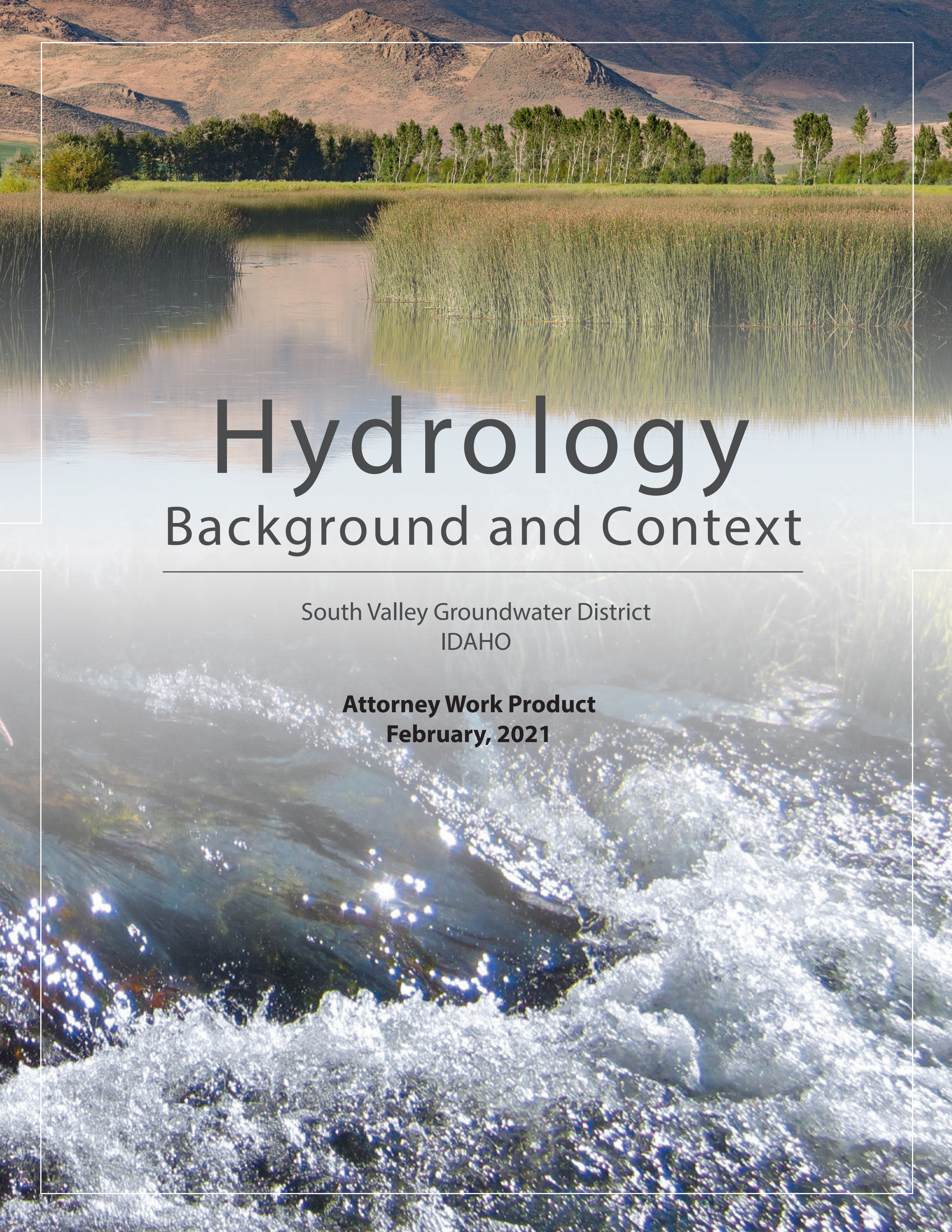


Hydrology

Background and Context

South Valley Groundwater District
IDAHO

Attorney Work Product
February, 2021

South Valley Groundwater District
PO Box 223
Bellevue, ID 83313

South Valley Groundwater District

Acknowledgements

South Valley Groundwater District

The Idaho Legislature adopted the Groundwater District Act in 1995, which enables land owners that hold groundwater irrigation rights to organize their own groundwater district pursuant to a local election authorized by a county commission. The creation and organization of a groundwater district is similar to that of an irrigation organization, and it has broader authorities than a water measurement district. The groundwater district can perform the measurement and reporting functions required by law and levy assessments. Additionally, the groundwater district may represent its members in various water use issues and related legal matters, develop and operate mitigation and recharge plans, and perform other duties as described under Idaho Code § 42-5224.

The South Valley Groundwater District (SVGWD)was established May 27, 2015.

Contributors

A collaborative approach was taken to incorporate historic and current data into this report. The preparation of this information was done to facilitate planning, context and understanding for the SVGWD Board and members.

The primary contributors for this document are:

Ecosystem Sciences, LLC. Hydrology, illustrations, narrative development, analyses, design and document production was provided by the team at Ecosystem Sciences, LLC.

Dave Shaw, ERO Resources Corporation. Hydrology data, narrative development, analyses and technical guidance was provided by Dave Shaw at ERO.

■ *Silver Creek, South Valley Groundwater District*

Executive Summary

Water is one of the key drivers of a sustainable future. Water is essential for the production of food and energy and is integral in the production of most all the goods and services in any economy. The natural ecosystems that convey water are critical for preserving biodiversity, regulating the environment, providing amenities and sustaining the continuous provision of water for maintaining life and economic progress.

The Big Wood River Ground Water Management Area was designated in 1991 in order to address the connection between ground and surface water within the Camas Creek, Silver Creek, and Upper Big Wood River drainages above Magic Reservoir. The South Valley Ground Water District (SVGWD) is part of this area and seeks to develop a long-term groundwater resource management plan.

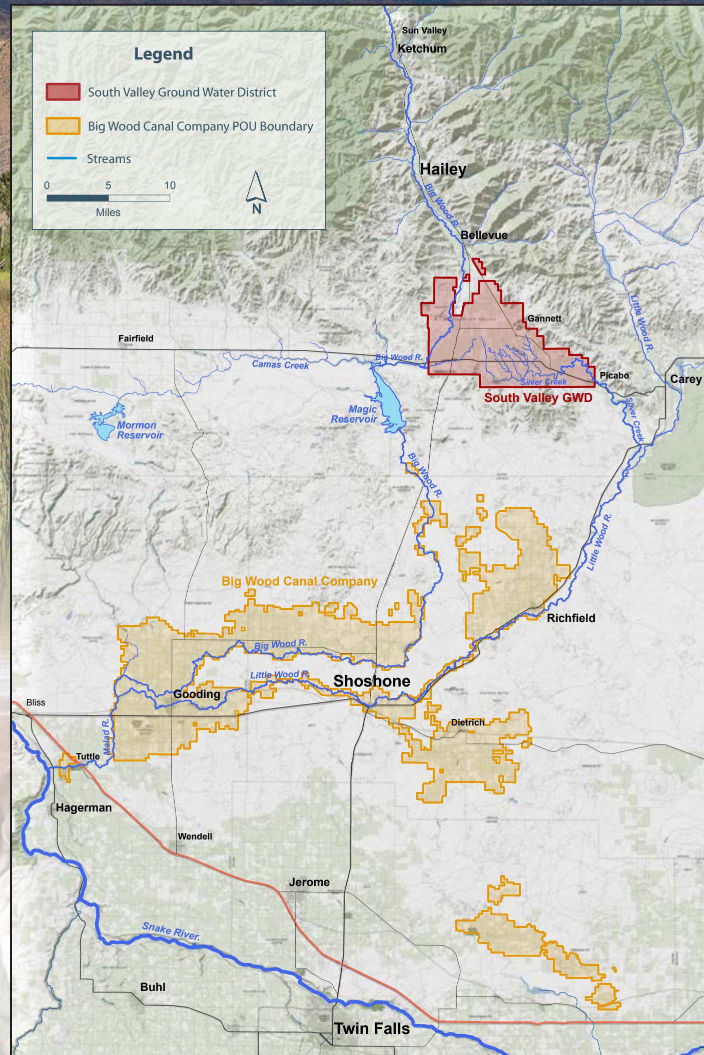
Innovative approaches to enhance water management, develop new water systems, design and implement improved water accounting methods as well as improving water governance are all means to better match water demand and available water supply.

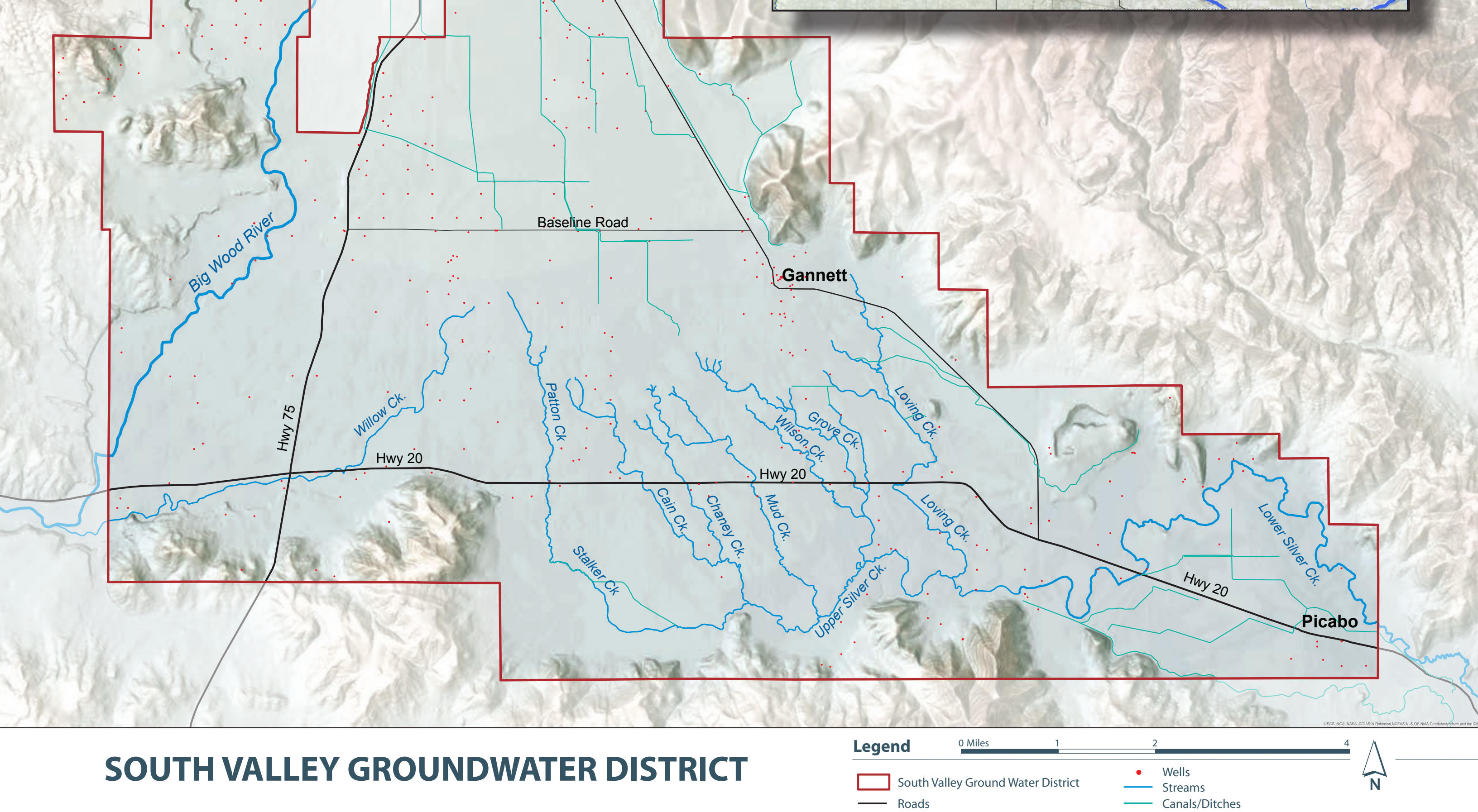
Protecting the water resources that sustain our farms, ranches and ecosystems, is a critical precondition to protect the future of the SVGWD.

The purpose of this report is to provide the SVGWD members with the context and background on the current hydrology of the basin. This context aims to provide a look at the changes that have occurred through time, as well as constraints and opportunities that exist to effectively manage the District water supply into the future.

This document:

- Focuses on the two major drivers of hydrology in the basin: **Water Availability and Water Delivery.**
- Illustrates the **hydrology of the Big Wood River basin** and the considerable changes in water supply conditions since the early 1970s.
- Shows that **Changes to hydrology** in the basin are due to:
    - Reduced water available from precipitation, and changes in timing of snowmelt and stream runoff.
    - Changes in irrigation practices and water delivery volumes.
    - Reduced groundwater levels.
    - Reduced flows in Silver Creek.
- Uses a **data-driven** summary of measured results over a long period time on hydrology in the Big Wood River basin.





