



— BUREAU OF —
RECLAMATION

What Would the River Do?

The Question behind the Klamath River Basin Revised Natural Flow Study

CWEMF

April 2026

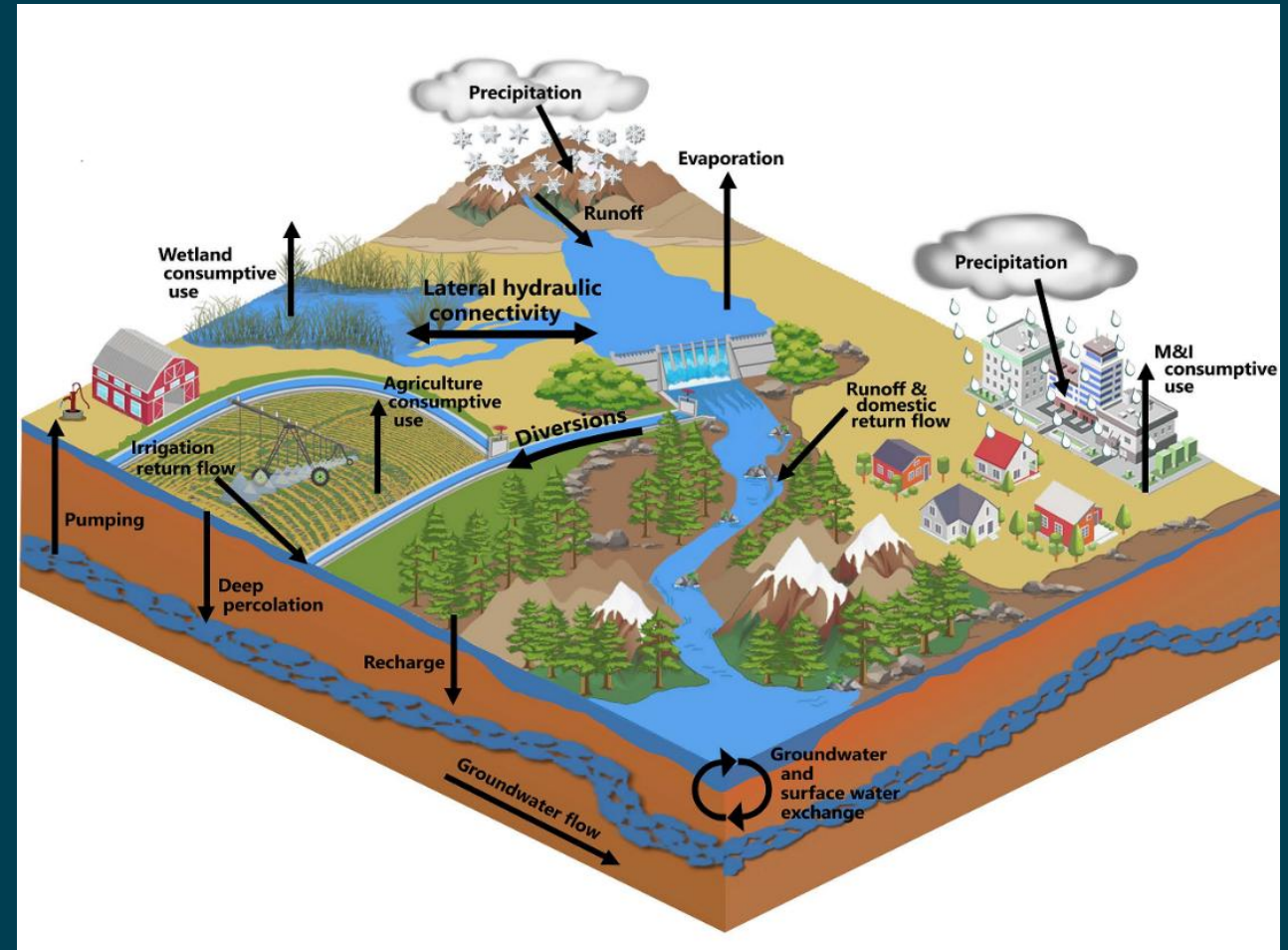
Presented by: Caroline Ubing, PE, PMP



Lost River (photo credit: Reclamation)

Agenda

- Context
- Study Motivation, Purpose, Objectives
- 2005 and Revised Study Comparison
- Process Models Overview
- Technical Review Process



Context

Klamath River

- Upside-down watershed
- Extensive Upper Basin wetlands drained to develop Reclamation's **Klamath Project** (1906), which spans 240,000 acres
- Home to **six federally recognized tribes**
- Threatened and endangered species
 - 1988 ESA listing of **Lost River sucker** and **shortnose sucker** as endangered
 - 1997 ESA listing of **SONCC coho salmon** as threatened species



