Final Report

ARSR Program Data Analysis and GIS Visualization Project

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In Cooperation with:
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1 Introduction

1.1 Overview

The Walla Walla River basin is a bi-state drainage basin that originates in Oregon and passes through the state of Washington on route to its confluence with the Columbia River. This drainage basin covers approximately 1760 square miles. Two primary drainage areas exist within the Walla Walla Basin: The Walla Walla River and The Touchet River. The Touchet River flows into the Lower Walla Walla River, which drains into the Columbia River. The main tributaries for this study are the North Fork Walla Walla River, South Fork Walla Walla River, Mill Creek, and the East and West Little Walla Walla Rivers. (Figure 1)

Figure 1. Walla Walla River Watershed

There are numerous agencies within the Walla Walla River Watershed conducting projects focusing on water quality, water quantity, river restoration, and fisheries management. The focus of this project is to pull the available dataset together into a single database and have the data accessible and available to all users.
The database is a collection of hydrologic and fishery based geographic feature datasets with associated features with robust attribute data tables. A GIS database is typically referred to as a geodatabase or a geospatial database. The geodatabase is designed to store, query, and manipulate geographic information and spatial data. Within a geodatabase, spatial data is treated as any other data type. Vector data can be stored as point, polyline, or polygon data types, and may have an associated spatial reference system. A geodatabase record can use a geometry data type to represent the location of an object in the physical world and other standard database data types to store the object’s associated attributes. Within a geographic information system (GIS) a geodatabase is one component that can be used to store and manipulate data. The primary advantage of spatial databases, over file-based data storage, is that they let a GIS build on the existing capabilities of relational database management systems (RDBMS).

1.2 Project Objectives

Develop and maintain a database of geographic data for the Walla Walla Basin

ESRI ArcView based geodatabase focusing on the Hydrology, Hydrography, and Fisheries spatial data for the Walla Walla Basin.

Maintain spatial and temporal GIS data models and build a data distribution system

Using collected Walla Walla River Basin data to maintain the structure of the surface flow and temperature data models with spatial reference. Build a data distribution system for the dissemination of hydrologic data.

Surface and Groundwater Model GIS Integration

ESRI ArcView based geodatabase focusing on the structure of the surface and groundwater model components.

2 Methodology

2.1 Walla Walla Basin Geodatabase

The geodatabase is populated with nine unique watershed feature datasets. The feature datasets are as follows: Basin Geology, Boundaries, Fisheries, Groundwater, Points of Diversions, Stream Layers, Surface Water Monitoring, Transportation, and Watershed. The features contained in the geodatabase provide the interface between numeric non-spatial

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1 Geographic features as points, lines, and polygons. “A to Z GIS”, ESRI Press 2006

2 A collection of feature classes stored together that share the same spatial reference. “A to Z GIS”, ESRI Press 2006
tabular data and spatial features in a GIS. Tabular data can be referenced to like identifiers such as stream names, monitoring site locations, and geologic layer names. Detailed information about each feature located in the individual feature datasets is located in appendix I.

**Feature Datasets**

**Basin Geology**
This feature dataset contains features focused on the geology of the Walla Walla Basin. Boundary and contour layers represent the individual layers that comprise the shallow aquifer of the Walla Walla Valley. The original geologic layers for the Walla Walla Basin were updated in 2015.

![Figure 2 Eastside Milton-Freewater Levee Cross Section through the basin geology datasets.](image)

**Boundaries**
This feature dataset contains features associated with areas of ownership, sections, townships, towns, and hydrologic unit boundaries within the basin.
Fisheries
This feature dataset contains features associated with past and current fisheries activity throughout the basin.

Groundwater
This feature dataset contains features associated with current and historic groundwater monitoring throughout the basin with a focus on the Walla Walla Valley. The data contained in this dataset populates the surface and groundwater model for the Walla Walla Valley.

Point Of Diversions
Points of Diversions and Place of Use features are located in this feature dataset. The information was compiled from the State of Oregon along with the available data from the state of Washington. Measured diversions from the seepage assessments conducted on the Walla Walla River in 2014 are included in this feature dataset.

Stream Layers
This feature dataset contains layers associated with the Walla Walla Basin Hydrography. A new digitized feature for the entire basin was created to accurately represent the streams, creeks, rivers, ditches, and piped sections within the basin with the focus being the Walla Walla Valley.

