

HYDROLOGIC CHARACTERIZATION AND INVENTORY OF
WATER RIGHTS, USES AND REQUIREMENTS AT
BRYCE CANYON NATIONAL PARK

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I. INTRODUCTION

A. Overview

Management of Bryce Canyon National Park (BRCA) has been faced with issues related to the development of water and other resources within and adjacent to BRCA which could potentially affect park water rights and water-related resource attributes. However, the park lacks water resource information necessary to respond to water-related issues in a timely manner. Management at BRCA has requested the NPS Water Resources Division (WRD) prepare a Hydrologic Characterization and Inventory of Water Rights, Uses and Requirements for BRCA.

B. Purpose

The specific purpose of this report is to characterize the hydrology and inventory the water rights, uses and requirements at BRCA. The report also presents a description of the location and movement of surface and ground water within BRCA particularly as influenced by local and regional geology.

C. Description of Bryce Canyon National Park

The park consists of 35,383 acres and lies on the Paunsaugunt Plateau in south-central Utah (See Figure 1). Erosional forces have sculpted a wide variety of colored limestones, clays and silts. The outstanding feature of BRCA is the multicolored-amphitheaters of eroded rock beds.

Elevations of 8,000 - 9,000 feet are common along the rim of the Paunsaugunt Plateau. However, the plateau breaks off abruptly to the east and south in a series of steep walls and slopes. At low elevations below the rim, pinyon pine and sagebrush predominate while at higher elevations, open stands of ponderosa pine are common. At the highest elevations, spruce-fir/aspen forests can be found (U.S. Department of the Interior, 1989, p. 9).

II. APPLICABLE LAWS REGULATIONS AND AUTHORITIES

A. National Park Service Authorities

1. Federal Legislation

Bryce Canyon National Park was originally established as a National Monument by Presidential Proclamation No. 1664 (43 Stat. 1914) on June 8, 1923. This proclamation stated in part:

