Probable Effects of Proposed Groundwater Pumping by Southern Nevada Water Authority in Cave, Dry Lake and Delamar Valleys, Nevada on Spring and Wetland-Dependent Biota.

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Myers (2007) concludes that the SNWA applications in Cave, Dry Lake, and Delamar valleys, if granted could ultimately dry up springs in Cave Valley and southern White River Valley, and reduce spring flows in Pahranagat Valley, at Panaca Hot Spring, and perhaps at the Muddy River springs. The reduced flow from Panaca Hot Spring would in turn result in reduced flow in Meadow Valley Wash. He estimates that springs in southern White River Valley are likely to experience a decline in flow of about 50% within 15 years. Most other effects will occur more gradually and may occur over a broader geographic area than defined above.

Obviously, when springs dry, species dependent on them disappear. Effects of diminished flow can also be profound, though sometimes more subtle. For example:

1. Thermal endemic aquatic species typically require a relatively narrow temperature regime to maintain healthy populations. Reduced flow causes water to cool more rapidly, thus reducing habitat suitable for maintenance of already severely restricted populations. For example, Moapa Dace reproduction occurs only below spring outflow in the headwaters of the Moapa River at temperatures of 30-32°C, and Moorman White River Springfish are restricted to springs in the southern portion of White River Valley that maintain temperatures of 33-37°C (Scoppetone et al. 1992, Scoppetone and Rissler 2002).

2. Fish, and other aquatic species, tend to adjust their maximum size to the habitat volume (Smith 1981), and reproductive output decreases exponentially as fish size decreases. Therefore reduction of habitat volume in isolated desert springs and streams reduces reproductive output. Longevity may also be reduced. If so, the decline in reproductive output will be magnified because each female will experience fewer reproductive seasons. For example, Scoppetone et al. (1992) found the largest, most fecund Moapa dace in the mainstem Moapa River. Tributary rheocrenes invariably contained dace of smaller average size. These fish, because of their smaller average size, also had a lower reproductive output.

3. Reduction in flow reduces opportunities for niche partitioning. This means that fewer species will be able to coexist. The effect is especially problematic with respect to introduced species. Therefore, native species may be able to coexist with introduced species in relatively large habitats, but become increasingly vulnerable to extinction as habitat size diminishes. For example, the population of Warm Springs Pupfish in the small South Indian Spring in Ash Meadows, Nevada disappeared following introduction of crayfish, yet the two species coexist in the larger Marsh, Scruggs, and Lovell Springs (Scoppetone, personal communication 2007).

4. Reduction in flow increases probability that the outflow channel below the spring source may become increasingly intermittent. This is especially damaging to biodiversity in areas where there are several spring heads with coalescing flows. As those flows become increasingly disconnected, habitats increasingly lose characteristics essential to completion of various aspects of complex lifecycles. The resulting habitat fragmentation is a major cause of extinction worldwide, and is known to already have had serious consequences for native fishes in areas likely to experience reduced spring discharge as a consequence of the proposed groundwater applications. For example, all five fish species native to White River Valley have declined in abundance over the past several decades as spring systems previously interconnected became progressively disconnected (Scoppetone et al. 2004, Scoppetone and Rissler 2002). White River Spinedace disappeared from 6 of 7 previously occupied habitats, White River Desert sucker from 4 of 6 habitats, White River Springfish from 2 of 6 habitats, Speckled dace from 2 of 20 habitats, and Moormon White River springfish became severely depleted in at least 1 of its 3 habitats.

The four mechanisms described above are the principal means by which diminished spring flow as a consequence of the proposed SNWA groundwater pumping in Cave, Dry Lake, and Delamar valleys will reduce or eliminate endemic spring dependent species. Species and the spring habitats that may be adversely affected should these applications be granted are listed in Table 1, along with each species' current status as indicated in the Nevada Natural Heritage Database. It is important to note that all fish species listed in table 1 from White River Valley, with the exception of the speckled dace, are protected under NRS 501. All fish species in Pahranagat Valley, including the speckled dace, are protected under NRS 501. In some cases Table 1 uses a group designator (such as amphipods or clams) in place of a species specific designator. This is in recognition of the fact that one or more members of the group identified are present in the spring, and there is a relatively high likelihood that, when carefully studied, many will prove to be undescribed endemic species. Such an eventuality has been well described for amphipods (Witt et al. 2006) and springsnails (Liu et al. 2003) living in isolated springs in the Great Basin. In fact, it is important to note that a previously unknown fish species (a sculpin) was discovered in Butterfield Springs in White River Valley in 1991 (Scoppetone et al. 2004). It is likely that this sculpin will prove to be an endemic species restricted to Butterfield Springs.

As groundwater levels and discharge from area springs decline, aerial extent and complexity of wetlands will be reduced, thereby reducing habitat available for wetland dependent species. While all wetland dependent species in the affected area will experience population declines, or even disappearance of some populations, those listed in Table 2 are of particular importance in consideration of the SNWA applications. These species are dependent on wetlands associated with Kirch Wildlife Management Area or the Pahranagat National Wildlife Refuge and have been specifically designated for protection by the state of Nevada. The Southwestern Willow Flycatcher is listed as an endangered species, and the Western Least Bittern, Western Yellow-billed Cuckoo, and Pahranagat Valley montane vole are listed as species of concern under the US Endangered Species Act.

