UPPER DESCHUTES BASIN

WATER MANAGEMENT 101

The Upper Deschutes Basin runs along the eastern flank of the Cascade Mountain Range from Crescent Lake to Lake Billy Chinook with the Deschutes River as the main waterway and several tributaries including the Little Deschutes River, Crescent Creek and Fall River. The Deschutes River and its tributaries serve as the primary source of water for six irrigation district diversions from [April to October]. This flow of water in the Deschutes River is simplistically called natural flow water. The amount of snowpack/precipitation and how quickly it may melt are the primary factors that impact the levels of natural flow throughout the irrigation season. *[see map page 2]*

There are three reservoirs in the Upper Deschutes Basin, Crescent Lake, Wickiup Reservoir and Crane Prairie Reservoir and are integral parts of the water management. These reservoirs retain water over the winter months as stored water and serve as a secondary source of water, after natural flow, for some irrigation districts (Districts). The reservoirs were built under contract with the U.S. Bureau of Reclamation (Reclamation) in the 1930s-1940s. Districts paid for the reservoirs' construction and in return have the rights to the stored water. The use and amount of stored water in Wickiup and Crane Prairie reservoirs is governed by Oregon Statutes and an Inter-District Agreement (Agreement). The Agreement was signed in 1938 between Reclamation and North Unit Irrigation District (NUID, Central Oregon Irrigation District (COID), Lone Pine Irrigation District (Lone Pine) and Arnold Irrigation District (Arnold). The 1938 Agreement was amended in 2020 to conform to the requirements of the Habitat Conservation Plan (HCP) for the Oregon spotted frog. Crescent Lake has similar agreements in place with Tumalo Irrigation District (Tumalo).

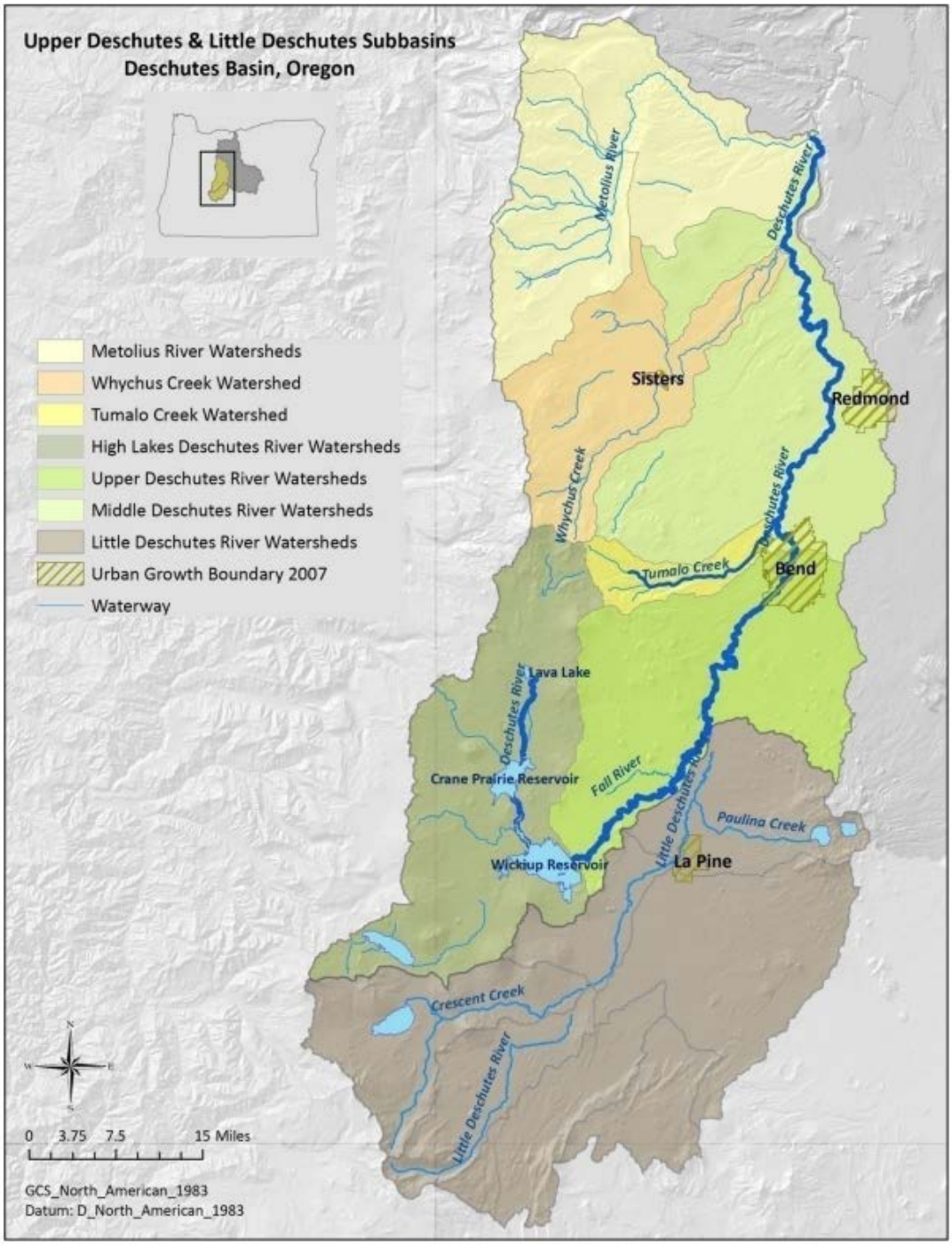
As with natural flow in the Deschutes River, the amount of water stored in the reservoirs is entirely dependent on the weather each year, with the amount of snowpack/precipitation the dominant contributor. The amount of water stored in each reservoir by April each year will dictate the amount of water a District will have available in its stored water account for that upcoming irrigation season.