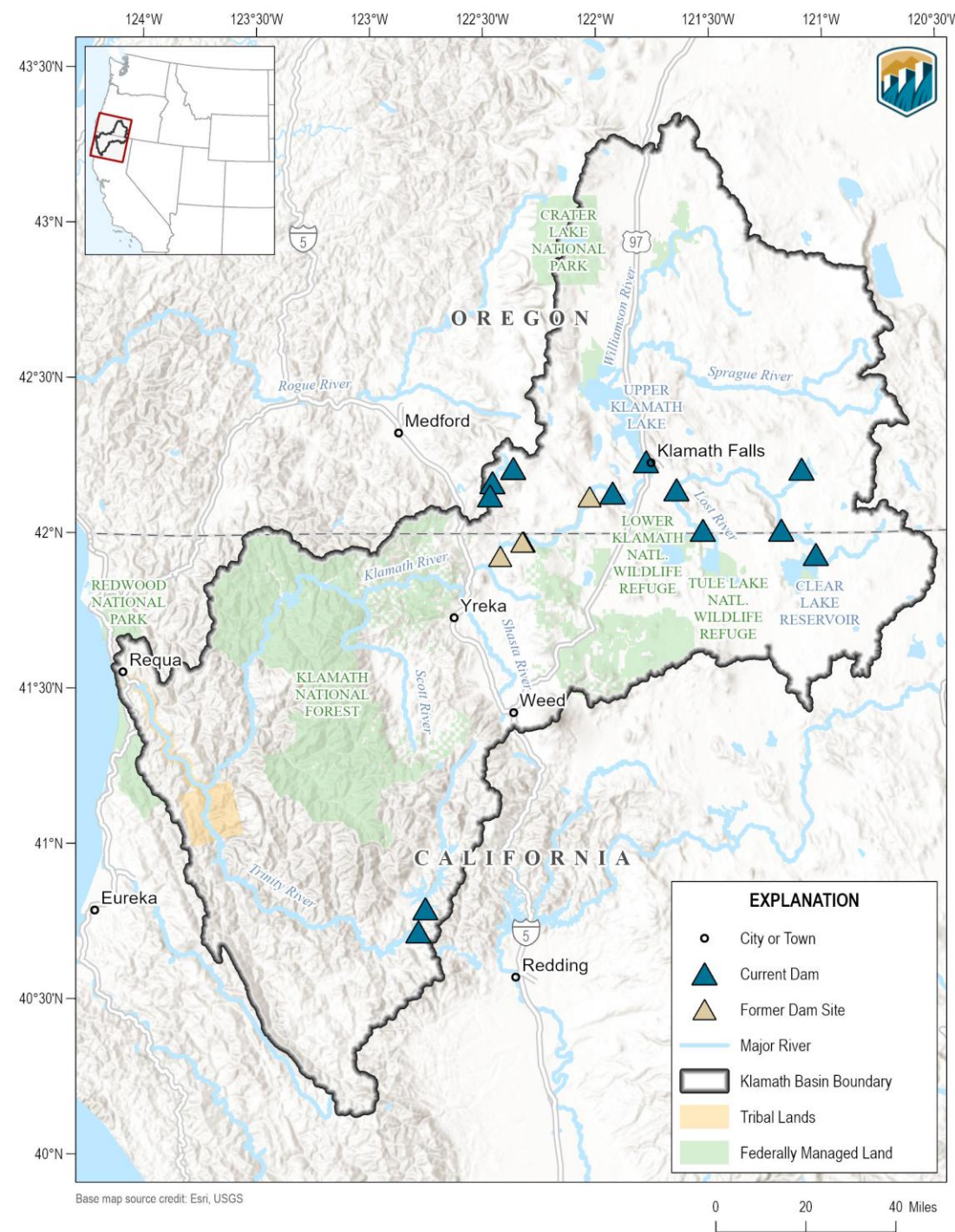
shortnose sucker



Lost River sucker



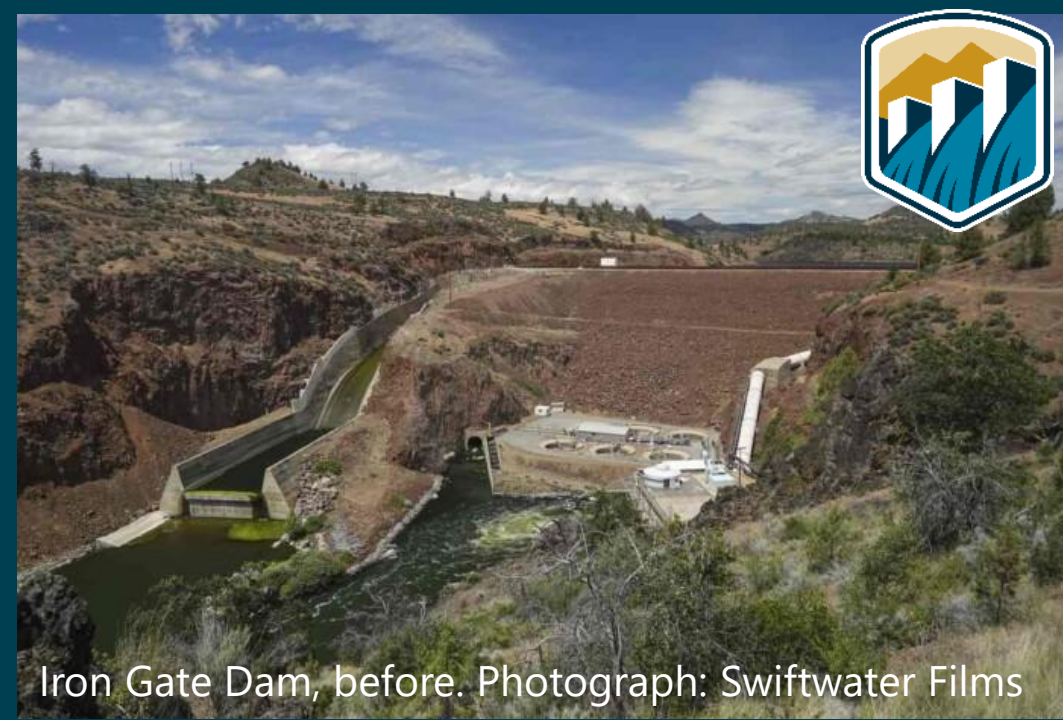
SONCC coho salmon



Context

The Klamath River

- Largest dam removal effort in U.S. History completed in 2024 with **removal of four Klamath River dams** (Iron Gate Dam shown to right)
 - Restored access to approximately **400 sq.mi. of habitat** for salmon and other native species
- Challenging water management setting
 - Little to **no carryover reservoir** storage
 - Several recent **drought** years
 - Frequent **Endangered Species Act** (ESA) consultations for Klamath Project



Iron Gate Dam, before. Photograph: Swiftwater Films



Iron Gate Dam, after. Photograph: Swiftwater Films

Klamath Revised Natural Flow Study

- **Motivation**

- **Improve scientific understanding** of Klamath Basin hydrology
- Contribute to **Klamath Basin Science Initiatives**
- Address National Research Council review of 2005 study, which called for **daily timestep and more in-depth analysis**

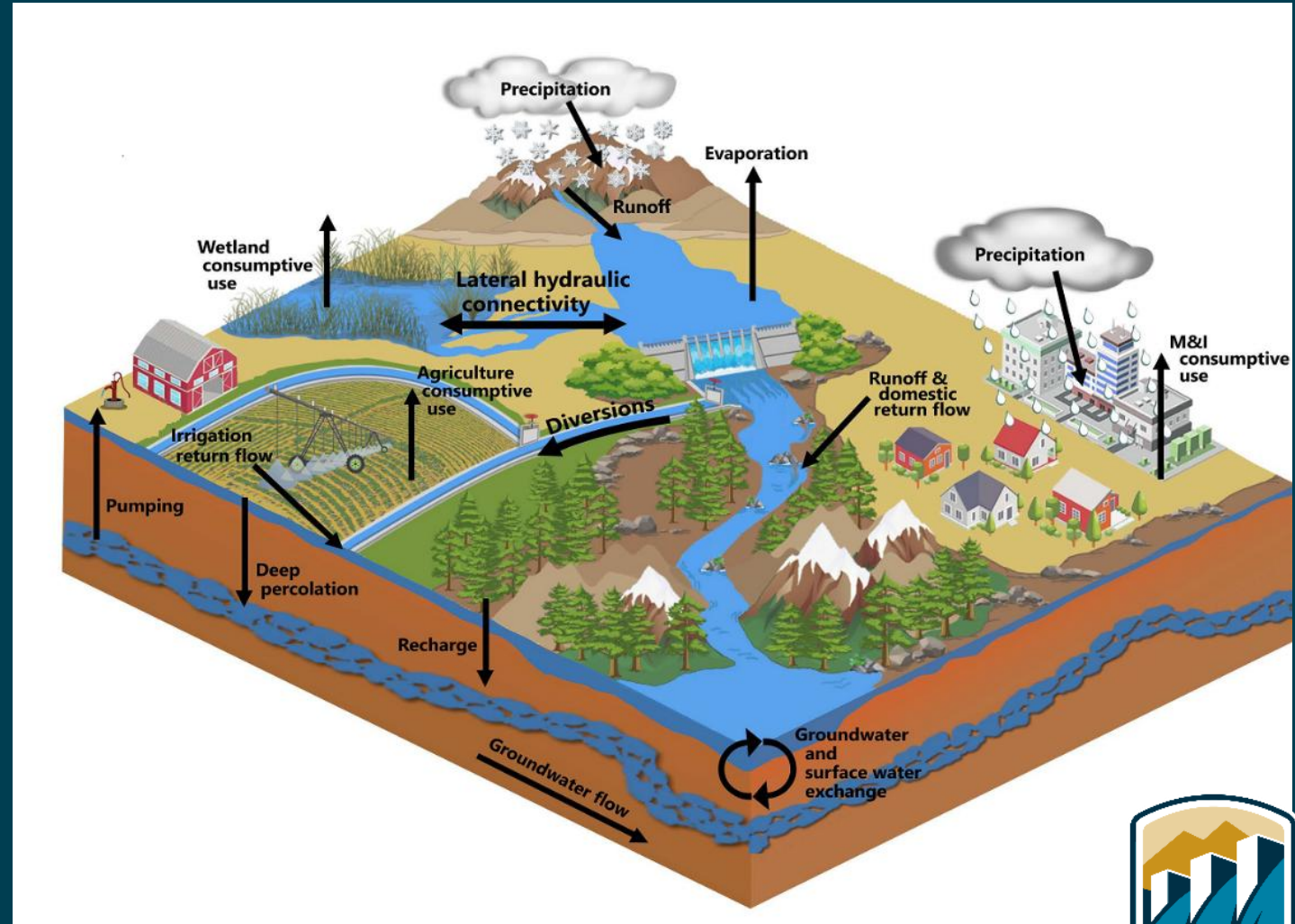
- **Purpose**

- **Estimate daily natural flows at chosen locations in the Klamath River basin**, removing the significant effects of human development