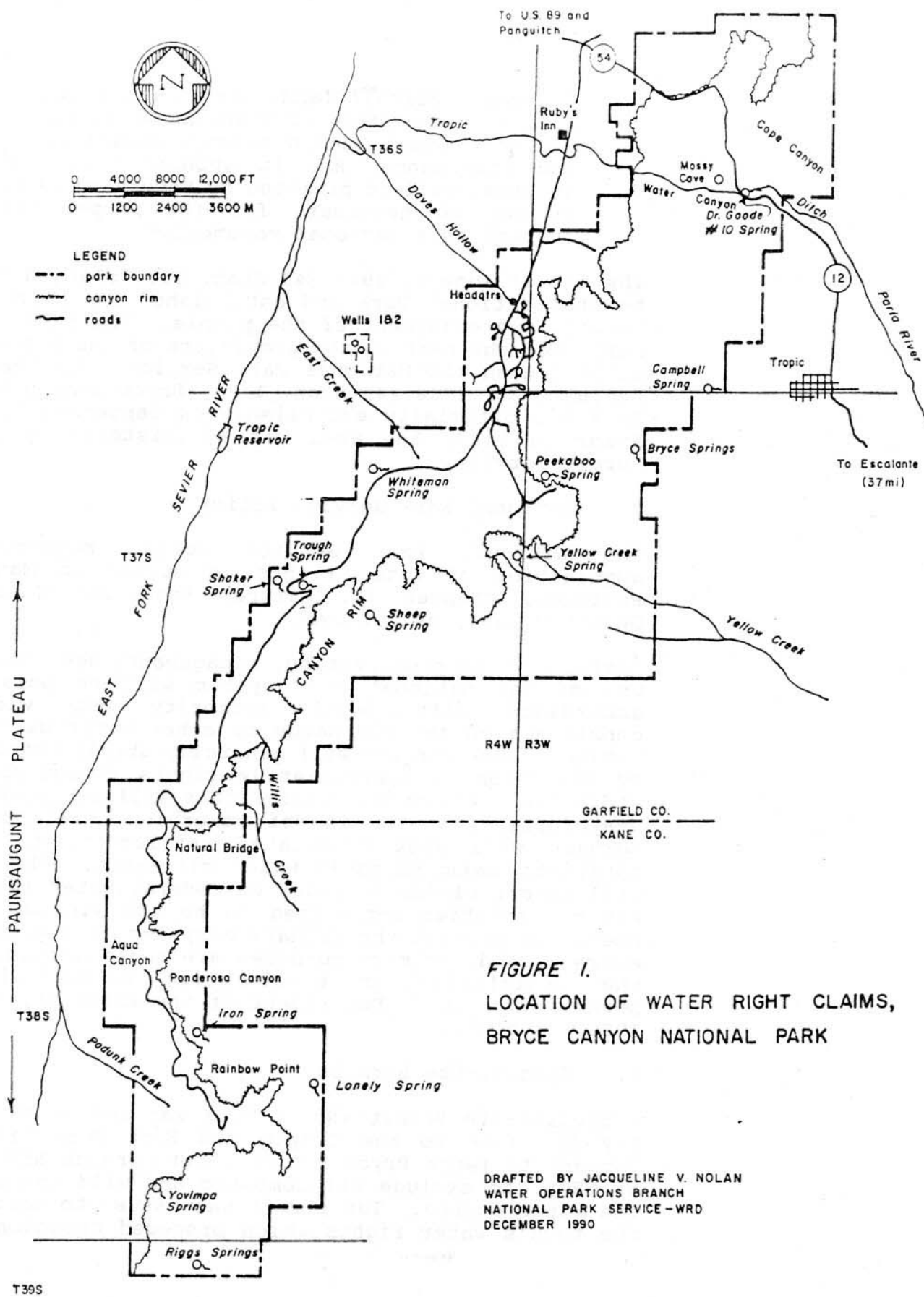


FIGURE 1.
LOCATION OF WATER RIGHT CLAIMS,
BRYCE CANYON NATIONAL PARK

DRAFTED BY JACQUELINE V. NOLAN
WATER OPERATIONS BRANCH
NATIONAL PARK SERVICE-WRD
DECEMBER 1990

"Whereas, certain lands within the Powell National Forest in the State of Utah, known as Bryce Canyon, are of unusual scenic beauty, scientific interest and importance, and it appears that the public interest will be promoted by reserving as much land as may be necessary for the proper protection thereof as a national monument."

The Act of June 7, 1924 (43 Stat. 593) changed the name to Utah National Park and established the park for the benefit and enjoyment of the people. The same act also subjected the park to the provisions of the Act of 1916, establishing the National Park Service. By the Act of February 25, 1928 (45 Stat. 147), Bryce Canyon National Park was officially established on September 15, 1928. Prior to 1928, the area was administered by the U.S. Forest Service.

2. National Park Service Policy

The National Park Service Policy regarding the acquisition of water rights is stated in Management Policies, Chapter IV, Natural Resources Management, December 1988, as follows:

"Water for the preservation, management, development and use of the national park system will be obtained in accordance with legal authority and with due consideration for the needs of other water users. The National Park Service will generally obtain water rights by assertion of appropriative rights recognized under state law. Essential water rights will be purchased if unappropriated water is not otherwise available. The Service will seek negotiated settlements to resolve conflicts among multiple water claimants. The Service will assert claims to reserved federal water rights for water quantities determined to be the minimum amounts needed to protect the primary purposes of a given park. Where stated, primary purposes are those articulated in the legislation or proclamation establishing the park....." (U.S. Department of the Interior, December 1988, p. 4:17).

3. Special-Use Permits

A Special-Use Permit (No. L3031) was issued by BRCA on May 10, 1956 to the Tropic and East Fork Irrigation Company to fence Bryce Springs, both inside and outside of BRCA, to exclude all domestic and wild animals from the water source. The permit was issued to accommodate the town's water rights which preceded creation of the

park and to comply with standards for culinary water established by the Utah Department of Health. The permit was cancelled in 1975 by Special-Use Permit No. 1330-75-01 which allowed the Tropic and East Fork Irrigation Company to use a right-of-way in the stream bed of Tropic Canyon and to develop Dr. Goode Spring No. 10. This Special-Use permit expired in 1985 and was replaced by the Right-of-Way Grant described below.

4. Right-of-Way Grant

A Right-of-Way Grant (No. RMR-BRCA-9500-001) was issued by BRCA to the Town of Tropic on November 30, 1987 for an underground pipeline of approximately three-fifths mile within the park to supply water for domestic and public purposes. A water right for the Town of Tropic in the amount of 0.224 cfs is based on Water User Claim 89-360, Diligence Claim No. 2878 with a priority date of 1880. This water right was acquired from the Tropic and East Fork Irrigation Company who used surface water for irrigation purposes. The claim was subsequently changed to Dr. Goode No. 10 Spring (Change Application No. A-7793 (89-1135)) for municipal purposes.

B. Management Objectives

BRCA's significance is based on its exceptional scenic qualities and scientific values. Colorful and intricately carved rock formations, cliffs and canyons, forests and meadows, vast panoramas and clean air combine to form one of the finest scenic spectacles to be found in the United States (U.S. Department of the Interior, 1989, p. 4).

