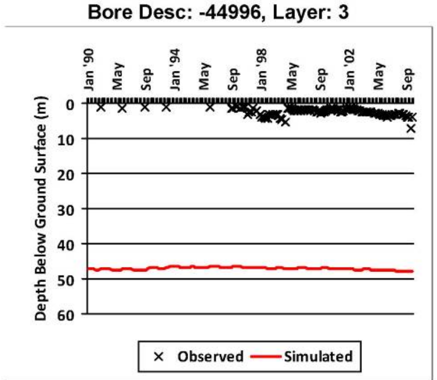
Bore Desc: -44976, Layer: 3



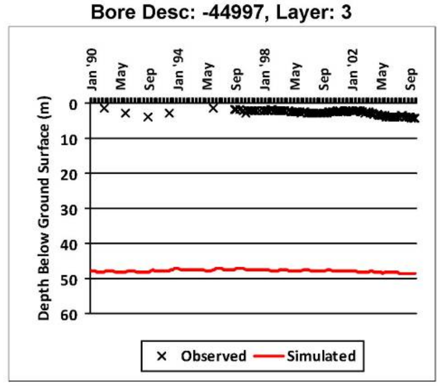
Bore Desc: -44978, Layer: 3



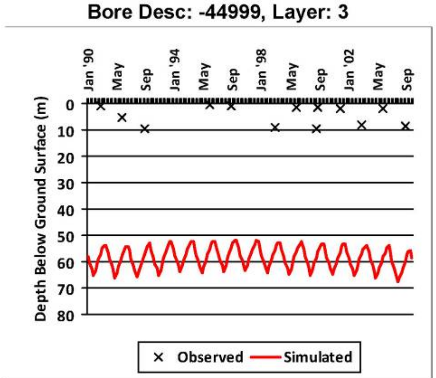
Bore Desc: -44996, Layer: 3



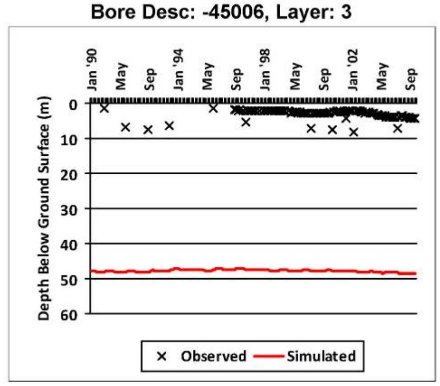
Bore Desc: -44997, Layer: 3



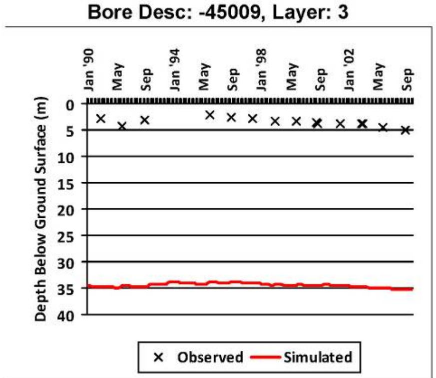
Bore Desc: -44999, Layer: 3



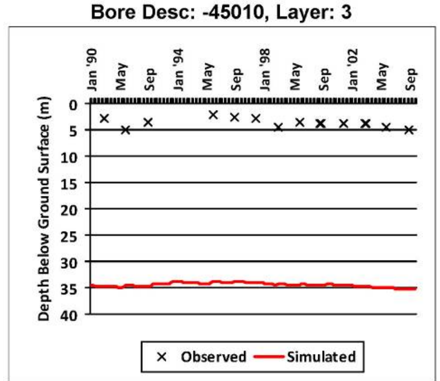
Bore Desc: -45006, Layer: 3



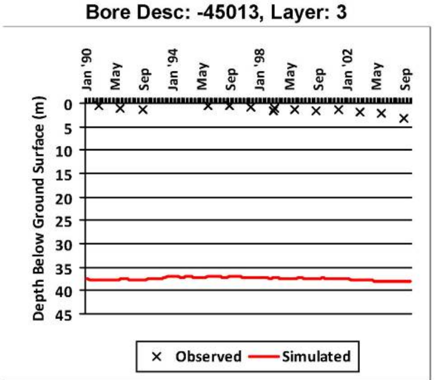
Bore Desc: -45009, Layer: 3



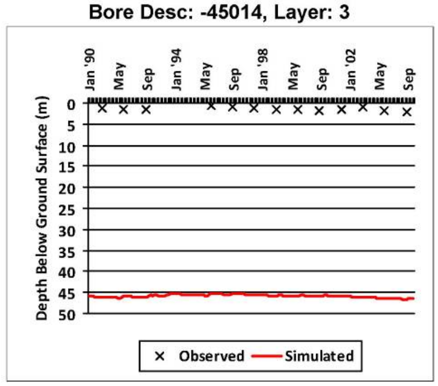
Bore Desc: -45010, Layer: 3



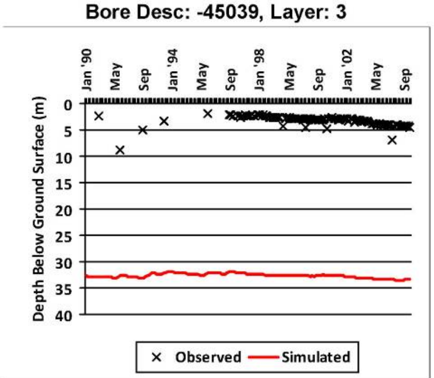
Bore Desc: -45013, Layer: 3



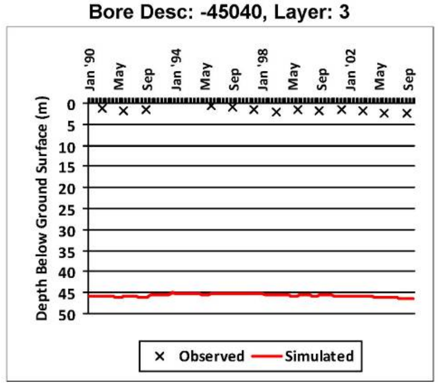
Bore Desc: -45014, Layer: 3



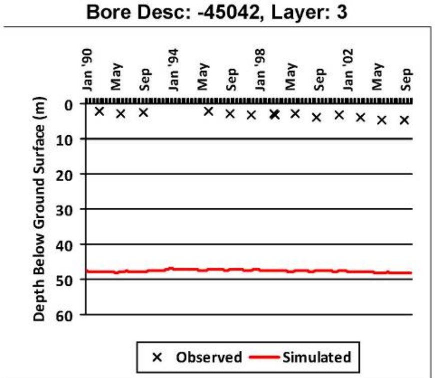
Bore Desc: -45039, Layer: 3



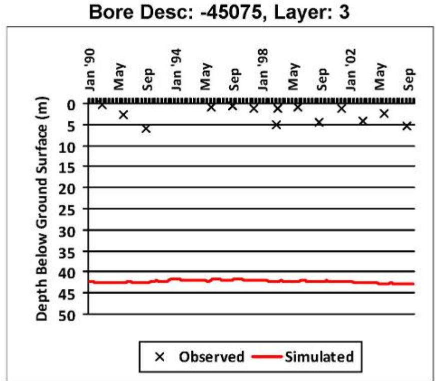
Bore Desc: -45040, Layer: 3



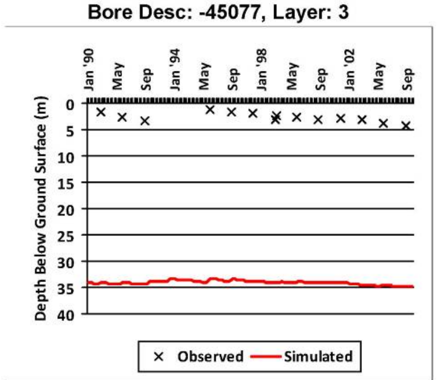
Bore Desc: -45042, Layer: 3



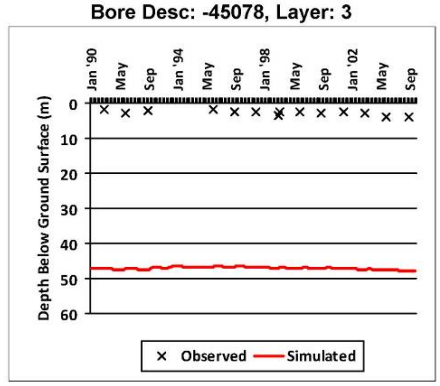
Bore Desc: -45075, Layer: 3



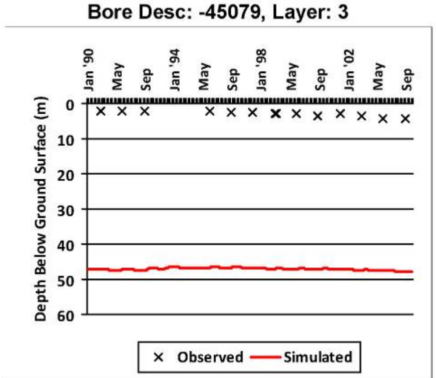
Bore Desc: -45077, Layer: 3



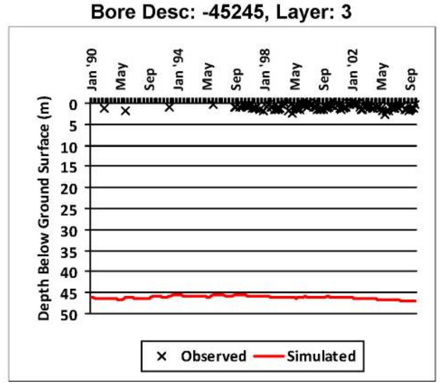
Bore Desc: -45078, Layer: 3



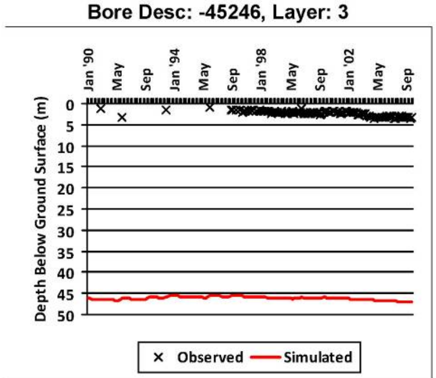
Bore Desc: -45079, Layer: 3



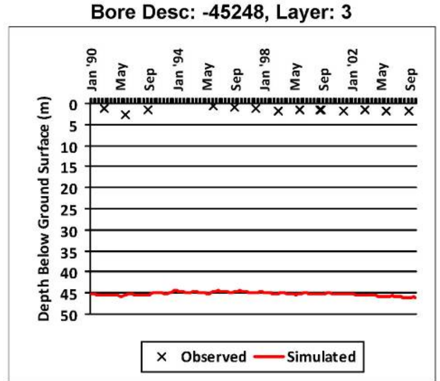
Bore Desc: -45245, Layer: 3

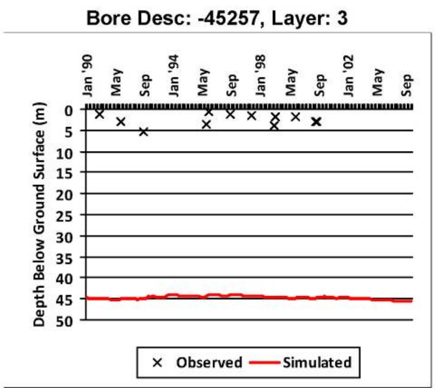


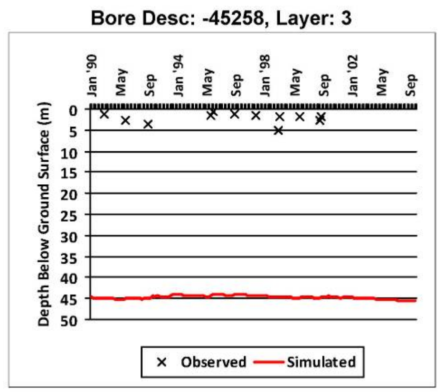
Bore Desc: -45246, Layer: 3

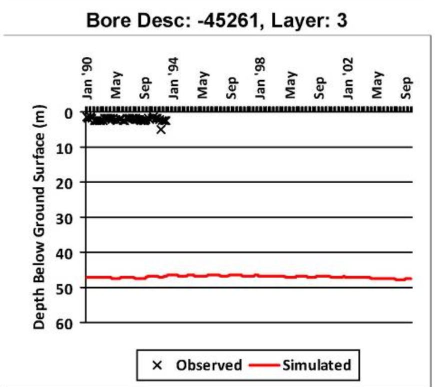


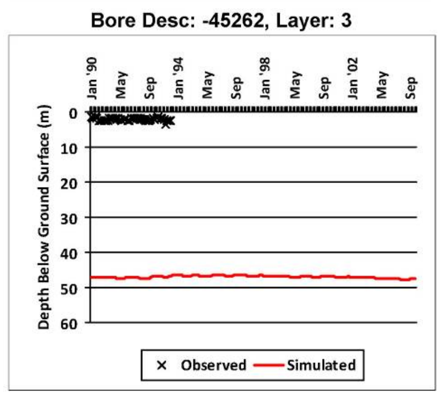
Bore Desc: -45248, Layer: 3

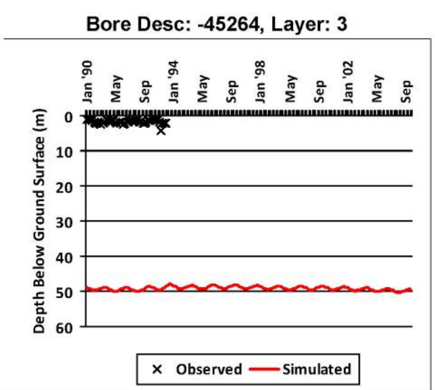


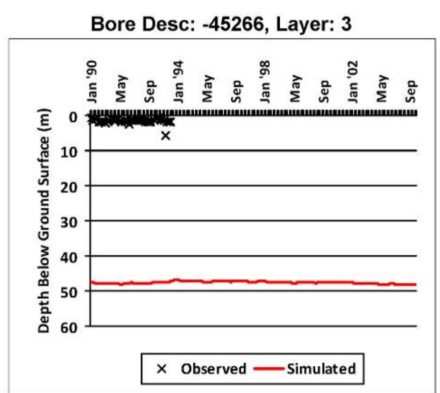

Bore Desc: -45257, Layer: 3
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
5
10
15
20
25
30
35
40
45
50
Observed
Simulated

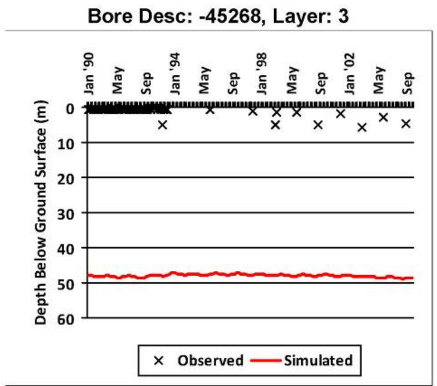

Bore Desc: -45258, Layer: 3
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
5
10
15
20
25
30
35
40
45
50
Observed
Simulated

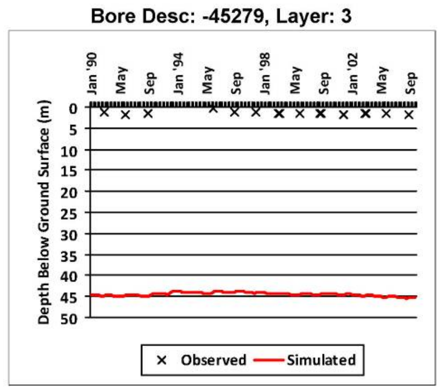

Bore Desc: -45261, Layer: 3
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
10
20
30
40
50
60
Observed
Simulated

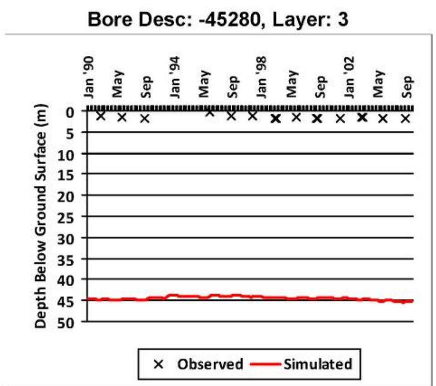

Bore Desc: -45262, Layer: 3
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
10
20
30
40
50
60
Observed
Simulated

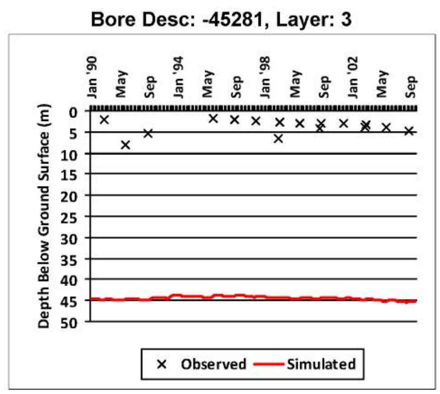

Bore Desc: -45264, Layer: 3
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
10
20
30
40
50
60
Observed
Simulated

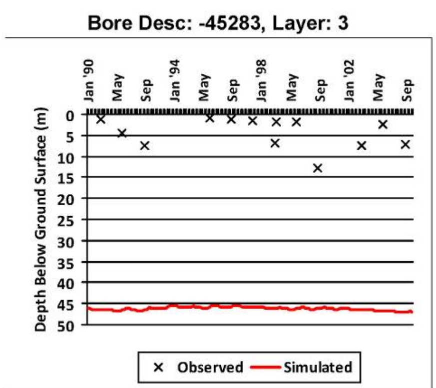

Bore Desc: -45266, Layer: 3
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
10
20
30
40
50
60
Observed
Simulated

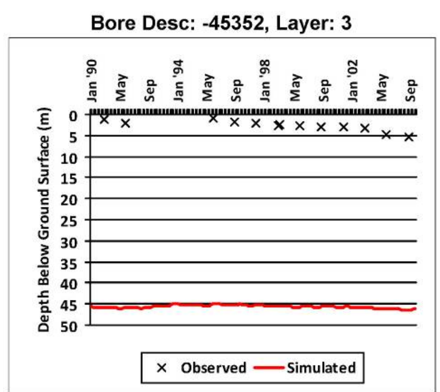

Bore Desc: -45268, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -45279, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

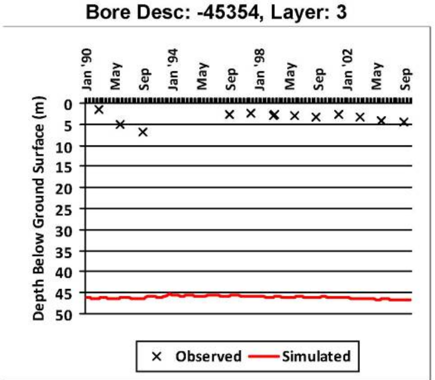

Bore Desc: -45280, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -45281, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

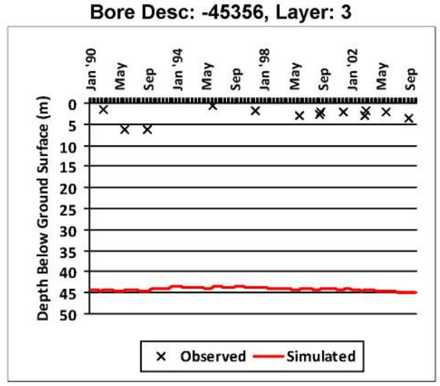

Bore Desc: -45283, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -45352, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

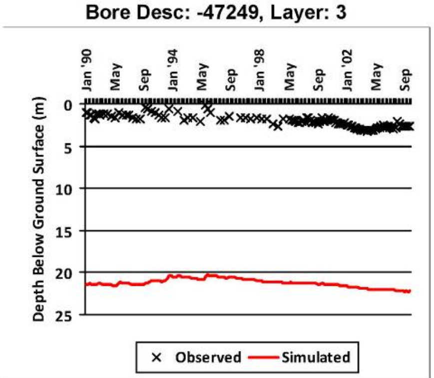
Bore Desc: -45354, Layer: 3



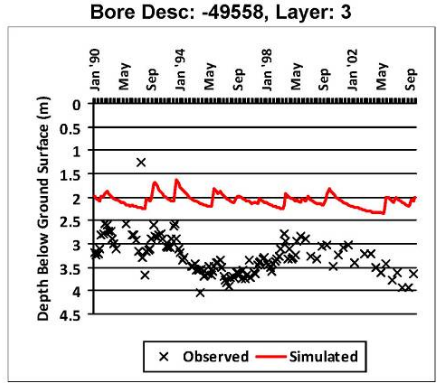
Bore Desc: -45356, Layer: 3



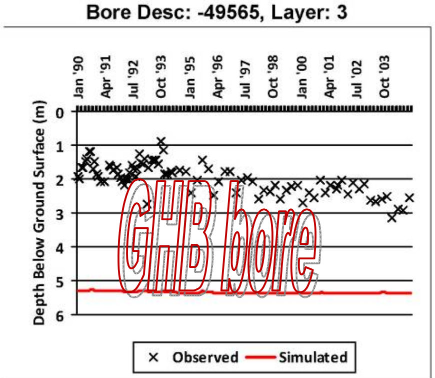
Bore Desc: -47249, Layer: 3



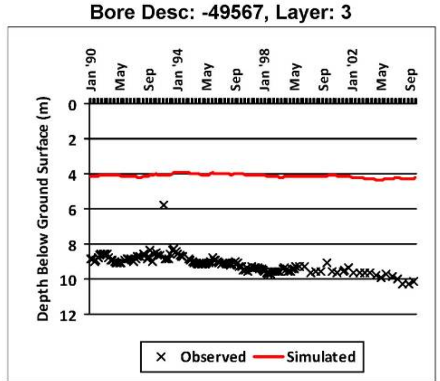
Bore Desc: -49558, Layer: 3



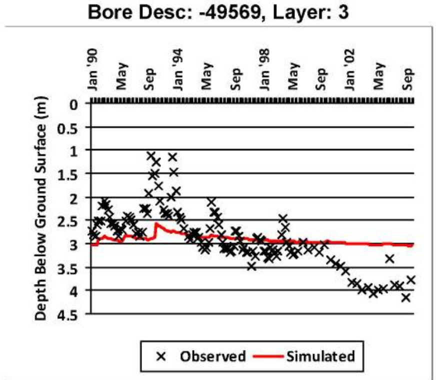
Bore Desc: -49565, Layer: 3



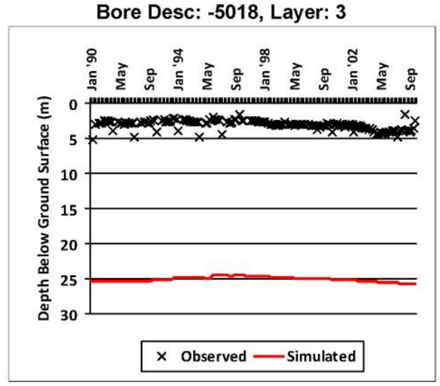
Bore Desc: -49567, Layer: 3



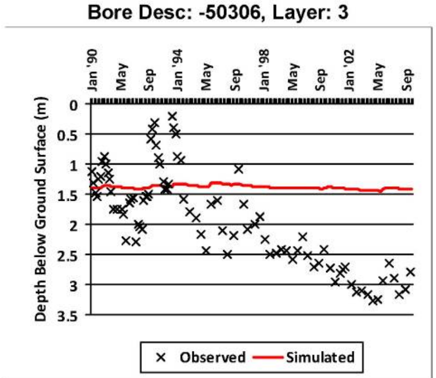
Bore Desc: -49569, Layer: 3



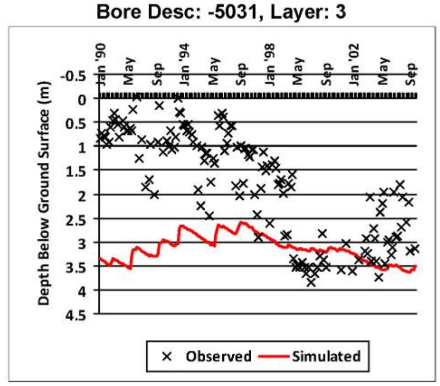
Bore Desc: -5018, Layer: 3



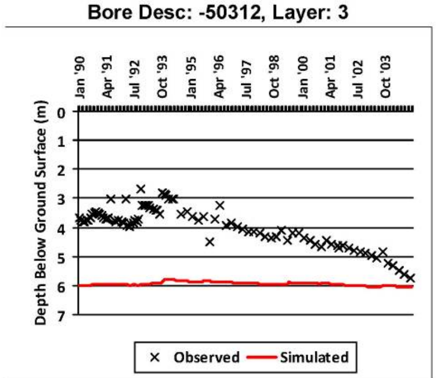
Bore Desc: -50306, Layer: 3



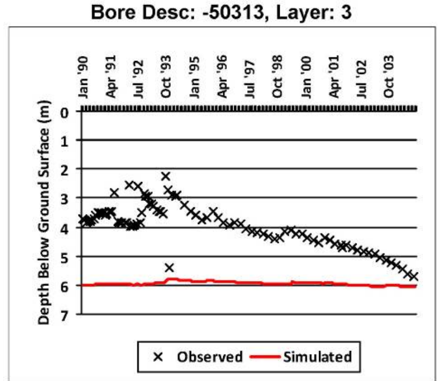
Bore Desc: -5031, Layer: 3



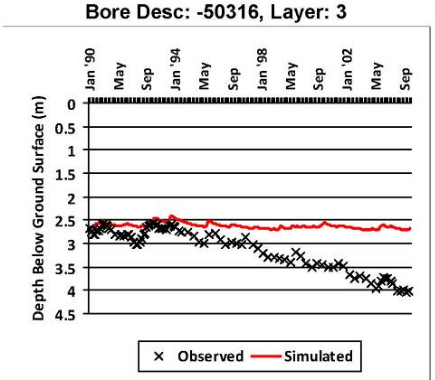
Bore Desc: -50312, Layer: 3



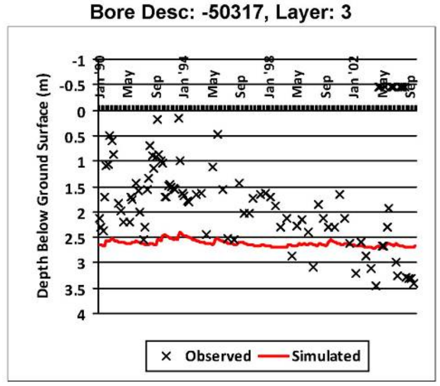
Bore Desc: -50313, Layer: 3



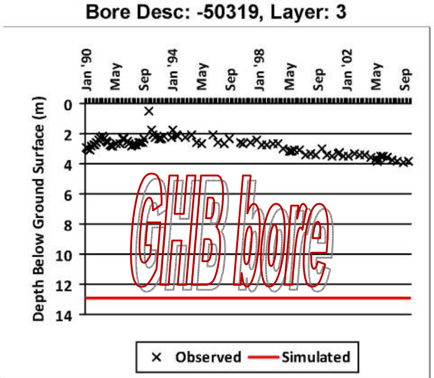
Bore Desc: -50316, Layer: 3



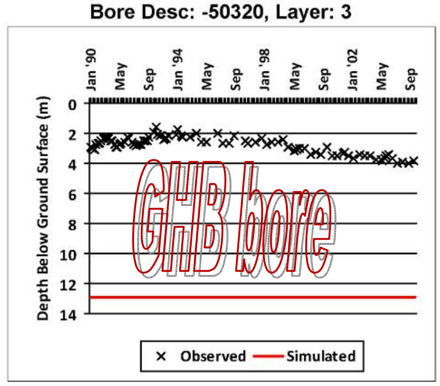
Bore Desc: -50317, Layer: 3



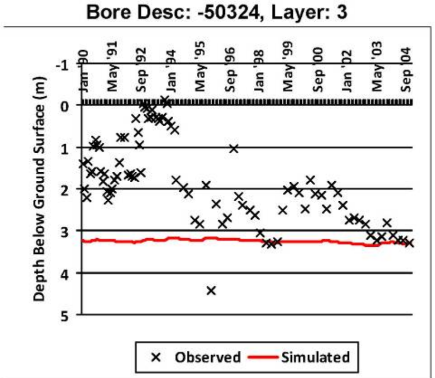
Bore Desc: -50319, Layer: 3



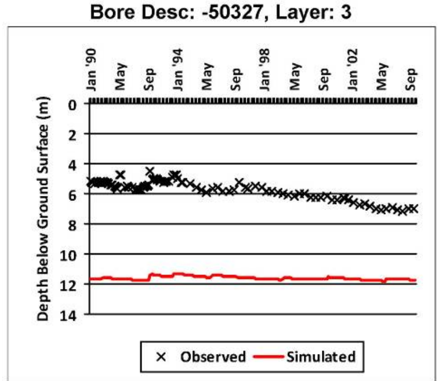
Bore Desc: -50320, Layer: 3



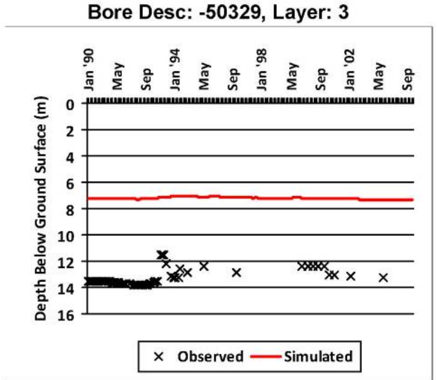
Bore Desc: -50324, Layer: 3



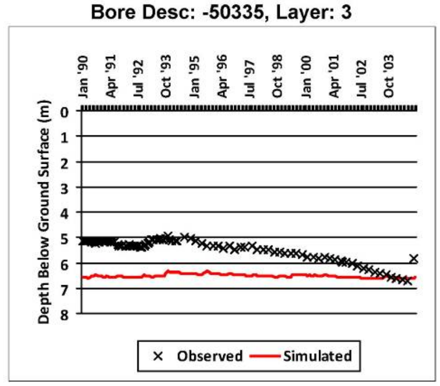
Bore Desc: -50327, Layer: 3



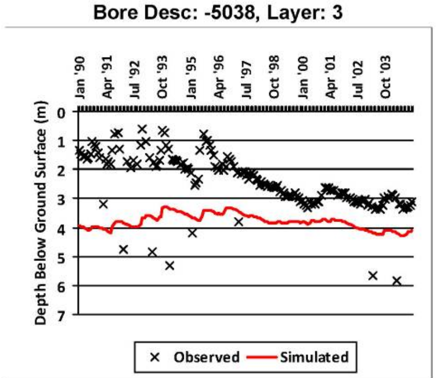
Bore Desc: -50329, Layer: 3



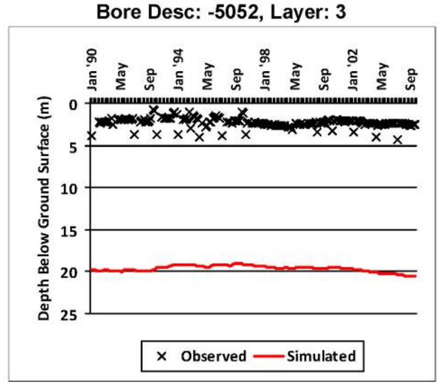
Bore Desc: -50335, Layer: 3



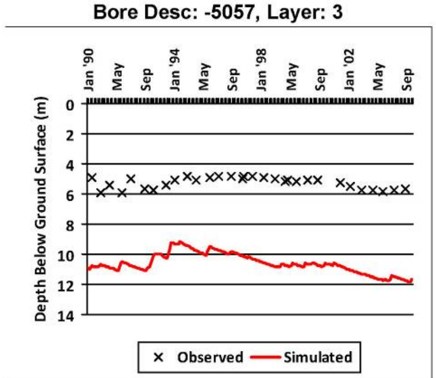
Bore Desc: -5038, Layer: 3



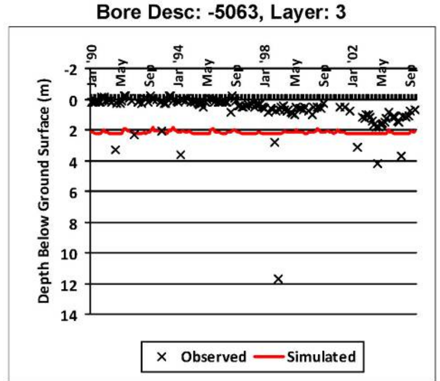
Bore Desc: -5052, Layer: 3



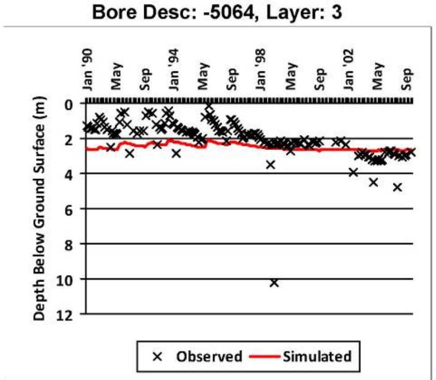
Bore Desc: -5057, Layer: 3



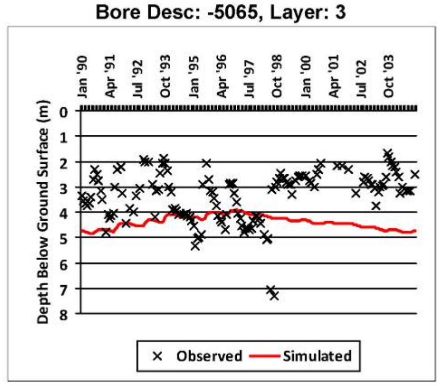
Bore Desc: -5063, Layer: 3



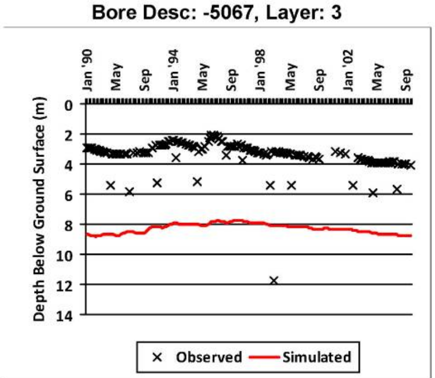
Bore Desc: -5064, Layer: 3



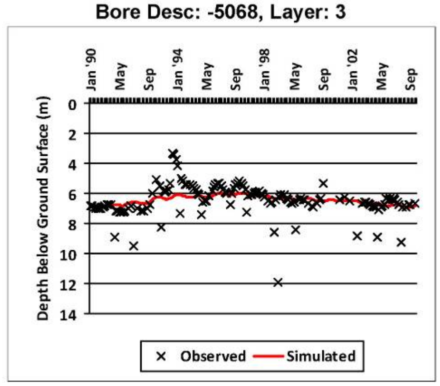
Bore Desc: -5065, Layer: 3



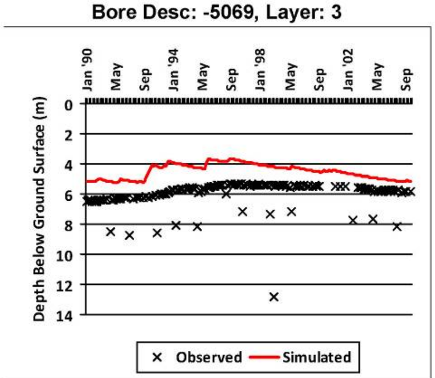
Bore Desc: -5067, Layer: 3



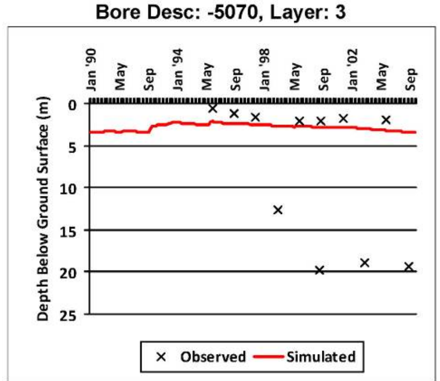
Bore Desc: -5068, Layer: 3



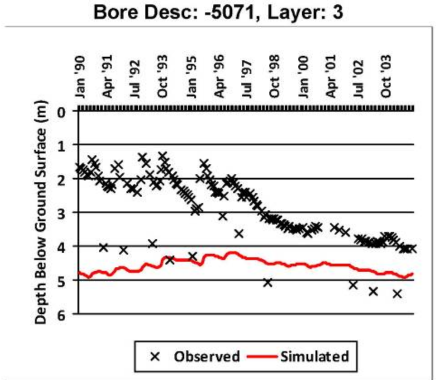
Bore Desc: -5069, Layer: 3



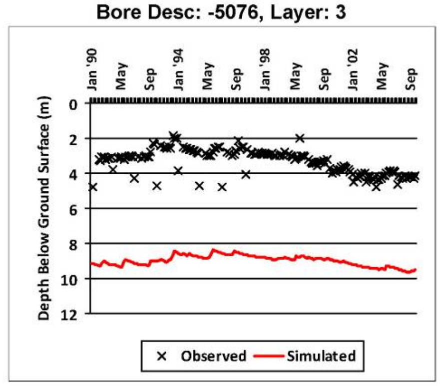
Bore Desc: -5070, Layer: 3



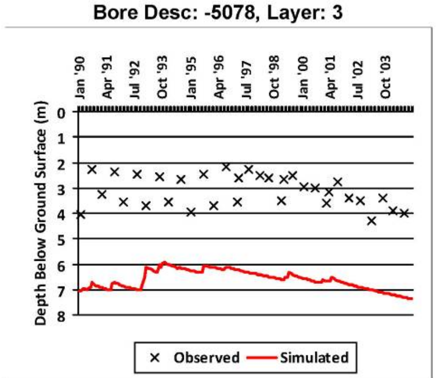
Bore Desc: -5071, Layer: 3



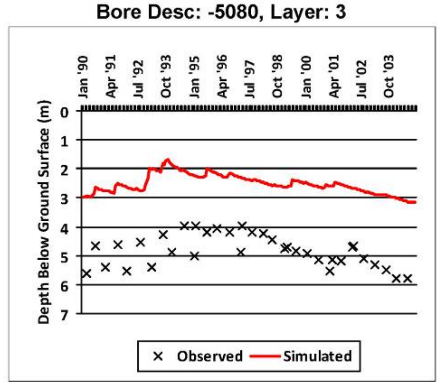
Bore Desc: -5076, Layer: 3



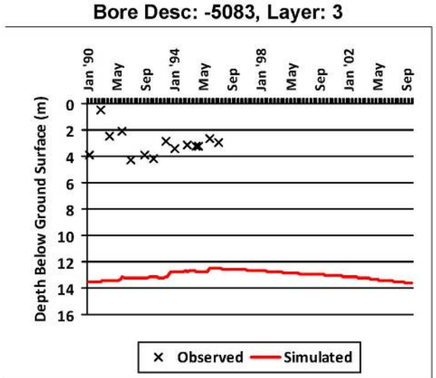
Bore Desc: -5078, Layer: 3



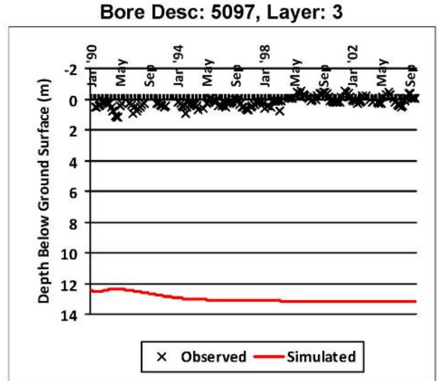
Bore Desc: -5080, Layer: 3



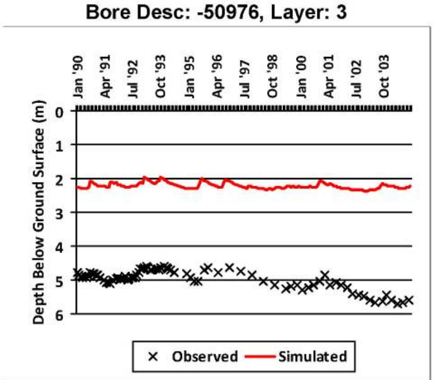
Bore Desc: -5083, Layer: 3



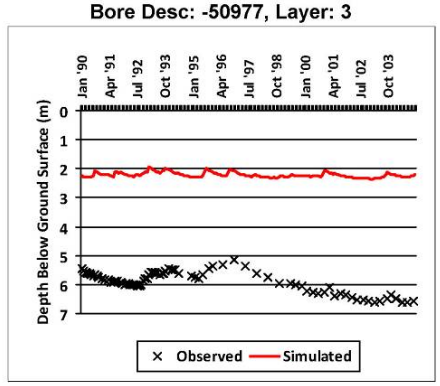
Bore Desc: 5097, Layer: 3



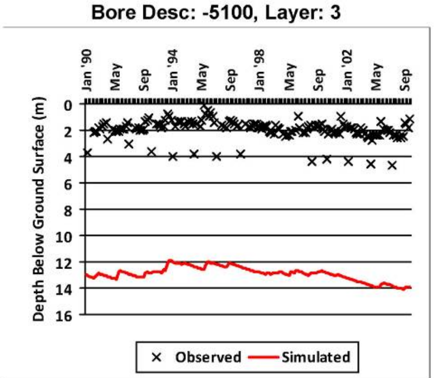
Bore Desc: -50976, Layer: 3



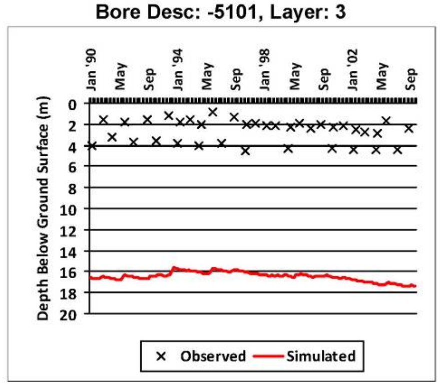
Bore Desc: -50977, Layer: 3



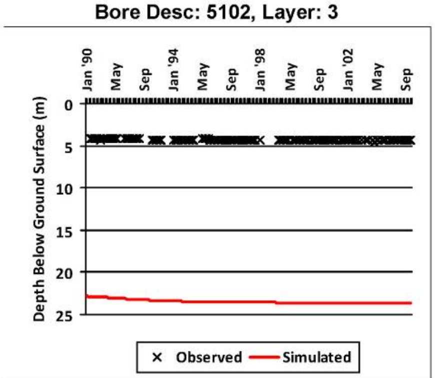
Bore Desc: -5100, Layer: 3



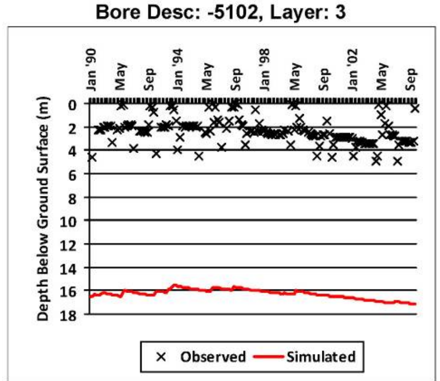
Bore Desc: -5101, Layer: 3

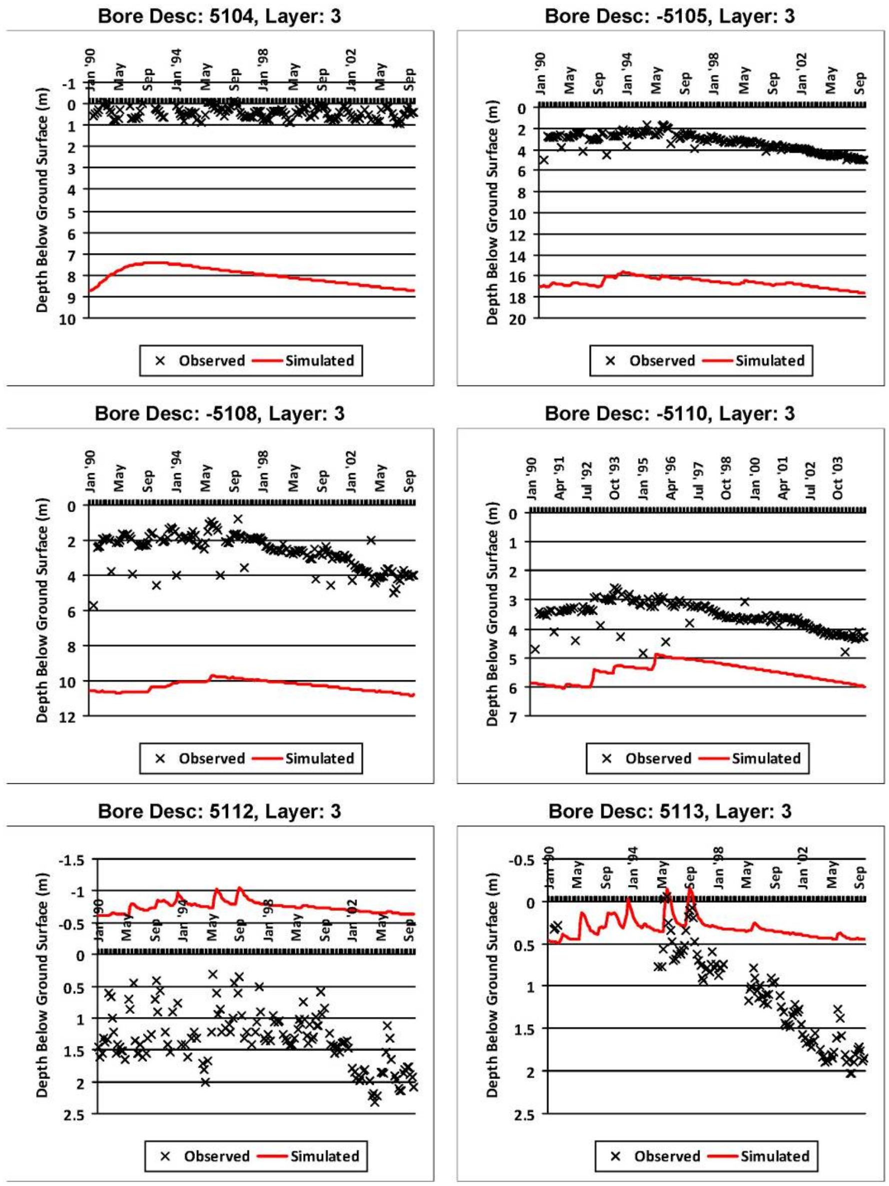


Bore Desc: 5102, Layer: 3

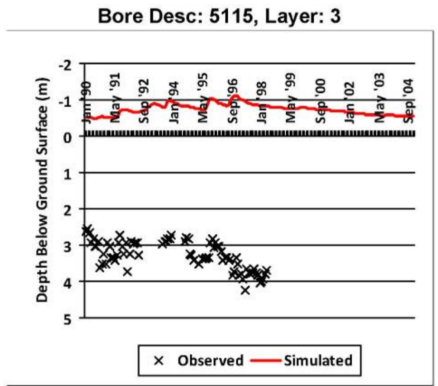


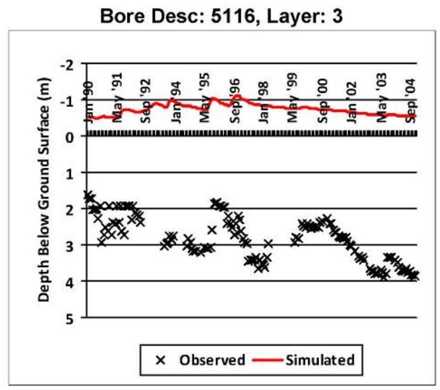
Bore Desc: -5102, Layer: 3

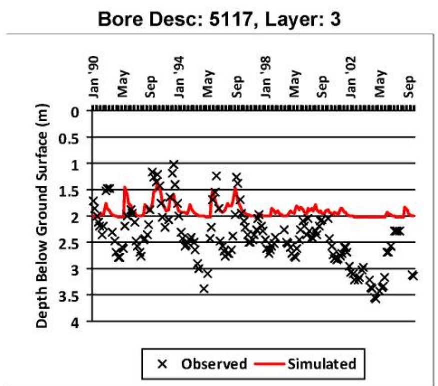


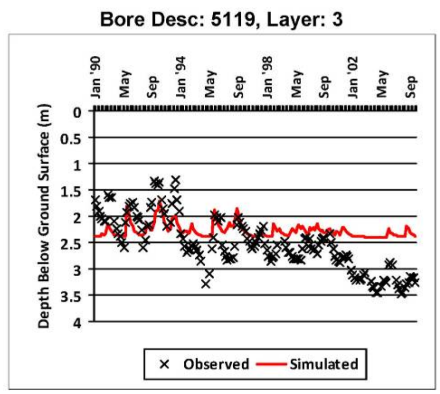


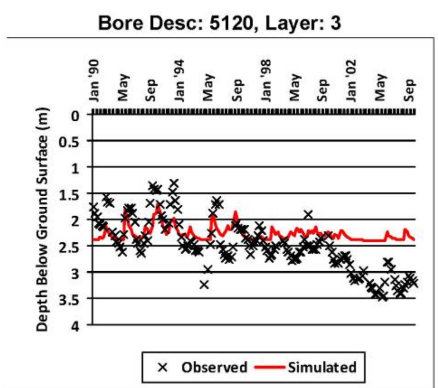
Bore Desc: 5104, Layer: 3
Bore Desc: -5105, Layer: 3
Bore Desc: -5108, Layer: 3
Bore Desc: -5110, Layer: 3
Bore Desc: 5112, Layer: 3
Bore Desc: 5113, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

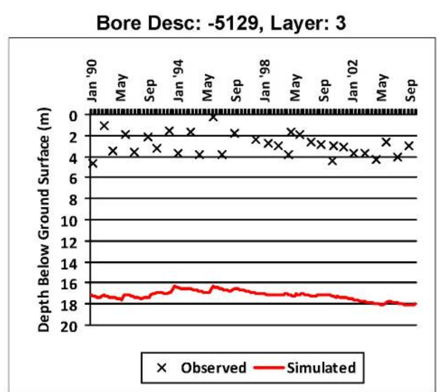

Bore Desc: 5115, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5116, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

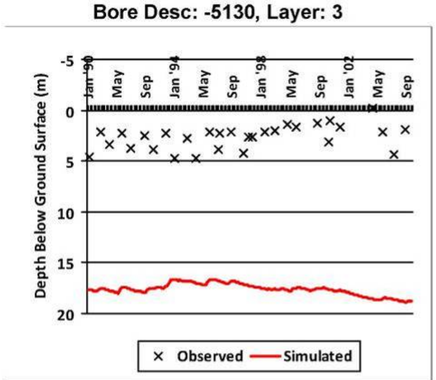

Bore Desc: 5117, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5119, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

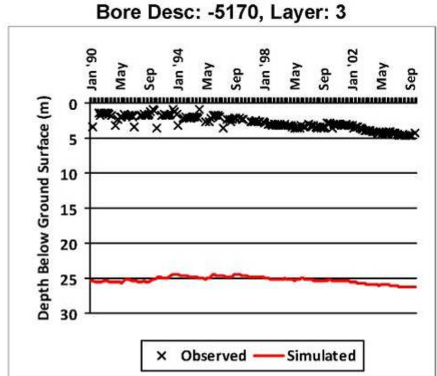

Bore Desc: 5120, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -5129, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

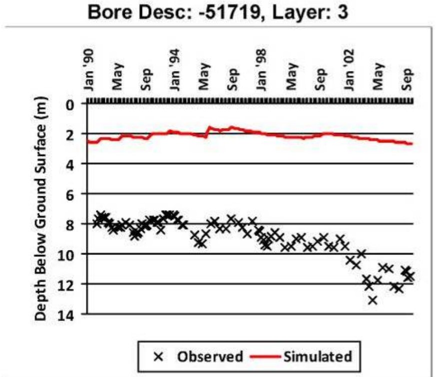
Bore Desc: -5130, Layer: 3



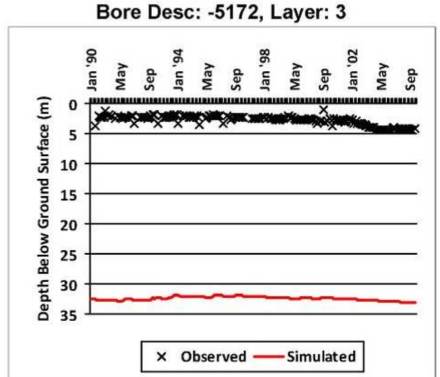
Bore Desc: -5170, Layer: 3



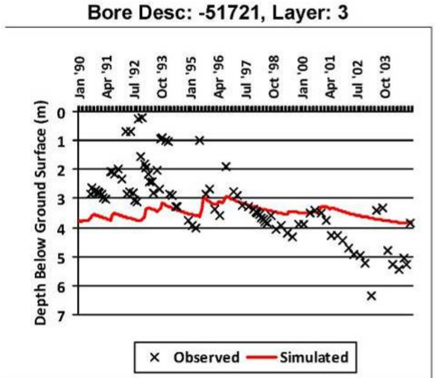
Bore Desc: -51719, Layer: 3



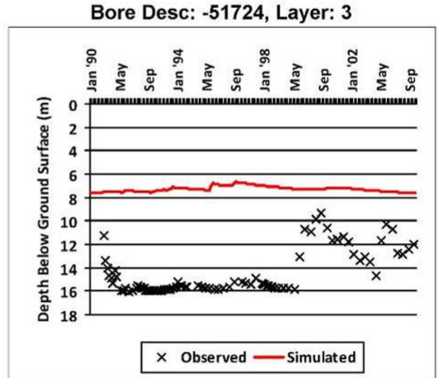
Bore Desc: -5172, Layer: 3



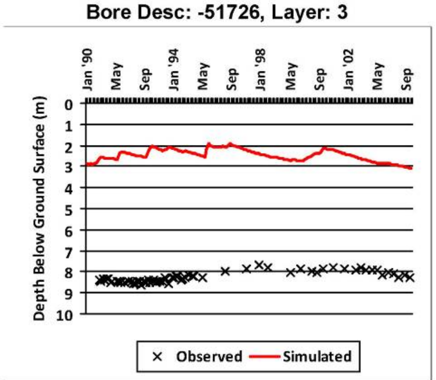
Bore Desc: -51721, Layer: 3



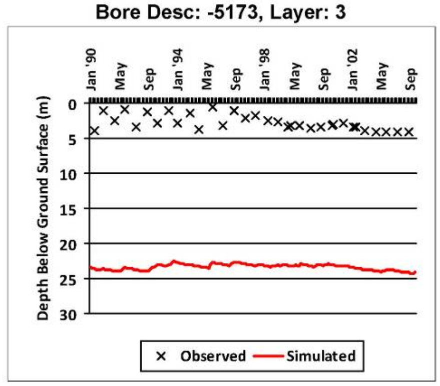
Bore Desc: -51724, Layer: 3



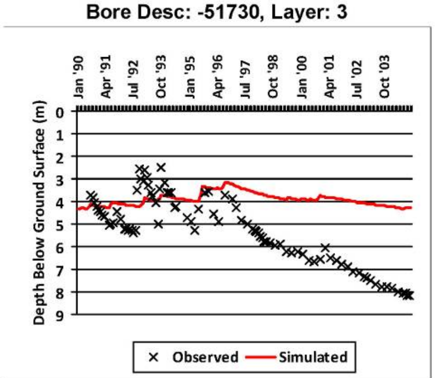
Bore Desc: -51726, Layer: 3



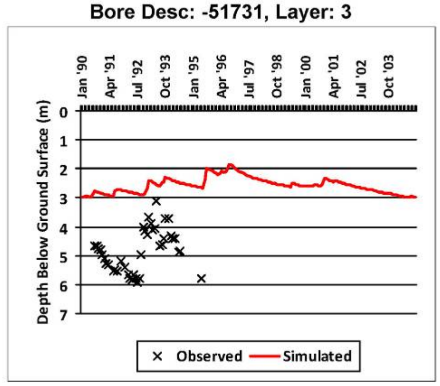
Bore Desc: -5173, Layer: 3



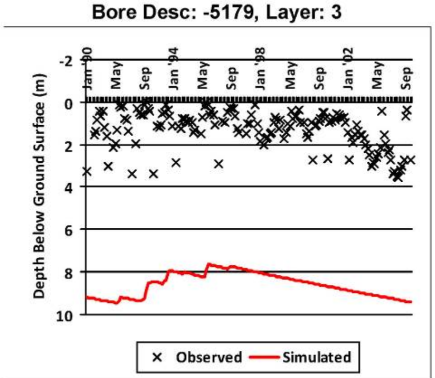
Bore Desc: -51730, Layer: 3



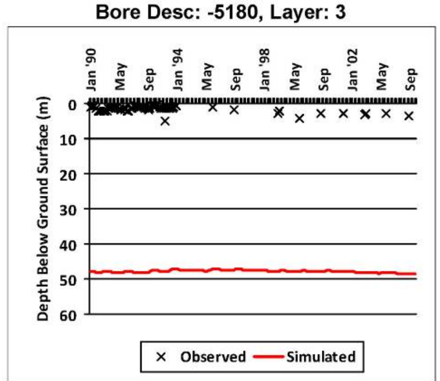
Bore Desc: -51731, Layer: 3



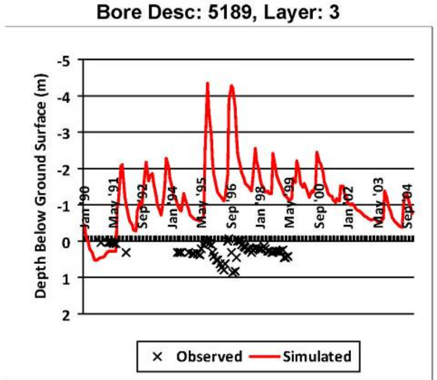
Bore Desc: -5179, Layer: 3



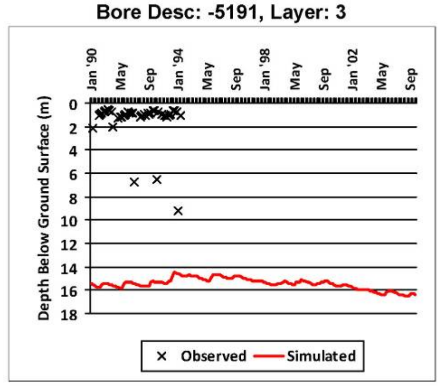
Bore Desc: -5180, Layer: 3



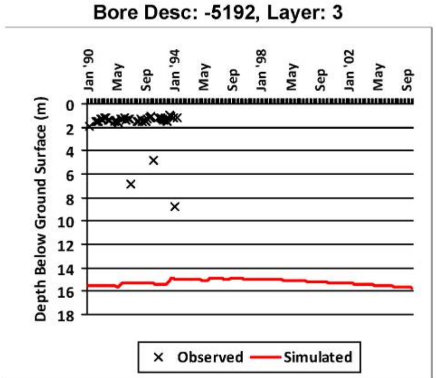
Bore Desc: 5189, Layer: 3



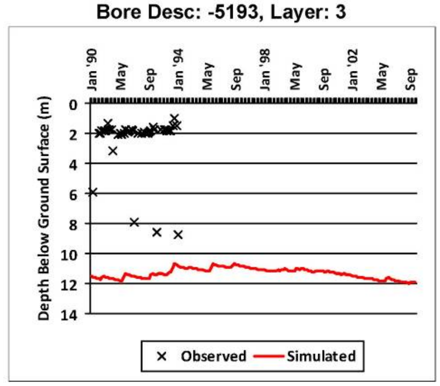
Bore Desc: -5191, Layer: 3



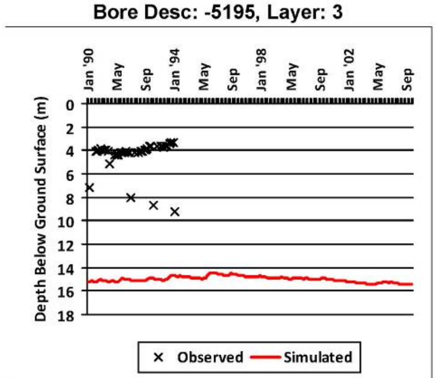
Bore Desc: -5192, Layer: 3



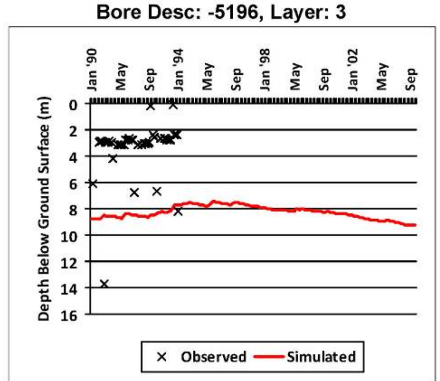
Bore Desc: -5193, Layer: 3



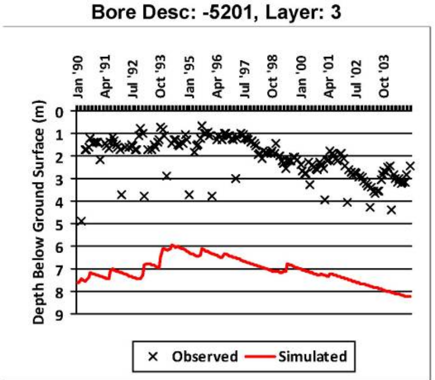
Bore Desc: -5195, Layer: 3



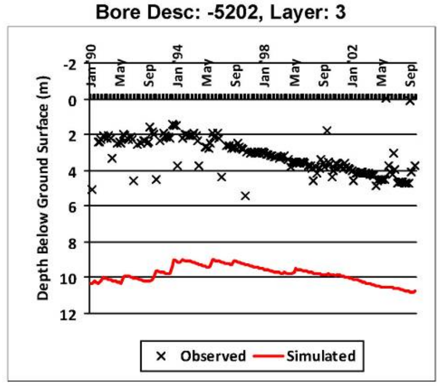
Bore Desc: -5196, Layer: 3



Bore Desc: -5201, Layer: 3



Bore Desc: -5202, Layer: 3



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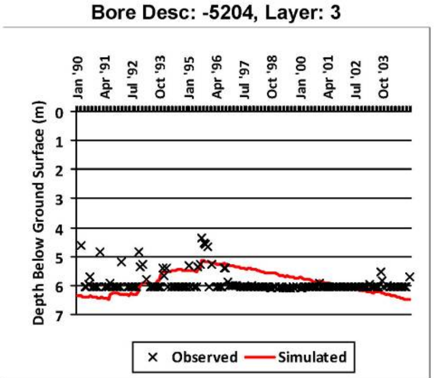

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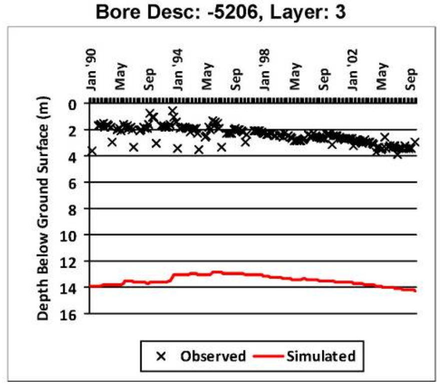
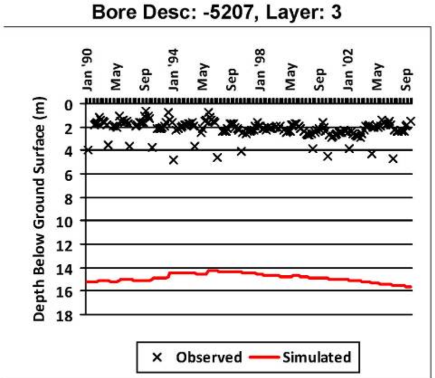


Bore Desc: -5207, Layer: 3



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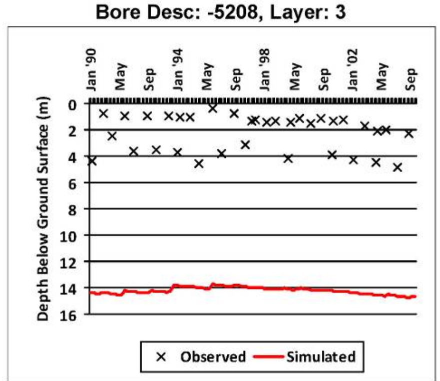
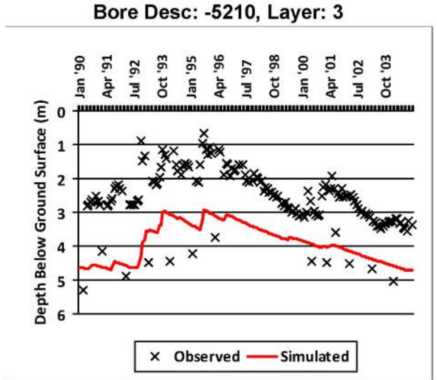
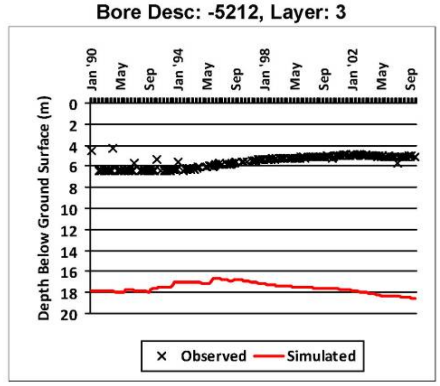


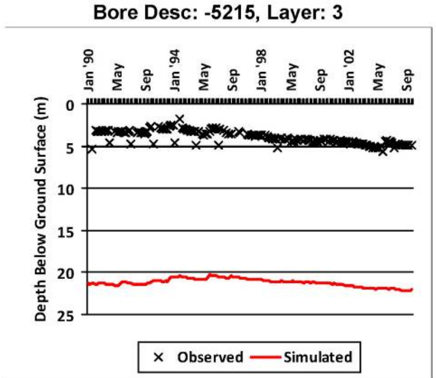
Bore Desc: -5210, Layer: 3



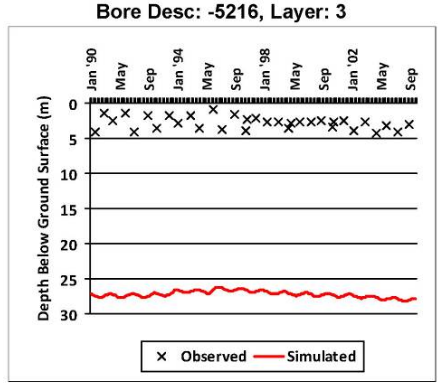
Bore Desc: -5212, Layer: 3



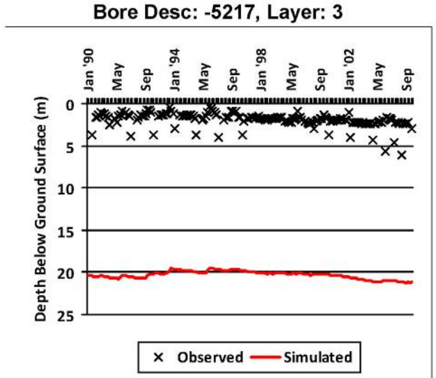
Bore Desc: -5215, Layer: 3



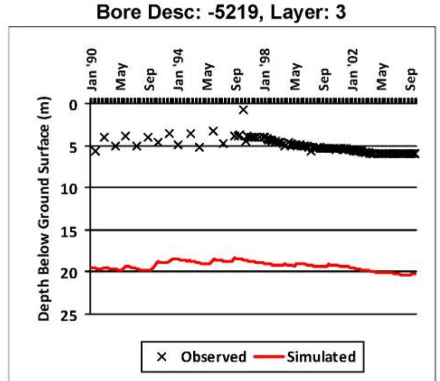
Bore Desc: -5216, Layer: 3



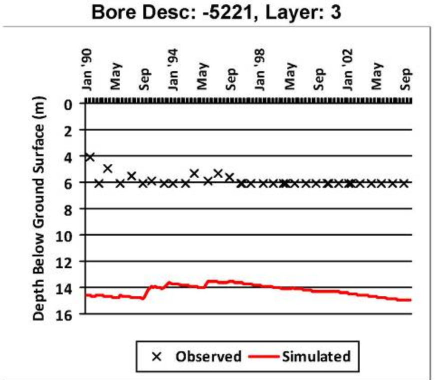
Bore Desc: -5217, Layer: 3



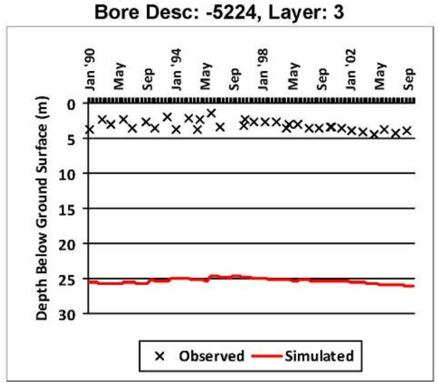
Bore Desc: -5219, Layer: 3



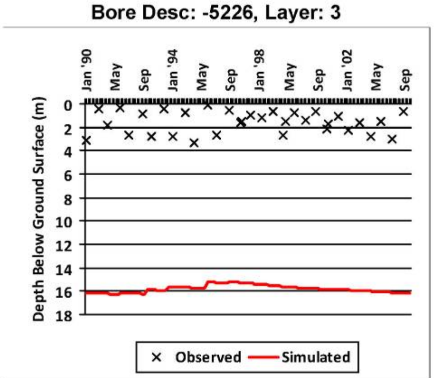
Bore Desc: -5221, Layer: 3



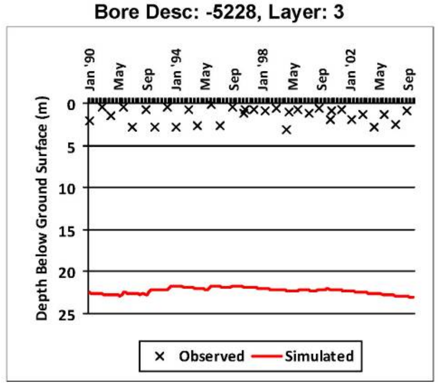
Bore Desc: -5224, Layer: 3



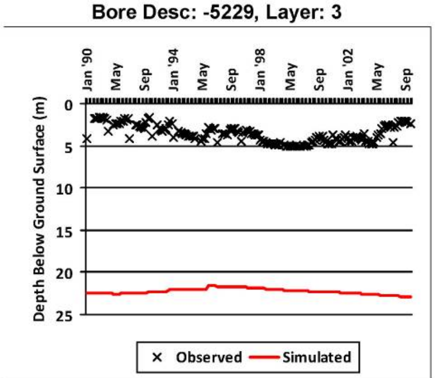
Bore Desc: -5226, Layer: 3



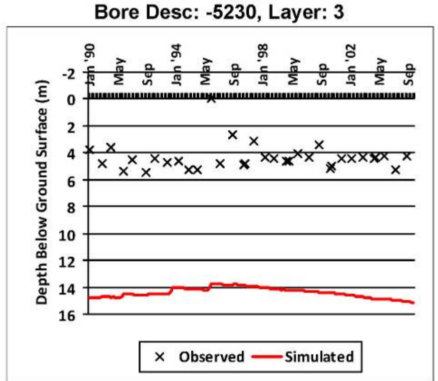
Bore Desc: -5228, Layer: 3



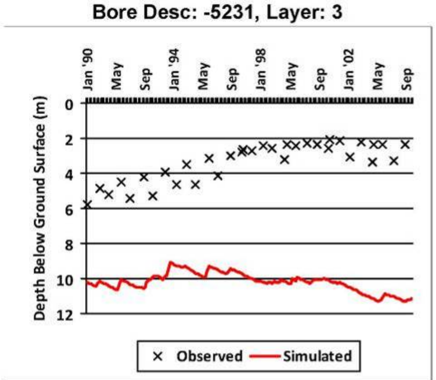
Bore Desc: -5229, Layer: 3



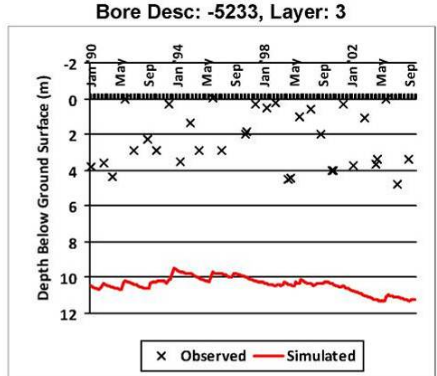
Bore Desc: -5230, Layer: 3



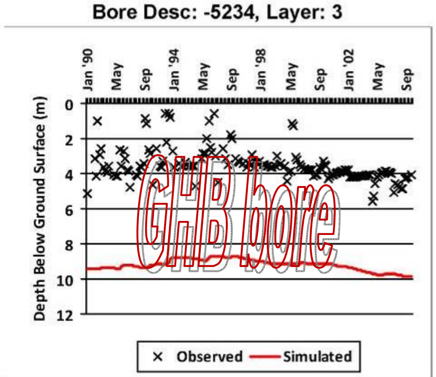
Bore Desc: -5231, Layer: 3



Bore Desc: -5233, Layer: 3



Bore Desc: -5234, Layer: 3



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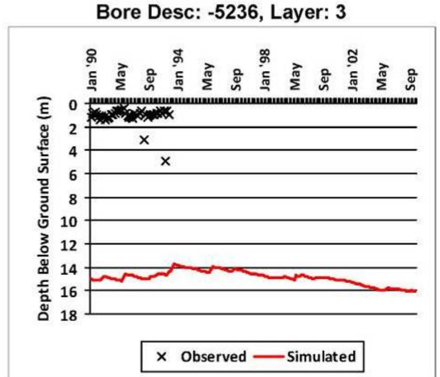

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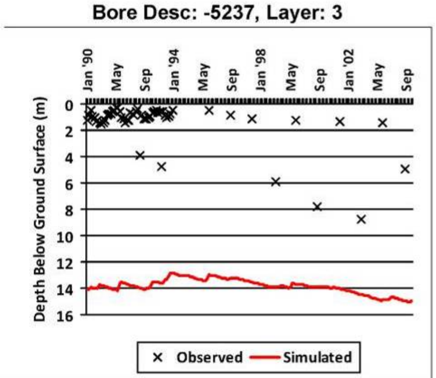

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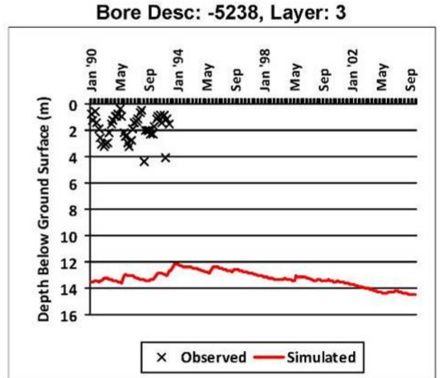
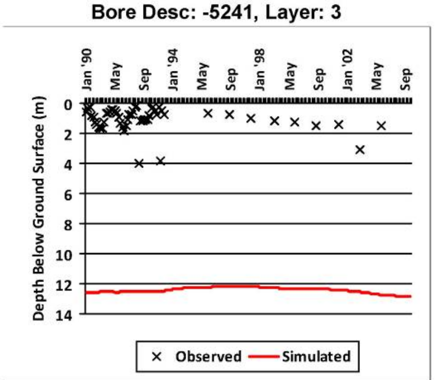


Bore Desc: -5241, Layer: 3



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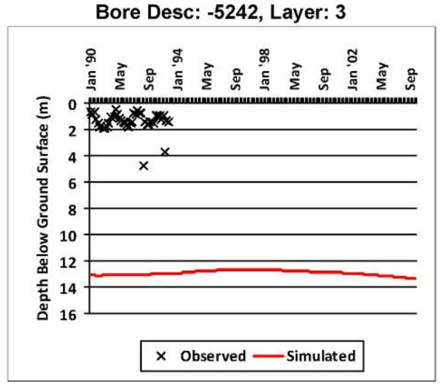

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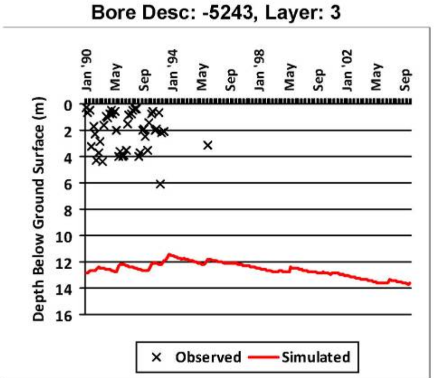
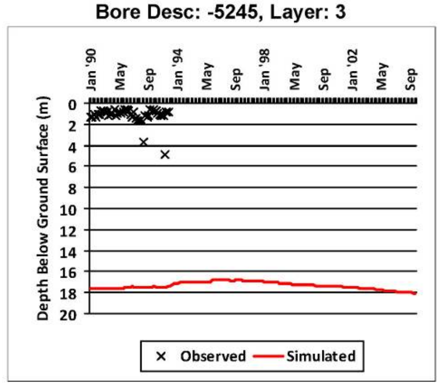
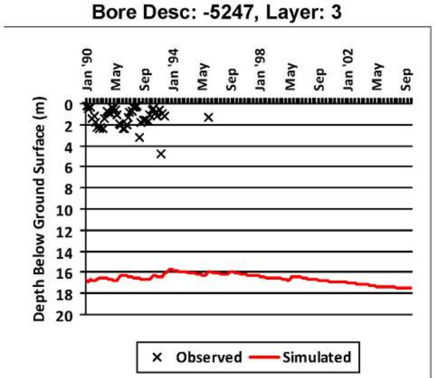


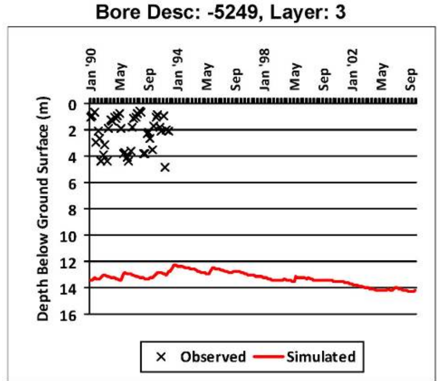
Bore Desc: -5245, Layer: 3

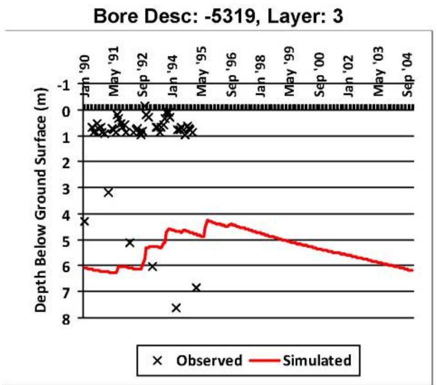


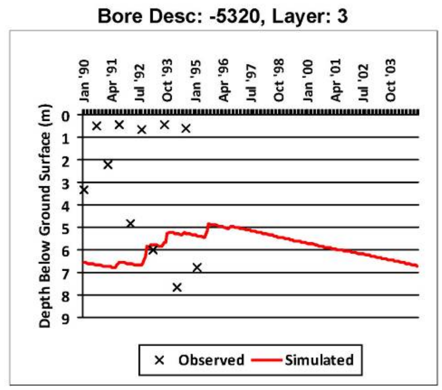
Bore Desc: -5247, Layer: 3

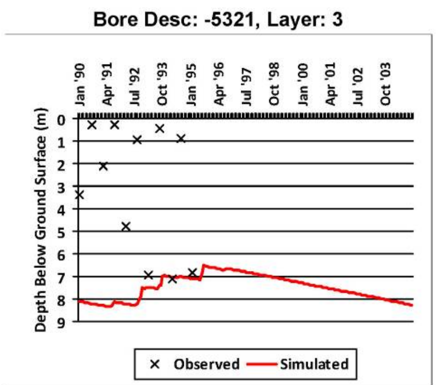


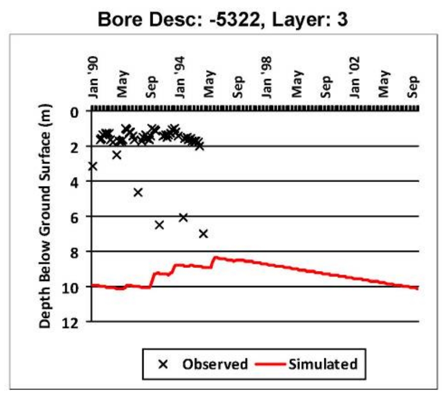
Bore Desc: -5249, Layer: 3

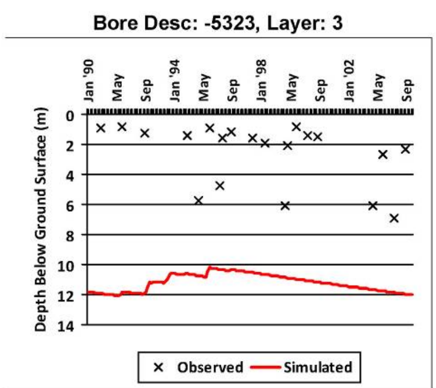


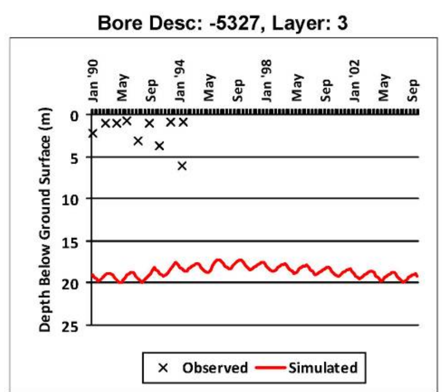

Bore Desc: -5319, Layer: 3
Jan '90 May '91 Sep '92 Jan '94 May '95 Sep '96 Jan '98 May '99 Sep '00 Jan '02 May '03 Sep '04
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -5320, Layer: 3
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Depth Below Ground Surface (m)
Observed
Simulated

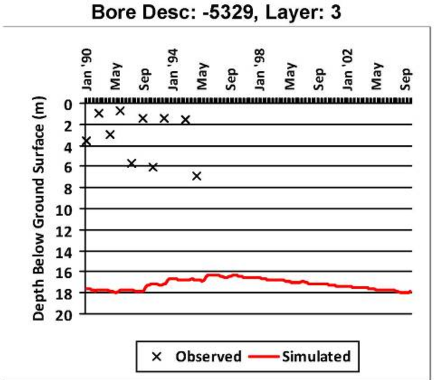

Bore Desc: -5321, Layer: 3
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -5322, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
Observed
Simulated

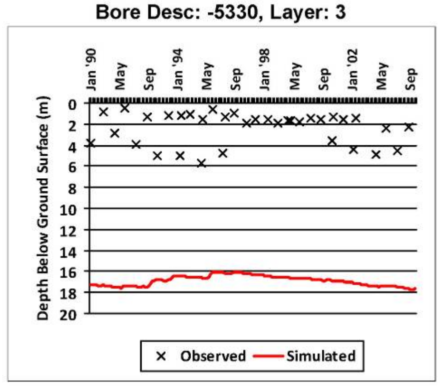

Bore Desc: -5323, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -5327, Layer: 3
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
Observed
Simulated

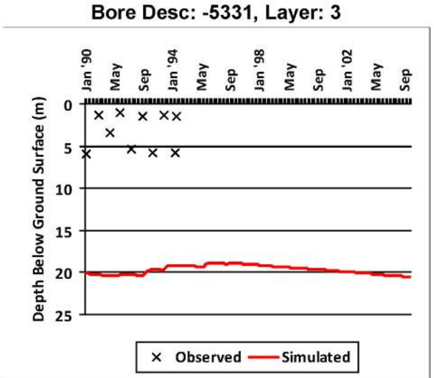
Bore Desc: -5329, Layer: 3



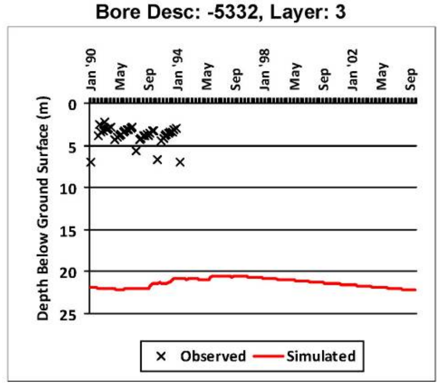
Bore Desc: -5330, Layer: 3



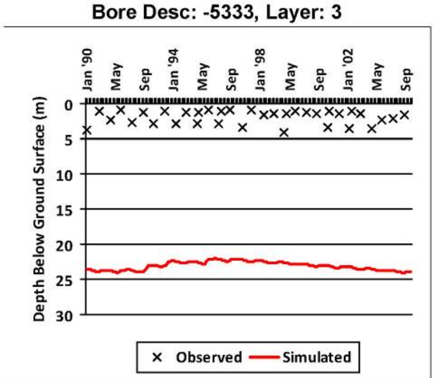
Bore Desc: -5331, Layer: 3



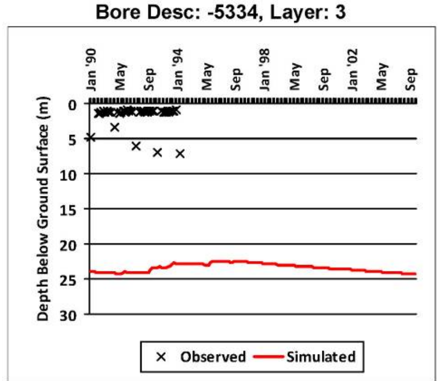
Bore Desc: -5332, Layer: 3



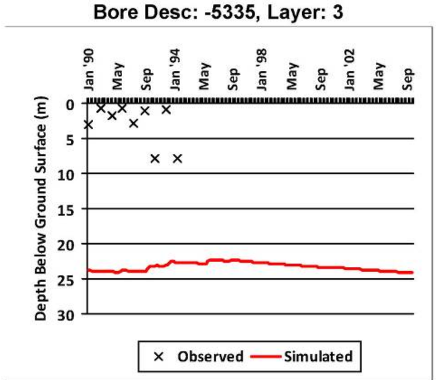
Bore Desc: -5333, Layer: 3



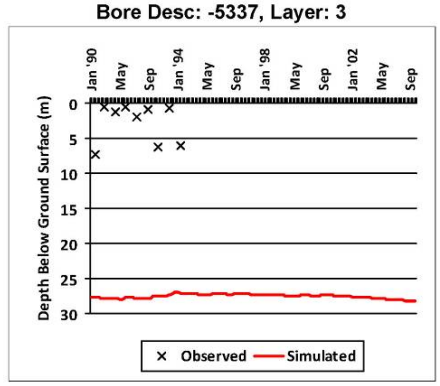
Bore Desc: -5334, Layer: 3



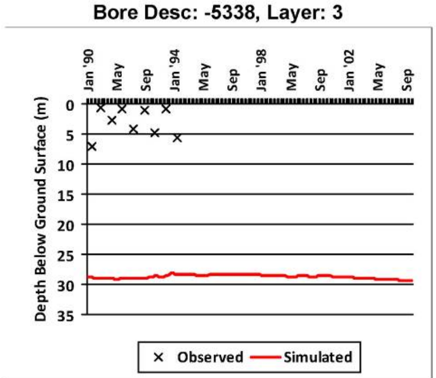
Bore Desc: -5335, Layer: 3



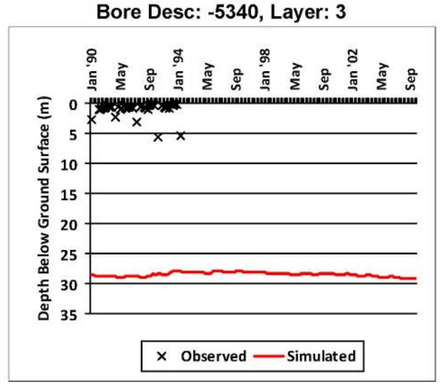
Bore Desc: -5337, Layer: 3



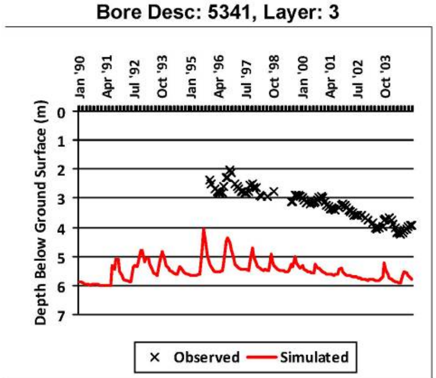
Bore Desc: -5338, Layer: 3



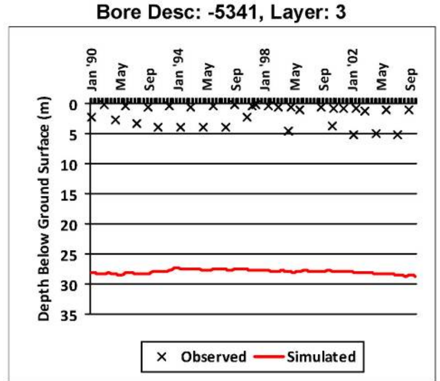
Bore Desc: -5340, Layer: 3



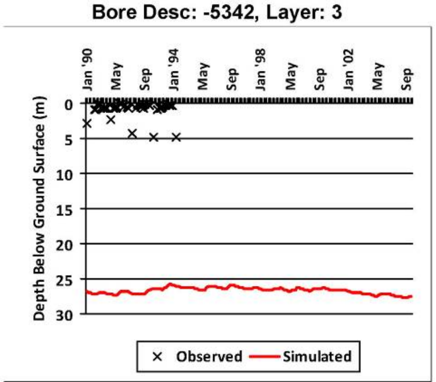
Bore Desc: 5341, Layer: 3



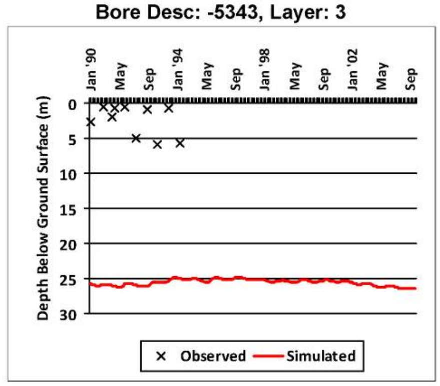
Bore Desc: -5341, Layer: 3



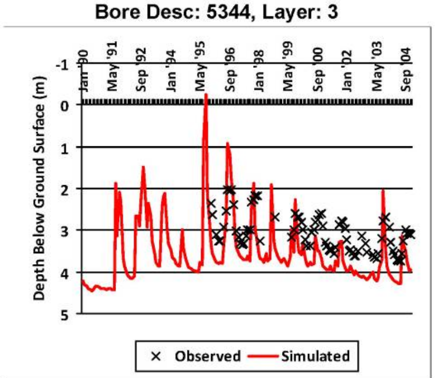
Bore Desc: -5342, Layer: 3



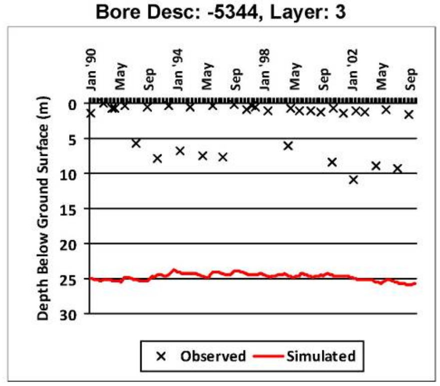
Bore Desc: -5343, Layer: 3



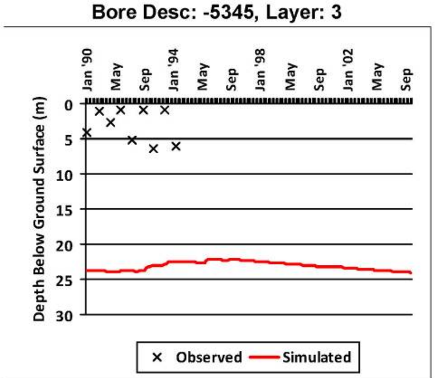
Bore Desc: 5344, Layer: 3



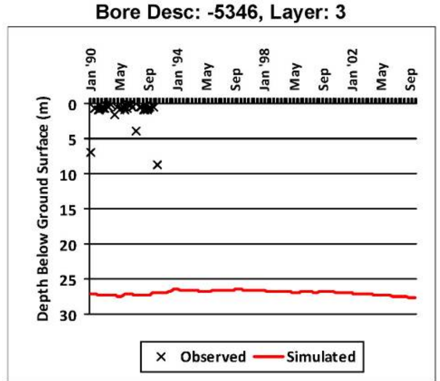
Bore Desc: -5344, Layer: 3



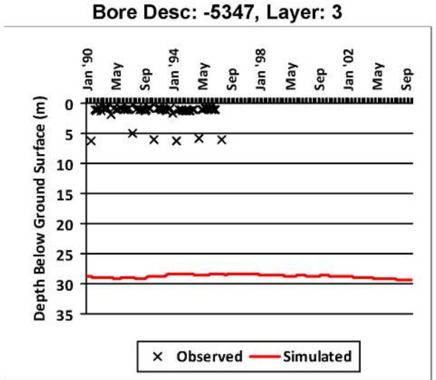
Bore Desc: -5345, Layer: 3



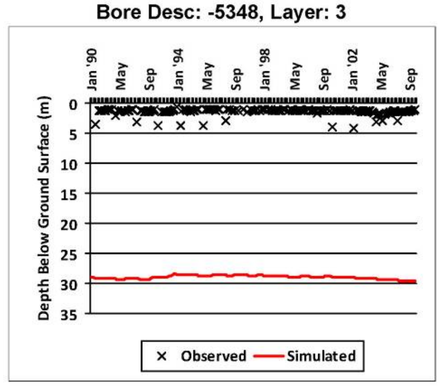
Bore Desc: -5346, Layer: 3



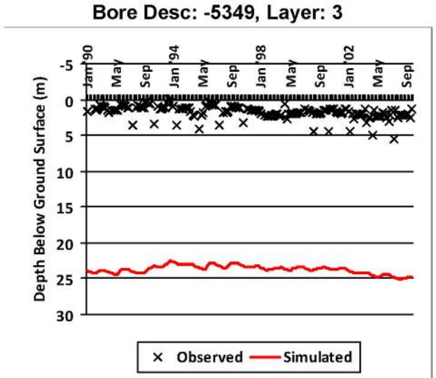
Bore Desc: -5347, Layer: 3



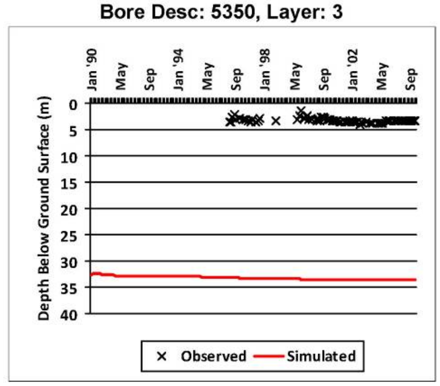
Bore Desc: -5348, Layer: 3



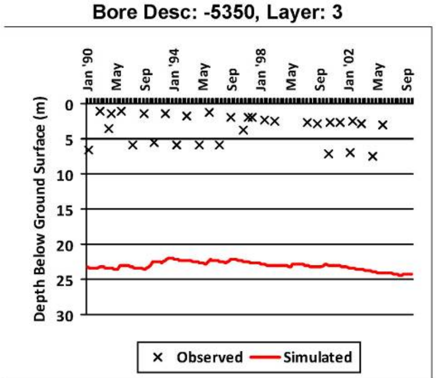
Bore Desc: -5349, Layer: 3



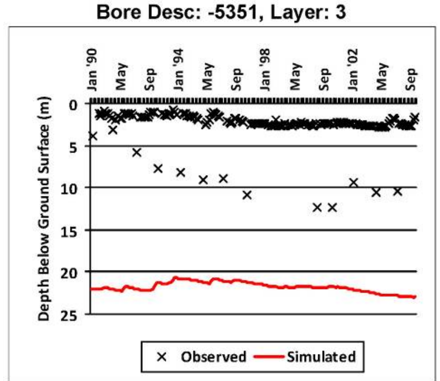
Bore Desc: 5350, Layer: 3

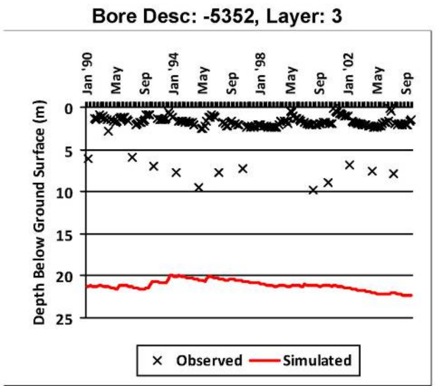


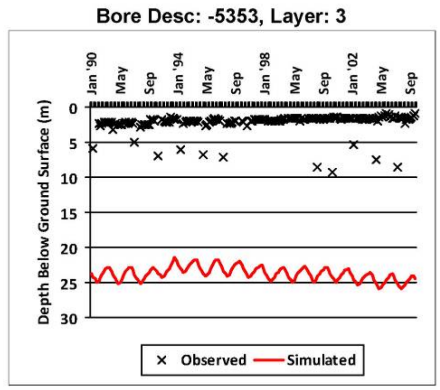
Bore Desc: -5350, Layer: 3

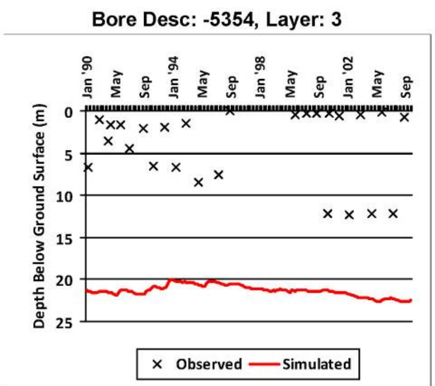


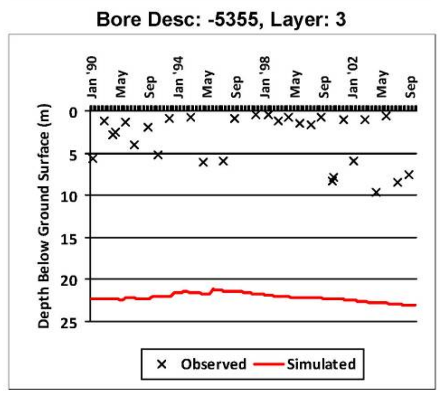
Bore Desc: -5351, Layer: 3

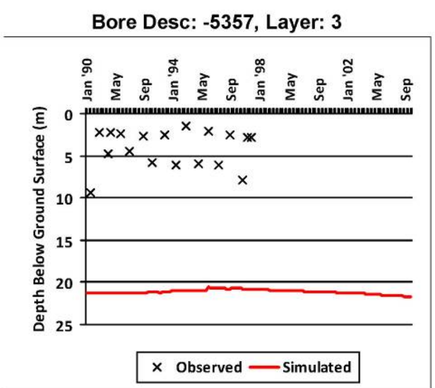


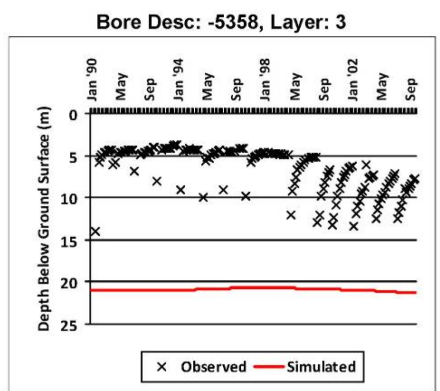

Bore Desc: -5352, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25
Observed
Simulated


Bore Desc: -5353, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30
Observed
Simulated

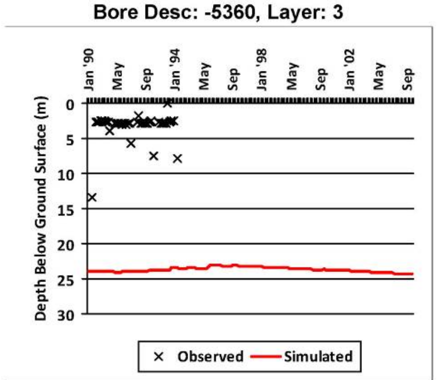

Bore Desc: -5354, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25
Observed
Simulated


Bore Desc: -5355, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25
Observed
Simulated

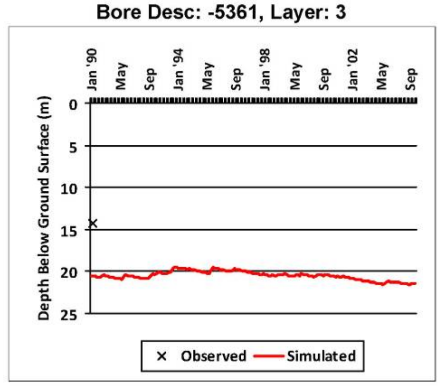

Bore Desc: -5357, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25
Observed
Simulated


Bore Desc: -5358, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25
Observed
Simulated

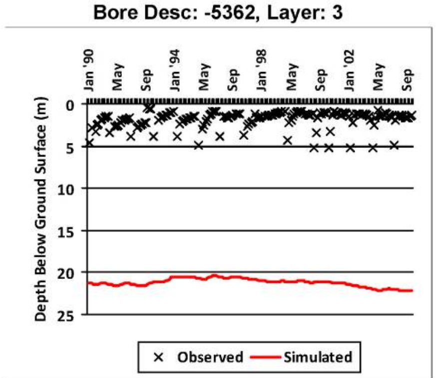
Bore Desc: -5360, Layer: 3



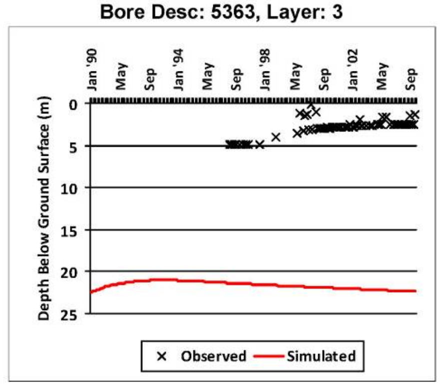
Bore Desc: -5361, Layer: 3



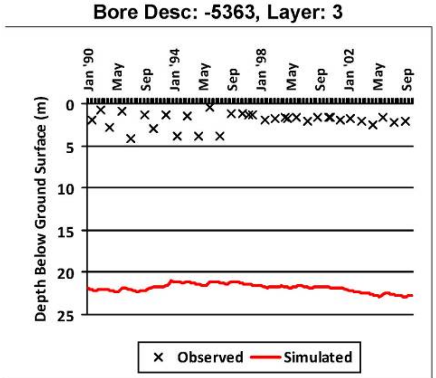
Bore Desc: -5362, Layer: 3



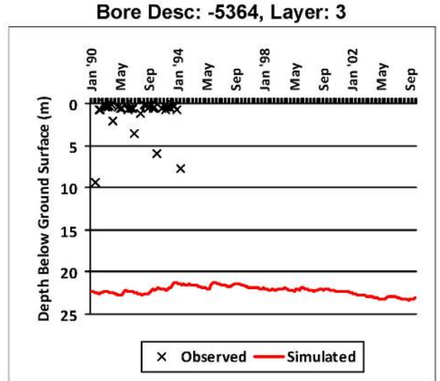
Bore Desc: 5363, Layer: 3



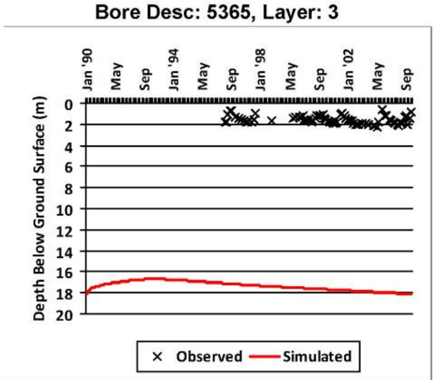
Bore Desc: -5363, Layer: 3



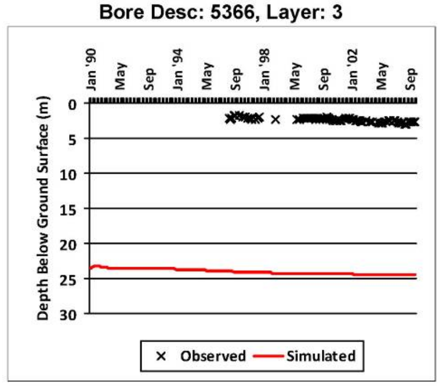
Bore Desc: -5364, Layer: 3



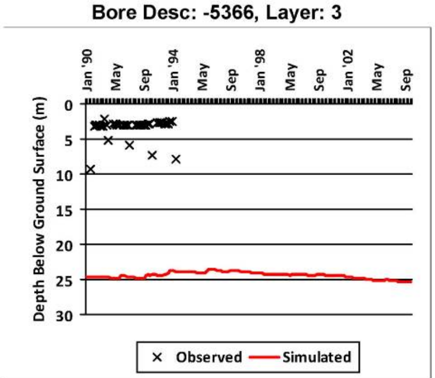
Bore Desc: 5365, Layer: 3



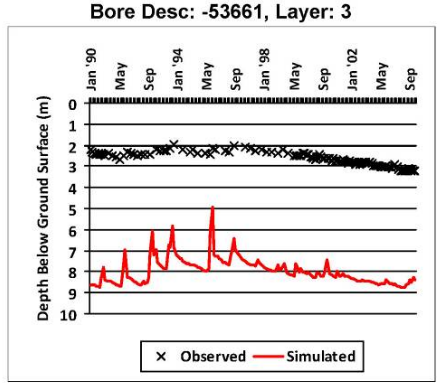
Bore Desc: 5366, Layer: 3



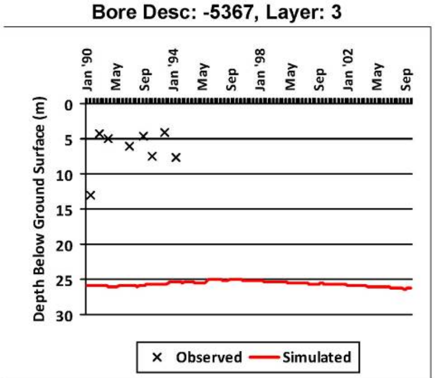
Bore Desc: -5366, Layer: 3



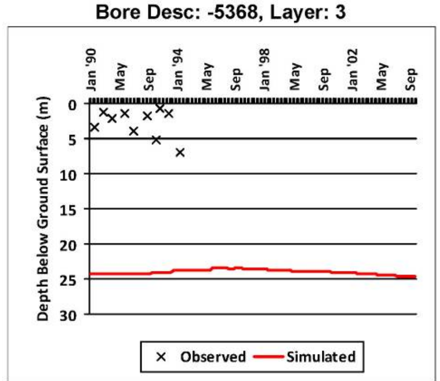
Bore Desc: -53661, Layer: 3

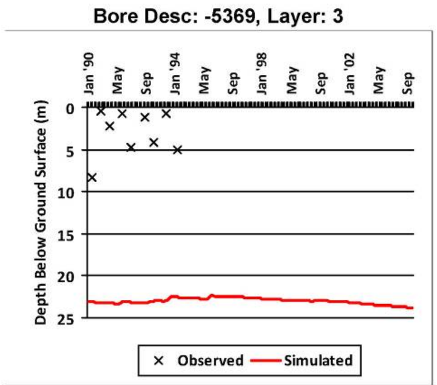


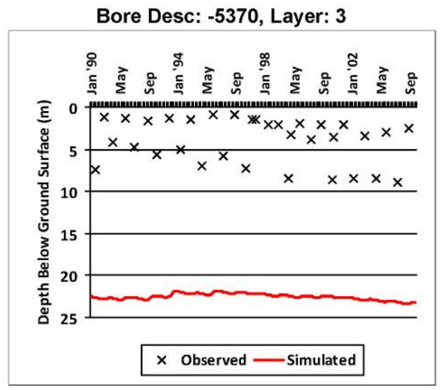
Bore Desc: -5367, Layer: 3

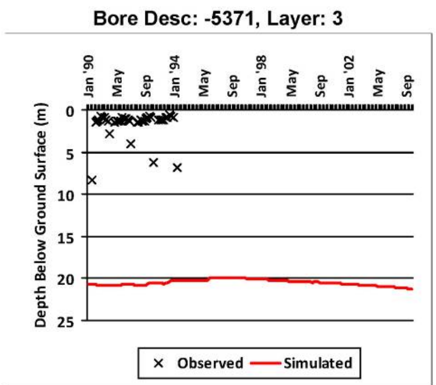


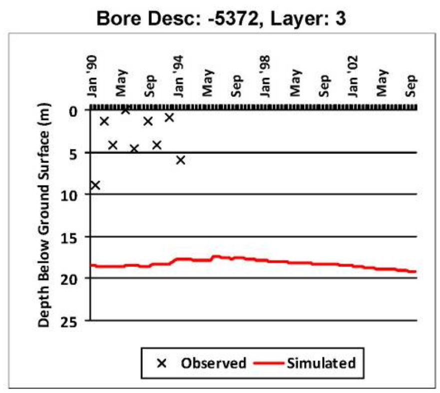
Bore Desc: -5368, Layer: 3

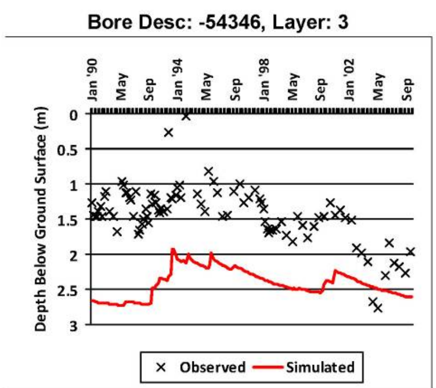


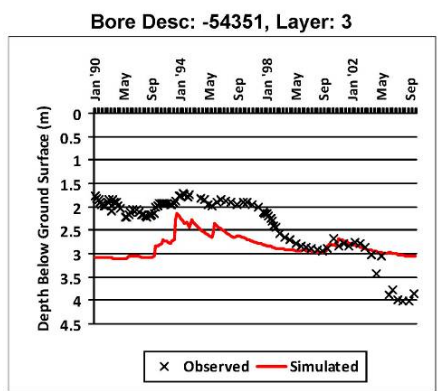

Bore Desc: -5369, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: -5370, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated

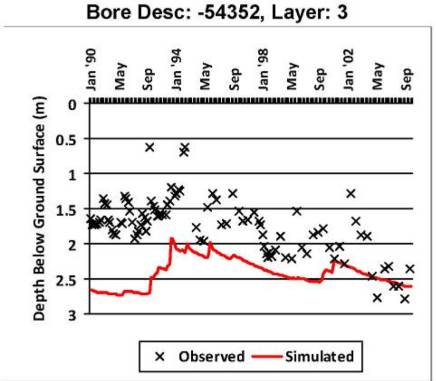

Bore Desc: -5371, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: -5372, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated

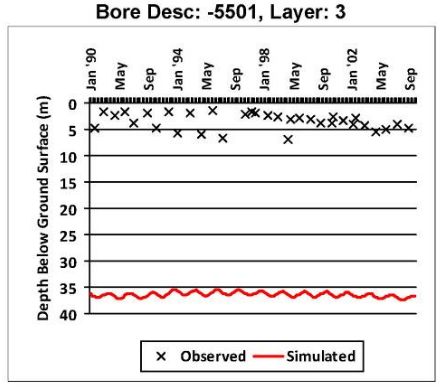

Bore Desc: -54346, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: -54351, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated

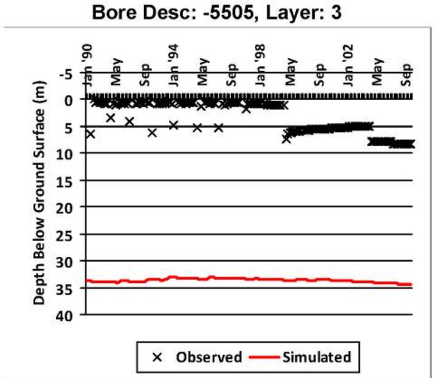
Bore Desc: -54352, Layer: 3



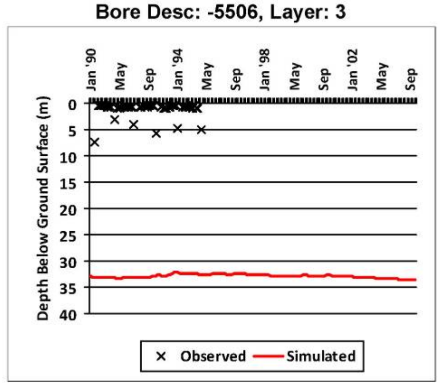
Bore Desc: -5501, Layer: 3



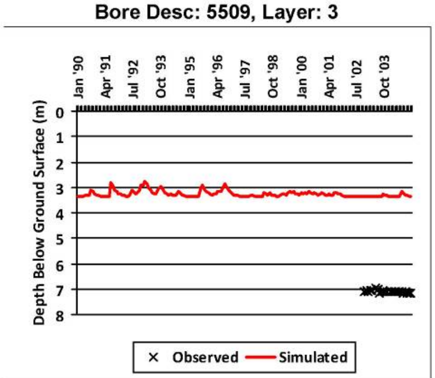
Bore Desc: -5505, Layer: 3



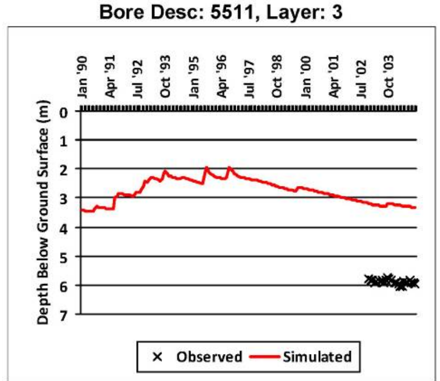
Bore Desc: -5506, Layer: 3



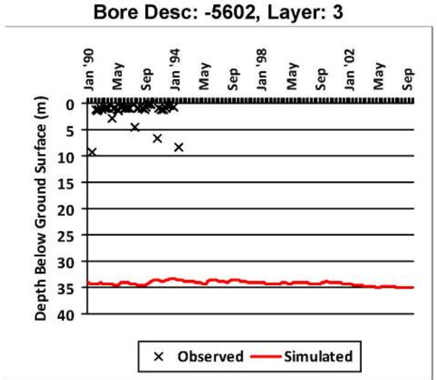
Bore Desc: 5509, Layer: 3



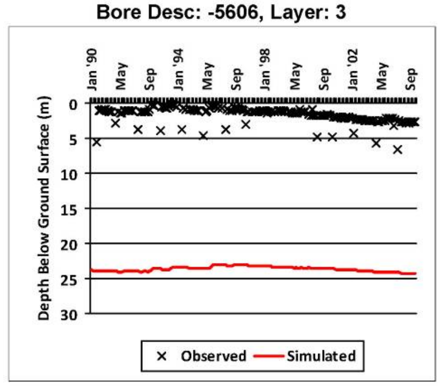
Bore Desc: 5511, Layer: 3



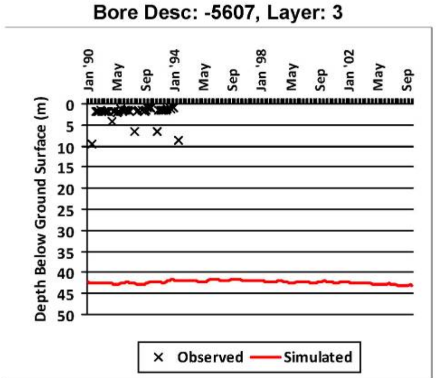
Bore Desc: -5602, Layer: 3



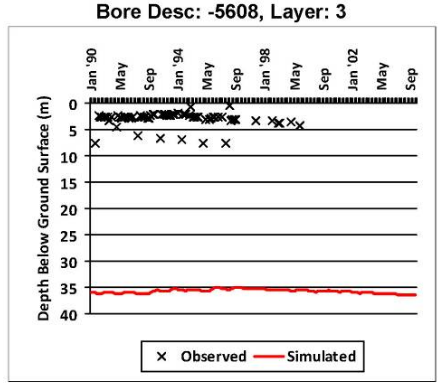
Bore Desc: -5606, Layer: 3



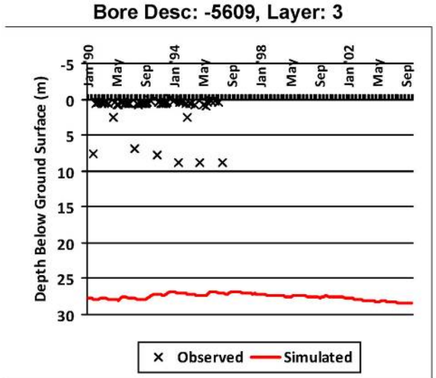
Bore Desc: -5607, Layer: 3



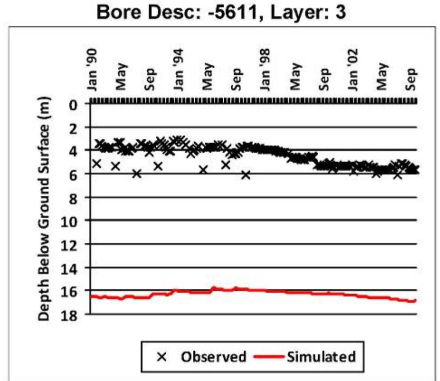
Bore Desc: -5608, Layer: 3



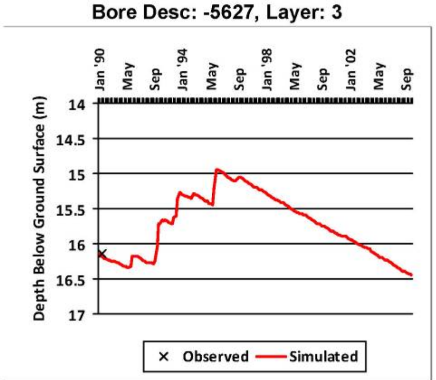
Bore Desc: -5609, Layer: 3



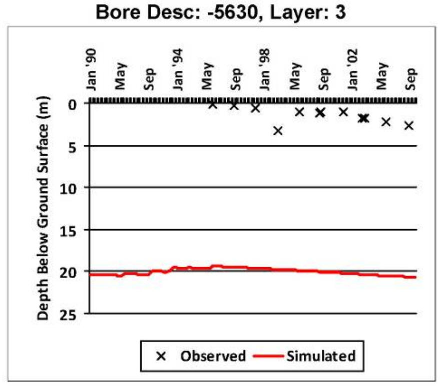
Bore Desc: -5611, Layer: 3



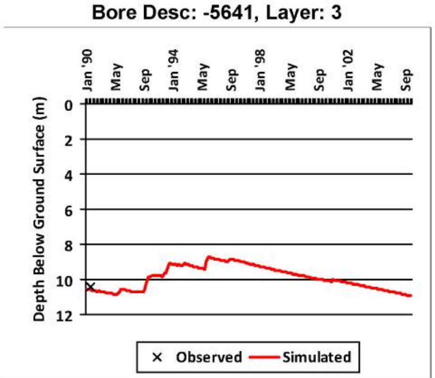
Bore Desc: -5627, Layer: 3



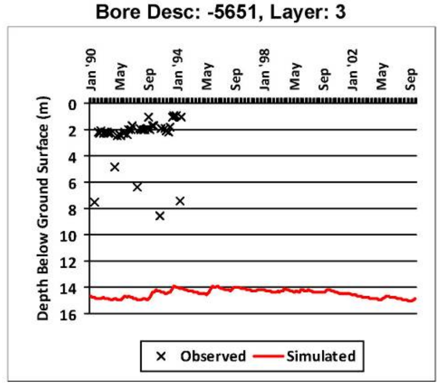
Bore Desc: -5630, Layer: 3



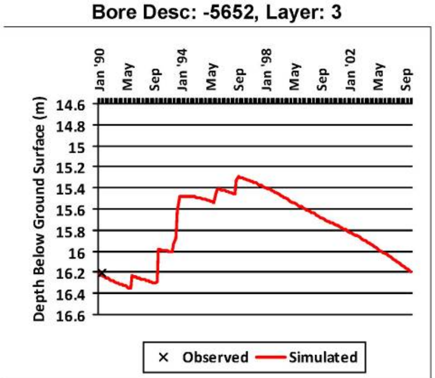
Bore Desc: -5641, Layer: 3



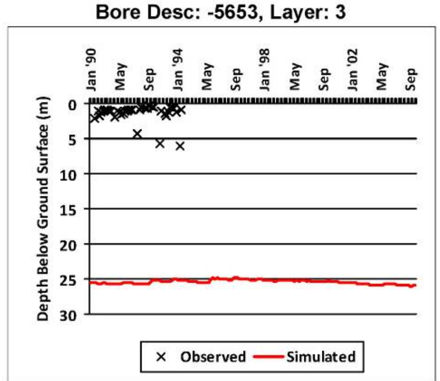
Bore Desc: -5651, Layer: 3



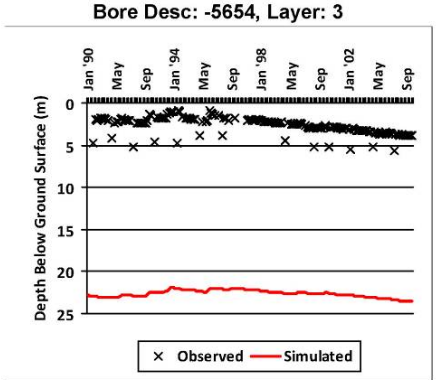
Bore Desc: -5652, Layer: 3



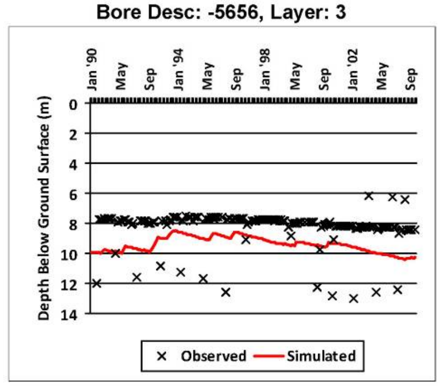
Bore Desc: -5653, Layer: 3



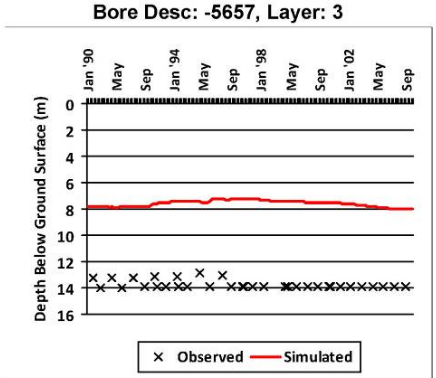
Bore Desc: -5654, Layer: 3



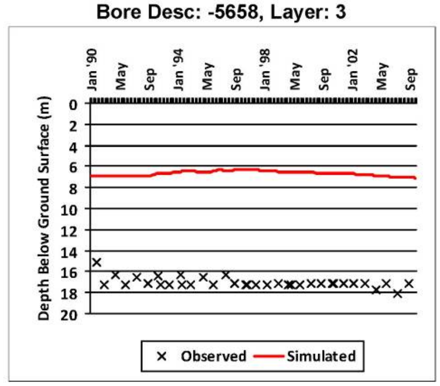
Bore Desc: -5656, Layer: 3



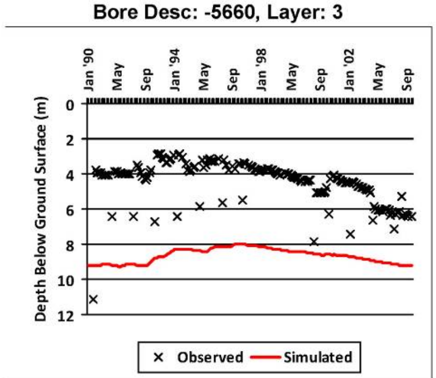
Bore Desc: -5657, Layer: 3



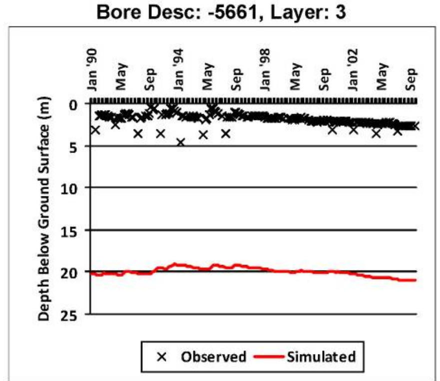
Bore Desc: -5658, Layer: 3



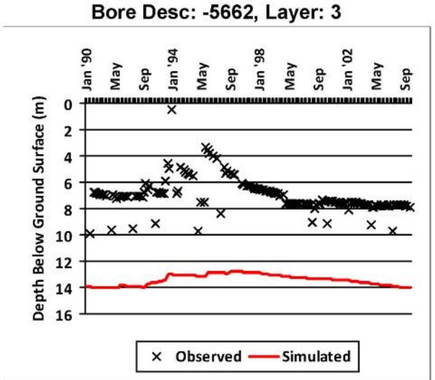
Bore Desc: -5660, Layer: 3



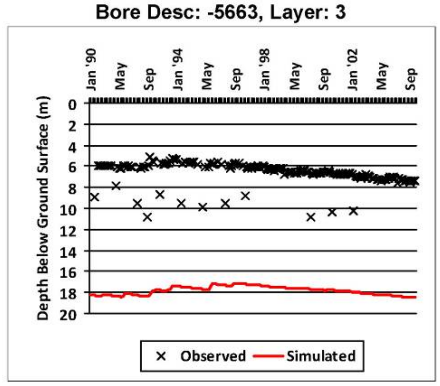
Bore Desc: -5661, Layer: 3



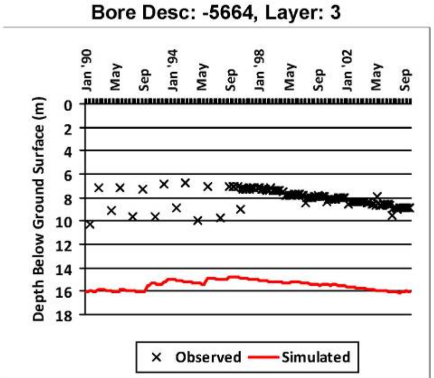
Bore Desc: -5662, Layer: 3



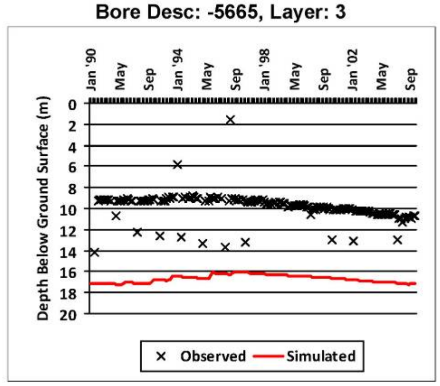
Bore Desc: -5663, Layer: 3



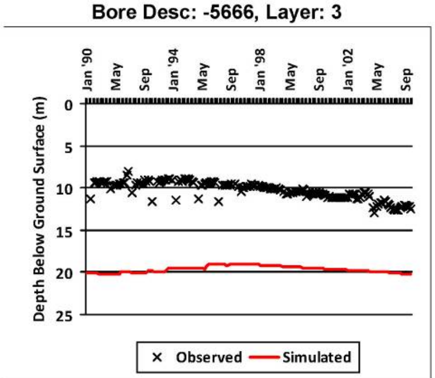
Bore Desc: -5664, Layer: 3



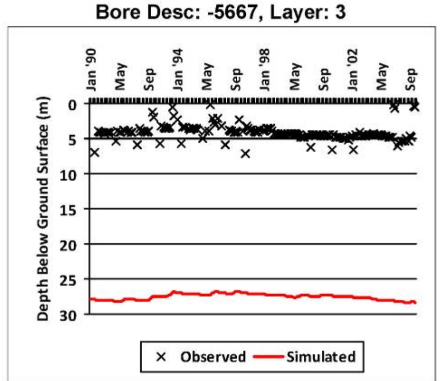
Bore Desc: -5665, Layer: 3



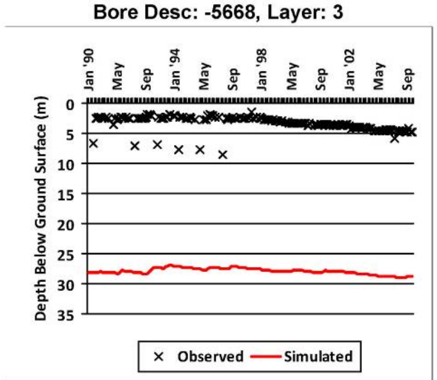
Bore Desc: -5666, Layer: 3



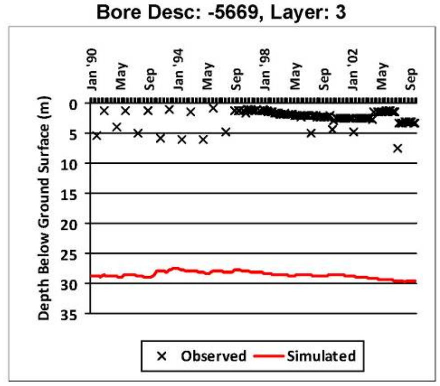
Bore Desc: -5667, Layer: 3



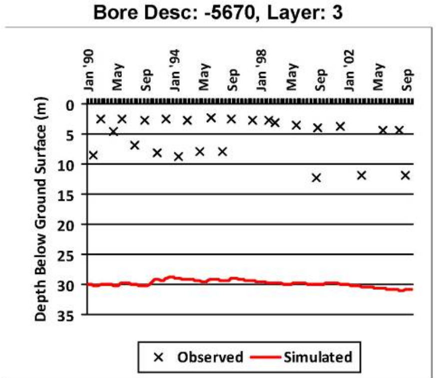
Bore Desc: -5668, Layer: 3



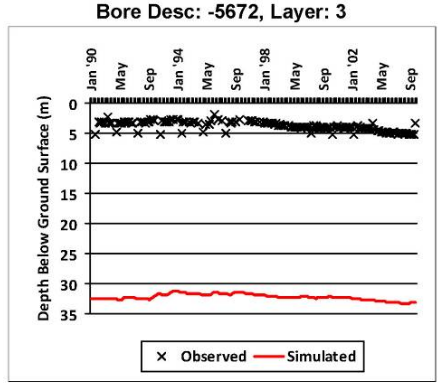
Bore Desc: -5669, Layer: 3



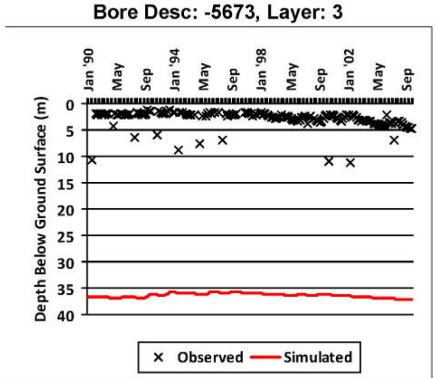
Bore Desc: -5670, Layer: 3



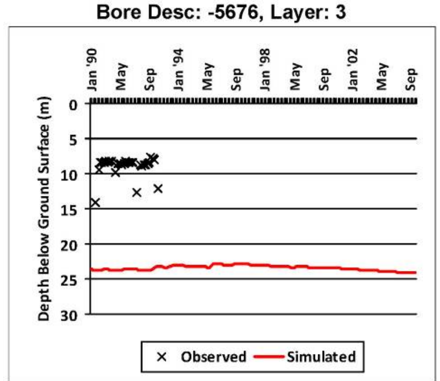
Bore Desc: -5672, Layer: 3



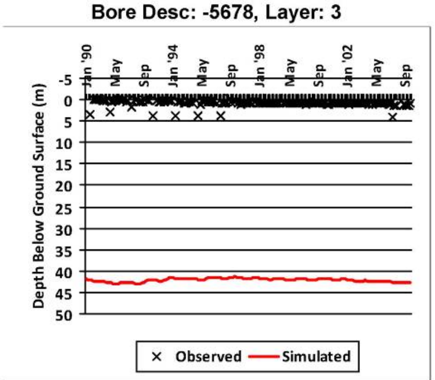
Bore Desc: -5673, Layer: 3



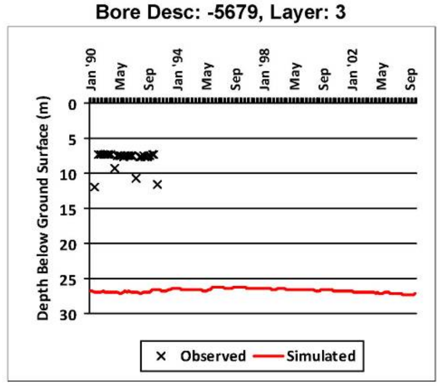
Bore Desc: -5676, Layer: 3



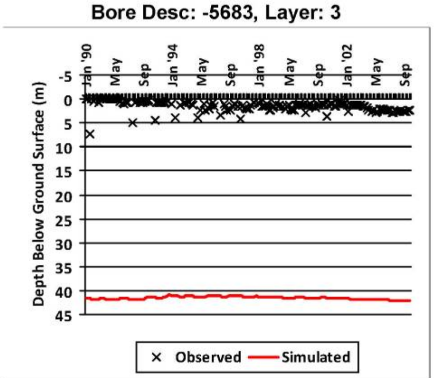
Bore Desc: -5678, Layer: 3



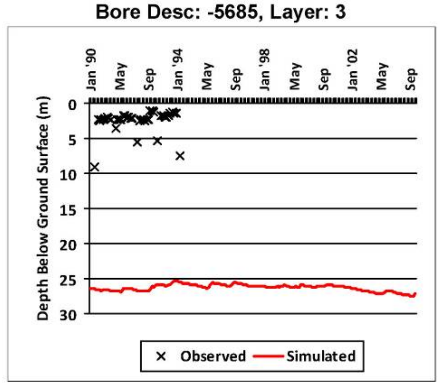
Bore Desc: -5679, Layer: 3



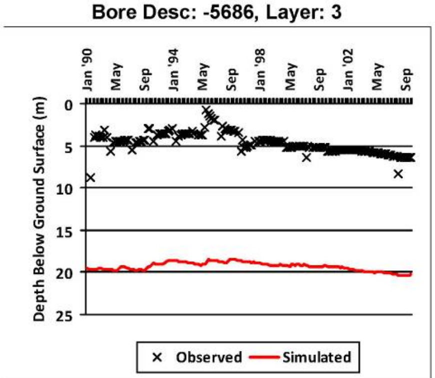
Bore Desc: -5683, Layer: 3



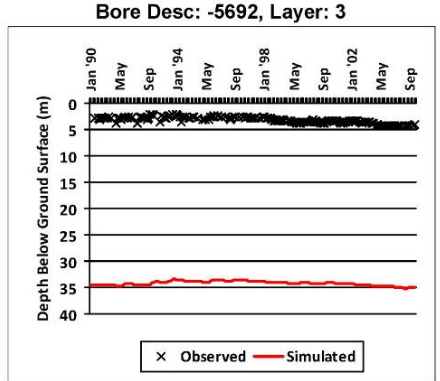
Bore Desc: -5685, Layer: 3



Bore Desc: -5686, Layer: 3



Bore Desc: -5692, Layer: 3



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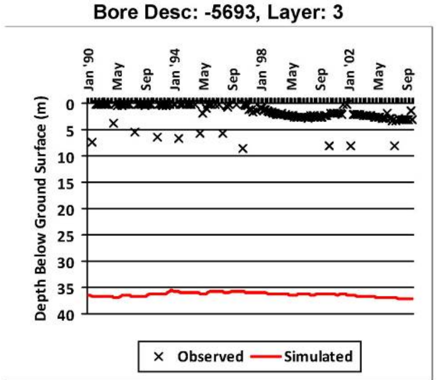

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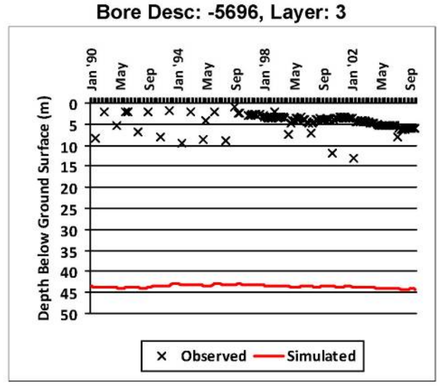