Surface Water Monitoring
Throughout the basin there are surface monitoring locations that record continuous, seasonal flow, and water quality data. This dataset contains surface water monitoring locations from various agencies within the basin. Also contained in this dataset are the locations of documented historic spring locations.

Transportation
This feature dataset contains road layers for both the Walla Walla County and the Umatilla County. There is a third feature which combines both county datasets that covers the entire basin.

Watershed
This feature dataset contains a wide range of features which are focused on the watershed.

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3 At the time of this report the Washington Department of Ecology did not have the POD and POU layers available for the inclusion in the geodatabase. When the layers become available they will be integrated.
2.2 Integrated Water Flow Model (IWFM) integration into GIS

Groundwater models require a number of disparate and large data sets that are difficult to manage. GIS can help with the modeling process by coordinating data collection, providing comprehensive database operations, supporting systematic model parameter assignments, conducting spatial analysis functions, and displaying model results in understandable color-map formats.4

The IWFM model was developed by the California Department of Water Resources, given its capability for modeling groundwater and its interactions with other hydrologic processes. It is a comprehensive physically-based water resource allocation model that is mathematically complex and computationally efficient by application of the finite element method.5

With the completion of the Walla Walla Valley Surface and Groundwater Model it was imperative to have the geodatabase with associated feature datasets built in GIS to insure the integration of the model outputs into the WWBWC’s GIS program. The structure in GIS is used to control model inputs, parameters, and to produce visual outputs.

The IWFM geodatabase is complete and contains seven feature datasets:

**Sub Regions**

This feature dataset contains a polygon feature which divides the groundwater modeling area into seven unique sub regions.

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5 Aristides Crisóstomos Petrides Jiménez, Modeling Surface and Groundwater Interactions near Milton-Freewater, Oregon, (March 17, 2008).
Nodes (Model Nodes)
This feature dataset contains point features (model nodes) for the entire modeling area (all nodes), boundary nodes, and stream nodes. The nodes are unique geographic locations within the model which control data inputs.

Streams
The Model Streams feature dataset contains a line feature of the model stream segments.

Elements
The IWFM model used a finite element approach to simulate groundwater flow, surface water flow, and surface water – groundwater interactions. This feature dataset contains a polygon feature of all of the elements used to build the framework of the model.
Recharge Locations
This feature dataset contains a point feature representing the locations of existing and potential recharge sites utilized in the model.

Inflow Points
This is a feature dataset containing locations at which flow enters into the model area at stream nodes.

Boundary
This feature dataset contains a polygon feature representing the geographic location of the extent of the modeling boundary.

2.3 GIS Data Model
The real world can only be depicted in a GIS through the use of models that define phenomena in a manner that computer systems can interpret, as well perform meaningful
To build the frame for the data models the Walla Walla River feature was converted into a linear route. The Walla Walla River route feature begins at the Highway 12 Bridge at the mouth of the Walla Walla River and extends 111 kilometers upstream. The route was divided into 25 meter segments (Figure 1) with segment 1 starting at the mouth of the river. The attribute table from the feature was then exported into Microsoft Excel. Two were created in Excel to interpret the flow and temperature conditions for the Walla Walla River.

The linear routing framework is currently used in the channel bed gain and loss calculation documented in the 2014 Seepage Assessment Report.

**Flow Data Model**

After the Walla Walla River was digitized and divided into 25-meter segments a digital spreadsheet was created with each row representing one of those segments. Columns in the spreadsheet were labeled with the dates for the study period (each day in 2007 and 2008). Daily average flow data from all available flow gauges (including WWBWC, OWRD, and WDOE gauge sites) on the Walla Walla River was compiled and put into the spreadsheet along with available diversion and tributary data.

Once all of the compiled flow data was entered into the spreadsheet, flow data for each 25-meter segment of the river was interpolated linearly between the nearest upstream measured flow and the nearest downstream measured flow. Flow changes resulting from diversions and tributaries whose flow data was available occur in the spreadsheet at their respective locations along the river feature. Diversions and tributaries whose daily flows are not recorded or were unknown were ignored and the changes resulting from them are spread out over the whole interpolated reach in which they lie.