Policies for management of BRCA are delineated in the Statement for Management, Bryce Canyon National Park, 1989. The majority of lands within BRCA are classified as natural and include the natural environment subzone (37%) and the wilderness subzone (62%). Most of the lands classified as natural environment are found above the rim. They are managed for preservation but lack wilderness characteristics. Lands classified as wilderness are located below the rim and management is in conformance with the Service's wilderness management policy.

Natural, cultural and visitor use management objectives potentially related to water resources are listed below:

1. Natural Resources

To maintain the quality and flow of water from all natural water sources that have been traditionally important in serving domestic needs and in perpetuating

the park's ecological communities (U.S. Department of the Interior, 1989, p. 28).

2. Cultural Resources

To identify, evaluate, monitor, preserve, and interpret the park's cultural resources in a manner consistent with historic preservation law, Natural Park Service policies, and the natural resources conservation objectives (U.S. Department of the Interior, 1989, p. 28).

3. Public Use

To provide opportunities for appropriate year-round public enjoyment of the park. To foster public understanding and appreciation of the park's unique features through interpretive programs and devices that focus on the forces responsible for their continued evolution (U.S. Department of the Interior, 1989, p. 28).

C. Utah Water Law

Utah has established an appropriation-by-permit system of water rights. This system defines and authorizes water use based on state-defined beneficial use and priority in time (Criddle, 1964, p. 24). The USA holds eight appropriative water rights in BRCA as listed in Section IV.A).

D. Water Rights Under Federal Doctrine

On December 13, 1983, the United States (USA) filed claims in the District Court, Sixth Judicial District, Wayne County, Utah for water rights for present and future use in BRCA. The claims were based on the Federal Reserved Water Rights Doctrine for the GENERAL ADJUDICATION OF WATER RIGHTS WITHIN THE DRAINAGE AREA OF THE COLORADO RIVER IN KANE, GARFIELD, WAYNE, PIUTE, EMERY, SEVIER AND SANPERE COUNTIES UTAH, AND EXCLUSIVE OF THE GREEN AND VIRGIN RIVER DRAINAGES (Civil Action Number 435).

III. HYDROLOGIC CHARACTERIZATION

A. Climate

The climate at BRCA is characterized by mild summers and cold winters. Precipitation is governed by the movement of storms from the Gulf of Mexico during June to September, and from the

Pacific coast during September through June (Lindquist, 1977). Winter precipitation occurs mainly as snow, which may remain on high plateaus until late spring or early summer. Summer thunderstorms often produce rapid runoff and occasional flash floods.

Precipitation records at BRCA and the Town of Tropic, have been kept since 1933 and 1935, respectively. Pan evaporation rates and precipitation were measured at another station in BRCA from mid-1971 to 1979. In addition, climatological records were kept at the airport north of BRCA from 1949 to 1980. Table 1 lists average annual precipitation at these four stations. At BRCA Headquarters, elevation 7,915 feet, average annual precipitation is 15.41 inches (U. S. Department of Commerce, 1960 through 1986). At higher elevations in the southern end of the park, average precipitation is over 20 inches.

TABLE 1. AVERAGE ANNUAL PRECIPITATION
IN THE VICINITY OF BRCA

Station Name	Station Number	Period of Record	Precipitation (inches)
Bryce Canyon National Park	1007	1933-1958	17.23
Bryce Canyon N.P. Headquarters	1008	1960-1986	15.41
Tropic	8847	1935-1986	12.84
Bryce Canyon	1002	1949-1980	11.94

Note: Station 1008 replaced Station 1007 in 1959.

Source: U. S. Department of Commerce

At BRCA, the wettest month is March with June being the driest. Other months occupy no persistent places. For some months the rainfall of the driest years exceeds that of the wettest year. In terms of consistency, about all that can be said for precipitation at BRCA is that seasons rank winter, spring, summer and fall in terms of descending amount of moisture (Gregory, 1951. p. 10).

B. GEOLOGY

1. History and Setting

Deposition of lower geologic strata presently exposed in BRCA began approximately 110 million years ago. At this time southeastern and central Utah was a flat coastal plain covered by a shallow sea. Sediment was eroded and washed from an adjoining belt of mountains to the northwest, and deposited in the sea and along the river channels. Periodic advance and retreat of the sea over the next 60 million years caused variations in the thickness and type of material deposited. The final recession of the sea was gradual and ended in the area of BRCA about 50 million years ago (Hintze, 1973). Subsequently, the depositional environment of the Claron (Wasatch) Formation (from which Bryce's famous pink cliffs and hoodoos are carved) was one of fluctuating lakes and streams.

Approximately 15 million years ago, a period of regional uplift began which elevated the Colorado Plateau. In southern Utah uplift was accompanied by faulting which broke the region into large blocks. Continued uplift of these tectonic blocks (masses of rock that have been transported through movement of the earth's crust) formed the high plateaus which are present today (Lindquist, 1977). The Paunsaugunt Plateau, on which BRCA is located, is one of these plateaus.