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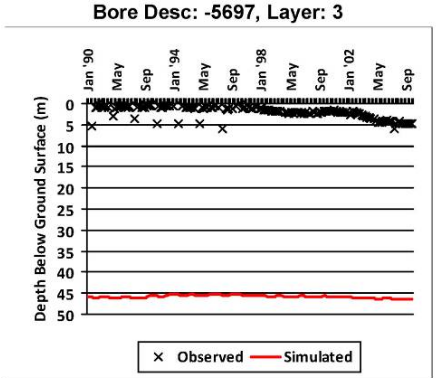

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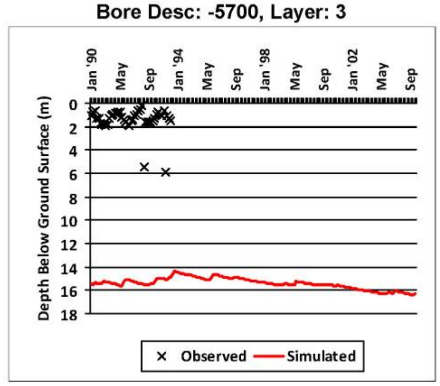

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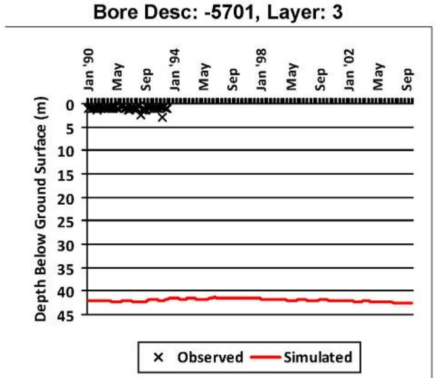

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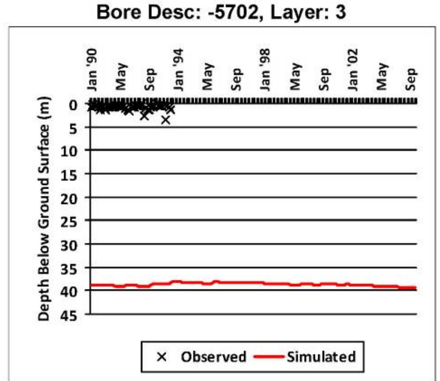

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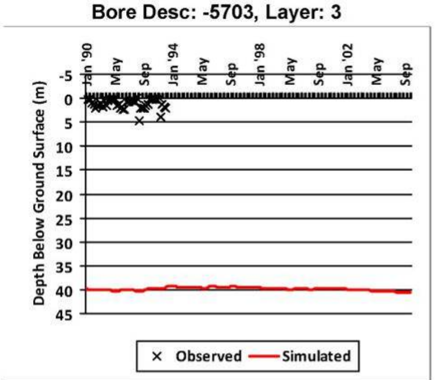

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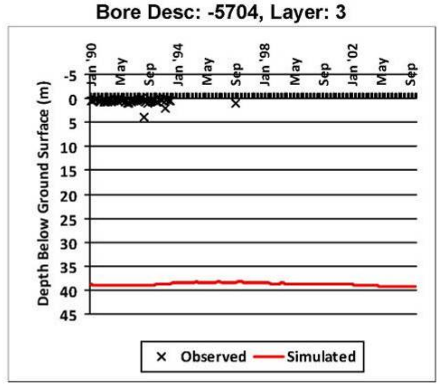

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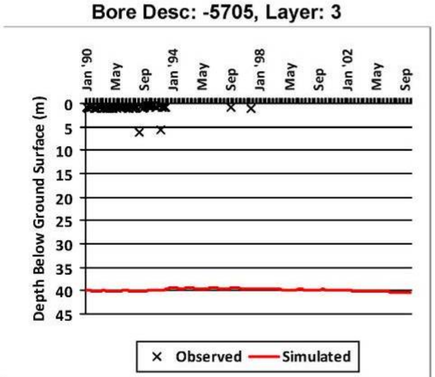

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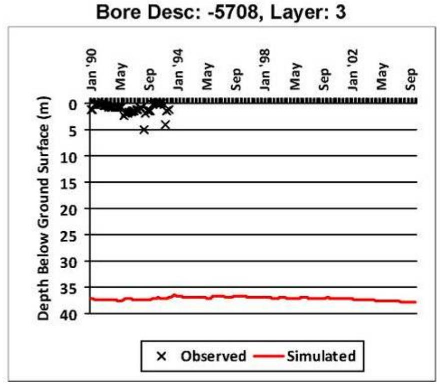

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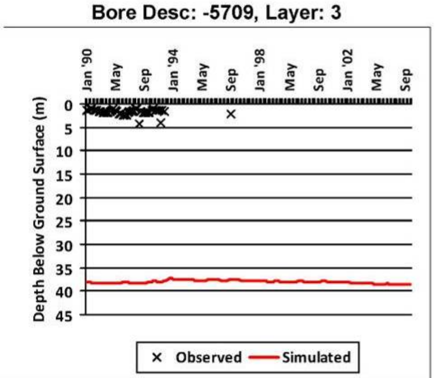

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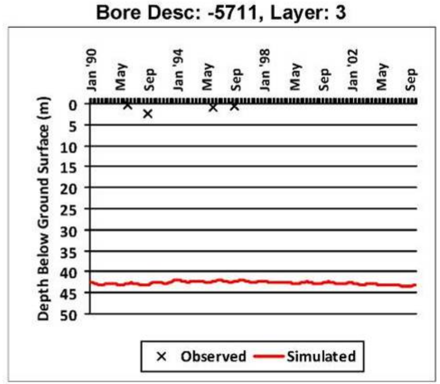

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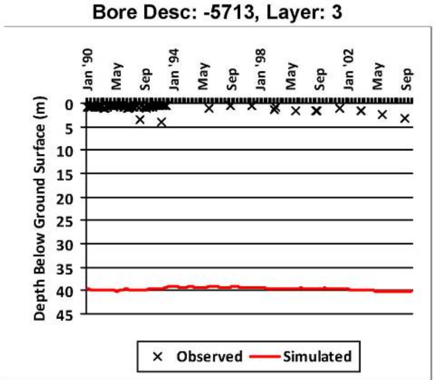

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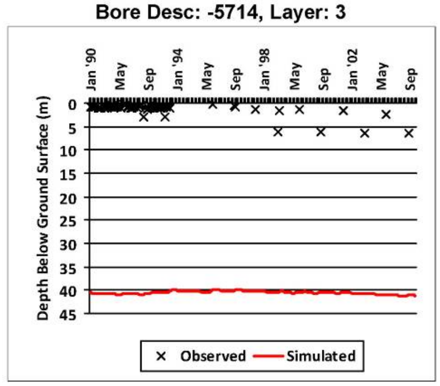

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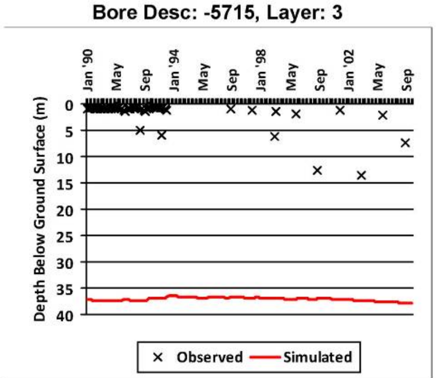

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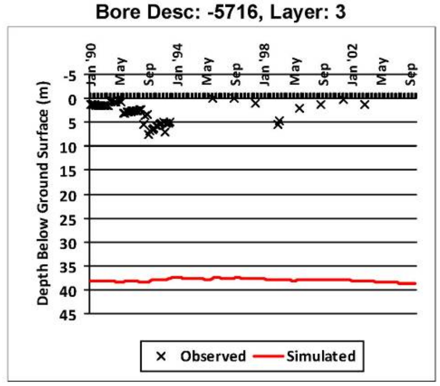

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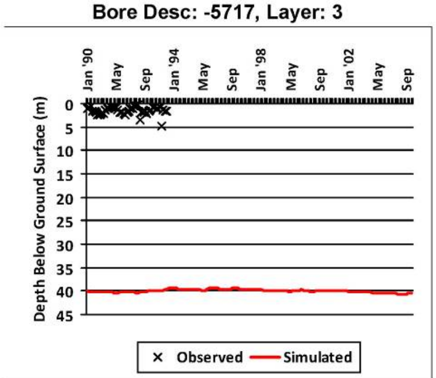

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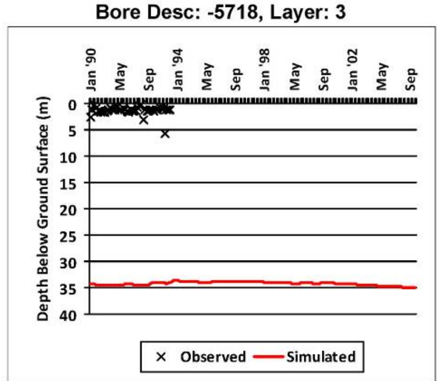

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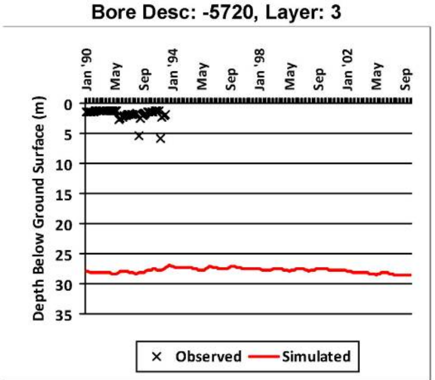

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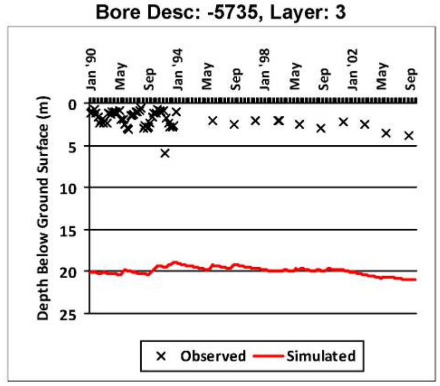

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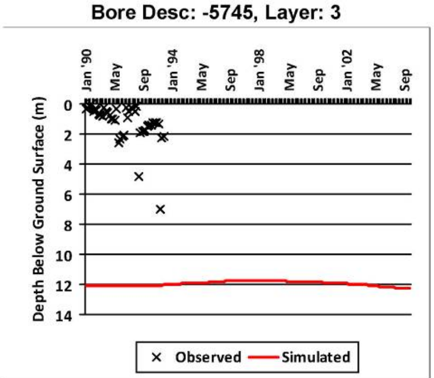

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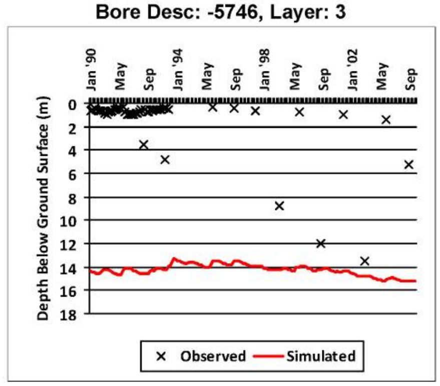

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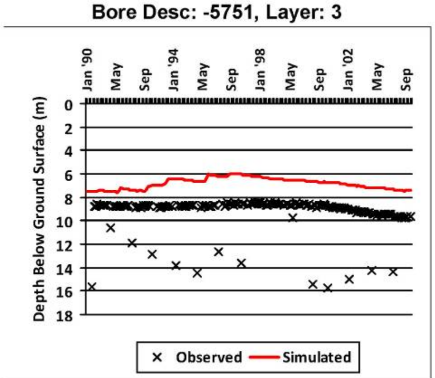

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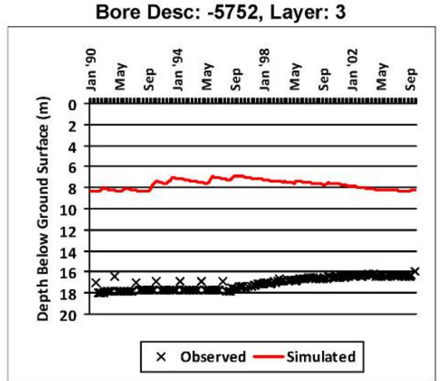

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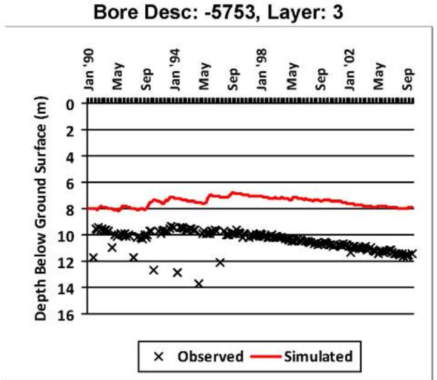

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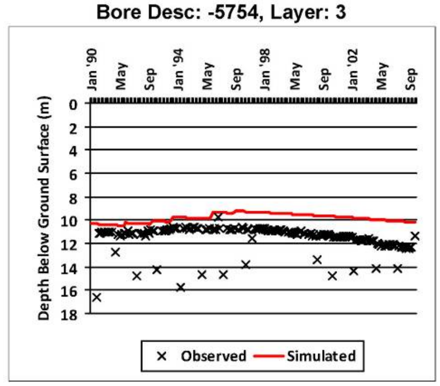

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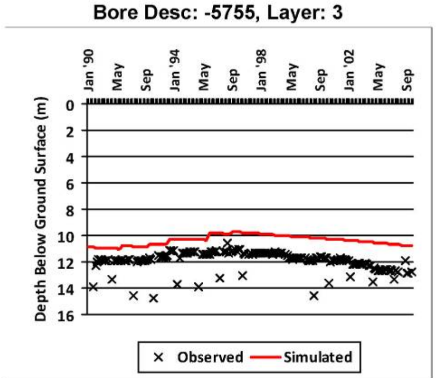

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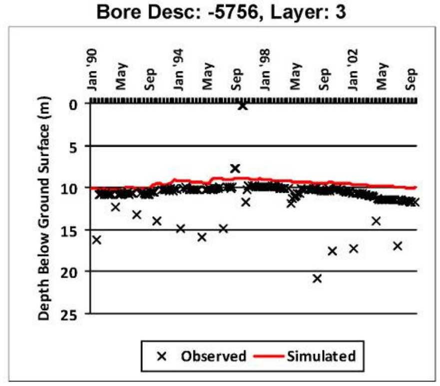

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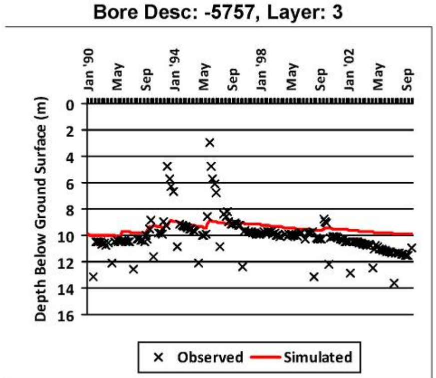

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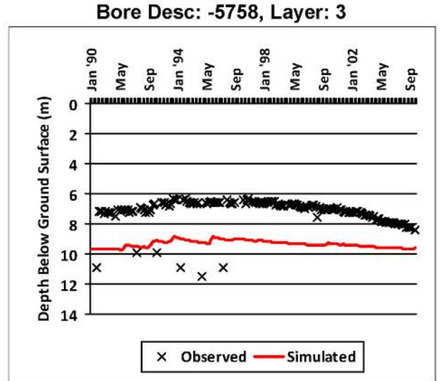

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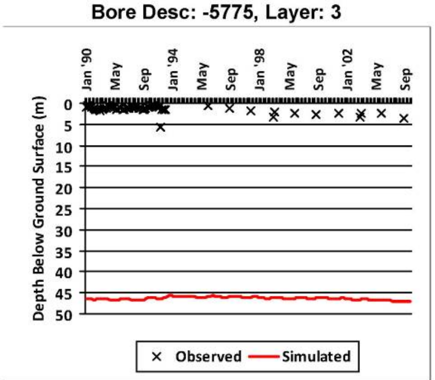

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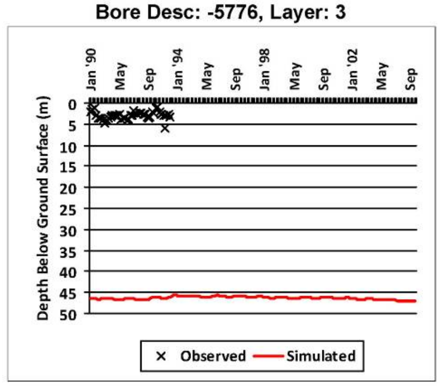

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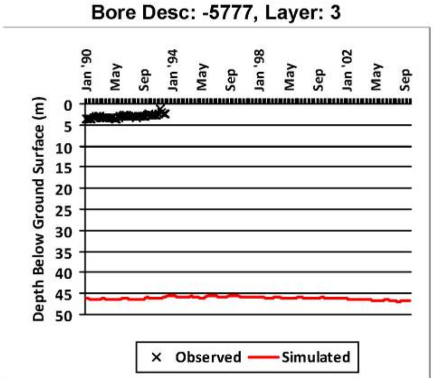

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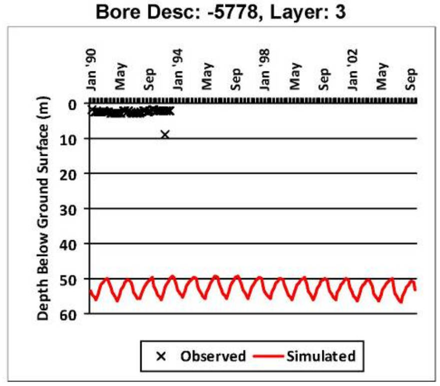

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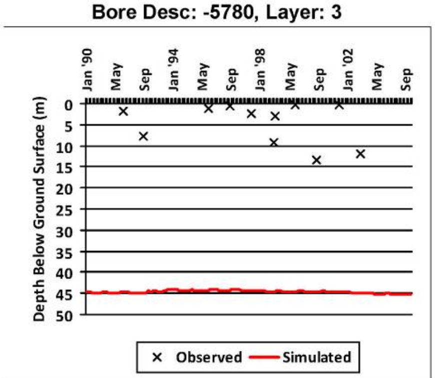

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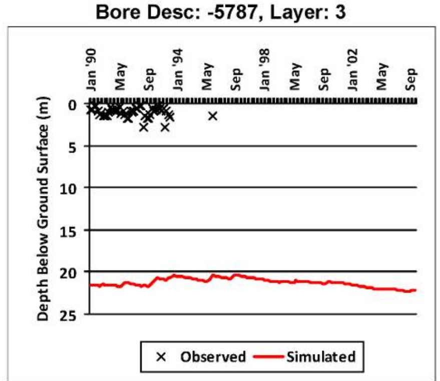

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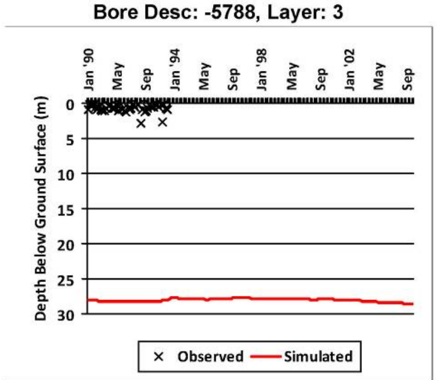

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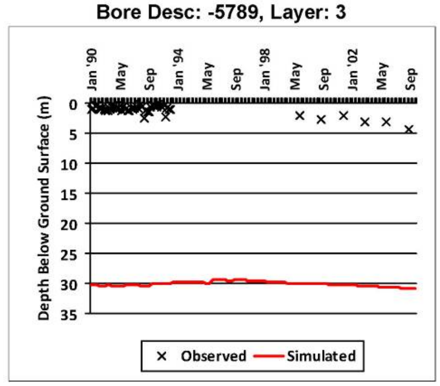

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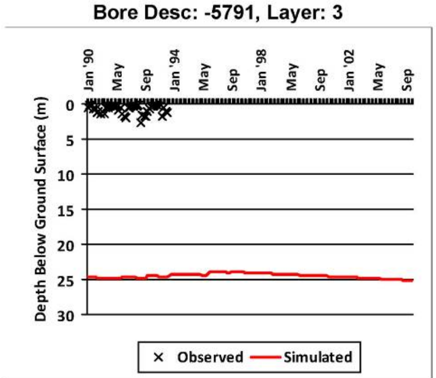

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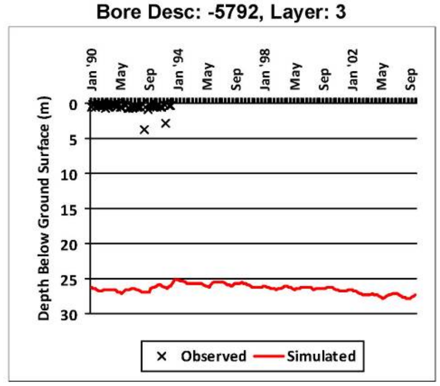

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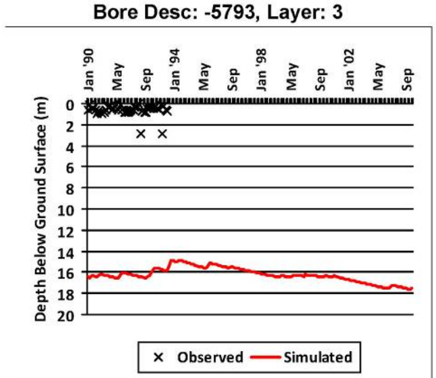

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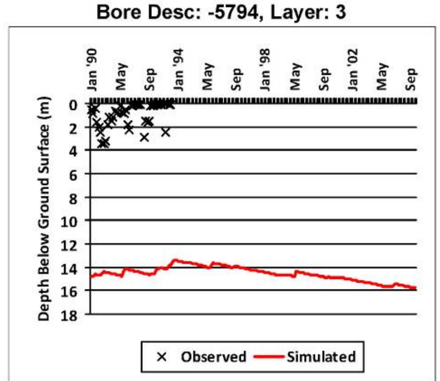

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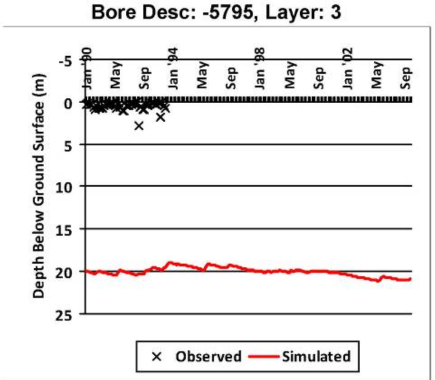

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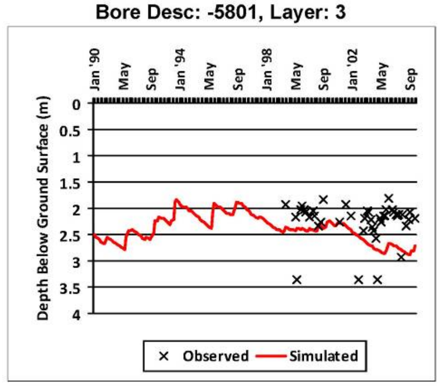

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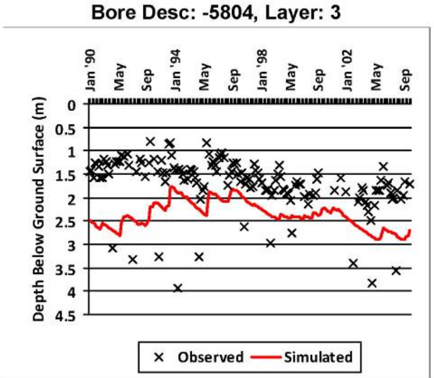

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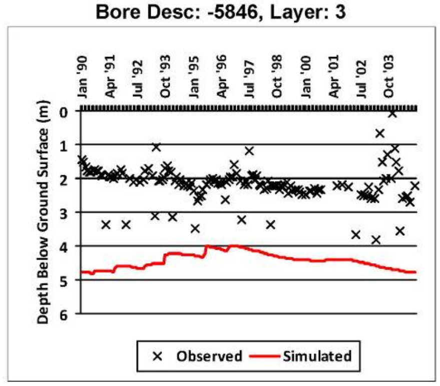

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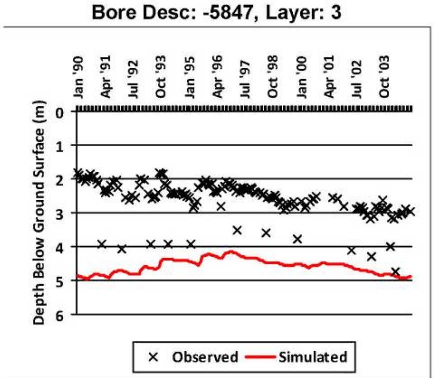

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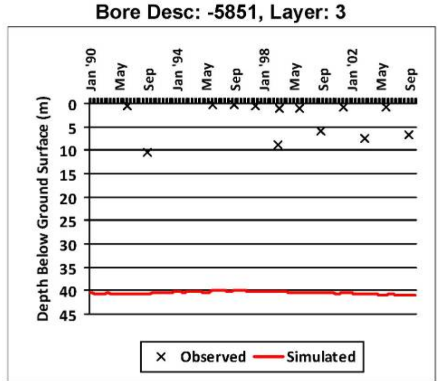
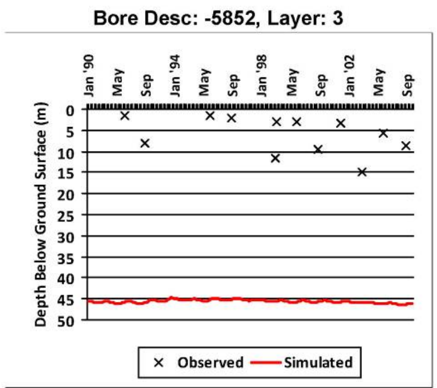
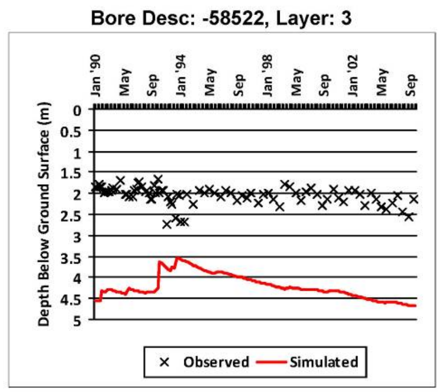
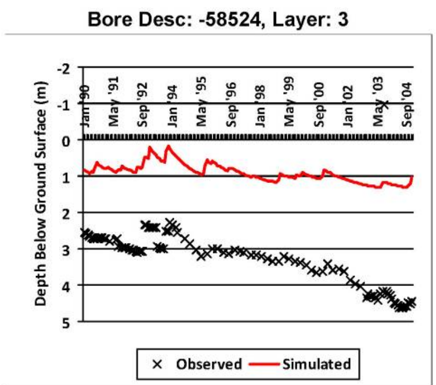



Bore Desc: -5852, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -58522, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated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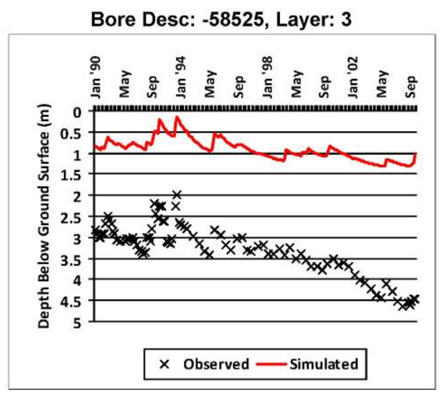
Depth Below Ground Surface (m)
Observed
Simulated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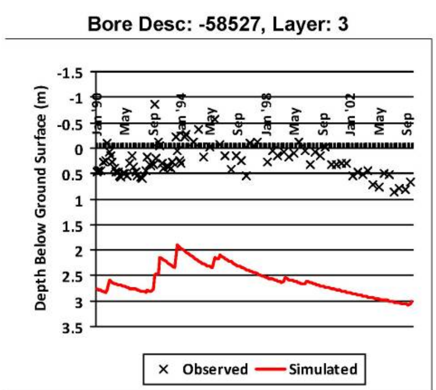
Depth Below Ground Surface (m)
Observed
Simulated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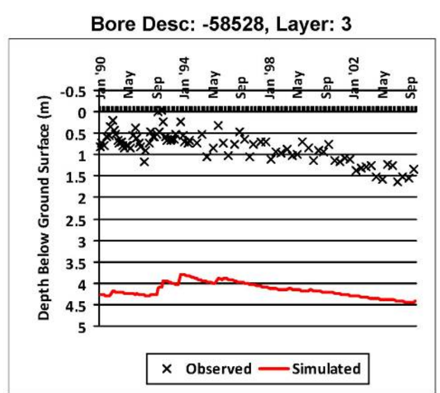
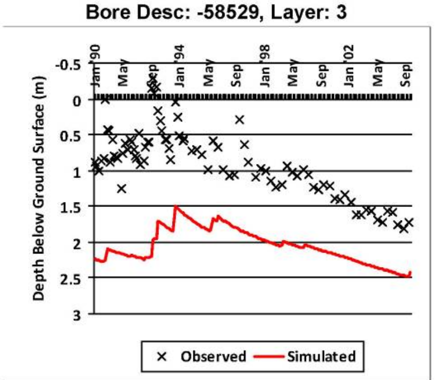
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -58528, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

Bore Desc: -58529, Layer: 3



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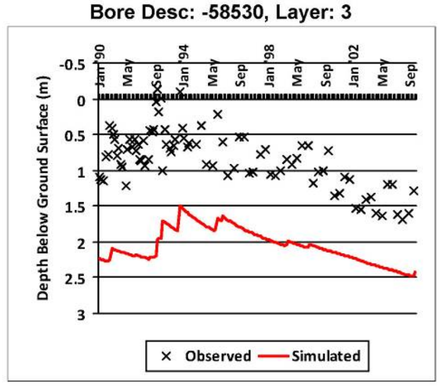

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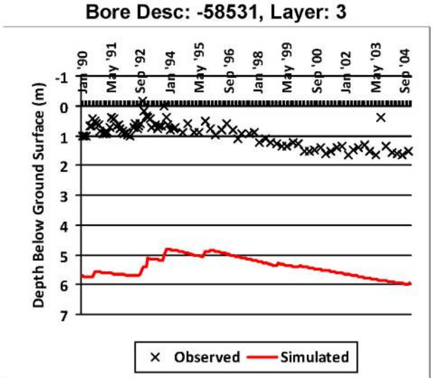

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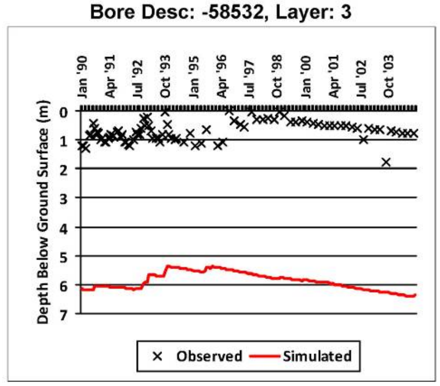

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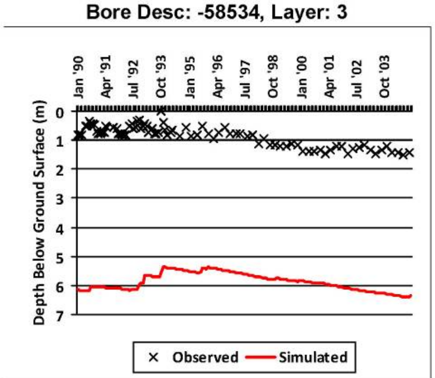

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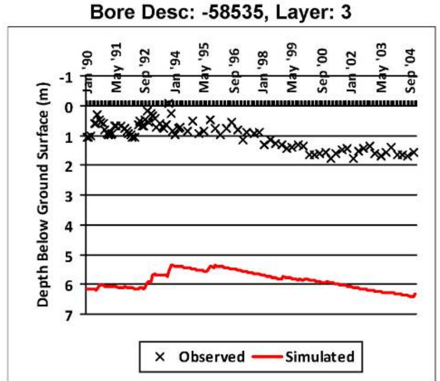

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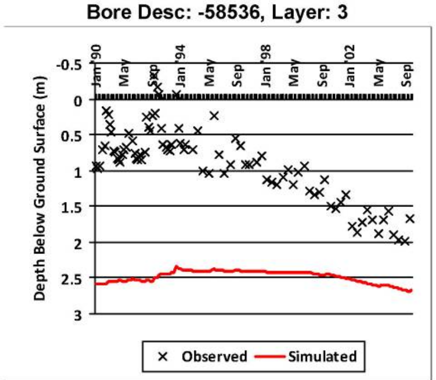

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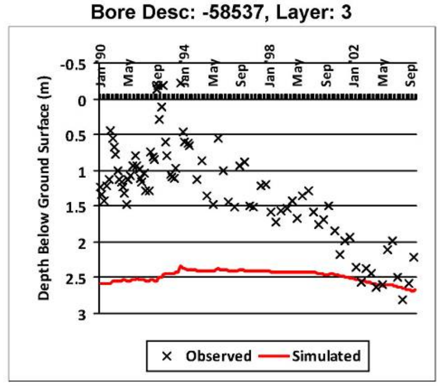

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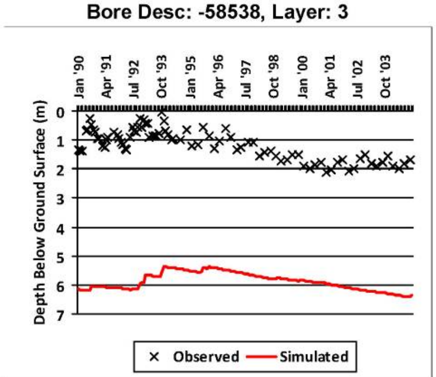

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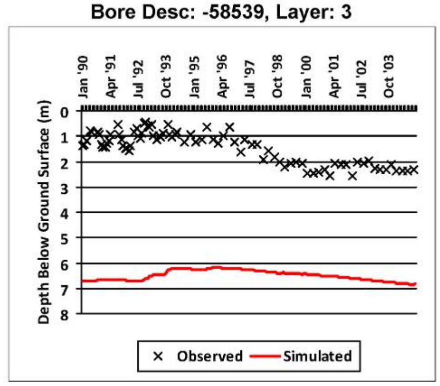

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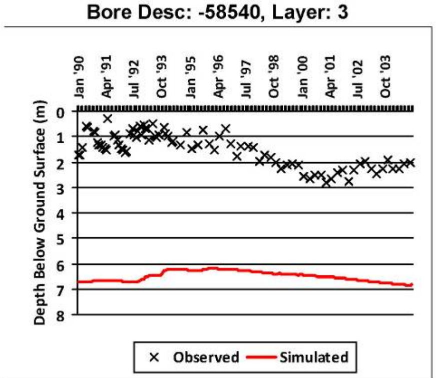

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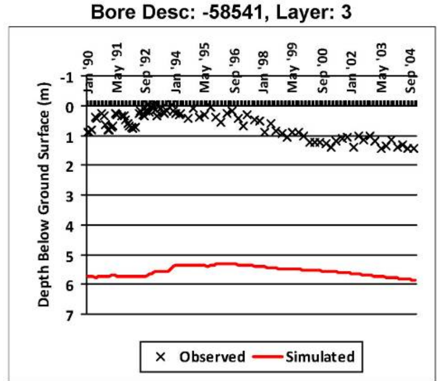

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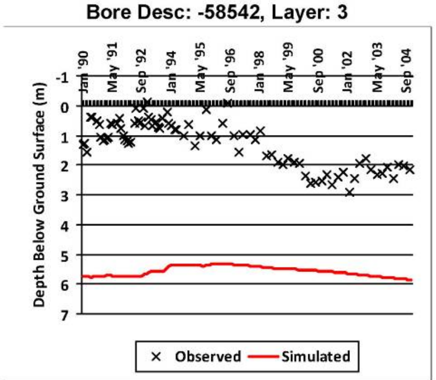

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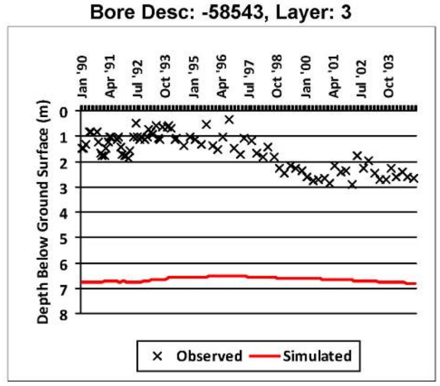

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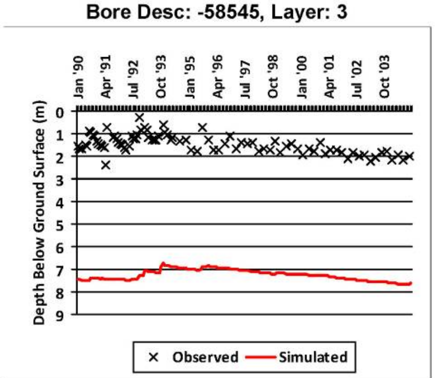

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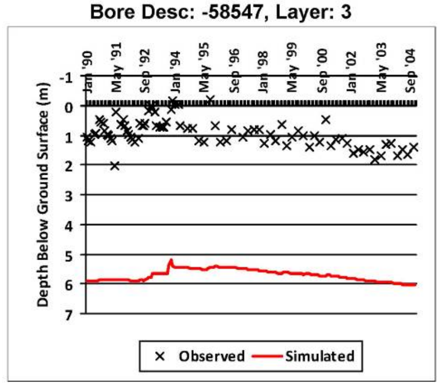

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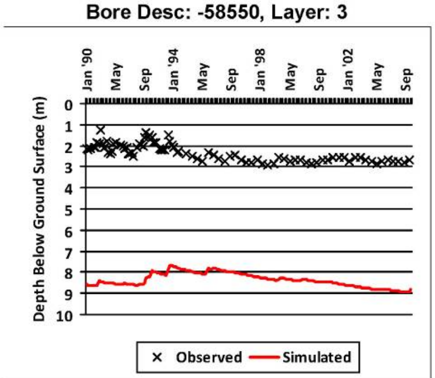

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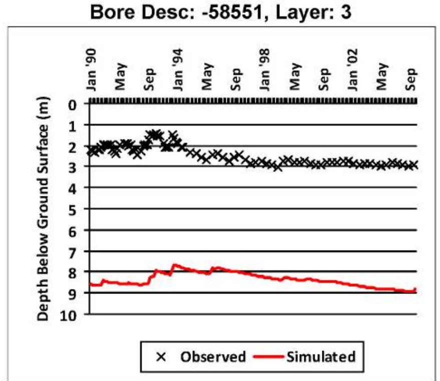

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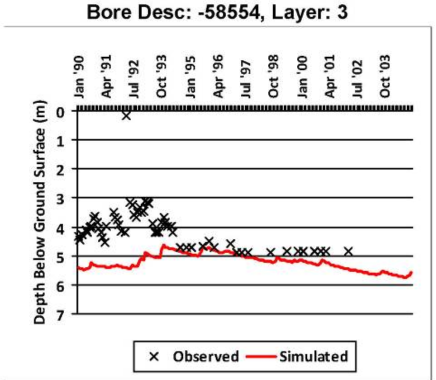

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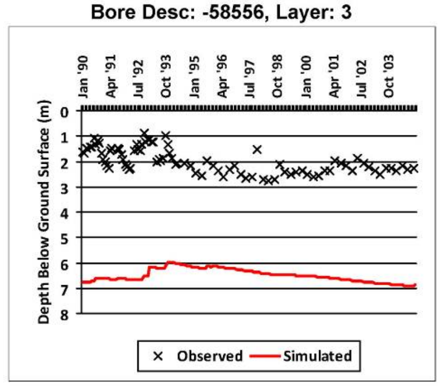

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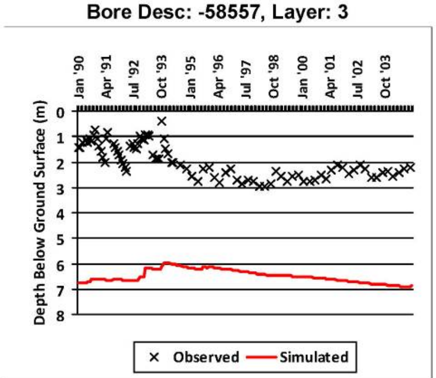

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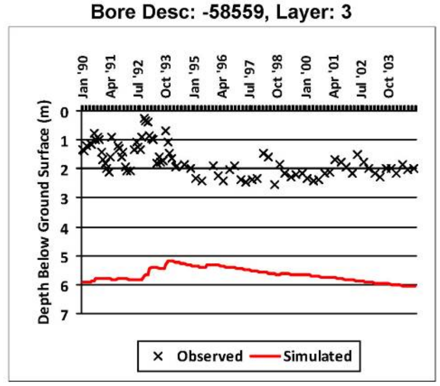

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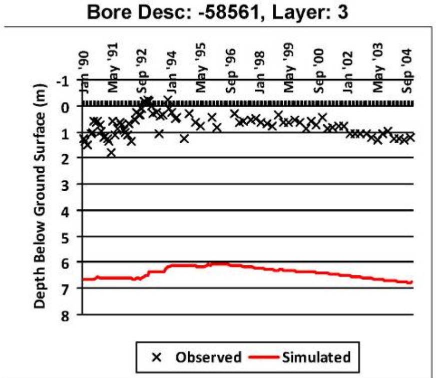

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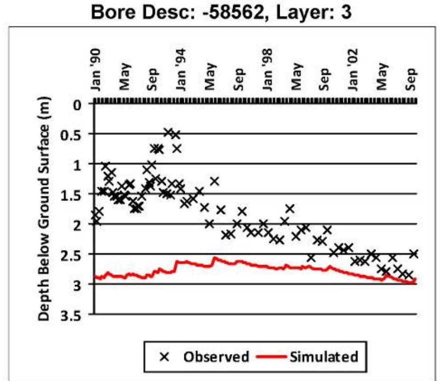

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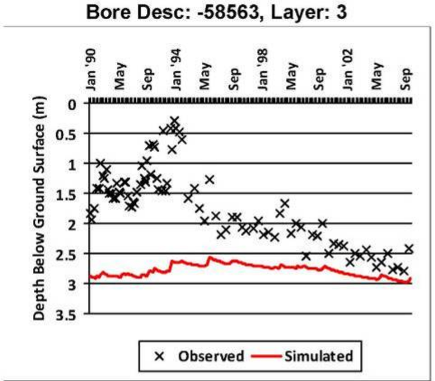

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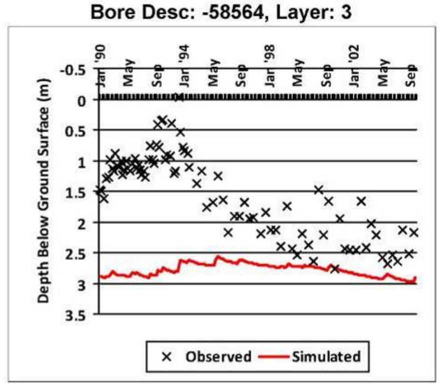

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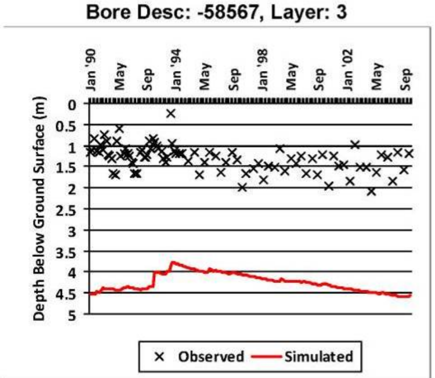

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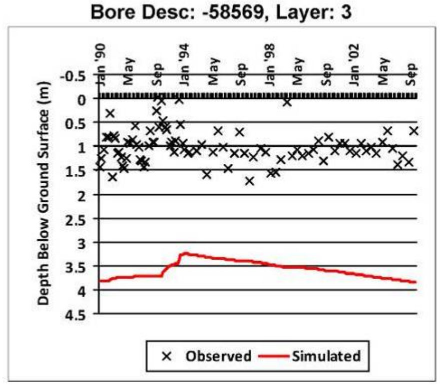

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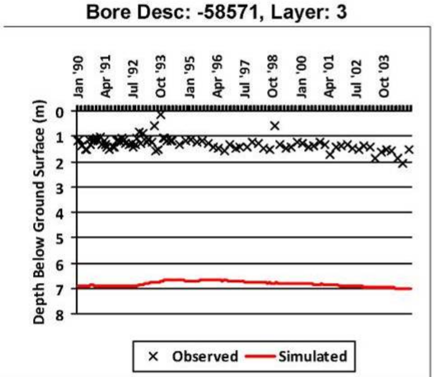

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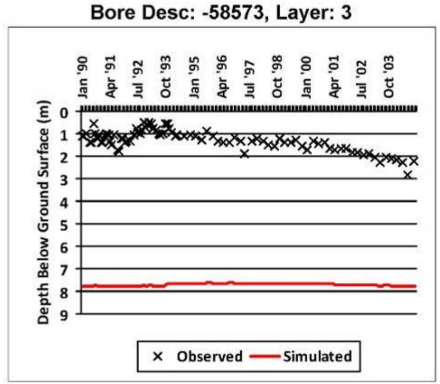

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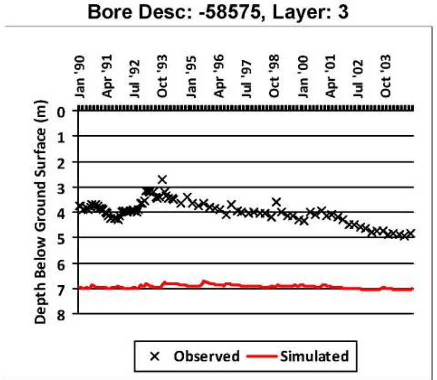

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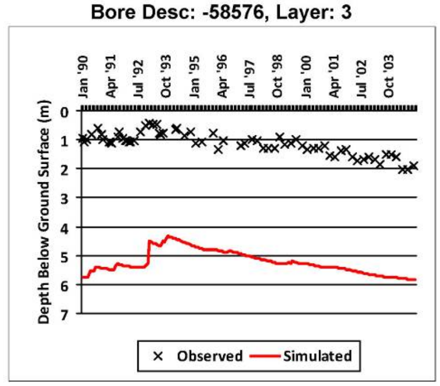

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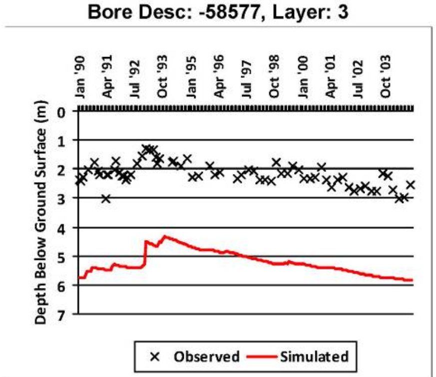

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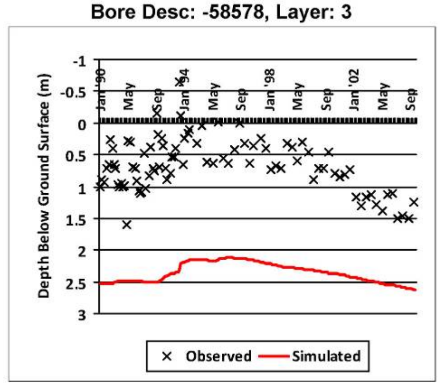

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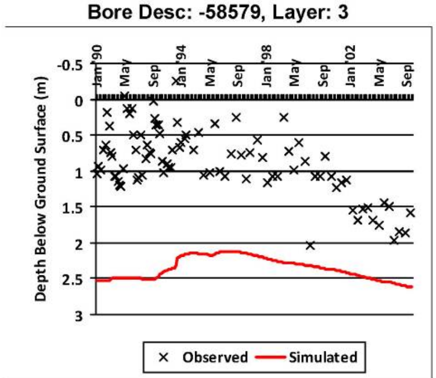

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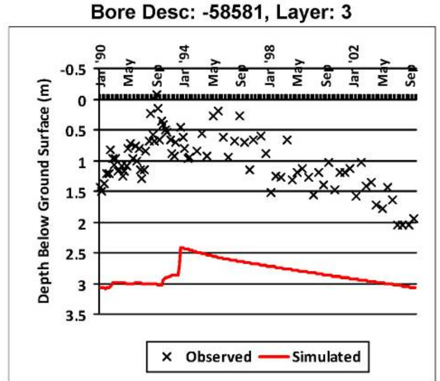

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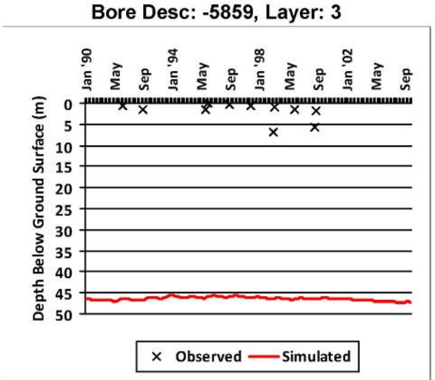

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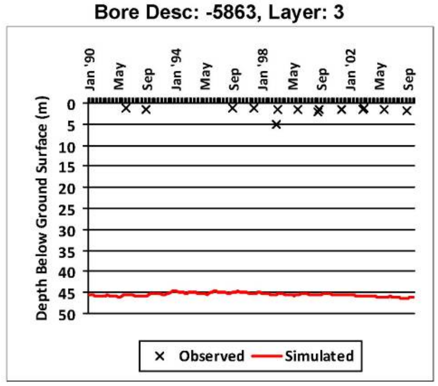

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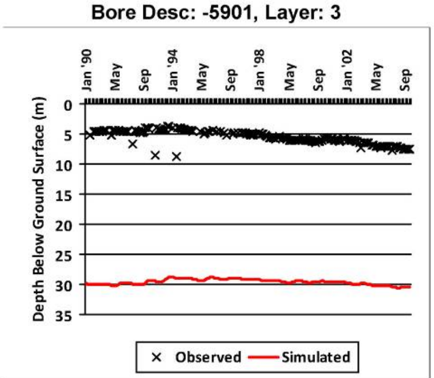

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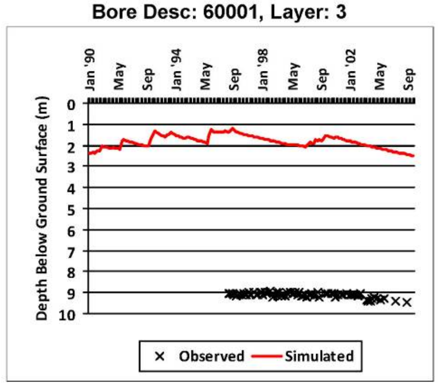

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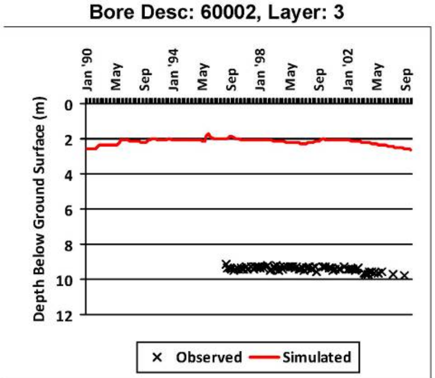

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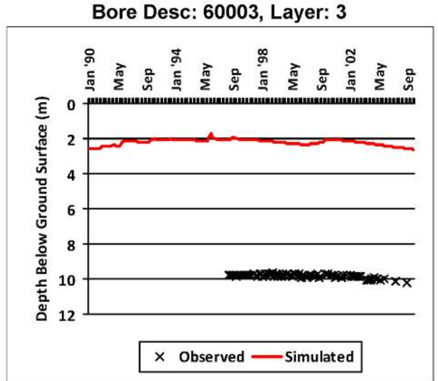
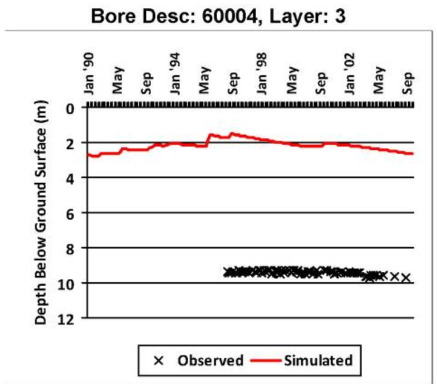
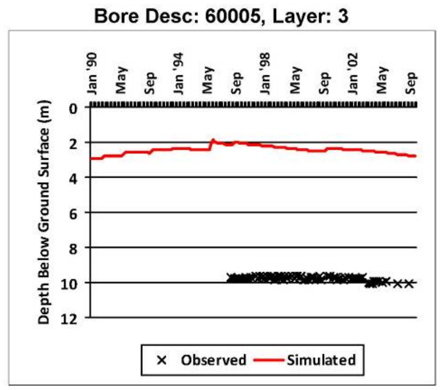



Bore Desc: 60004, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated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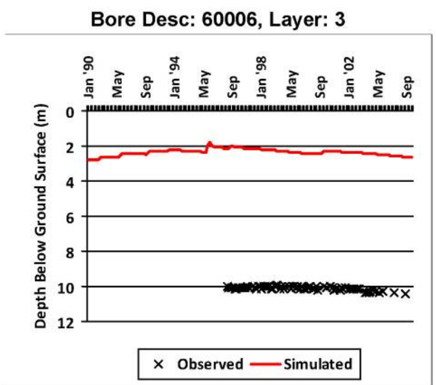
Observed
Simulated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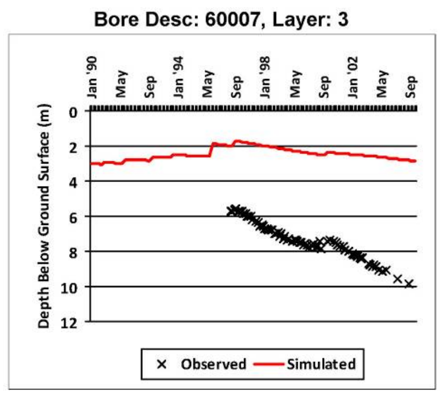
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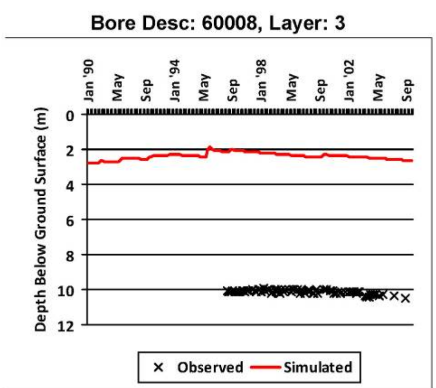
Observed
Simulated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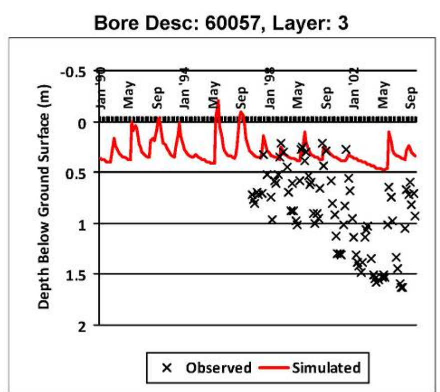
Observed
Simulated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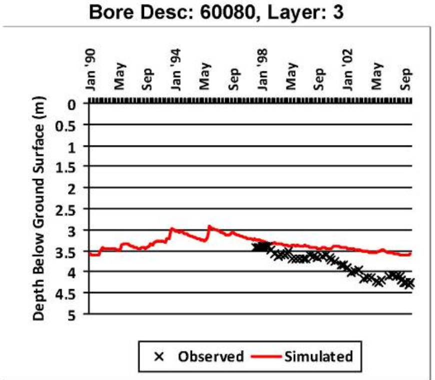
Depth Below Ground Surface (m)
Observed
Simulated

Bore Desc: 60080, Layer: 3



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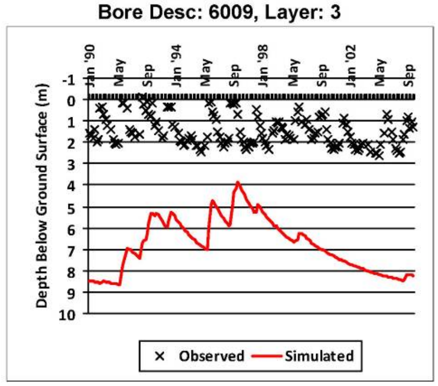

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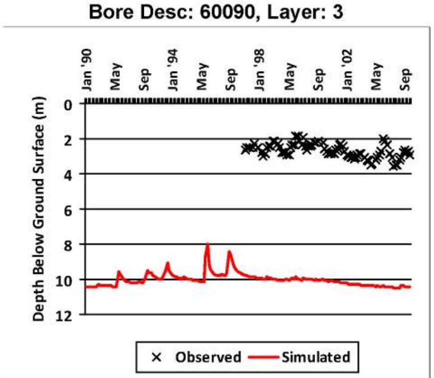

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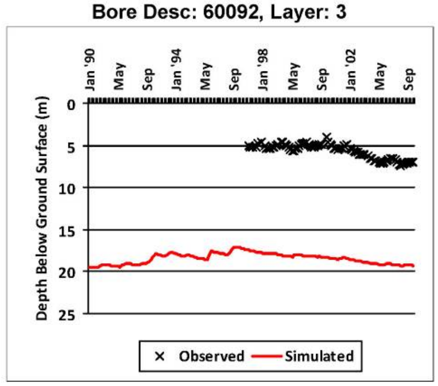

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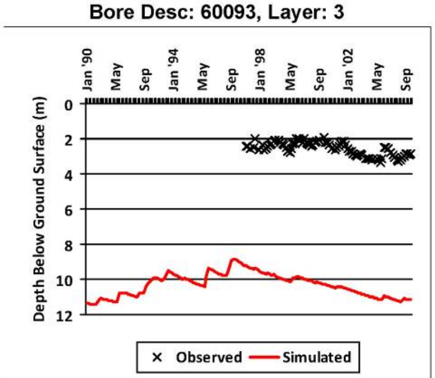

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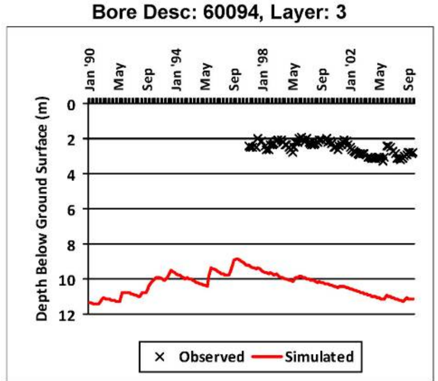

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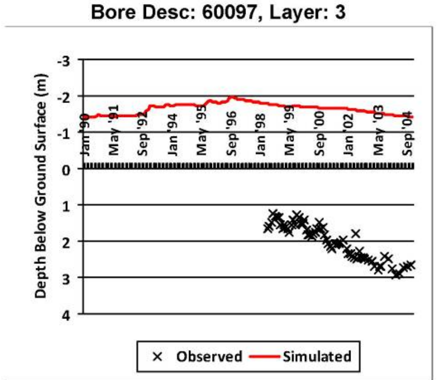

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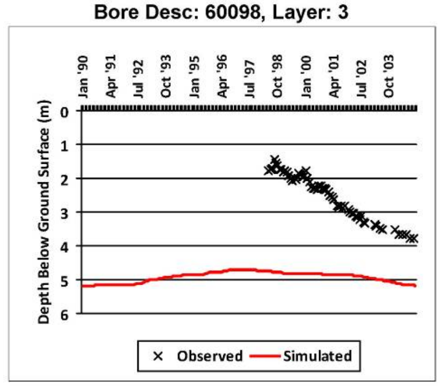

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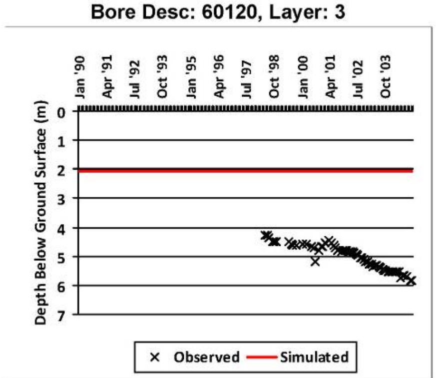

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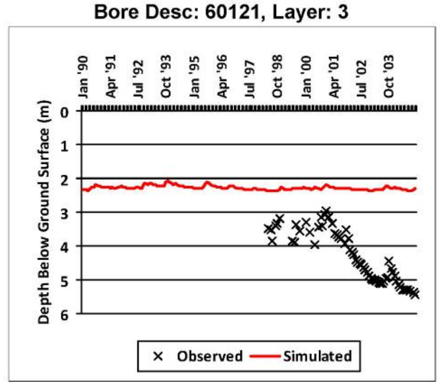

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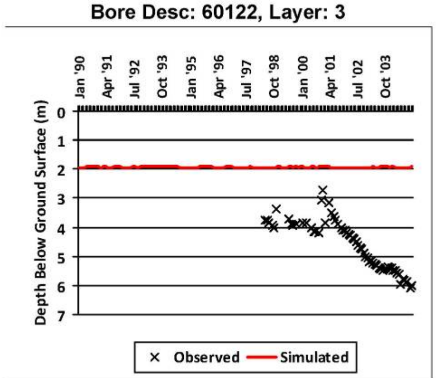

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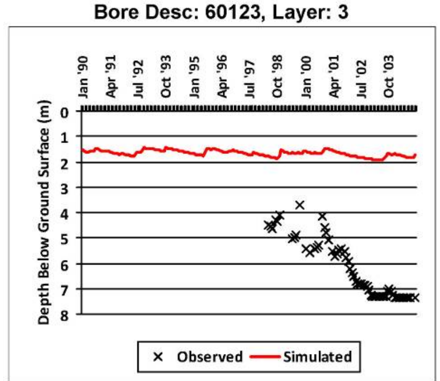

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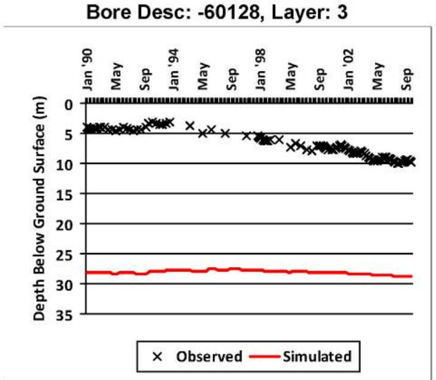

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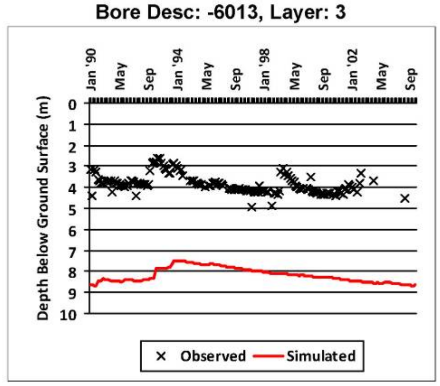

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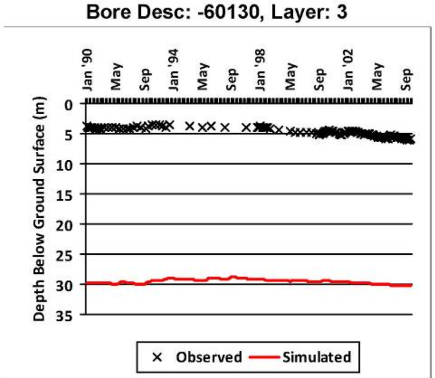

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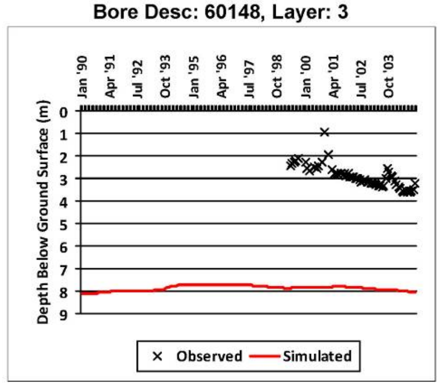

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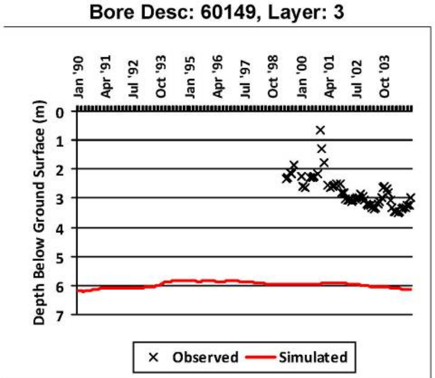

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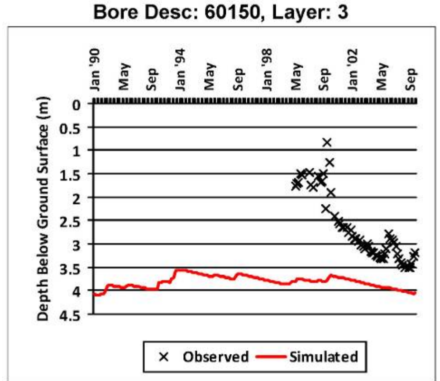

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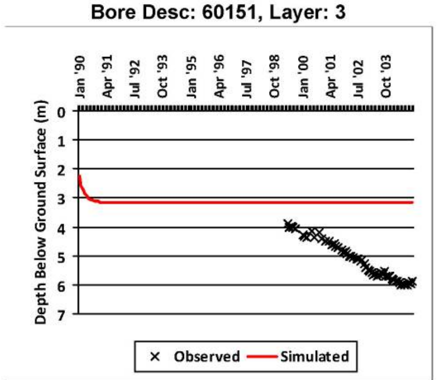

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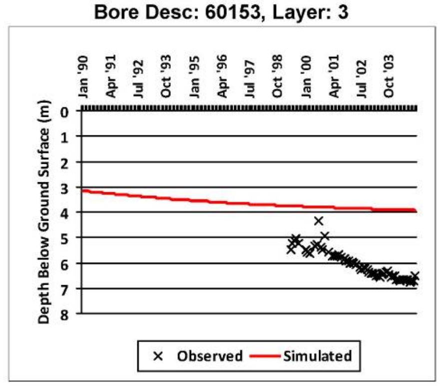

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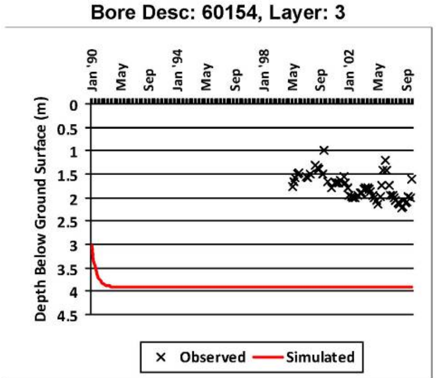

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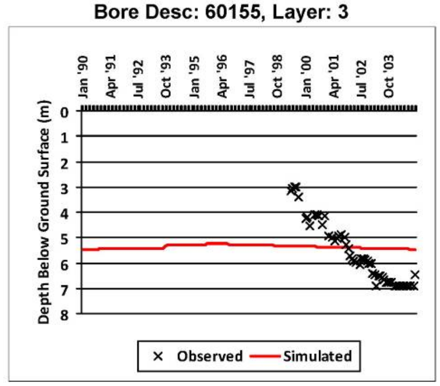

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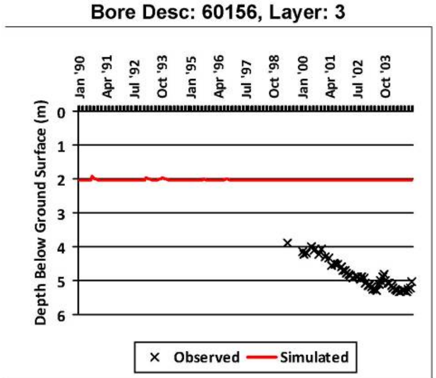

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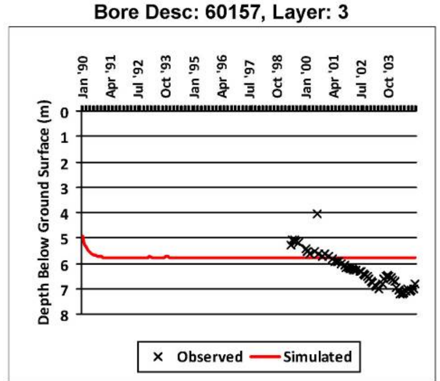

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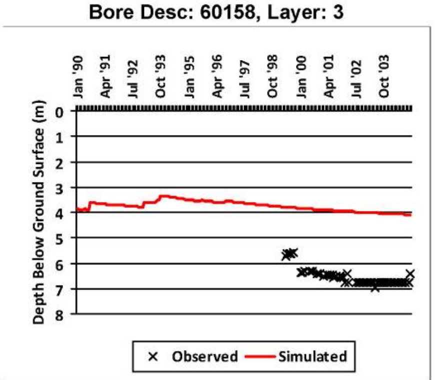

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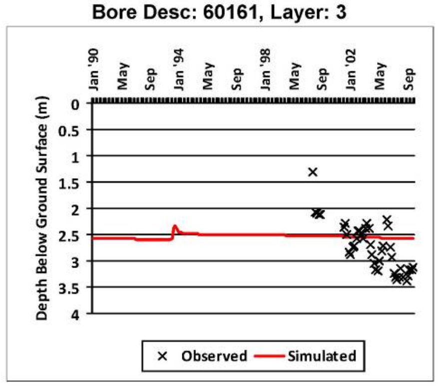

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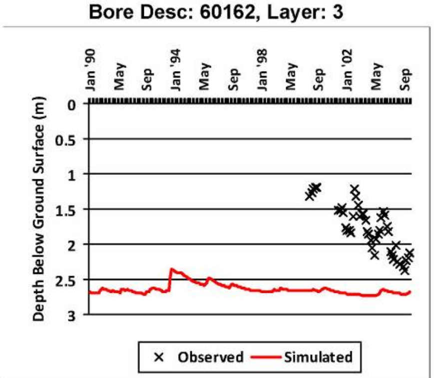

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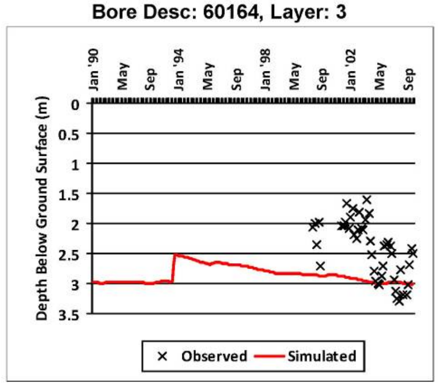

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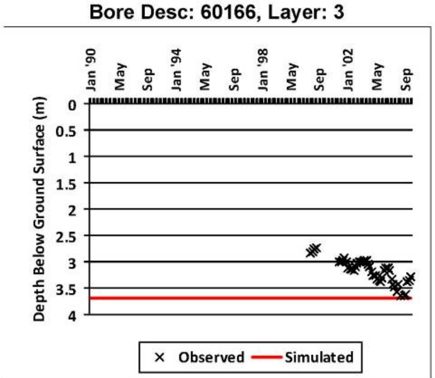

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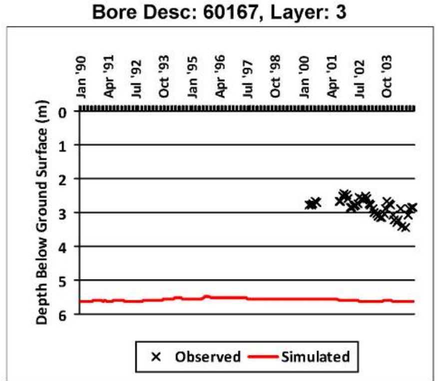

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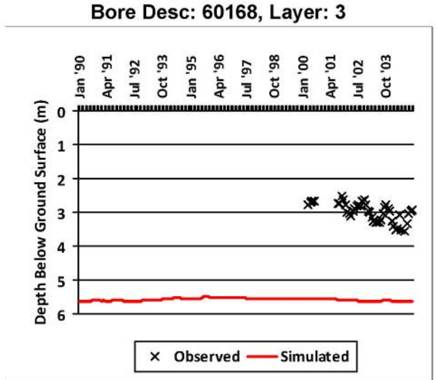

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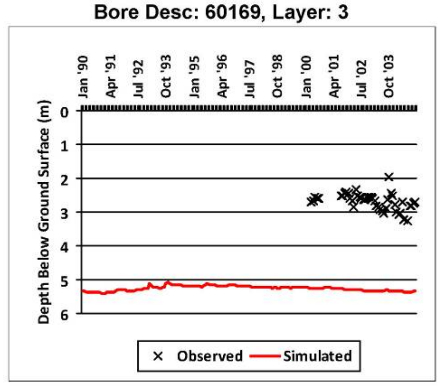

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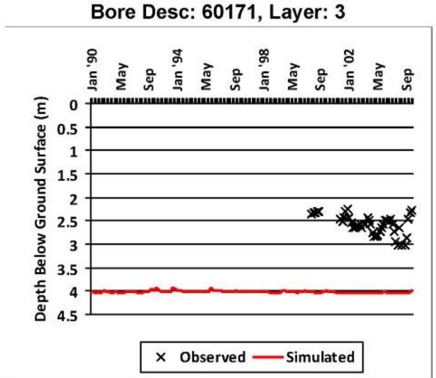

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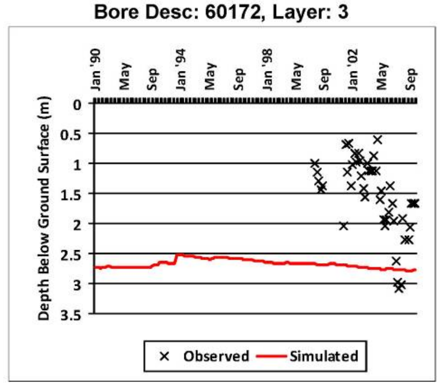

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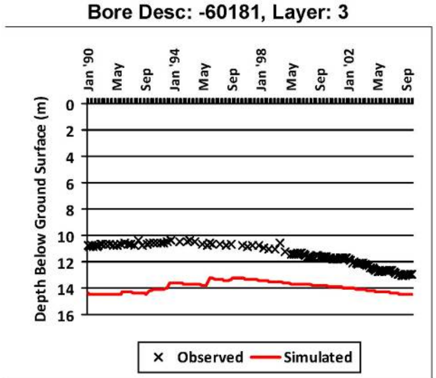

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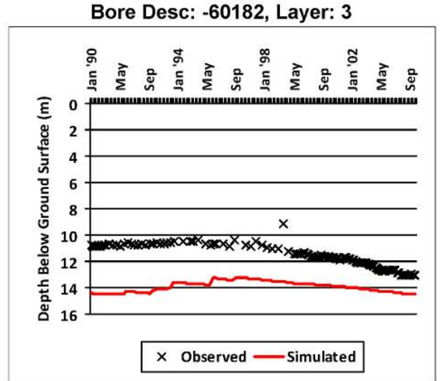

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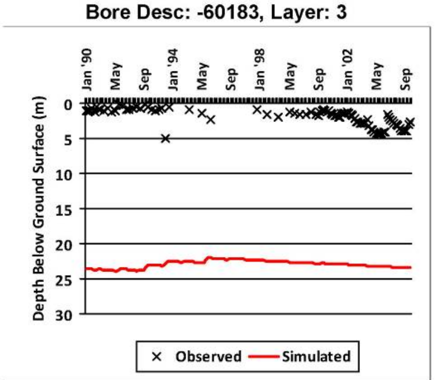

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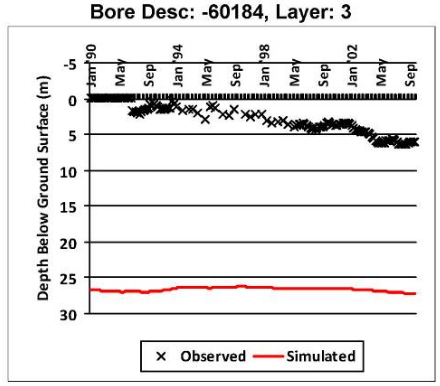

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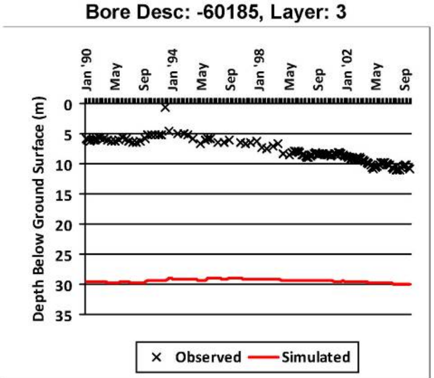

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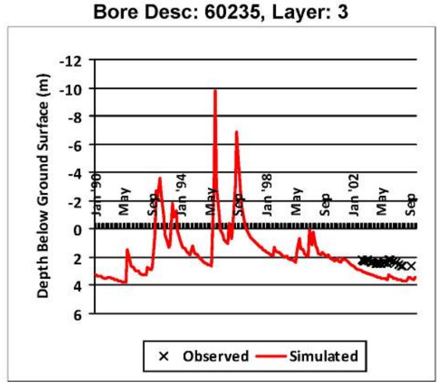

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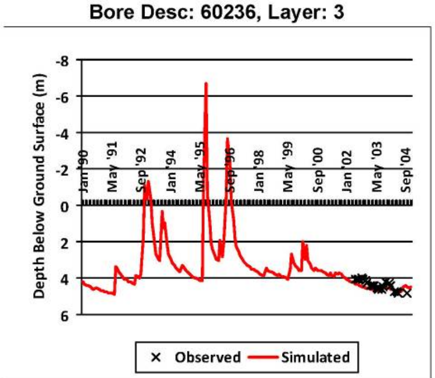

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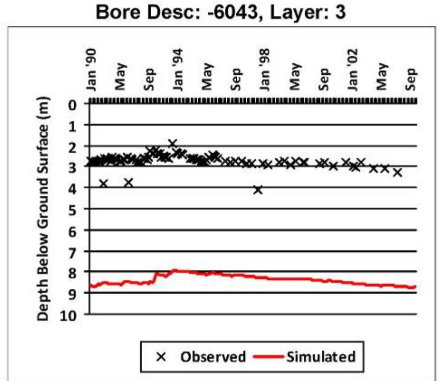

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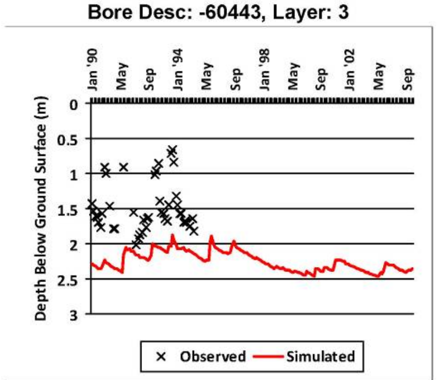

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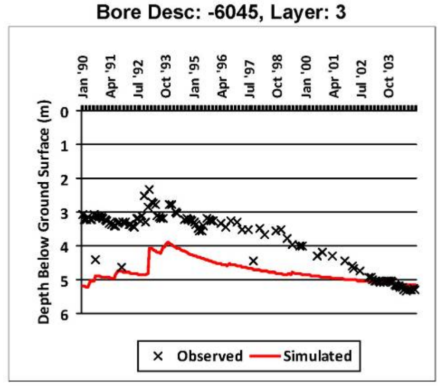

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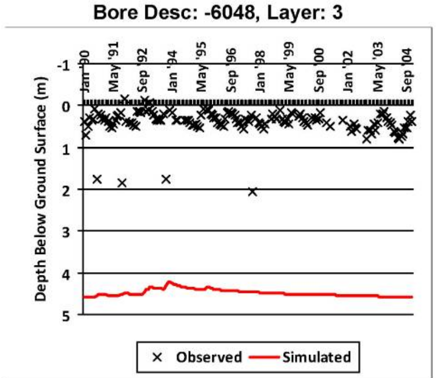

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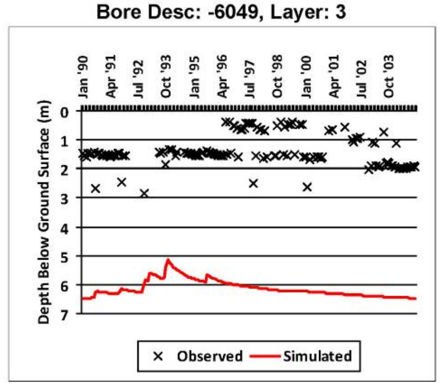

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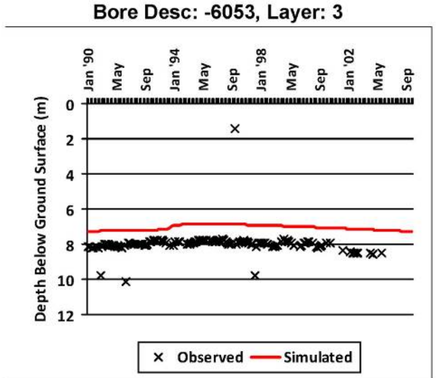

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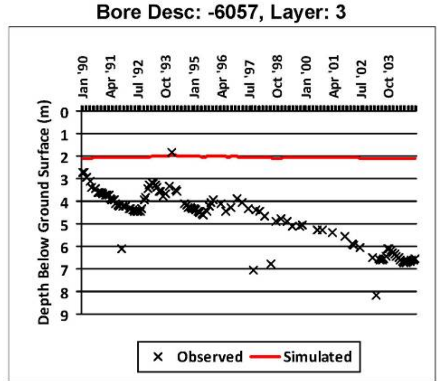

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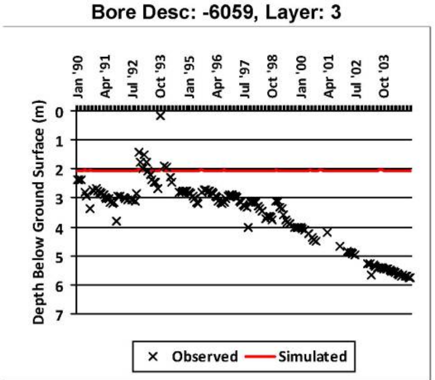

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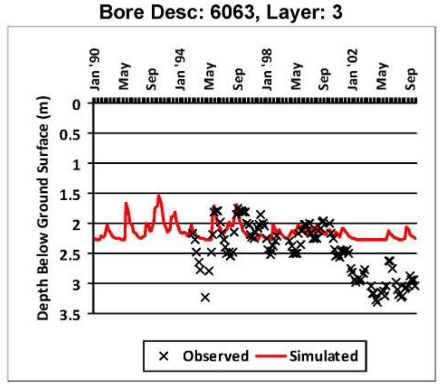

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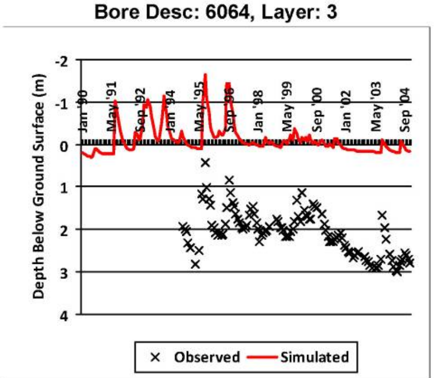

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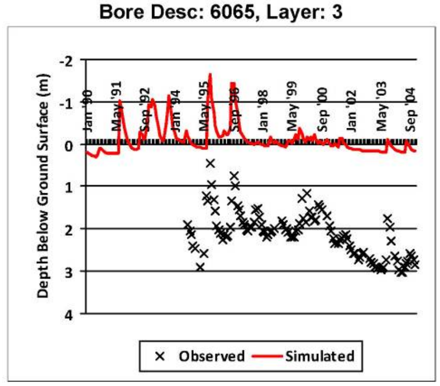

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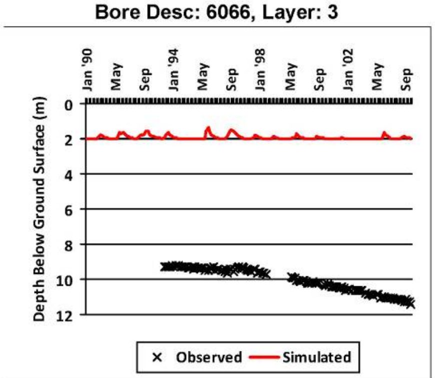

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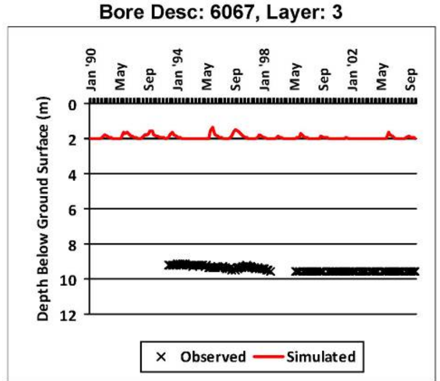

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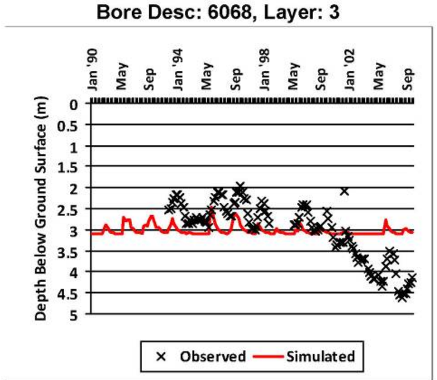

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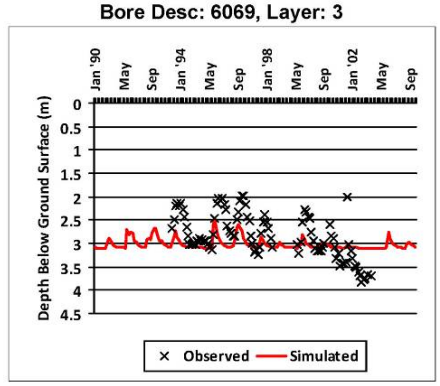

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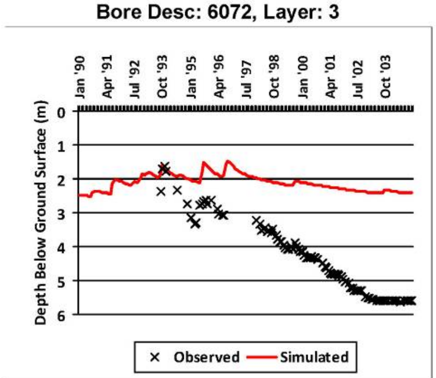

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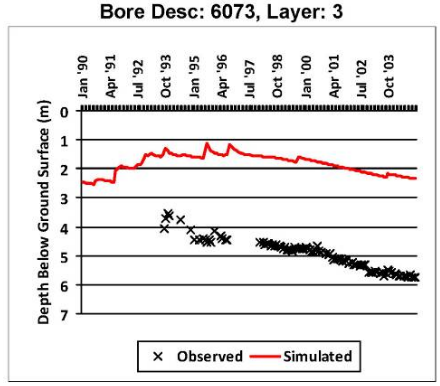

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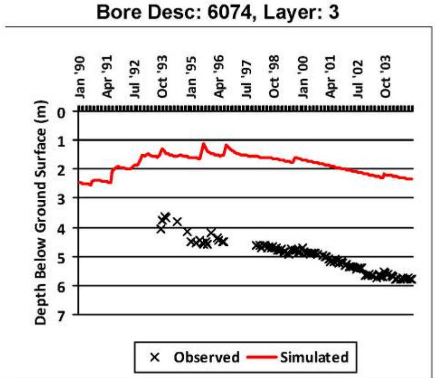

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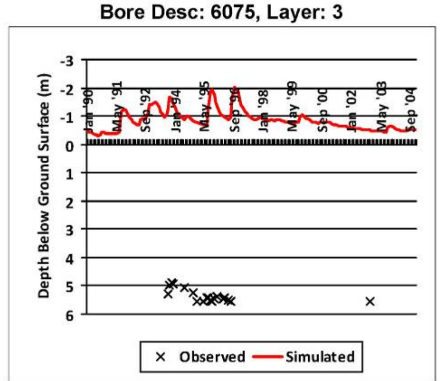

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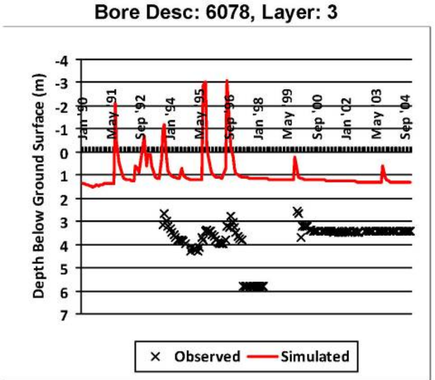

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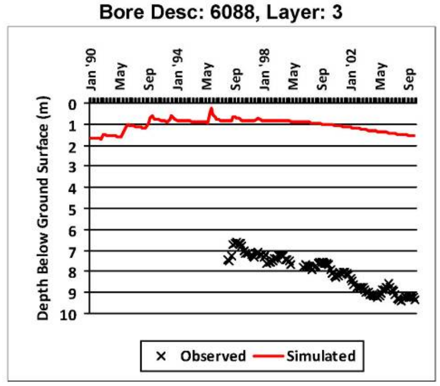

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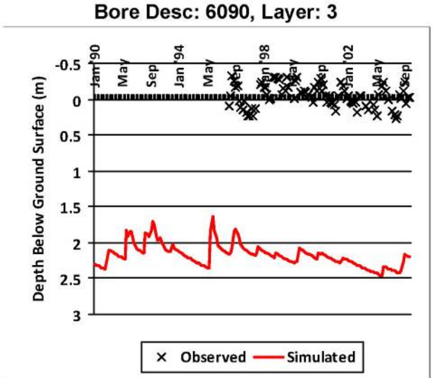

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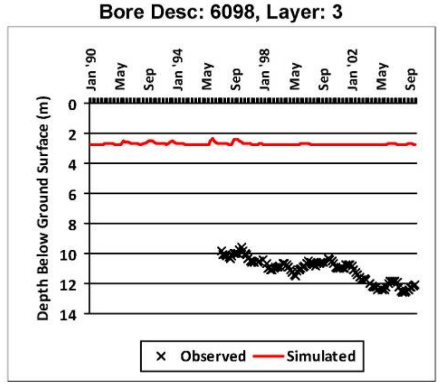

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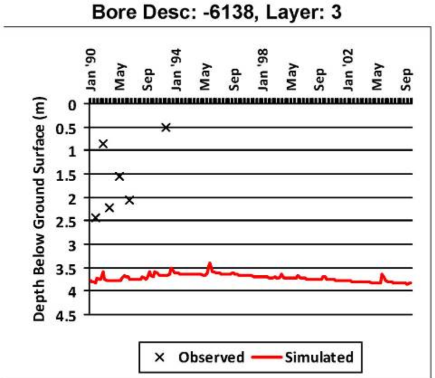

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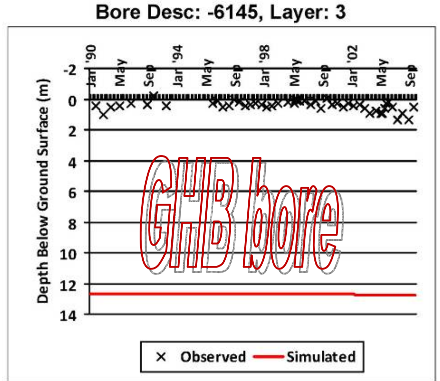

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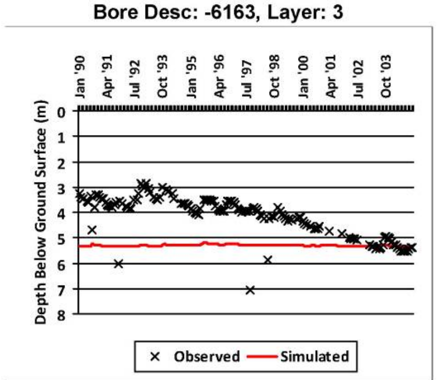

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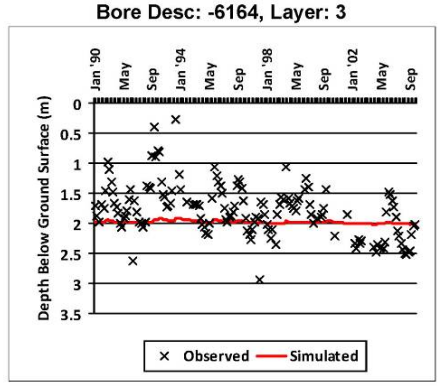

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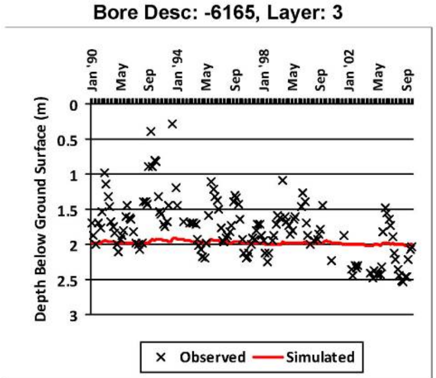

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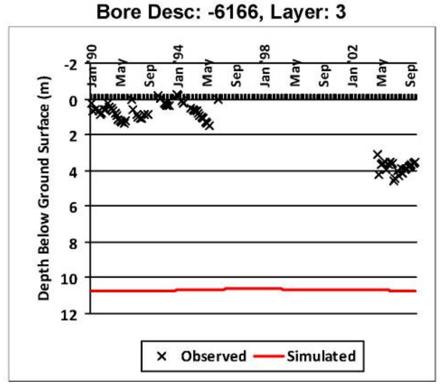

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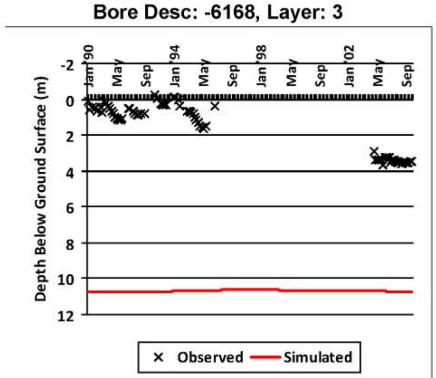

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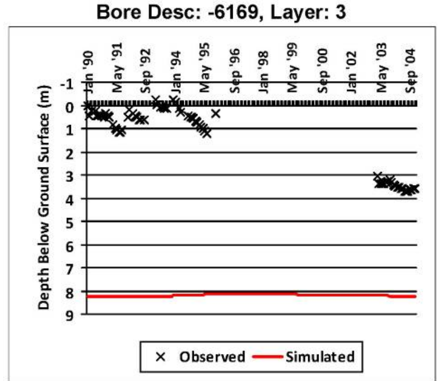

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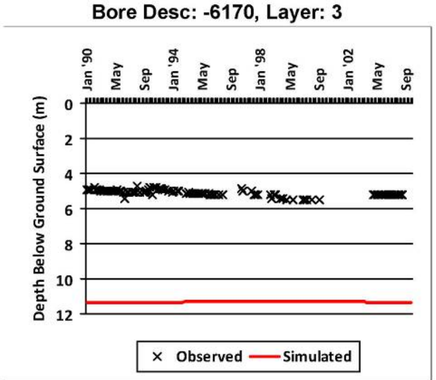

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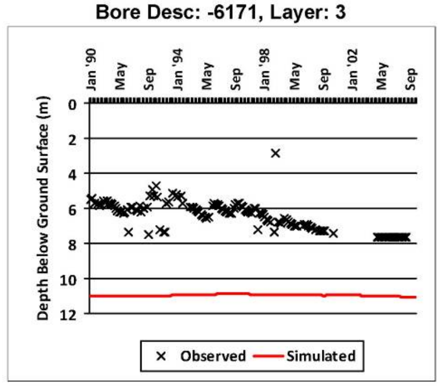

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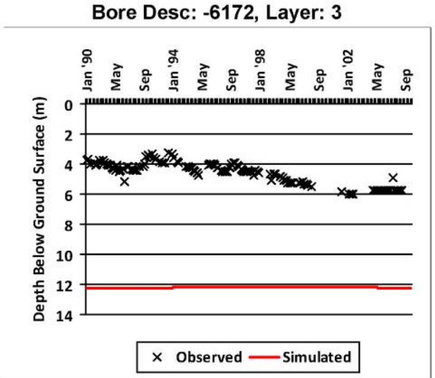

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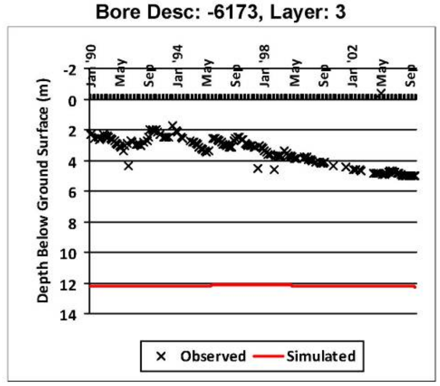

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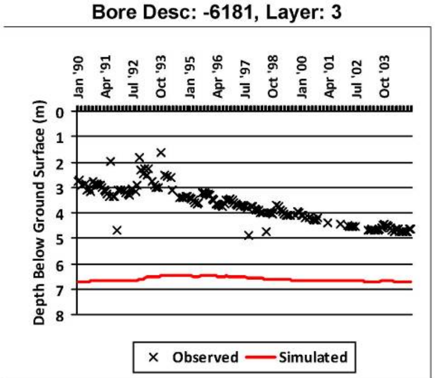

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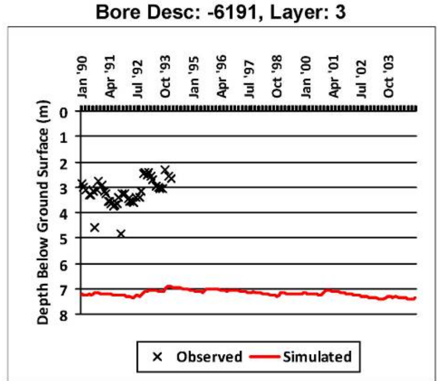

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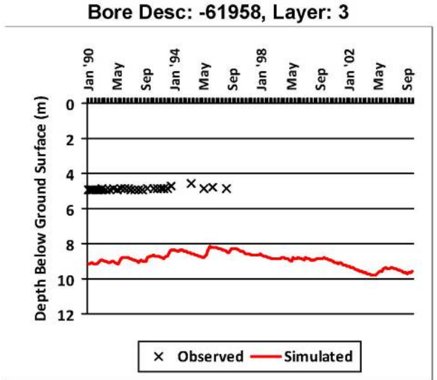

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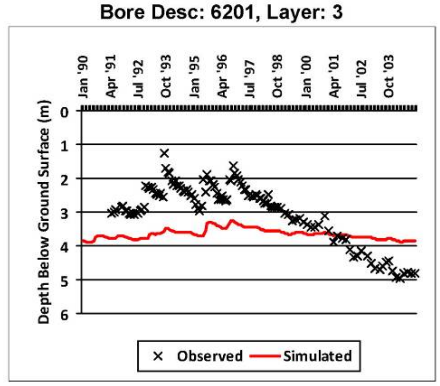

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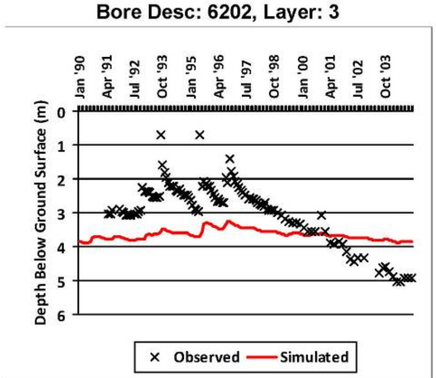

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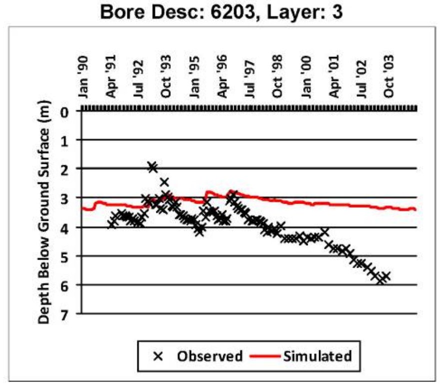

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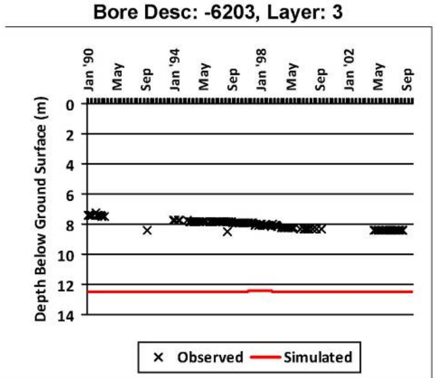

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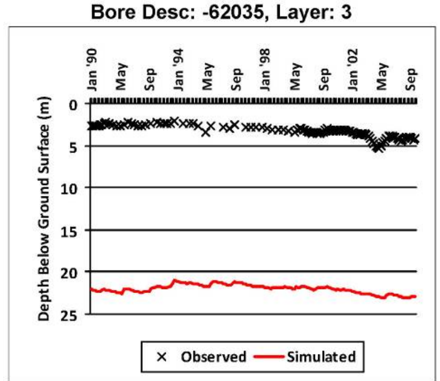

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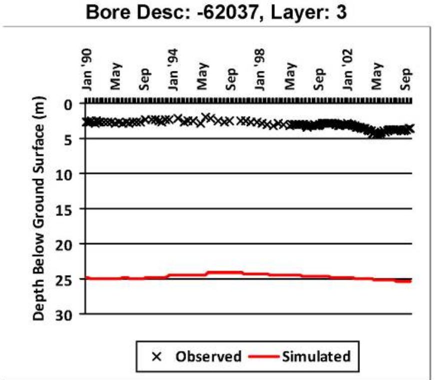

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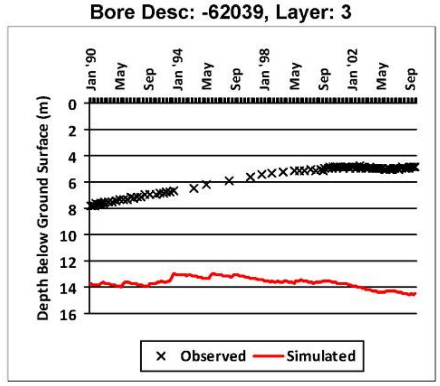

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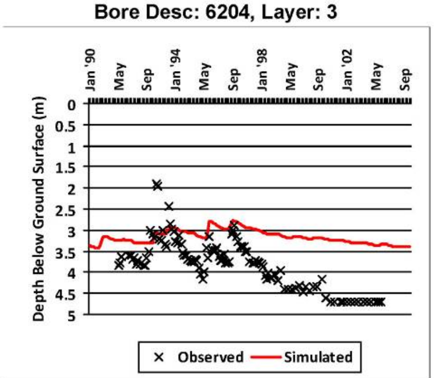

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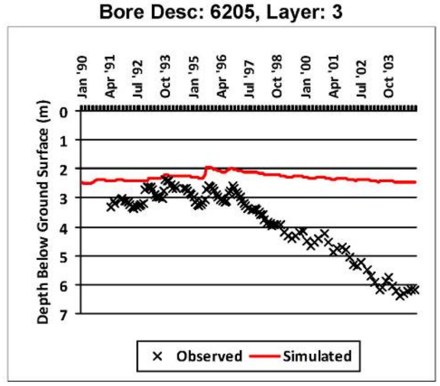

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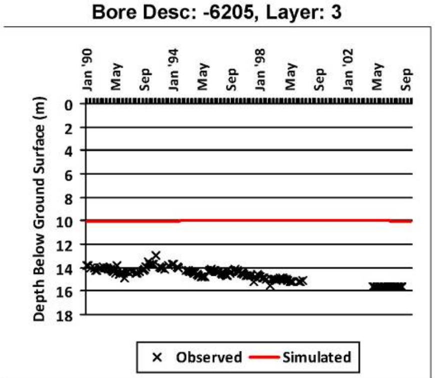

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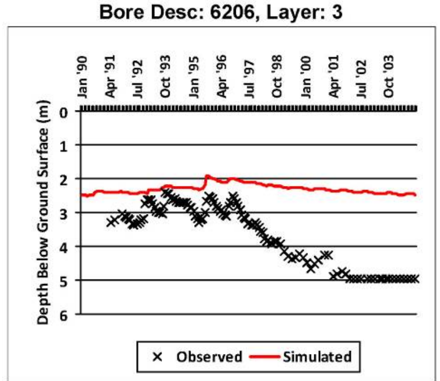

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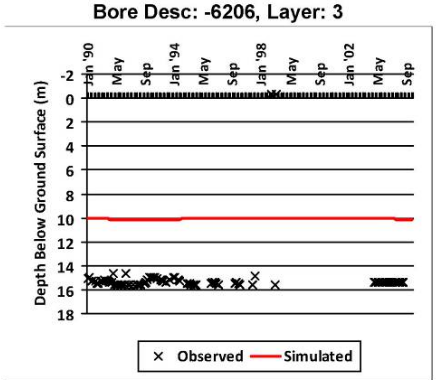

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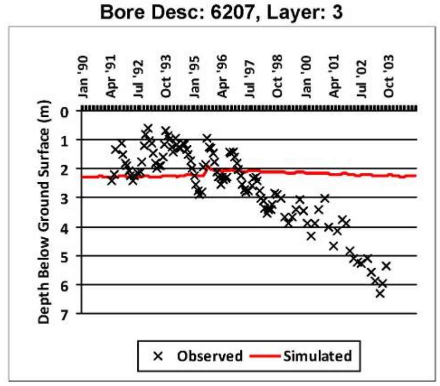

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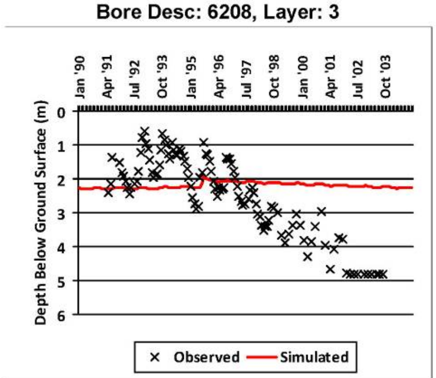

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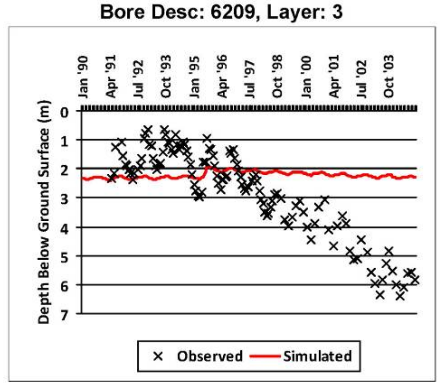

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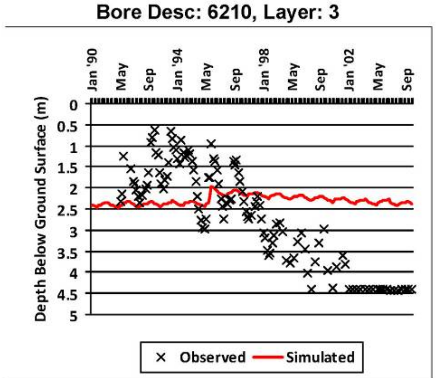

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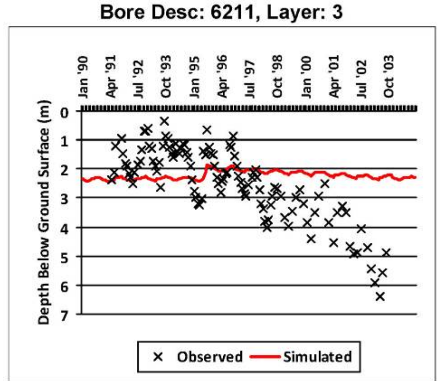

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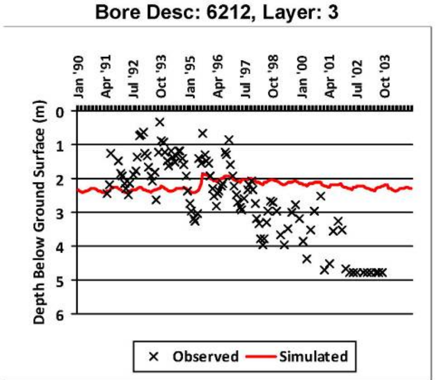

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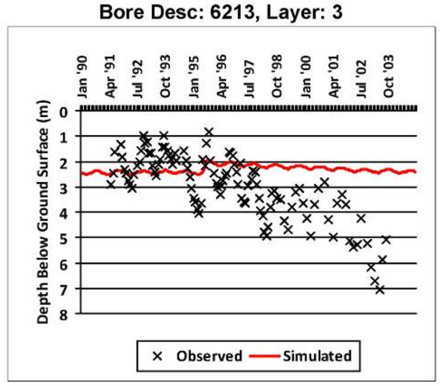

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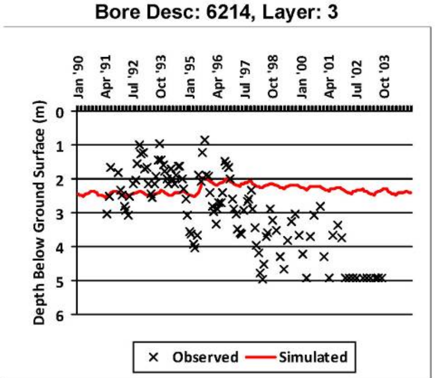

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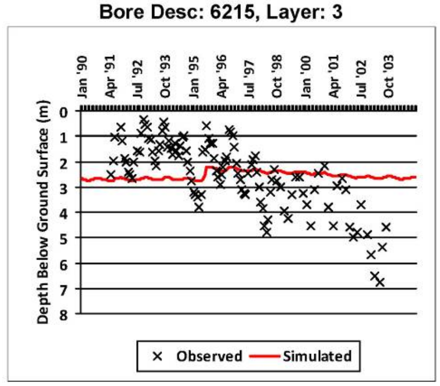
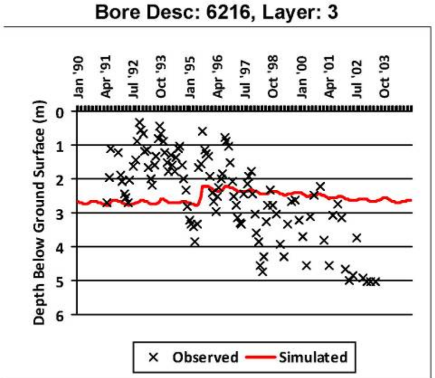
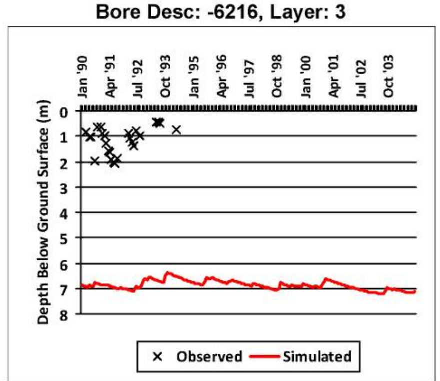


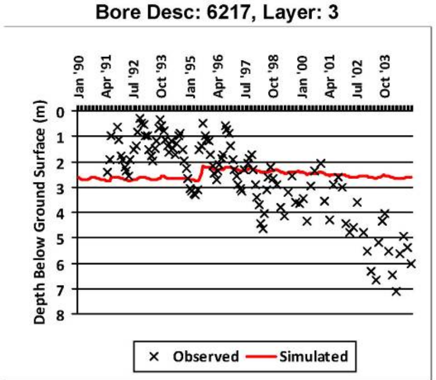
Bore Desc: 6216, Layer: 3



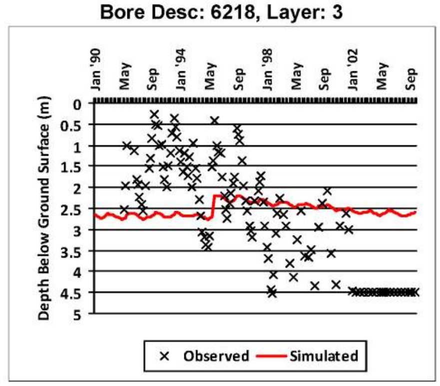
Bore Desc: -6216, Layer: 3



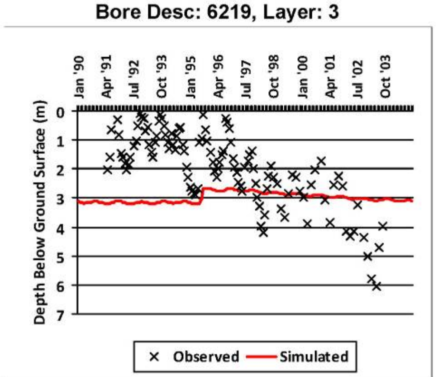
Bore Desc: 6217, Layer: 3



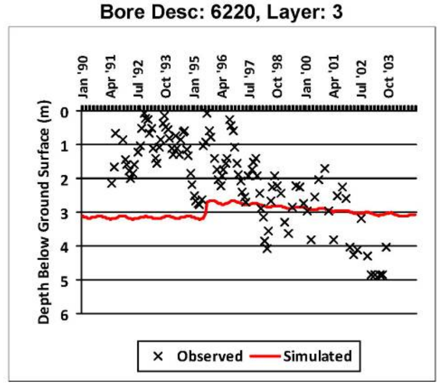
Bore Desc: 6218, Layer: 3



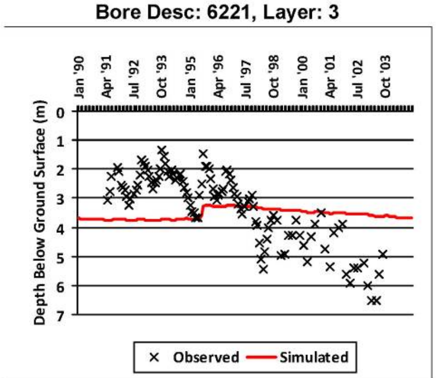
Bore Desc: 6219, Layer: 3



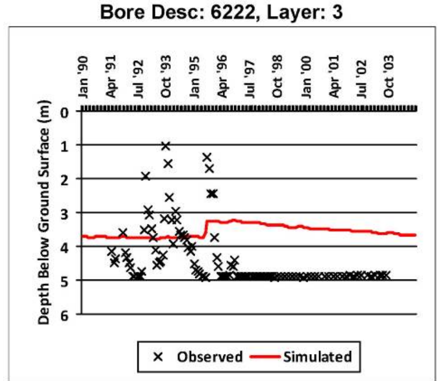
Bore Desc: 6220, Layer: 3



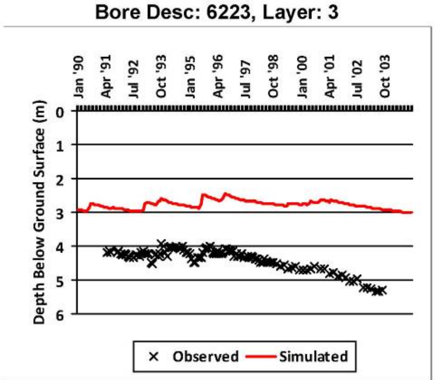
Bore Desc: 6221, Layer: 3



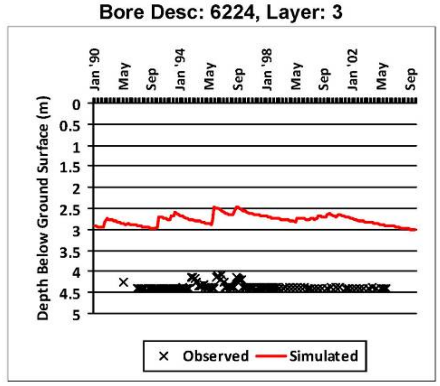
Bore Desc: 6222, Layer: 3



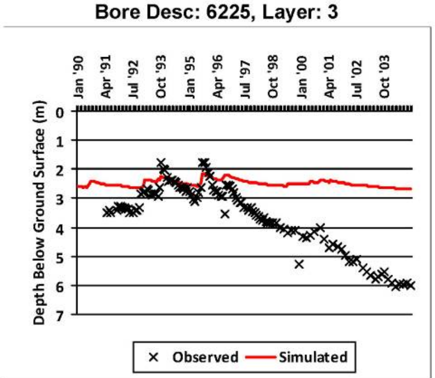
Bore Desc: 6223, Layer: 3



Bore Desc: 6224, Layer: 3



Bore Desc: 6225, Layer: 3



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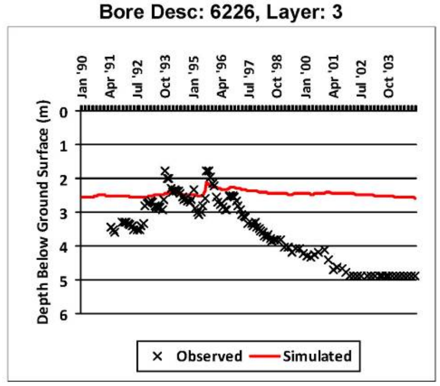

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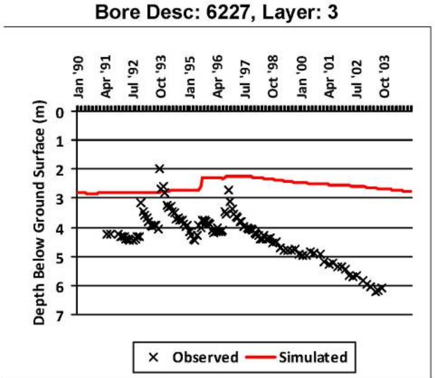
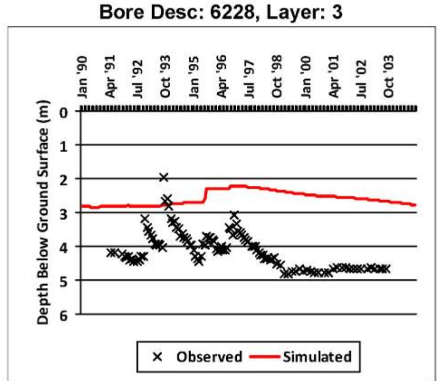
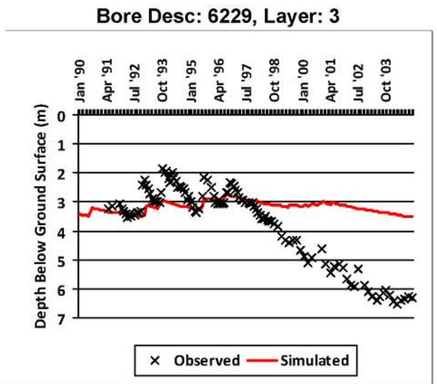
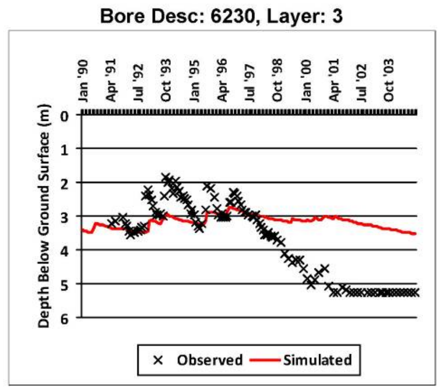
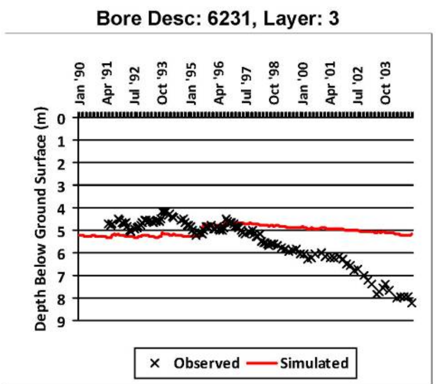


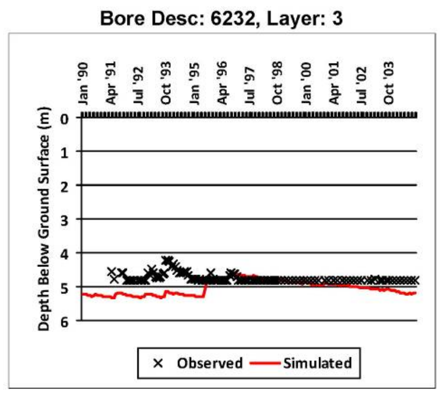
Bore Desc: 6228, Layer: 3

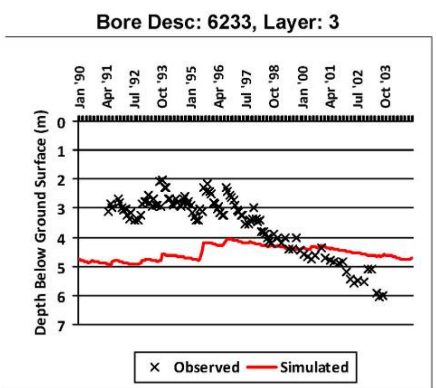


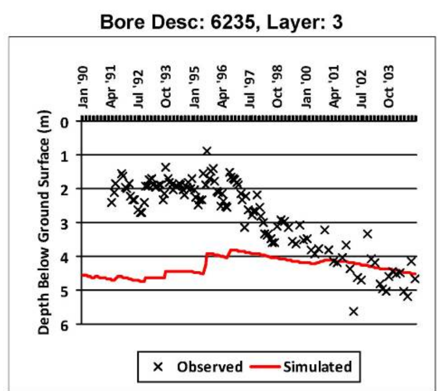

Bore Desc: 6229, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
0
1
2
3
4
5
6
7
Observed
Simulated


Bore Desc: 6230, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
0
1
2
3
4
5
6
Observed
Simulated

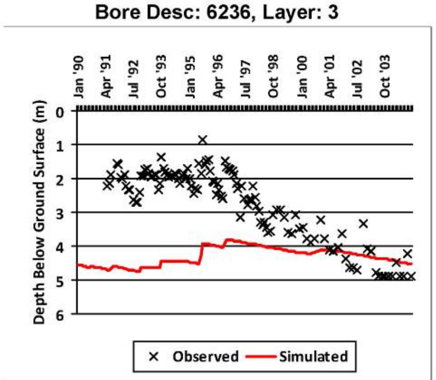

Bore Desc: 6231, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
0
1
2
3
4
5
6
7
8
9
Observed
Simulated


Bore Desc: 6232, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
0
1
2
3
4
5
6
Observed
Simulated

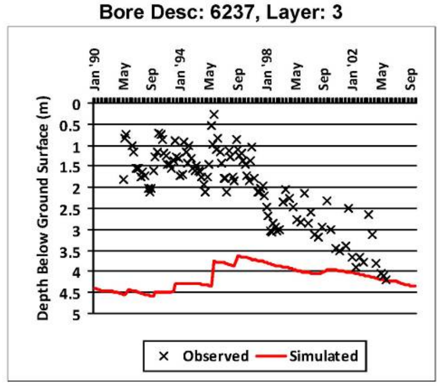

Bore Desc: 6233, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
0
1
2
3
4
5
6
7
Observed
Simulated


Bore Desc: 6235, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
0
1
2
3
4
5
6
Observed
Simulated

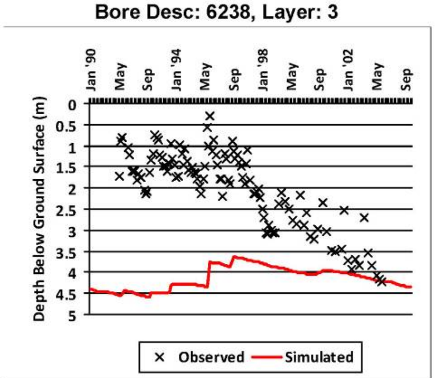
Bore Desc: 6236, Layer: 3



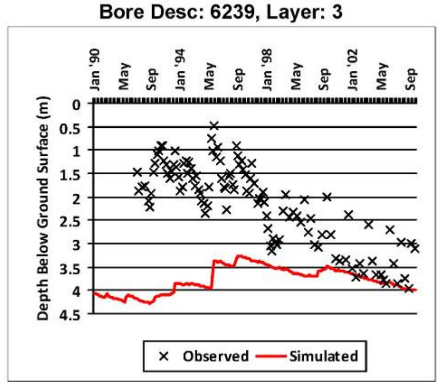
Bore Desc: 6237, Layer: 3



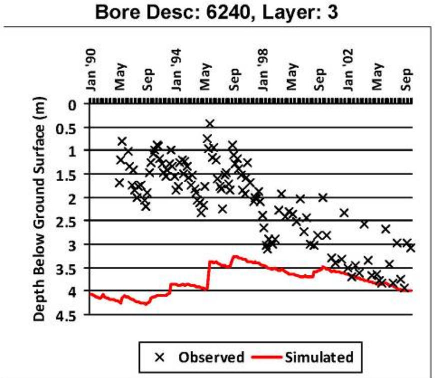
Bore Desc: 6238, Layer: 3



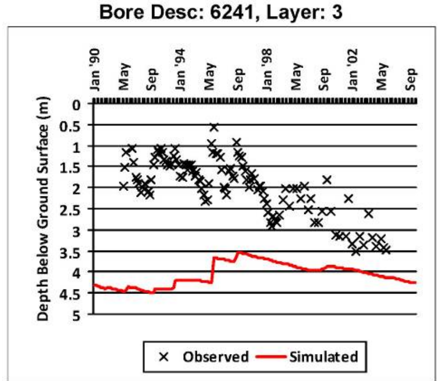
Bore Desc: 6239, Layer: 3



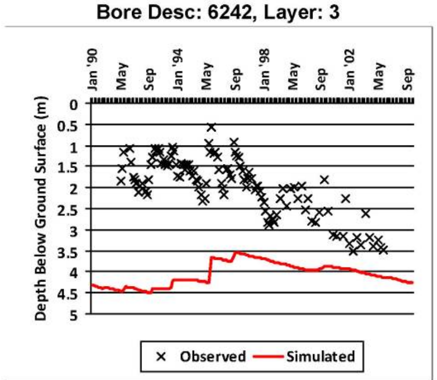
Bore Desc: 6240, Layer: 3



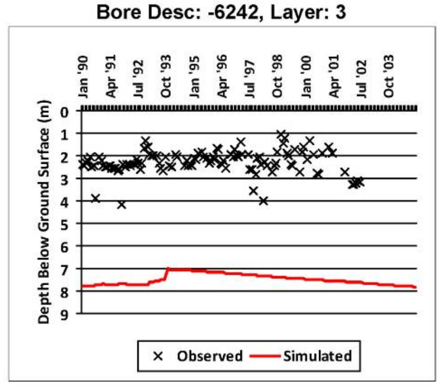
Bore Desc: 6241, Layer: 3



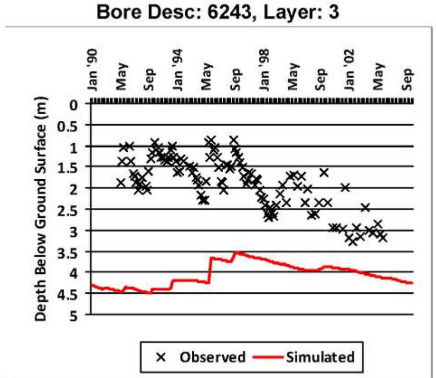
Bore Desc: 6242, Layer: 3



Bore Desc: -6242, Layer: 3



Bore Desc: 6243, Layer: 3



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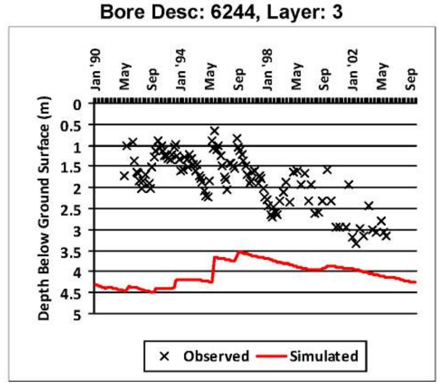
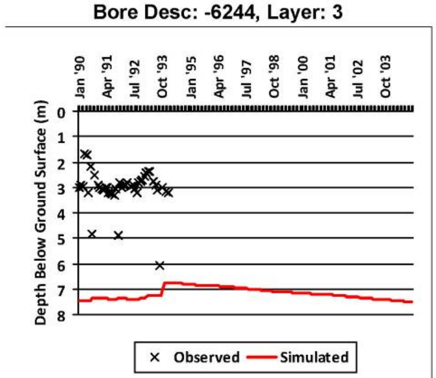
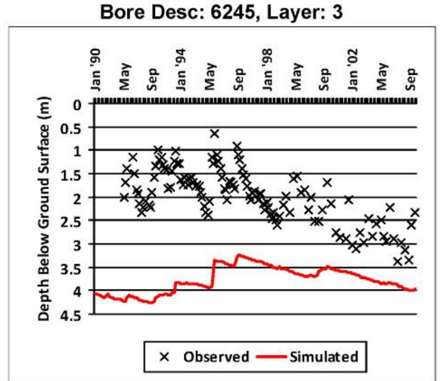


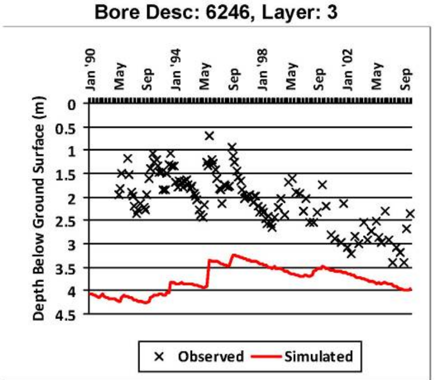
Bore Desc: -6244, Layer: 3



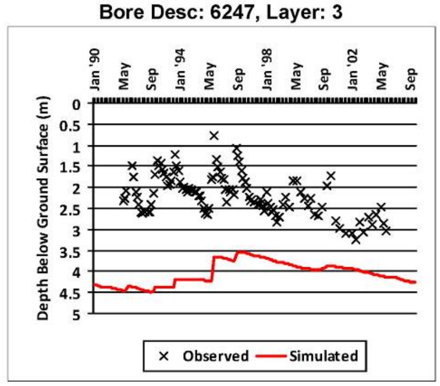
Bore Desc: 6245, Layer: 3



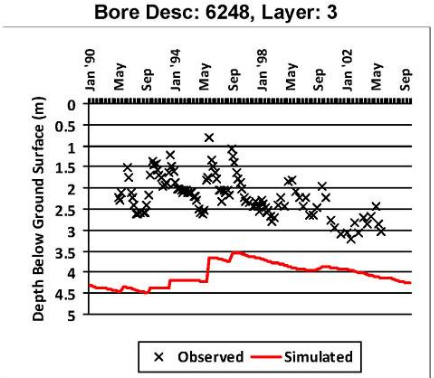
Bore Desc: 6246, Layer: 3



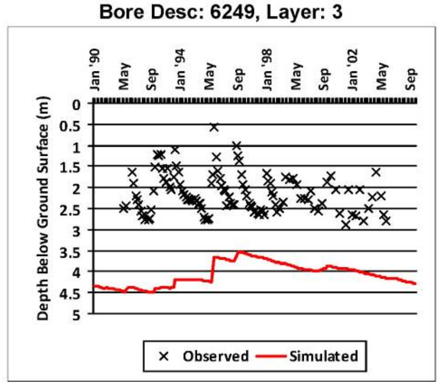
Bore Desc: 6247, Layer: 3



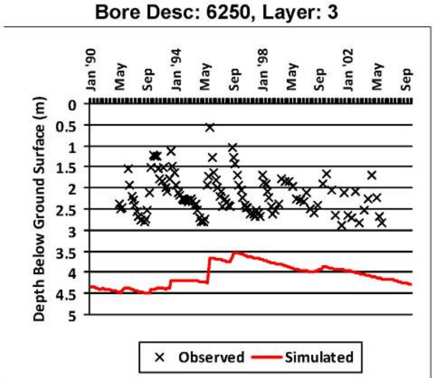
Bore Desc: 6248, Layer: 3



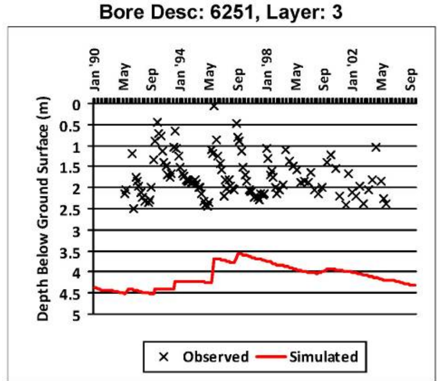
Bore Desc: 6249, Layer: 3



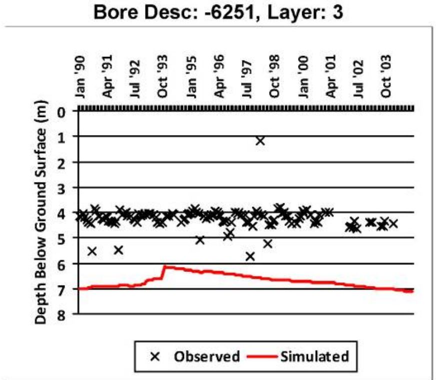
Bore Desc: 6250, Layer: 3



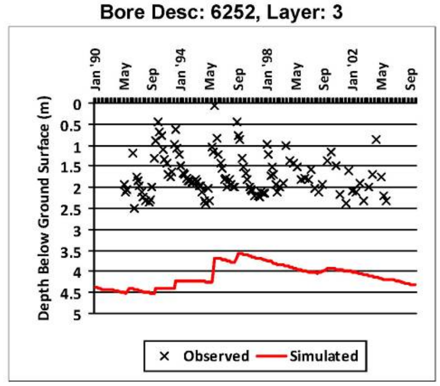
Bore Desc: 6251, Layer: 3



Bore Desc: -6251, Layer: 3



Bore Desc: 6252, Layer: 3



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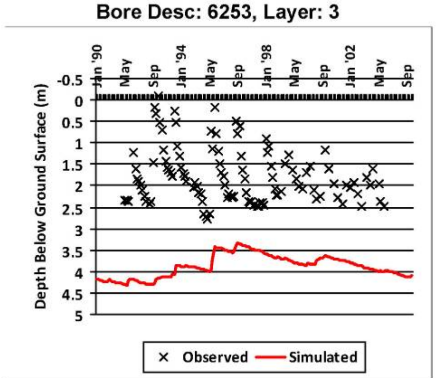

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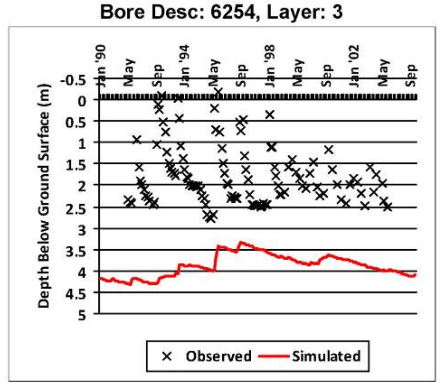
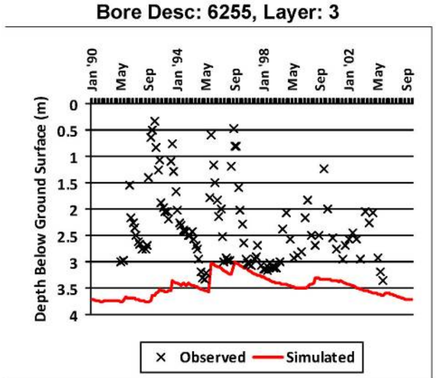


