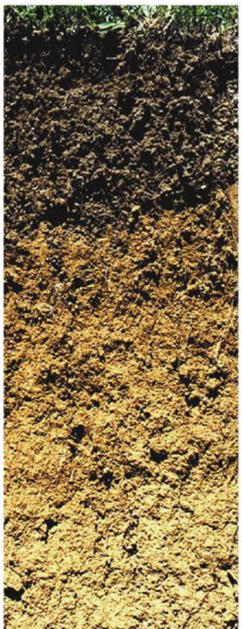
AquiferSim modelling of the mid-Mataura Basin

Envirolink project 1004-ESRC238



Landcare Research
Manaaki Whenua

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Project and Client

A pilot AquiferSim case study has been set up for the mid-Mataura Basin. AquiferSim is a model designed to help regional councils determine the likely long-term effects of land-use change (e.g. conversion from sheep to dairy) on groundwater in their region and how long before these cumulative effects will become problematic. This report was prepared by Landcare Research, ESR and Lincoln Ventures for Environment Southland and builds upon some preliminary data preparation work (Envirolink grant 963-ESRC147).

Objective

- To apply the AquiferSim groundwater model in a case study area in Southland to determine whether it adequately represents the groundwater processes in the Mataura Basin.

Methods

- GIS layers for the boundary, soil, land use, climate, aquifer transmissivity and river–aquifer fluxes were created from various sources including Environment Southland, S-Map and a parallel aquifer modelling study. Leaching rates were obtained from an Environment Canterbury report.

Results

- Preliminary results are generally consistent with outputs from Modflow and a map of nitrate-N concentrations from measured data.

Recommendations

- Further evaluation of the results is recommended (and planned for within the parallel study) before AquiferSim is used to explore alternative land-use scenarios.

1 Introduction

A pilot AquiferSim case study has been set up for the mid-Mataura Basin. AquiferSim is a model designed to help regional councils determine the likely long-term effects of land-use change (e.g. conversion from sheep to dairy) on groundwater in their region and how long before these cumulative effects will become problematic. This report was prepared by Landcare Research, ESR and Lincoln Ventures for Environment Southland and builds upon the the data preparation work done under Envirolink grant 963-ESRC147

2 Background

AquiferSim is a new approach to modelling contaminant transport in groundwater and was developed during the IRAP (Integrated Research for Aquifer Protection) programme for the purpose of linking land use to water quality. The specific application is the transport of nitrate-nitrogen from soil-water drainage under various land uses, through groundwater to surface waters as the dominant transport pathway. The outputs of interest were the spatial distribution in the aquifer of nitrate-N with depth, and the total nitrate-N loads to groundwater-fed springs. AquiferSim was designed to be applied at catchment scales of a few thousand square kilometres and to use a land use database that allows the effect of alternative farm-scale land uses to be examined, i.e. about one-hectare resolution. The use of conventional groundwater modelling packages at these scales posed difficulties with run times and data requirements.

The model run time for this problem of potentially a few million computational cells is reduced to a few minutes by use of a steady-state, 2D/3D modelling approach. The model is steady state for groundwater flow and contaminant transport, which means that water quality predictions correspond to the long-term effect of designated land uses. However, the model also simulates groundwater age, so that predictions can be associated with a particular transport time-lag.

The 2D/3D modelling approach (Bidwell & Good 2007) means that the horizontal pattern of groundwater flow is first predicted. Then the 2D vertical distribution of contaminants in the aquifer is predicted along selected groundwater flowpaths. These distributions are corrected for divergence and convergence of groundwater flow. Selection of flowpaths can be manually or automatically sampled.

A GIS interactive front end has been built around the contaminant transport model component that manages the spatial inputs and processes the outputs (Bidwell et al. 2005). This GIS-based groundwater contaminant transport tool is called AquiferSim. There are four primary components in the model:

- A GIS to manage the spatial data required by the models, including land use, soil, and aquifer characteristics
- A tool (‘Generate Nitrate and Recharge’) that brings together land use, soil, climate and leaching rates from a lookup table

- A groundwater model (GWEngine) that integrates the effects of nitrate-contaminated recharge at farm scale, and provides information about the resulting horizontal and vertical distribution of effects in the aquifer
- An end-user interface for the user to define ‘what-if’ catchment-scale scenarios, and to view model outputs

The model outputs include:

- Maps of nitrate-N load and concentration below the root zone
- Flowpaths showing the horizontal movement of water/contaminants
- 1D and 2D vertical slices below a point or flowpath
- Horizontal layers of average or maximum concentration over specific depth ranges in the aquifer
- Total nitrate-N loads to groundwater-fed springs
- Groundwater catchments

There are some implicit assumptions in the AquiferSim model with regard to the sources and transport pathways of nitrate-N in the freshwater environment:

- Most surface water flows in the lower part of a catchment, for most of the time, are sustained by groundwater discharge
- The nitrate-N content of these surface water flows is determined by the blending of the spatial distribution of nitrate-N in the contributing groundwater
- The spatial distribution of nitrate-N in a groundwater body is determined by the locations, fluxes, and qualities of recharge sources
- Flux and quality of land surface recharge, from soil-water drainage, is provided by the GIS-based nitrate-N load maps

The AquiferSim model approach incorporates the ability to simulate transformation processes within groundwater that reduce the concentration of nitrate-N.

AquiferSim has been applied in two case studies prior to this project: The central plains area in Canterbury (between the Rakaia and Waimakariri rivers) and the Hurunui Plains also in Canterbury. The aquifer-related inputs in the first case study were derived from a Modflow ground water model of the area, whereas the Hurunui case study was aimed at testing AquiferSim in a situation where there is only limited knowledge of some of the key aquifer parameters (Lilburne et al. 2011).

3 Objective

- To apply the AquiferSim groundwater model in a case study area in Southland to determine whether it adequately represents the groundwater processes in the Mataura Basin. (See Appendix 1 for data set-up steps.)

4 Data inputs

The following sections describe the inputs needed to set up AquiferSim for the mid-Mataura Basin. Note that the focus in the first instance has been on getting the model up and running. All inputs can be refined and improved at a later date.

4.1 Boundary

The study area is identical to that defined in Environment Southland's existing mid-Mataura Groundwater model (Phreatos Limited 2007) and for the most part traces the extent of the Quaternary alluvial gravels in the mid Mataura basin. It covers the Wendonside, Wendon, Waipounamu, Riversdale, Longridge, and Knapdale groundwater zones, the southern part of the Cattle Flat zone and a small part (NE) of the Waimea Plain groundwater zone. In addition it includes some land that is not part of a zone. The whole area is henceforth referred to as the area of interest (AOI) (Figure 1). It is approximately 45 km × 35 km. A cell resolution of 50 m was adopted (note that a cell resolution of 200 m is used in the Phreatos Modflow model).

The AquiferSim boundary layer has been created as per the AquiferSim specification (Lilburne & Bidwell 2011).

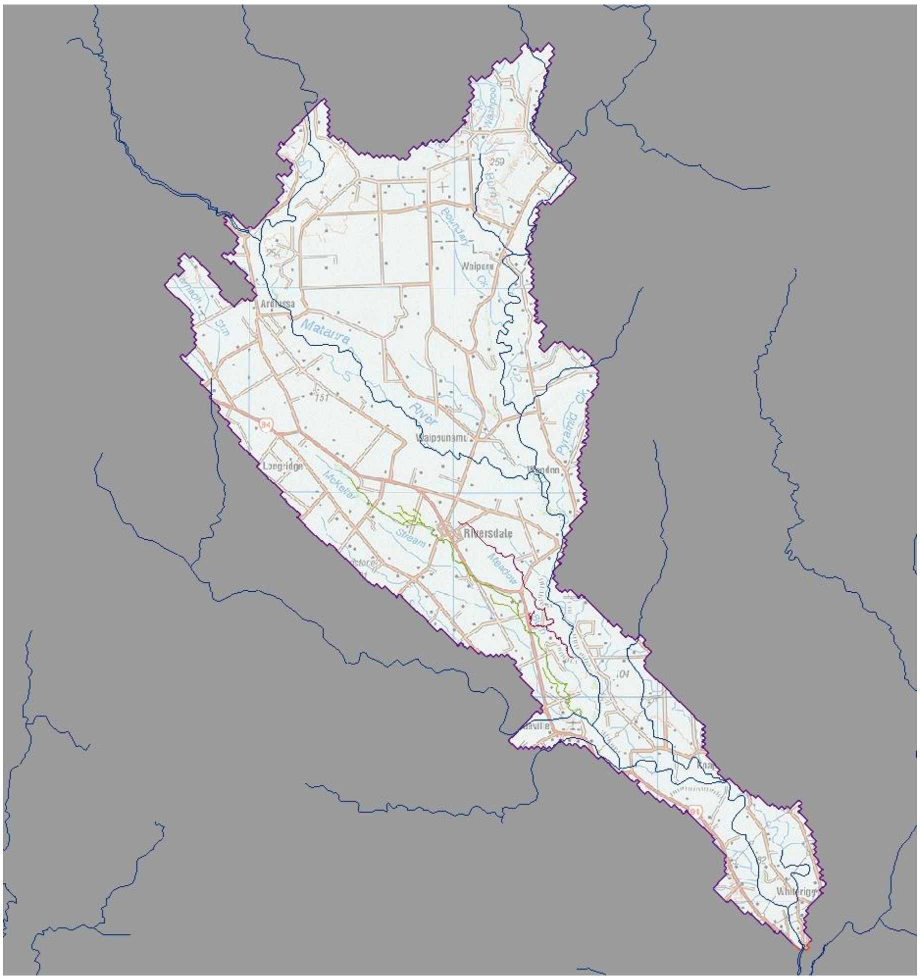


Figure 1 Area of interest for modelling the mid-Mataura Basin in AquiferSim.

4.2 Soils

The Toposouth soils layer provides spatial information for most of the AOI. Some of the area in the east and north does not have soil data. Soils in the project area have been entered into S-Map (New Zealand's new soil database, developed by Landcare Research) based on the Toposouth soils layer and new mapping was done by Sam Carrick (Landcare Research) to fill in the gaps. Many of the soils are very similar to Canterbury soils (S. Carrick pers. comm.) so the Environment Canterbury soil classes from appendix 3 of Lilburne et al. (2010) will be used. The rules used within S-map to generate these classes are listed in Table 1 and the resulting map is shown in Figure 2.

Table 1 Definition of the soil groupings used in the modelling work (Note; shallow = light in S-Map legend)

Soil Class	Number	Definition	Profile Available Water	Drainage class
XL	20	Extremely shallow	≤ 50 mm	w, mw, i
VL	21	Very shallow	50–80 mm	
L	22	Shallow	80–110 mm	
M	23	Medium	110–150 mm	
H	24	Heavy	150–200 mm	
D	25	Deep	> 200 mm	
Pd	27	Poorly drained	> 110 mm	p, vp
PdL	26	Poorly drained shallow	≤ 110 mm	

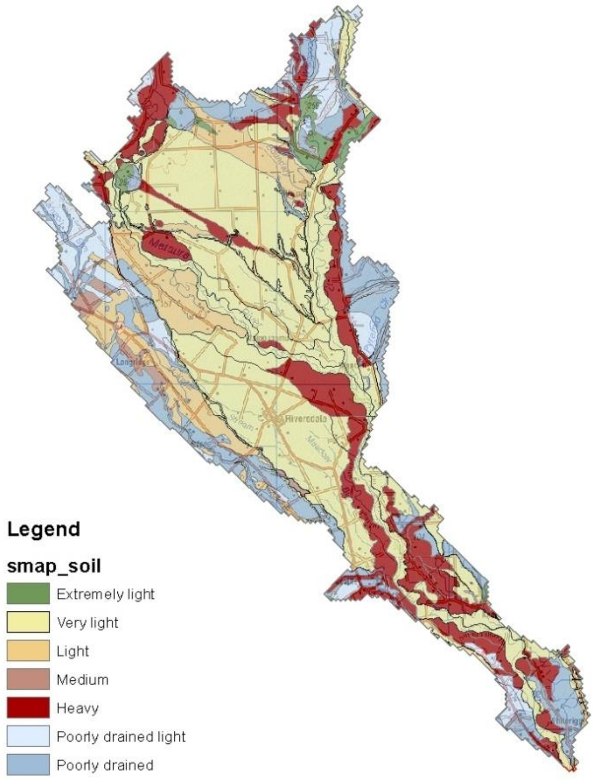


Figure 2 Map of the seven main soil types in the mid-Mataura Basin.

4.3 Climate

According to the LENZ annual rainfall layer, rainfall varies from 772 to 954 mm/year. This could either be divided into two rainfall zones, < 850 mm and > 850 mm, if nitrate-N leaching/drainage information is available for the two zones – or be treated as one zone with an average of 850 mm. Use of the Environment Canterbury lookup table (with rainfall categories of 650, 750 and 850 mm) suggests defining just one climate zone of 850 mm rainfall.

4.4 Land use

Environment Southland has supplied a land use layer that appears to be derived primarily from LCDB2 plus identification of dairy farms. The categories are:

Afforestation (imaged, post-LCDB 1)
Broadleaved Indigenous Hardwoods
Built-up Area
Cropping
Dairy
Deciduous Hardwoods
Forest Harvested
Gorse and Broom
Grey Scrub
Herbaceous Freshwater Vegetation
High Producing Exotic Grassland
Indigenous Forest
Lake and Pond
Low Producing Grassland
Major Shelterbelts
Manuka and/or Kanuka
Matagouri
Mixed Exotic Shrubland
Other Exotic Forest
Pine Forest – Closed Canopy
Pine Forest – Open Canopy
River
River and Lakeshore Gravel and Rock
Short-rotation Cropland
Surface Mine
Tall Tussock Grassland
Urban Parkland/ Open Space

They group into non-vegetated, native forest and scrubland, exotic forestry, and a set of agricultural categories (cropping, short-rotation cropland. dairy, high producing exotic grassland, low producing exotic grassland, and tall tussock grassland). The boundaries do not map to cadastral boundaries except for the dairy farms. These farms also have stock numbers. The estimated cows per hectare range from 0.8 to 7.7, which is unlikely to be correct but is used to separate the dairy farms into two categories: less than 3.5 cows/ha and more than 3.5 cows/ha.

It is noted that there can be substantial change in these agricultural land uses from year to year according to market pressures. There may be some inaccurate classifications – for example, one farm classified as Dairy (supply_no 33108) is unirrigated despite being on very stony soils, and is recorded as being Sheep in Agribase 2008. Other potential sources of information that might improve the accuracy are Agribase and FarmOnline.

It may be appropriate to distinguish gorse and broom as a separate nitrate-N leaching category (see Monaghan et al. (2010, p. 17) for a value) if it is present in the AOI and can be identified spatially.

The cadastral layer could be used in the future to identify likely lifestyle blocks (e.g. those titles or parcels classified as being high producing exotic grassland that are < 20 ha). However, this approach may well incorrectly identify land that is actually part of a larger farm, particularly where the [titles] attribute is blank.

A GIS layer of irrigated areas (parcels) was supplied by Environment Southland. There is also some point information from a June 2011 survey for the location of winter grazing by cows, sheep, deer or an unknown stock type. If the cadastral parcel containing the point where cows (or an unknown stock type) were observed to be grazing is classified as being Dairy then the parcel is classified as being ‘Dairy winter on’. If the classification is high producing exotic grassland, then the parcel is reclassified as ‘Dairy support’. Observation of winter grazing of sheep or deer does not change a Sheep & Beef farm type classification as some winter grazing is already catered for in this farm type. Cropping farms are separated into seasonal and mixed cropping depending on the presence or not of winter grazing of sheep or deer respectively. This is summarised in Table 2.