BRCA lies on the eastern edge of the Paunsaugunt Plateau in an 18-mile long north-south band. The park contains parts of the plateau and the adjoining canyons which lie farther to the east. Elevations in BRCA on top of the plateau range from approximately 7,700 feet in the north to over 9,100 feet in the south at Rainbow Point. The cliffs along the edge of the plateau range in height from 200 to 500 feet. The canyons below the rim are deeply incised and valley floors are generally 500 to 1,000 feet lower than the plateau.

2. Stratigraphy

The rock strata exposed in BRCA range in age from lower Cretaceous (136 million years ago) through Holocene (present) and include limestones, sandstones and shales, and unconsolidated alluvial deposits. The oldest unit exposed in BRCA is the Dakota Formation (136 million years ago) which only appears in a very small area east of the Paunsaugunt Fault (Doelling and Graham, 1972).

Overlying the Dakota Formation is the Tropic Shale, an

easily eroded claystone with minor quantities of bentonite, mudstone, sandstone, and moderately erosion resistant limestone (Robison, 1966). It outcrops in several locations in the eastern part of BRCA. The unit is approximately 700 feet thick in the park vicinity (Doelling and Graham, 1972). The great thickness of impermeable claystone and mudstone make the Tropic Shale an important regional aquitard (a formation that retards ground water flow, though it may store large quantities of water), restricting the vertical movement of water between the overlying Straight Cliffs Formation and the underlying Dakota Sandstone. Sandy lenses might yield small amounts of water, but the water quality would probably be poor due to high levels of calcium and sulfate (Marine, 1963). No springs are reported to flow from the Tropic Shale in BRCA.

Immediately above the Tropic Shale are the Straight Cliffs and Wahweap Formations. Because extensive sandstone beds found in both formations are reportedly saturated with water throughout much of the region, these formations are important aquifers (bodies of rock that yield significant quantities of water to wells or springs) in BRCA. Within the Park, Campbell, Bryce, Yellow, Sheep, and Riggs Springs, as well as other small seeps and springs, issue from these formations (Marine, 1963).

The Kaiparowits Formation is the youngest of the Cretaceous strata in BRCA and is found above the Straight Cliffs and Wahweap Formations. The unit is chiefly comprised of poorly cemented sandstone. Exposure of the formation within BRCA is limited, however, due to post-depositional erosion. Between the south boundary of BRCA and Yellow Creek, the formation is approximately 400 feet thick. North of Yellow Creek, the unit begins to thin and is not present between Paria View and Bryce Point. Springs which flow from the Kaiparowits Formation, (i.e. Iron and Lonely Springs) generally have low yields (Marine, 1963).

The Claron (Wasatch) Formation, located above the Kaiparowits formation, is the well known limestone from which the hoodoos (rock pillars produced by weathering or erosion) of Bryce Canyon have been carved. (Robison, 1966). Although much of the Claron (Wasatch) Formation is not saturated, the bottom-most conglomerate contains many small springs in BRCA which occur at the base of the Pink Cliffs where this layer outcrops. Springs in Agua, Ponderosa and Natural Bridge Canyons all issue from the basal conglomerate. Sandy layers in the Claron (Wasatch) Formation support small springs on the plateau (Shaker,

Trough, and Whiteman Springs), as well as below the rim (at Mossy Cave, in Cope and Water Canyons, and Yovimpa Springs) (Marine, 1963).

The youngest geologic strata in BRCA are alluvial deposits which occur in many of the valleys and stream channels. On top of the Paunsaugunt Plateau, broad flat valleys (i.e. East and Podunk Creeks and Daves Hollow) are filled with alluvial deposits. (Marine, 1963). Below the plateau's rim, where stream channels are deeply incised in bedrock, alluvium covers the valley floors (i.e. Yellow and Sheep Creeks, and Bryce and Tropic Canyons). The thickness of these deposits is unknown and can vary seasonally due to frequent transport by flash floods. Alluvial deposits contribute to the ground water resources of BRCA, but due to limited extent and thickness in relation to other aquifers, alluvium stores and transmits only a small fraction of the region's ground water.

. Structural Features

Structural features are produced by deformation or displacement of rock. In the vicinity of BRCA, the uplift of the Colorado Plateau produced faulting (fracture and displacement of the strata), jointing (fractures without offset), and minor folding (bending of the strata). The bedding on the Paunsaugunt Plateau is nearly horizontal, dipping 1 to 3 degrees north, northeast, and east (Gregory, 1951).