SOUTH VALLEY GROUNDWATER DISTRICT

■ *Map of the South Valley Groundwater District*

The Water System

The relationship and interconnection between the Big Wood River, diversions into the irrigation canals, storage in Magic Reservoir, ground water levels in the Bellevue Triangle aquifer, and the stream flow of Silver Creek are vital to understand and quantify. This relationship, and the change in conditions through time, is the basis for actions that are proposed in the SVGWD Management Plan. This hydrologic information will also provide the basis for understanding how those actions will benefit the discharge of Silver Creek and the Little Wood River water supply.

This report elaborates on the relationship between the discharge of the Big Wood River (BWR) at Hailey, the diversions into the District 45 and Baseline Canals, and storage in Magic Reservoir, ground water levels in the Bellevue Triangle, and the discharge of Silver Creek at Sportsman's Access (Silver Creek) over time.

The Big Wood River and Silver Creek are the two major streams traversing the area. Both are perennial but are fed in quite different ways. The Big Wood River is fed primarily by snow melt in the upper reaches of the drainage. Silver Creek base flow is fed almost entirely by ground water fed springsheads in the Bellevue Triangle.

The Big Wood River enters the SVGWD at Bellevue, flows along the west side of the valley and exits the area at the southwest comer at Stanton Crossing. Silver Creek rises within the SVGWD from a multitude of ground water fed springs located south of Baseline Road. Silver Creek flows southeastward toward Picabo and exits the SVGWD to the southeast, eventually joining the Little Wood River.

The Big Wood River and Silver Creek are a complex, interconnected hydrologic system. The relationship between the surface and ground water systems is such that any stress on one system will result in an effect on the other. Recharge to the aquifers in the SVGWD is from precipitation, loss from the Big Wood River and irrigation canals, and a small amount as percolation of irrigation water applied in excess of consumptive use of crops. Percolation into groundwater from irrigation practices has changed through time and is discussed in detail in this document.

Water Availability

Water availability is that water available to supply a water need that is taken from a water source. The most common sources of water for irrigation include rivers, reservoirs, lakes, and ground water.

Big Wood River

The Big Wood River is a primary source of available surface water to the area:

- Precipitation in the basin is the main driver of water availability in the BWR.
- Amount of precipitation and water discharge in the BWR have changed through time.
- Runoff has been occurring earlier in recent years, which diminishes the summer-fall water supply even during average and above average water years.

Discharge

Big Wood River water discharge is measured at the Hailey gage. The period of record at this gage is from 1916 to present; over 100 years of water data.

Water Storage - Magic Reservoir

Magic Reservoir is the only significant reservoir on the Big Wood River and is located on the border of Blaine and Camas Counties, Idaho.

The reservoir is impounded by Magic Dam, which was completed in 1910 by the Idaho Irrigation Company for irrigation storage and now stores up to 191,500-acre feet of water since the dam was raised in 1916. In 1921, the operation and ownership of the dam was taken over by irrigators and the Big Wood Canal Company was formed. Water from the reservoir is used to irrigate 36,542 acres near Shoshone, Richfield, Dietrich and Gooding.

Snowpack / Snow Water Equivalent

In the Big Wood Basin most of the annual precipitation falls during the winter months, yet the highest demands for water use are seen in the summer and fall. Ideally, river basins have the capability to store water from the wet season until it is needed. The largest storage of water in the Big Wood Basin, above Magic Reservoir, occurs naturally in the form of annual snowpack.

The snowpack is variable on an annual basis. Historic snow data is maintained by the USDA Natural Resources Conservation Service (NRCS). The NRCS calculates a monthly "snow index" for the Big Wood Basin based on seven Snowpack Telemetry (SNOTEL) monitoring sites that are within or very close to the drainage boundary. The April snow index, which is the sum of snow water equivalent on April 1 of each year at seven SNOTEL locations, is useful to understand the change in water availability in the snowpack through time.

A snow index is a tool that allows you to compare the snow water amount for a specific basin with the historical period. Snow indexes are calculated by summing the snow water amount for the same list of SNOTEL sites for each year. These values can then be sorted to rank the current year versus the historical period to see how the current snowpack conditions compare to those of the past.

In general, the 10-year average April 1 Snow Index has slightly decreased since the 1960s when record keeping began.

Precipitation

Precipitation in the Big Wood Basin is highly dependent on elevation, with the higher elevations receiving the most precipitation. Precipitation shows a high degree of variability from year-to-year. From 1980-2009, the lower elevations received anywhere from 6-17 inches of precipitation; the mid elevations received from 8-22 inches, and the higher elevations from 17-37 inches in a year.

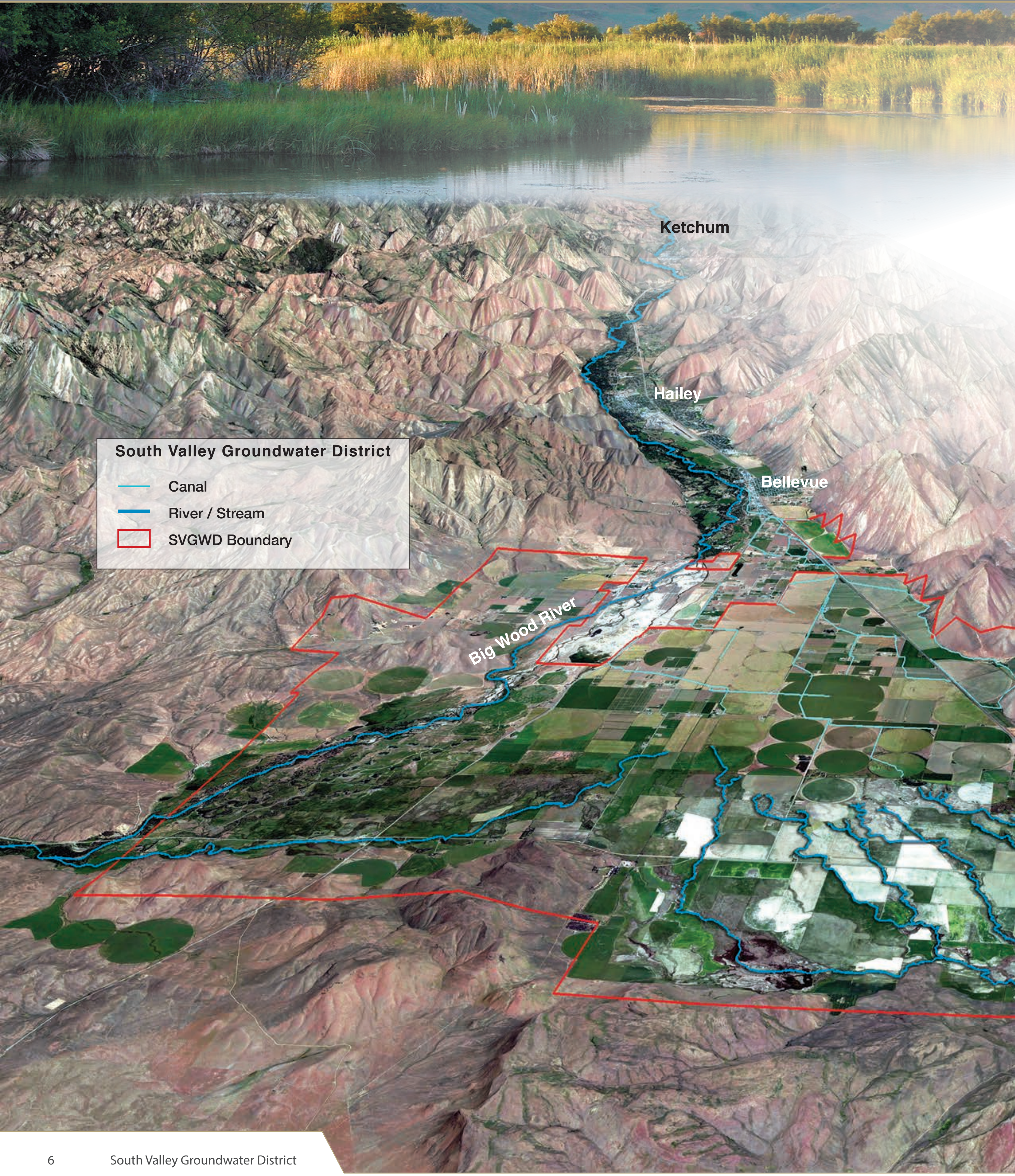
Looking at 10-year decadal averages, the basin received nearly 15% less precipitation in the 2000-2009 decade than 1980-1989. On average, in the decade 2000-2009, lower elevations received 1.6 inches less; mid-elevations 2.3 inches less; and higher elevations 4.1 inches less precipitation than in 1980-1989.

Groundwater

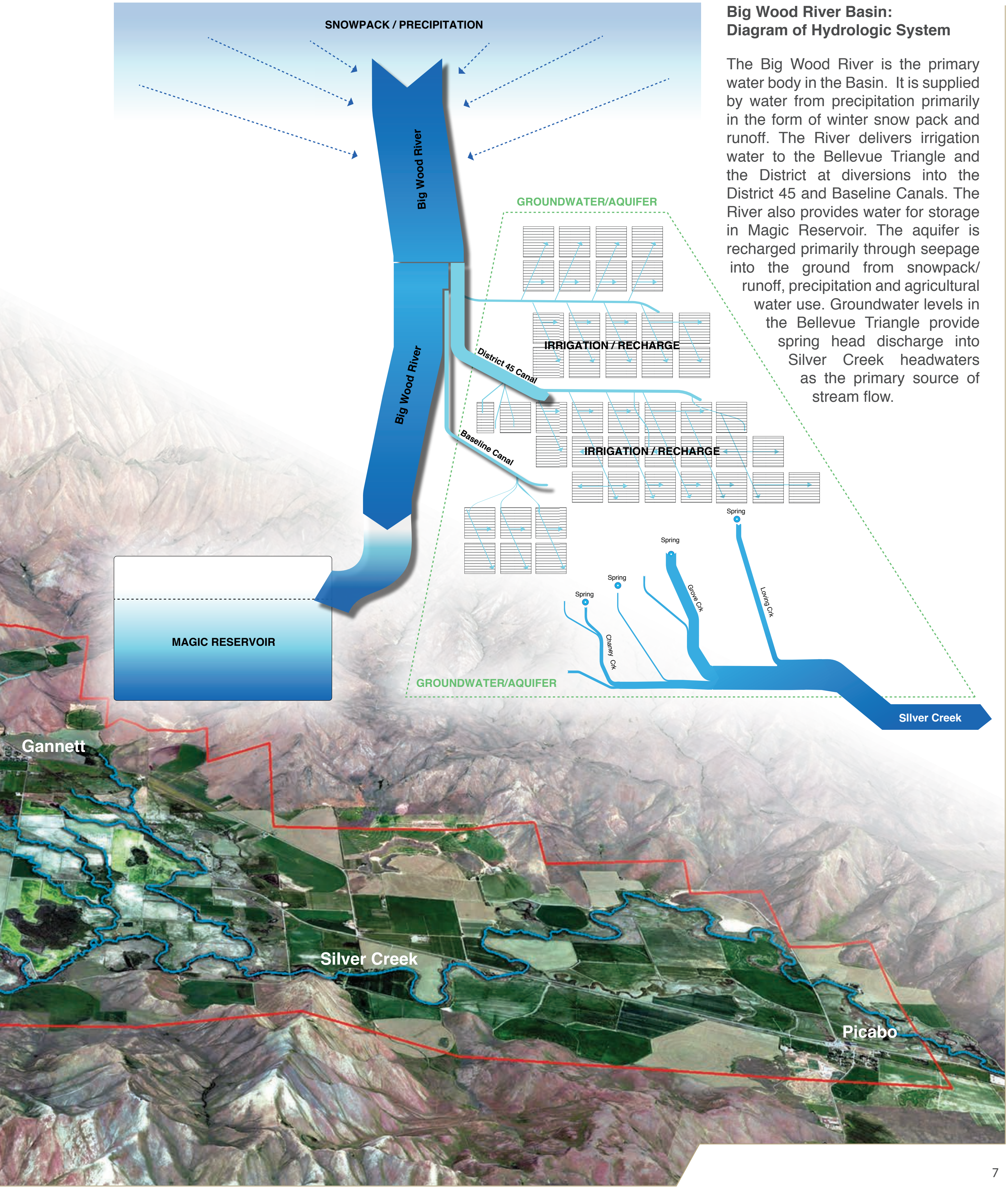
The Wood River Aquifer is complex and varies by location within the basin north of the Timmerman Hills:

- In the northern portion of the basin, north of Bellevue, the aquifer consists primarily of shallow groundwater from precipitation and is tributary to the BWR and to the tributaries that feed the BWR.
- In the southern portion of the basin, consisting primarily of the Bellevue Triangle, the aquifer is fed by precipitation, the BWR and by irrigation diversions taken from the BWR for irrigation in the Triangle.
- Groundwater use in the basin also influences ground water levels.

