Kaibab National Forest:

An Evaluation of Water Resource Characteristics, and their Contribution in Ecosystem Diversity and Ecological Sustainability

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Introduction-Background

In 2006, the Kaibab National Forest is embarking on Forest Plan revision. With implementation of the 2005 Forest Planning Rule, the Forest Service is charged with developing management plans that create a framework for contributing to economic, social and ecological sustainability on National Forests and Grasslands. The planning rule and directives defines ecological sustainability as providing for the diversity of plant and animal communities using a multi-scale approach that evaluates and provides guidance for ecosystem and species management. The primary focus for assessing ecological sustainability in the current Rule is to provide for ecosystem diversity which contributes to a diversity of native plant and animal species.

A. Purpose and Objective of Analysis

The purpose of this analysis is to evaluate water resource characteristics most important in assessing ecosystem diversity from broad scales to finer scales below the Forest. This analysis includes an evaluation of current and historic (where possible) water resources, disturbances and processes, trends and projected future conditions, and an evaluation of ecosystem risks with the objective of identifying specific ecological needs for changes in the Forest Plan. Tables 11 and 12 near the end of this report summarizes departure between reference and current conditions, projected future trend and aquatic characteristic of greatest concern (ecological need for change) by 4th or 5th Code watershed followed by the Table 13 trend analysis by aquatic characteristic.

Water resource characteristics to be analyzed include the following, quantity of streams, riparian areas, wetlands, stock tanks, seeps, and springs, watershed water yield, groundwater supply and demand, water quality and aquatic ecosystem diversity, (Aquatic Ecosystem Diversity Report fishes provided by Albert Sillas) for fish species richness and fish community by 4th and 5th Hydrologic Unit Code (HUC) watersheds. In addition, we are providing supplemental information (by Forest, where information is available) on current condition and quantity riparian areas and wetlands to better characterize the need for change.

These are the water resource characteristics identified by the Region 3 Ecological Working Group as those most important in assessing water resource ecosystem diversity and will be analyzed from broad scales 4th HUC watersheds to finer scales 5th HUC watersheds and at the planning unit (Forest) scale. This analysis focuses on the Comprehensive Evaluation Report (CER) Phase 1, Need for Change Evaluation for water resource ecosystem diversity and describes the ecological niche of the Forest at multiple scales in order to evaluate the contributions to ecological sustainability that may occur at those scales. Key findings are highlighted where appropriate.

Species diversity and economic and social sustainability will be analyzed in a separate document and interwoven with this analysis to provide guidance in overall need for change. A list of recommended specific needs for change and rationale will be provided subsequent to this analysis and may include eliminating, modifying, or adding to current plan direction.

Scales and Data Used In the Analysis

1. Appropriate Scales beyond the Planning Unit Forest Boundary. This analysis uses the 4th HUC watershed at the broadest scale and 5th HUC at a finer scale. The 4th HUC occupies large acreages and extends into and well beyond the Forest boundary. There are eight 4th HUC watersheds intersecting parts of the Kaibab Forest. Table 1 displays Watershed names and relative area.

The 5th HUC are smaller watersheds than the 4th HUC and are either located entirely within or extend a little beyond the Forest boundary. There are twenty-two 5th HUC watersheds within or connected to the Forest. Table 1 displays Watershed names and relative area. This analysis uses 4th and 5th HUC watersheds to determine the contribution Forest water resources have towards ecological sustainability.

2. Appropriate Scales at the Planning Unit and below. This analysis uses 5th HUC watersheds and the Forest area to characterize water resources and conditions within the Forest.
3. Tabular, quantifiable data used comes from the most recent Region 3 tables (kai_stats_aquatic_owner_20070105.xls). The Ownership layer is used for the determination of the Forest contribution towards ecological sustainability for perennial stream miles, riparian miles to the 4th HUC watershed, springs, seeps, stock tanks and water quality miles. Analysis of wetlands and riparian areas at the Planning unit (Forest scale) and below (5th HUC watershed) uses the Administrative boundary layer and Forest-specific data.
4. The National Hydrologic Dataset was consulted for perennial stream extent and found to be extremely inaccurate on the Kaibab National Forest – overestimating it by an order of magnitude across the Forest when checked on the ground and within Forest records. Therefore Forest records and personal communications with past and present Forest personnel who have observed conditions on-site are used for on-Forest data. The NHD is used elsewhere.

Current, Historic Condition and Niche by Resource

A. Watershed Extent, and Perennial Streams

Current Conditions:

Scale Above Planning Unit (4th HUC): Table 1 displays watershed and perennial stream extent, and water yield by 4th HUC watershed (subbasin) in areas outside and within the Forest. Figure 1 displays the 4th HUCs in the Forest context.

Watershed conditions on the Forest continue to be satisfactory. Unsatisfactory soil conditions within these watersheds have contributed to a decline in portions primarily in desert and pinyon-juniper communities. Past livestock grazing and the lack of fire have contributed to these downward trends. Currently, vegetation departures from historic conditions pose threats to a number of watersheds from the risk of large fires and the increase in fuels in these watersheds. Fires in high fuel areas burn with a high intensity, damage soils, remove ground cover, and deliver high amounts of sediment to stream channels. Table 2 displays these threats in a relative way. Dark shading indicates higher risk. Trellised shading of some 4th Code watersheds indicates those where the Forest contribution to the subbasin – favorable or unfavorable – is small.

North Canyon Creek in North Canyon Wash 5th Code watershed is thought to be at or near historic water flow conditions. Riparian conditions are thought be near current conditions with a wide array of riparian species. This stream channel is classified in good condition and is not diverted or substantially altered so is not departed from reference condition.

Kanab Creek (Grama Canyon and Jumpup Canyon 5th Code watersheds) has been converted to an ephemeral stream, due to upstream diversion and use. Flooding disturbance is greatly reduced. Kanab Creek is now dominated by tamarisk, which is crowding out the native willow and

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cottonwood community. Livestock grazing was a factor in this area but livestock have been excluded from grazing since 1996. Occasional unauthorized use continues.

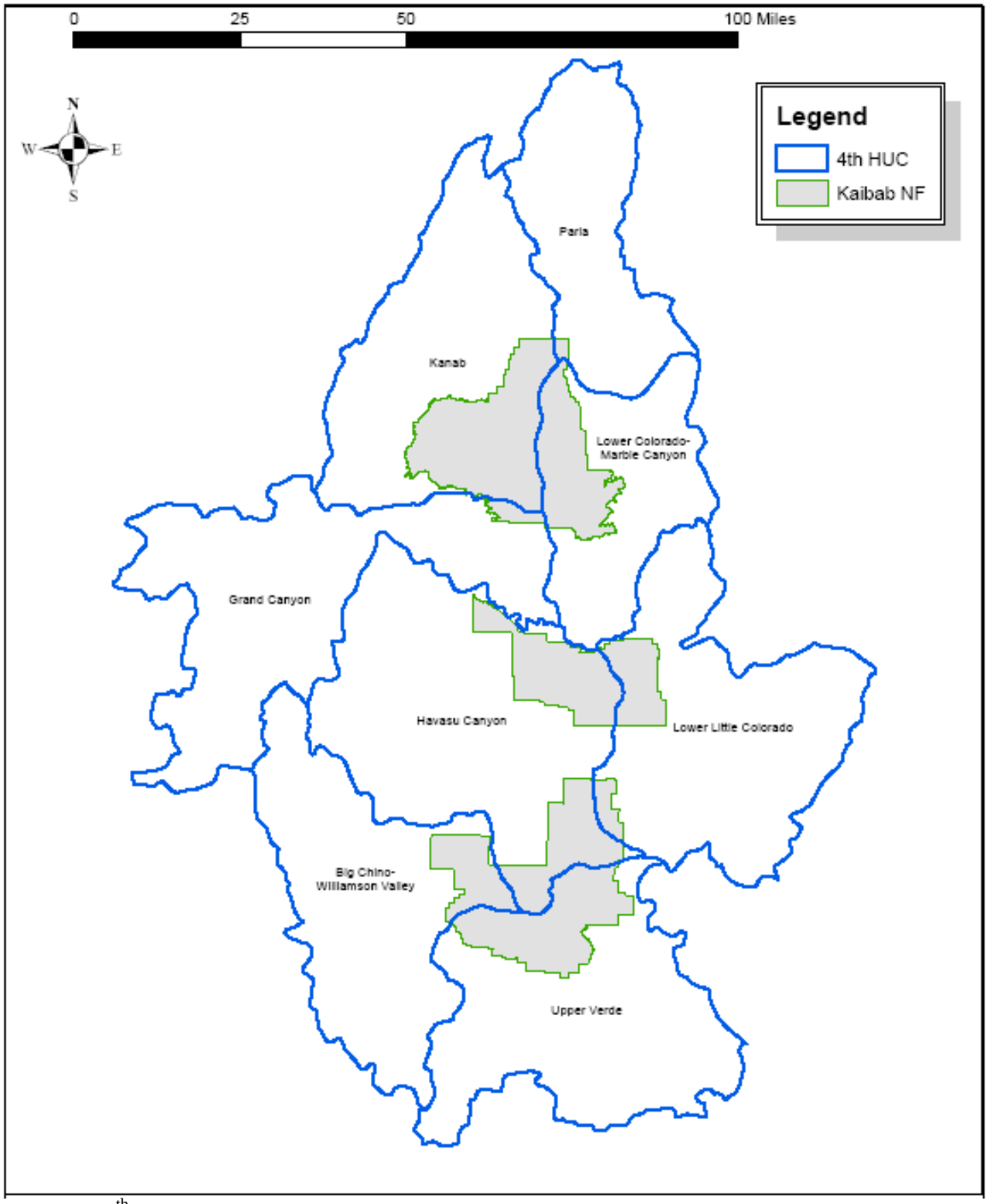

Figure 1. 4th HUC watersheds intersecting the Kaibab National Forest.

Table 1. Subbasin (HUC 4) Watershed Extent and Perennial Streams - Kaibab National Forest 1/18/2007

Subbasin Name	Subbasin Area (square miles)	Kaibab Area (square miles)	Kaibab as % of Subbasin	NHD Perennial Stream Miles in Watershed	NHD Perennial Stream Miles on Forest Administered Lands	Existing Perennial Stream Miles on Forest Administered Lands	Percent of Existing Perennial Miles on Forest Within Watershed[1]
Kanab	1710	596	34.9%	69.8	[2]20.0	0.0	0.0%
Lower Colorado-Marble Canyon	1467	360	24.5%	67.2	1.4	1.5	2.2%
Havasu Canyon	2933	607	20.7%	13.9	[3]1.4	0.0	0.0%
Upper Verde	2507	425	17.0%	78.5	[4]9.9	0.0	0.0%
Lower Little Colorado	2393	204	8.5%	5.0	0.0	0.0	0.0%
Big Chino-WIlliamson Valley	2153	178	8.2%	11.9	0.0	0.0	0.0%
Paria	382	10	2.6%	25.1	0.0	0.0	0.0%
Grand Canyon	2551	58	2.3%	69.2	[5]0.5	0.0	0.0%
Total	**16,096**	**2438**	**15.1%**	**340.6**	**33.2**	**1.5**	**0.5%**

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[1] Where a difference between existing and NHD stream miles exists, the difference was removed from the perennial stream miles in the watershed before calculating a percent.
[2] Personal communications with Russ Truman, Bruce Higgins indicate no perennial reaches of Kanab Creek are known to exist on the Kaibab NF. Historically, this was a perennial stream. Permanent upstream impoundments have changed Kanab Creek to an intermittent flow. Big Springs is the only known perennial stream known in this watershed.
[3] Personal communication with several Kaibab NF personnel (past and present), including Dave Brewer, John Holmes and Bruce Higgins, as well as consultation of Forest records indicates no perennial stream on-Forest in this watershed.
[4] Personal communication with Kaibab NF personnel (past and present), including Bill Noble and Bruce Higgins, as well as consultation of Forest records indicates only one short stretch of perennial stream on-Forest in this watershed – Big Spring.. Sycamore Canyon, which forms the boundary between the Coconino and Kaibab NFs may contain perennial water in its lower reach but is not covered by the Kaibab NF Plan. The Coconino NF Plan covers this area and should be addressed therein.
[5] Personal communication with several Kaibab NF personnel (past and present), including Steve Martinet, Russ Truman and Dustin Burger, as well as consultation of Forest records indicates no perennial stream on-Forest in this watershed.

Table 2. 4th and 5th Code Watershed Relative Risk from Historic Vegetation Departure.

Watershed Name		Acres of Unchar. Disturbance Risk				Relative Risk
4th	5th	H	M	L	Total	
	Grama Canyon-Kanab Creek	1,271	3,024	16,872	21,168	**Low**
	Hack Canyon		224	158	382	**Low**
	Jumpup Canyon-Kanab Creek	29,908	9,795	73,669	113,372	**Low**
	Lower Johnson Wash	13,109	609	17,223	30,941	**Moderate**
	Snake Gulch	76,583	13,487	69,782	159,852	**High**
	White Sage Wash	15,780	4,641	27,368	47,788	**Low**
Kanab		**136,650**	**31,780**	**205,072**	**373,502**	**Lower**
	Bright Angel Creek-Lower Colorado River	29		22	51	**High**
	House Rock Wash	21,506	24,181	54,630	100,317	**High**
	North Canyon Wash	20,013	1,646	31,967	53,626	**High**
	Shinumo Wash-Lower Colorado River	6,333	2,142	33,485	41,960	**Low**
	Tatahatso Wash-Lower Colorado River	1,287	738	14,976	17,001	**Low**
Lower Colorado - Marble Canyon		**49,167**	**28,707**	**135,081**	**212,956**	**Lower**
	Cataract Creek	52,112	5,207	22,417	79,736	**High**
	Heather Wash	34,929	3,293	73,187	111,409	**Low**
	Middle Havasu Creek	6		581	586	**Low**
	Miller Wash	11,993	2,790	20,883	35,665	**Low**
	Red Horse Wash	42,237	5,037	57,651	104,925	**Moderate**
	Spring Valley Wash	35,903	1,292	28,388	65,583	**High**
Havasu Canyon		**177,180**	**17,619**	**203,107**	**397,905**	**Moderate**
	Grindstone Wash-Upper Verde River	2,954	0	953	3,908	**High**
	Hell Canyon	61,966	8,811	35,836	106,613	**High**
	Sycamore Creek	106,518	2,578	20,621	129,717	**High**
Upper Verde		**171,439**	**11,389**	**57,410**	**240,238**	**Higher**
	Lee Canyon-Lower Little Colorado River	12,184	1,645	39,266	53,095	**Low**
	Lower Cedar Wash-Tappan Wash	12,618	13,624	26,800	53,042	**High**
	Upper Cedar Wash	10,499	2,062	12,490	25,051	**High**
Lower Little Colorado		**35,301**	**17,331**	**78,555**	**131,187**	**Lower**
	Ash Fork Draw-Jumbo Tank	22,392	9,460	29,281	61,134	**High**
	Lower Partridge Creek	665	212	1,639	2,516	**Low**
	Upper Partridge Creek	17,076	4,644	30,605	52,325	**Low**
Big Chino - Williamson Valley		**40,133**	**14,317**	**61,526**	**115,975**	**Moderate**
	Lower Buckskin Gulch	603	9	5,640	6,251	**Low**
Paria		**603**	**9**	**5,640**	**6,251**	**Lower**
	Shinumo Creek-Lower Colorado River	1,602	176	334	2,112	**High**
	Tapeats Creek-Lower Colorado River	20,743	406	7,783	28,931	**High**
Grand Canyon		**22,344**	**582**	**8,117**	**31,043**	**Higher**
Grand Totals		**632,817**	**121,733**	**754,507**	**1,509,057**	

Watershed Extent and Perennial Streams:

Context/Niche:

Scale Above Planning Unit (4th HUC): The Forest contains eight 4th code watersheds. The Forest occupies an average of 15% of these watershed and less than 35% of any one watershed. The Forest makes up more than ten percent of four watersheds (Table 1). These will be considered further for on-Forest threats to these sub-basins. Historically watershed conditions were satisfactory. Overall management of water resources plays its largest role in overall ecological sustainability in these watersheds; however, it is extremely limited in terms of perennial streams.