Table 2 Final farm type given the land use class, information on winter grazing, and number of cows

Land use classification		Winter grazing indicator	Assumed farm type (for leaching estimates)
Dairy	≤ 3.5 cows/ha	No winter grazing	Dairy winter off (3 cows/ha)
		Cows or unknown	Dairy winter on (3 cows/ha)
	> 3.5 cows/ha	No winter grazing	Dairy winter off (4 cows/ha)
		Cows or unknown	Dairy winter on (4 cows/ha)
Cropping		Any winter grazing	Mixed cropping rotation
		No winter grazing	Seasonal rotation
High Producing Exotic Grassland		Sheep or deer	Sheep & Beef farm
		Cow or unknown	Dairy support
		No winter grazing	Sheep & Beef farm

This approach may not be the most appropriate given that Monaghan et al. (2010) note that winter grazing is usually part (2–3 years) of a pasture renewal cycle. More needs to be known about the spatial pattern of winter grazing of dairy stock.

The farm-type categories are matched to the nearest farm-type category from the Environment Canterbury nitrate/drainage lookup table as shown in Table 3. Stock numbers are used to separate the dairy farms. Modelled land use for the mid-Mataura Basin is shown in Figure 3.

Table 3 Available land use information

Farm type	Lookup table farm type	Irri-gated	Winter grazing	Land-use code for AquiferSim model		Notes
				Code	Number	
Cropping – seasonal	Seasonal grazing rotation	y	n	Ara3i	103	
		n	n	Ara3	106	
Cropping – mixed	Mixed cropping including some winter grazing of sheep and beef.	y	y	Ara2i	102	Assumes 65:35 ratio of crop to grazing
		n	y	Ara2	105	
Dairy	Dairy – up to 3.5 cows/ha		y	Dai1	404	Winter on
			n	Dai2	402	Winter off
	Dairy – more than 3.5 cows/ha		y	Dai5	405	Winter on
			n	Dai3	401	Winter off
Dairy support	Winter grazing of cows	y	y	Gra1i	451	
		n	y	Gra1	450	
Sheep & Beef	Intensive sheep & beef 80:20	y		Snb2i	602	Deer are included in this category
		n		Snb2	604	Deer are included in this category
Low Producing Grassland	Sheep – assume dryland			Shp1	302	
Tall Tussock Grassland	Sheep – assume dryland			Shp1	302	

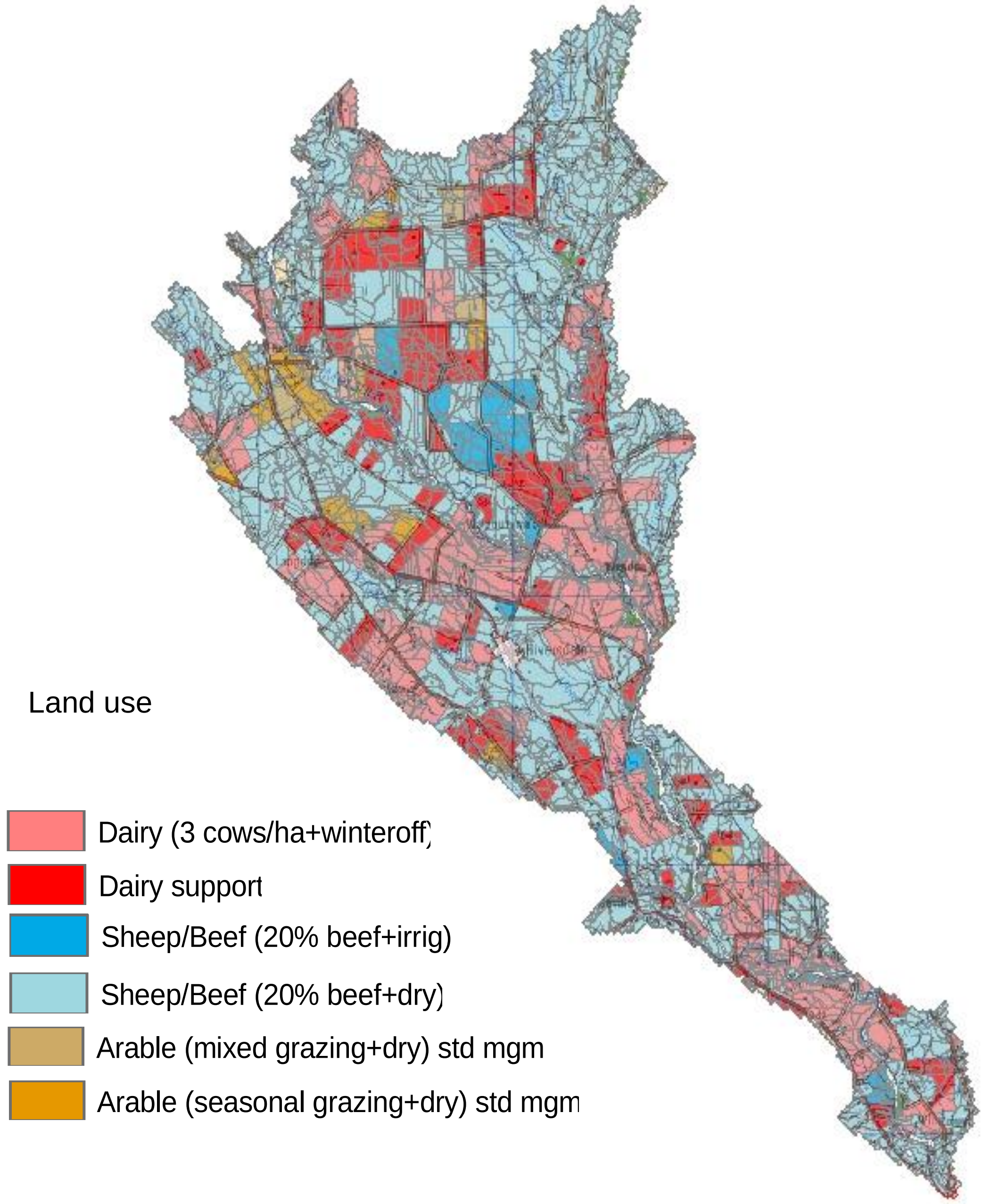


Figure 3 Map of land use in the mid-Mataura Basin.

4.5 Nitrate/Drainage lookup table

Monaghan et al. (2007) give model predictions of nitrate-N leached from dairy milking platform, dairy wintering, dry stock, forestry and grass seed producing land uses (Table 4). Meteorological data from Winton climate station were used (long-term annual mean rainfall 843 mm/year). The Pukemutu soil was used for the dairy modelling. Sheep and beef are mostly found on the Mossburn soil in Monaghan et al.'s study area but it is not clear which soil was used for the dry stock modelling. Forestry and dairy winter values were taken from the literature and ongoing field trials. Measured data are presented in table 3.1 of Monaghan et al (2010) and reproduced below (Table 5).

Table 4 Modelled leaching rates taken from Monaghan et al. (2010)

Land use	Soil	N leached kg/ha/yr
Milking platform	Pukemutu	16
Dairy wintering	Pukemutu	55
Dry stock	?	6
Forestry	?	1.3
Grass seed	?	1

Table 5 Reproduction of the relevant information from table 3.1 of Monaghan et al. (2010)

Land use	Soil	NO_3-N leached kg/ha/yr
Dairy – nil fert	Woodlands-Waikoikoi	30
Dairy – 100kg N/ha/yr	Woodlands-Waikoikoi	34
Dairy – 200kg N/ha/yr	Woodlands-Waikoikoi	46
Dairy – 400kg N/ha/yr	Woodlands-Waikoikoi	56
Dairy	Pukemutu	17
Dairy – restricted autumn grazing	Pukemutu	11
Dairy – 85 kg N/ha/yr	Pallic (drained)	52
Winter grazing	Pukemutu	52

Table 4.1 in Monaghan et al. (2010) – partly reproduced in Table 6 – shows a simple index of the relative differences between some soils and land management practices. This index does not give absolute losses but may have some use in evaluating any modelled estimates of leaching. The higher the number, the greater the losses.

The currently available nitrate-N data as listed in Tables 4 and 5 are insufficient for use in AquiferSim, because the Mossburn, Pukemutu, and Woodlands–Waikoikoi zones are not representative of most of the mid-Mataura catchment (S. Carrick pers. comm.). Ideally some more modelling would be done by AgResearch but this is not within the scope of this project. The alternatives are to take an expert opinion approach (i.e. using Ross Monaghan) to extrapolate the measured data to the soils and land uses in the mid-Mataura. Another approach is to use the Environment Canterbury nitrate lookup table (Lilburne et al. 2010) as most of the soils in the mid-Mataura are very similar to those in Canterbury (S. Carrick pers. comm.), and the rainfall is comparable with that of the Hororata station. This is the approach that will be taken in the first instance. The setuplanduse model documents all the steps taken to create the land use layers for AquiferSim (Appendix 2).

An important factor for which there are no data is the presence of mole tile drains. Nitrate-N leaching losses from drained perch-gley soils are expected to be quite high.

Table 6 Repoduction of the relevant information from table 4.1 of Monaghan et al. (2010). Su = stock units

Land use	Soil	Management	Relative index
Dairy	Free draining	Poor (< 2 weeks FDE storage; no stock exclusion; forage crop wintering)	6
		– with stock exclusion	5
		– with stock exclusion & FDE storage	4
		Optimal (with off paddock wintering)	3
Dairy	Poor draining	Poor (< 2 weeks FDE storage; no stock exclusion; forage crop wintering)	5
		– with stock exclusion	4
		– with stock exclusion & FDE storage	3
		Optimal (with off paddock wintering)	2
Sheep	Free-draining	15 Su/ha, unfenced or fenced	2
	Poor-draining	15 Su/ha, unfenced or fenced	2
Cropping	Shallow soils	Sub-optimal	6
		Optimal	3
	Deeper soils	Optimal	2
Deer	All	Fenced	2
Forestry			1

4.6 River–aquifer fluxes

This layer quantifies the fluxes between surface and ground water. It was compiled directly from the river and streams recharge layer of the existing Modflow model of the mid-Mataura groundwater system (Phreatos Limited 2007), which was recently re-calibrated by Cath Moore as part of ESR's Groundwater Assimilative Capacity project. The Process Modflow Data model was used to convert the data (Appendix 3). Figure 4 shows the fluxes: brown cells are discharges to the river/streams, blue cells represent river recharges to the aquifer.

Note that in terms of other information that could be used to define the river recharge layer (in the absence of a Modflow model), some gauging data are available in Wilson (2008) that can be used to set flows between the aquifer and the Meadow Burn. The same report suggests that McKellar Stream has a very low level of hydraulic connection to the aquifer. There are some unnamed springs that could also be described in the river recharge layer if their flows or values are significant enough.

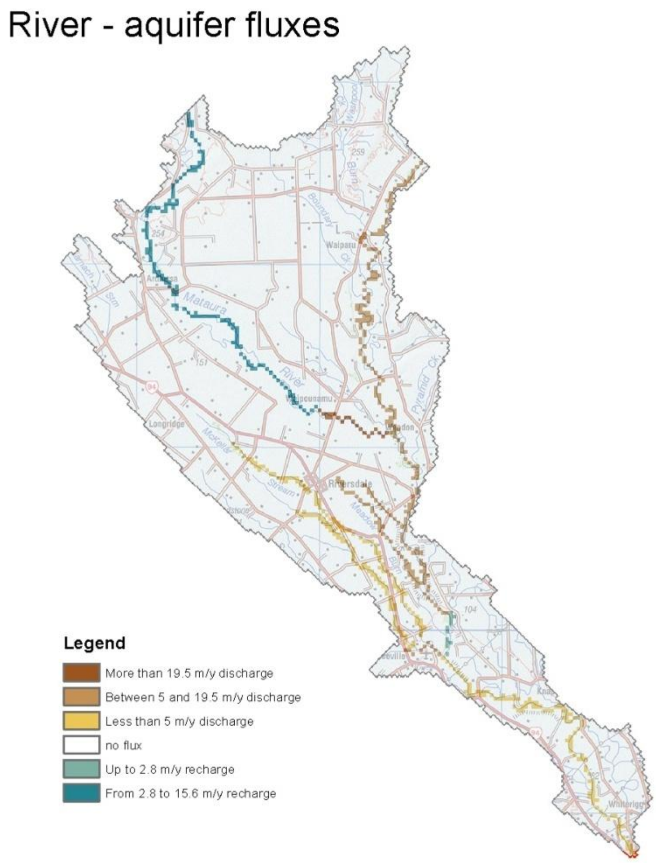


Figure 4 Map showing the river–aquifer flux information for the mid-Mataura Basin, derived from Modflow outputs.

4.7 Transmissivity

There are two approaches for deriving transmissivity information. The first is to use the transmissivity information from the Modflow model. This is shown in Figure 5. If there were no Modflow model the second approach is to assign each aquifer or water management zone an approximate transmissivity value based on hydrogeological characteristics.

4.8 Porosity

A constant value of 0.25 (Cath Moore) as a typical value for an unconfined aquifer was assumed.

4.9 Aquifer thickness

A constant value of 100 m was assumed. One of the simplifying assumptions of AquiferSim is a constant aquifer depth, although the transmissivity layer does integrate the effects of varying hydraulic conductivity and aquifer thickness.

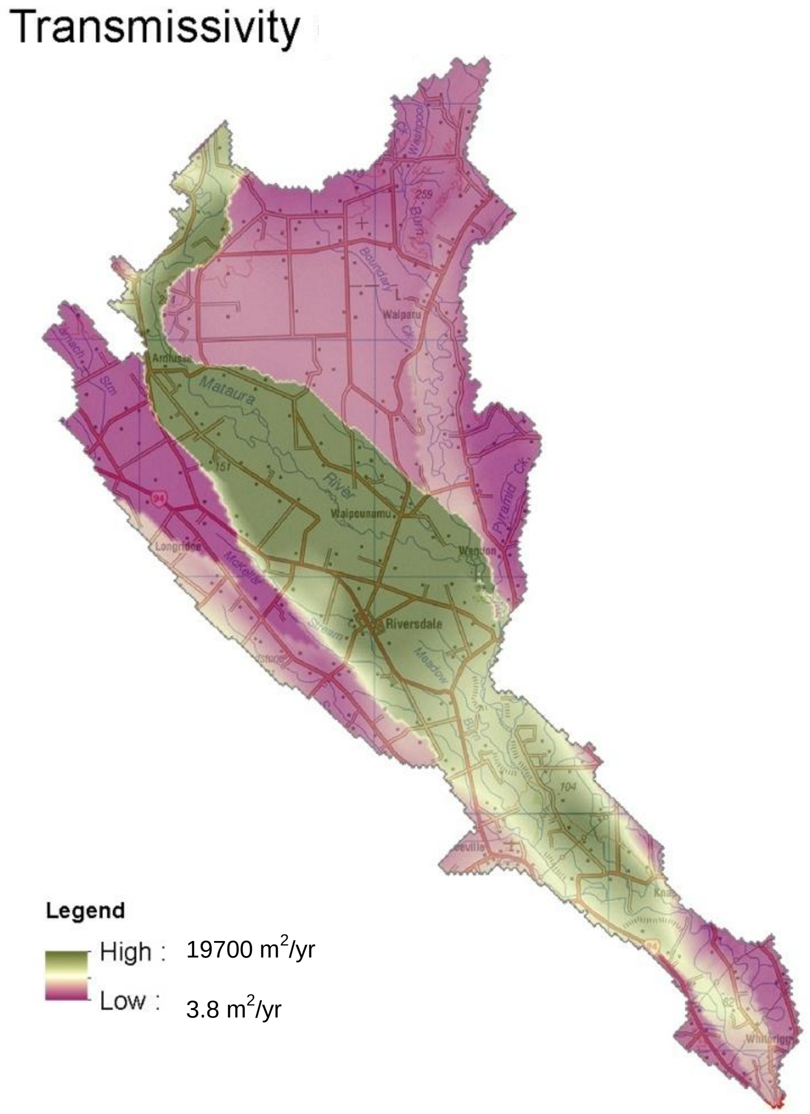


Figure 5 Map of transmissivity for the mid-Mataura Basin as imported from Modflow.