Bore Desc: 6255, Layer: 3



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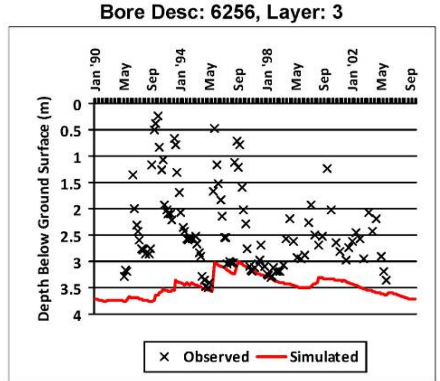
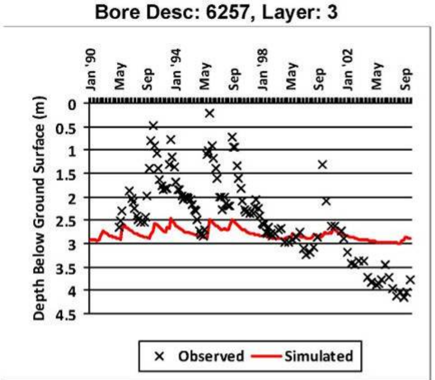
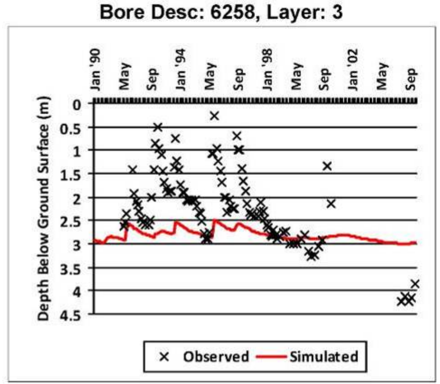


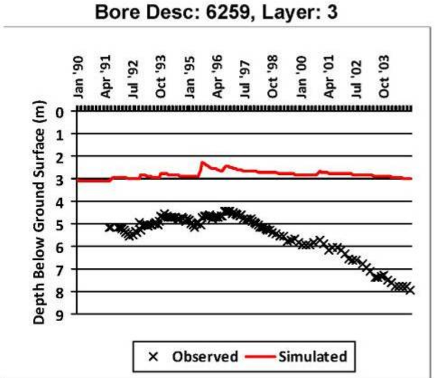
Bore Desc: 6257, Layer: 3



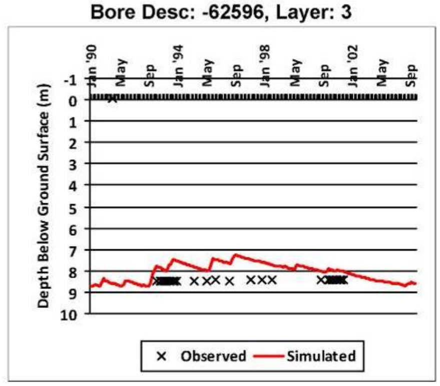
Bore Desc: 6258, Layer: 3



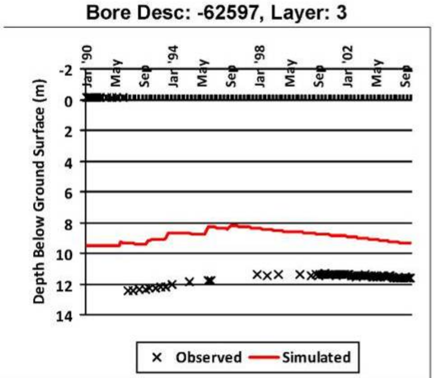
Bore Desc: 6259, Layer: 3



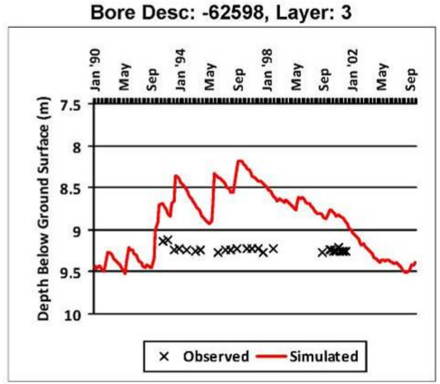
Bore Desc: -62596, Layer: 3



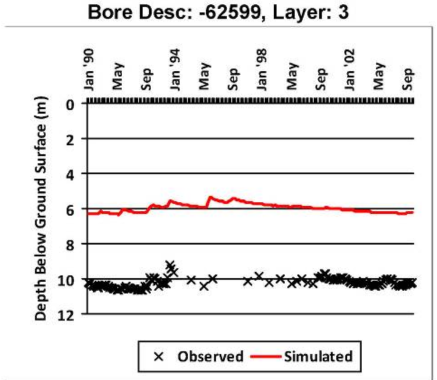
Bore Desc: -62597, Layer: 3



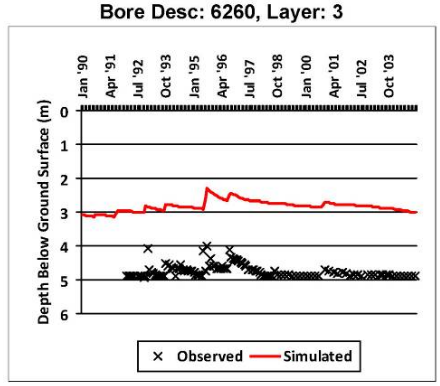
Bore Desc: -62598, Layer: 3



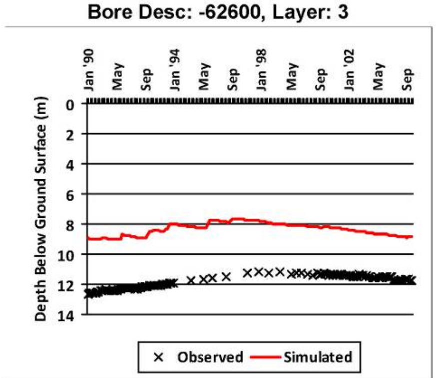
Bore Desc: -62599, Layer: 3



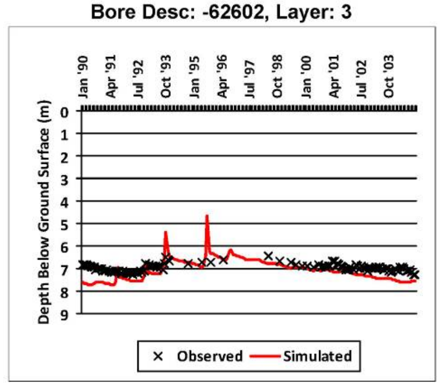
Bore Desc: 6260, Layer: 3



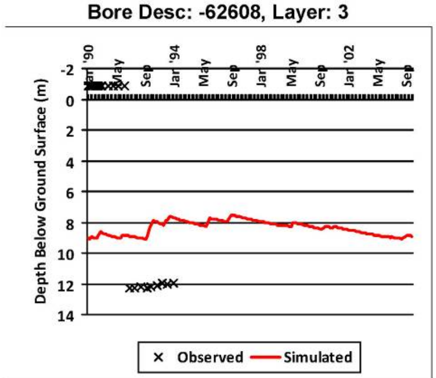
Bore Desc: -62600, Layer: 3



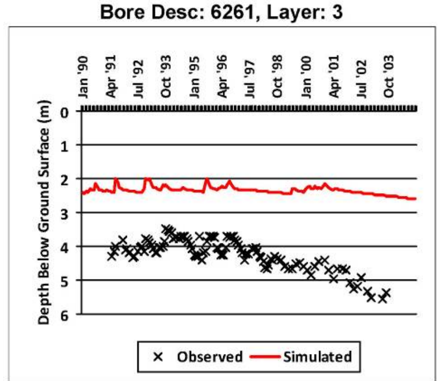
Bore Desc: -62602, Layer: 3



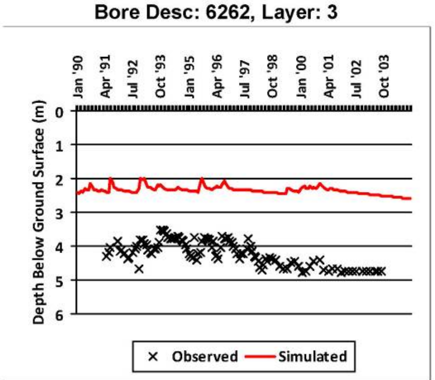
Bore Desc: -62608, Layer: 3



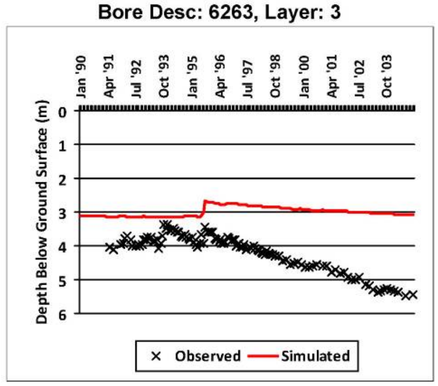
Bore Desc: 6261, Layer: 3



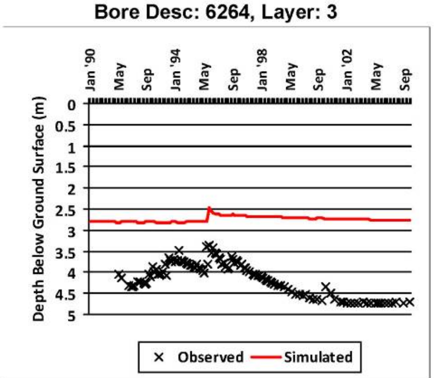
Bore Desc: 6262, Layer: 3



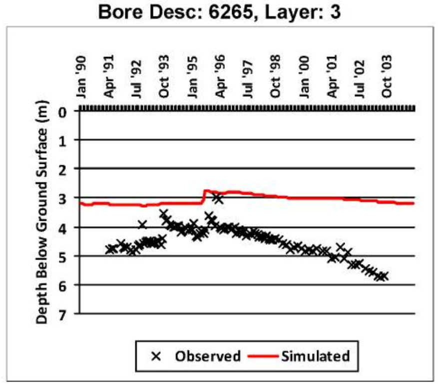
Bore Desc: 6263, Layer: 3



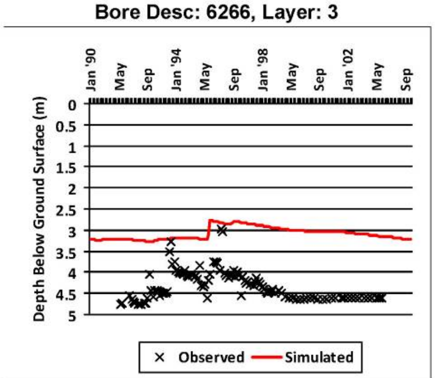
Bore Desc: 6264, Layer: 3



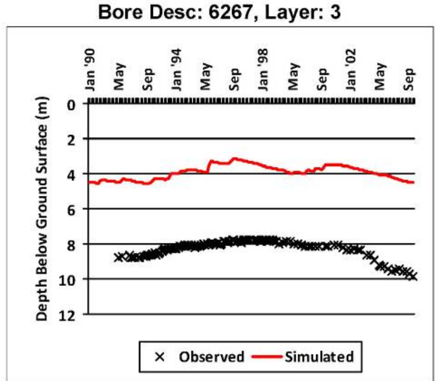
Bore Desc: 6265, Layer: 3

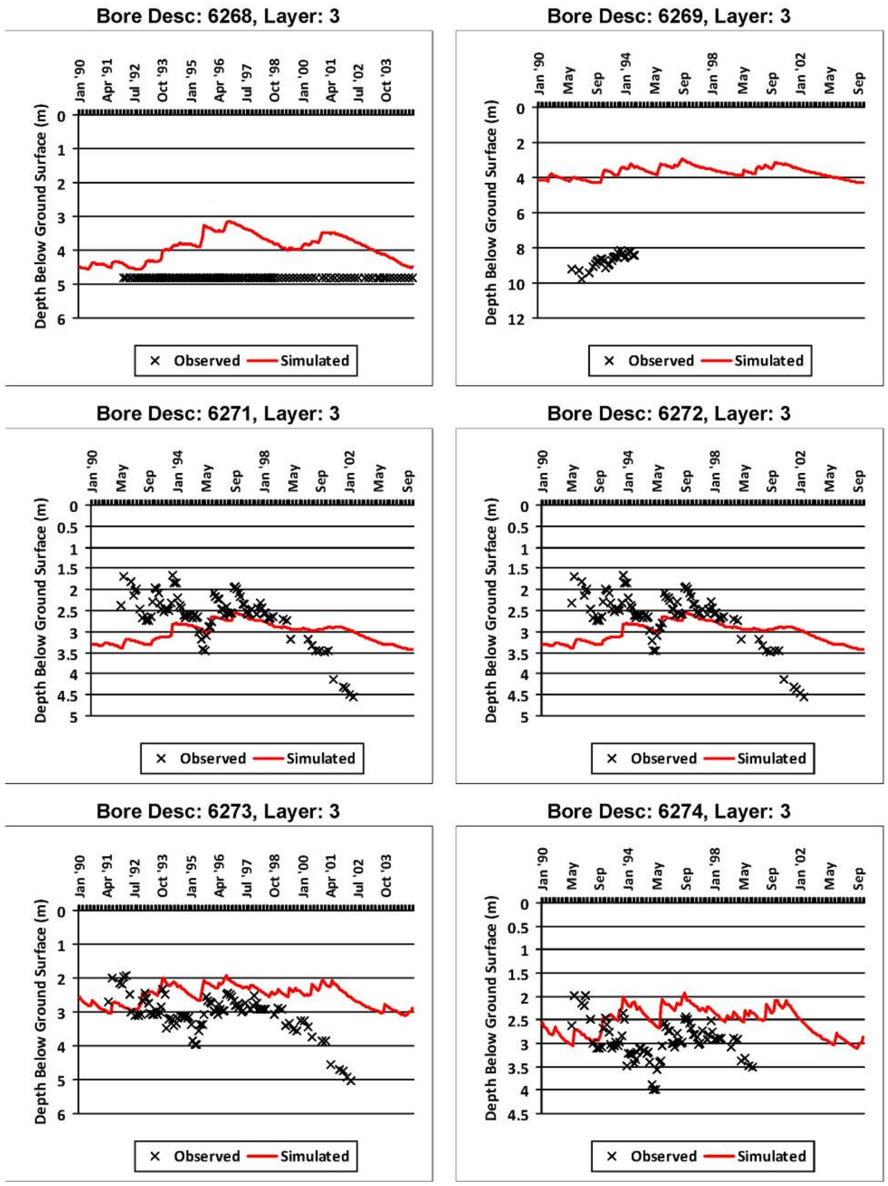


Bore Desc: 6266, Layer: 3



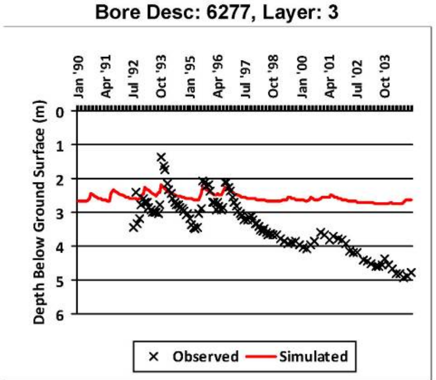
Bore Desc: 6267, Layer: 3





Bore Desc: 6268, Layer: 3
Bore Desc: 6269, Layer: 3
Bore Desc: 6271, Layer: 3
Bore Desc: 6272, Layer: 3
Bore Desc: 6273, Layer: 3
Bore Desc: 6274, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
May
Sep
Jan '94
Jan '98
Jan '02
Observed
Simulated

Bore Desc: 6277, Layer: 3



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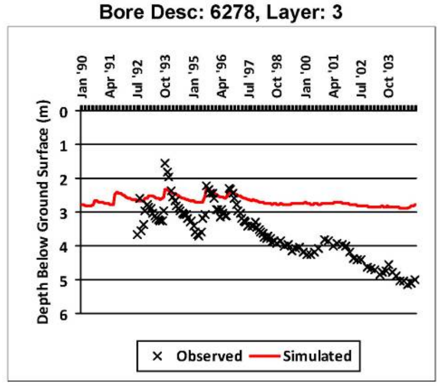

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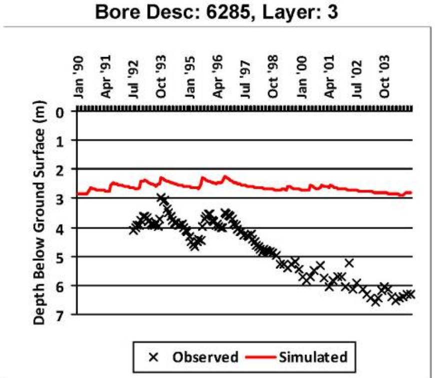

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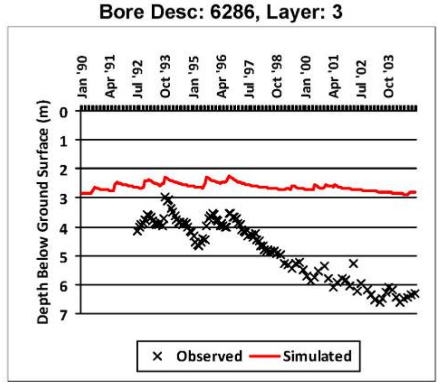

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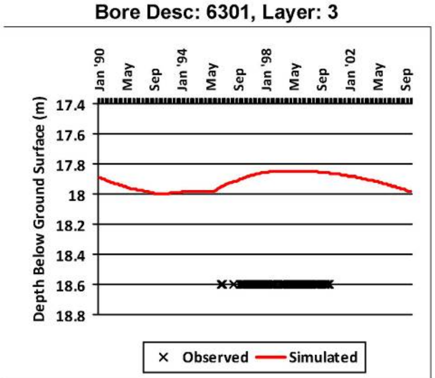

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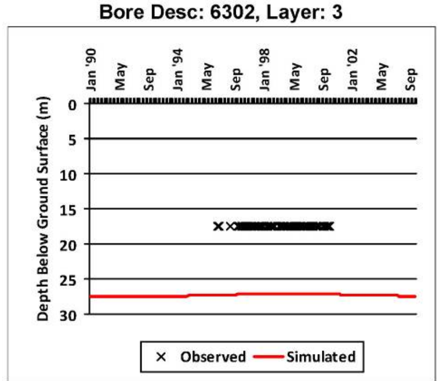
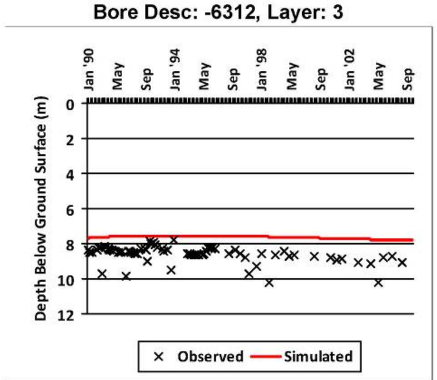


Bore Desc: -6312, Layer: 3



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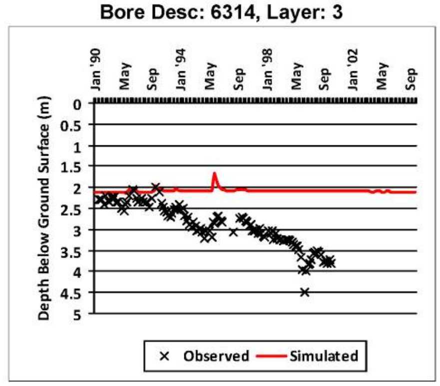

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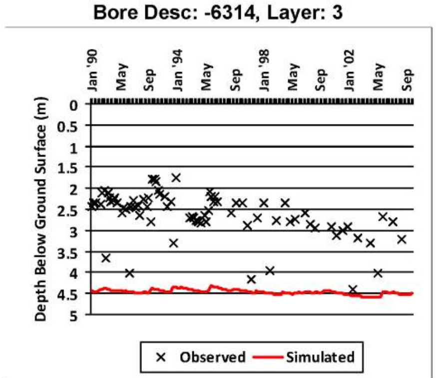

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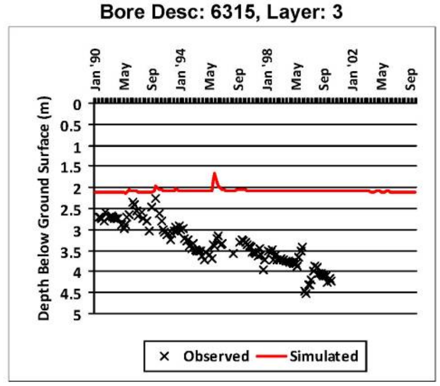

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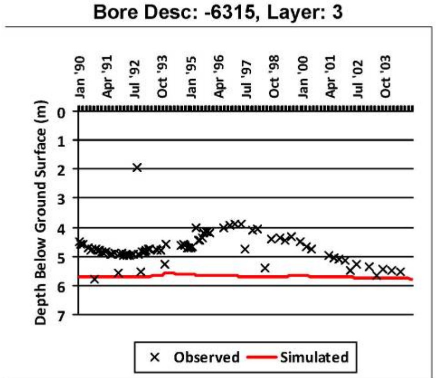

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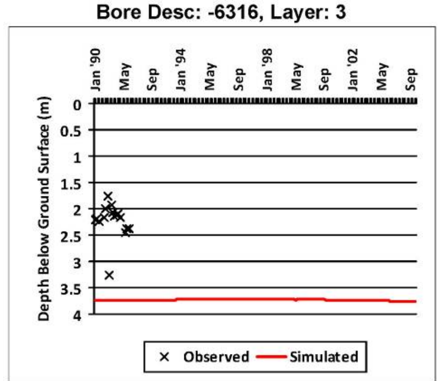
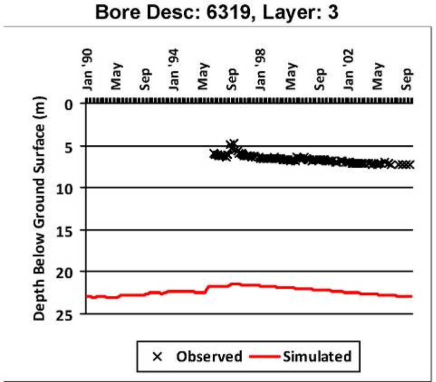


Bore Desc: 6319, Layer: 3



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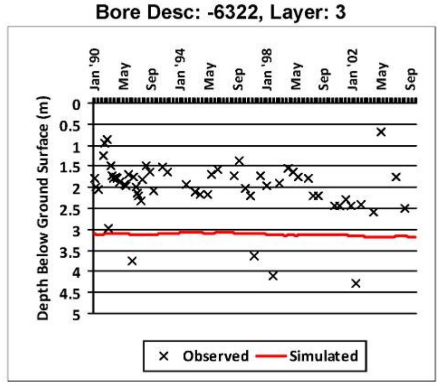

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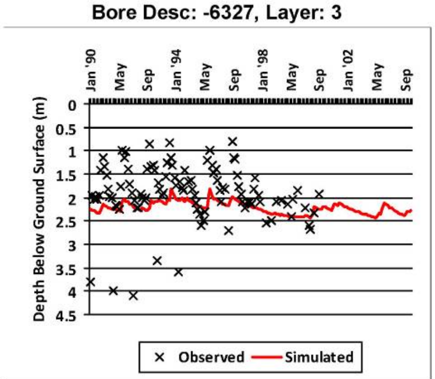

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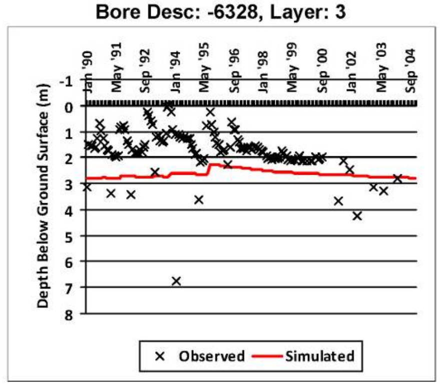

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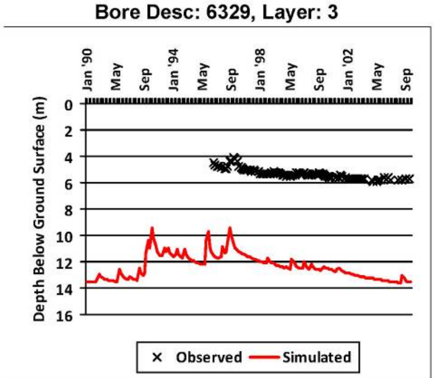

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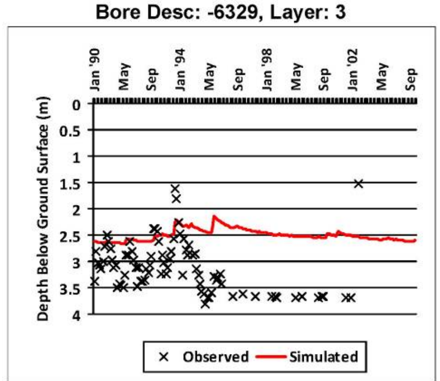

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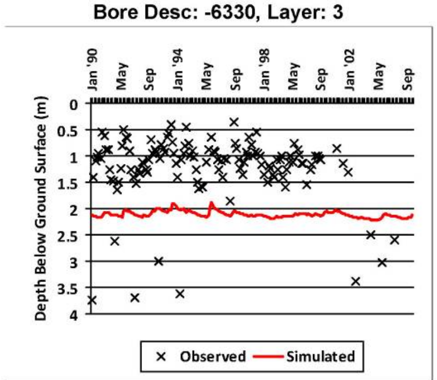
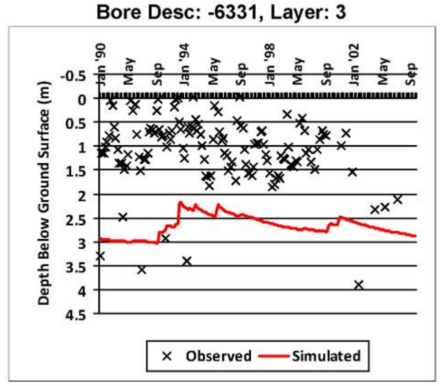


Bore Desc: -6331, Layer: 3



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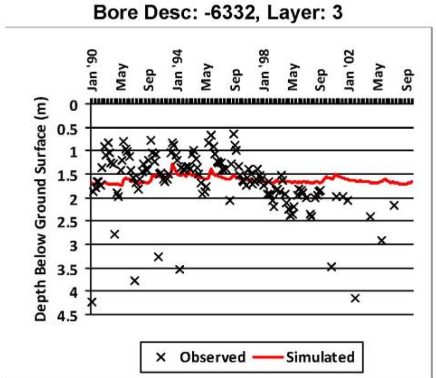

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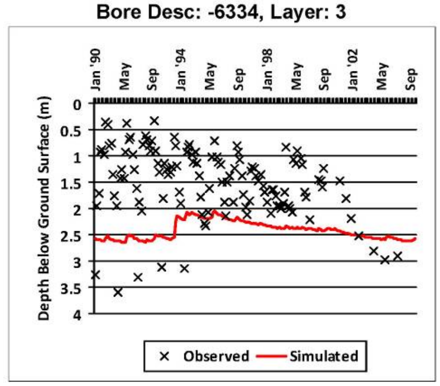

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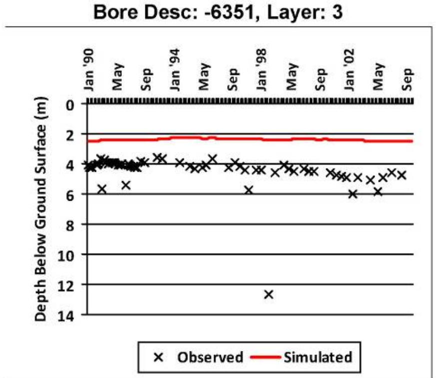

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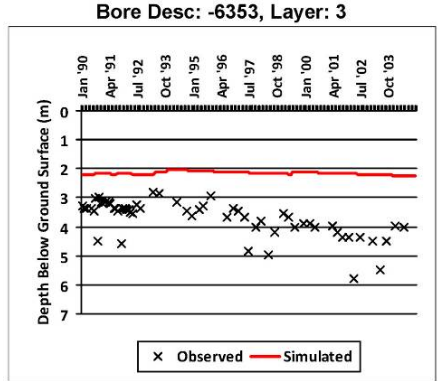

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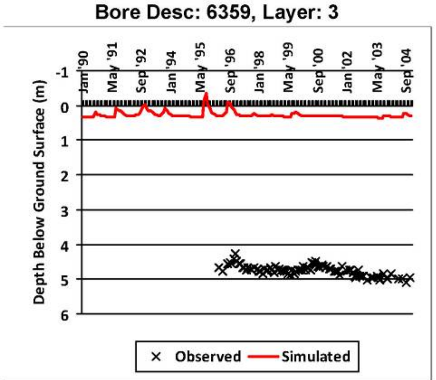

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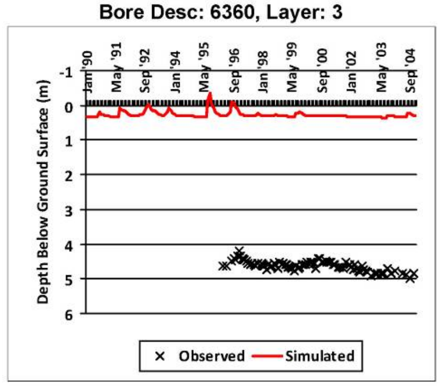

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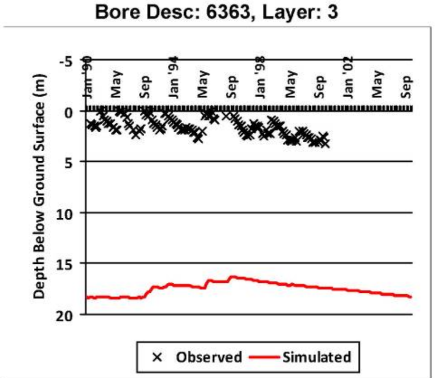

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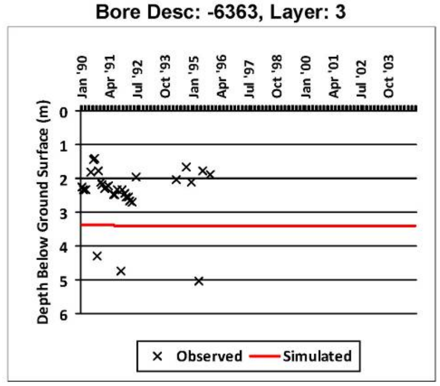

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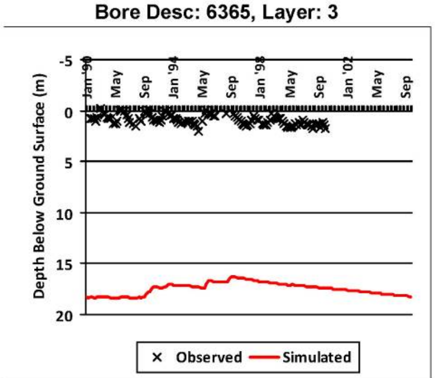

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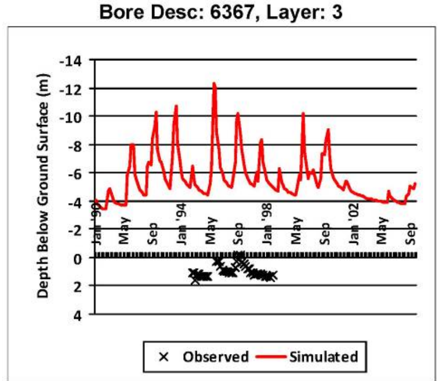

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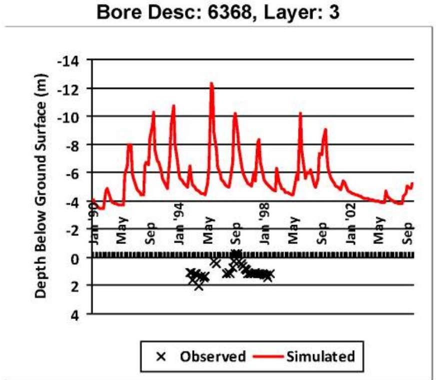

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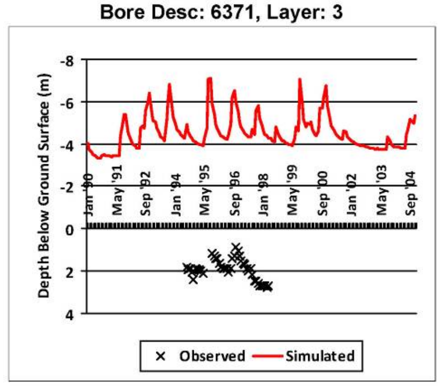

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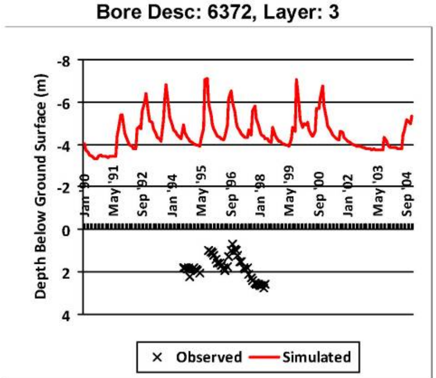

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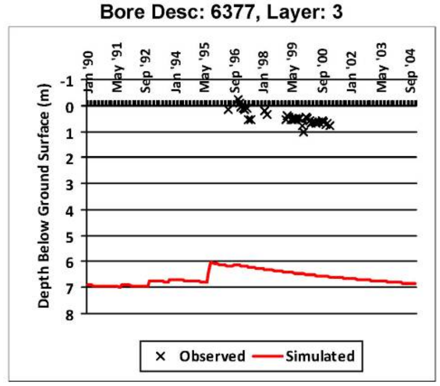

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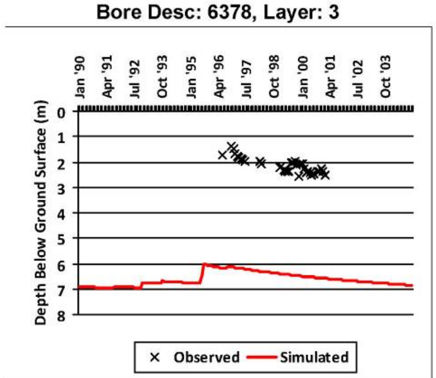

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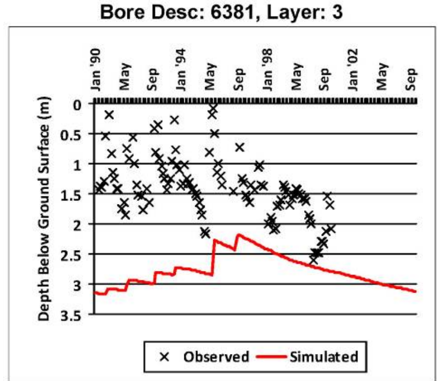

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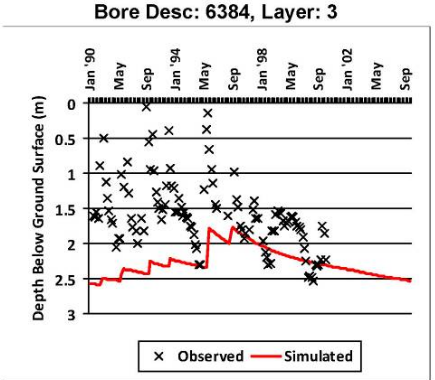

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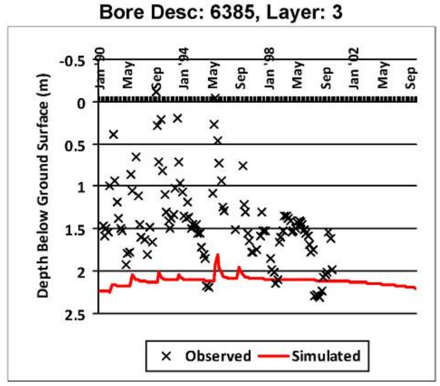

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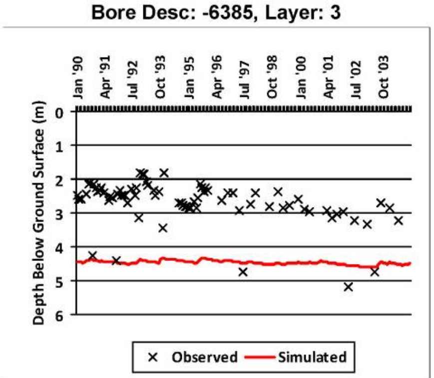

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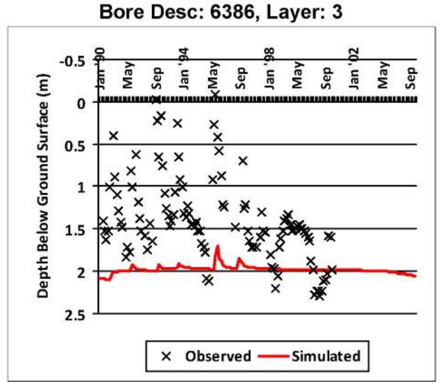

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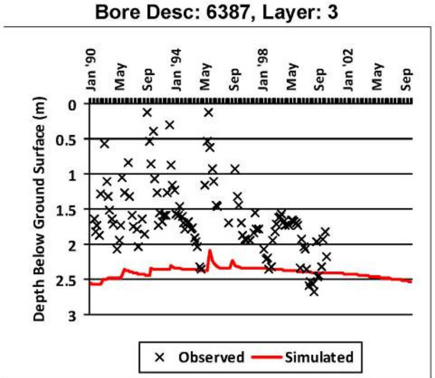

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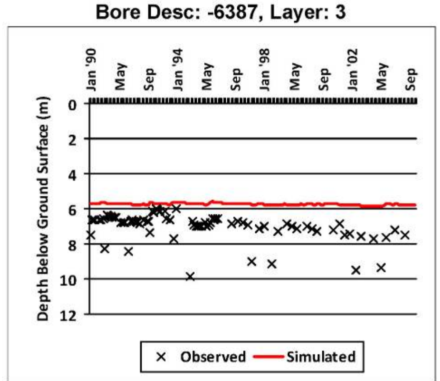

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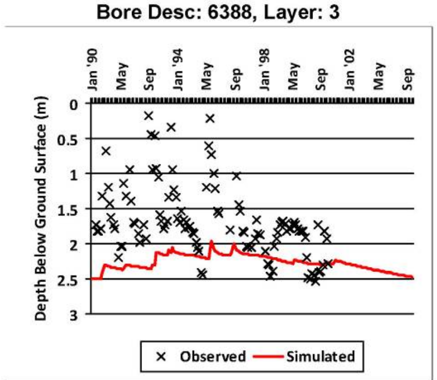

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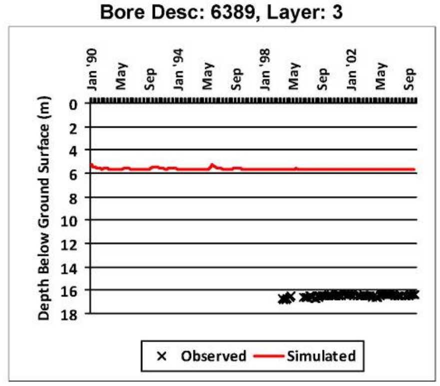

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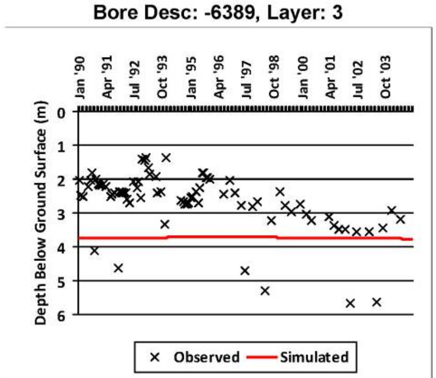

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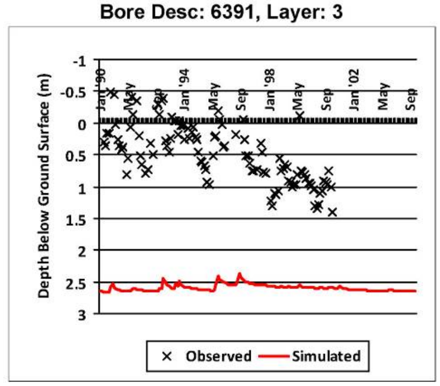

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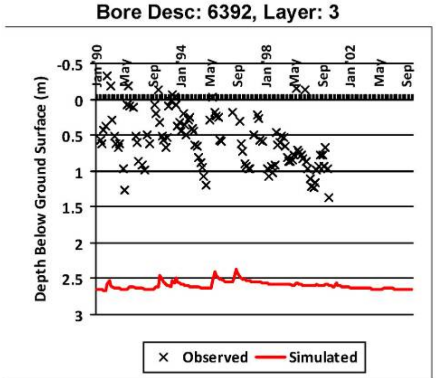

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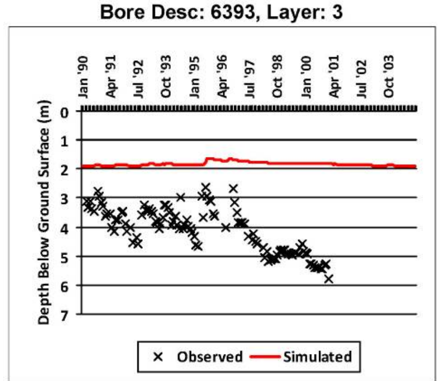

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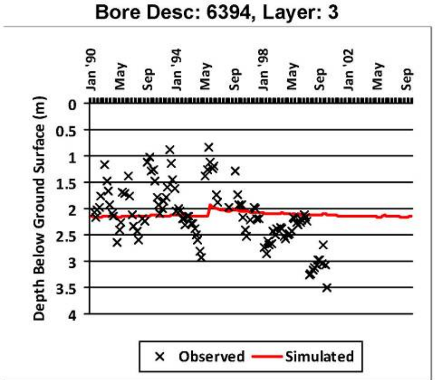

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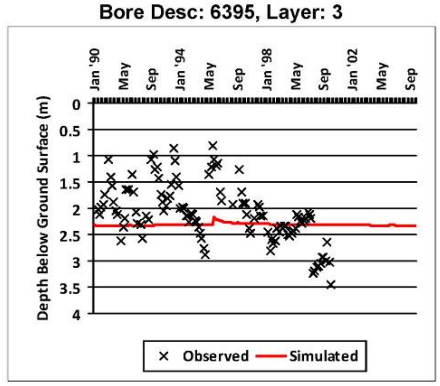

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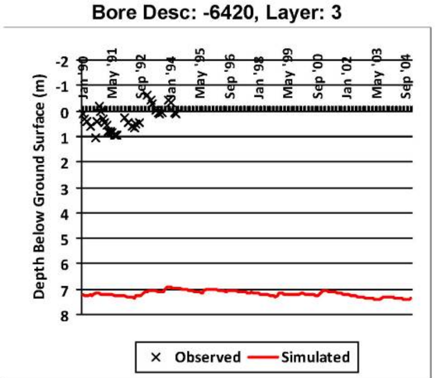

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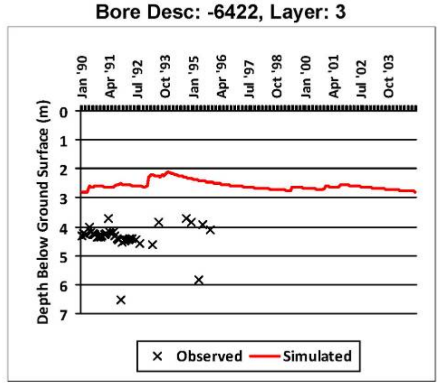

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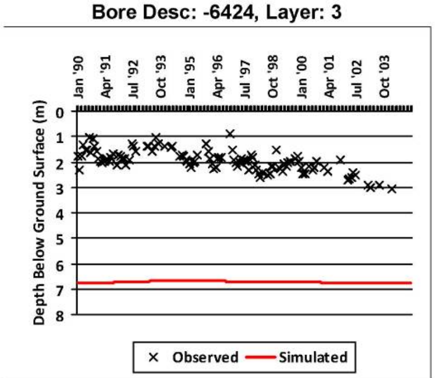

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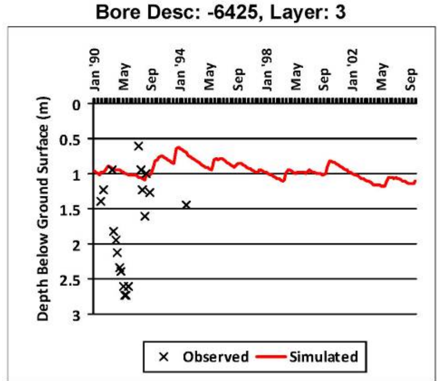

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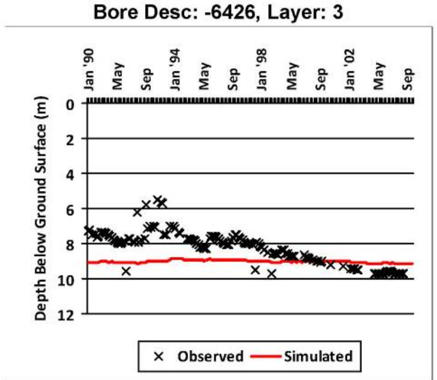

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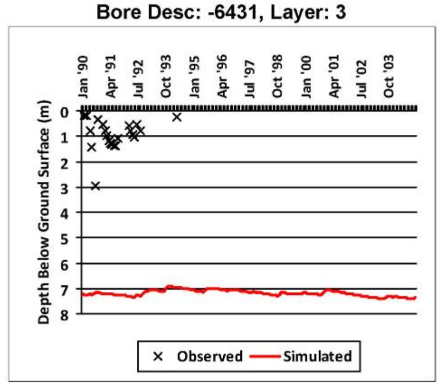

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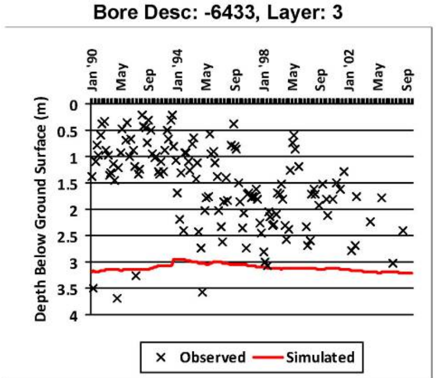

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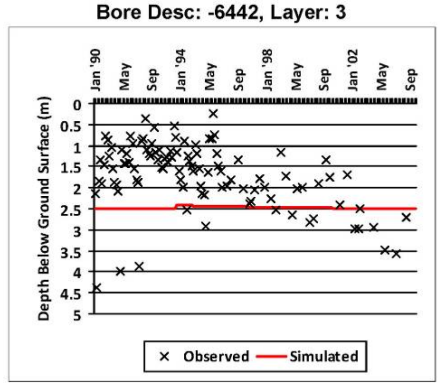

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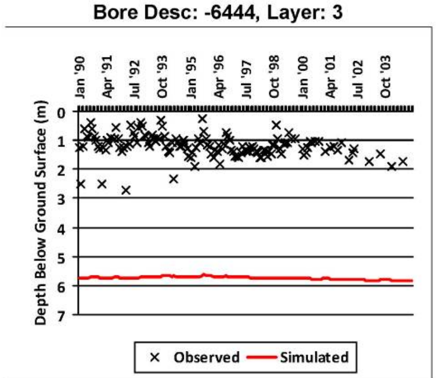

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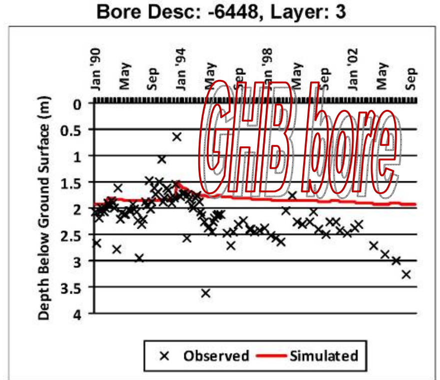

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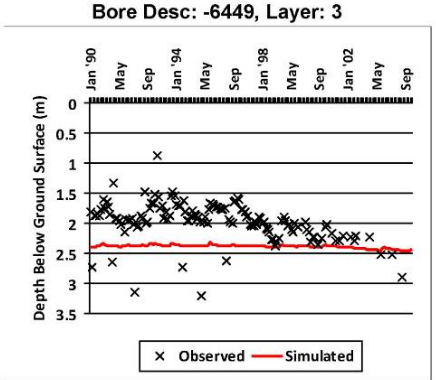

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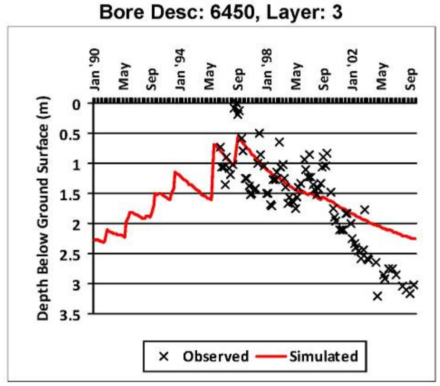
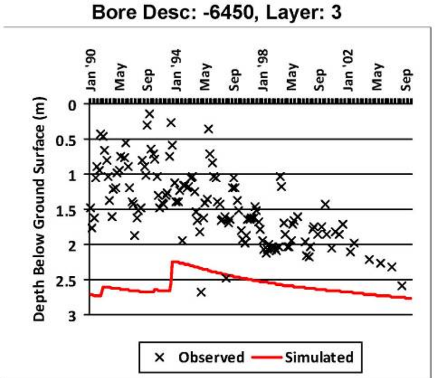


Bore Desc: -6450, Layer: 3



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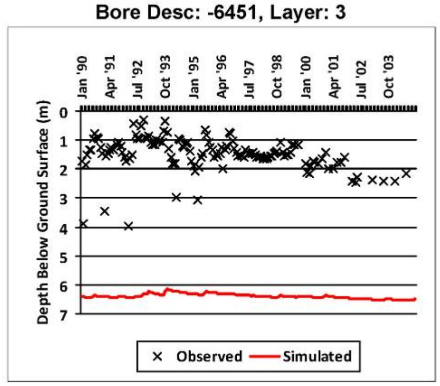
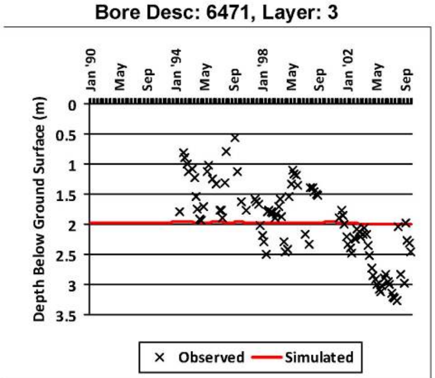
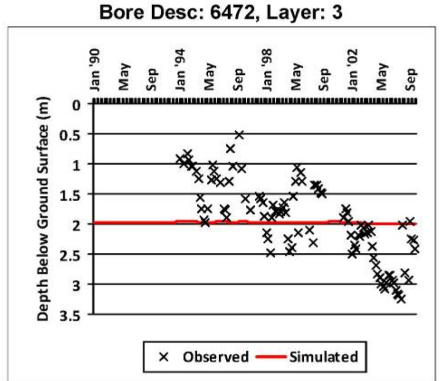


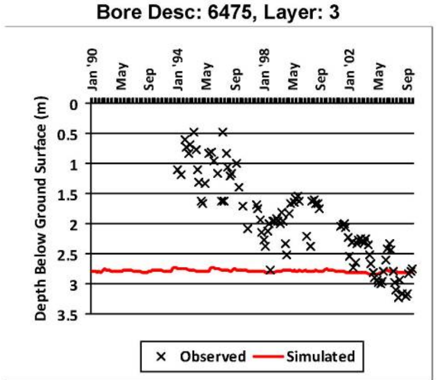
Bore Desc: 6471, Layer: 3



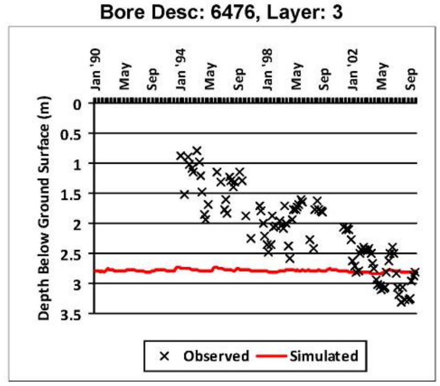
Bore Desc: 6472, Layer: 3



Bore Desc: 6475, Layer: 3



Bore Desc: 6476, Layer: 3



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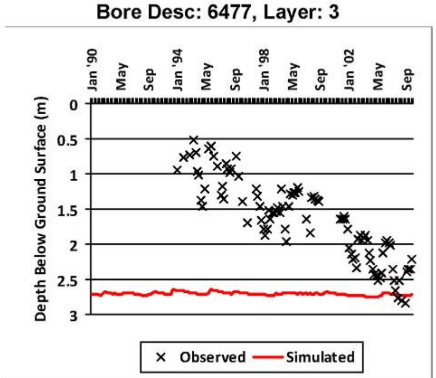
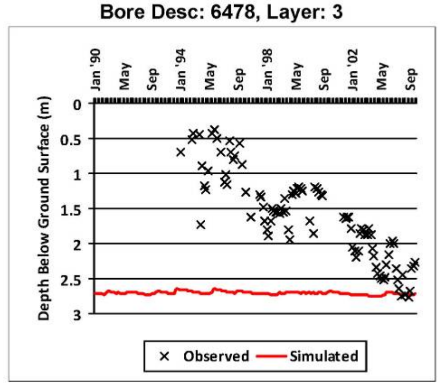
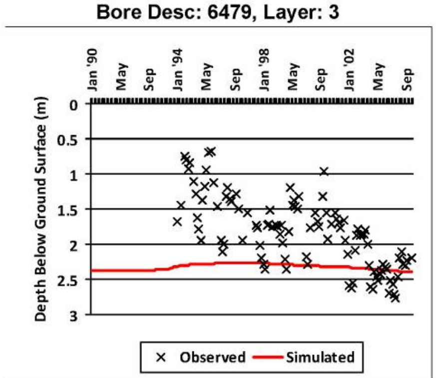


Bore Desc: 6478, Layer: 3



Bore Desc: 6479, Layer: 3



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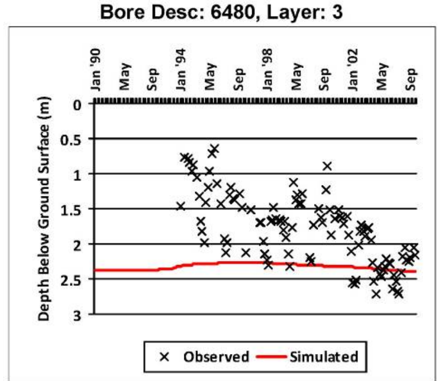
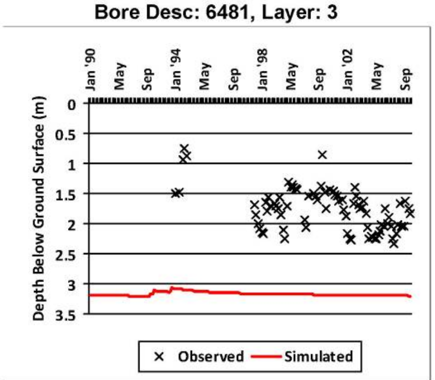
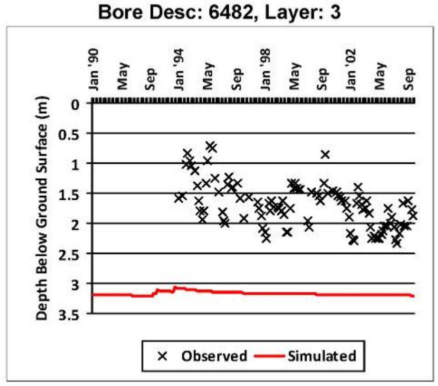


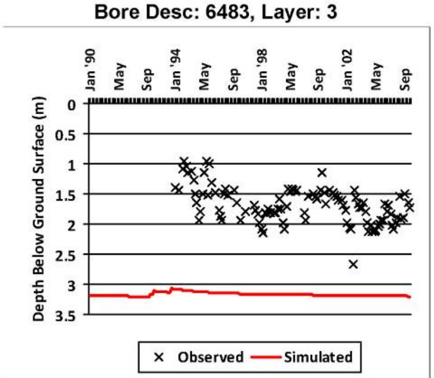
Bore Desc: 6481, Layer: 3



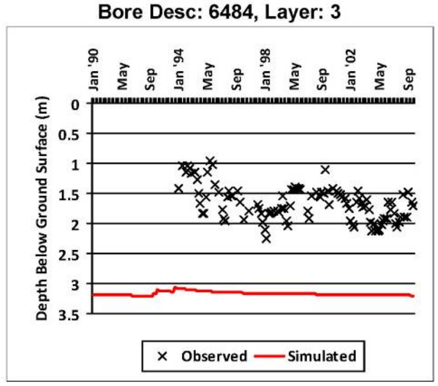
Bore Desc: 6482, Layer: 3



Bore Desc: 6483, Layer: 3



Bore Desc: 6484, Layer: 3



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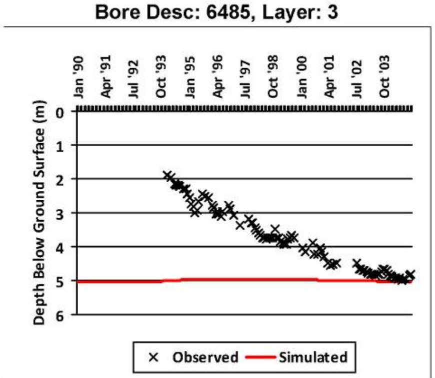
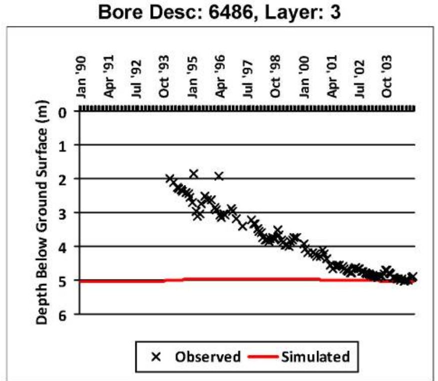


Bore Desc: 6486, Layer: 3



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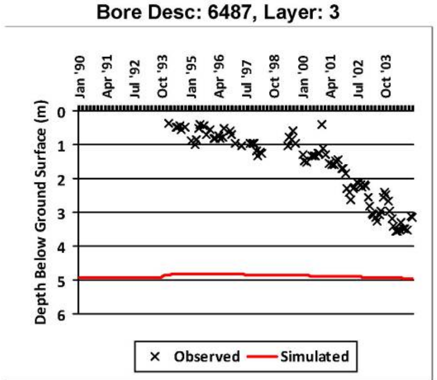
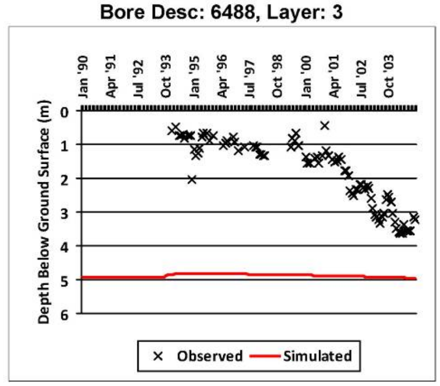
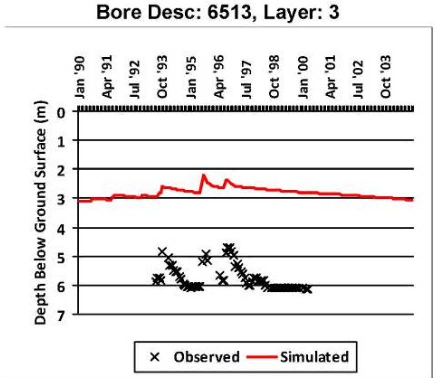


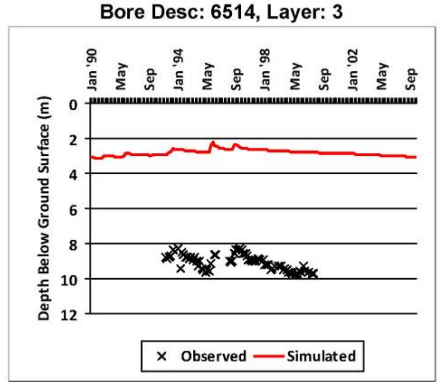
Bore Desc: 6488, Layer: 3



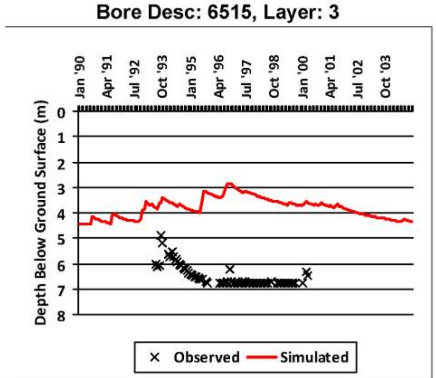
Bore Desc: 6513, Layer: 3



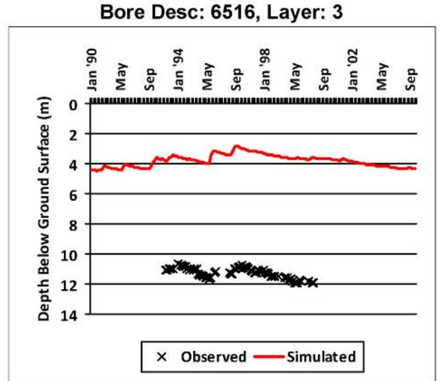
Bore Desc: 6514, Layer: 3



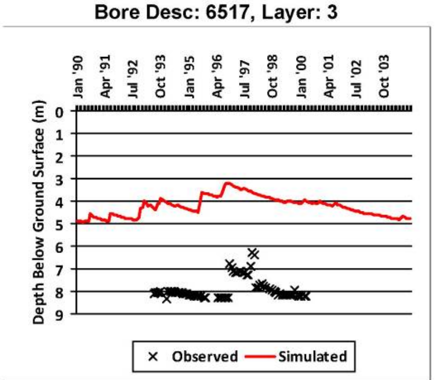
Bore Desc: 6515, Layer: 3



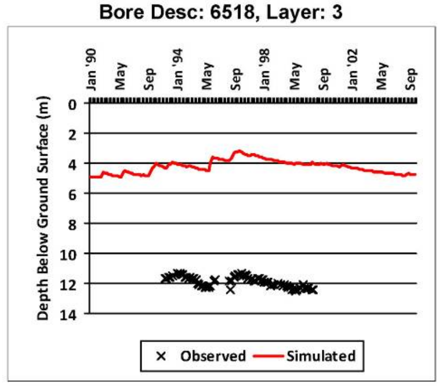
Bore Desc: 6516, Layer: 3



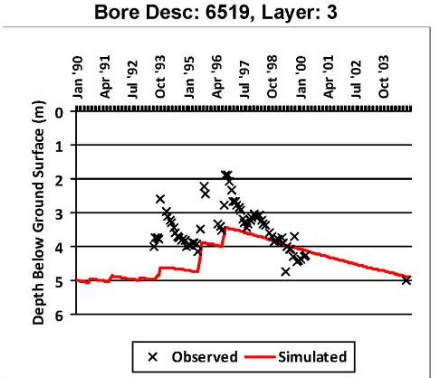
Bore Desc: 6517, Layer: 3



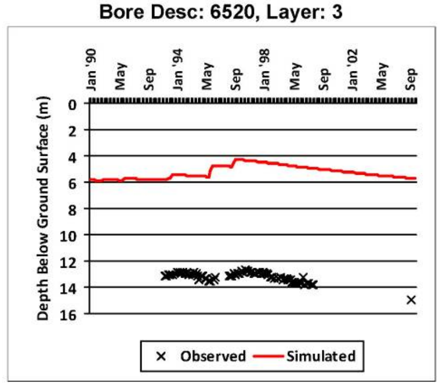
Bore Desc: 6518, Layer: 3



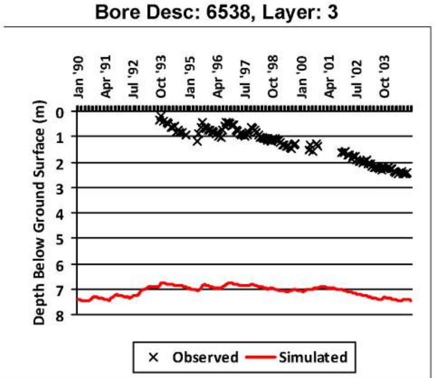
Bore Desc: 6519, Layer: 3



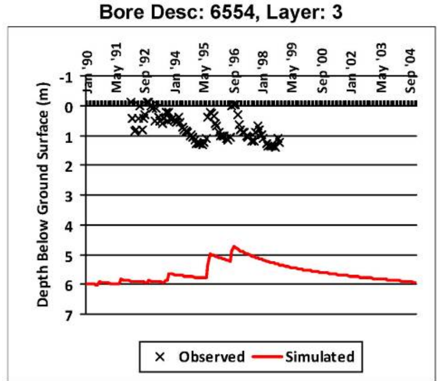
Bore Desc: 6520, Layer: 3



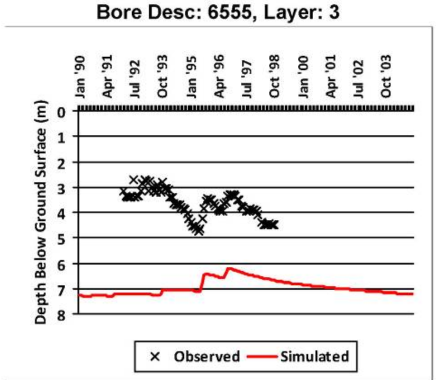
Bore Desc: 6538, Layer: 3



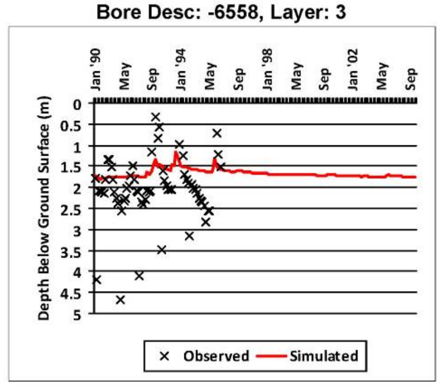
Bore Desc: 6554, Layer: 3



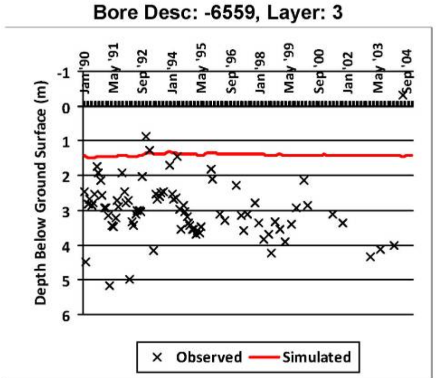
Bore Desc: 6555, Layer: 3



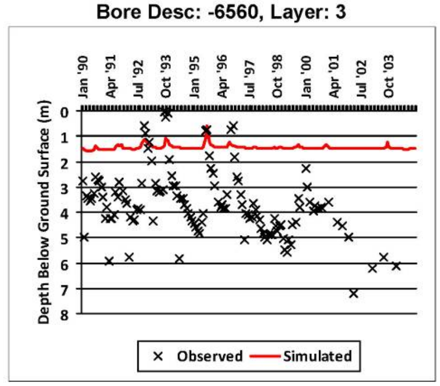
Bore Desc: -6558, Layer: 3



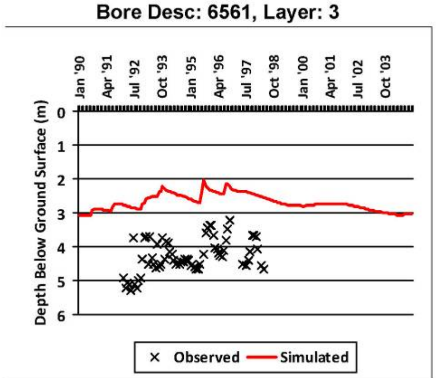
Bore Desc: -6559, Layer: 3



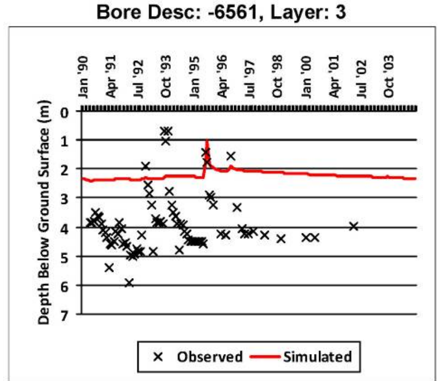
Bore Desc: -6560, Layer: 3



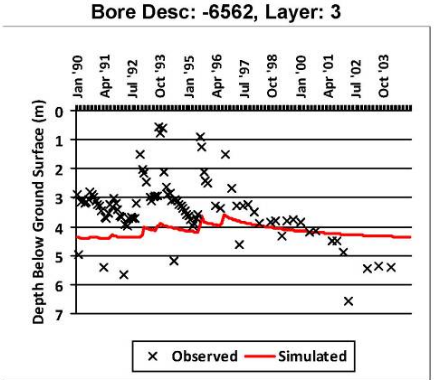
Bore Desc: 6561, Layer: 3



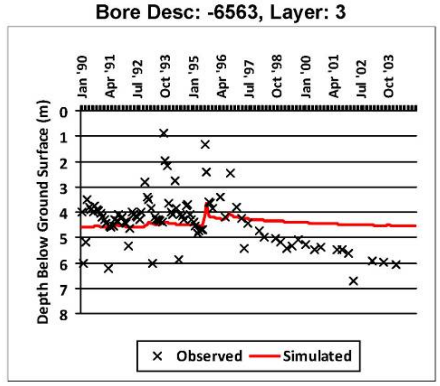
Bore Desc: -6561, Layer: 3



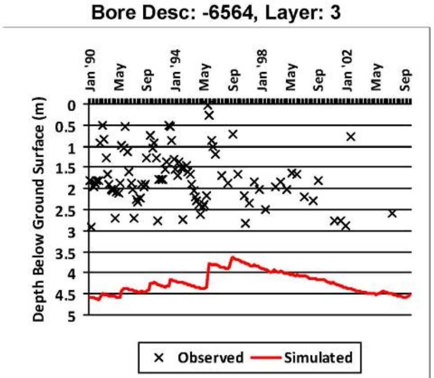
Bore Desc: -6562, Layer: 3



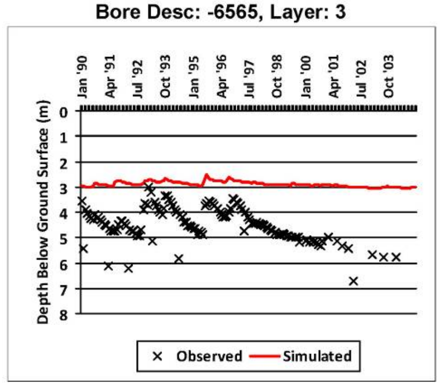
Bore Desc: -6563, Layer: 3



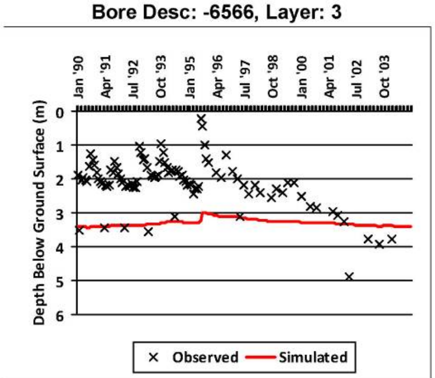
Bore Desc: -6564, Layer: 3



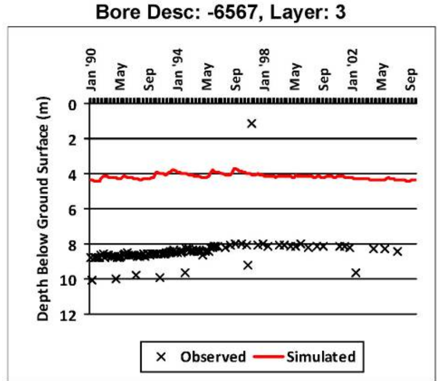
Bore Desc: -6565, Layer: 3

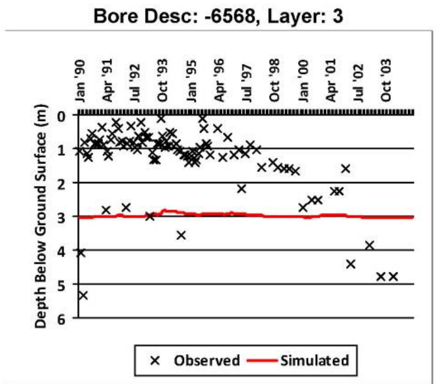


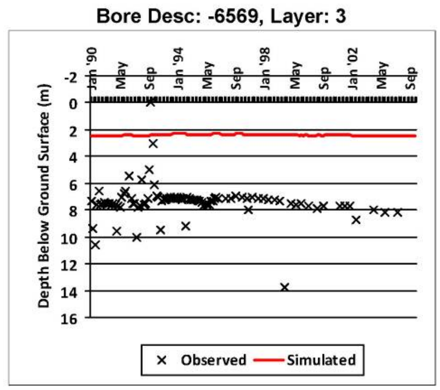
Bore Desc: -6566, Layer: 3

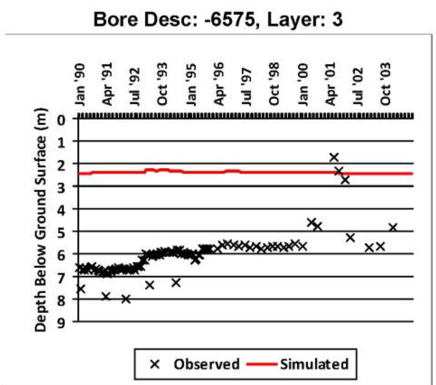


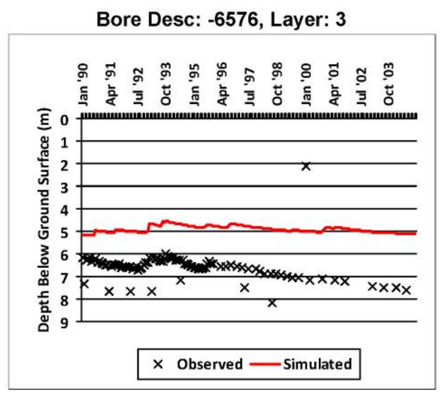
Bore Desc: -6567, Layer: 3

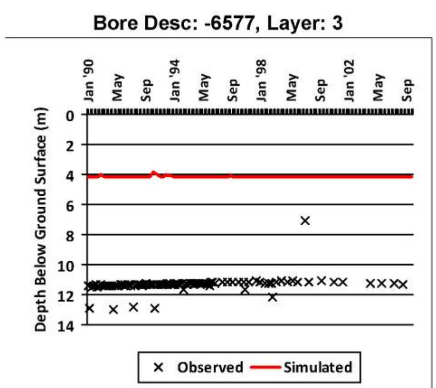


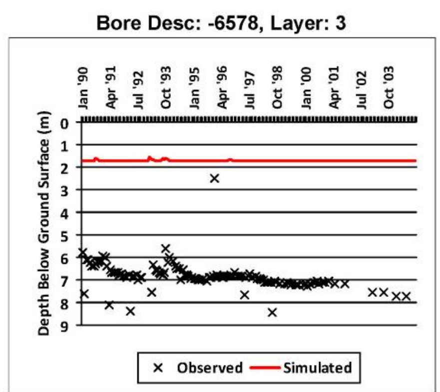

Bore Desc: -6568, Layer: 3
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed Simulated


Bore Desc: -6569, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed Simulated

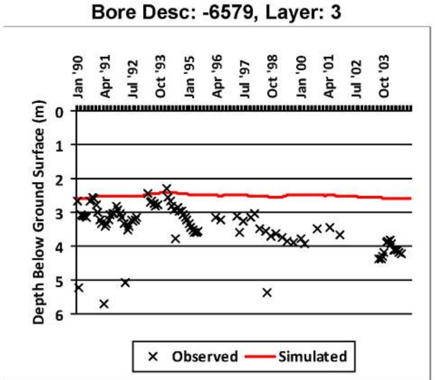

Bore Desc: -6575, Layer: 3
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed Simulated


Bore Desc: -6576, Layer: 3
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed Simulated

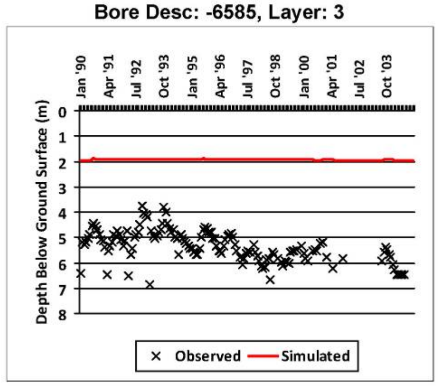

Bore Desc: -6577, Layer: 3
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed Simulated


Bore Desc: -6578, Layer: 3
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed Simulated

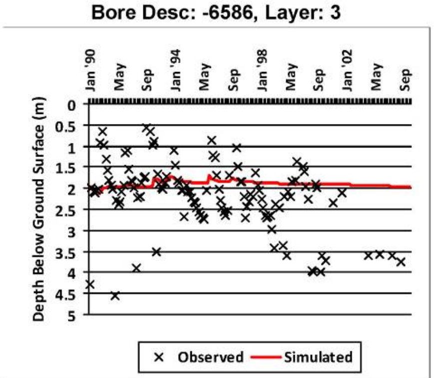
Bore Desc: -6579, Layer: 3



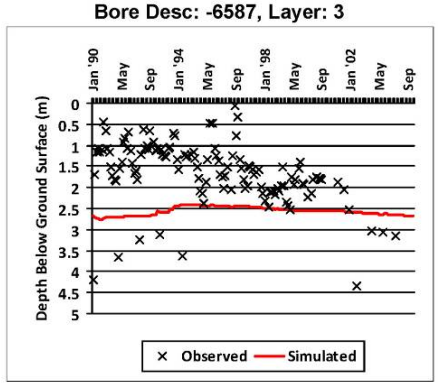
Bore Desc: -6585, Layer: 3



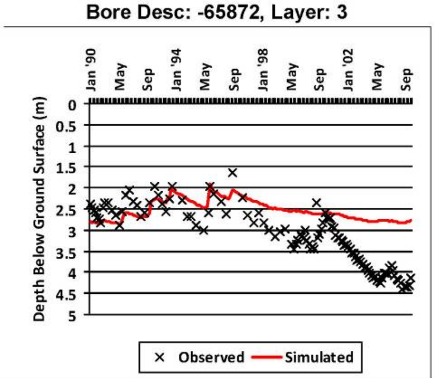
Bore Desc: -6586, Layer: 3



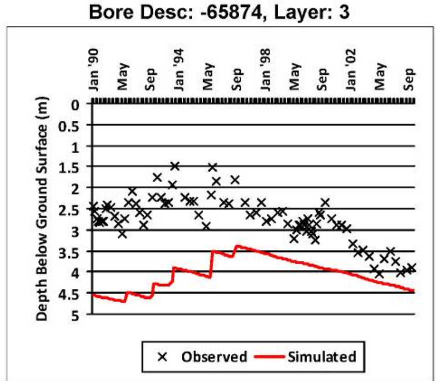
Bore Desc: -6587, Layer: 3



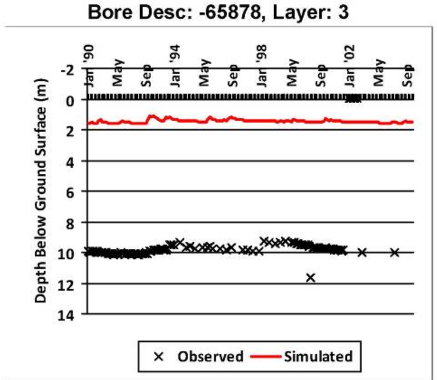
Bore Desc: -65872, Layer: 3



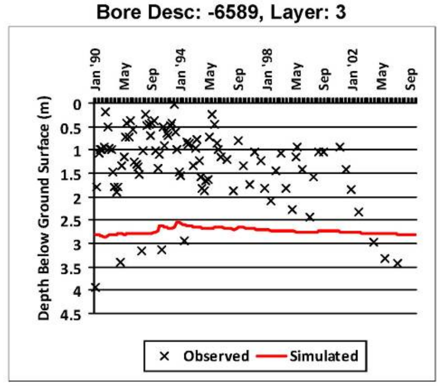
Bore Desc: -65874, Layer: 3



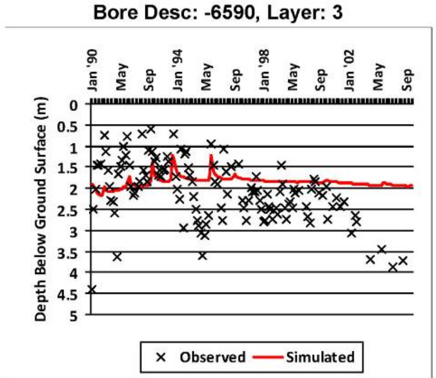
Bore Desc: -65878, Layer: 3



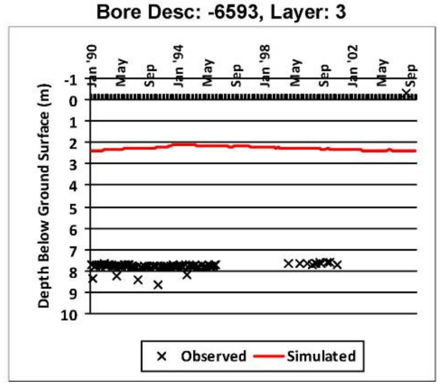
Bore Desc: -6589, Layer: 3



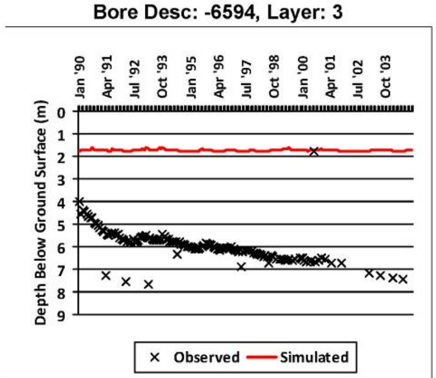
Bore Desc: -6590, Layer: 3



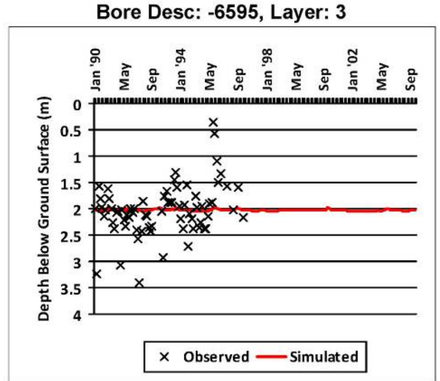
Bore Desc: -6593, Layer: 3



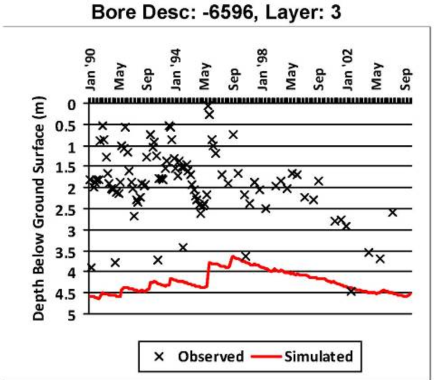
Bore Desc: -6594, Layer: 3



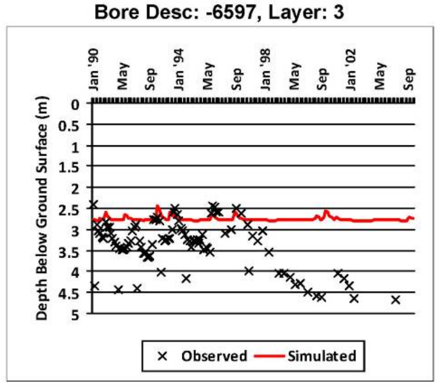
Bore Desc: -6595, Layer: 3



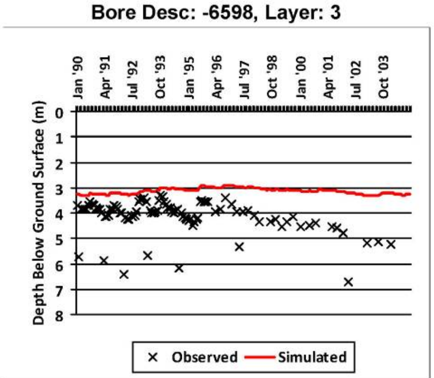
Bore Desc: -6596, Layer: 3



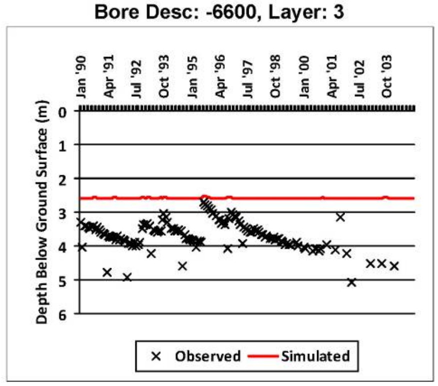
Bore Desc: -6597, Layer: 3



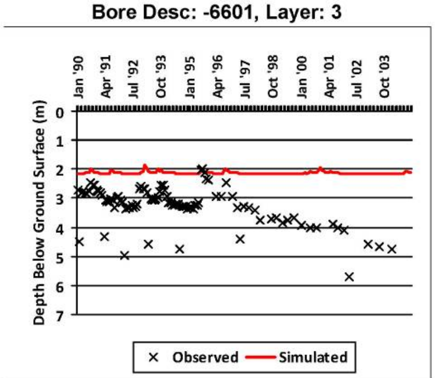
Bore Desc: -6598, Layer: 3



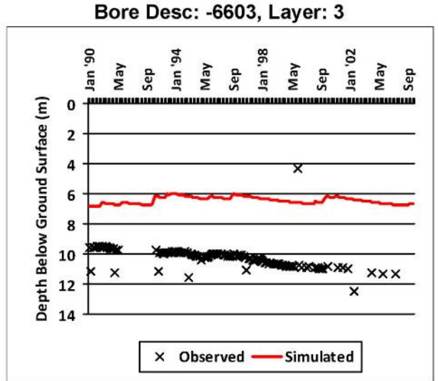
Bore Desc: -6600, Layer: 3

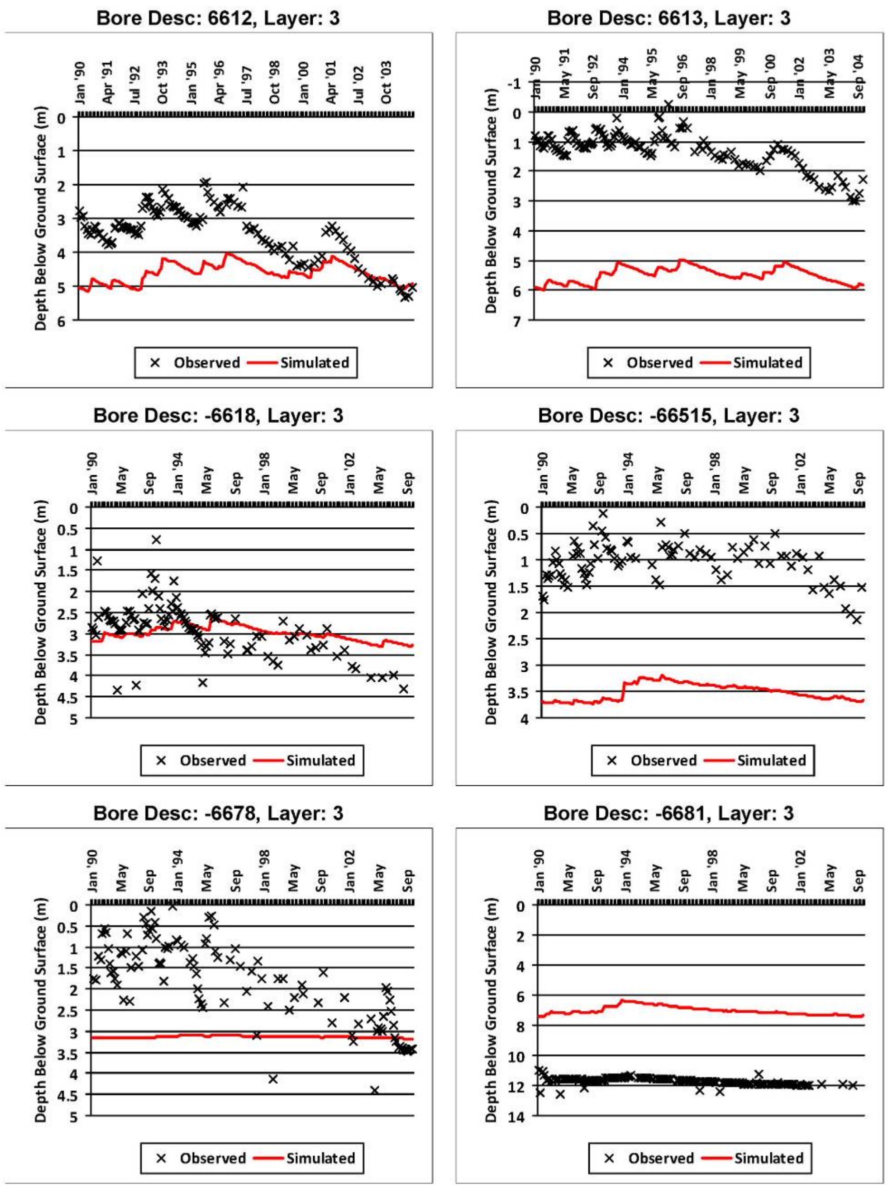


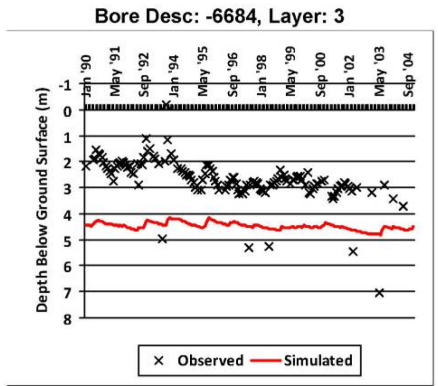
Bore Desc: -6601, Layer: 3

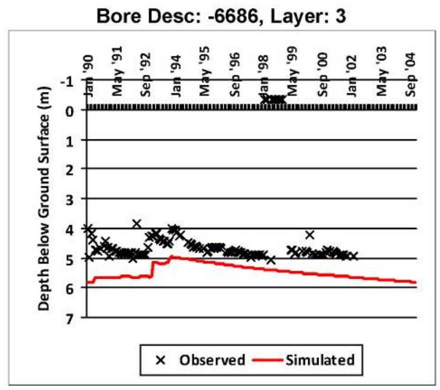


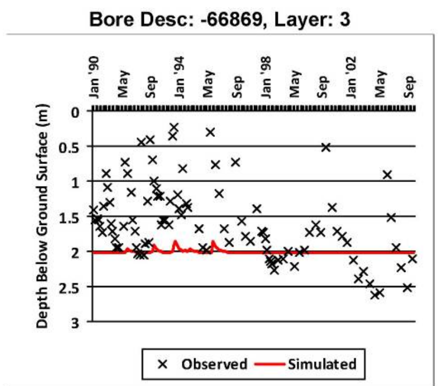
Bore Desc: -6603, Layer: 3

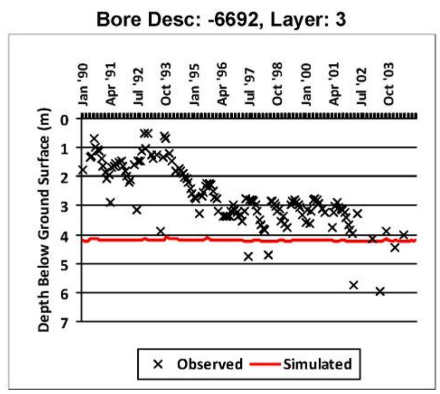


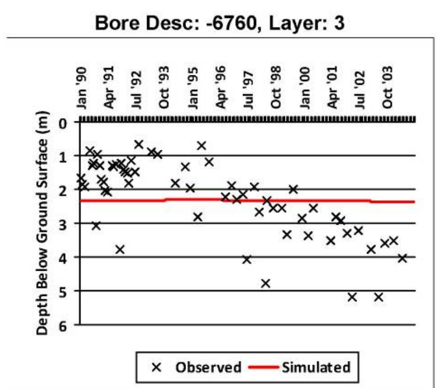

Bore Desc: 6612, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Observed
Simulated
Bore Desc: 6613, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May '91
Sep '92
Jan '94
May '95
Sep '96
Jan '98
May '99
Sep '00
Jan '02
May '03
Sep '04
Observed
Simulated
Bore Desc: -6618, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Jan '94
Jan '98
Jan '02
Observed
Simulated
Bore Desc: -66515, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Jan '94
Jan '98
Jan '02
Observed
Simulated
Bore Desc: -6678, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Jan '94
Jan '98
Jan '02
Observed
Simulated
Bore Desc: -6681, Layer: 3
Depth Below Ground Surface (m)
Jan '90
Jan '94
Jan '98
Jan '02
Observed
Simulated

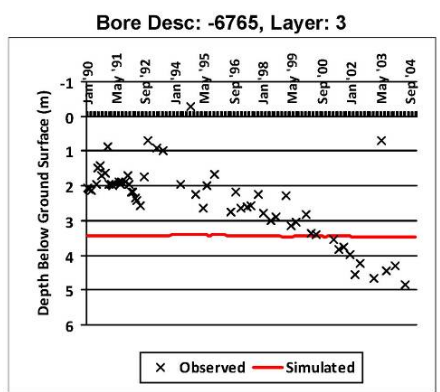

Bore Desc: -6684, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

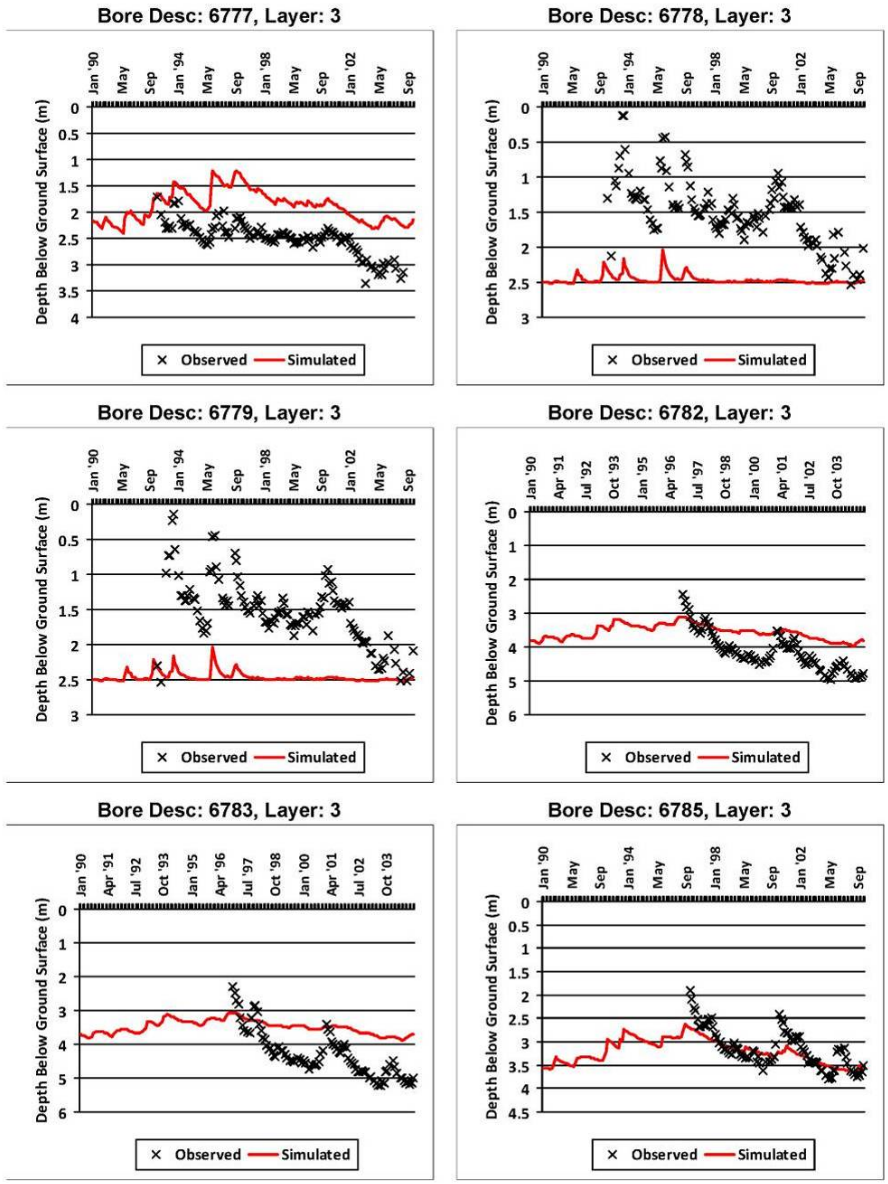

Bore Desc: -6686, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

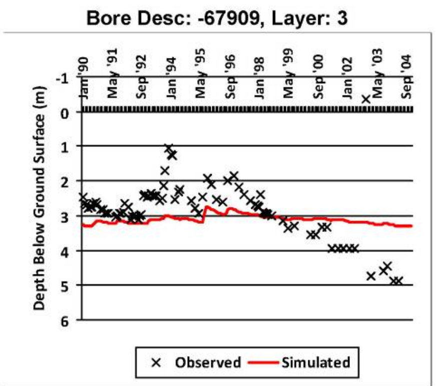

Bore Desc: -66869, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

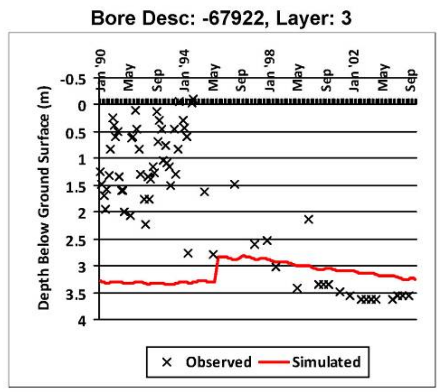

Bore Desc: -6692, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

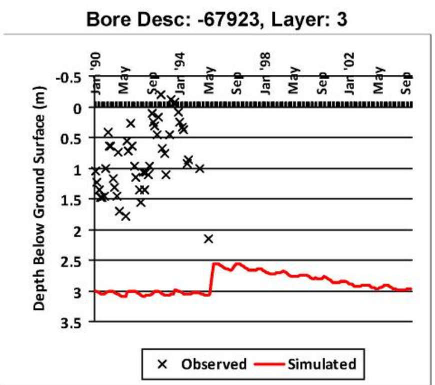

Bore Desc: -6760, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

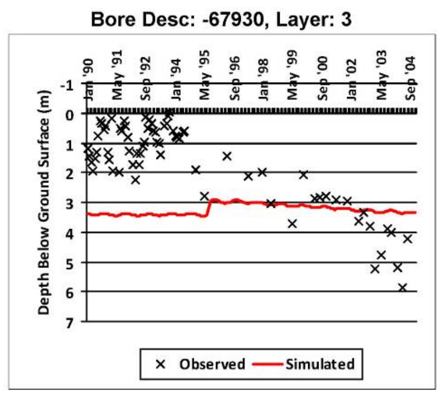

Bore Desc: -6765, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

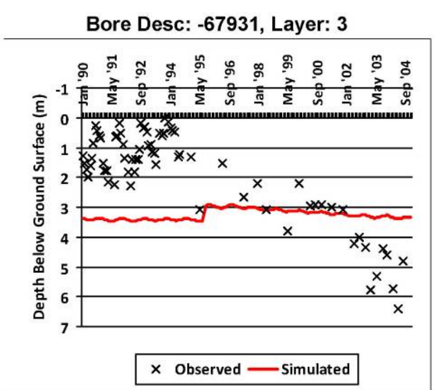

Bore Desc: 6777, Layer: 3
Bore Desc: 6778, Layer: 3
Bore Desc: 6779, Layer: 3
Bore Desc: 6782, Layer: 3
Bore Desc: 6783, Layer: 3
Bore Desc: 6785, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
Jan '98
Jan '02
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Observed
Simulated

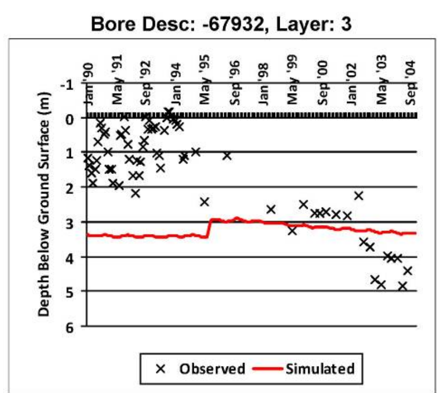

Bore Desc: -67909, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -67922, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

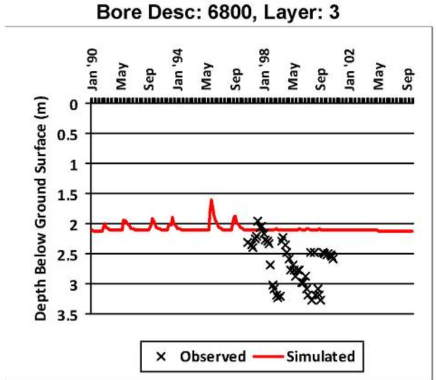

Bore Desc: -67923, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -67930, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

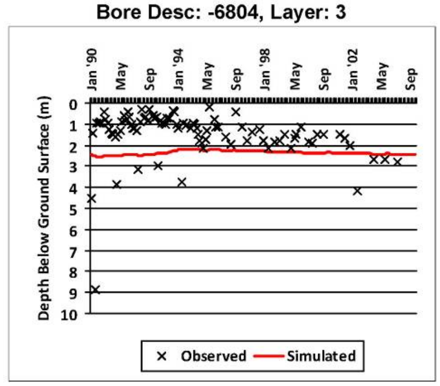

Bore Desc: -67931, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -67932, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

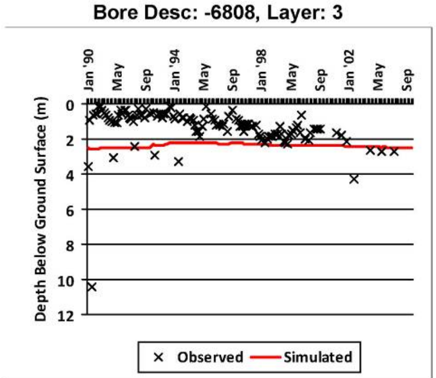
Bore Desc: 6800, Layer: 3



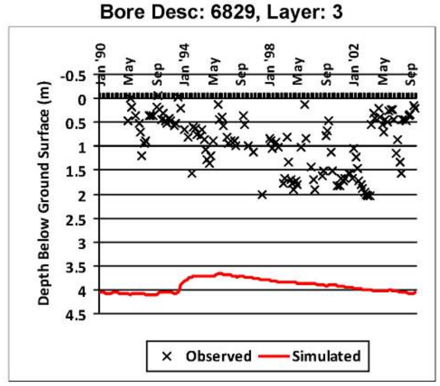
Bore Desc: -6804, Layer: 3



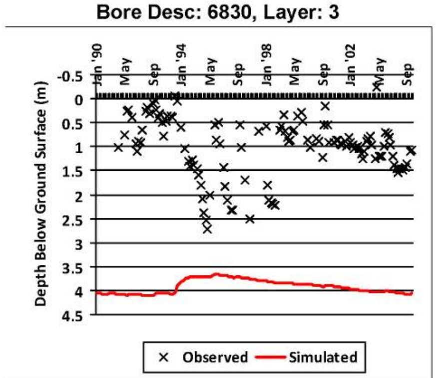
Bore Desc: -6808, Layer: 3



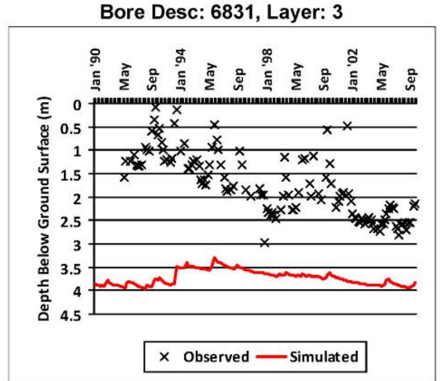
Bore Desc: 6829, Layer: 3



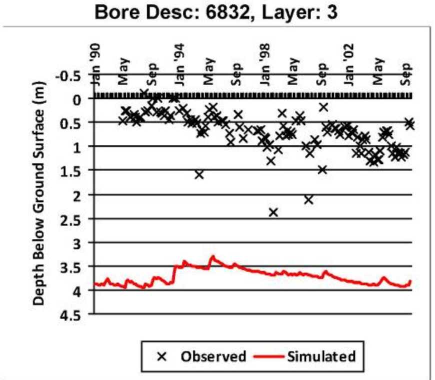
Bore Desc: 6830, Layer: 3



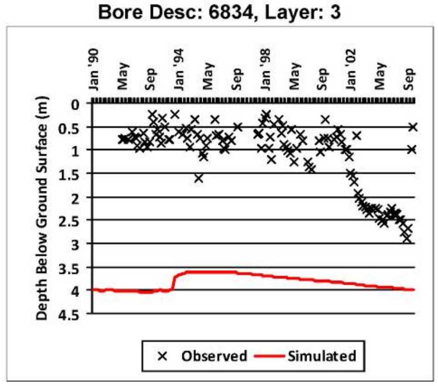
Bore Desc: 6831, Layer: 3



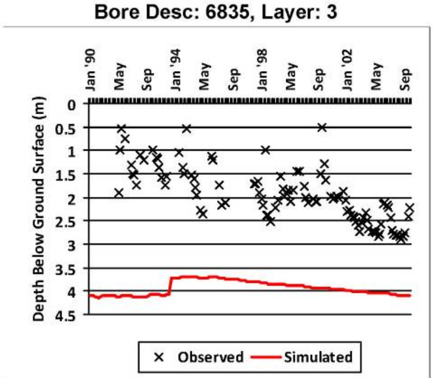
Bore Desc: 6832, Layer: 3



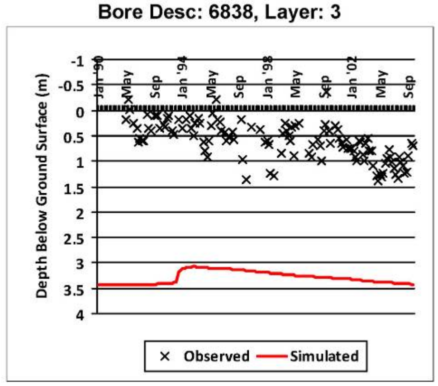
Bore Desc: 6834, Layer: 3



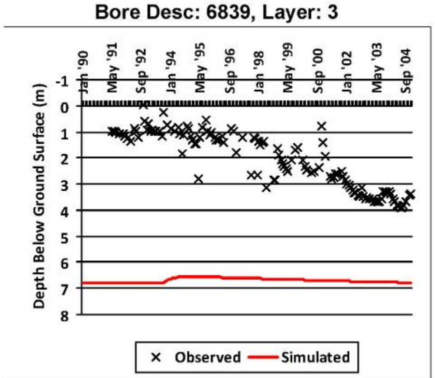
Bore Desc: 6835, Layer: 3



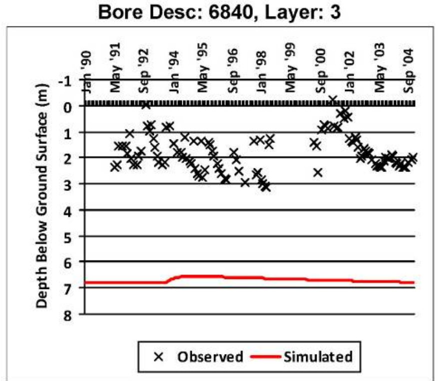
Bore Desc: 6838, Layer: 3



Bore Desc: 6839, Layer: 3



Bore Desc: 6840, Layer: 3



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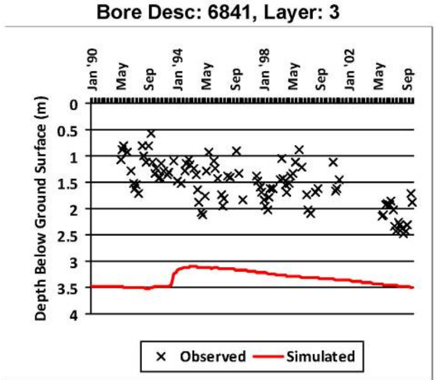
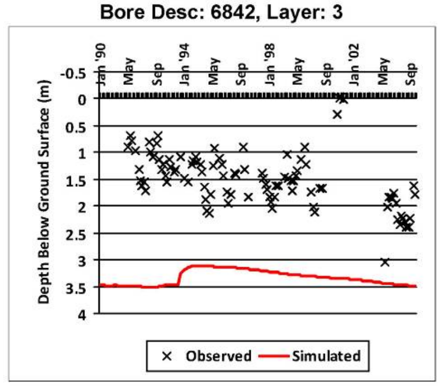
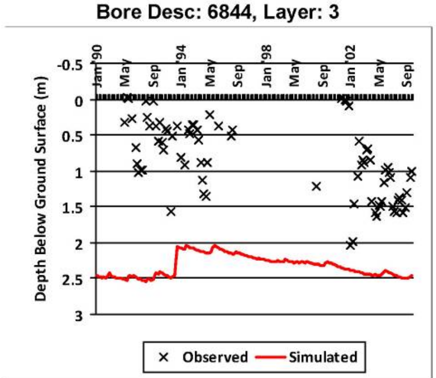


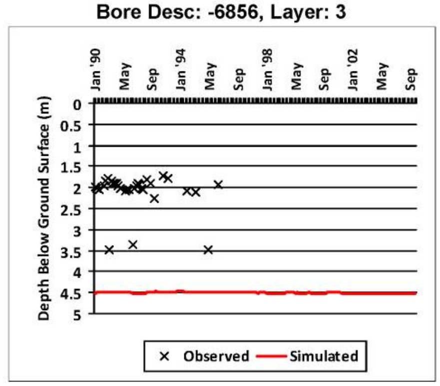
Bore Desc: 6842, Layer: 3



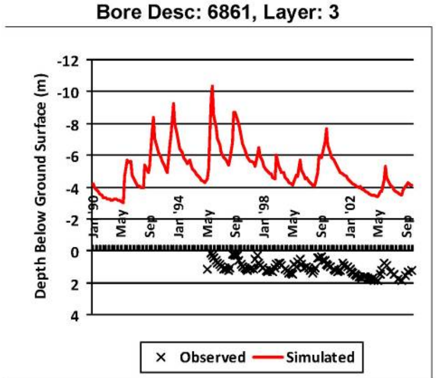
Bore Desc: 6844, Layer: 3



Bore Desc: -6856, Layer: 3



Bore Desc: 6861, Layer: 3



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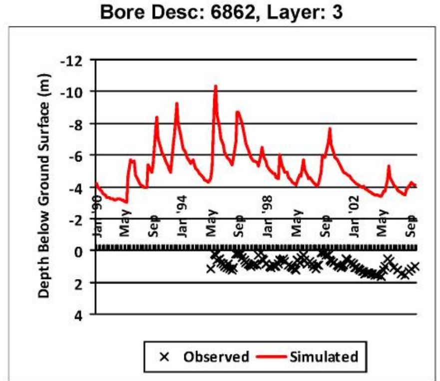
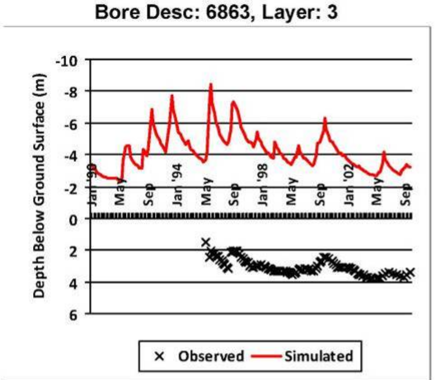
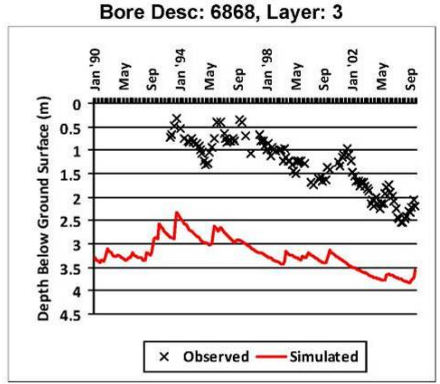


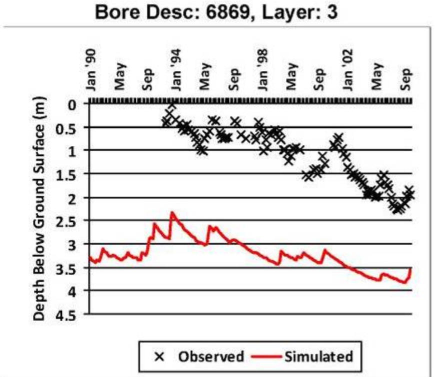
Bore Desc: 6863, Layer: 3



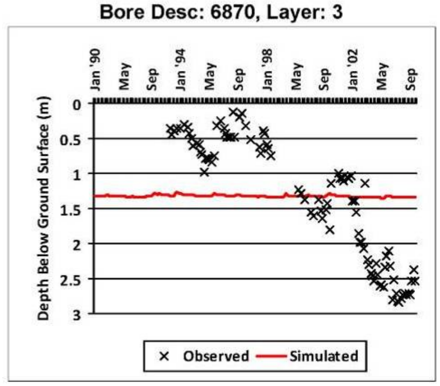
Bore Desc: 6868, Layer: 3



Bore Desc: 6869, Layer: 3



Bore Desc: 6870, Layer: 3



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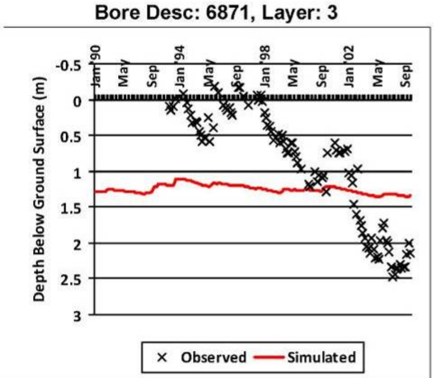

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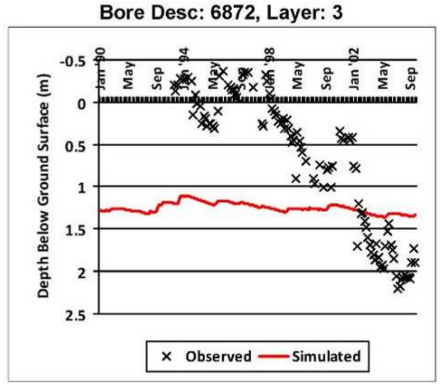
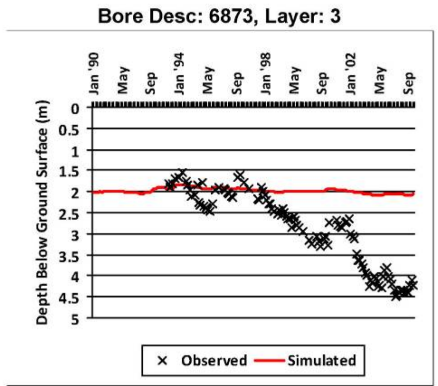
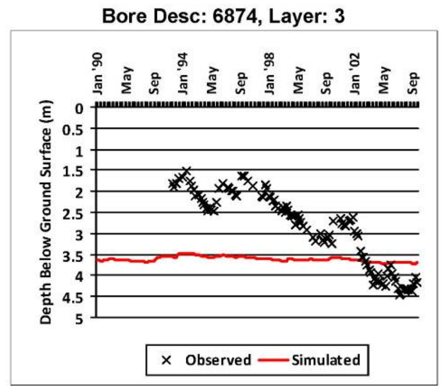
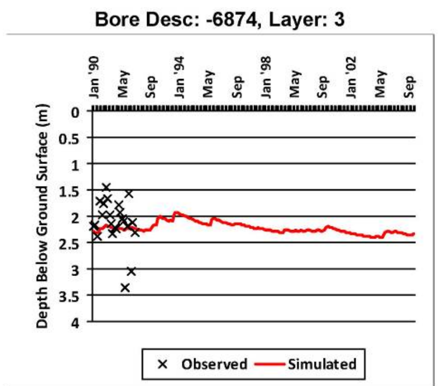
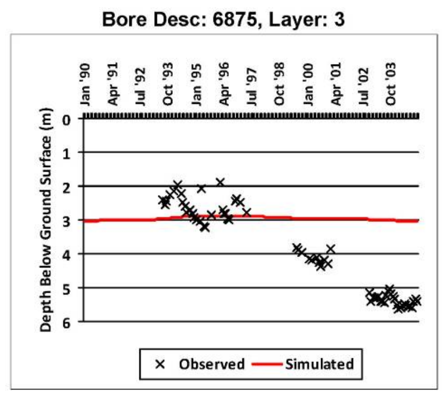
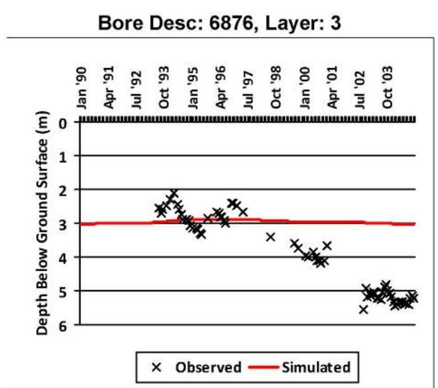


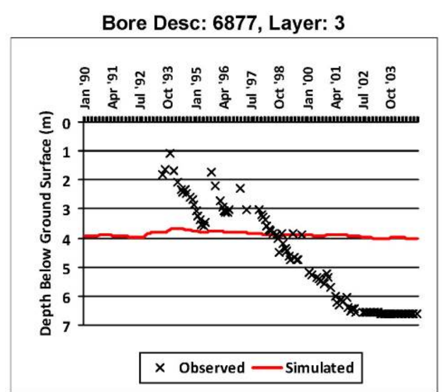

Bore Desc: 6873, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6874, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

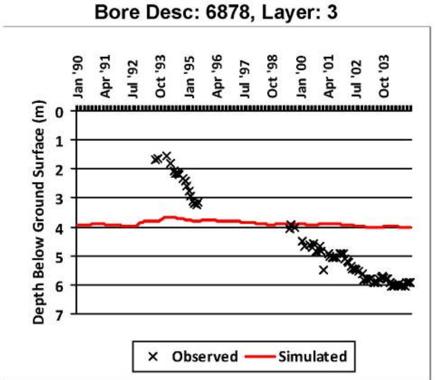

Bore Desc: -6874, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6875, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

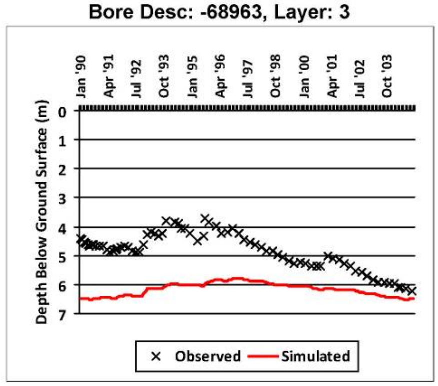

Bore Desc: 6876, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6877, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

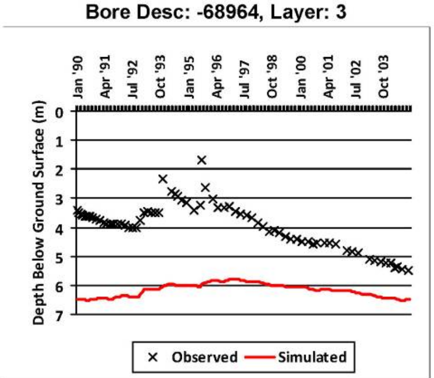
Bore Desc: 6878, Layer: 3



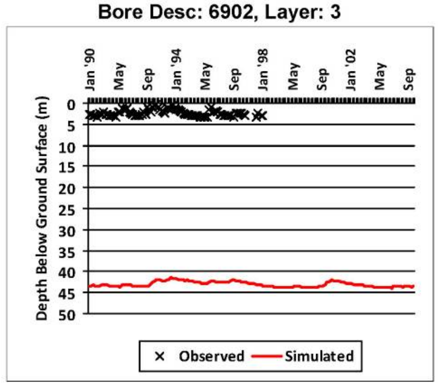
Bore Desc: -68963, Layer: 3



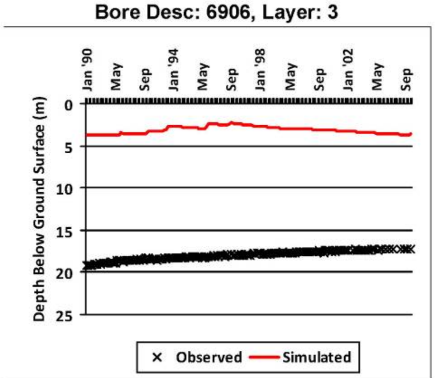
Bore Desc: -68964, Layer: 3



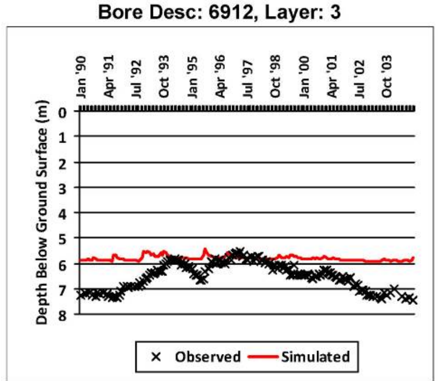
Bore Desc: 6902, Layer: 3

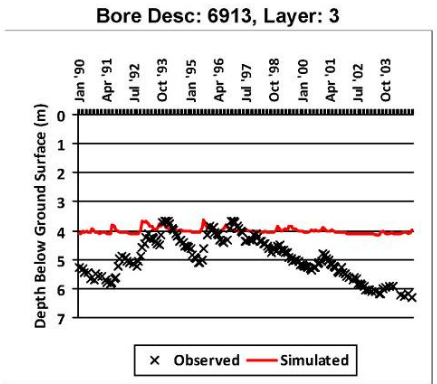


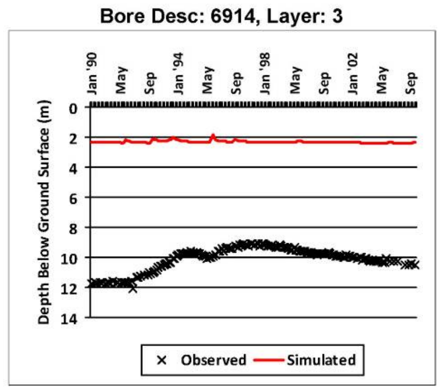
Bore Desc: 6906, Layer: 3

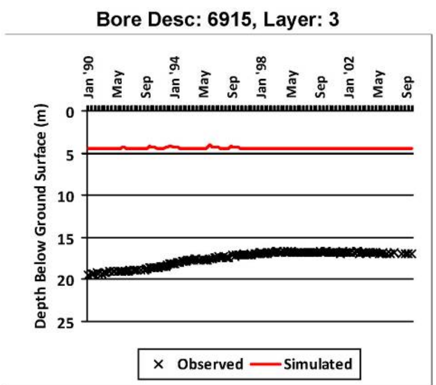


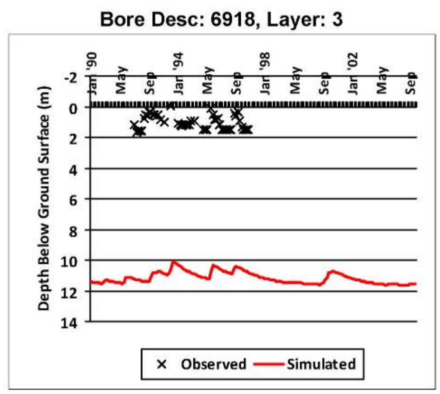
Bore Desc: 6912, Layer: 3

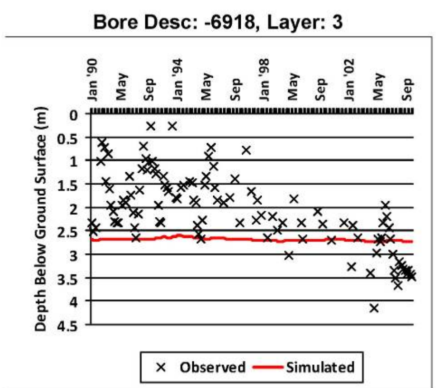


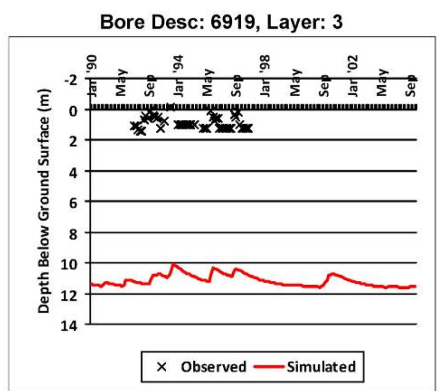

Bore Desc: 6913, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6914, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

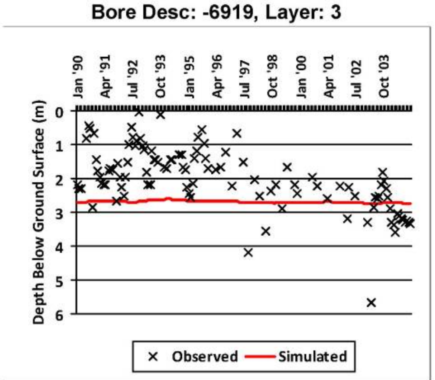

Bore Desc: 6915, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6918, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

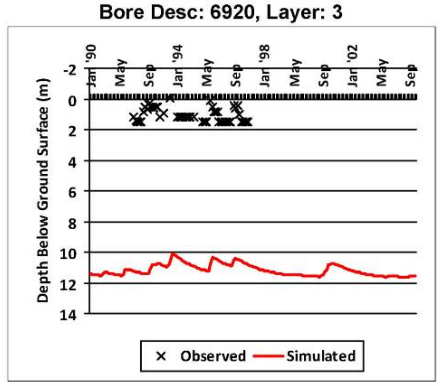

Bore Desc: -6918, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6919, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

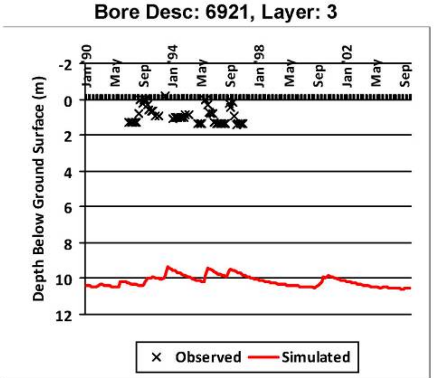
Bore Desc: -6919, Layer: 3



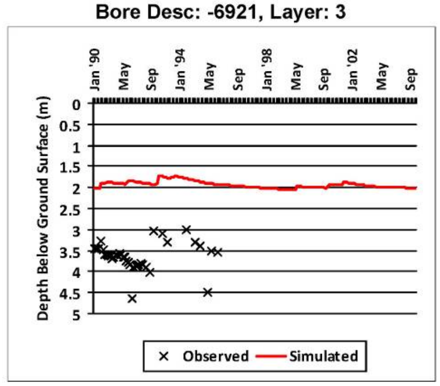
Bore Desc: 6920, Layer: 3



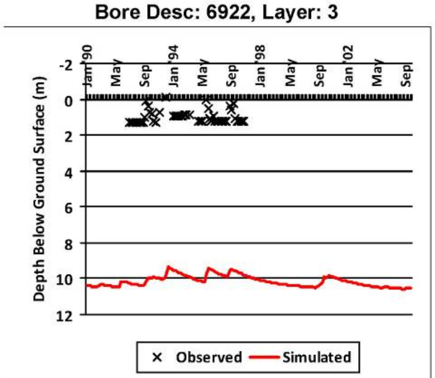
Bore Desc: 6921, Layer: 3



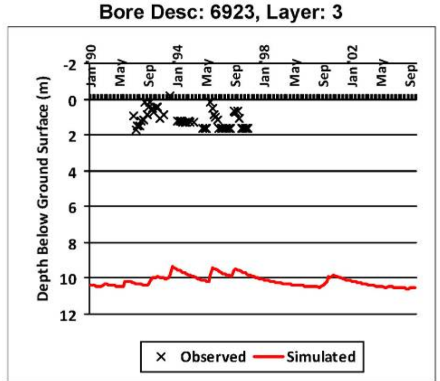
Bore Desc: -6921, Layer: 3



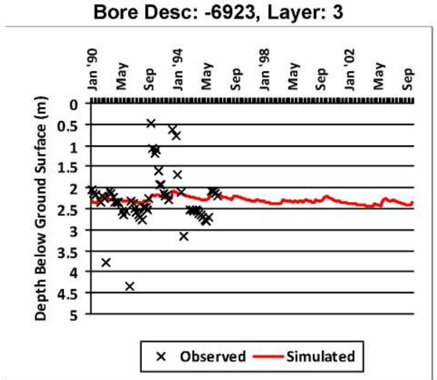
Bore Desc: 6922, Layer: 3



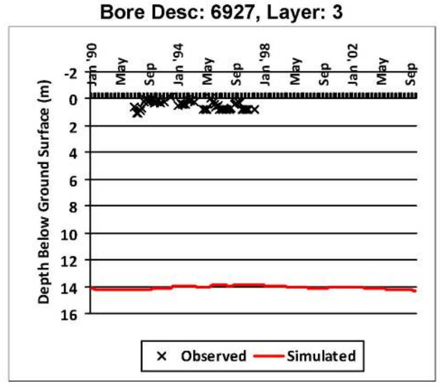
Bore Desc: 6923, Layer: 3



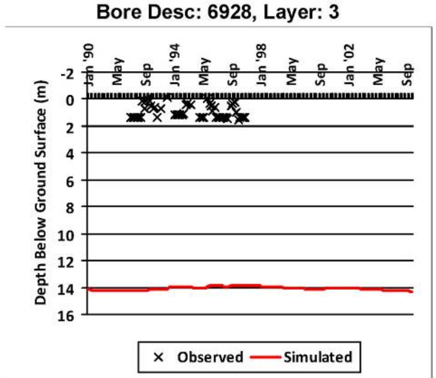
Bore Desc: -6923, Layer: 3



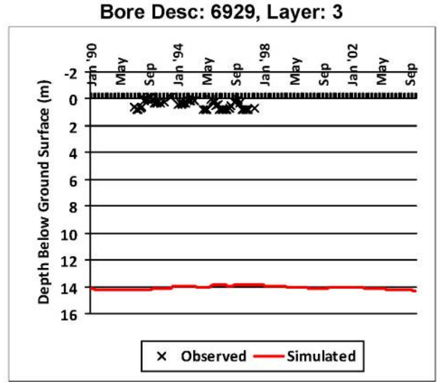
Bore Desc: 6927, Layer: 3



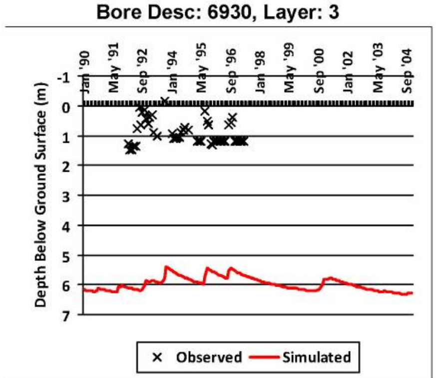
Bore Desc: 6928, Layer: 3



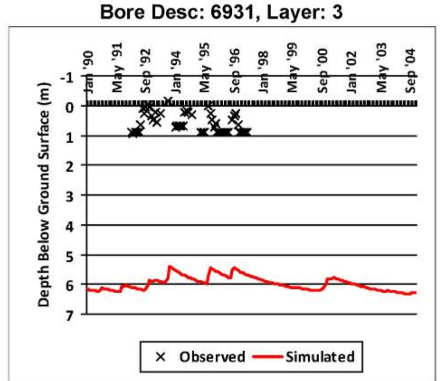
Bore Desc: 6929, Layer: 3



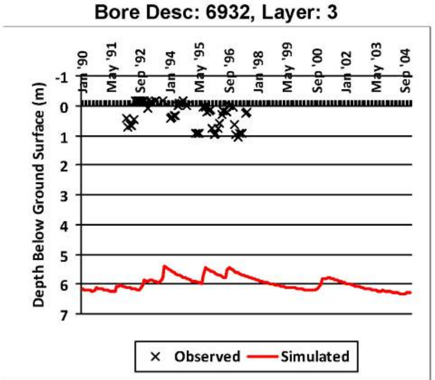
Bore Desc: 6930, Layer: 3



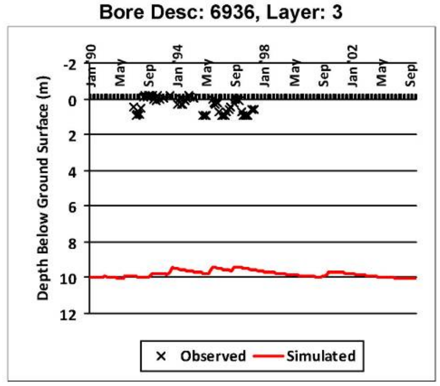
Bore Desc: 6931, Layer: 3



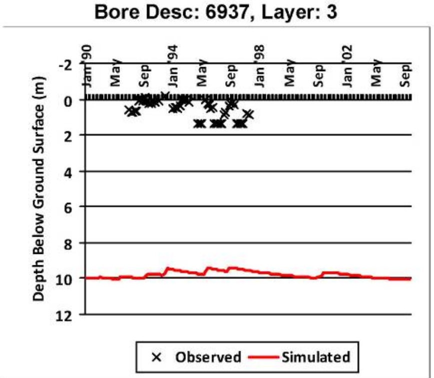
Bore Desc: 6932, Layer: 3



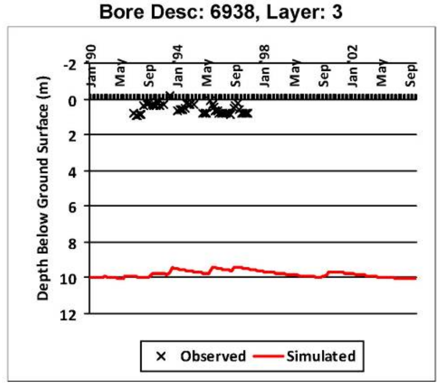
Bore Desc: 6936, Layer: 3



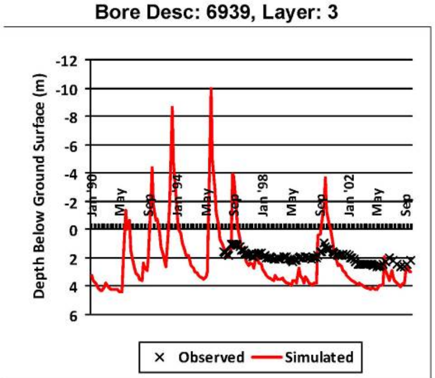
Bore Desc: 6937, Layer: 3



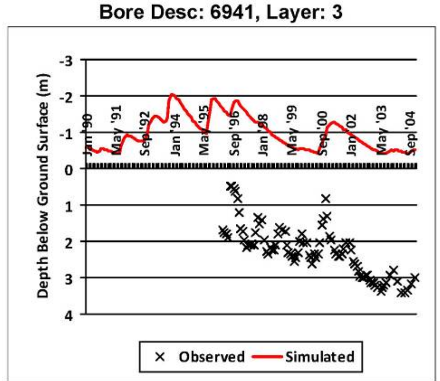
Bore Desc: 6938, Layer: 3

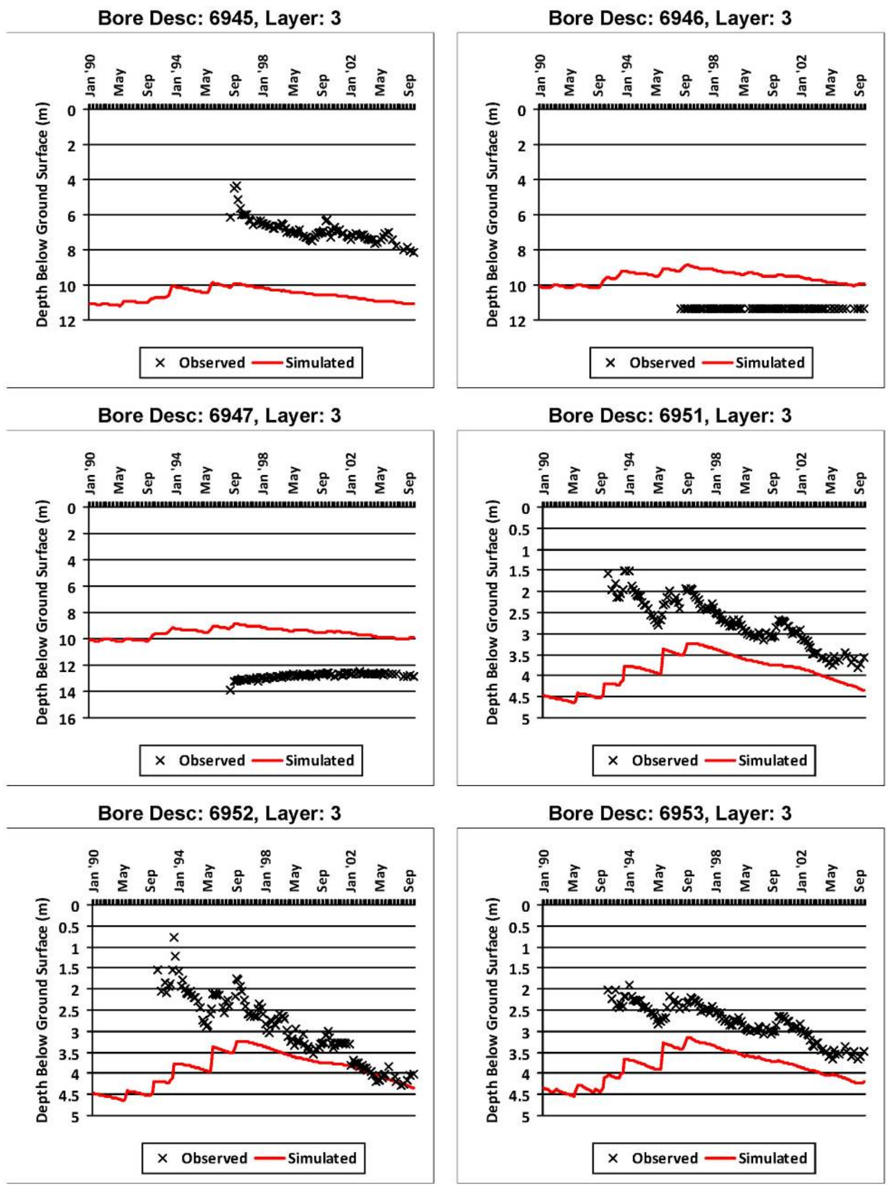


Bore Desc: 6939, Layer: 3

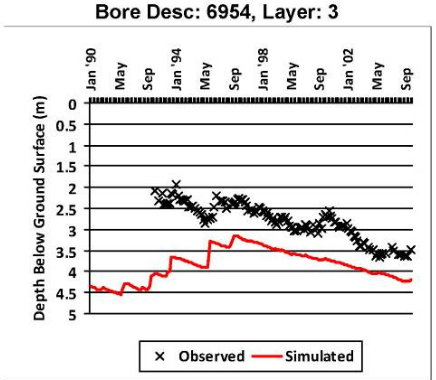


Bore Desc: 6941, Layer: 3

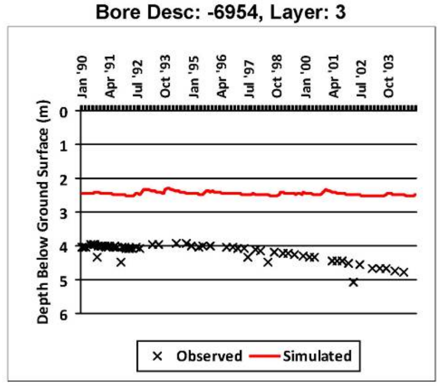



Bore Desc: 6945, Layer: 3
Bore Desc: 6946, Layer: 3
Bore Desc: 6947, Layer: 3
Bore Desc: 6951, Layer: 3
Bore Desc: 6952, Layer: 3
Bore Desc: 6953, Layer: 3
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
Jan '98
Jan '02
Observed
Simulated

