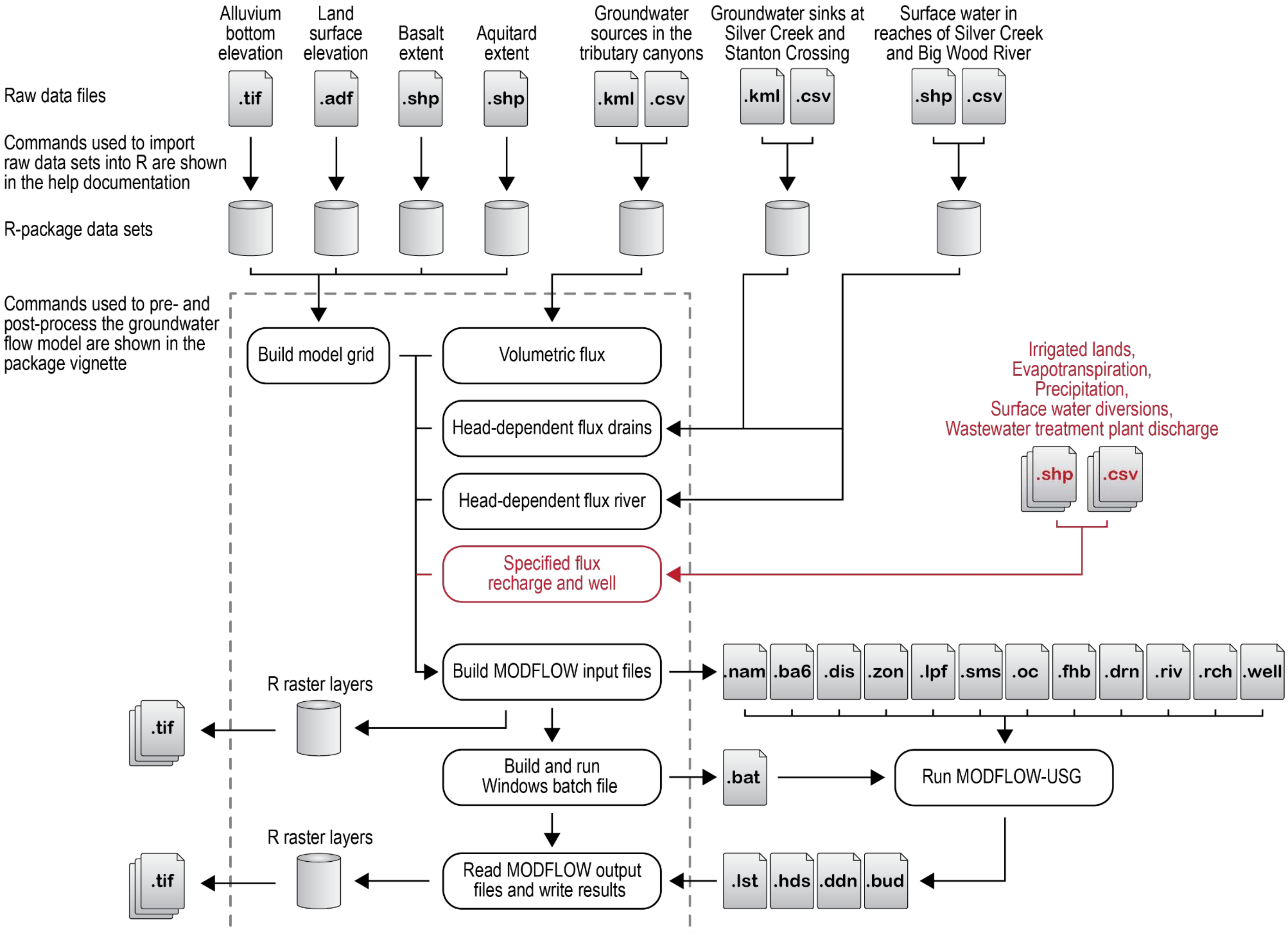
Wood River Valley
Model Process Flow Diagrams

Jason C. Fisher

U.S. Geological Survey
Idaho Department of Water Resources

PROVISIONAL: FOR INFORMATIONAL PURPOSES ONLY

These slides were presented at the Wood River Valley Modeling Technical Advisory Committee meeting Thursday, 06Feb2014, 10am-4pm at the Community Campus, Rm 200, in Hailey. Taken outside the context of the original presentation, these slides may not provide a complete or accurate representation of the speaker’s intent.


Alluvium bottom elevation
Land surface elevation
Basalt extent
Aquitard extent
Groundwater sources in the tributary canyons
Groundwater sinks at Silver Creek and Stanton Crossing
Surface water in reaches of Silver Creek and Big Wood River
Raw data files
.tif
.adf
.shp
.shp
.kml
.csv
.kml
.csv
.shp
.csv
Commands used to import raw data sets into R are shown in the help documentation
R-package data sets
Commands used to pre- and post-process the groundwater flow model are shown in the package vignette
Build model grid
Volumetric flux
Head-dependent flux drains
Head-dependent flux river
Specified flux recharge and well
Irrigated lands, Evapotranspiration, Precipitation, Surface water diversions, Wastewater treatment plant discharge
.shp
.csv
Build MODFLOW input files
.nam
.ba6
.dis
.zon
.lpf
.sms
.oc
.fhb
.drn
.riv
.rch
.well
R raster layers
.tif
Build and run Windows batch file
.bat
Run MODFLOW-USG
R raster layers
.tif
Read MODFLOW output files and write results
.lst
.hds
.ddn
.bud