For each reservoir, the Districts holding storage water rights are as follows:

- Wickiup Reservoir – NUID (100%)
- Crane Prairie Reservoir – COID, Lone Pine and Arnold (Allocated Amounts)
- Crescent Lake – Tumalo (100%)

Natural flow and reservoir levels rise and fall every year based on the amount of water received from snowfall/precipitation. When snowpack levels are above average there is a correlation with above average reservoir storage levels and natural flow. Conversely if there is a below average snowpack the correlation to below average reservoir levels and natural flows. Due to an enormous aquifer that runs

underground beneath the Upper Deschutes Basin from south to north, there is generally a two-three year lag between the level of the snowpack and resulting natural flows in the Deschutes and its tributaries. Consecutive years of drought creates a deficit of water in the aquifer that must be recharged with consecutive years of above average precipitation to get back to “average” natural river flows.



Natural Flow Water Rights

Water rights in the western U.S. are governed by the legal doctrine of Prior Appropriation. Prior Appropriation holds that the first person to take a quantity of water from a water source for "beneficial use" has the right to continue to use that quantity of water for that purpose. The first water right holders are generally referred to as Senior water right holders and holders of water rights granted at later dates than the Senior rights are known as Junior water right holders.

While all the water belongs to the State of Oregon (State), the State issues the right to use water to users thru an official certificate that sets the priority date, type of water uses and the amount of the water that can be used by each water right. The State began issuing water rights on the Upper Deschutes River in the 1890s. These water rights were officially adjudicated and decreed by a judge in 1928 with some amendments in the early 1930s. This adjudication process formally established the priority date and amounts of a State issued water right certificate to each District. This certificate dictates that the most senior District has first rights to divert up to its full amount of water right from the available natural flow supply but no more than that amount, then to the next oldest priority date District which has second rights and continuing in sequence to the most junior District. ***There is no guarantee, or legal requirement, that natural flow water is available by the time you get to the most junior District***. In fact, over time, the State issued water right quantities in excess of the natural supply. *[map of the Central Oregon Districts on page 5]*

The irrigation period is legally defined between April 1 through October 31 and is divided into five seasons. The quantity of water a District can divert is also established by the water right certificate but generally follows as below:

1. April 1 to 30 @ 50% of the maximum water right
2. May 1-14 @ 75%
3. May 15-September 14 @ 100%
4. September 15-30 @ 75%
5. October 1-31 @ 50%

The list of Deschutes River water right holders, priority date and the full mid-summer amount [Season 3] of natural flow water allowed to divert is below and ranked from most senior to junior:

1. 1899 Swalley Irrigation District – 84 cubic feet per second (cfs)
2. 1900 COID – 930 cfs
3. 1900 Lone Pine – 39 cfs
4. 1905 Arnold - 150 cfs
5. 1905 Tumalo – 9.5 cfs
6. 1907 COID – 371 cfs
7. 1911 Tumalo – 41 cfs
8. 1913 NUID – 1,099 cfs

Per the legal doctrine of Prior Appropriation, Swalley has first rights to divert up to 84 cfs in the middle of the summer, then second is COID with rights to divert up to 930 cfs, then Lone Pine, etc… ***The primary element to understand is that after each District diverts water there needs to be water available for the next District to be able to divert. If there is no more available***

natural flow water, then that next user is not allowed by law to divert any water*. [water measurement and management are discussed later].*

Example:

Deschutes River Natural Flow	1,050 cfs		
1899 Swalley diversion	65 cfs	Remaining balance	985 cfs
1900 COID diversion	875 cfs	Remaining balance	110 cfs
1900 Lone Pine diversion	39 cfs	Remaining balance	71 cfs
1905 Arnold diversion	95 cfs	Remaining balance	-24 cfs

For this example, Arnold wants to divert 95 cfs but there is only 71 cfs of natural flow available, therefore Arnold can divert 95 cfs but only 71 cfs is available. In addition, in this example no other District junior to Arnold can divert any water.