Klamath Revised Natural Flow Study

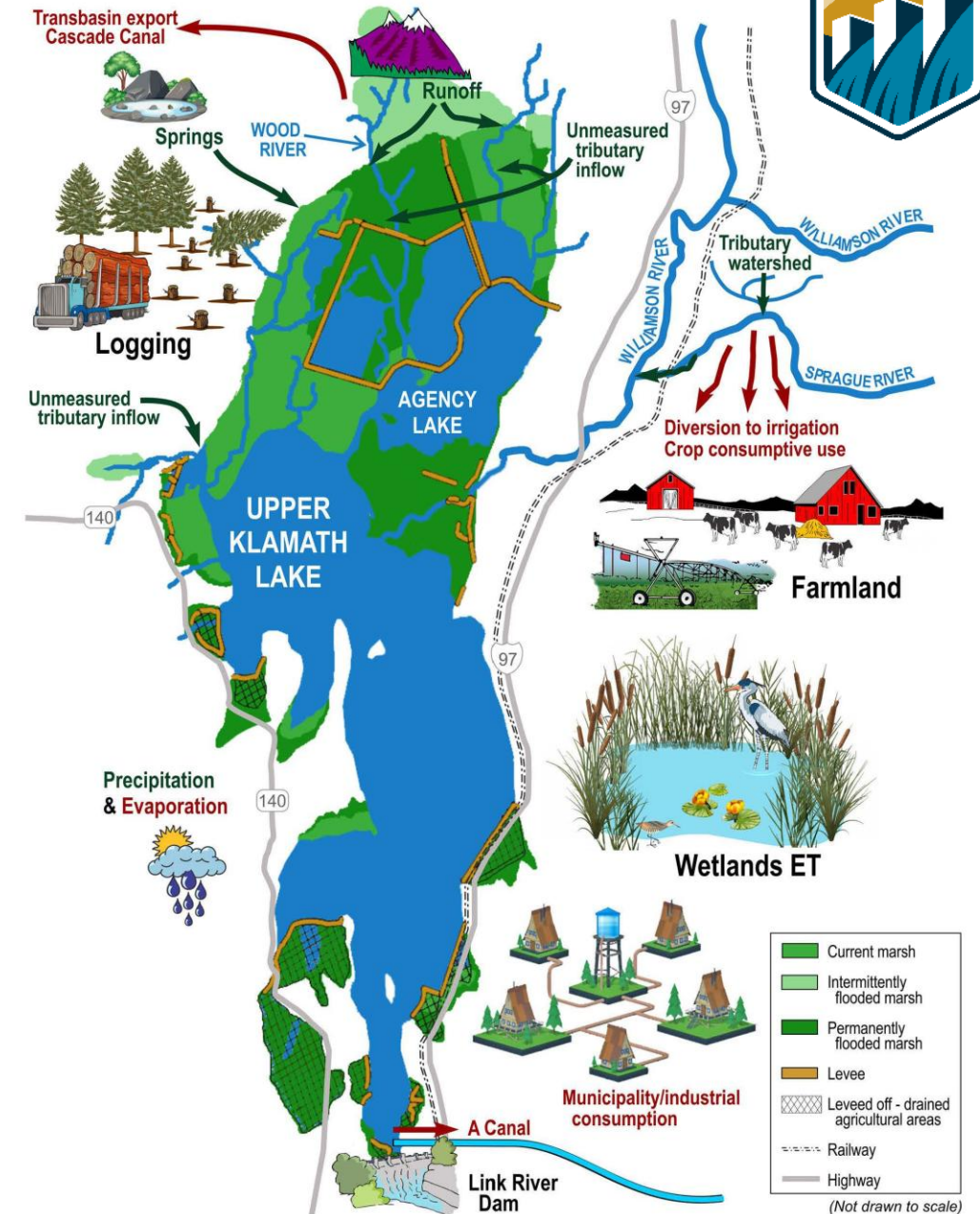
- **Objectives**

- **Inform** future:
 - habitat studies,
 - drought planning,
 - streamflow forecasting,
 - water supply/allocation planning,
 - scenario planning, etc.
- Use current data, novel scientific technologies and methods
- **Develop datasets** for pre-development and 1981-2020 conditions
- **Quantify uncertainty** in pre-development streamflow estimation



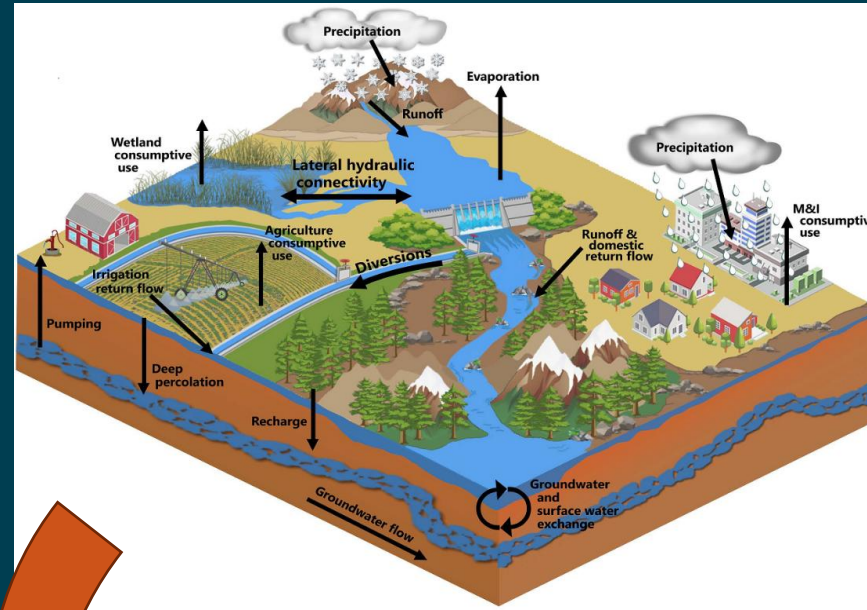
2005 Natural Flow Study

- Monthly flow timeseries for water years 1949-2000
- Basin upstream of Keno Dam
- National Research Council Recommendations (2008)
 - Daily time step
 - Quantitative groundwater assessment
 - Improve ET estimates
 - Incorporate land cover changes
 - Include investigation of high flows and their implications
 - Adhere closely to scientific standards by calibrating and testing models



Revised Natural Flow Study

- Supply the most scientifically thorough estimates of **daily** natural flows
- Process Models include:
 - Open Water Evaporation
 - Consumptive Use
 - Hydraulics
 - Surface Water Hydrology
 - Groundwater Hydrology
 - Mass Balance



Study Locations

	USGS ID	Description
Upper Basin	11501000	Sprague River near Chiloquin, OR
	11502500	Williamson River below Sprague River near Chiloquin, OR
	11507500	Link River at Klamath Falls, OR
	11504115	Wood River near Klamath Agency, OR
	11509500	Klamath River at Keno, OR
	11510700	Klamath River below JC Boyle Powerplant near Keno, OR
	11516530	Klamath River below Iron Gate Dam, CA
Lower Basin	11517500	Shasta River near Yreka, CA
	11519500	Scott River near Fort Jones, CA
	11520500	Klamath River near Seiad Valley, CA
	11523000	Klamath River at Orleans, CA
	N/A	Klamath River at Weitchpec, CA