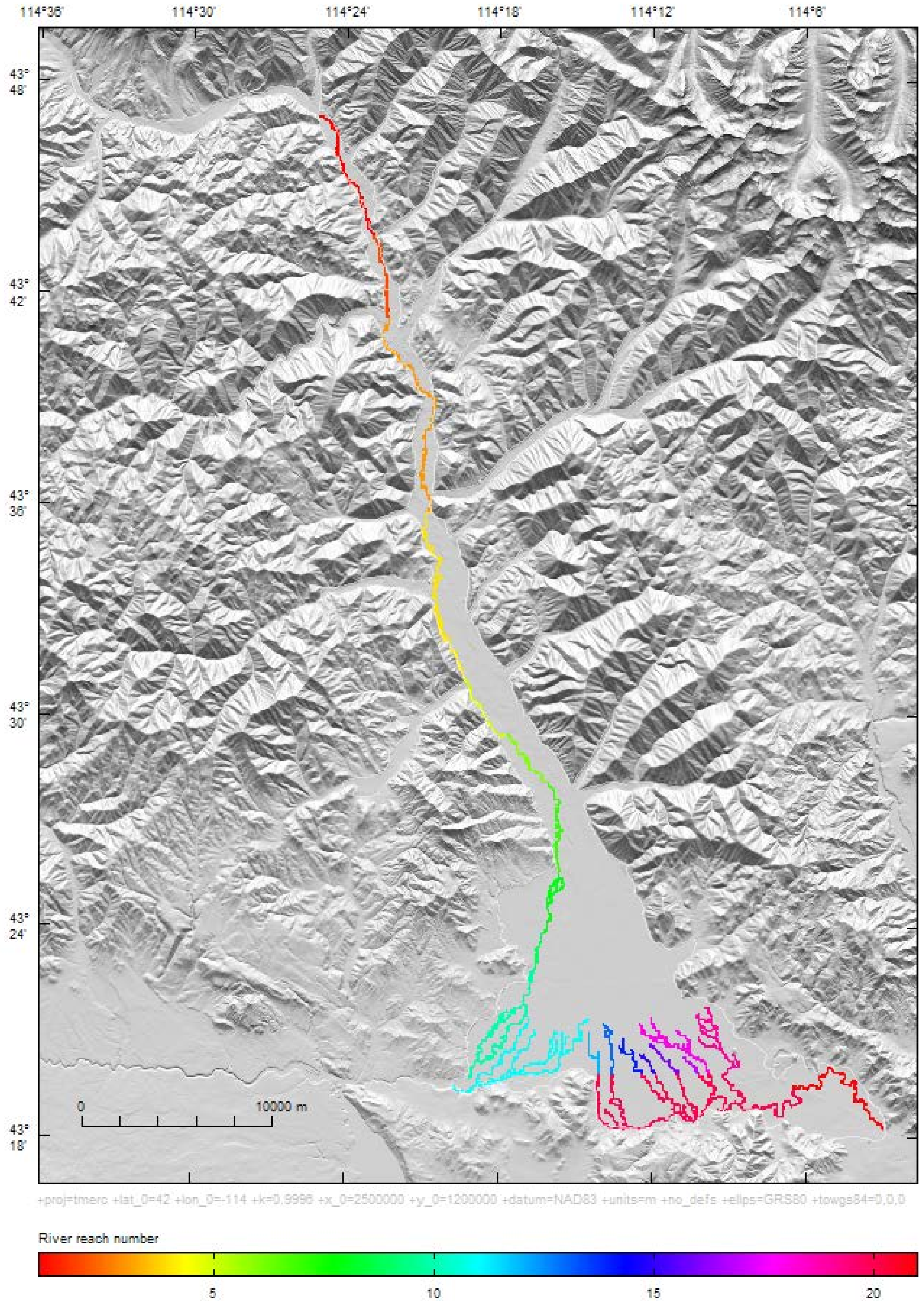
Boundary condition	File	MODFLOW-USG Input Files	Simulates in the WRV Aquifer System
	.nam	Name file: names of input and output text files	NA
	.ba6	Basic Package file: used to specify - locations of active, inactive, and specified head cells - initial heads in all cells	Describes the spatial domain of the aquifer system, the location of inflow and outflow boundaries (such as stream channels), and an initial estimate of the water table surface
	.dis	Discretization file: description of model grid - number of rows, columns and layers - cell size	NA
	.zon	Zone file: zone arrays used to specify the cells that are associated with a parameter	Describes the locations of hydrogeologic zones in the aquifer system
	.lpf	Layer-Property Flow package file: properties controlling flow between cells	Describes the hydraulic conductivity, porosity, storativity (confined), and specific yield (unconfined) for each hydrogeologic zone
	.sms	Sparse Matrix Solver file: options for the nonlinear solution method that uses a Newton-Raphson iteration scheme with under relaxation	Solves the groundwater flow equations in the unconfined (water-table fluctuations) and confined aquifers
	.oc	Output control file: options for writing output files	NA
Specified head boundary condition	.fhb	Flow and Head Boundary file: specified flow cells where flow can vary within a stress period	Groundwater entering the aquifer system through the tributary canyons and upper boundary of the BWR valley
Head-dependent flux boundary conditions	.drn	Drain Package file: if head in the cell falls below a certain threshold, the flux from the drain to the model cell drops to zero	Groundwater leaving the aquifer system beneath Silver Creek and Stanton Crossing
	.riv	River Package file: if head in the cell falls below a certain threshold, the flux from the river to the model is set to a specified lower boundary	Streamflow gains and losses
Flux boundary condtions	.rch	Recharge Package file: specified flux distribution over the top of the model in units of length per unit time	Precipitation and excess irrigation, direct evapotranspiration
	.well	Well Package file: specified flux to individual cells in units of length cubed per unit time	Canal losses, pumping (irrigation, domestic, municipal), wastewater infiltration