Stored Water Rights

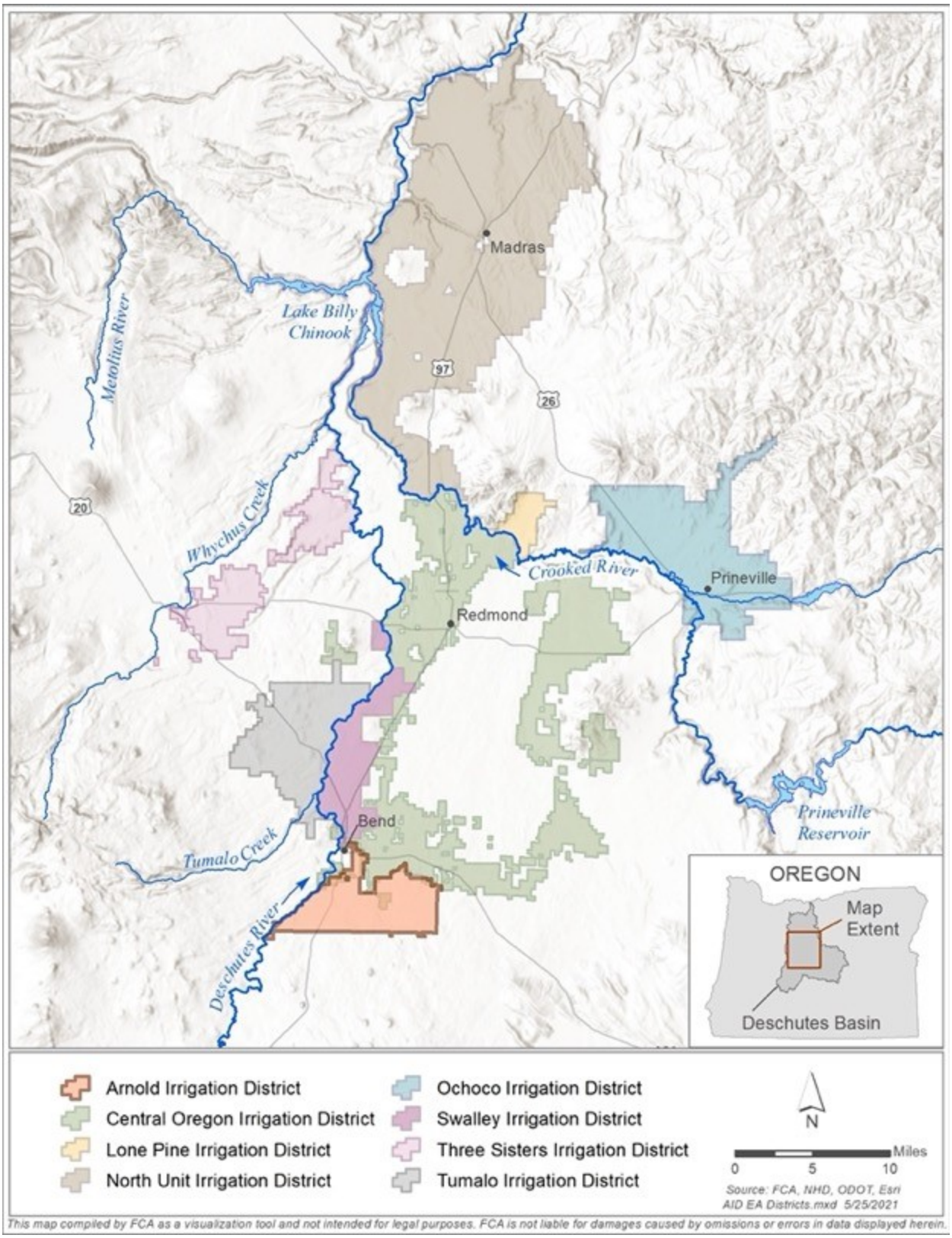
Stored water is a secondary source of water available to Districts that are attached to one of the three reservoirs as explained above. The stored water can be utilized when the natural flow water availability is less than what a District wants to divert to meet its patron demand. In a way it is like a savings account to be used when your normal income runs out, but it is an amount reset every year based on the amount in the reservoir.

Using the above example, Arnold wanted to divert 95 cfs but there was only 71 cfs of available natural flow. Arnold can release 24 cfs from its Crane Prairie storage account to make up the difference if it has water in its storage account.