Scorecard 2006 (NNHP 2006) identifies 69 highest priority conservation sites in Nevada. According to the state of Nevada, these are locations that currently require management and/or protection actions in order to conserve a significant assemblage of the at-risk species living at those specific locations. Myers (2007) report suggests that major adverse effects may occur at the following highest priority conservation sites: Moon River Spring, Camp Spring, Sunnyside/Kirch WMA, Hiko Spring, Crystal Springs, Ash Springs/Pahranagat River, and Pahranagat NWR (7 of the highest priority sites). Lesser but noticeable adverse effects may occur at Lake Valley Springs, Big Jack Ranch, Condor Canyon, and Moapa NWR/Warm Springs (4 of the highest priority sites).

Because applications by SNWA for groundwater rights in Cave, Dry Lake, and Delamar Valleys represent only a portion of a larger, integrated groundwater development project, probable effects of these applications cannot honestly or adequately be evaluated separately from the entire project. It is important to recognize that the full SNWA groundwater development project includes groundwater rights already granted for Three Lakes Valley north and south, Tickaboo Valley north and south, California Wash, and Spring Valley (~58,000 acre-feet per year). It also includes pending applications in Cave, Dry Lake, Delamar, Snake, and Railroad Valley north and south (~218,000 acre-feet per year). The general outlines of the full groundwater development project have been described by SNWA, and the general consequences for the regional groundwater system have been evaluated by Schaeffer and Harrill (1995). Based on Schaeffer and Harrill's (1995) evaluation, Deacon et al. (2007) estimated probable consequences to regional biodiversity. That evaluation suggests that cumulative effects of the SNWA groundwater project are likely to adversely influence at least 157 endemic wetland species, 20 of them listed as endangered or threatened under the US Endangered Species Act. The Deacon et al. (2007) publication along with the appendix listing wetland dependent species likely to be affected is appended here.

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Table 1. Native spring-dependent aquatic species susceptible to adverse impacts from decreased spring flow as a consequence of proposed SNWA groundwater pumping from Cave, Dry Lake and Delamar Valleys.
State rank, global rank, and ESA designators are as assigned by the Nevada Natural Heritage Database. S1 = critically imperiled and especially vulnerable to extinction within the state of Nevada. S2 = imperiled within the state of Nevada due to rarity or other demonstrable factors. S3 = vulnerable to decline within the state of Nevada the species is rare and and has a very restricted range. G1 = species is critically imperiled and especially vulnerable to extinction throughout the world. G2 = species is imperiled throughout the world due to rarity or other demonstrable factors. G3 vulnerable to decline throughout the world because the species is rare with a very restricted range. G4 = species is of long-term concern throughout the world, though now apparently secure, but rare in parts of its range, especially at its periphery. G5 = species is demonstrably secure, widespread, and abundant throughout its natural range. T1 = Nevada subspecies is critically imperiled throughout its range. T2 = Nevada subspecies is imperiled throughout its range due to rarity or other demonstrable factors. T3 = Nevada subspecies is vulnerable throughout its range due to restricted distribution. Q = taxonomic status uncertain. LE = listed endangered under the US Endangered Species Act. xC2 = listed as species of concern under the US Endangered Species Act. *= protected under NRS 501.

Basin	Location	Species	Common Name	State Rank	Global Rank	ESA
Cave	Parker Station Springs	*Pyrgulopsis marcida*	Hardy pyrg	S1	G1	
			pulmonates			
			clams			
			amphipods			
Dry Lake	Meloy Spring	*P. breviloba*	Flag pyrg	S1	G1	
Lake	Wambolt Springs	*P. sublata*	Lake Valley pyrg			
			clams			
			amphipods			
White River	Ruppos Bog hole	*P. marcida*	Hardy pyrg	S1	G1	
		Rhinichthys osculus ssp.	White River speckled dace	S2S3	G5T2T3Q	xC2
			pulmonates			
			amphipods			
	Hardy Spring	*P. marcida*	Hardy pyrg	S1	G1	
		Rhinichthys osculus ssp.	White River speckled dace	S2S3	G5T2T3Q	xC2
			amphipods			
	Emigrant Springs	*P. marcida*	Hardy pyrg	S1	G1	
		P. gracilis	Emigrant pyrg	S1	G1	
		P. sathos	White River Valley pyrg	S1	G1	
		Rhinichthys osculus ssp.	White River speckled dace	S2S3	G5T2T3Q	xC2
			amphipods			
			clams			
	Moorman Spring	*P. merriami*	Pahranagat pebblesnail	S1	G1	
		T. clathrata	grated tryonia	S2	G2	
		Crenichthys baileyi thermophilus	Moorman White River springfish	S1*	G2T1	xC2
			pulmonates			
			amphipods			
	Silver Springs	*P. marcida*	Hardy pyrg	S1	G1	
			amphipods			
	Butterfield Spring	*P. marcida*	Hardy pyrg	S1	G1	
		P. lata	Butterfield pyrg	S1	G1	
		Rhinichthys osculus ssp.	White River speckled dace	S2S3	G5T2T3Q	xC2
		Cottus sp.	White River mottled sculpin	S1	G1	