North Canyon Wash and Kanab Creek are the only known historic perennial streams on the Forest. North Canyon Creek is located in the Lower Colorado-Marble Canyon 4th code watershed. It historically ran from one to six miles, depending on precipitation, before going underground. Riparian conditions are thought be near current conditions with a wide array of riparian species. However, the stream contributes only 2% of the perennial stream miles in this watershed while the Forest area makes up almost 25% of the watershed. Historically, Kanab Creek was a perennial stream within the Forest, nearly in proportion to the Forest land area in the sub-basin (29% of stream mileage vs. 35% of the land area.

Key Findings:

The Kaibab NF planning unit contains 15.1% of the total extent of 4th HUC watersheds but contributes only about 1% or less of perennial stream miles (Table 1). North Canyon Creek (Lower Colorado River watershed) has the only extent has 1.5 miles of perennial stream on the Forest. The Forest makes up more than nine percent of four of the 4th HUCs (shaded in Table 1).

A more detailed analysis of perennial waters follows at the 5th HUC scale below.

Summary:

Based on Forest-specific observations (and not NHD data) of perennial stream extent, the Forest only contributes about 1.5 miles (or 2.2%) of perennial streams out of about 340 miles watershed-wide at the 4th HUC. The opportunity for Forest perennial waters and associated ecological diversity to contribute towards ecological diversity is extremely limited at this scale.

Current Conditions:

Scale at and Below Planning Unit (5th HUC): Table 3 displays watershed and perennial stream extent, by 5th HUC watershed (subbasin) in areas outside and within the Forest. Figure 1 displays the 4th HUCs in the Forest context.

Forest information is used to compare stream miles within the Forest boundary to NHD stream miles outside the Forest boundary for an analysis of Forest contributions towards ecological sustainability. All perennial stream reaches within the Forest boundary are managed by the Forest. A small portion of Sycamore Creek is located adjacent to the Forest and is managed by the Coconino NF Plan.

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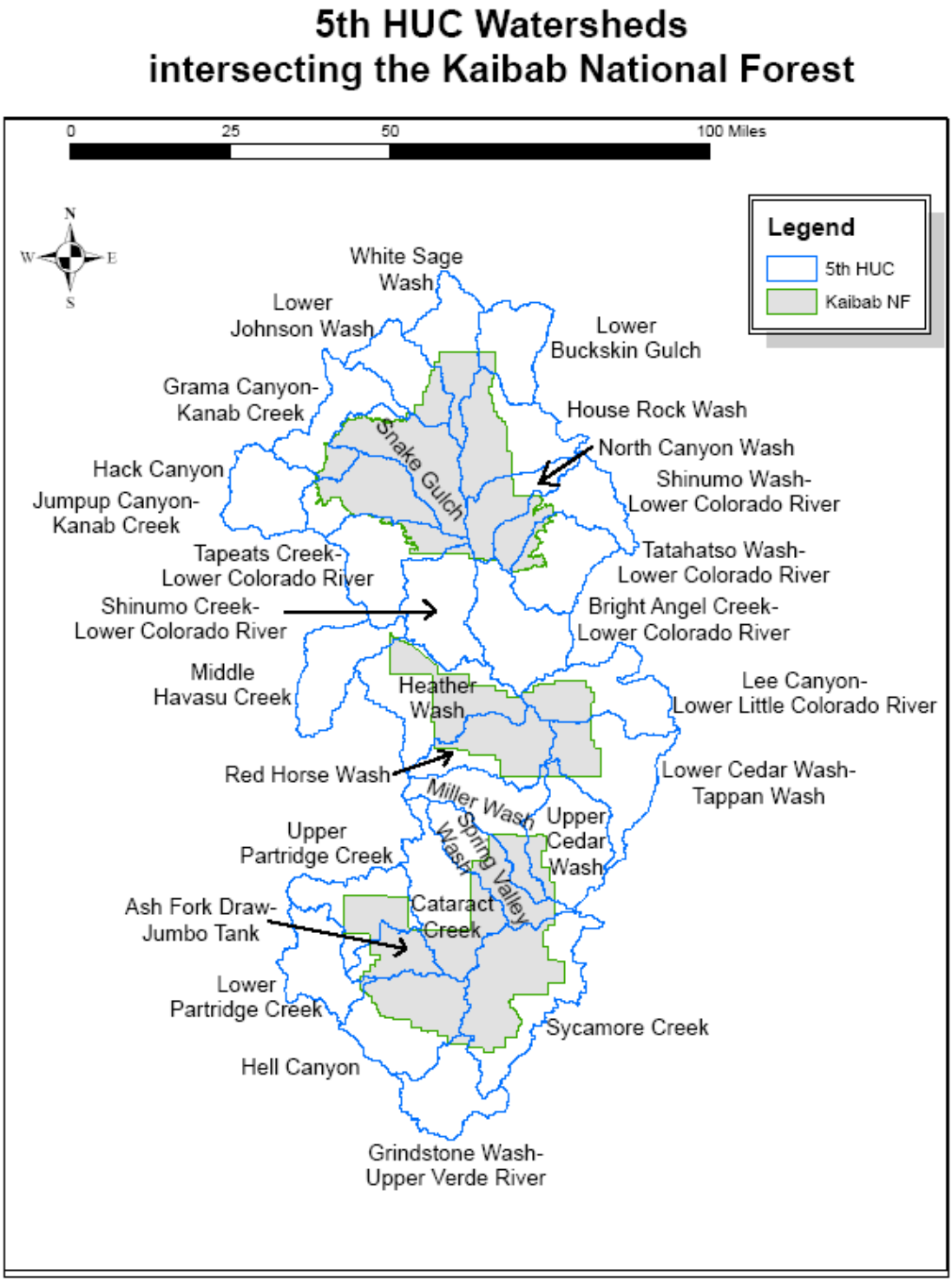

Figure 2. 5th HUC watersheds intersecting the Kaibab National Forest.

Table 3. Subbasin (HUC 5) Watershed Extent and Perennial Stream Miles – Kaibab National Forest

Subbasin Name	Subbasin Area (acres)			Subbasin Perennial Streams (miles)			
	Subbasin Total	Kaibab NF	Kaibab as % of Subbasin	Forest-Administered Land (Forest data)	Within Forest – Other Management (NHD)	Watershed (NHD)	Percent on Forest Within Watershed
Snake Gulch	179138	167722	94%	0.0	0.0	0.0	-
Ash Fork Draw-Jumbo Tank	74809	61727	83%	0.0	0.0	0.0	-
Jumpup Canyon-Kanab Creek	147426	113501	77%	0.0	0.0	23.0	0.0%
Red Horse Wash	152883	105354	69%	0.0	0.0	0.0	-
North Canyon Wash	100747	67912	67%	1.5	0.0	1.4	100%
Sycamore Creek	305493	177678	58%	0.0	0.0	7.6	-
House Rock Wash	192674	101112	52%	0.0	0.0	0.0	-
Spring Valley Wash	131371	68588	52%	0.0	0.0	0.0	-
Hell Canyon	213376	109239	51%	0.0	0.0	4.4	0.0%
Heather Wash	244156	112348	46%	0.0	0.0	1.9	0.0%
Cataract Creek	208324	82457	40%	0.0	0.0	0.0	-
Upper Partridge Creek	148840	52401	35%	0.0	0.0	0.0	-
White Sage Wash	137020	47907	35%	0.0	0.0	0.0	-
Shinumo Wash-Lower Colorado River	140302	43538	31%	0.0	0.0	0.0	-
Lee Canyon-Lower Little Colorado River	181398	53340	29%	0.0	0.0	0.5	0.0%
Lower Johnson Wash	119068	31004	26%	0.0	0.0	0.0	-
Lower Cedar Wash-Tappan Wash	205845	53234	26%	0.0	0.0	0.0	-
Miller Wash	160547	36041	22%	0.0	0.0	0.0	-
Tapeats Creek-Lower Colorado River	175669	31710	18%	0.0	0.0	11.2	0.0%
Grama Canyon-Kanab Creek	145743	21185	15%	0.0	0.0	25.8	0.0%
Upper Cedar Wash	190716	25377	13%	0.0	0.0	0.0	-
Tatahatso Wash-Lower Colorado River	153191	17487	11%	0.0	0.0	18.4	0.0%
Lower Buckskin Gulch	122060	6271	5.1%	0.0	0.0	0.0	-
Shinumo Creek-Lower Colorado River	166592	5141	3.1%	0.0	0.0	39.9	0.0%
Grindstone Wash-Upper Verde River	136099	3931	2.9%	0.0	0.0	16.0	0.0%
Lower Partridge Creek	130880	2530	1.9%	0.0	0.0	0.0	-
Middle Havasu Creek	140941	600	0.4%	0.0	0.0	0.0	-
Hack Canyon	135297	384	0.3%	0.0	0.0	0.0	-
Bright Angel Creek-Lower Colorado River	188248	277	0.1%	0.0	0.0	47.2	0.0%
Grand Total	**4728854**	**1599997**	**34%**	**1.5**	**0.0**	**197.3**	**0.8%**

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Context/Niche:

From analysis of Table 3 we can understand the ability of the Kaibab National Forest to contribute towards ecological sustainability at the 5th HUC watershed scale.

Key Findings:

There are only about 1.5 miles of perennial stream at North Canyon Wash on the Forest. North Canyon Wash is located within the Lower Colorado-Marble Canyon watershed. Springs are found within the Forest, but run less then 0.2 miles from their source for most of the year. Sycamore Canyon runs perennially adjacent to the Forest and is managed by the Coconino National Forest.

Therefore, the Forest only contributes about 1.5 miles (2.2%) of perennial streams out of about 340.6 miles watershed-wide. The opportunity for Forest perennial waters and associated ecological diversity to contribute towards ecological diversity is extremely limited.

The Forest contains eight 4th HUC watersheds. The Forest makes up less than 35% of all these watersheds. The Forest makes up less three percent of the Grand Canyon and Paria watersheds. The Forest contains 15% of the total extent of 4th HUC watersheds but contributes a disproportional 1% or less of perennial stream miles.

The Forest overlaps 29 5th HUC watersheds. Snake Gulch and Sycamore watersheds are the dominant watersheds (have the greatest number of acres) on the Forest and have some of the largest acres extending off Forest. No watersheds are totally contained within the Forest boundary. The following watersheds have the greatest proportion, and are more than 2/3rds contained within the Forest (from highest to lower), Snake Gulch, Ashfork Draw, Jumpup Canyon-Kanab Creek, Red Horse Wash and North Canyon Wash. Water resource management activities including maintaining perennial water quantity, quality and timing of flows contribute a very important role in overall ecological sustainability in these watersheds.

Conversely, Bright Angel Creek, Hack Canyon, Middle Havasu Creek, Lower Partridge Creek, Grindstone Wash, Shinumu Creek and Lower Buckskin Gulch 5th HUC watersheds occupy less than about 6% extent on the Forest. Forest water resource management activities including maintaining perennial waters contribute little in overall ecological sustainability.

All other watersheds occupy intermediate extent on the Forest. Management activities including maintaining perennial water quantity, quality and timing of flows play an important role in overall ecological sustainability in these watersheds.

Watershed conditions on the Forest will continue to be in satisfactory condition. Unsatisfactory soil conditions, in desert and pinyon-juniper communities, within these watersheds will remain static or continue to improve with better livestock grazing management over the last 50 years and where pinyon-juniper canopy reduction treatments occur. Risk of heavy sediment events from uncharacteristic fire are expected to increase over time as departures in many PNVTs increase.

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Key Findings of Perennial Stream Extent:

According to Forest data, there are 1.5 miles of perennial streams on the Forest contained in 1 watershed and 340.6 miles in all intersecting watersheds. North Canyon Wash (Canyon Creek) accounts for all of the miles.

Key Findings:

North Canyon Wash perennial stream miles is contained in the Forest. Forest water resource management is solely responsible for water quantity and aquatic ecosystem diversity and contributes exclusively to ecological sustainability. Forest water resource management is largely responsible for water quantity, aquatic diversity and ecological sustainability of these waters. Forest water resource management plays a nearly exclusive role in maintaining these perennial waters and aquatic ecosystem diversity.

Key Findings:

Of interest is the fact that there are about 1.5 miles of perennial streams on Forest managed lands and no miles of perennial streams on other lands within the Forest boundary. Since about 98% of stream miles are in other ownership, the Forests ability to manage all stream miles according to Forest Plan Standards and Guidelines is severely limited. The opportunity for Forest perennial waters and associated ecological diversity to contribute towards ecological diversity is extremely limited. Management of perennial streams in other lands, while outside the direction of the Forest, plays a large role in overall ecosystem diversity and sustainability. It is critical to partner with other land owners to assure perennial waters are being maintained to provide habitat for all species that rely on water and riparian areas for their survival.

Reference Dynamics (Historic Conditions and Niche):

Scales Above and Below Planning Unit

Historic conditions analyzed here generally estimate Pre-European settlement conditions unless otherwise noted.

Little information is available to document historic range of variation and conditions of perennial stream extent other than some anecdotal and inferring past conditions based on knowledge of current conditions. As an alternate approach (defined on page 25, Ecological Sustainability Work Group Product, 10/10/2006), this analysis will identify the general ecological conditions needed to sustain perennial stream extent and related ecosystem diversity.

Context/Niche:

Historically, perennial stream extent is inferred to have been similar in location and length with similar to slightly more actual flow than today's extent. Anecdotal information (Cline, 1976) suggest water was available for livestock use starting in the 1870's but does not identify where and how much. For the ca 1930 Tusayan NF, water was generally available from most sources through May, then limited to only a few sources until summer rains began (Water Inventory Records – Tusayan NF Range Atlas). Perennial streams have riparian vegetation (including deciduous trees) associated with

their location. Visual and documented observations of perennial streams show most streams have varying age distribution of riparian vegetation indicating stream extent has been present for several decades and disturbance has contributed towards vegetative composition and structure.

Stream and associated riparian areas are very resilient to disturbances. Observations and documentation indicate disturbances over time have resulted in varying plant age and composition and static stream extent. Analysis of stream flow indicated water flow has been static to slightly downward over time (water yield section below). A very large portion of plant and animal species rely on perennial stream water for survival. Perennial stream water only amounts to about 1.5 miles on the Forest which equates to very little acreage. Maintaining riparian vegetation in Proper Functioning Condition is necessary in sustaining perennial stream extent and associated plant and animal diversity.

Disturbances and Processes: The following is a list and analysis of current and historic disturbances that occur on the Forest affecting all identified water resource characteristics including perennial stream extent, water yield including groundwater, riparian areas and condition, wetland areas and condition and water quality.