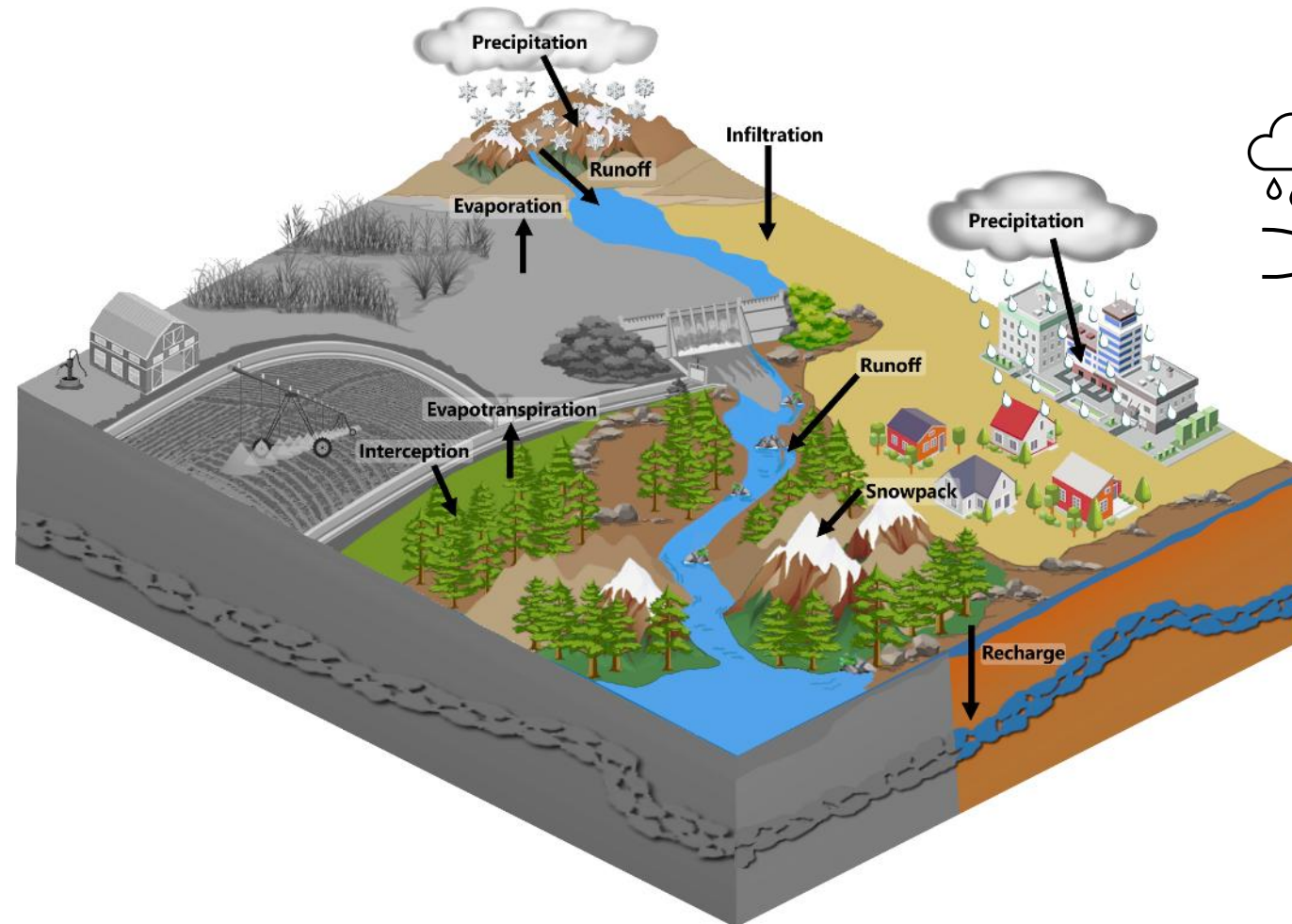


Surface Water Hydrology

Objective: To quantify how groundwater recharge from precipitation and surface runoff has changed between pre-development and 1981 – 2020 conditions

Output Use:

- GW model input data
- Fill data-gaps for natural flow timeseries
- Possibly disaggregate monthly natural flow estimates to daily



Surface Water
Hydrology



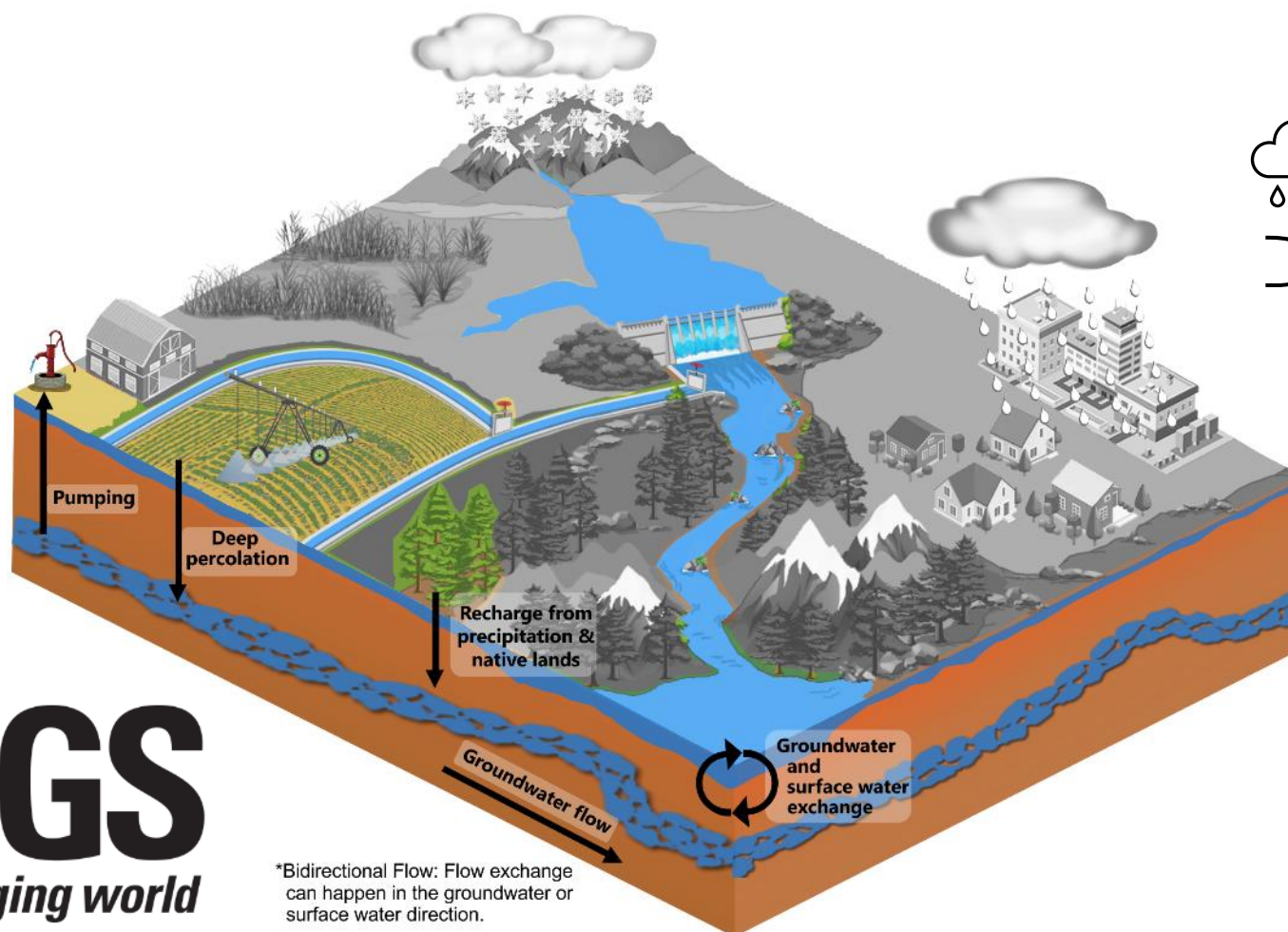
Process Models

Groundwater Hydrology

Objective: To quantify baseflow to streams and seepage to and from lakes and reservoirs.

Output Use: Mass balance model input data

 Groundwater Hydrology



Surface Water Hydrology

*Bidirectional Flow: Flow exchange can happen in the groundwater or surface water direction.