South Valley Groundwater District



Phsical Setting and Water Relationships



Big Wood River Basin: Diagram of Hydrologic System

The Big Wood River is the primary water body in the Basin. It is supplied by water from precipitation primarily in the form of winter snow pack and runoff. The River delivers irrigation water to the Bellevue Triangle and the District at diversions into the District 45 and Baseline Canals. The River also provides water for storage in Magic Reservoir. The aquifer is recharged primarily through seepage into the ground from snowpack/runoff, precipitation and agricultural water use. Groundwater levels in the Bellevue Triangle provide spring head discharge into Silver Creek headwaters as the primary source of stream flow.

- Amount of and timing of precipitation and water recharge into the aquifer have changed through time.
- Groundwater pumping has increased through time, since groundwater well development.
- Groundwater levels decreased early after well development, but have since stabilized and even increased slightly since the groundwater management area was established in 1991.

Groundwater Levels

Groundwater levels are measured at selected monitoring wells throughout the Wood River Aquifer. There are 2 long term wells in the SVGWD that have been measured since 1954. The record at these wells indicate reductions in groundwater levels over time. The groundwater levels at one of the sites have fallen about 4 feet through time with the increase in wells, pumping and reductions in incidental recharge. Water levels in this well fluctuate by over 2 feet, and up to 4 feet annually, reflecting periods of recharge and water withdrawal, either through pumping or seepage to Silver Creek or Willow Creek in the southwest corner of the Triangle. The second well shows larger annual fluctuations of over 10 feet in some years yet the water level decline is about 1 foot over the same period.

The aquifer in the Bellevue Triangle is complex, as evidenced by the differences in the 2 long-term well records. The aquifer also responds very quickly to stress, either positive or negative, as evidenced by the annual water level fluctuations in these same 2 wells. The WRV Model developed by the USGS and IDWR is the best tool available to analyze the relationship between recharge and pumping and how these stresses impact the Silver Creek water supply.

Well Development and Groundwater Pumping

Several hundred wells have been drilled in the District since 1940. These include irrigation wells, domestic wells and stock, industrial or observation wells. Depths of the wells range from 11 to over 500 feet, with most being less than 200 feet. Irrigation well development was intensive during the period 1947 to 1963, with a significant increase from 1958 to 1961. This is likely a result of a period of several extremely dry years in the basin. Domestic well development has increased steadily for the period of record.

Groundwater pumping has affected groundwater levels and available water. Groundwater pumps increased steadily for the period of record and have affected the delivery of surface water and groundwater levels in the SVGWD.

Water Delivery

Much of the irrigated areas throughout the SVGWD use surface water that is partly or fully supplied from a delivery system of canals and ditches. The primary surface water delivery canals are the District 45 (D45) and Baseline Canals. Groundwater is delivered through wells and pumps and may be conveyed through surface canals or streams from the well to the ultimate place of use. The combined use of groundwater and surface water is the primary method by which irrigation is achieved in the SVGWD. The dependence on a collective system comes with constraints and need for close coordination.

Reliability

Reliability of water deliveries is a prerequisite for the application of any irrigation schedule. It is necessary that water be supplied to the users in conformity with the expected level of service. Besides the technical advantage of irrigating in the best possible conditions, reliability of water deliveries is an essential condition for establishing, sustaining or restoring a climate of confidence between the water supplier and the water users. This is a prerequisite for the success of any move towards measures aiming at improved water management, such as improved delivery scheduling and irrigators participation in operation, maintenance and management through water users' associations.

Surface Water Diversion

The Big Wood River is the primary source of available surface water used for diversions and water deliveries, primarily for irrigation purposes.

- Water is diverted from the BWR for surface water irrigation purposes.
- Amount of surface water diverted has changed through time, with significant decreases in volume.
- Irrigation practices have changed through time from predominantly flood to pivot and wheel line / solid set irrigation.
- Historically, flood irrigation was the primary method of irrigation, which began in the late 1800s.
- More recently, (since 1970's) pivot / sprinkler line irrigation has become the primary method of crop and field irrigation.
- Changes in irrigation practices have resulted in less demand for surface water deliveries; thus, the volume of water diverted from the BWR has decreased significantly.
- Changes in irrigation practices have resulted in greater demand for groundwater water resources; increased groundwater pumping for pivot irrigation has increased through time.

District 45 Canal

The D45 Canal is the largest diversion from the BWR into the Bellevue Triangle.

- D45 water diversion volumes and rates have changed through time.
- There have been significant reductions in water volume diverted from the BWR and delivered into the Bellevue Triangle over time.
- Reductions in surface water deliveries for irrigation purposes result in much less water applied to the land and much less water recharging into the aquifer.

Baseline Canal

The Baseline Canal (55) is a diversion from the BWR into the Bellevue Triangle for irrigation purposes.

- Baseline water diversion volumes and rates have changed through time.
- There have been reductions in water volume diverted from the BWR and delivered to the Bellevue Triangle over time.
- Reductions in surface water deliveries for irrigation purposes result in much less water applied to the land and much less water into the aquifer through incidental recharge.

Irrigation Practices

Changes in irrigation practices have contributed to reduced incidental recharge from surface water irrigation over time, and reduced discharge of Silver Creek. This is described in more detail in the following pages. It is possible to quantify the reduction in surface irrigation diversions that have resulted from reduced water supply and changes in irrigation practices. These changes relate to reduced recharge in the Bellevue Triangle and corresponding reductions in ground water levels and Silver Creek discharge. Restoring the historical incidental recharge and Silver Creek discharge through a managed recharge program is a primary goal of the District Management Plan.

Silver Creek

Silver Creek is the primary source of available surface water leaving the SVGWD, carrying water downstream to the Little Wood River. Silver Creek is a spring-fed stream system relying primarily on groundwater flowing from spring head sources into headwater streams.

- Discharge water volume in Silver Creek has diminished through time.
- Discharge water volumes in Silver Creek have trended downward at similar rates when compared with:
    - D45 water diversions
    - Baseline water diversions
    - Groundwater levels
    - BWR discharge volumes
- The relationship between water availability in the BWR, water diverted from the BWR for irrigation, method of irrigation, groundwater levels and Silver Creek discharge is significant.
- Silver Creek water discharge is measured at the Sportsman's Access USGS gage. The period of record is from 1975 to present.

History of Water Infrastructure

Water issues have increased in the Wood River Valley in recent years. Water shortages affect all users, and increased water demand and climate change presents significant challenges for future water resources. In 2015, downstream senior Big and Little Wood River water rights holders issued a water call against upstream users.

Water shortages and their impact on users are problems that have existed since the first settlement of the Valley.

Water was critical to early settlement of the Wood River Valley. Obtaining water for domestic use, agriculture, and industrial uses was vital. Towns needed water for domestic use, fire-fighting, and irrigation. Farming in the arid Idaho climate required large amounts of water for irrigation provided by canals. Industrial uses included mining, smelting, electricity, sawmills, ice ponds, etc. The Desert Land Act of 1877 provided that any citizen could claim up to 320 acres of federal land in the arid west, but had to provide sufficient water to the land within 4 years before title could be obtained.

In 1881, Idaho law required irrigators to post a notice of intended water diversion at the Point of Diversion (POD), state the amount of water claimed, the purpose and place of its use, and how it would be diverted, then record it with the County Recorder.

"Priority in time securing priority of right," known as the doctrine of prior appropriation, established priority for water rights. There had to be a "beneficial use" for the water, a diversion and water works proved, and then land owners could obtain the right of way through the lands of others for irrigation projects.

Over-claiming of water rights led to over allocation of limited surface water availability. While there was a system of registering water rights, there was no control over how much water any individual could claim, and no process to account for the water claimed. Many water claims were wildly excessive of what was needed or used, and consequently, were not fully utilized. This led to water claims that were well in excess of the capacity of the rivers to supply them. The prior appropriation doctrine meant the first claimants had priority over later claimants. This led to disputes over water rights, and lawsuits where courts had to determine actual water rights and their priority. These legal actions were typically initiated by downstream farmers whose senior water rights were interfered with by water taken from the rivers upstream by junior water rights holders.

There are numerous canals that divert water from the Big Wood River. Water from the Big and Little Wood Rivers is primarily used for irrigation and other purposes, and many irrigation ditches and canals were constructed over the years for domestic, agriculture, and industrial uses. The Big Wood River Water District 37 includes the Big and Little Wood watersheds to the Snake River. The portion in the Wood River Valley from north of Ketchum down to Magic Reservoir has 75 Points of Diversion (POD) for canals or ditches diverting water from the river. Some of these PODs are for major canals that take large amounts of water from the river for large tracts of land. Others are for small ditches, or community ditches, that irrigate individual farms or smaller parcels of land.

District 45 Canal was begun in 1885. A significant amount of water was claimed between 1884 - 1891 at POD #45 on the west side of Bellevue. The canal was constructed and carried water to irrigate land south of Bellevue, east of the railroad right-of-way, south to the Baseline Road.

In 1908, the Utah & Idaho Land Improvement Co. was formed and built a dam west of Bellevue to divert water into a canal as part of a plan to develop a large agriculture tract (between 23,000 to 46,000 acres) and a new town south of Bellevue. After the company was forfeited in 1924, the canal became known as the District 45 canal. The District 45 Canal splits into several branches south of Bellevue to deliver water throughout the Bellevue Triangle area. There are over 500 separate water rights that have water delivered through the District 45 Canal.

Glendale Canal diverts Big Wood River water (with 1884 water rights) from the river north of the Glendale Bridge at POD # 50, irrigating 1,560 acres of land (known as Poverty Flats) west of the river. There are 59 separate water rights that take water from the Glendale Canal.

The Bypass and Baseline Canal (55 Canal) divert Big Wood River water north of Glendale Bridge at POD #55. The Bypass Canal was constructed to deliver water to the most downstream senior right on the river without the losses incurred in the river reach downstream of the Glendale Bridge (the dry bed). The BWR is primarily a gaining stream upstream of Bellevue, but below the Glendale bridge the river loses water to the aquifer. Since the most senior right on the river is downstream of the dry bed, it benefitted all BWR water users to construct the Bypass Canal to serve the senior downstream water right and leave water available for upstream, more junior water rights. During the times when the Bypass Canal is taking all of the water available in the river, the delivery to the Baseline Canal is made at the headgate along the Bypass Canal and not at the river.

The Baseline Canal (55 Canal) diverts Big Wood River water north of Glendale Bridge at POD #55, and irrigates land east of the river.

Water in the Early 1970s

Since the early 1970s, water availability and water delivery has changed significantly in the Big Wood River basin. This has affected stream flows in Silver Creek and groundwater levels in the aquifer.

The Big Wood River is the primary surface water source for irrigation diversions into the SVGWD. Surface diversions for irrigation from the Big Wood River have been declining since the mid 1970's. Irrigation with surface water diversions from the Big Wood River are crucial for maintaining the aquifer water table elevations and associated spring flows to the lower Big Wood River and Silver Creek.

In the early 1970s, the general view on water resources in the District was that the present level of land development had not adversely affected the water supply of the basin.

The net amount of water removed from the aquifer would be only that which was consumptively used by vegetation and the amount leaving as surface runoff. Prior to the early 1970's, there were no restrictions on water development (restrictions began in 1963 for groundwater and 1971 for surface water). Since then, any new appropriator has the burden of proving to the State that there is unappropriated water available before a new water use can be developed. The population of Blaine County in 1970 was 5,749. In 2018, the population was estimated at over 22,000.

Managed recharge of the aquifer system from available Big Wood River flows have the potential for the largest positive impact on aquifer levels and Silver Creek flows of any water use changes. The largest increased flow to Silver Creek is simulated to occur when managed recharge is performed with excess Big Wood River flows. Silver Creek flow could increase by as much as 45 cfs with a consistent recharge of available river flows.

Primary Drivers of Hydrology and Change

Water Availability - water needed to supply irrigation that is taken from a water source. The Big Wood River and the Wood River Aquifer (groundwater) are the primary sources of water for irrigation in the SVGWD.