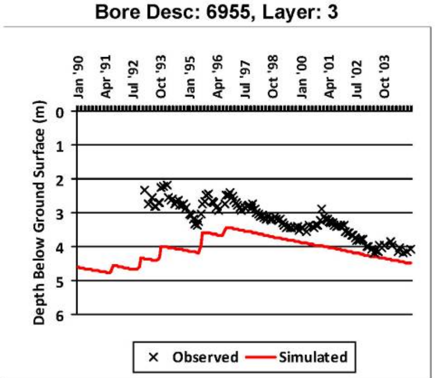
Bore Desc: 6954, Layer: 3



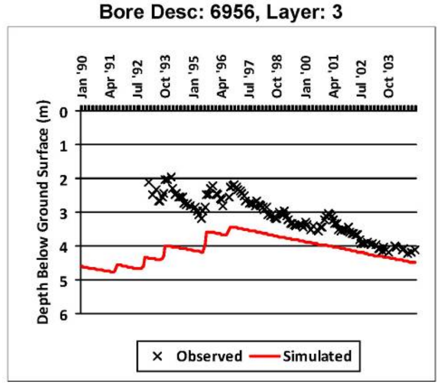
Bore Desc: -6954, Layer: 3



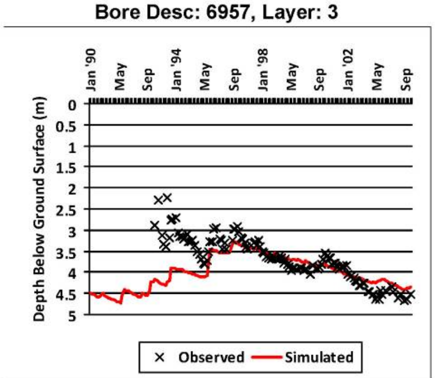
Bore Desc: 6955, Layer: 3



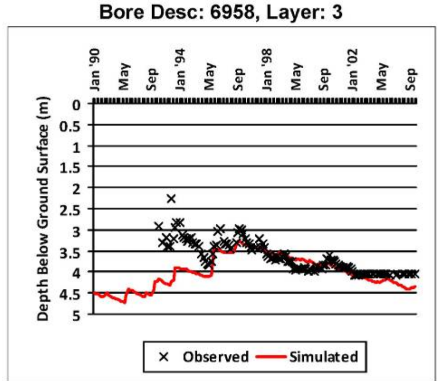
Bore Desc: 6956, Layer: 3

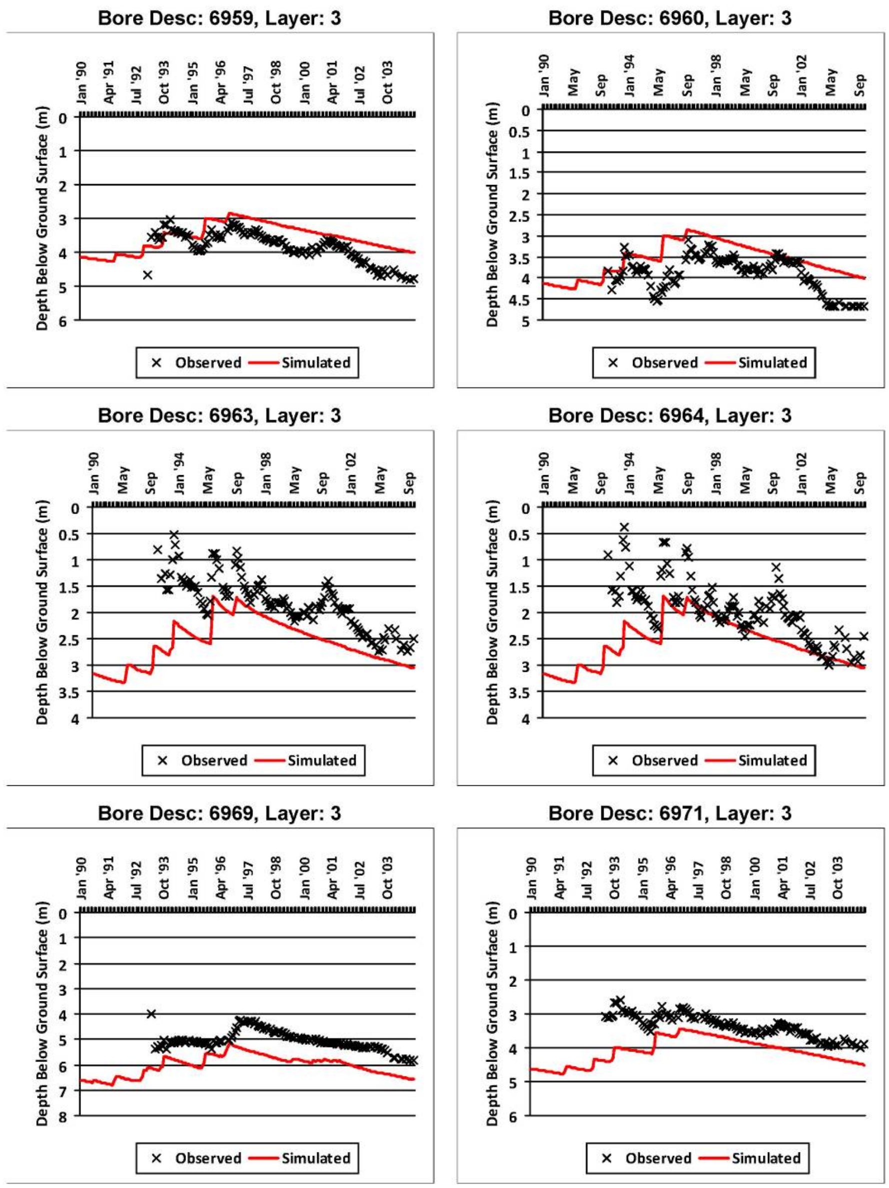


Bore Desc: 6957, Layer: 3



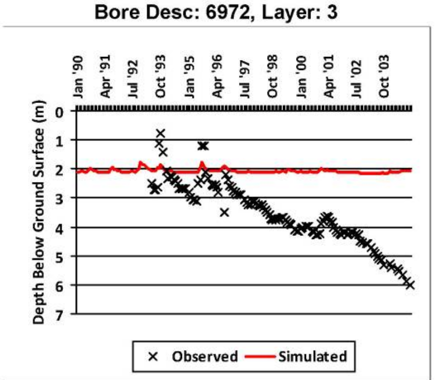
Bore Desc: 6958, Layer: 3



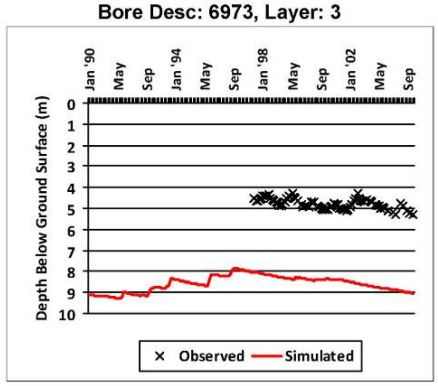


Bore Desc: 6959, Layer: 3
Bore Desc: 6960, Layer: 3
Bore Desc: 6963, Layer: 3
Bore Desc: 6964, Layer: 3
Bore Desc: 6969, Layer: 3
Bore Desc: 6971, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

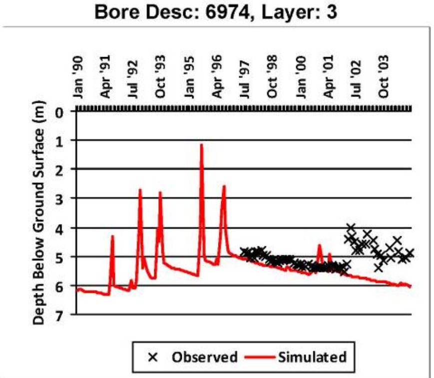
Bore Desc: 6972, Layer: 3



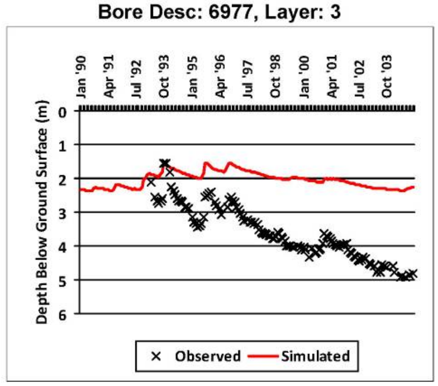
Bore Desc: 6973, Layer: 3



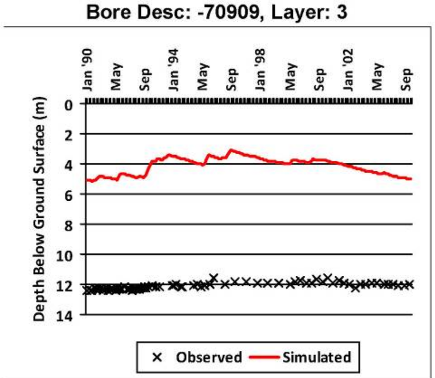
Bore Desc: 6974, Layer: 3



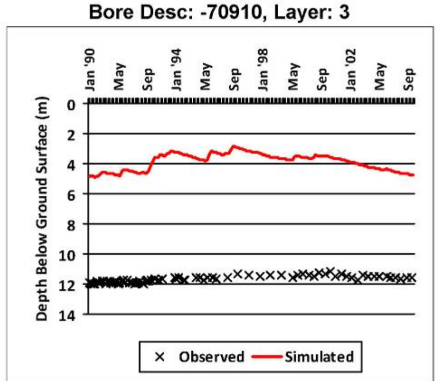
Bore Desc: 6977, Layer: 3



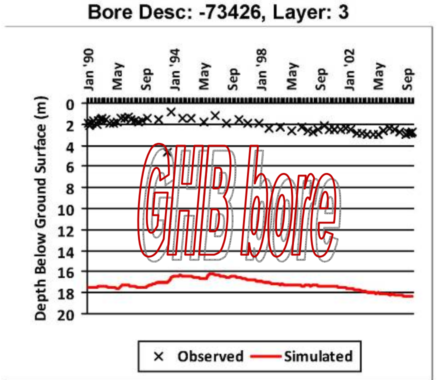
Bore Desc: -70909, Layer: 3



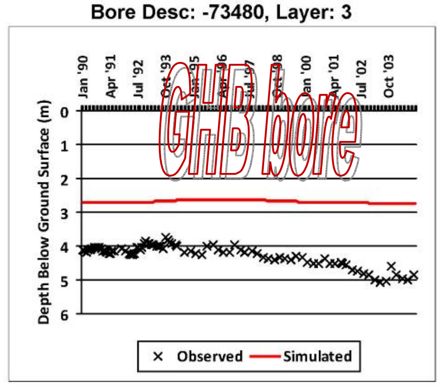
Bore Desc: -70910, Layer: 3



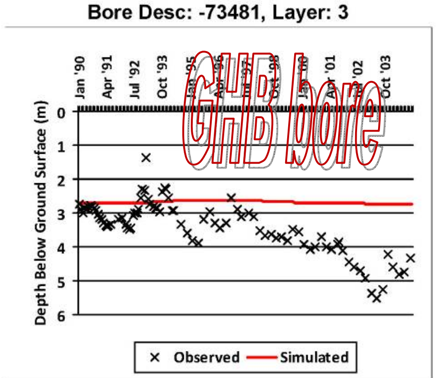
Bore Desc: -73426, Layer: 3



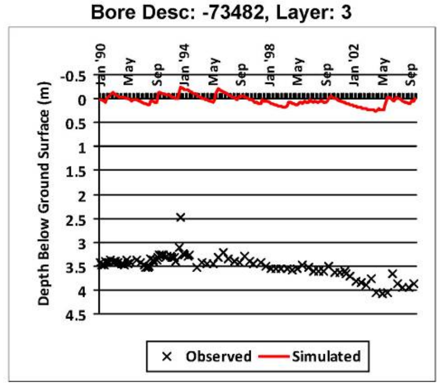
Bore Desc: -73480, Layer: 3



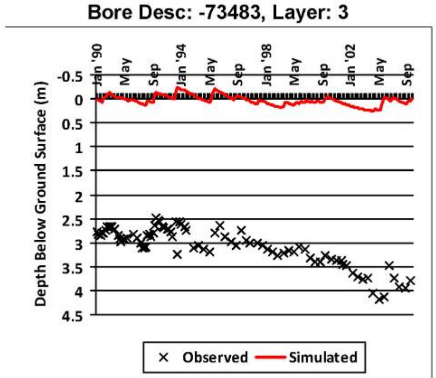
Bore Desc: -73481, Layer: 3



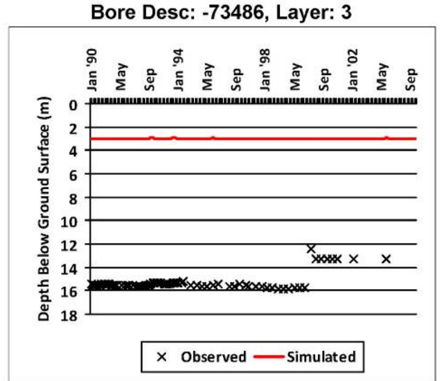
Bore Desc: -73482, Layer: 3

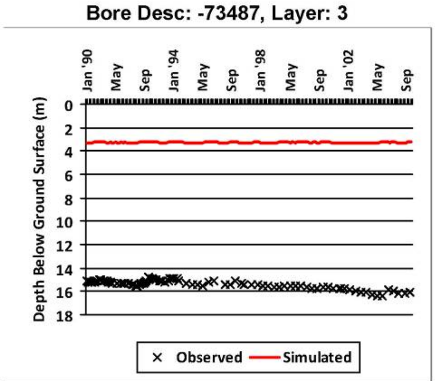


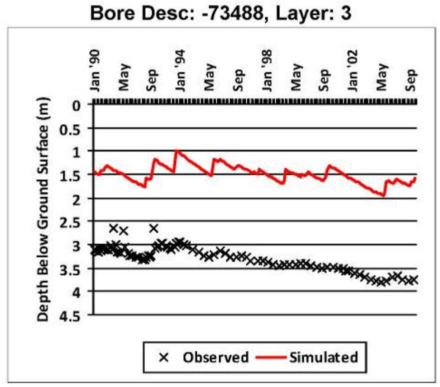
Bore Desc: -73483, Layer: 3

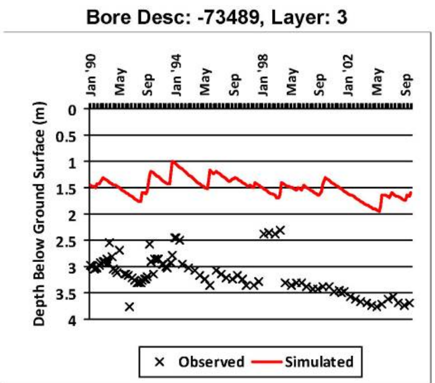


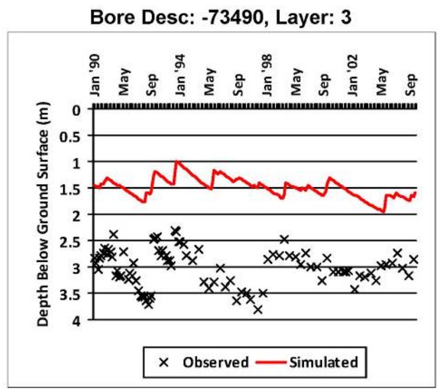
Bore Desc: -73486, Layer: 3

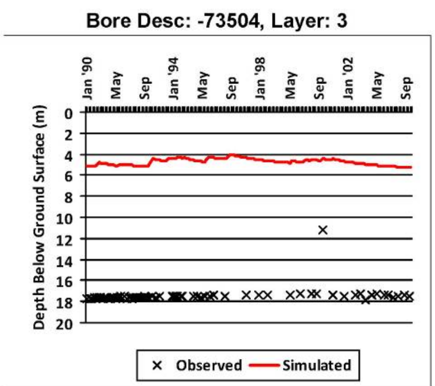


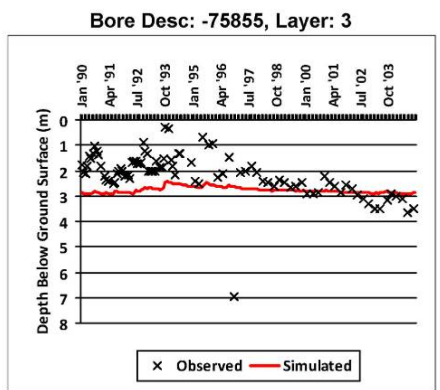

Bore Desc: -73487, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

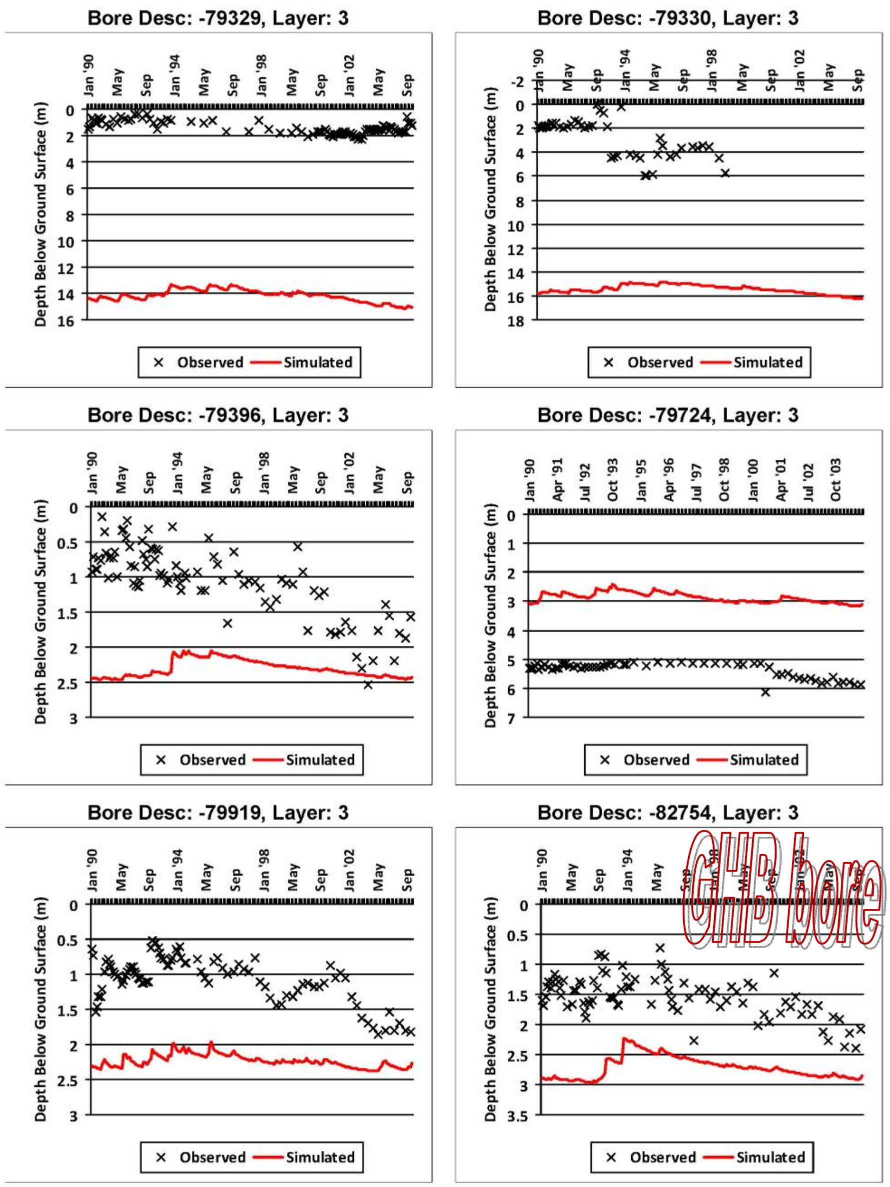

Bore Desc: -73488, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -73489, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

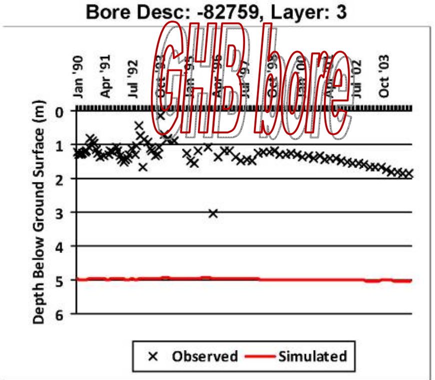

Bore Desc: -73490, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -73504, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated

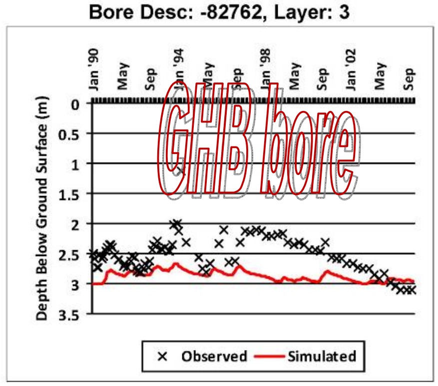

Bore Desc: -75855, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -79329, Layer: 3
Bore Desc: -79330, Layer: 3
Bore Desc: -79396, Layer: 3
Bore Desc: -79724, Layer: 3
Bore Desc: -79919, Layer: 3
Bore Desc: -82754, Layer: 3
Depth Below Ground Surface (m)
Observed
Simulated
GHB bore

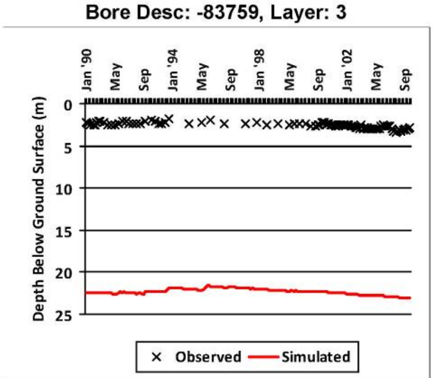
Bore Desc: -82759, Layer: 3



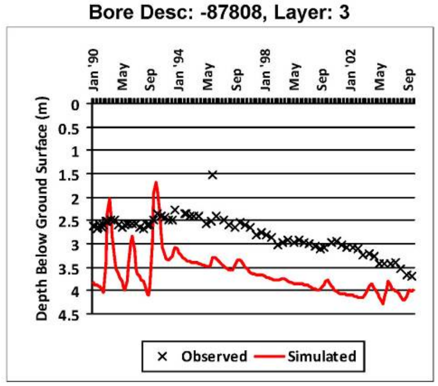
Bore Desc: -82762, Layer: 3



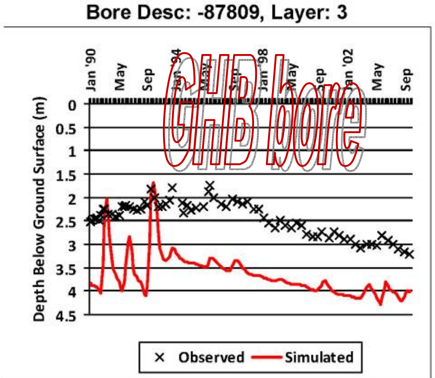
Bore Desc: -83759, Layer: 3



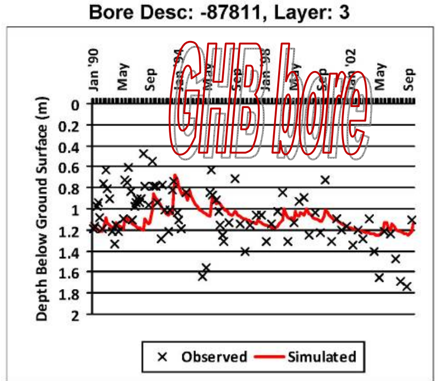
Bore Desc: -87808, Layer: 3



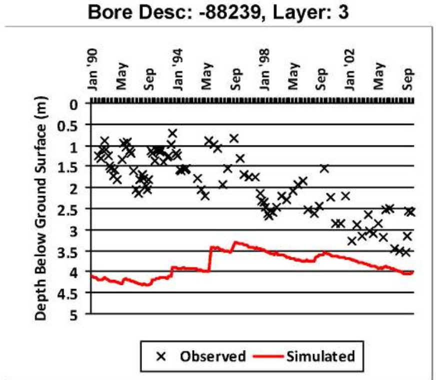
Bore Desc: -87809, Layer: 3



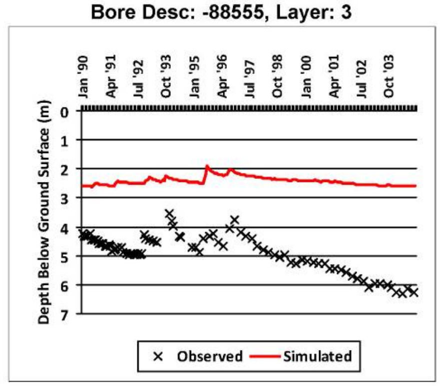
Bore Desc: -87811, Layer: 3



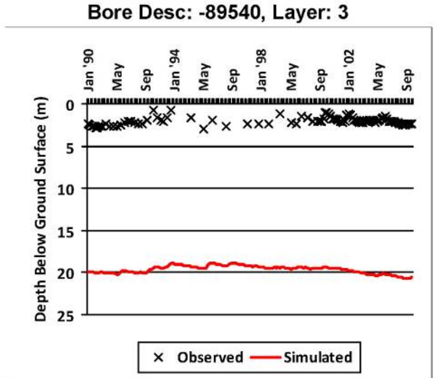
Bore Desc: -88239, Layer: 3



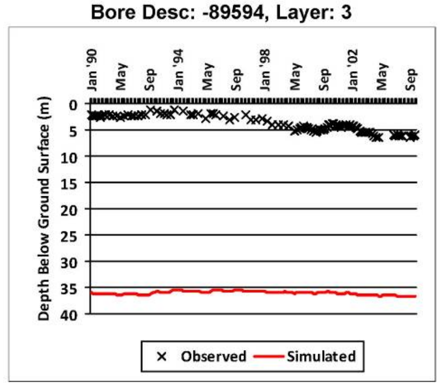
Bore Desc: -88555, Layer: 3



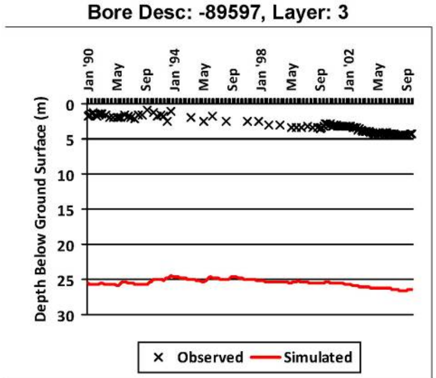
Bore Desc: -89540, Layer: 3



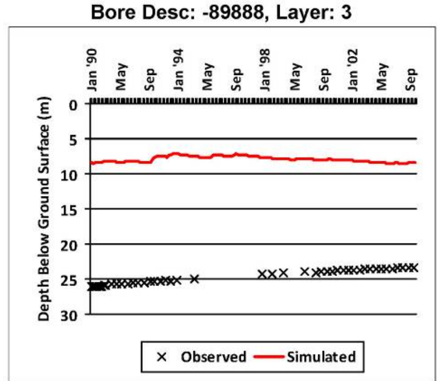
Bore Desc: -89594, Layer: 3



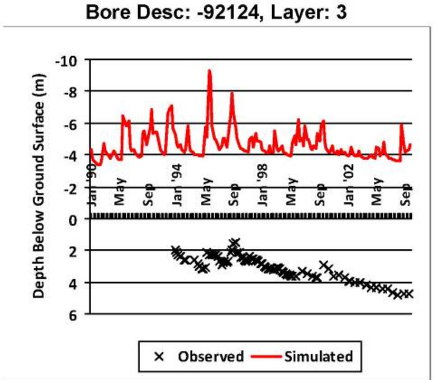
Bore Desc: -89597, Layer: 3



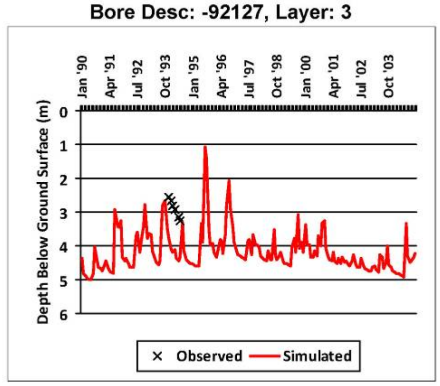
Bore Desc: -89888, Layer: 3



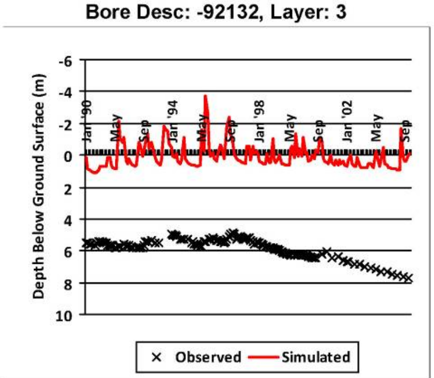
Bore Desc: -92124, Layer: 3



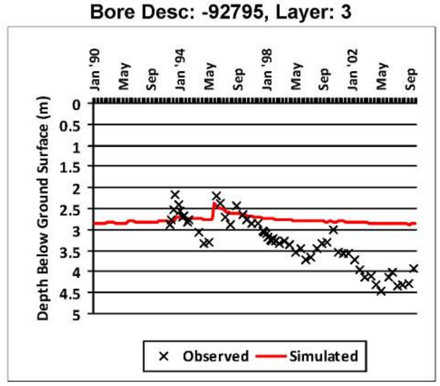
Bore Desc: -92127, Layer: 3



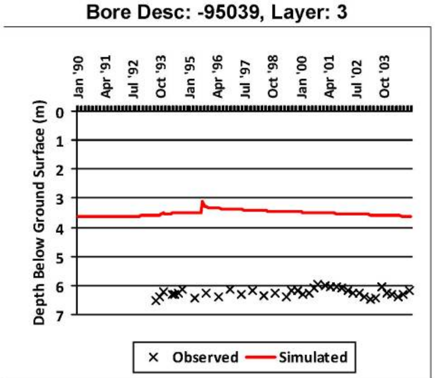
Bore Desc: -92132, Layer: 3



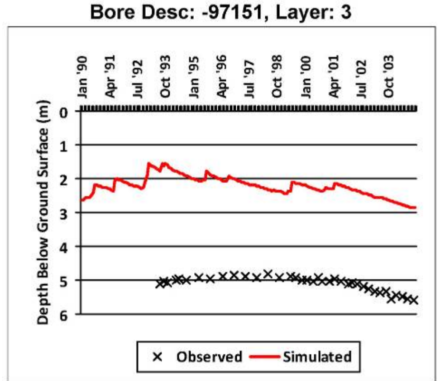
Bore Desc: -92795, Layer: 3



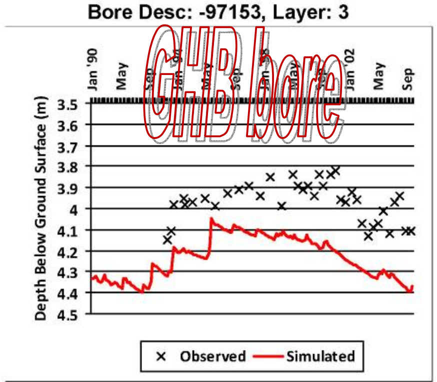
Bore Desc: -95039, Layer: 3



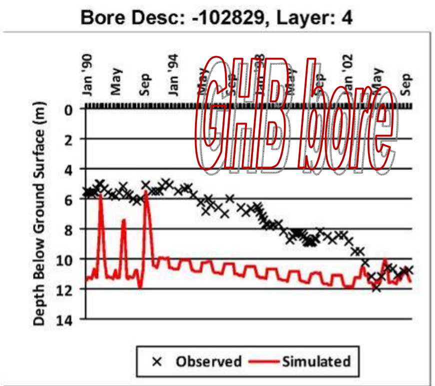
Bore Desc: -97151, Layer: 3

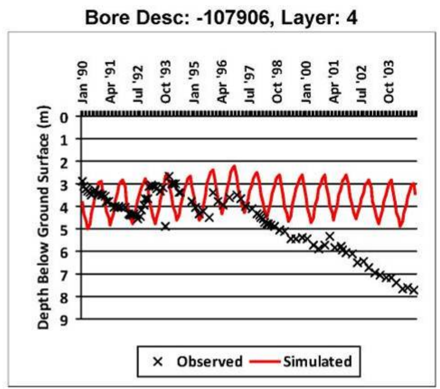


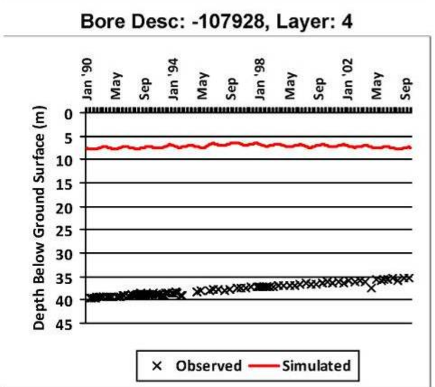
Bore Desc: -97153, Layer: 3

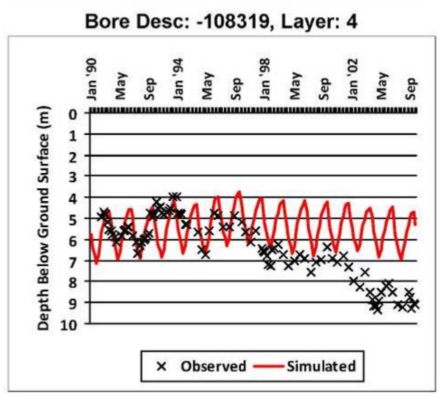


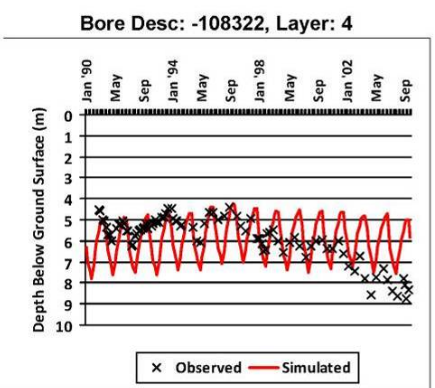
Layer 4 (lower Shepparton Formation)

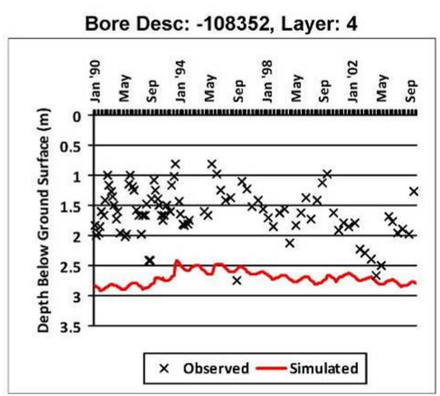




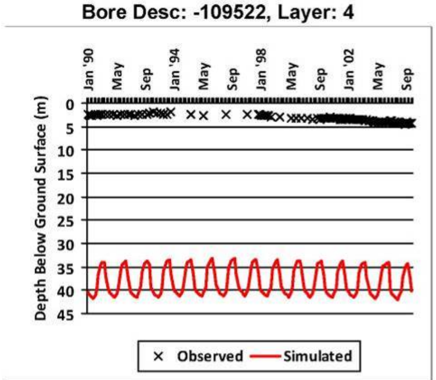




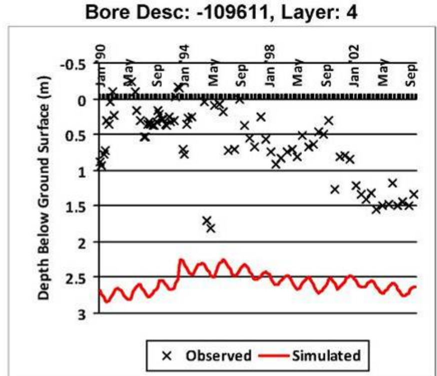




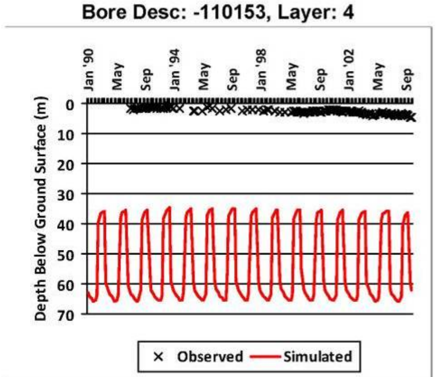
Bore Desc: -109522, Layer: 4



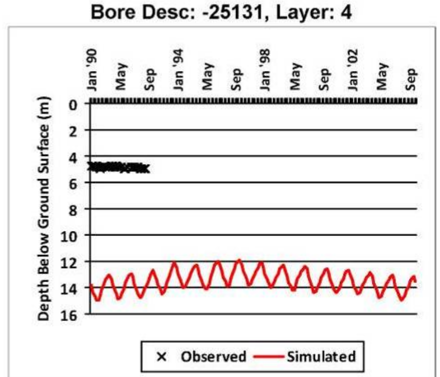
Bore Desc: -109611, Layer: 4



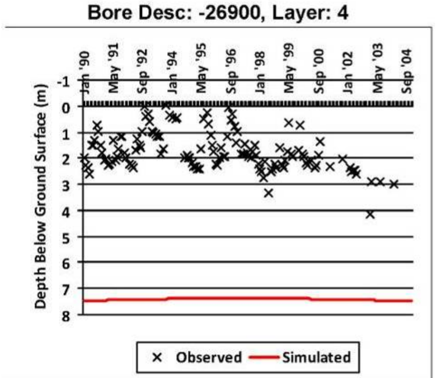
Bore Desc: -110153, Layer: 4



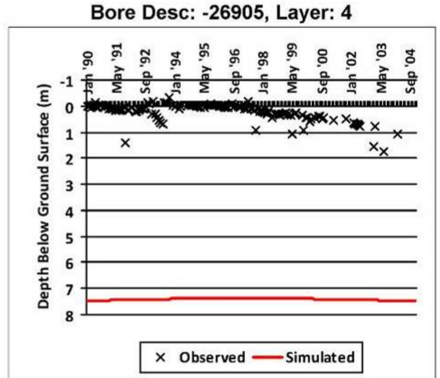
Bore Desc: -25131, Layer: 4



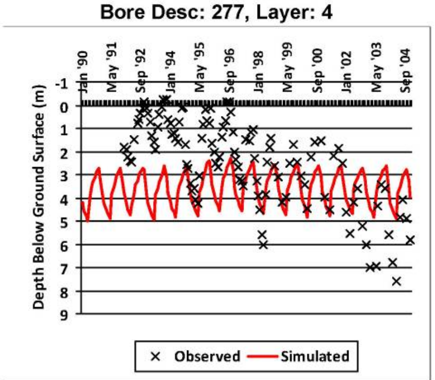
Bore Desc: -26900, Layer: 4



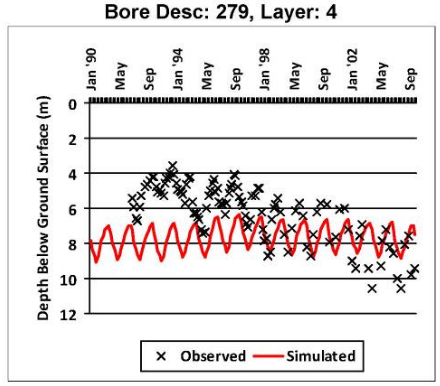
Bore Desc: -26905, Layer: 4



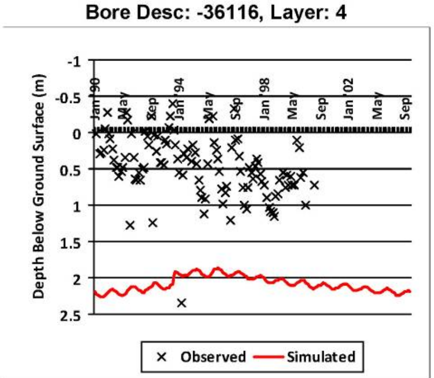
Bore Desc: 277, Layer: 4



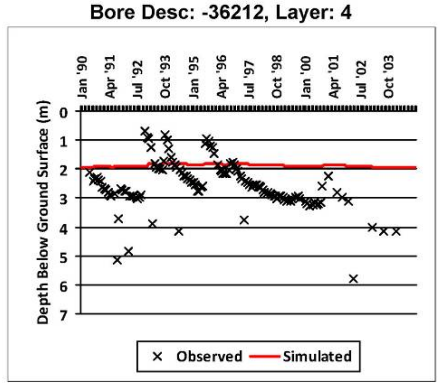
Bore Desc: 279, Layer: 4



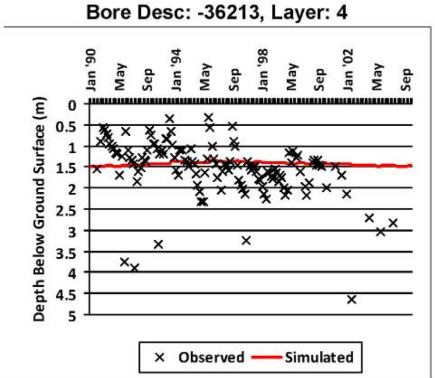
Bore Desc: -36116, Layer: 4



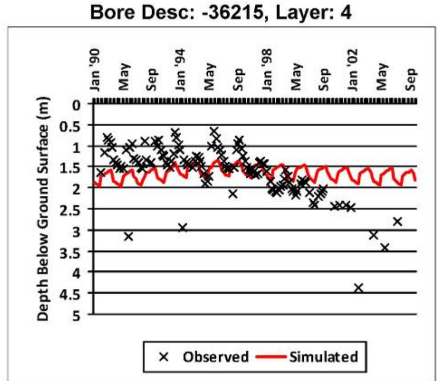
Bore Desc: -36212, Layer: 4



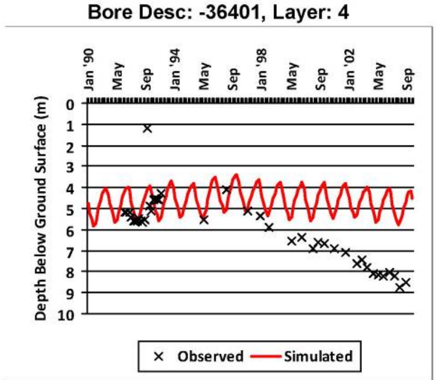
Bore Desc: -36213, Layer: 4



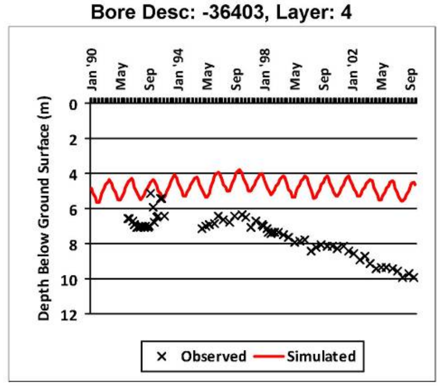
Bore Desc: -36215, Layer: 4



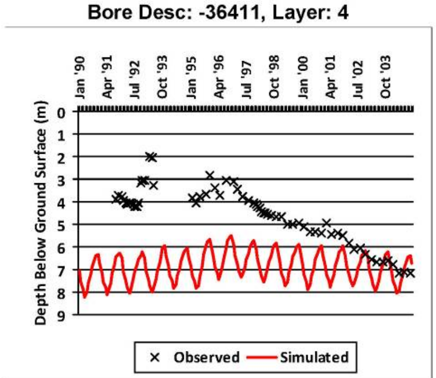
Bore Desc: -36401, Layer: 4



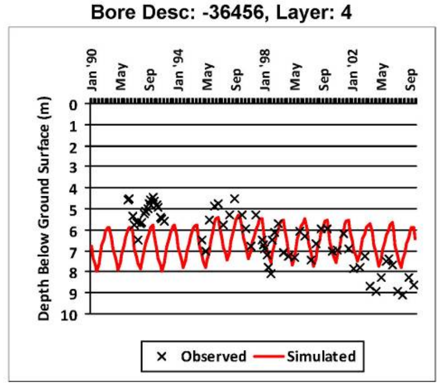
Bore Desc: -36403, Layer: 4



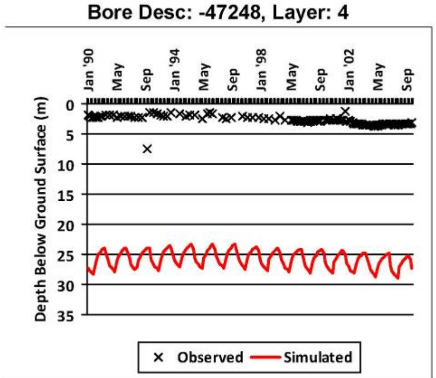
Bore Desc: -36411, Layer: 4



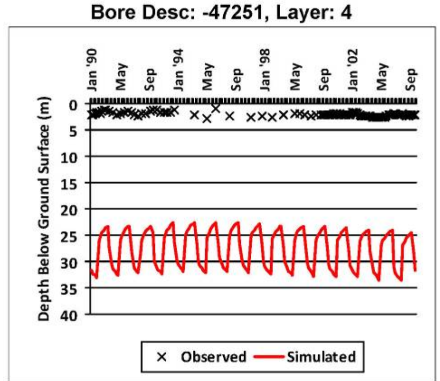
Bore Desc: -36456, Layer: 4



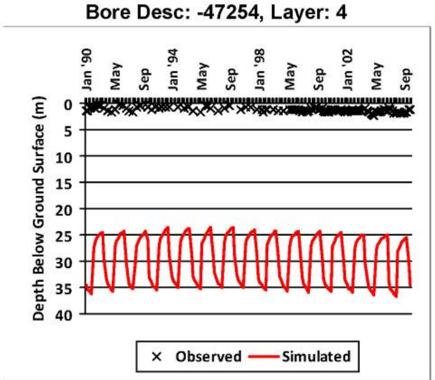
Bore Desc: -47248, Layer: 4



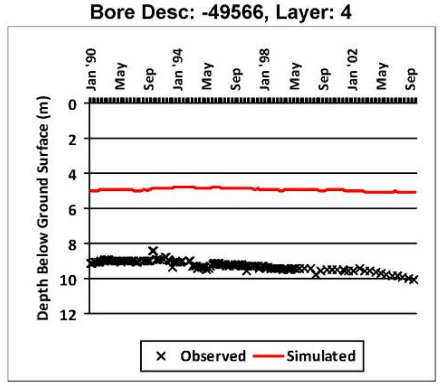
Bore Desc: -47251, Layer: 4



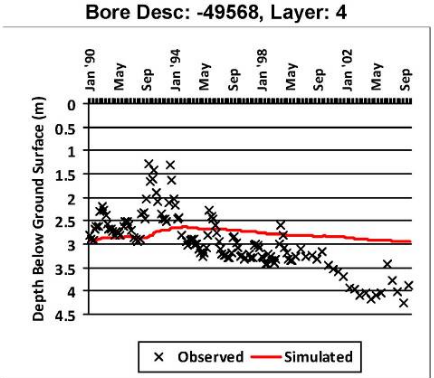
Bore Desc: -47254, Layer: 4



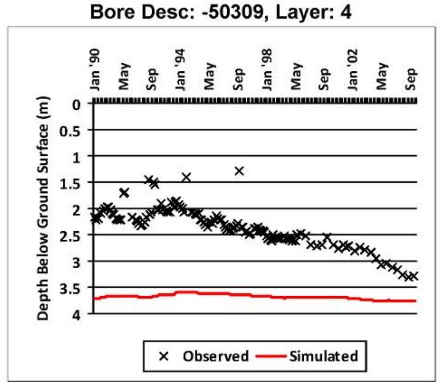
Bore Desc: -49566, Layer: 4



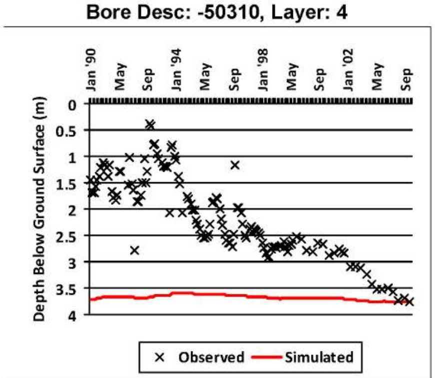
Bore Desc: -49568, Layer: 4



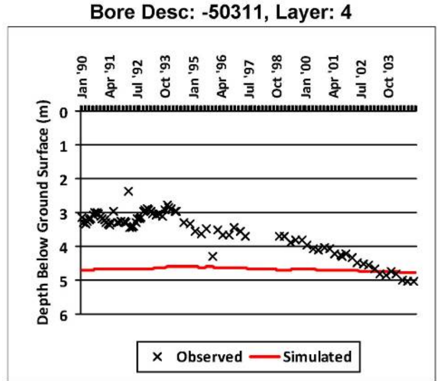
Bore Desc: -50309, Layer: 4



Bore Desc: -50310, Layer: 4



Bore Desc: -50311, Layer: 4



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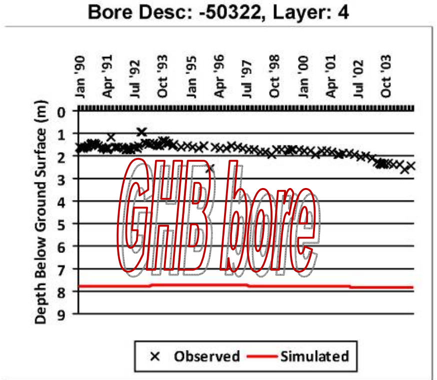
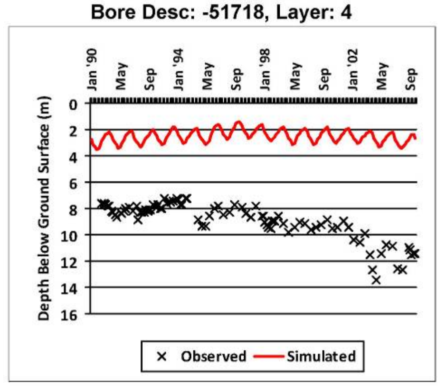
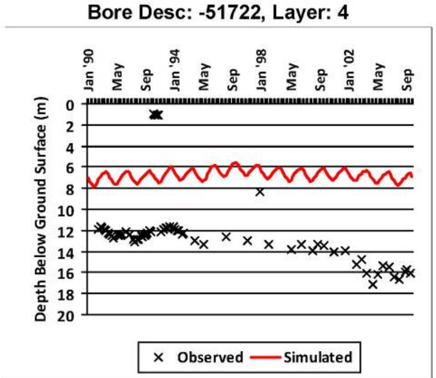


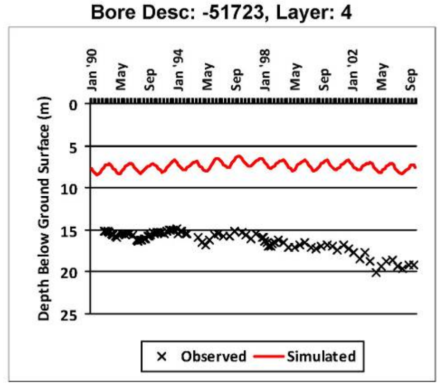
Bore Desc: -51718, Layer: 4



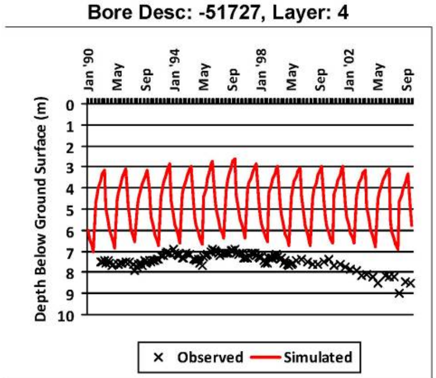
Bore Desc: -51722, Layer: 4



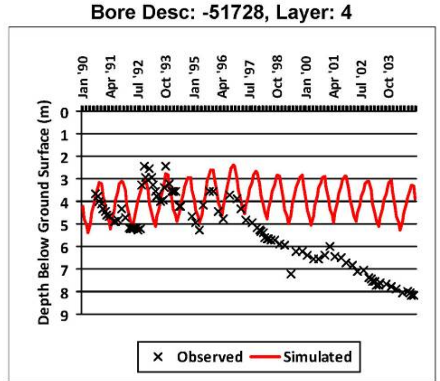
Bore Desc: -51723, Layer: 4

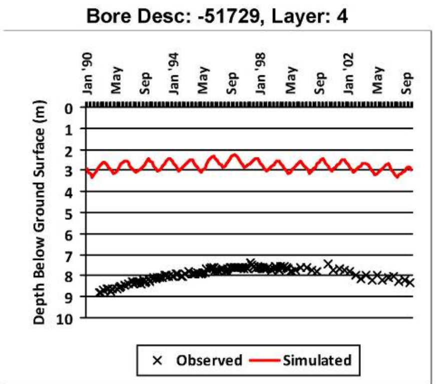


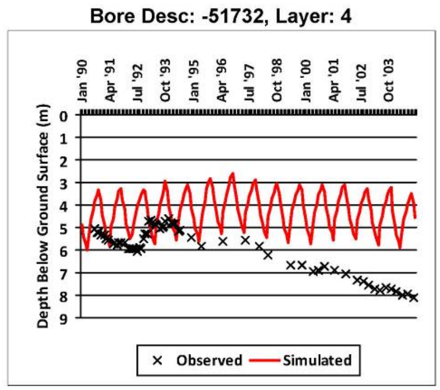
Bore Desc: -51727, Layer: 4

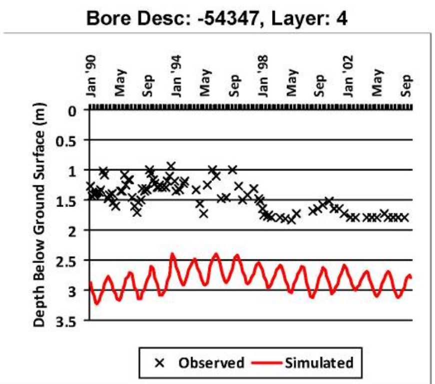


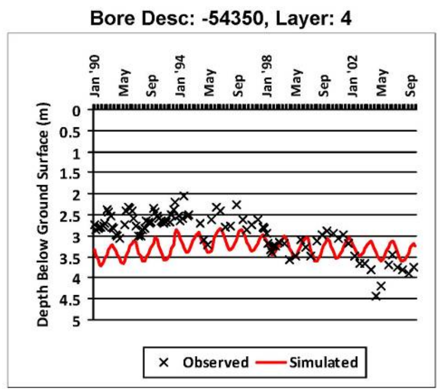
Bore Desc: -51728, Layer: 4

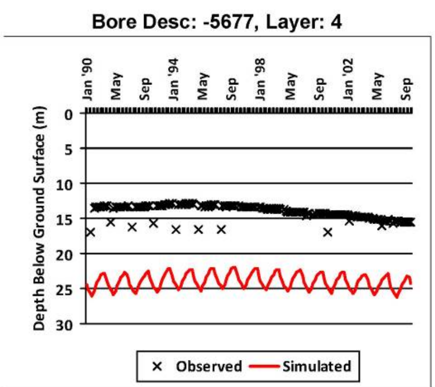


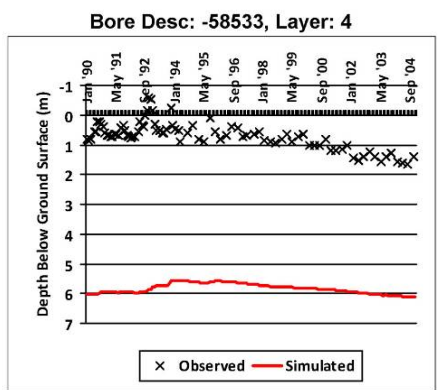

Bore Desc: -51729, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -51732, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated

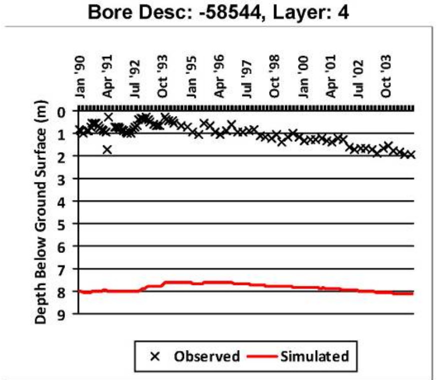

Bore Desc: -54347, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -54350, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated

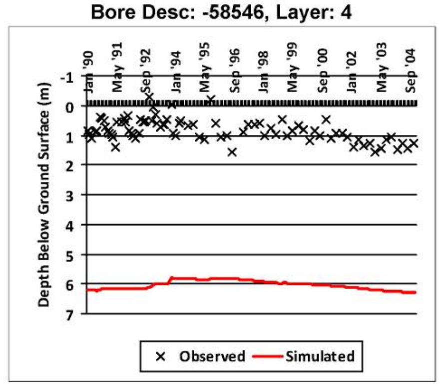

Bore Desc: -5677, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -58533, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated

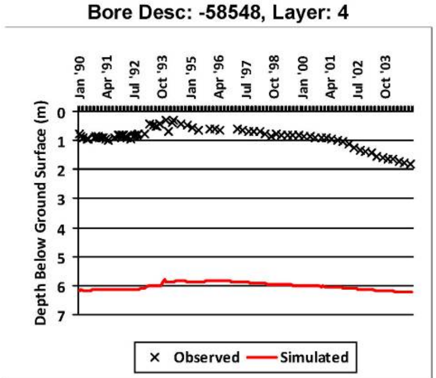
Bore Desc: -58544, Layer: 4



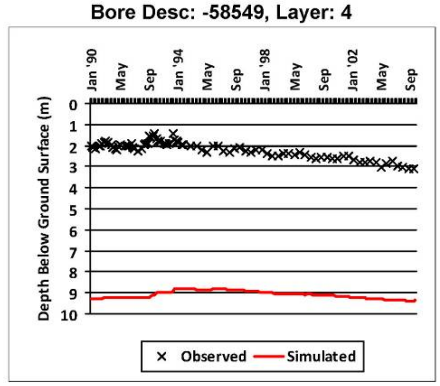
Bore Desc: -58546, Layer: 4



Bore Desc: -58548, Layer: 4



Bore Desc: -58549, Layer: 4



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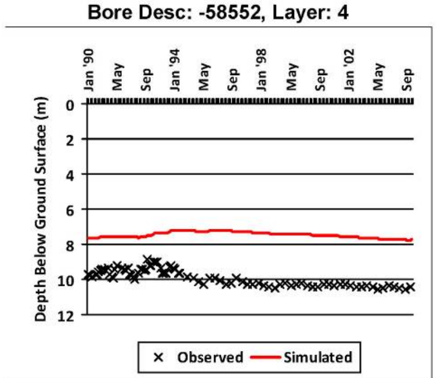
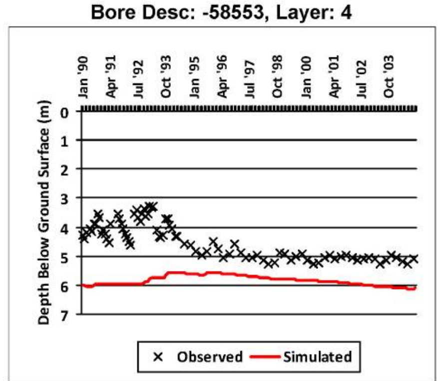
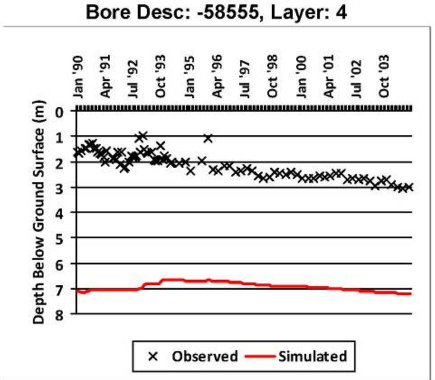


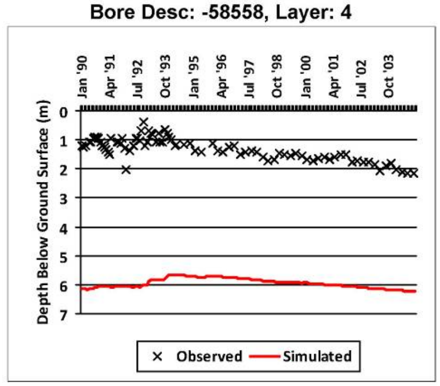
Bore Desc: -58553, Layer: 4



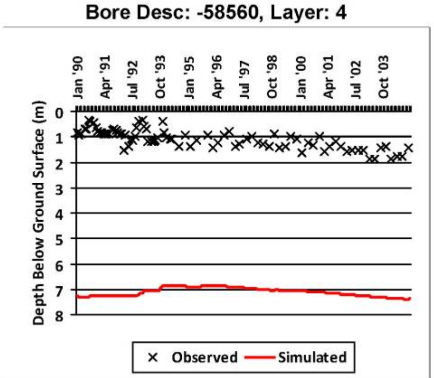
Bore Desc: -58555, Layer: 4



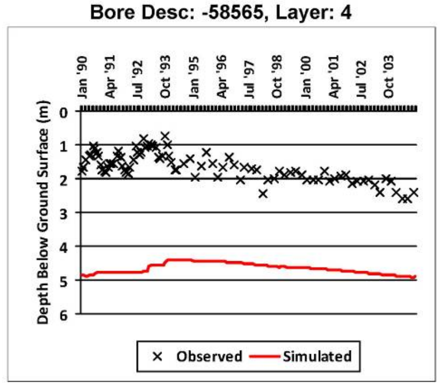
Bore Desc: -58558, Layer: 4



Bore Desc: -58560, Layer: 4



Bore Desc: -58565, Layer: 4



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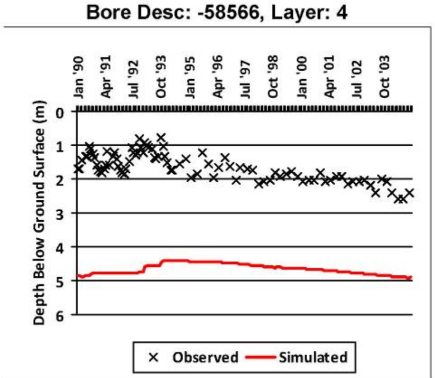

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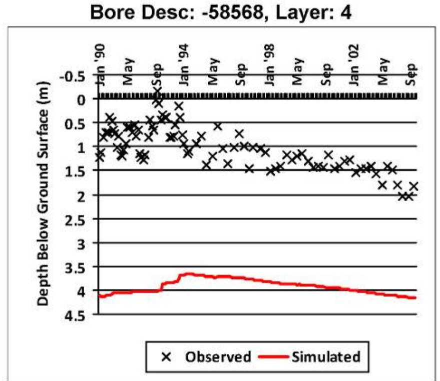
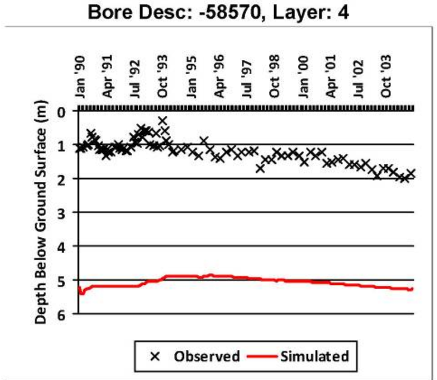
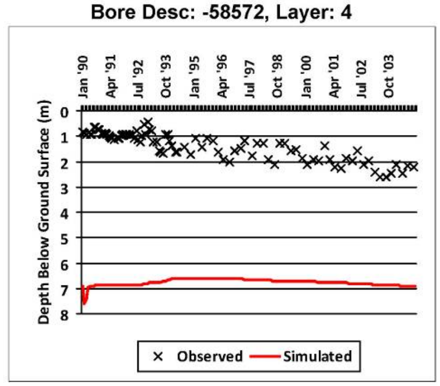


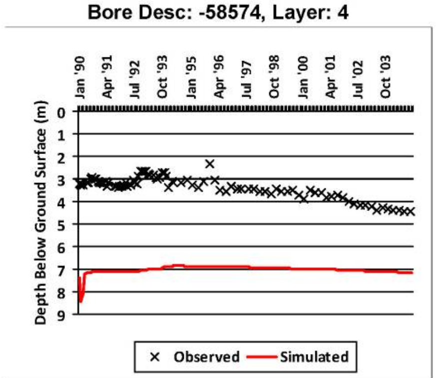
Bore Desc: -58570, Layer: 4



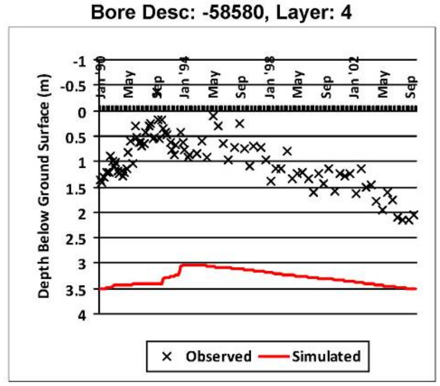
Bore Desc: -58572, Layer: 4



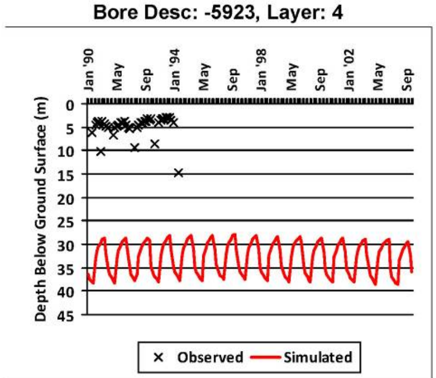
Bore Desc: -58574, Layer: 4



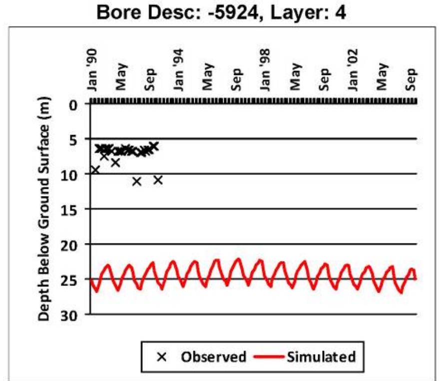
Bore Desc: -58580, Layer: 4

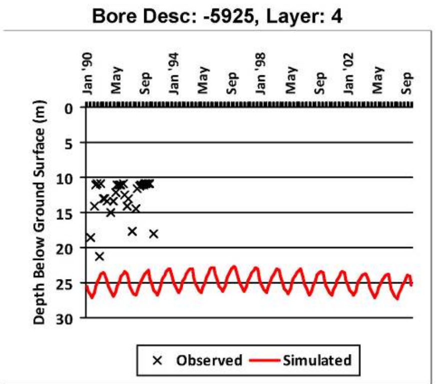


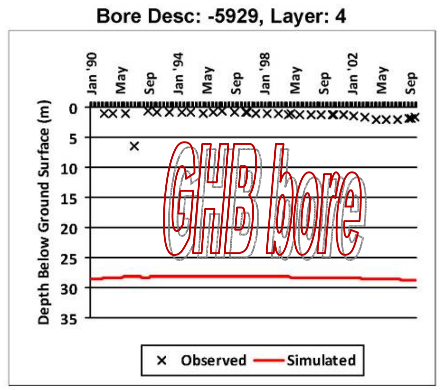
Bore Desc: -5923, Layer: 4

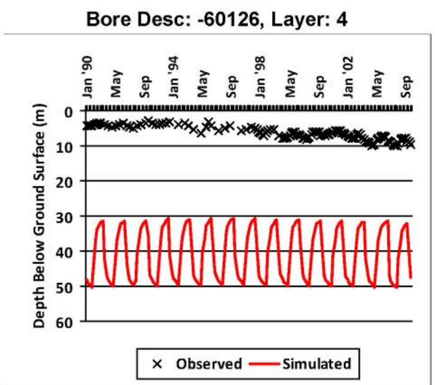


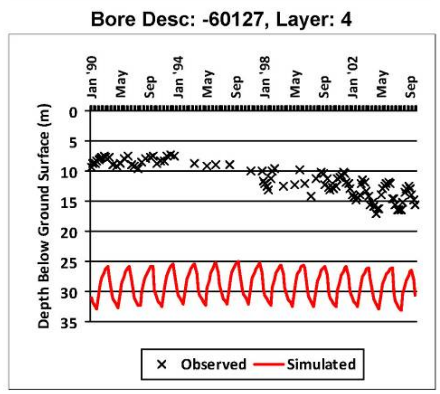
Bore Desc: -5924, Layer: 4

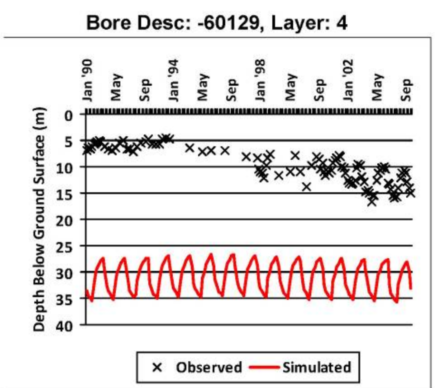


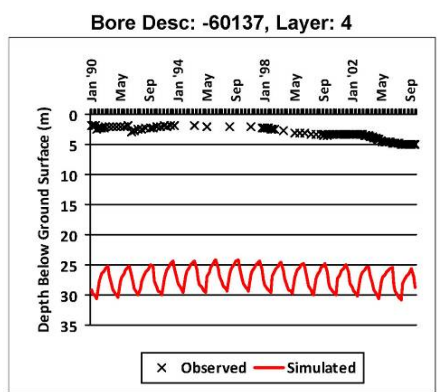

Bore Desc: -5925, Layer: 4
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
0 5 10 15 20 25 30
Observed
Simulated


Bore Desc: -5929, Layer: 4
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
0 5 10 15 20 25 30 35
GHB bore
Observed
Simulated

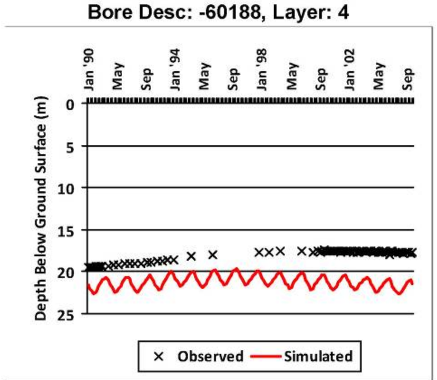

Bore Desc: -60126, Layer: 4
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
0 10 20 30 40 50 60
Observed
Simulated


Bore Desc: -60127, Layer: 4
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
0 5 10 15 20 25 30 35
Observed
Simulated

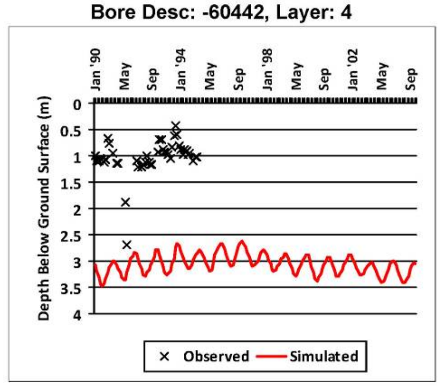

Bore Desc: -60129, Layer: 4
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
0 5 10 15 20 25 30 35 40
Observed
Simulated


Bore Desc: -60137, Layer: 4
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
0 5 10 15 20 25 30 35
Observed
Simulated

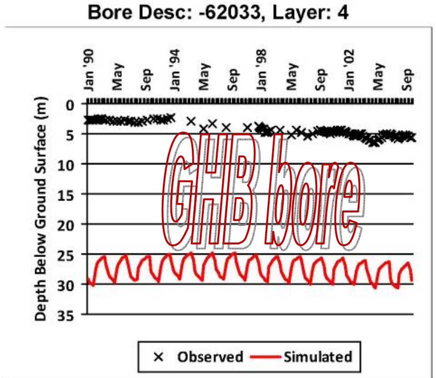
Bore Desc: -60188, Layer: 4



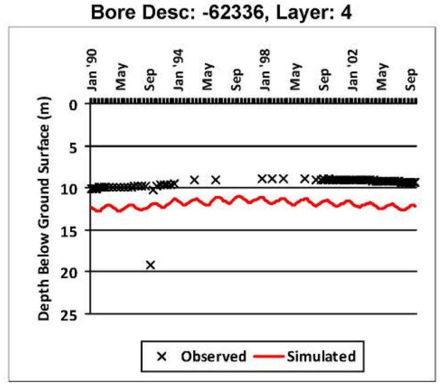
Bore Desc: -60442, Layer: 4



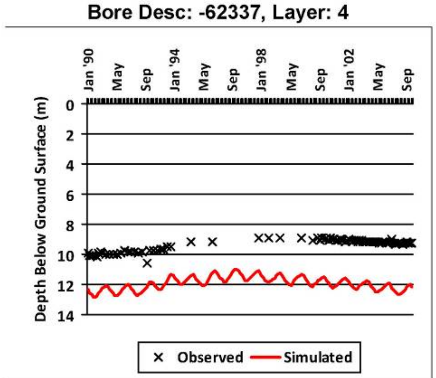
Bore Desc: -62033, Layer: 4



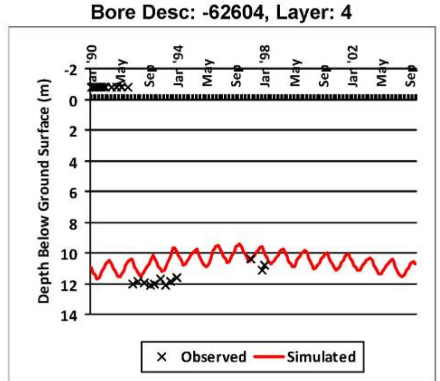
Bore Desc: -62336, Layer: 4



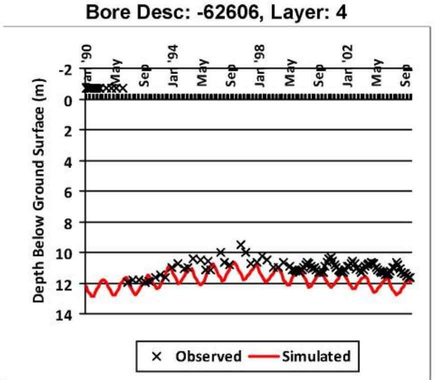
Bore Desc: -62337, Layer: 4



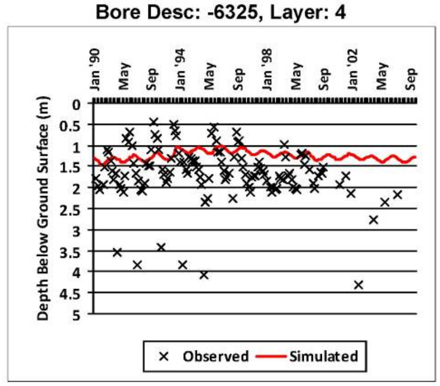
Bore Desc: -62604, Layer: 4



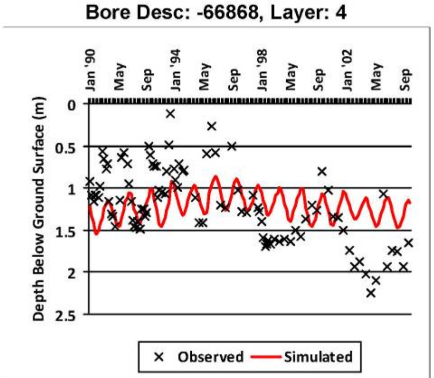
Bore Desc: -62606, Layer: 4



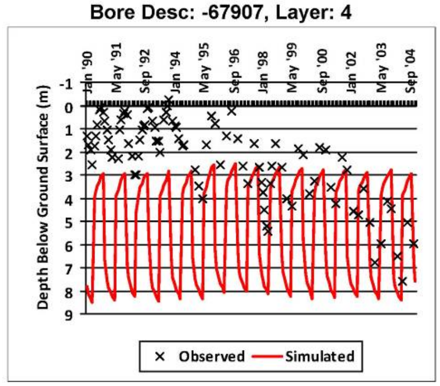
Bore Desc: -6325, Layer: 4



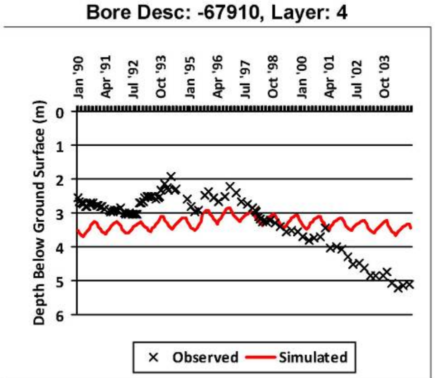
Bore Desc: -66868, Layer: 4



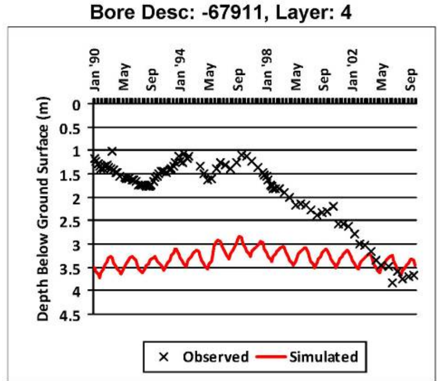
Bore Desc: -67907, Layer: 4



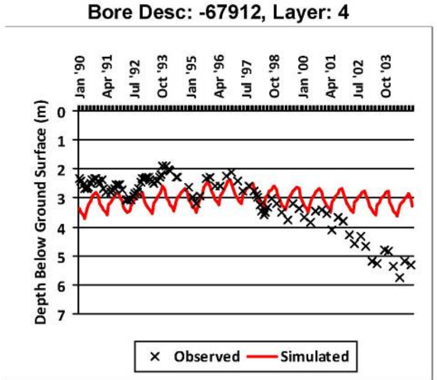
Bore Desc: -67910, Layer: 4



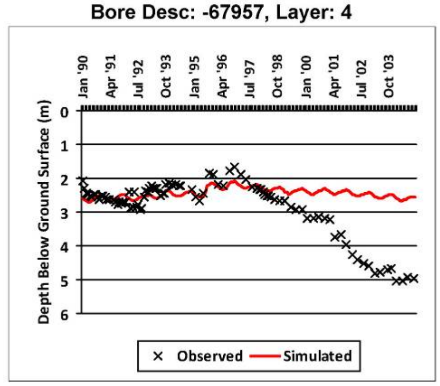
Bore Desc: -67911, Layer: 4



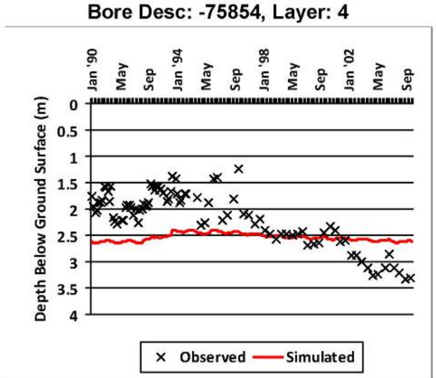
Bore Desc: -67912, Layer: 4



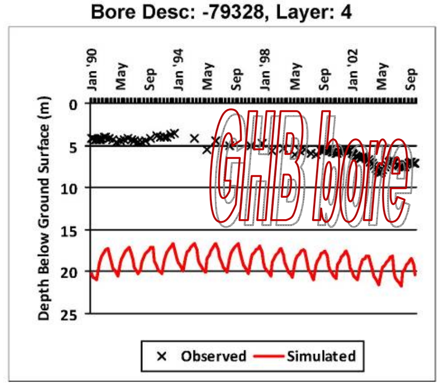
Bore Desc: -67957, Layer: 4



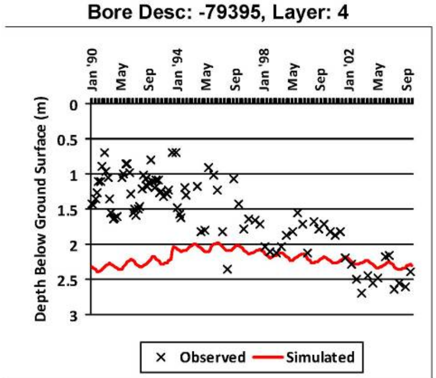
Bore Desc: -75854, Layer: 4



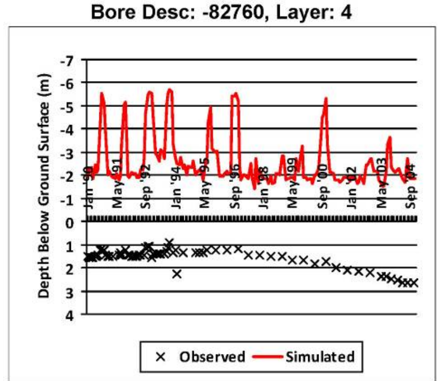
Bore Desc: -79328, Layer: 4

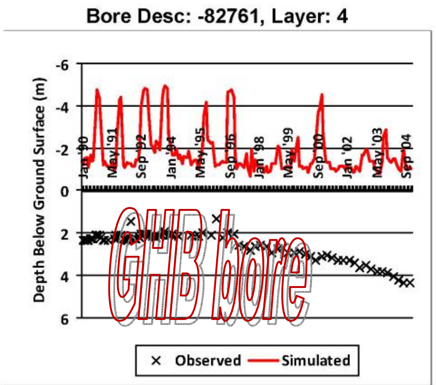


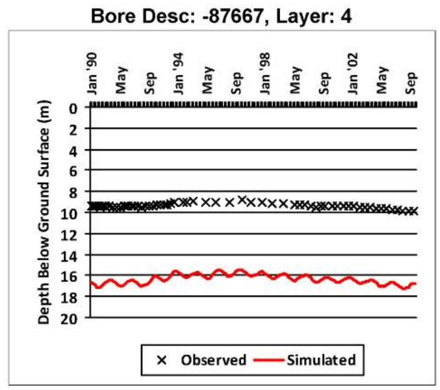
Bore Desc: -79395, Layer: 4

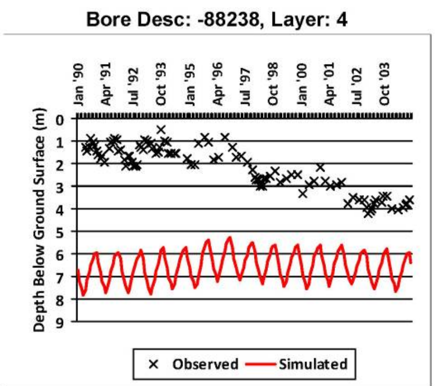


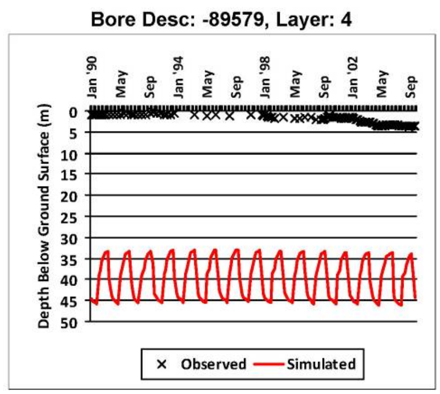
Bore Desc: -82760, Layer: 4

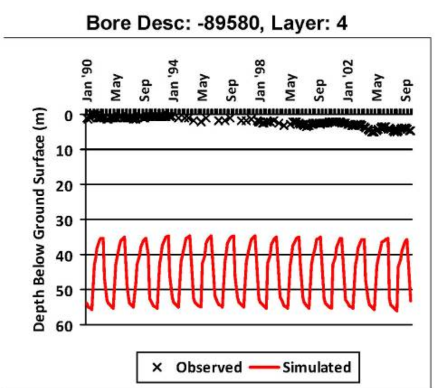


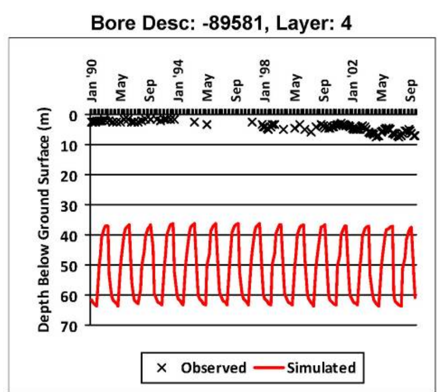

Bore Desc: -82761, Layer: 4
Depth Below Ground Surface (m)
GHB bore
Observed
Simulated


Bore Desc: -87667, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated

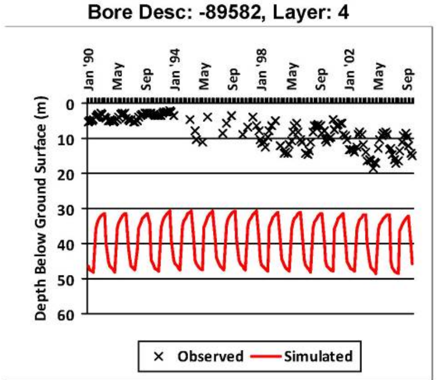

Bore Desc: -88238, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -89579, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated

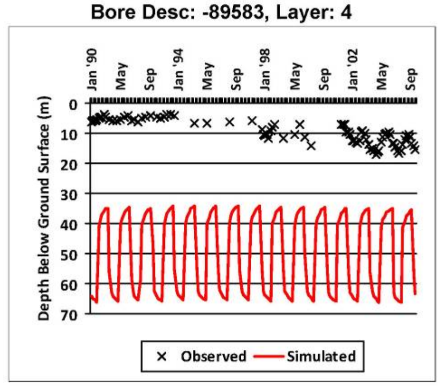

Bore Desc: -89580, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -89581, Layer: 4
Depth Below Ground Surface (m)
Observed
Simulated

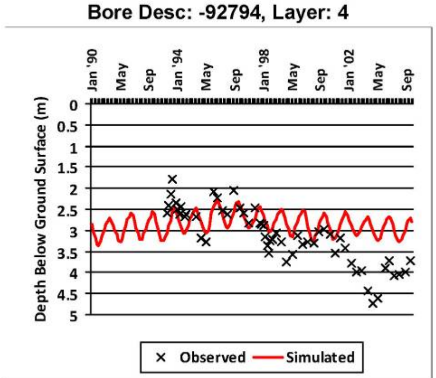
Bore Desc: -89582, Layer: 4



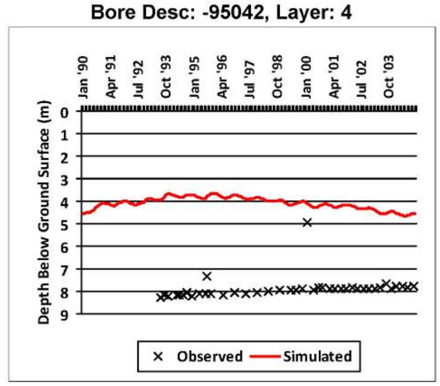
Bore Desc: -89583, Layer: 4



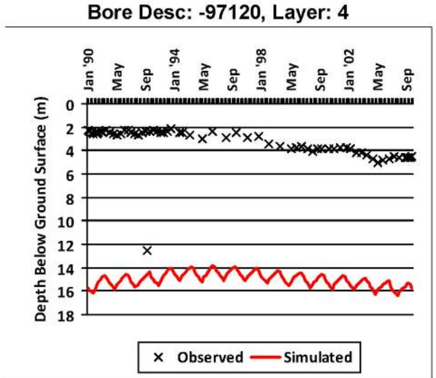
Bore Desc: -92794, Layer: 4



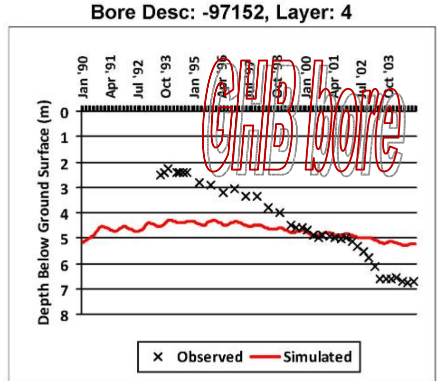
Bore Desc: -95042, Layer: 4



Bore Desc: -97120, Layer: 4

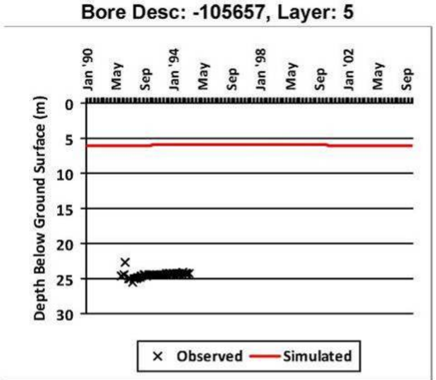


Bore Desc: -97152, Layer: 4

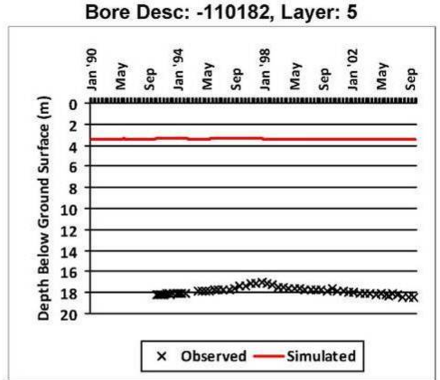


Layer 5 (Parilla Sand)

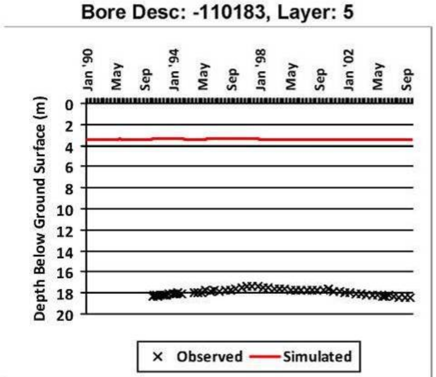
Bore Desc: -105657, Layer: 5



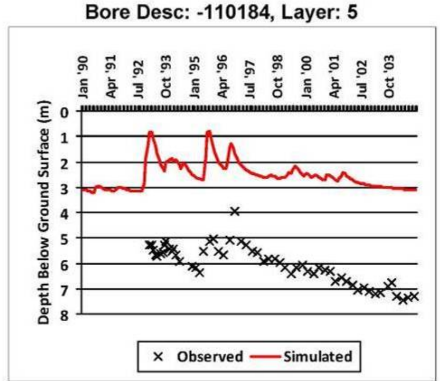
Bore Desc: -110182, Layer: 5



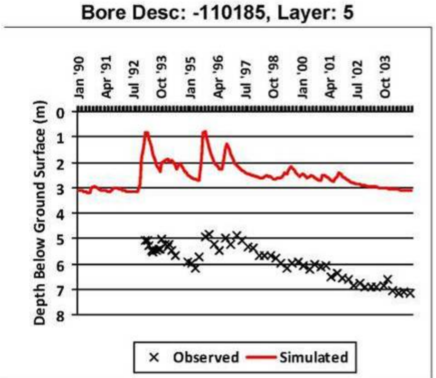
Bore Desc: -110183, Layer: 5



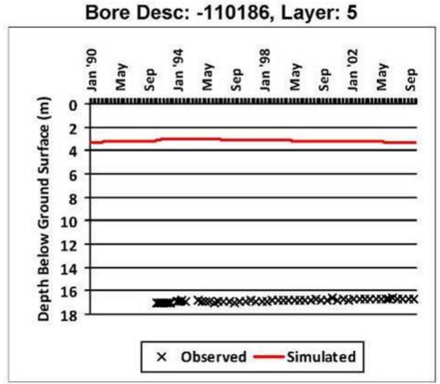
Bore Desc: -110184, Layer: 5

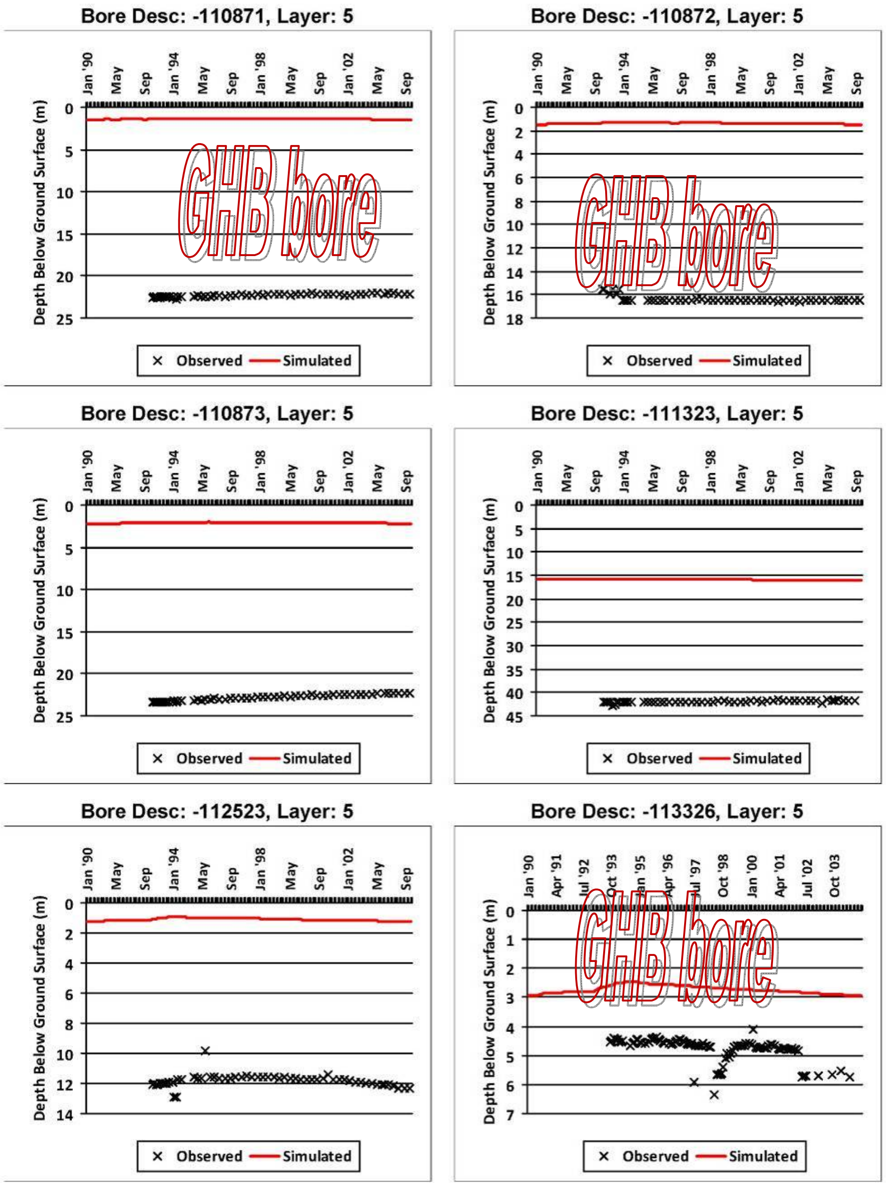


Bore Desc: -110185, Layer: 5

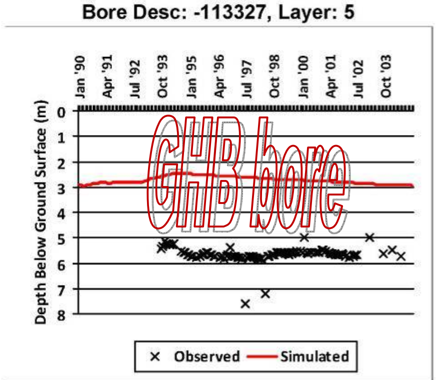


Bore Desc: -110186, Layer: 5

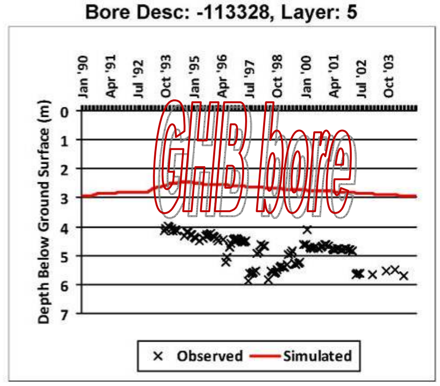



Bore Desc: -110871, Layer: 5
Depth Below Ground Surface (m)
GHB bore
Observed
Simulated
Bore Desc: -110872, Layer: 5
Depth Below Ground Surface (m)
GHB bore
Observed
Simulated
Bore Desc: -110873, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated
Bore Desc: -111323, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated
Bore Desc: -112523, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated
Bore Desc: -113326, Layer: 5
Depth Below Ground Surface (m)
GHB bore
Observed
Simulated

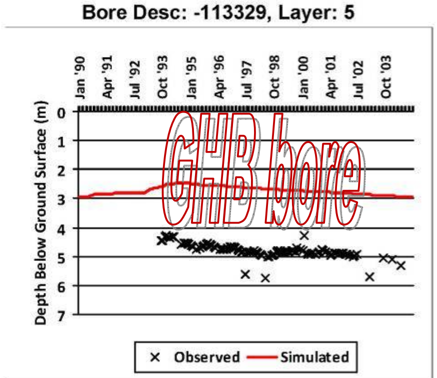
Bore Desc: -113327, Layer: 5



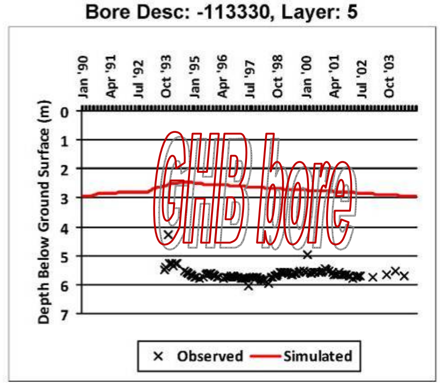
Bore Desc: -113328, Layer: 5



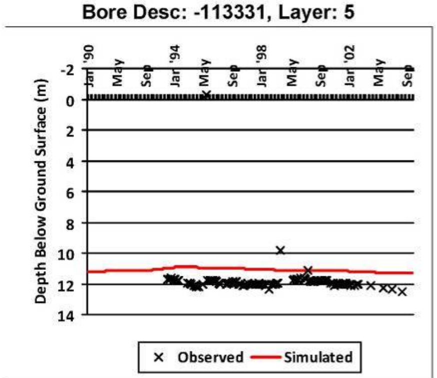
Bore Desc: -113329, Layer: 5



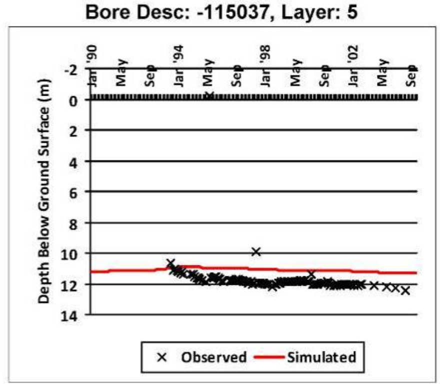
Bore Desc: -113330, Layer: 5



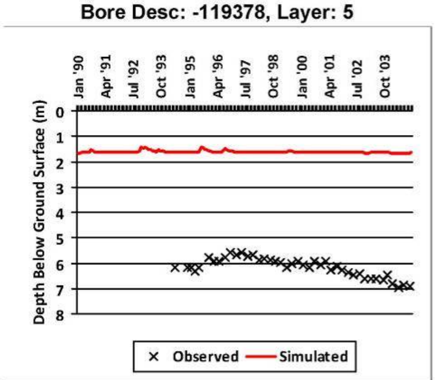
Bore Desc: -113331, Layer: 5



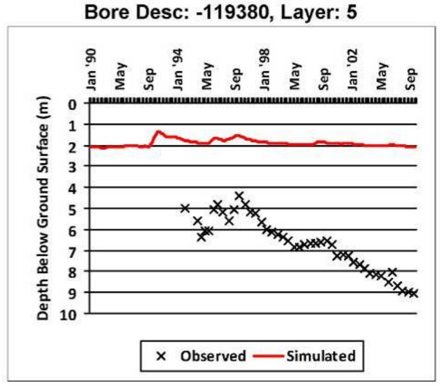
Bore Desc: -115037, Layer: 5



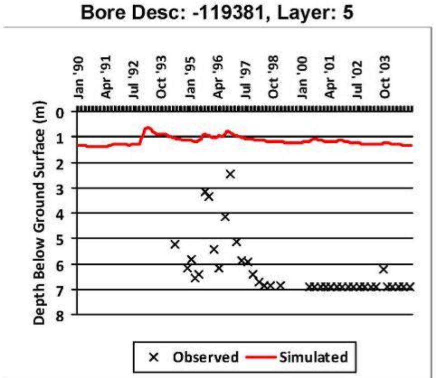
Bore Desc: -119378, Layer: 5



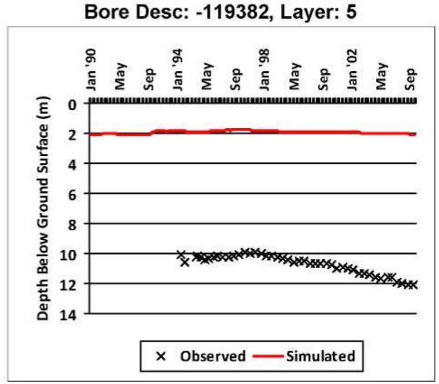
Bore Desc: -119380, Layer: 5



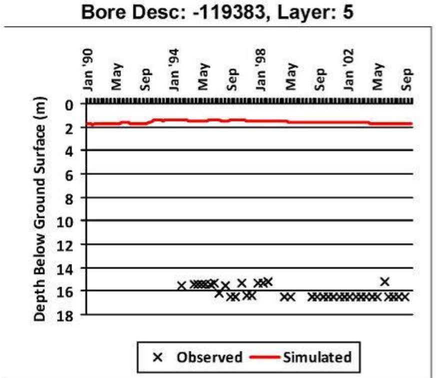
Bore Desc: -119381, Layer: 5



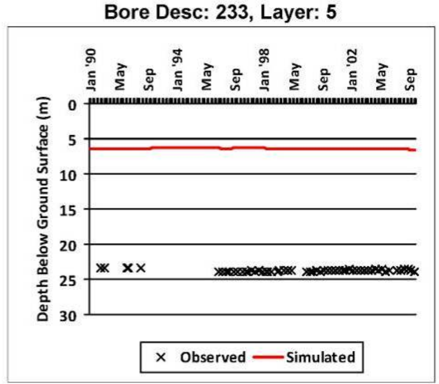
Bore Desc: -119382, Layer: 5



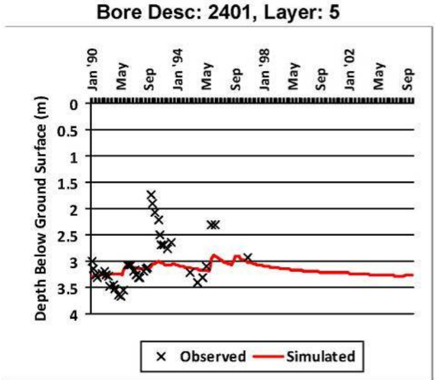
Bore Desc: -119383, Layer: 5



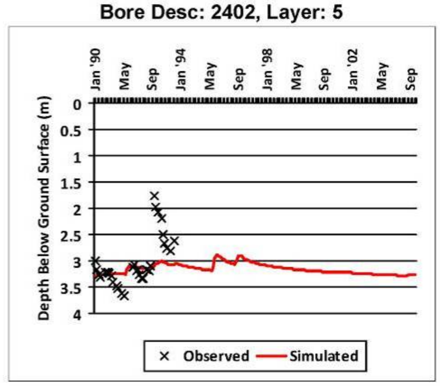
Bore Desc: 233, Layer: 5



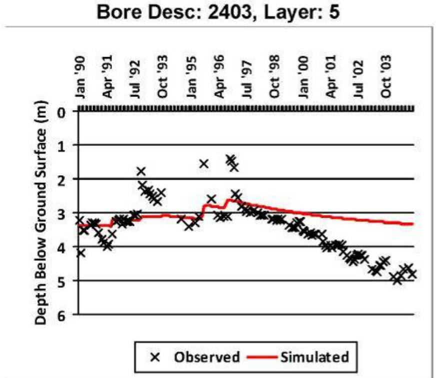
Bore Desc: 2401, Layer: 5



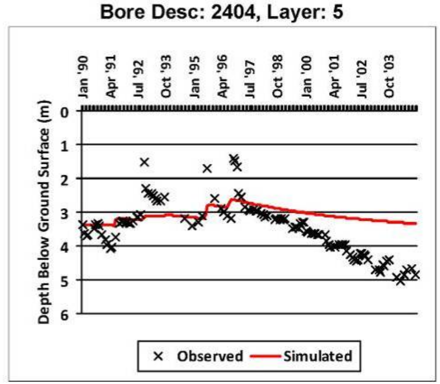
Bore Desc: 2402, Layer: 5



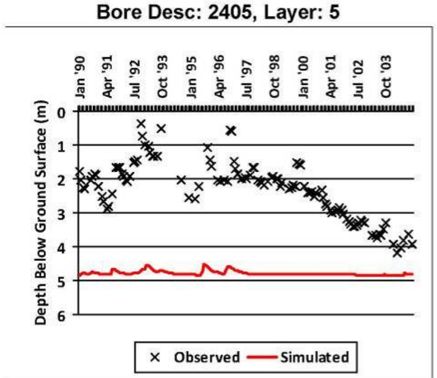
Bore Desc: 2403, Layer: 5



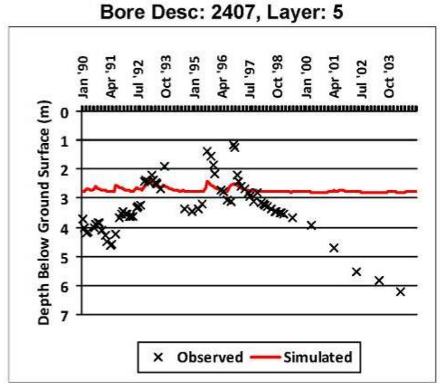
Bore Desc: 2404, Layer: 5



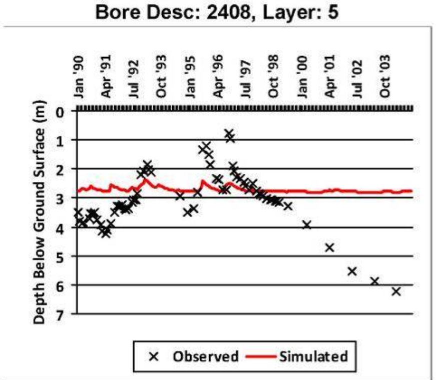
Bore Desc: 2405, Layer: 5



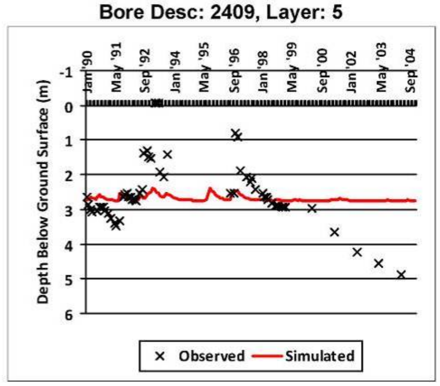
Bore Desc: 2407, Layer: 5



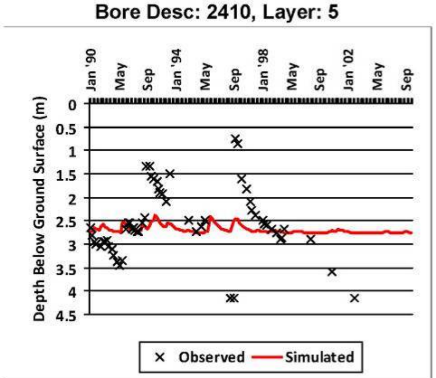
Bore Desc: 2408, Layer: 5



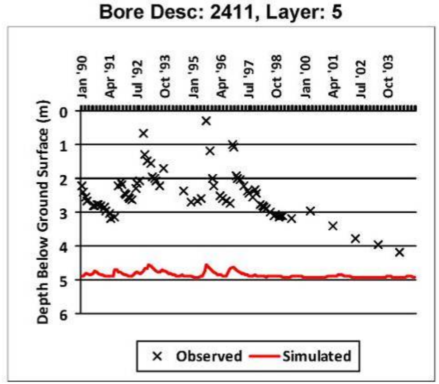
Bore Desc: 2409, Layer: 5



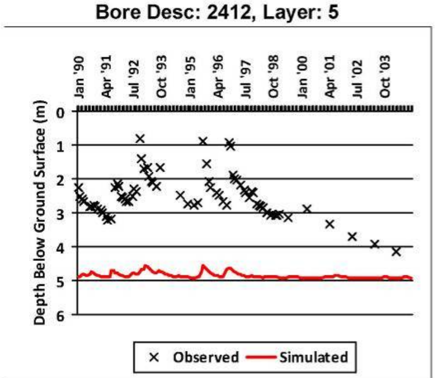
Bore Desc: 2410, Layer: 5



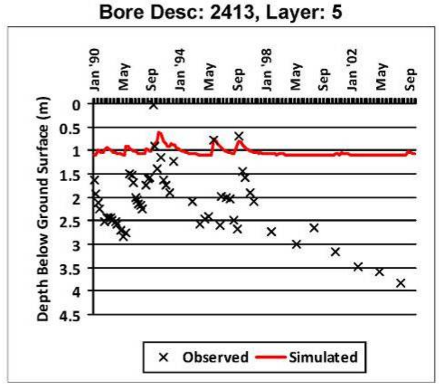
Bore Desc: 2411, Layer: 5



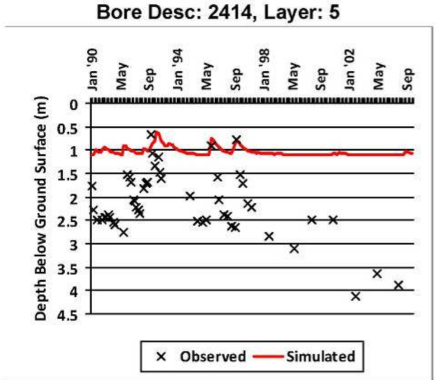
Bore Desc: 2412, Layer: 5



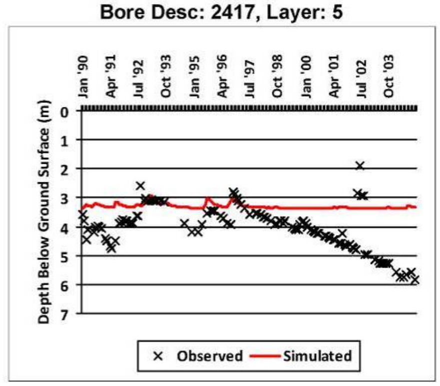
Bore Desc: 2413, Layer: 5



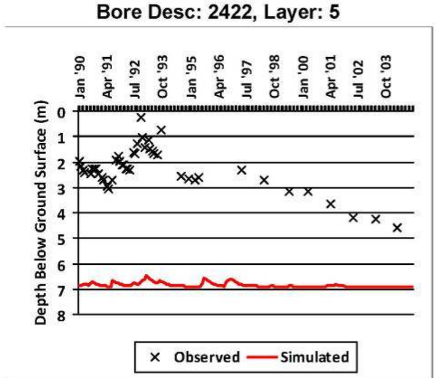
Bore Desc: 2414, Layer: 5



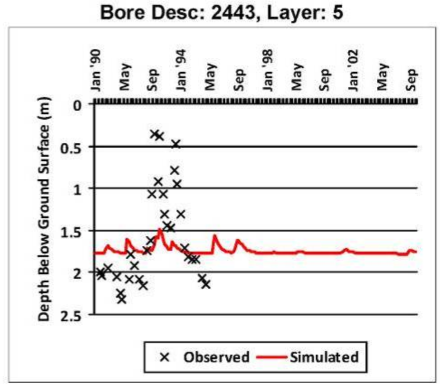
Bore Desc: 2417, Layer: 5



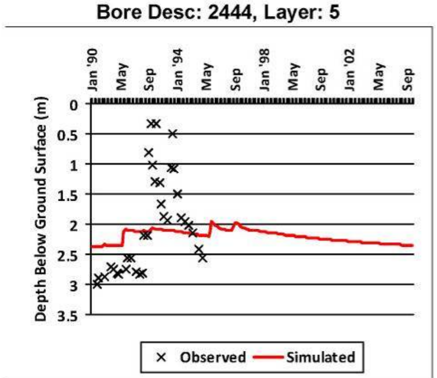
Bore Desc: 2422, Layer: 5



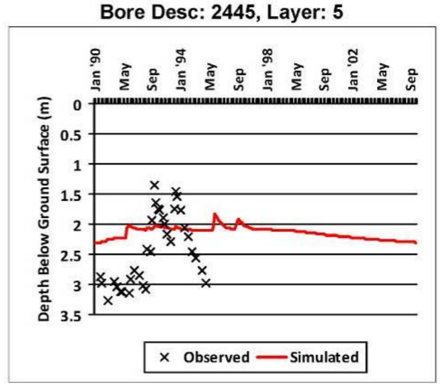
Bore Desc: 2443, Layer: 5



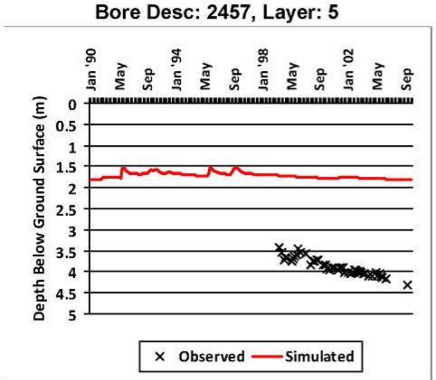
Bore Desc: 2444, Layer: 5



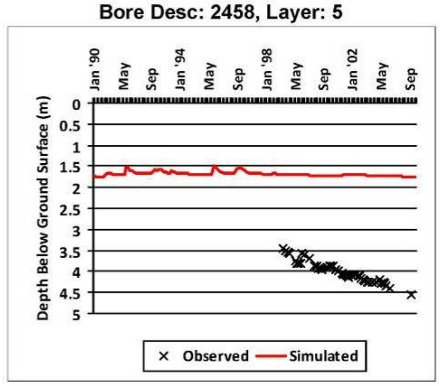
Bore Desc: 2445, Layer: 5



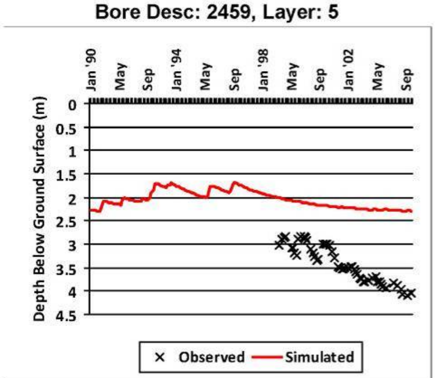
Bore Desc: 2457, Layer: 5



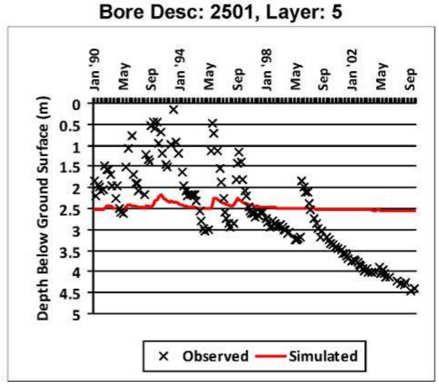
Bore Desc: 2458, Layer: 5



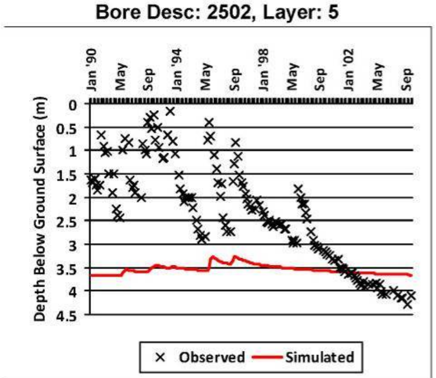
Bore Desc: 2459, Layer: 5



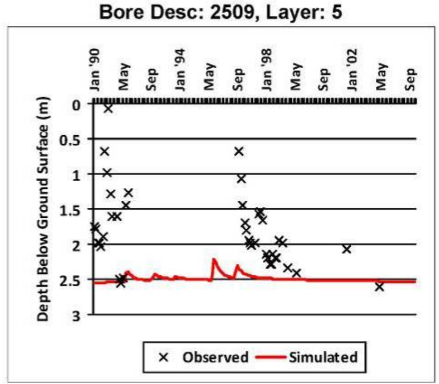
Bore Desc: 2501, Layer: 5



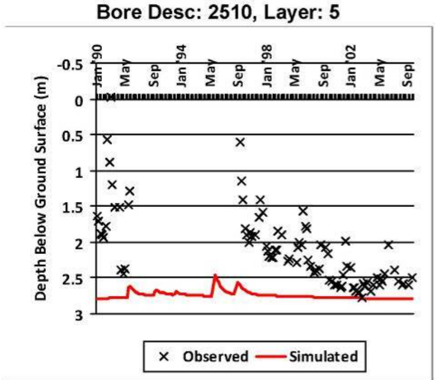
Bore Desc: 2502, Layer: 5



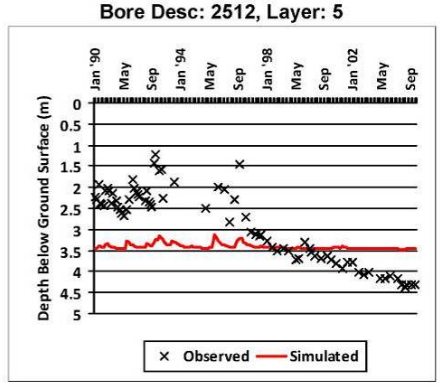
Bore Desc: 2509, Layer: 5



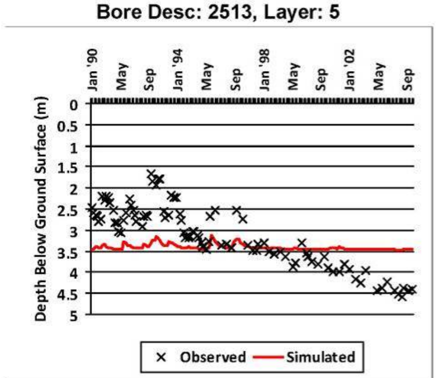
Bore Desc: 2510, Layer: 5



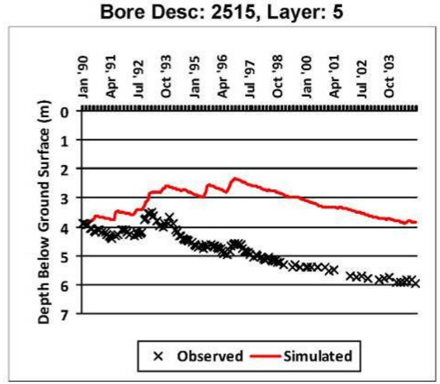
Bore Desc: 2512, Layer: 5



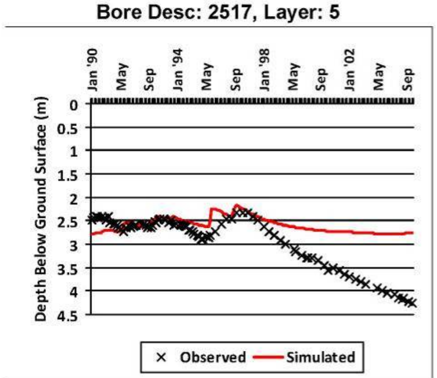
Bore Desc: 2513, Layer: 5



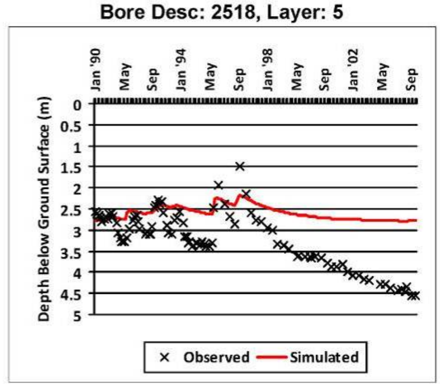
Bore Desc: 2515, Layer: 5



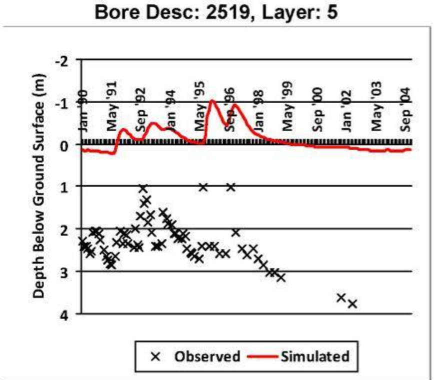
Bore Desc: 2517, Layer: 5



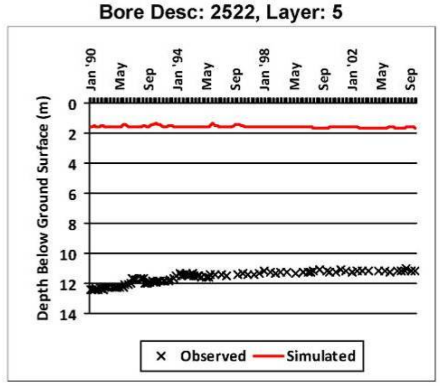
Bore Desc: 2518, Layer: 5



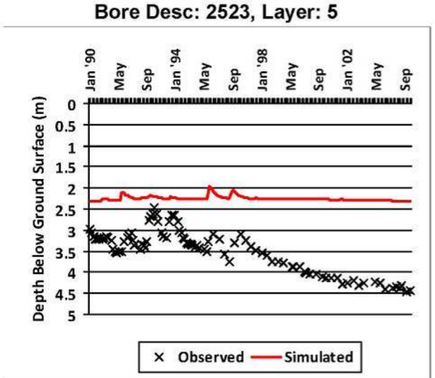
Bore Desc: 2519, Layer: 5



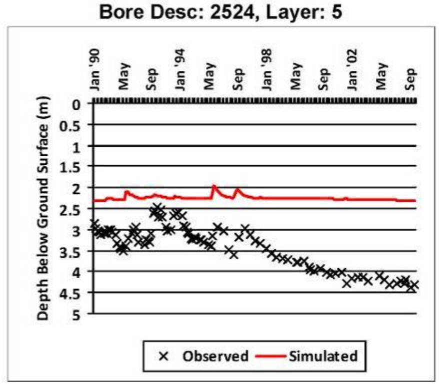
Bore Desc: 2522, Layer: 5



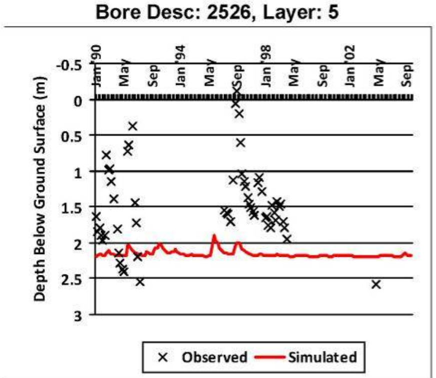
Bore Desc: 2523, Layer: 5



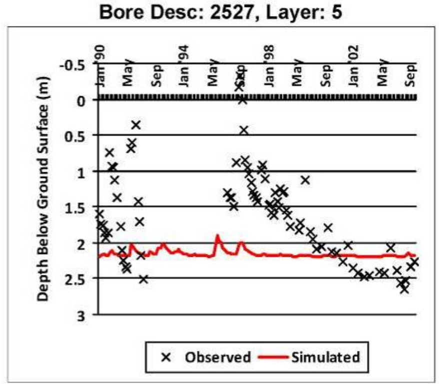
Bore Desc: 2524, Layer: 5



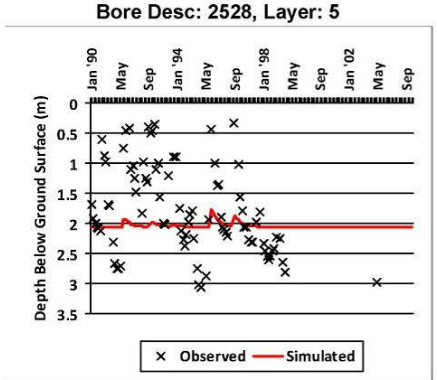
Bore Desc: 2526, Layer: 5



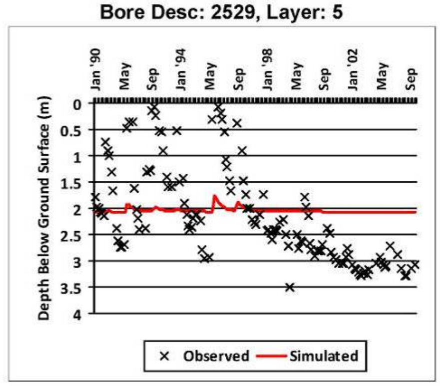
Bore Desc: 2527, Layer: 5



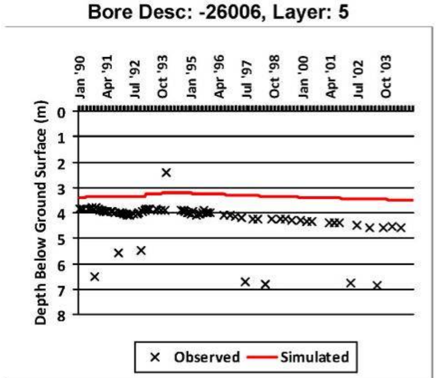
Bore Desc: 2528, Layer: 5



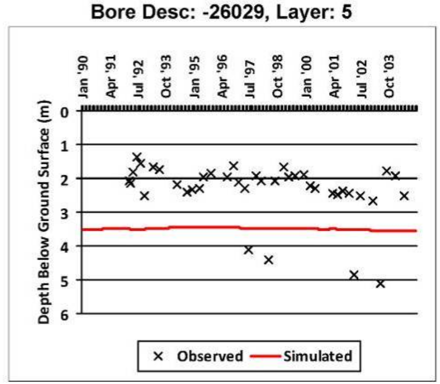
Bore Desc: 2529, Layer: 5



Bore Desc: -26006, Layer: 5



Bore Desc: -26029, Layer: 5



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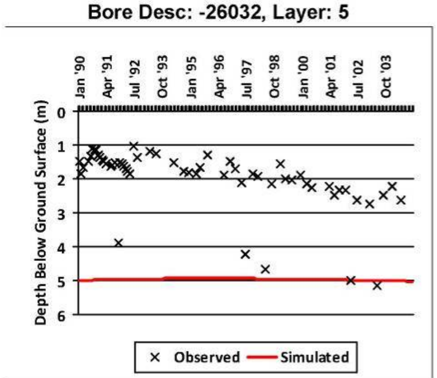
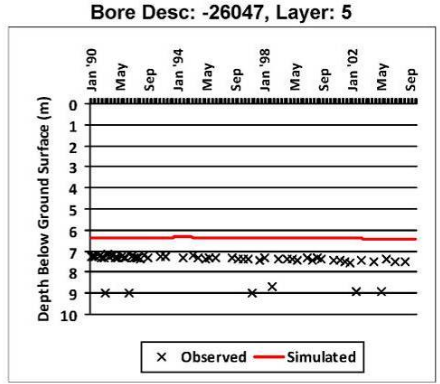
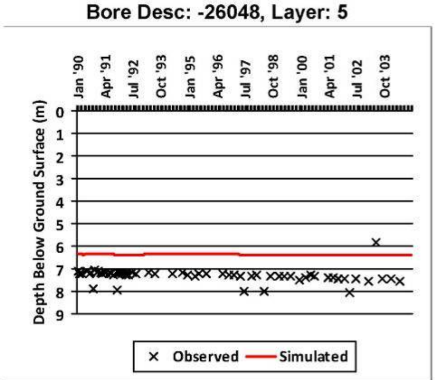


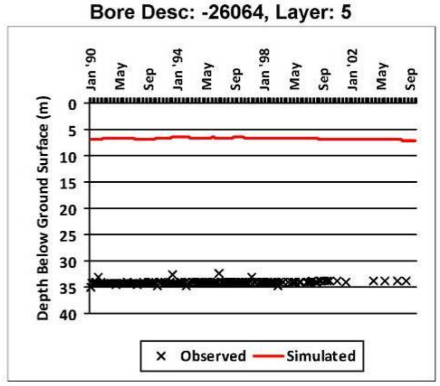
Bore Desc: -26047, Layer: 5



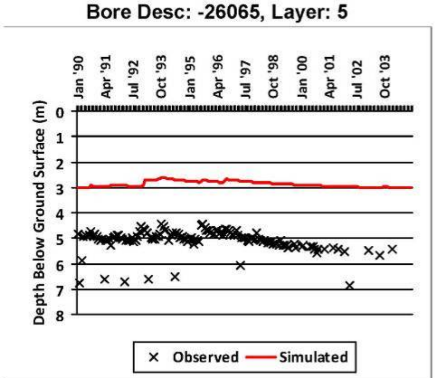
Bore Desc: -26048, Layer: 5



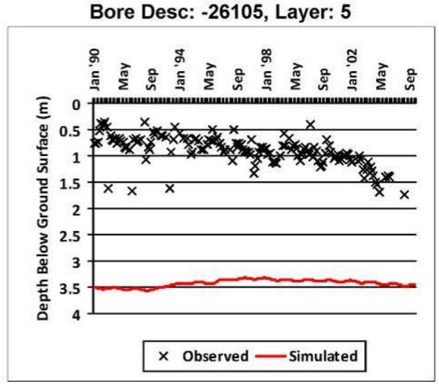
Bore Desc: -26064, Layer: 5



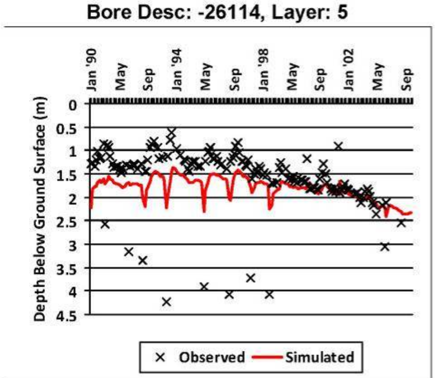
Bore Desc: -26065, Layer: 5



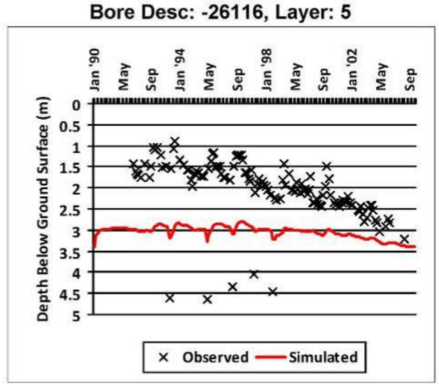
Bore Desc: -26105, Layer: 5



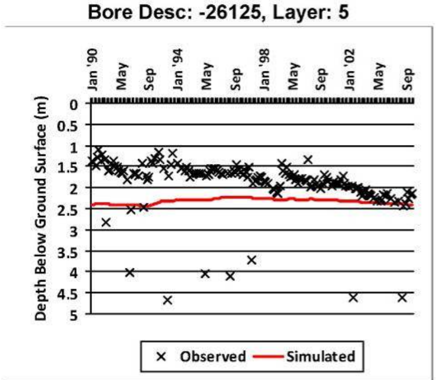
Bore Desc: -26114, Layer: 5



Bore Desc: -26116, Layer: 5



Bore Desc: -26125, Layer: 5



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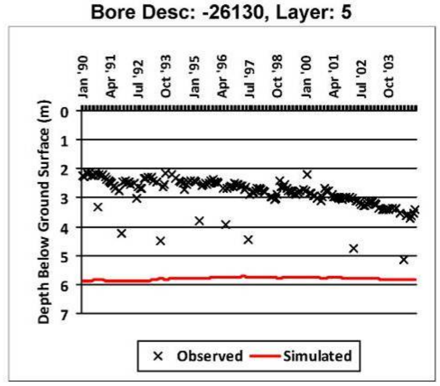
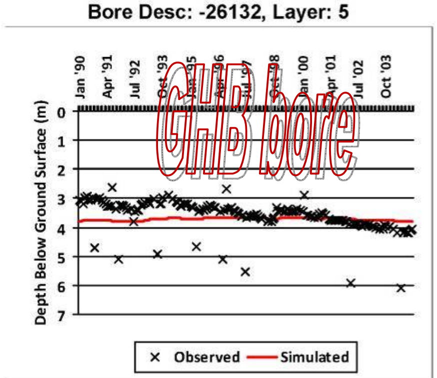
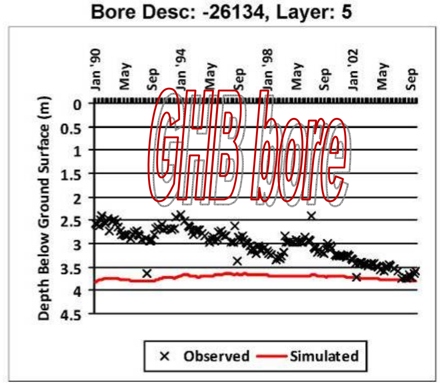