Disturbances:

Current:

1. Herbivory: **Key Findings:** Cattle grazing occurs throughout many riparian and wetlands areas. High levels of ungulate grazing (both livestock and elk) has been observed to reduce effective vegetative ground cover and riparian vegetation and contributes to accelerated erosion, soil compaction (GTES, 1991) and sedimentation to connected perennial waters and reduce or impair water quality . High levels of elk grazing is largely uncontrolled and has been observed in riparian areas and especially in unfenced wetlands and has resulted in similar adverse effects on the vegetation, soil and riparian condition and function. Excessive or poorly timed ungulate grazing in riparian areas can reduce plant and animal diversity and negatively affect riparian habitat and those species that depend on it for their survival. Many allotments have reduced livestock grazing in riparian areas or to times when grazing pressure does not adversely affect riparian area condition. Other allotments have built exclosure fences around these riparian areas.

2. Drought: The Forest has experienced several years of drought (roughly since about 1999) with occasional normal levels of seasonal moisture. Reduced precipitation results in reduced upland vegetative growth, reduced surface organic matter and ineffective vegetative ground cover putting the soil at risk of accelerated erosion and sediment delivery to connected streams during storm events. As vegetation dries out, there is increased risk of wildfire spread and subsequent accelerated erosion and watershed degradation. Riparian vegetation is very resilient to drought but can dramatically decrease during these dry periods, Drought can lower plant composition and ecosystem diversity for those species that rely on it for their survival.

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3. Flooding: Flooding affects the Riparian Forests and Wetland Potential Natural Vegetation Types (PNVTs) as well as unmapped stream courses throughout all PNVTs. Flooding may cause localized soil loss, sediment delivery and reduced water quality in the stream channel, streambanks and floodplains if not well protected with vegetative ground cover. Frequent and flash flooding is a natural process and disturbance. Flash flooding can occur in perennial, intermittent and ephemeral streams in all PNVTs), especially in large watersheds where short duration, high intensity storms occur. Maintaining native vegetation described in the Potential Plant Community of the TES provides channel stability, functional riparian areas and good water quality for wildlife and aquatic species.
4. Prescribed and Wildfires, Fire Regime (fuel loading or buildup): Riparian areas are not identified as fire-adapted ecosystems but may be in paths way of wildfires. Since the majority of wildlife species rely on vegetation, food and water supplied by perennial streams, wetlands and riparian areas, it is essential to minimize the destruction that may be caused by adjacent, prescribed or uncontrolled wildfires to these areas.
5. Road Location: Roads located adjacent and connected to stream courses serve to concentrate and accelerate water flow and may increase peak flows over natural levels causing decreased channel stability, riparian area function and water quality.

   Key Findings: With the exclusion of wildfire through out most PNVTs in the last 130 years, fuel loading has increased in woodland and forest PNVTs resulting in high risk of accelerated erosion, loss of soil and vegetative productivity, and sediment transport to connected stream courses following wildfires in areas with moderate and high erosion hazard on the Forest. High levels of sediment can reduce fishery, aquatic and even endemic plant species (*Pediocactus paradenii*) habitat and those species that rely on it for their survival. Wildfire frequency, severity and Fire Regime Condition Class (FRCC) by PNVT can be found in the Vegetation and Fire Section of the CER Phase 1 Report. [6]Over 63 % of the Forest (with high proportions in Pinyon-Juniper and Ponderosa Pine PNVTs) is in FRCC III (highly departed vegetation compared to PNVT) and poses risk to watershed degradation following wildfires.

Historic:

1. Herbivory: Very little range condition data is available before 1935 (GTES, 1991). However the GTES shows that from 1902 – 1987 that as more livestock numbers and acres were grazed, range and therefore soil condition declined. This resulted in local areas of accelerated erosion and sediment delivery to connected stream courses probably reducing water quality. Livestock grazed in riparian areas and probably altered riparian (wetland) area function. As fewer number and acres were grazed, range condition and trend and riparian area (wetlands) improved. One can surmise that domestic livestock grazing was not present (before European settlement) and therefore did not cause accelerated erosion and

[6] FRCC determined by RAPID assessment protocol in 12/2007 Kaibab PNVT tables.

loss of water quality or riparian function. Merriam elk did not exist across most of the Forest and therefore did not appreciably affect water quality or riparian function.

2. Drought: Cyclic drought patterns are known to have occurred throughout the last few centuries as evidenced through tree ring studies. A large drought occurred in 1892-1893 when 50 -75 % of range animals perished or shipped to market (GTES, 1991). Some studies suggest periods of drought are believed to have contributed to cause higher levels of soil loss and sediment delivery than periods of normal or above moisture due to reduced effective vegetative ground cover soil protection. No historic quantitative data was found to analyze water quantity, water quality or riparian area function.
3. Flooding: No historic quantitative data was found to analyze flooding but historic processes are similar to current condition disturbances described above. It is likely that streambanks and wetlands were better vegetated providing for greater stability, less soil erosion and sediment delivery and higher amounts of proper functioning condition riparian areas and wetlands.
4. Prescribed and Wildfires, Fire Regime, (fuel loading or buildup): It is likely fuel build-ups were much lower in Woodland and Forest PNVTs and consequently did not pose as high a risk to accelerated soil loss, sediment delivery and water quality. FRCCs were probably not highly departed from their reference conditions.

B. Water Yield (Surface, Groundwater and Instream Flow Water Rights)

Current Conditions:

Scales At and Below Planning Unit

Water Yield: As of December 2006, current water yield by 4th HUC and 5th HUC watershed has not been calculated. However, Forest water yield is predicted by comparing gauged streamflow data in a few 4th HUC watersheds described below and found in Appendix A. This data may be useful in assessing trend in streamflow yield on and off Forest for those streams and watersheds with available information. 5th HUC water yield was not compiled and analyzed (labor intensive and beyond scope of CER Phase 1. All other watersheds do not have data and overall Forest water yield is estimated based on knowledge of ecosystem function.

Output of water yield or water supply (the terms are used synonymously) is the amount of water which leaves the immediate site to become surface water yield or groundwater recharge. Essentially, it is the difference between total precipitation and actual evapotranspiration. Groundwater yield is difficult to measure and has only been analyzed in a USGS Colorado Plateau Study (Hydrologeology of the Regional Aquifer, 1994 – 1997) for areas in the Upper Verde River 4th HUC watershed and portions of the Lower Little Colorado River and Havasu 4th HUC watersheds (all located in the Williams

Ranger District. More specific, watershed water yield determination must be based on prediction methods using precipitation, soils, and vegetation conditions and beyond the scope of this analysis.

A comparison of actual USGS gauged streamflow from major, perennial streams from about 1917 to 2006 is used to estimate streamflow water yield trend with major emphasis placed on recent years from about 1985 to present. Streamflow water yield is calculated for those streams where USGS has gauged data over the last 20 years or more. Analysis of streamflow trend is useful to determine if major changes in water yield has occurred for that given stream. This analysis should provide useful information to help determine if there is a need to change current water quantity management direction in the Forest Plan .

Appendix A (Streamflow Water Yield Trend, in back part of document) displays average annual streamflow for each water year from the period of 1917 (or earlier) to 2006 for those streams with USGS gauged data for that period. Appendix A graphically shows linear trend for perennial stream by 4th HUC watershed.

Table 4 (below) summarizes streamflow water yield by 4th HUC watershed (subbasin) and trend from about 1985 to the present. 5 watersheds have reliable, annual gauged streamflow data useful in trend analysis with the exception of Havasu Creek where there are only limited annual measurements and they predate 1973.

None of the stations are located on the Forest, nor is there surface flow on the Forest that contributes to the flow monitored.

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Table 5. Streamflow (Water Yield) Linear Trend by 4th HUC Watershed

Forest Stream	**Watershed (4th HUC)**	**Trend 1985 – December, 2005**
Lower Colorado River near Desert View	Lower Colorado River of Marble Canyon Area	Static to Slightly Upward
Havasu Creek Above mouth	Lower Colorado River of Grand Canyon	Static to Slightly Upward
Cataract Creek Near Williams	Havasu Creek	Downward (1965 – 1972)
Kanab Creek Near Fredonia	Kanab Creek	Upward (1965 - 1980)
Verde River Near Paulden	Upper Verde	Static to Slightly Upward
Verde River Near Clarkdale	Upper Verde	Static

Key Findings:

All data were compiled on nearby streams and may not represent overall watershed yield. There is no other gauged data to analyze streamflow water yield in all other watersheds. Therefore, there is no departure between reference and current conditions or trend or ecological need for change on the Forest.

All streams have variable streamflow with some high spikes and low flows although the LCR near Desert view flows the most consistently.

Context/Niche:

Key Findings: As of December 2006, current water yield by 4th HUC and 5th HUC watershed has not been calculated. However, analysis of Table 5 (Streamflow Trend) indicates that perennial streams in the Lower Colorado River watersheds are static to slightly upward in streamflow trend. Verde River gauging and associated watersheds are static to slightly upward in streamflow trend. As you move downstream in the Verde River, streamflow is static to slightly downward as documented by the Coconino National Forest Ecological Sustainability Analysis for Water Resources, 1/2007. Limited gauging done from 1965 – 1972 in Cataract Creek in Havasu Creek watershed indicate downward trend. This data precedes the current Kaibab Forest Plan and cannot be used to analyze trend since the Forest Plan was completed. Similarly, Kanab Creek (Kanab Creek watershed) near Fredonia shows upward trend from 1965 – 1980 and predates the current Forest Plan. However, Kanab creek has not had a perennial flow of water since 1990's. Impoundments near Kanab, Utah and Fredonia have reduced the flow of Kanab Creek on the Forest to an intermittent flow.

Stream flow trend may approximate watershed water yield trend because watershed runoff results as streamflow across the watershed. Unfortunately, no recent, long-term gauging has occurred for streams located in other watersheds.

Speculative Statement Using Knowledge of Ecosystem Function (Forest Water Yield):

It is estimated that overall Forest water yield is static to slightly upward in non-forested areas to slightly downward in forested areas over the last 20 years due to analysis of streamflow water yield and the following three conditions.

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1. Greater tree and shrub basal area and canopy cover has been recorded over the last 20 years which probably results in increased evapotranspiration and decreased runoff and water yield.
2. Drought conditions have prevailed in most years since about 1999 and have probably contributed to decreased precipitation and runoff and water yield. Climatic (drought) and vegetative conditions on the Lower Colorado River watersheds are similar to the Verde River watersheds and therefore, water yield trend is estimated to be similar (static to slightly downward).
3. Non-forested areas have less vegetative ground cover than forested areas (pinyon-juniper and conifers) and in many areas have less vegetative ground cover than under the Potential Plant Community as identified in the Kaibab Terrestrial Ecosystem Survey. In addition, many of these areas have disturbance resulting in compacted soil surfaces. Decreased vegetative ground cover and compacted soils can result in water runoff rates and amounts more than would occur under conditions of the Potential Plant Community.

Past studies indicate vegetative treatments to increase water yield only result in short-term water yield increase (1-3 years). Today, treatments to increase water yield are not being considered on the Forest and therefore, a detailed analysis of water yield has not been done. However, it is estimated that Forest-wide, current water yield (supply) is similar to or slightly less than in the early 1980's due to recent climatic drought conditions and greater evapotranspiration stemming from increased tree basal areas resulting in increased water consumption.

Key Findings: It is estimated that current Forest water use is only slightly higher today than in 1980 because new campgrounds and day-use areas have opened due to an increase in recreational use stemming from increased population and a desire to spend more time recreating on Forest lands. Williams's population is expected to slightly increase over the next 20 years. Flagstaff population is expected to double by 2050 with demand predicted to exceed supply. The Colorado Plateau Water Advisory Council has been established to study alternatives and seek solutions to increase water supply in the Colorado Plateau area.

Forest-wide, cattle ranching permittees are expected to continue to rely on stock tanks and riparian areas for watering.

Instream Flow Water Rights:

North canyon Creek does not currently have an application in requesting an instream flow water right because there is no risk for diversion because there is no associated private land.

Groundwater Resource:

Ground water on the Forest is located within the regional aquifers with average depths to water of 1200 feet below the surface. Historically this aquifer was primarily charged with surface precipitation at the higher attitudes and in areas of heavily fractured rock.

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In recent years, cities have become more dependant on groundwater. Water use in Flagstaff and Colorado Plateau Cities increased about 30% from the mid-1980's to the mid-1990's (Hydrogeology of the Regional Aquifer, 1994 – 1997). No data was found on groundwater use for cities and private wells within or near the Forest. The effect of Forest and adjacent private well pumping to seep, spring or down stream water flow is possible but the effect is not currently documented.

Key Findings Groundwater recharge occurs throughout all 4th and 5th HUC watersheds but is greatest at higher altitudes where precipitation is greater and in areas with heavily fractured rock units. Consequently, groundwater management and protection is vital on Forest lands because Forest watersheds contribute most groundwater recharge in watersheds located within and outside of the Forest (Hydrologeology of the Regional Aquifer, 1994 – 1997). The effects of Forest well pumping are not known to affect adjacent seep, spring or down stream water flow.

Middle and Lower Little Colorado River 4th HUC Watersheds:

The estimated annual average recharge on the Colorado Plateau (covers portions of Havasu and Lower Colorado River 4th HUC watersheds) is 290,000 acre-feet and the saturated thickness of the Regional aquifer averages about 1200 feet and water storage could be as much as 4,800,000 acre-feet or about 10% of the total volume of the aquifer (Hydrologeology of the Regional Aquifer, 1994 – 1997). Water quality of the Regional aquifer is generally good.

Key Findings Surface water resources are limited because there is little runoff and surface water rights are either fully appropriated or under adjudication (Little Colorado and Verde River Adjudications). T herefore, groundwater is one of the few remaining alternatives for communities adjacent to the Forest. Because the depth to groundwater in the aquifer is generally over 1000-1500 feet (Hydrologeology of the Regional Aquifer, 1994 – 1997), the cost of drilling and developing wells is very expensive. The City of Flagstaff has developed high yielding wells but operates under a safe-yield policy so water withdrawal should not negatively affect groundwater recharge or adjacent surface water flow and its connected stream and riparian habitats (per. comm.. Ron Doba, Flagstaff City Utilities Director, 2005).

In recent years, Colorado Plateau cities have become more dependant on groundwater. Water use in Flagstaff and Colorado Plateau Cities increased about 30% from the mid-1980's to the mid-1990's (Hydrogeology of the Regional Aquifer, 1994 – 1997) and the use of groundwater has surpassed the use of surface water. No data was found on groundwater use, or declines in the City of Williams area and there fore groundwater yield and trend are unknown.

Key Finding: Additional demand may pose a risk if groundwater is pumped beyond the safe yield concept.

Water levels fluctuate in wells and aquifers respond to rainfall, climate and local pumping. Water levels do recover to some degree depending on climate and local pumping. It is important to work closely with the City and other major users to be sure safe-water yield and other conservation practices are observed so groundwater

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withdrawals (where it occurs and is proposed) will not negatively affect Forest water and riparian resources downslope.

Upper Verde 4th HUC Watershed:

Seventeen percent of the Upper Verde River 4th HUC watershed is located on Forest lands. Therefore, a substantial portion of water is recharged in the watershed and discharged into the Verde River downstream. Forest management affects how water is collected and how it is shed (runoff). Little is known about how much groundwater is stored and in many areas of the Verde Watershed or about how much use in the Upper Verde may affect water availability in the Verde Valley, which depends on the Verde River flows. These issues have caused water users of the Upper Verde areas as well as downstream, a great deal of concern about the future availability of surface and groundwater. Where groundwater discharge exceeds recharge (common in portions of the Verde River watershed) numerous springs, seeps and perennial streams result (Hydrologeology of the Regional Aquifer, 1994 – 1997).