Orientation of the bedding is important because movement of ground water is, in general, parallel to the bedding planes (Todd, 1980). Ground water in the aquifers of the eastern part of the Paunsaugunt Plateau flows eastward into BRCA, and results in the many springs and seeps along the eastern cliffs of the plateau.

a. Faults and Joints

The tectonic block which forms the Paunsaugunt Plateau is bounded on the east by the Paunsaugunt Fault which trends north-northeast and passes through the north half of BRCA, just inside the eastern boundary. The fault plane ranges from vertical to a dip of 45 degrees eastward.

The Paunsaugunt Fault has a significant effect on the movement of ground water. Offset of the fault in BRCA is approximately 1,500 feet in Tropic Canyon, putting Tropic Shale on the east side of

the fault against the Straight Cliffs and Wahweap formations on the west, and decreases to the south to 1,000 feet near Yellow Creek (Gregory, 1951). The impermeable Tropic Shale blocks the eastward movement of ground water in the permeable sandstone layers of the Straight Cliffs and Wahweap Formations, and forces ground water to rise to the surface. Springs occur along the fault trace (line marking the intersection of the fault plane with the ground surface) in Tropic, Campbell and Bryce Canyons, and Yellow Creek (Marine, 1963).

Joint systems and small, discontinuous faults with vertical offsets of a few feet can be seen in the exposure of the Claron Formation. These fractures allow rain or melting snow to percolate into the formation and provide a means of spring discharge where saturated rock intersects the surface, as in cliffs or steep canyon walls (Gregory, 1951). Many springs that flow from the basal conglomerate and sandy layers in the Claron Formation discharge from joints.

b. Folds

Several minor folds are present in the vicinity of BRCA. They are small variations in the general regional dip of strata and may have local influence on the direction of ground water movement.

C. Water Resources

1. Surface Water

BRCA occupies the headwaters of two major watersheds, each of which is drained by a perennial stream. The East Fork Sevier River, which lies just outside the western boundary of BRCA, drains the Paunsaugunt Plateau and flows north into the Great Basin. The Paria River, just east of the Park and below the plateau's rim, drains the Tropic amphitheater and flows south to the Colorado River.

Within BRCA, segments of several tributaries to the Paria River are reported to be perennial, including Sheep Creek, Yellow Creek and Willis Creek (Marine, 1963). Other tributaries to the Paria and East Fork Sevier Rivers are intermittent or ephemeral.

Surface water resources in BRCA are affected by the Tropic Ditch, an irrigation canal that crosses the

northern part of BRCA. It was constructed in the 1890's to bring water from the East Fork Sevier River across the Paunsaugunt Plateau to the Tropic area. Flow in the ditch enters BRCA just east of Ruby's Inn and runs east to the rim of the plateau, where the water drops into the headwaters of Water Canyon. The flow continues down Water Canyon to just upstream of the confluence with Tropic Canyon, adjacent to Utah Highway 12. At this point, a small check dam pools the water and a pipeline diverts flow under the highway and across the Paria streambed of Tropic Canyon to a continuation of the irrigation ditch.

Only during high flow does water occur in Water Canyon downstream of the check dam when it is opened so that silt laden water will not clog ditches and pipes. This diversion thus includes not only water from the Tropic Ditch, but virtually all runoff from springs and precipitation in the Water Canyon watershed. The flow in the ditch exits BRCA approximately 4,000 feet east of the diversion dam.

2. Ground Water

The most reliable source of water in the BRCA region is ground water. Many perennial seeps and springs throughout the area issue from saturated aquifers underlying BRCA.

a. Aquifers

As described earlier, there are several major aquifers and one aquitard important to ground water resources in the BRCA region. Recharge of ground water on the Paunsaugunt Plateau is principally from percolation of snowmelt. Water moves downward through unsaturated soil and infiltrates into the saturated zone of the uppermost aquifer, the basal conglomerate of the Claron Formation. Some downward percolation continues to the Straight Cliffs and Wahweap Formations where saturated zones form above clay lenses and at the contact with the Tropic Shale. The latter formation is a thick aquitard, acting as virtually a complete barrier to the downward movement of water. Ground water flow does occur in the Tropic; however, the rate is several orders of magnitude slower than in the overlying formations.

Movement of ground water in the saturated zones of BRCA aquifers is eastward and nearly horizontal, closely following the dip of the strata. The

aquifers underlying BRCA, therefore, receive water from both percolating recharge and flow from the west. Springs occur where the saturated zone intersects the ground surface at the cliffs bordering the eastern edge of the Paunsaugunt Plateau. This is evidenced by the large number of springs and seeps in the park along the eastern escarpment of the Paunsaugunt Plateau.

b. Springs

Springs within BRCA can be divided into two groups: bedrock and alluvial. Generally, springs which have a source in bedrock have a fairly constant discharge throughout the year, while the discharge of springs that have a source in alluvium can vary greatly in response to precipitation.