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6 University of North Carolina GIS Program
7 A line feature that has a unique identifier. “A to Z GIS”, ESRI Press 2006
In this way a cfs flow value was generated for each 25-meter segment of the main stem of the Walla Walla River. This way, when the spreadsheet’s data was imported into GIS, the flow for each segment of the river could be represented in varying symbols according to that segment’s interpolated flow value.
The model is designed to allow for the continued addition of known flow data. As diversion, tributary, and mainstem flows from new locations become available, the model can be easily improved by adding that data to the row of the spreadsheet for its corresponding 25-meter segment of river.

Temperature Data Model
After the Walla Walla River was digitized and divided into 25-meter segments three digital spreadsheets (Daily average temperature, daily minimum temperature, and daily maximum temperature) were created with each row representing one of those segments. Columns in the spreadsheets were labeled with the dates for the study period. Daily average, daily minimum and daily maximum temperature from 30 sites (including WWBWC, OWRD, and WDOE sites) on the Walla Walla River were compiled and put into the spreadsheet at the appropriate 25-meter segment.

![Walla Walla River Daily Temperature (F)](image)

Once all of the compiled temperature data was entered into the spreadsheets, temperature for each 25-meter segment of the river was interpolated linearly between the nearest upstream measured temperature and the nearest downstream measured temperature. Temperature changes resulting from diversions and tributaries were ignored due to a lack of temperature data for the diversions and tributaries. In this way a temperature value was generated for each 25-meter segment of the main stem of the Walla Walla River. This way,
when the spreadsheet’s data was imported into GIS, the temperature for each segment of the river could be represented in varying symbols according to that segment’s interpolated temperature value. As temperature monitoring locations increase or decrease over time the collected data can easily be incorporated into the datasets.

2.4 Groundwater in GIS

Methods for collecting data
The WWBWC maintains a bi-state monitoring well network in the Walla Walla Valley (Figure 10). Well monitoring consists of measuring the static water level (SWL), or the depth to water, water temperature and specific conductivity. The well monitoring network is comprised of two types of monitoring wells: continuous monitoring wells, instrumented with pressure transducers that measure static water level once per hour, and non-continuous wells which are measured manually every three months. Temperature and conductivity measurements are taken quarterly at both types of monitoring wells. The collected hourly data from the continuous data loggers was used to create a daily average for each individual continuous monitoring well. The daily average data tables are processed looking for any data inconsistencies or errors. The final data tables (AllWells data table) after the quality check are then used for the creation of the water table grids.


Monitoring well network data tables are incorporated into the Walla Walla Basin geodatabase.
Building Water Table Grids

The general procedure to build water tables was to summarize the Water Elevation (feet) field from the AllWells data table for each month, and create an output with the Min, Max, Mean, and Range. This provides information that can be used to create water tables from the average elevation in feet, and also document the range during the month. A model tool (Well Data All) was created for this procedure that started with querying on the dates, to creating the water table using Spline in ArcView Spatial Analyst. (See model and specifics on steps in Figure 12). The tool was incorporated into the WWBasin toolbox\(^\text{11}\) in the geodatabase.

\(^\text{11}\) Set of tools specific to a given project or database in ArcView
Water table grids produced by the ArcView water table model are an approximation of the water table for set interval parameter of the model.

### 2.5 Fisheries
In the Walla Walla Basin there are numerous monitoring and evaluation sites operated by the WDFW, USFWS, CTUIR, and other state and local agencies. The WWBWC collected fisheries data from the agencies with the initial focus being fisheries data with a geographic and temporal associated attributes. Our goal was to compile geographic and temporal fisheries data\(^\text{12}\) to be added to the flow and temperature data models. The initial flow and temperature data models were built for the Walla Walla River and such the focus on the fisheries data was also on, but not limited to, the Walla Walla River. Species Distribution covers the entire Walla Walla Basin. Focus was on the three main species of interest in the basin: Bull Trout, Summer Steelhead, and the Spring Chinook. All of the fisheries

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\(^{12}\) Data collected for the period between 2007 and 2009.
geographic and temporal data was integrated into the geographic database. In the past 10 years, a considerable effort and resources have been put towards flow restoration in the Walla Walla Basin. The geodatabase provides a tool to begin to examine the added benefits that increased flow and increased water quality and the benefits to fish.