Wells occur on Forest and Private lands. Some wells located on Private lands are tapping into adjacent stream groundwater, withdrawing water that would otherwise be maintained within the stream and for riparian habitat. Forest wells are located predominantly outside zones of depression (adjacent to streams) and therefore are not withdrawing water from streams and riparian areas and are not negatively affecting plant and animal habitat and diversity. National and Regional ground water policy directs management of groundwater resources and emphasizes protection of water quantity and quality.

Key Findings: A new, Regional Groundwater policy (FSM 2541.03, 2001) prohibits drilling wells adjacent to Forest streams (within the zone of depression) and provides adequate protection of groundwater and adjacent stream water quantity on Forest lands. Excessive water withdrawal from Private or City wells located adjacent to Forest streams on Private or other owned lands pose a risk to stream water quantity and riparian habitat it supports.

Reference Dynamics (Historic Conditions and Niche):

Scales Above and Below Planning Unit: There is little information available to analyze historic (pre-European) water yield. Information provided below, discusses conditions since about 1950 and research done on water yield enhancement.

Until the 1950's the water needs of Flagstaff and surrounding areas were met by developed springs, surface water impoundments, and a few shallow wells. By the early 1960's, Flagstaff and surrounding Cities grew and drilled many deep wells and by mid-1990's Flagstaff began drawing down the water table (North Central Arizona WSS, 2006).

In the 1950's, water-users and ranching groups in the Salt-Verde Basin called attention to the possibility of treating watersheds to increase irrigation water yields and provide more grass for grazing. In response to these concerns the Chief of the Forest Service approved the Arizona Water Management Project, Beaver Creek (Baker et. al, 1974) to observe treatment effects on water yield. The basic conclusion was water yield (runoff) does indeed increase for a few years until revegetation becomes more established at which point water yields stabilize to pre-treatment levels.

Disturbances:

Current and Historic disturbances are similar to those listed in Section A above (Watershed Extent and Perennial Streams) with the following additions primarily in the Verde Watersheds.

People have diverted and pumped water, built dams and channelized rivers, cut down trees for homes, fuel, and cropland, mined sand and gravel, pored chemicals and waste into the rivers and recreated for more than 100 years (Verde River Watershed Study, 2000).

C. Riparian Areas (Stream Systems)

Current Conditions:

Scale Above Planning Unit (4th HUC):

Table 6 (Subbasin HUC 4) Riparian Areas – Kaibab National Forest) displays riparian area extent both on the Forest and throughout the 4th HUC intersecting watersheds using AZ Game and Fish data (see footnote).

Key Statement: For a more accurate analysis of Forest riparian area extent and condition at the Forest Planning Unit and 5th HUC watershed scale, please see Section E, Forest Wetlands and Riparian Areas and Condition further in the document. On-site Forest information more accurately represents Forest riparian acreage and condition.

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Table 6. Subbasin (HUC 4) Riparian Areas – Kaibab National Forest

Subbasin Name	**[7]Riparian Area Acres in Watershed**	**Riparian Area, Acres on Kaibab Administered by Forest Service**	**Percent Forest Contribution**
Paria River	3.6	0	0%
Lower Colorado River of Marble Canyon Area	0	0	
Lower Colorado River of Grand Canyon Area	0	0	
Kanab Creek	0	0	
Havasu Creek	0	0	
Lower Little Colorado River	0	0	
Big Chino Wash	0	0	
Upper Verde River	5424.7	128.7	2.4%
Totals	**5428.3**	**128.7**	**2.4%**

Context/Niche: **Key Findings:** According to the AZ Game & Fish Department data the Kaibab National Forest lands contain about 128.7 miles or 2.4% of total riparian acres in all 4th HUC watersheds. That means lands outside the Forest contain about 5428.3 or 97.6% of all riparian areas within all watersheds. Only about 12 acres of riparian areas are located on Private lands within the Forest boundary. The Forest does not contain any riparian acres in the Paria River watershed and only 128.7 acres in the Upper Verde River watersheds just outside of the Sycamore Canyon Wilderness area.

According to NHD data, the Kaibab NF planning unit contains 15.1% of the total extent of 4th HUC watersheds but contributes a disproportional 2.4% of all riparian areas. Forest riparian area extent, diversity and condition only contribute a very small amount towards riparian area ecological sustainability. Forest seeps and springs analyzed in section D below are not included in this section of the analysis but provide essential riparian area habitat. Due to the very limited extent of Forest riparian areas, it is critical to provide functional riparian areas and conditions that provide for the best habitat for those plant and animal species that rely on it for their survival

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[7]Riparian acres (1st three columns) are from the riparian area layer from the AZ Game and Fish Dept (1993-1994). Derived from Landsat and Multiple Resolution Aerial Videography. Released June 1994.

Scale at and Below Planning Unit (5th HUC): Table 7 (Subbasin HUC 5 Riparian Areas – Kaibab National Forest) displays riparian area extent both on the Forest and 5th HUC extent as well as riparian condition for known areas on the Forest.

Table 7. Subbasin (HUC 5) Riparian (Stream or Lotic Types) Areas – Kaibab National Forest

Subbasin Name	**[8]Riparian Area Acres in Watershed**	**Riparian Area Acres on Kaibab Forest Service Owned Lands**	**Kaibab Forests Portion (percent) of Riparian Areas Within Watershed**
Lower Buckskin Gulch	0	0	0
House Rock Wash	0	0	0
North Canyon Wash	0	0	0
Shinumo Wash-Lower Colorado River	0	0	0
Tatahatso Wash-Lower Colorado River	0	0	0
Bright Angel Creek-Lower Colorado River	0	0	0
Shinumo Creek-Lower Colorado River	0	0	0
Tapeats Creek-Lower Colorado River	0	0	0
White Sage Wash	0	0	0
Lower Johnson Wash	0	0	0
Snake Gulch	0	0	0
Hack Canyon	0	0	0
Jacob Canyon-Kanab Creek	0	0	0
Jumpup Canyon-Kanab Creek	0	0	0
Spring Valley Wash	0	0	0
Red Horse Wash	0	0	0
Miller Wash	0	0	0
Cataract Creek	0	0	0
Heather Wash	0	0	0
Middle Havasu Creek	0	0	0
Upper Cedar Wash	0	0	0
Lower Cedar Wash	0	0	0
Lee Canyon-Lower Little Colorado River	0	0	0
Ash Fork Draw-Jumbo Tank	0	0	0
Upper Partridge Creek	0	0	0
Lower Partridge Creek	0	0	0
Hell Canyon	0	0	0
Sycamore Creek	255.2	128.7	50.4%
Grindstone Wash-Upper Verde River	656.2	0	0%
Total	911.4	128.7	14.1%

[8]Riparian acres (1st three columns) are from the riparian area layer from the AZ Game and Fish Dept (1993-1994). Derived from Landsat and Multiple Resolution Aerial Videography. Released June 1994.

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Context/Niche:

Current Conditions (cont.) and Context Niche:

Key Findings: According to the AZ Game and Fish Riparian layer, the Forest contains about 129 riparian acres or 14% of total riparian acres in all intersecting watersheds. The Forest contains about half of all riparian acres in the Sycamore Creek watershed and no riparian acres in the Grindstone Wash-Upper Verde River watershed. There are no other mapped riparian areas in any other watersheds on or off Forest, so the Forest does not contribute riparian area diversity and habitat towards ecological sustainability.

Sycamore Creek 5th HUC Watershed: Forest riparian area condition and vegetative diversity greatly contributes (about half of all watershed acres) towards ecological sustainability for those plant and animal species that rely on it for their survival.

Grindstone Wash – Upper Verde River 5th HUC Watershed: According to the Game & Fish data layer, this is the only other watershed with mapped riparian areas. All but 12 of the 656 acres occur on lands outside the Forest boundary but within the watershed. Consequently, the Forest has no ability to provide diverse, riparian habitat and sustain ecological systems. The Forest does not contribute riparian area function towards ecological sustainability in watersheds where no riparian areas were identified (listed above).

Key Findings: seeps and springs are located in these watersheds and offer small areas of riparian habitat and support those species that rely on them for survival. Seeps and springs are analyzed in Section D below.

<u>Reference Dynamics (Historic Conditions and Niche):</u>

Scales Above and Below Planning Unit Little information is available to document historic range of variation and conditions of riparian areas and function other than inferring past conditions based on knowledge of current conditions. Riparian area extent and condition Pre-European settlement probably was dominated by proper functioning condition riparian areas because there was little anthropogenic disturbance.

<u>Disturbances:</u>

Current and Historic disturbances are similar to those listed in Section A above (Watershed Extent and Perennial Streams) and include the following detail on flooding and reliance.

Flooding is the major natural disturbance in riparian areas. Flooding has the effect of altering older growth, later seral stage riparian areas into younger growth, early seral stage riparian areas. Riparian areas should not have a climax ecological class because flood disturbances are frequent (range from 1 – 10 years depending on intensity) and range in intensity from low to high depending on amount of cfs force applied to the stream system.

Key Findings: Riparian areas are resilient and have the capacity to recover from disturbance quicker than terrestrial ecosystems because water is available longer and more frequently to grow plants that provide streambank or wetland stability and improved riparian function

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D. Springs, Seeps, Stocktanks and Wetland Extent

Current Conditions:

Scale Above and Below Planning Unit: Arizona has the 2nd highest density of springs in the U.S. The Mogollon Rim and the North Kaibab have the highest density of springs in Arizona (pers. comm. Larry Stevens). According to the NHD layer, there are 709 springs and seeps in all Forest connected 4th CODE watersheds. The Forest contains 129 springs and seeps or about 18% of the total. The historic extent and flow of springs and seeps are unknown, but are presumed to be at least equal to the current extent. No spring exist on the Forest that flow more than 0.2 miles. Springs and seeps extent and flow have been observed to fluctuate depending on precipitation. Historically, no substantial network of constructed reservoirs or stock tanks occurred on the Forest. Table 8 (Subbasin HUC 4 Springs, Seeps, Stocktanks and Wetland Extent – Kaibab National Forest) displays known springs, seeps, stocktanks and wetlands both on the Forest and throughout the 4th HUC watershed extent. The Land Use Land Cover layer provided by USGS (not displayed here) shows 0 wetlands located on the Forest.

Springs and seeps continue to flow at rates similar to historic levels. A substantial number of the springs are known to be developed which probably occurred after the Homestead Act of 1862. These developed springs remove water from the site and reduce riparian vegetation extent. Several springs have been observed and documented to be at risk or are nonfunctional riparian areas due to ungulate grazing and recreational impact but overall these impacts are believed to be minor in the Forest context. Springs and seeps flow can also experience reduced flows from the transpirational effect of increasingly closed forest canopies, but this is undocumented on the Forest. In addition, springs and seeps located adjacent to existing wells may experience reduced flow, but this has not been observed on the Forest.

There are 492 reservoirs and stock tank claims on the Forest, and 3,281 in the 4th code watersheds according to the Arizona Department of Water Resources. This represents 15% of the structures – equivalent to the land area in the subbasins affected. The Forest reservoir and stock tanks were primarily built from the 1930-1980's. These impoundments have reduced flows volume and duration running through some ephemeral and intermittent streams on the Forest. However, a reduction in riparian vegetation has not been seen because of the very short duration of water historically in these stream channels. The reservoirs and stock tanks have increase perennial water on the Forest for livestock and wildlife as well as increasing riparian vegetation surrounding them.

Key Findings: The Forest has a more accurate inventory of wetland (lentic) extent and condition and identified 64 wetlands and 24 riparian areas for a total of 494 acres (Table 8 below) and is analyzed in Section E below at the Forest Planning Unit and 5th HUC watershed scale.

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Table 8. Subbasin (HUC 4) Springs, Seeps, Stocktanks and Wetlands – Kaibab National Forest

Subbasin Name	[9]Springs and Seeps in Watershed	Springs and Seeps on Forest Lands	Percent on Forest Lands	[10]Stocktanks in Watershed	Stocktanks on Forest Lands	[11]Wetland Acreage in Watershed	Wetland Acreage on Forest Lands	Percent on Forest Lands
Paria River	7	0	0.0%	0	0	0	0	0%
Lower Colorado River of Marble Canyon Area	98	10	12.0%	0	0	0	0	0%
Lower Colorado River of Grand Canyon Area	118	12	9.5%	0	0	0	0	0%
Kanab Creek	66	44	60.3%	0	0	0	0	0%
Havasu Creek	33	12	46.9%	46	6	0	0	0%
Lower Little Colorado River	38	0	0.0%	334	57	0	0	0%
Big Chino Wash	76	1	2.3%	1062	141	0	0	0%
Upper Verde River	273	50	19.0%	1839	288	396	0	0%
Totals	**709**	**129**	**18.2%**	**3281**	**492**	**396**	**0**	**0%**

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[9]Springs and ps were pulled from the NHDH water points (Fcode 45800)
[10] Stocktanks are pulled from ADWR Statement of Claimant (SOC) layer and based on filed water right claims.
[11]Wetland acreages were derived from The Land Use Land Cover (LULC) layer from the USGS. All features labeled "wetlands" were used.

Wetland Extent: Key Findings: Undocumented observations made from about 1940 to present indicate wetland extent varies according to annual precipitation amounts.

Context/Niche: **Springs and Seeps:**

Seeps and springs are really small, riparian areas that serve as habitat to sustain a variety of plant and animal species. According to the NHD layer, there are 709 springs and seeps in all Forest connected 4th HUC watersheds. The Forest contains 129 springs and seeps or about 18% of the total.

Key Findings: Forest land contained in all 4th HUC watersheds is about 15% so spring and seep totals contribute a very proportional, (18% compared to 15%) amount on Forest.

Key Findings: Spring and seep location are nicely nested and are mostly located in the Upper Verde River and Kanab Creek 4th HUC watersheds with very few located on the Tusayan and NW portions of the Williams Ranger Districts

As of the date of this analysis, spring and seep functional condition assessments have not been made Forest-wide or are very limited. Observations and limited documentation indicate accessible, unfenced areas are not functioning well. Where areas are properly fenced or ungulate grazing is excluded, these areas are in functional condition. Maintenance of these waters in functioning condition contributes to diverse ecological riparian and aquatic ecosystems and is vital to sustain those species that depend on these areas for their survival.

Stocktanks:

According to ADWR Statement of Claim (SOC) Filings for water rights, there are 492 stocktank claims located on the Forest and there are 3281 stocktank claims located in all affected 4th HUC watersheds. These claims include several watershed-level reserved water right claims allowing use of stockwater for fire fighting and road watering maintenance.

Key Finding: Stocktank locations are nested very nicely at the 4th HUC watershed level are mostly located in the Upper Verde River, Big Chin Wash and Lower Little Colorado River 4th HUC watersheds. For a list of corresponding 5th HUC watersheds, please see the AZ SOCS Stockponds layer with intersecting watersheds provided in the Regional or Forest GIS files. Very few are found in all other watersheds. The vast majority of water right claims are stocktank claims used for livestock, and wildlife watering purposes followed by domestic use claims for well water and diverted springs used at campgrounds and administrative sites.

There are some private, duplicate stocktank claims filed on several tanks. The purpose of use, user and amount of water to be used will be determined during both Little Colorado River and Verde River adjudications.