Bedrock springs can be further separated into those on top of the Paunsaugunt Plateau and those below the rim, based on the uniformity of discharge throughout the year. Springs on the plateau, (i.e. Shaker and Trough Springs), generally have small, localized recharge areas and discharge can vary with annual precipitation. Springs below the rim are not as affected by annual fluctuations in precipitation. The long travel path of ground water, from recharge on top of the plateau to discharge below the cliffs, minimizes seasonal and long term fluctuations in rates of recharge allowing fairly constant discharge. Because of its reliable discharge, Bryce Spring (located in lower Bryce Canyon in BRCA) was used for many years as a municipal water supply for the Town of Tropic (Goode, 1970).

Alluvial springs occur in stream valleys both on top of the Paunsaugunt Plateau and below the rim. These springs usually respond quickly to precipitation and vary greatly in discharge. However, because alluvium mantles much of the bedrock below the rim, it is sometimes difficult to determine whether spring discharge is from a 'true' alluvial spring or from a bedrock spring situated beneath the alluvium. However, springs of the latter type have the constancy of flow of bedrock springs. Examples of 'true' alluvial springs exist in East Creek Valley, approximately 1.5 miles outside of the park boundary. Springs issuing from alluvium which are probably bedrock springs are present in Yellow and Sheep Creeks (Marine, 1963).

IV. INVENTORY OF EXISTING WATER RIGHTS AND USES

A. Water Rights

1. State Appropriative Rights

The Utah Division of Water Rights reports that the NPS holds eight appropriative water rights within BRCA as listed below in Table 2. A claim number for each water right is listed along with a water right number (WR NUM) assigned by the State for rights that have been perfected.

Table 2. Appropriative Water Rights held by the NPS within and adjacent to BRCA.

<u>Claim #, (WR NUM)</u>	<u>Source</u>	<u>CFS</u>	<u>Use</u>	<u>Priority</u>	<u>Location</u>
20278 (89-1486)	Yovimpa Springs	0.0343	Municipal Fire prot.	10/19/48	(See Fig. 2)
21353 (61-121)	Ground Water	0.003	Municipal (no current use)	02/09/51	Headquarters Area
30802	Ground Water	0.75	Municipal (no current use)	3/20/59	Yellow Creek Springs
27154 (61-893)	Ground Water	0.25	Domestic Fire prot.	1888 Diligence	Well #1 East Fork (Creek)
27385	Ground Water	0.16	Domestic Fire prot.	1888 Diligence	Well #2 East Fork (Creek)
9406 (61-48)	Trough Spring	0.05	Domestic (no current use)	9/26/23	(See Fig. 3)
8888 (89-10)	Hopkins Springs	0.00011	Domestic Fire prot.	9/13/24	(See Fig. 3)
9221 (89-11)	Shaker Spring	0.20	Domestic (no current use)	1/12/23	(See Fig. 3)

In the early 1920's, the Union Pacific Railroad (UPRR) recognized the potential for profit through development of scenic attractions of southern Utah. In 1922, the UPRR negotiated a long-term concession agreement with the NPS and operated in BRCA as two separate companies. Transportation was handled by the railroad. The Utah Parks Company (UPC), a subsidiary of UPRR, was incorporated in 1923 and developed a wide range of tourist facilities (Scrattish. p. 27, 43). Eventually, the UPC acquired all but the first three water rights listed above in Table 2 from various individuals for use at BRCA. By the late 1950's and early 1960's the UPC encountered severe business setbacks. After repeated attempts to sell the failing UPC, the UPRR, on December 31, 1971, donated all of its facilities and equipment, including its water rights to the NPS (Scrattish. p. 137).

The Utah Division of Water Rights also lists alien water rights (water rights not owned by the USA with a point of diversion and/or use within or adjacent to BRCA) located in four areas: Water Canyon, Tropic Canyon, Campbell Creek, and Bryce Creek as listed on the next page in Table 3. A claim number for each water right is listed along with a water right number (WR NUM) assigned by the State for rights that have been perfected.