4.10 Denitrification

There are assumed to be no significant denitrification transformations in the aquifers in the AOI, apart from in poorly drained soil (which is already accounted for in the nitrate leaching lookup table).

5 Model outputs

The Generate Nitrate and Recharge tool (which is a stand-alone component used in AquiferSim) combines land use (farm type), soil, and climate layers together with the lookup table of leaching rates. The outputs from this tool (run in ArcGIS) are layers of predicted nitrate-N leached from below the root zone. Figure 6 shows this as a concentration level and Figure 7 shows the nitrate-N lost in mass units.

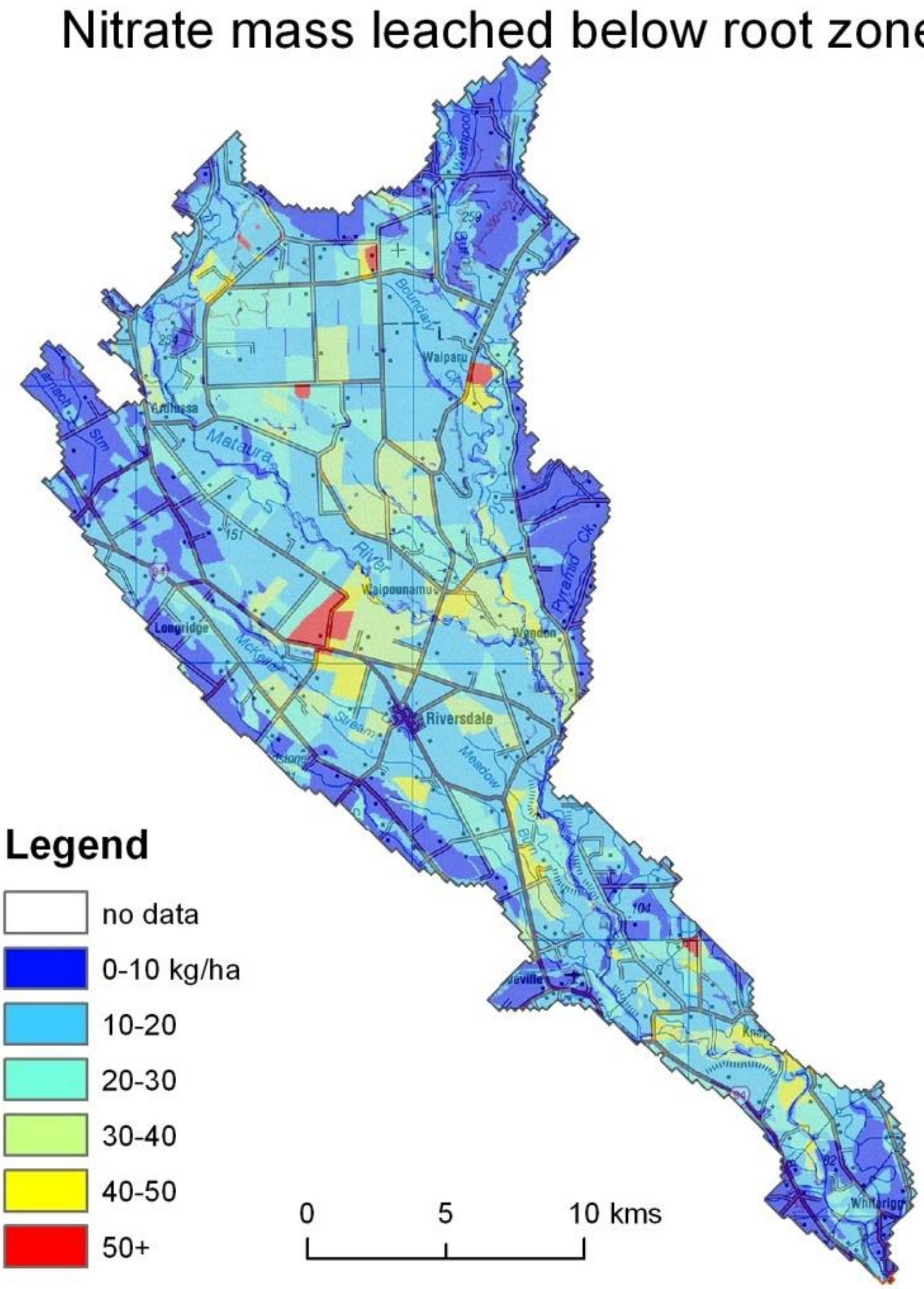


Figure 6 Map of the estimate nitrate-N losses from below the root zone in the mid-Mataura Basin.

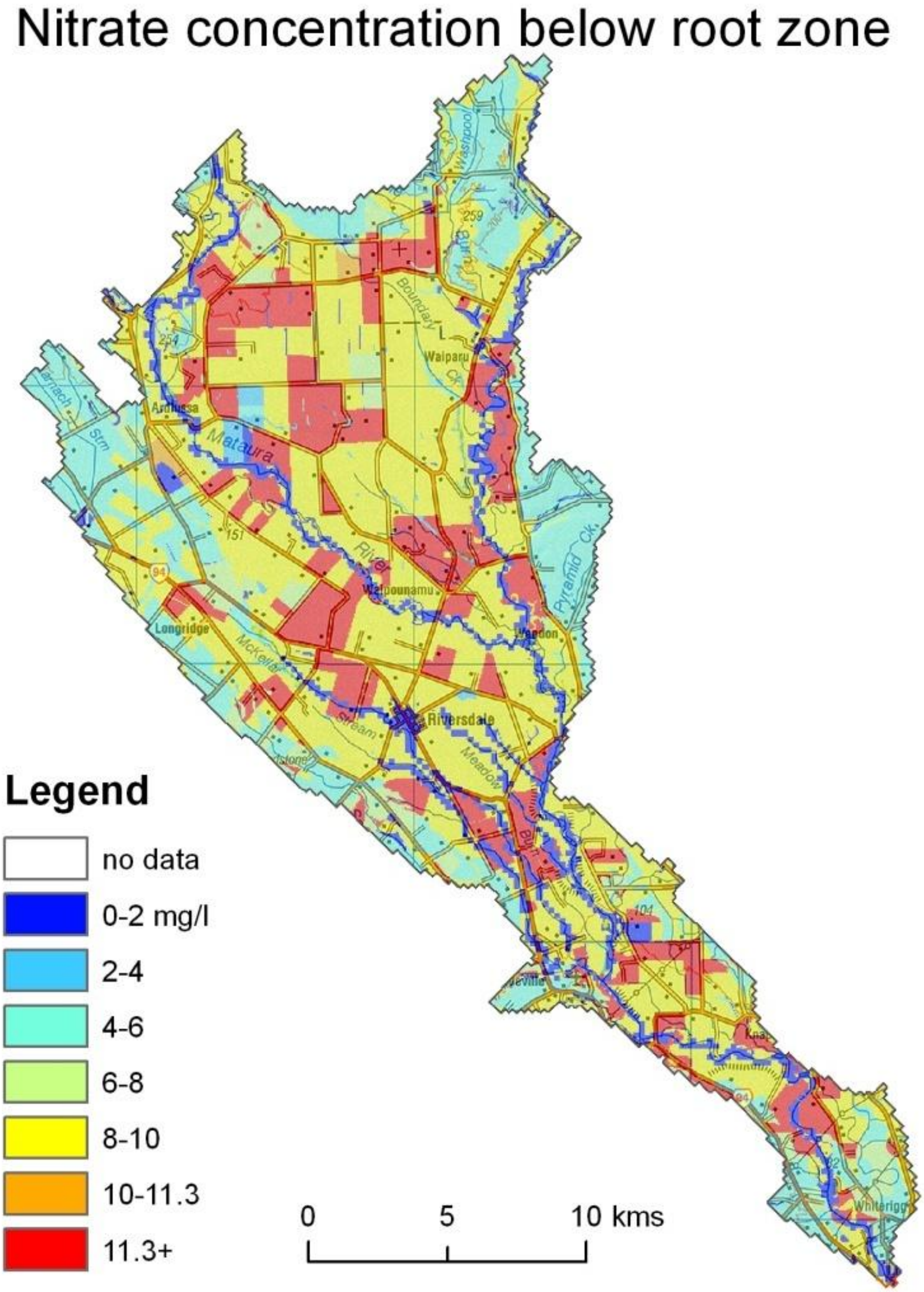


Figure 7 Map of the estimated nitrate-N concentration below the root zone for the mid-Mataura Basin.

All outputs from the AquiferSim model provide a long-term steady-state view of nitrate-N transport. The set of outputs include:

- Flowpaths showing the horizontal movement of water/contaminants
- 1D and 2D vertical slices below a point or flowpath
- Horizontal layers of average or maximum concentration of nitrate-N over specific depth ranges (including the root zone)
- Groundwater catchments of the lowland streams and gaining parts of the main river
- Estimates of nitrate-N loads to the lowland streams and gaining parts of the main river

The horizontal groundwater flowpaths are shown in Figure 8. These flowpaths are consistent with the velocity vectors in the Modflow model output. The greatest velocity, and the greatest flow and dilution capacity, occurs adjacent to the Mataura River, particularly in the upper and middle reaches.

The vertical cross-section or 'slice' below the three highlighted flowpaths is shown in Figure 9. The top row of images show the streamtubes, i.e. path along which groundwater flows; the second row of images shows the estimated groundwaterage; and the images on the bottom row show the profile of nitrate-N concentrations in the groundwater.

The young age and relatively low nitrate-N levels in groundwater flowpath B (Figure 8) is characteristic of a fast-flowing (i.e. generally young) stream of water dominated by recharge from and discharge to the Mataura River. This is consistent with Environment Southland's definition of the Waipounamu aquifer zone (which flowpath B represents) as a riparian aquifer. In contrast flowpaths A and C (both in areas with lower transmissivity) indicate high levels of nitrate-N contamination at some depths and locations along the flowpath, commensurate with the slower groundwater and less dilution capacity. The estimated groundwater age in these profiles is generally older, as a consequence of the lower throughflow of (river) recharge water, but is also linked to the lower aquifer transmissivity. This is particularly evident in the case of flowpath C (which represents the Wendonside aquifer) which contains the oldest groundwater despite being the shortest groundwater flowpath shown in Figure 9. Furthermore, the mass of nitrate-N entering the aquifer at the land surface boundary penetrates relatively deeper in flowpaths A and C than it does in flowpath B, where the stream of fresh river recharge water effectively suppresses the depth of influence of land surface recharge water and dilutes any nitrate-N leached to the groundwater system before it is discharged from the aquifer.

A recommended improvement to AquiferSim is to allow some flexibility in defining the linear scale of the age graph as the very high maximum age values on the legend are likely to relate to the slow-moving 'bottom edges' of the aquifer rather than the bulk of the aquifer.

This variable pattern of nitrate-N levels at depth can also be seen in the nitrate-N profile graphs. Figure 10 shows a set of points where graphs of the 1-D distribution of nitrate-N below each point have been created (Figure 11). The scales on each graph differ. Most of the points show zones of higher nitrate-N at some depth, which correspond to descending plumes of high-nitrate groundwater, as illustrated in Figure 9.

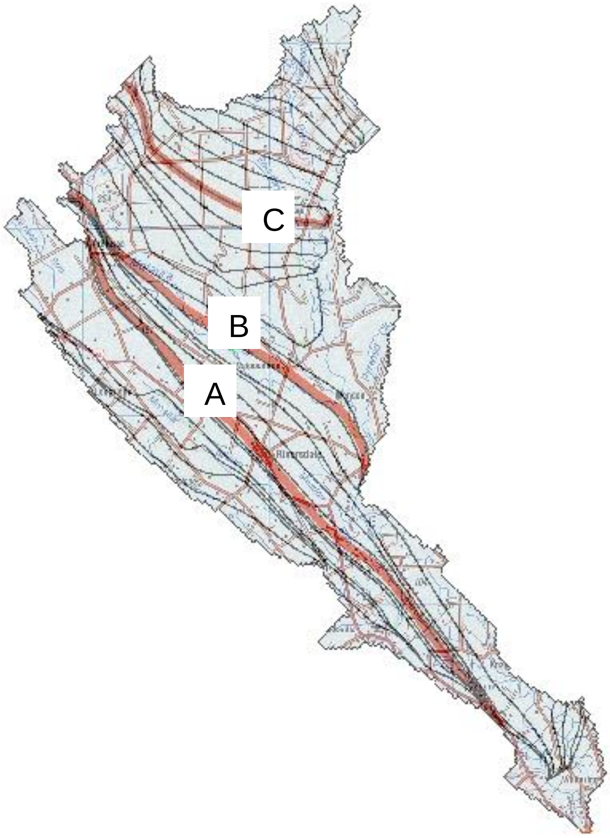


Figure 8 Flowpaths showing the horizontal direction of the groundwater flows in the mid-Mataura Basin. The three highlighted lines show the surface location of the vertical 'slices' shown in Figure 9.

Vertical slice along flowpath A | Vertical slice along flowpath B | Vertical slice along flowpath C

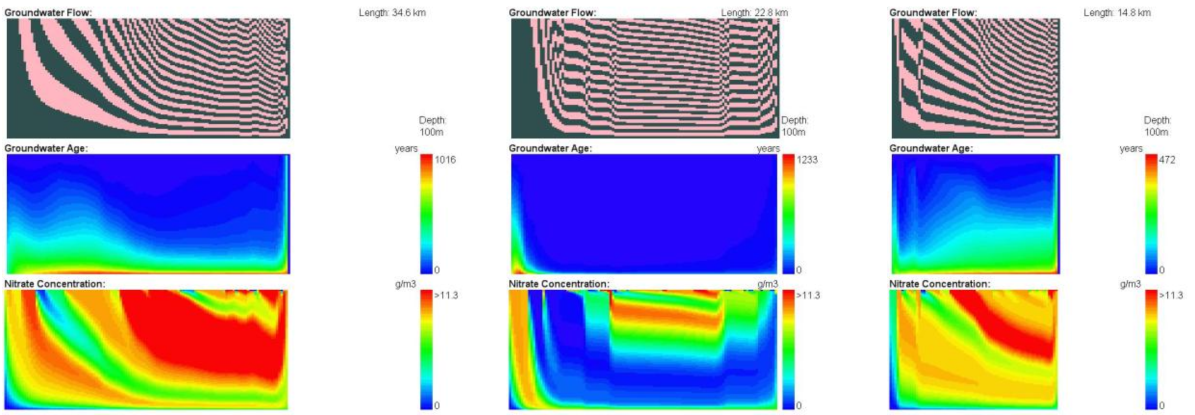


Figure 9 Vertical slices along the flowpaths shown in Figure 8.