Each reservoir is allowed to legally retain water, instead of it all flowing downstream from the end of October to the beginning of April. (There are minimum water release requirements for each reservoir). The amount of water retained, or stored, accumulates during the winter and is measured and monitored by the State, Reclamation and the associated District(s) for each reservoir. The amount of water that accumulates in a reservoir is entirely dependent on the weather and resulting precipitation. There is a maximum capacity for each reservoir as follows:

- Wickiup Reservoir – 200,000 Acre Feet (AF)
- Crane Prairie Reservoir – 50,000 AF
- Crescent Lake – 86,900 AF

As mentioned above, the AF in Wickiup are dedicated to NUID and the AF in Crescent are dedicated to Tumalo. Crane Prairie is more complicated as the full amount of capacity is not available for Districts' use as the HCP carries conditions on the management of the water in Crane Prairie. Generally, Crane Prairie fills to 48,000 – 49,000 AF every year and out of that capacity Lone Pine and Arnold get between 10,000 – 12,000 AF to equally share each season, or 5,000 – 6,000 AF to Lone Pine and that same amount to Arnold. Arnold has utilized the maximum amount of the storage account in each of the past two years and will assuredly need to do the same again in 2022.


Madras
Lake Billy Chinook
Metolius River
Whychus Creek
Crooked River
Prineville