The Forest actually has many more roadside stocktanks that are not filed for water rights as SOC's because they are not subject to appropriation. In a 1982 Letter to Forest Supervisors, and recent discussions, Forest Hydrologists summarized pertinent laws and concluded that roadside and tricktanks collect diffuse surface water that is waters that have not found their way into a natural watercourse, are not subject to appropriation in Arizona.

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Key Findings: Stocktanks provide necessary water for livestock and wildlife use (including elk, waterfowl, other birds and leopard frogs) and have the effect of dispersing ungulate grazing more equally across the landscape reducing concentrated impacts to adjacent soils. Cattle tend to congregate close to stocktanks and reduce soil and vegetative condition towards unsatisfactory conditions but the aerial extent of disturbance is fairly minimal usually covering no more than a couple of acres. There are several stocktanks that currently are not functioning either because they are breached or silted in and do not have capacity to store water.

Key Finding: Several Forest stocktanks meet conditions of wetland habitat and provide significant contribution to the limited wetland habitat on the Forest. A more detailed discussion of wetland extent and condition can be found in the Wetland Section and Condition portion of this analysis below.

Reference Dynamics (Historic Conditions and Niche):

Scales Above and Below Planning Unit: Historic water use is largely not documented. Springs and seeps are natural water feature and existed prior to European settlement and were probably largely in functional conditions due to the lack of anthropogenic disturbances. Native Americans and wildlife used these waters and caused some level of disturbance but probably not as extensively as livestock operations.

Constructed stocktanks did not exist prior to European settlement. Some stocktanks were constructed in the early 1900's for livestock watering. The vast majority were constructed in the mid-late 1900's.

Disturbances:

Current disturbances are similar to those listed in Section A above (Watershed Extent and Perennial Streams). Since stocktanks were not historically (Pre-European) present, there are no historical disturbances. Drought has a large effect on the amount and duration of ponded water and wetland vegetation on Forest wetlands.

E. Forest Wetlands and Riparian Areas and Condition:

Current Conditions:

Scale At and Below Planning Unit (5th HUC): This section of the analysis is really an extension of the last section (Springs, Seeps, Stocktanks and Wetlands). This section analyzes Forest riparian and wetland area extent and condition at the Forest and 5th HUC watershed scale. Understanding and knowing wetland condition allows a better analysis of the ecological and Forest Plan need for change. Table 10 summarizes departure, and trend and aquatic characteristics of greatest concern needing change.

Known Forest wetlands (lentic areas that are basin landforms and depressional springs and seeps) and riparian areas (lotic streams and linear, flowing springs) were inventoried in 1990 and data input into a relational database (RBase). The database was converted into and access database (knf_riparian.mdb) by Bruce Higgins (Kaibab National Forest Planner) and Rory Steinke (Watershed Program Manager, Coconino NF) in November, 2006 for use in this analysis. The inventory assessed riparian and wetland area condition as poor, fair or good and identified if the area was a natural or manmade water

impoundment. The inventory classified 16 - 18 stocktanks (impounded areas) as wetland areas which may actually meet wetland classification but are managed under different Forest guidelines for livestock and wildlife watering. There are other riparian and wetland areas not inventoried.

Table 9. Subbasin (HUC 5) Wetlands and Wetland Condition displays Forest wetland extent by 5th or 4th HUC watershed and wetland condition as determined by field inventory. The actual protocol used to determine wetland/riparian condition is unknown but the Forest feels confident in the quality of the information.

Table 9 displays basin type lentic wetlands that are natural or impounded (man altered) and springs or seeps that function as wetlands. Impounded wetlands now may serve as stocktanks for livestock and wildlife watering and amount to about 16 - 18 of the 88 identified wetlands.

Table 9a displays lotic type riparian area extent and condition (stream-type or springs with linear flow) by watershed as identified by the Kaibab National Forest Riparian Survey, 1990. This on-site survey is the most accurate inventory of riparian areas and wetlands on the Forest and should be used in lieu of PNVT and riparian and wetland acreages listed in Table 6 and Table 7.

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Table 9. Subbasin (HUC 5 or HUC 4, where noted) Forest Wetlands and Condition

5th HUC Subbasin Name	Number of Wetland (W) lentic areas and Acres on Forest		(Wetlands) Extent and Condition Class			Percent of Forest Total	
			Poor	Fair	Good		
	Num	Acres	Num	Num	Num	By No.	By Acres
Lower Buckskin Gulch	0	0	0	0	0	0	0
House Rock Wash	6	12	1	3	2	7	2
North Canyon Wash	0		0	0	0	0	0
Shinumo Wash-Lower Colorado River	0		0	0	0	0	0
Tatahatso Wash-Lower Colorado River	0		0	0	0	0	0
Bright Angel Creek-Lower Colorado River	0		0	0	0	0	0
Shinumo Creek-Lower Colorado River	0		0	0	0	0	0
Tapeats Creek-Lower Colorado River	1	2	0	0	1	1	<1
Kanab Creek 4th HUC	34	45	17	12	3	39	9
Cataract Creek and Spring Valley Wash 5th	18	235	10	8	0	20	48
Red Horse Wash	0		0	0	0	0	0
Partridge Creek	1	1	0	1	0	1	<1
Miller Wash and Heather Wash 5ths	0		0	0	0	0	0
Middle Havasu Creek	0		0	0	0	0	0
Upper and Lower Cedar Wash 5ths	0		0	0	0	0	0
Lee Canyon-Lower Little Colorado River	0		0	0	0	0	0
Ash Fork Draw-Jumbo Tank	0		0	0	0	0	0
Upper and Lower Partridge Creek 5ths	0		0	0	0	0	0
Hell Canyon and Grindstone Wash-Upper Verde River 5th HUCS	8	46	1	5	2	9	9
Sycamore Creek	20	156	2	14	4	23	31
Total	**88**	**494**	**31**	**45**	**12**	**100%**	**100%**
Percent in Class			**35%**	**51%**	**14%**		

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Table 9a. Subbasin (HUC 5 or HUC 4, where noted) Forest Riparian Areas (lotic streams and springs) and Condition

5th HUC Subbasin Name	Number of Riparian (R) lotic or areas		Riparian Areas Extent and Condition Class			Percent of Forest Total	
			Poor	Fair	Good		
	Num	Acres	Num	Num	Num	By No.	By Acres
Lower Buckskin Gulch	0	0	0	0	0	0	0
House Rock Wash (includes N. Cyn Ck)	0	0	0	0	0	0	0
North Canyon Wash	2	14	0	2	0	6	1
Shinumo Wash-Lower Colorado River	0	0	0	0	0	0	0
Tatahatso Wash-Lower Colorado River	0	0	0	0	0	0	0
Bright Angel Creek-Lower Colorado River	0	0	0	0	0	0	0
Shinumo Creek-Lower Colorado River	0	0	0	0	0	0	0
Tapeats Creek-Lower Colorado River	0	0	0	0	0	0	0
Kanab Creek 4th HUC	4	12	0	3	1	13	1
Cataract Creek and Spring Valley Wash 5th	0	0	0	0	0	0	0
Red Horse Wash	0	0	0	0	0	0	0
Miller Wash and Heather Wash 5ths	0	0	0	0	0	0	0
Middle Havasu Creek	0	0	0	0	0	0	0
Upper and Lower Cedar Wash 5ths	0	0	0	0	0	0	0
Lee Canyon-Lower Little Colorado River	0	0	0	0	0	0	0
Ash Fork Draw-Jumbo Tank	0	0	0	0	0	0	0
Upper and Lower Partridge Creek 5ths	0	0	0	0	0	0	0
Hell Canyon and Grindstone Wash-Upper Verde River 5th HUCS (w/ Hells Cyn.)	9	957	0	7	2	29	87
Sycamore Creek	16	126	5	10	1	52	11
Total	**31**	**1109**	**5**	**22**	**4**	**100%**	**100%**
Percent in Class			**16%**	**71%**	**13%**		

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The following 5th HUC watersheds were aggregated into the Kanab Creek 4th HUC watersheds because field inventory sheets did not recognize the recent approved watershed splits made by the Natural Resource Conservation Service and consequently cannot provide more accurate site location; White Sage Wash, Lower Johnson Wash, Snake Gulch, Hack Canyon, Jacob Canyon-Kanab Creek, Jump-up Canyon-Kanab Creek.

Similarly, Cataract Creek and Spring Valley 5th HUC watersheds are aggregated into a combined 5th HUC watershed and Hell Canyon and Grindstone Wash-Upper Verde River are combined into one 5th HUC watershed.

If specific 5th HUC watersheds locations are needed for these watersheds, analysis of legal descriptions could be made to pinpoint location on new; approved NRCS watersheds (maybe do in ER, Phase 2 if needed).

Current Conditions and Context/Niche:

Forest-Wide Key Findings (Wetlands):

Analysis of data and Table 9 above reveal that Forest-wide, there are 88 Forest wetlands totaling 494 acres mapped by the 1990 Riparian Survey of the Kaibab National Forest. Only 7 out of 29, 5th HUC watersheds have identified wetland areas.

The vast majority of these wetland areas (about 70 out of 88 or 80%) is located in natural depressions and is not impounded by man-made machinery such as dozers. The remainder of inventoried wetlands (16-18 or 30%) are impoundments made by man for the purpose of storing water for livestock and wildlife watering but function as wetlands.

Key Finding: Overall analysis of livestock fenced areas indicates that fenced wetland and riparian area condition is better than unfenced condition indicating improved trend can be expected with fencing.

Key Findings: Forest-wide, 31 wetland areas or 35% are in poor condition, 45 or 51% are in fair condition, and 12 or 14% are in good condition. Wetland areas in fair and poor condition do not provide optimum riparian area habitat conditions including vegetative diversity essential to support and sustain those species that rely on it for their survival.

Watershed-Wide (Wetlands): Most Forest wetlands occur in the Kanab Creek 4th HUC watershed and Sycamore Creek 5th HUC watershed followed by Cataract Creek/Spring Valley Wash and Hell Canyon – Grindstone Wash Upper Verde 5th HUC watersheds.

Key Findings: Kanab Creek and Cataract Creek and Spring Valley Wash watersheds contain the greatest amount of wetland and riparian areas in poor condition (27 poor, 20 fair), followed by Sycamore Creek watershed.

House Rock, Hell Canyon-Grindstone Upper Verde River and Sycamore watersheds have significant areas in fair condition. Maintenance and improvement of wetland and riparian vegetation composition, structure, diversity, and overall condition is essential to provide habitat for those species that rely on it for their survival.

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Forest-Wide Key Findings (Riparian Areas):

Analysis of data and Table 9a above reveal that Forest-wide, there are 31 Forest riparian areas totaling 1109 acres mapped by the 1990 Riparian Survey of the Kaibab National Forest. Only 4 out of 31 or 13%, 5th HUC watersheds have identified lotic type (streams and springs) riparian areas.

Forest-wide, 5 riparian areas or 16% are in poor condition, 22 or 71% are in fair condition, and 4 or 13% are in good condition. Riparian areas in fair and poor condition do not provide optimum riparian area habitat conditions including vegetative diversity essential to support and sustain those species that rely on it for their survival.

Watershed-Wide (Riparian Areas): Most Forest riparian areas occur in Sycamore Creek 5th HUC watershed followed Hell Canyon – Grindstone Wash Upper Verde HUC watersheds followed by Kanab and North Canyon Wash watersheds..

Key Findings: Sycamore Creek watershed contains the only identified riparian areas in poor condition (5) and also contains the greatest amount of areas in fair condition (10), poor, 20 fair) followed by Sycamore Creek watershed.

Hells Canyon, Kanab Creek (includes Kanab Creek itself) and House Rock watersheds are dominated by riparian areas in fair condition.

Key Findings (Wetlands and Riparian Areas): Other portions of these Forest watersheds include wetland and riparian areas in good condition. Wetland and riparian areas in good condition support and contribute ecological conditions that are capable of sustaining ecosystem functions although improvements can be made to enhance ecological sustainability.

<u>Reference Dynamics (Historic Conditions and Niche):</u>

Scales Above and Below Planning Unit: Little information is available to document historic range of variation, extent and conditions of wetland, riparian areas other than anecdotal (Cline, They Came to the Mountains) inferring past conditions based on knowledge of current conditions. Wetland condition Pre-European settlement probably was dominated functional conditioned wetland, riparian areas because there was little anthropogenic disturbance compared to today.

Historic (Pre-European) wetland extent is largely unknown except for anecdotal excerpts from a few publications. More recent aerial photo analysis (post about 1940 on Coconino National Forest land) indicates wetland extent is about the same as it is today but water level ponding fluctuates according to annual precipitation. Mostly undocumented observations and communications with Forest employees indicate that from about 1984 – 1996 show Forest wetlands ponding water more frequently and for longer periods of time than over the last 8-10 years as a result of more recent sustained drought. Using Coconino Forest analysis may approximate wetland extent on the Kaibab National Forest, because both Forests share boundaries and similar section and sub section ecological types.

Disturbances:

Current and Historic disturbances are similar to those listed in Section A above (Watershed Extent and Perennial Streams).

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F. Water Quality

Current Conditions:

Scale At and Below Planning Unit (5th HUC): This section focuses on actual Forest water quality. It includes an Introduction, Current Water Quality and Trend, Water Quality Monitoring and BMP's, Reference Dynamics (Historic Conditions) and Disturbances. Table 10 summarizes water quality departure by watershed and lists characteristics of greatest concern needing change.

Introduction: Improvements to the nation's waters over the past three decades are largely due to the control of traditional point sources of water pollution. However, a large number of waterbodies remain impaired and the goal of eliminating pollutant discharge and attaining fishable and swimmable waters is still unrealized. Nonpoint sources of pollution such as agriculture, construction, forestry, and mining are responsible for much of the nation's remaining water quality impairment. Currently on Kaibab National Forest land, the most important nonpoint sources of pollution are ungulate grazing, and roads. Before about 1992 and the initiation of Best Management Practices (BMP's), timber harvesting was widespread and was also an important nonpoint source of pollution in the form of sediment delivery off site and into adjoining streamcourses.

Water quality is assessed by comparing existing conditions (State Water Quality Category 1 – 5) with desired conditions that are set by the States under authority of the Clean Water Act. Waters that are not impaired (those not on 303 (d) list or category 4 or 5) are providing for beneficial uses identified for that stream and can be considered in a desired condition. The Arizona Department of Environmental Quality (ADEQ) is the regulating authority for water quality in Arizona.

Water quality has been assessed in major perennial stream reaches and lakes on the Forest. The general classification used for surface water quality by ADEQ are: Attaining; Impaired; and Inconclusive/Not Assessed for the identified uses. The classification designates each waterbody in one of five categories.

The categories are defined as follows:

Category 1: Attaining All Uses – All designated uses assessed as "attaining"

Category 2: Attaining Some Uses – At least one designated use assessed as "attaining" and all other sues assessed as "inconclusive"

Category 3: Inconclusive – All designated uses are "inconclusive" (be default, any surface water not assessed due to lack of credible data is actually included in this category)

Category 4: Not attaining – At least one designated use is "not attaining" and no designated use is "impaired"

Category 5: Impaired – At least one designated use was assessed as "impaired"

Key Findings: Knowing which waters are "Impaired" or "Not Attaining" is important. These lakes and stream reaches have been identified by ADEQ as those with the most

severe water quality problems. Permit requirements for discharge into these waters are very strict and ADEQ and the Forest must make sure that any new discharges or modifications will not further degrade water quality.

Current Water Quality and Trend:

Table 10. Subbasin (HUC 5) Water Quality – Kaibab National Forest, displays surface water quality within each 5th HUC watershed, and within the Forest. Trend is displayed by comparing actual water quality data from about 1993 to present or inferred from changes ADEQ made in listing water quality Categories. .