**Distribution Maps**

![Bull Trout Distribution Map](image)

*Figure 13 Bull Trout Distribution*

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13 WWBASIN geodatabase, WWBWC, 2014
Figure 14  Spring Chinook Distribution

Figure 15  Summer Steelhead Distribution
2.6 Seasonal Movement and Stream Conditions

In 2014 flow gauges were installed at two PIT tag array sites in the lower Walla Walla River. Each site collects water temperature, Discharge (cfs), and air temperature along with interrogation information regarding salmonid upstream and downstream migration. The information gathered at each site in the future will help fisheries managers on the Walla Walla River to fish movements and the conditions in which they're moving. Future analysis on the collected data will help provide an understanding locally of needed conditions for fish migration within the system.

Fish movement can be plotted against flow and temperature conditions in GIS using the data models along with the radio telemetry and PIT tag data that is incorporated in the geodatabase. There are limitations to knowing exactly where fish are in between detection site, but the conditions per reach can be identified. As more data is being collected through various projects in the basin the temperature and flow data models will continue to be refined. Figure 16 shows the flow conditions of the Walla Walla River as a hatchery spring Chinook salmon (150,110,184) migrates up the river.
3 Results
Basin wide spatial data was collected, created, and incorporated into a single geodatabase. One of the created features is a hydrography layer that was digitized to the 2006 NAIP and was updated to the 2013 NAIP satellite imagery. The created feature locates streams, ditches, and piped sections throughout the basin and is linked to the GIS data models. The GIS data models were created for flow and temperature for the Walla Walla River. A product of this project is a flow and temperature animation for the Walla Walla River. As future datasets are collected from the recent additions to the monitoring network, additional datasets will be used to analyze and create flow and temperature animations.

3.1 Data Availability
The Walla Walla Geodatabase is currently available online for distribution to agency partners. The database provides a base of information for the Walla Walla Watershed and is continually being updated when additional data becomes available. The WWBWC website not only contains downloadable GIS data sets, maps, and videos which are products of the geodatabase, but it also contains robust groundwater and surface water datasets.

Figure 17 GIS Download Section (WWBWC.org)
The Walla Walla Basin Watershed Council currently monitors over 100 wells in the Walla Walla Valley. On the WWBWC website in the Groundwater Monitoring section a Google map shows the locations of each well. If you click on the map marker, a balloon will appear that shows a hydrograph for that well. Below the hydrograph are links where you can download the hydrograph, the data table for that well (in a .csv format), and a year to year hydrograph comparing each year of data (Jan-Dec) to other years. You can also download a .kml file at the bottom of the page to use on your local computer using Google Earth. Meta data for the dataset is also available for download from the site.

As with the Groundwater Monitoring Network the Walla Walla Basin Watershed Council is actively monitoring the surface water in the springs, streams and rivers in the Walla Walla Basin. The monitoring network's purpose is to provide the community with supplemental water flow data, which can aid management of the valley’s water resources. Since 2002, the network has gradually expanded into Washington and evolved to include 50 sites in the Walla Walla Valley, including springs, small order streams, and irrigation ditch sites. On the WWBWC website in the Surface Water Monitoring section a Google map shows the locations of each surface water monitoring location. The map markers when clicked display the current hydrograph for each monitored location. The data associated with the surface and groundwater monitoring networks is updated on a quarterly basis.

In addition to all of the surface and groundwater monitoring locations that are updated on a quarterly basis the WWBWC also provides surface flow real-time data for numerous sites on the Walla Walla River. In 2014 a real-time dedicated monitoring well was added to the information available on the WWBWC.org website.

4 Discussion and Summary

4.1 Management Tool
The GIS geodatabase program is expanding every year and has become a vital tool in the management of the Walla Walla Valley shallow alluvial aquifer. The surface water and groundwater monitoring programs are now integrated into the database. The data once
tied to geographic locations within the basin in GIS is now providing managers valley wide water tables (Figure 11), groundwater conductivity visualizations, seepage assessment gains and losses (Figure 19), and cross sectional shallow aquifer maps (Figure 2).

Figure 19 Touchet River Seepage Assessment (August 5th, 2014)

4.2 Modeling
With the completion and subsequent expansion of the IWFM Surface and Groundwater Model the IWFM geodatabase will play a key role in the conceptual and statistical modeling of the Walla Walla Valley. Identifying potential shallow alluvial aquifer artificial recharge sites through the modeling process will lead to localized investigations in GIS for each site. Cross sections through the valley stratigraphy, topographic mapping using survey quality
GPS for accurate elevations and levels, and visualizations of each project for public education and planning will be key roles in site development.

Figure 20 Existing shallow alluvial aquifer recharge sites.