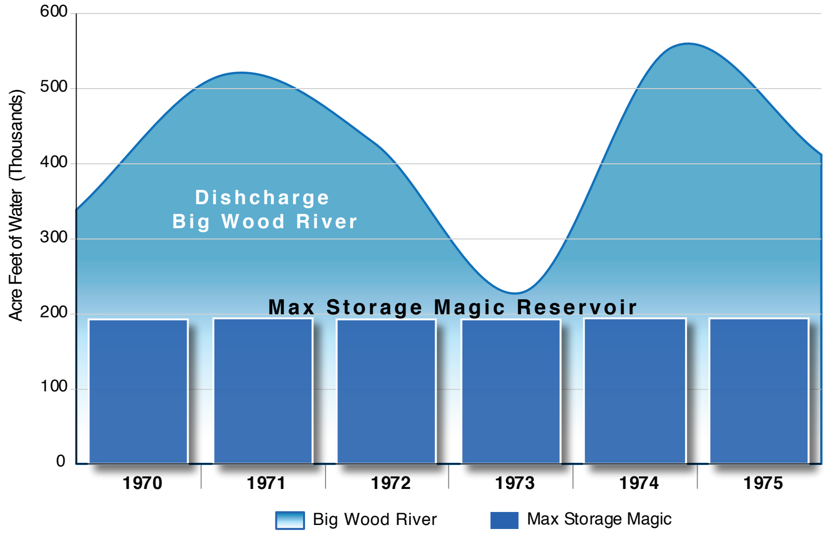
Water Delivery - most irrigated areas throughout the District use surface water that are partly or fully supplied from a delivery systems of canals. The dependence on this system comes with constraints and a need for close coordination. The primary surface water delivery systems are the D45 and Baseline Canals. Groundwater is delivered through wells.

Change in Water Over Time - Changes to hydrology in the Basin are due to:

- Reduced water available from precipitation, and changes in timing of snowmelt and stream runoff
- Changes in irrigation practices and water delivery volumes
- Reduced flows in Silver Creek
- Reduced groundwater levels

1970 - 1975 Water Volumes

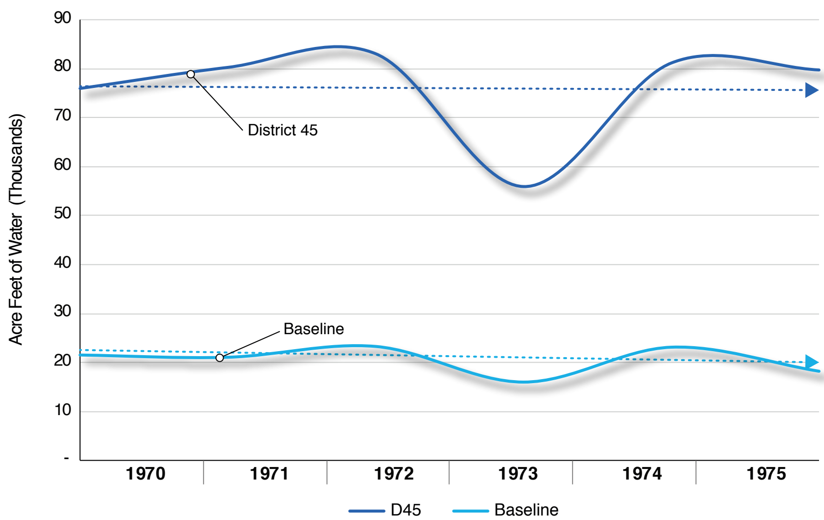
Big Wood River and Maximum Annual Storage in Magic Resv.



Annual water discharge (volume in acre feet) of the Big Wood River was above normal in the first half of the 1970s. 1973 was a lower water year for runoff and stream flows.

Magic Reservoir was filled to maximum capacity each of these years, allowing a full irrigation schedule and carry over water into the following year.

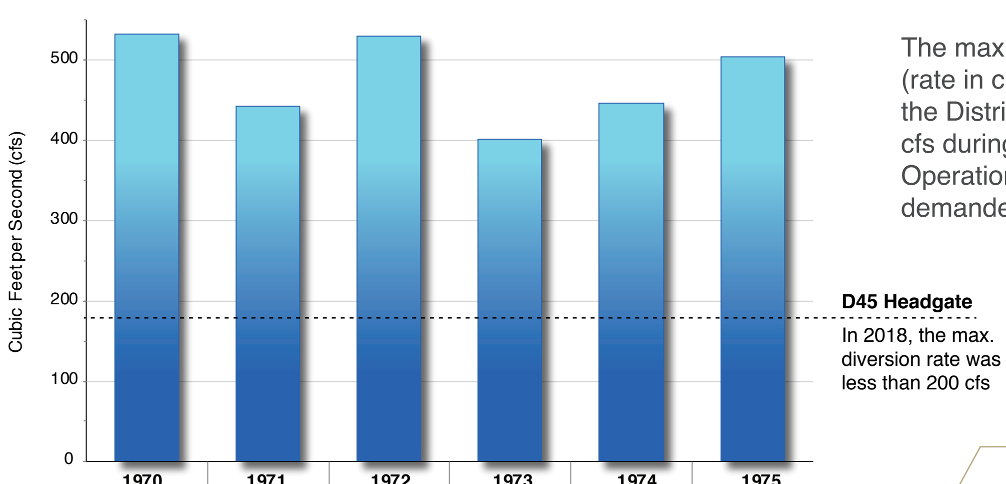
District 45 and Baseline Canal Annual Diversion Volumes



Annual water diversions (volume in acre feet) into both the District 45 and Baseline canals remained consistent throughout this time period. During the lower water year of 1973, total water diverted at the headgates decreased slightly, though the trend over this time period remained consistent.

Operations in the Bellevue Triangle demanded maximum water deliveries during this time period.

District 45 Canal Maximum Diversions Rate at Headgate

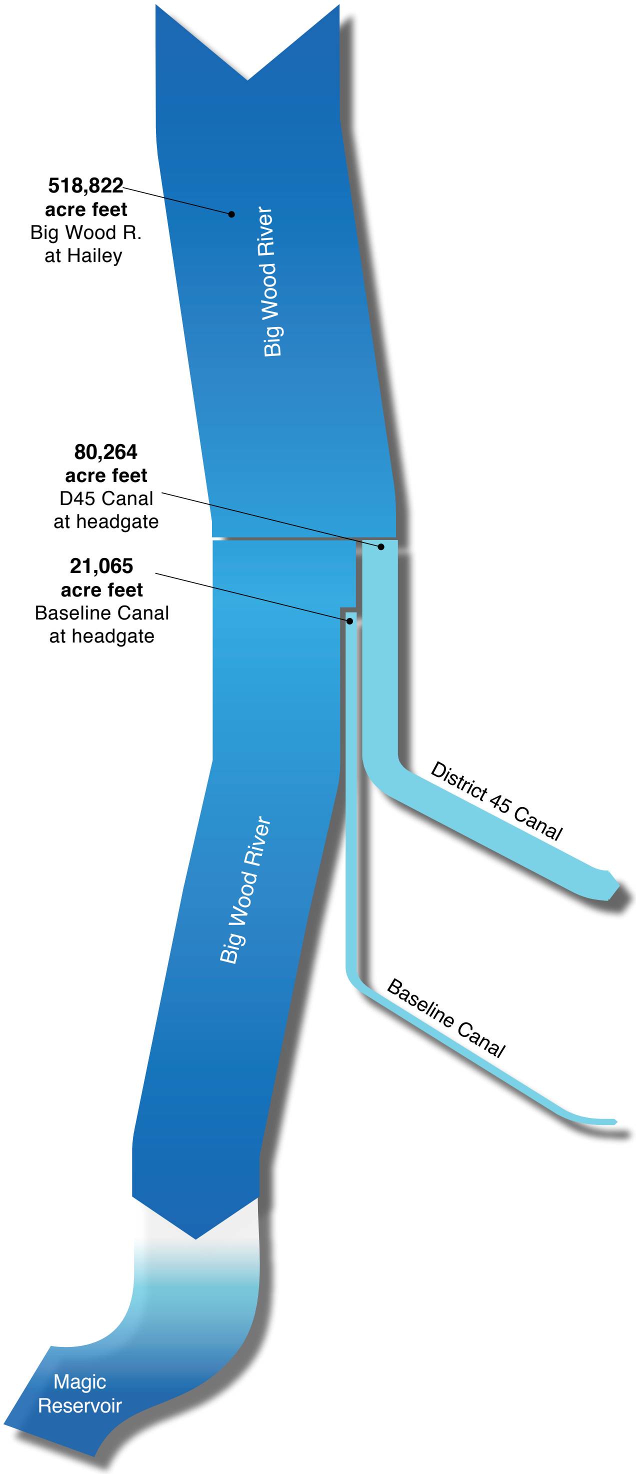


The maximum amount of water diverted (rate in cubic feet per second) into the District 45 canal went above 500 cfs during 3 out of the 6 years shown. Operations in the Bellevue Triangle demanded maximum water deliveries during this time period.

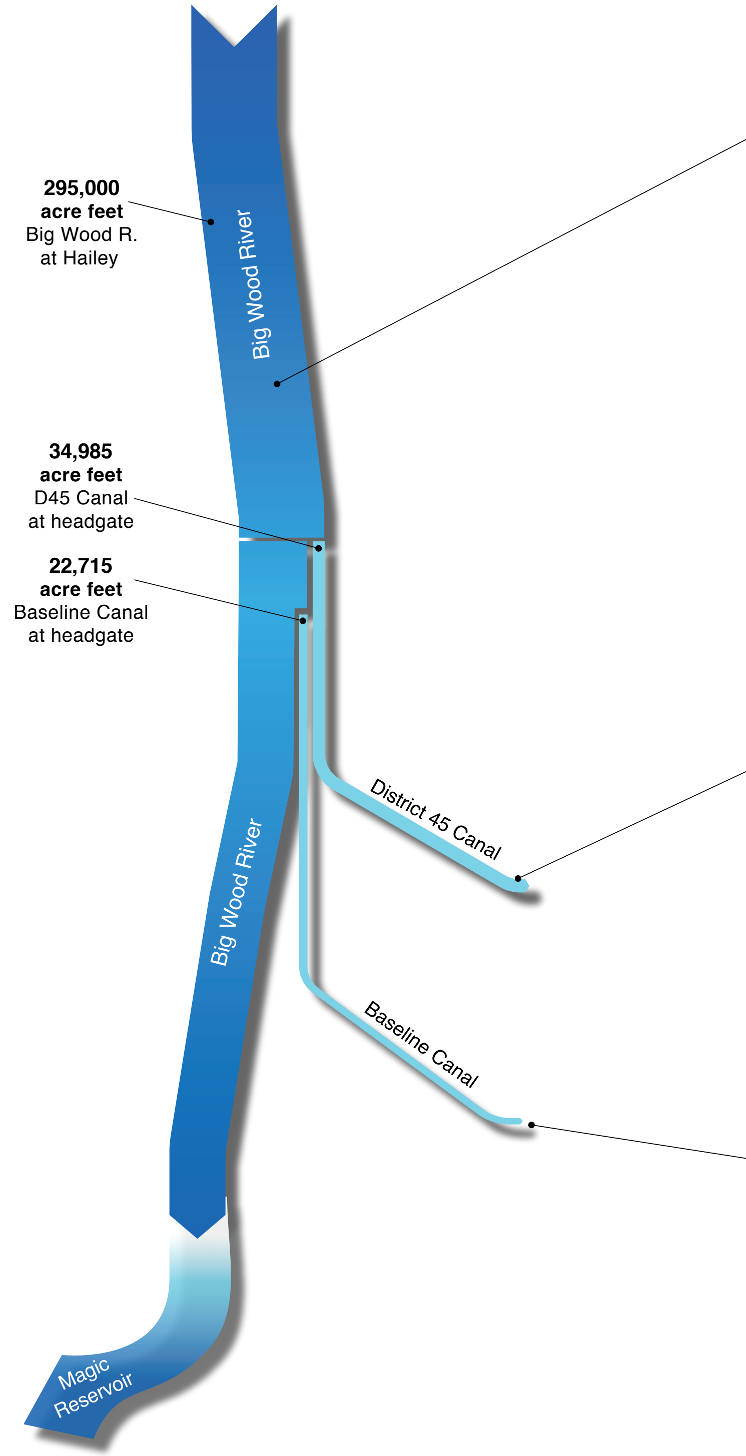
By 2018, the maximum amount diverted at the headgate did not go over 200 cfs for the season.

Change in Water Volume

1971 Water Volumes



2016 Water Volumes



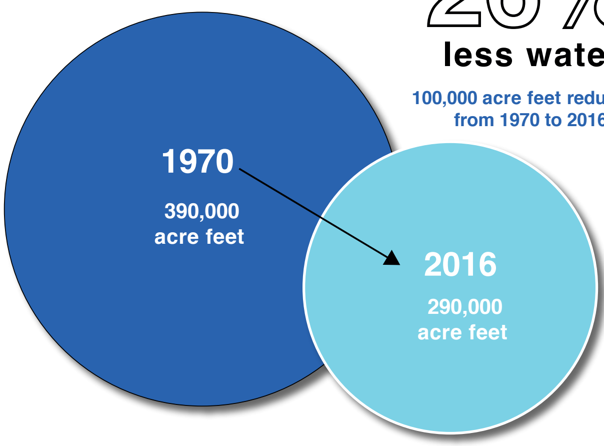
The diagrams on this page and the facing page illustrate the change in water volume in the Big Wood River and its water delivery canals from the early 1970's to 2016.