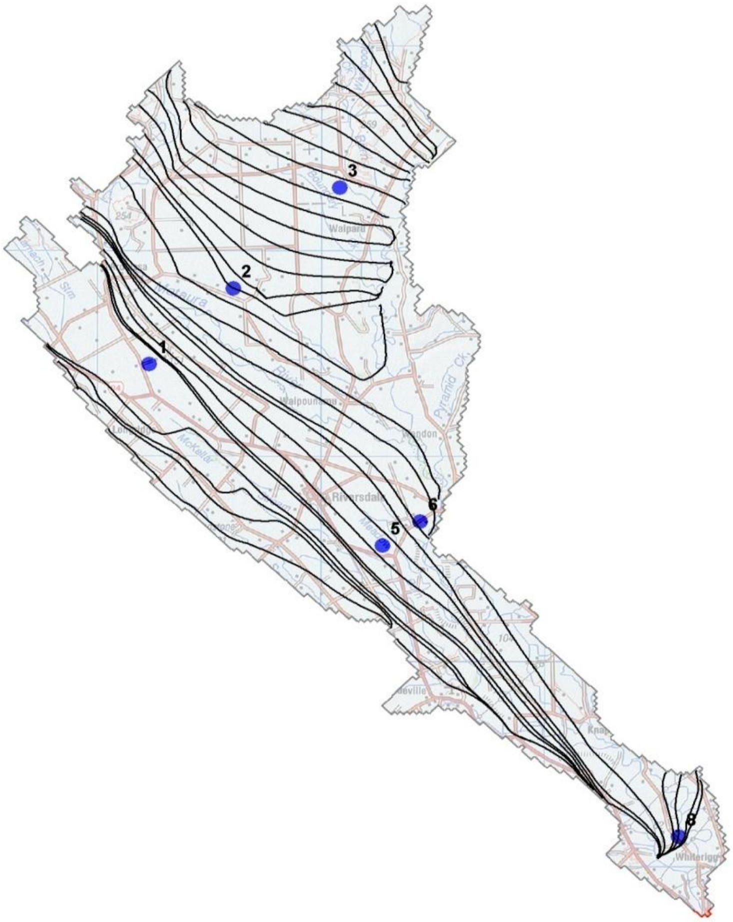


Figure 10 Map with flowpaths and a set of numbered points.

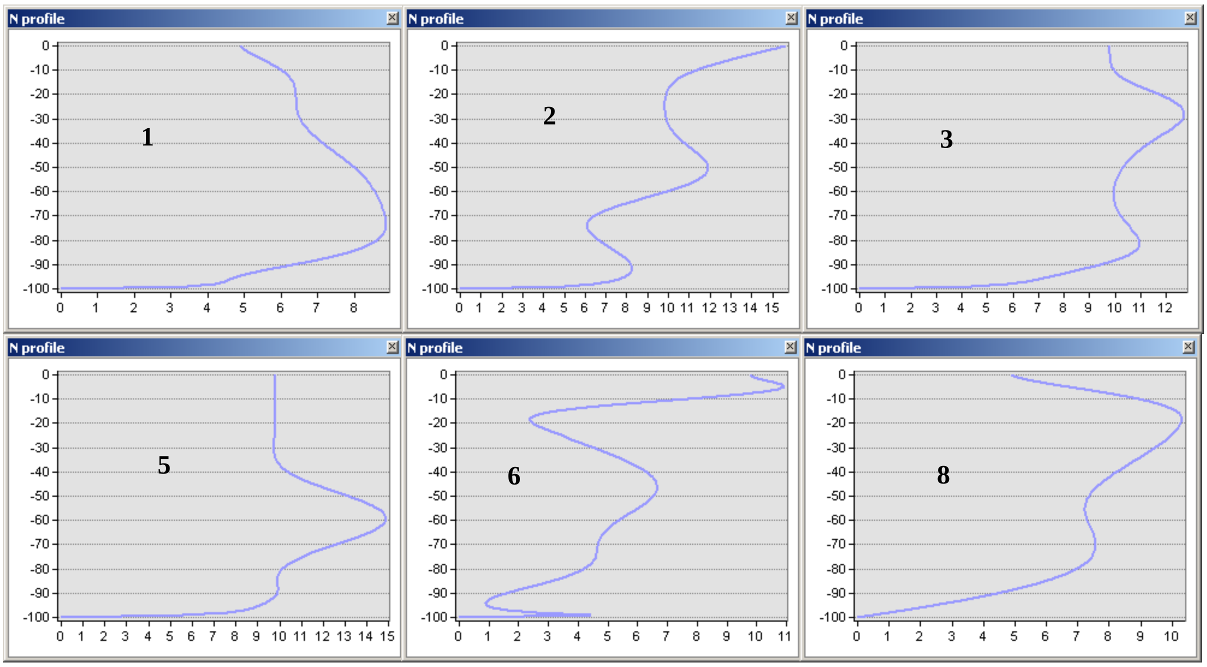


Figure 11 Vertical profile graphs of nitrate-N concentrations below the set of numbered points on Figure 10.

By sampling along a comprehensive set of flowpaths to generate a network of points covering the catchment, vertically sampling each point, aggregating to depth intervals, then interpolating spatially, horizontal cross sections can be generated. Figure 12 shows the mean average concentration level in the top half of the catchment, Figure 13 shows the mean average concentration in the bottom half. Note that these maps only indicate the general spatial distribution – the spots are an artefact of the interpolation process. The principal difference between Figure 12 and Figure 13 is the reduction of nitrate-N concentration peaks through dispersion with lower nitrate zones, within the groundwater flow.

The nitrate-N concentrations are consistent with the knowledge assimilated within the groundwater model. There is generally agreement between measured groundwater nitrate-N concentrations and these model outputs, with the exception of the Knapdale area, where measurements are higher than modelled, which would indicate that groundwater fluxes in this region are not as high as currently simulated within the models. This issue is currently being addressed within ESR's Assimilative Groundwater project.

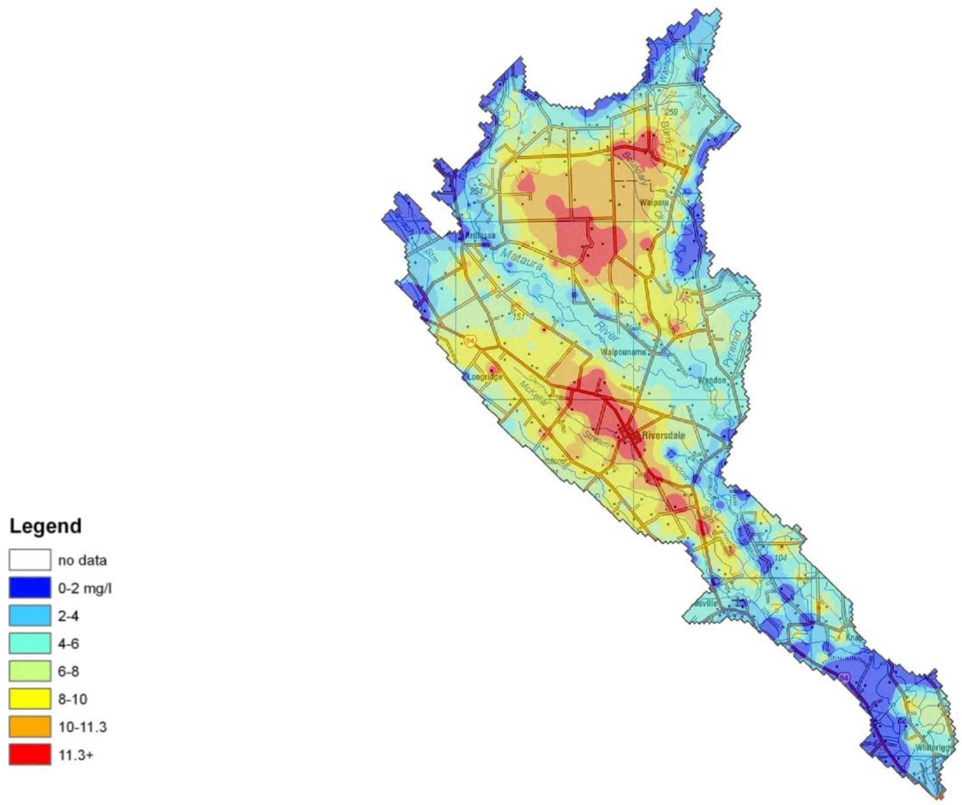


Figure 12 Nitrate-N concentration levels in the upper half of the aquifer in the mid-Mataura Basin.

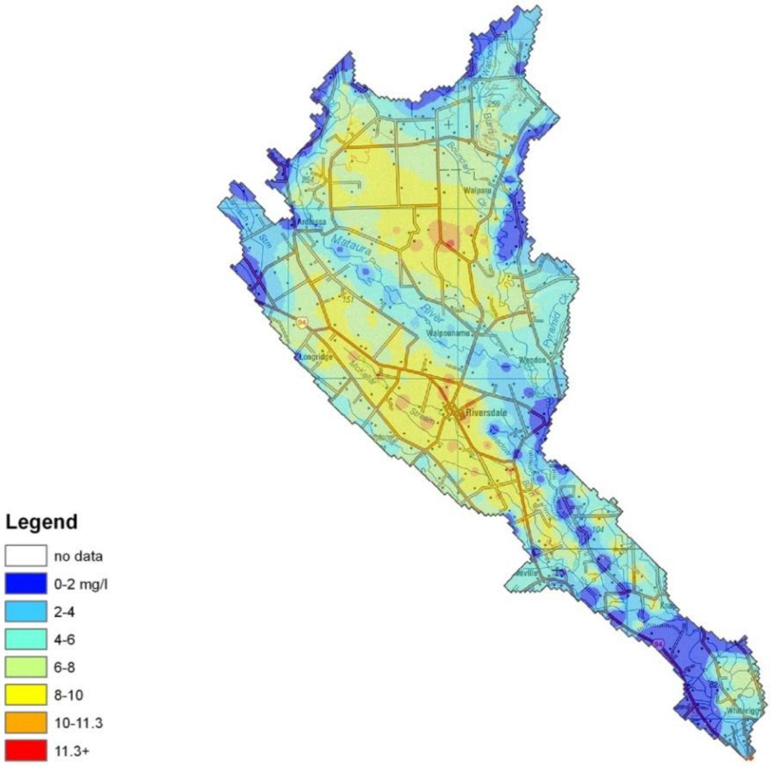


Figure 13 Nitrate-N concentration levels in the lower half of the aquifer in the mid-Mataura Basin.

Finally the groundwater catchments as defined by AquiferSim-flowpath-derived capture zones are shown in Figure 14. The lighter shades show the groundwater catchment of the stream denoted by a darker shade of the same colour. For example the brown-shaded area feeds into the Waikaia River. Note that some areas are uncoloured because the arbitrary choice of seedpoints (Figure 10) meant that some areas had no flowpaths.

Figure 14 indicates that the Wakaia River has a large capture zone (brown in Figure 14) that corresponds to the Wendonside aquifer. The modelled capture zone for the Meadow Burn spring-fed stream (pink in Figure 14) seems to agree with preconceptions of this system and extends back to the Mataura River at Ardlussa. The results indicate that McKellar Stream (grey in Figure 14) is not influenced directly by Matuara River recharge, which corroborates with the observation that this stream is perched above the Riversdale aquifer and drains land surface recharge from the Longridge Terrace (Wilson, 2008).

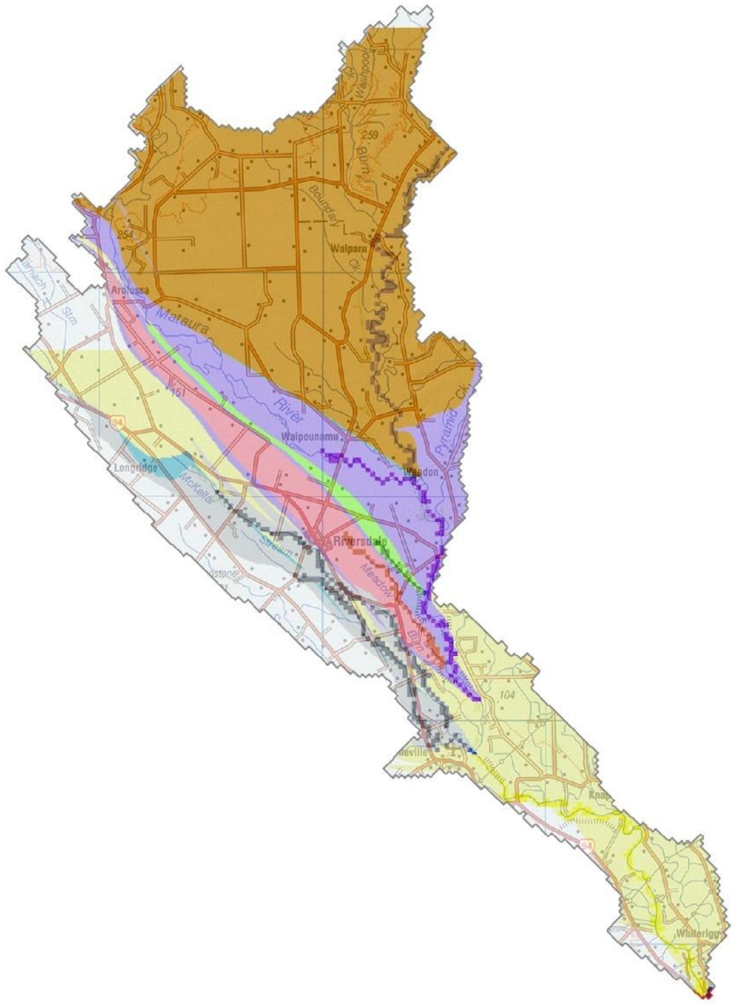


Figure 14 Groundwater catchments in the mid-Mataura Basin.

6 Recommendations and next steps

The mid-Mataura has now been set up in AquiferSim. The next step is to further evaluate the model. The design parameters of AquiferSim (which does not explicitly model any temporal dynamics) along with the data uncertainties mean that it is unrealistic to expect predictions at a specific time, location and depth to be accurate. However, results can be used to understand the general spatial pattern of the long-term mean annual nitrate-N contamination. At this stage we note that the modelled long-term distribution of nitrate-N in the mid-Mataura basin using AquiferSim is not inconsistent with the observed distribution of nitrate-N as mapped in figure 7 of Rissmann (2011). The greatest disparity between modelled and observed nitrate-N levels is in the vicinity of Knapdale where modelled values are less than the much higher observed values. Further investigation is required to explore this anomaly. There is also scope for the total predicted nitrate-N load in tonnes per year to the groundwater-fed streams and rivers to be calculated, converted into concentration values given annual-flow information, and compared with surface-water-quality measurements.

As part of ESR's Groundwater Assimilative Capacity research programme, a comparison of the AquiferSim with a steady-state version of the Modflow/MT3D model will be undertaken. This work project will investigate the differences between the model outputs and determine the impact of the assumptions and simplifications underlying AquiferSim, as well as assess the advantages/disadvantages of using AquiferSim over Modflow/MT3D. If the evaluation confirms that AquiferSim adequately represents the groundwater processes in the Mataura Basin then it could be used to explore the impact of further land intensification (by running some *'what if'* simulations), and to help council and stakeholders to better appreciate and understand the dynamics of the mid-Mataura groundwater system.

Note that if the above comparison is favourable, AquiferSim may be suitable for other catchments where there is no Modflow/MT3D model in place as other information such as river gaugings and geohydrological expertise can be used to define the necessary input layers. Thus this may be a practical method for examining possible contamination concerns (particularly under different land-use scenarios) in a catchment where no modelling has been done.

7 Acknowledgements

This work was carried out with funding from an Envirolink medium advice grant to Environment Southland (1004-ESRC238) from the Ministry of Science and Innovation.

8 References

Bidwell VJ, Good JM 2007. Development of the AquiferSim model of cumulative effect on groundwater of nitrate discharge from heterogeneous land use over large regions. In: Oxley L, Kulasiri D eds MODSIM 2007 International Congress on Modelling and Simulation. Christchurch, Modelling and Simulation Society of Australia and New Zealand. Pp. 1617–1622.

Bidwell VJ, Lilburne LR, Good JM 2005. Strategy for developing GIS-based tools for management of the effects on groundwater of nitrate leaching from agricultural land use. In: Zerger A, Argent RM eds MODSIM 2005 International Congress on Modelling and Simulation. Melbourne, Australia, Modelling and Simulation Society of Australia and New Zealand. Pp. 1354–1360.

Lilburne L, Bidwell V 2011. AquiferSim user documentation. Lincoln, Landcare Research & Lincoln Ventures.

Lilburne L, Webb T, Ford R, Bidwell V 2010. Estimating nitrate-nitrogen leaching rates under rural land uses in Canterbury. Technical Report R10/127. Christchurch, Environment Canterbury. 37 p.