			amphipods			
	Flag Spring	*P. breviloba*	Flag pyrg	S1	G1	
		P. sathos	White River Valley pyrg	S1	G1	
		Lepidomeda albivallis	White River spinedace	S1*	G1	LE
		Rhinichtyhys osculus ssp.	White River speckled dace	S2S3	G5T2T3Q	xC2
		Catostomus clarki intermedius	White River desert sucker	S1S2*	G3G4T1T2Q	xC2
	Hot Creek Spring	*P. merriami*	Pahranagat pebblesnail	S1	G1	
		T. clathrata	grated tryonia	S2	G2	
		C.baileyi thermophilus	Moorman White River springfish	S1*	G2T1	xC2
			amphipods			
	Moon River Spring	*P. merriami*	Pahranagat pebblesnail	S1	G1	
		Crenichthys baileyi thermophilus	Moorman White River springfish	S1*	G2T1	xC2
	Camp Spring	*P. sathos*	White River Valley pyrg	S1	G1	
		Rhinichthys osculus ssp.	White River speckled dace	S2S3	G5T2T3Q	xC2
Pahranagat	Hiko Spring	*P. hubbsi*	Hubbs pyrg	S1	G1	
		Crenichthys baileyi grandis	Hiko White River springfish	S1*	G2T1	LE
	Crystal Spring	*P. hubbsi*	Hubbs pyrg	S1	G1	
		Crenichtyis baileyi grandis	Hiko White River springfish	S1*	G2T1	LE
		Rhinichthys osculus velifer	Pahranagat speckled dace	S1*	G5T1Q	xC2
			amphipods			
	Ash Spring	*P. merriami*	Pahranagat pebblesnail	S1	G1	
		T. clathrata	grated tryonia	S2	G2	
		Crenichthys baileyi baileyi	White River springfish	S1*	G2T1	LE
		Stenelmis lariversi	Ash Springs riffle beetle	S1	G1	
		Pelocoris biimpressus shoshone				
		Microcylloepus moapus fraxinus				
			amphipods			
	Pahranagat Creek	*Gila robusta jordani*	Pahranagat roundtail chub	S1*	G3T1	LE
		Rhinichthys osculus velifer	Pahranagat speckled dace	S1*	G5T1Q	xC2
	Cottonwood Springs North	*Rhinichthys osculus velifer*	Pahranagat speckled dace	S1*	G5T1Q	xC2
	L Springs	*Rhinichthys osculus velifer*	Pahranagat speckled dace	S1*	G5T1Q	xC2

Table 2. Native wetland-dependent terrestrial species susceptible to adverse impacts from the reduced wetland area, complexity, and diversity resulting from the proposed SNWA groundwater pumping in Cave, Dry Lake and Delamar Valleys.
State rank, global rank, and ESA designators are as assigned by the Nevada Natural Heritage Database. S1 = critically imperiled and especially vulnerable to extinction within the state of Nevada. S2 = imperiled within the state of Nevada due to rarity or other demonstrable factors. S3 = vulnerable to decline within the state of Nevada the species is rare and and has a very restricted range. G4 = species is of long-term concern throughout the world, though now apparently secure, but rare in parts of its range, especially at its periphery. G5 = species is demonstrably secure, widespread, and abundant throughout its natural range. T1 = Nevada subspecies is critically imperiled throughout its range. T2 = Nevada subspecies is imperiled throughout its range due to rarity or other demonstrable factors. T3 = Nevada subspecies is vulnerable throughout its range due to restricted distribution. T4 = Nevada subspecies is of long-term concern, though now apparently secure, but rare in parts of its range. B = breeds in Nevada. Q = taxonomic status uncertain. LE = listed endangered under the US Endangered Species Act. xC2 = listed as species of concern under the US Endangered Species Act. C = listed as a candidate species under the US Endangered Species Act. *= protected under NRS 501.

Location	Species	Common Name	State Rank	Global Rank	ESA
	Birds				
Kirch WMA	*Charadrius alexandrinus nivosus*	Western Snowy Plover	S3B*	G4T3	
	Ixobrychus exilis hesperis	Western Least Bittern	S2B*	G5T3T4	xC2
Pahranagat NWR	*Coccyzus americanus occidentalis*	Western Yellow-billed Cuckoo	S1B*	G5T3Q	C
	Empidonax traillii extimus	Southwestern Willow Flycatcher	S1B*	G5T1T2	LE
	Phainopepla nitens	Phainopepla	S2B*	G5	
	Mammals				
	Microtus montanus fucosus	Pahranagat Valley montane vole	S2*	G5T2	xC2