Questions

Wood River Valley
Model Construction Update

Jason C. Fisher

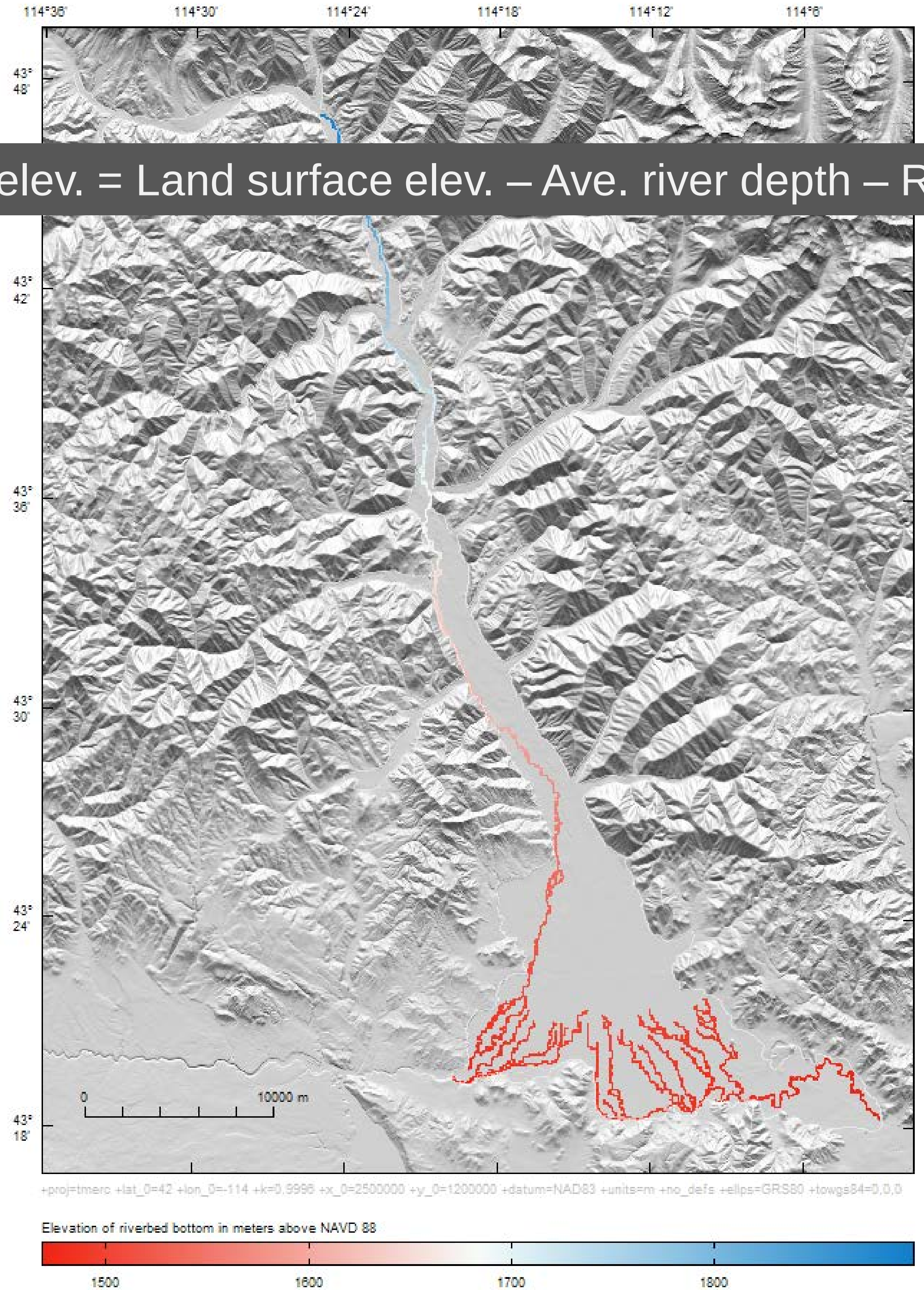
U.S. Geological Survey
Idaho Department of Water Resources


114°36'
114°30'
114°24'
114°18'
114°12'
114°6'
43° 48'
43° 42'
43° 36'
43° 30'
43° 24'
43° 18'
0
10000 m
+proj=tmerc +lat_0=42 +lon_0=-114 +k=0.9996 +x_0=2500000 +y_0=1200000 +datum=NAD83 +units=m +no_defs +ellps=GRS80 +towgs84=0,0,0
River reach number
5
10
15
20