The diagrams above illustrate the total volume of water in the Big Wood River and the amount of water diverted into the D45 and Baseline canals. The width of the flow diagrams are scaled to the total amount of water discharge (acre-feet) for each year, illustrating the change in water volume over a 45 year period.

1970 - 2016

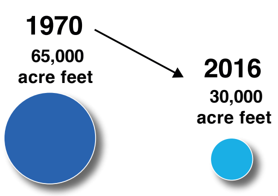
Change in Trend

Big Wood River
1970 to 2016



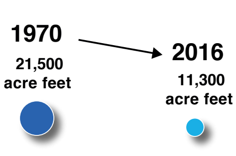
26%
less water
100,000 acre feet reduction from 1970 to 2016

District 45 Canal Diversions
1970 to 2016



54%
less water
35,000 acre feet reduction from 1970 to 2016

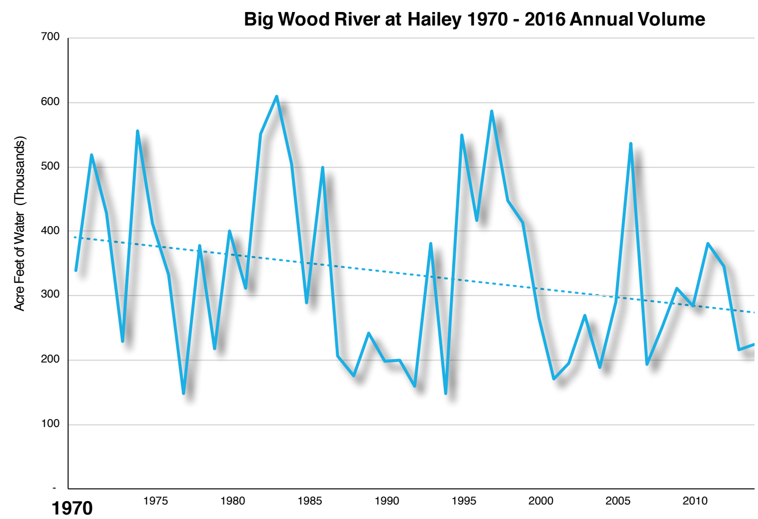
Baseline Canal Diversions
1970 to 2016

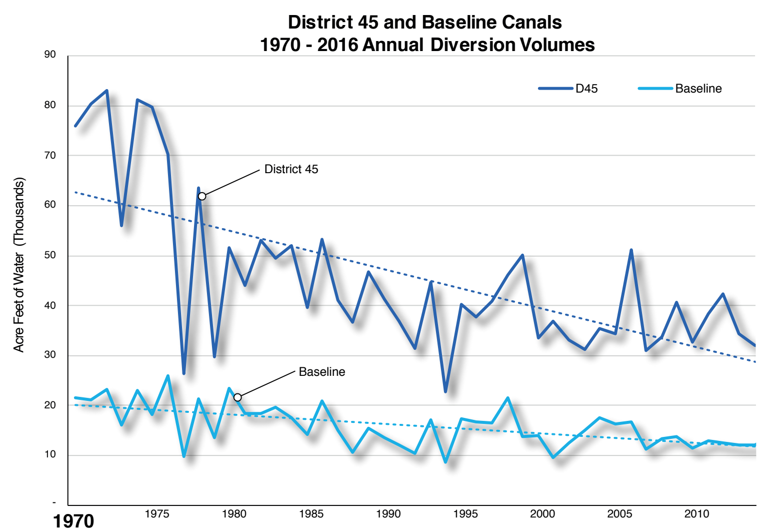


47%
less water
10,200 acre feet reduction from 1970 to 2016

The graphs above illustrate the significant change in water availably and delivery over the time period. The Big Wood River total water discharge has decreased by 26%, a reduction of 100,000 acre feet of water. The amount of water diverted and delivered for irrigation use has reduced by about 50% in both the D45 and Baseline canals.

Change in Water Volumes

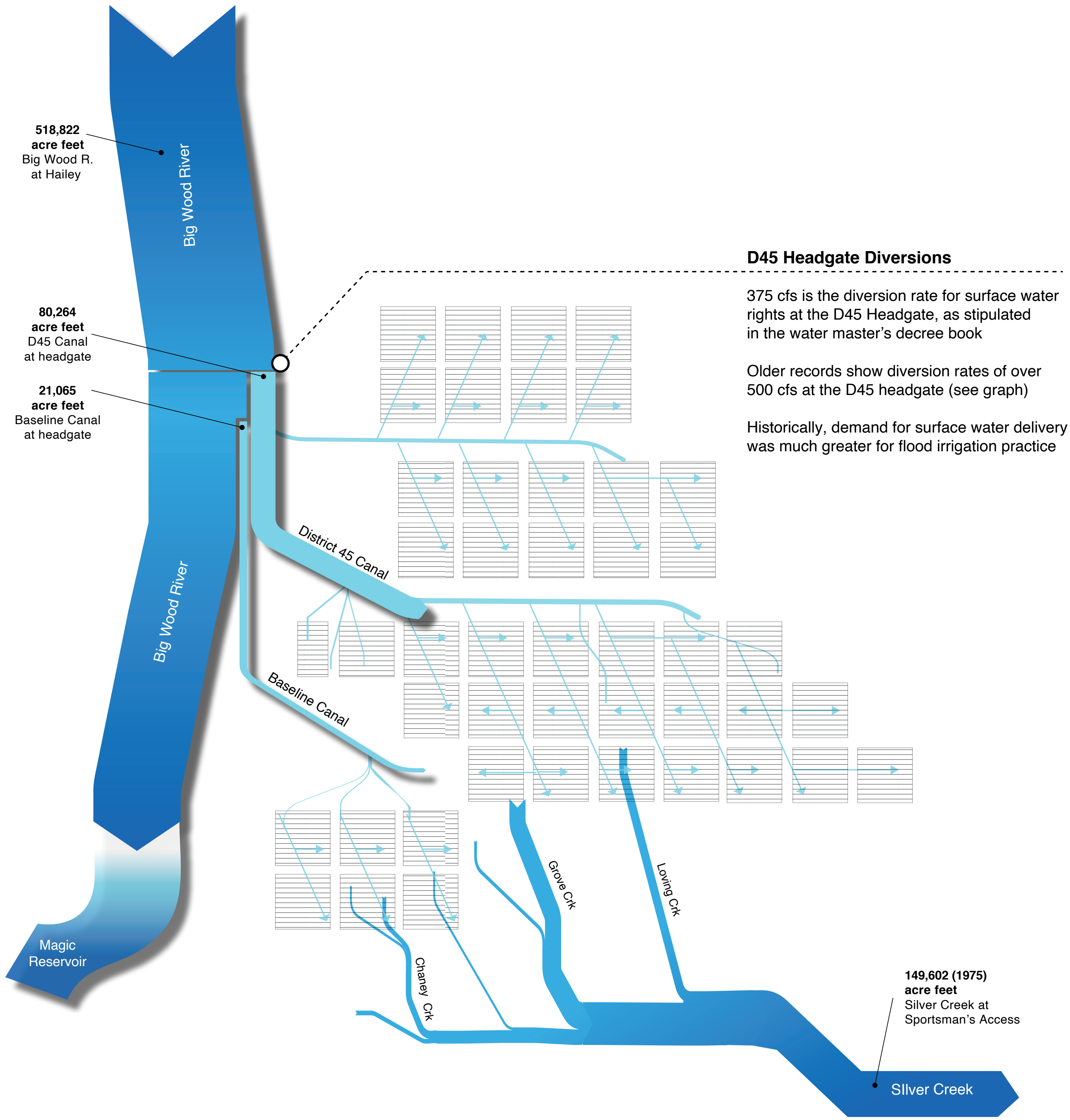




The trend over this time period illustrates the decline in Big Wood River flows and the decline in water delivered in both canal systems. The relationship in the amount of water volumes in the river and irrigation delivery systems is evident.

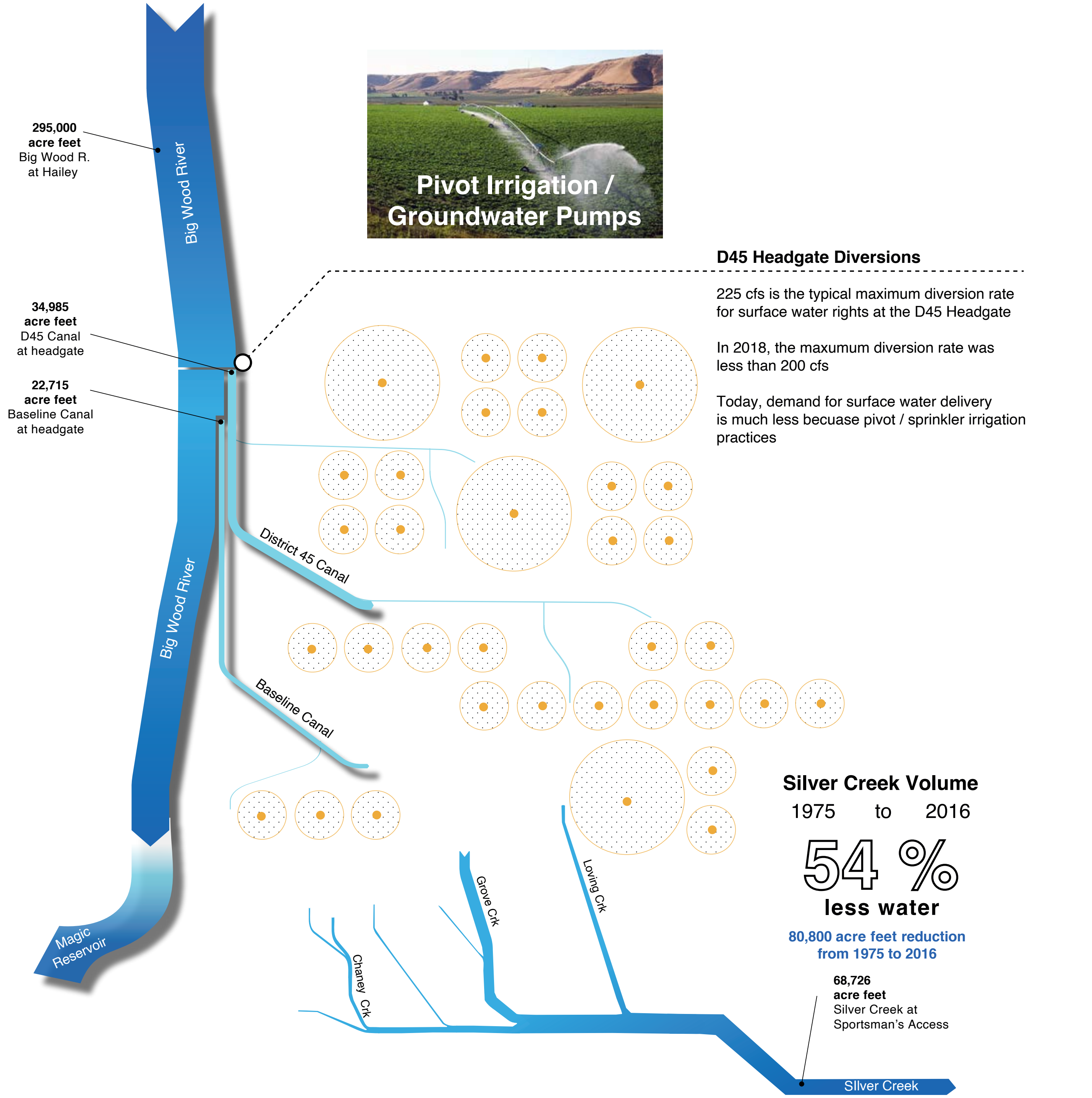
Change in Irrigation Practices

1971 Water Volumes - Flood Irrigation



The diagrams on this page and the facing page illustrate the change in water delivery for irrigation purposes from the early 1970's to 2016. They also illustrate the change in irrigation practices and the subsequent reductions in Silver Creek flows over the same period of time. In the early 1970's, irrigation practices were predominantly flood irrigation method. Water diversions and deliveries in the canal systems were at or near the peak of historic water volume. Maximum diversion rates at the D45 headgate reached and/or exceeded 500 cfs at times, and total volumes delivered were high in order to meet irrigation demands

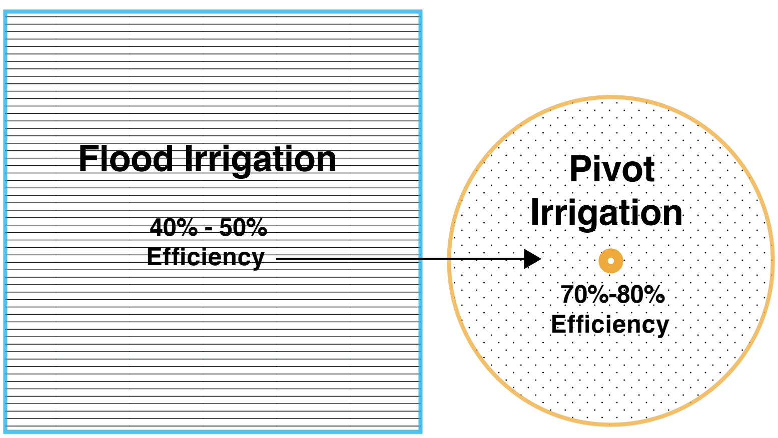
2016 Water Volumes - Pivot Irrigation



for flood irrigation. By 2016, irrigation practices had changed to pivot and sprinkler irrigation methods that demanded much less surface water delivery, and also increased groundwater well development. This caused the total water volume delivered for irrigation to be reduced significantly. In 2018, the maximum water diversion rate at the D45 headgate was less then 200 cfs. The reduction in total flow in Silver Creek changed significantly during this time period. The change in irrigation practices and the amount of irrigation water delivered to the Triangle are related to flow volumes in Silver Creek.