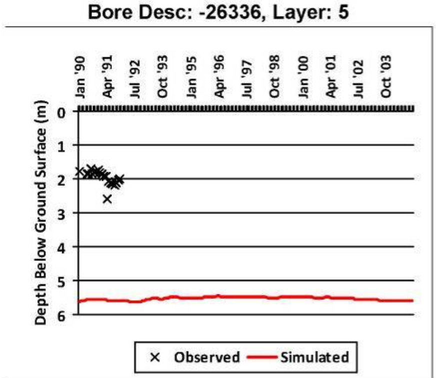
Bore Desc: -26132, Layer: 5



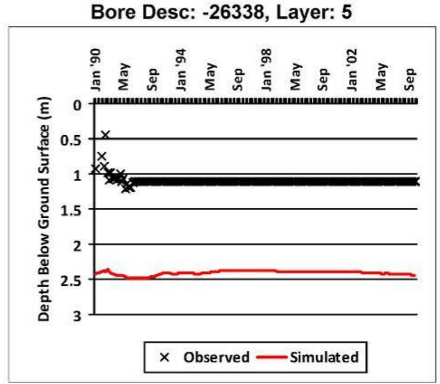
Bore Desc: -26134, Layer: 5



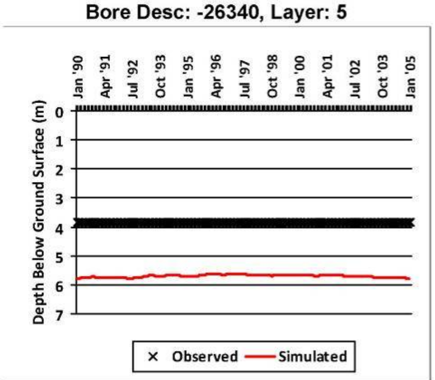
Bore Desc: -26336, Layer: 5



Bore Desc: -26338, Layer: 5



Bore Desc: -26340, Layer: 5



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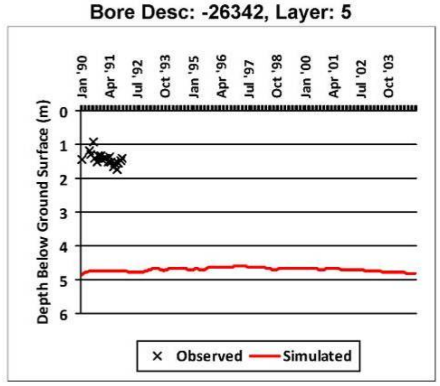
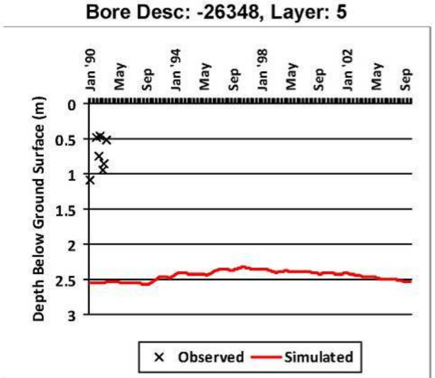
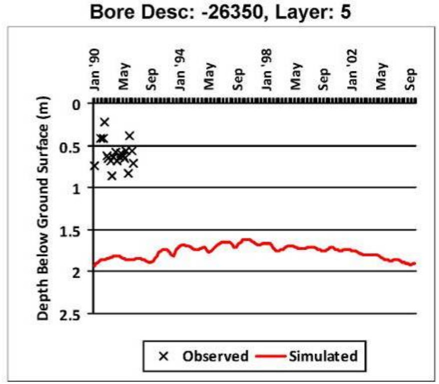


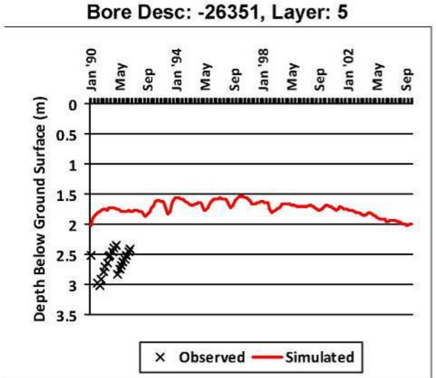
Bore Desc: -26348, Layer: 5



Bore Desc: -26350, Layer: 5



Bore Desc: -26351, Layer: 5



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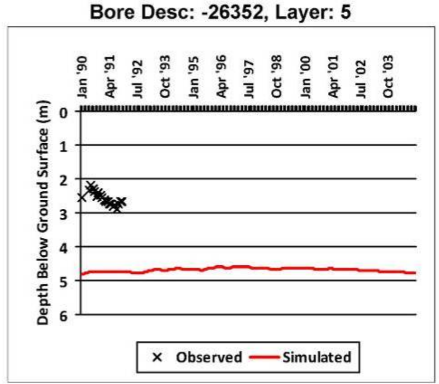

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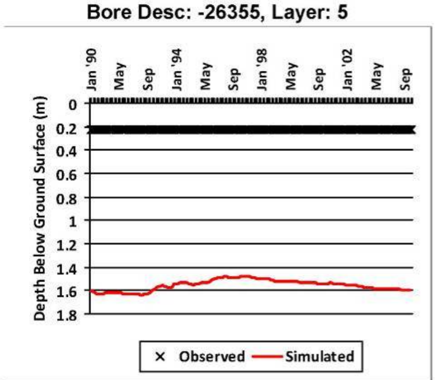

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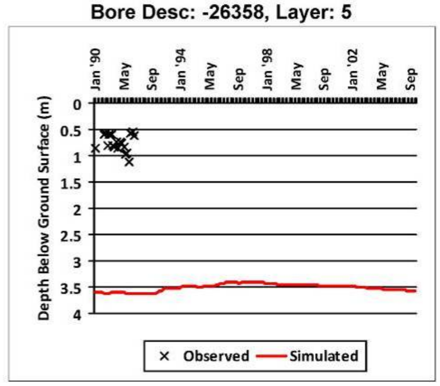

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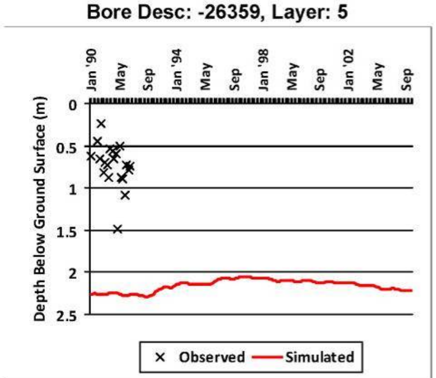

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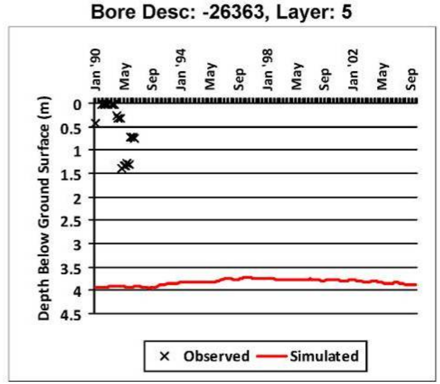
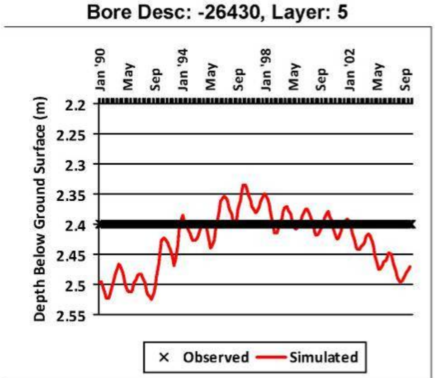
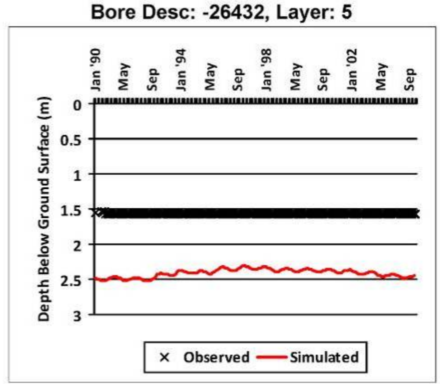


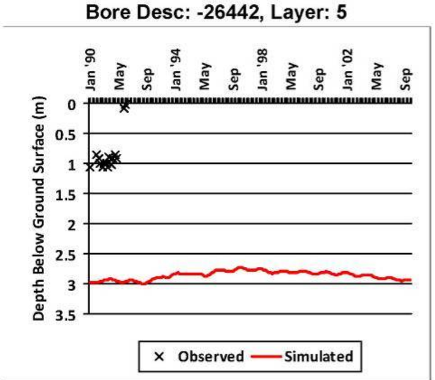
Bore Desc: -26430, Layer: 5



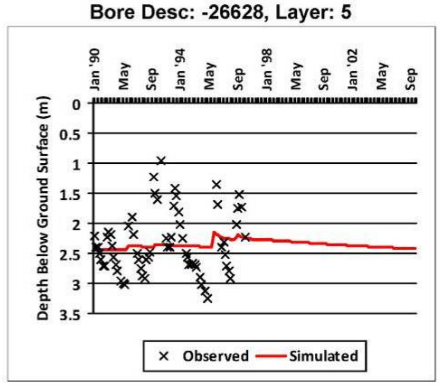
Bore Desc: -26432, Layer: 5



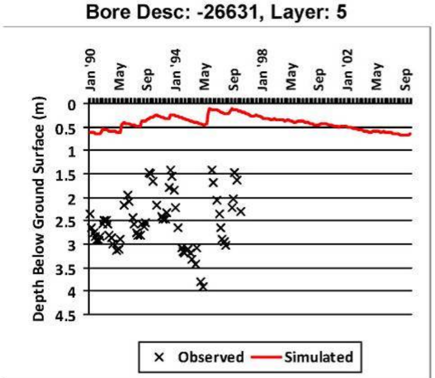
Bore Desc: -26442, Layer: 5



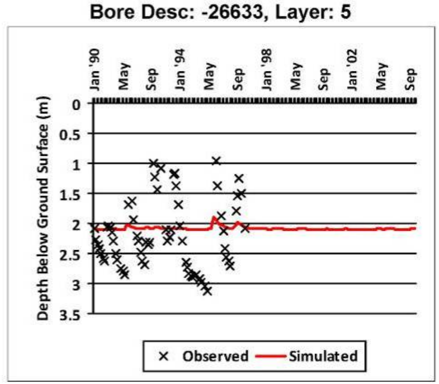
Bore Desc: -26628, Layer: 5



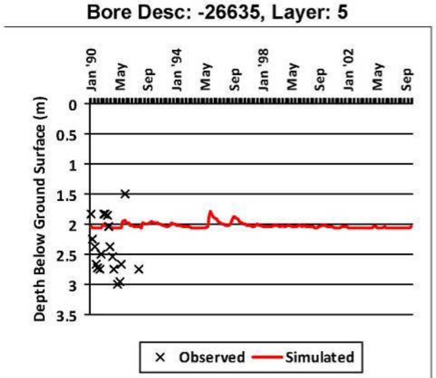
Bore Desc: -26631, Layer: 5



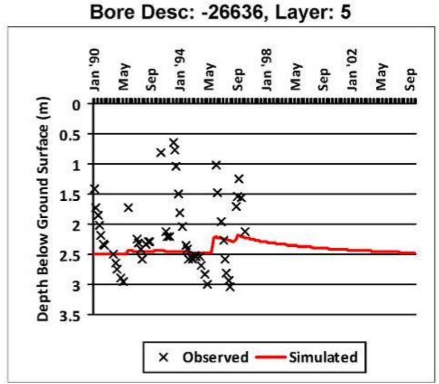
Bore Desc: -26633, Layer: 5

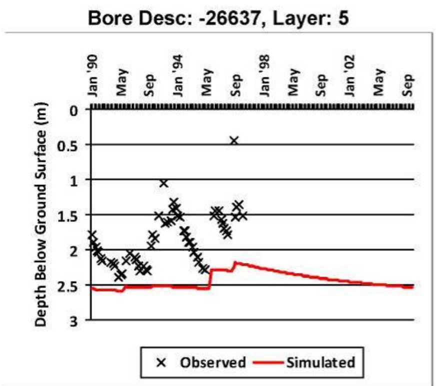


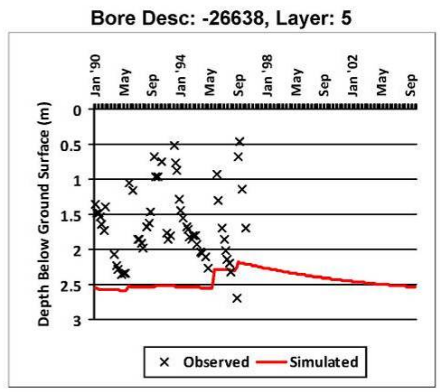
Bore Desc: -26635, Layer: 5

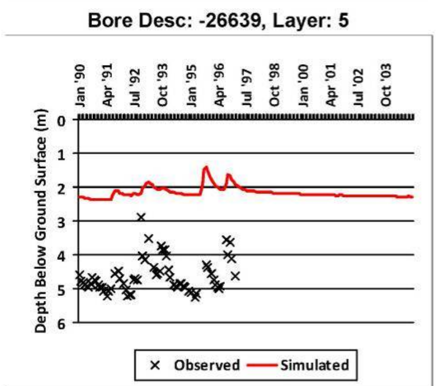


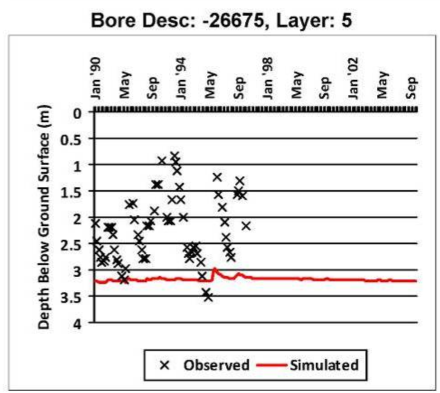
Bore Desc: -26636, Layer: 5

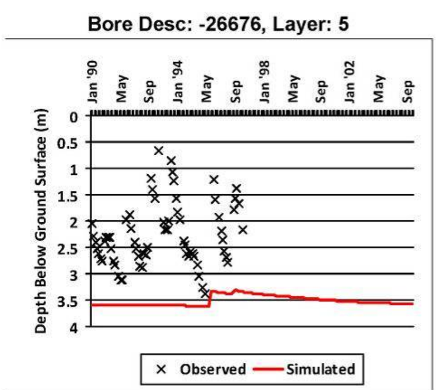


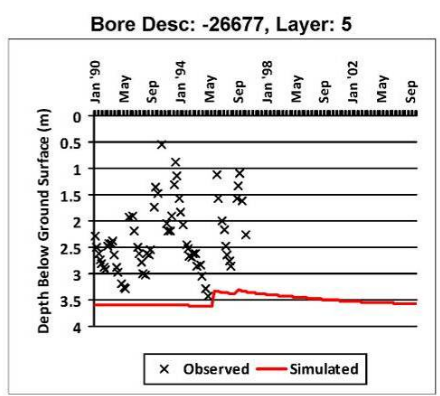

Bore Desc: -26637, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
Observed
Simulated


Bore Desc: -26638, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
Observed
Simulated

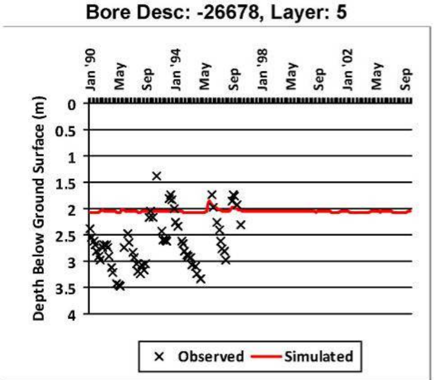

Bore Desc: -26639, Layer: 5
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Depth Below Ground Surface (m)
0
1
2
3
4
5
6
Observed
Simulated


Bore Desc: -26675, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
Observed
Simulated

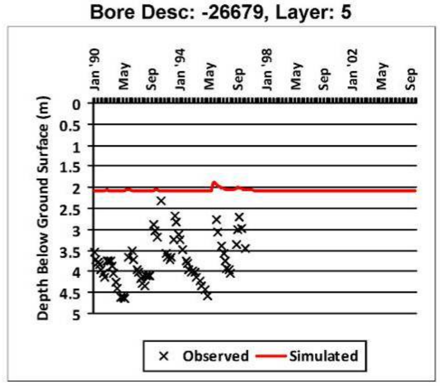

Bore Desc: -26676, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
Observed
Simulated


Bore Desc: -26677, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
Observed
Simulated

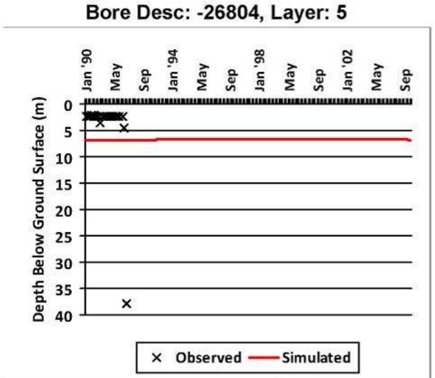
Bore Desc: -26678, Layer: 5



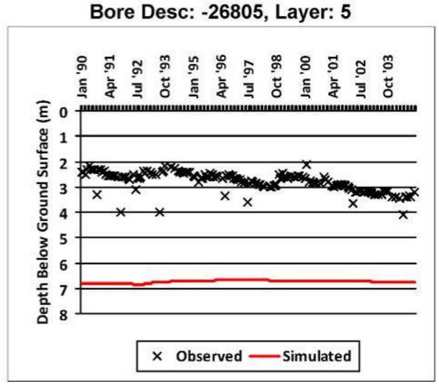
Bore Desc: -26679, Layer: 5



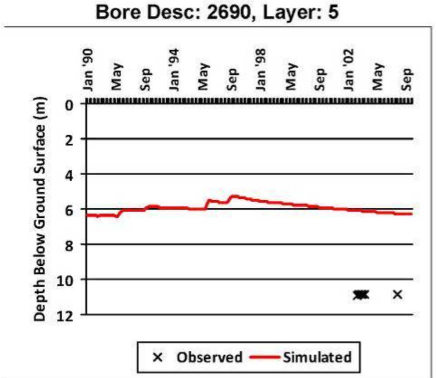
Bore Desc: -26804, Layer: 5



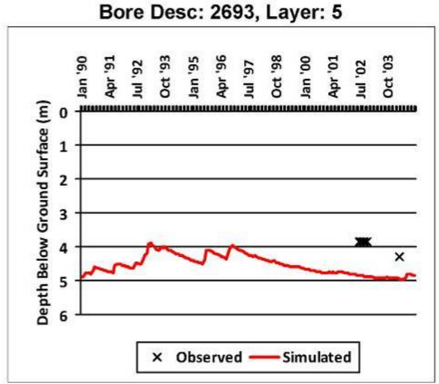
Bore Desc: -26805, Layer: 5



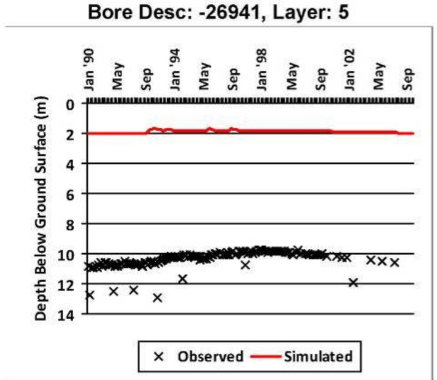
Bore Desc: 2690, Layer: 5



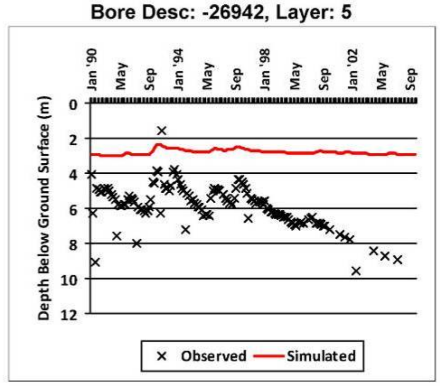
Bore Desc: 2693, Layer: 5



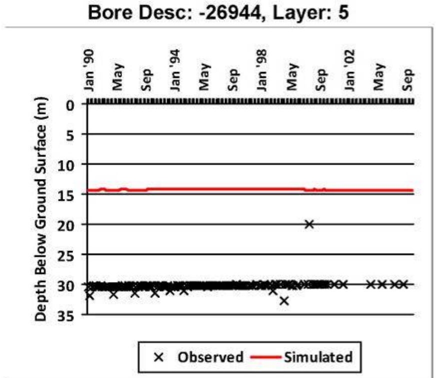
Bore Desc: -26941, Layer: 5



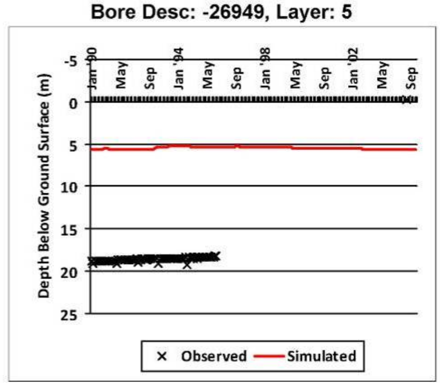
Bore Desc: -26942, Layer: 5



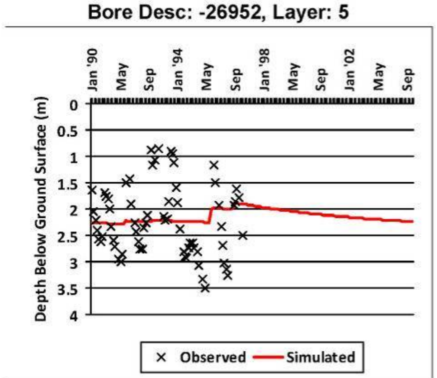
Bore Desc: -26944, Layer: 5



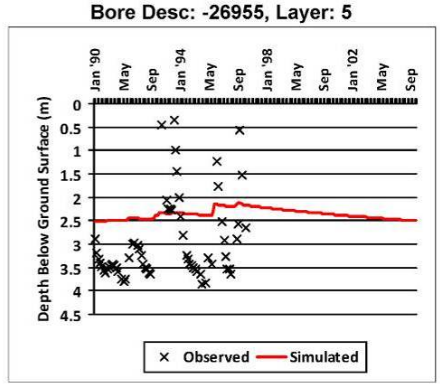
Bore Desc: -26949, Layer: 5

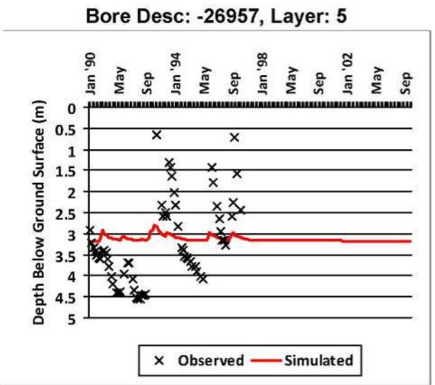


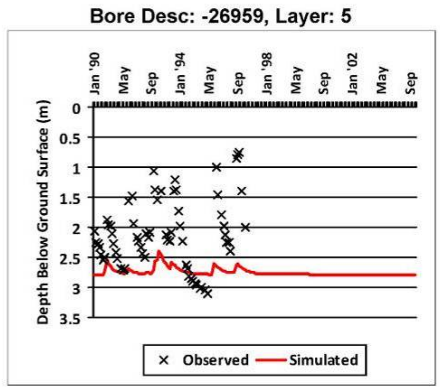
Bore Desc: -26952, Layer: 5

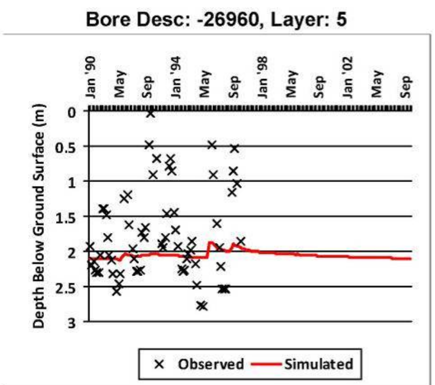


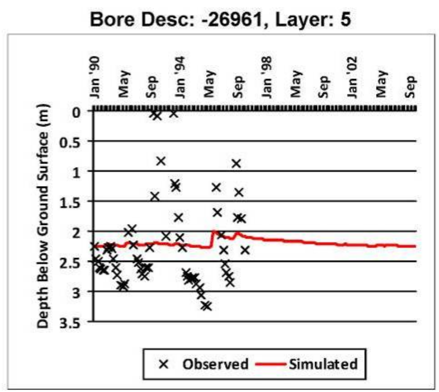
Bore Desc: -26955, Layer: 5

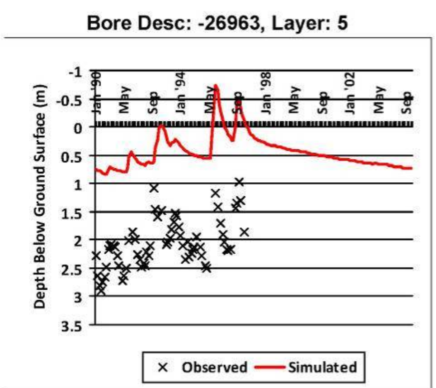


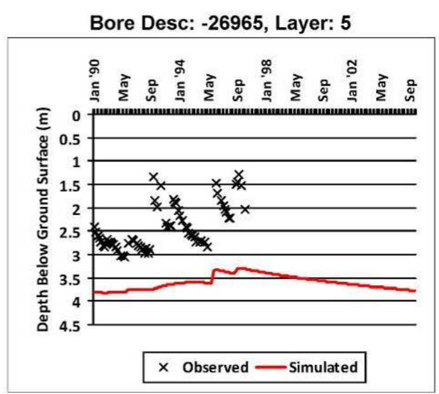

Bore Desc: -26957, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Observed
Simulated

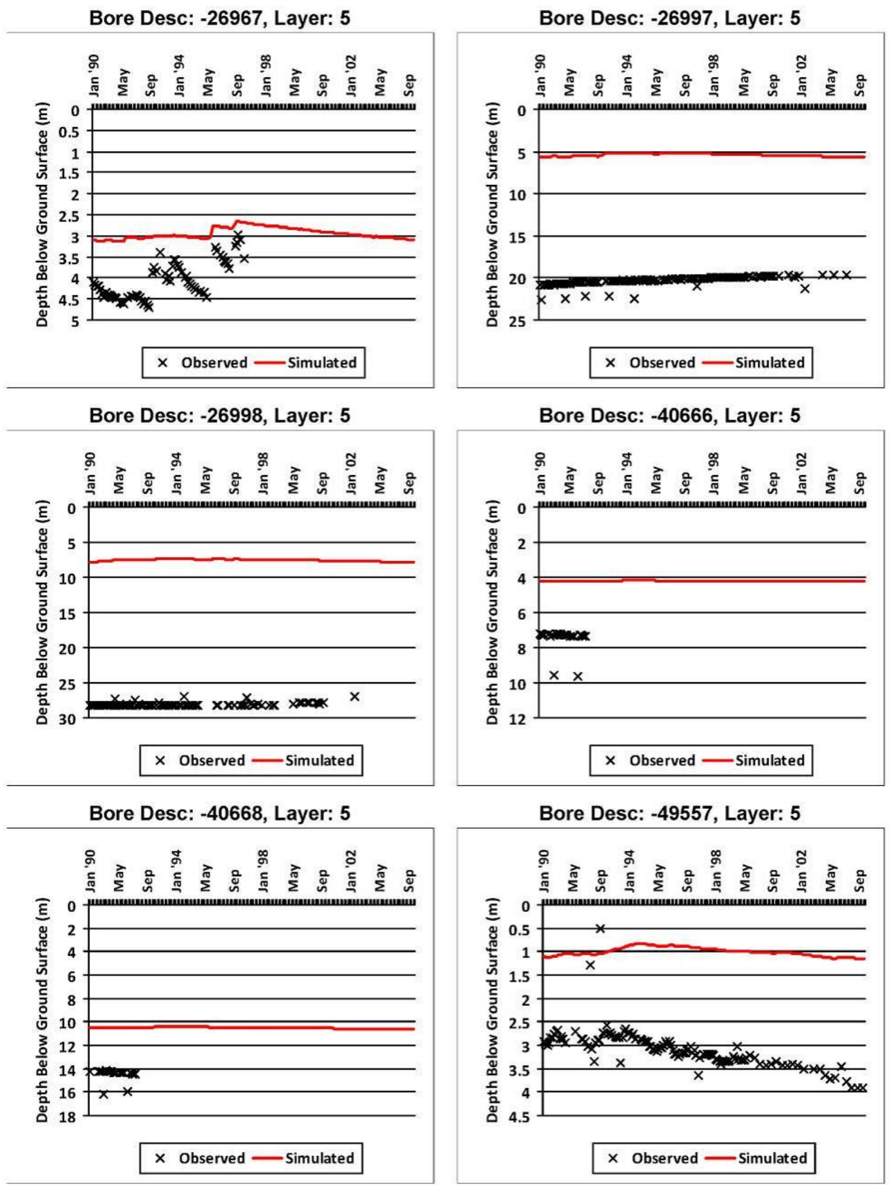

Bore Desc: -26959, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
Observed
Simulated


Bore Desc: -26960, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
Observed
Simulated

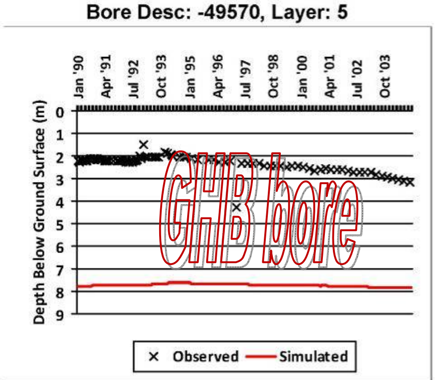

Bore Desc: -26961, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
Observed
Simulated


Bore Desc: -26963, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
Observed
Simulated

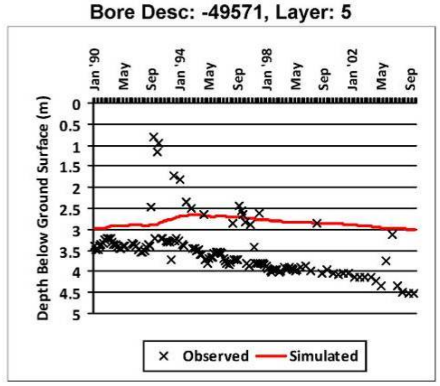

Bore Desc: -26965, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Simulated


Bore Desc: -26967, Layer: 5
Bore Desc: -26997, Layer: 5
Bore Desc: -26998, Layer: 5
Bore Desc: -40666, Layer: 5
Bore Desc: -40668, Layer: 5
Bore Desc: -49557, Layer: 5
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
Jan '98
Jan '02
Observed
Simulated

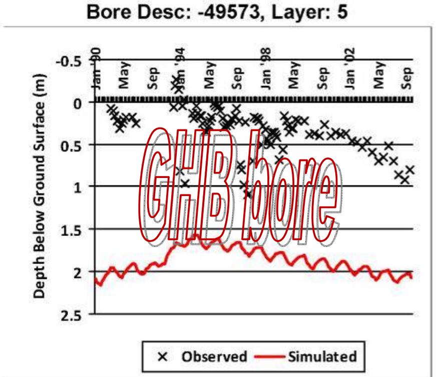
Bore Desc: -49570, Layer: 5



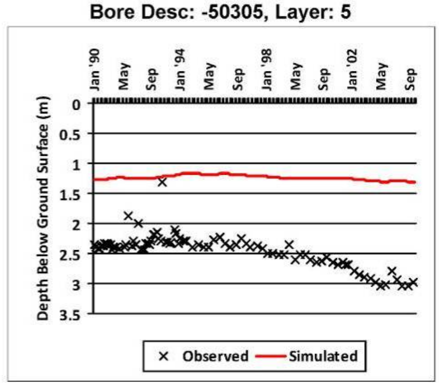
Bore Desc: -49571, Layer: 5



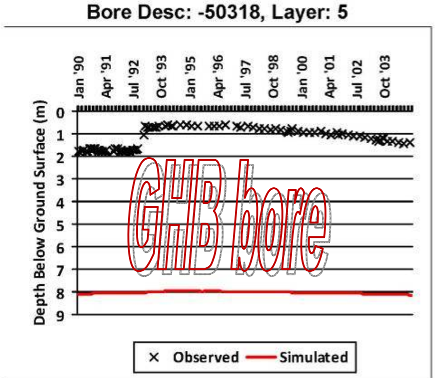
Bore Desc: -49573, Layer: 5



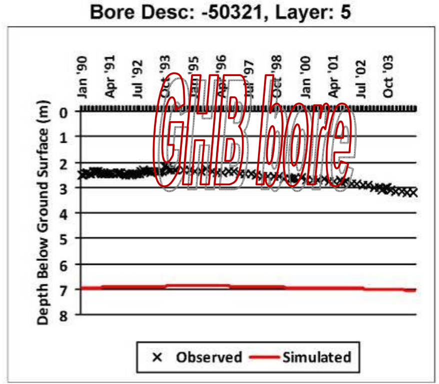
Bore Desc: -50305, Layer: 5



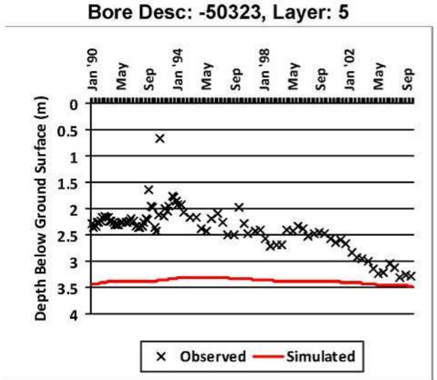
Bore Desc: -50318, Layer: 5



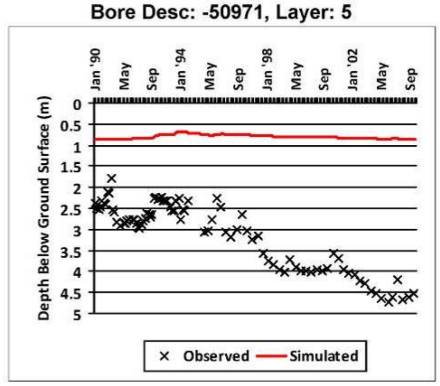
Bore Desc: -50321, Layer: 5



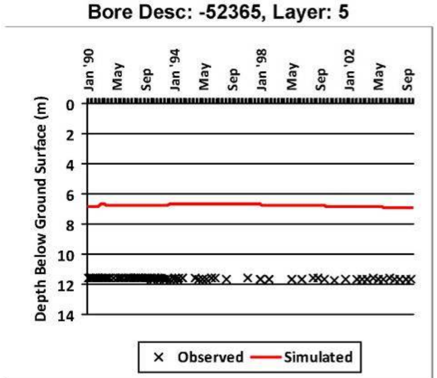
Bore Desc: -50323, Layer: 5



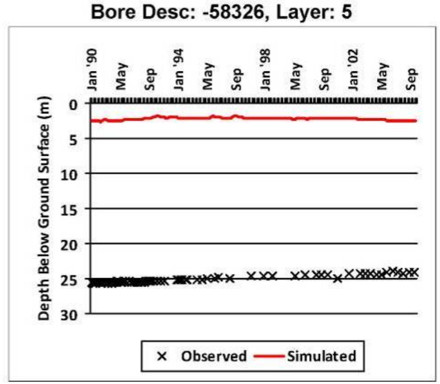
Bore Desc: -50971, Layer: 5



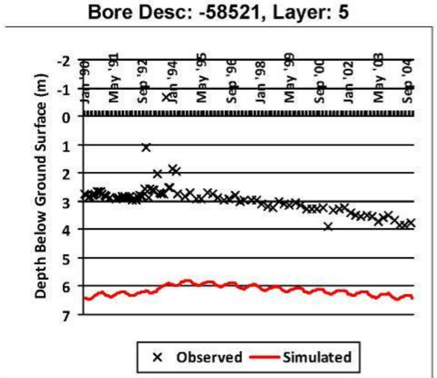
Bore Desc: -52365, Layer: 5



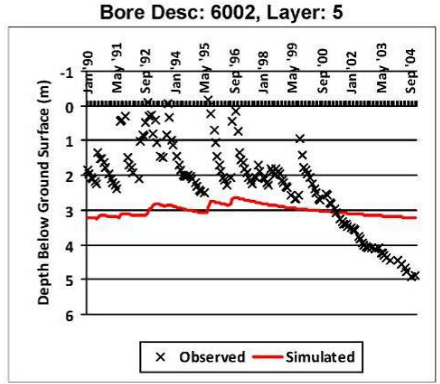
Bore Desc: -58326, Layer: 5



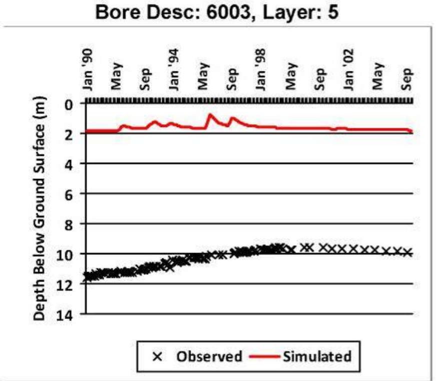
Bore Desc: -58521, Layer: 5



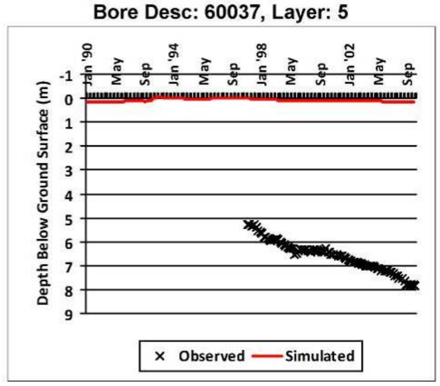
Bore Desc: 6002, Layer: 5



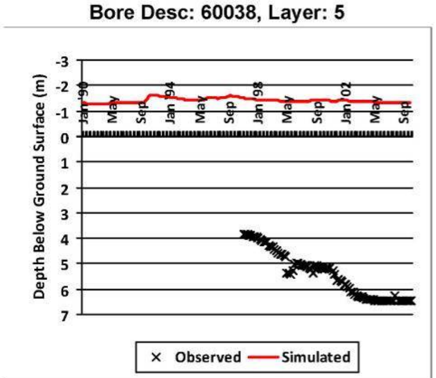
Bore Desc: 6003, Layer: 5



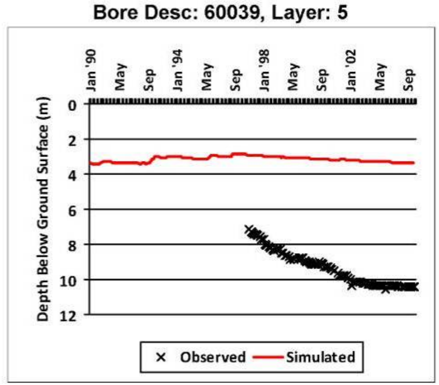
Bore Desc: 60037, Layer: 5



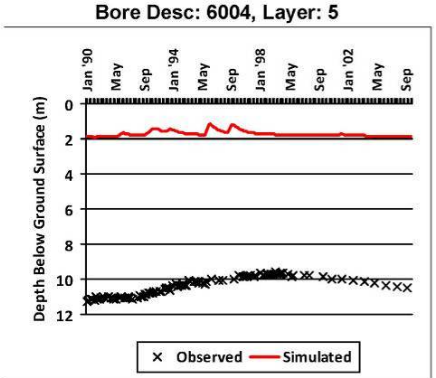
Bore Desc: 60038, Layer: 5



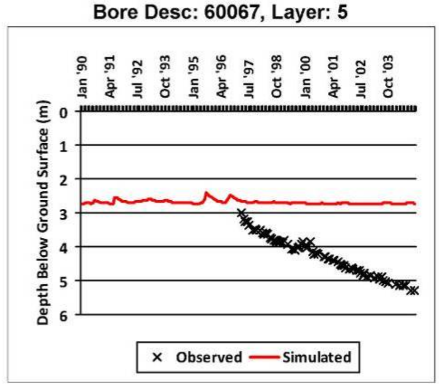
Bore Desc: 60039, Layer: 5



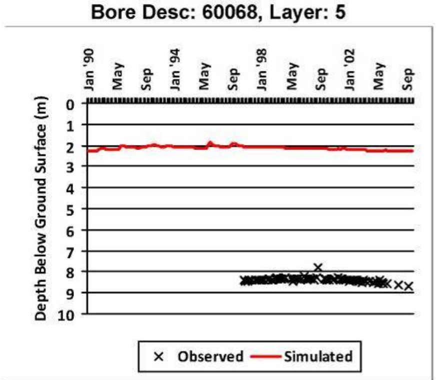
Bore Desc: 6004, Layer: 5



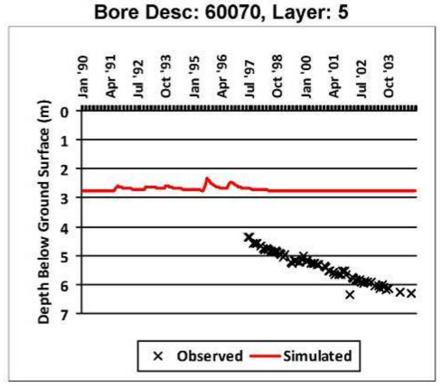
Bore Desc: 60067, Layer: 5



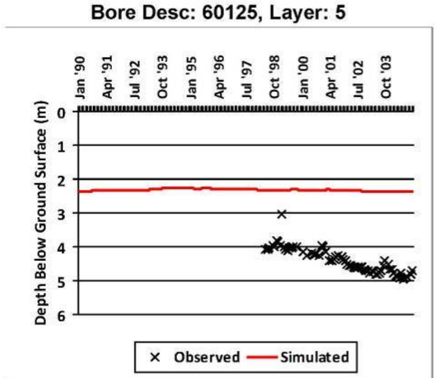
Bore Desc: 60068, Layer: 5



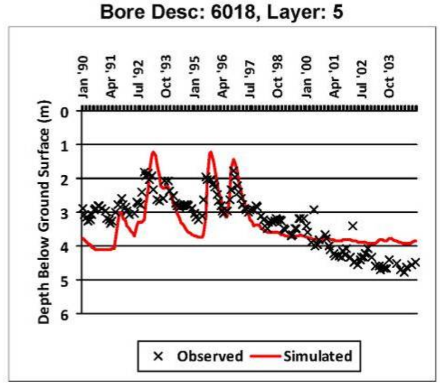
Bore Desc: 60070, Layer: 5



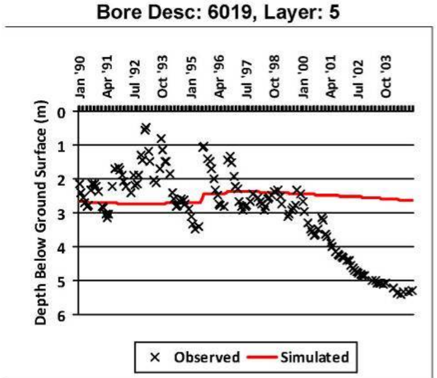
Bore Desc: 60125, Layer: 5



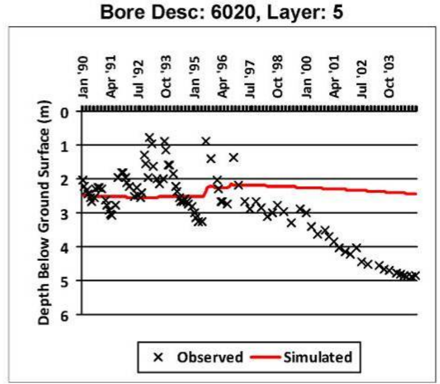
Bore Desc: 6018, Layer: 5



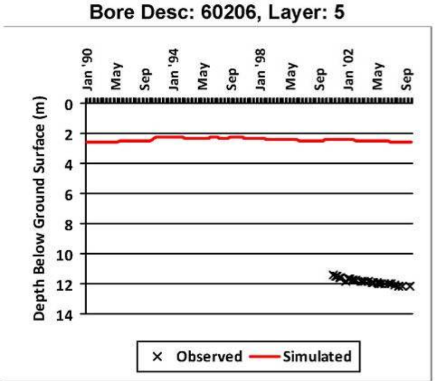
Bore Desc: 6019, Layer: 5



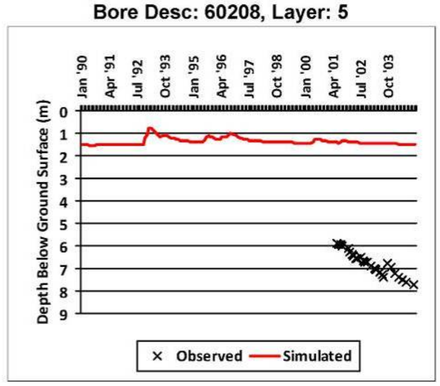
Bore Desc: 6020, Layer: 5



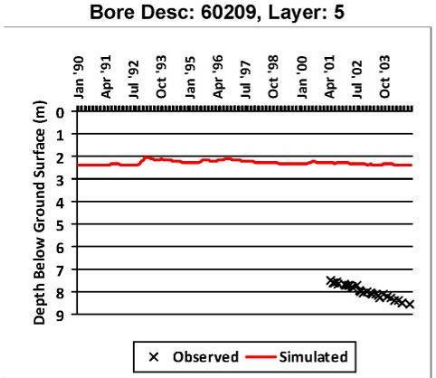
Bore Desc: 60206, Layer: 5



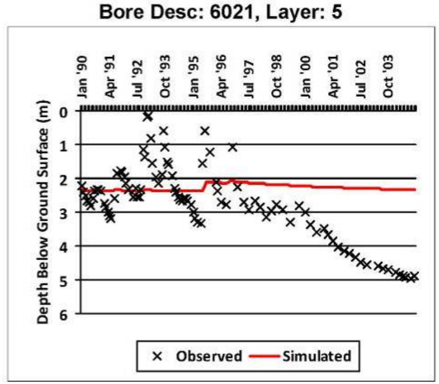
Bore Desc: 60208, Layer: 5



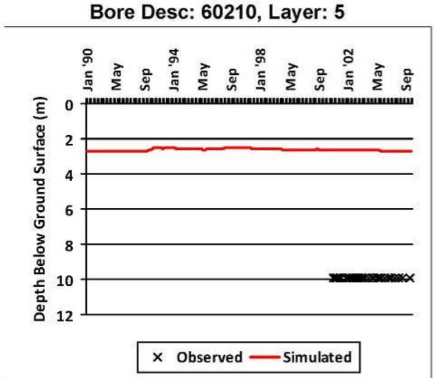
Bore Desc: 60209, Layer: 5



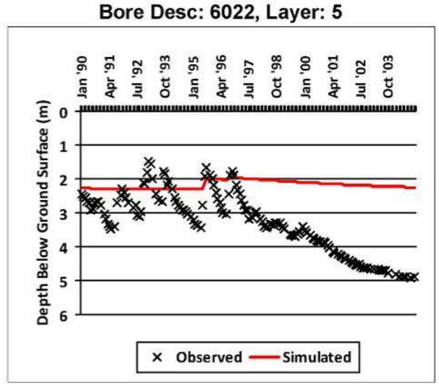
Bore Desc: 6021, Layer: 5



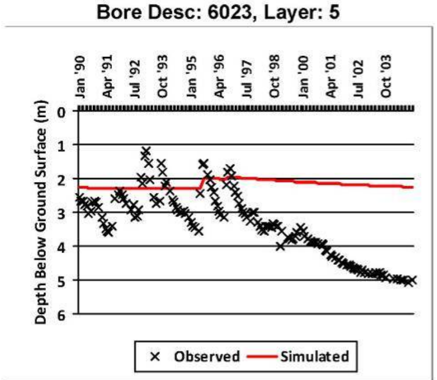
Bore Desc: 60210, Layer: 5



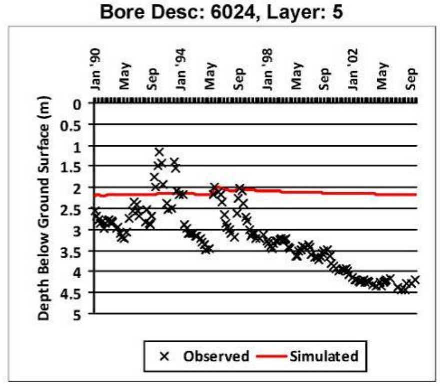
Bore Desc: 6022, Layer: 5



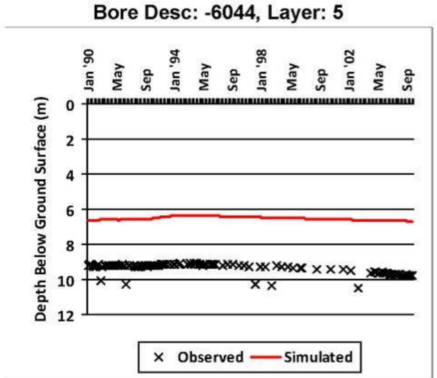
Bore Desc: 6023, Layer: 5



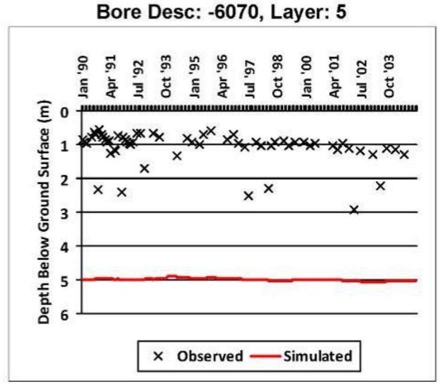
Bore Desc: 6024, Layer: 5



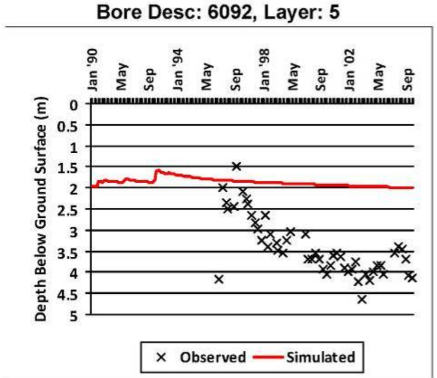
Bore Desc: -6044, Layer: 5



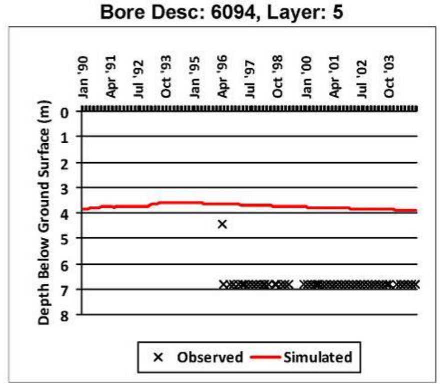
Bore Desc: -6070, Layer: 5



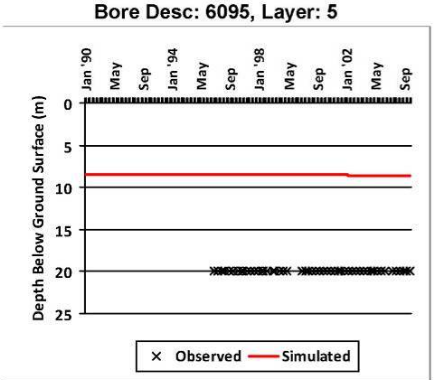
Bore Desc: 6092, Layer: 5



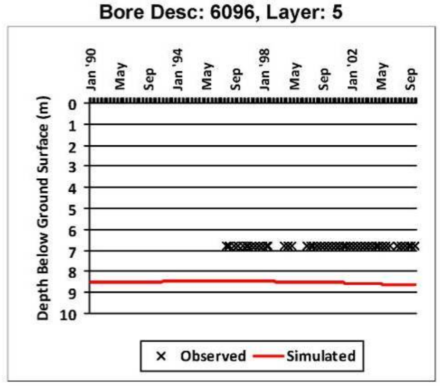
Bore Desc: 6094, Layer: 5



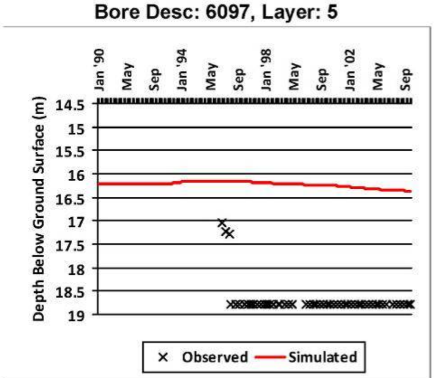
Bore Desc: 6095, Layer: 5



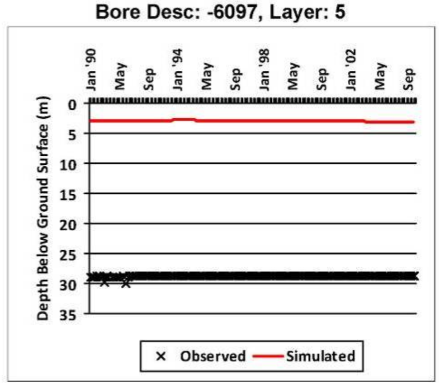
Bore Desc: 6096, Layer: 5



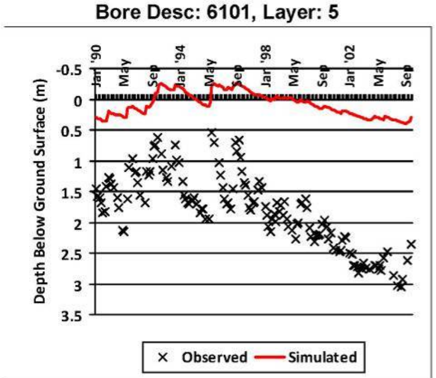
Bore Desc: 6097, Layer: 5



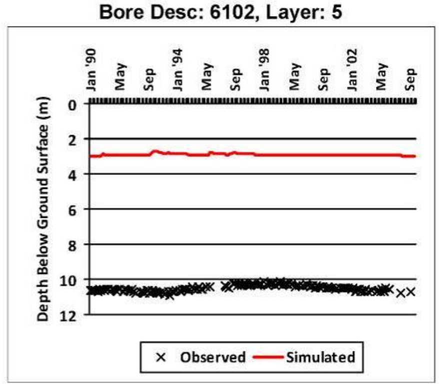
Bore Desc: -6097, Layer: 5



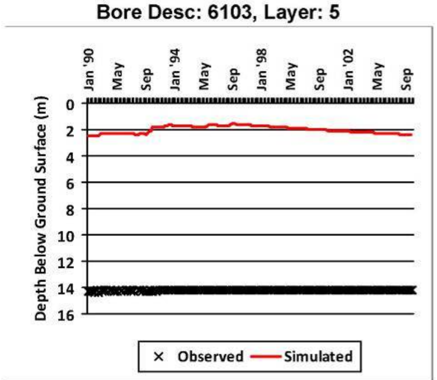
Bore Desc: 6101, Layer: 5



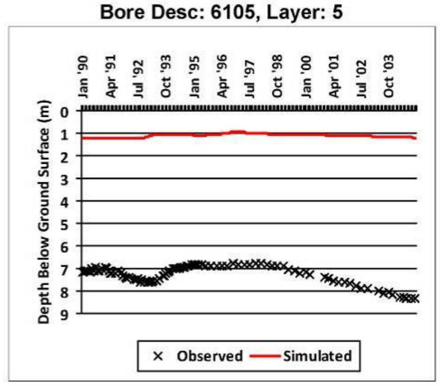
Bore Desc: 6102, Layer: 5



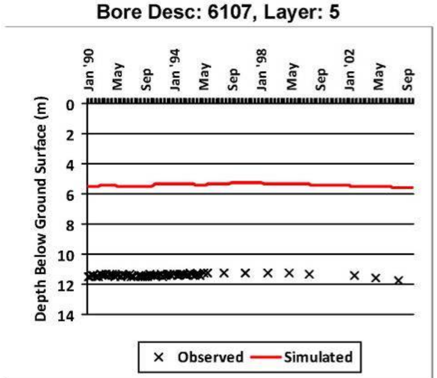
Bore Desc: 6103, Layer: 5



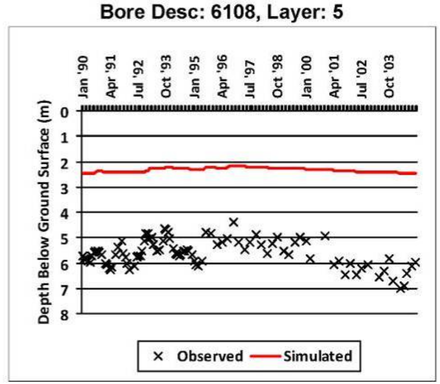
Bore Desc: 6105, Layer: 5



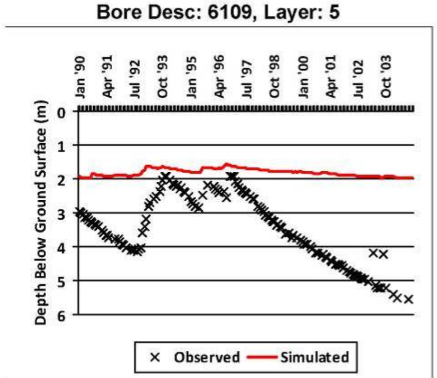
Bore Desc: 6107, Layer: 5



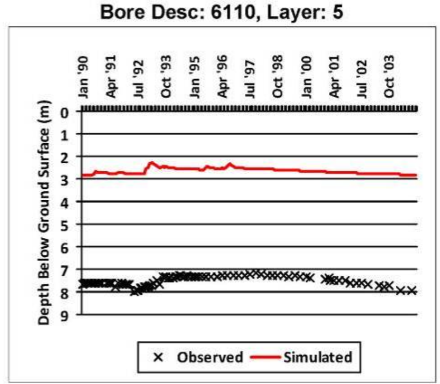
Bore Desc: 6108, Layer: 5



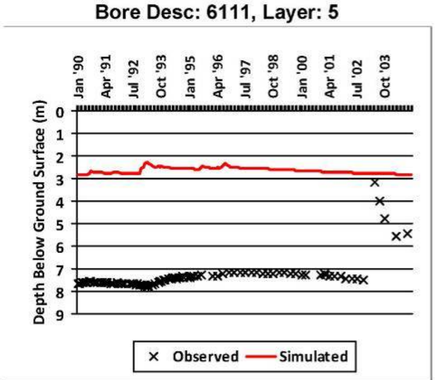
Bore Desc: 6109, Layer: 5



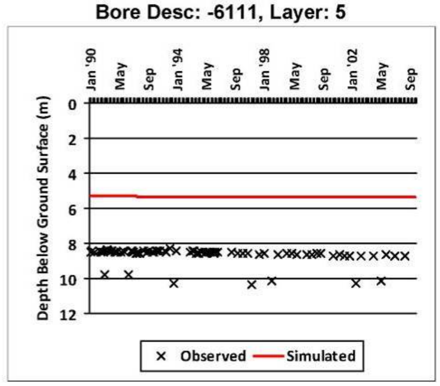
Bore Desc: 6110, Layer: 5



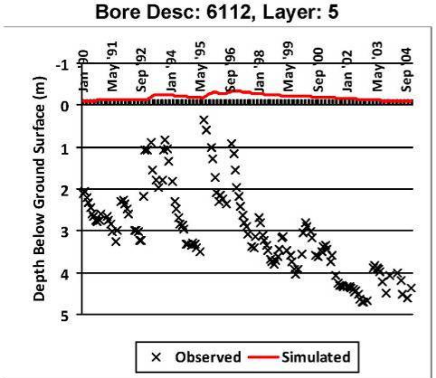
Bore Desc: 6111, Layer: 5



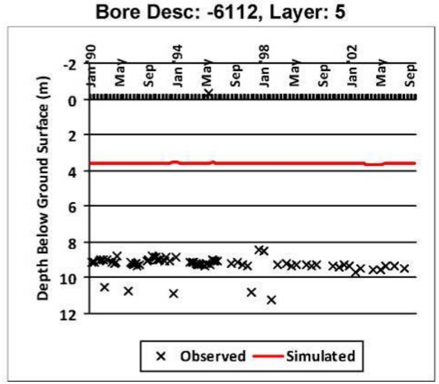
Bore Desc: -6111, Layer: 5



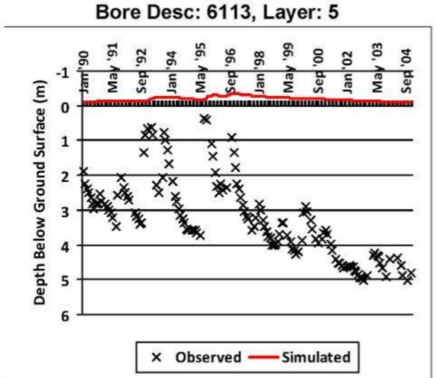
Bore Desc: 6112, Layer: 5



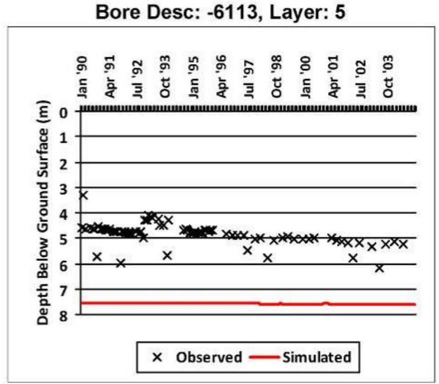
Bore Desc: -6112, Layer: 5



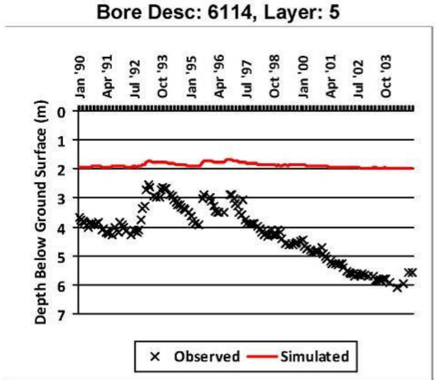
Bore Desc: 6113, Layer: 5



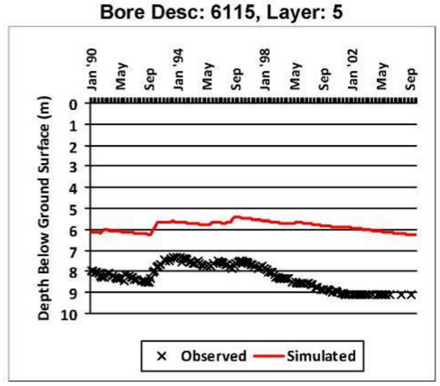
Bore Desc: -6113, Layer: 5



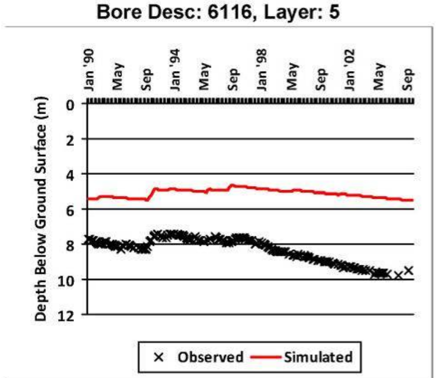
Bore Desc: 6114, Layer: 5



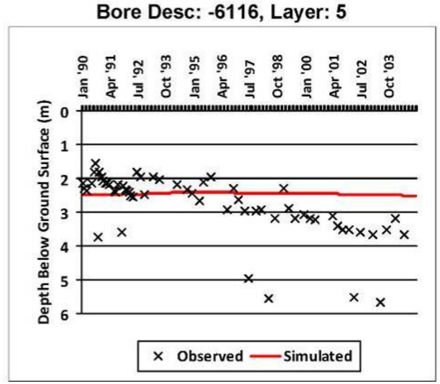
Bore Desc: 6115, Layer: 5



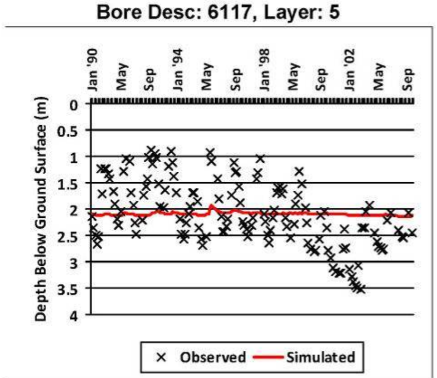
Bore Desc: 6116, Layer: 5



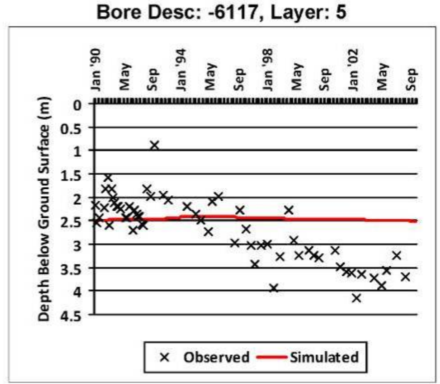
Bore Desc: -6116, Layer: 5

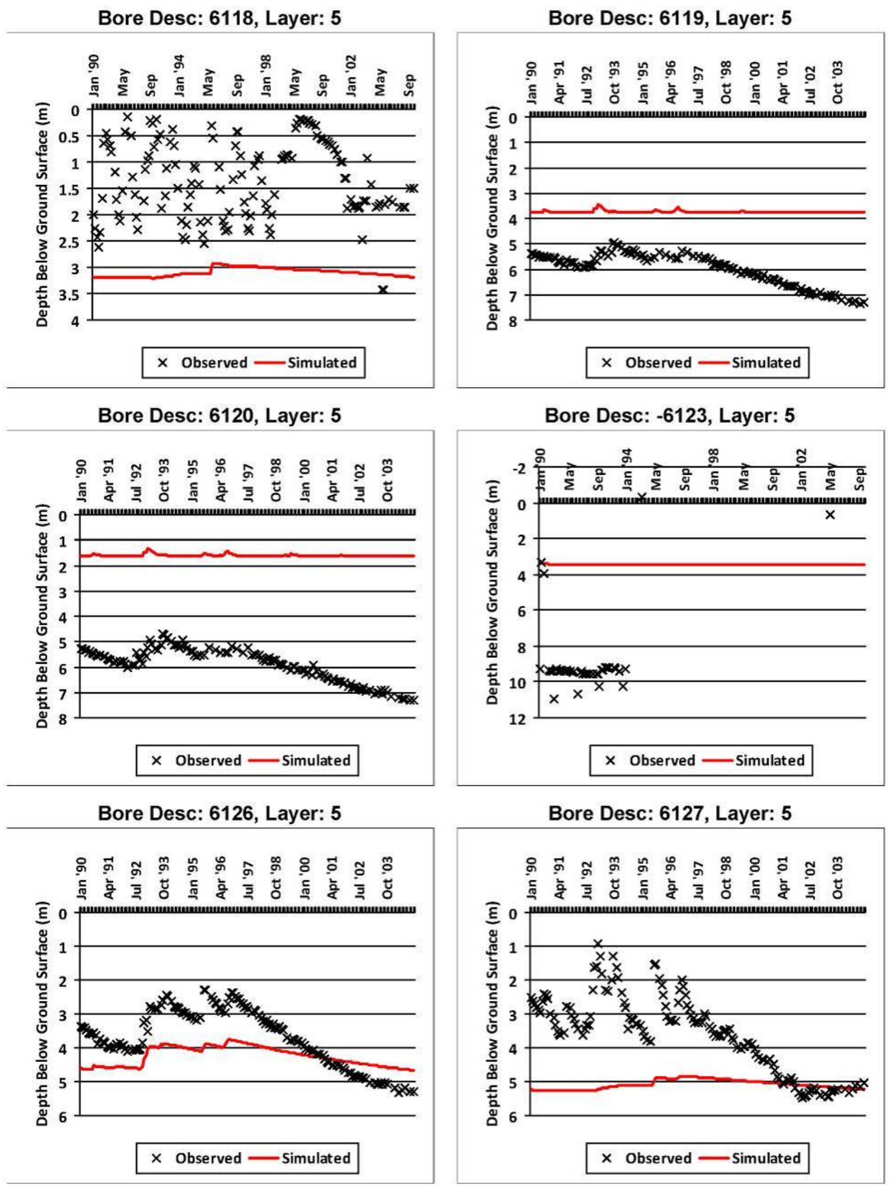


Bore Desc: 6117, Layer: 5

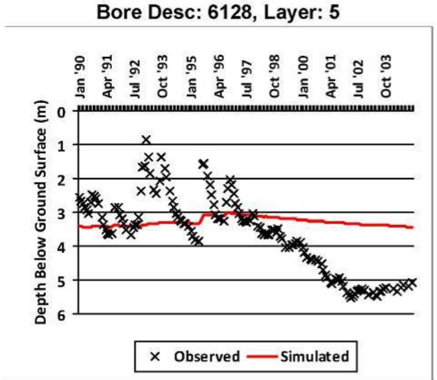


Bore Desc: -6117, Layer: 5

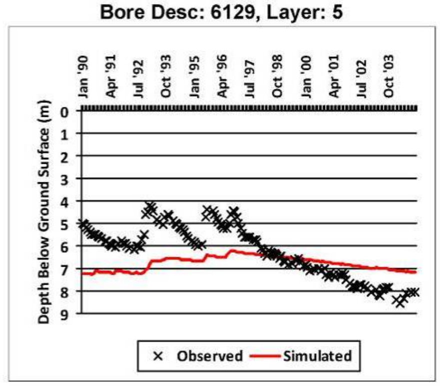



Bore Desc: 6118, Layer: 5
Bore Desc: 6119, Layer: 5
Bore Desc: 6120, Layer: 5
Bore Desc: -6123, Layer: 5
Bore Desc: 6126, Layer: 5
Bore Desc: 6127, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated

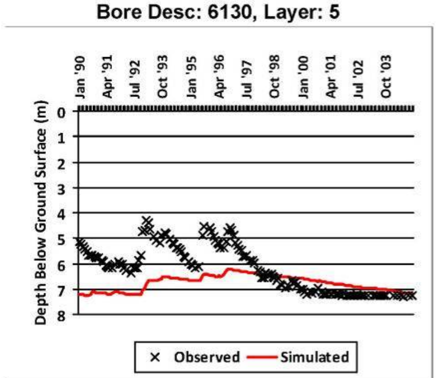
Bore Desc: 6128, Layer: 5



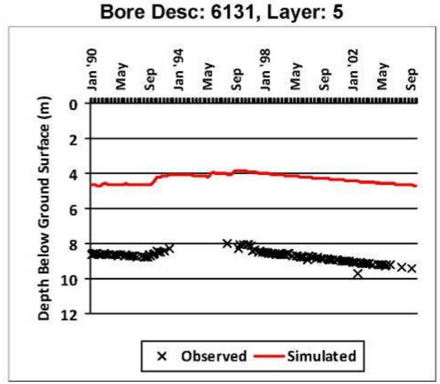
Bore Desc: 6129, Layer: 5



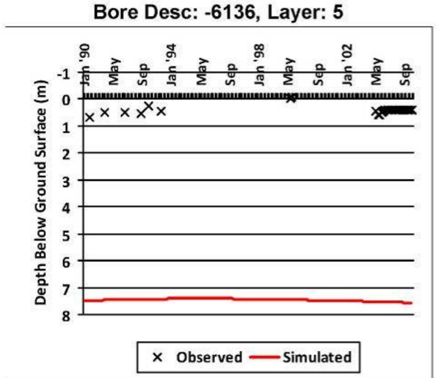
Bore Desc: 6130, Layer: 5



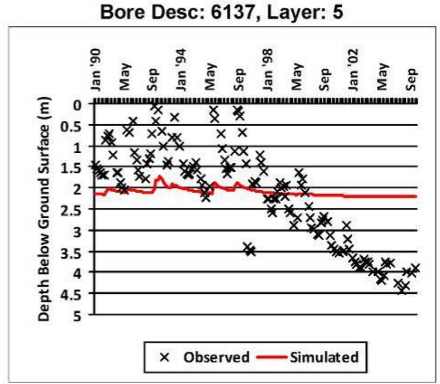
Bore Desc: 6131, Layer: 5



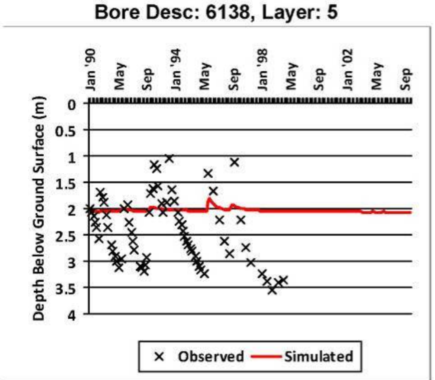
Bore Desc: -6136, Layer: 5



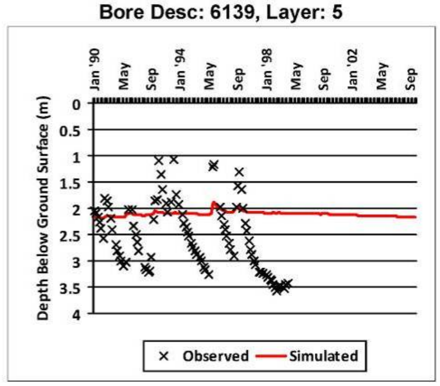
Bore Desc: 6137, Layer: 5



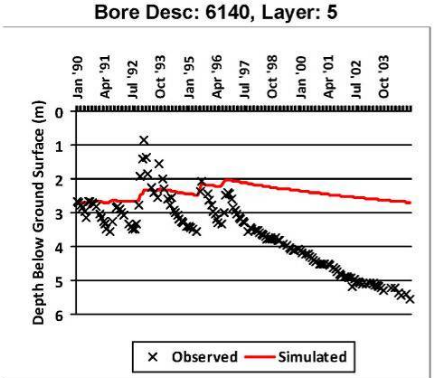
Bore Desc: 6138, Layer: 5



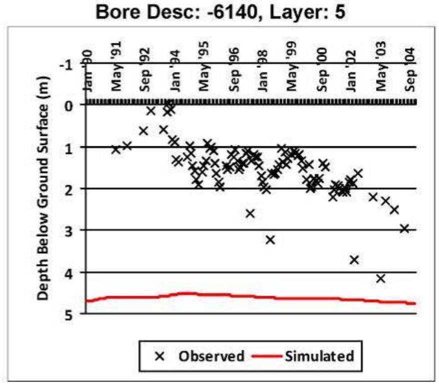
Bore Desc: 6139, Layer: 5



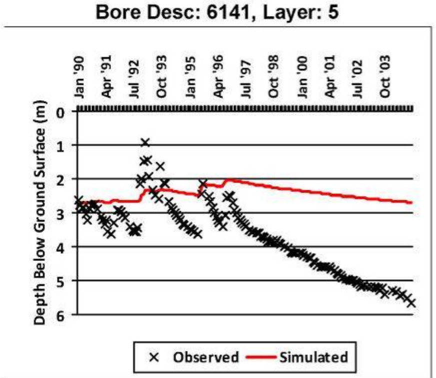
Bore Desc: 6140, Layer: 5



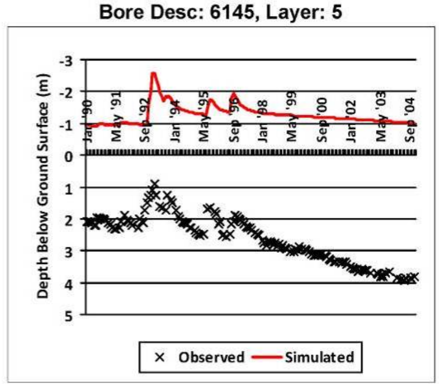
Bore Desc: -6140, Layer: 5

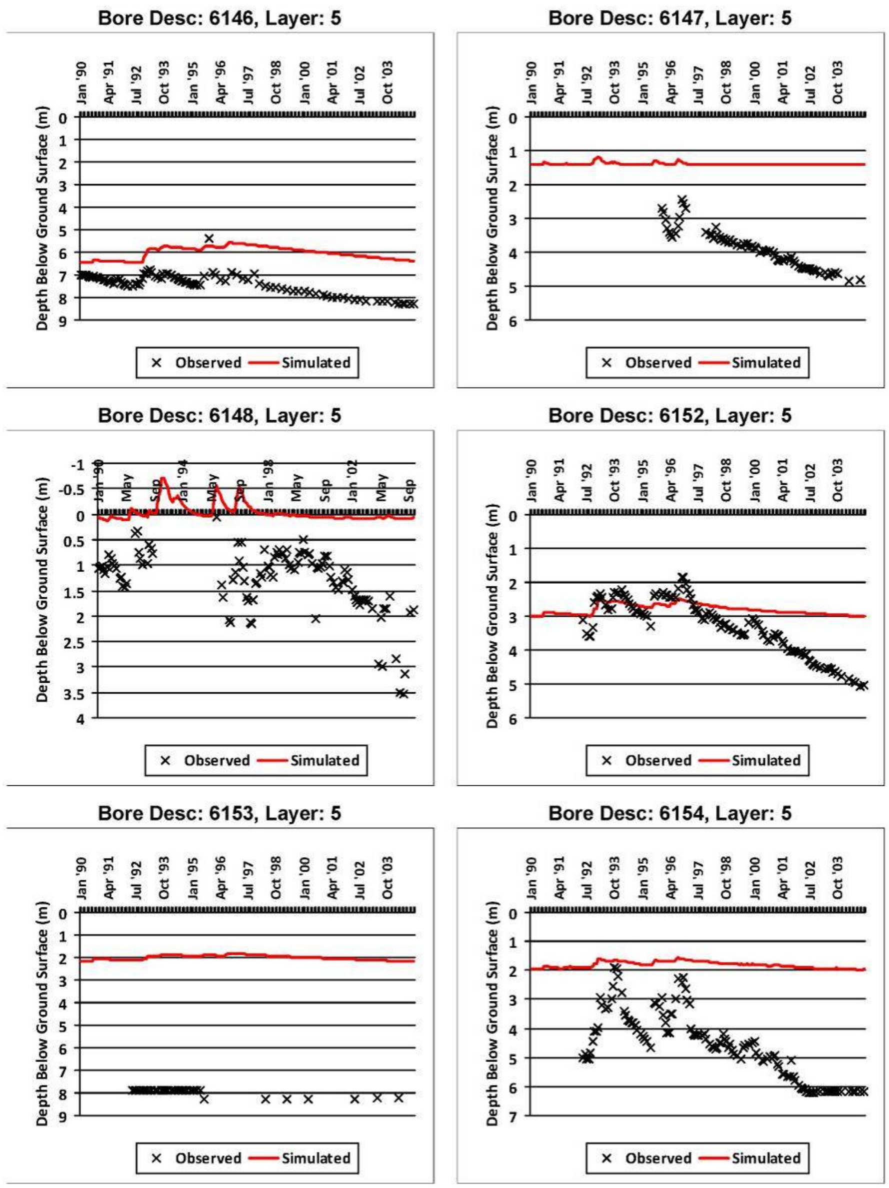


Bore Desc: 6141, Layer: 5

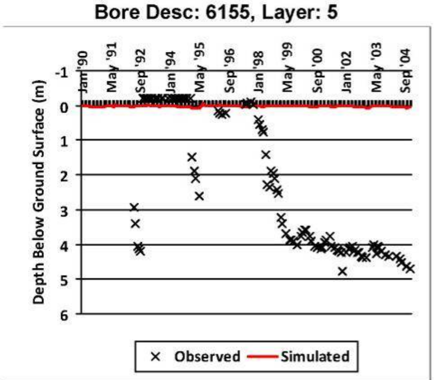


Bore Desc: 6145, Layer: 5

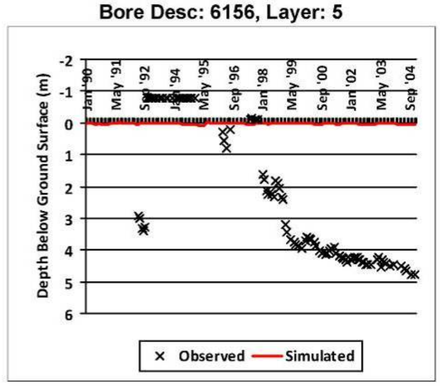



Bore Desc: 6146, Layer: 5
Bore Desc: 6147, Layer: 5
Bore Desc: 6148, Layer: 5
Bore Desc: 6152, Layer: 5
Bore Desc: 6153, Layer: 5
Bore Desc: 6154, Layer: 5
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Observed
Simulated

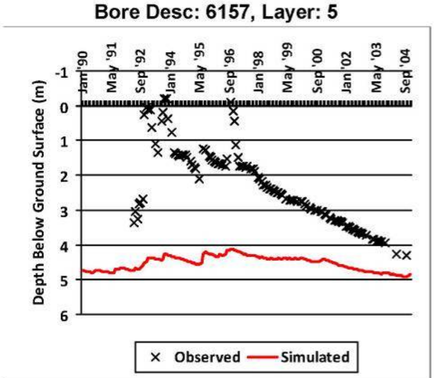
Bore Desc: 6155, Layer: 5



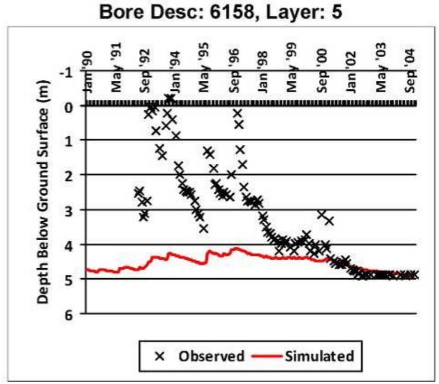
Bore Desc: 6156, Layer: 5



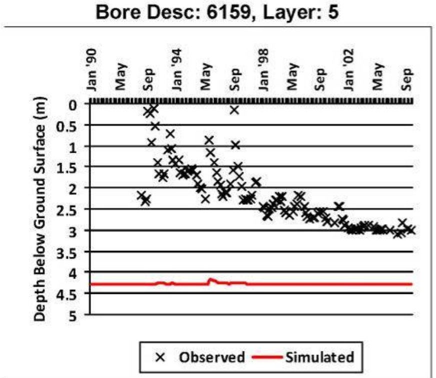
Bore Desc: 6157, Layer: 5



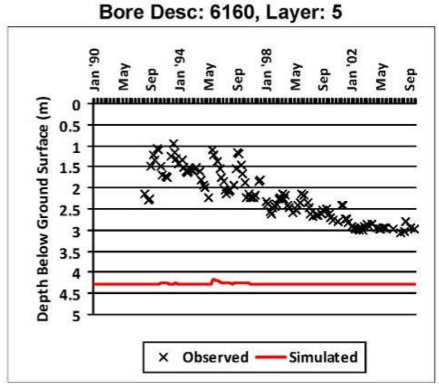
Bore Desc: 6158, Layer: 5



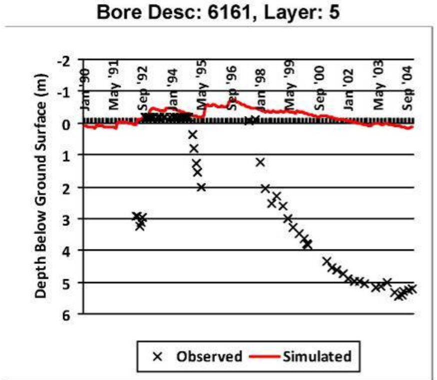
Bore Desc: 6159, Layer: 5



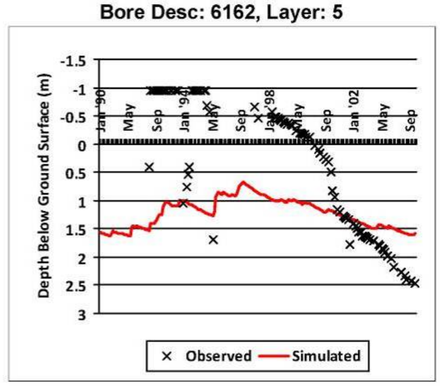
Bore Desc: 6160, Layer: 5



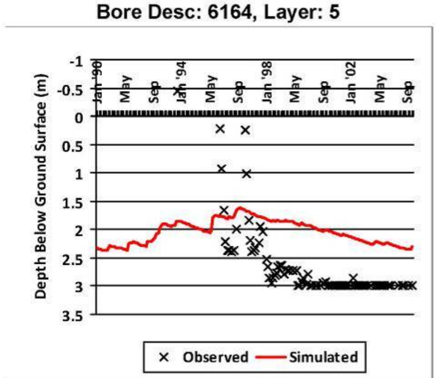
Bore Desc: 6161, Layer: 5



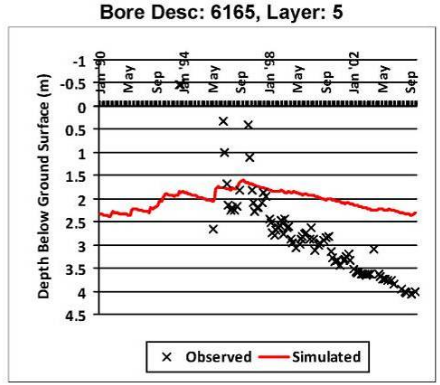
Bore Desc: 6162, Layer: 5



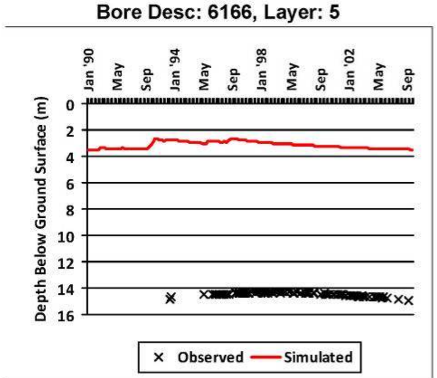
Bore Desc: 6164, Layer: 5



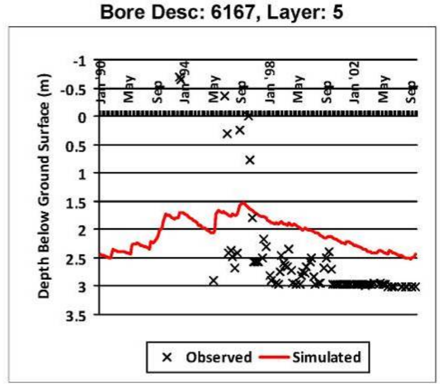
Bore Desc: 6165, Layer: 5



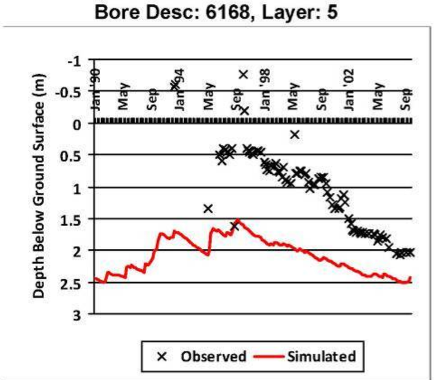
Bore Desc: 6166, Layer: 5



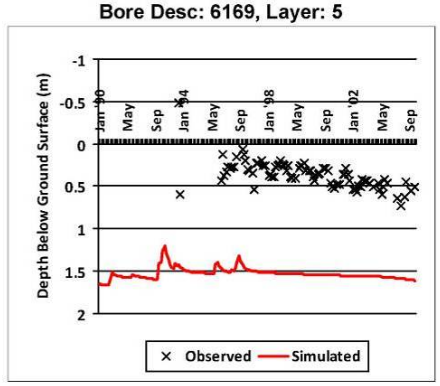
Bore Desc: 6167, Layer: 5



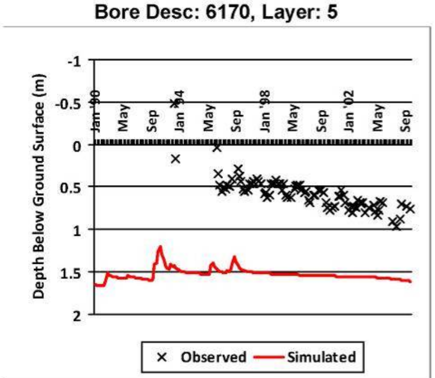
Bore Desc: 6168, Layer: 5



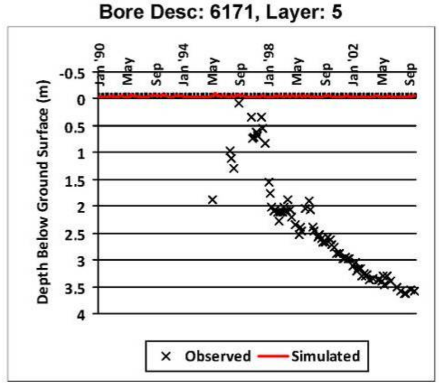
Bore Desc: 6169, Layer: 5



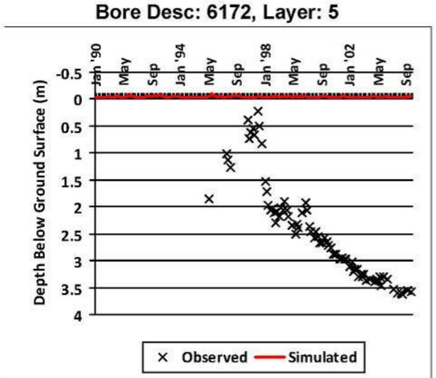
Bore Desc: 6170, Layer: 5



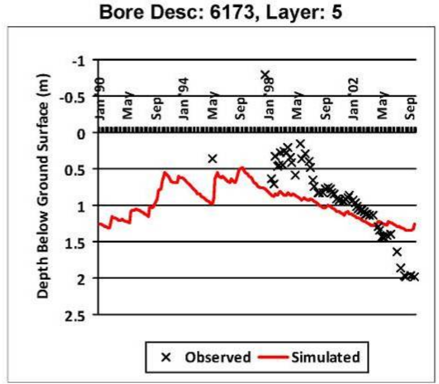
Bore Desc: 6171, Layer: 5



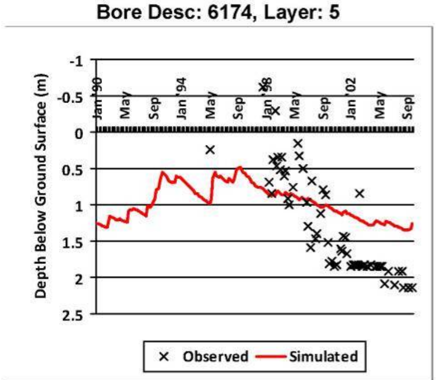
Bore Desc: 6172, Layer: 5



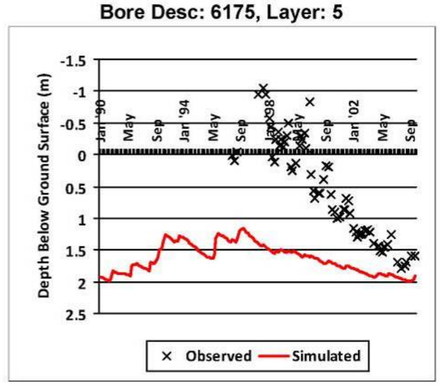
Bore Desc: 6173, Layer: 5



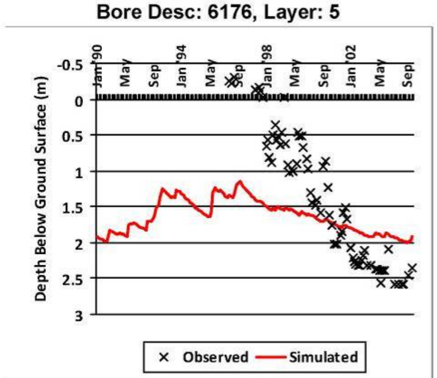
Bore Desc: 6174, Layer: 5



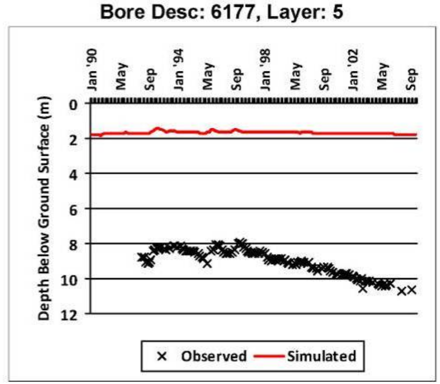
Bore Desc: 6175, Layer: 5



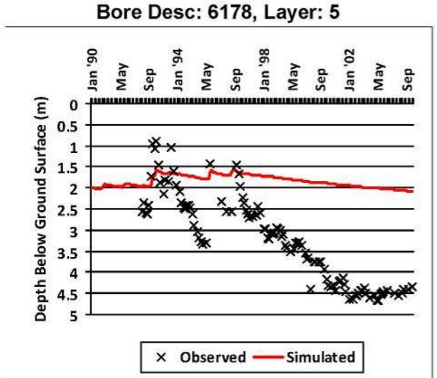
Bore Desc: 6176, Layer: 5



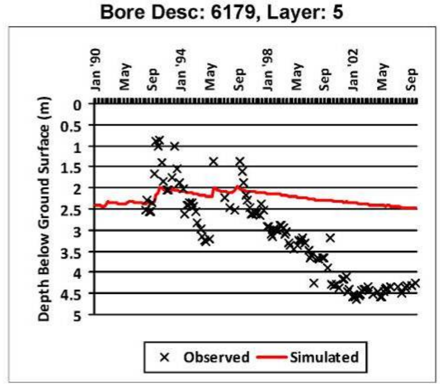
Bore Desc: 6177, Layer: 5

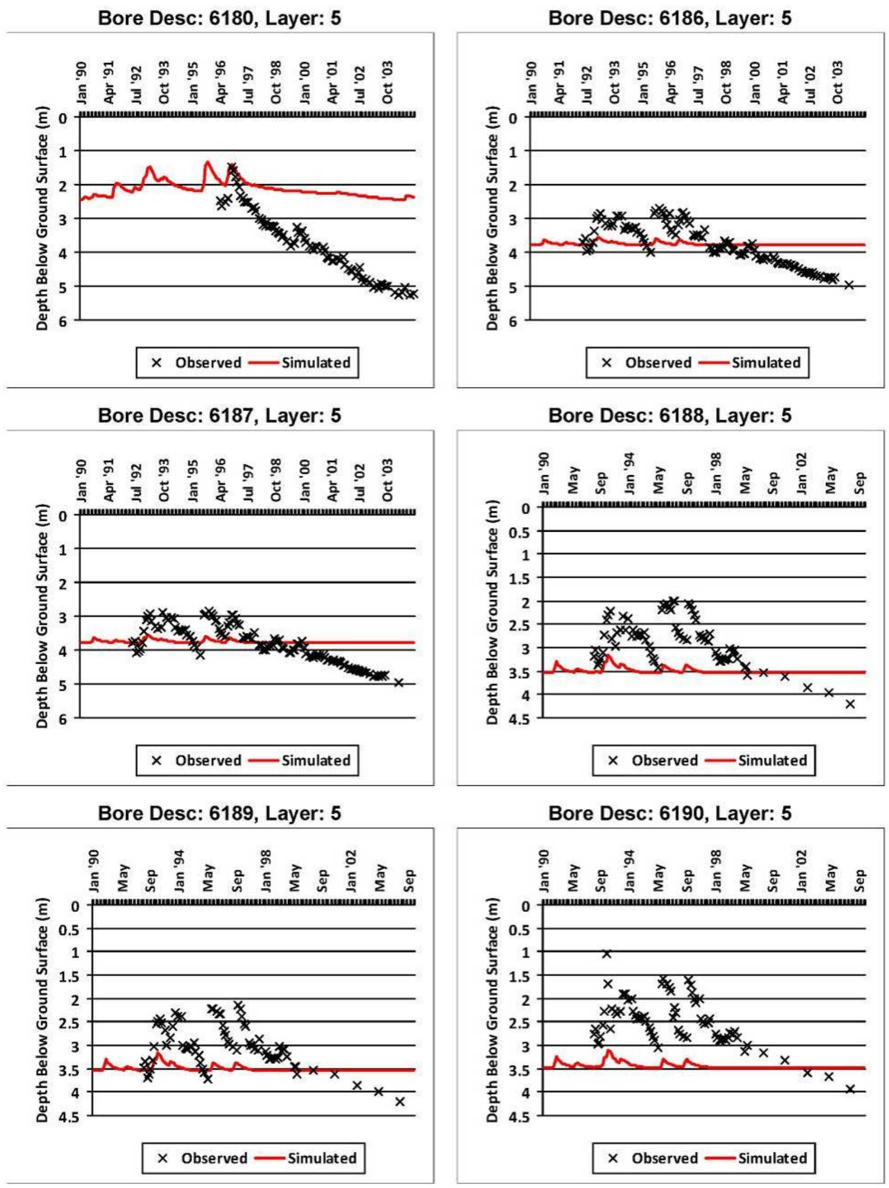


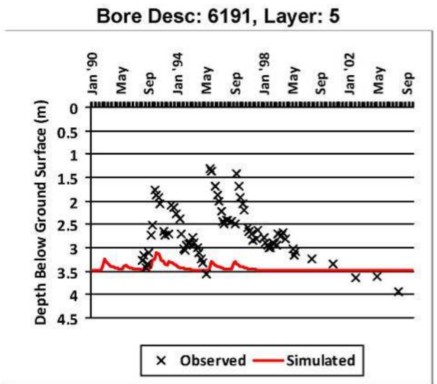
Bore Desc: 6178, Layer: 5

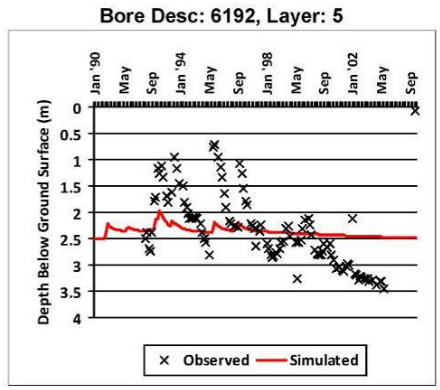


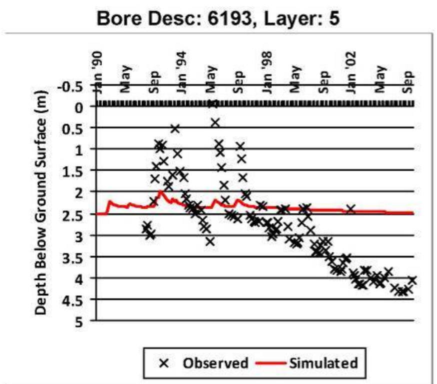
Bore Desc: 6179, Layer: 5

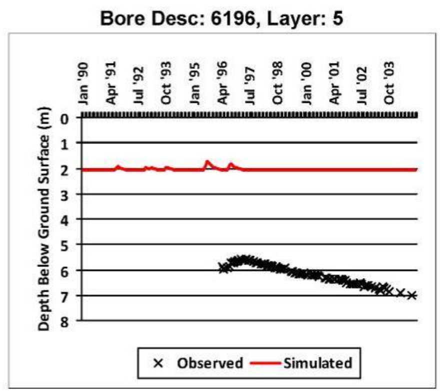


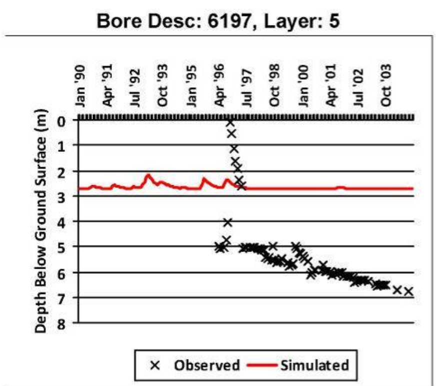

Bore Desc: 6180, Layer: 5
Bore Desc: 6186, Layer: 5
Bore Desc: 6187, Layer: 5
Bore Desc: 6188, Layer: 5
Bore Desc: 6189, Layer: 5
Bore Desc: 6190, Layer: 5
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
May
Sep
Jan '94
Jan '98
Jan '02
Observed
Simulated

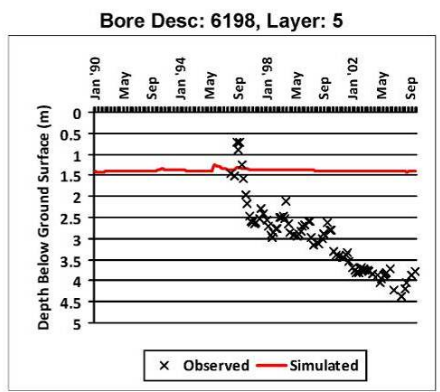

Bore Desc: 6191, Layer: 5
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6192, Layer: 5
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
Observed
Simulated

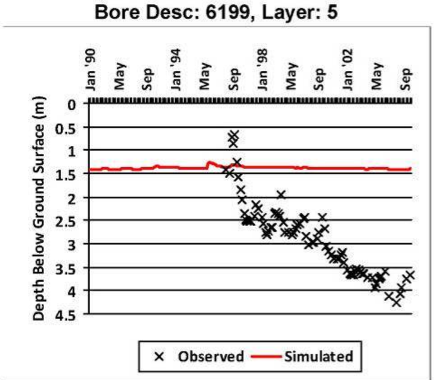

Bore Desc: 6193, Layer: 5
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6196, Layer: 5
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Depth Below Ground Surface (m)
Observed
Simulated

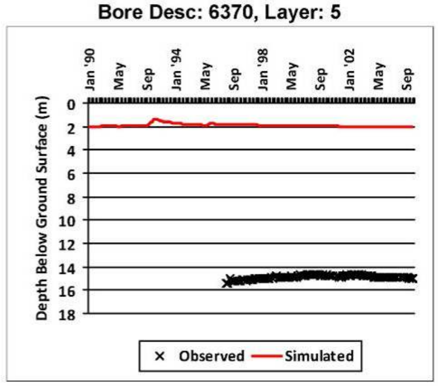

Bore Desc: 6197, Layer: 5
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6198, Layer: 5
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Depth Below Ground Surface (m)
Observed
Simulated

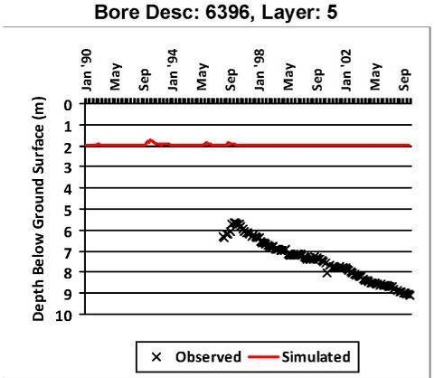
Bore Desc: 6199, Layer: 5



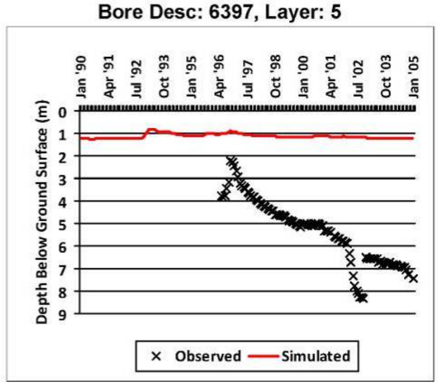
Bore Desc: 6370, Layer: 5



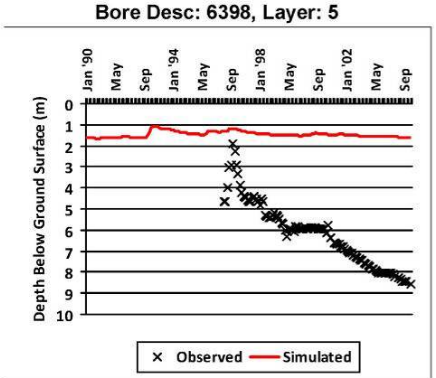
Bore Desc: 6396, Layer: 5



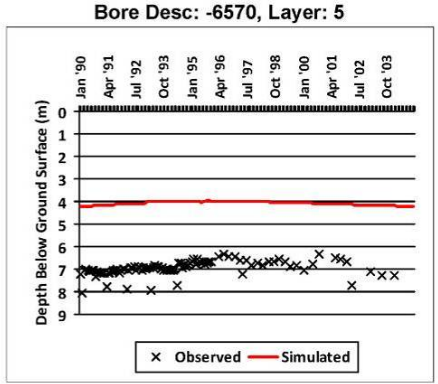
Bore Desc: 6397, Layer: 5



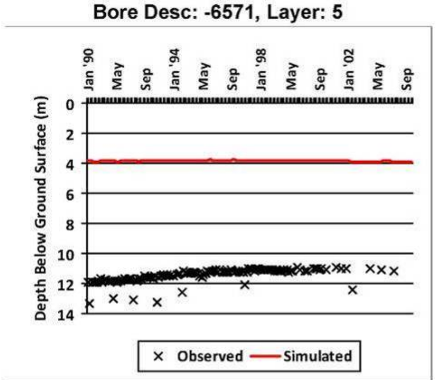
Bore Desc: 6398, Layer: 5



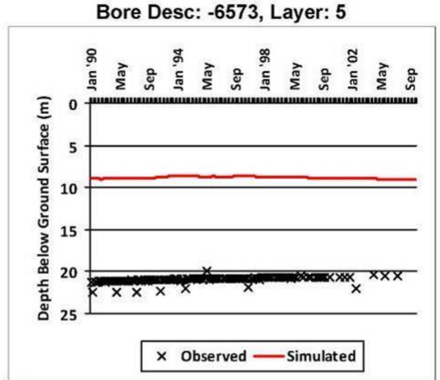
Bore Desc: -6570, Layer: 5



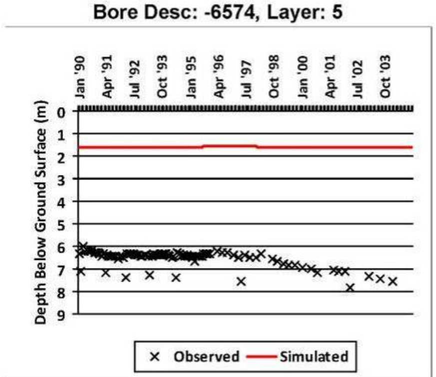
Bore Desc: -6571, Layer: 5



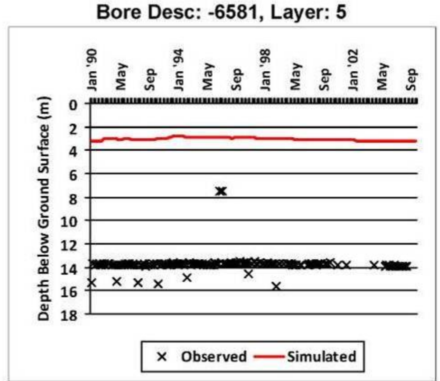
Bore Desc: -6573, Layer: 5



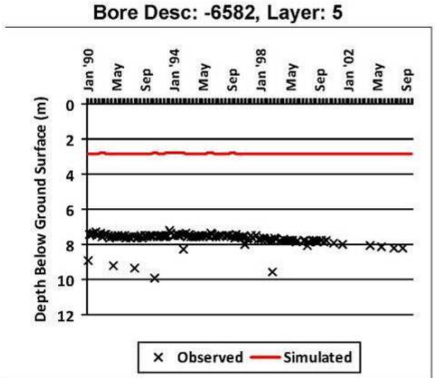
Bore Desc: -6574, Layer: 5



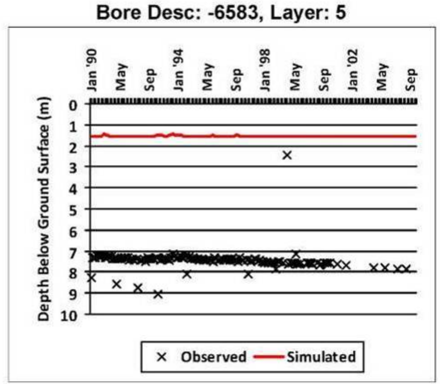
Bore Desc: -6581, Layer: 5



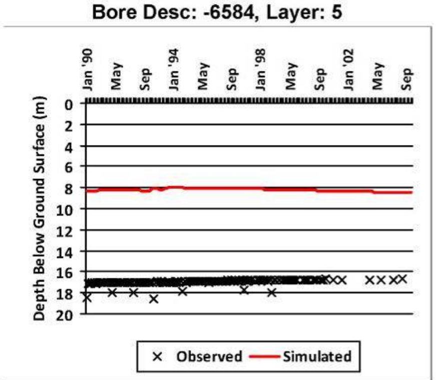
Bore Desc: -6582, Layer: 5



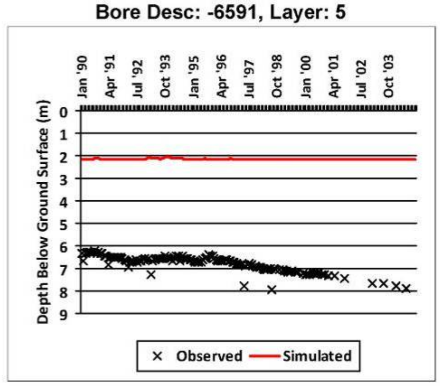
Bore Desc: -6583, Layer: 5



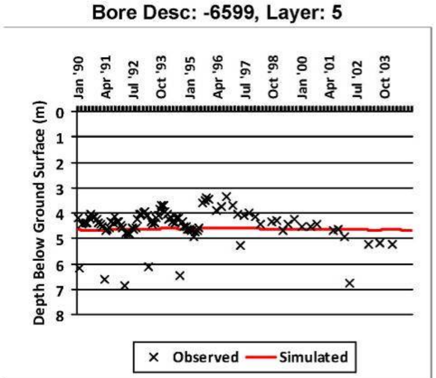
Bore Desc: -6584, Layer: 5



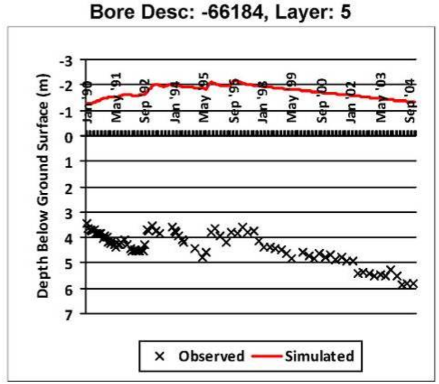
Bore Desc: -6591, Layer: 5



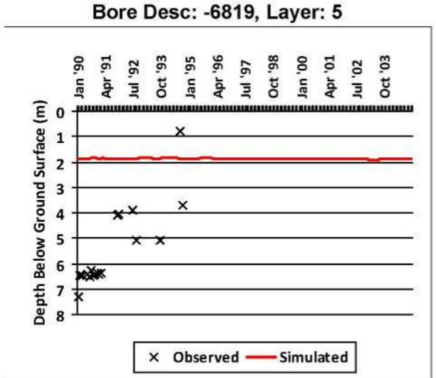
Bore Desc: -6599, Layer: 5



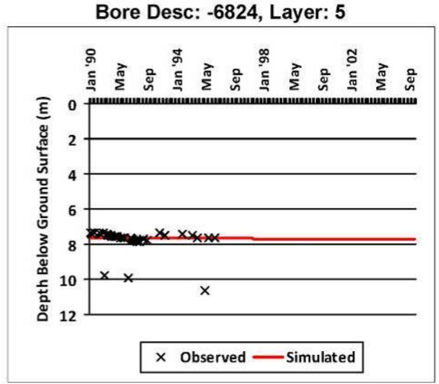
Bore Desc: -66184, Layer: 5

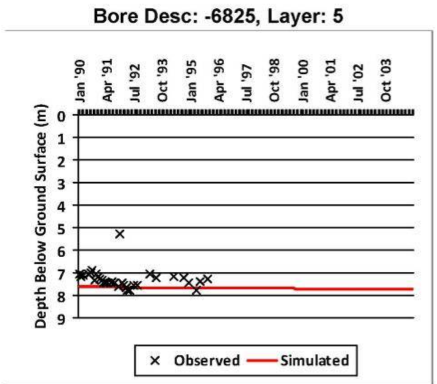


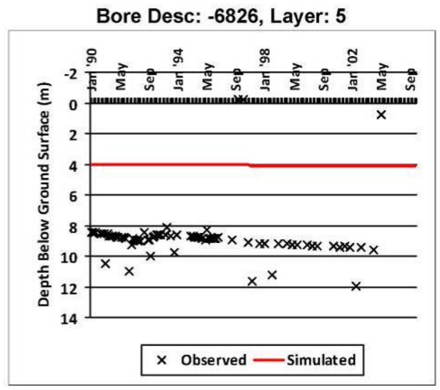
Bore Desc: -6819, Layer: 5

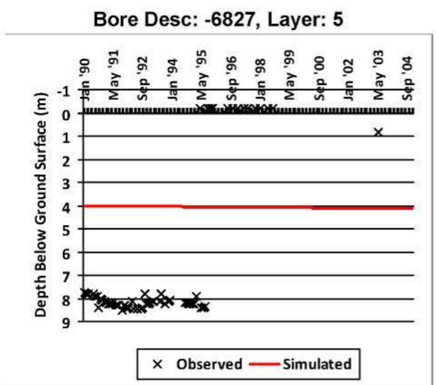


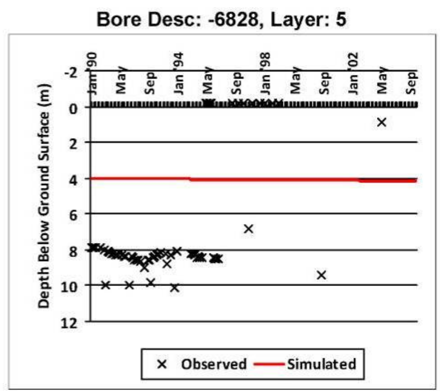
Bore Desc: -6824, Layer: 5

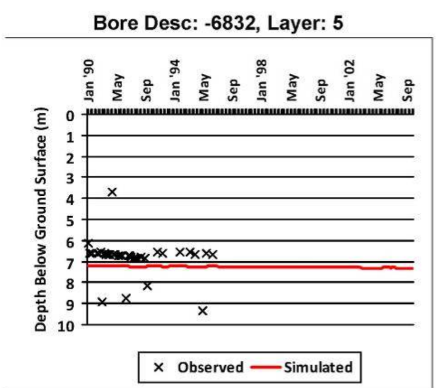


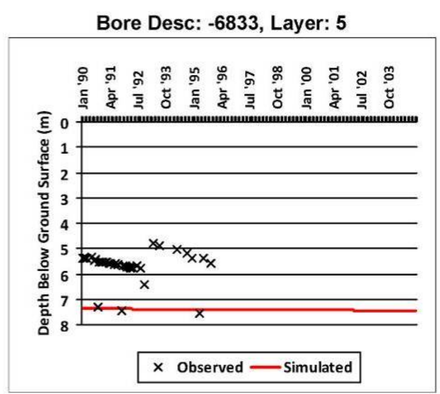

Bore Desc: -6825, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -6826, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated

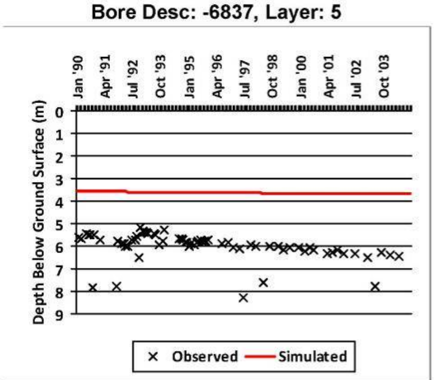

Bore Desc: -6827, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -6828, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated

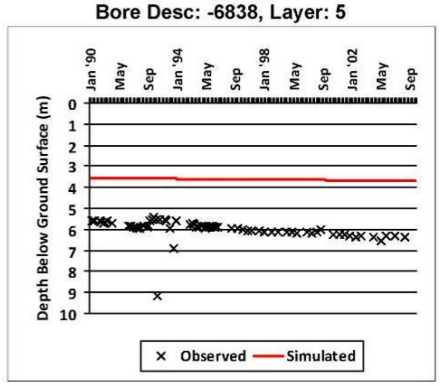

Bore Desc: -6832, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -6833, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated

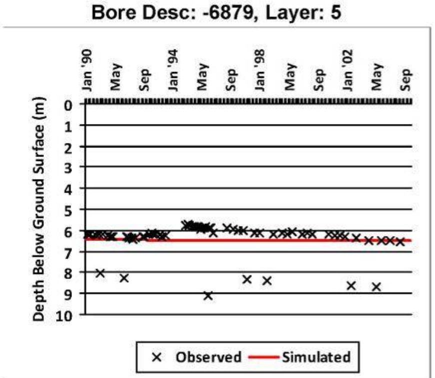
Bore Desc: -6837, Layer: 5



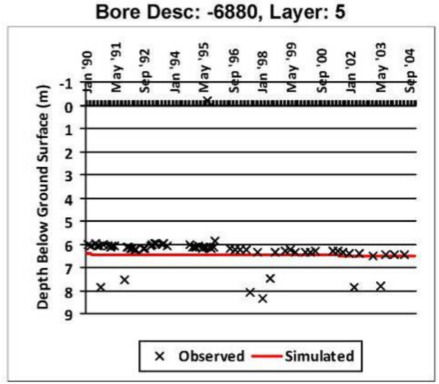
Bore Desc: -6838, Layer: 5



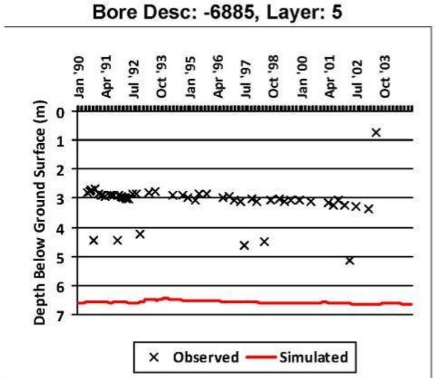
Bore Desc: -6879, Layer: 5



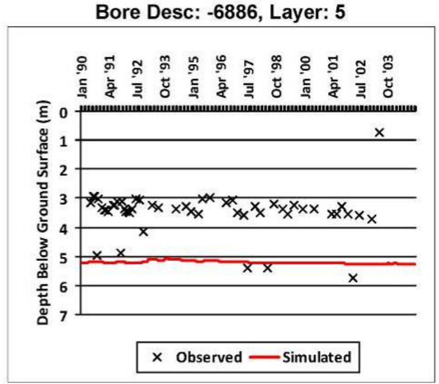
Bore Desc: -6880, Layer: 5



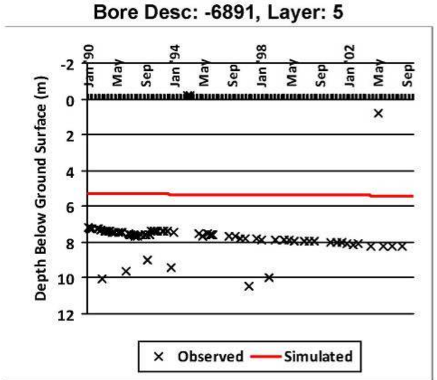
Bore Desc: -6885, Layer: 5



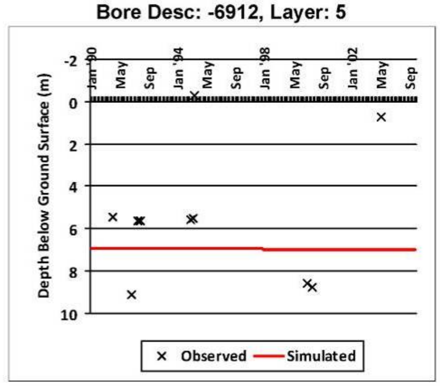
Bore Desc: -6886, Layer: 5



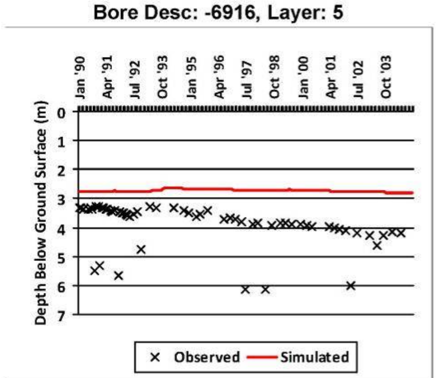
Bore Desc: -6891, Layer: 5



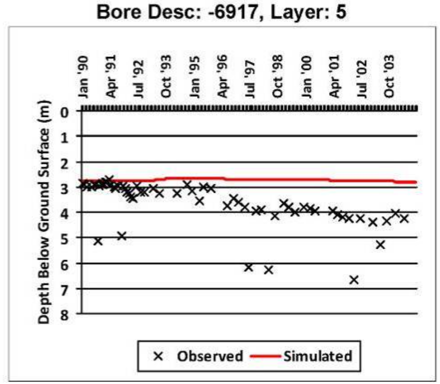
Bore Desc: -6912, Layer: 5



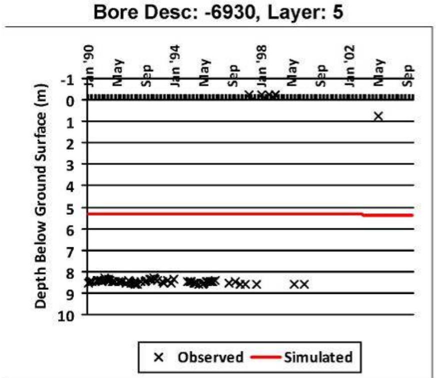
Bore Desc: -6916, Layer: 5



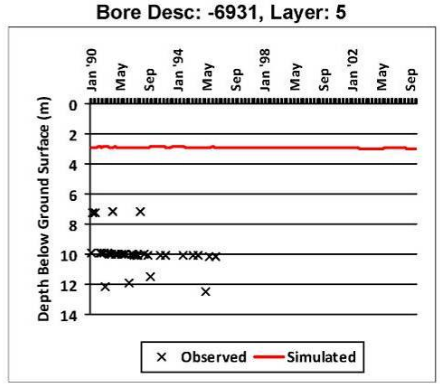
Bore Desc: -6917, Layer: 5

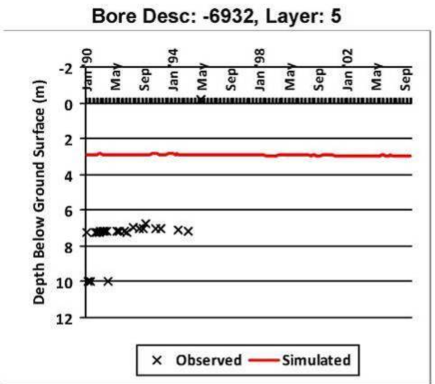


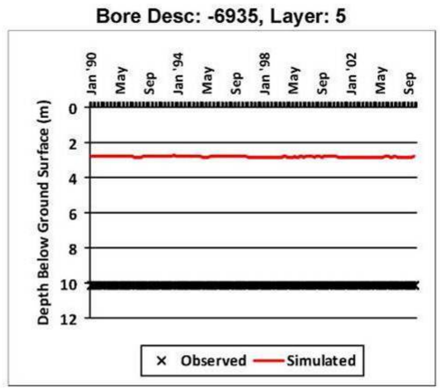
Bore Desc: -6930, Layer: 5

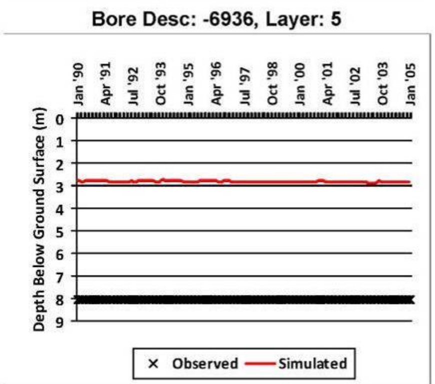


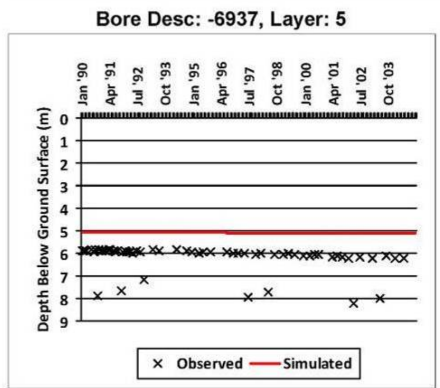
Bore Desc: -6931, Layer: 5

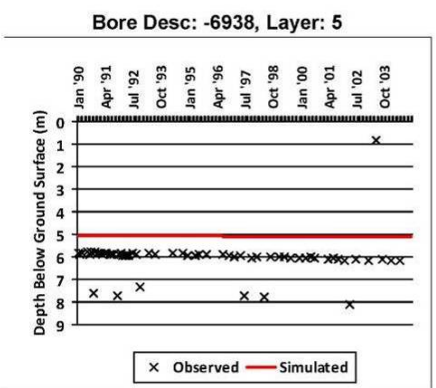


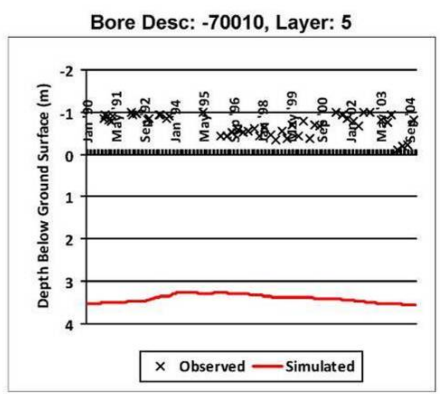

Bore Desc: -6932, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated

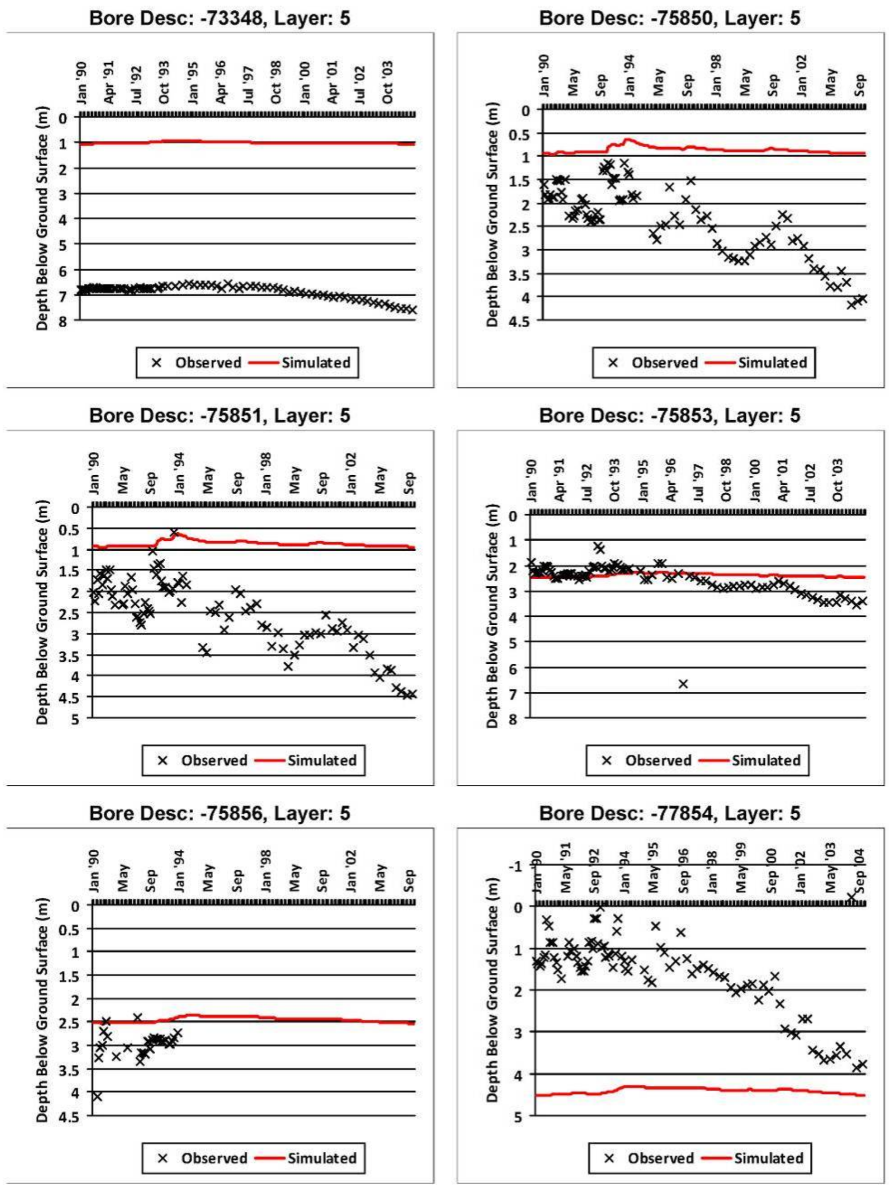

Bore Desc: -6935, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -6936, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated

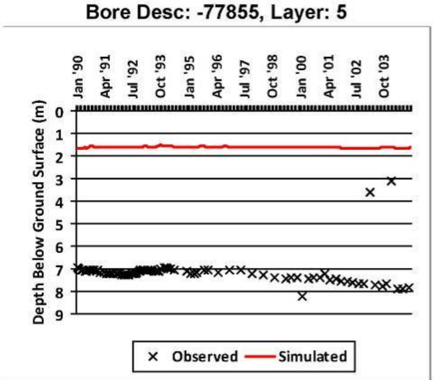

Bore Desc: -6937, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -6938, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated

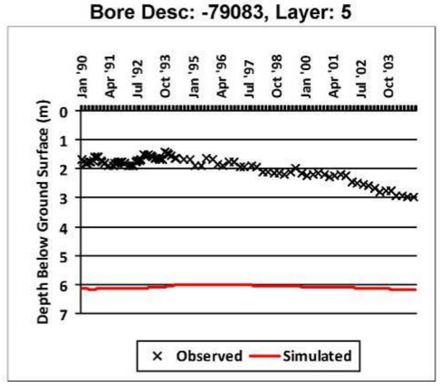

Bore Desc: -70010, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -73348, Layer: 5
Bore Desc: -75850, Layer: 5
Bore Desc: -75851, Layer: 5
Bore Desc: -75853, Layer: 5
Bore Desc: -75856, Layer: 5
Bore Desc: -77854, Layer: 5
Depth Below Ground Surface (m)
Observed
Simulated