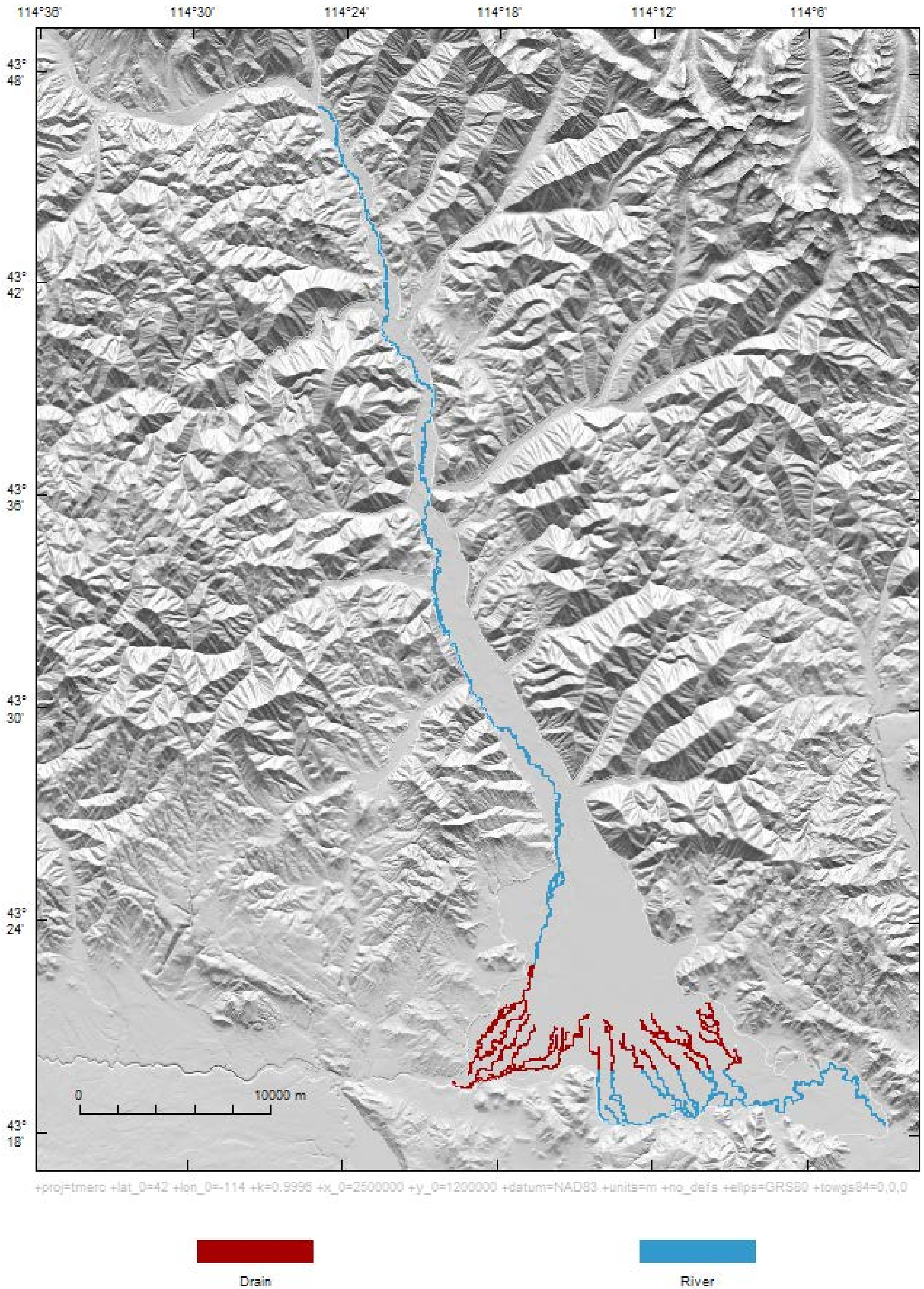
Reach	Depth (m)	Depth (ft)	Riverbed (m)	Riverbed (ft)
Big Wood, Nr Ketchum to Hulen Rd	0.61	2	0.30	1
Big Wood, Hulen Rd to Ketchum	0.61	2	0.30	1
Big Wood, Ketchum to Gimlet	0.61	2	0.30	1
Big Wood, Gimlet to Hailey	0.61	2	0.30	1
Big Wood, Hailey to N Broadford	0.61	2	0.30	1
Big Wood, N Broadford to S Broadford	0.61	2	0.30	1
Big Wood, S Broadford to Glendale	0.61	2	0.30	1
Big Wood, Glendale to Sluder	0.61	2	0.30	1
Big Wood, Sluder to Wood River Ranch	0.61	2	0.30	1
Big Wood, Wood River Ranch to Stanton Crossing	0.61	2	0.30	1
Willow Creek	0.30	1	0.91	3
Buhler Drain abv Hwy 20	0.30	1	0.91	3
Patton Creek abv Hwy 20	0.30	1	0.91	3
Cain Creek abv Hwy 20	0.30	1	0.91	3
Chaney Creek abv Hwy 20	0.30	1	0.91	3
Mud Creek abv Hwy 20	0.30	1	0.91	3
Wilson Creek abv Hwy 20	0.30	1	0.91	3
Grove Creek abv Hwy 20	0.30	1	0.91	3
Loving Creek abv Hwy 20	0.30	1	0.91	3
spring creeks blw Hwy 20	0.61	2	0.91	3
Silver Creek, Sportsman Access to Nr Picabo	0.61	2	0.91	3

Table 3: Description of reaches in the Big Wood River and Silver Creek.

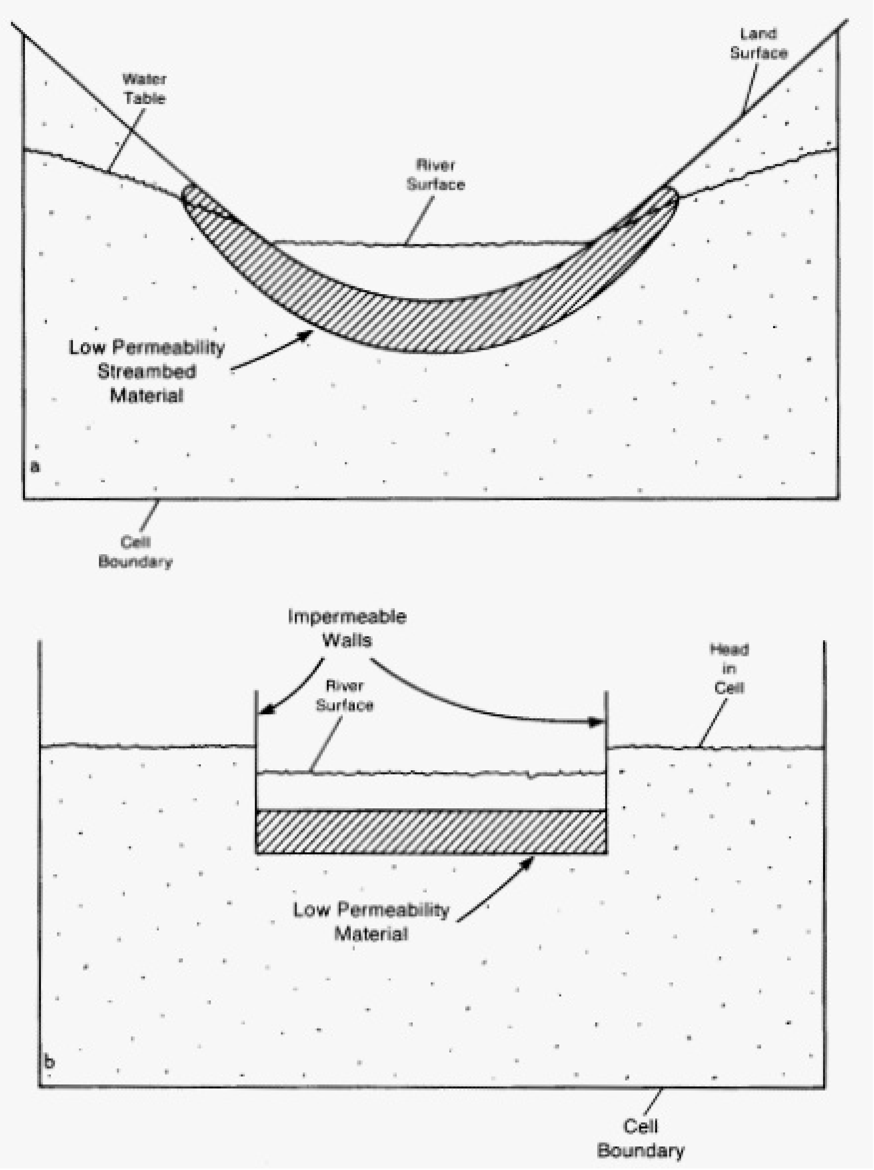
Riverbed bottom elev. = Land surface elev. – Ave. river depth – Riverbed thickness