Fields left blank indicate no information was collected by ADEQ because either there are no perennial streams or lakes present or ADEQ does not believe they are not extensive enough to require monitoring. Trend is not analyzed for streams and lakes outside of Forest boundaries.

Key Findings:

There are no Forest streams classified in any Category. Therefore, no Forest streams are monitored (too short and too few miles) by ADEQ or listed as Category 5 or "Impaired" on the 2004 EPA 303(d) list.

There are about 116 miles of streams classified as Categories 1 – 3 located off Forest lands in the Lower Colorado River and Grindstone-Upper Verde 5th HUC watersheds (Table 10). The Forest does not contribute any towards maintenance of stream water quality; aquatic and ecological diversity in these ADEQ monitored streams.

Large fires, drought or extreme flood events continue to have an affect on water quality. Typically, these events only adversely affect soil and water conditions on the Forest for a short period of time and recover quickly. The subbasin risk is primarily a function of potential delivery of sediment in ephemeral systems, should a large fire occur.

Sycamore Creek 5th HUC:

Whitehorse Lake is located on Forest land in the Sycamore Creek 5th HUC watershed and is the only Forest Lake monitored by ADEQ. In 1993, 3 samples were collected resulting in partial to full support of Aquatic and Coldwater Fisheries beneficial uses.

In 1998, the Lake was placed on the EPA 303 (d) list for exceeding the turbidly standard for Aquatic and Coldwater Fisheries designated use. ADEQ had recommended delisting this Lake because there were not enough samples collected to support listing even though turbidity exceeded 11 out of 11 samples.

From 1997-2000, ADEQ collected 12 samples that resulted in attaining some uses and added is to the Planning List for exceeding the DO, pH, and turbidity standards. In 2002, the EPA listed it as impaired for exceeding the water quality Dissolved Oxygen standard and placed it on the 303(d) list where it remained for 4 years. The ADEQ classified the lake as Category 5 (for hi pH, fish kills in 1994, ammonia and turbidity exceedences). Designated uses at Whitehorse Lake include full body contact (swimming) and fish consumption and aquatic and cold water fisheries.

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In 2006, ADEQ placed Whitehorse Lake into an improved class, Category 2 “Attaining Some Uses” where it remains to date.

Key Findings: Whitehorse Lake is an impounded lake that was not present historically and provides recreation opportunity and is one of the most frequently visited recreation destinations on the Forest. Therefore, water quality that meets State Water Quality Standards and provide for the identified designated uses is of utmost importance. The Forest is solely responsible for water quality and the contributions clean water makes towards aquatic and ecological diversity and overall sustainability.

Trend in Whitehorse Lake from 1993 to 2006 is difficult to assess because there has been inadequate sampling throughout the years. Analysis of actual data appears to indicate mostly static trend and under Category 2, does not have ecological need for change although could be improved to Category 1 and should be managed to comply with water quality standards.

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Table 10. Subbasin (HUC 5) Current Water Quality and Trend – Kaibab National Forest

Subbasin Name	[12]Miles of Category 1 and 2 Streams/in Watershed	[13]Miles of Category 1 and 2 Streams on Forest	Miles of Category 3 Streams/Lakes in Watershed	Miles of Category 3 Streams/Lakes on Forest	Mile/Acres of Category 4 and 5 "Impaired" Streams/Lakes in Watershed	Miles/Acres o of Category 4 and 5 "Impaired" Streams/Lakes on Forest	[14]Trend from 1993 - Present
Lower Buckskin Gulch							NA. No perennial streams
House Rock Wash							NA. No perennial streams
North Canyon Wash							No streams assessed
Shinumo Wash-Lower Colorado River							NA. No perennial streams
Tatahatso Wash-Lower Colorado River			14.1				Unknown
Bright Angel Creek-Lower Colorado River			10.7				Unknown
Shinumo Creek-Lower Colorado River			32.5				Unknown
Tapeats Creek-Lower Colorado River			15.4				Unknown
White Sage Wash							NA. No perennial streams
Lower Johnson Wash							NA. No perennial streams
Snake Gulch							NA. No perennial streams
Hack Canyon							NA. No perennial streams
Jacob Canyon-Kanab Creek							NA. No streams
Jumpup Canyon-Kanab Creek							NA. No perennial streams

[12] The water quality of streams/lakes dataset was provided by the AZ State DEQ to Roy Jemison (2004 version).
[13] The water quality of streams/lakes dataset was provided by the AZ State DEQ to Roy Jemison (2004 version).
[14] Trend is an evaluation of ADEQ water quality data (not shown in this document) from 1993 – present (2005).

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Subbasin Name	[12]Miles of Category 1 and 2 Streams/in Watershed	[13]Miles of Category 1 and 2 Streams on Forest	Miles of Category 3 Streams/Lakes in Watershed	Miles of Category 3 Streams/Lakes on Forest	Mile/Acres of Category 4 and 5 "Impaired" Streams/Lakes in Watershed	Miles/Acres o of Category 4 and 5 "Impaired" Streams/Lakes on Forest	[14]Trend from 1993 - Present
Spring Valley Wash							NA. No perennial streams
Red Horse Wash							NA. No perennial streams
Miller Wash							NA. No perennial streams
Cataract Creek							NA. No perennial streams
Heather Wash							NA. No perennial streams
Middle Havasu Creek							NA. No perennial streams
Upper Cedar Wash							NA. No perennial streams
Lower Cedar Wash							NA. No perennial streams
Lee Canyon-Lower Little Colorado River							NA. No perennial streams
Ash Fork Draw-Jumbo Tank							NA. No perennial streams
Upper Partridge Creek							NA. No perennial streams
Lower Partridge Creek							NA. No perennial streams
Hell Canyon							NA. No perennial streams
Sycamore Creek	Whitehorse Lake (41 acres)	Whitehorse Lake (41 acres)	11.7				Static
Grindstone Wash – Upper Verde River	17.1		14.2				Unknown
Total	**17.1**	**0**	**98.6**	**0**	**41 acres**	**41 acres**	**NA**

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Groundwater:

Surface water quality standards do not apply to groundwater. The ADEQ has independent statutory authority to develop aquifer water quality standards, and has adopted Aquifer Water Quality Standards. Groundwater standards in Arizona are the Safe Drinking Water standards established for public water systems and surface water standards for the Domestic Water Source designated use. No exceedences of State Water Quality Standards were reported within the Forest administrative boundary on the few wells monitored by ADEQ from 1996 – 2000. In general, ground water quality is good.

Water Quality Monitoring

Arizona's water quality monitoring program includes a network of fixed monitoring stations, watershed characterization monitoring, and targeted monitoring. One core of the ambient water quality monitoring program is the Fixed Station Network (FSN). The purpose of the FSN is to characterize baseline water quality of perennial, wadeable streams and to provide data to determine long-term water quality trends. The fixed sampling sites in the FSN are sampled quarterly each year every 3 years but there are no fixed station sites on the 1.5 miles of perennial stream on the Forest.

BMP's:

The State has implemented their nonpoint source management plans through State approved BMPs. BMPs (FSH 2509.22) are methods, measures, or practices to prevent or reduce water pollution, including, but not limited to, structural and nonstructural controls and operation and maintenance procedures. These practices are usually applied as a system of practices rather than a single practice and are selected on the basis of site-specific conditions that reflect natural background conditions and political, social, economic, and technical feasibility. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. Section 310 of the Clean Water Act directed States to identify BMPs for categories of nonpoint source problems, and develop programs to implement the BMPs. Through a Memorandum of Understanding (MOU), ADEQ has designated the Forest Service to be responsible to identify, implement and monitor the effectiveness of BMP's to assure SWQS's are being met.

Key Findings: Currently, timber harvesting primarily occurs as hazardous fuel reduction thinning projects and disturbs much less soil and consequently, does not contribute a significant nonpoint source of pollution. Since about 1992, BMP's have been incorporated in timber harvesting and fuels reduction process mitigating nonpoint source pollution.

Grazing BMP's: Arizona law also has specific requirements regarding grazing. ADEQ has adopted a "surface water quality general grazing permit consisting of voluntary best management practices for grazing activities." Although the DEQ must require the application of economically feasible voluntary BMPs that are "the most practical and effective means" of reducing or preventing discharge of pollutants by grazing activities,

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the DEQ "shall not require application of more stringent practices if such a requirement would result in cessation of significant reduction of grazing activity." http://www.blm.gov/nstc/WaterLaws/arizona2.html - Anchor-49813 The law requires the development and issuance of a permit, but because the BMPs are voluntary, there may be little enforceable action beyond simply requiring the permit.

CWA § 401: State Certification for Grazing and Wetland Dredging and Mining

Section 401(a) requires any applicant for a federal license or permit which may result in any discharge into waters of the United States to provide to the licensing agency a certification from the state in which the discharge originates that the discharge will comply with applicable provisions of the CWA including WQS and any other appropriate state law. This provision applies to federal licenses and permits, and has been used to control pollution from hydroelectric projects, mining projects, and wetland dredging. A more recent ruling concludes that grazing does not constitute a point source of pollution and does not require State 401 certification. However, for wetland dredging and mining activities, State certification is required and as such will mitigate adverse sources of pollution in wetland

Reference Dynamics (Historic Conditions and Niche):

Scales Above and Below Planning Unit

Too little information is available to characterize and understand the historic range in variability of water quality. It may be theorized that before European settlement, waters were cleaner than today and probably met SWQS's due to a lack of increased anthropogenic disturbances over time that may have contributed towards water pollution. Native Americans were known to use burning in farming practices and probably caused short-term increased in water turbidity from connected watercourses and fields.

The Ecological Sustainability Work Group has provided alternative approaches to historic condition analysis (pg 25, working group product). An understanding of the ecological conditions (in this case, water quality standards) needed to sustain water quality of ecosystem diversity will be used and described in Plan components and as the basis to determine ecological and Forest Plan need for change. SWQ's are intended to quantify those levels needed to provide for the beneficial uses of water and sustain aquatic, ecological systems

Disturbances: Current and Historic disturbances are similar to those listed in Section A above (Watershed Extent and Perennial Streams).

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Table 11: Departure Between Reference and Current Conditions, and Projected Trends and Ecological Need for Change by Aquatic Characteristic by 5th Code Watershed on Forest

4th Code Watershed	**Groundwater Yield**	**Stream flow Yield**	**Seeps / Springs Extent**	**Stock Pond Extent**	**Overall Watershed Departure / Trend**
Kanab	Unknown	None on Forest	Low to High	High	Low/Static
Lower Colorado-Marble Canyon			Low		
Havasu Canyon					
Upper Verde			Low to High		
Lower Little Colorado			Low		
Big Chino-WIlliamson Valley					
Paria					
Grand Canyon					

Towards = trend is towards reference; Away = away from reference; Static = no trend; Variable = variable trends. High=highly departed, Moderate= moderately departed, Low= low departure.

Low represents less than 33% of wetland areas are currently in fair or poor condition. M represents from 34-66% are in fair or poor condition and H departure represents from 67-100% of areas are in fair or poor condition. Data taken from tables 9 and 10 above.

Watersheds with high departure from reference to current condition and have a projected future static trend or are trending away from reference are of concern. They are North Canyon Wash, Kanab Creek 4th HUC , Cataract Creek and Spring Wash, Partridge Creek, Hell Canyon-Grindstone Wash, Upper Verde 5th HUCs and Sycamore Creek. These departed watersheds need riparian and wetland change parameters improvement to move towards reference conditions.

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Table 12: Departure Between Reference and Current Conditions and Projected Trends by Aquatic Characteristic at the 4th CodeWatershed Scale (groundwater and streamflow yield, stocktanks, seeps and springs) on Forest Lands

4th Code Watershed	5th Code Watershed	Water Quality Departure and Trend	Riparian Condition Departure and Trend		Aquatic Char. of Greatest Concern
			Stream	Wetland	
Kanab Creek	Kanab Creek	Not applicable/no surface water body present or monitored	H/Static for invasive species and no perennial water	H/Static for unfenced areas to towards for fenced or deferred grazing	Stream and wetland condition
Lower Colorado – Marble Canyon	House Rock Wash		Not applicable / no identified riparian area	Not applicable / no identified wetlands present.	None
	North Canyon Wash		L/Static	H/Static for unfenced areas to towards for fenced or deferred grazing.	Stream and Wetland Condition
	Shinumo Wash		Not applicable/no identified riparian area	Not applicable / no identified wetlands present.	None
	Tatahatso Wash				
	Bright Angel Creek				
Havasu Canyon	Cataract/Spring Valley			H/Static for unfenced areas to towards for fenced or deferred grazing	Wetland condition
	Red Horse Wash			Not applicable/no identified wetlands present.	None
Upper Verde	Hell Canyon – Grindstone Wash			H/Static for unfenced areas to towards for fenced or deferred grazing	Wetland condition
	Sycamore	L/Slightly Variable but generally Static, not historic			Wetland condition. Monitor water quality
Lower Little Colorado	Cedar Wash	Not applicable / no surface water body present or monitored		Not applicable/no identified wetlands present.	None
	Lee Canyon				
Big Chino – Williamson. Valley	Ash Fork Draw Jumbo Tank				
	Heather Wash				
	Partridge Creek				
Paria	Lower Buckskin Gulch				
Grand Canyon	Shinumo Creek				
	Tapeats Creek				

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Towards = trend is towards reference; Away = away from reference; Static = no trend; Variable = variable trends. H=highly departed, M= moderately departed, L= low departure. Low represents less than 33% of wetland areas are currently in fair or poor condition. M represents from 34-66% are in fair or poor condition and H departure represents from 67-100% of areas are in fair or poor condition.

Key Finding Summary: There is about 1.5 miles of perennial streamflow on the Forest and is not diverted or altered so is not departed from reference. All other streamflow is off Forest lands outside the control and authority of Forest management and therefore has no need for change. Departure in stockpond extent does not affect overall watershed departure because stockponds do not impound large amounts of water and do not appreciably affect downsteam water yield. The effects of Forest well pumping are not known to affect adjacent seep, spring or downstream water flow.

Seeps and springs are really small, riparian areas that serve as habitat to sustain a variety of plant and animal species. According to the NHD layer, there are 709 springs and seeps in all Forest connected 4th HUC watersheds. The Forest contains 129 springs and seeps or about 18% of the total. Forest land contained in all 4th HUC watersheds is about 15% so spring and seep totals contribute a very proportional, (18% compared to 15%) amount on Forest.

Spring and seep location are nicely nested and are mostly located in the Upper Verde River and Kanab Creek 4th HUC watersheds with very few located on the Tusayan and NW portions of the Williams Ranger Districts

As of the date of this analysis, spring and seep functional condition assessments have not been made Forest-wide or are very limited. Observations and limited documentation indicate accessible, unfenced areas are not functioning well. Where areas are properly fenced or ungulate grazing is excluded, these areas are in functional condition. Maintenance of these waters in functioning condition contributes to diverse ecological riparian and aquatic ecosystems and is vital to sustain those species that depend on these areas for their survival.