Lilburne L, Elliott S, Bidwell V, Shankar U, Kelly D, Hanson C 2011. Hurunui catchment-scale land use and water quality modelling report. Technical Report R11/15. Christchurch, Environment Canterbury.

Monaghan RM, Wilcock RJ, Smith LC, Tikkisetty B, Thorrold BS, Costall D 2007. Linkages between land management activities and water quality in an intensively farmed catchment in southern New Zealand. Agriculture, Ecosystems & Environment 118: 211–222.

Monaghan RM, Semadeni-Davies A, Muirhead RW, Elliott S, Shankar U 2010. Land use and land management risks to water quality in Southland. Report prepared by AgResearch for Environment Southland. Dunedin, AgResearch.

Phreatos Limited 2007. Mid-Mataura Groundwater Model – Environment Southland. Final report. 13 p.

Rissmann C 2011. Regional mapping of groundwater denitrification potential and aquifer sensitivity. Environment Southland Technical Report 2011-12. 38 p.

Wilson K 2008. Surface water and groundwater relationships in the Mataura Catchment above Gore. Environment Southland Technical Report 2008-03. 65 p.

Appendix 1 – Notes on data set-up steps

Steps taken

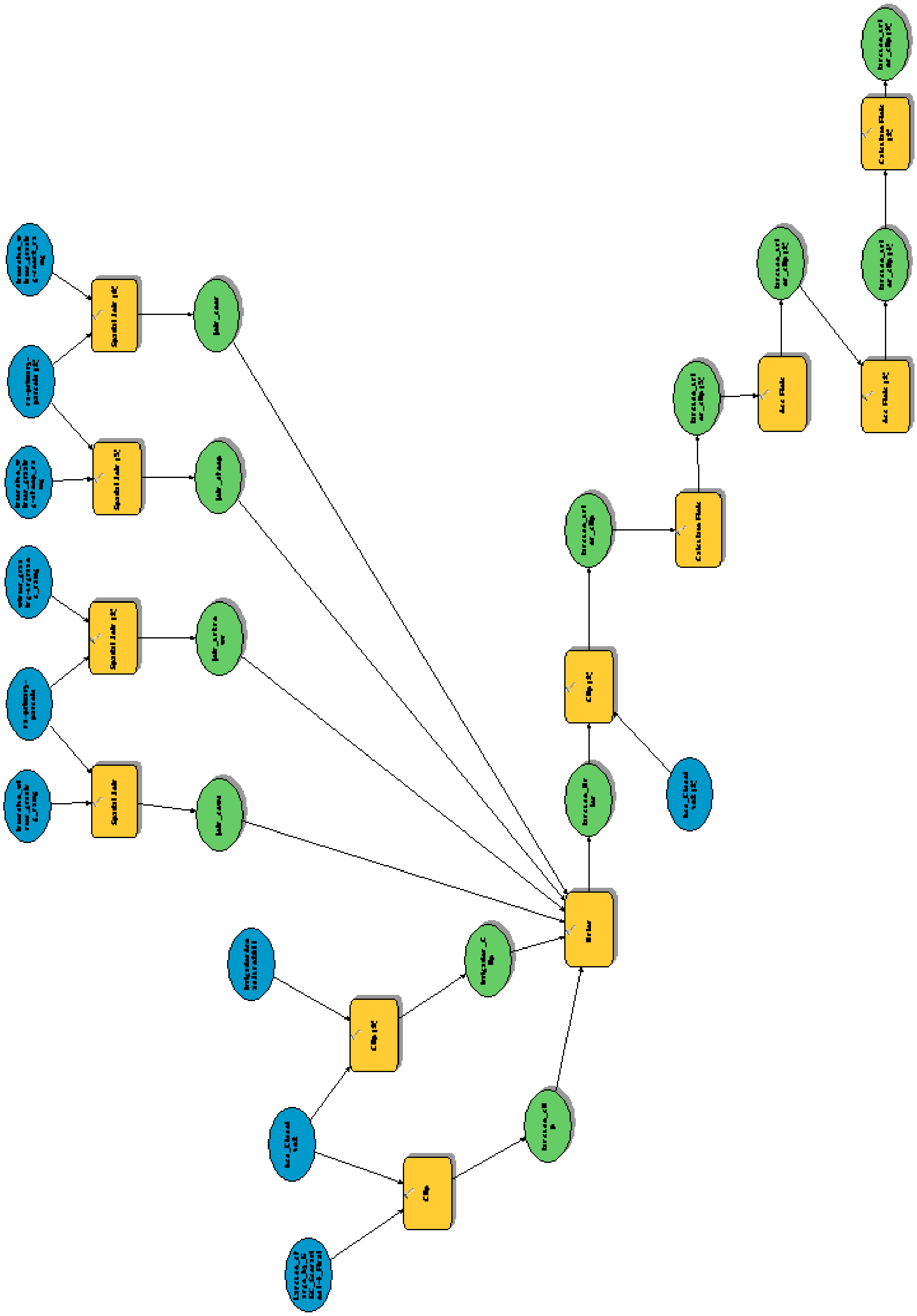
1. Ran model setuplanduse generate landuse_union_clip, join landuse_rcl.dbf to populate lu_scen, and export to current_scenario.shp

2. Run the Generate Nitrate and Discharge tool

3. Calculate river – aquifer fluxes by importing the Modflow data – see the Process Modflow Data model

4. Create the transmissivity layer (add the points into a point layer, do a nearest neighbour interpolation (boundary raster extent and cellsize), then fill in the gaps around the edges with a constant value of 500

Appendix 2 – Schematic and code for the 'setuplanduse' model



```
# ---------------------------------------------------------------------------
--
# setuplanduse.py
# Created on: 2012-03-08 12:25:38.00000
# (generated by ArcGIS/ModelBuilder)
# Description:
# Clips landuse, adds irrigation and lookup values
# ---------------------------------------------------------------------------
--

# Import arcpy module
import arcpy


# Local variables:
Landuse_change_by_REC_Scenarios1-4_Final =
"Landuse_change_by_REC_Scenarios1-4_Final"
IrrigationAreasJune2011 = "IrrigationAreasJune2011"
bcs_Dissolve2 = "bcs_Dissolve2"
nz-primary-parcels = "nz-primary-parcels"
intensive_winter_grazing_nzmg = "intensive_winter_grazing_nzmg"
winter_grazing-ungrazed_nzmg = "Point survey\\winter_grazing-ungrazed_nzmg"
nz-primary-parcels__2_ = "nz-primary-parcels"
intensive_winter_grazing-sheep_nzmg = "Point
survey\\intensive_winter_grazing-sheep_nzmg"
intensive_winter_grazing-deer2_nzmg = "Point
survey\\intensive_winter_grazing-deer2_nzmg"
bcs_Dissolve2__2_ = "bcs_Dissolve2"
landuse_clip =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\landuse_clip"
join_cows = "C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\join_cows"
landuse_union_clip =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\landuse_union_clip"
landuse_Union =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\landuse_Union"
Irrigation_Clip = "C:\\Temp\\tmpGIS\\data.gdb\\Irrigation_Clip"
join_unknown =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\join_unknown"
join_sheep =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\join_sheep"
join_deer = "C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\join_deer"
landuse_union_clip__5_ =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\landuse_union_clip"
landuse_union_clip__2_ =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\landuse_union_clip"
landuse_union_clip__4_ =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\landuse_union_clip"

# Process: Clip
arcpy.Clip_analysis(Landuse_change_by_REC_Scenarios1-4_Final,
bcs_Dissolve2, landuse_clip, "")

# Process: Clip (3)
arcpy.Clip_analysis(IrrigationAreasJune2011, bcs_Dissolve2,
Irrigation_Clip, "")

# Process: Spatial Join
arcpy.SpatialJoin_analysis(nz-primary-parcels,
intensive_winter_grazing_nzmg, join_cows, "JOIN_ONE_TO_ONE", "KEEP_COMMON",
"id \"id\" true true false 10 Double 0 10
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
```

```
parcels.shp,id,-1,-1;appellatio \"appellatio\" true true false 80 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,appellatio,-1,-1;affected_s \"affected_s\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,affected_s,-1,-1;parcel_int \"parcel_int\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,parcel_int,-1,-1;topology_t \"topology_t\" true true false 100
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,topology_t,-1,-1;statutory_ \"statutory_\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,statutory_,-1,-1;land_distr \"land_distr\" true true false 100
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,land_distr,-1,-1;titles \"titles\" true true false 80 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,titles,-1,-1;survey_are \"survey_are\" true true false 16
Double 4 15 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,survey_are,-1,-1;calc_area \"calc_area\" true true false 16
Double 4 15 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,calc_area,-1,-1;LRL_areaha \"LRL_areaha\" true true false 19
Double 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,LRL_areaha,-1,-1;Id_1 \"Id_1\" true true false 6 Long 0 6
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ES\\intensive_winter
_grazing_nzmg.shp,Id,-1,-1", "CONTAINS", "", "")

# Process: Spatial Join (2)
arcpy.SpatialJoin_analysis(nz-primary-parcels, winter_grazing-
ungrazed_nzmg, join_unknown, "JOIN_ONE_TO_ONE", "KEEP_COMMON", "Id_1
\"Id_1\" true true false 6 Long 0 6
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ES\\winter_grazing-
ungrazed_nzmg.shp,Id,-1,-1;id \"id\" true true false 10 Double 0 10
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,id,-1,-1;appellatio \"appellatio\" true true false 80 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,appellatio,-1,-1;affected_s \"affected_s\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,affected_s,-1,-1;parcel_int \"parcel_int\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,parcel_int,-1,-1;topology_t \"topology_t\" true true false 100
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,topology_t,-1,-1;statutory_ \"statutory_\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,statutory_,-1,-1;land_distr \"land_distr\" true true false 100
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,land_distr,-1,-1;titles \"titles\" true true false 80 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,titles,-1,-1;survey_are \"survey_are\" true true false 16
Double 4 15 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,survey_are,-1,-1;calc_area \"calc_area\" true true false 16
Double 4 15 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,calc_area,-1,-1;LRL_areaha \"LRL_areaha\" true true false 19
Double 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,LRL_areaha,-1,-1", "CONTAINS", "", "")

# Process: Spatial Join (5)
arcpy.SpatialJoin_analysis(nz-primary-parcels__2_,
intensive_winter_grazing-sheep_nzmg, join_sheep, "JOIN_ONE_TO_ONE",
"KEEP_COMMON", "id \"id\" true true false 10 Double 0 10
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,id,-1,-1;appellatio \"appellatio\" true true false 80 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,appellatio,-1,-1;affected_s \"affected_s\" true true false 80
```

```
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,affected_s,-1,-1;parcel_int \"parcel_int\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,parcel_int,-1,-1;topology_t \"topology_t\" true true false 100
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,topology_t,-1,-1;statutory_ \"statutory_\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,statutory_,-1,-1;land_distr \"land_distr\" true true false 100
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,land_distr,-1,-1;titles \"titles\" true true false 80 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,titles,-1,-1;survey_are \"survey_are\" true true false 16
Double 4 15 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,survey_are,-1,-1;calc_area \"calc_area\" true true false 16
Double 4 15 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,calc_area,-1,-1;LRL_areaha \"LRL_areaha\" true true false 19
Double 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,LRL_areaha,-1,-1;Id_1 \"Id_1\" true true false 6 Long 0 6
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ES\\intensive_winter
_grazing-sheep_nzmg.shp,Id,-1,-1", "CONTAINS", "", "")

# Process: Spatial Join (6)
arcpy.SpatialJoin_analysis(nz-primary-parcels__2_,
intensive_winter_grazing-deer2_nzmg, join_deer, "JOIN_ONE_TO_ONE",
"KEEP_COMMON", "id \"id\" true true false 10 Double 0 10
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,id,-1,-1;appellatio \"appellatio\" true true false 80 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
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Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,affected_s,-1,-1;parcel_int \"parcel_int\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,parcel_int,-1,-1;topology_t \"topology_t\" true true false 100
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,topology_t,-1,-1;statutory_ \"statutory_\" true true false 80
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,statutory_,-1,-1;land_distr \"land_distr\" true true false 100
Text 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
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,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,titles,-1,-1;survey_are \"survey_are\" true true false 16
Double 4 15 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,survey_are,-1,-1;calc_area \"calc_area\" true true false 16
Double 4 15 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,calc_area,-1,-1;LRL_areaha \"LRL_areaha\" true true false 19
Double 0 0 ,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\nz-primary-
parcels.shp,LRL_areaha,-1,-1;Id_1 \"Id_1\" true true false 6 Long 0 6
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ES\\intensive_winter
_grazing-deer2_nzmg.shp,Id,-1,-1", "CONTAINS", "", "")

# Process: Union
arcpy.Union_analysis("C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\la
nduse_clip #;C:\\Temp\\tmpGIS\\data.gdb\\Irrigation_Clip
#;C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\join_cows
#;C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\join_unknown
#;C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\join_sheep
#;C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb\\join_deer #",
landuse_Union, "ALL", "", "GAPS")

# Process: Clip (2)
```
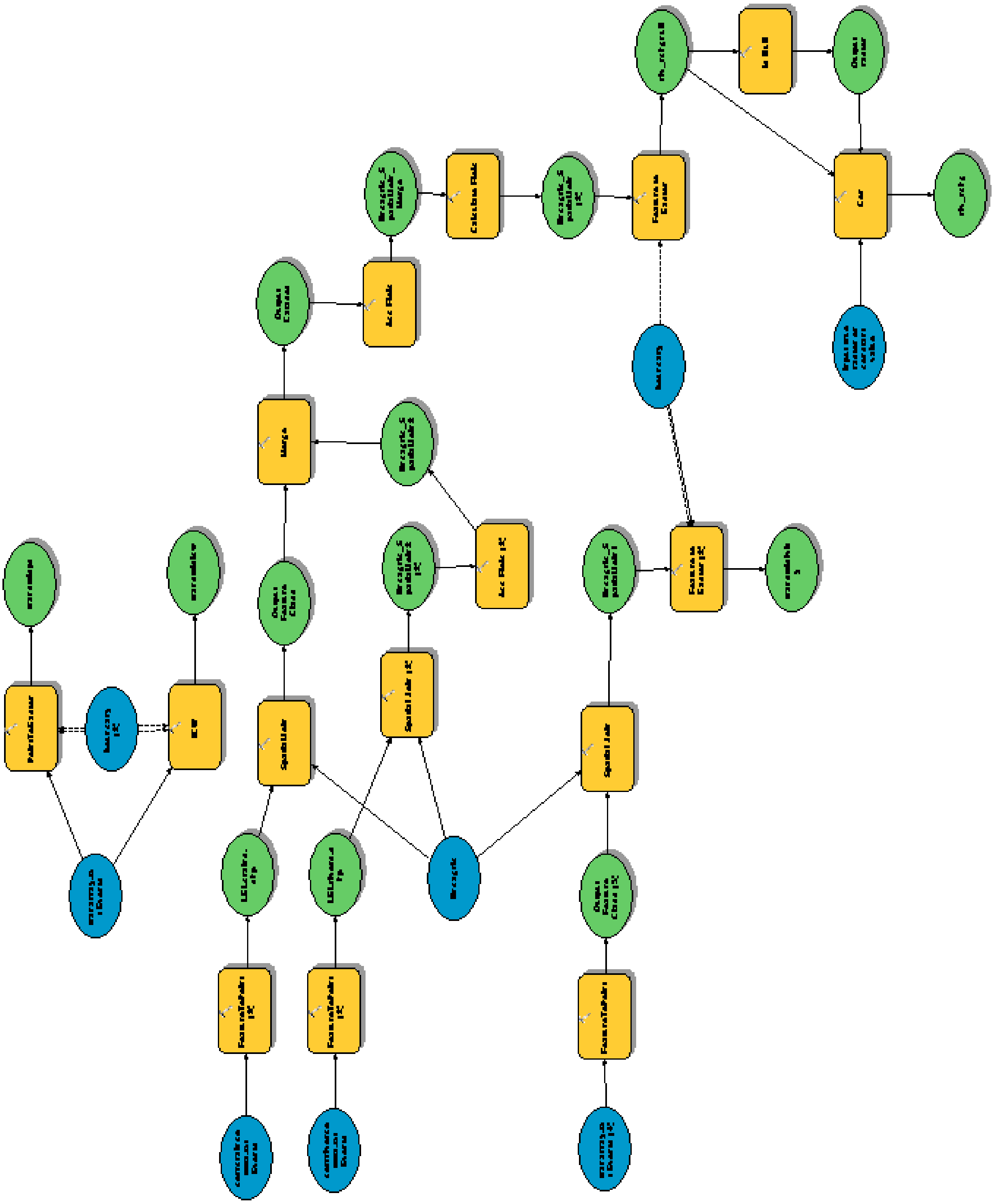

```
arcpy.Clip_analysis(landuse_Union, bcs_Dissolve2__2_, landuse_union_clip,
"")

# Process: Calculate Field
arcpy.CalculateField_management(landuse_union_clip, "Use_Final", "reclass(
!Use_Final!, !FID_Irrigation_Clip! , !FID_join_cows!, !FID_join_unknown!,
!FID_join_sheep!, !FID_join_deer! )", "PYTHON_9.3", "def reclass(lu, irrig,
cow,unknown,sheep,deer): \\n if (lu.find('High Producing') >= 0 and (cow >
-1 or unknown > -1)):\\n return 'Dairy Support'\\n else:\\n return lu")

# Process: Add Field
arcpy.AddField_management(landuse_union_clip__5_, "AqS_code", "TEXT", "",
"", "10", "", "NULLABLE", "NON_REQUIRED", "")

# Process: Add Field (2)
arcpy.AddField_management(landuse_union_clip__2_, "lu_scen", "LONG", "",
"", "", "", "NULLABLE", "NON_REQUIRED", "")

# Process: Calculate Field (2)
arcpy.CalculateField_management(landuse_union_clip__4_, "AqS_code",
"AqSclass( !Use_Final! , !FID_Irrigation_Clip! ,!FID_join_cows! ,
!FID_join_unknown! , !FID_join_sheep! , !FID_join_deer! ,!Stock_No! ,
!Hectares_1! )", "PYTHON_9.3", "def AqSclass(lu, irrig,
cow,unknown,sheep,deer,numcows, area ):\\n if (lu.find(\"Support\") >= 0
and irrig > -1):\\n return 'Gra1i'\\n elif (lu.find(\"Support\") >= 0 and
irrig == -1):\\n return 'Gra1'\\n elif (lu.find(\"Dairy\") >= 0 and
numcows/area <= 3.5 and (cow > 0 or unknown > 0)):\\n return 'Dai1'\\n elif
(lu.find(\"Dairy\") >= 0 and numcows/area<= 3.5) :\\n return 'Dai2'\\n elif
(lu.find(\"Dairy\") >= 0 and numcows/area> 3.5 and (cow > 0 or unknown >
0)):\\n return 'Dai5'\\n elif (lu.find(\"Dairy\") >= 0 and numcows/area>
3.5) :\\n return 'Dai3'\\n elif (lu.find(\"Cropping\") >= 0 and irrig == -1
and (cow > 0 or unknown > 0 or sheep > 0 or deer > 0)):\\n return 'Ara2'\\n
elif (lu.find(\"Cropping\") >= 0 and irrig > -1 and (cow > 0 or unknown > 0
or sheep > 0 or deer > 0)):\\n return 'Ara2i'\\n elif (lu.find(\"Crop\") >=
0 and irrig == -1 ):\\n return 'Ara3'\\n elif (lu.find(\"Crop\") >= 0 and
irrig > -1 ):\\n return 'Ara2i'\\n elif (lu.find(\"Tall Tussock\") >= 0
):\\n return 'Shp1'\\n elif (lu.find(\"Low Producing\") >= 0 ):\\n return
'Shp1'\\n elif (lu.find(\"High Producing\") >= 0 and irrig > -1 ):\\n
return 'Snb2i'\\n elif (lu.find(\"High Producing\") >= 0):\\n return
'Snb2'\\n elif (lu.find(\"River\") >= 0 or lu.find(\"Lake\") >= 0 or
lu.find(\"Freshwater\") >= 0 or lu.find(\"Mine\") >= 0):\\n return 'Msk'\\n
elif (lu.find(\"Pine\") >= 0 or lu.find(\"Exotic\") >= 0 or
lu.find(\"Harvested\") >= 0 or lu.find(\"Afforestation\") >= 0) :\\n return
'For1'\\n elif (lu.find(\"Shelterbelt\") >= 0 or lu.find(\"Hardwood\") >=
0) :\\n return 'For2'\\n elif (lu.find(\"Indigenous\") >= 0 ) :\\n return
'Nat'\\n elif (lu.find(\"Matagouri\") >= 0 or lu.find(\"Gorse\") >= 0 or
lu.find(\"Manuka\") >= 0 or lu.find(\"Scrub\") >= 0 ) :\\n return
'Scrub'\\n elif (lu.find(\"Built\") >= 0 or lu.find(\"Urban\") >= 0 ) :\\n
return 'Msk'\\n else:\\n return '?'")
```