Redmond
Bend
Tumalo Creek
Deschutes River
Prineville Reservoir
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OREGON
Map Extent
Deschutes Basin
Arnold Irrigation District
Central Oregon Irrigation District
Lone Pine Irrigation District
North Unit Irrigation District
Ochoco Irrigation District
Swalley Irrigation District
Three Sisters Irrigation District
Tumalo Irrigation District
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Source: FCA, NHD, ODOT, Esri
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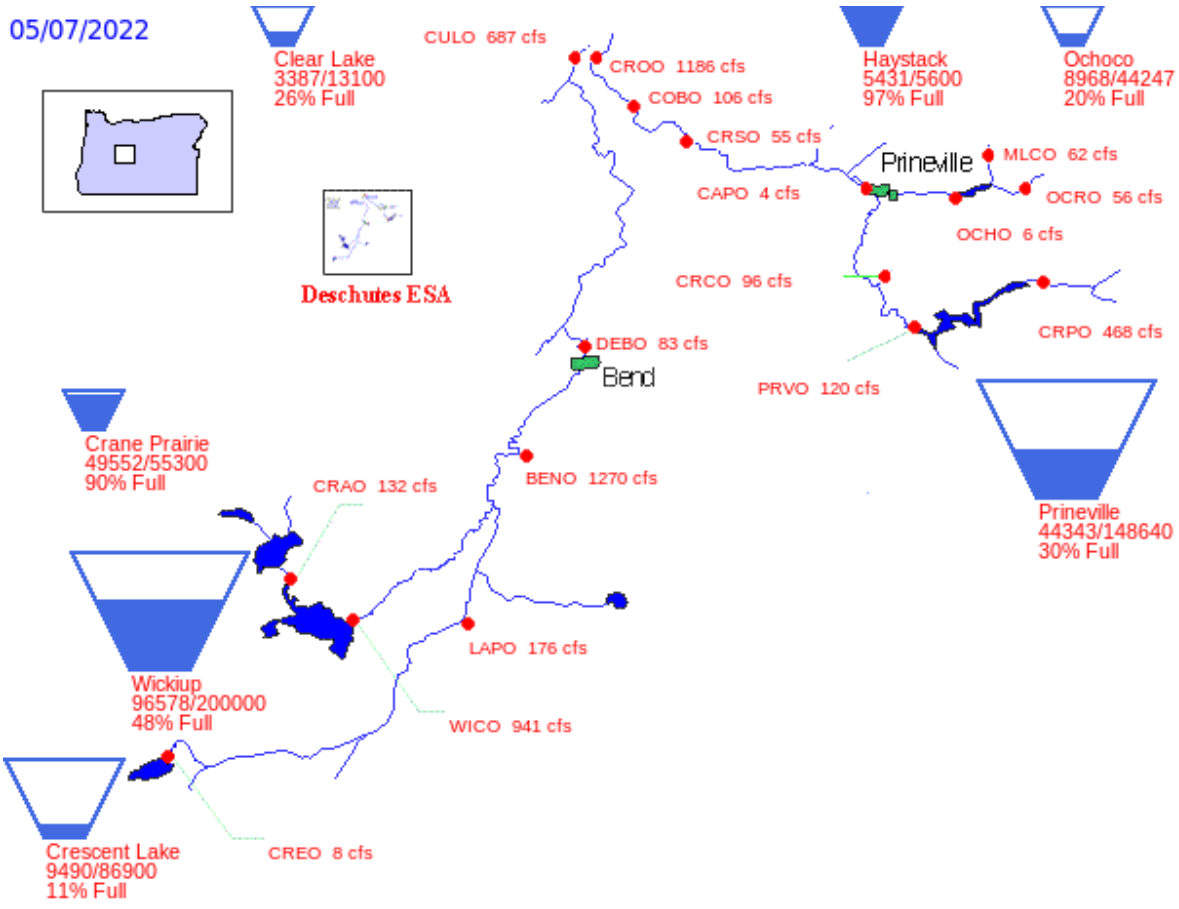
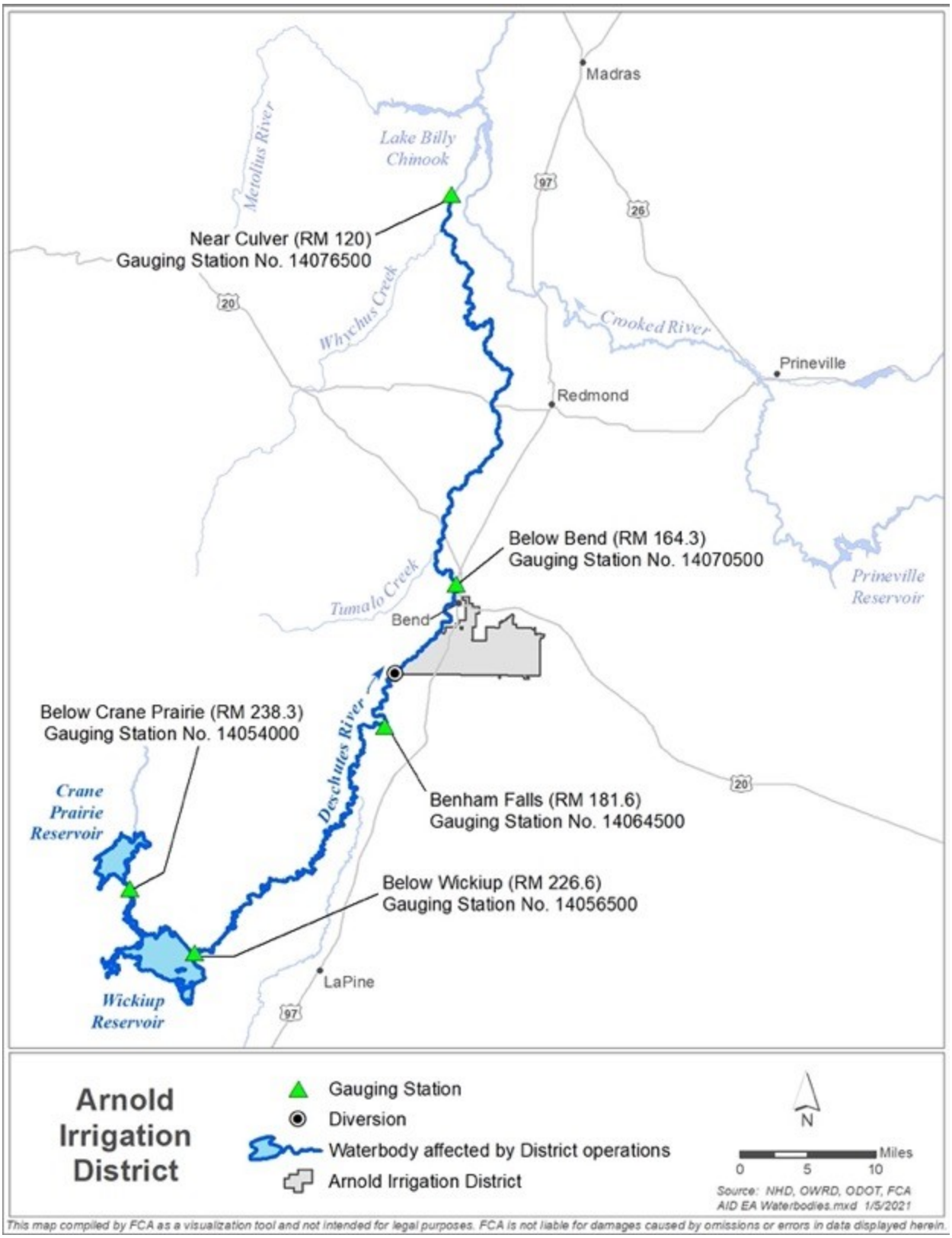
Water Measurement & Management

The fundamental capability to monitor and manage the complexity of the water resource and its use is through measurement. There are significant resources dedicated to 24 hour/365 days a year electronic water measurement in the Upper Deschutes Basin. These water measurement resources have been implemented over time through coordination and expenditures by Reclamation, the Oregon Water Resources Department (OWRD) and the Districts, with the resulting data being available to view on the internet. The figure below is commonly referred to as "the teacup" diagram as the shape of the reservoirs and is a snapshot of several, but not all, measuring locations on the Upper Deschutes and Crooked Rivers. *[list of specific resources and instructions on how to utilize follows]* .