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Trend Analysis for Water Resource Characteristics of the Kaibab NF, 6/27/2007

Table 13. Water Resource Trends and Ecological Need for Change Perennial Streams, Water Yield and Water Quality at the Forest Planning Unit and 5th HUC Watersheds (where listed)

Ecosystem or Resource Characteristic			
	Perennial Stream Extent	**Water Yield (Surface Streamflow, Groundwater)**	**Water Quality**
Historic Condition	Largely unknown but inferred and estimated to be similar to current extent and location (see Section II Historic Conditions in Water Ecological Sustainability Report):	Pre-European condition is largely unknown (see Section II Historic Conditions in Water Ecological Sustainability Report): 12th century Native Americans are reported to have diverted select rivers for irrigation and prehistoric sites confirm this in Verde basins (Dahms, 1997, and per. Obs. Steinke, 1990 – 2005. Water diversion, pumped water, dams, farming, mining for sand and gravel have occurred for more than 100 years.	Largely unknown but inferred to meet Arizona State Water Quality Standards as described in Section II, F, and Water Quality in Water Ecological Sustainability Report. State water quality standards are intended to quantify levels needed to provide beneficial uses and sustain aquatic, ecological systems. All lakes and miles would meet State Water Quality Standards and be classified in Categories 1 and 2.
Current Condition **(from Section II, KNF Water Ecological analysis, 2/2007)**	11 miles (NHD) 1.5 miles (per. Comm. B. Higgins, 1/2007) on Forest administered lands. Geomorphic features and gallery riparian forest indicate current perennial stream network has	**Streamflow Water Yield (1985-Present):** Annual precipitation directly affects yearly streamflow and overall trend (analysis of streamflow and precipitation data from USGS (see water report for trend analysis). Varies by perennial stream but recent trend	No Forest streams are monitored or classified by ADEQ because they are very limited in extent. There are 99 miles of Category 3 and 17 miles of Category 1 and 2 streams outside of Forest lands located in watersheds intersecting Forest

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Ecosystem or Resource Characteristic			
	Perennial Stream Extent	**Water Yield (Surface Streamflow, Groundwater)**	**Water Quality**
	been in same location for at least several decades (Section II, CNF Water Ecological analysis, 2/2007). 26 miles (NHD) total on all Forest intersecting 5th HUC watersheds.	ranges from downward (Cataract Creek, 1965-1972) to static to slightly upward (Lower Colorado River, Havasu Creek, Verde River to upward (Kanab Creek 1965-1980). See Section II, KNF Water Ecological analysis, 2/2007 for details by stream. Dates preceding the KNF may not be accurate representations of current streamflow. **Groundwater yield is unquantified**. Since 1950, water demand has increased in areas adjacent to Williams and the Verde Valley and more groundwater pumped from wells. Existing FS Groundwater policy protects excessive groundwater withdrawals from wells located on Forest administered lands. City of Flagstaff data shows some groundwater levels have drastically dropped from pumping of wells with some recovery during precipitation events. Other private owned lands adjacent to FS might pump groundwater beyond safe yield reducing nearby water table levels in streams, springs and seeps.	boundaries but managed by other agencies or Private individuals. No Forest lakes are impaired or classified ADEQ Category 5 or on EPA 303d Impaired List. Whitehorse Lake (41 acres) was listed as impaired on 303 (d) list in 1994 - 1998 for exceeding, DO, pH, ammonia, fish kills and turbidity standards but delisted in 2004-2006 to attaining some uses and placed in Category 4 (Planning List) for futre monitoring with new Suspended Sediment Concentration standard.
Projected Future Condition (PFC) & Trends	North Canyon Creek will continue to be at or near historic conditions for water flow and	**Streamflow water yield** Streamflow is directly dependant on annual	Overall water quality condition for streams, lakes and wetlands mirrors watershed conditions and will continue

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Ecosystem or Resource Characteristic			
	Perennial Stream Extent	**Water Yield (Surface Streamflow, Groundwater)**	**Water Quality**
	riparian vegetation. However, the currently high risk of uncharacteristic fire and associated soil erosion and sedimentation is expected to rise further. Kanab Creek will continue to be intermittent stream because of the high and increasing demand for water in its upper watershed. Tamarisk could be treated in the future with beetles and/or herbicide to return the native cottonwood and willow community. **Static**	precipitation received and is projected to have variable but similar to current trend from slightly downward to slightly upward (logical deduction from analysis of trends, see recent streamflow trend analysis in water report) **Groundwater Yield: (**FS administered lands): Current management protects excessive groundwater withdrawals with implementation of groundwater policy. In years of normal or above precipitation, groundwater yield is projected to be **Static**. Private Lands: Excessive pumping beyond safe yield concept of groundwater on wells located on Private lands may reduce the groundwater table adjacent to FS lands resulting in downward trend to groundwater and connected perennial streams but is largely unknown to what extent. Safe-yield pumping should result in static trend. **Overall Static to downward trend.**	to be in good and static condition except immediately after large fires, drought or extreme flood events. History shows that good and static conditions return quickly after these disturbances with favorable climatic conditions. Water quality in Whitehorse Lake will remain static or improve under current management. Water quality for other surface waters will be protected as appropriate soil and water conservation practices and BMP's are implemented during ground disturbing activities reducing non-point source pollution. Since no streams are classified, no trend can be projected. Recent trend analysis from Table 9 indicates White Horse Lake management (since about 1993 – present) is difficult to assess because of inadequate water sampling and change from turbidity to Suspended Sediment Concentration standard. However, data appears to indicate current management has resulted in **Static trend.**

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Ecosystem or Resource Characteristic			
	Perennial Stream Extent	**Water Yield (Surface Streamflow, Groundwater)**	**Water Quality**
Interpretation and Analysis	Very little to no gap between historic, current and Projected Future Condition. Forest management adequately strives to maintain the very limited perennial waters it has. Fire risk is a threat to the long term health of North Canyon Creek. Tamarisk in Kanab Creek could be treated in the future with beetles and/or herbicide to return the native cottonwood and willow community and possibly increase water flows.	**Streamflow water yield:** Current management strives to maintain favorable conditions of surface water flow with appropriate grazing, timber and recreational management. When Forest Plan grazing utilization guidelines are met, suitable vegetation is left protecting streambanks, riparian function and maintaining water quantity and timing of flows. Thinning of overstocked Forest vegetation located in connected watersheds should reduce evapotranspiration, increase runoff somewhat and improve timing of water flows. Continued relocation of roads out of riparian areas and use of Forest BMPs including use of suitable filter strips for roads adjacent to streams should maintain favorable condition of water flow. **Groundwater Yield:** Annual recharge depends on amount of annual precipitation received and amount withdrawed. Excessive pumping beyond safe yield concept of groundwater on wells located on Private lands may reduce the groundwater table adjacent to FS lands.	Overall water quality condition for streams, lakes and wetlands mirrors watershed conditions and will continue to be in good and static condition except immediately after large fires, drought or extreme flood events. History shows that good and static conditions return quickly after these disturbances with favorable climatic conditions. Gap between historic and current condition of Whitehorse Lake. Continued implementation of BMP's and Travel Management Rule cross-country restrictions should result in maintaining or improving water quality Forest-wide.

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Ecosystem or Resource Characteristic			
	Forest Wetlands	**Forest Riparian Areas**	**Forest Springs, Seeps and Stocktanks**
Historic Condition	Extent is largely unknown but the number is inferred and estimated to be similar to current 88 (natural impoundments and 16-18 modified and 494 acres (Kaibab National Forest Riparian Survey, 1990) as listed in Section II Historic Conditions in Water Ecological Sustainability Report. Other stocktanks are not included. Impounded wetlands may have been altered by man on pre-existing wetlands. Most wetlands are located in Kanab Creek, 5th HUC watershed and Sycamore Creek 5th HUC watershed followed by Cataract Creek, Spring Valley Wash and Hell Canyon-Grindstone Wash Upper Verde 5th HUC watersheds. Wetland condition is inferred to have been properly functioning since man-made disturbances were not present aside from limited Native American influences as detailed in Section II, Water Quality Report, 2/2007. 88 wetlands in PFC.	Largely unknown about riparian area extent but condition is inferred and estimated to be in Good Condition because no man-made disturbances were present other than limited Native American disturbances as listed in Section II Historic Conditions in Water Ecological Sustainability Report. Extent is assumed to be 31, same as current and about 1109 acres (Kaibab National Forest Riparian Survey, 1990).	Springs and Seeps extent is largely unknown. Reports (Cline, 1976) document their existence before 1900 but do not quantify their extent or qualify their condition (see section II Historic Conditions in Water Ecological Sustainability Report). Similar to historic riparian and wetland condition, it may be logical to assume that seeps and springs were mostly in good or functional Condition because of limited man-made disturbance (logical assumption, R. Steinke). Constructed Stocktanks did not exist prior to European Settlement although Native America archaeological sites show small reservoir collection basins for used for farming and watering (Steinke, 1990 – 2000).

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Ecosystem or Resource Characteristic			
	Forest Wetlands	**Forest Riparian Areas**	**Forest Springs, Seeps and Stocktanks**
Current Condition **(from Section II KNF Water Ecological analysis, 2/2007)**	About 70 are natural wetlands(494 acres) and (natural impoundments) and 16-18 are modified to store more water. These probably impounded some water but it is unknown if they were natural wetland areas before modification. Most wetlands are located in Kanab Creek, 5th HUC watershed and Sycamore Creek 5th HUC watershed followed by Cataract Creek, Spring Valley Wash and Hell Canyon-Grindstone Wash Upper Verde 5th HUC watersheds.	31 riparian areas (Riparian Inventory, KNF, 1990) or 1109 acres Almost all riparian acres are located in the Sycamore Creek 5th HUC watershed and Hells Canyon – Grindstone Wash 5th HUC watershed (Kaibab National Forest Riparian Survey, 1990)	129 identified springs and seeps on Forest lands. Functional condition is largely unknown. However, where data was collected on nearby Coconino National Forest, (Norman, 2001 – 2006), unfenced and grazed areas are either Function At-Risk or Non Functional. Fenced areas are in better condition. 492 stocktanks on Forest lands. Watersheds adjudications will determine who will have right to use water, for what and how much.
	Wetland Conditions: 31 or 35% are in poor condition 45 or 51% are in fair condition 12 or 14% are in good condition Kanab Creek and Cataract Creek and Spring Valley Wash watersheds contain the greatest amount of wetland and riparian areas in poor condition (27 poor, 20 fair) followed by Sycamore Creek watershed. House Rock, Hell Canyon-Grindstone Upper Verde River and Sycamore watersheds have significant areas in fair	Riparian Area Condition 5 or 16% are in poor condition 22 or 71% are in fair condition 4 or 13% are in good condition Sycamore Creek watershed contains the only identified riparian areas in poor condition (5). Sycamore Creek and Hells Canyon 5th HUC watersheds contain appreciable areas in fair condition. Maintenance and improvement of riparian vegetation composition, structure, diversity, and overall condition is	

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Ecosystem or Resource Characteristic			
	Forest Wetlands	**Forest Riparian Areas**	**Forest Springs, Seeps and Stocktanks**
	condition. Maintenance and improvement of wetland vegetation composition, structure, diversity, and overall condition is essential to provide habitat for those species that rely on it for their survival. Wetlands in poor and fair condition so not have characteristics that can sustain riparian habitat and those species that rely on it for their survival. Other portions of watersheds are in good condition and support ecological conditions to sustain ecosystem functions. Annual precipitation has large affect on vegetative growth and water permanency. Several wetlands and riparian areas have been fenced (per. Comm. D. Brewer, 2007). However, up to 50% of these fenced wetlands and riparian areas have fence maintenance concerns and are not functional today and therefore are grazed (per. Comm. B. Higgins, 2007). Currently, livestock only have access to about 50% of Forest wetlands but fences are intended to restrict almost all livestock access and grazing activity.	essential to provide habitat for those species that rely on it for their survival. Riparian areas in poor and fair condition so not have characteristics that can sustain riparian habitat and those species that rely on it for their survival. Other portions of watersheds are in good condition and support ecological conditions to sustain ecosystem functions. Annual precipitation has large affect on vegetative growth and water permanency. Several wetlands and riparian areas have been fenced (per. Comm. D. Brewer, 2007). However, up to 50% of these fenced wetlands and riparian areas have fence maintenance concerns and are not functional today and therefore are grazed (per. Comm. B. Higgins, 2007). Livestock and select elk grazing are heavy where unfenced (check with Forest on this statement) resulting in declined riparian function. Where elk graze, they routinely utilize more than appropriate under Forest Plan	

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Ecosystem or Resource Characteristic			
	Forest Wetlands	**Forest Riparian Areas**	**Forest Springs, Seeps and Stocktanks**
	Livestock and select elk grazing are heavy where unfenced (check with Forest on this statement) resulting in declined wetland and riparian function. Where elk graze, they routinely utilize more than appropriate under Forest Plan standards even before livestock can be rotated in. Exact locations where elk grazing occurs is unknown but may be important to identify during Phase 2 CER. When livestock are rotated in unmaintained fenced areas, overall utilization commonly exceeds Forest standards and reduces overall wetland function. Cooperation with AZ Game and Fish elk herd management is not addressed adequately in current Forest Plan. Plan utilization standards do not specifically cover herbaceous, wetland utilization but are covered by upland range utilization by range condition class and have resulted in declined wetland function (check FP and Bruce Higgins).	standards even before livestock can be rotated in. Exact locations where elk grazing occurs is unknown but may be important to identify during Phase 2 CER. When livestock are rotated in unmaintained fenced areas, overall utilization commonly exceeds Forest standards and reduces overall riparian function.	

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Ecosystem or Resource Characteristic			
	Forest Wetlands	**Forest Riparian Areas**	**Forest Springs, Seeps and Stocktanks**
Projected Future Condition (PFC) & Trends	**Wetlands and Riparian Areas:** The most productive wetlands and riparian areas are fenced and fences are maintained, or have restricted livestock access. Rapid improvement of litter and vegetation diversity and productivity where fences are maintained. The Plan option of deferred cattle grazing may show some improved conditions where grazing occurs and utilization guidelines are met. Where elk grazing occurs in wetlands and riparian areas, conditions would be static. Restricted cross-country OHV travel will allow for some improvement overall. Following Plan direction with BMP implementation should reduce Forest management impacts and maintain or improve wetland function. Plan language is adequate for establishment of road or disturbed area/riparian area filter strip but many roads do not have adequate filter strips adjacent to wetlands and roads located adjacent to wetlands provide additional impacts to wetland from recreational use. Travel Management should resolve this. Following Plan direction with BMP implementation should reduce Forest management impacts and maintain or wetland and riparian function **Static** for those areas without elk and livestock fencing. **Upward trend** for areas where fences are maintained and where no elk have access under normal years of precipitation. **Slight upward trend** for those areas with option of deferred to no livestock.		Springs and seeps will continue to flow at rates similar to historic levels. Developed springs will continue to be used near levels used during the homestead era. Springs will continue to be excluded from livestock grazing to improve riparian vegetation. Where livestock grazing continues at the springs, riparian conditions will remain static. Where forest canopies are reduced in watersheds above springs, it is likely that spring flow would increase. Where wells are located in watershed above these springs on Forest or private lands, it is likely that spring flow would decrease. Spring and seep extent to remain similar to current **(Static Trend).** Continued livestock grazing in unfenced seep and spring locations is expected to further impact spring and seeps resulting in similar to declined conditions (**(Static to Downward trend).** Stocktanks number to remain the same **(Static Trend)**. Forest expected to procure water rights for livestock and wildlife watering in watersheds

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Ecosystem or Resource Characteristic			
	Forest Wetlands	**Forest Riparian Areas**	**Forest Springs, Seeps and Stocktanks**
			adjudications (recent adjudication and court proceedings).
Interpretation and Analysis	**Wetlands and Riparian Areas:** Gap between current and PFC conditions largely due to livestock grazing and fence maintenance issues. PFC trend is variable (ranges from static to upward) depending on livestock grazing management, fence maintenance, elk utilization and management option to graze wetlands and riparian areas. Forest Plan does not direct cooperative elk herd management with State Game and Fish.		**Seeps and Springs**: Gap in extent is unknown between historic and current condition. Projected Future extent similar to current with years of normal to above precipitation. Continued and sustained drought may shrink extent (logical deduction, Steinke, 2007). Condition: Gap (limited or unknown documentation) between historic and current and projected future. Stocktanks number to remain the same. Springs and seeps will continue to flow at rates similar to historic levels. Springs will continue to be excluded from livestock grazing to improve riparian vegetation. Where livestock grazing continues at the springs, riparian conditions will remain static. Where forest canopies are reduced in watersheds above springs, it is likely that spring flow would increase. Where wells are located in watershed above these springs on Forest or private lands, it is likely that spring flow would decrease.