Process Models

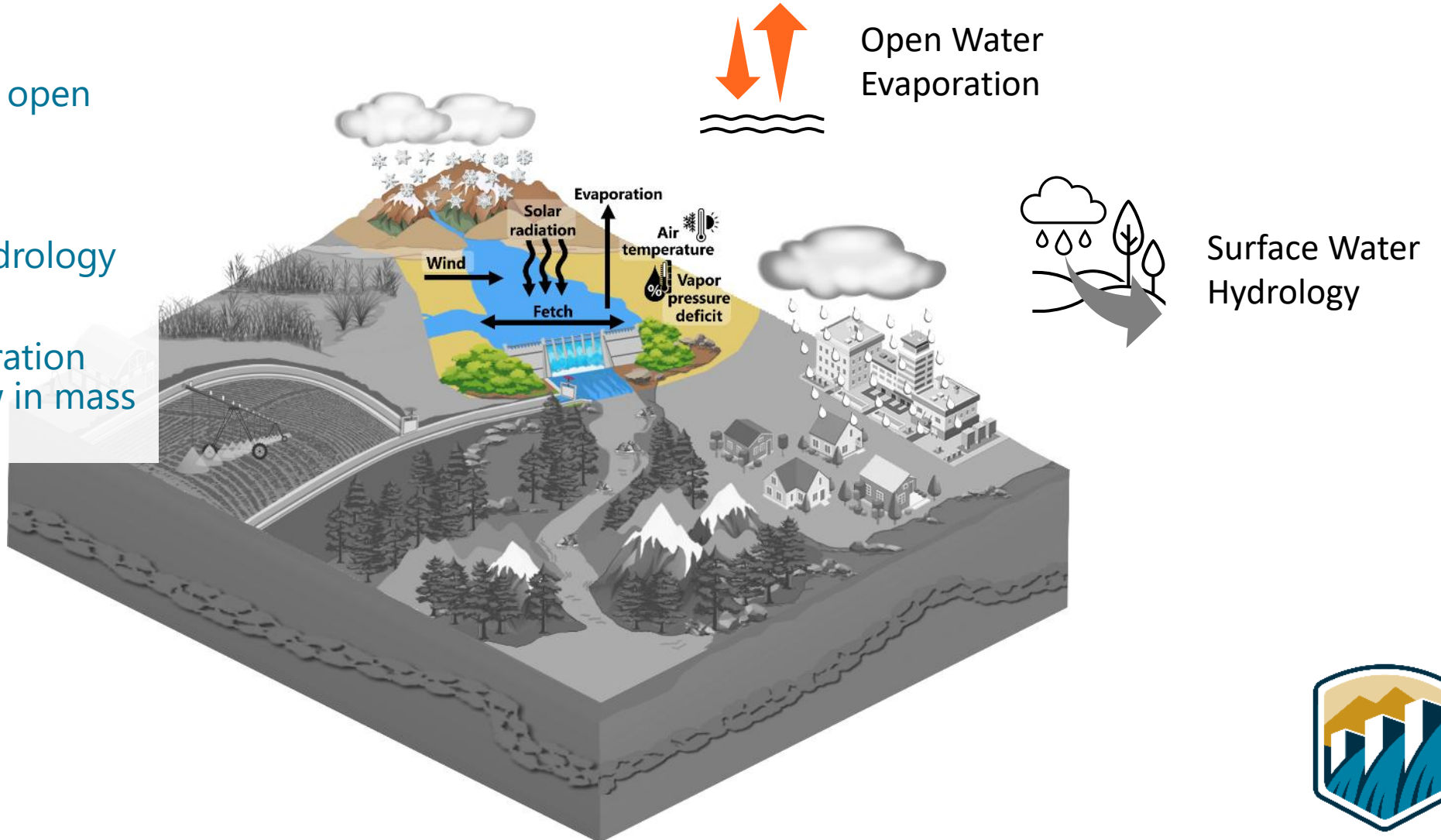
Open Water Evaporation

Objective: To quantify evaporation volumes from open water bodies.

Output Use:

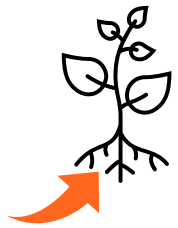
- inform surface water hydrology model calibration
- Subtracting daily evaporation volume from streamflow in mass balance model

 Groundwater Hydrology

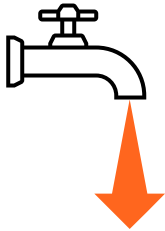


Process Models

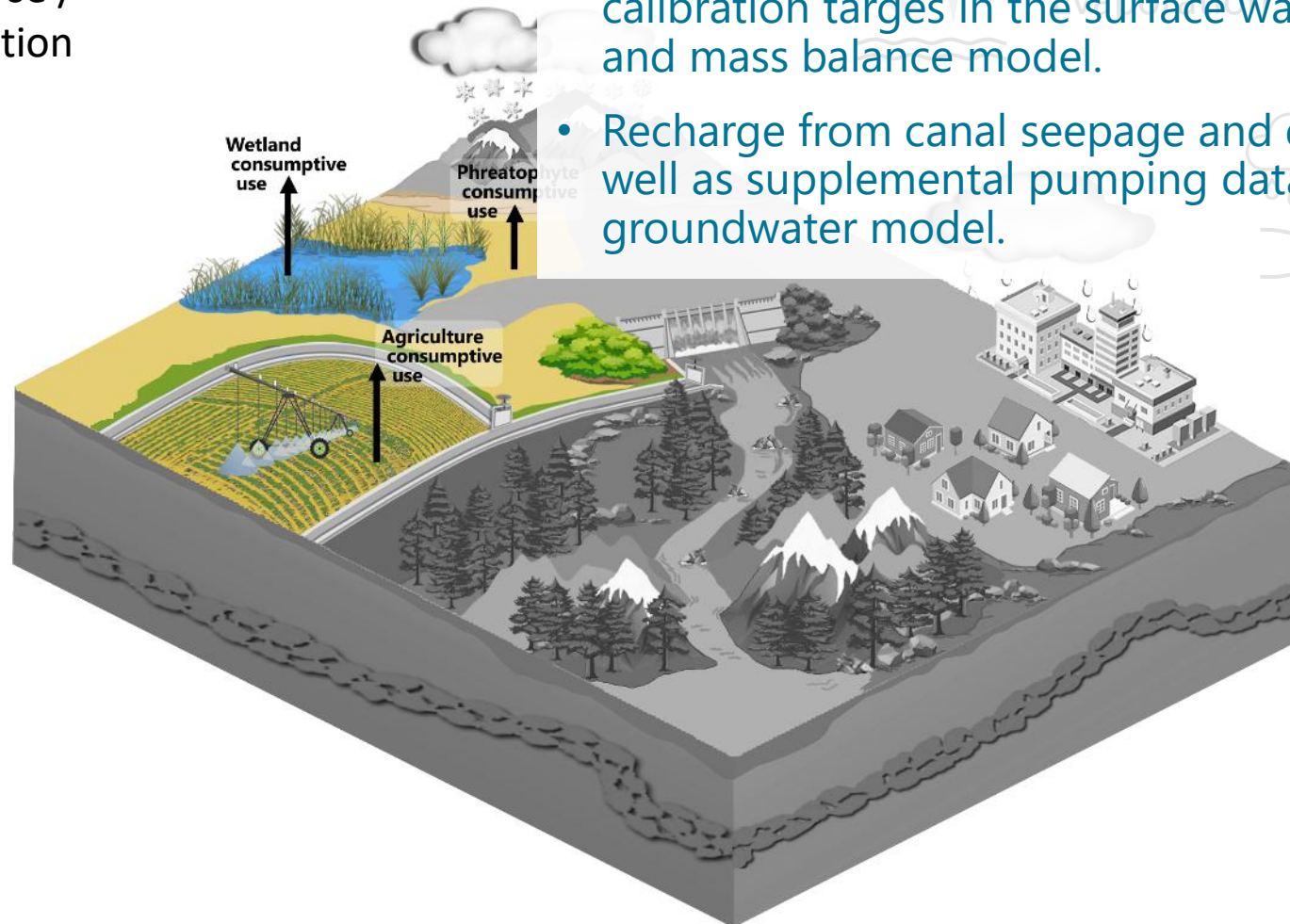
Consumptive Use



Consumptive Use /
Evapotranspiration



Agricultural
Processes



Objective: To quantify daily water volume applied to estimate agricultural processes such as vegetation consumptive use, irrigation, canal seepage, and groundwater pumping.

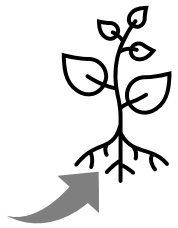
Output Use:

- Net diversions were used to estimate naturalized flow as calibration targets in the surface water hydrology model and mass balance model.
- Recharge from canal seepage and deep percolation, as well as supplemental pumping data as inputs into the groundwater model.