Appendix 3 – Schematic and code for the 'Process modflow data' model



```
# ---------------------------------------------------------------------------
--
# process modflow data.py
# Created on: 2012-03-08 12:16:06.00000
# (generated by ArcGIS/ModelBuilder)
# Description:
# ---------------------------------------------------------------------------
--

# Set the necessary product code
# import arcinfo


# Import arcpy module
import arcpy

# Check out any necessary licenses
arcpy.CheckOutExtension("spatial")


# Local variables:
lindagrid = "lindagrid"
boundary = "boundary"
tranarray_txt_Events__4_ = "tranarray.txt Events"
corrrivercomma_txt_Events = "corrrivercomma.txt Events"
corrdraincomma_txt_Events = "corrdraincomma.txt Events"
tranarray_txt_Events = "tranarray.txt Events"
boundary__2_ = "boundary"
Input_true_raster_or_constant_value = "0"
transmispt = "C:\\projects\\irap\\AquiferSim\\Mataura\\transmispt"
transmisidw = "C:\\projects\\irap\\AquiferSim\\Mataura\\transmisidw"
LRLdrains_shp =
"C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLdrains.shp"
Output_Feature_Class =
"C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spat
ialJoin"
Output_Dataset =
"C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spat
ialJoin_Merge"
lindagrid_SpatialJoin_Merge =
"C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spat
ialJoin_Merge"
Output_Feature_Class__5_ =
"C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLtrans.shp"
lindagrid_SpatialJoin1 =
"C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spat
ialJoin1"
LRLrivers_shp =
"C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLrivers.shp"
lindagrid_SpatialJoin2__2_ =
"C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spat
ialJoin2"
lindagrid_SpatialJoin__2_ =
"C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spat
ialJoin_Merge"
riv_rchgnull = "C:\\projects\\irap\\AquiferSim\\Mataura\\riv_rchgnull"
transmisivity = "C:\\projects\\irap\\AquiferSim\\Mataura\\transmisivity"
Output_raster =
"C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\IsNull_riv_r1"
riv_rchg = "C:\\projects\\irap\\AquiferSim\\Mataura\\riv_rchg"
```

```
# Process: PointToRaster
tempEnvironment0 = arcpy.env.newPrecision
arcpy.env.newPrecision = "SINGLE"
tempEnvironment1 = arcpy.env.autoCommit
arcpy.env.autoCommit = "1000"
tempEnvironment2 = arcpy.env.XYResolution
arcpy.env.XYResolution = ""
tempEnvironment3 = arcpy.env.XYDomain
arcpy.env.XYDomain = ""
tempEnvironment4 = arcpy.env.scratchWorkspace
arcpy.env.scratchWorkspace =
"C:\\projects\\irap\\AquiferSim\\Mataura\\Temp"
tempEnvironment5 = arcpy.env.terrainMemoryUsage
arcpy.env.terrainMemoryUsage = "false"
tempEnvironment6 = arcpy.env.MTolerance
arcpy.env.MTolerance = ""
tempEnvironment7 = arcpy.env.compression
arcpy.env.compression = "LZ77"
tempEnvironment8 = arcpy.env.coincidentPoints
arcpy.env.coincidentPoints = "MEAN"
tempEnvironment9 = arcpy.env.randomGenerator
arcpy.env.randomGenerator = "0 ACM599"
tempEnvironment10 = arcpy.env.outputCoordinateSystem
arcpy.env.outputCoordinateSystem = ""
tempEnvironment11 = arcpy.env.rasterStatistics
arcpy.env.rasterStatistics = "STATISTICS 1 1"
tempEnvironment12 = arcpy.env.ZDomain
arcpy.env.ZDomain = ""
tempEnvironment13 = arcpy.env.snapRaster
arcpy.env.snapRaster = ""
tempEnvironment14 = arcpy.env.projectCompare
arcpy.env.projectCompare = "NONE"
tempEnvironment15 = arcpy.env.cartographicCoordinateSystem
arcpy.env.cartographicCoordinateSystem = ""
tempEnvironment16 = arcpy.env.configKeyword
arcpy.env.configKeyword = ""
tempEnvironment17 = arcpy.env.outputZFlag
arcpy.env.outputZFlag = "Same As Input"
tempEnvironment18 = arcpy.env.qualifiedFieldNames
arcpy.env.qualifiedFieldNames = "true"
tempEnvironment19 = arcpy.env.tileSize
arcpy.env.tileSize = "128 128"
tempEnvironment20 = arcpy.env.pyramid
arcpy.env.pyramid = "PYRAMIDS -1 NEAREST DEFAULT 75"
tempEnvironment21 = arcpy.env.referenceScale
arcpy.env.referenceScale = ""
tempEnvironment22 = arcpy.env.extent
arcpy.env.extent = "boundary"
tempEnvironment23 = arcpy.env.XYTolerance
arcpy.env.XYTolerance = ""
tempEnvironment24 = arcpy.env.tinSaveVersion
arcpy.env.tinSaveVersion = "CURRENT"
tempEnvironment25 = arcpy.env.MDomain
arcpy.env.MDomain = ""
tempEnvironment26 = arcpy.env.spatialGrid1
arcpy.env.spatialGrid1 = "0"
tempEnvironment27 = arcpy.env.cellSize
arcpy.env.cellSize = "MAXOF"
tempEnvironment28 = arcpy.env.outputZValue
arcpy.env.outputZValue = ""
tempEnvironment29 = arcpy.env.outputMFlag
```

```
arcpy.env.outputMFlag = "Same As Input"
tempEnvironment30 = arcpy.env.geographicTransformations
arcpy.env.geographicTransformations = ""
tempEnvironment31 = arcpy.env.spatialGrid2
arcpy.env.spatialGrid2 = "0"
tempEnvironment32 = arcpy.env.ZResolution
arcpy.env.ZResolution = ""
tempEnvironment33 = arcpy.env.mask
arcpy.env.mask = ""
tempEnvironment34 = arcpy.env.spatialGrid3
arcpy.env.spatialGrid3 = "0"
tempEnvironment35 = arcpy.env.maintainSpatialIndex
arcpy.env.maintainSpatialIndex = "false"
tempEnvironment36 = arcpy.env.workspace
arcpy.env.workspace = "C:\\projects\\irap\\AquiferSim\\Mataura"
tempEnvironment37 = arcpy.env.MResolution
arcpy.env.MResolution = ""
tempEnvironment38 = arcpy.env.derivedPrecision
arcpy.env.derivedPrecision = "HIGHEST"
tempEnvironment39 = arcpy.env.ZTolerance
arcpy.env.ZTolerance = ""
arcpy.PointToRaster_conversion(tranarray_txt_Events, "z", transmispt,
"MEAN", "NONE", boundary__2_)
arcpy.env.newPrecision = tempEnvironment0
arcpy.env.autoCommit = tempEnvironment1
arcpy.env.XYResolution = tempEnvironment2
arcpy.env.XYDomain = tempEnvironment3
arcpy.env.scratchWorkspace = tempEnvironment4
arcpy.env.terrainMemoryUsage = tempEnvironment5
arcpy.env.MTolerance = tempEnvironment6
arcpy.env.compression = tempEnvironment7
arcpy.env.coincidentPoints = tempEnvironment8
arcpy.env.randomGenerator = tempEnvironment9
arcpy.env.outputCoordinateSystem = tempEnvironment10
arcpy.env.rasterStatistics = tempEnvironment11
arcpy.env.ZDomain = tempEnvironment12
arcpy.env.snapRaster = tempEnvironment13
arcpy.env.projectCompare = tempEnvironment14
arcpy.env.cartographicCoordinateSystem = tempEnvironment15
arcpy.env.configKeyword = tempEnvironment16
arcpy.env.outputZFlag = tempEnvironment17
arcpy.env.qualifiedFieldNames = tempEnvironment18
arcpy.env.tileSize = tempEnvironment19
arcpy.env.pyramid = tempEnvironment20
arcpy.env.referenceScale = tempEnvironment21
arcpy.env.extent = tempEnvironment22
arcpy.env.XYTolerance = tempEnvironment23
arcpy.env.tinSaveVersion = tempEnvironment24
arcpy.env.MDomain = tempEnvironment25
arcpy.env.spatialGrid1 = tempEnvironment26
arcpy.env.cellSize = tempEnvironment27
arcpy.env.outputZValue = tempEnvironment28
arcpy.env.outputMFlag = tempEnvironment29
arcpy.env.geographicTransformations = tempEnvironment30
arcpy.env.spatialGrid2 = tempEnvironment31
arcpy.env.ZResolution = tempEnvironment32
arcpy.env.mask = tempEnvironment33
arcpy.env.spatialGrid3 = tempEnvironment34
arcpy.env.maintainSpatialIndex = tempEnvironment35
arcpy.env.workspace = tempEnvironment36
arcpy.env.MResolution = tempEnvironment37
```

```
arcpy.env.derivedPrecision = tempEnvironment38
arcpy.env.ZTolerance = tempEnvironment39

# Process: IDW
tempEnvironment0 = arcpy.env.extent
arcpy.env.extent = "boundary"
tempEnvironment1 = arcpy.env.cellSize
arcpy.env.cellSize = "boundary"
arcpy.gp.Idw_sa(tranarray_txt_Events, "z", transmisidw, "50", "2",
"VARIABLE 12", "")
arcpy.env.extent = tempEnvironment0
arcpy.env.cellSize = tempEnvironment1

# Process: FeatureToPoint
tempEnvironment0 = arcpy.env.newPrecision
arcpy.env.newPrecision = "SINGLE"
tempEnvironment1 = arcpy.env.autoCommit
arcpy.env.autoCommit = "1000"
tempEnvironment2 = arcpy.env.XYResolution
arcpy.env.XYResolution = ""
tempEnvironment3 = arcpy.env.XYDomain
arcpy.env.XYDomain = ""
tempEnvironment4 = arcpy.env.scratchWorkspace
arcpy.env.scratchWorkspace =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb"
tempEnvironment5 = arcpy.env.terrainMemoryUsage
arcpy.env.terrainMemoryUsage = "false"
tempEnvironment6 = arcpy.env.MTolerance
arcpy.env.MTolerance = ""
tempEnvironment7 = arcpy.env.compression
arcpy.env.compression = "LZ77"
tempEnvironment8 = arcpy.env.coincidentPoints
arcpy.env.coincidentPoints = "MEAN"
tempEnvironment9 = arcpy.env.randomGenerator
arcpy.env.randomGenerator = "0 ACM599"
tempEnvironment10 = arcpy.env.outputCoordinateSystem
arcpy.env.outputCoordinateSystem = ""
tempEnvironment11 = arcpy.env.rasterStatistics
arcpy.env.rasterStatistics = "STATISTICS 1 1"
tempEnvironment12 = arcpy.env.ZDomain
arcpy.env.ZDomain = ""
tempEnvironment13 = arcpy.env.snapRaster
arcpy.env.snapRaster = ""
tempEnvironment14 = arcpy.env.projectCompare
arcpy.env.projectCompare = "NONE"
tempEnvironment15 = arcpy.env.cartographicCoordinateSystem
arcpy.env.cartographicCoordinateSystem = ""
tempEnvironment16 = arcpy.env.configKeyword
arcpy.env.configKeyword = ""
tempEnvironment17 = arcpy.env.outputZFlag
arcpy.env.outputZFlag = "Same As Input"
tempEnvironment18 = arcpy.env.qualifiedFieldNames
arcpy.env.qualifiedFieldNames = "true"
tempEnvironment19 = arcpy.env.tileSize
arcpy.env.tileSize = "128 128"
tempEnvironment20 = arcpy.env.pyramid
arcpy.env.pyramid = "PYRAMIDS -1 NEAREST DEFAULT 75"
tempEnvironment21 = arcpy.env.referenceScale
arcpy.env.referenceScale = ""
tempEnvironment22 = arcpy.env.extent
arcpy.env.extent = "DEFAULT"
```

```
tempEnvironment23 = arcpy.env.XYTolerance
arcpy.env.XYTolerance = ""
tempEnvironment24 = arcpy.env.tinSaveVersion
arcpy.env.tinSaveVersion = "CURRENT"
tempEnvironment25 = arcpy.env.MDomain
arcpy.env.MDomain = ""
tempEnvironment26 = arcpy.env.spatialGrid1
arcpy.env.spatialGrid1 = "0"
tempEnvironment27 = arcpy.env.cellSize
arcpy.env.cellSize = "MAXOF"
tempEnvironment28 = arcpy.env.outputZValue
arcpy.env.outputZValue = ""
tempEnvironment29 = arcpy.env.outputMFlag
arcpy.env.outputMFlag = "Same As Input"
tempEnvironment30 = arcpy.env.geographicTransformations
arcpy.env.geographicTransformations = ""
tempEnvironment31 = arcpy.env.spatialGrid2
arcpy.env.spatialGrid2 = "0"
tempEnvironment32 = arcpy.env.ZResolution
arcpy.env.ZResolution = ""
tempEnvironment33 = arcpy.env.mask
arcpy.env.mask = ""
tempEnvironment34 = arcpy.env.spatialGrid3
arcpy.env.spatialGrid3 = "0"
tempEnvironment35 = arcpy.env.maintainSpatialIndex
arcpy.env.maintainSpatialIndex = "false"
tempEnvironment36 = arcpy.env.workspace
arcpy.env.workspace = "C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb"
tempEnvironment37 = arcpy.env.MResolution
arcpy.env.MResolution = ""
tempEnvironment38 = arcpy.env.derivedPrecision
arcpy.env.derivedPrecision = "HIGHEST"
tempEnvironment39 = arcpy.env.ZTolerance
arcpy.env.ZTolerance = ""
arcpy.FeatureToPoint_management(tranarray_txt_Events__4_,
Output_Feature_Class__5_, "CENTROID")
arcpy.env.newPrecision = tempEnvironment0
arcpy.env.autoCommit = tempEnvironment1
arcpy.env.XYResolution = tempEnvironment2
arcpy.env.XYDomain = tempEnvironment3
arcpy.env.scratchWorkspace = tempEnvironment4
arcpy.env.terrainMemoryUsage = tempEnvironment5
arcpy.env.MTolerance = tempEnvironment6
arcpy.env.compression = tempEnvironment7
arcpy.env.coincidentPoints = tempEnvironment8
arcpy.env.randomGenerator = tempEnvironment9
arcpy.env.outputCoordinateSystem = tempEnvironment10
arcpy.env.rasterStatistics = tempEnvironment11
arcpy.env.ZDomain = tempEnvironment12
arcpy.env.snapRaster = tempEnvironment13
arcpy.env.projectCompare = tempEnvironment14
arcpy.env.cartographicCoordinateSystem = tempEnvironment15
arcpy.env.configKeyword = tempEnvironment16
arcpy.env.outputZFlag = tempEnvironment17