Natural flow and stored water are measured by either manual or electronic reading of staff gauges. A staff gauge is like a big ruler that is used to measure water level. Digital equivalents are utilized now and the height of a water column on a staff gauge is correlated to an amount of streamflow in cfs or storage in AF. Historical water measurement information is also readily available online.



In addition to the reservoir and streamflow measurements above, each District's river diversion is also measured, recorded and available on the internet 24/7. A map showing the staff gauge locations for Arnold is on page 7.


Madras
Lake Billy Chinook
Metolius River
Near Culver (RM 120)
Gauging Station No. 14076500
Whychus Creek
Crooked River
Prineville
Redmond
Below Bend (RM 164.3)
Gauging Station No. 14070500
Prineville Reservoir
Tumalo Creek
Bend
Below Crane Prairie (RM 238.3)
Gauging Station No. 14054000
Deschutes River
Crane Prairie Reservoir
Benham Falls (RM 181.6)
Gauging Station No. 14064500
Below Wickiup (RM 226.6)
Gauging Station No. 14056500
LaPine
Wickiup Reservoir
97
26
20
Arnold Irrigation District
Gauging Station
Diversion
Waterbody affected by District operations
Arnold Irrigation District
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Miles
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Source: NHD, OWRD, ODOT, FCA
AID EA Waterbodies.mxd 1/5/2021
This map compiled by FCA as a visualization tool and not intended for legal purposes. FCA is not liable for damages caused by omissions or errors in data displayed herein.

A representative example of online real time data for the Districts' diversions is shown below. It is important to recognize that these readings are total water and does not separate natural flow and stored water. The readings let you know what is being diverted at any moment in time and generally follows the physical location of the river diversions as you head downstream from Arnold which is the furthest south to Swalley which is the furthest north (excluding Haystack Reservoir which serves as a buffering reservoir internal to NUID operations). Protected instream water from past water conservation projects by Districts and instream leasing is one important element missing from the automated gauge readings and acts as the most senior right and gets filled first as if it were a diversion.

Every District's Manager and staff follow these numbers several times during the day and night during the irrigation season. Each District will then manage its own staff gauge readings internal to their own systems to manage flows to the headgates.

Canals

Code	Station Name	Last Data Value		
ARNO	Arnold Canal	8-May-10:15	2.14	78.8 cfs
CENO	Central Oregon Canal	8-May-10:30	4.83	341 cfs
DCMO	Deschutes County MID Canal	8-May-10:30	17.2 cfs	
HAY	Haystack Reservoir near Culver, OR	8-May-11:00	1.68	137 cfs
NCAO	North Canal near Bend, OR	8-May-10:30	7.68	368 cfs
NMCO	North Unit Main Canal	8-May-10:30	7.86	289 cfs
SWCO	Swalley Canal	8-May-10:30	38.9 cfs	
TFCO	Tumalo Feed Canal (Flowmeter)	8-May-10:15	65.8 cfs	

Natural Flow Calculation

All these readings are utilized by the OWRD WaterMaster and the Districts to determine how much natural flow and stored water is flowing down the Deschutes River. An additional factor is the amount of water that is protected instream. It is frankly a complex, near byzantine, combination of how much snowpack is melting and flowing into the reservoirs and tributaries and measuring the reservoir changes and releases. The reservoirs do not retain all their water and experience seepage and evapotranspiration losses and these factors are incorporated in the water availability calculations. In addition, the Deschutes River also loses water as it flows north so it is not an exact science and there are variables at play every day.