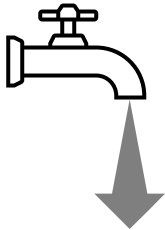


Process Models

Hydraulics



Consumptive Use /
Evapotranspiration



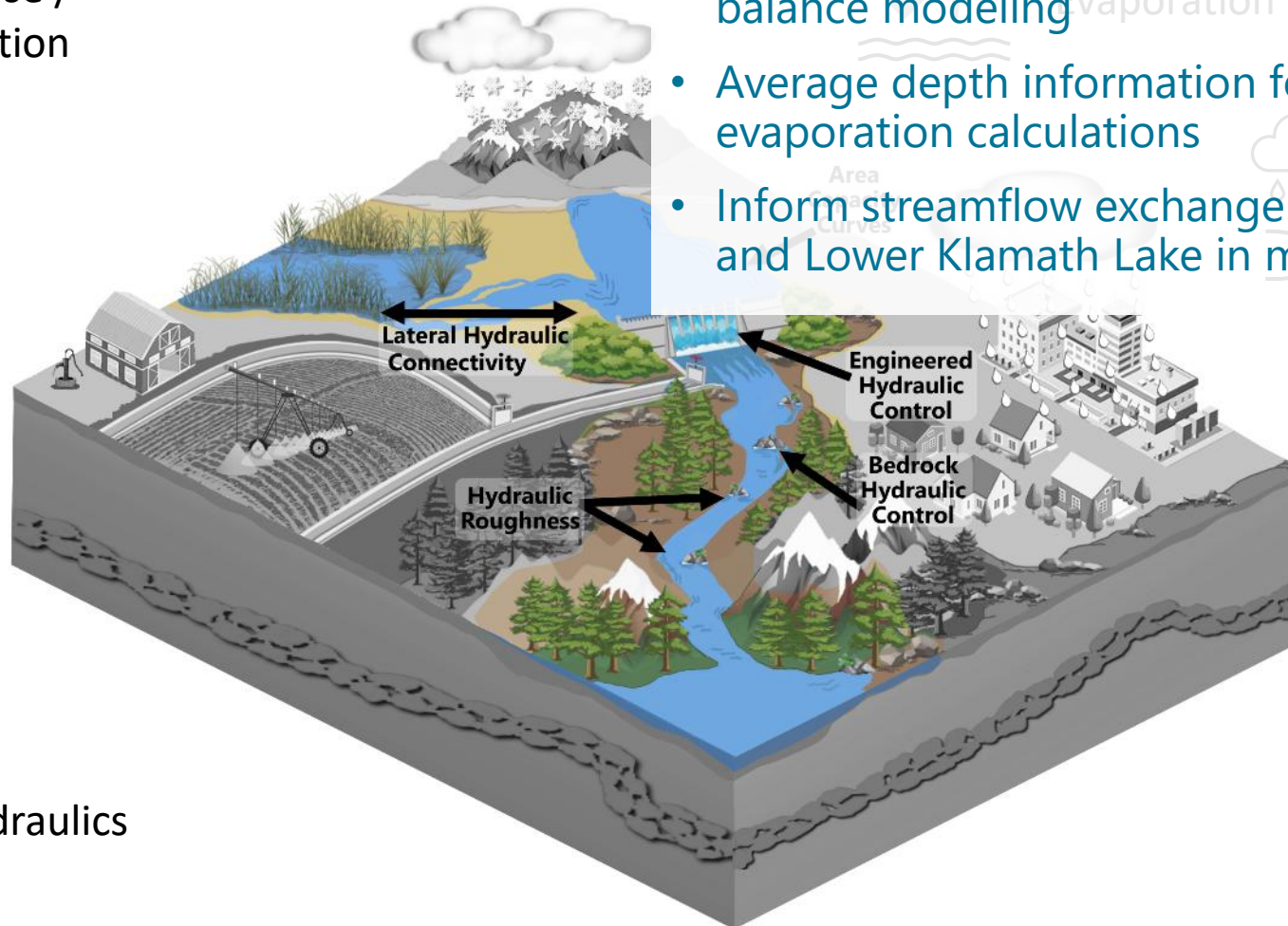
Agricultural
Processes



Groundwater
Hydrology



Hydraulics



Objective: To quantify storage capacity of lakes/reservoirs, water level and flow comparison at hydraulic controls, and surface water exchanges between the river and adjacent lands.

Output Use:

- Reservoir/lake area capacity input data for mass balance modeling
- Average depth information for open water evaporation calculations
- Inform streamflow exchange between Klamath River and Lower Klamath Lake in mass balance model.