Head Dependent Flux Boundary:
River Package (RIV) + Drain Package (DRN)


114°36'
114°30'
114°24'
114°18'
114°12'
114°6'
43° 48'
43° 42'
43° 36'
43° 30'
43° 24'
43° 18'
0
10000 m
+proj=tmerc +lat_0=42 +lon_0=-114 +k=0.9996 +x_0=2500000 +y_0=1200000 +datum=NAD83 +units=m +no_defs +ellps=GRS80 +towgs84=0,0,0
Drain
River

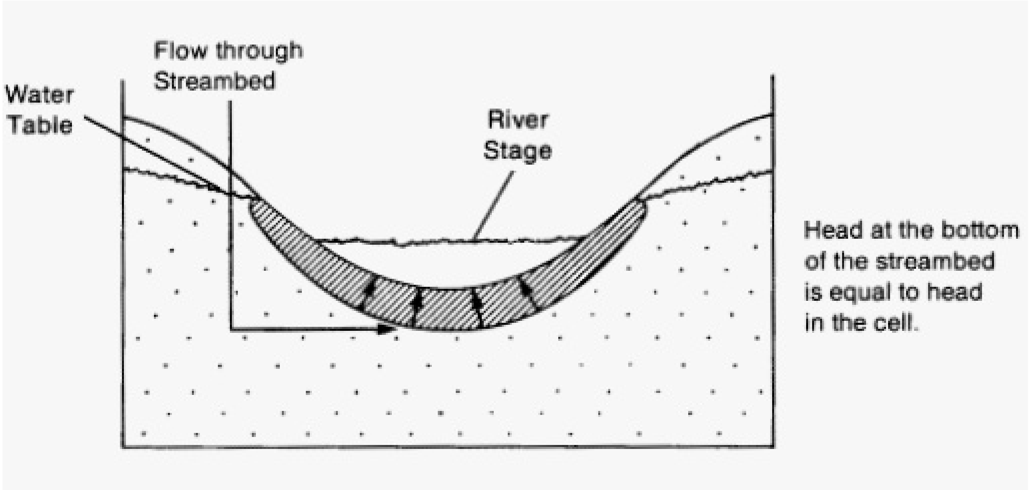
River in the field and in a model grid cell



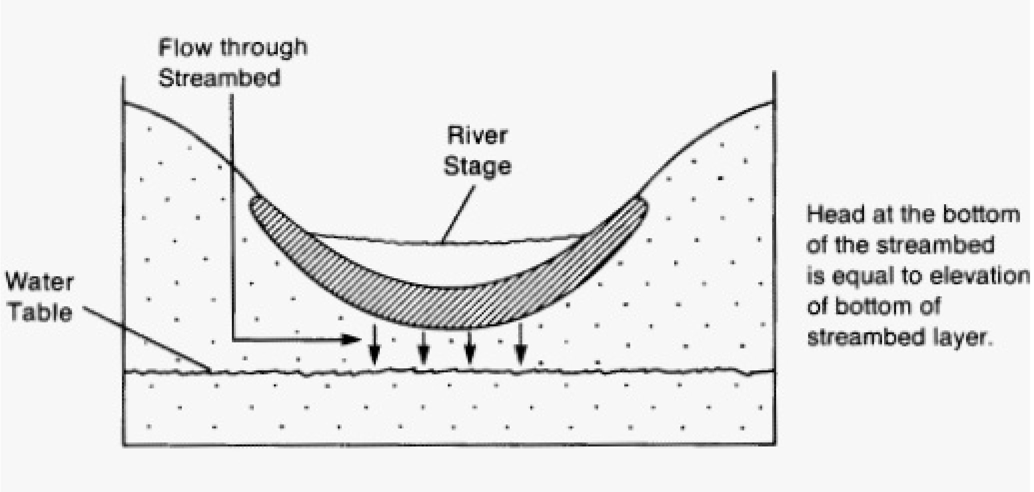
http://inside.mines.edu/~epoeter/583/08/exercise/riv.htm

River in the field and in a model grid cell

Gaining reach (flow into river)