Change in Irrigation Practices

Pivot Irrigation Efficiencies



Change in
Irrigation Practice
1970 to 2016

40%
water savings

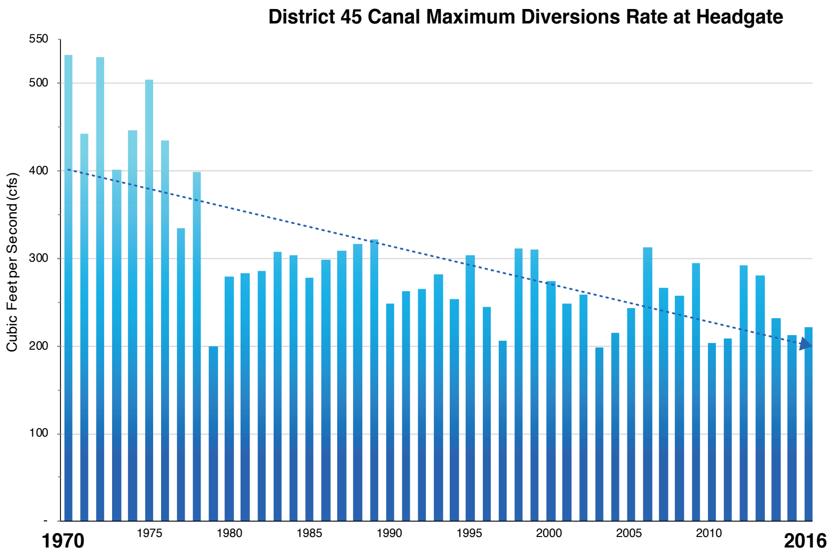
the potentials annual savings associated with switching from flood to pivot irrigation ranges from 1.5 - 3.0 acre-feet/acre.

Flood irrigation (also known as "surface or furrow irrigation") is an irrigation method used to apply water to field crops by distributing the water over the field through corrugations, furrows, seep ditches, and berms or dikes. Due to the porous soils in the Triangle, much of the irrigation water percolated into the ground water.

Beginning in the 1970s, much of the irrigated land in the SVGWD was being converted from flood irrigation to sprinkler irrigation. The new sprinklers were more efficient than flood irrigation, but had higher front-end costs for equipment and ongoing power costs for pumping. Flood irrigation in the SVGWD has a low efficiency due to the porous soils and sprinklers allowed more efficient and uniform application of the available irrigation water to the field crops. Beginning in the late 1970s and early 1980s, pivot sprinklers began being installed; some as direct conversions from flood irrigation and some as conversions from other forms of sprinkler irrigation.

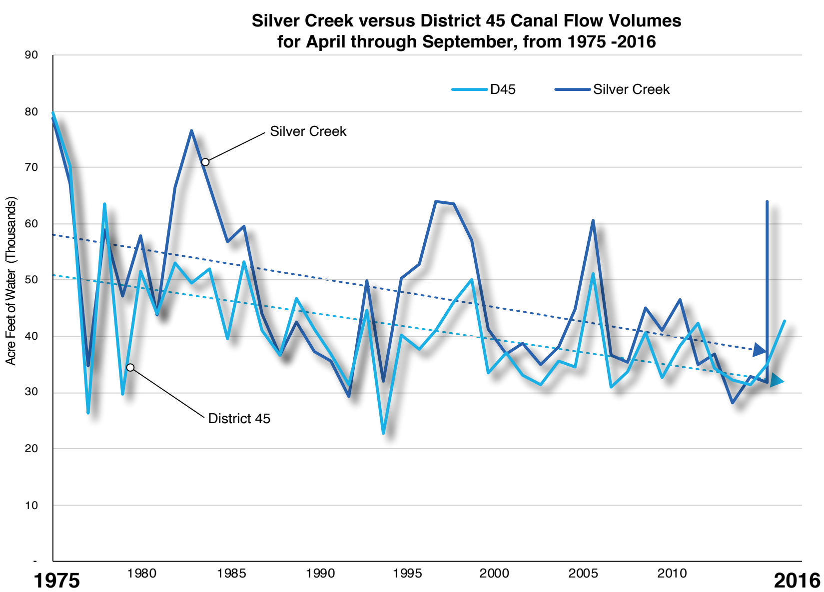
1970 - 2016

Change in Water Delivery - 1970 to 2016



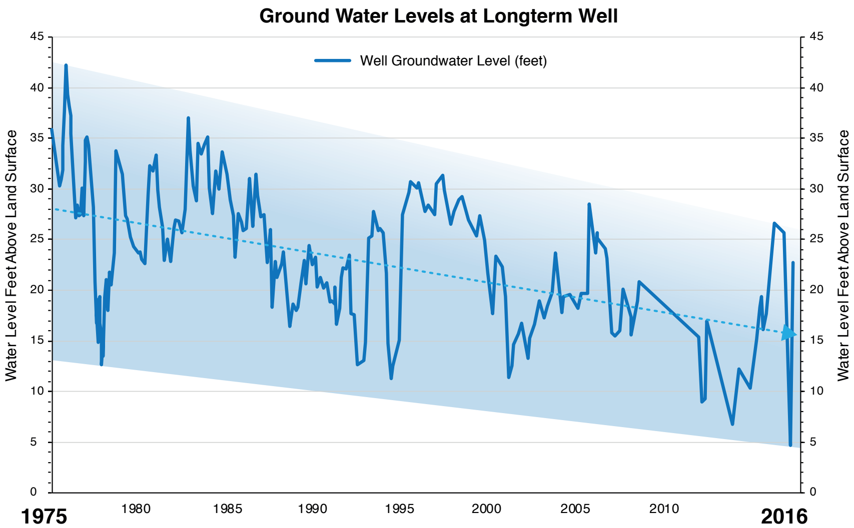
District 45 Canal Headgate Diversion

Center pivots require a constant supply of water during much of the growing season and a fixed and continuous water supply that is typically supplied by a well. Flood irrigation systems require large heads of water at intervals that allow the surface water supply to be located at a more remote location (diversion headgate and canals). The graph on the left shows the significant reduction in the maximum diversion rate at the D45 Canal headgate over time. The increase in pivot irrigation methods and development of wells reduced the demand for surface water deliveries. The maximum diversion rate at the D45 headgate has decreased by over 200 cfs between 1970 and 2016.



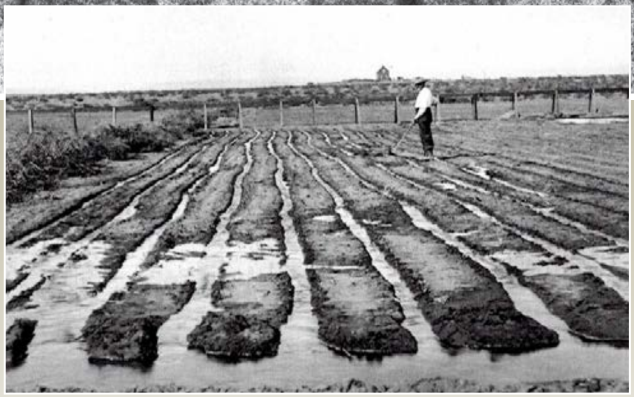
District 45 vs. Silver Creek Flows

Annual water diversions (volume in acre feet) into the District 45 canal has reduced significantly due to reduced water delivery demands. Operations in the Bellevue Triangle have required less water delivery due to increased use of pivot irrigation and well development. The reduction in annual water volume diverted at the D45 headgate matches the reduced stream flow volumes in Silver Creek over the same time period. These two systems have a mutual relationship or connection. Silver Creek flow volumes depend on surface water deliveries into the Triangle. Reduced surface water deliveries and changes in irrigation practices led to reduced incidental recharge into the groundwater and reduced stream flow volumes in Silver Creek.



Groundwater Levels

Groundwater levels have been measured for a long period of time (1954 to 2018) at a select well in the District. The graph to the left shows the decrease in groundwater level through time at this well and matches with reduced surface water deliveries, increased groundwater pumping at wells, and reduced stream flow volumes in Silver Creek. The water system in the District is strongly interrelated. Surface water delivery and groundwater use are directly tied to groundwater levels and stream flow volumes in Silver Creek.



FLOOD IRRIGATION, 1977

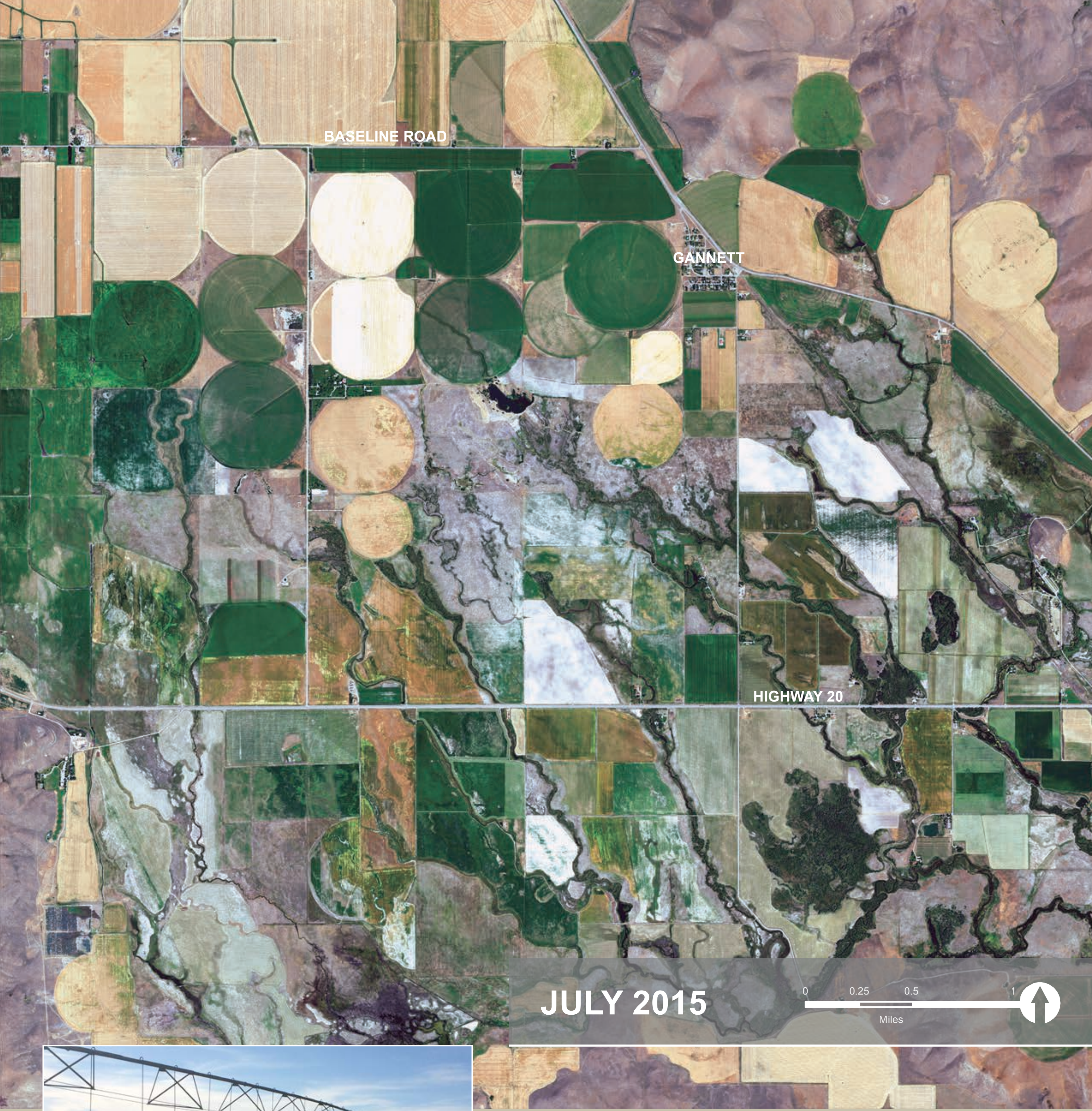
The Bellevue Triangle employed flood irrigation methods primarily from surface water deliveries via canals from the turn of the century up to the mid-1980s when conversion to sprinkler and center pivot irrigation eventually replaced all the flood irrigation.