Table 3. Alien Water Rights within BRCA

<u>Claim #, (WR NUM)</u>	<u>Source</u>	<u>CFS</u>	<u>Use</u>	<u>Priority</u>	<u>Location</u>
D2877 (89-359)	Water Canyon Creek	1.0	Irrig., Stock	1880 Diligence	Mossy Cave
(89-404)	*Water Canyon Creek	1.0	Irrig., Stock	1890 Diligence	(See Fig. 4)
(89-1083)	*Water Canyon Creek	1.0	Irrig.	1890 Diligence	(See Fig. 4)
D2878 (89-1135)	Paria River	0.224	Irrigation	Diligence 1880	Dr. Goode Spring #10 (See Fig. 4)
(89-1469)	Paria River	0.444	Municipal	Diligence 1880	Dr. Goode Spring #10 & unnamed spring (See Fig. 4)
19146	Campbell Creek	0.33	Irrig.	9/29/1947 (Lapsed on 9/25/1952)	Campbell Canyon Springs (See Fig. 4)
A35996 (89-75)	Campbell Creek	0.05	Municipal	1876 (Protested & withdrawn)	Campbell Canyon Springs (See Fig. 5)
D2237 (89-127)	Bryce Creek	2.50	Irrig.	2/20/1880 Diligence	Spring area (See Fig. 3)
U8174 (89-96)	Bryce Creek	0.34	Irrig., Stock	7/1934	Underground (See Fig. 3)

* This same flow is intermittently diverted by any, each or all claimants in any, each or all points of diversion. Rights are covered by WRNUMs 404 and 1083.

In Tropic Canyon there are two water rights (WRNUMs 89-1135 and 89-1469) for diversion of water from a spring known locally as Dr. Goode Spring #10. The point of diversion is about 3/5 mile within BRCA from the spring located within the bed of the Paria River just downstream

from the Highway 54 Bridge. The water is used as the municipal supply for the Town of Tropic and for irrigation by the Tropic and East Fork Irrigation Company. Total diversion is 0.668 cfs (0.224 and 0.444 cfs). These two rights were segregated from 89-360 with application #D2878, approved on 7/17/1975.

For three water rights in Water Canyon (WRNUMs 89-359, 89-404, 89-1083), water is diverted at the same point to transfer water in the canyon into the lower continuation of Tropic Ditch.

Two alien water rights located in Bryce Creek (WRNUMs 89-127 and 89-96) comprise the former municipal water supply for the Town of Tropic. Though the points of diversion are different, water is diverted from the same general marshy area. This site was abandoned as a municipal supply in the 1970's, when the town developed Dr. Good Spring # 10 in Tropic Canyon and moved the point of diversion for WRNUM 89-96 to the new location and changed the purpose of use to municipal.

The Tropic and East Fork Irrigation Company holds water rights (outside of BRCA) from springs tributary to East Creek, a tributary of the East Fork, Sevier River. Water is stored in Tropic Reservoir and then diverted via the Tropic Ditch across BRCA into the headwaters of Water Canyon. Additionally, the diversion may intercept water originating from springs or other tributaries in the watershed.

2. Federal Reserved

On December 13, 1983, the United States (USA) filed claims in the District Court, Sixth Judicial District, Wayne County, Utah for water rights for present and future use in BRCA. The claims were based on the Federal Reserved Water Rights Doctrine for the GENERAL ADJUDICATION OF WATER RIGHTS WITHIN THE DRAINAGE AREA OF THE COLORADO RIVER IN KANE, GARFIELD, WAYNE, PIUTE, EMERY, SEVIER AND SANPERE COUNTIES UTAH, AND EXCLUSIVE OF THE GREEN AND VIRGIN RIVER DRAINAGES (Civil Action Number 435).

Federal reserved water rights have been claimed for both surface and subsurface water including all perennial and intermittent streams and all springs, seeps and other natural sources of water. Claimed priority dates are of June 7, 1924; February 25, 1928; May 12, 1928; June 13, 1930; January 5, 1931; February 17, 1931; and March 7, 1942 for lands reserved on the respective dates. The USA has claimed in all surface sources, the minimum amount of

flow necessary to fulfill reservation purposes which include preservation in their natural state of the outstanding scenic features and conservation of the scenery and the natural and historic objects and the wildlife and provision for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

Federal reserved rights are subject to all valid water rights under Utah law having priority dates earlier than June 7, 1924; February 25, 1928; May 12, 1928; June 13, 1930; January 5, 1931; February 17, 1931; and March 7, 1942, depending on the date the land was withdrawn from the Public Domain. Claims were also filed for all appropriative rights included in the general adjudication.

An adjudication was completed for the Sevier River Basin in 1936. This was prior to the McCarran Amendment, 43 U.S.C. 666, and therefore, did not include Federal reserved water rights. This decree notwithstanding, the USA also claims reserved rights for BRCA in the Sevier River drainage and will present its claims in Utah State Courts when properly joined under the McCarran Amendment.

B. Water Use

1. Visitor and Administrative Uses

Three separate water supply systems serve different areas of the park. The Main System supplies the main visitor services area. The Rainbow Point System provides water at the Rainbow/Yovimpa Point visitor area at the south end of the park. The Peek-A-Boo System serves only horses below the rim.