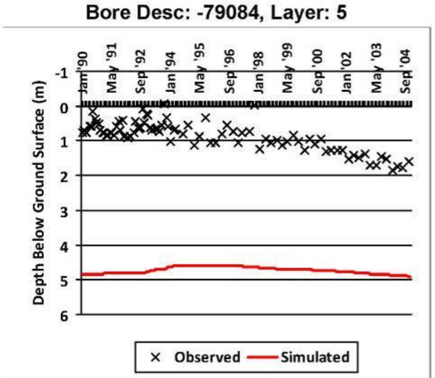
Bore Desc: -77855, Layer: 5



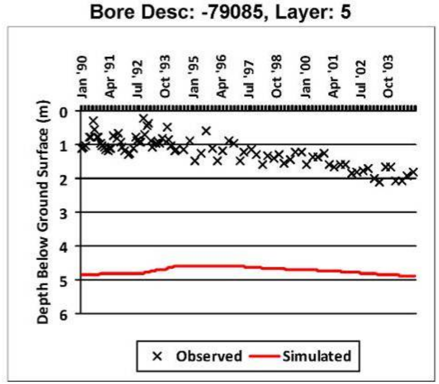
Bore Desc: -79083, Layer: 5



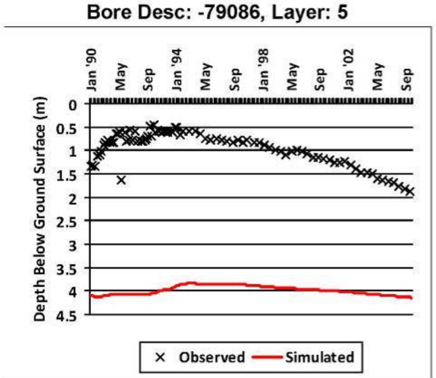
Bore Desc: -79084, Layer: 5



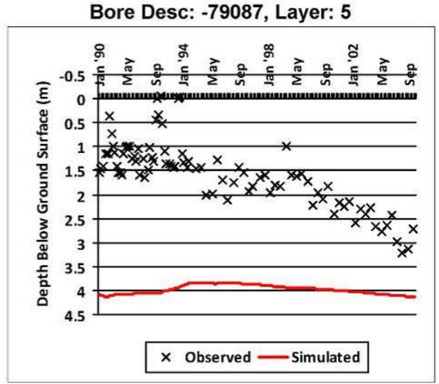
Bore Desc: -79085, Layer: 5



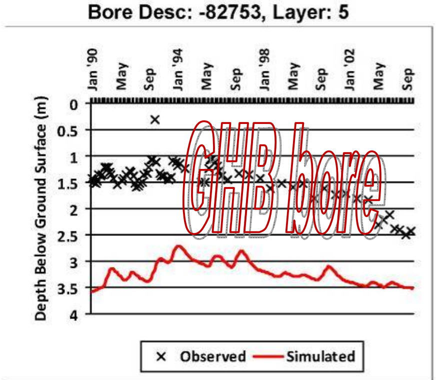
Bore Desc: -79086, Layer: 5



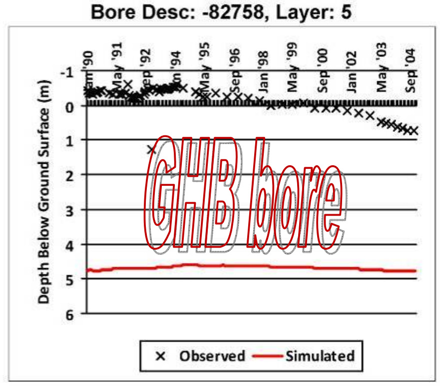
Bore Desc: -79087, Layer: 5



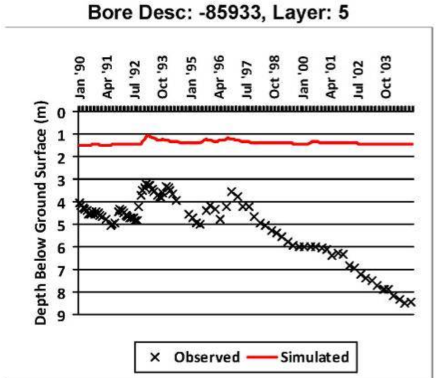
Bore Desc: -82753, Layer: 5



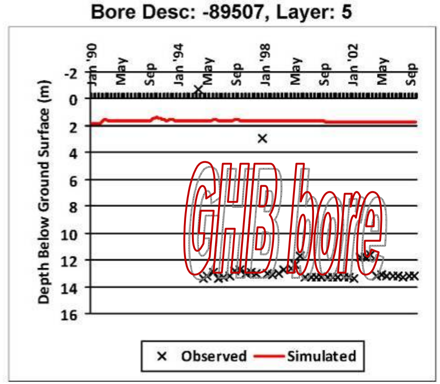
Bore Desc: -82758, Layer: 5



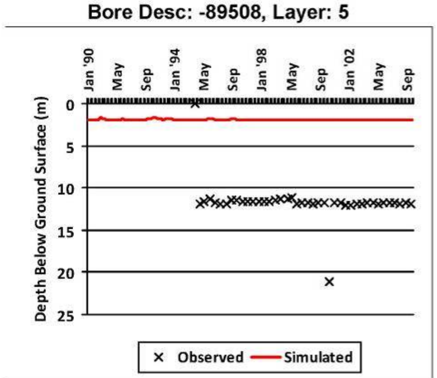
Bore Desc: -85933, Layer: 5



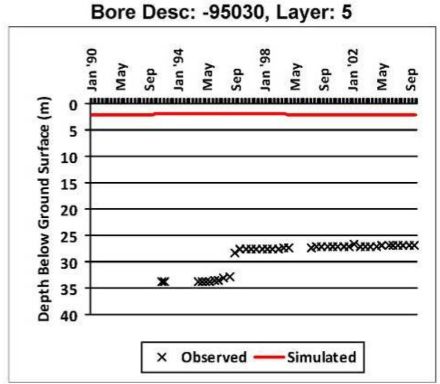
Bore Desc: -89507, Layer: 5

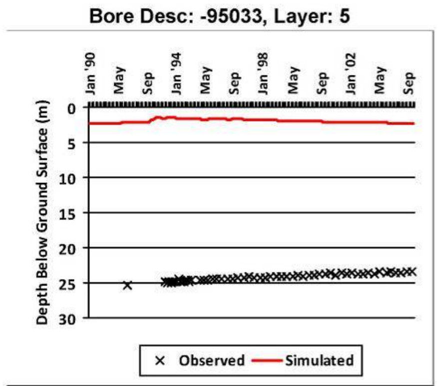


Bore Desc: -89508, Layer: 5

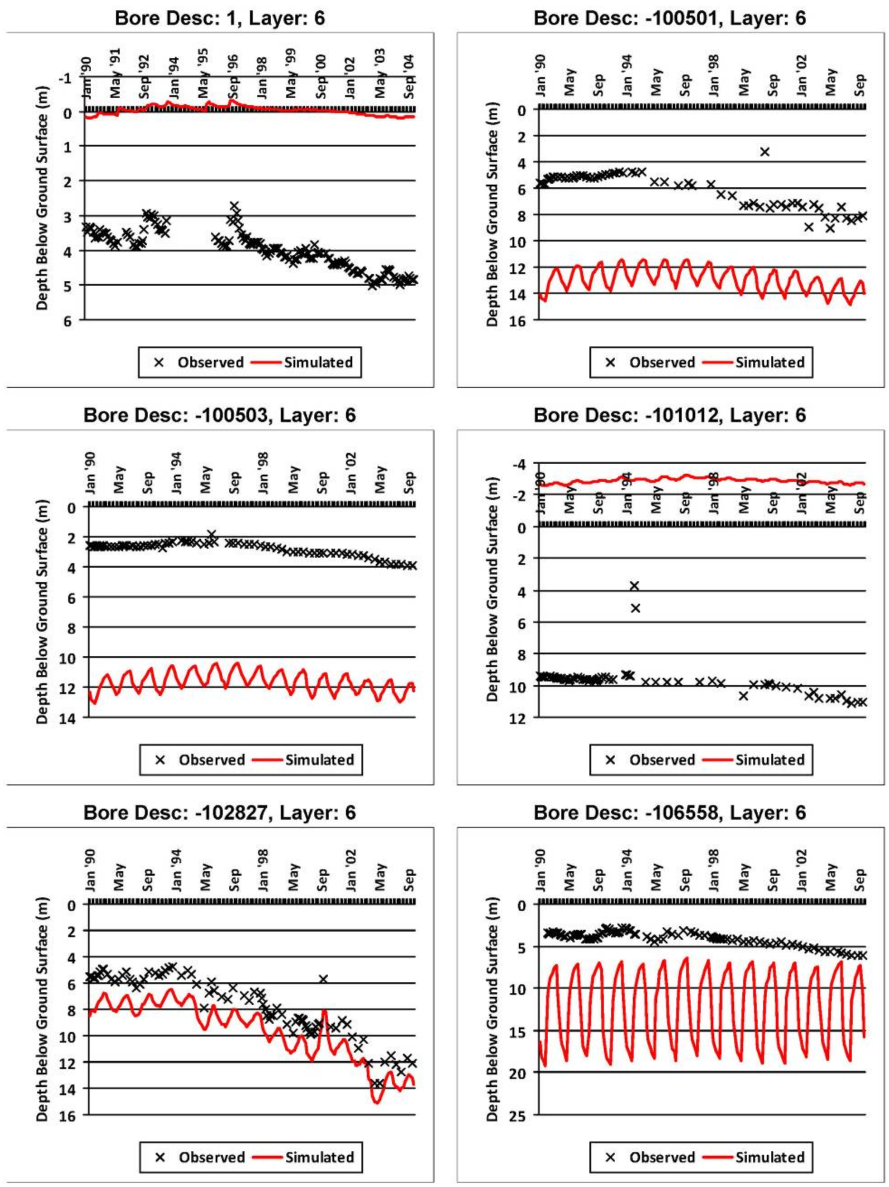


Bore Desc: -95030, Layer: 5

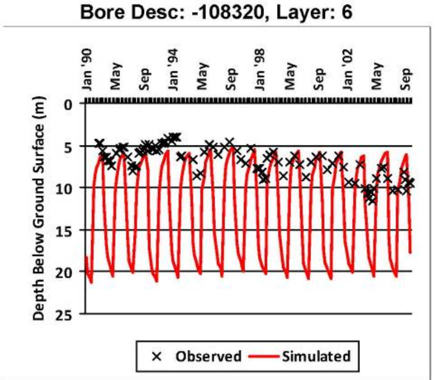



Bore Desc: -95033, Layer: 5
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
0
5
10
15
20
25
30
Observed
Simulated

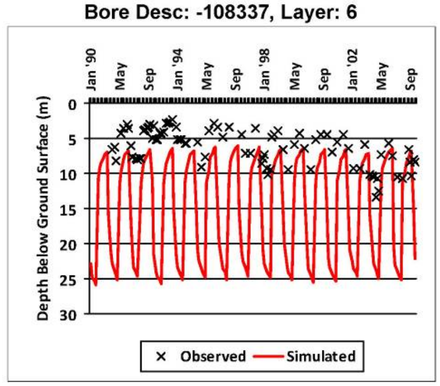
Layer 6 (Calivil Formation)



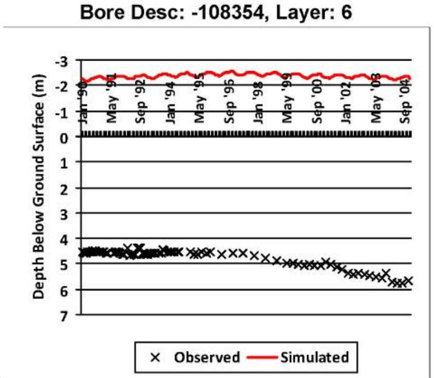
Bore Desc: -108320, Layer: 6



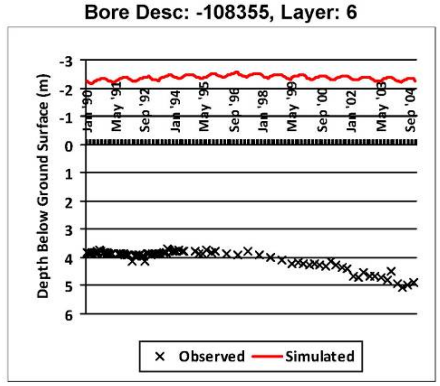
Bore Desc: -108337, Layer: 6



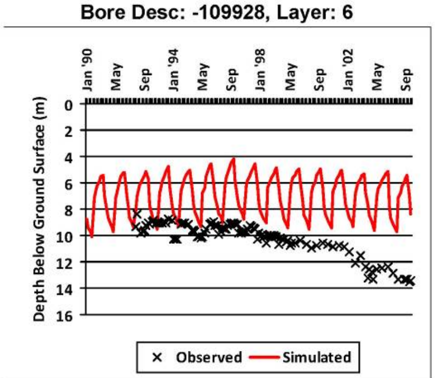
Bore Desc: -108354, Layer: 6



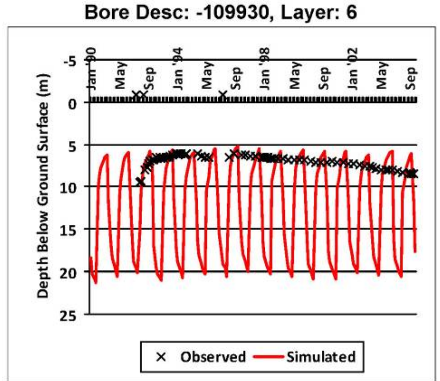
Bore Desc: -108355, Layer: 6



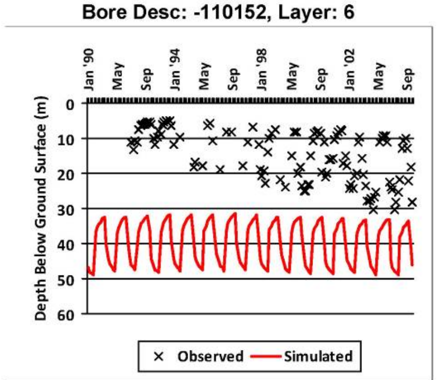
Bore Desc: -109928, Layer: 6



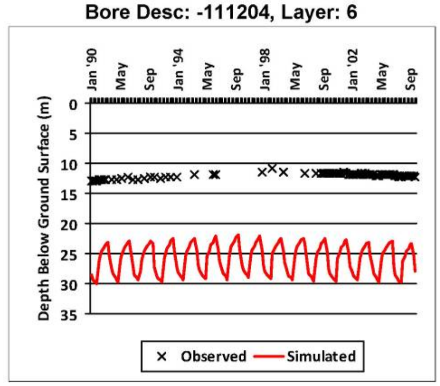
Bore Desc: -109930, Layer: 6



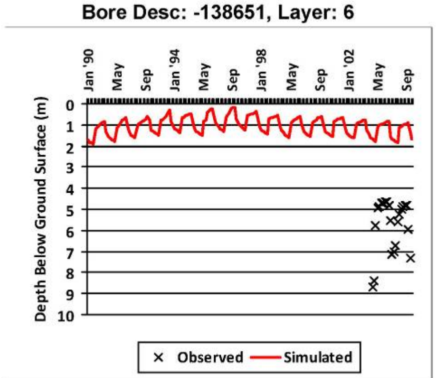
Bore Desc: -110152, Layer: 6



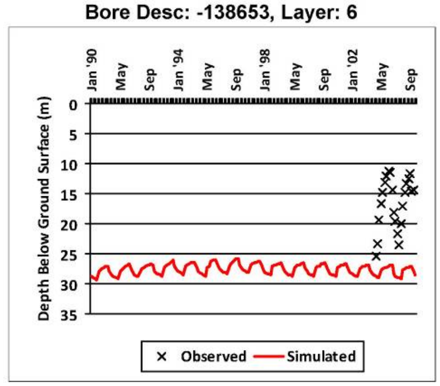
Bore Desc: -111204, Layer: 6



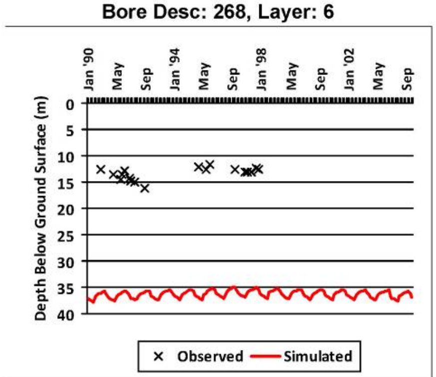
Bore Desc: -138651, Layer: 6



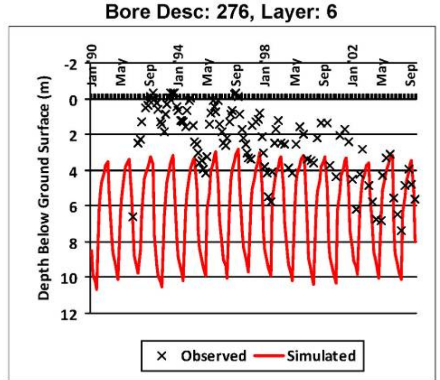
Bore Desc: -138653, Layer: 6



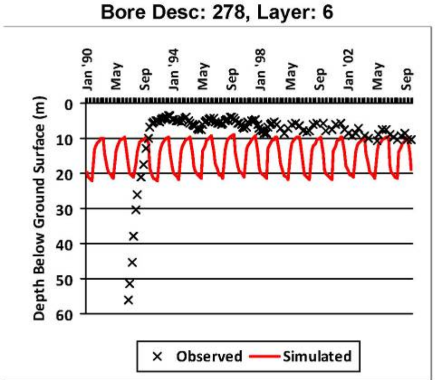
Bore Desc: 268, Layer: 6



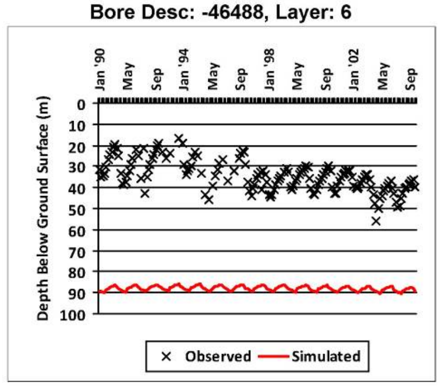
Bore Desc: 276, Layer: 6



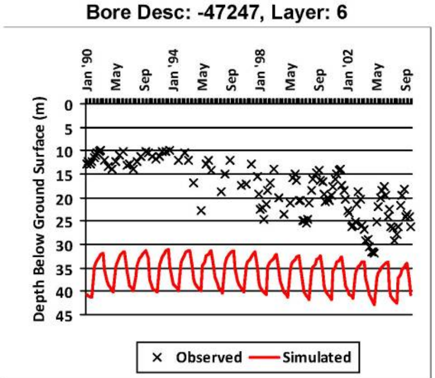
Bore Desc: 278, Layer: 6



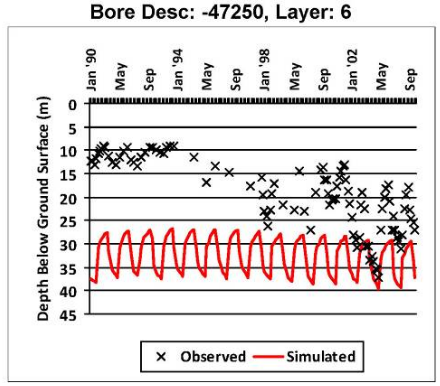
Bore Desc: -46488, Layer: 6



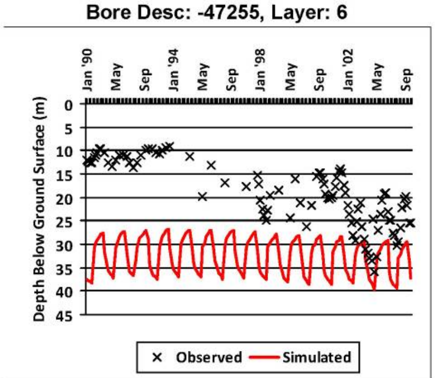
Bore Desc: -47247, Layer: 6



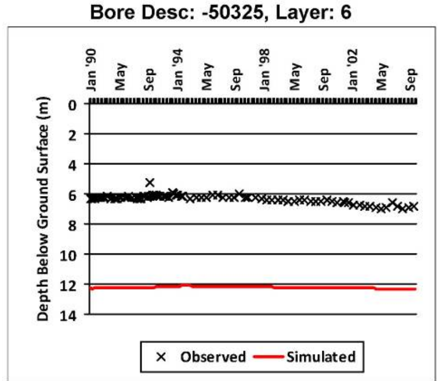
Bore Desc: -47250, Layer: 6



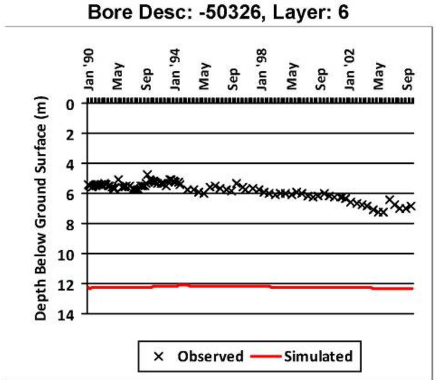
Bore Desc: -47255, Layer: 6



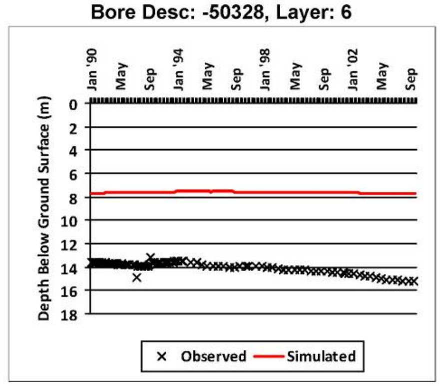
Bore Desc: -50325, Layer: 6



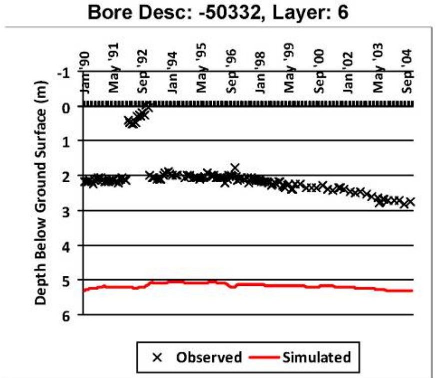
Bore Desc: -50326, Layer: 6



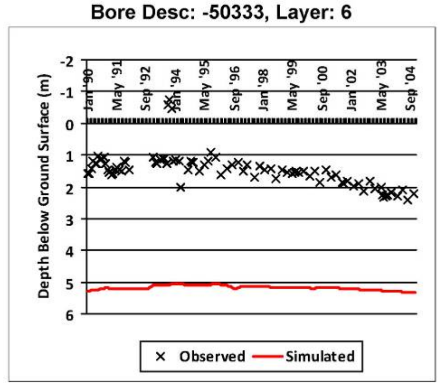
Bore Desc: -50328, Layer: 6



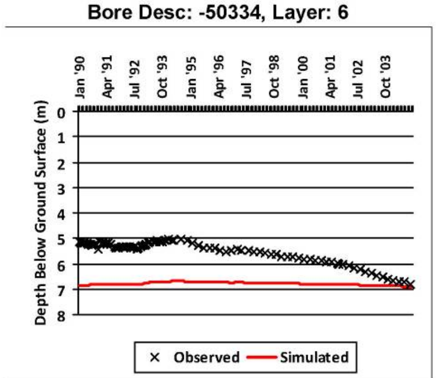
Bore Desc: -50332, Layer: 6



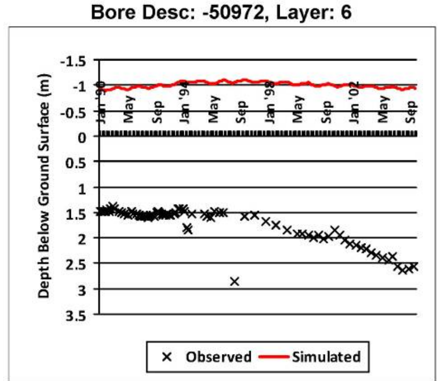
Bore Desc: -50333, Layer: 6



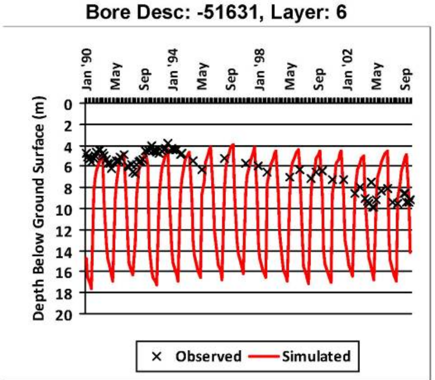
Bore Desc: -50334, Layer: 6



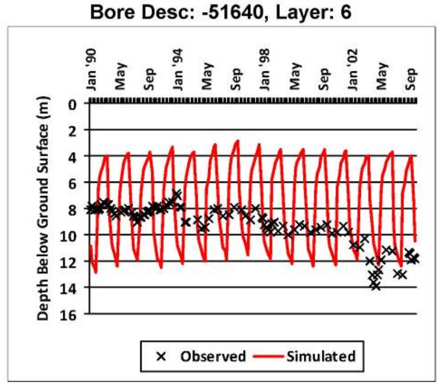
Bore Desc: -50972, Layer: 6



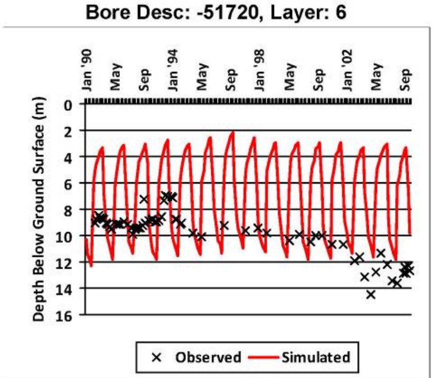
Bore Desc: -51631, Layer: 6



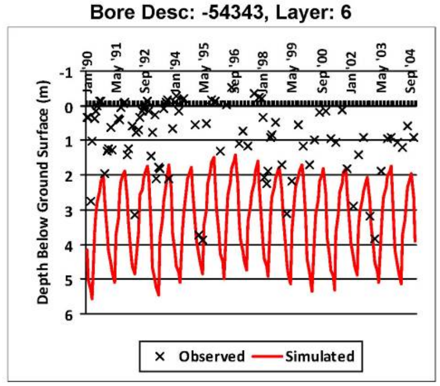
Bore Desc: -51640, Layer: 6



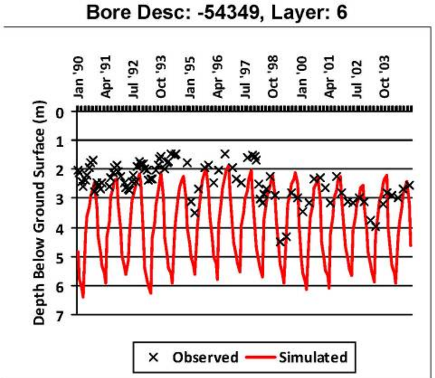
Bore Desc: -51720, Layer: 6



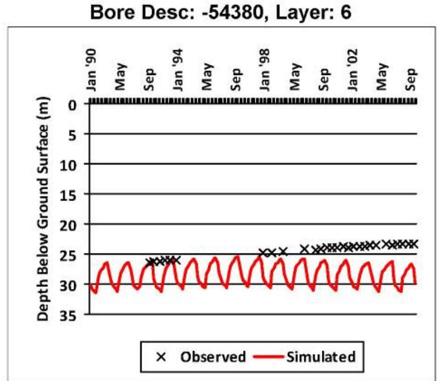
Bore Desc: -54343, Layer: 6



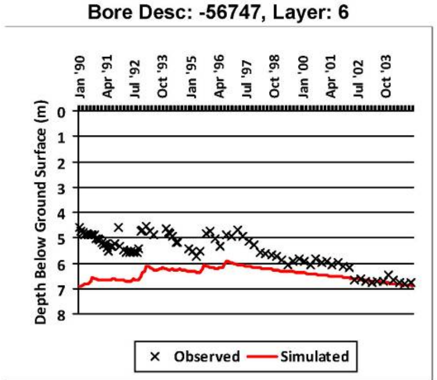
Bore Desc: -54349, Layer: 6



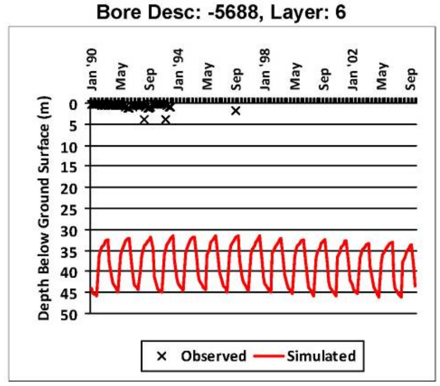
Bore Desc: -54380, Layer: 6



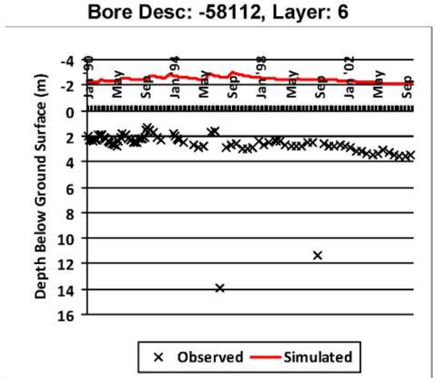
Bore Desc: -56747, Layer: 6



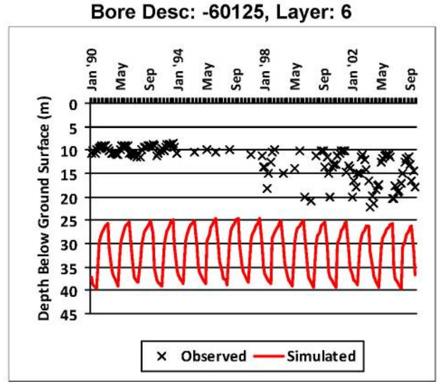
Bore Desc: -5688, Layer: 6



Bore Desc: -58112, Layer: 6



Bore Desc: -60125, Layer: 6



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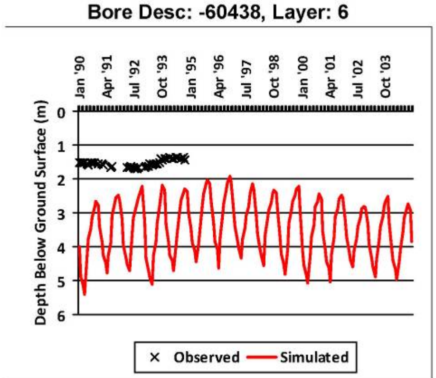
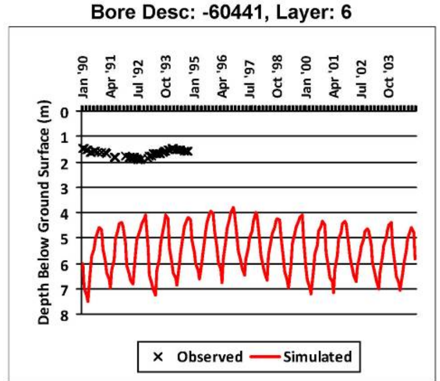
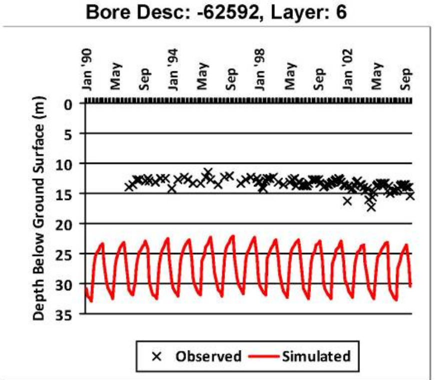


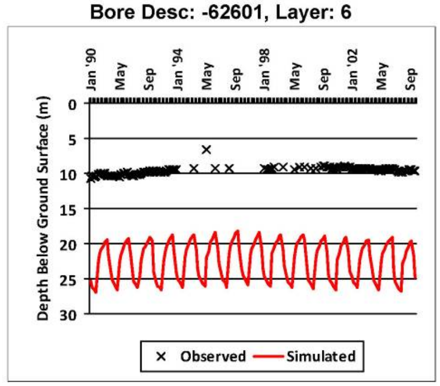
Bore Desc: -60441, Layer: 6



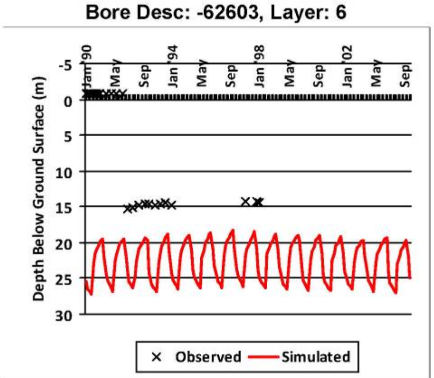
Bore Desc: -62592, Layer: 6



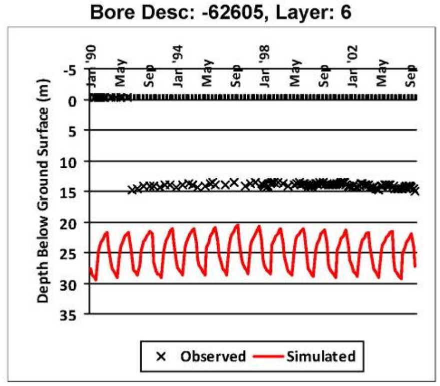
Bore Desc: -62601, Layer: 6



Bore Desc: -62603, Layer: 6



Bore Desc: -62605, Layer: 6



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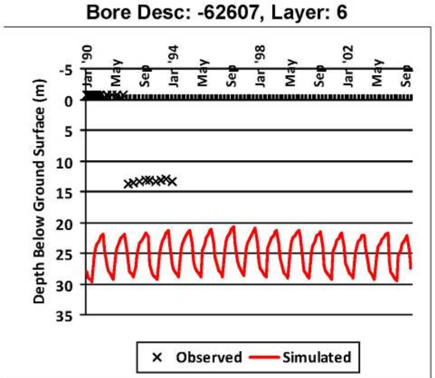

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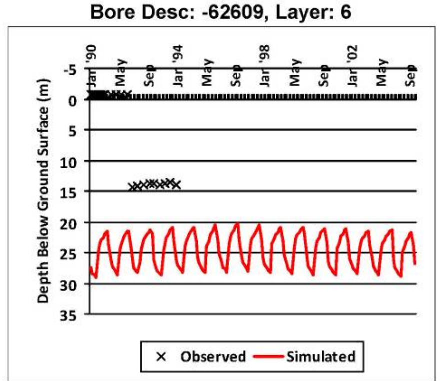
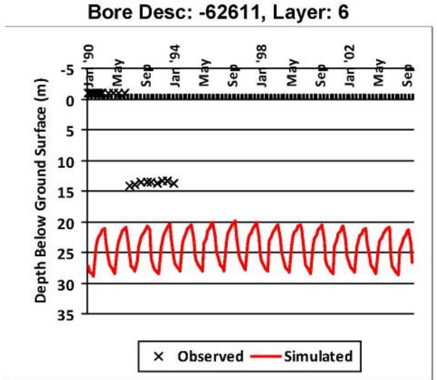
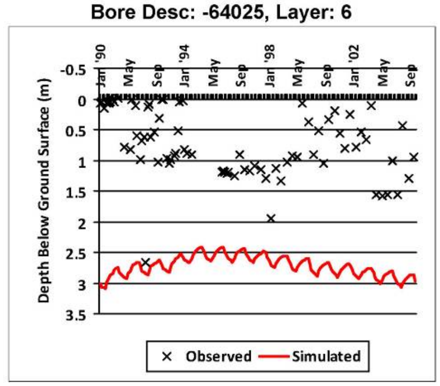


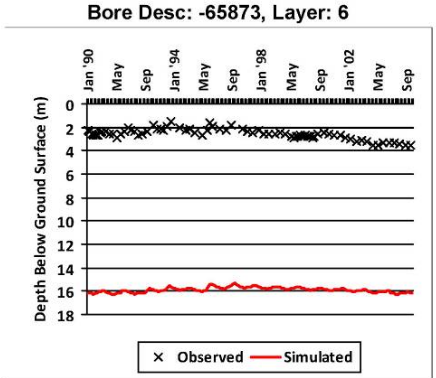
Bore Desc: -62611, Layer: 6



Bore Desc: -64025, Layer: 6



Bore Desc: -65873, Layer: 6



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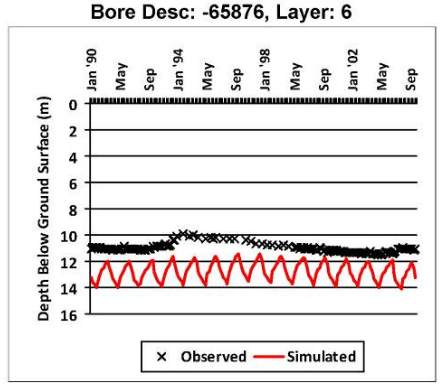
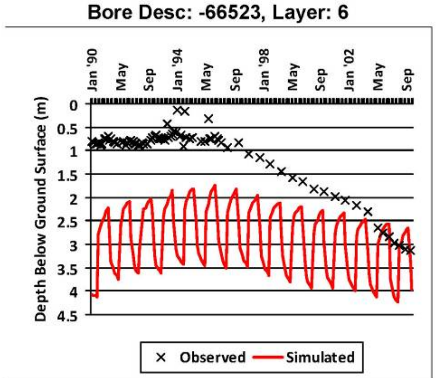
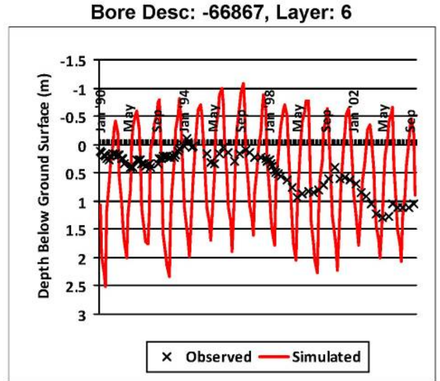
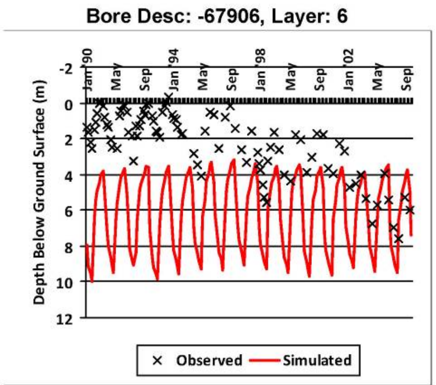


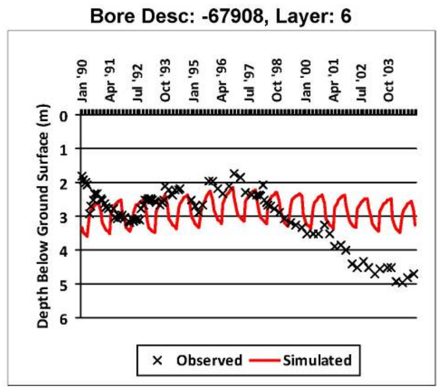
Bore Desc: -66523, Layer: 6

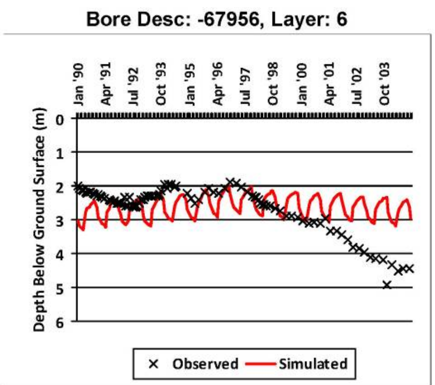


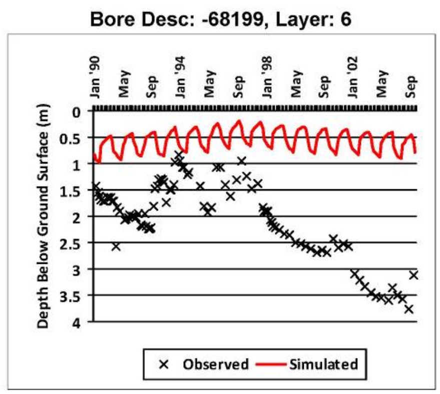
Bore Desc: -66867, Layer: 6

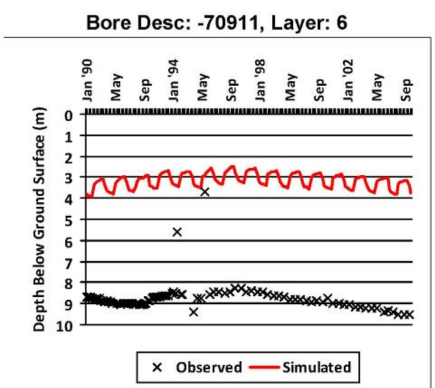


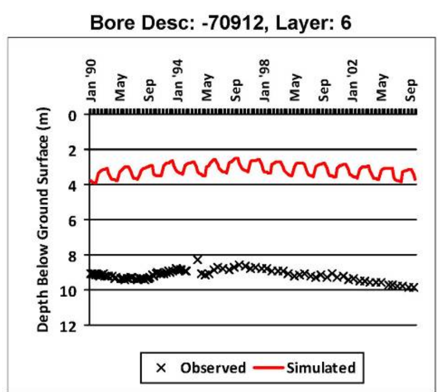

Bore Desc: -67906, Layer: 6
Depth Below Ground Surface (m)
× Observed
Simulated

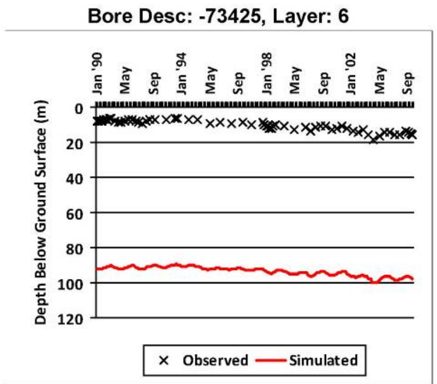

Bore Desc: -67908, Layer: 6
Depth Below Ground Surface (m)
× Observed
Simulated

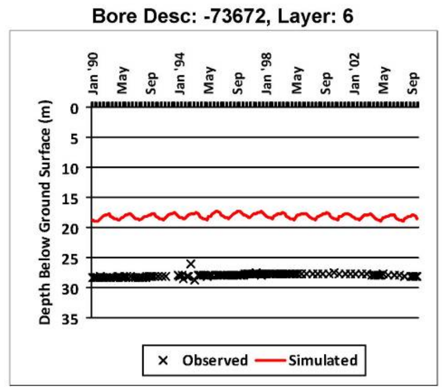

Bore Desc: -67956, Layer: 6
Depth Below Ground Surface (m)
× Observed
Simulated

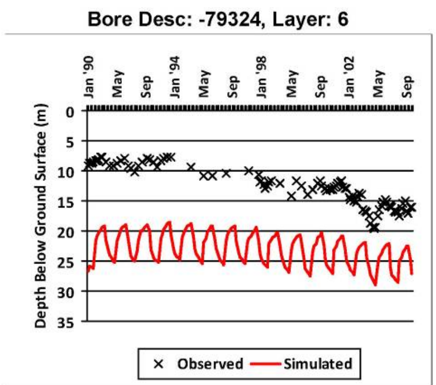

Bore Desc: -68199, Layer: 6
Depth Below Ground Surface (m)
× Observed
Simulated

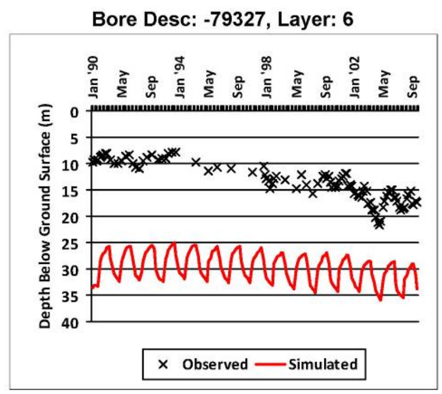

Bore Desc: -70911, Layer: 6
Depth Below Ground Surface (m)
× Observed
Simulated

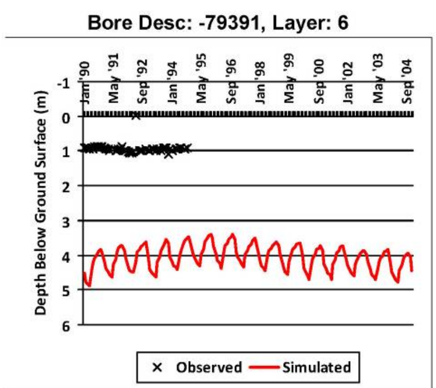

Bore Desc: -70912, Layer: 6
Depth Below Ground Surface (m)
× Observed
Simulated

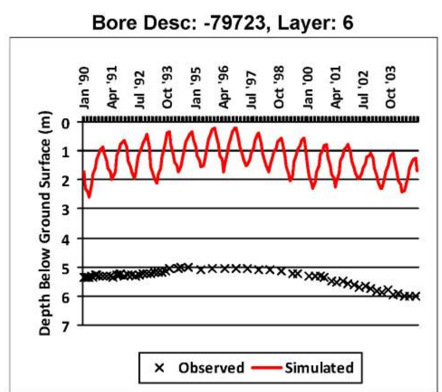

Bore Desc: -73425, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -73672, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated

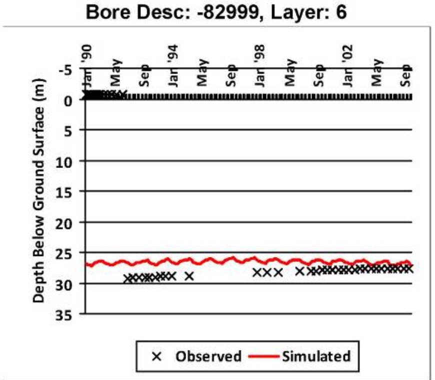

Bore Desc: -79324, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -79327, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated

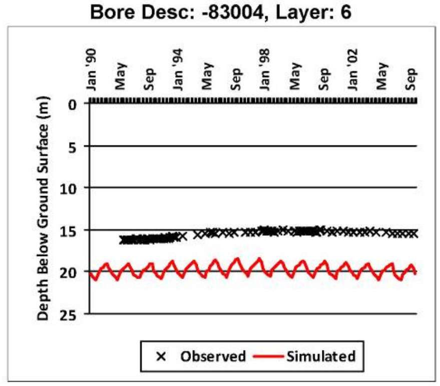

Bore Desc: -79391, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -79723, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated

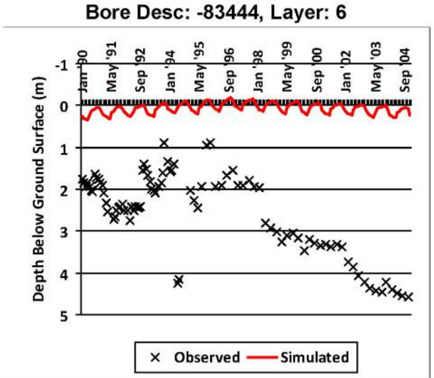
Bore Desc: -82999, Layer: 6



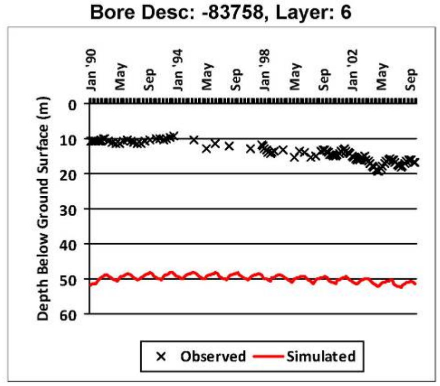
Bore Desc: -83004, Layer: 6



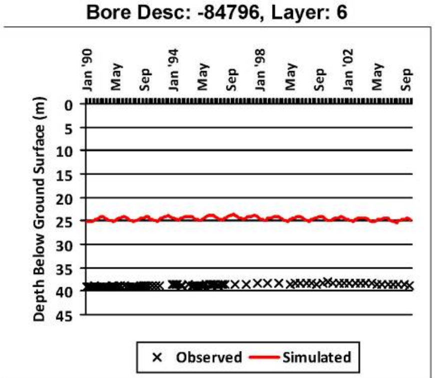
Bore Desc: -83444, Layer: 6



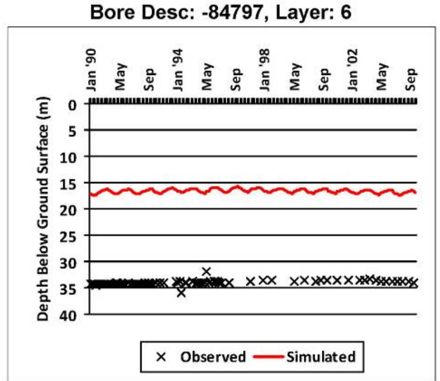
Bore Desc: -83758, Layer: 6

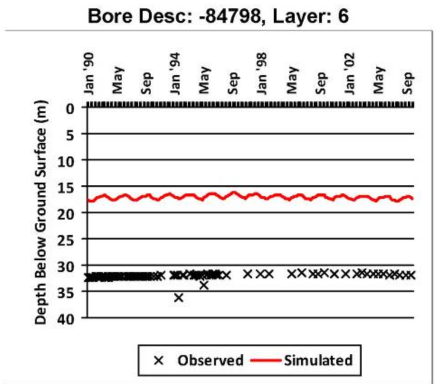


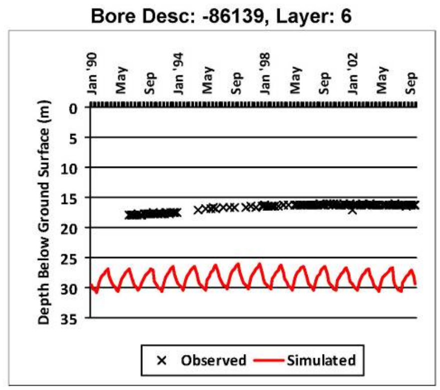
Bore Desc: -84796, Layer: 6

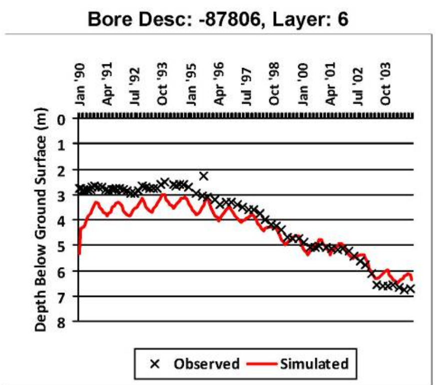


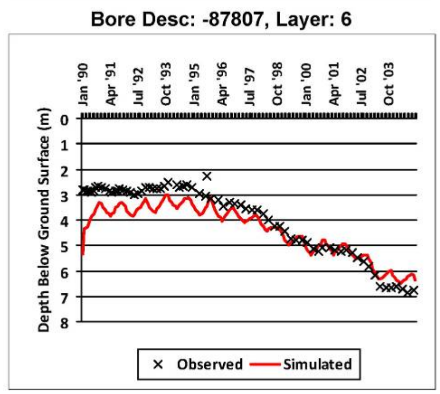
Bore Desc: -84797, Layer: 6

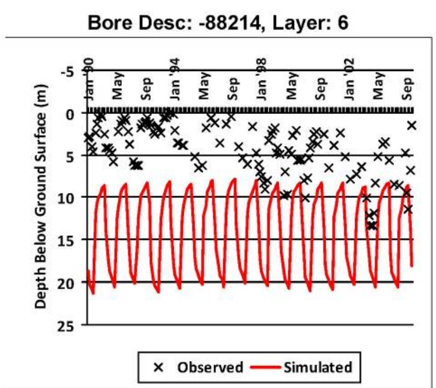


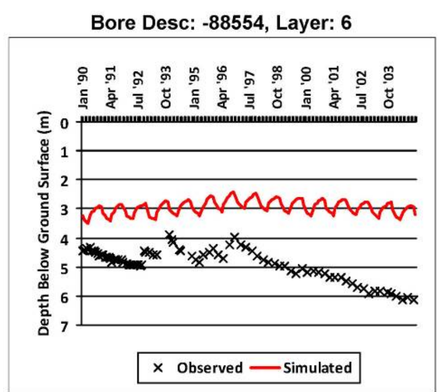

Bore Desc: -84798, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -86139, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated

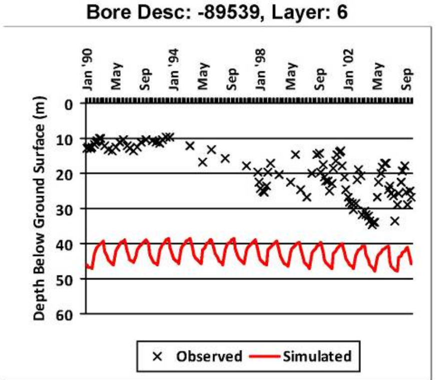

Bore Desc: -87806, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -87807, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated

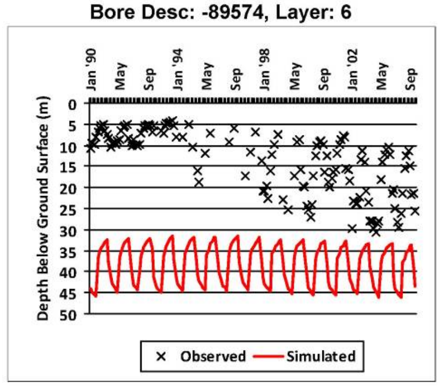

Bore Desc: -88214, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -88554, Layer: 6
Depth Below Ground Surface (m)
Observed
Simulated

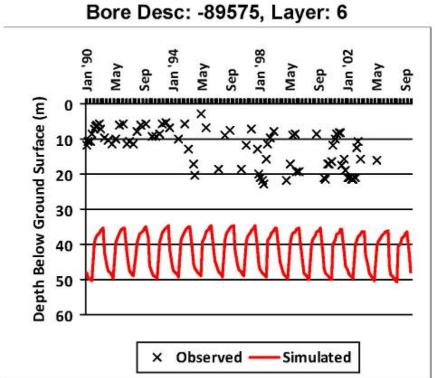
Bore Desc: -89539, Layer: 6



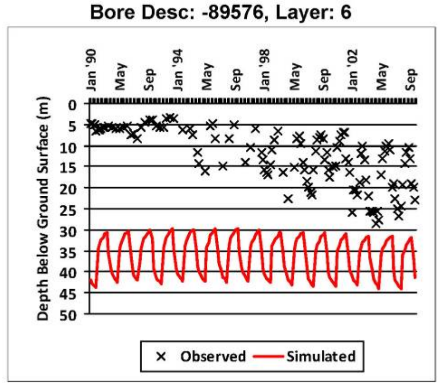
Bore Desc: -89574, Layer: 6



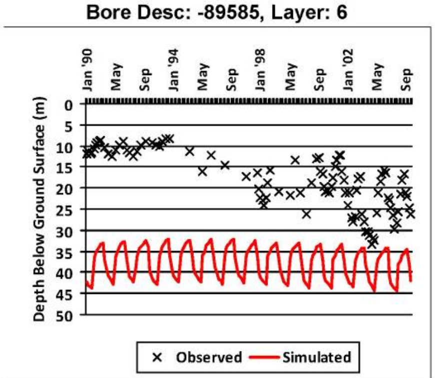
Bore Desc: -89575, Layer: 6



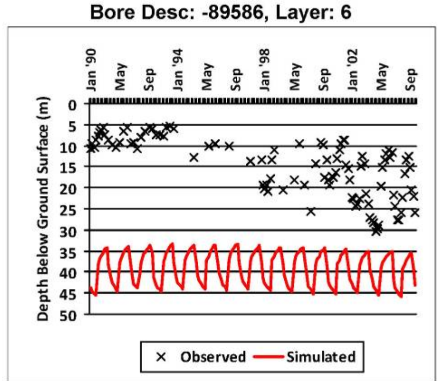
Bore Desc: -89576, Layer: 6

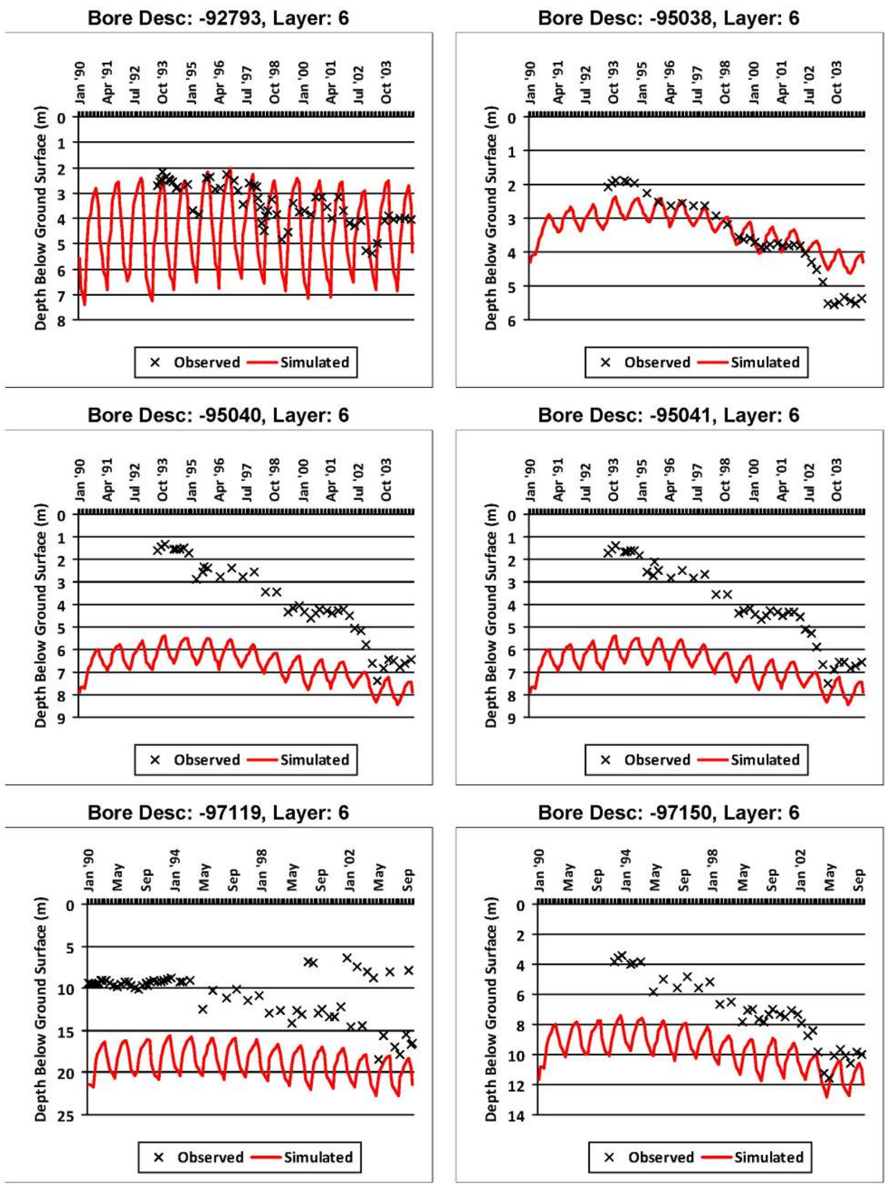


Bore Desc: -89585, Layer: 6



Bore Desc: -89586, Layer: 6



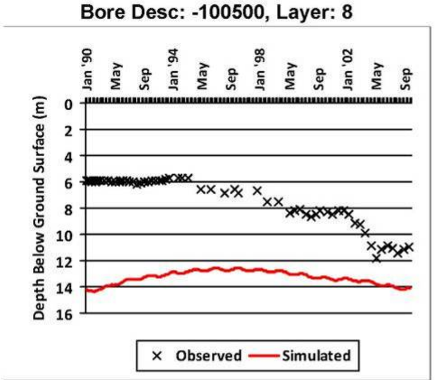


Layer 7 (Tertiary aquitard)

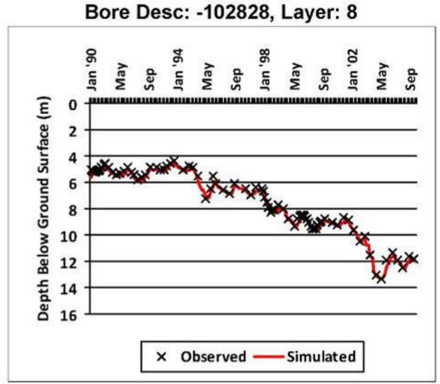
No observation bores

Layer 8 (Renmark Group)

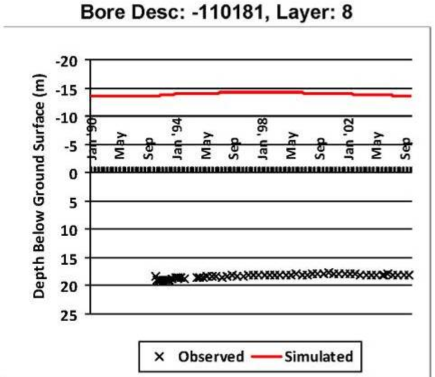
Bore Desc: -100500, Layer: 8



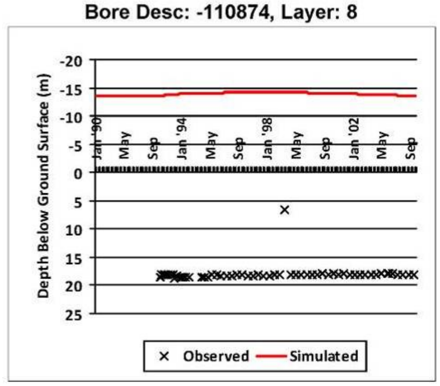
Bore Desc: -102828, Layer: 8



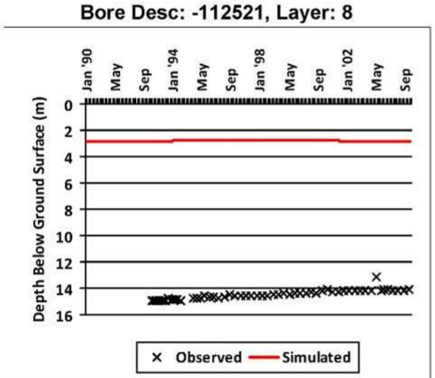
Bore Desc: -110181, Layer: 8



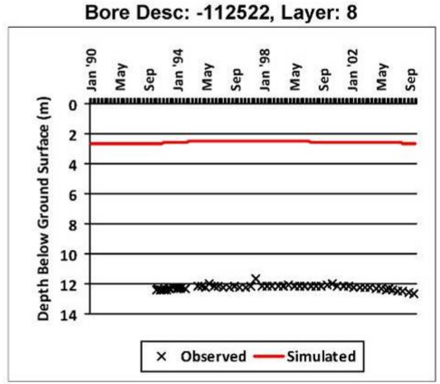
Bore Desc: -110874, Layer: 8



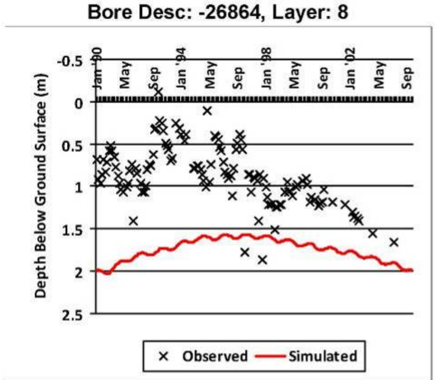
Bore Desc: -112521, Layer: 8



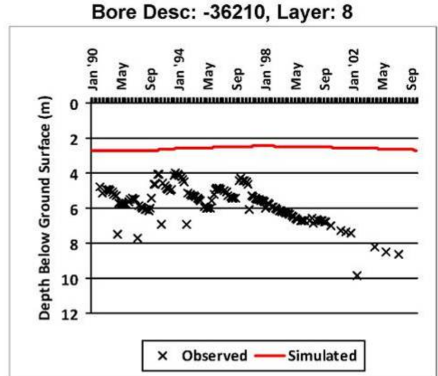
Bore Desc: -112522, Layer: 8



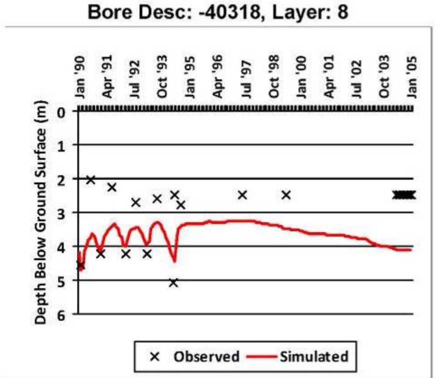
Bore Desc: -26864, Layer: 8



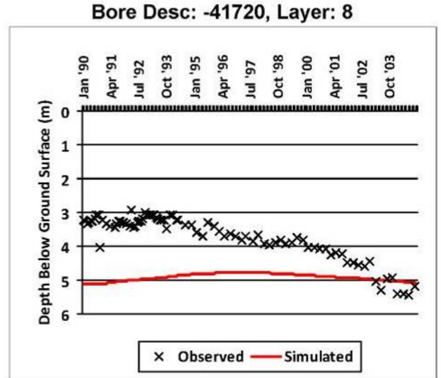
Bore Desc: -36210, Layer: 8



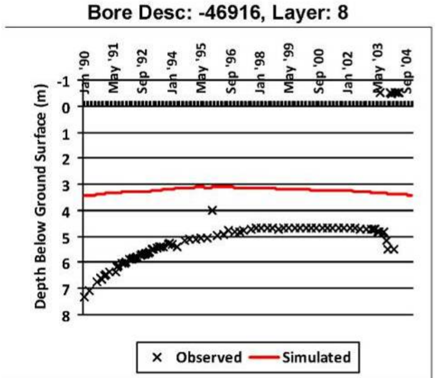
Bore Desc: -40318, Layer: 8



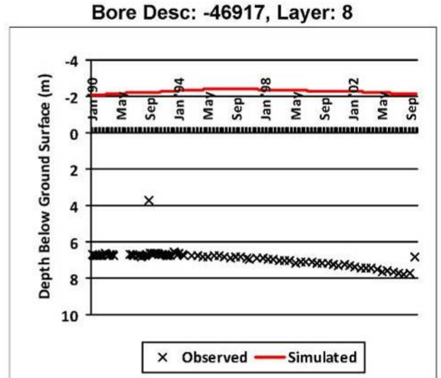
Bore Desc: -41720, Layer: 8



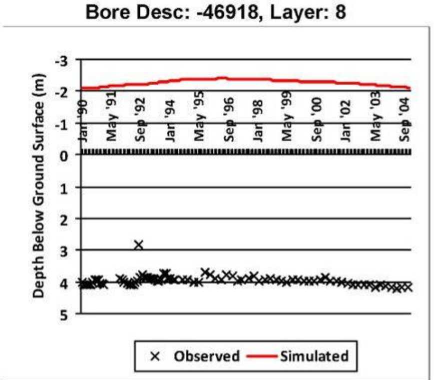
Bore Desc: -46916, Layer: 8



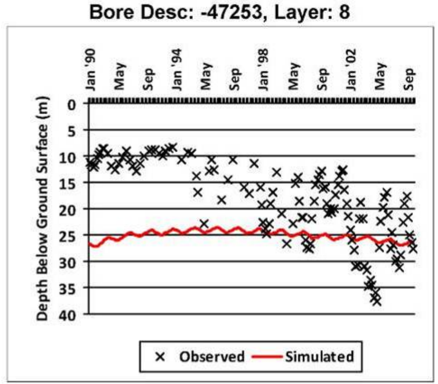
Bore Desc: -46917, Layer: 8



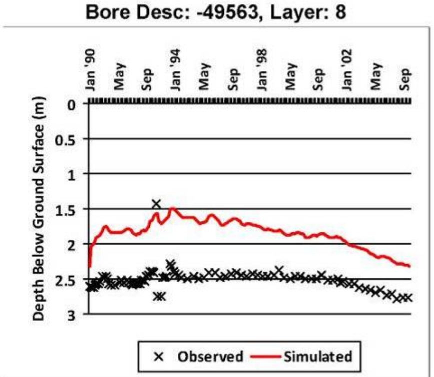
Bore Desc: -46918, Layer: 8



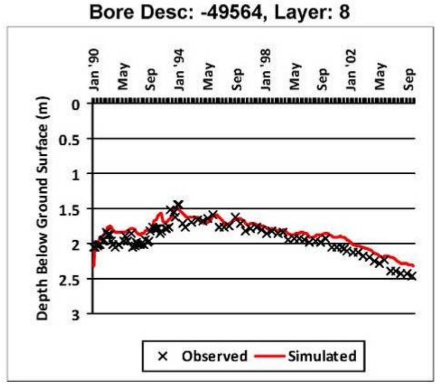
Bore Desc: -47253, Layer: 8



Bore Desc: -49563, Layer: 8



Bore Desc: -49564, Layer: 8



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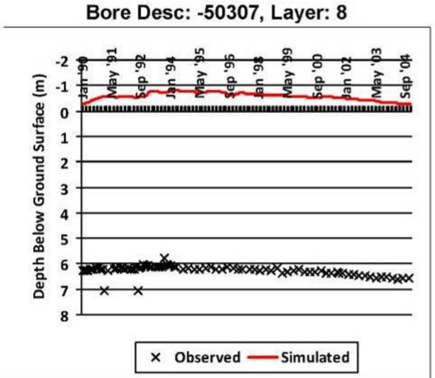

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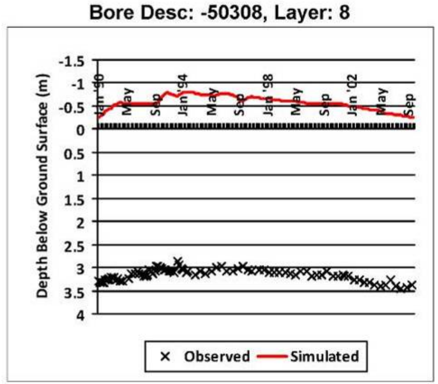

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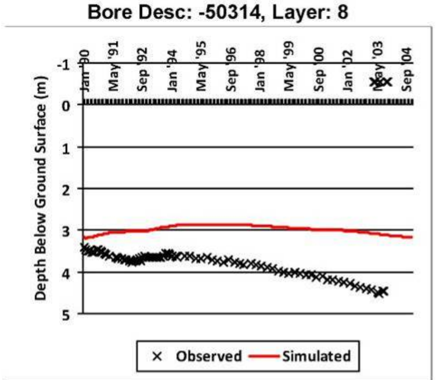

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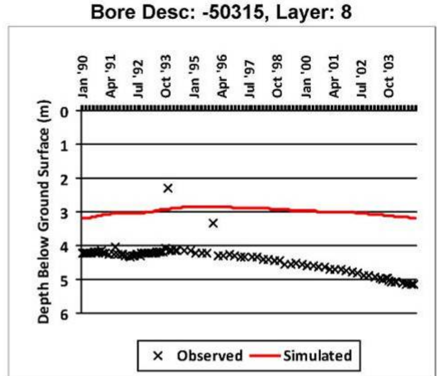

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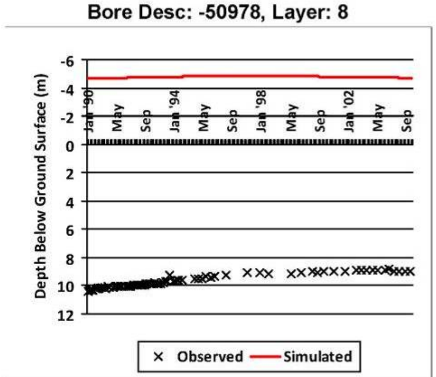

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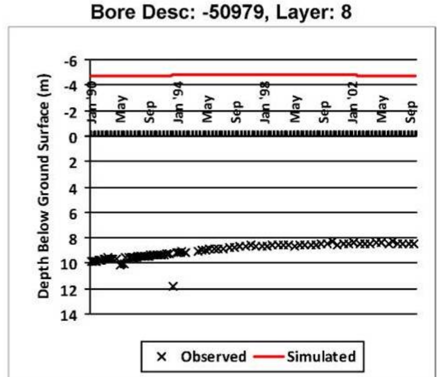

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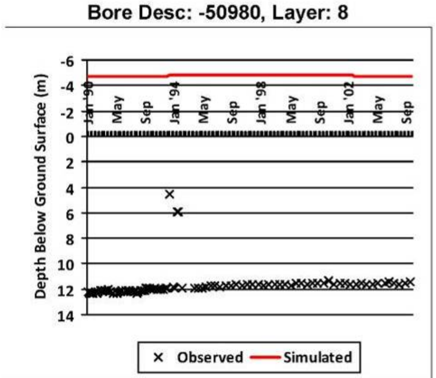

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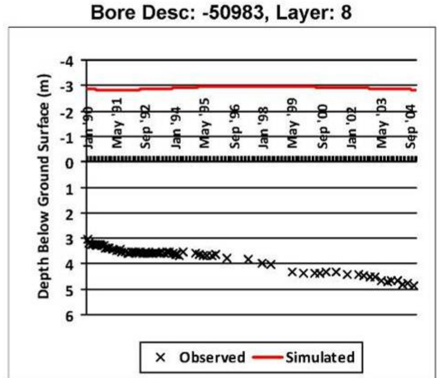

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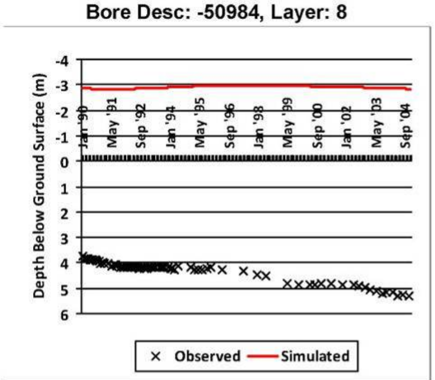

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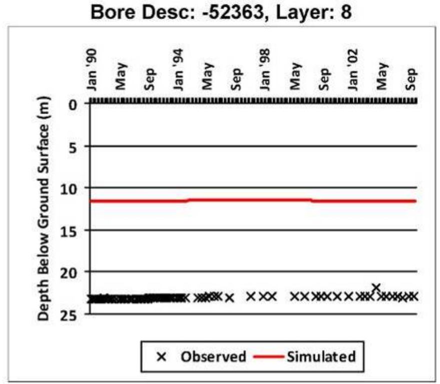

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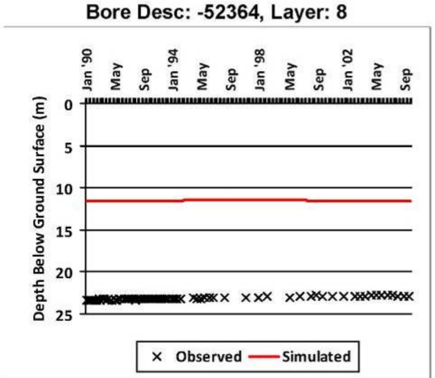

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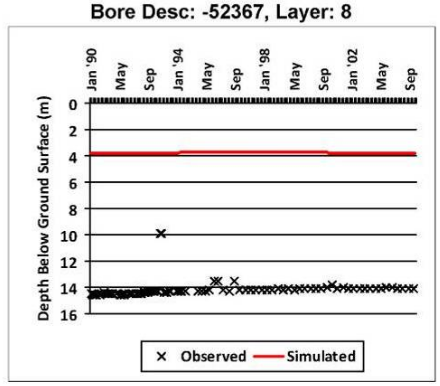

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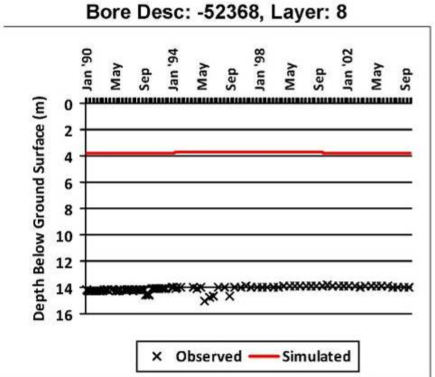

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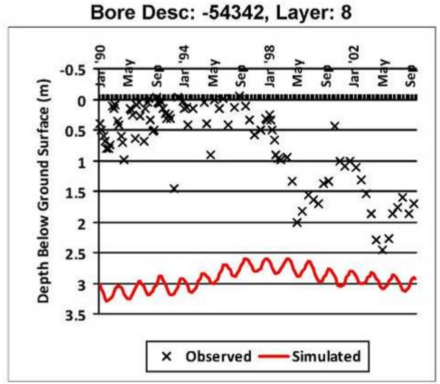

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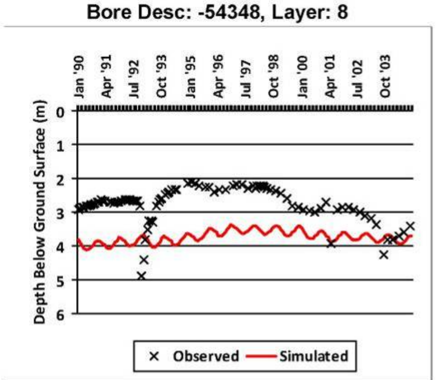

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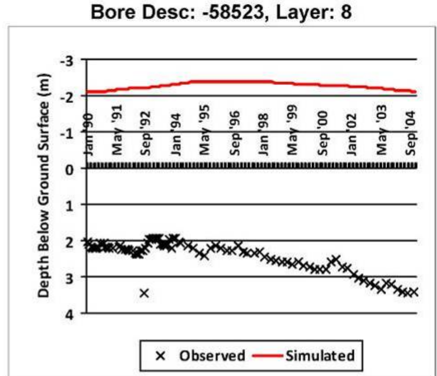

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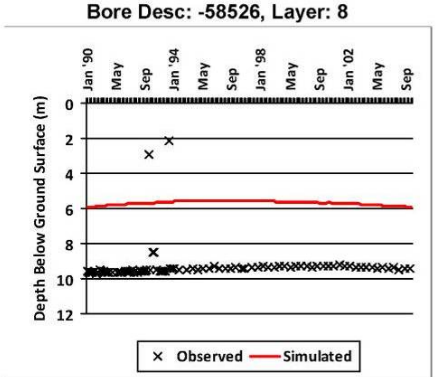

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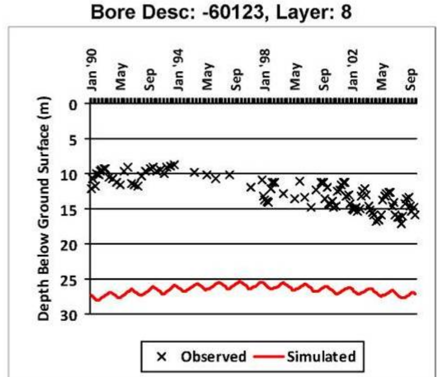

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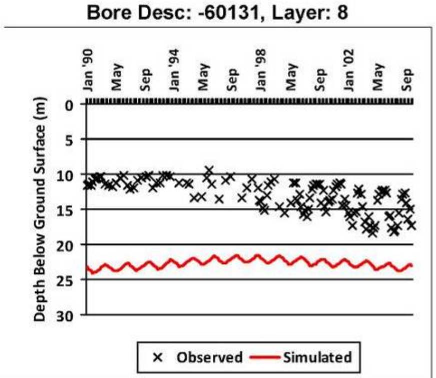

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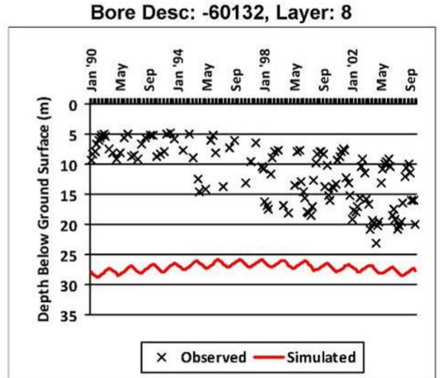

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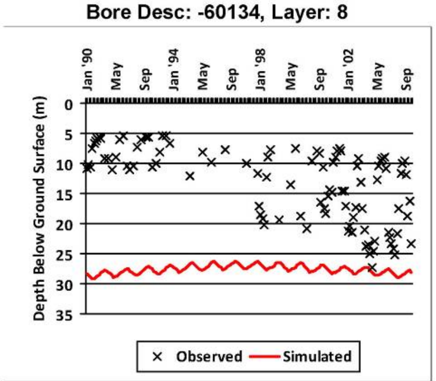

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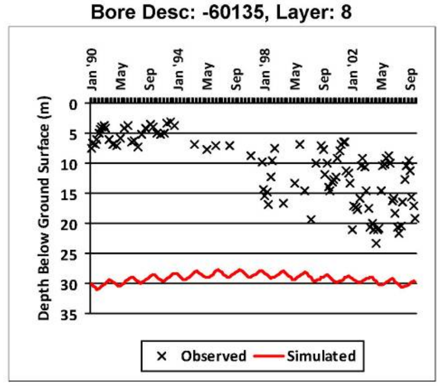

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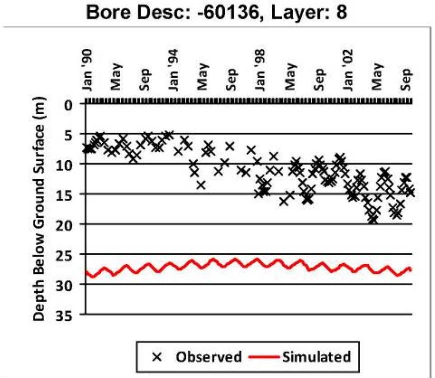

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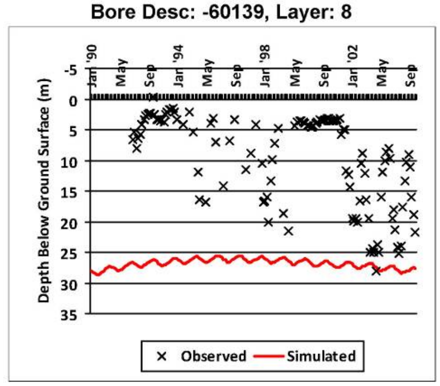

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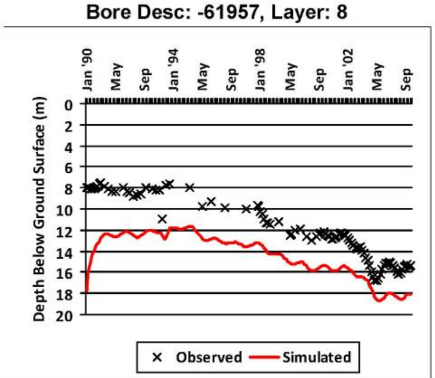

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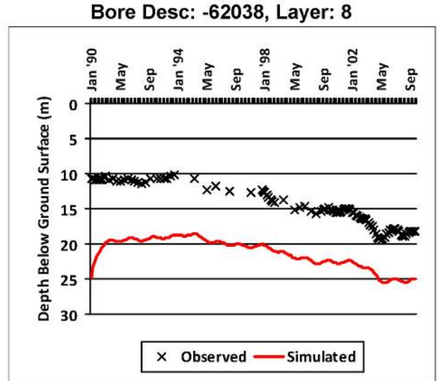
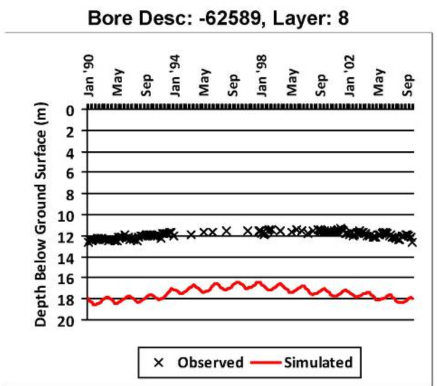
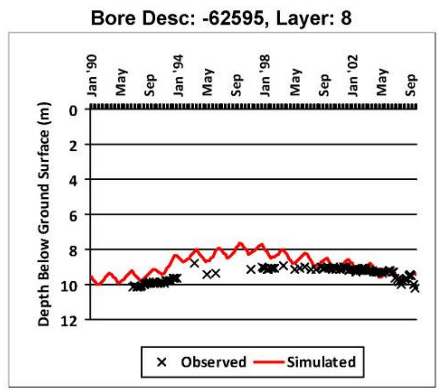



Bore Desc: -62589, Layer: 8
Depth Below Ground Surface (m)
× Observed
Simulated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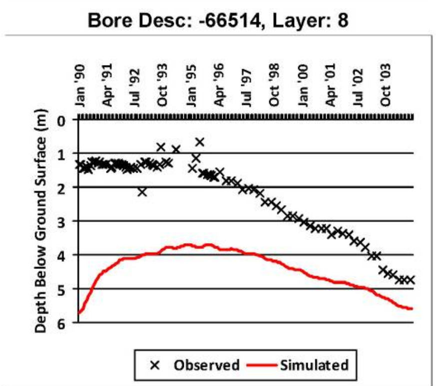
Depth Below Ground Surface (m)
× Observed
Simulated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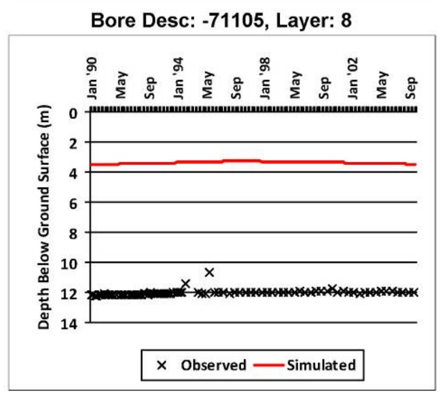
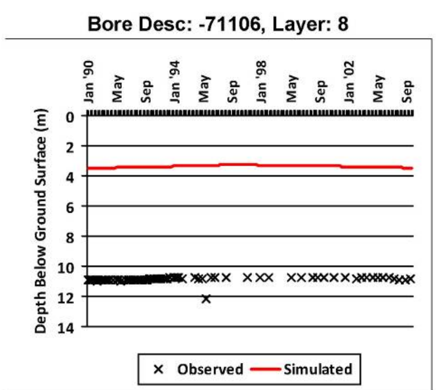
Depth Below Ground Surface (m)
× Observed
Simulated


Bore Desc: -71105, Layer: 8
Depth Below Ground Surface (m)
× Observed
Simulated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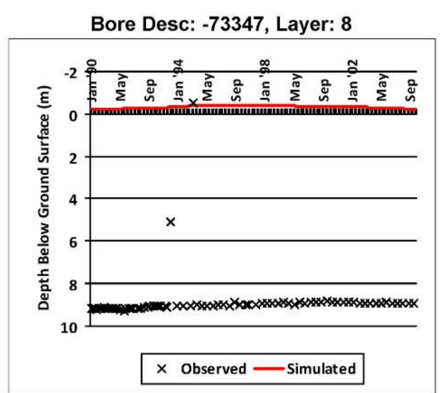
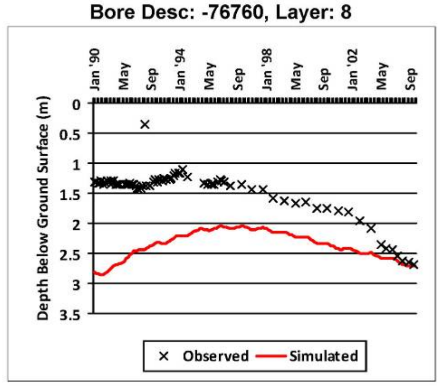
× Observed
Simulated


Bore Desc: -73347, Layer: 8
Depth Below Ground Surface (m)
× Observed
Simulated

Bore Desc: -75323, Layer: 8

Bore Desc: -76760, Layer: 8



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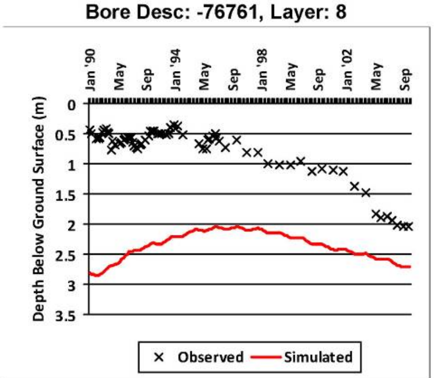

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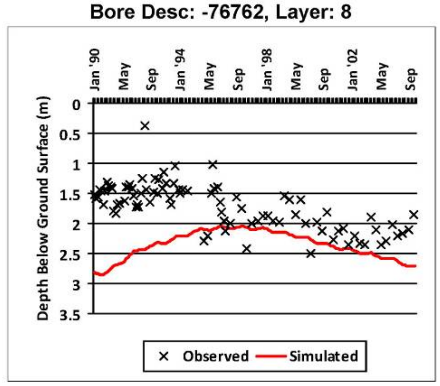

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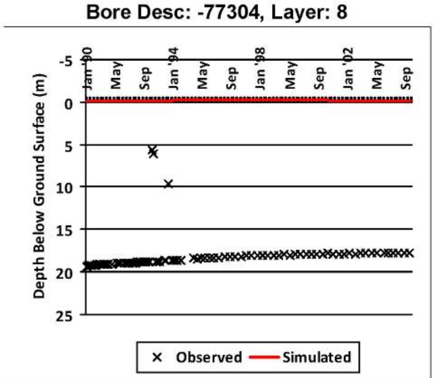

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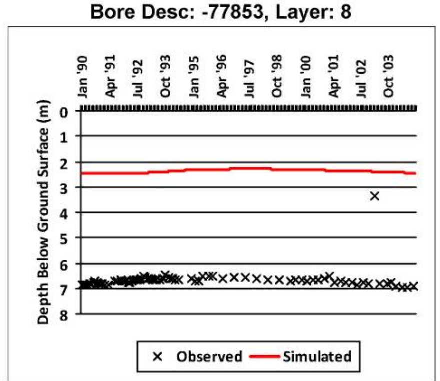

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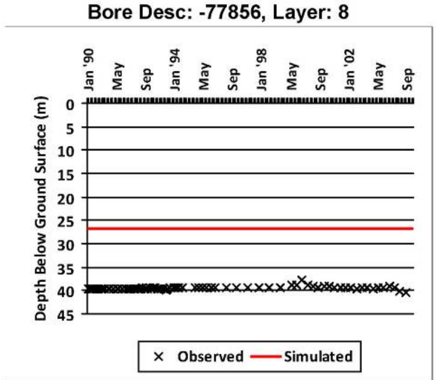

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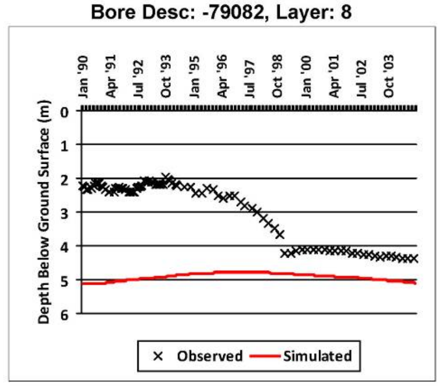

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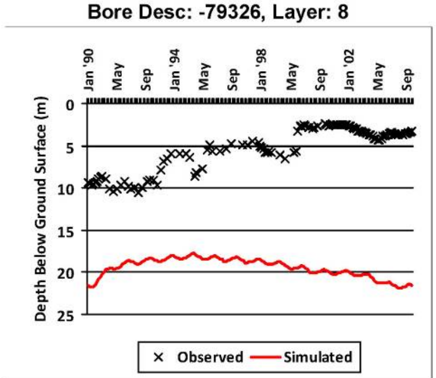

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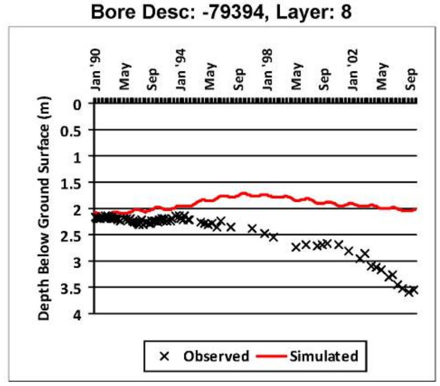

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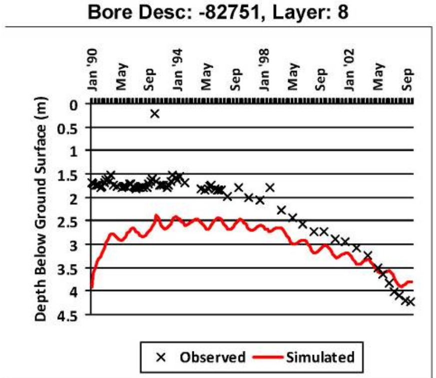

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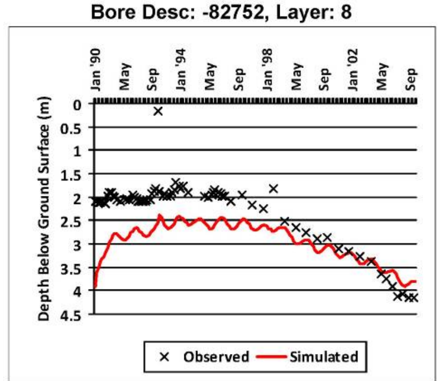

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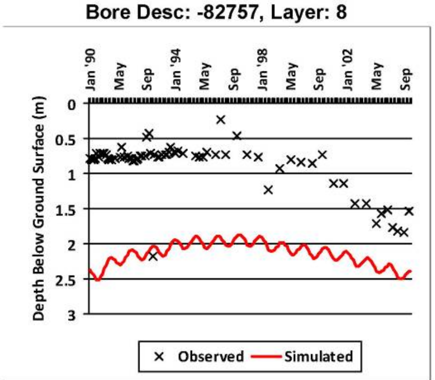

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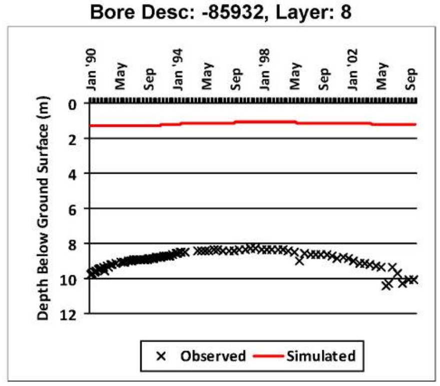

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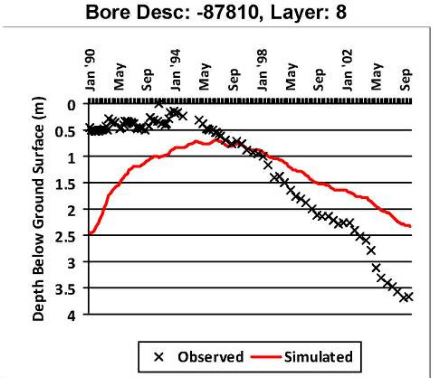

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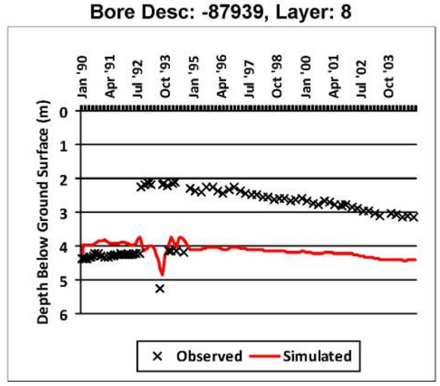

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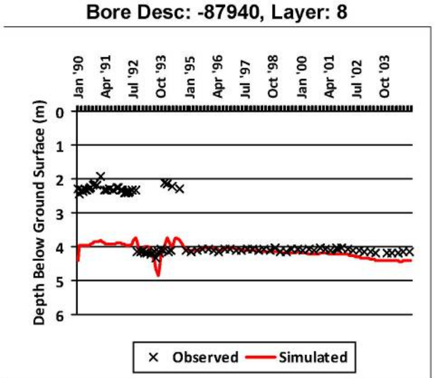

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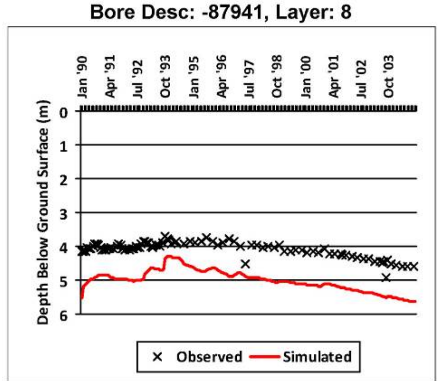

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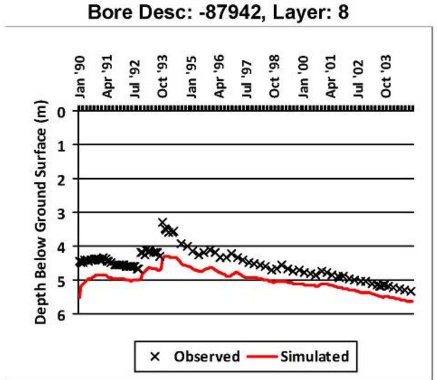

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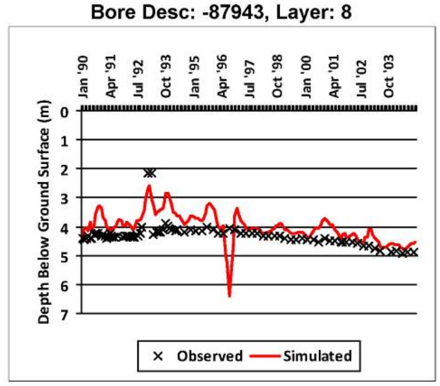

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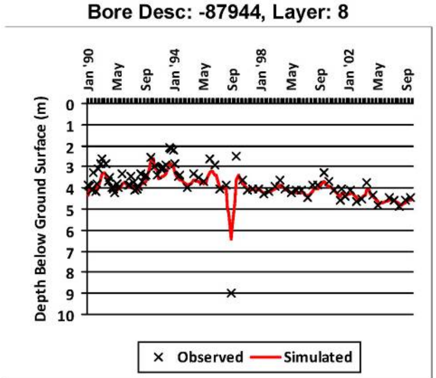

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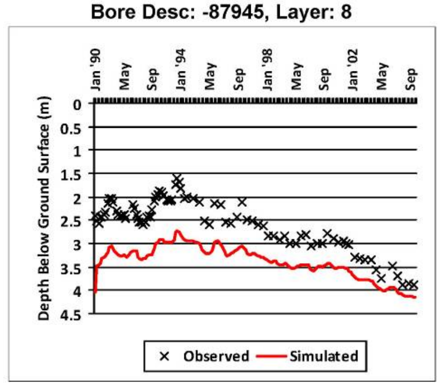

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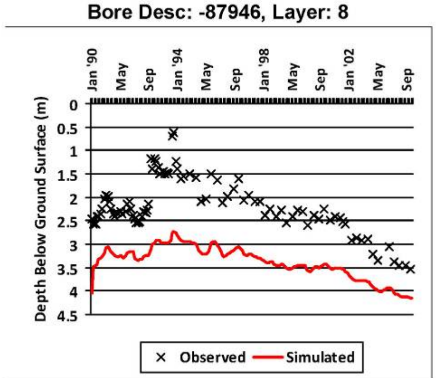

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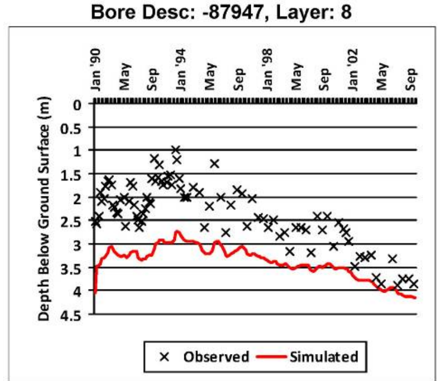

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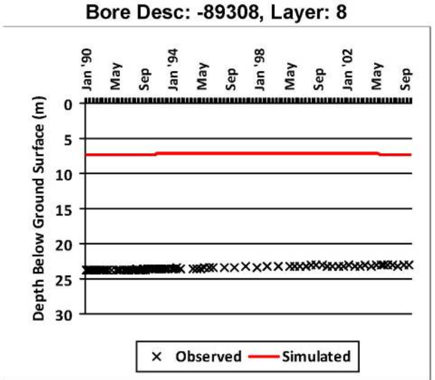

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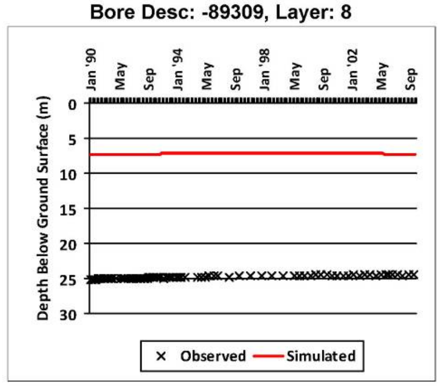

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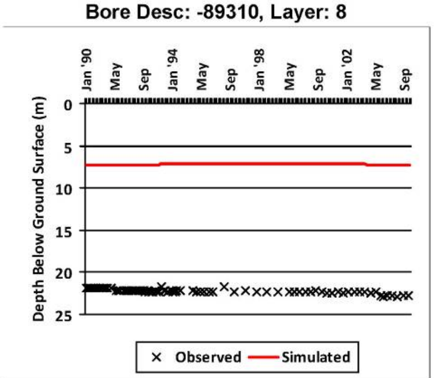

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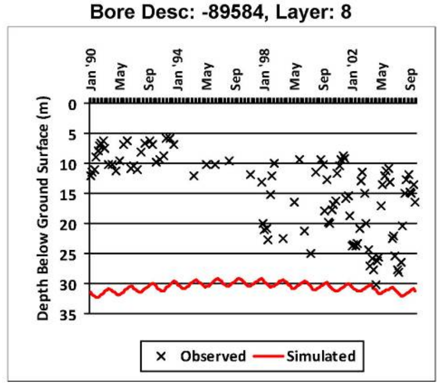

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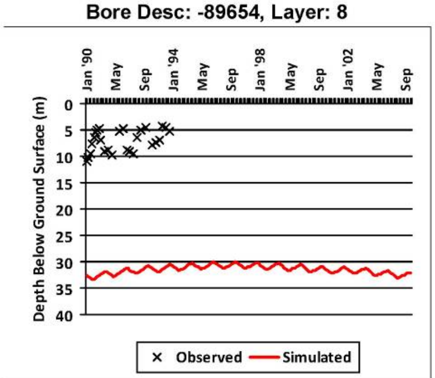

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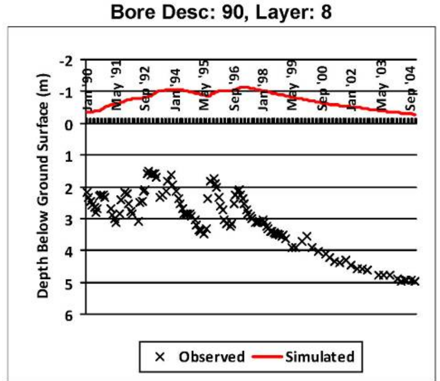

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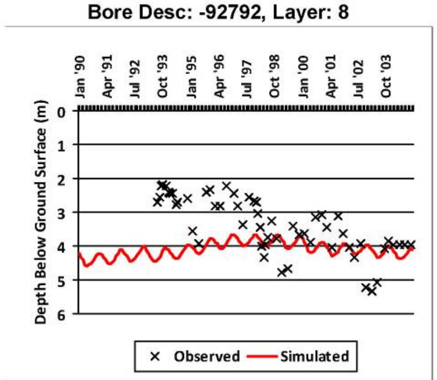

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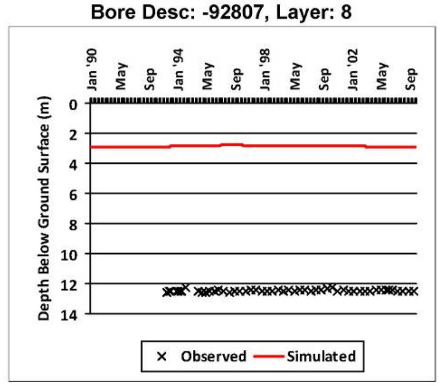

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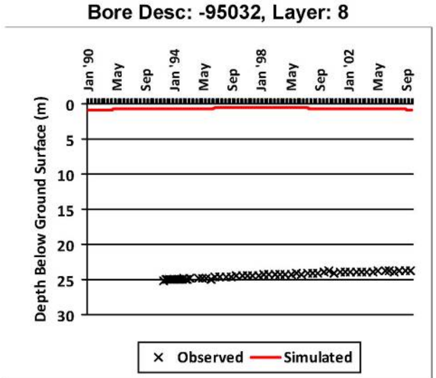

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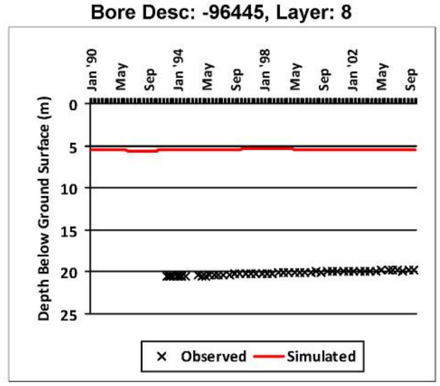

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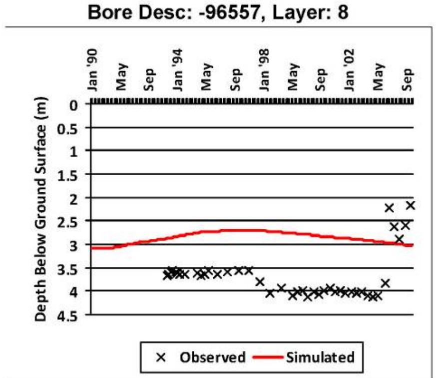
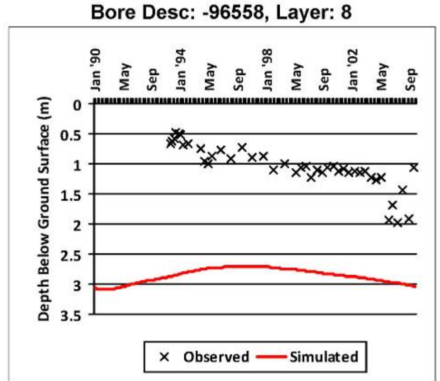
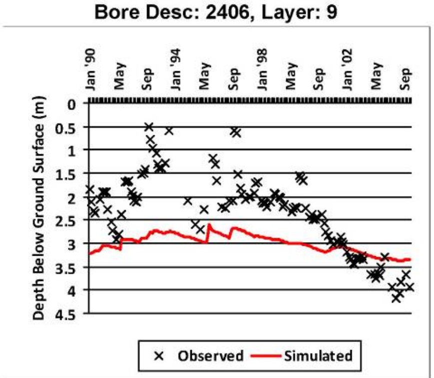


Bore Desc: -96558, Layer: 8

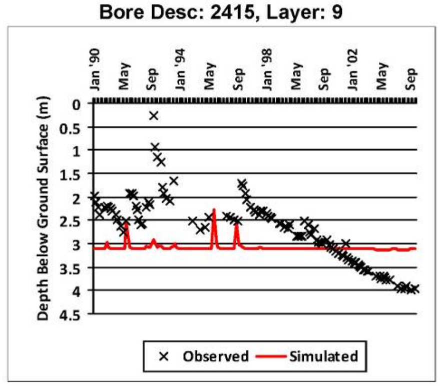


Layer 9 (Deeply weathered Palaeozoic basement)

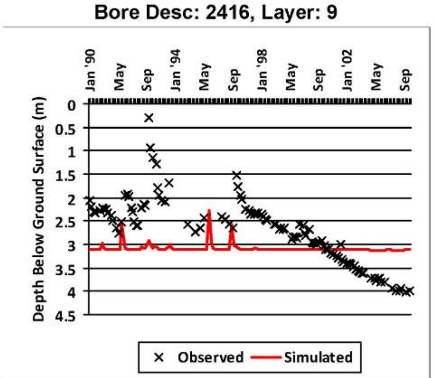
Bore Desc: 2406, Layer: 9



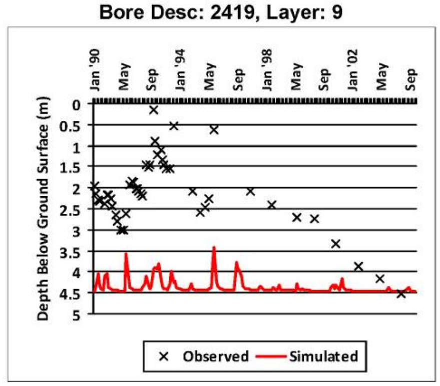
Bore Desc: 2415, Layer: 9



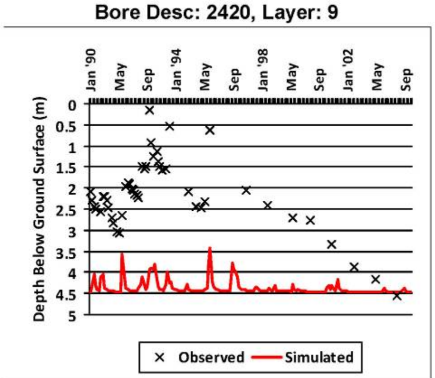
Bore Desc: 2416, Layer: 9



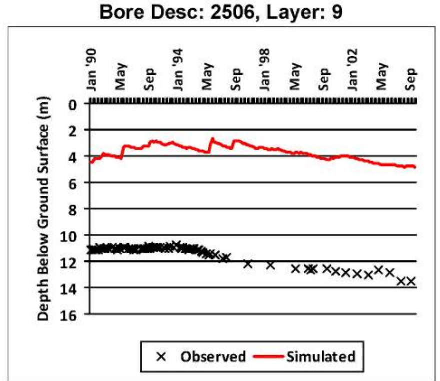
Bore Desc: 2419, Layer: 9



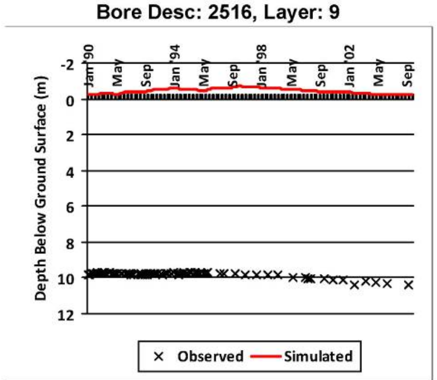
Bore Desc: 2420, Layer: 9



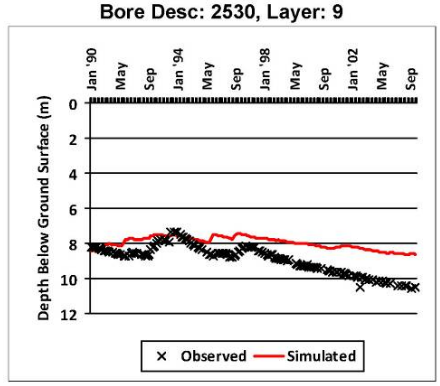
Bore Desc: 2506, Layer: 9



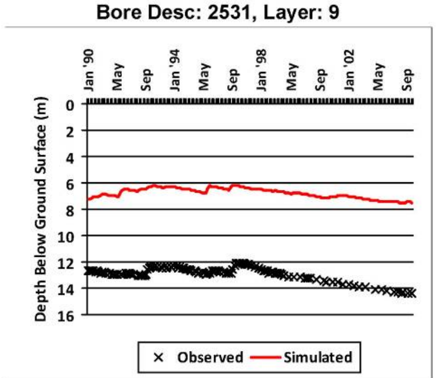
Bore Desc: 2516, Layer: 9



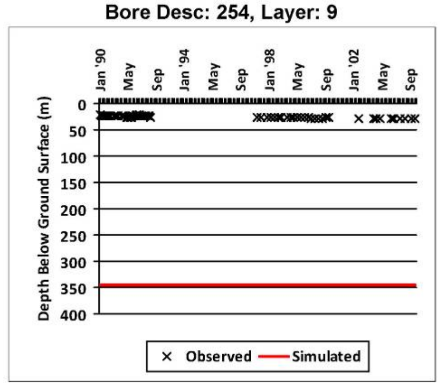
Bore Desc: 2530, Layer: 9



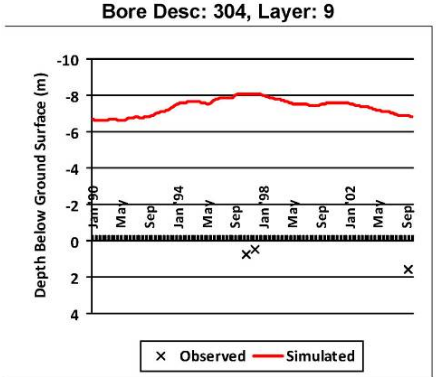
Bore Desc: 2531, Layer: 9



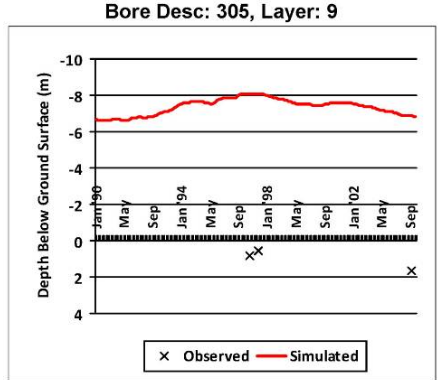
Bore Desc: 254, Layer: 9



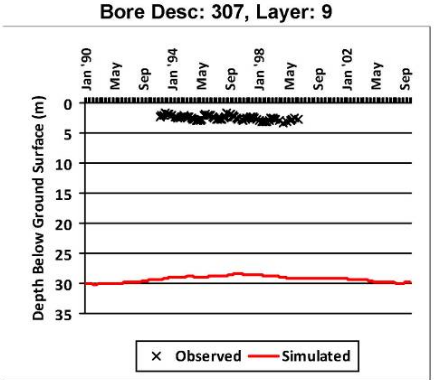
Bore Desc: 304, Layer: 9



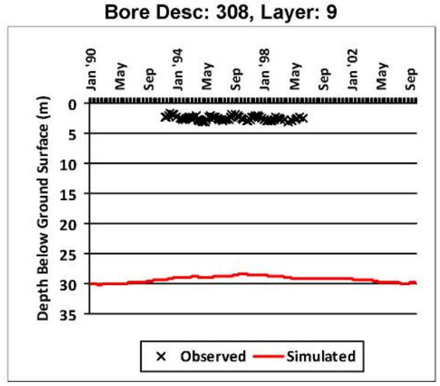
Bore Desc: 305, Layer: 9



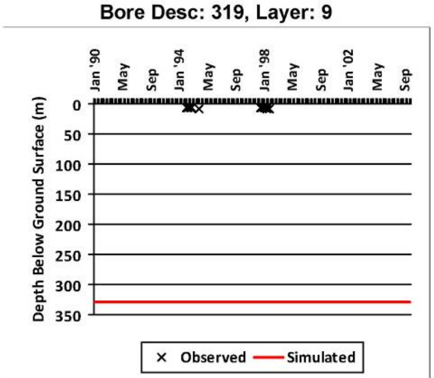
Bore Desc: 307, Layer: 9



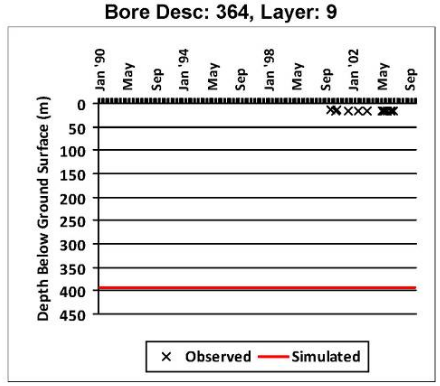
Bore Desc: 308, Layer: 9



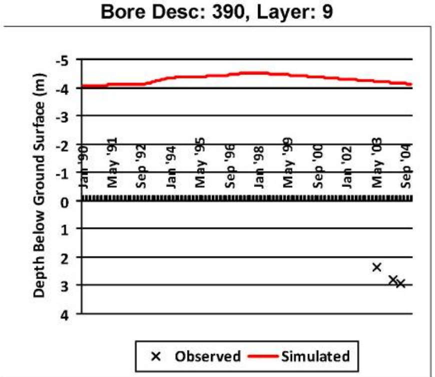
Bore Desc: 319, Layer: 9



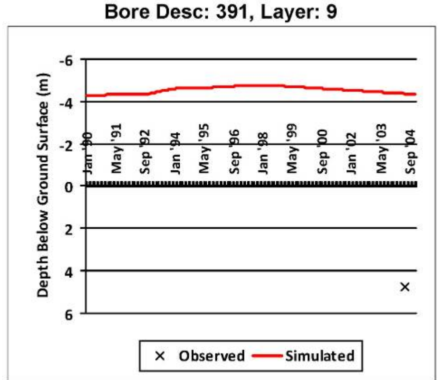
Bore Desc: 364, Layer: 9



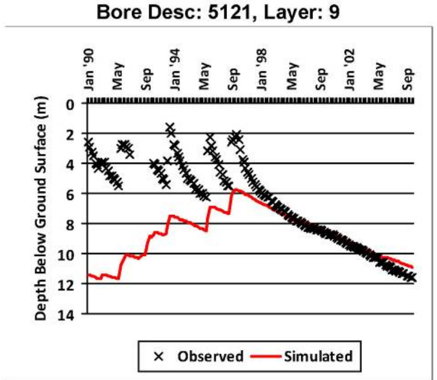
Bore Desc: 390, Layer: 9



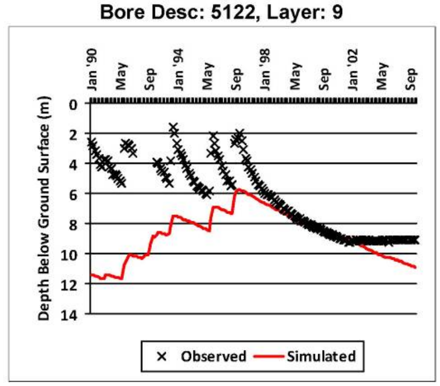
Bore Desc: 391, Layer: 9



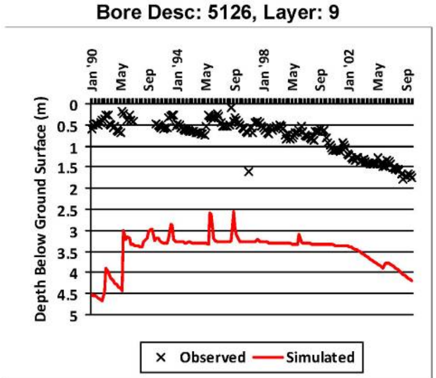
Bore Desc: 5121, Layer: 9



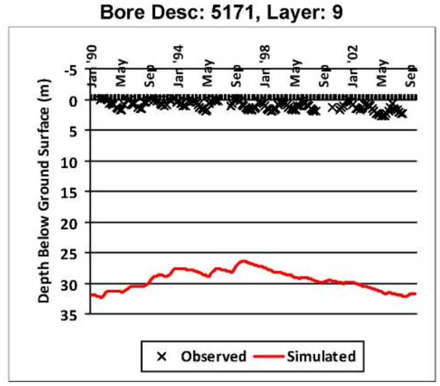
Bore Desc: 5122, Layer: 9



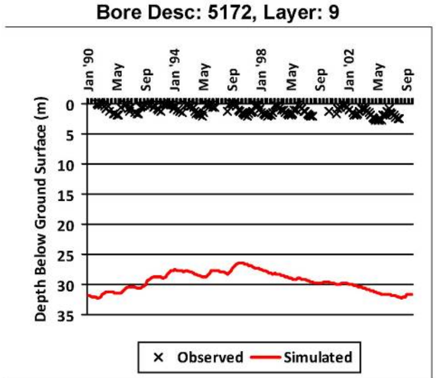
Bore Desc: 5126, Layer: 9



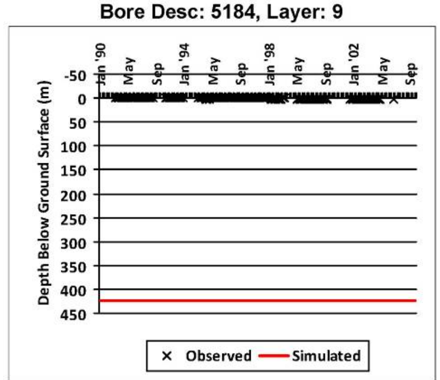
Bore Desc: 5171, Layer: 9

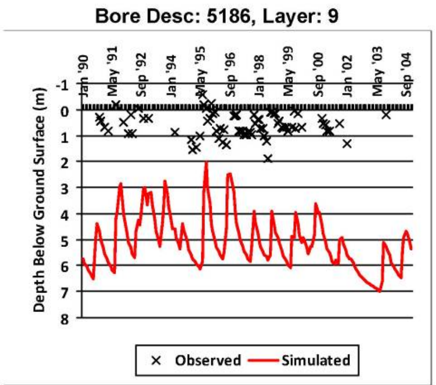


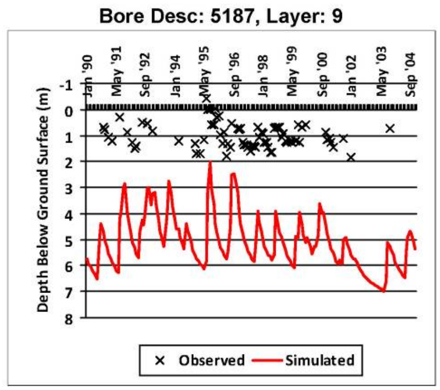
Bore Desc: 5172, Layer: 9

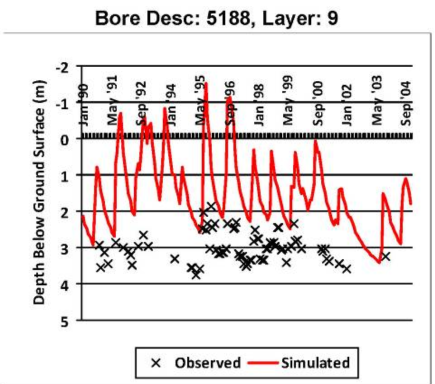


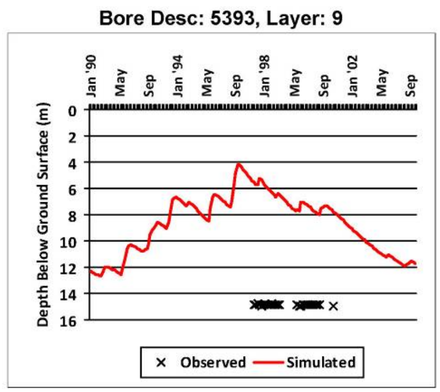
Bore Desc: 5184, Layer: 9

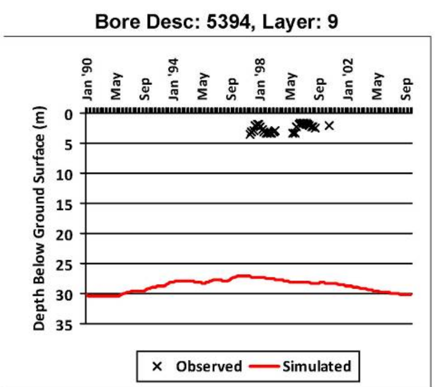


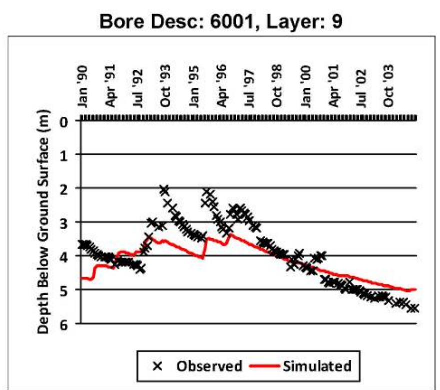

Bore Desc: 5186, Layer: 9
Jan '90
May '91
Sep '92
Jan '94
May '95
Sep '96
Jan '98
May '99
Sep '00
Jan '02
May '03
Sep '04
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5187, Layer: 9
Jan '90
May '91
Sep '92
Jan '94
May '95
Sep '96
Jan '98
May '99
Sep '00
Jan '02
May '03
Sep '04
Depth Below Ground Surface (m)
Observed
Simulated

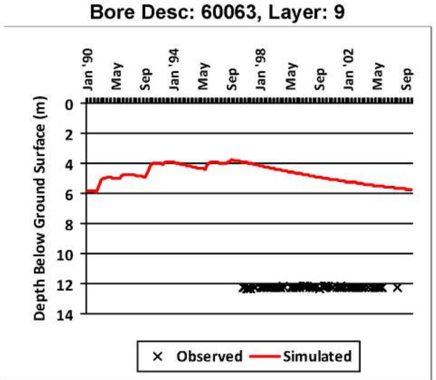

Bore Desc: 5188, Layer: 9
Jan '90
May '91
Sep '92
Jan '94
May '95
Sep '96
Jan '98
May '99
Sep '00
Jan '02
May '03
Sep '04
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5393, Layer: 9
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

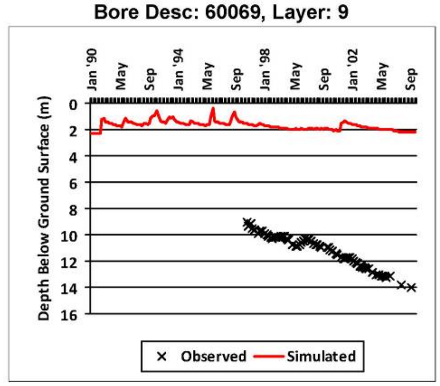

Bore Desc: 5394, Layer: 9
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6001, Layer: 9
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Depth Below Ground Surface (m)
Observed
Simulated

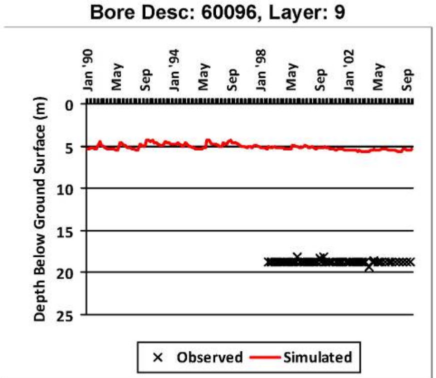
Bore Desc: 60063, Layer: 9



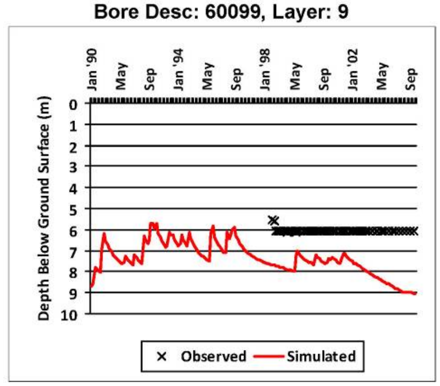
Bore Desc: 60069, Layer: 9



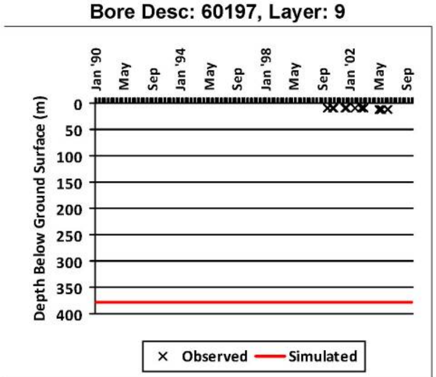
Bore Desc: 60096, Layer: 9



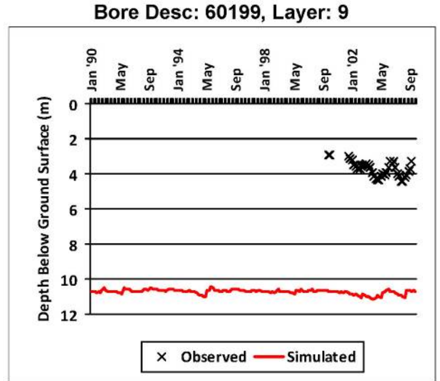
Bore Desc: 60099, Layer: 9

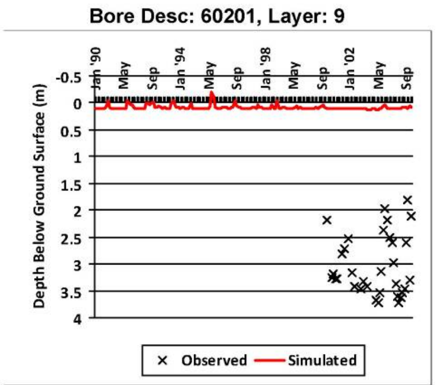


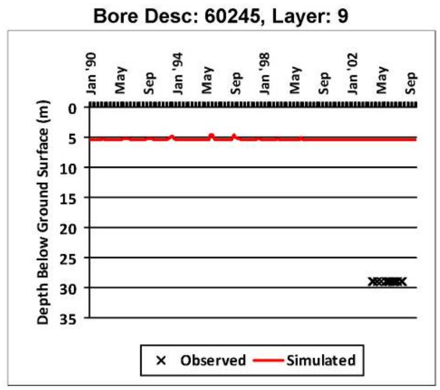
Bore Desc: 60197, Layer: 9

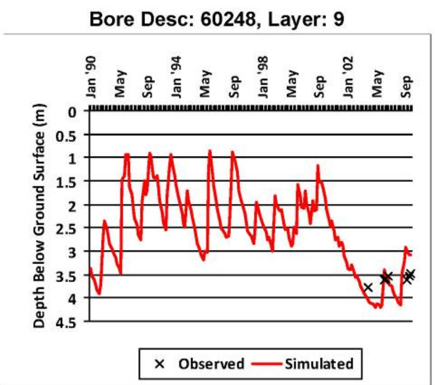


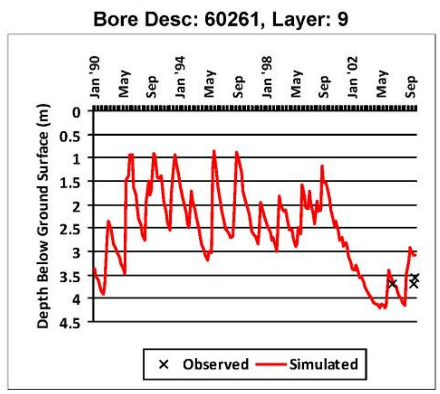
Bore Desc: 60199, Layer: 9

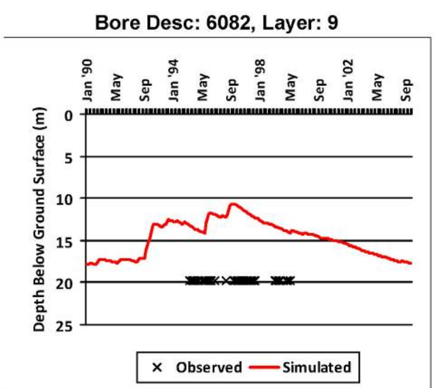


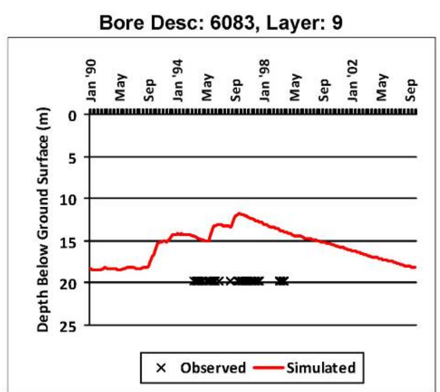

Bore Desc: 60201, Layer: 9
Depth Below Ground Surface (m)
Observed
Simulated

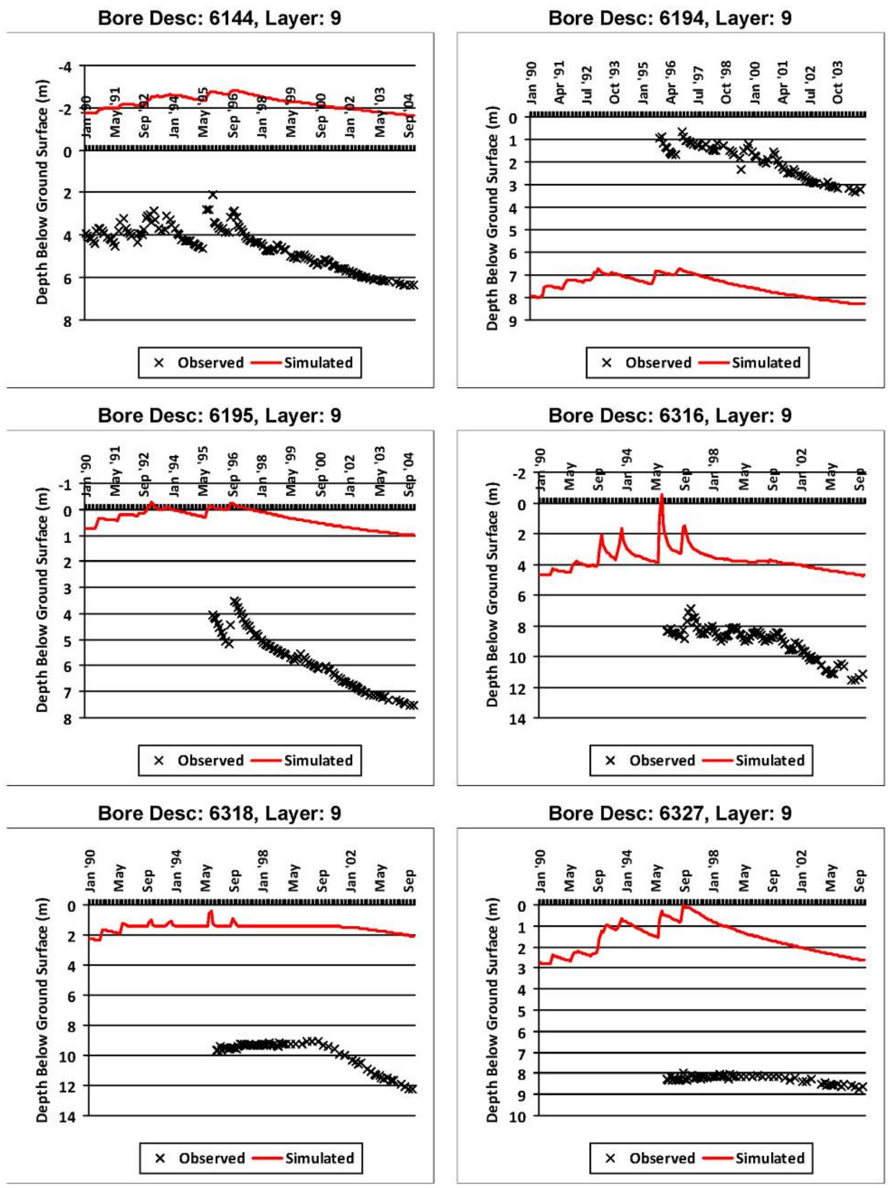

Bore Desc: 60245, Layer: 9
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 60248, Layer: 9
Depth Below Ground Surface (m)
Observed
Simulated

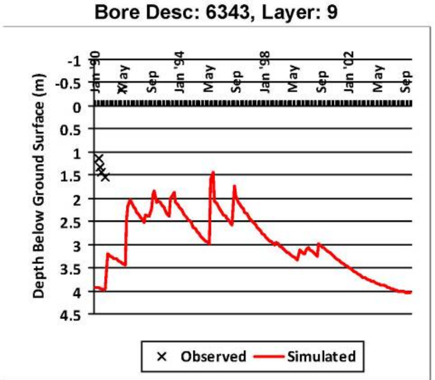

Bore Desc: 60261, Layer: 9
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6082, Layer: 9
Depth Below Ground Surface (m)
Observed
Simulated

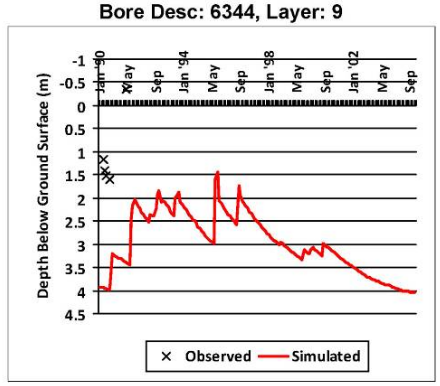

Bore Desc: 6083, Layer: 9
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6144, Layer: 9
Bore Desc: 6194, Layer: 9
Bore Desc: 6195, Layer: 9
Bore Desc: 6316, Layer: 9
Bore Desc: 6318, Layer: 9
Bore Desc: 6327, Layer: 9
Depth Below Ground Surface (m)
Observed
Simulated