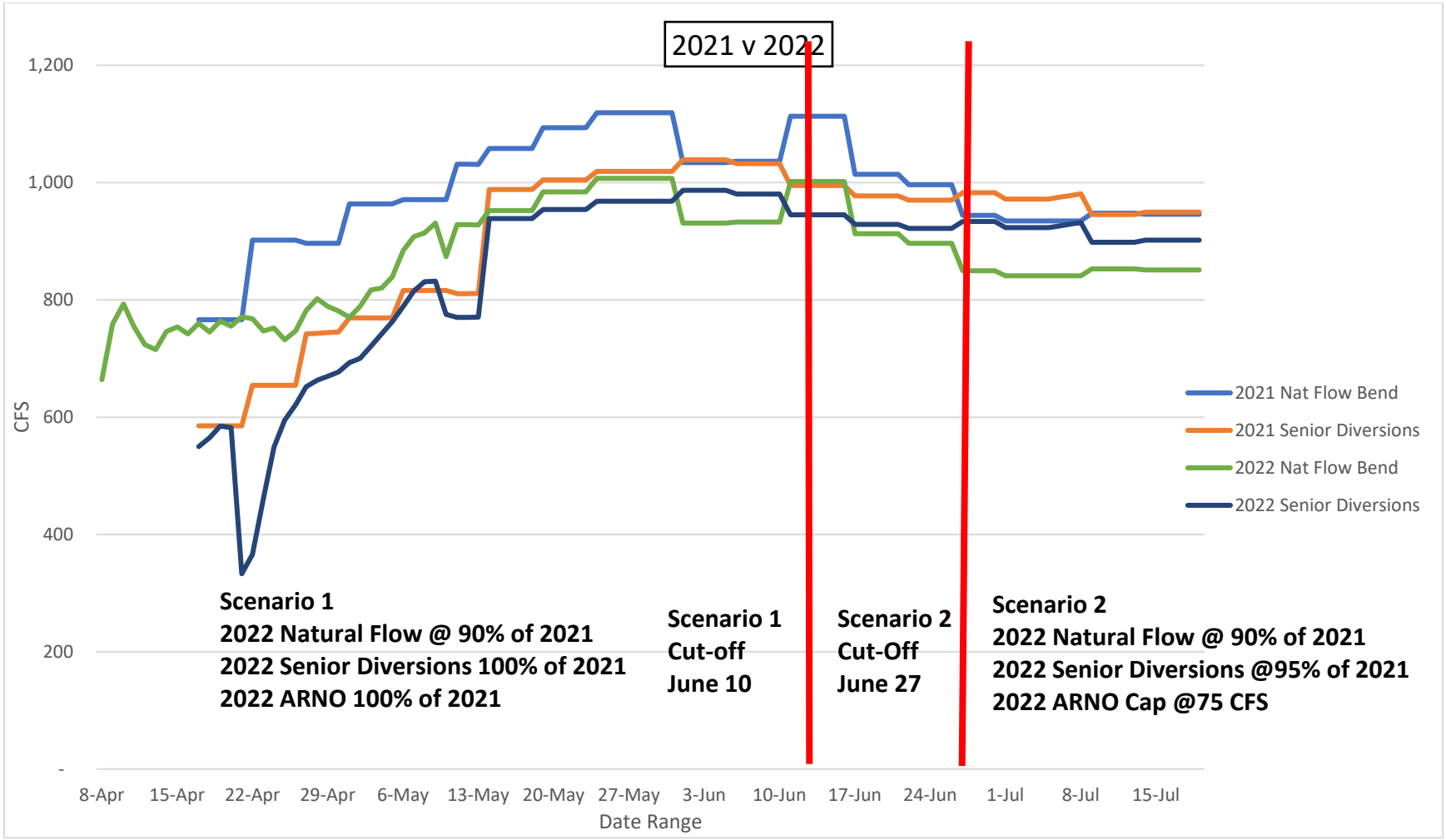
In past years where there was plenty of snowpack and all the reservoirs were full there was less urgency on determining the natural flow availability for each District. Consecutive years of severe drought have now made it necessary to monitor on a daily basis. All the Districts have recently begun using a shared spreadsheet in order to calculate the daily natural flows to each District and there is awareness when a given District is "on storage" or natural flow to meet its diversion needs. It is difficult to accurately forecast natural flow beyond comparing to past years totals, but rough forecasts can be used for planning purposes.

Using Real Time Data to Manage

Referencing the Canal flows above as an example and reorganizing by prior appropriation, the following table demonstrates the interaction of natural flow and storage as allocated to each District. This is based on the new tool developed this year by the Districts with oversight by OWRD. Previously these numbers were known only every two weeks. *[all numbers below in cfs]*

Flow at Benham Falls (BENO)		1,280		
[Deschutes River loses 6-7% on the way from BENO to the Bend diversions]				
Natural Flow at Bend		908		
Storage Flow at Bend		372		
	Diverted	Nat Flow Used	Nat Flow Remaining	Storage Used
Instream Protected Water	81	81	827	
1899 Swalley	39	39	788	
1900 COID (two canals)	681	681	107	
1900 Lone Pine	28	28	79	
1905 Arnold	79	79	-	
1905 Tumalo	17	-	-	17
1913 NUID	289	-	-	289

The result of this effort is to as accurately as possible know what amount of daily natural flow is available to each District as it follows prior appropriation. This is critical as to when Arnold starts drawing from its storage account and the clock starts ticking on when we would run out of water to divert. Operationally once Arnold is drawing storage it will attempt to divert less water to consume less from its storage account and use as much natural flow as possible to extend the irrigation season as long as possible. The challenge with our existing system is that there is a minimum amount of diversion necessary for the system to function properly and equitably deliver to all the headgates with the weather as a major influence on that goal. The hotter the temperature gets the higher demand for water deliveries but the less water becoming available later. With continued drought and lower natural flow levels in consecutive years the importance of water conservation is absolutely imperative for the sustainability of Arnold. District modernization through conserved water projects reduce the overall amount of water the District needs because it "loses" less water from seepage and therefore does not need to divert as much. In addition, lower diverted water levels also mean less demand on the storage account and will extend the irrigation season.