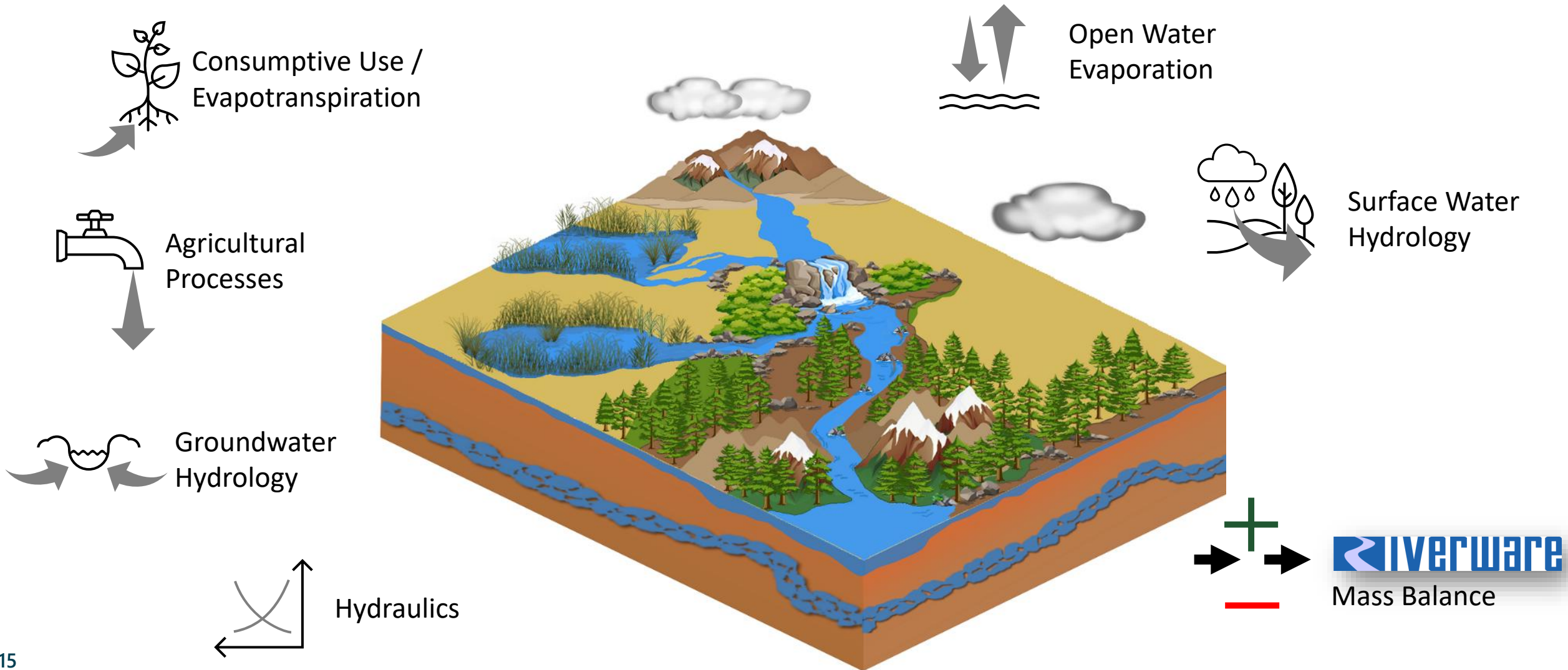




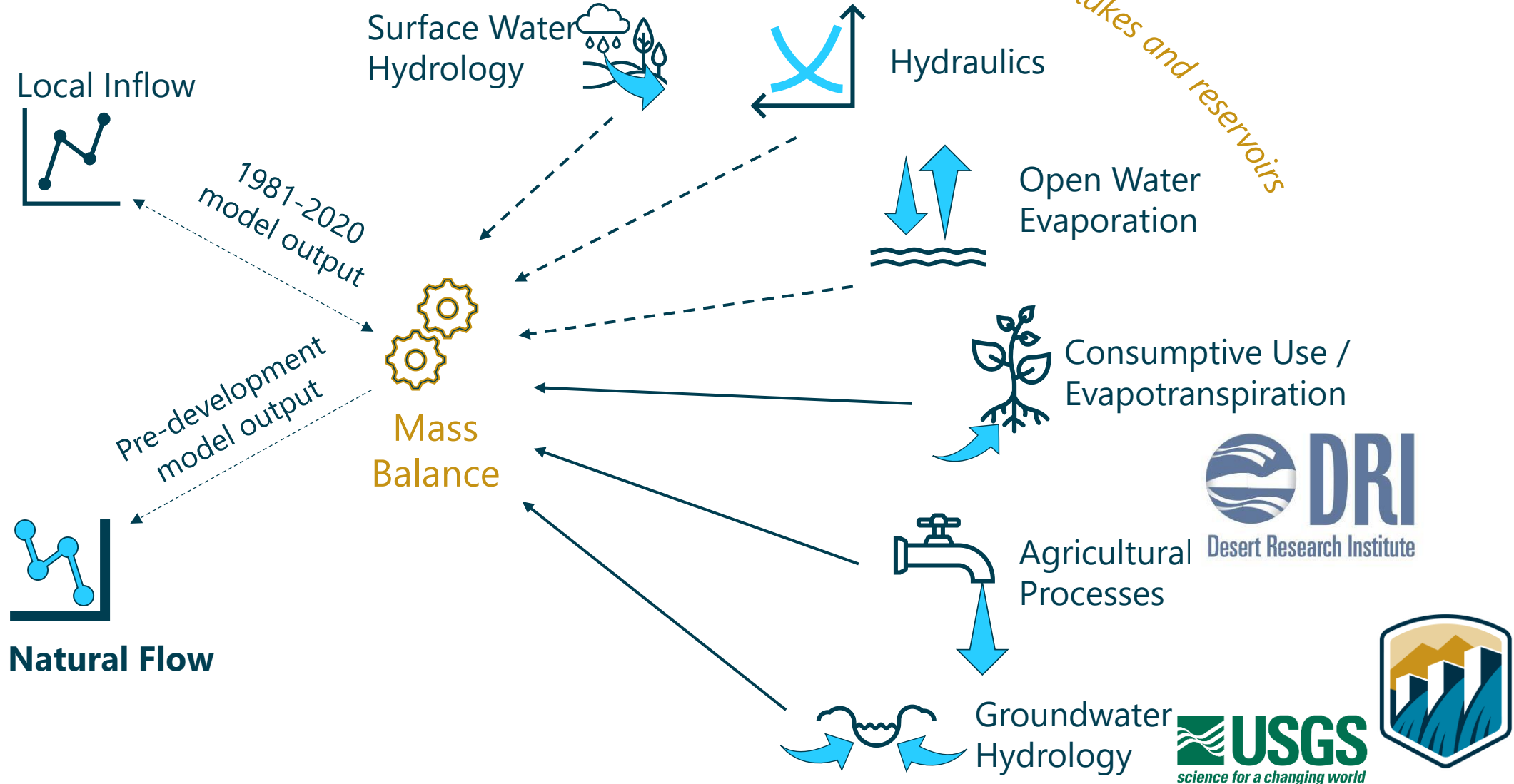
Process Models

Mass Balance

Objective: integrate all hydrologic components to simulate 1981-2020 and pre-development streamflow