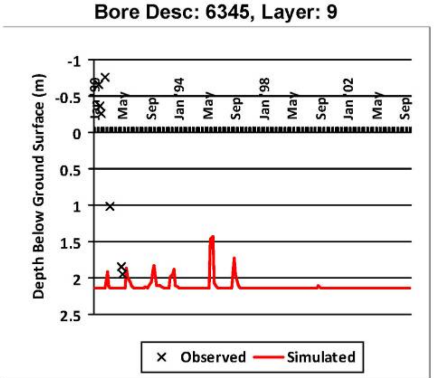
Bore Desc: 6343, Layer: 9



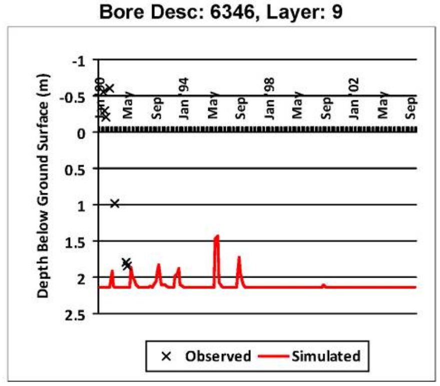
Bore Desc: 6344, Layer: 9



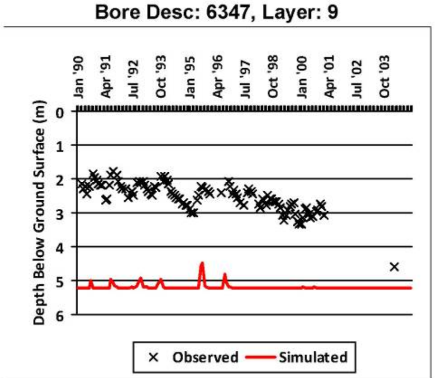
Bore Desc: 6345, Layer: 9



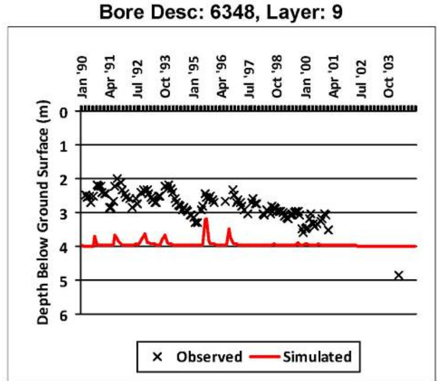
Bore Desc: 6346, Layer: 9



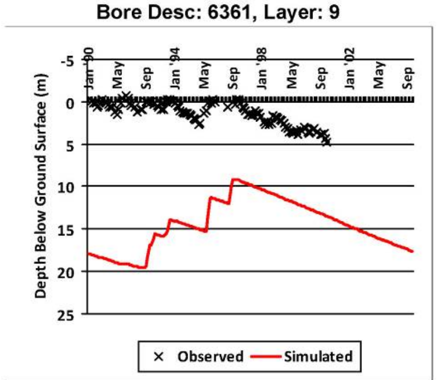
Bore Desc: 6347, Layer: 9



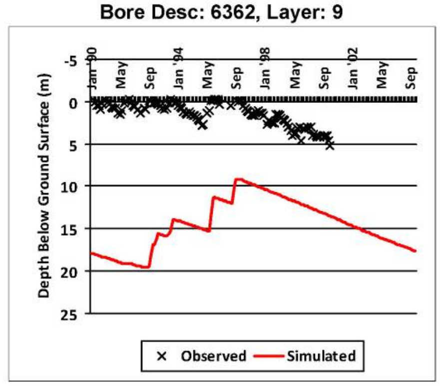
Bore Desc: 6348, Layer: 9



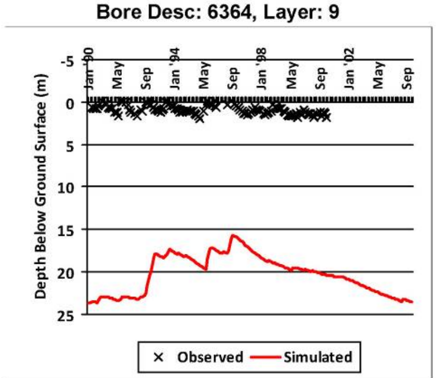
Bore Desc: 6361, Layer: 9



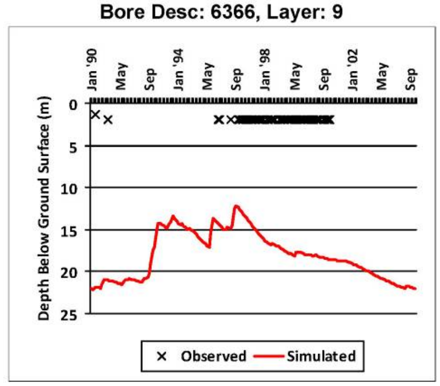
Bore Desc: 6362, Layer: 9



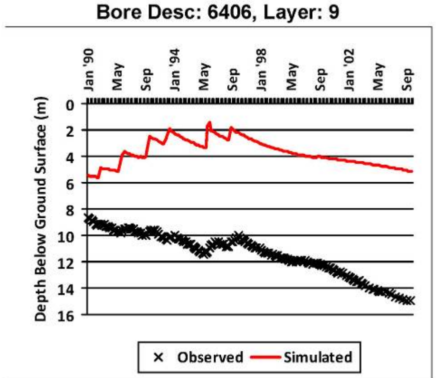
Bore Desc: 6364, Layer: 9



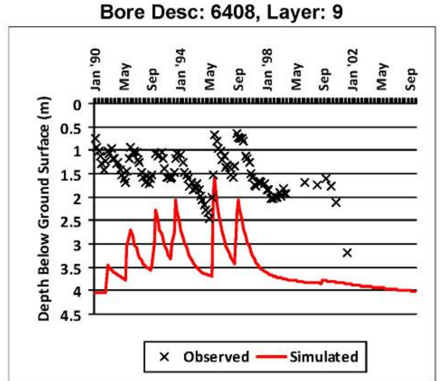
Bore Desc: 6366, Layer: 9



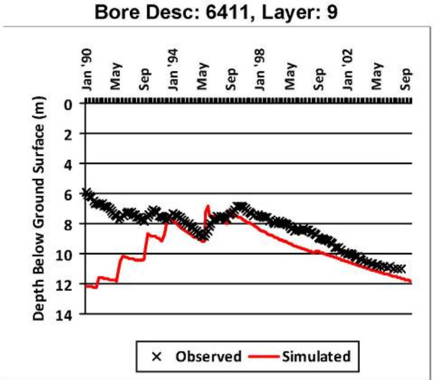
Bore Desc: 6406, Layer: 9



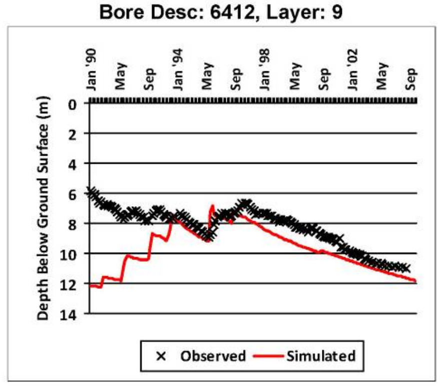
Bore Desc: 6408, Layer: 9



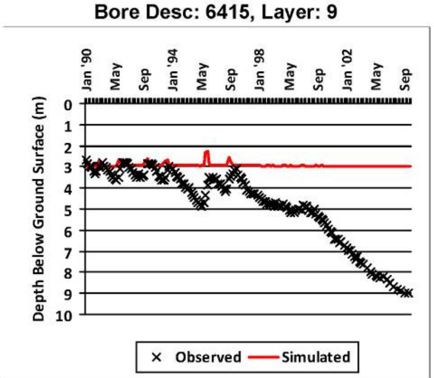
Bore Desc: 6411, Layer: 9



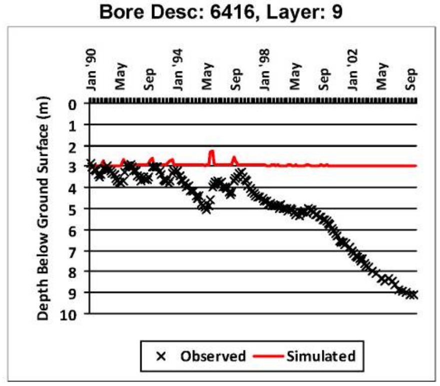
Bore Desc: 6412, Layer: 9



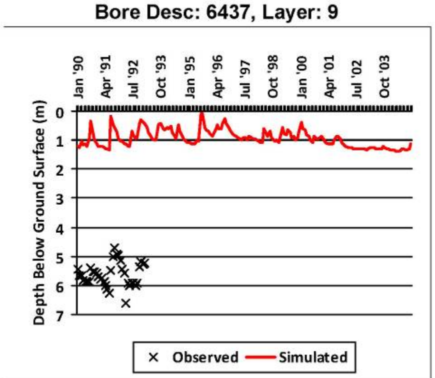
Bore Desc: 6415, Layer: 9



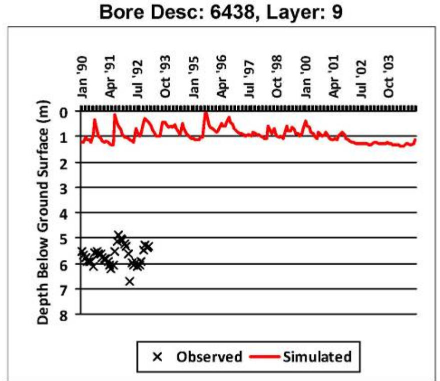
Bore Desc: 6416, Layer: 9

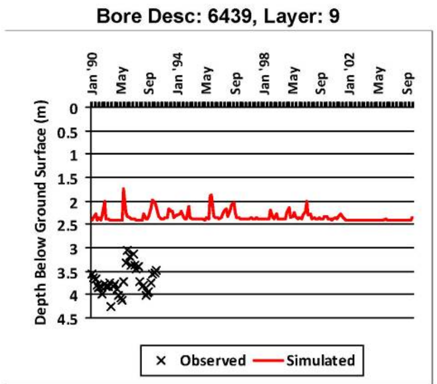


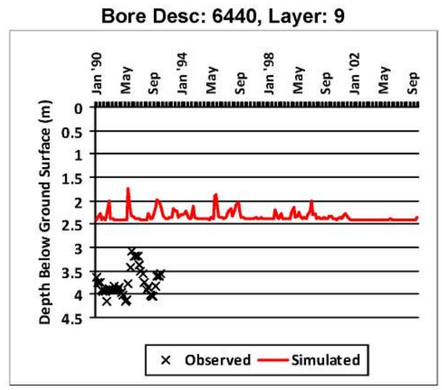
Bore Desc: 6437, Layer: 9

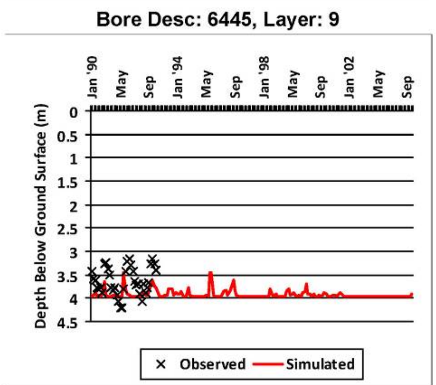


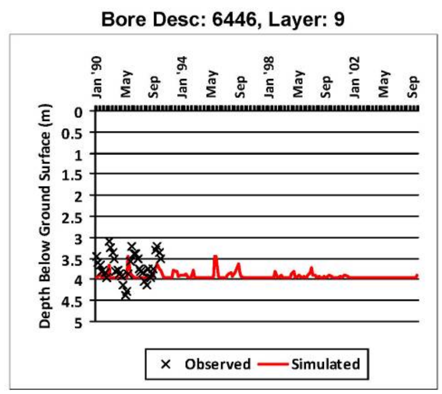
Bore Desc: 6438, Layer: 9

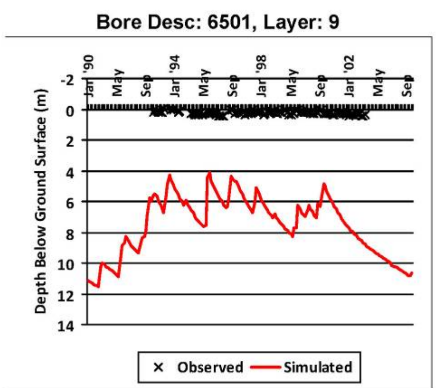


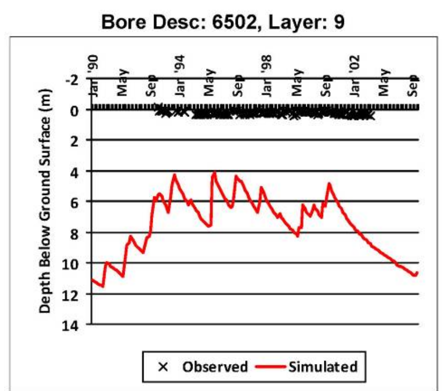

Bore Desc: 6439, Layer: 9
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

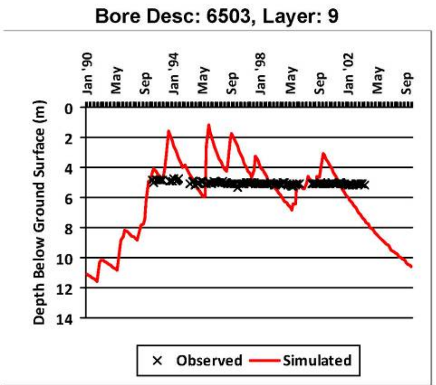

Bore Desc: 6440, Layer: 9
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

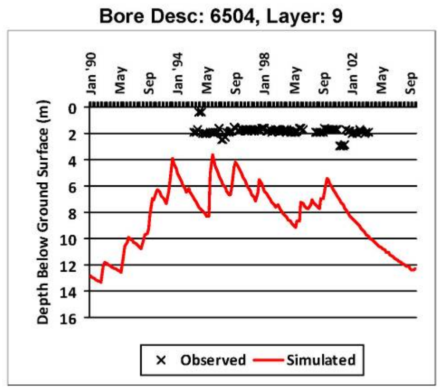

Bore Desc: 6445, Layer: 9
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

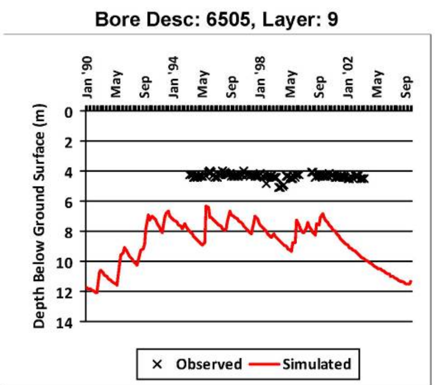

Bore Desc: 6446, Layer: 9
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

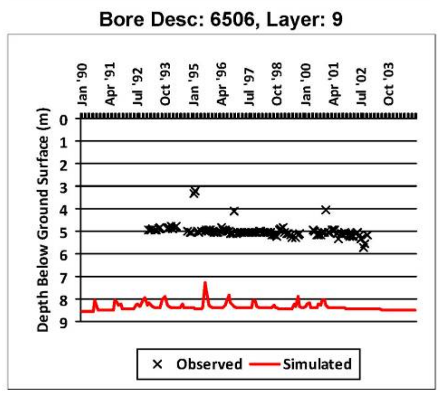

Bore Desc: 6501, Layer: 9
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

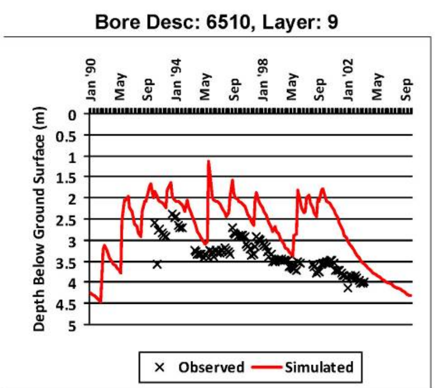

Bore Desc: 6502, Layer: 9
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

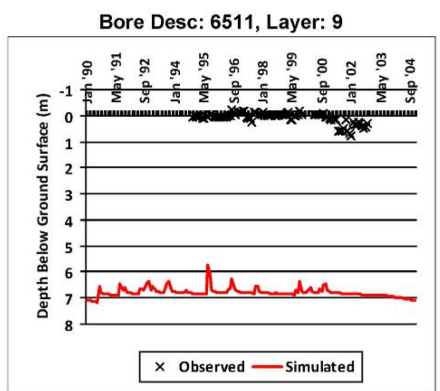

Bore Desc: 6503, Layer: 9
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: 6504, Layer: 9
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated

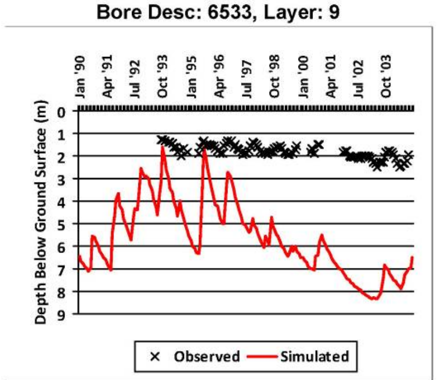

Bore Desc: 6505, Layer: 9
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: 6506, Layer: 9
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Observed
Simulated

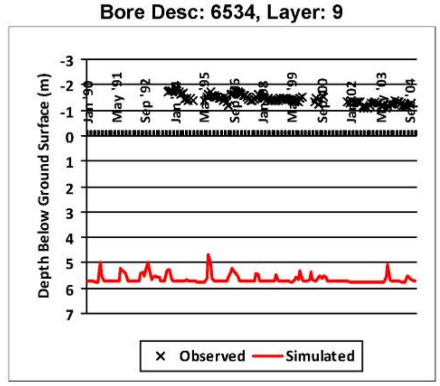

Bore Desc: 6510, Layer: 9
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: 6511, Layer: 9
Depth Below Ground Surface (m)
Jan '90
May '91
Sep '92
Jan '94
May '95
Sep '96
Jan '98
May '99
Sep '00
Jan '02
May '03
Sep '04
Observed
Simulated

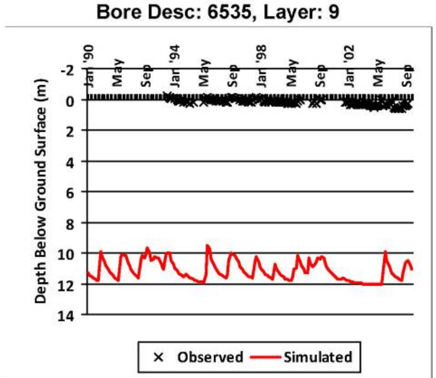
Bore Desc: 6533, Layer: 9



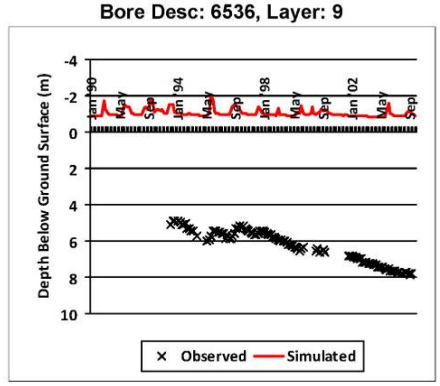
Bore Desc: 6534, Layer: 9



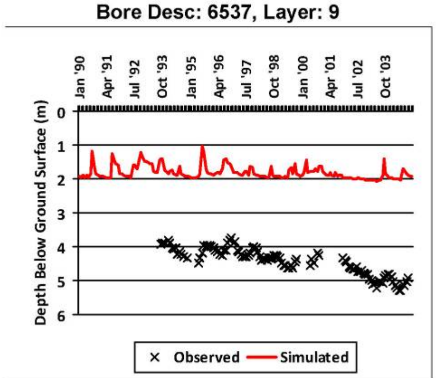
Bore Desc: 6535, Layer: 9



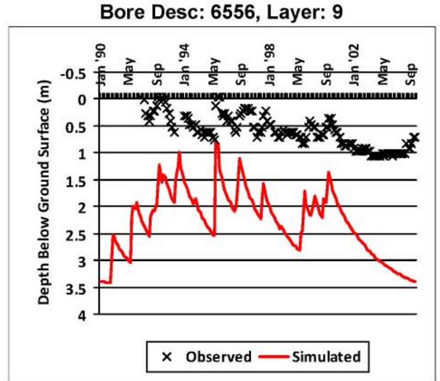
Bore Desc: 6536, Layer: 9



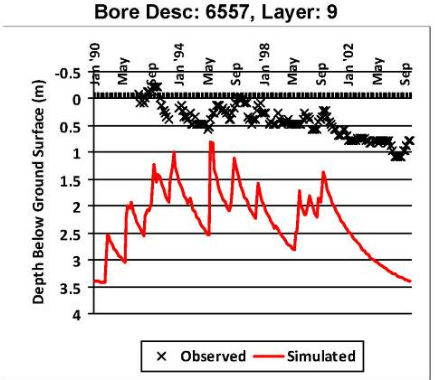
Bore Desc: 6537, Layer: 9



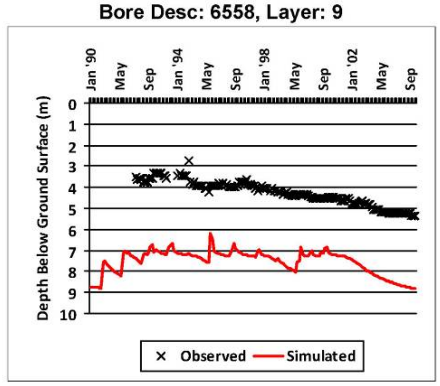
Bore Desc: 6556, Layer: 9



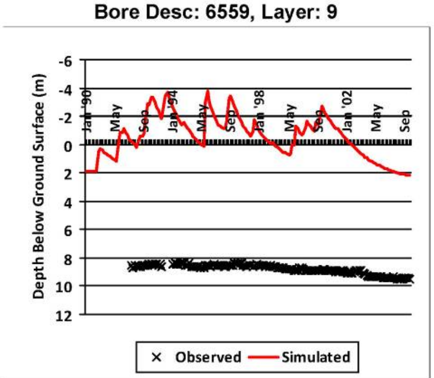
Bore Desc: 6557, Layer: 9



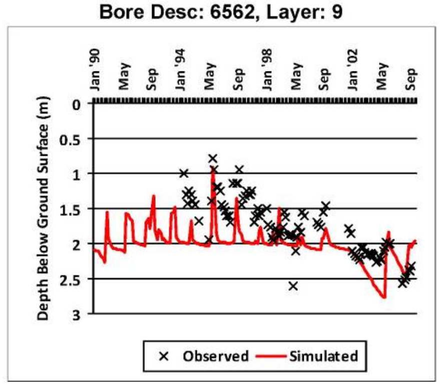
Bore Desc: 6558, Layer: 9



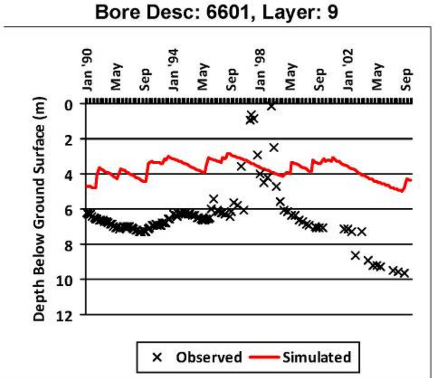
Bore Desc: 6559, Layer: 9



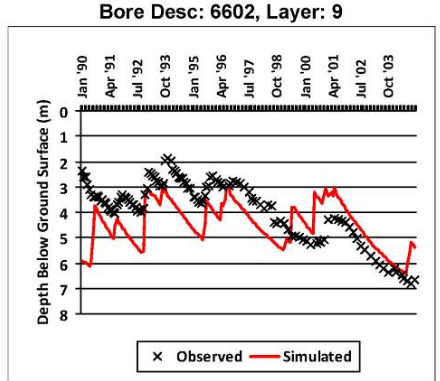
Bore Desc: 6562, Layer: 9

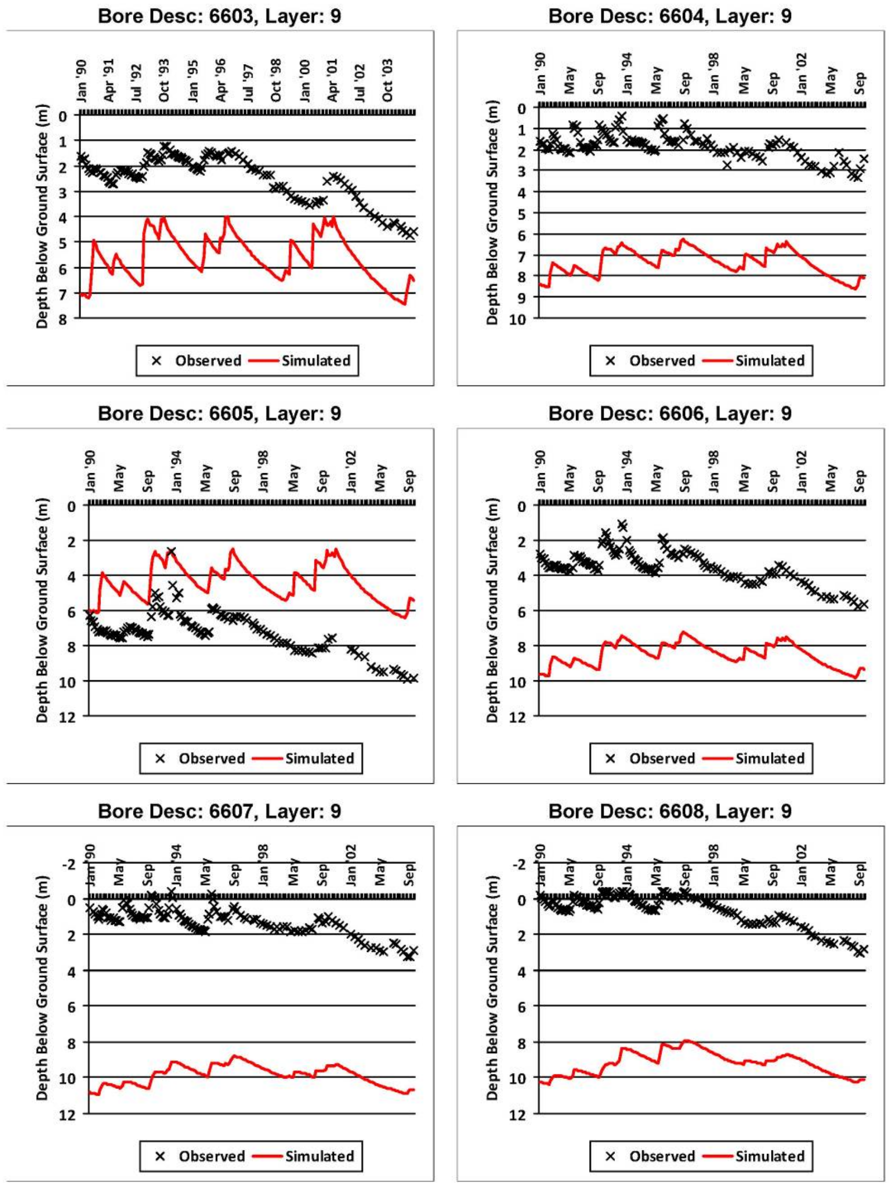


Bore Desc: 6601, Layer: 9

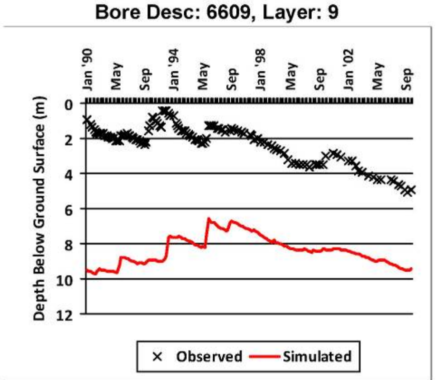


Bore Desc: 6602, Layer: 9

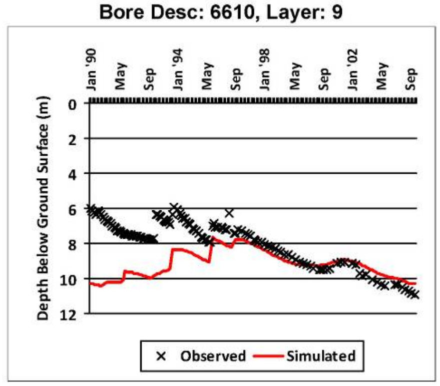



Bore Desc: 6603, Layer: 9
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
Observed Simulated
Bore Desc: 6604, Layer: 9
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed Simulated
Bore Desc: 6605, Layer: 9
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed Simulated
Bore Desc: 6606, Layer: 9
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed Simulated
Bore Desc: 6607, Layer: 9
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed Simulated
Bore Desc: 6608, Layer: 9
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
Observed Simulated

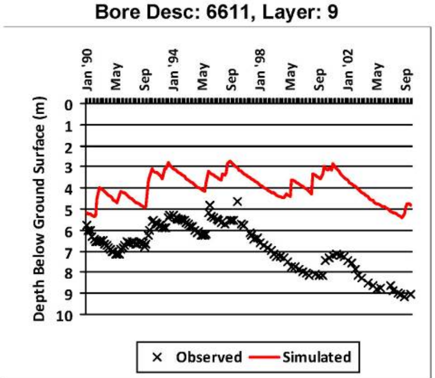
Bore Desc: 6609, Layer: 9



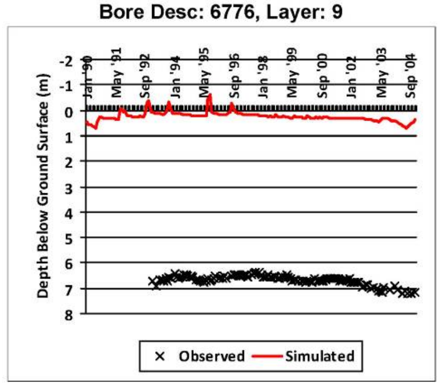
Bore Desc: 6610, Layer: 9



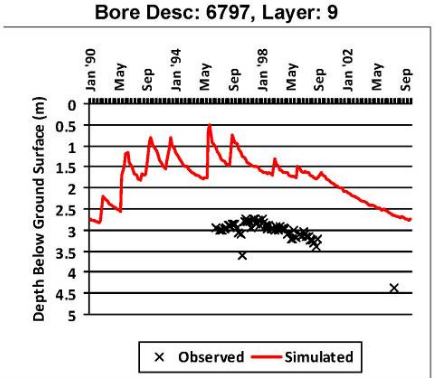
Bore Desc: 6611, Layer: 9



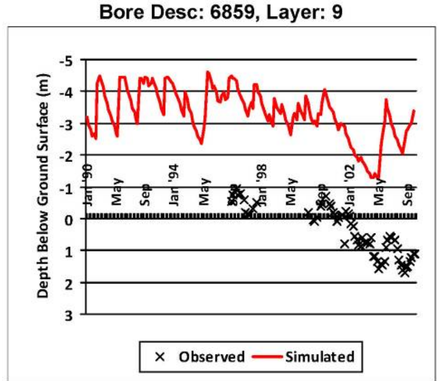
Bore Desc: 6776, Layer: 9



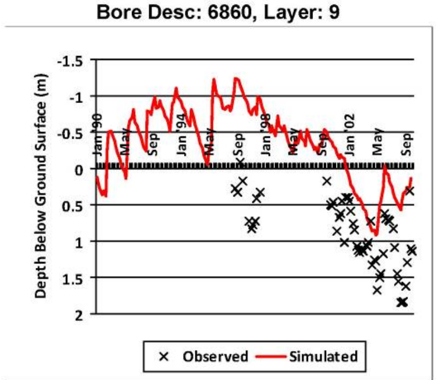
Bore Desc: 6797, Layer: 9



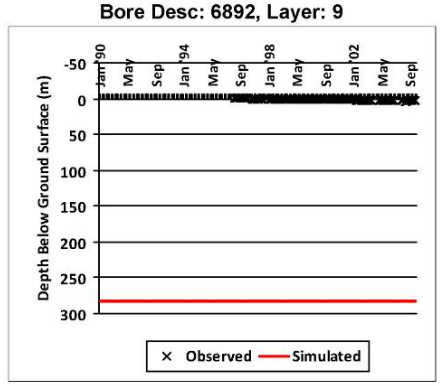
Bore Desc: 6859, Layer: 9



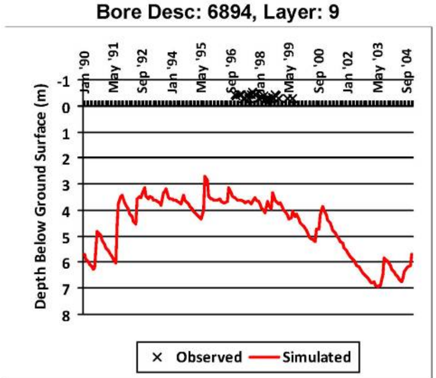
Bore Desc: 6860, Layer: 9



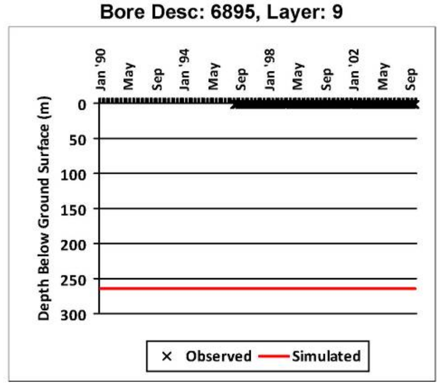
Bore Desc: 6892, Layer: 9



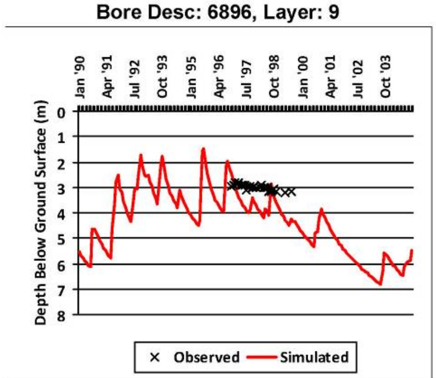
Bore Desc: 6894, Layer: 9



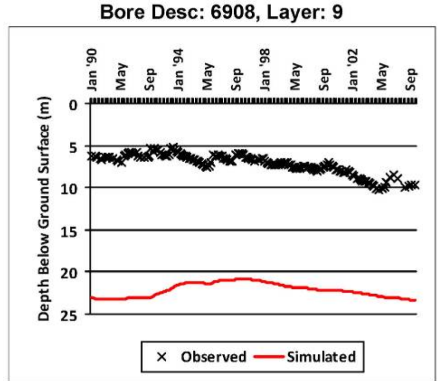
Bore Desc: 6895, Layer: 9



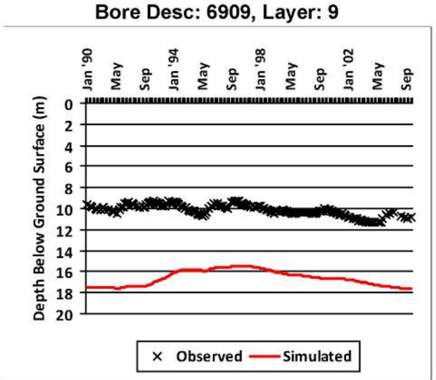
Bore Desc: 6896, Layer: 9



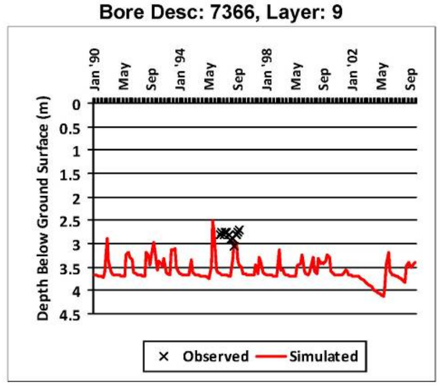
Bore Desc: 6908, Layer: 9



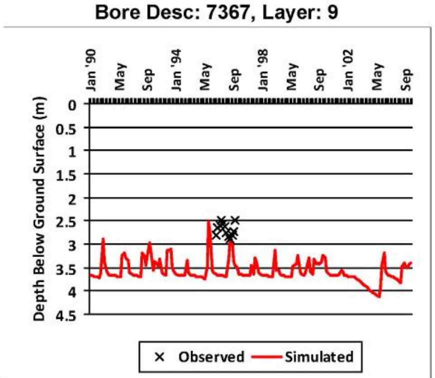
Bore Desc: 6909, Layer: 9



Bore Desc: 7366, Layer: 9

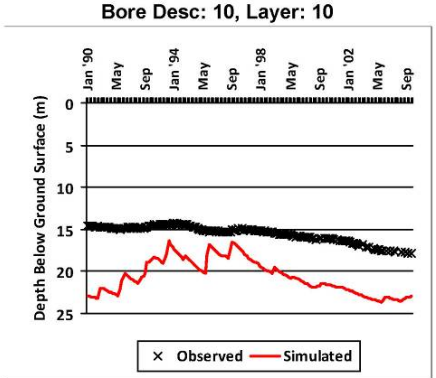


Bore Desc: 7367, Layer: 9

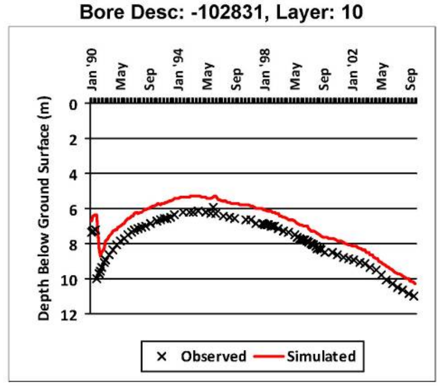


Layer 10 (Palaeozoic basement)

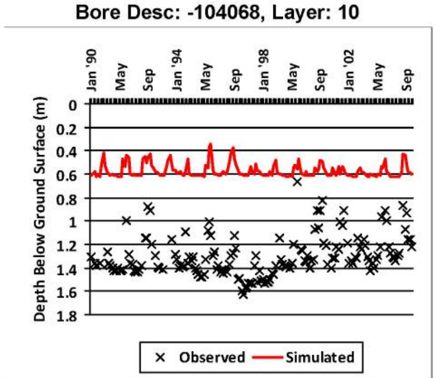
Bore Desc: 10, Layer: 10



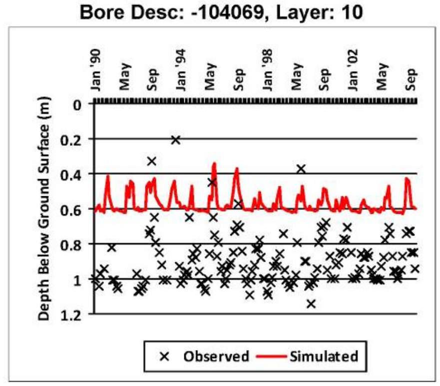
Bore Desc: -102831, Layer: 10



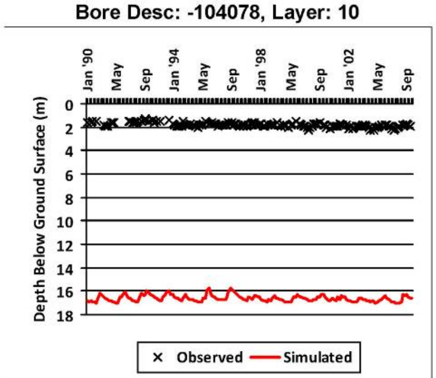
Bore Desc: -104068, Layer: 10



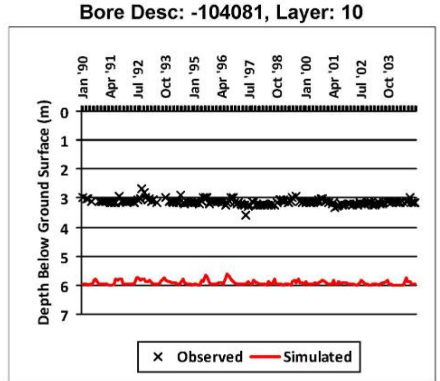
Bore Desc: -104069, Layer: 10

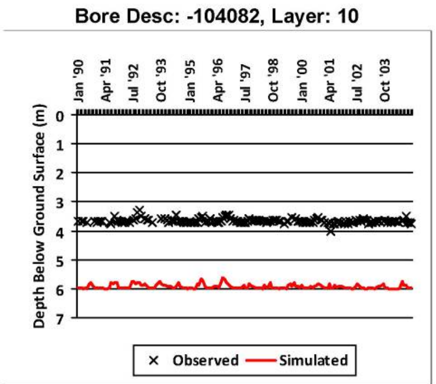


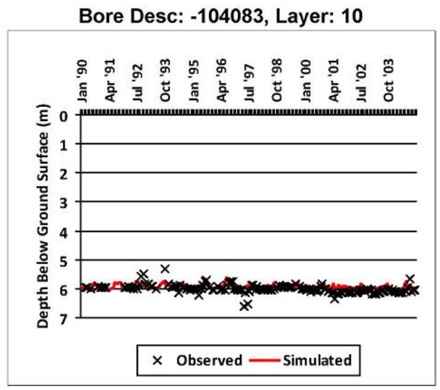
Bore Desc: -104078, Layer: 10

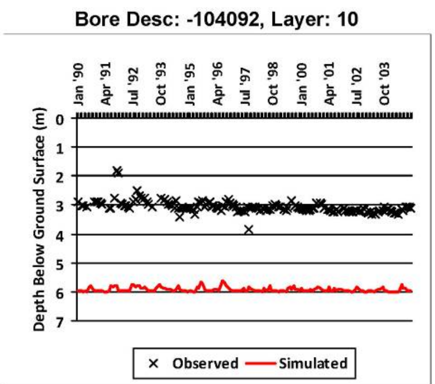


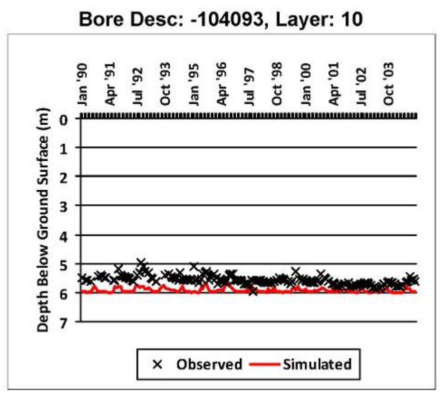
Bore Desc: -104081, Layer: 10

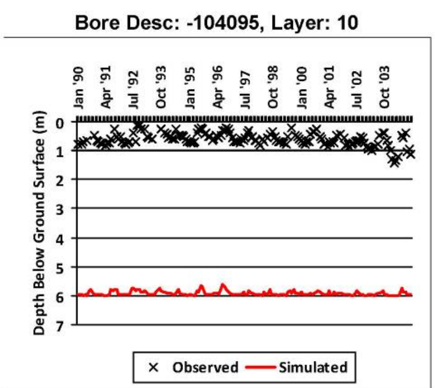


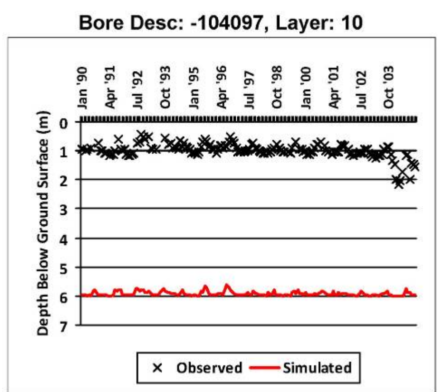

Bore Desc: -104082, Layer: 10
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
0 1 2 3 4 5 6 7
Observed
Simulated

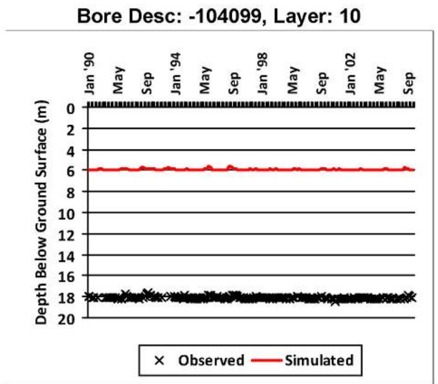

Bore Desc: -104083, Layer: 10
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
0 1 2 3 4 5 6 7
Observed
Simulated

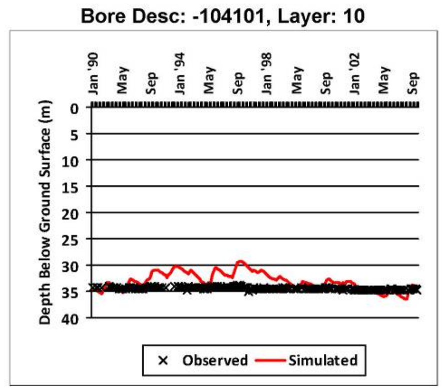

Bore Desc: -104092, Layer: 10
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
0 1 2 3 4 5 6 7
Observed
Simulated

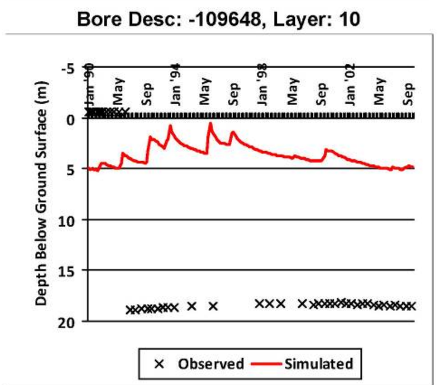

Bore Desc: -104093, Layer: 10
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
0 1 2 3 4 5 6 7
Observed
Simulated

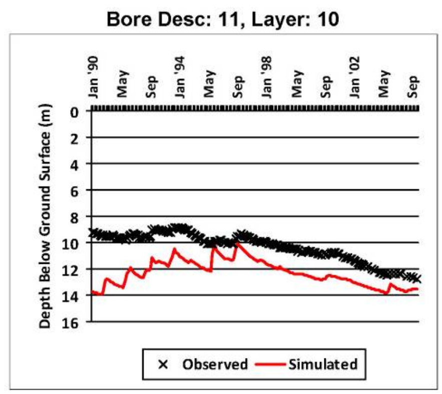

Bore Desc: -104095, Layer: 10
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
0 1 2 3 4 5 6 7
Observed
Simulated

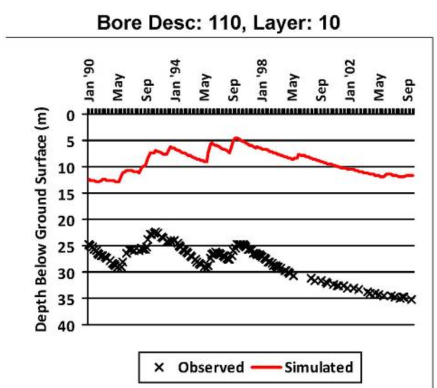

Bore Desc: -104097, Layer: 10
Depth Below Ground Surface (m)
Jan '90 Apr '91 Jul '92 Oct '93 Jan '95 Apr '96 Jul '97 Oct '98 Jan '00 Apr '01 Jul '02 Oct '03
0 1 2 3 4 5 6 7
Observed
Simulated

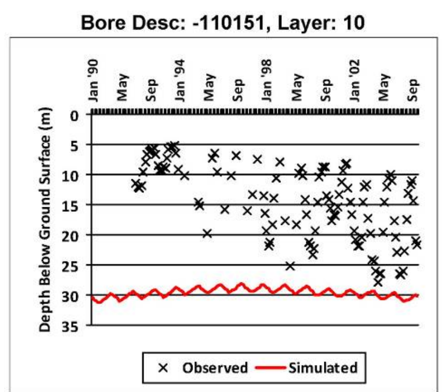

Bore Desc: -104099, Layer: 10
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 2 4 6 8 10 12 14 16 18 20
Observed
Simulated


Bore Desc: -104101, Layer: 10
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40
Observed
Simulated

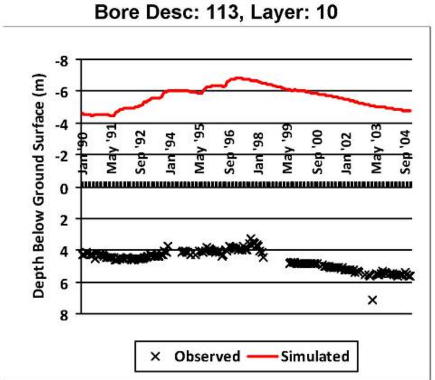

Bore Desc: -109648, Layer: 10
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
-5 0 5 10 15 20
Observed
Simulated


Bore Desc: 11, Layer: 10
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 2 4 6 8 10 12 14 16
Observed
Simulated

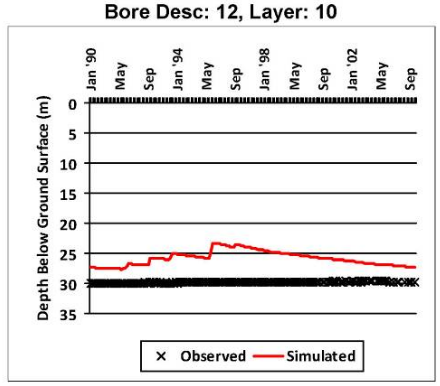

Bore Desc: 110, Layer: 10
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35 40
Observed
Simulated


Bore Desc: -110151, Layer: 10
Depth Below Ground Surface (m)
Jan '90 May Sep Jan '94 May Sep Jan '98 May Sep Jan '02 May Sep
0 5 10 15 20 25 30 35
Observed
Simulated

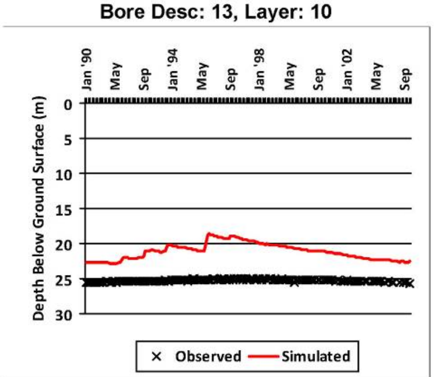
Bore Desc: 113, Layer: 10



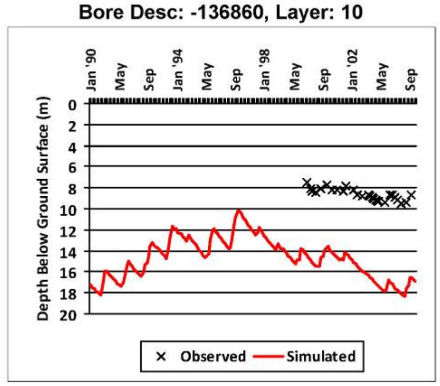
Bore Desc: 12, Layer: 10



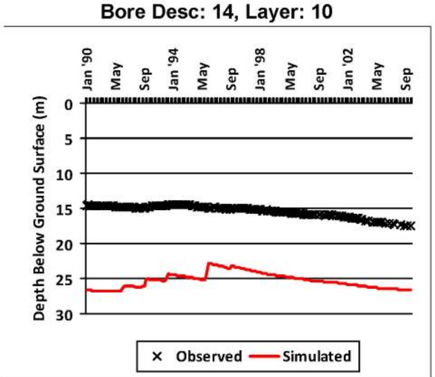
Bore Desc: 13, Layer: 10



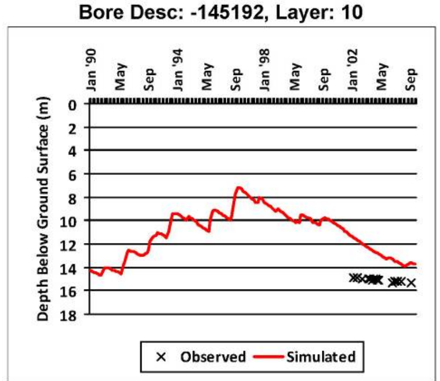
Bore Desc: -136860, Layer: 10

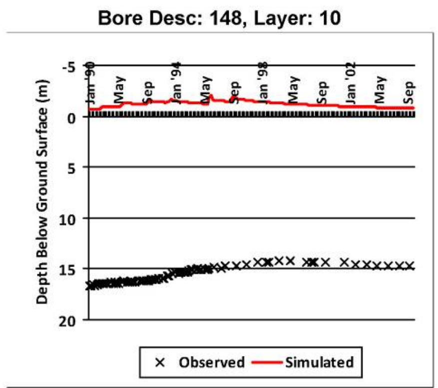


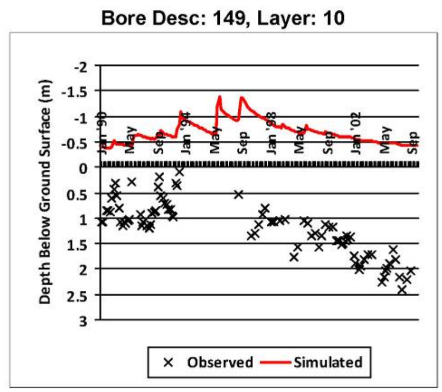
Bore Desc: 14, Layer: 10

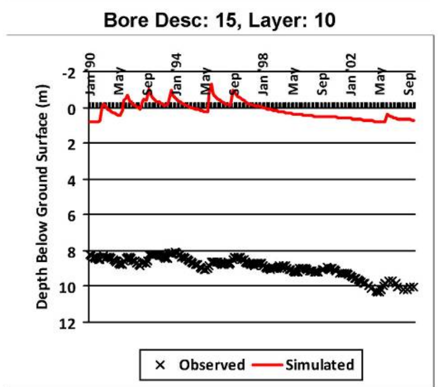


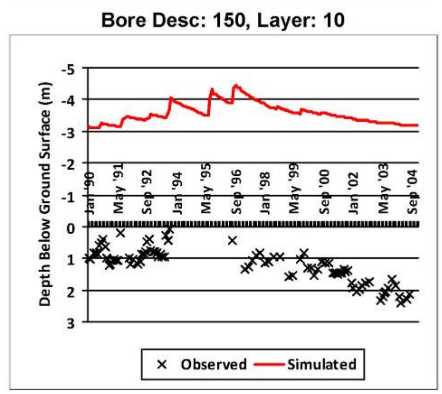
Bore Desc: -145192, Layer: 10

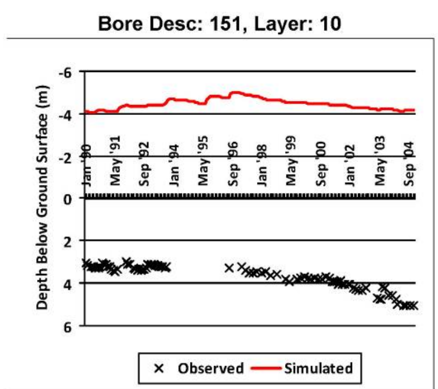


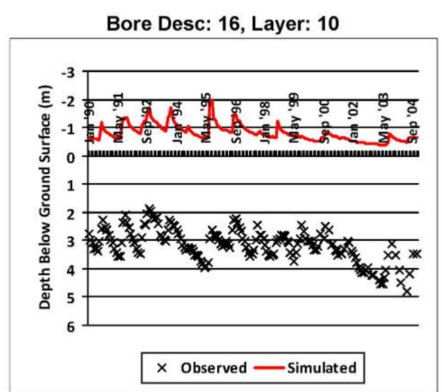

Bore Desc: 148, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 149, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

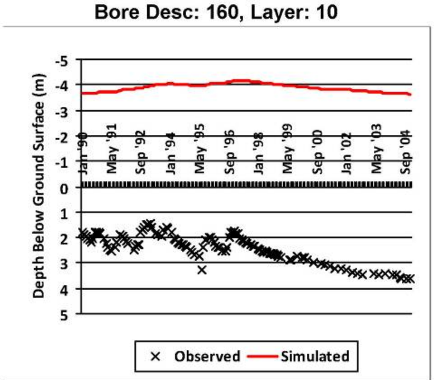

Bore Desc: 15, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 150, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

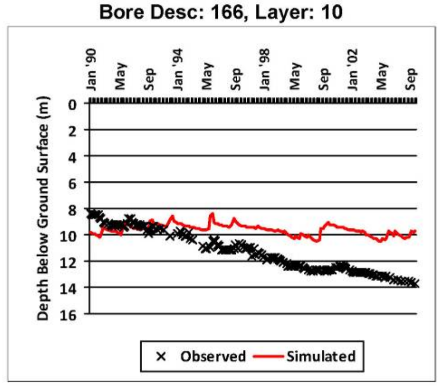

Bore Desc: 151, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 16, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

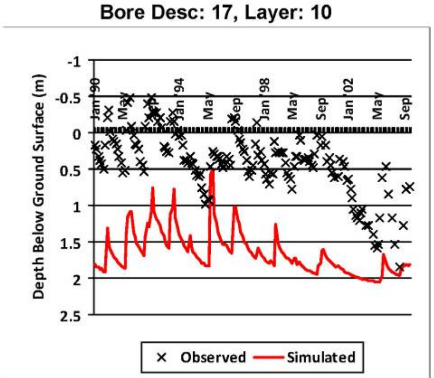
Bore Desc: 160, Layer: 10



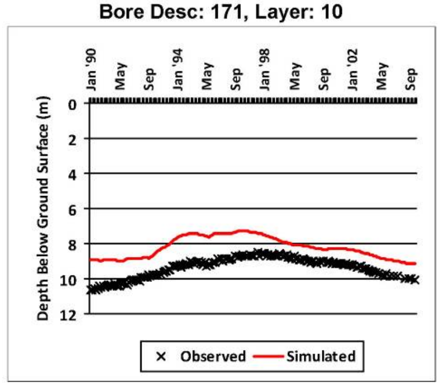
Bore Desc: 166, Layer: 10



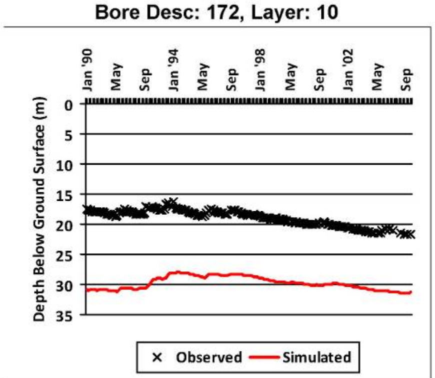
Bore Desc: 17, Layer: 10



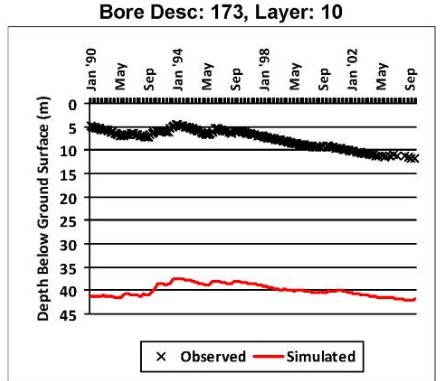
Bore Desc: 171, Layer: 10

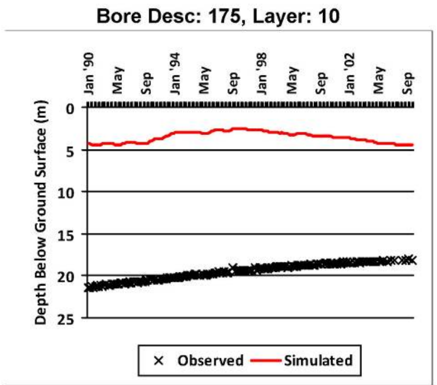


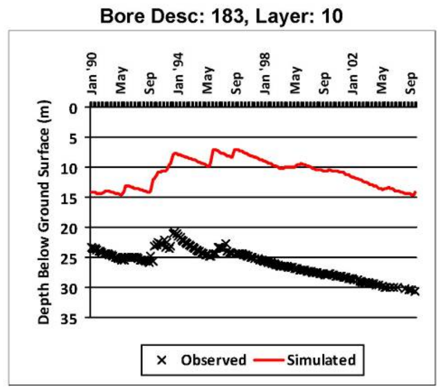
Bore Desc: 172, Layer: 10

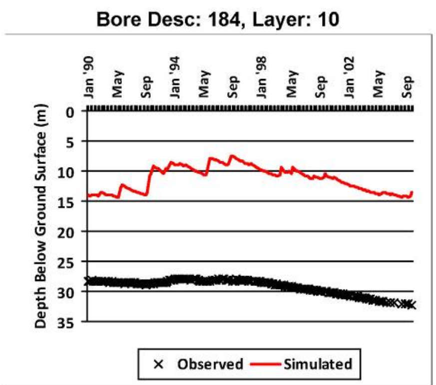


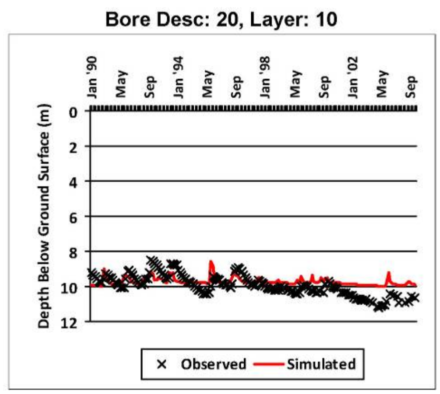
Bore Desc: 173, Layer: 10

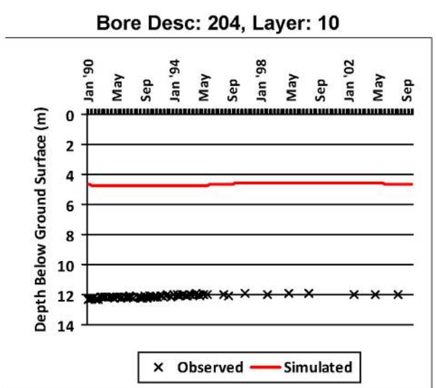


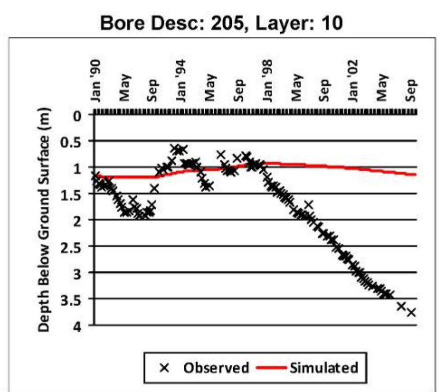

Bore Desc: 175, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 183, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

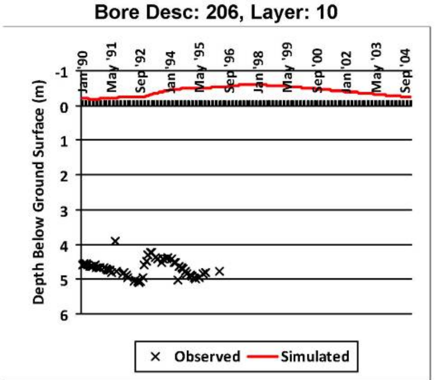

Bore Desc: 184, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 20, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

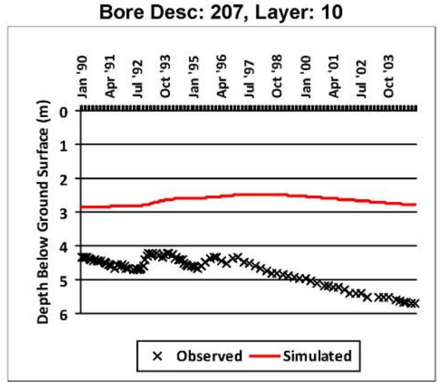

Bore Desc: 204, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 205, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

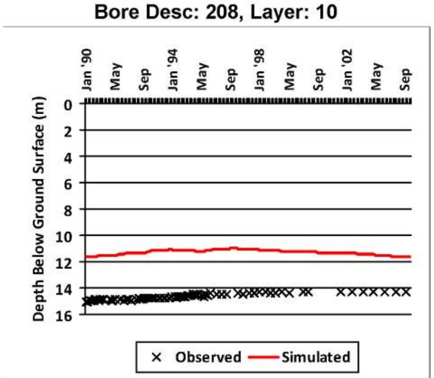
Bore Desc: 206, Layer: 10



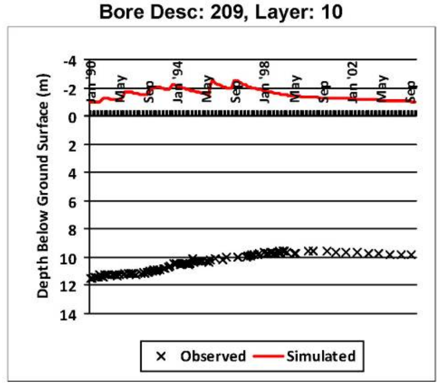
Bore Desc: 207, Layer: 10



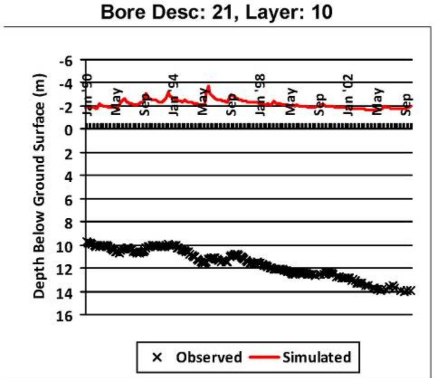
Bore Desc: 208, Layer: 10



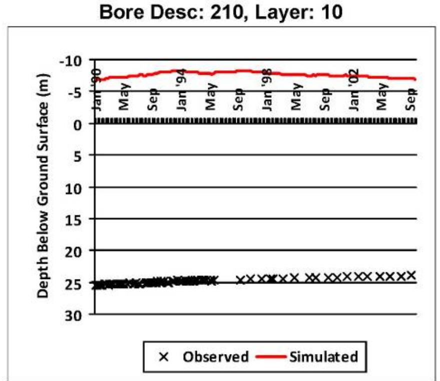
Bore Desc: 209, Layer: 10

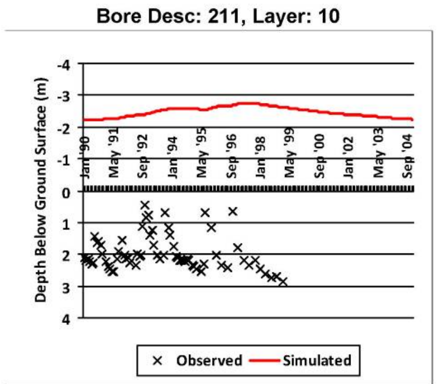


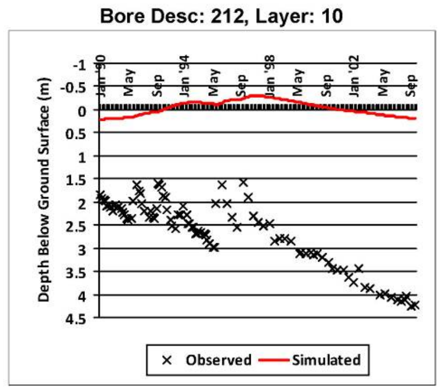
Bore Desc: 21, Layer: 10

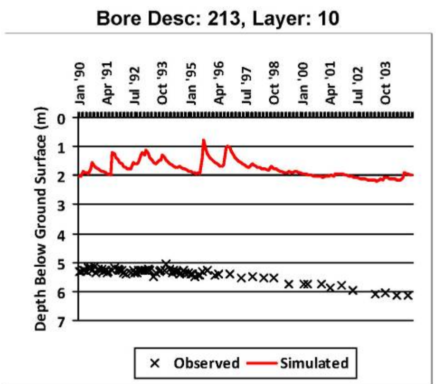


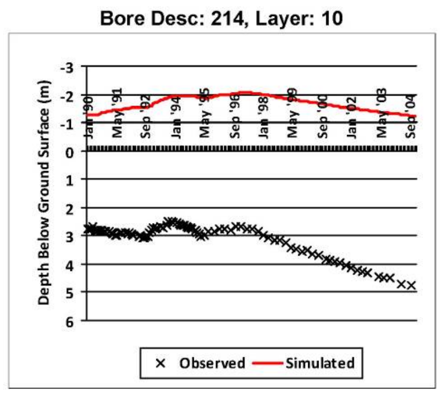
Bore Desc: 210, Layer: 10

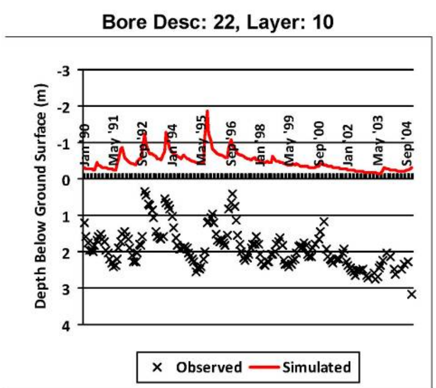


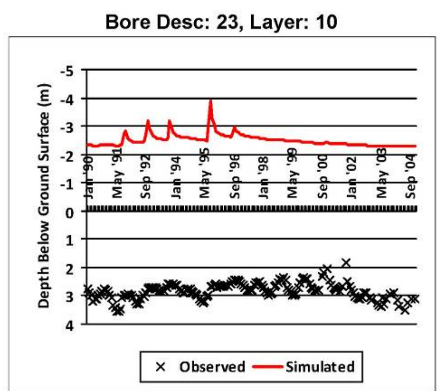

Bore Desc: 211, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 212, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

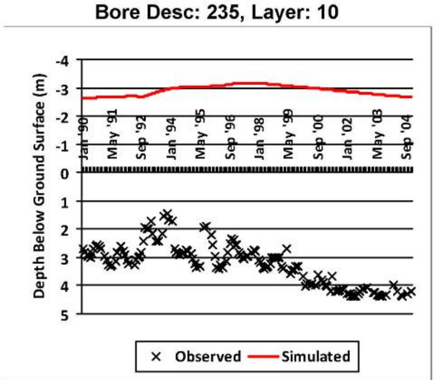

Bore Desc: 213, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 214, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

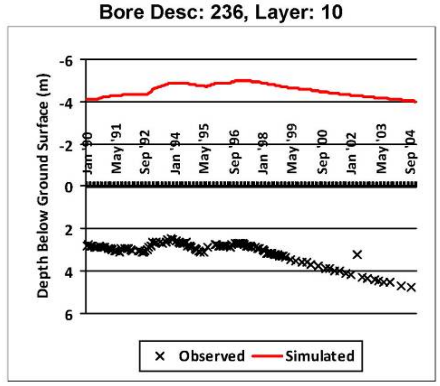

Bore Desc: 22, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 23, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

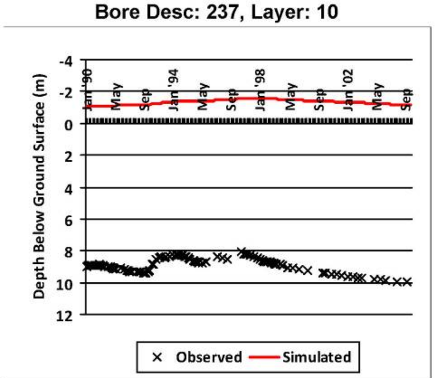
Bore Desc: 235, Layer: 10



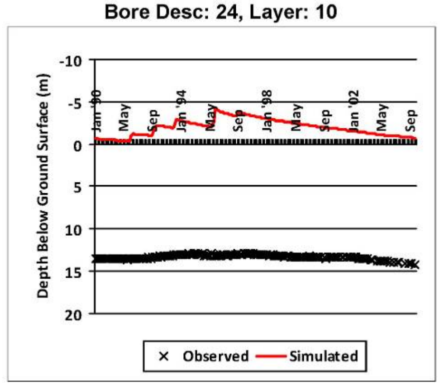
Bore Desc: 236, Layer: 10



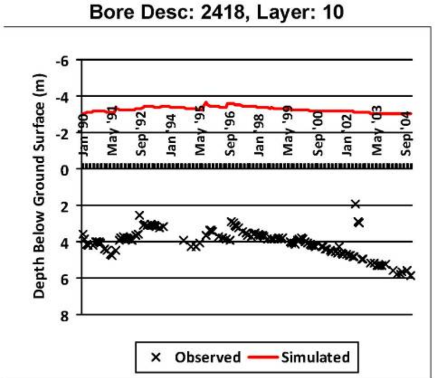
Bore Desc: 237, Layer: 10



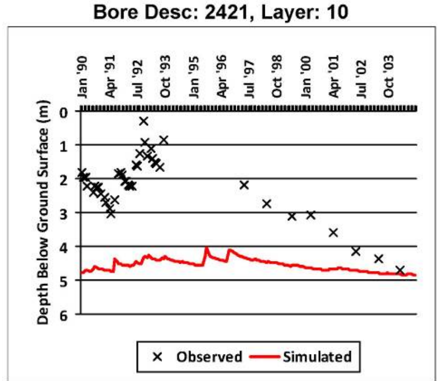
Bore Desc: 24, Layer: 10

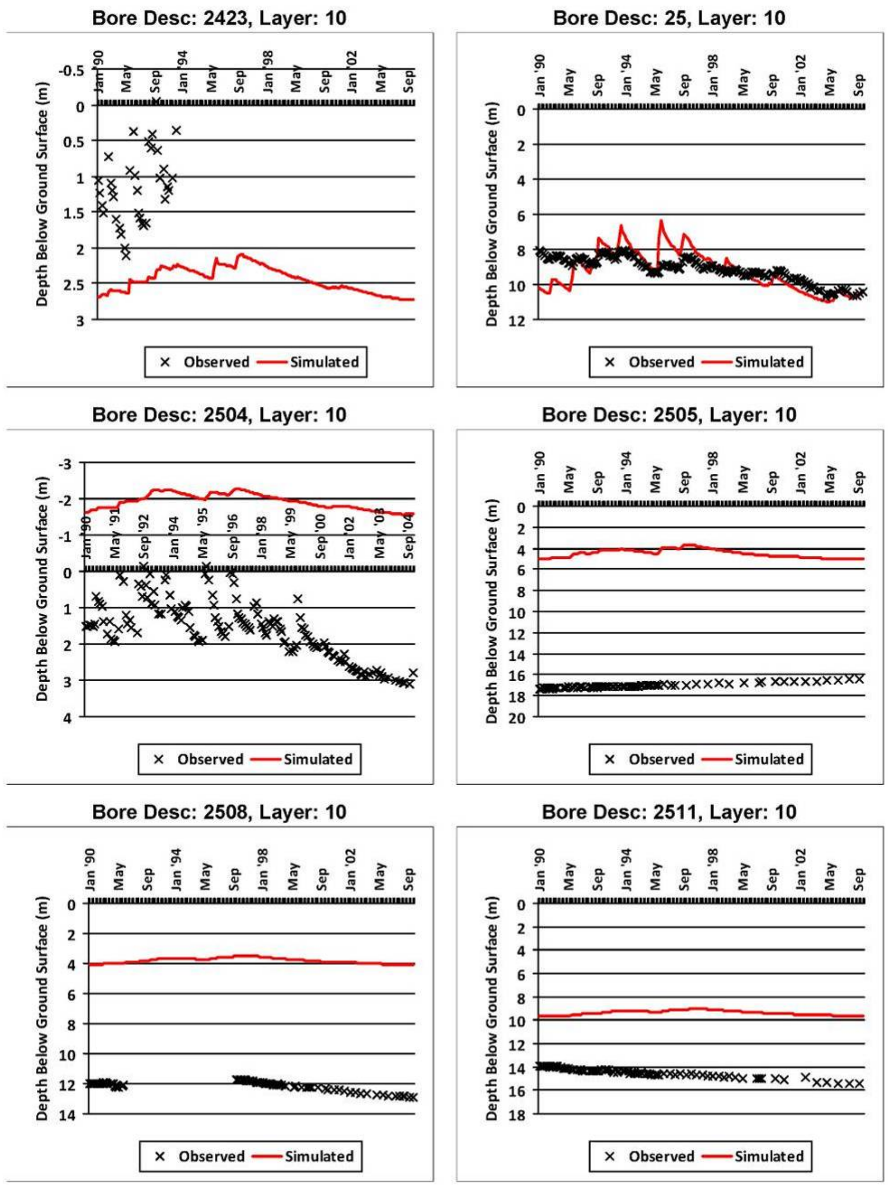


Bore Desc: 2418, Layer: 10

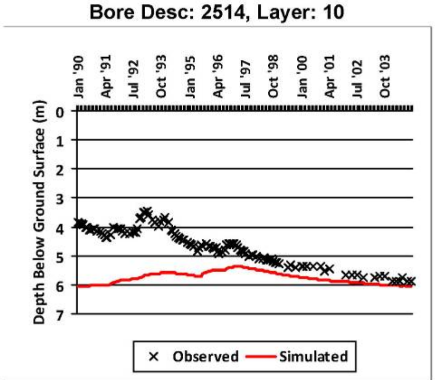


Bore Desc: 2421, Layer: 10

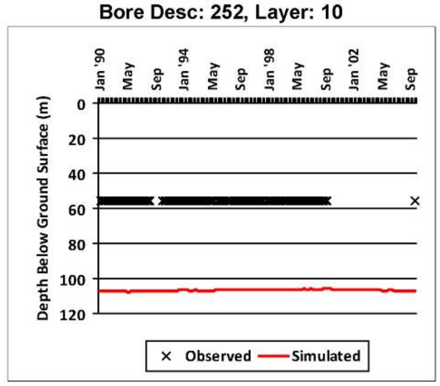



Bore Desc: 2423, Layer: 10
Bore Desc: 25, Layer: 10
Bore Desc: 2504, Layer: 10
Bore Desc: 2505, Layer: 10
Bore Desc: 2508, Layer: 10
Bore Desc: 2511, Layer: 10
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
Jan '98
Jan '02
May '91
Sep '92
May '95
Sep '96
May '99
Sep '00
May '03
Sep '04
Observed
Simulated

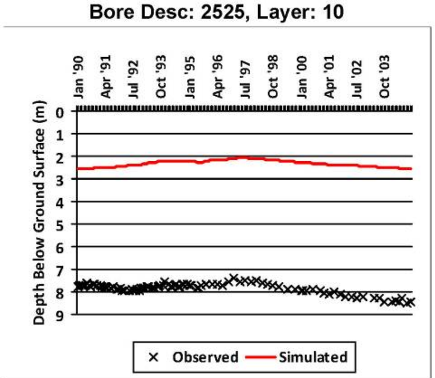
Bore Desc: 2514, Layer: 10



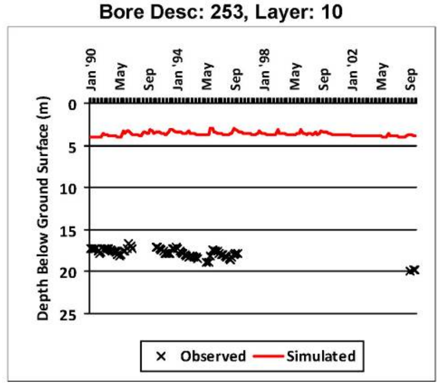
Bore Desc: 252, Layer: 10



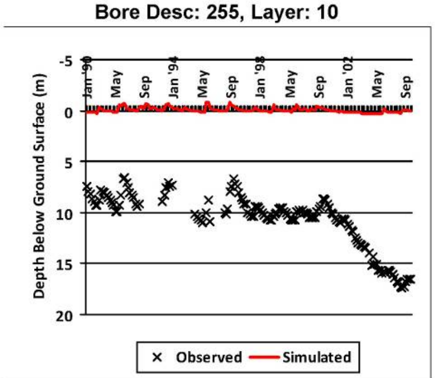
Bore Desc: 2525, Layer: 10



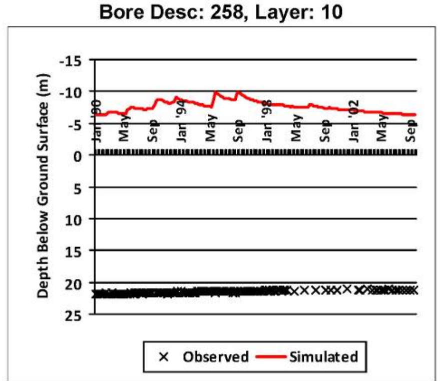
Bore Desc: 253, Layer: 10



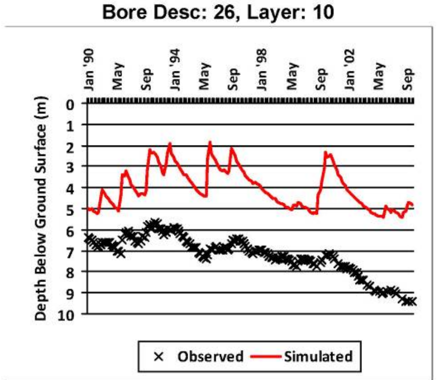
Bore Desc: 255, Layer: 10



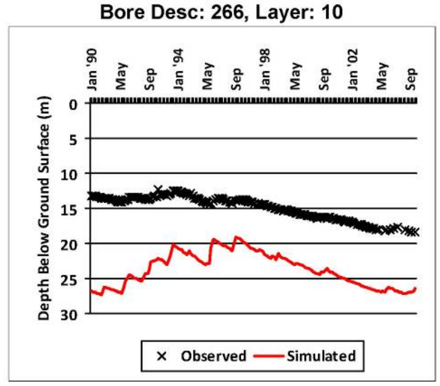
Bore Desc: 258, Layer: 10



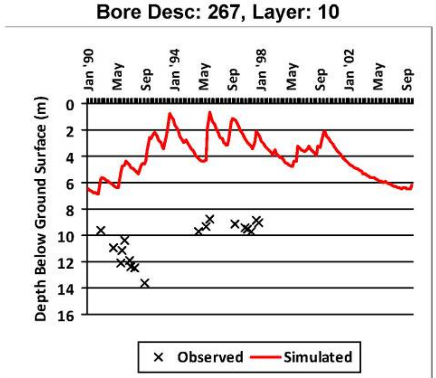
Bore Desc: 26, Layer: 10



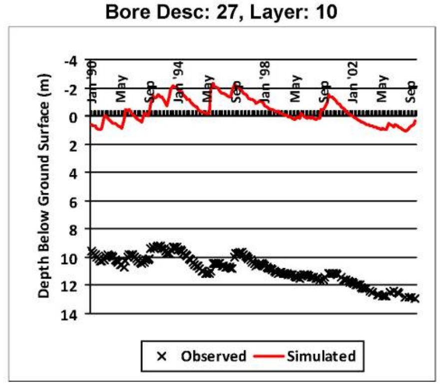
Bore Desc: 266, Layer: 10



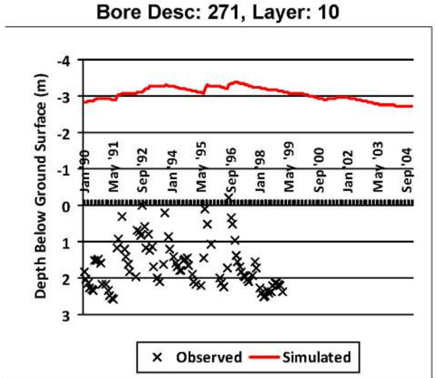
Bore Desc: 267, Layer: 10



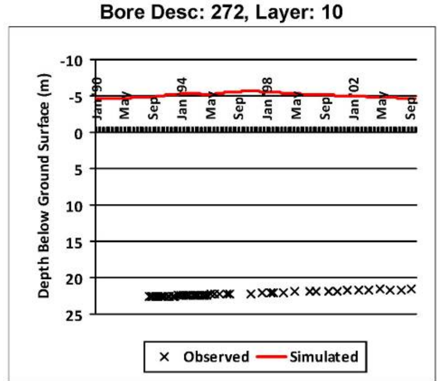
Bore Desc: 27, Layer: 10



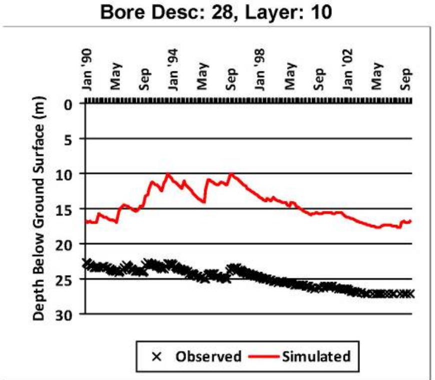
Bore Desc: 271, Layer: 10



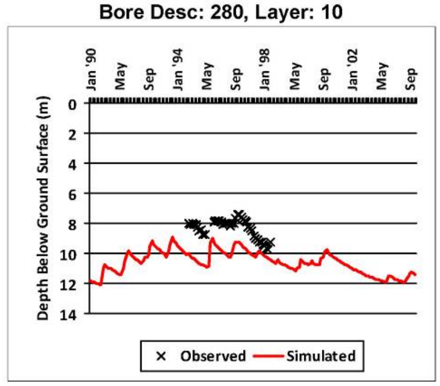
Bore Desc: 272, Layer: 10



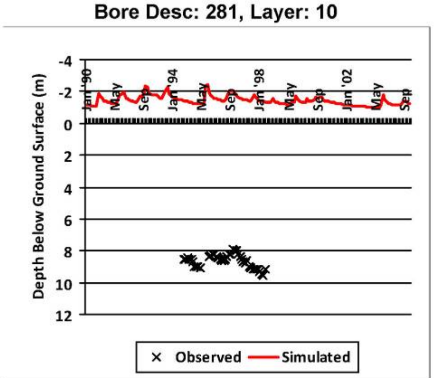
Bore Desc: 28, Layer: 10



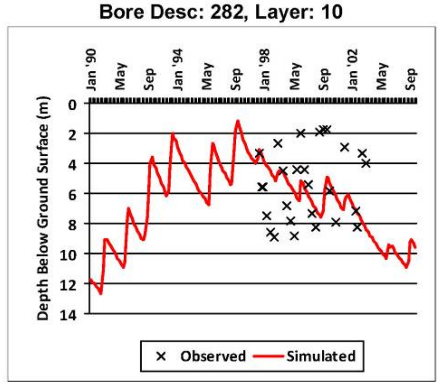
Bore Desc: 280, Layer: 10



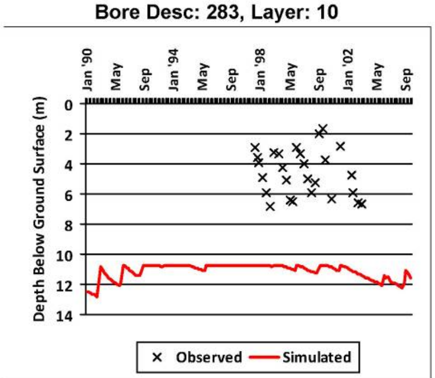
Bore Desc: 281, Layer: 10



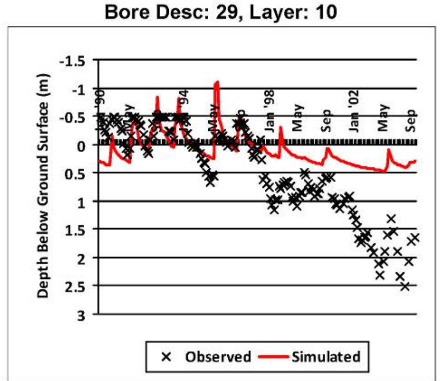
Bore Desc: 282, Layer: 10

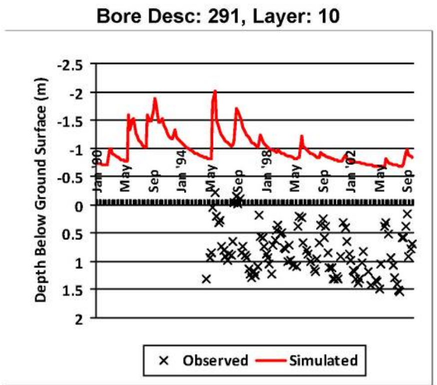


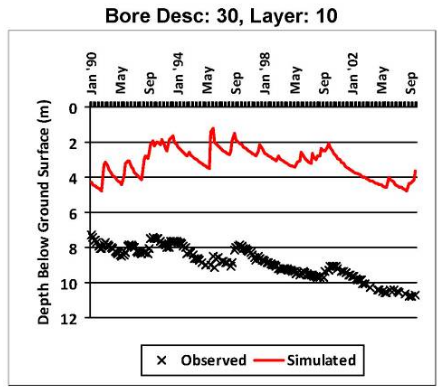
Bore Desc: 283, Layer: 10

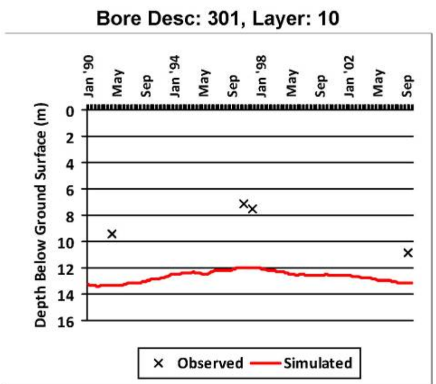


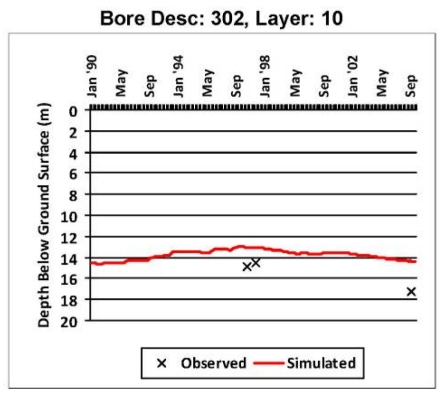
Bore Desc: 29, Layer: 10

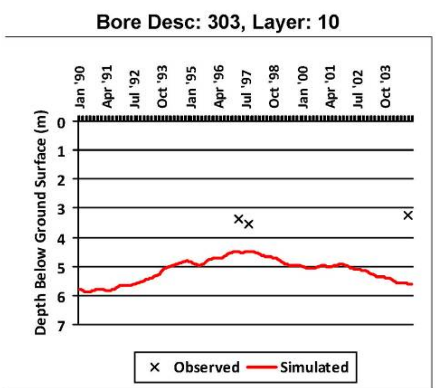


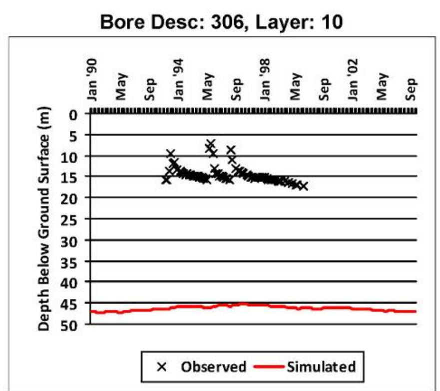

Bore Desc: 291, Layer: 10
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: 30, Layer: 10
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated

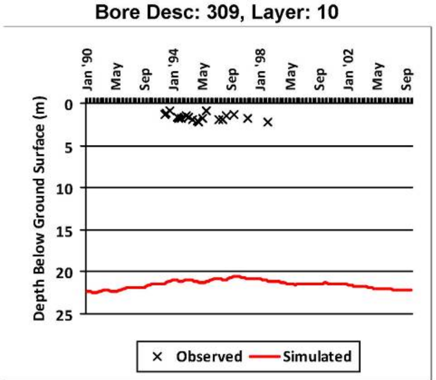

Bore Desc: 301, Layer: 10
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: 302, Layer: 10
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated

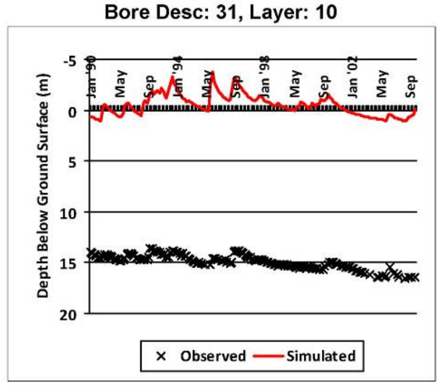

Bore Desc: 303, Layer: 10
Depth Below Ground Surface (m)
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Observed
Simulated


Bore Desc: 306, Layer: 10
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated

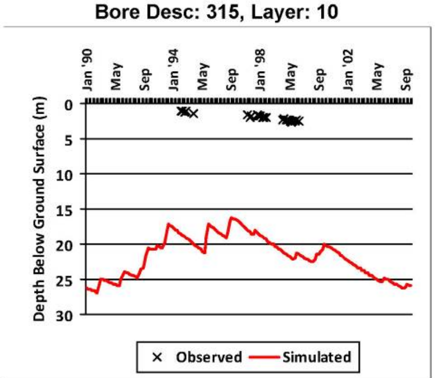
Bore Desc: 309, Layer: 10



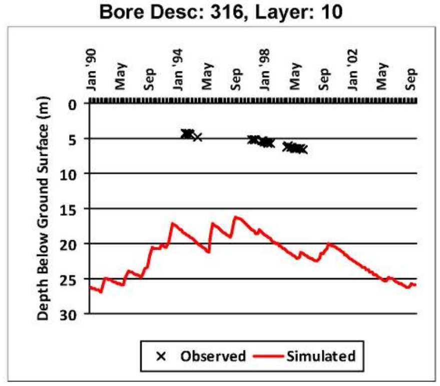
Bore Desc: 31, Layer: 10



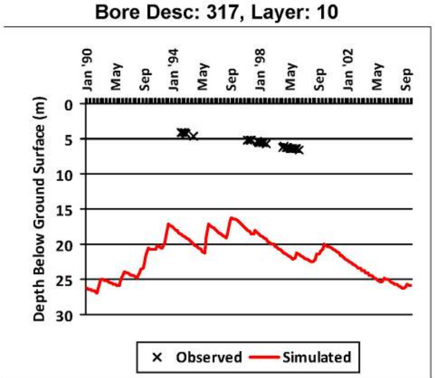
Bore Desc: 315, Layer: 10



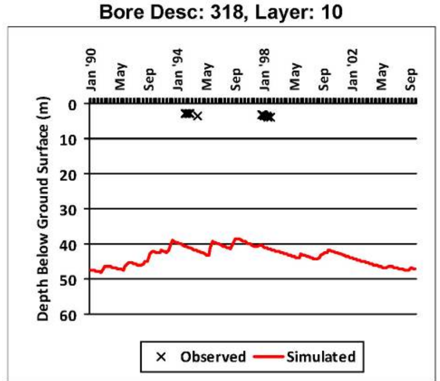
Bore Desc: 316, Layer: 10



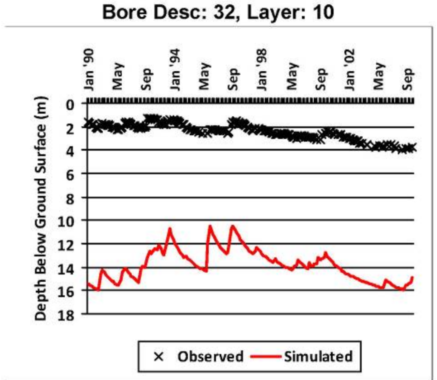
Bore Desc: 317, Layer: 10



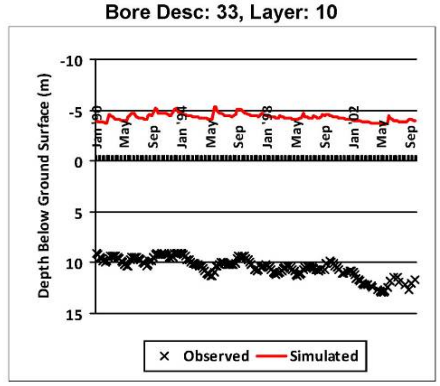
Bore Desc: 318, Layer: 10



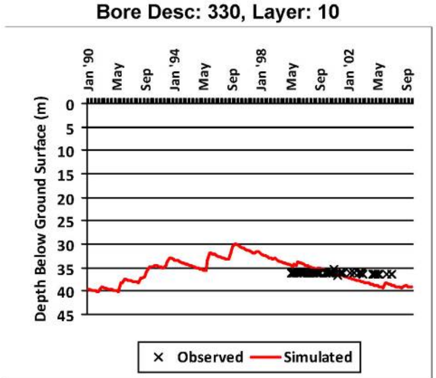
Bore Desc: 32, Layer: 10



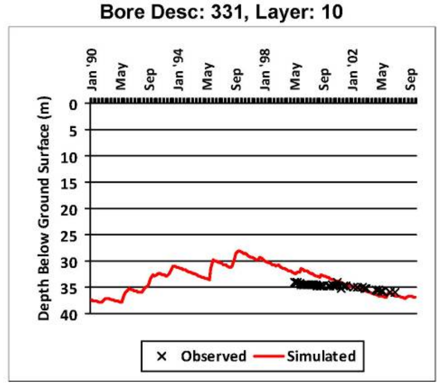
Bore Desc: 33, Layer: 10



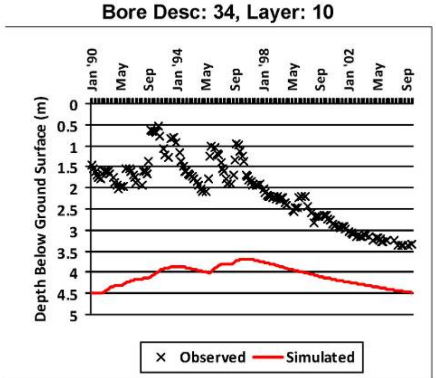
Bore Desc: 330, Layer: 10



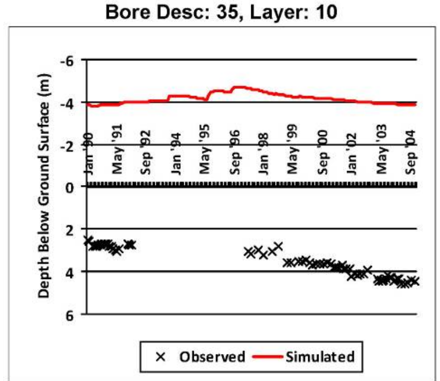
Bore Desc: 331, Layer: 10



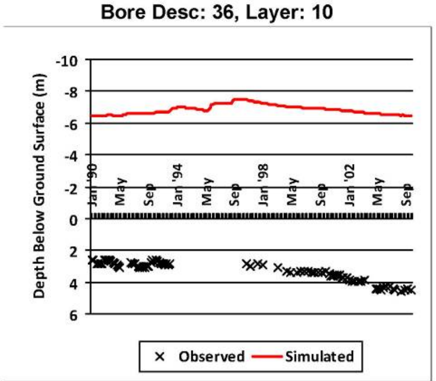
Bore Desc: 34, Layer: 10



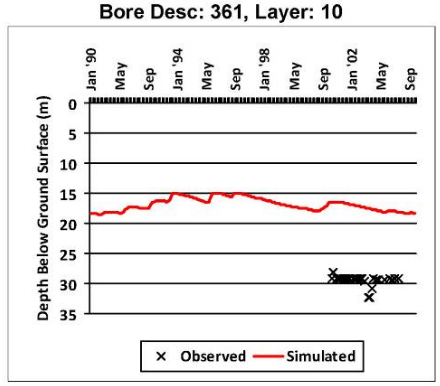
Bore Desc: 35, Layer: 10



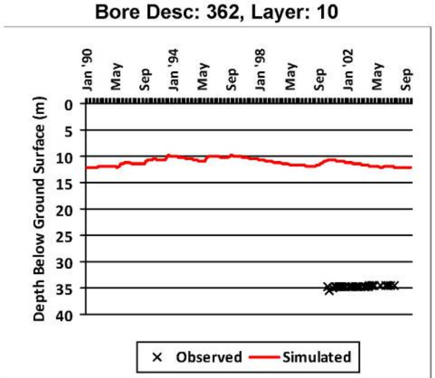
Bore Desc: 36, Layer: 10



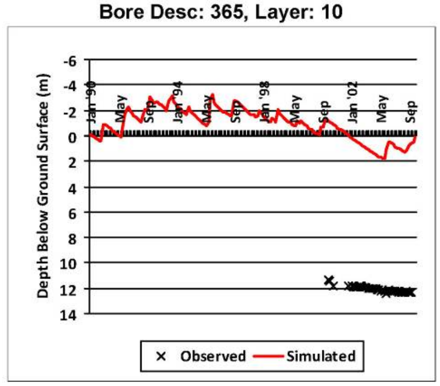
Bore Desc: 361, Layer: 10



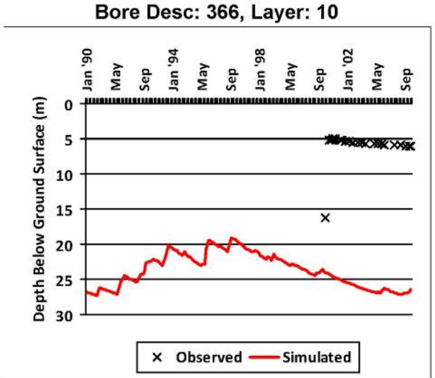
Bore Desc: 362, Layer: 10



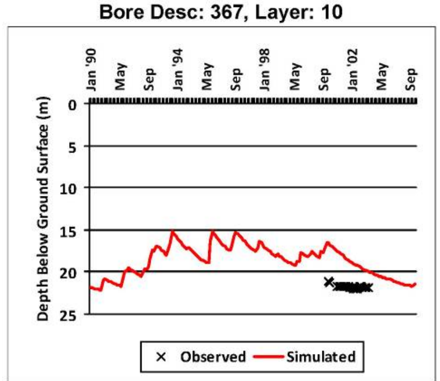
Bore Desc: 365, Layer: 10



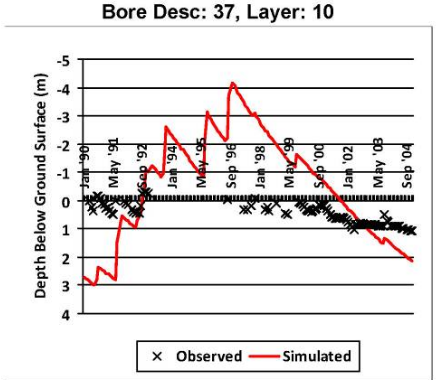
Bore Desc: 366, Layer: 10



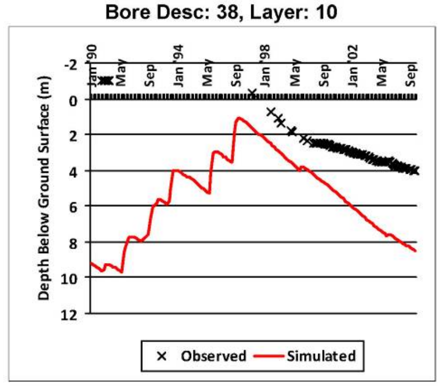
Bore Desc: 367, Layer: 10



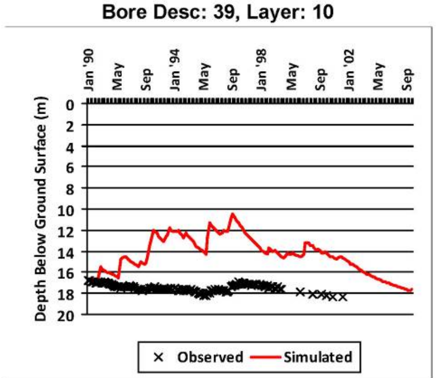
Bore Desc: 37, Layer: 10



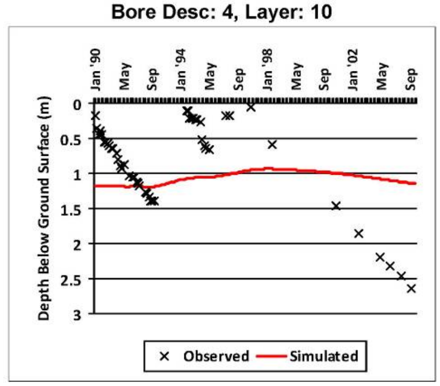
Bore Desc: 38, Layer: 10



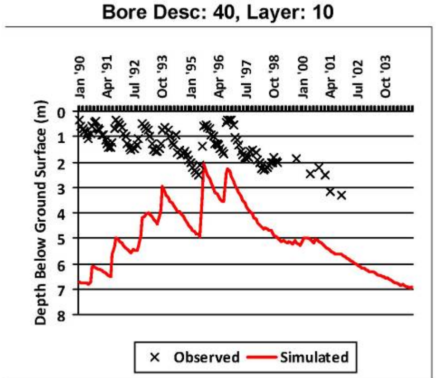
Bore Desc: 39, Layer: 10



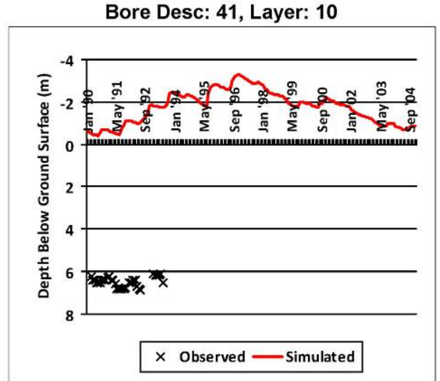
Bore Desc: 4, Layer: 10

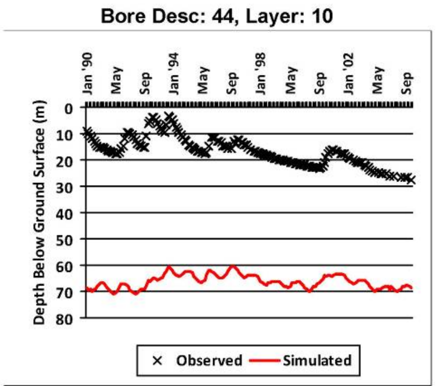


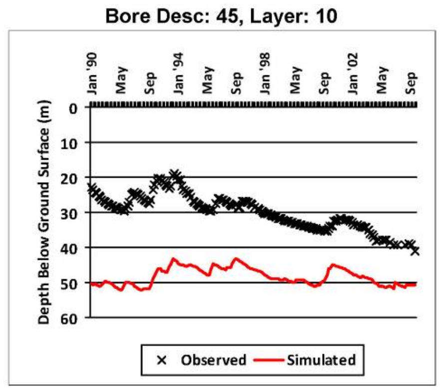
Bore Desc: 40, Layer: 10

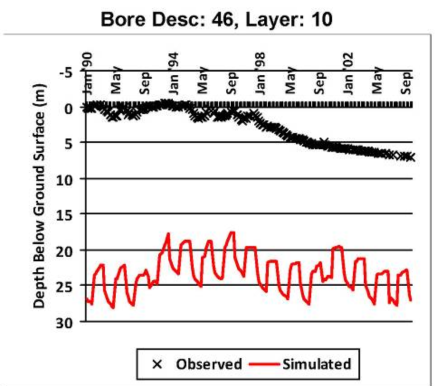


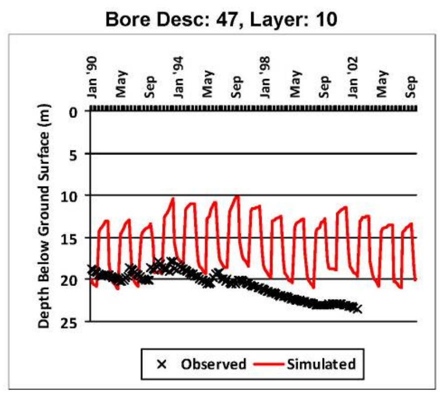
Bore Desc: 41, Layer: 10

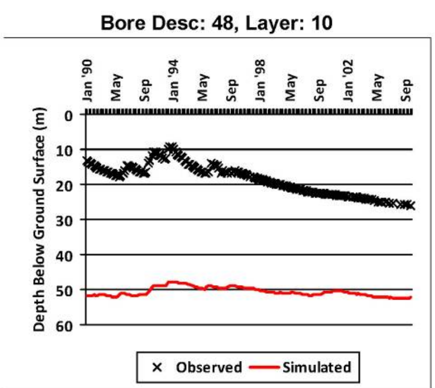


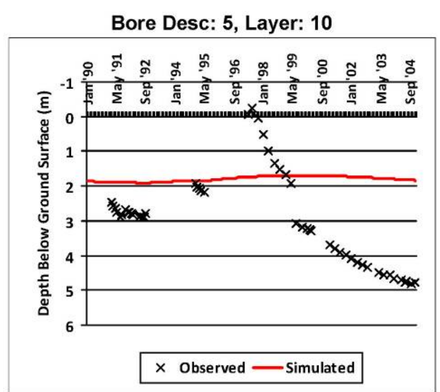

Bore Desc: 44, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 45, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

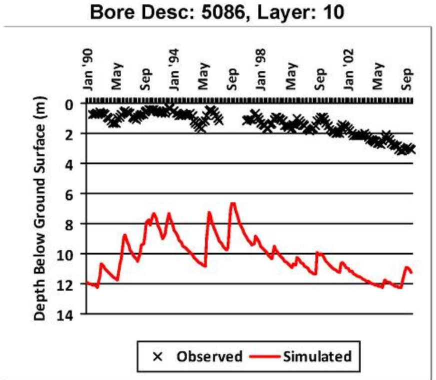

Bore Desc: 46, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 47, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

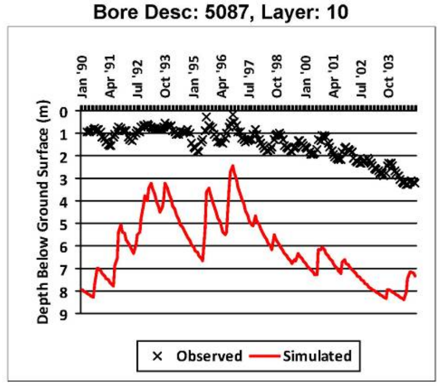

Bore Desc: 48, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

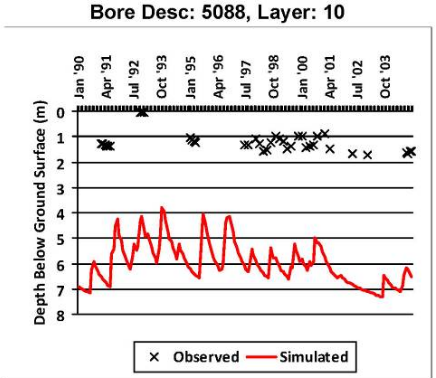
Bore Desc: 5086, Layer: 10



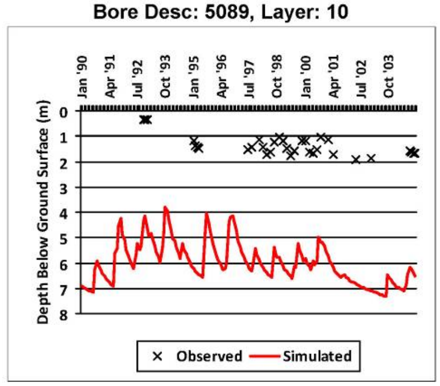
Bore Desc: 5087, Layer: 10



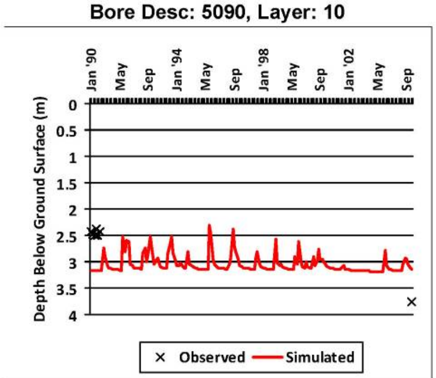
Bore Desc: 5088, Layer: 10



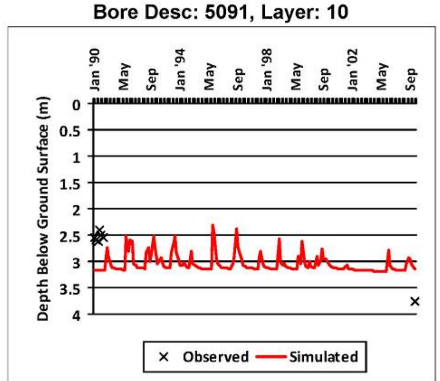
Bore Desc: 5089, Layer: 10



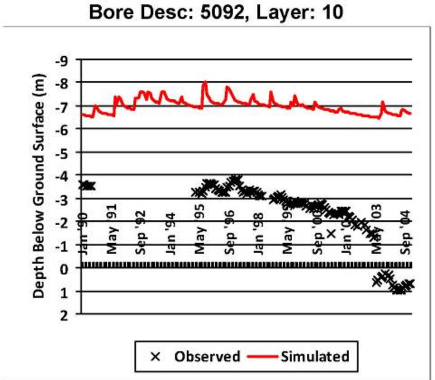
Bore Desc: 5090, Layer: 10



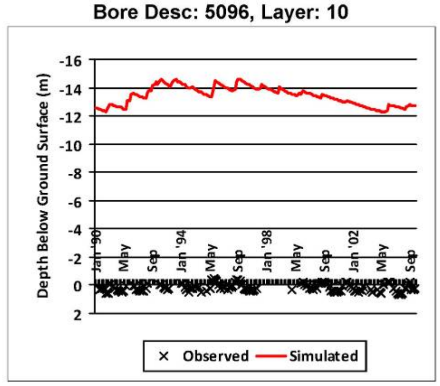
Bore Desc: 5091, Layer: 10



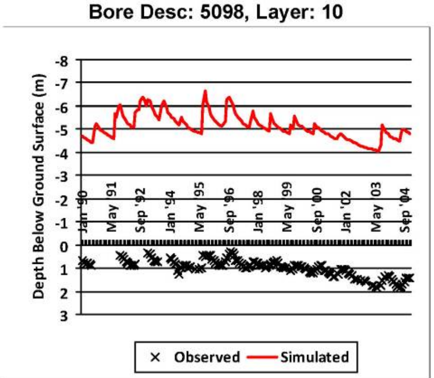
Bore Desc: 5092, Layer: 10



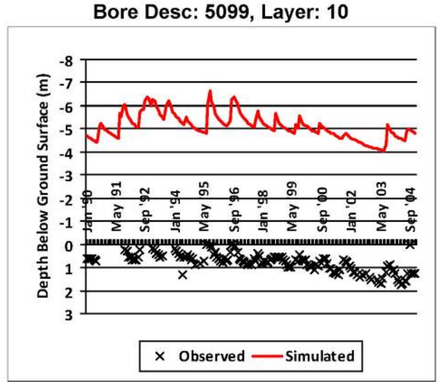
Bore Desc: 5096, Layer: 10



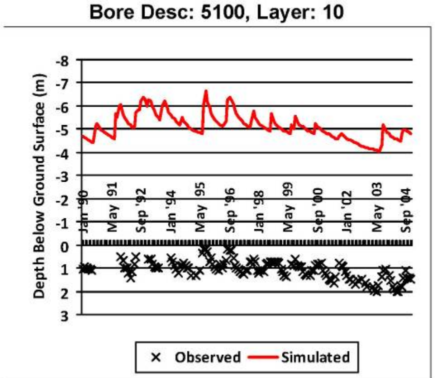
Bore Desc: 5098, Layer: 10



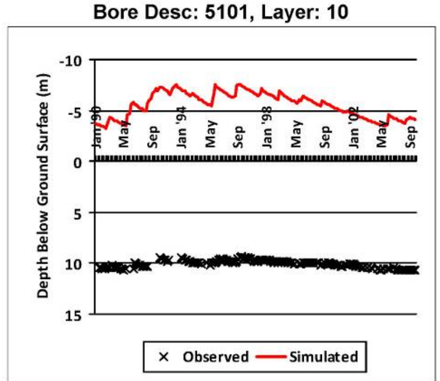
Bore Desc: 5099, Layer: 10



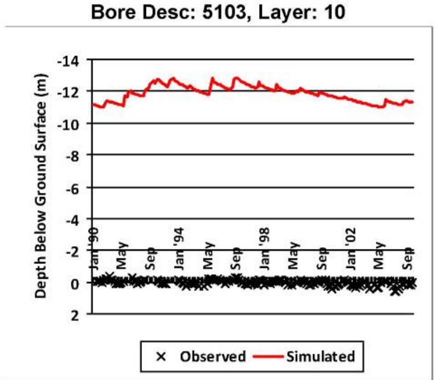
Bore Desc: 5100, Layer: 10



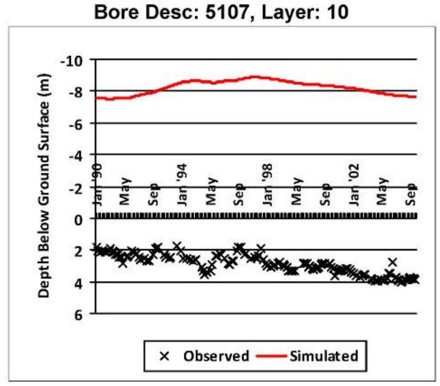
Bore Desc: 5101, Layer: 10



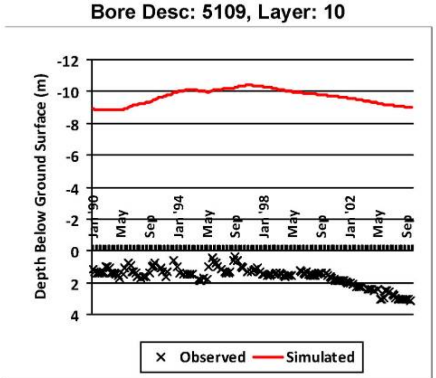
Bore Desc: 5103, Layer: 10



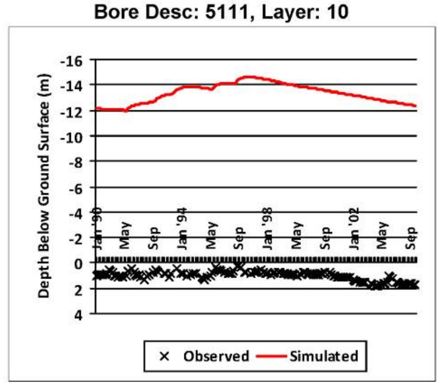
Bore Desc: 5107, Layer: 10



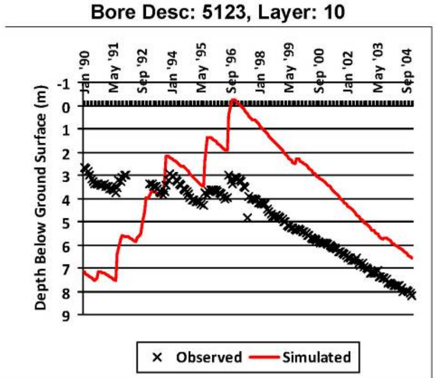
Bore Desc: 5109, Layer: 10



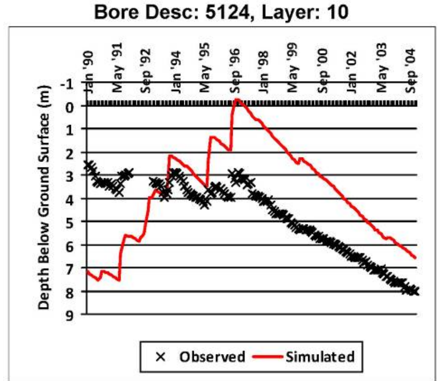
Bore Desc: 5111, Layer: 10



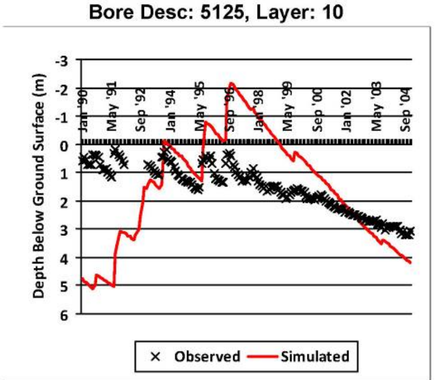
Bore Desc: 5123, Layer: 10



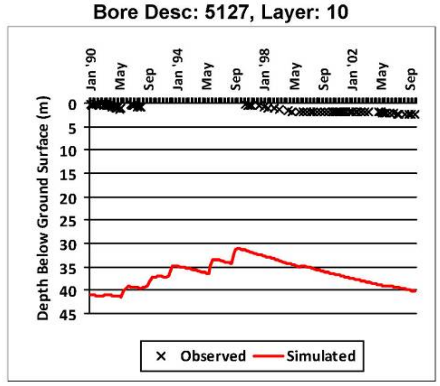
Bore Desc: 5124, Layer: 10



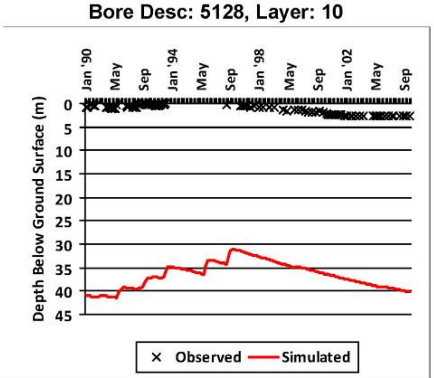
Bore Desc: 5125, Layer: 10



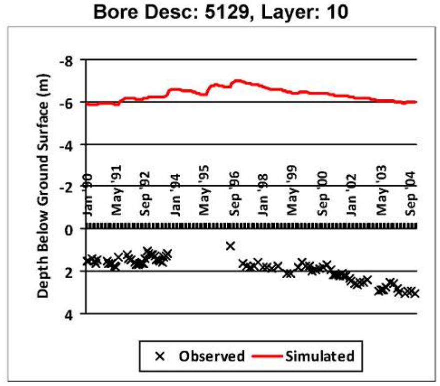
Bore Desc: 5127, Layer: 10



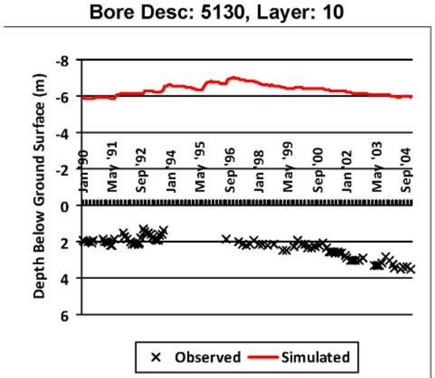
Bore Desc: 5128, Layer: 10



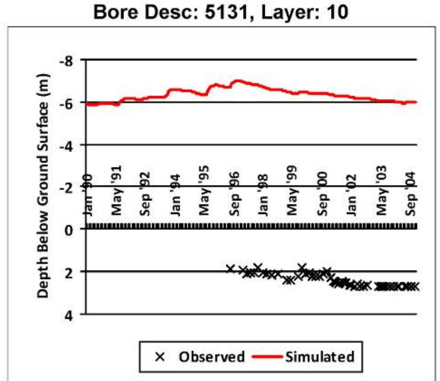
Bore Desc: 5129, Layer: 10



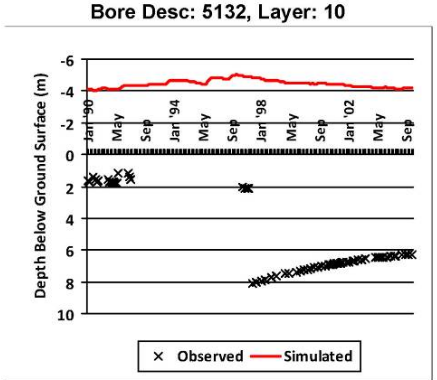
Bore Desc: 5130, Layer: 10



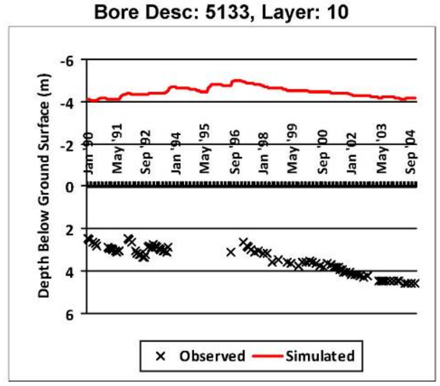
Bore Desc: 5131, Layer: 10



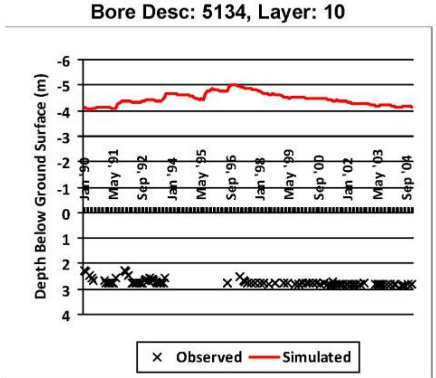
Bore Desc: 5132, Layer: 10



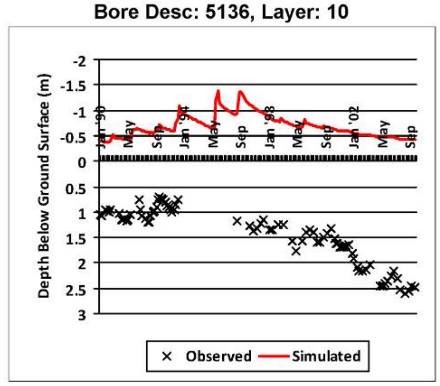
Bore Desc: 5133, Layer: 10



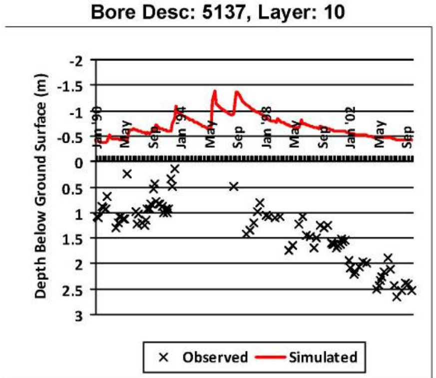
Bore Desc: 5134, Layer: 10



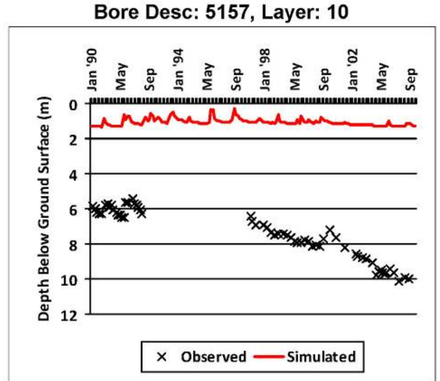
Bore Desc: 5136, Layer: 10

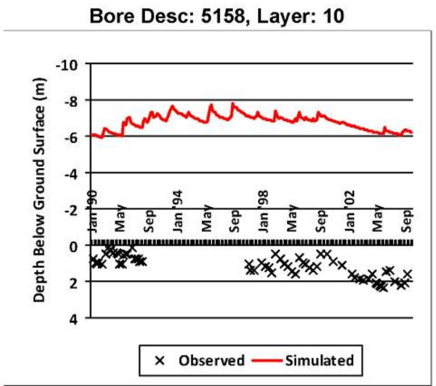


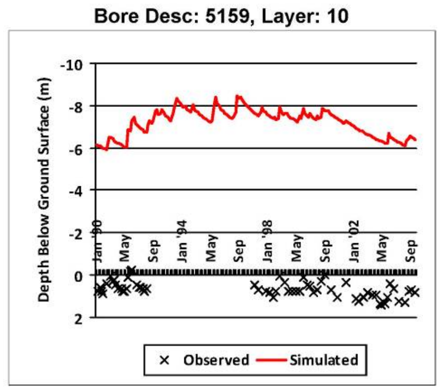
Bore Desc: 5137, Layer: 10

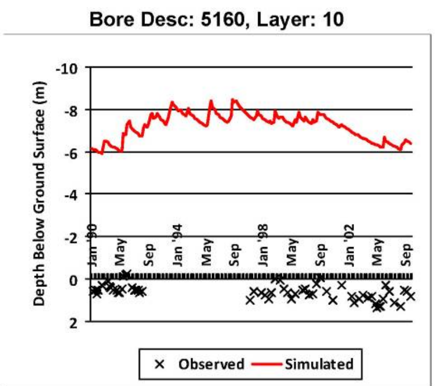


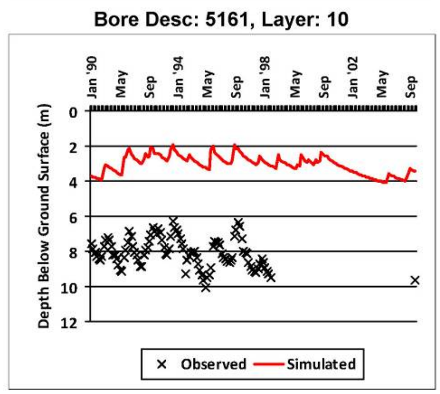
Bore Desc: 5157, Layer: 10

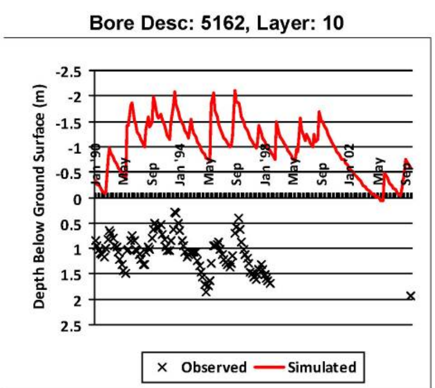


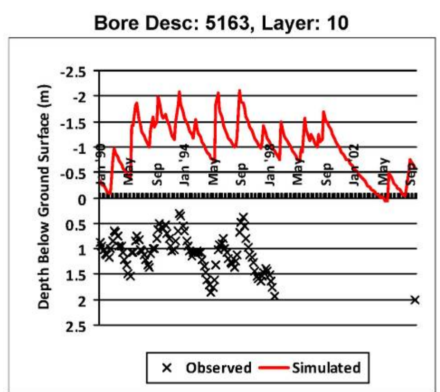

Bore Desc: 5158, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5159, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

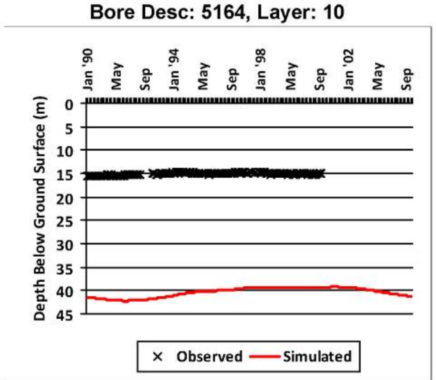

Bore Desc: 5160, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5161, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

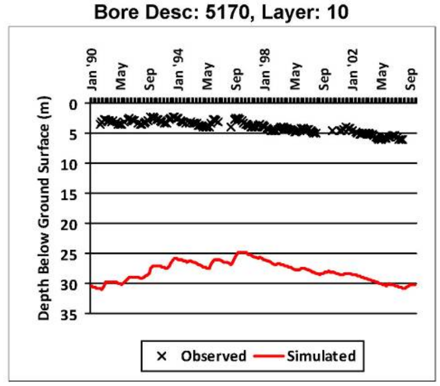

Bore Desc: 5162, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5163, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

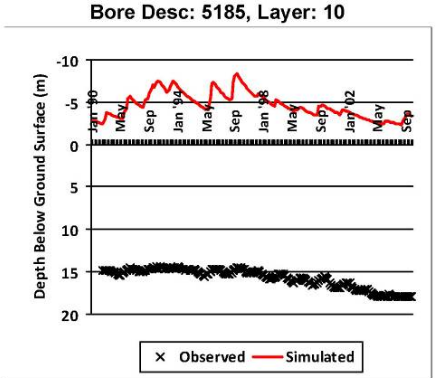
Bore Desc: 5164, Layer: 10



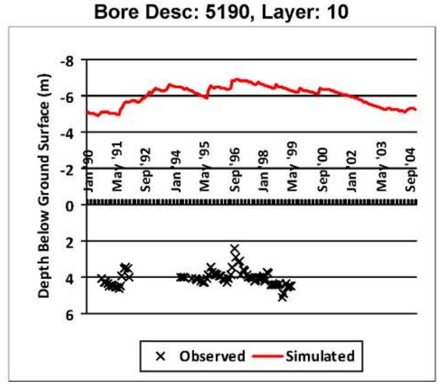
Bore Desc: 5170, Layer: 10



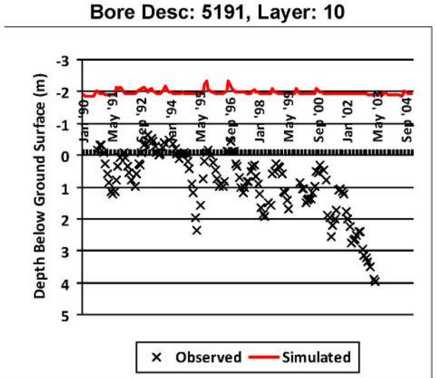
Bore Desc: 5185, Layer: 10



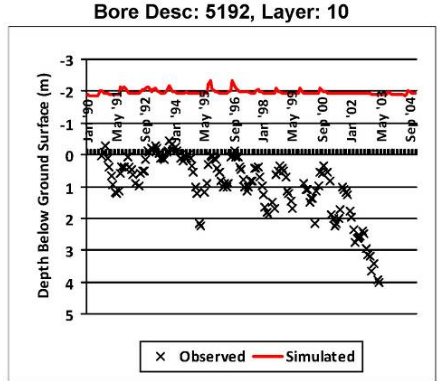
Bore Desc: 5190, Layer: 10



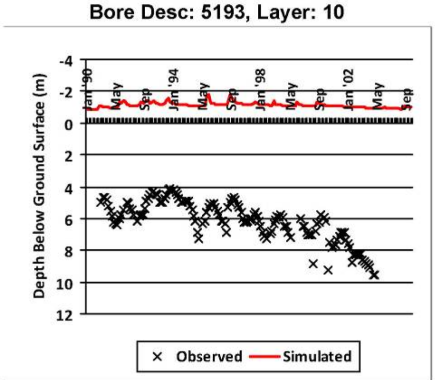
Bore Desc: 5191, Layer: 10



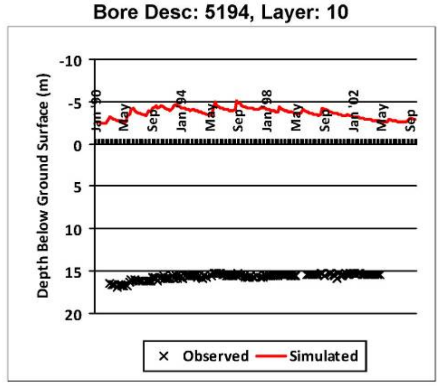
Bore Desc: 5192, Layer: 10



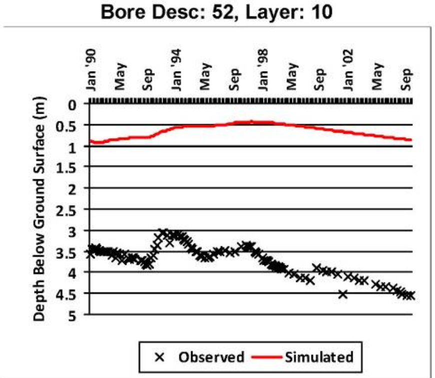
Bore Desc: 5193, Layer: 10



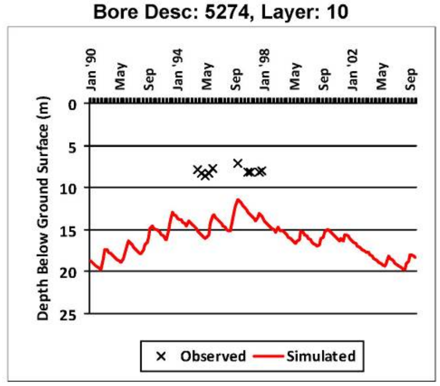
Bore Desc: 5194, Layer: 10



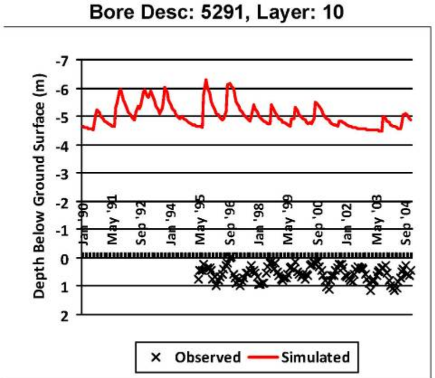
Bore Desc: 52, Layer: 10



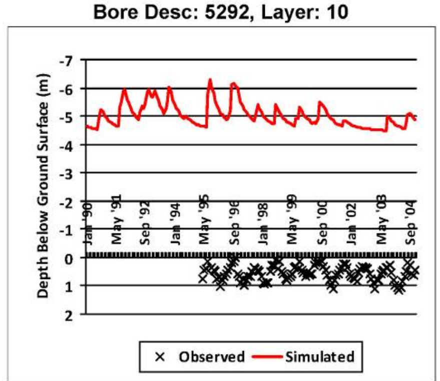
Bore Desc: 5274, Layer: 10



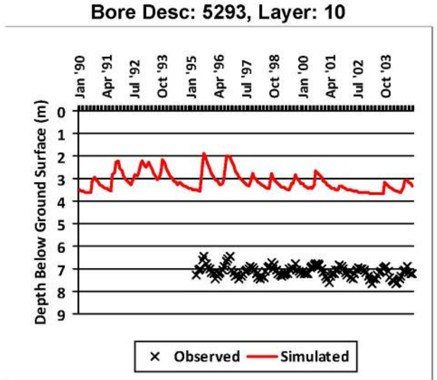
Bore Desc: 5291, Layer: 10



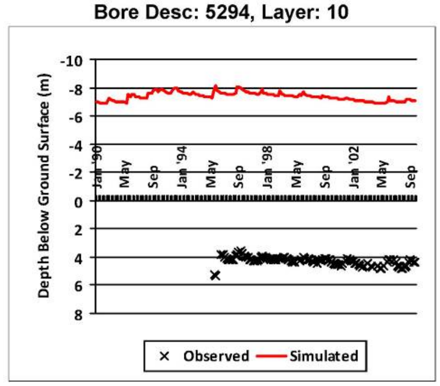
Bore Desc: 5292, Layer: 10



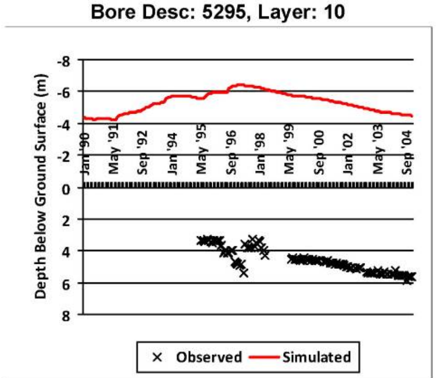
Bore Desc: 5293, Layer: 10



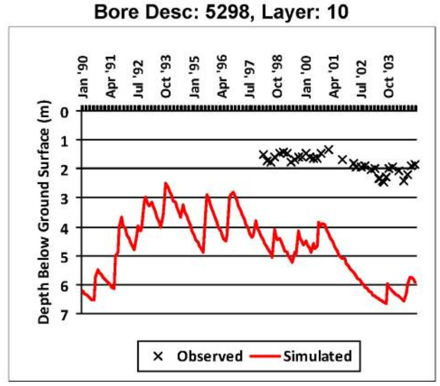
Bore Desc: 5294, Layer: 10



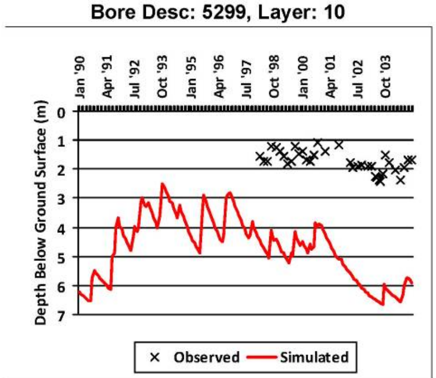
Bore Desc: 5295, Layer: 10



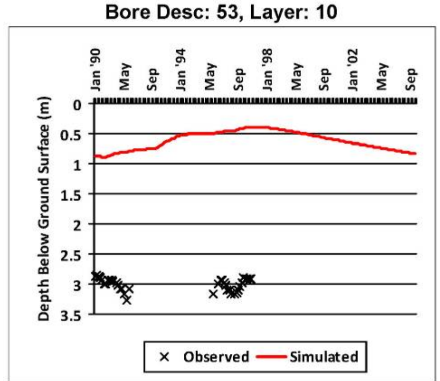
Bore Desc: 5298, Layer: 10

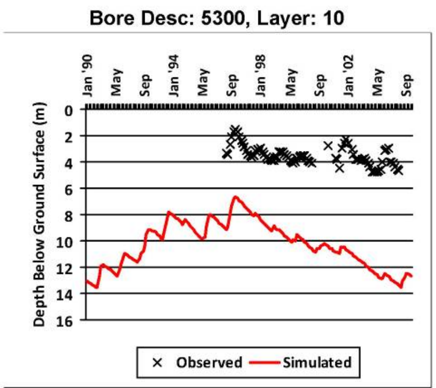


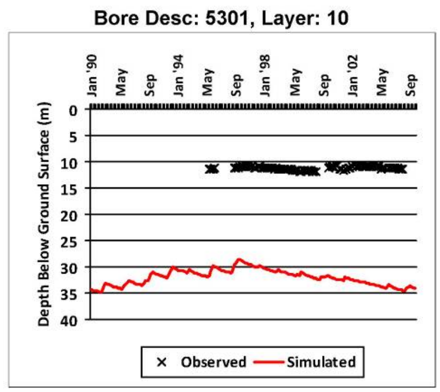
Bore Desc: 5299, Layer: 10

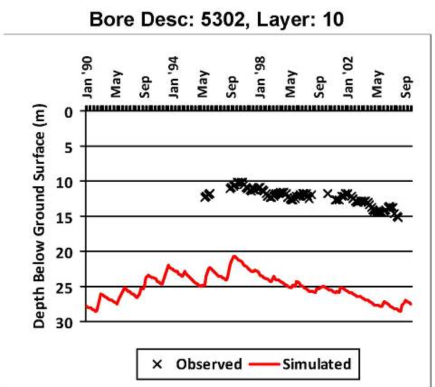


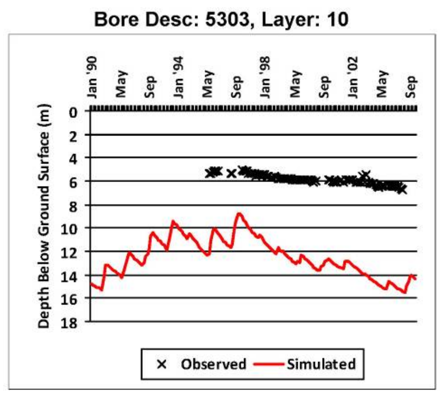
Bore Desc: 53, Layer: 10

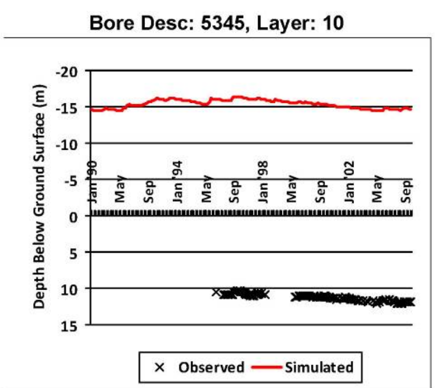


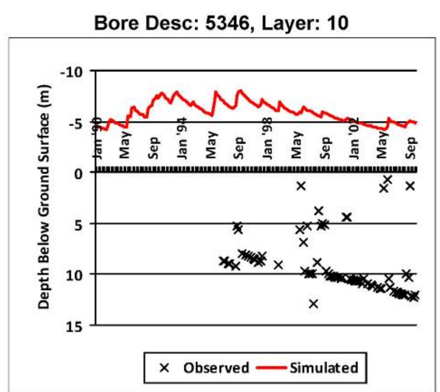

Bore Desc: 5300, Layer: 10
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Observed
Simulated