The Main System is the oldest and has undergone many changes and renovations. East Creek Valley alluvial springs, Shaker and Trough, and a drilled well have all served as water supplies for the Main System at different times. Currently, water is supplied from two wells in the East Creek Valley about two miles west of Park Headquarters.

The East Creek wells were constructed in the 1950's to replace the cistern collection system. These wells, numbered 1a and 2a, are 90 and 52 feet deep, respectively. Water is pumped to a control house and two water tanks via a 6-inch pipeline. The tanks, located about 1.5 miles south of BRCA Headquarters, can store

1,000,000 and 300,000 gallons, respectively. Mean annual use from this system for visitor and administrative purposes in the headquarters area, including irrigation of about 3 acres, is about 15 million gallons (Barton, 1989).

Water supply for the Rainbow Point System is provided by Yovimpa Spring, located approximately two miles southwest of the Rainbow Point visitor area (See Figure 1). Development of the spring was completed in 1947. Water from Yovimpa Spring seeps out of fractures in the rock face on the south side of Yovimpa Pass and is collected by an array of buried perforated pipe. Water is stored in a 5,000 gallon cistern and then pumped to Rainbow Point through a 4-inch pipeline. At Rainbow Point, water is treated before entering a 24,000 gallon storage tank. Water facilities at Rainbow Point include restrooms, a drinking fountain, and an outside tap. Annual amount of water use is estimated to be about 250,000 gallons (Barton, 1989). Water usage was curtailed in 1990 due to drought conditions. Water fountains and outside taps were closed.

Peek-A-Boo Spring, seeping from the Pink Cliffs below the plateau's rim, provides water for horses. The spring is located at the head of an unnamed canyon tributary to Bryce Creek (See Figure 1). Water is collected in a perforated pipe and transmitted to a concrete cistern. It is then piped to a trough for horses. No estimates are available for the amount of water used at this site.

2. Fire Protection

Structural and similar fires within Bryce Canyon National Park are suppressed by the park's fire brigade. A mutual aid agreement is in effect with Garfield County which provides for responses within the County. Water for fires in the headquarters area is obtained from 27 hydrants located at strategic locations in the developed area (U.S. Department of the Interior, 1989, p. 1). The main water system described in IV.B.1 above supplies water to the hydrants from storage tanks.

3. Protection of Water-dependent Recreational and Environmental Values

As described above in Surface Water, Section III.C.1, three perennial streams (Yellow, Willis and Sheep Creeks) are found in BRCA which contain values of importance for wildlife maintenance and enhancement, recreational, environmental and aesthetic purposes. Specifically, the riparian vegetation associated with these streams

provides habitat for wildlife, adds to the aesthetic diversity of the park and enhances the recreational experience for visitors that hike in the park's backcountry. Shade and running water are rare in an arid environment and, therefore, visitors tend to be attracted to and congregate along the streams. In addition, the "ribbons of green" created by riparian vegetation add contrast to the pink and grey hues of the canyon walls and are an important component of the visual experience available at BRCA.

Three peregrine falcon (Falco peregrinus anatum) eyries and associated territories for this federally endangered species are located in proximity to the above mentioned streams as well as Black Birch Creek, an ephemeral stream (Johnson, 1989, p. 2.). Also, "wet areas" near Yellow Creek were listed as the location of numerous sightings of adult and fledgling peregrines and are the nearest perennial water source for the birds (Johnson, 1989, p. 14.). In addition, the hunting ranges (observed and suspected) for peregrines from the Black Birch Creek eyrie extends over the Yellow and Willis Creek drainages (Hallows, 1990, p. 12.). It is believed the streams and wetlands near the eyries are important in supporting the prey species.

Mossy Cave, a unique cavern located just west of the State Highway 54 bridge across the Paria River, contains plants (mosses and lichens) that are relatively uncommon in this arid environment. The cave and its environs are fed by groundwater which exits the cave and then flows into water canyon. Small stalactites are found on the roof of the cave. In addition, icicles are common in the cave and were reported to have been removed by early settlers as a source of ice. This area receives heavy visitation from the public and is the focus of interpretive tours presented by park staff.

B. Future Water Uses

1. Visitor and Administrative Uses

The General Management Plan / Development Concept Plan for BRCA calls for a continuation of the ceiling of 110 rooms within the park for visitor accommodations. Any additional lodging will be supplied outside the Park by the private sector. As visitation continues to increase, additional water will be required for visitor needs. Also, additional needs for water may be required for administrative purposes to serve an increasing number of visitors.

2. Fire Protection

Future requirements for fire protection may increase due to increased number of visitors.

3. Protection of Water-dependent Recreational and Environmental Values

Future requirements for protection of water-dependent recreational and environmental values would be the same as present needs described above in Section IV.B.3.

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