PIVOT IRRIGATION, 2015

The above images display the change in irrigation practices on the same lands from 1953 to 2015. These images, known as a *change pair*, contrast and compare the change to the landscape through time. The images clearly show the difference in land use between the flood irrigation method and the center pivot / sprinkler method.

FLOOD IRRIGATION = INCREASED RECHARGE

Soil type represents an important site characteristic that affects irrigation efficiency and groundwater infiltration. Large portions of the Bellevue Triangle have very coarse textured soils. Flood irrigation losses, due to deep percolation, can be very high, which leads to increased recharge into the groundwater. Flood systems are better suited to finer textured soils with lower infiltration rates that allow growers to apply smaller quantities of water in a more uniform manner. Flood irrigation typically had high incidental recharge.

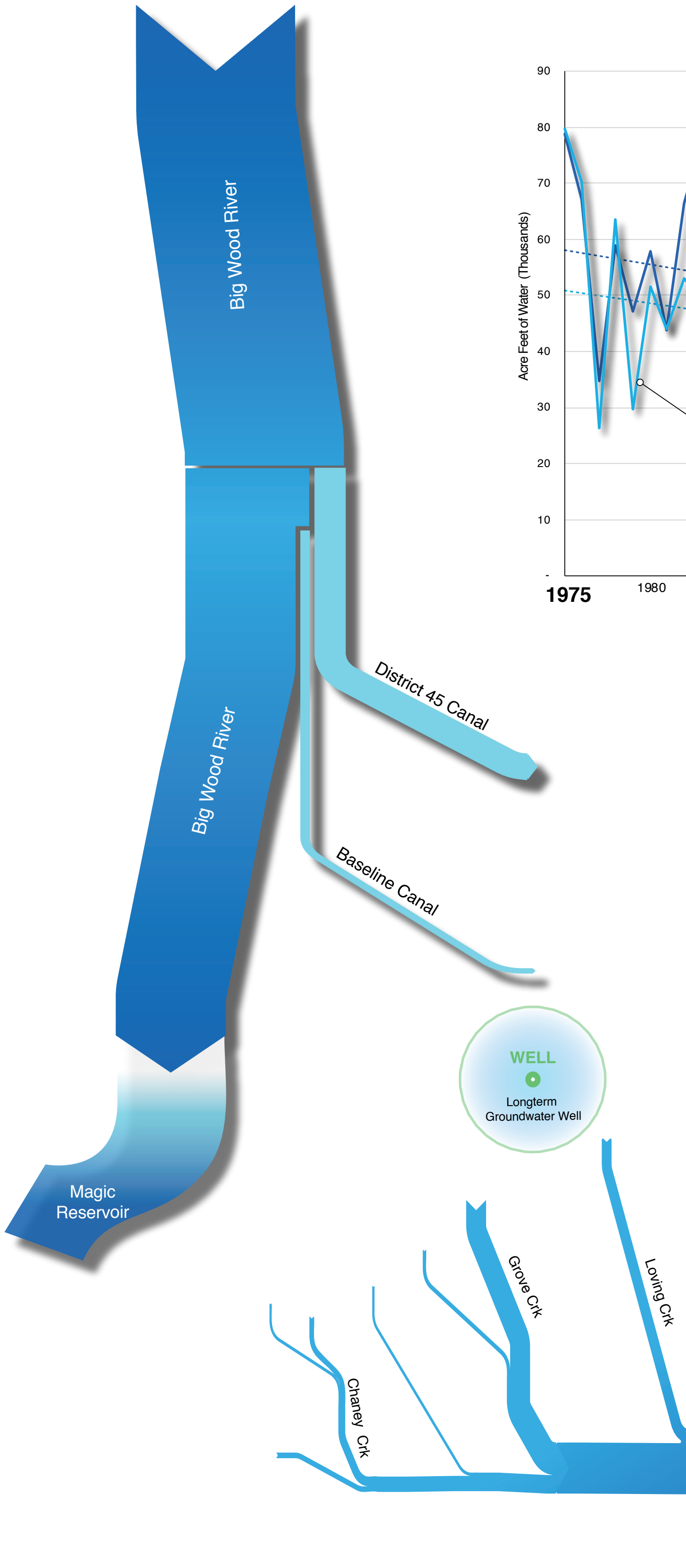


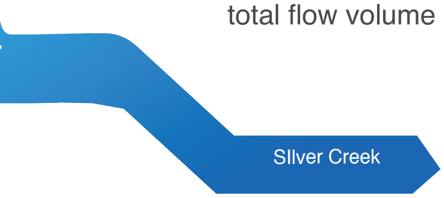
PIVOT IRRIGATION = DECREASED RECHARGE

Center pivots are well suited for soils with high infiltration rates, provided the pivots are engineered to keep up with evaporative demand. A center pivot system can apply small amounts of water at frequent intervals and avoid the larger swings in soil moisture associated with flood systems that apply water every 7-14 days in large quantities. With pivot irrigation, water application is reduced and so is incidental recharge. However, more uniform application of irrigation water by pivots may increase the water consumed by the plants.

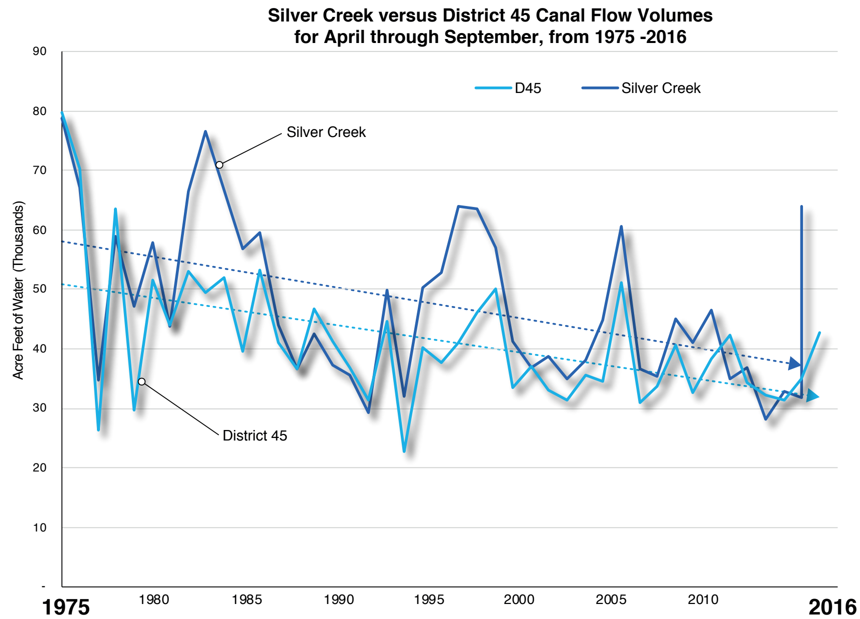
Change in Water Volume

1971 Water Volumes





Silver Creek vs. D45 Water Volume



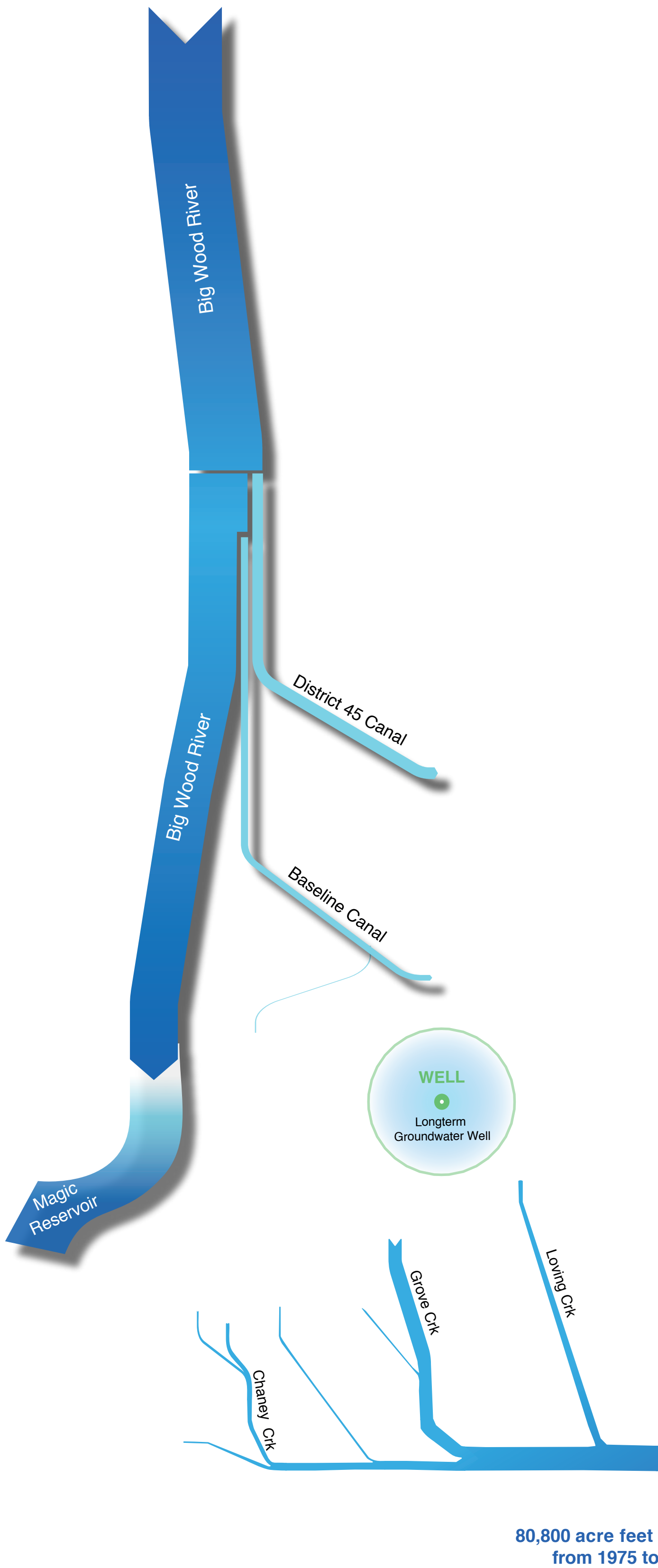
The data graphs on this page and the facing page illustrate the relationship between surface water flows and groundwater levels in the SVGWD between the early 1970's and 2016.

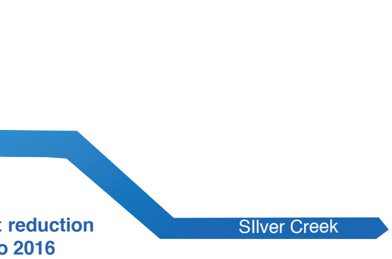
The graph above show the relationship between Silver Creek flow volumes and water delivery flow volumes in the D45 canal over the same period of time. The decrease in flow volume of both systems are strongly related.

The graphs on the facing page illustrate the relationship between surface water flow volumes and groundwater levels. There is a well in the SVGWD that has long-term groundwater level data, dating back to 1954. The reduction in groundwater levels is strongly related to the reduction in surface water flow volumes in the Big Wood River, D45 Canal diversion volumes and Silver Creek flow volumes. The overall decrease in water flow volumes over the past 45 years is reflected in the decrease in groundwater levels and an overall reduction of 54% of the total flow volume in Silver Creek.