Bore Desc: 5301, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

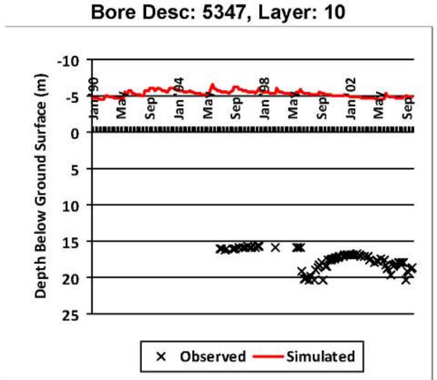

Bore Desc: 5302, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5303, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

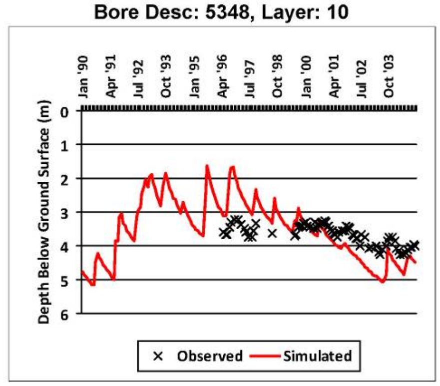

Bore Desc: 5345, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 5346, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

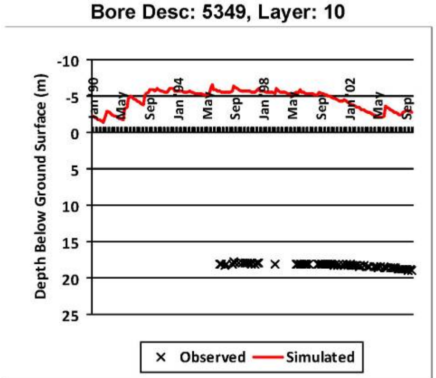
Bore Desc: 5347, Layer: 10



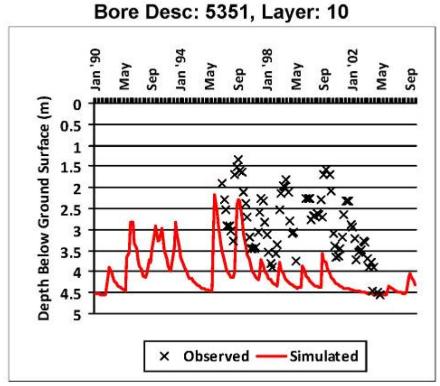
Bore Desc: 5348, Layer: 10



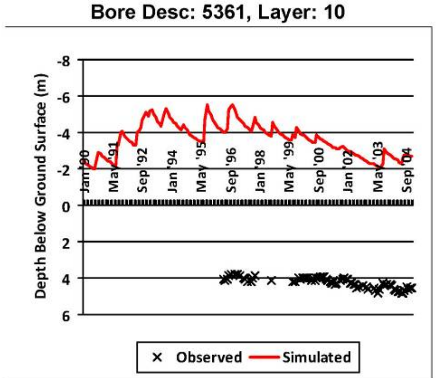
Bore Desc: 5349, Layer: 10



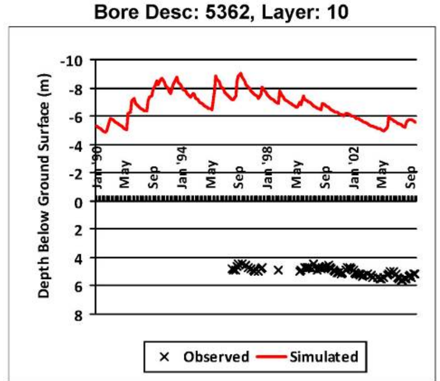
Bore Desc: 5351, Layer: 10



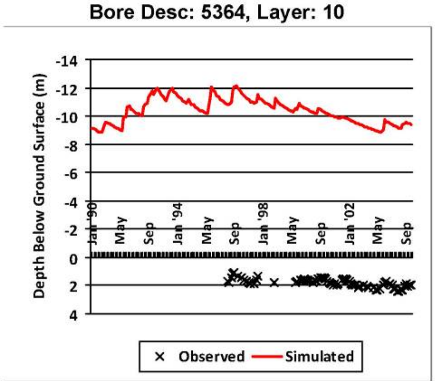
Bore Desc: 5361, Layer: 10



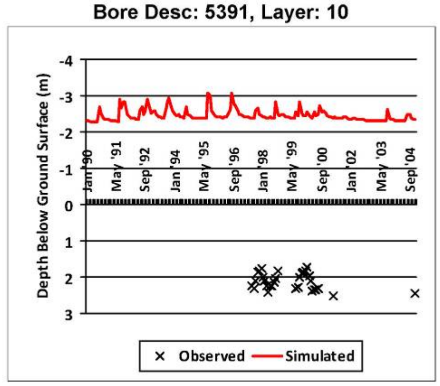
Bore Desc: 5362, Layer: 10



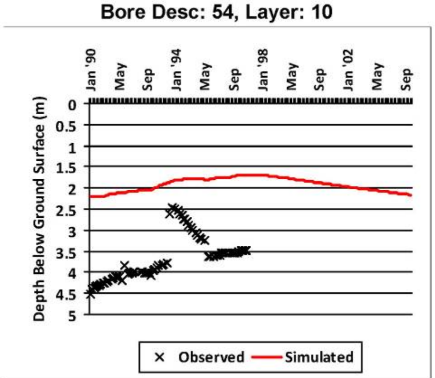
Bore Desc: 5364, Layer: 10



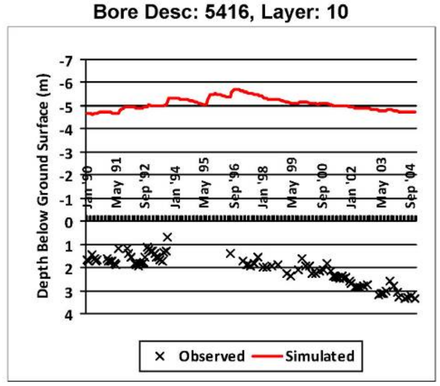
Bore Desc: 5391, Layer: 10



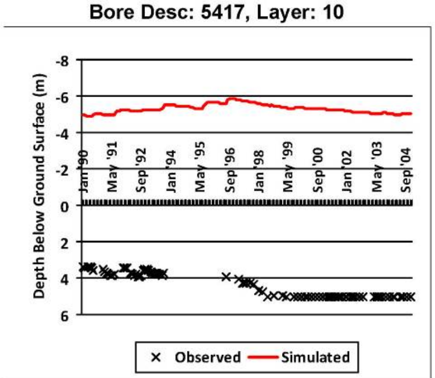
Bore Desc: 54, Layer: 10



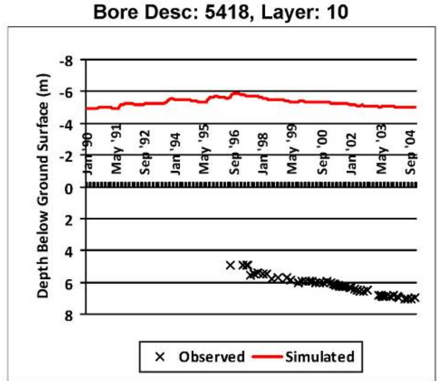
Bore Desc: 5416, Layer: 10



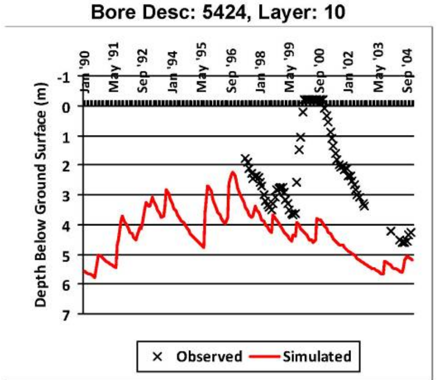
Bore Desc: 5417, Layer: 10



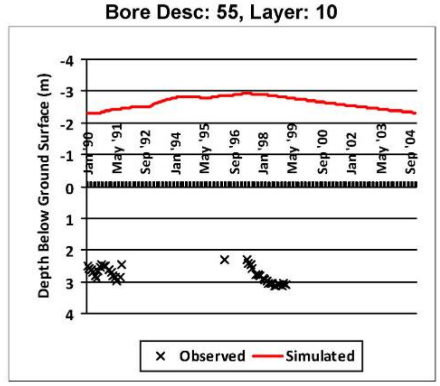
Bore Desc: 5418, Layer: 10



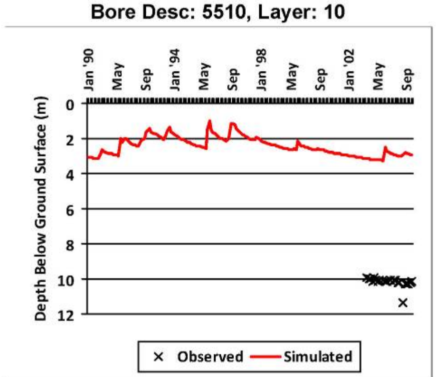
Bore Desc: 5424, Layer: 10



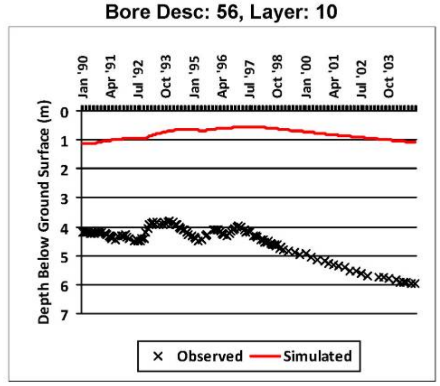
Bore Desc: 55, Layer: 10



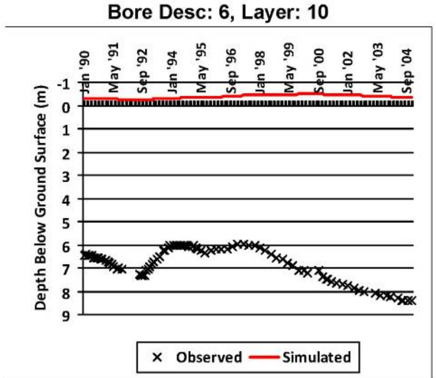
Bore Desc: 5510, Layer: 10



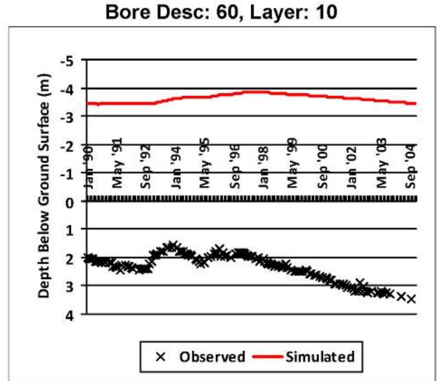
Bore Desc: 56, Layer: 10



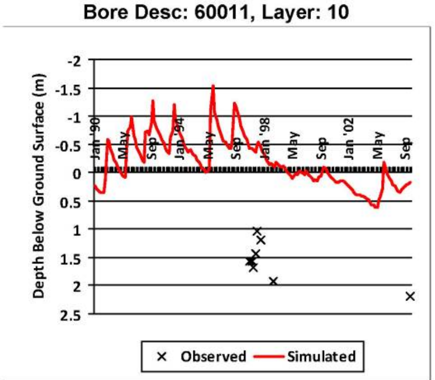
Bore Desc: 6, Layer: 10



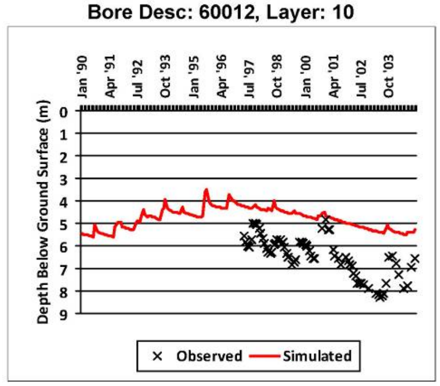
Bore Desc: 60, Layer: 10



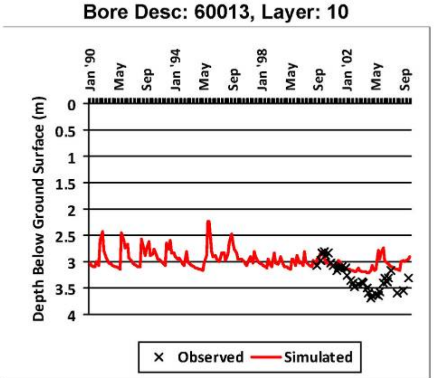
Bore Desc: 60011, Layer: 10



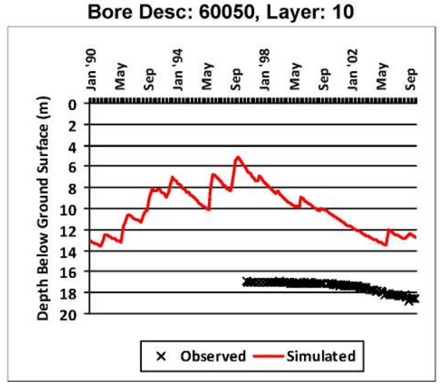
Bore Desc: 60012, Layer: 10



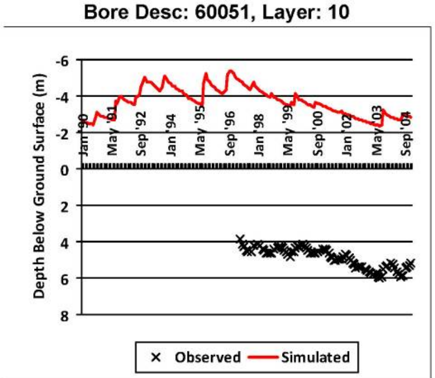
Bore Desc: 60013, Layer: 10



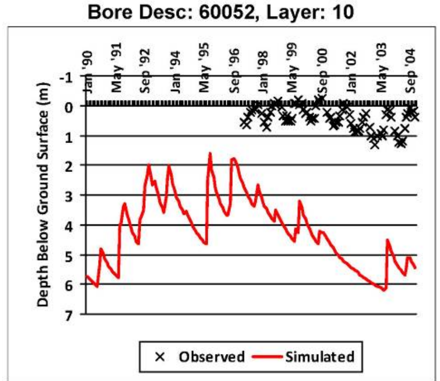
Bore Desc: 60050, Layer: 10

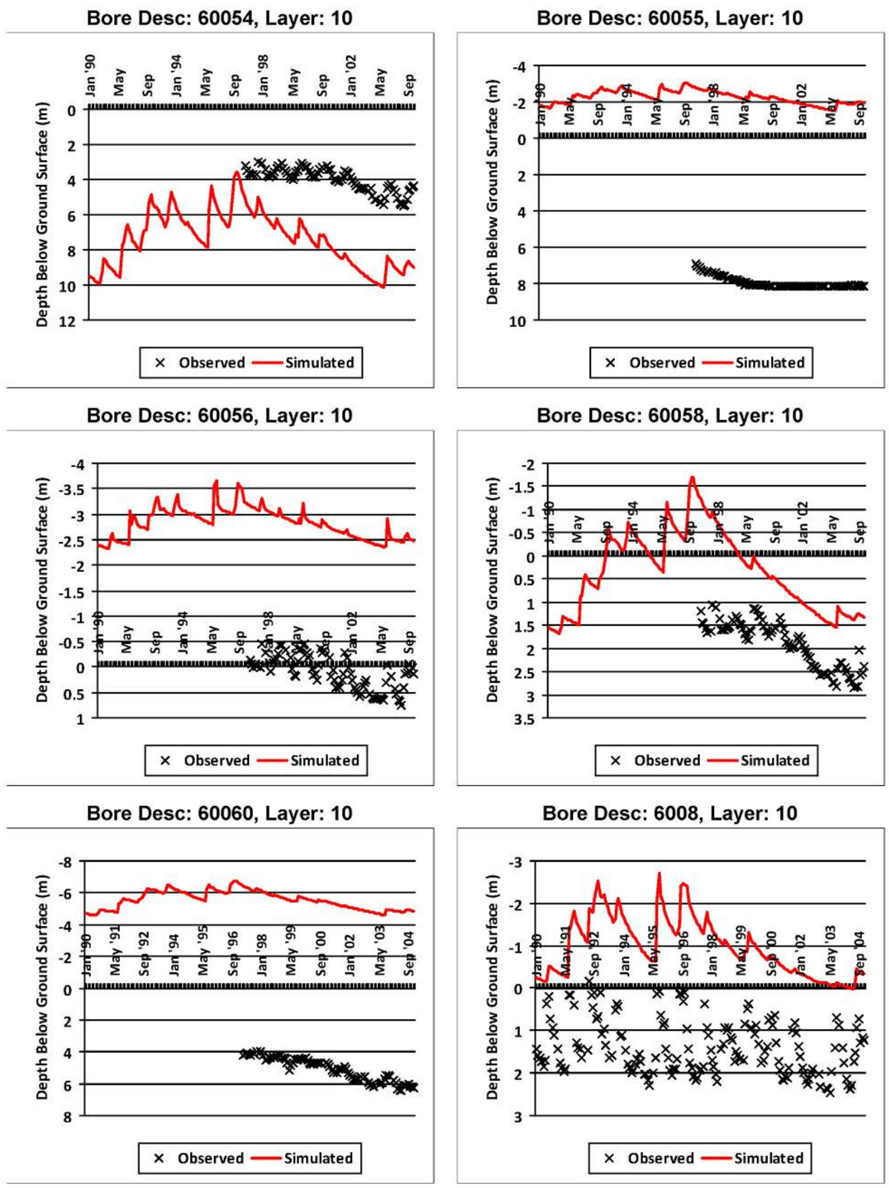


Bore Desc: 60051, Layer: 10

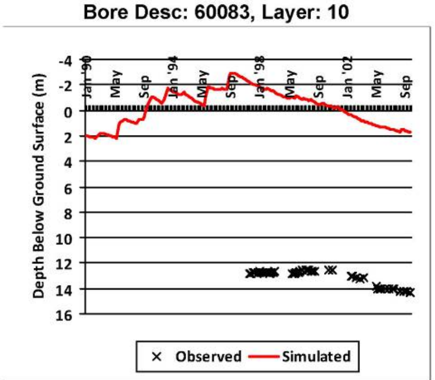


Bore Desc: 60052, Layer: 10

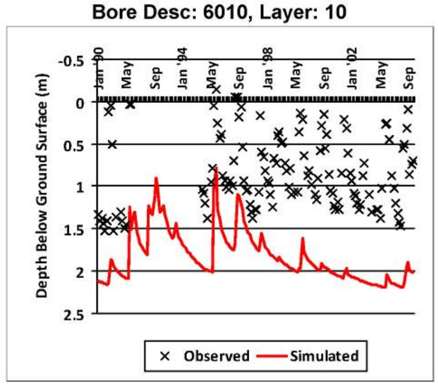



Bore Desc: 60054, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated
Bore Desc: 60055, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated
Bore Desc: 60056, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated
Bore Desc: 60058, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated
Bore Desc: 60060, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated
Bore Desc: 6008, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

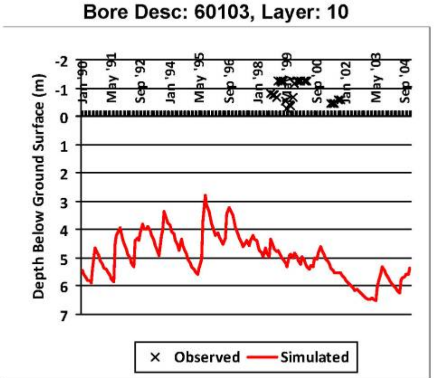
Bore Desc: 60083, Layer: 10



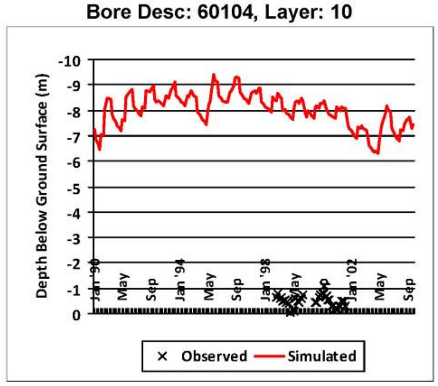
Bore Desc: 6010, Layer: 10



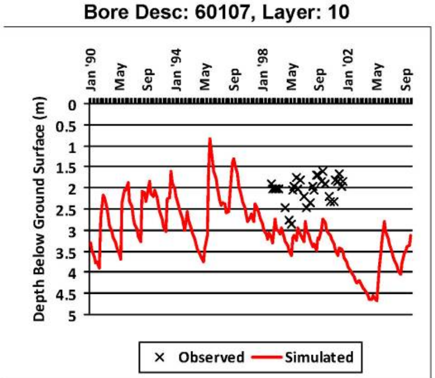
Bore Desc: 60103, Layer: 10



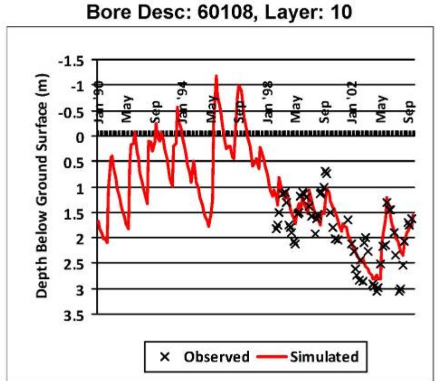
Bore Desc: 60104, Layer: 10

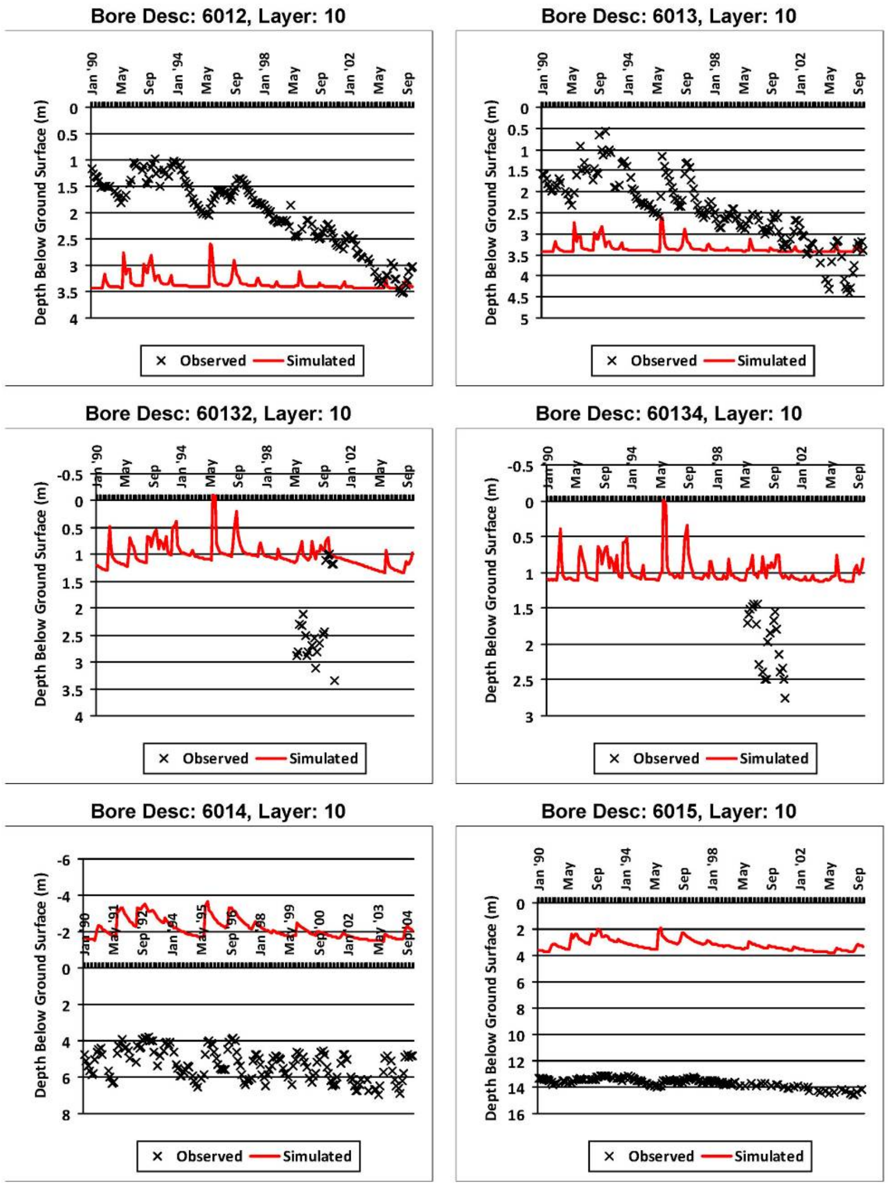


Bore Desc: 60107, Layer: 10

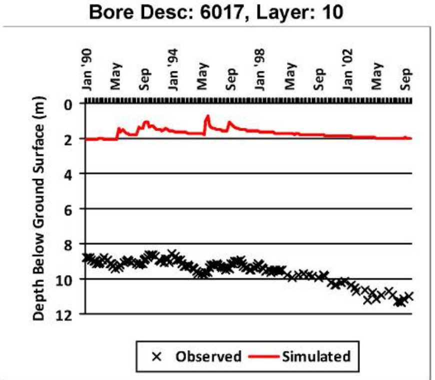


Bore Desc: 60108, Layer: 10

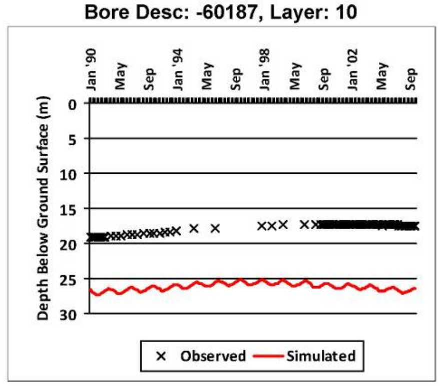



Bore Desc: 6012, Layer: 10
Bore Desc: 6013, Layer: 10
Bore Desc: 60132, Layer: 10
Bore Desc: 60134, Layer: 10
Bore Desc: 6014, Layer: 10
Bore Desc: 6015, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

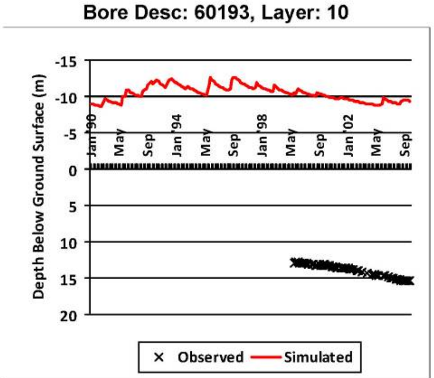
Bore Desc: 6017, Layer: 10



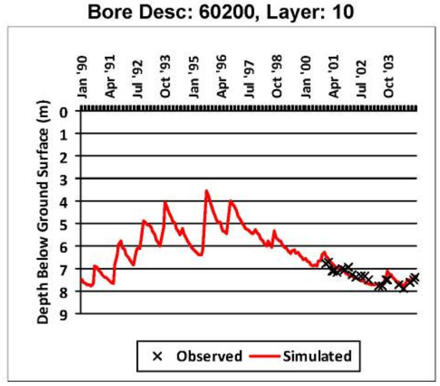
Bore Desc: -60187, Layer: 10



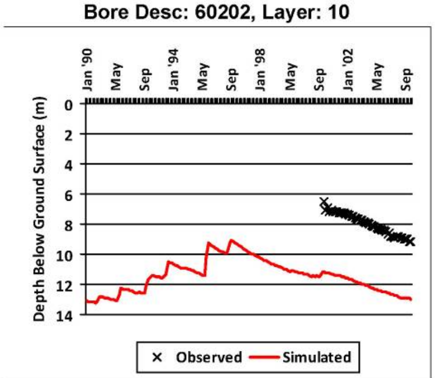
Bore Desc: 60193, Layer: 10



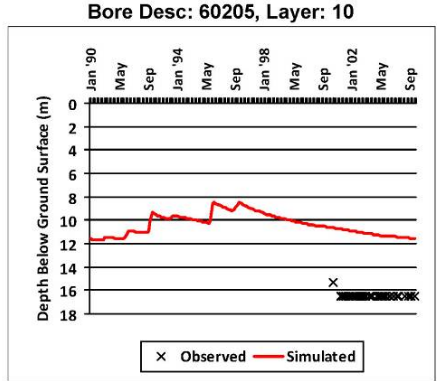
Bore Desc: 60200, Layer: 10



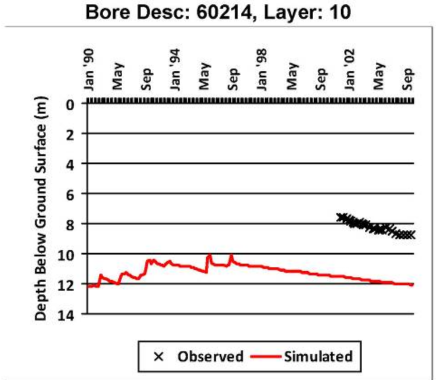
Bore Desc: 60202, Layer: 10



Bore Desc: 60205, Layer: 10



Bore Desc: 60214, Layer: 10



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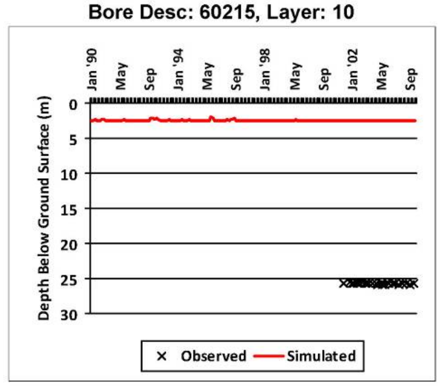

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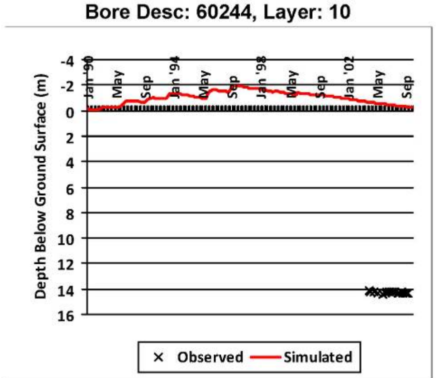

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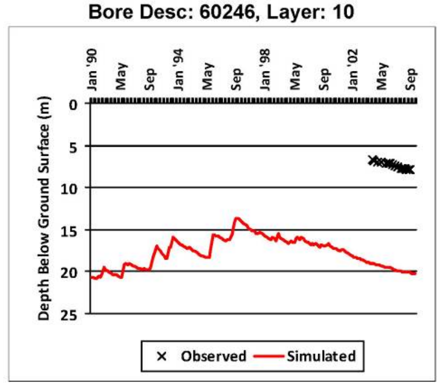

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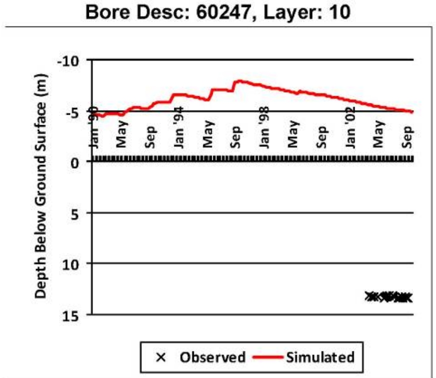

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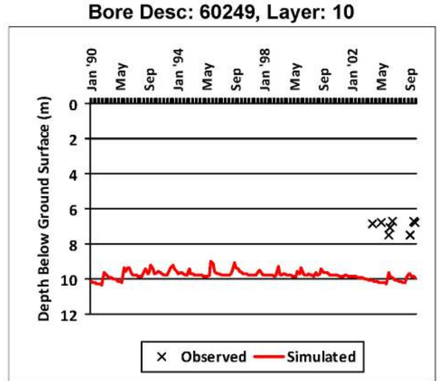

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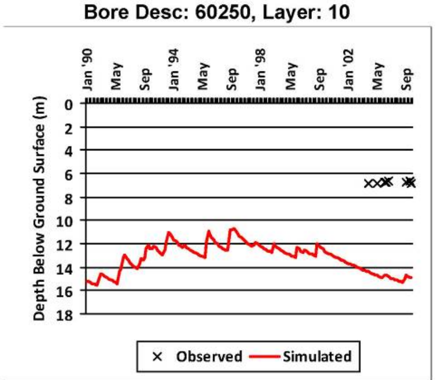

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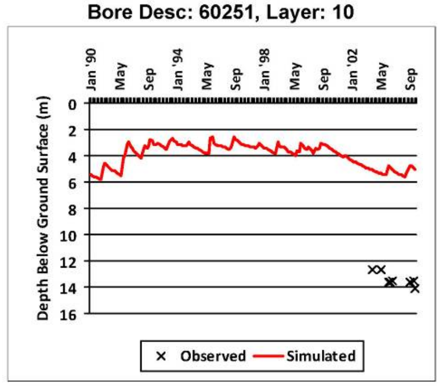

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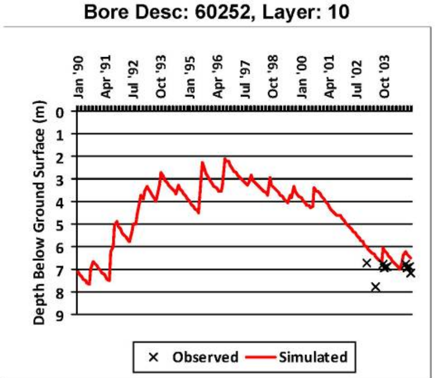

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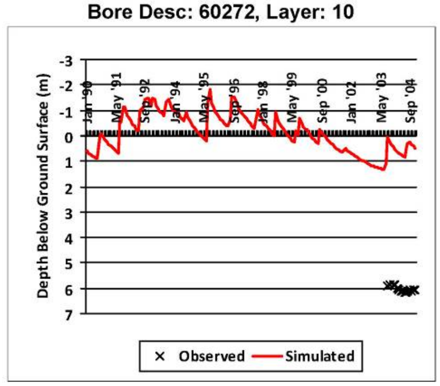

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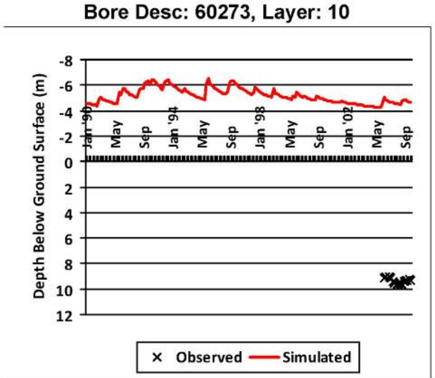

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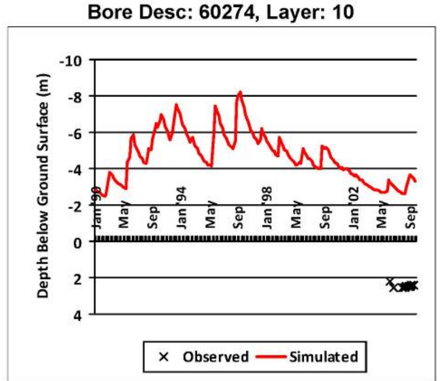
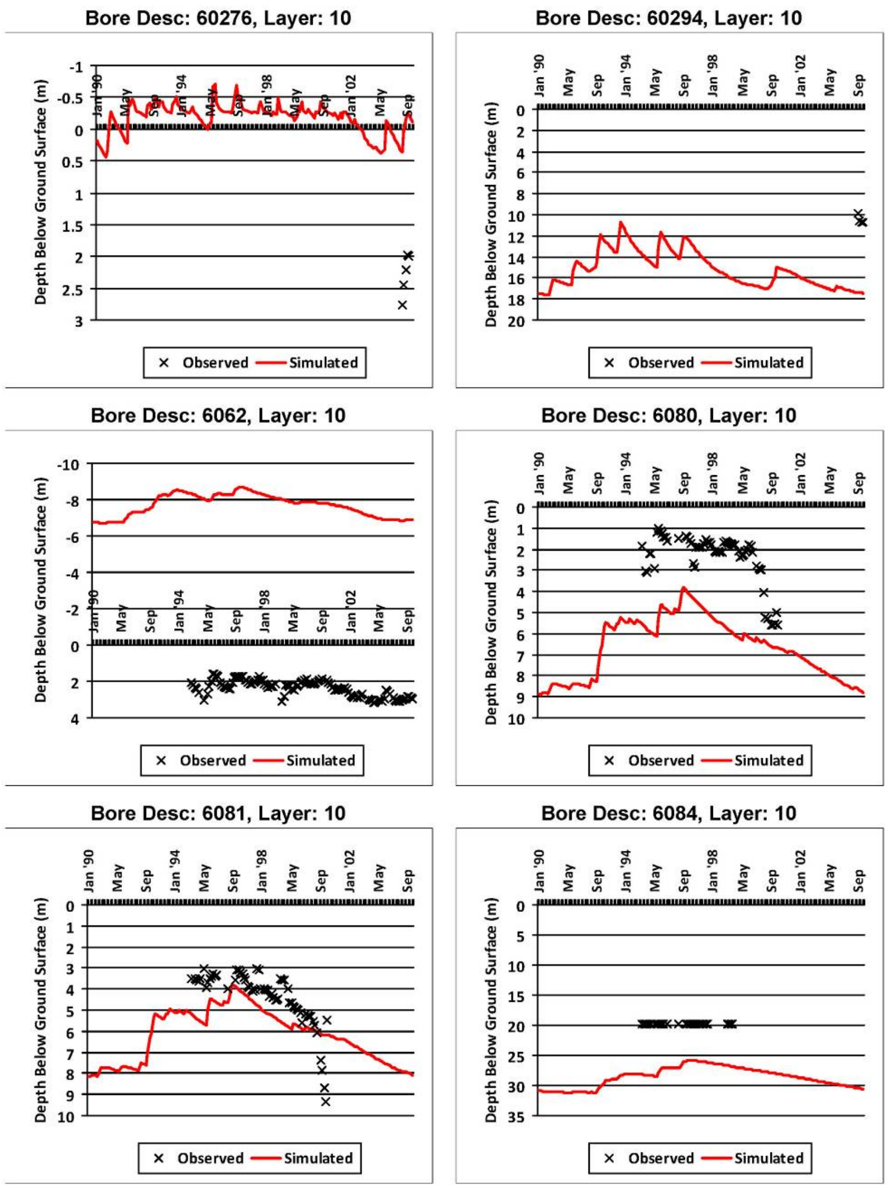
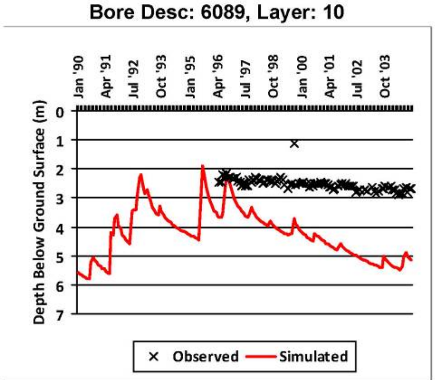
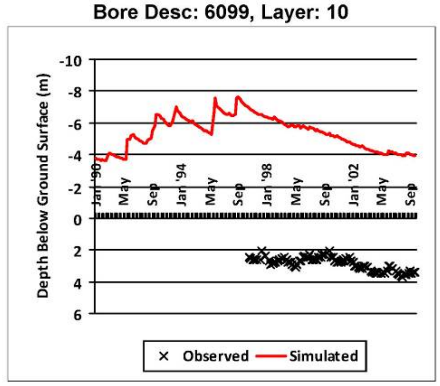



Bore Desc: 60276, Layer: 10
Bore Desc: 60294, Layer: 10
Bore Desc: 6062, Layer: 10
Bore Desc: 6080, Layer: 10
Bore Desc: 6081, Layer: 10
Bore Desc: 6084, Layer: 10
Depth Below Ground Surface (m)
Jan '90
May
Sep
Jan '94
Jan '98
Jan '02
Observed
Simulated

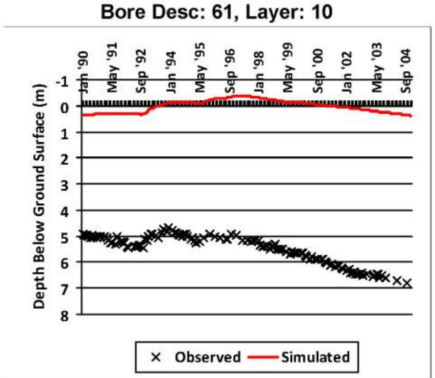
Bore Desc: 6089, Layer: 10



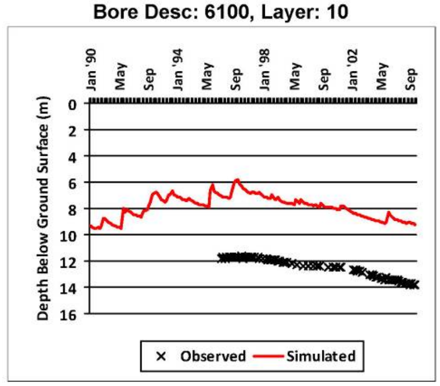
Bore Desc: 6099, Layer: 10



Bore Desc: 61, Layer: 10



Bore Desc: 6100, Layer: 10



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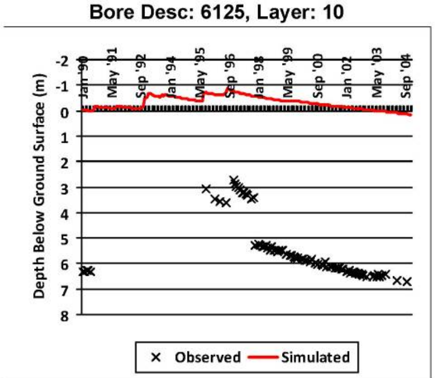

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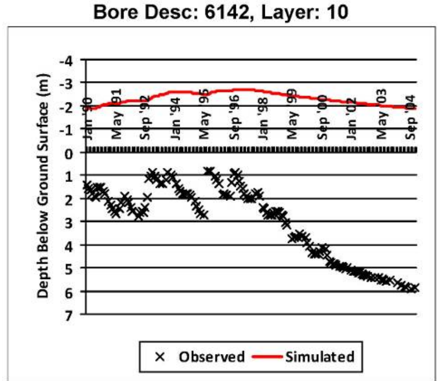
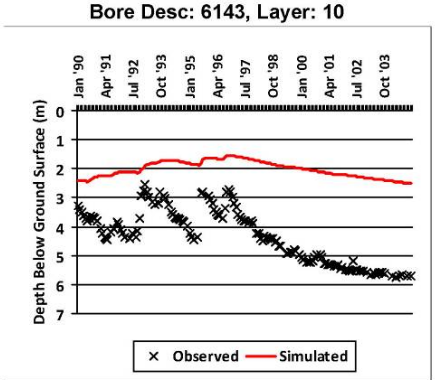
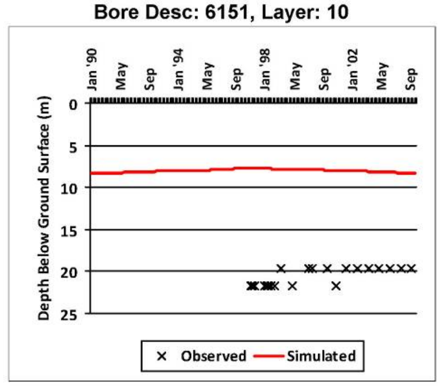


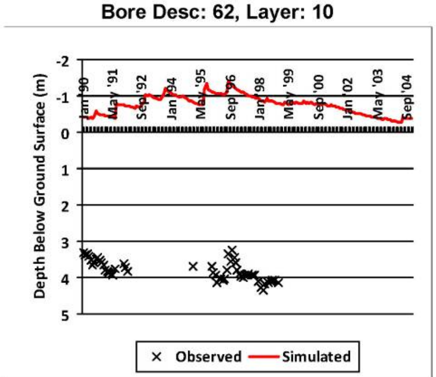
Bore Desc: 6143, Layer: 10



Bore Desc: 6151, Layer: 10



Bore Desc: 62, Layer: 10



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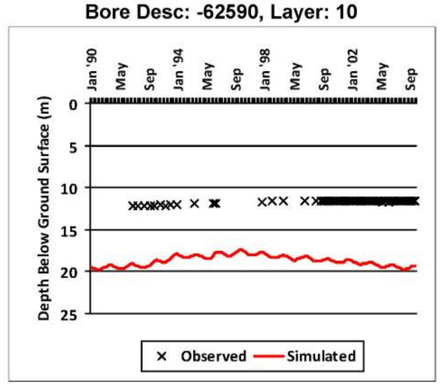

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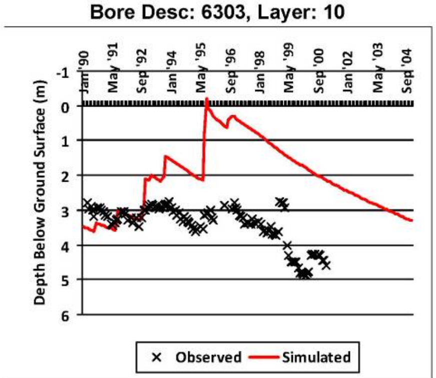

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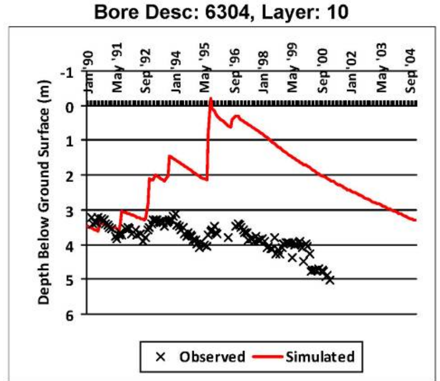

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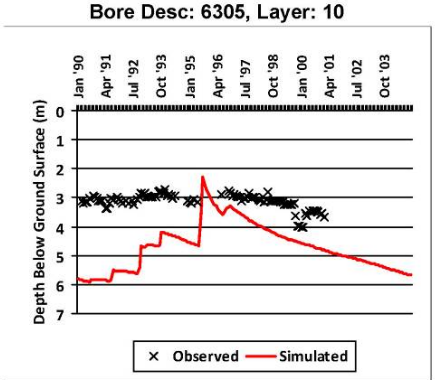

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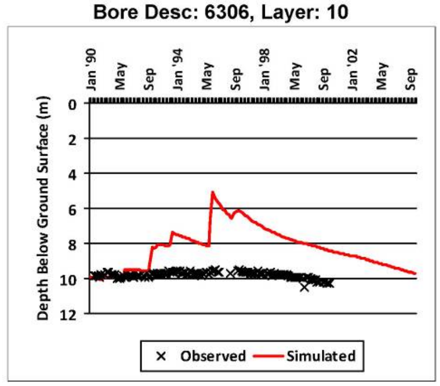

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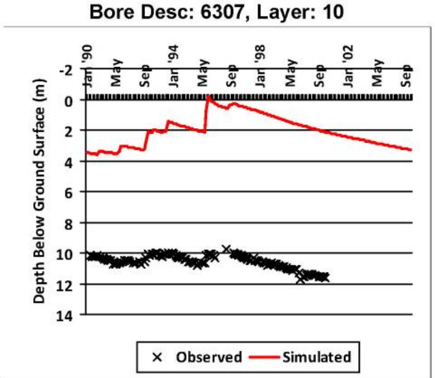

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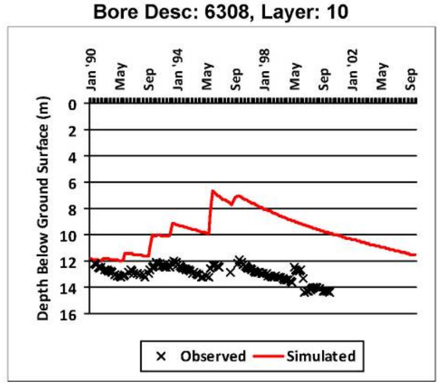

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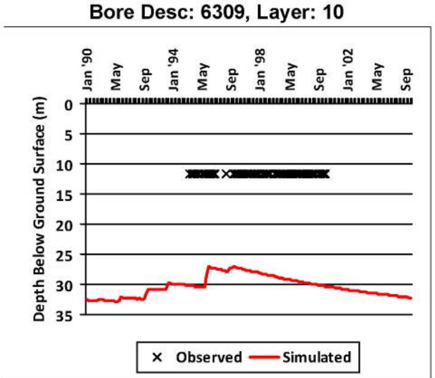

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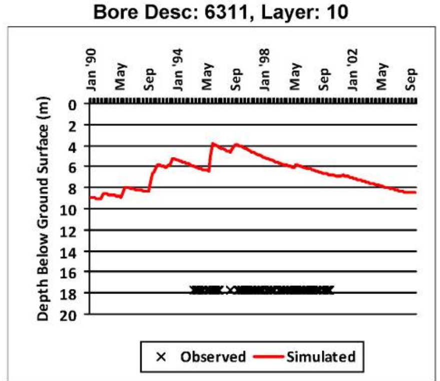

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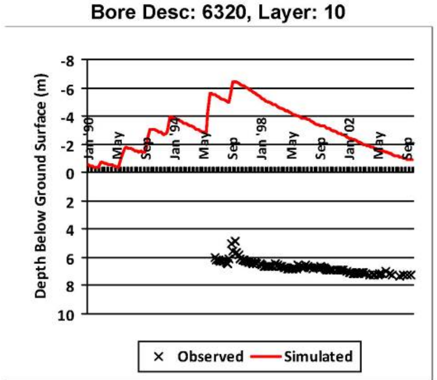

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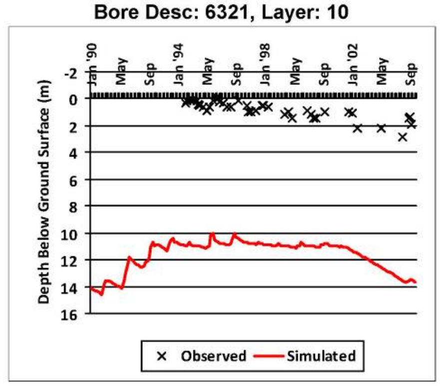

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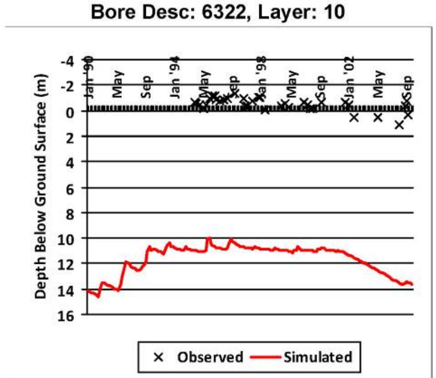

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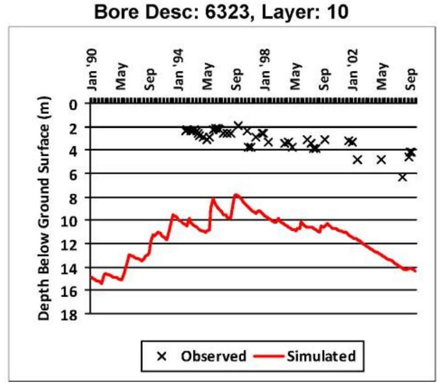

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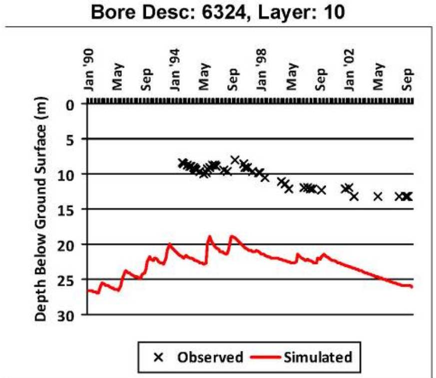

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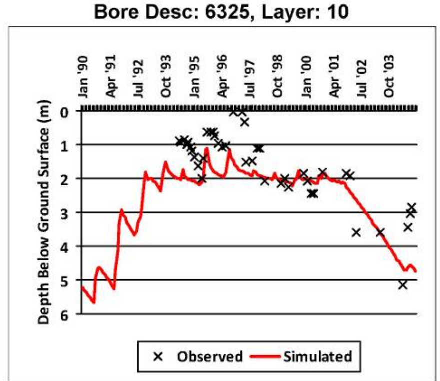

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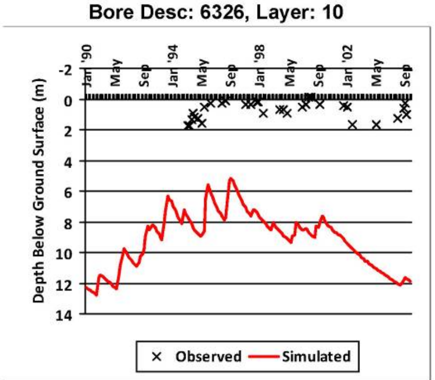

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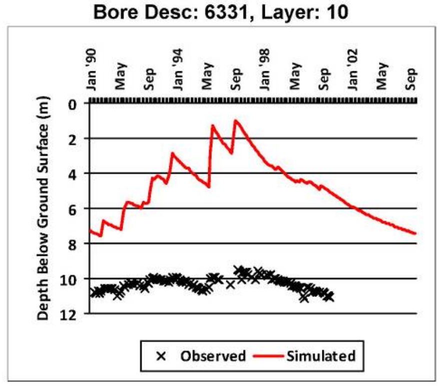

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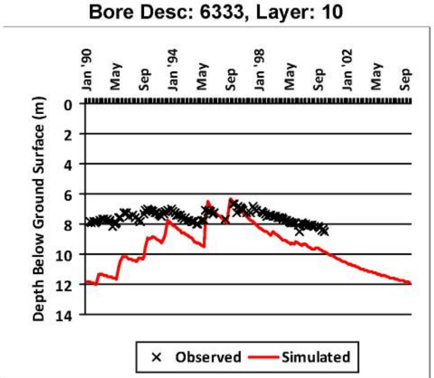

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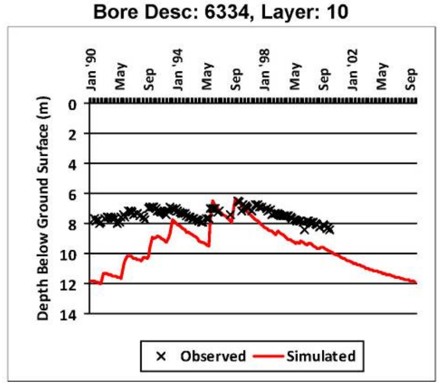

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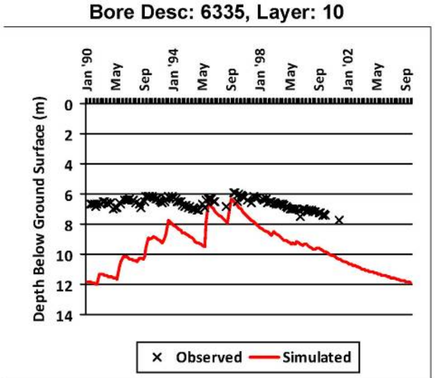

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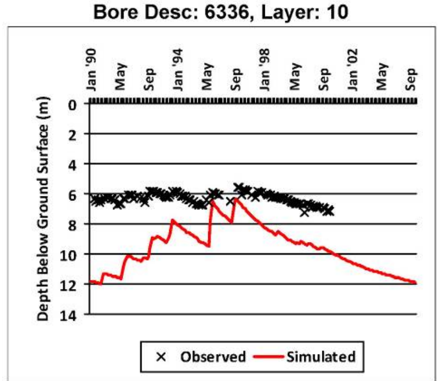

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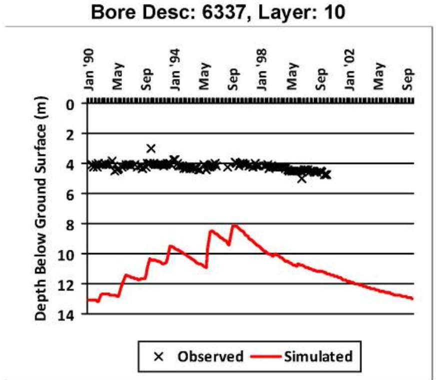

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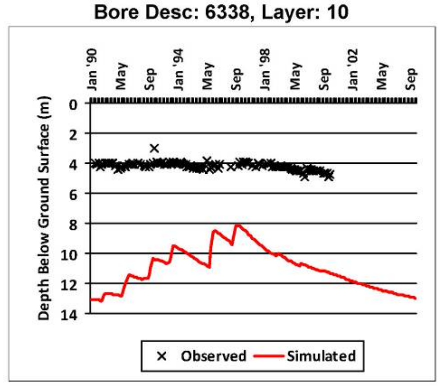

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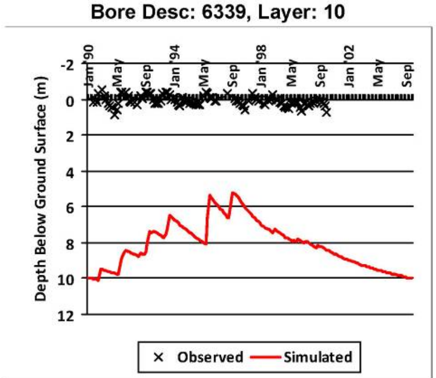

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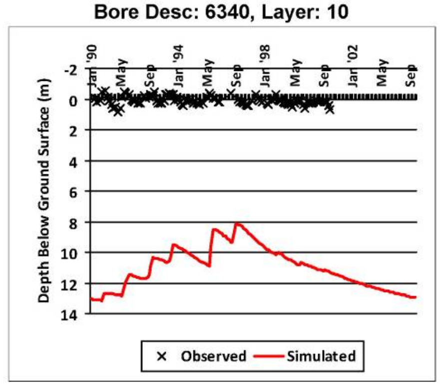

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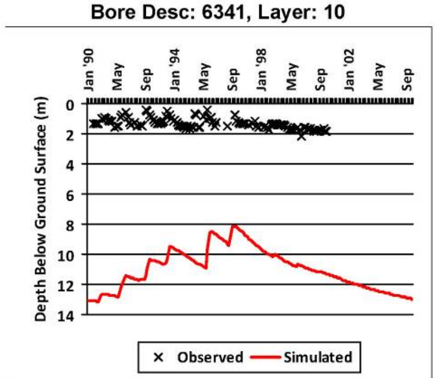

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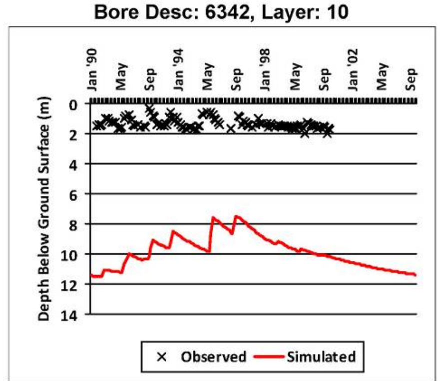

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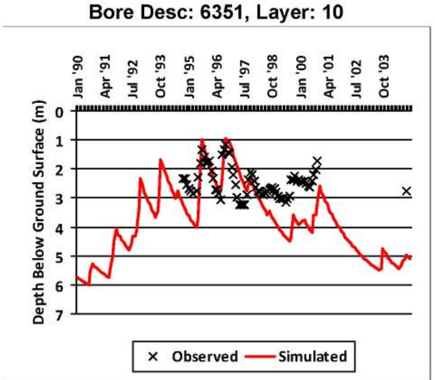

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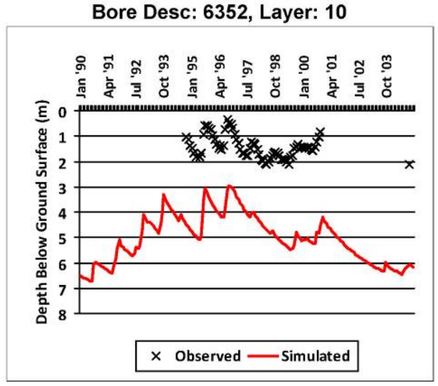

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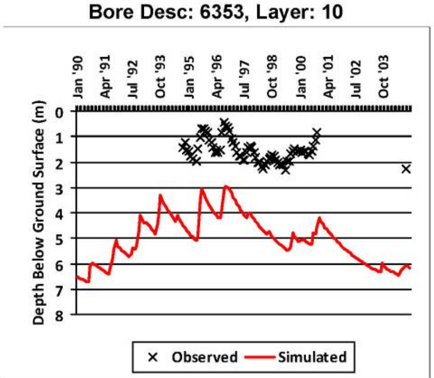

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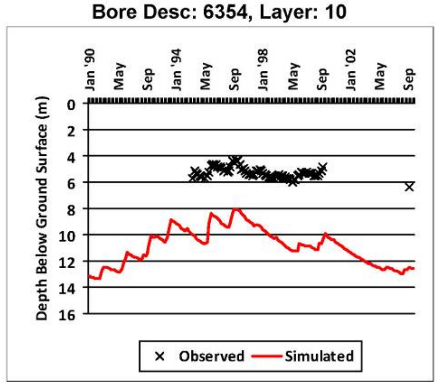

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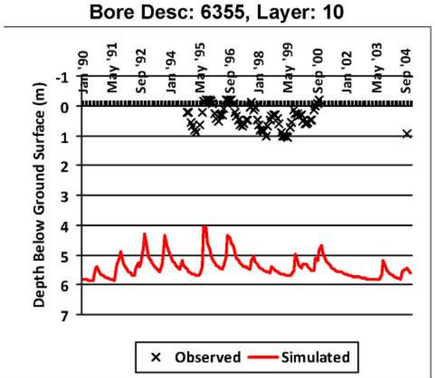

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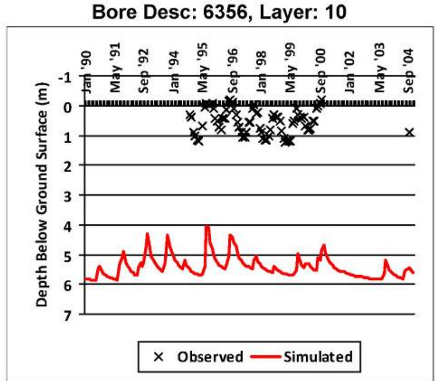

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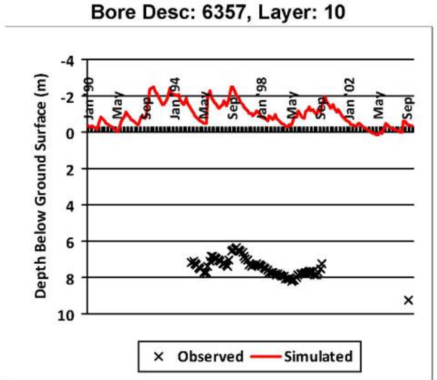

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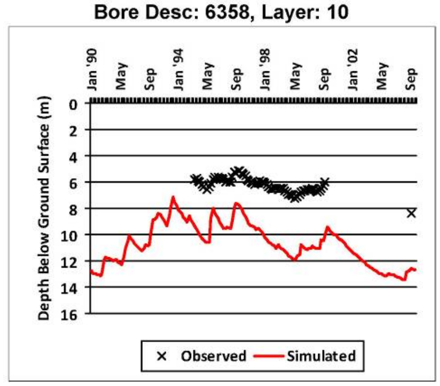

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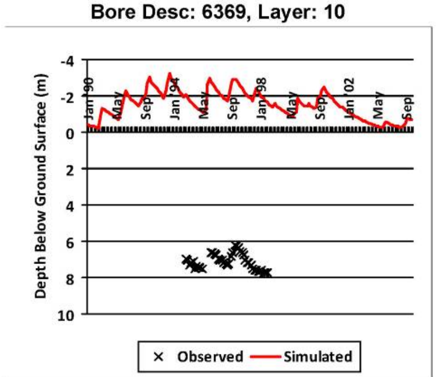

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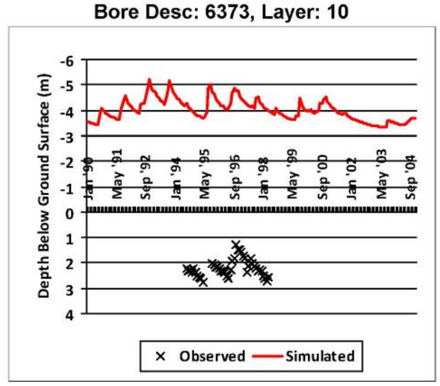

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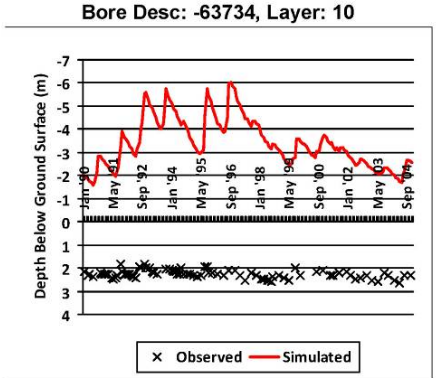

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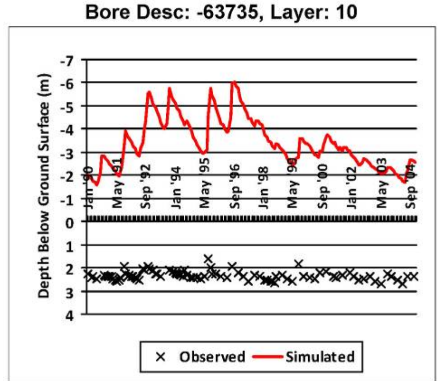

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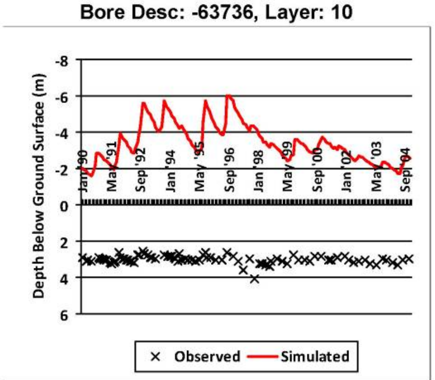

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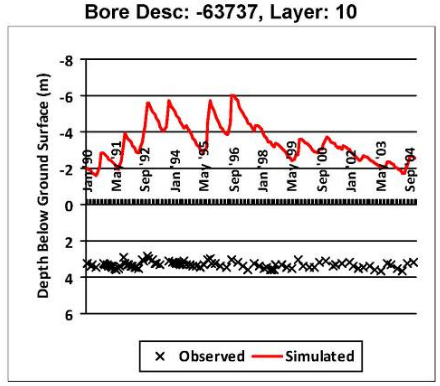

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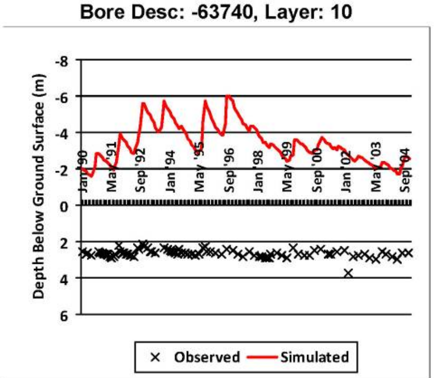

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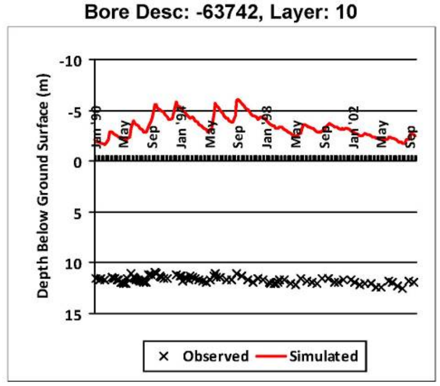

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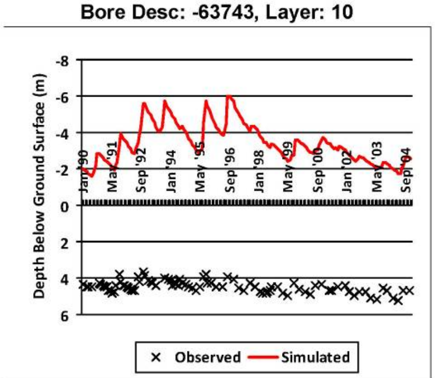

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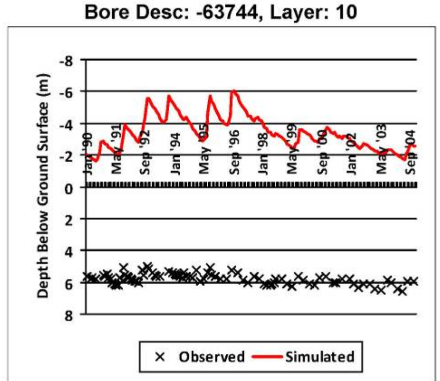
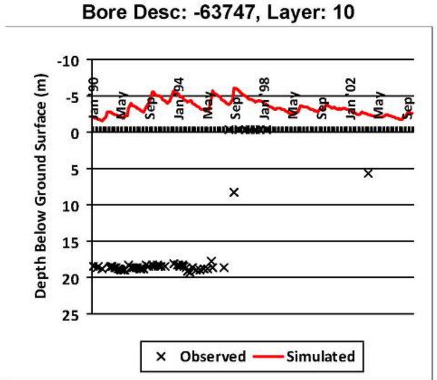


Bore Desc: -63747, Layer: 10



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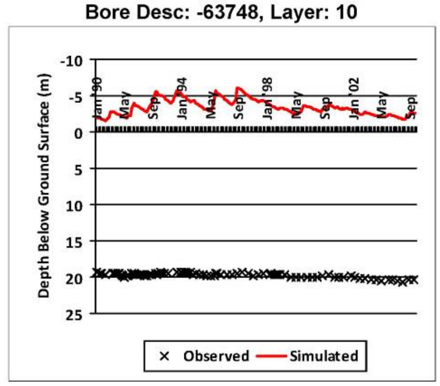

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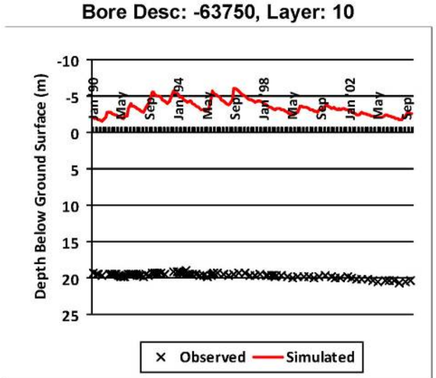

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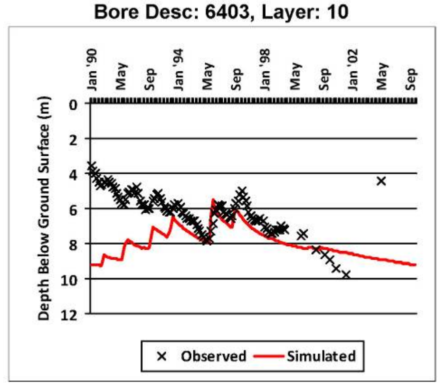

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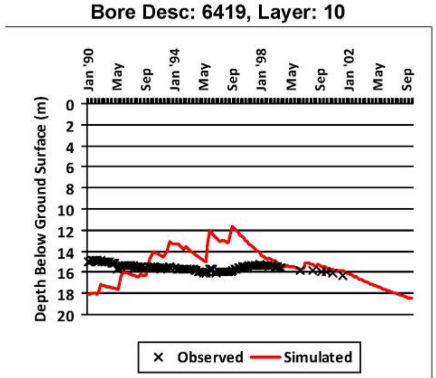
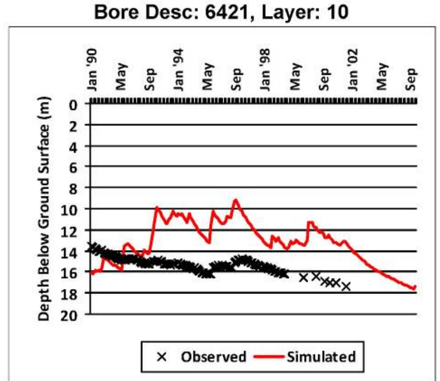


Bore Desc: 6421, Layer: 10



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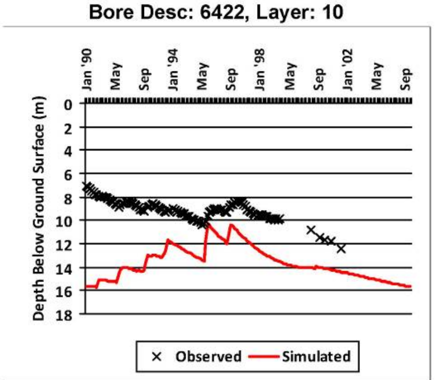

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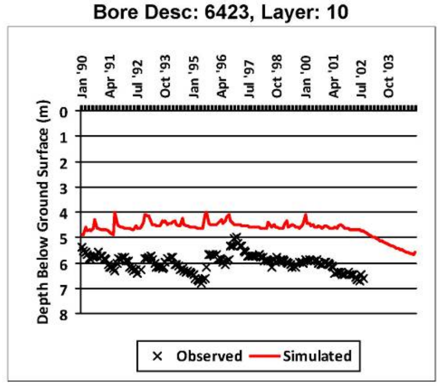

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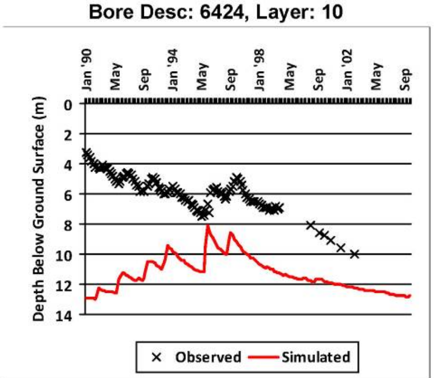

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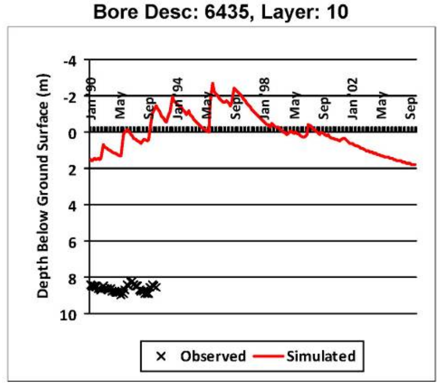

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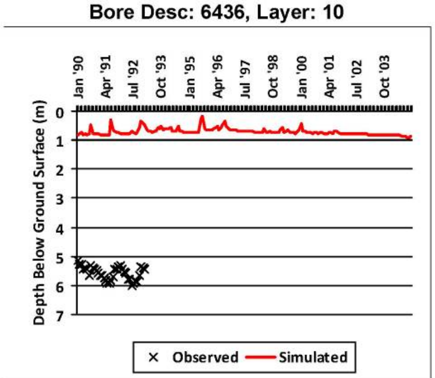

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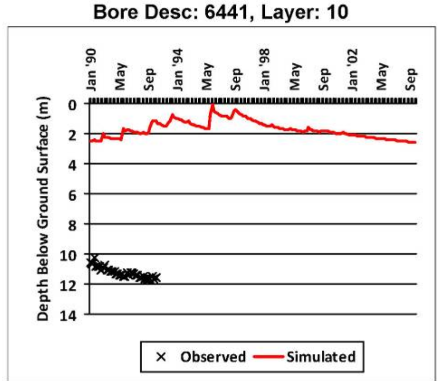

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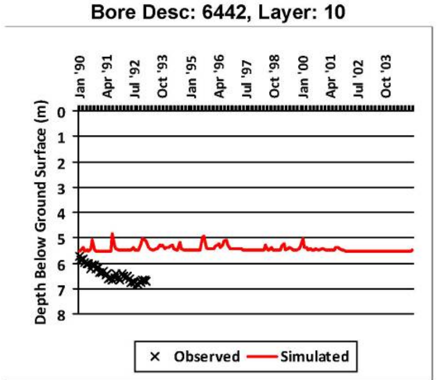

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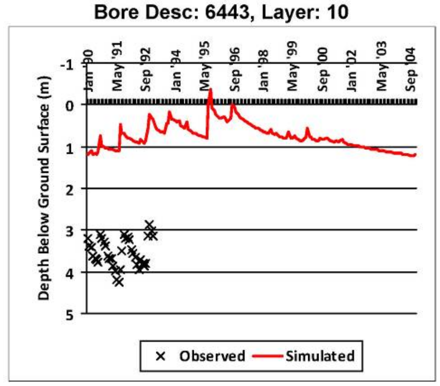

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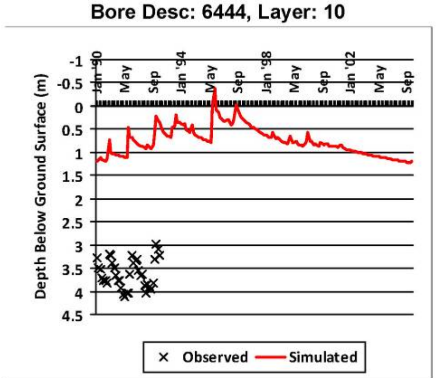

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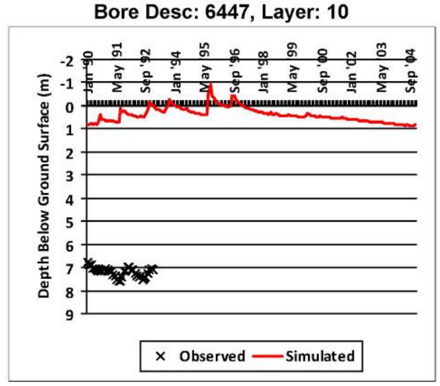

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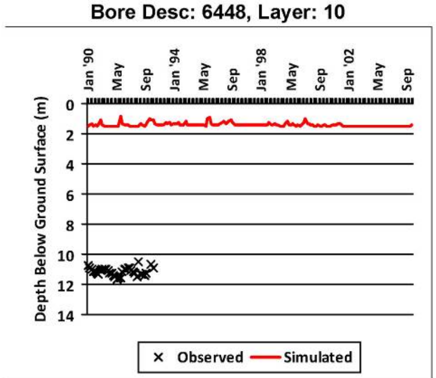

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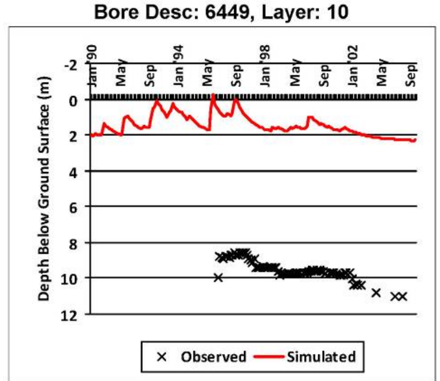

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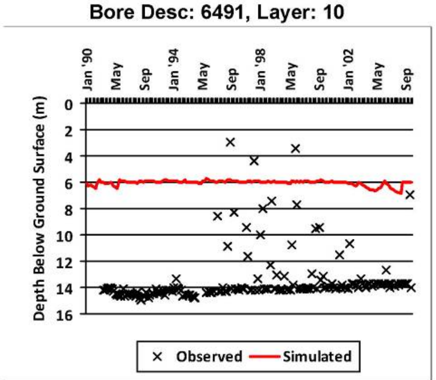
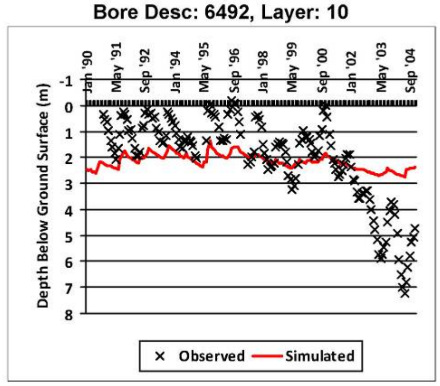


Bore Desc: 6492, Layer: 10



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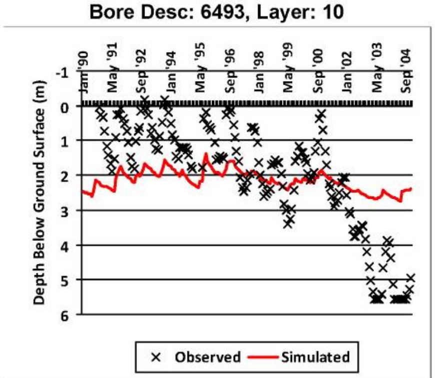
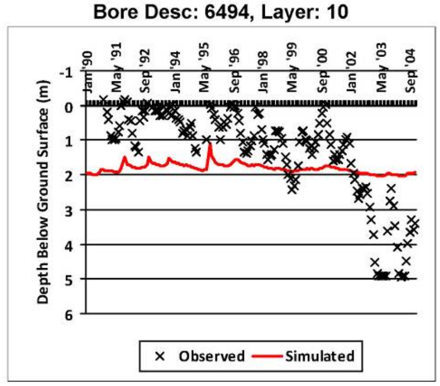
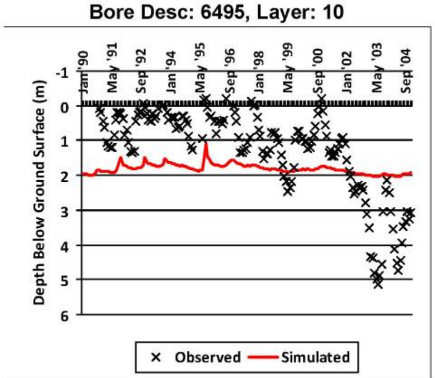


Bore Desc: 6494, Layer: 10



Bore Desc: 6495, Layer: 10



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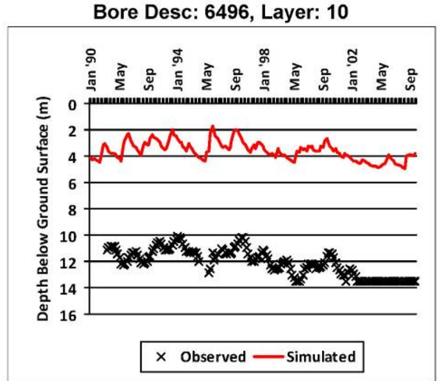

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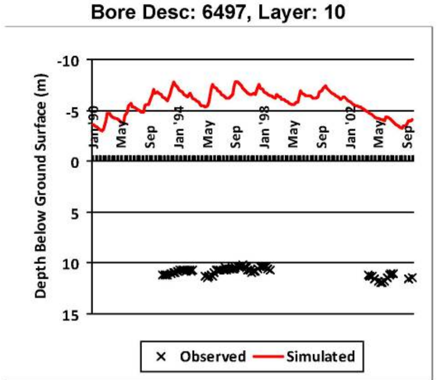

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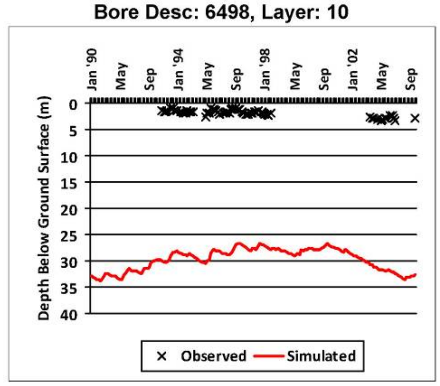
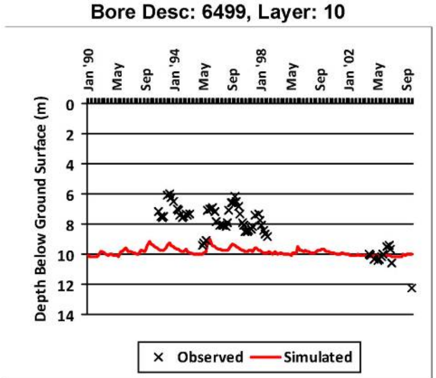
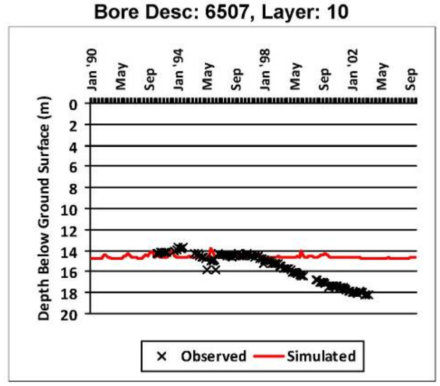


Bore Desc: 6499, Layer: 10



Bore Desc: 6507, Layer: 10



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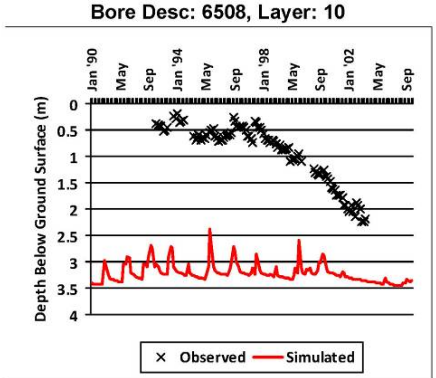

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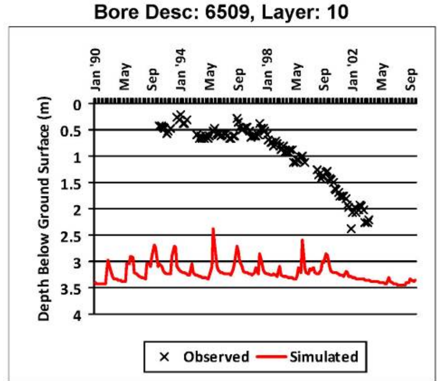
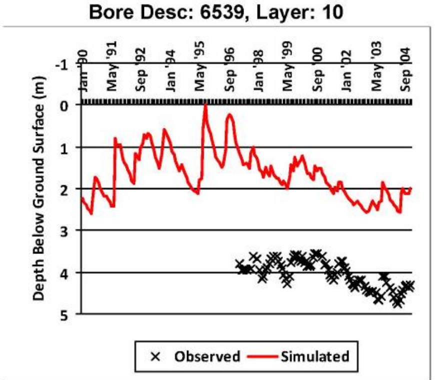


Bore Desc: 6539, Layer: 10



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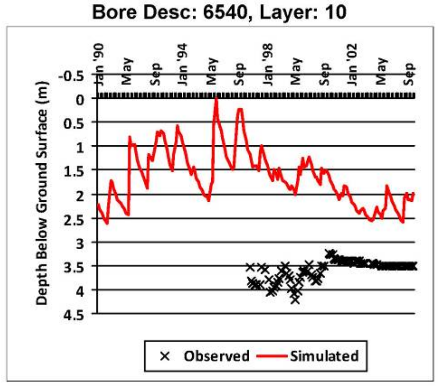

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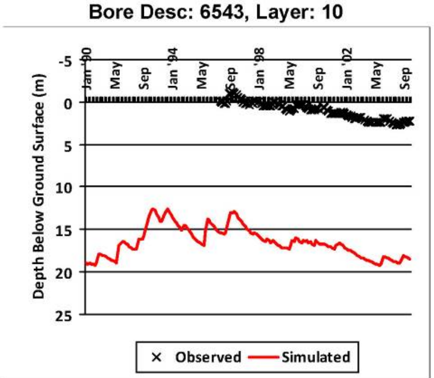

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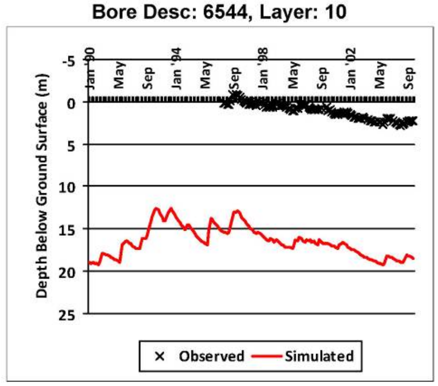

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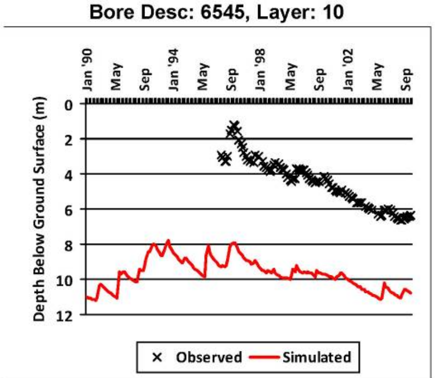
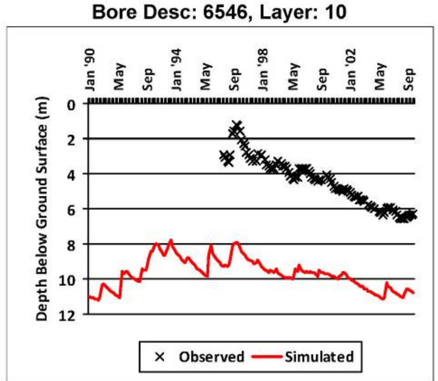
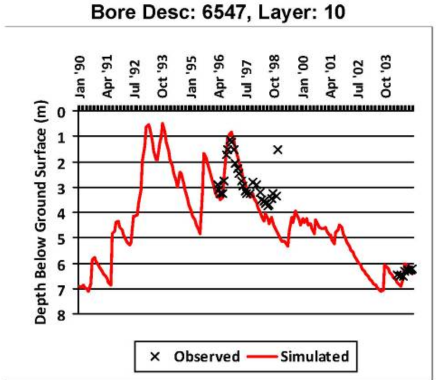


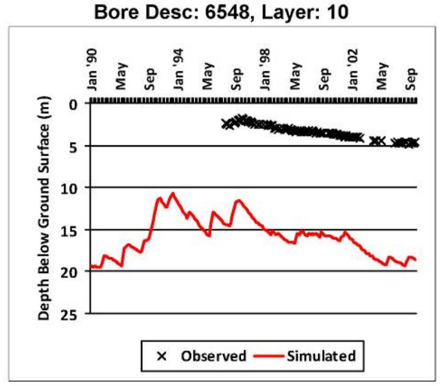
Bore Desc: 6546, Layer: 10



Bore Desc: 6547, Layer: 10



Bore Desc: 6548, Layer: 10



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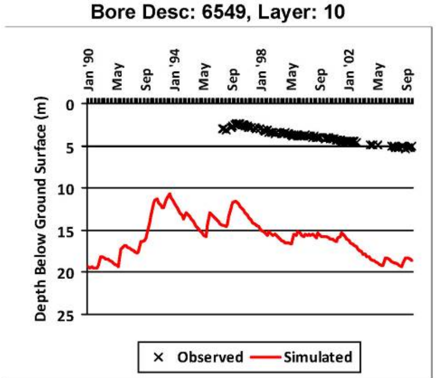
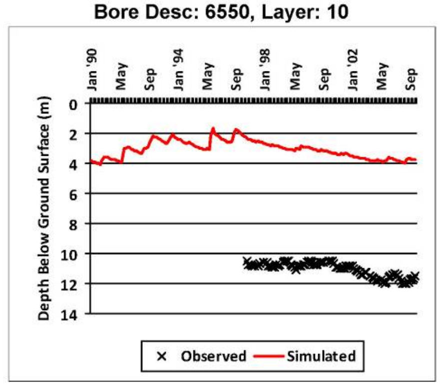
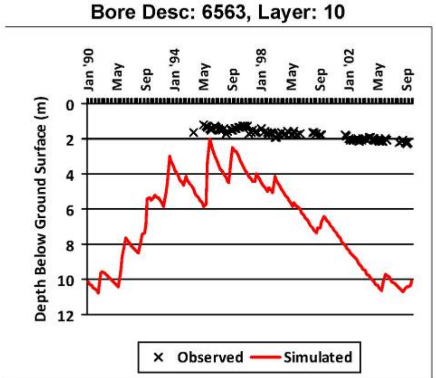


Bore Desc: 6550, Layer: 10



Bore Desc: 6563, Layer: 10



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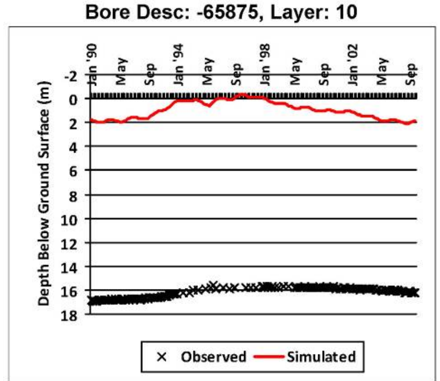
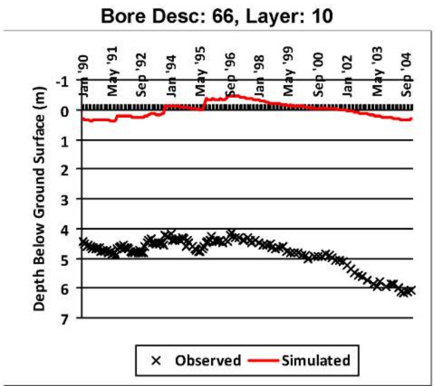
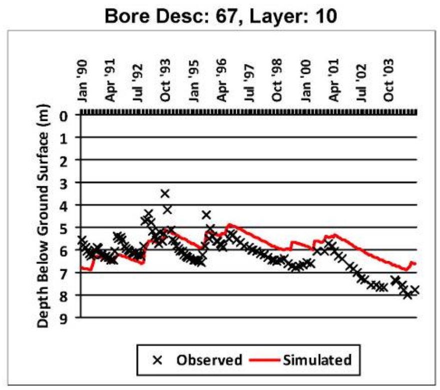
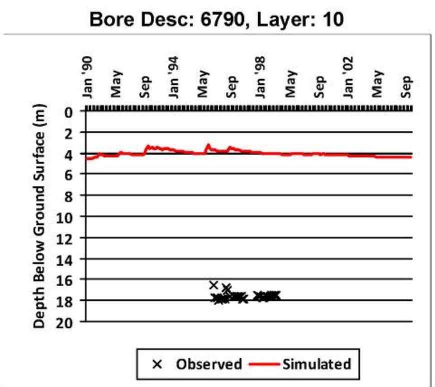
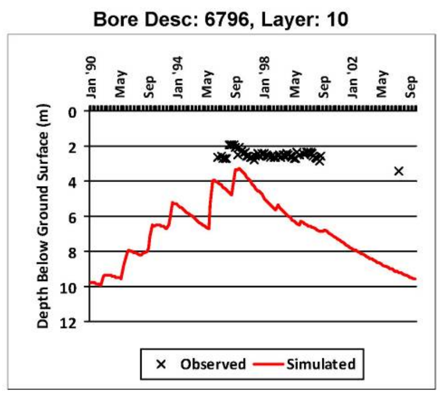
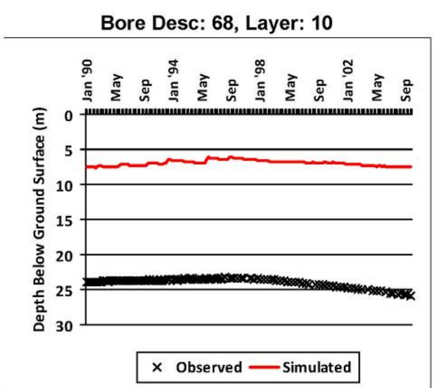


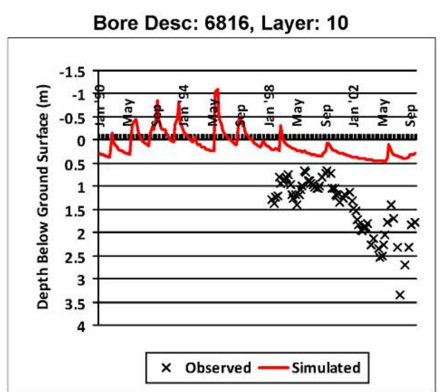

Bore Desc: 66, Layer: 10
Jan '90
May '91
Sep '92
Jan '94
May '95
Sep '96
Jan '98
May '99
Sep '00
Jan '02
May '03
Sep '04
Depth Below Ground Surface (m)
Observed
Simulated

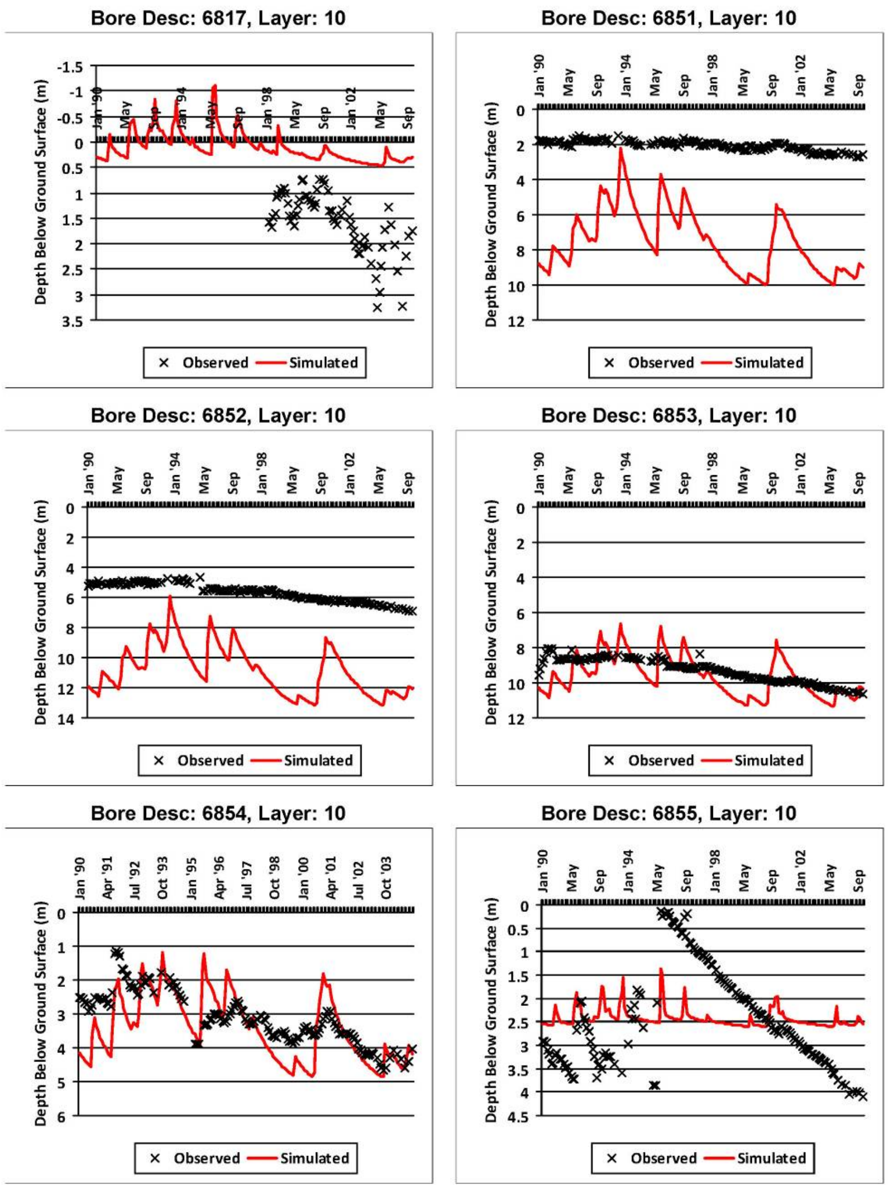

Bore Desc: 67, Layer: 10
Jan '90
Apr '91
Jul '92
Oct '93
Jan '95
Apr '96
Jul '97
Oct '98
Jan '00
Apr '01
Jul '02
Oct '03
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6790, Layer: 10
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

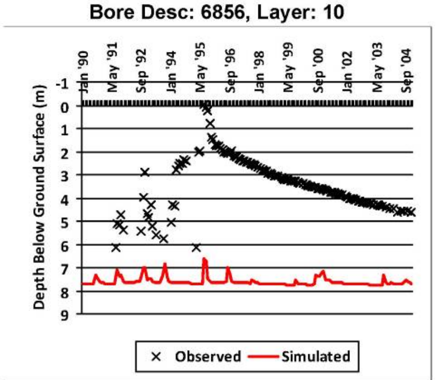

Bore Desc: 6796, Layer: 10
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 68, Layer: 10
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated

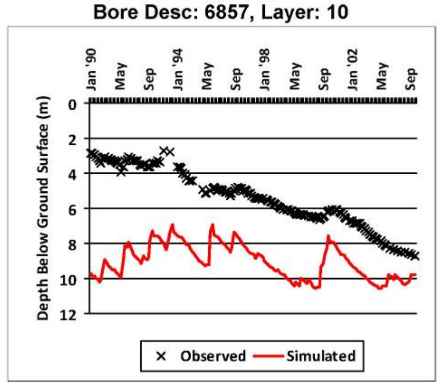

Bore Desc: 6816, Layer: 10
Jan '90
May
Sep
Jan '94
May
Sep
Jan '98
May
Sep
Jan '02
May
Sep
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 6817, Layer: 10
Bore Desc: 6851, Layer: 10
Bore Desc: 6852, Layer: 10
Bore Desc: 6853, Layer: 10
Bore Desc: 6854, Layer: 10
Bore Desc: 6855, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

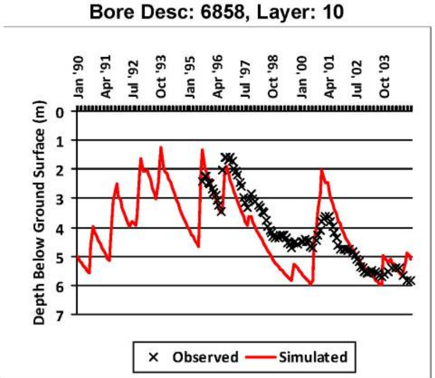
Bore Desc: 6856, Layer: 10



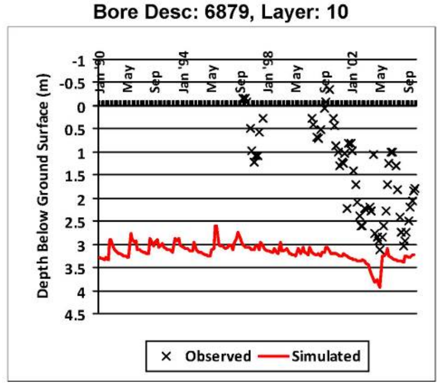
Bore Desc: 6857, Layer: 10



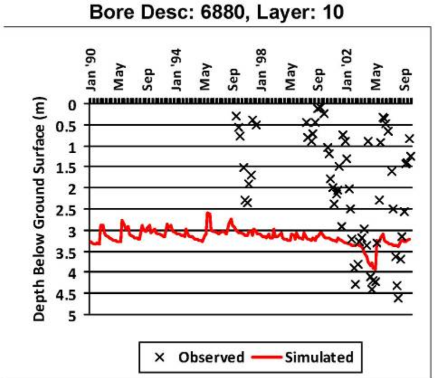
Bore Desc: 6858, Layer: 10



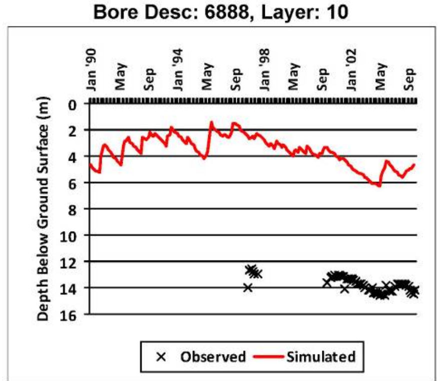
Bore Desc: 6879, Layer: 10



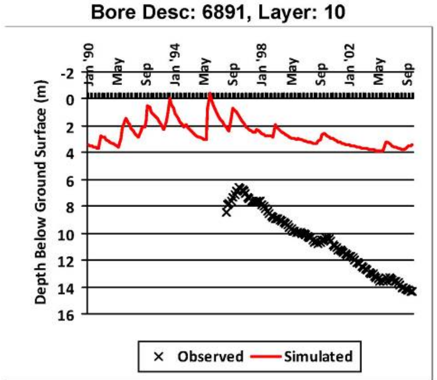
Bore Desc: 6880, Layer: 10



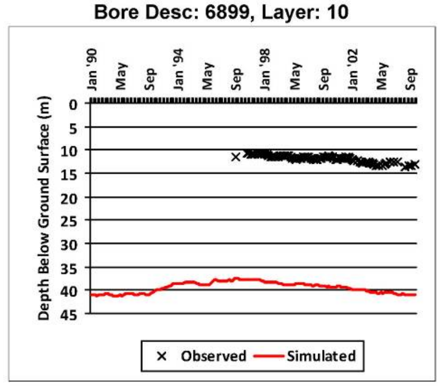
Bore Desc: 6888, Layer: 10



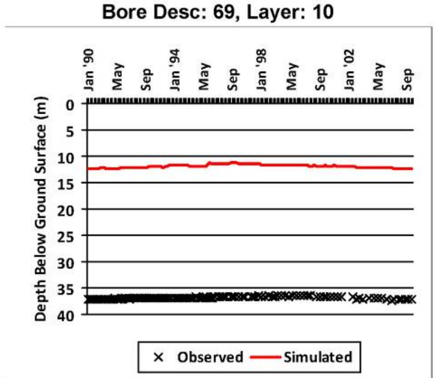
Bore Desc: 6891, Layer: 10



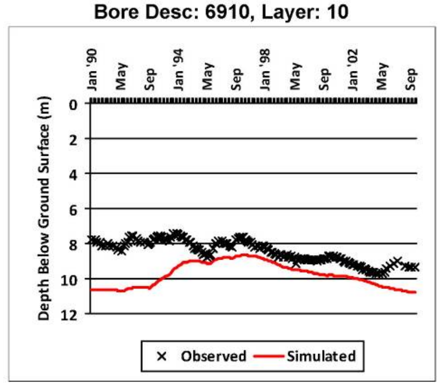
Bore Desc: 6899, Layer: 10



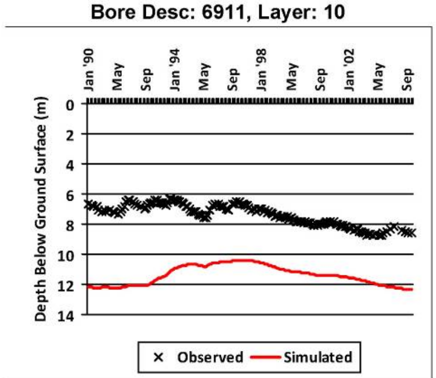
Bore Desc: 69, Layer: 10



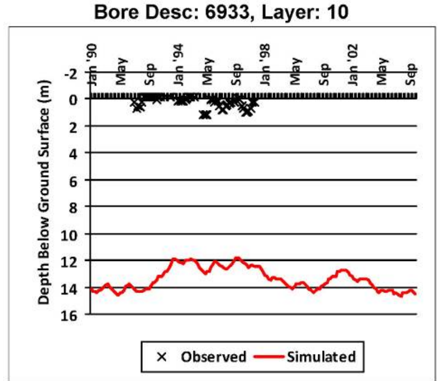
Bore Desc: 6910, Layer: 10



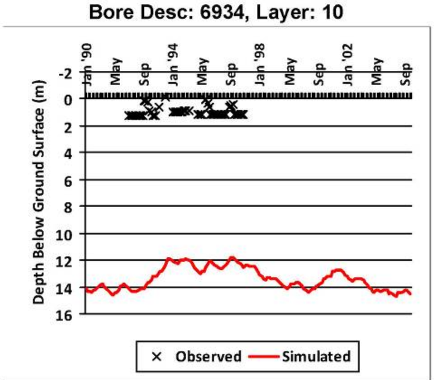
Bore Desc: 6911, Layer: 10



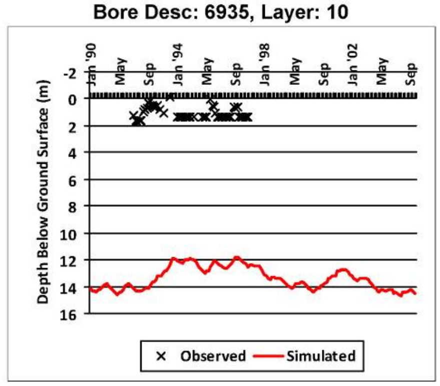
Bore Desc: 6933, Layer: 10



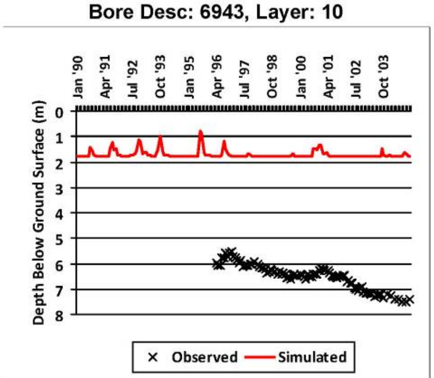
Bore Desc: 6934, Layer: 10



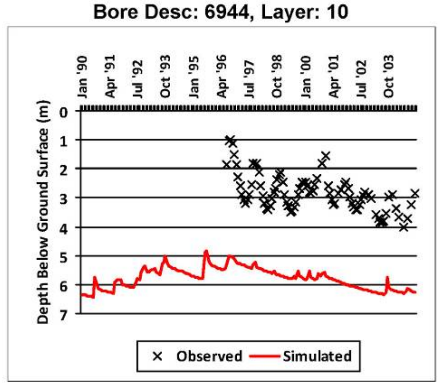
Bore Desc: 6935, Layer: 10



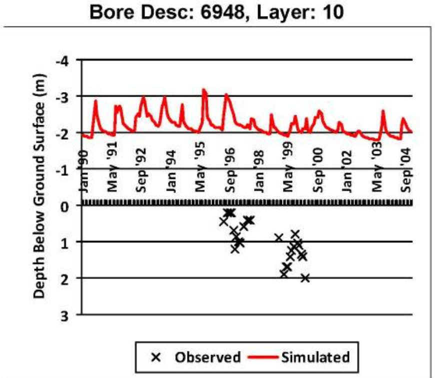
Bore Desc: 6943, Layer: 10



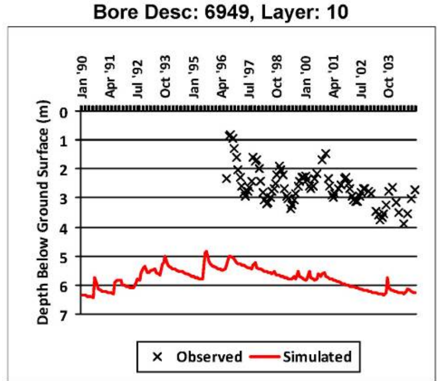
Bore Desc: 6944, Layer: 10

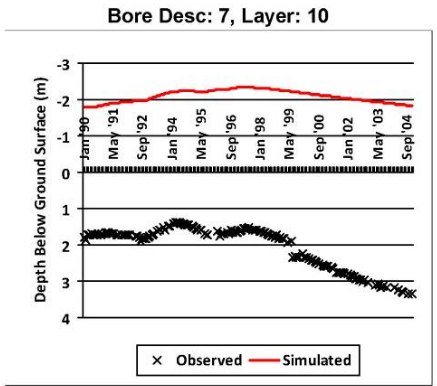


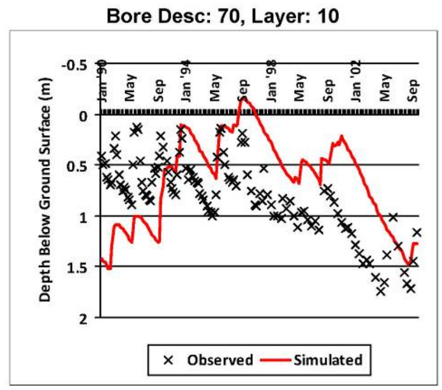
Bore Desc: 6948, Layer: 10

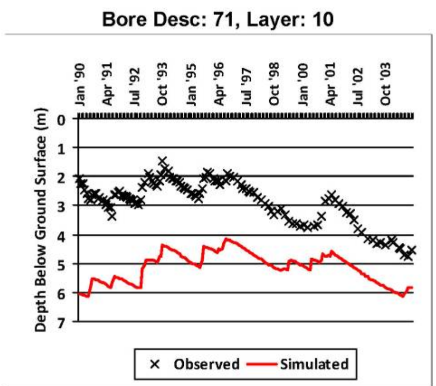


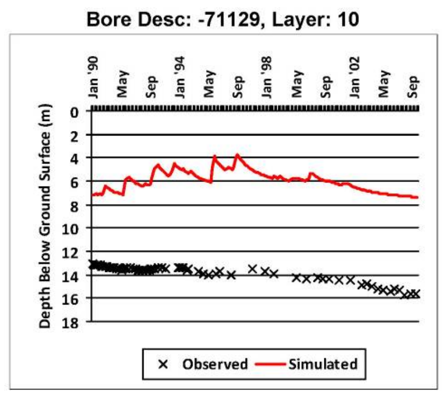
Bore Desc: 6949, Layer: 10

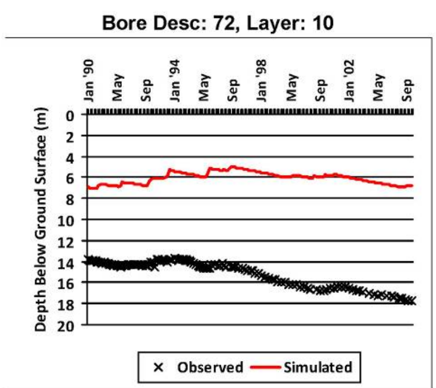


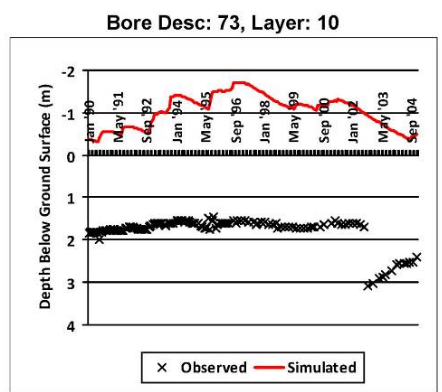

Bore Desc: 7, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 70, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

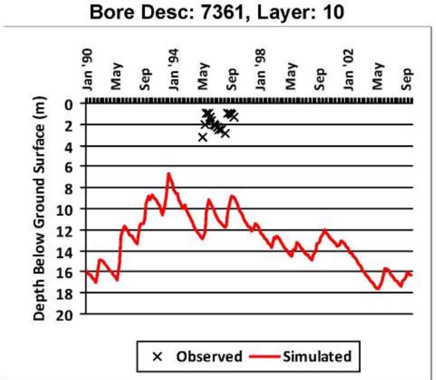

Bore Desc: 71, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: -71129, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

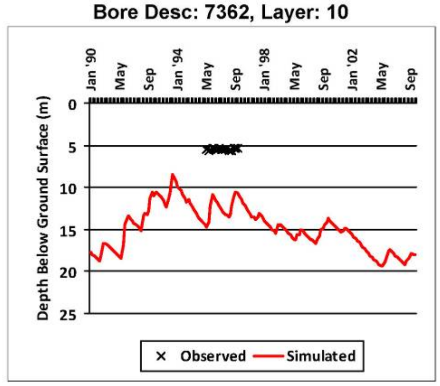

Bore Desc: 72, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 73, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

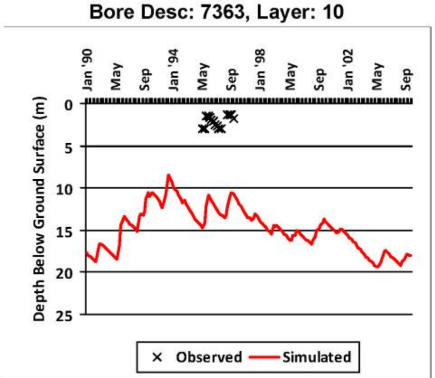
Bore Desc: 7361, Layer: 10



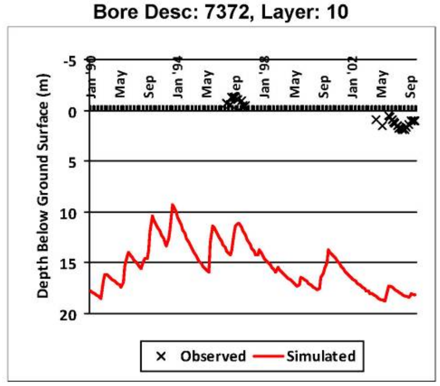
Bore Desc: 7362, Layer: 10



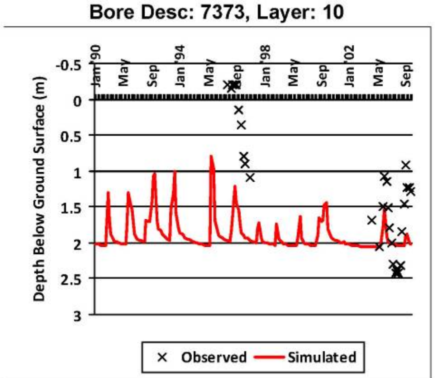
Bore Desc: 7363, Layer: 10



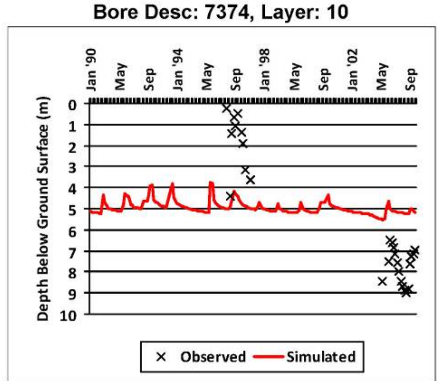
Bore Desc: 7372, Layer: 10

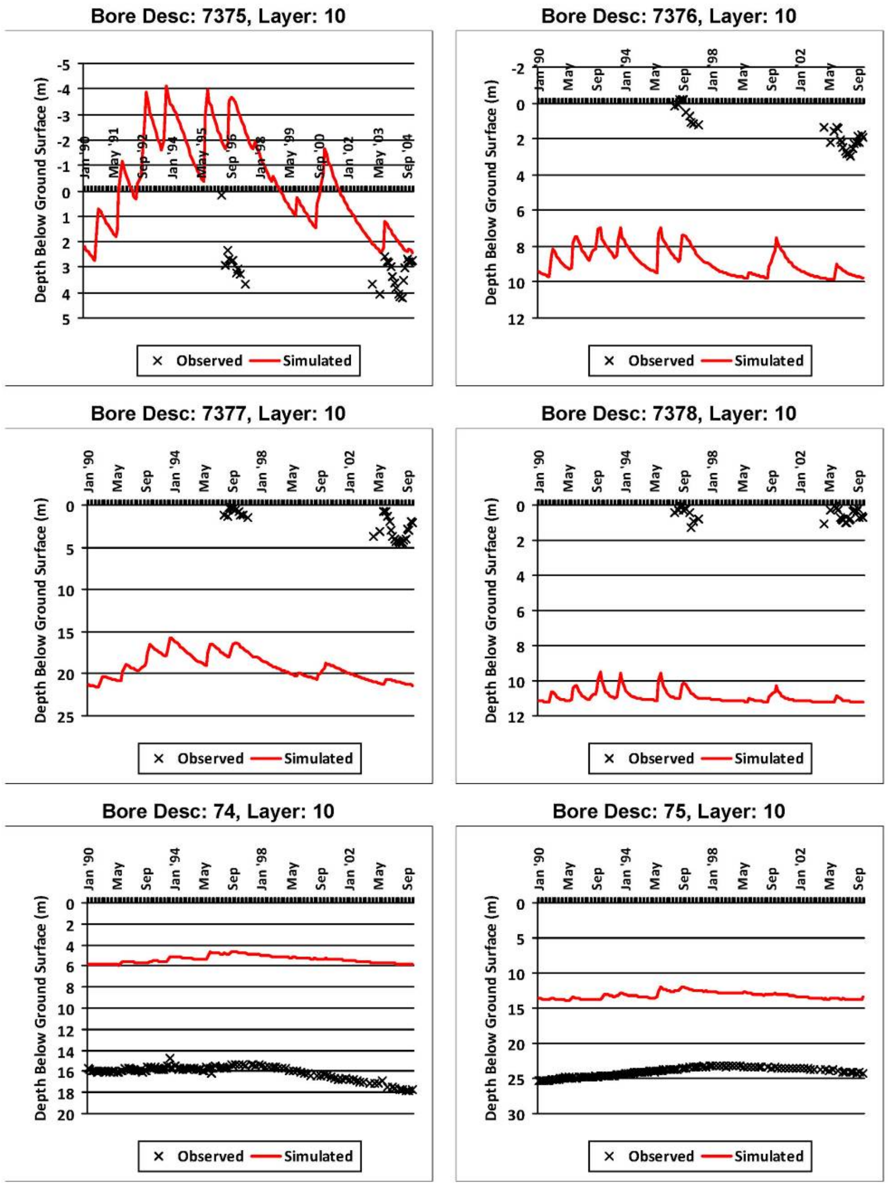


Bore Desc: 7373, Layer: 10

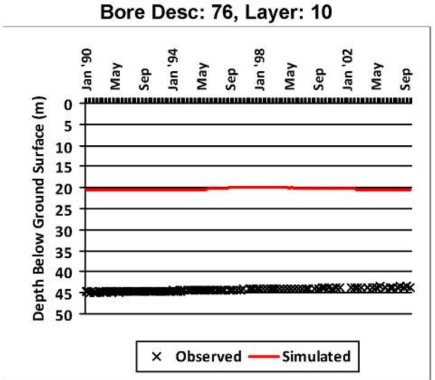


Bore Desc: 7374, Layer: 10

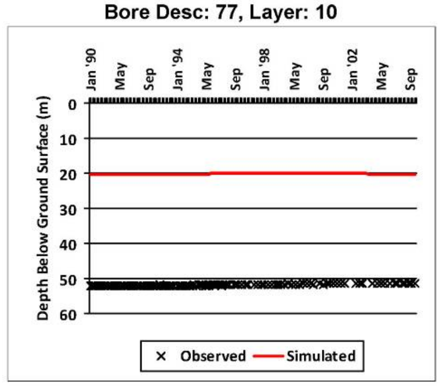



Bore Desc: 7375, Layer: 10
Bore Desc: 7376, Layer: 10
Bore Desc: 7377, Layer: 10
Bore Desc: 7378, Layer: 10
Bore Desc: 74, Layer: 10
Bore Desc: 75, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated
Jan '90
May '91
Sep '92
Jan '94
May '95
Sep '96
Jan '98
May '99
Sep '00
Jan '02
May '03
Sep '04

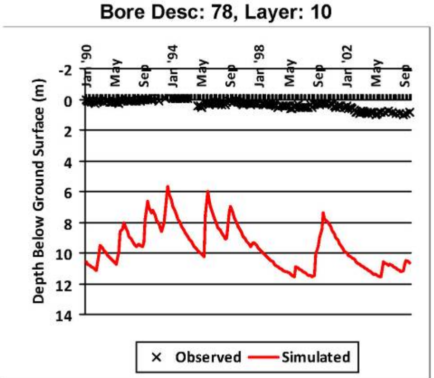
Bore Desc: 76, Layer: 10



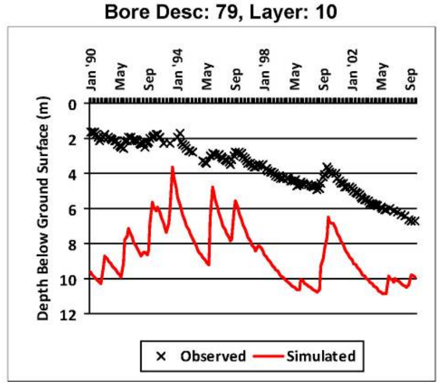
Bore Desc: 77, Layer: 10



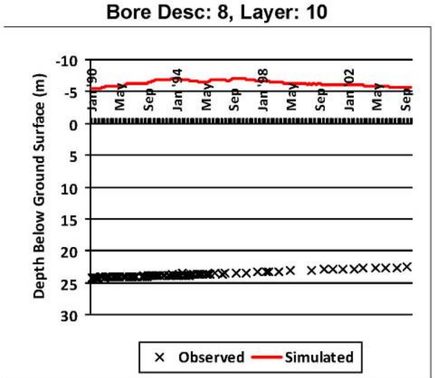
Bore Desc: 78, Layer: 10



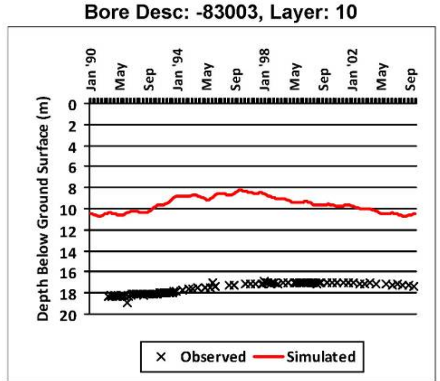
Bore Desc: 79, Layer: 10



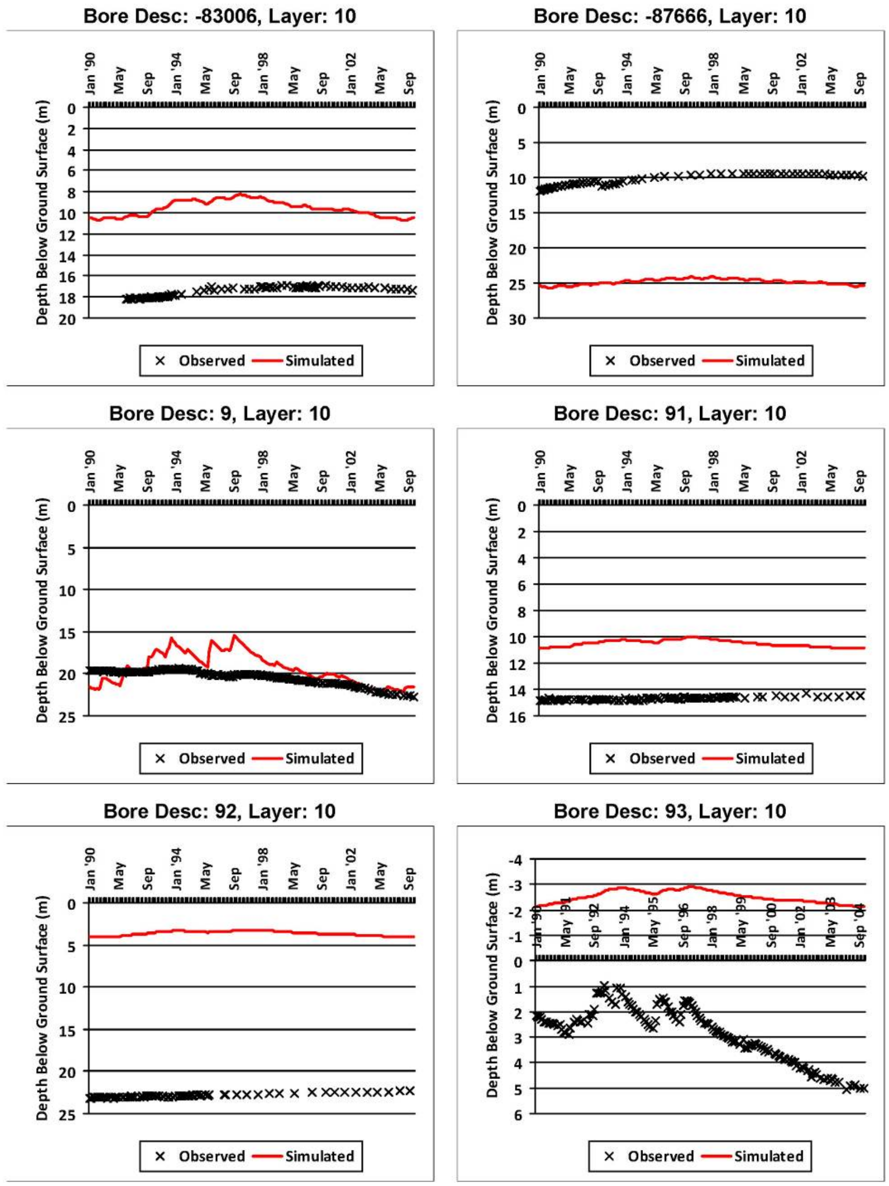
Bore Desc: 8, Layer: 10

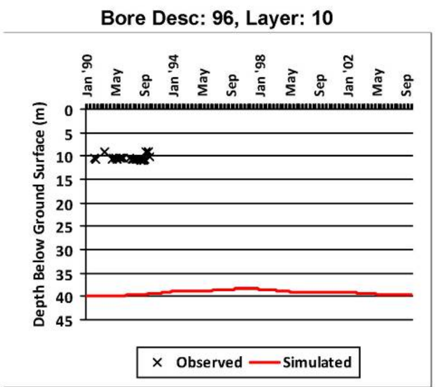
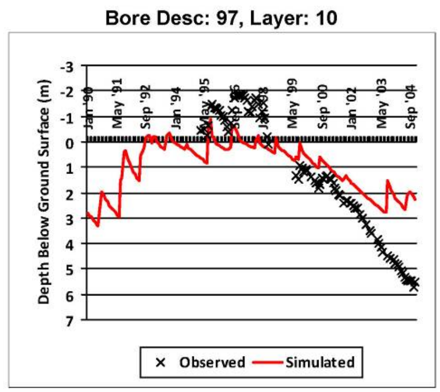
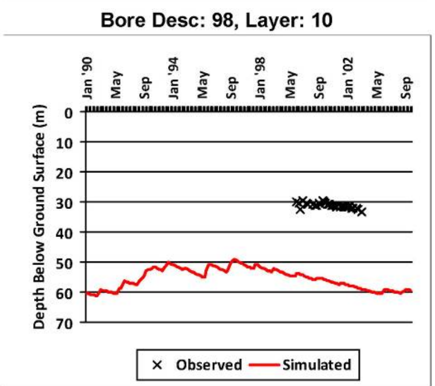
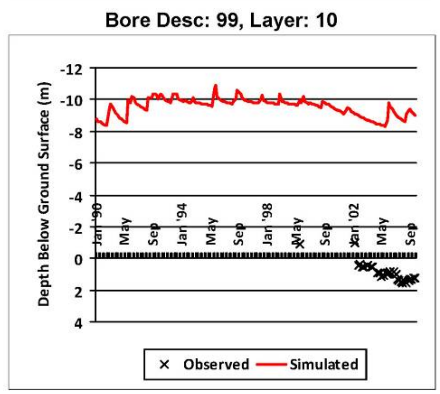


Bore Desc: -83003, Layer: 10



GHB bore


Bore Desc: -83006, Layer: 10
Bore Desc: -87666, Layer: 10
Bore Desc: 9, Layer: 10
Bore Desc: 91, Layer: 10
Bore Desc: 92, Layer: 10
Bore Desc: 93, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated


Bore Desc: 96, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

Bore Desc: 97, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

Bore Desc: 98, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated

Bore Desc: 99, Layer: 10
Depth Below Ground Surface (m)
Observed
Simulated