arcpy.env.qualifiedFieldNames = tempEnvironment18
arcpy.env.tileSize = tempEnvironment19
arcpy.env.pyramid = tempEnvironment20
arcpy.env.referenceScale = tempEnvironment21
arcpy.env.extent = tempEnvironment22
arcpy.env.XYTolerance = tempEnvironment23
arcpy.env.tinSaveVersion = tempEnvironment24
```

```
arcpy.env.MDomain = tempEnvironment25
arcpy.env.spatialGrid1 = tempEnvironment26
arcpy.env.cellSize = tempEnvironment27
arcpy.env.outputZValue = tempEnvironment28
arcpy.env.outputMFlag = tempEnvironment29
arcpy.env.geographicTransformations = tempEnvironment30
arcpy.env.spatialGrid2 = tempEnvironment31
arcpy.env.ZResolution = tempEnvironment32
arcpy.env.mask = tempEnvironment33
arcpy.env.spatialGrid3 = tempEnvironment34
arcpy.env.maintainSpatialIndex = tempEnvironment35
arcpy.env.workspace = tempEnvironment36
arcpy.env.MResolution = tempEnvironment37
arcpy.env.derivedPrecision = tempEnvironment38
arcpy.env.ZTolerance = tempEnvironment39

# Process: Spatial Join
arcpy.SpatialJoin_analysis(lindagrid, Output_Feature_Class__5_,
lindagrid_SpatialJoin1, "JOIN_ONE_TO_ONE", "KEEP_COMMON", "row \"row\" true
true false 4 Short 0 4
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,r
ow,-1,-1;column_ \"column_\" true true false 4 Short 0 4
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,c
olumn,-1,-1;delx \"delx\" true true false 16 Double 4 15
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,d
elx,-1,-1;dely \"dely\" true true false 16 Double 4 15
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,d
ely,-1,-1;area \"area\" true true false 20 Double 4 19
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,a
rea,-1,-1;x \"x\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLtrans.shp,x,
-1,-1;y \"y\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLtrans.shp,y,
-1,-1;z \"z\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLtrans.shp,z,
-1,-1;ORIG_FID \"ORIG_FID\" true true false 0 Long 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLtrans.shp,OR
IG_FID,-1,-1", "INTERSECT", "", "")

# Process: Feature to Raster (2)
tempEnvironment0 = arcpy.env.extent
arcpy.env.extent = "boundary"
arcpy.FeatureToRaster_conversion(lindagrid_SpatialJoin1, "z",
transmisivity, boundary)
arcpy.env.extent = tempEnvironment0

# Process: FeatureToPoint (3)
tempEnvironment0 = arcpy.env.newPrecision
arcpy.env.newPrecision = "SINGLE"
tempEnvironment1 = arcpy.env.autoCommit
arcpy.env.autoCommit = "1000"
tempEnvironment2 = arcpy.env.XYResolution
arcpy.env.XYResolution = ""
tempEnvironment3 = arcpy.env.XYDomain
arcpy.env.XYDomain = ""
tempEnvironment4 = arcpy.env.scratchWorkspace
arcpy.env.scratchWorkspace =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb"
tempEnvironment5 = arcpy.env.terrainMemoryUsage
arcpy.env.terrainMemoryUsage = "false"
tempEnvironment6 = arcpy.env.MTolerance
```

```
arcpy.env.MTolerance = ""
tempEnvironment7 = arcpy.env.compression
arcpy.env.compression = "LZ77"
tempEnvironment8 = arcpy.env.coincidentPoints
arcpy.env.coincidentPoints = "MEAN"
tempEnvironment9 = arcpy.env.randomGenerator
arcpy.env.randomGenerator = "0 ACM599"
tempEnvironment10 = arcpy.env.outputCoordinateSystem
arcpy.env.outputCoordinateSystem = ""
tempEnvironment11 = arcpy.env.rasterStatistics
arcpy.env.rasterStatistics = "STATISTICS 1 1"
tempEnvironment12 = arcpy.env.ZDomain
arcpy.env.ZDomain = ""
tempEnvironment13 = arcpy.env.snapRaster
arcpy.env.snapRaster = ""
tempEnvironment14 = arcpy.env.projectCompare
arcpy.env.projectCompare = "NONE"
tempEnvironment15 = arcpy.env.cartographicCoordinateSystem
arcpy.env.cartographicCoordinateSystem = ""
tempEnvironment16 = arcpy.env.configKeyword
arcpy.env.configKeyword = ""
tempEnvironment17 = arcpy.env.outputZFlag
arcpy.env.outputZFlag = "Same As Input"
tempEnvironment18 = arcpy.env.qualifiedFieldNames
arcpy.env.qualifiedFieldNames = "true"
tempEnvironment19 = arcpy.env.tileSize
arcpy.env.tileSize = "128 128"
tempEnvironment20 = arcpy.env.pyramid
arcpy.env.pyramid = "PYRAMIDS -1 NEAREST DEFAULT 75"
tempEnvironment21 = arcpy.env.referenceScale
arcpy.env.referenceScale = ""
tempEnvironment22 = arcpy.env.extent
arcpy.env.extent = "DEFAULT"
tempEnvironment23 = arcpy.env.XYTolerance
arcpy.env.XYTolerance = ""
tempEnvironment24 = arcpy.env.tinSaveVersion
arcpy.env.tinSaveVersion = "CURRENT"
tempEnvironment25 = arcpy.env.MDomain
arcpy.env.MDomain = ""
tempEnvironment26 = arcpy.env.spatialGrid1
arcpy.env.spatialGrid1 = "0"
tempEnvironment27 = arcpy.env.cellSize
arcpy.env.cellSize = "MAXOF"
tempEnvironment28 = arcpy.env.outputZValue
arcpy.env.outputZValue = ""
tempEnvironment29 = arcpy.env.outputMFlag
arcpy.env.outputMFlag = "Same As Input"
tempEnvironment30 = arcpy.env.geographicTransformations
arcpy.env.geographicTransformations = ""
tempEnvironment31 = arcpy.env.spatialGrid2
arcpy.env.spatialGrid2 = "0"
tempEnvironment32 = arcpy.env.ZResolution
arcpy.env.ZResolution = ""
tempEnvironment33 = arcpy.env.mask
arcpy.env.mask = ""
tempEnvironment34 = arcpy.env.spatialGrid3
arcpy.env.spatialGrid3 = "0"
tempEnvironment35 = arcpy.env.maintainSpatialIndex
arcpy.env.maintainSpatialIndex = "false"
tempEnvironment36 = arcpy.env.workspace
arcpy.env.workspace = "C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb"
```

```
tempEnvironment37 = arcpy.env.MResolution
arcpy.env.MResolution = ""
tempEnvironment38 = arcpy.env.derivedPrecision
arcpy.env.derivedPrecision = "HIGHEST"
tempEnvironment39 = arcpy.env.ZTolerance
arcpy.env.ZTolerance = ""
arcpy.FeatureToPoint_management(corrdraincomma_txt_Events, LRLdrains_shp,
"CENTROID")
arcpy.env.newPrecision = tempEnvironment0
arcpy.env.autoCommit = tempEnvironment1
arcpy.env.XYResolution = tempEnvironment2
arcpy.env.XYDomain = tempEnvironment3
arcpy.env.scratchWorkspace = tempEnvironment4
arcpy.env.terrainMemoryUsage = tempEnvironment5
arcpy.env.MTolerance = tempEnvironment6
arcpy.env.compression = tempEnvironment7
arcpy.env.coincidentPoints = tempEnvironment8
arcpy.env.randomGenerator = tempEnvironment9
arcpy.env.outputCoordinateSystem = tempEnvironment10
arcpy.env.rasterStatistics = tempEnvironment11
arcpy.env.ZDomain = tempEnvironment12
arcpy.env.snapRaster = tempEnvironment13
arcpy.env.projectCompare = tempEnvironment14
arcpy.env.cartographicCoordinateSystem = tempEnvironment15
arcpy.env.configKeyword = tempEnvironment16
arcpy.env.outputZFlag = tempEnvironment17
arcpy.env.qualifiedFieldNames = tempEnvironment18
arcpy.env.tileSize = tempEnvironment19
arcpy.env.pyramid = tempEnvironment20
arcpy.env.referenceScale = tempEnvironment21
arcpy.env.extent = tempEnvironment22
arcpy.env.XYTolerance = tempEnvironment23
arcpy.env.tinSaveVersion = tempEnvironment24
arcpy.env.MDomain = tempEnvironment25
arcpy.env.spatialGrid1 = tempEnvironment26
arcpy.env.cellSize = tempEnvironment27
arcpy.env.outputZValue = tempEnvironment28
arcpy.env.outputMFlag = tempEnvironment29
arcpy.env.geographicTransformations = tempEnvironment30
arcpy.env.spatialGrid2 = tempEnvironment31
arcpy.env.ZResolution = tempEnvironment32
arcpy.env.mask = tempEnvironment33
arcpy.env.spatialGrid3 = tempEnvironment34
arcpy.env.maintainSpatialIndex = tempEnvironment35
arcpy.env.workspace = tempEnvironment36
arcpy.env.MResolution = tempEnvironment37
arcpy.env.derivedPrecision = tempEnvironment38
arcpy.env.ZTolerance = tempEnvironment39

# Process: SpatialJoin
tempEnvironment0 = arcpy.env.newPrecision
arcpy.env.newPrecision = "SINGLE"
tempEnvironment1 = arcpy.env.autoCommit
arcpy.env.autoCommit = "1000"
tempEnvironment2 = arcpy.env.XYResolution
arcpy.env.XYResolution = ""
tempEnvironment3 = arcpy.env.XYDomain
arcpy.env.XYDomain = ""
tempEnvironment4 = arcpy.env.scratchWorkspace
arcpy.env.scratchWorkspace =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb"
```

```
tempEnvironment5 = arcpy.env.terrainMemoryUsage
arcpy.env.terrainMemoryUsage = "false"
tempEnvironment6 = arcpy.env.MTolerance
arcpy.env.MTolerance = ""
tempEnvironment7 = arcpy.env.compression
arcpy.env.compression = "LZ77"
tempEnvironment8 = arcpy.env.coincidentPoints
arcpy.env.coincidentPoints = "MEAN"
tempEnvironment9 = arcpy.env.randomGenerator
arcpy.env.randomGenerator = "0 ACM599"
tempEnvironment10 = arcpy.env.outputCoordinateSystem
arcpy.env.outputCoordinateSystem = ""
tempEnvironment11 = arcpy.env.rasterStatistics
arcpy.env.rasterStatistics = "STATISTICS 1 1"
tempEnvironment12 = arcpy.env.ZDomain
arcpy.env.ZDomain = ""
tempEnvironment13 = arcpy.env.snapRaster
arcpy.env.snapRaster = ""
tempEnvironment14 = arcpy.env.projectCompare
arcpy.env.projectCompare = "NONE"
tempEnvironment15 = arcpy.env.cartographicCoordinateSystem
arcpy.env.cartographicCoordinateSystem = ""
tempEnvironment16 = arcpy.env.configKeyword
arcpy.env.configKeyword = ""
tempEnvironment17 = arcpy.env.outputZFlag
arcpy.env.outputZFlag = "Same As Input"
tempEnvironment18 = arcpy.env.qualifiedFieldNames
arcpy.env.qualifiedFieldNames = "true"
tempEnvironment19 = arcpy.env.tileSize
arcpy.env.tileSize = "128 128"
tempEnvironment20 = arcpy.env.pyramid
arcpy.env.pyramid = "PYRAMIDS -1 NEAREST DEFAULT 75"
tempEnvironment21 = arcpy.env.referenceScale
arcpy.env.referenceScale = ""
tempEnvironment22 = arcpy.env.extent
arcpy.env.extent = "DEFAULT"
tempEnvironment23 = arcpy.env.XYTolerance
arcpy.env.XYTolerance = ""
tempEnvironment24 = arcpy.env.tinSaveVersion
arcpy.env.tinSaveVersion = "CURRENT"
tempEnvironment25 = arcpy.env.MDomain
arcpy.env.MDomain = ""
tempEnvironment26 = arcpy.env.spatialGrid1
arcpy.env.spatialGrid1 = "0"
tempEnvironment27 = arcpy.env.cellSize
arcpy.env.cellSize = "MAXOF"
tempEnvironment28 = arcpy.env.outputZValue
arcpy.env.outputZValue = ""
tempEnvironment29 = arcpy.env.outputMFlag
arcpy.env.outputMFlag = "Same As Input"
tempEnvironment30 = arcpy.env.geographicTransformations
arcpy.env.geographicTransformations = ""
tempEnvironment31 = arcpy.env.spatialGrid2
arcpy.env.spatialGrid2 = "0"
tempEnvironment32 = arcpy.env.ZResolution
arcpy.env.ZResolution = ""
tempEnvironment33 = arcpy.env.mask
arcpy.env.mask = ""
tempEnvironment34 = arcpy.env.spatialGrid3
arcpy.env.spatialGrid3 = "0"
tempEnvironment35 = arcpy.env.maintainSpatialIndex
```

```
arcpy.env.maintainSpatialIndex = "false"
tempEnvironment36 = arcpy.env.workspace
arcpy.env.workspace = "C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb"
tempEnvironment37 = arcpy.env.MResolution
arcpy.env.MResolution = ""
tempEnvironment38 = arcpy.env.derivedPrecision
arcpy.env.derivedPrecision = "HIGHEST"
tempEnvironment39 = arcpy.env.ZTolerance
arcpy.env.ZTolerance = ""
arcpy.SpatialJoin_analysis(lindagrid, LRLdrains_shp, Output_Feature_Class,
"JOIN_ONE_TO_ONE", "KEEP_COMMON", "row \"row\" true true false 4 Short 0 4
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,r
ow,-1,-1;column_ \"column_\" true true false 4 Short 0 4
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,c
olumn,-1,-1;delx \"delx\" true true false 16 Double 4 15
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,d
elx,-1,-1;dely \"dely\" true true false 16 Double 4 15
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,d
ely,-1,-1;area \"area\" true true false 20 Double 4 19
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,a
rea,-1,-1;x \"x\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLdrains.shp,x
,-1,-1;y \"y\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLdrains.shp,y
,-1,-1;zone \"zone\" true true false 4 Long 0 10
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLdrains.shp,z
one,-1,-1;flux \"flux\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLdrains.shp,f