1970 - 2016

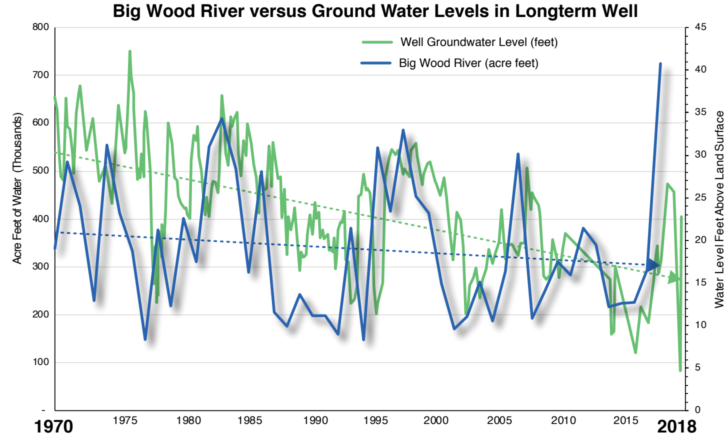
2016 Water Volumes



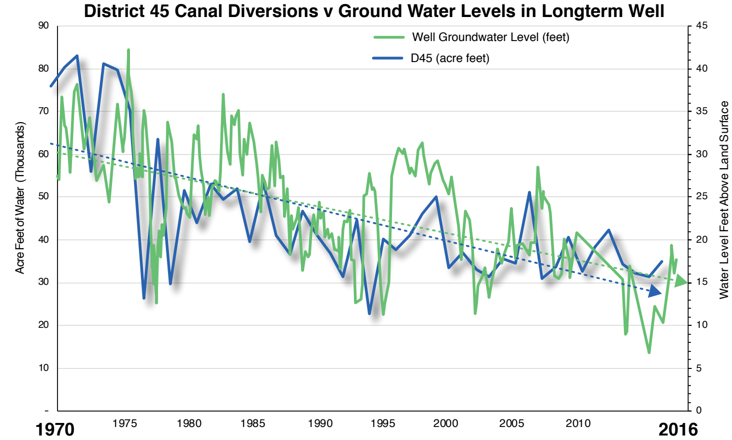


Change in Water Volumes

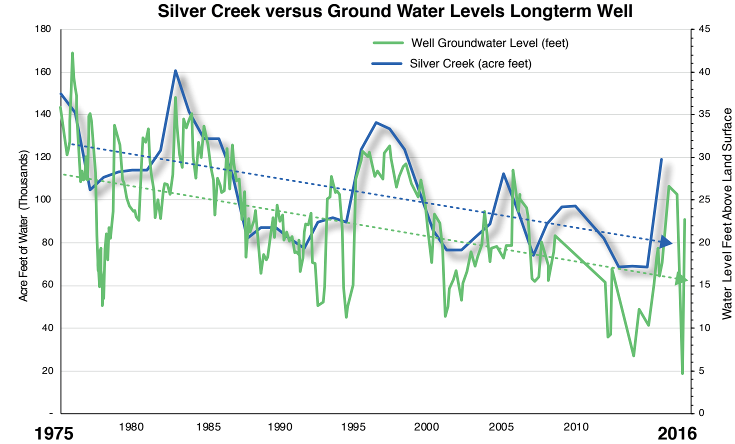
Big Wood River versus Ground Water Levels in Longterm Well



District 45 Canal Diversions v Ground Water Levels in Longterm Well



Silver Creek versus Ground Water Levels Longterm Well



Silver Creek Volume

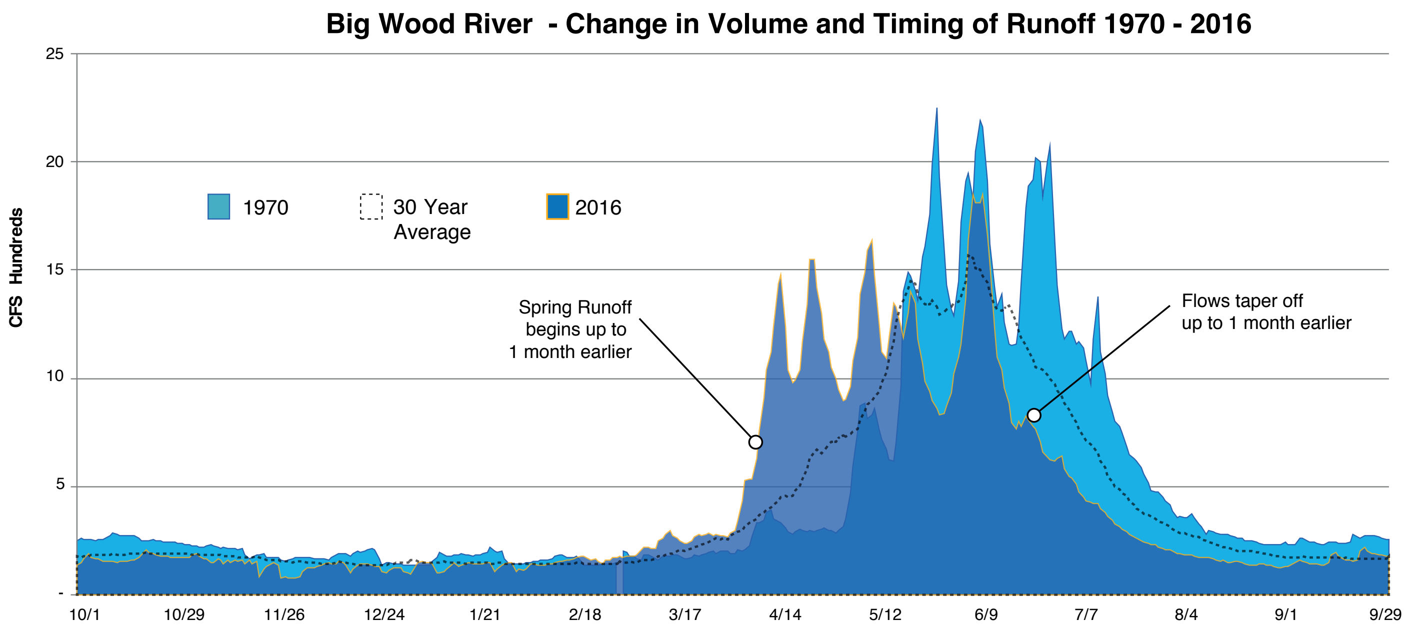
1975 to 2016

54 %

less water

Change in Water Runoff

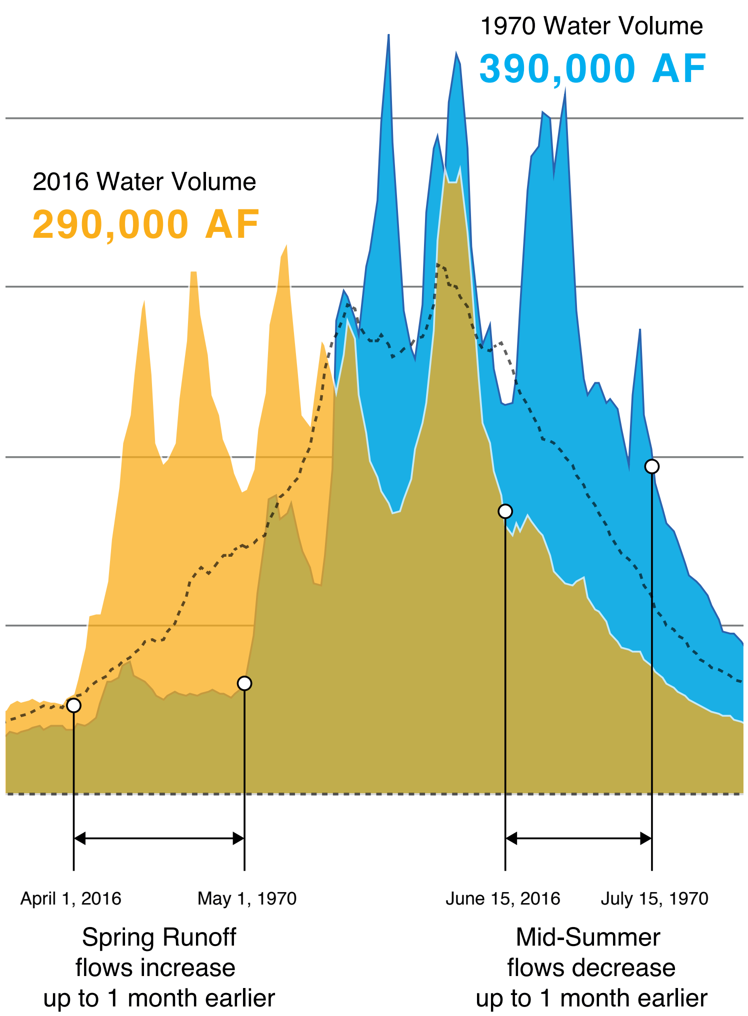
Availability: Change in Timing and Volume of Water Runoff



In the Big Wood Basin, as in many river basins in the Western United States, most of the annual precipitation falls during the winter months, yet the highest demands for water use are seen in the summer and fall. Ideally, river basins have the capability to store water from the wet season until it is needed.

The largest storage of water in the Big Wood Basin occurs naturally in the form of annual snowpack. Between 1970 and 2016 flows in the Big Wood River decreased in total volume of water available. Also, in recent years spring runoff has begun earlier, while flows have begun declining earlier than by what is indicated by the 30-year average.

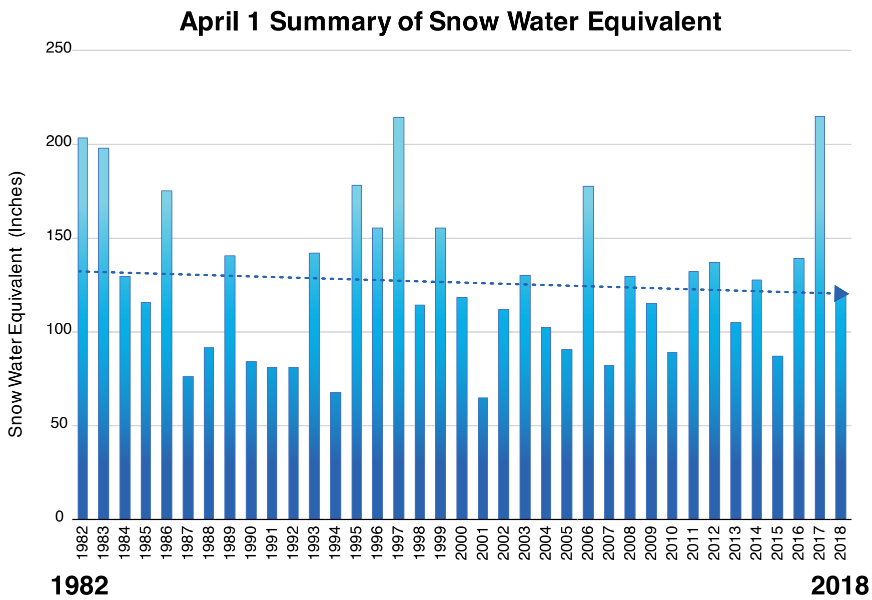
The consequences of earlier spring runoff and reduced total discharge volume greatly affect the delivery timing and availably of water for use. This is particularly problematic as it affects irrigation diversions, priority water cuts and delivery, and use of water later in the irrigation season.



Variability of Snowpack

The variability and change in the snowpack in the Basin are important. The Big Wood Basin above Hailey has seven stations that measure annual snow pack and are used to develop a Snow Index. Data has been documented at these stations for years 1981-2018; the stations are Dollarhide, Galena, Galena Summit, Hyndman, Lost-Wood Divide, Vienna Mine.

When the snow accumulation is below average during the core winter months (typically Nov-Feb), users are often interested in the chance that snow water equivalent will increase to normal seasonal levels by early April, which is when the snowpack typically reaches its seasonal peak. Snow water data are sorted from low to high, using first-of-the-month values for January, February, and March to compare across the accumulation season, ending on April 1st. The graph on the right illustrates a slight decrease in the snow water equivalent over time.



Summary

The relationship and interconnection between the Big Wood River, diversions into the irrigation canals, storage in Magic Reservoir, ground water levels in the Bellevue Triangle aquifer, and the stream flow of Silver Creek are vital to understand and quantify. This relationship and the change in conditions through time are the basis for actions that are proposed in the SVGWD Management Plan. This hydrologic information can also provide the basis for understanding how those actions will benefit the discharge of Silver Creek and the Little Wood River water supply.

This report elaborates on the relationship between the discharge of the Big Wood River (BWR) at Hailey, the diversions into the District 45 and Baseline Canals, and storage in Magic Reservoir, ground water levels in the Bellevue Triangle, and the discharge of Silver Creek at Sportsman's Access (Silver Creek) over time.

The primary drivers of hydrology in the SVGWD include the following major themes.

Water Availability - water needed to supply irrigation that is taken from a water source. The Big Wood River and the Wood River Aquifer (groundwater) are the primary sources of water for irrigation in the SVGWD. These sources have decreased through time and will affect the future of the SVGWD.

Water Delivery - most irrigated areas throughout the SVGWD use surface water that are partly or fully supplied from a delivery systems of canals. The primary surface water delivery systems are the D45 and Baseline Canals. Groundwater is delivered through wells.

Change in Water Over Time - changes to hydrology in the Basin are due to:

- Reduced water available from precipitation, and changes in timing of snowmelt and stream runoff
- Changes in irrigation practices and water delivery volumes
- Reduced flows in the Big Wood River and Silver Creek

Hydrology and Context

South Valley Groundwater District