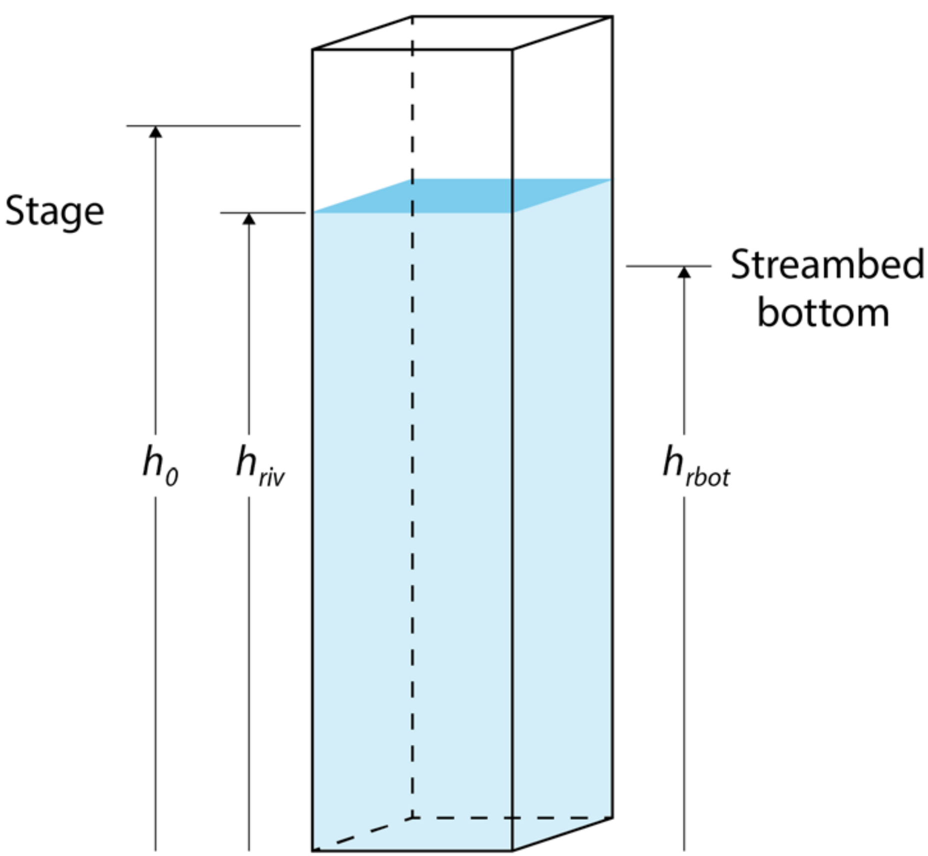
Losing reach (flow into aquifer)



http://inside.mines.edu/~epoeter/583/08/exercise/riv.htm

Head Dependent Flux Boundary: River (RIV)

River cell



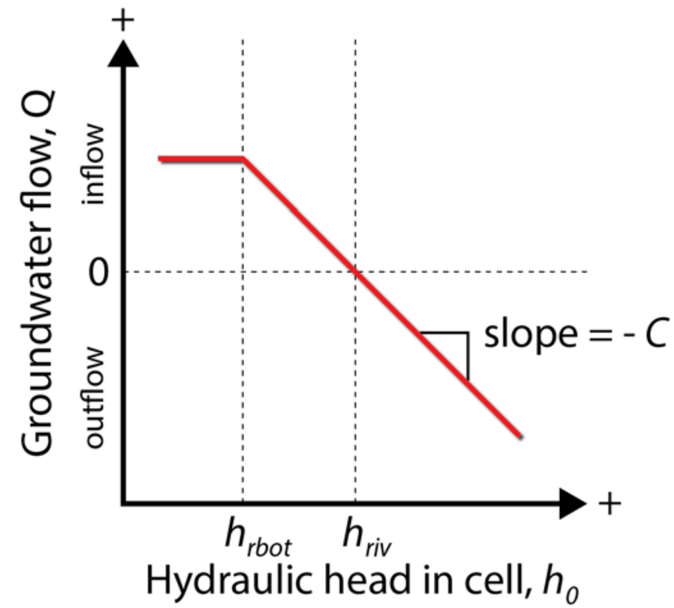
Darcy's Law:

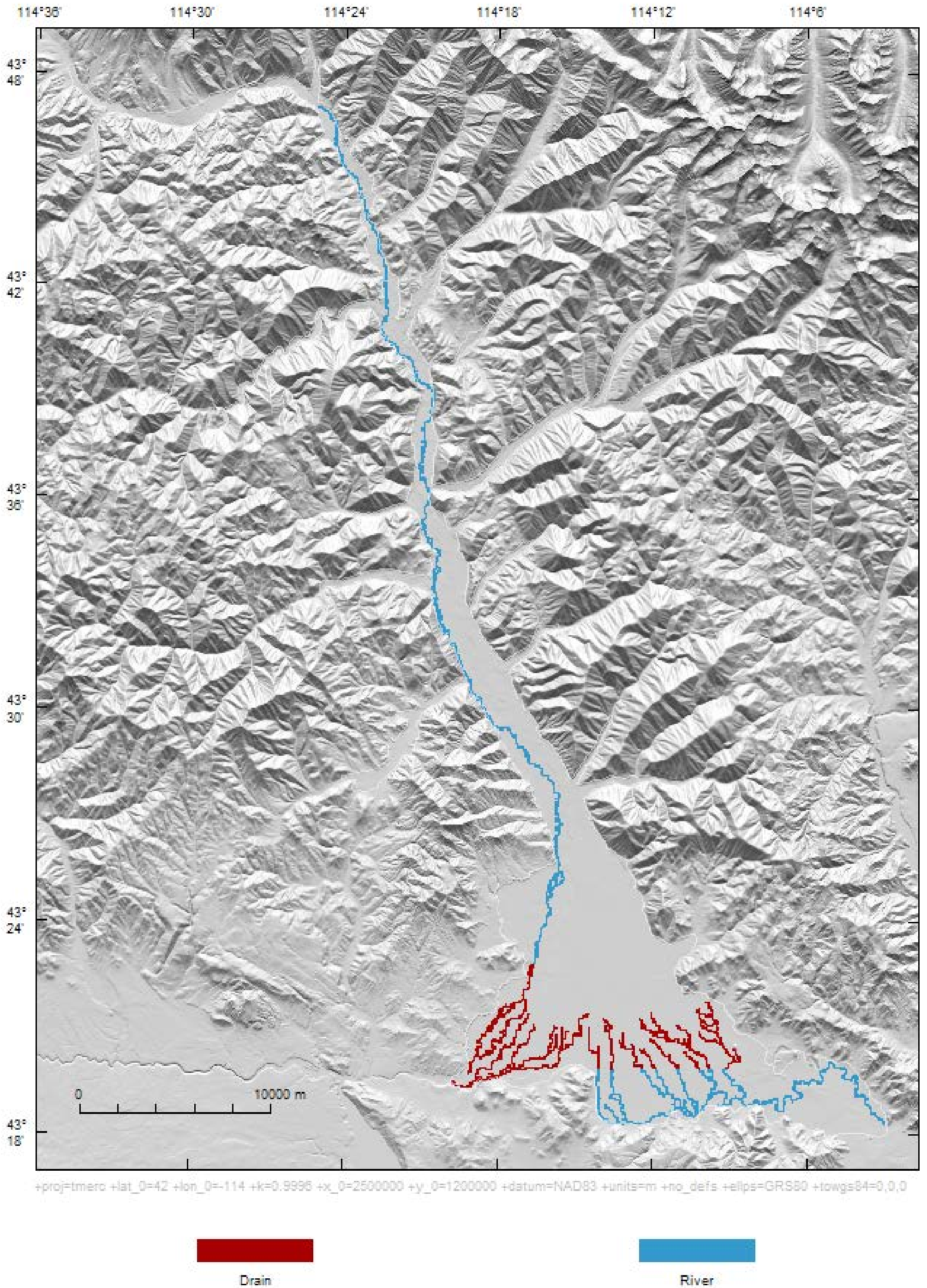
$$Q = -KA\,[(h_{riv} - h_0) / L]$$

$$Q = -C\,(h_{riv} - h_0)$$

where riverbed conductance is

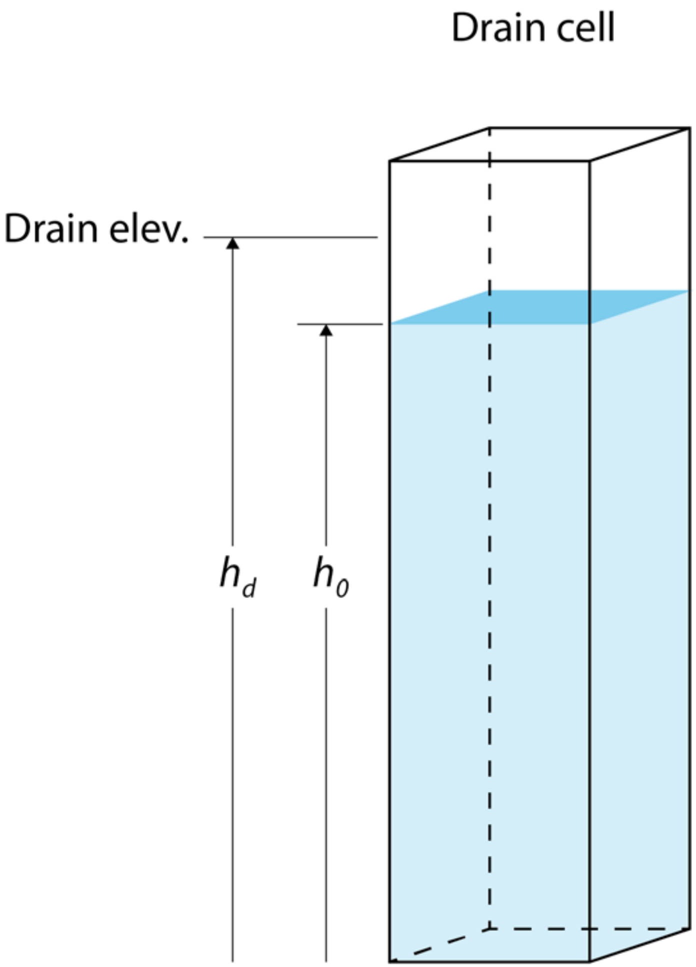
$$C = KA / L$$





114°36'
114°30'
114°24'
114°18'
114°12'
114°6'
43° 48'
43° 42'
43° 36'
43° 30'
43° 24'
43° 18'
0
10000 m
+proj=tmerc +lat_0=42 +lon_0=-114 +k=0.9996 +x_0=2500000 +y_0=1200000 +datum=NAD83 +units=m +no_defs +ellps=GRS80 +towgs84=0,0,0
Drain
River

Head Dependent Flux Boundary: Drain (DRN)