4.3 Moving Forward
In the winter of 2013/2014 the WWBWC completed integrating the surface water monitoring, groundwater monitoring, and evapotranspiration monitoring stations that are fitted with telemetry equipment into the AQUARIUS software created by Aquatic Informatics™. AQUARIUS has enable the WWBWC to better manage the vast amounts of hydrologic time series data, discrete water quality data and river gauging measurements from within the Walla Walla Watershed. The WWBWC now has the ability to leverage a robust notification system for each telemetry site and expand on the current website based publication of data. The WWBWC will continue to expand its’ capabilities to produce high quality data and insure the data is available to local, federal, and state agencies along with the general public.
Acknowledgements

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Appendix

**WWBASIN Geodatabase Feature Classes and Features**

**IWFM Geodatabase Feature Classes and Features**

The geodatabases of information can be downloaded on the WWBWC website here:

http://wwbwc.org/images/GIS/2015_GIS_VIS_REPORT_GDBS.zip
Appendix I

Walla Walla Basin Geodatabase

WATERSHED GEOLOGY

**MPbc_Bound**: Mio Pliocene Basal Coarse Unit

**Mpbc_surface_ci50**: Mio Pliocene Basal Coarse Unit surface contours at 50’ intervals

**Mpbc_thick_ci50**: Mio Pliocene Basal Coarse Unit thickness contours at 50’ intervals

**Mpc_Bound**: Mio Pliocene Coarse Unit Boundary

**Mpc_surface_ci50**: Mio Pliocene Coarse Unit surface contours at 50’ intervals

**Mpc_thick_ci50**: Mio Pliocene Coarse Unit thickness contours at 50’ intervals

**Mpf_Bound**: Mio Pliocene Fine Unit Boundary

**Mpf_surface_ci50**: Mio Pliocene Fine Unit surface contours at 50’ intervals

**Mpf_thick_ci50**: Mio Pliocene Fine Unit thickness contours at 50’ intervals

**Qc_Bound_1**: Quaternary Coarse Unit Boundary 1

**Qc_Bound_2**: Quaternary Coarse Unit Boundary 2

**Qc_surface_ci50**: Quaternary Coarse Unit surface contours at 50’ intervals

**Qc_thick_ci50**: Quaternary Coarse Unit thickness contours at 50’ intervals

**Qf_Bound_1**: Quaternary Fine Unit Boundary 1

**Qf_Bound_2**: Quaternary Fine Unit Boundary 2

**Qf_surface_ci50**: Quaternary Fine Unit surface contours at 50’ intervals

**Qf_thick_ci50**: Quaternary Fine Unit thickness contours at 50’ intervals

**TOB_Boundary**: Top of Basalt Boundary

**Tob_surface_ci50**: Top of Basalt surface contours at 50’ intervals
GRIDS

Shallow Aquifer GRIDS

G_mpbc_surface: Mio Pliocene Basal Coarse Unit, Surface
G_mpbc_thick: Mio Pliocene Basal Coarse Unit, Thickness
G_mpc_surface: Mio Pliocene Coarse Unit, Surface
G_mpc_thick: Mio Pliocene Coarse Unit, Thickness
G_mpf_surface: Mio Pliocene Fine Unit, Surface
G_mpf_thick: Mio Pliocene Fine Unit, Thickness
G_qc_surface: Quaternary Coarse Unit, Surface
G_qc_thick: Quaternary Coarse Unit, Thickness
G_qf_surface: Quaternary Fine Unit, Surface
G_qf_thick: Quaternary Fine Unit, Thickness
G_tob_surface: Top of Basalt, Surface
WATERSHED SURF MONITORING