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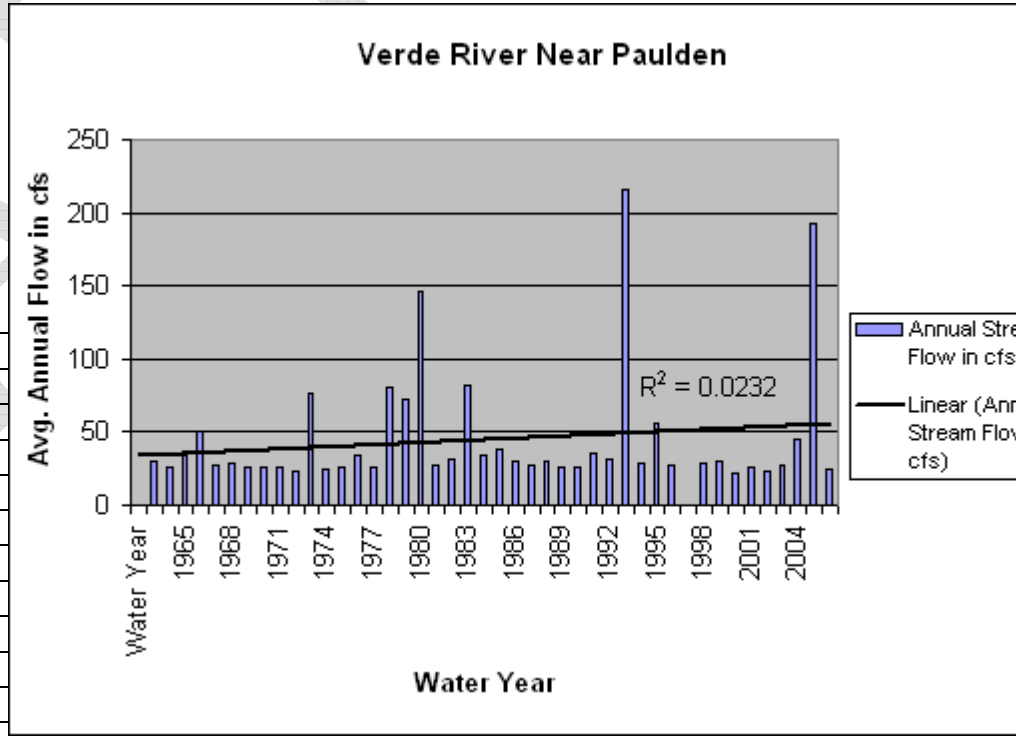
Appendix A – Streamflow Water Yield Trend

Verde River Near Paulden
Upper Verde River 4th HUC Latitude 34°53'42", Longitude 112°20'32" NAD27

Water Year	**Annual Stream Flow in cfs**
1963	29.6
1964	26.2
1965	33.6
1966	50.5
1967	27.8
1968	29
1969	26.2
1970	25.8
1971	26.2
1972	23.9
1973	76.4
1974	25
1975	25.5
1976	34.2
1977	25.6
1978	80.2
1979	72.1
1980	146.7
1981	26.8
1982	31.9
1983	81.4
1984	34
1985	37.6
1986	29.7



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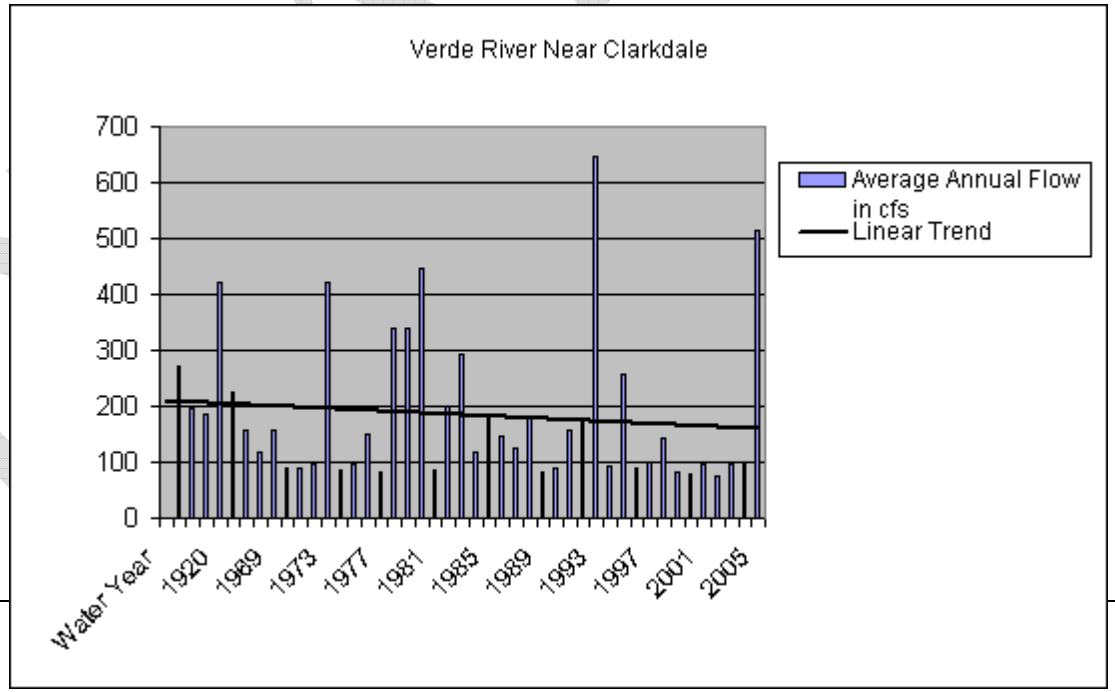
1987	28	
1988	30.1	
1989	26	
1990	26.6	
1991	35.6	
1992	31.1	
1993	215.2	

Verde River Near Clarkdale – Upper Verde River 4th HUC

Average Annual Flow in cfs

Water Year	
1917	272.8
1918	195.9
1919	186.6
1920	420.8
1966	225.4
1967	156.5
1968	116.6
1969	156.8
1970	91
1971	88.1
1972	95.9
1973	423.1
1974	84.2
1975	95.9
1976	149.5
1977	81.6
1978	339.9
1979	337.8



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1980	447.6
1981	85.9
1982	199.6
1983	294.4
1984	118
1985	178
1986	145.1

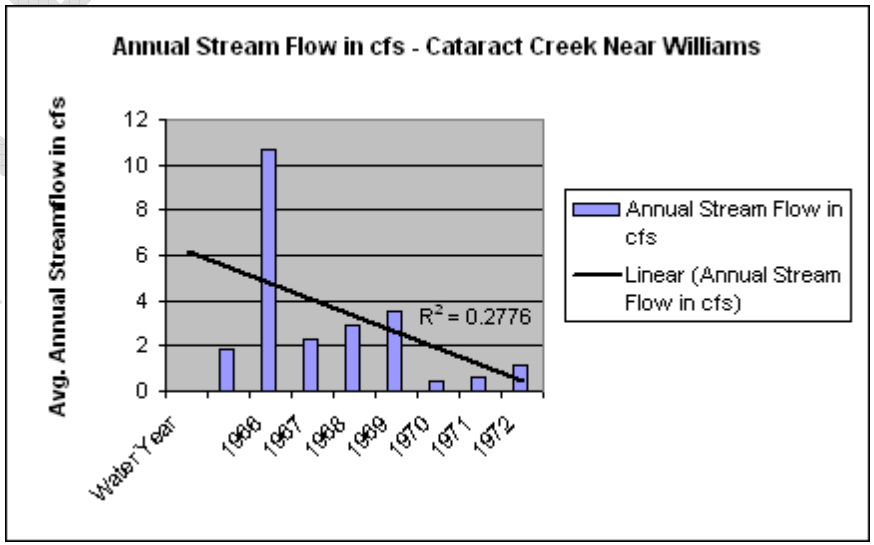
1987 123.6

Cataract Creek Near Williams, Havasu Creek 4th HUC

Latitude 35°18'54", Longitude 112°10'42" NAD27

Annual Stream Flow in cfs

Water Year	
	1.83
1966	10.7
1967	2.27
1968	2.93
1969	3.53
1970	0.474
1971	0.619
1972	1.16



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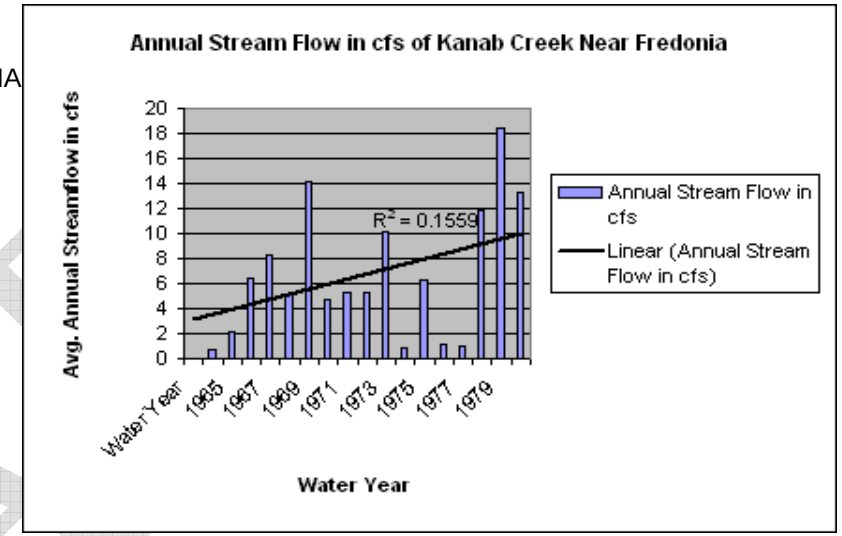
Kanab Creek Near Fredonia
Kanab Creek 4th HUC

Latitude 36°51'50", Longitude 112°34'45" NA

Water Year	Annual Stream Flow in cfs
	0.775
1965	2.2
1966	6.47
1967	8.27
1968	5.15
1969	14.1
1970	4.71
1971	5.35
1972	5.25
1973	10.1
1974	0.867



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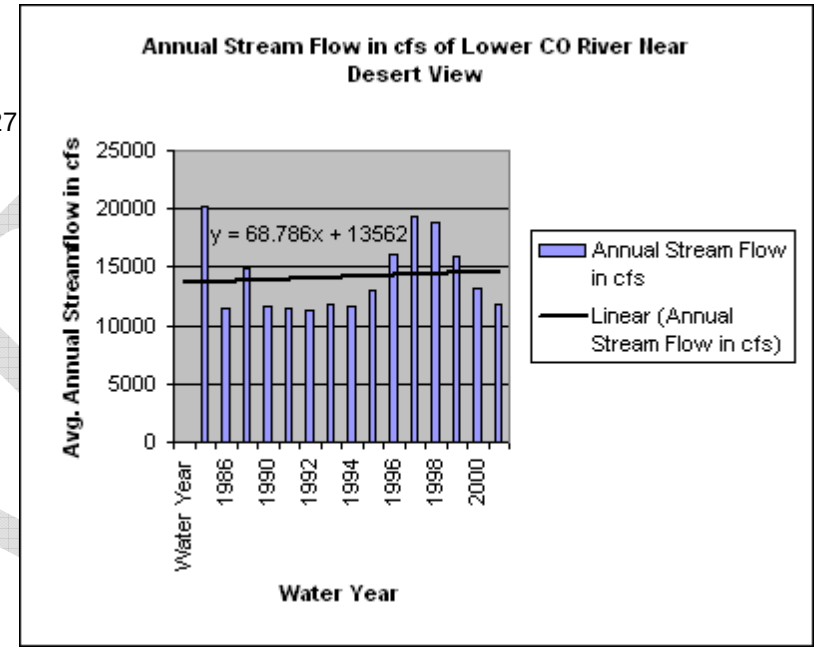
LCR Near Desert View
Lower Colorado River -
Marble Canyon 4th HUC

Latitude 36°12'08", Longitude 111°48'59" NAD27

Annual Stream Flow in cfs

Water Year	
1985	20,170
1986	11,490
1989	14,940
1990	11,710
1991	11,450
1992	11,290
1993	11,770
1994	11,620
1995	13,090
1996	16,180
1997	19,330
1998	18,860
1999	15,840
2000	13,240
2001	11,730



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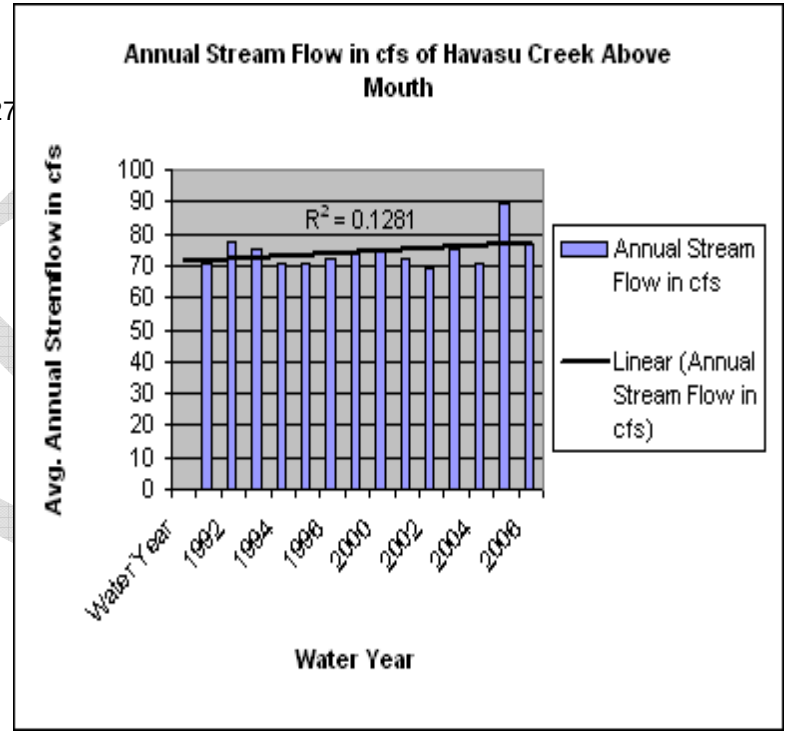
Havasu Creek above Mouth
Lower Colorado River of
Grand Canyon 4th HUC

Latitude 36°18'21", Longitude 112°45'38" NAD27

Annual Stream Flow in cfs

Water Year	
1991	71
1992	77.6
1993	75
1994	70.9
1995	71
1996	72.1
1997	73.7
2000	75.2
2001	72.1
2002	69.5
2003	75.1
2004	71



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