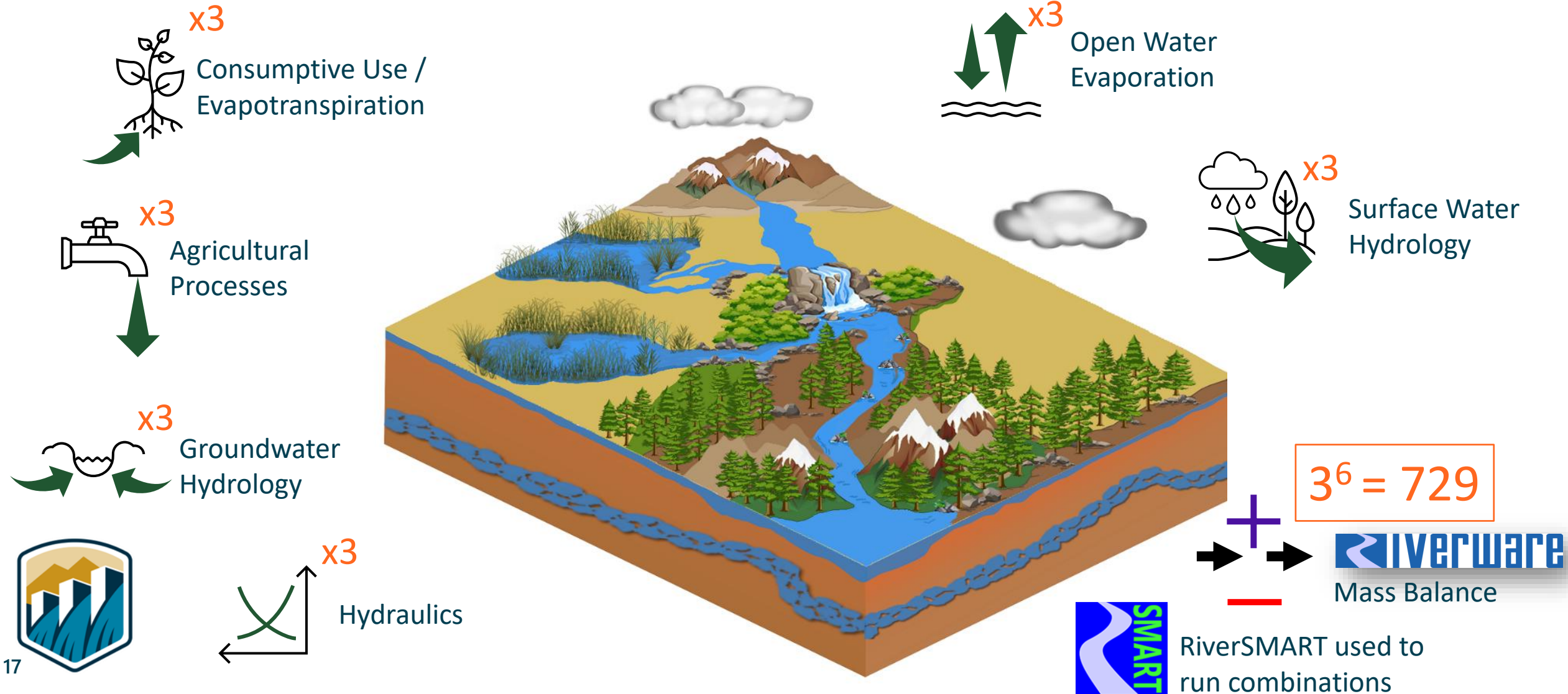


Integration analysis platforms



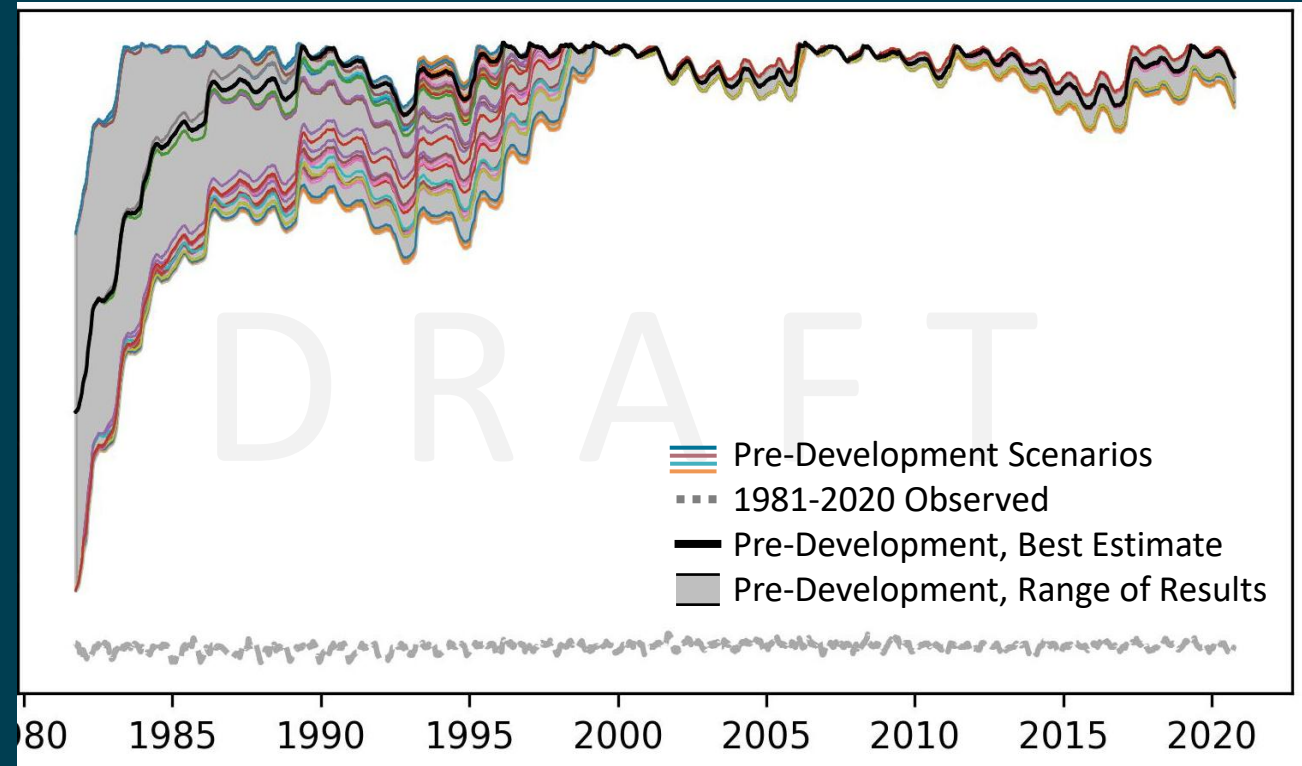
Uncertainty and Sensitivity

The final number of sensitivity runs and combinations considered has not yet been finalized or determined.



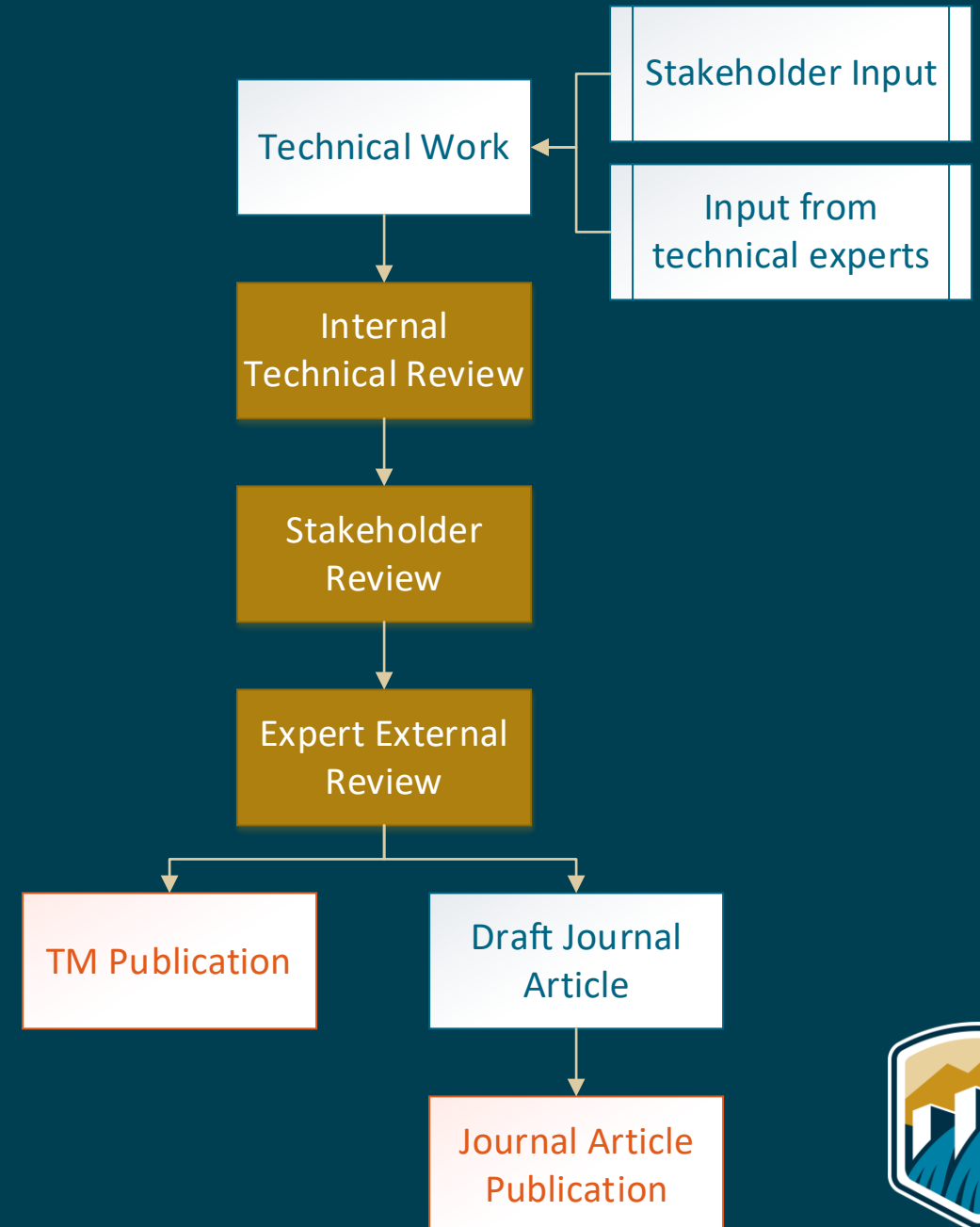
Uncertainty and Sensitivity

- RiverSMART used to run combinations of process model sensitivity output in the RiverWare Mass Balance Model
- Will result in “best” estimate and range of results



Technical Review Process

- Highly influential Scientific Assessment (**HISA**) Classification (DOI)
 - The dissemination is novel, controversial, or precedent-setting, or has significant interagency interest
- **Input from collaborators solicited throughout the study**



More Information

- Historic presentations
- Available data



<https://www.usbr.gov/mp/kbao/nfs.html>

A screenshot of the Bureau of Reclamation website. The top header is dark blue with the Bureau of Reclamation logo and name. Below the header is a yellow navigation bar with links: Water & Power, Resources & Research, About Us, Recreation & Public Use, and News & Multimedia. The main content area has a large image of a dam with water flowing over it. Below the image, the text reads "Klamath Basin Area Office" and "Welcome to the Bureau of Reclamation California-Great Basin". To the left is a sidebar menu with links: REGION 10, Region 10 Home, About Us, Area Offices, Klamath Basin Area Office, About Us, Klamath Project, Operations Planning, Meeting Materials, Environmental Compliance & Biological Opinions, Klamath Summit, Natural Flow Study, Drought Information, News Stories, Programs & Activities, Facilities, Maps, Videos, and Recreation. The main content area shows a large image of a river flowing through a landscape. Below the image, the text reads "Natural Flow Study". At the bottom, there is a paragraph of text: "The Bureau of Reclamation's Technical Service Center (TSC) is conducting the Revised Klamath River Basin Natural Flow Study (Natural Flow Study) as part of the Klamath Basin Science Initiative. The TSC is taking a comprehensive, unified".



Questions?

Upper Basin Natural Streamflow Estimates expected **2027** – stay tuned!

Many **thanks** to the Study Team:

- Reclamation
 - Project Manager: Caroline Ubing
 - Technical Lead: Marketa McGuire
 - Klamath Basin Area Office: Viktor Stromberg
 - Subject Matter Experts
 - Colin Byrne
 - Kristin Mikkelsen
 - Kelleen Lanagan
 - Austen Cutrell
 - Tim Clarkin
 - With contributions from many others!
- Desert Research Institute
 - Matt Bromley
 - Justin Huntington
 - Chris Pearson
 - Blake Minor
- USGS
 - Jon Traum
 - Riley Gannon