**SURF_MON_NETWORK**: Walla Walla Basin Continuous Gauge Sites (All Agencies)

**SURF_CONDUCTIVITY09**: Surface Conductivity Monitoring Locations 2009

**WDOE_WATERQUAL_SURFMON**: Washington Department of Ecology Water Quality Surface Monitoring Site

**WWBWC_TEMP**: Walla Walla Basin Temperature Monitoring Sites
WATERSHED_W

**ADMINISTRATIVE_STREAM_CLOSURES:** Administrative Stream Closures Walla Walla County

**CROP_TYPE_09_MODEL:** Crop types for the 2009 IWFM model.

**ETO_STATION_WWBWC:** Evapotranspiration Station Locations WWBWC

**IMPLEMENTATION_AREAS:** Implementation Areas Walla Walla County

**NEW_MANAGEMENT_AREAS:** New Management Areas Walla Walla County

**PRIORITY_RESTORATION_AREAS:** Priority Restoration Areas Walla Walla County

**RECOMMENDED_SURFACE_WATER_REGULATIONS:** Recommended Surface Water Regulations Walla Walla County

**WA_STATE_BASEFLOW:** Washington State Base Flow Dataset

**WATER_QUALITY_AND_HABITAT_IMPROVEMENTS:** Water Quality and Habitat Improvement Locations Walla Walla County

**WATERBODY_TEMP_RANGES:** Water body Temperature Ranges Walla Walla County

**WQ_TEMP:** Water Quality Temperature Monitoring Locations Multi Agencies

**WRIA_PRECIPITATION:** Water Resource Inventory Area 32 Precipitation

**WSU_PAWS_WEATHER_STATION:** Washington State PAWS Weather Station Locations in the Walla Walla Basin
Transportation

UMA_CO_ROADS: Umatilla County Roads

WWB_ROADS: Walla Walla Basin Roads

WWCO_ROADS: Walla Walla County Roads
Groundwater Monitoring

**WDOE_OBSWELLS**: Washington Department of Ecology Dedicated Monitoring Wells in Basin

**WDOE_WELLLOG**: Washington Department of Ecology Well Log information for the Walla Walla Basin

**WWBASIN_USGS_WELLS**: Walla Walla Basin United States Geological Survey Wells

**WWBASON_SEDIMENT_DATA**: Walla Walla Basin Sediment Data Wells

**WWBWC_MON_WELLS**: Walla Walla Basin Watershed Council Monitoring Well Network
Stream Layers

CITY_WW_CULVERTS: City of Walla Walla Culverts

LAKES: Walla Walla Valley Lakes or Ponds

LITTLE_WW_RIVER_SPRINGS: Little Walla Walla River Springs

STREAM_NET_BASIN_STREAMS: StreamNet Base Routed Hydrology Layer for the Walla Walla Basin 1:100K Scale

WALLAWALLA_STREAMORDERS: Base Walla Walla Stream Order 1:100k Scale

WRIA32_RIVERS: Water Resource Inventory Area 32 Rivers

WRIA32_STREAMS: Water Resource Inventory Area 32 Streams

WWBASIN_STREAM_ROUTES: Walla Walla Basin Routed Streams

NAIP06_STREAMS: Walla Walla Basin Streams Digitized to the National Agriculture Imagery Program Satellite Image
Fisheries

CTUIR_Telemetry:  Telemetry Data from the Confederated Tribes of the Umatilla Indian Reservation

BullTrout_Dist:  Bull Trout Distribution

CHS_Dist:  Spring Chinook Distribution

STS_Dist:  Summer Steelhead Distribution

CTUIR_REDD_SUR:  Redd Survey data from the Confederated Tribes of the Umatilla Indian Reservation

FISH_PASS_BARRIER_WDFW:  Stream Barriers in the Walla Walla Basin

WDFW_Density:  Washington Department of Fish and Wildlife Density Survey Data

WDFW_Spawn:  Washington Department of Fish and Wildlife Spawning Survey Data

USFWS_PITAG_SITES:  USFW Pit Tag interrogation sites.

MillCK_EVAL_SITES_CTUIR:  CTUIR evaluation sites located on Mill Creek.

TELEMETRY_CTUIR:  Fish telemetry information.
Appendix II

IWFM Geodatabase Feature Datasets and Features

**Boundary**
Model_Boundary: Polygon feature of the IWFM model boundary area.

**BYPASSES**
BYPASSES_ALL: Point feature of all surface water bypasses used in the model area.

**CALIBRATION**
GROUNDWATER: Point feature of the groundwater monitoring wells used in the calibration of the model.

**ELEMENTS**
ELEMENTS: Polygon feature of all of the elements in the model area.

**MODEL STREAMS**
STREAMS: Polyline feature of the stream segments that represent the Walla Walla Valley stream network.

**NODES**
NODES: Point feature of all the nodes within the model area.

NODES_BOUNDARY: Point feature of the nodes which represent the boundary of the model area.

NODES_Stream: Point feature of nodes that represent the stream, spring, and river locations in the model area.
**SUBREGIONS**

SUBREGIONS: Polygon feature that represents the seven regions in the modeling area.