Update May 10. 2022

Natural flow continues to lag behind last year approximately 10% with the senior diversions taking slightly less water than last year.
If this trend continues with moderate weather and we hold our diversion where it is right now @ 75cfs we estimate our water supply will hold out until June 27th. The situation changes daily and there are no guarantees, but we will continue to deliver to all headgates in an equitable manner.

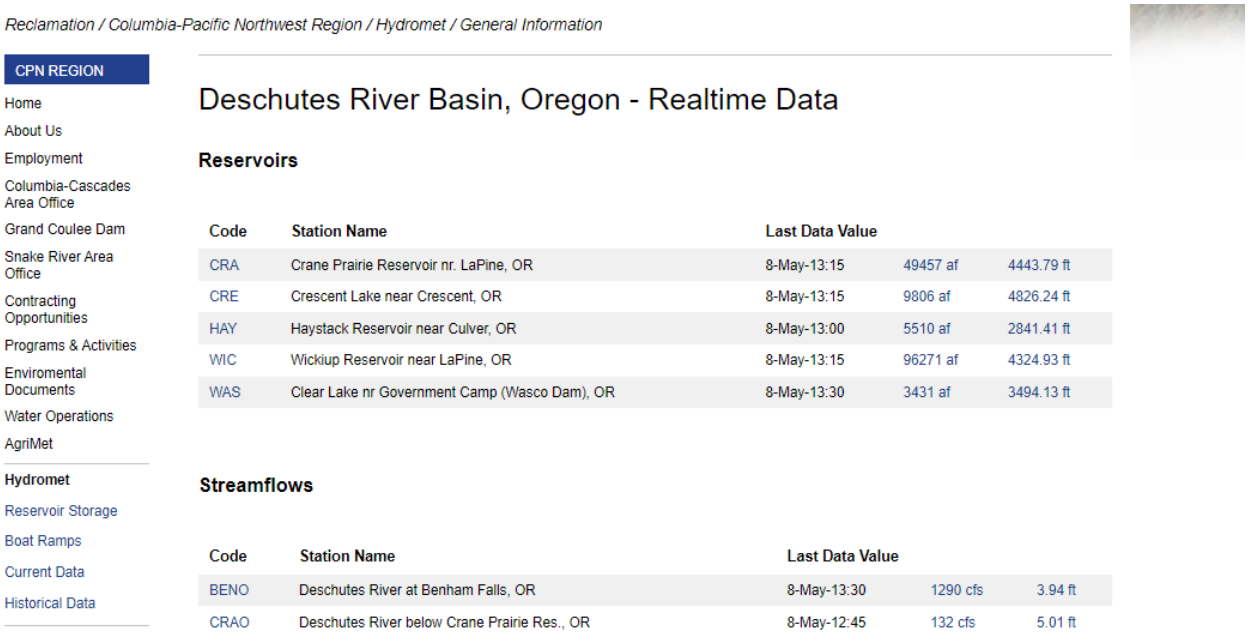
Resources

Water rights per prior appropriation table (cfs)

District	Irrigation Acres	4/1 - 4/30	5/1 - 5/15	5/15 - 9/15	9/16 - 9/30	10/1 - 10/31
Swalley (1899)	4,364	33.267	44.485	83.982	44.485	33.267
COID (1900)	43,163	516.163	694.474	930.389	694.474	516.163
Lone Pine (1900)	2,369	24.5	30.8	38.8	30.8	24.5
AID (1905)	4,384	85.96	112.41	150	112.4	85.96
Tumalo (1905)	8,114	9.5	9.5	9.5	9.5	9.5
COID (1907)		0	0	371.595	0	0
Tumalo (1911)	Storage	41	41	41	41	41
North Unit (1913)	49,943	1,099	1,099	1,099	1,099	1,099

Reclamation Hydromet

- Realtime Data - https://www.usbr.gov/pn/hydromet/rtindex/deschutes.html



- From the Realtime Data page above select Historic Data. From there use the drop-down box to find the four letter abbreviation for the gauge reading you wish to select – click "Find Available Data" and then enter the date range you wish to review. For reservoir levels select the AF parameter box then click "Retrieve Daily Data". For stream flows select the QD parameter box or for canal diversions select the QJ parameter box.

- Teacup – https://www.usbr.gov/pn/hydromet/destea.html

Monthly Drought Updates -
https://apps.wrd.state.or.us/apps/wr/wr_drought/current_updates.aspx

This provides information and data on Oregon water conditions, snowpack levels and percent of average per basin , drought monitor from the USDA and weather forecasts on precipitation and temperature from NOAA.