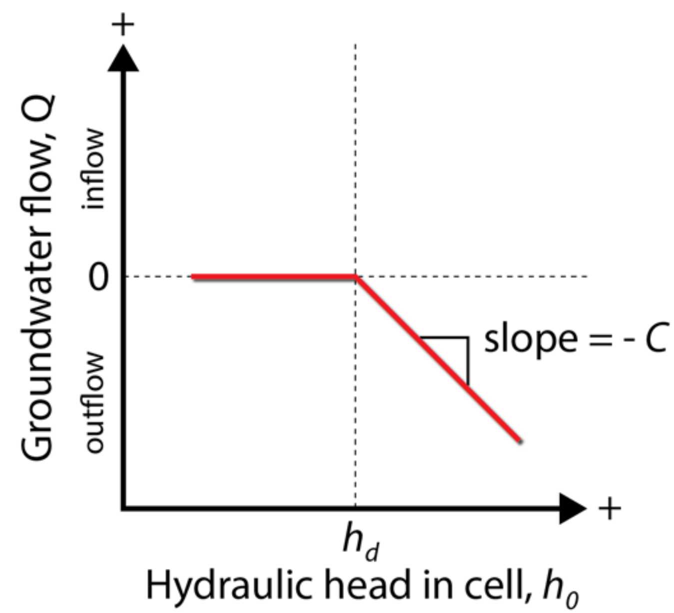
Darcy's Law:

$$Q = -KA\,[(h_d - h_0)/L]$$

$$Q = -C\,(h_d - h_0)$$

where drain conductance is

$$C = KA/L$$



Work-In-Progress

Calculating recharge on irrigated lands and municipal/subdivision

Converting ESRI ArcGIS processing instructions into R code

UPPER WOOD RIVER IRRIGATED LANDS PROCESSING STEPS

1. **IRRIGATED/SEMI-IRRIGATED AREA**. For each year available (currently 7 years), eliminate wetlands and BLM/USFS land from irrigated and semi-irrigated lands, and classify irrigated and semi-irrigated lands by water source and irrigation entity.
    a. Add irrigated lands file BW_YEAR_xxxxxx from BigWoodIrrigatedLands.gdb with Definition Query: STATUSYEAR<>Non-irrigated
    b. Add wetlands file wetlands_nwi_idaho with Definition Query: SYS_DESCRI<>UPLAND
    c. Erase (Analysis Tools/Overlay/Erase) wetlands from irrigated lands, save as a temporary file
    d. Erase (Analysis Tools/Overlay/Erase) BLM_USFS_Blaine from temporary file created in 1.c., save as a temporary file
    e. Clip (Analysis Tools/Extract/Clip) IrrigationEntities with temporary file created in 1.d. Save as IrrByEntityYEAR in BigWoodIrrigatedLands.gdb
    f. Add “acres” field (Double) to IrrByEntityYEAR attribute table and calculate geometry
    g. Summarize by field “EntitySrce” with Sum of “acres” , save as SumAcresbyEntityYEAR.dbf in BigWoodIrrigatedLands.gdb
    h. Repeat for other available years

2. **CIR**. For each month (April through October), calculate ET, precipitation, and CIR for each irrigation entity and water source
    a. Calculate mean ET by irrigation entity and water source:

        Run Spatial Analyst/Zonal Statistics as Table with
        Feature zone data = IrrByEntityYEAR
        Zone field = EntitySrce
        Input value raster = bw_met_YEARMO or BW_NET_YEARMO
        Output table = AvgETbyEntityYEARMO.dbf
        Statistics type = MEAN

    b. SumAcresByEntityYEAR does not exist for some years. Look up IL_YEAR to use for YEAR in IL_YEAR.csv.
    c. Join SumAcresByEntityYEAR to AvgETByEntityYEARMO, add fields “ET_AF”, “SumAcres”, “PrecipZone”, “Precip”, and “CIR” to AvgETByEntityYEARMO and calculate fields
        i. “SumAcres” = “Sum_acres”
        ii. “PrecipZone” = “First_prec”
        iii. Remove join
        iv. “ET_AF” = “MEAN”/25.4/12 * “SumAcres”
        v. “Precip_ft” = monthly depth in feet for PrecipZone, look up in BigWood_Precip.csv
        vi. “Precip_AF” = “Precip_ft” * ”SumAcres”
        vii. “CIR_AF” = “ET_AF” – “Precip_AF”
    d. Repeat for other months (April through October of all years)

3. **DIVERSIONS**. Calculate canal seepage, field headgate delivery, and incidental recharge.
    a. **SURFACE WATER DIVERSIONS**. Sum surface water diversions (AF) in WRV_SWDiv.csv by irrigation entity for each stress period. (Measured returns are included as negative values. Assign to *SWDiv*.
    b. **GROUNDWATER DIVERSIONS.**

```r
library(wrv)
setwd("D:/Projects/WRV/R")
crs <- alluvium.bottom@proj4string

ReadShapefile <- function(dsn, layer, crs) {
  obj <- readOGR(dsn=dsn, layer=layer, verbose=FALSE)
  obj <- spTransform(obj, crs)
  if (all(suppressWarnings(gIsValid(obj, byid=TRUE))))
    return(obj)
  obj <- gBuffer(obj, width=0, byid=TRUE)
  return(obj[gIsValid(obj, byid=TRUE), ])
}

# 1. IRRIGATED/SEMI-IRRIGATED AREA

dsn <- file.path(getwd(), "Data", "Irrigated_Lands")

wetlands     <- ReadShapefile(dsn, "Wetlands_nwi_idaho", crs)
blm.usfs     <- ReadShapefile(dsn, "BLM_USFS_Blaine", crs)
irr.entities <- ReadShapefile(dsn, "IrrigationEntities", crs)

layers <- c("BW_1996_060713", "BW_2000_061213", "BW_2002_061713",
            "BW_2006_061913", "BW_2008_062513", "BW_2009_062513",
            "BW_2010_062713")
years <- substr(layers, 4L, 7L)
irr <- lapply(layers, function(i) ReadShapefile(dsn, i, crs))
names(irr) <- years

col.names <- paste0("STATUS_", substr(years, 1, 3))
Fun <- function(i) irr[[i]][irr[[i]]@data[, col.names[i]] != "non-irrigated", ]
irr <- lapply(seq_along(irr), Fun)

Fun <- function(i) SetPolygons(i, wetlands, "gDifference", buffer.width=0.001)
irr.erase <- lapply(irr, Fun)
Fun <- function(i) SetPolygons(i, blm.usfs, "gDifference", buffer.width=0.001)
irr.erase <- lapply(irr.erase, Fun)
names(irr.erase) <- years
```

Questions