lux,-1,-1;name \"name\" true true false 255 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLdrains.shp,n
ame,-1,-1;ORIG_FID \"ORIG_FID\" true true false 0 Long 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLdrains.shp,O
RIG_FID,-1,-1", "INTERSECT", "", "")
arcpy.env.newPrecision = tempEnvironment0
arcpy.env.autoCommit = tempEnvironment1
arcpy.env.XYResolution = tempEnvironment2
arcpy.env.XYDomain = tempEnvironment3
arcpy.env.scratchWorkspace = tempEnvironment4
arcpy.env.terrainMemoryUsage = tempEnvironment5
arcpy.env.MTolerance = tempEnvironment6
arcpy.env.compression = tempEnvironment7
arcpy.env.coincidentPoints = tempEnvironment8
arcpy.env.randomGenerator = tempEnvironment9
arcpy.env.outputCoordinateSystem = tempEnvironment10
arcpy.env.rasterStatistics = tempEnvironment11
arcpy.env.ZDomain = tempEnvironment12
arcpy.env.snapRaster = tempEnvironment13
arcpy.env.projectCompare = tempEnvironment14
arcpy.env.cartographicCoordinateSystem = tempEnvironment15
arcpy.env.configKeyword = tempEnvironment16
arcpy.env.outputZFlag = tempEnvironment17
arcpy.env.qualifiedFieldNames = tempEnvironment18
arcpy.env.tileSize = tempEnvironment19
arcpy.env.pyramid = tempEnvironment20
arcpy.env.referenceScale = tempEnvironment21
arcpy.env.extent = tempEnvironment22
arcpy.env.XYTolerance = tempEnvironment23
arcpy.env.tinSaveVersion = tempEnvironment24
arcpy.env.MDomain = tempEnvironment25
arcpy.env.spatialGrid1 = tempEnvironment26
arcpy.env.cellSize = tempEnvironment27
```

```
arcpy.env.outputZValue = tempEnvironment28
arcpy.env.outputMFlag = tempEnvironment29
arcpy.env.geographicTransformations = tempEnvironment30
arcpy.env.spatialGrid2 = tempEnvironment31
arcpy.env.ZResolution = tempEnvironment32
arcpy.env.mask = tempEnvironment33
arcpy.env.spatialGrid3 = tempEnvironment34
arcpy.env.maintainSpatialIndex = tempEnvironment35
arcpy.env.workspace = tempEnvironment36
arcpy.env.MResolution = tempEnvironment37
arcpy.env.derivedPrecision = tempEnvironment38
arcpy.env.ZTolerance = tempEnvironment39

# Process: FeatureToPoint (2)
tempEnvironment0 = arcpy.env.newPrecision
arcpy.env.newPrecision = "SINGLE"
tempEnvironment1 = arcpy.env.autoCommit
arcpy.env.autoCommit = "1000"
tempEnvironment2 = arcpy.env.XYResolution
arcpy.env.XYResolution = ""
tempEnvironment3 = arcpy.env.XYDomain
arcpy.env.XYDomain = ""
tempEnvironment4 = arcpy.env.scratchWorkspace
arcpy.env.scratchWorkspace =
"C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb"
tempEnvironment5 = arcpy.env.terrainMemoryUsage
arcpy.env.terrainMemoryUsage = "false"
tempEnvironment6 = arcpy.env.MTolerance
arcpy.env.MTolerance = ""
tempEnvironment7 = arcpy.env.compression
arcpy.env.compression = "LZ77"
tempEnvironment8 = arcpy.env.coincidentPoints
arcpy.env.coincidentPoints = "MEAN"
tempEnvironment9 = arcpy.env.randomGenerator
arcpy.env.randomGenerator = "0 ACM599"
tempEnvironment10 = arcpy.env.outputCoordinateSystem
arcpy.env.outputCoordinateSystem = ""
tempEnvironment11 = arcpy.env.rasterStatistics
arcpy.env.rasterStatistics = "STATISTICS 1 1"
tempEnvironment12 = arcpy.env.ZDomain
arcpy.env.ZDomain = ""
tempEnvironment13 = arcpy.env.snapRaster
arcpy.env.snapRaster = ""
tempEnvironment14 = arcpy.env.projectCompare
arcpy.env.projectCompare = "NONE"
tempEnvironment15 = arcpy.env.cartographicCoordinateSystem
arcpy.env.cartographicCoordinateSystem = ""
tempEnvironment16 = arcpy.env.configKeyword
arcpy.env.configKeyword = ""
tempEnvironment17 = arcpy.env.outputZFlag
arcpy.env.outputZFlag = "Same As Input"
tempEnvironment18 = arcpy.env.qualifiedFieldNames
arcpy.env.qualifiedFieldNames = "true"
tempEnvironment19 = arcpy.env.tileSize
arcpy.env.tileSize = "128 128"
tempEnvironment20 = arcpy.env.pyramid
arcpy.env.pyramid = "PYRAMIDS -1 NEAREST DEFAULT 75"
tempEnvironment21 = arcpy.env.referenceScale
arcpy.env.referenceScale = ""
tempEnvironment22 = arcpy.env.extent
arcpy.env.extent = "DEFAULT"
```

```
tempEnvironment23 = arcpy.env.XYTolerance
arcpy.env.XYTolerance = ""
tempEnvironment24 = arcpy.env.tinSaveVersion
arcpy.env.tinSaveVersion = "CURRENT"
tempEnvironment25 = arcpy.env.MDomain
arcpy.env.MDomain = ""
tempEnvironment26 = arcpy.env.spatialGrid1
arcpy.env.spatialGrid1 = "0"
tempEnvironment27 = arcpy.env.cellSize
arcpy.env.cellSize = "MAXOF"
tempEnvironment28 = arcpy.env.outputZValue
arcpy.env.outputZValue = ""
tempEnvironment29 = arcpy.env.outputMFlag
arcpy.env.outputMFlag = "Same As Input"
tempEnvironment30 = arcpy.env.geographicTransformations
arcpy.env.geographicTransformations = ""
tempEnvironment31 = arcpy.env.spatialGrid2
arcpy.env.spatialGrid2 = "0"
tempEnvironment32 = arcpy.env.ZResolution
arcpy.env.ZResolution = ""
tempEnvironment33 = arcpy.env.mask
arcpy.env.mask = ""
tempEnvironment34 = arcpy.env.spatialGrid3
arcpy.env.spatialGrid3 = "0"
tempEnvironment35 = arcpy.env.maintainSpatialIndex
arcpy.env.maintainSpatialIndex = "false"
tempEnvironment36 = arcpy.env.workspace
arcpy.env.workspace = "C:\\projects\\irap\\AquiferSim\\Mataura\\data.gdb"
tempEnvironment37 = arcpy.env.MResolution
arcpy.env.MResolution = ""
tempEnvironment38 = arcpy.env.derivedPrecision
arcpy.env.derivedPrecision = "HIGHEST"
tempEnvironment39 = arcpy.env.ZTolerance
arcpy.env.ZTolerance = ""
arcpy.FeatureToPoint_management(corrrivercomma_txt_Events, LRLrivers_shp,
"CENTROID")
arcpy.env.newPrecision = tempEnvironment0
arcpy.env.autoCommit = tempEnvironment1
arcpy.env.XYResolution = tempEnvironment2
arcpy.env.XYDomain = tempEnvironment3
arcpy.env.scratchWorkspace = tempEnvironment4
arcpy.env.terrainMemoryUsage = tempEnvironment5
arcpy.env.MTolerance = tempEnvironment6
arcpy.env.compression = tempEnvironment7
arcpy.env.coincidentPoints = tempEnvironment8
arcpy.env.randomGenerator = tempEnvironment9
arcpy.env.outputCoordinateSystem = tempEnvironment10
arcpy.env.rasterStatistics = tempEnvironment11
arcpy.env.ZDomain = tempEnvironment12
arcpy.env.snapRaster = tempEnvironment13
arcpy.env.projectCompare = tempEnvironment14
arcpy.env.cartographicCoordinateSystem = tempEnvironment15
arcpy.env.configKeyword = tempEnvironment16
arcpy.env.outputZFlag = tempEnvironment17
arcpy.env.qualifiedFieldNames = tempEnvironment18
arcpy.env.tileSize = tempEnvironment19
arcpy.env.pyramid = tempEnvironment20
arcpy.env.referenceScale = tempEnvironment21
arcpy.env.extent = tempEnvironment22
arcpy.env.XYTolerance = tempEnvironment23
arcpy.env.tinSaveVersion = tempEnvironment24
```

```
arcpy.env.MDomain = tempEnvironment25
arcpy.env.spatialGrid1 = tempEnvironment26
arcpy.env.cellSize = tempEnvironment27
arcpy.env.outputZValue = tempEnvironment28
arcpy.env.outputMFlag = tempEnvironment29
arcpy.env.geographicTransformations = tempEnvironment30
arcpy.env.spatialGrid2 = tempEnvironment31
arcpy.env.ZResolution = tempEnvironment32
arcpy.env.mask = tempEnvironment33
arcpy.env.spatialGrid3 = tempEnvironment34
arcpy.env.maintainSpatialIndex = tempEnvironment35
arcpy.env.workspace = tempEnvironment36
arcpy.env.MResolution = tempEnvironment37
arcpy.env.derivedPrecision = tempEnvironment38
arcpy.env.ZTolerance = tempEnvironment39

# Process: Spatial Join (2)
arcpy.SpatialJoin_analysis(lindagrid, LRLrivers_shp,
lindagrid_SpatialJoin2__2_, "JOIN_ONE_TO_ONE", "KEEP_COMMON", "row \"row\"
true true false 4 Short 0 4
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,r
ow,-1,-1;column_ \"column_\" true true false 4 Short 0 4
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,c
olumn,-1,-1;delx \"delx\" true true false 16 Double 4 15
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,d
elx,-1,-1;dely \"dely\" true true false 16 Double 4 15
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,d
ely,-1,-1;area \"area\" true true false 20 Double 4 19
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\lindagrid.shp,a
rea,-1,-1;x \"x\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLrivers.shp,x
,-1,-1;y \"y\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLrivers.shp,y
,-1,-1;zone \"zone\" true true false 4 Long 0 10
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLrivers.shp,z
one,-1,-1;flux \"flux\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLrivers.shp,f
lux,-1,-1;ORIG_FID \"ORIG_FID\" true true false 0 Long 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\from_ESR\\LRLrivers.shp,O
RIG_FID,-1,-1", "INTERSECT", "", "")

# Process: Add Field (2)
arcpy.AddField_management(lindagrid_SpatialJoin2__2_, "name", "TEXT", "",
"", "255", "", "NULLABLE", "NON_REQUIRED", "")

# Process: Merge
arcpy.Merge_management("C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Defa
ult.gdb\\lindagrid_SpatialJoin;C:\\projects\\irap\\AquiferSim\\Mataura\\Tem
p\\Default.gdb\\lindagrid_SpatialJoin2", Output_Dataset, "Join_Count
\"Join_Count\" true true false 0 Long 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,Join_Count,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,Join_Count,-1,-1;TARGET_FID \"TARGET_FID\" true true false 0 Long
0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,TARGET_FID,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,TARGET_FID,-1,-1;row \"row\" true true false 4 Short 0 4
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,row,-1,-
```

```
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,row,-1,-1;column_ \"column_\" true true false 4 Short 0 4
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,column_,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,column_,-1,-1;delx \"delx\" true true false 16 Double 4 15
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,delx,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,delx,-1,-1;dely \"dely\" true true false 16 Double 4 15
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,dely,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,dely,-1,-1;area \"area\" true true false 20 Double 4 19
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,area,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,area,-1,-1;x \"x\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,x,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,x,-1,-1;y \"y\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,y,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,y,-1,-1;zone \"zone\" true true false 4 Long 0 10
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,zone,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,zone,-1,-1;flux \"flux\" true true false 8 Double 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,flux,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,flux,-1,-1;name \"name\" true true false 255 Text 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,name,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,name,-1,-1;ORIG_FID \"ORIG_FID\" true true false 0 Long 0 0
,First,#,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindag
rid_SpatialJoin,ORIG_FID,-1,-
1,C:\\projects\\irap\\AquiferSim\\Mataura\\Temp\\Default.gdb\\lindagrid_Spa
tialJoin2,ORIG_FID,-1,-1")

# Process: Add Field
arcpy.AddField_management(Output_Dataset, "realflux", "DOUBLE", "", "", "",
"", "NULLABLE", "NON_REQUIRED", "")

# Process: Calculate Field
arcpy.CalculateField_management(lindagrid_SpatialJoin_Merge, "realflux",
"[flux] * 365 / 40000", "VB", "")

# Process: Feature to Raster
tempEnvironment0 = arcpy.env.extent
arcpy.env.extent = "boundary"
arcpy.FeatureToRaster_conversion(lindagrid_SpatialJoin__2_, "realflux",
riv_rchgnull, boundary)
arcpy.env.extent = tempEnvironment0

# Process: Is Null
arcpy.gp.IsNull_sa(riv_rchgnull, Output_raster)
```

```
# Process: Con
arcpy.gp.Con_sa(Output_raster, Input_true_raster_or_constant_value,
riv_rchg, riv_rchgnull, "VALUE = 1")
```