Feasibility of Rejuvenating the West-Side Springs of the Rush Creek Bottomlands, Mono County, California

This report addresses the feasibility of rewatering the springs on the west side of the Rush Creek bottomlands. Former California Fish and Game biologist Elden Vestal has stressed the positive contribution that these springs made to the historical Rush Creek fishery. This has led to an interest in rejuvenating the springs to a level that would be of direct benefit to fish (that is, to a level of flow that would permit fish from Rush Creek to enter, forage in, and rear in, the spring-fed rills). We have studied, and are in a position to report on, the history, stratigraphy, and hydrology of the springs. We also feel that we are in a position to recommend certain measures that could markedly increase springflow into the west side of the Rush Creek bottomlands. The most important of these involves rewatering the natural distributaries that head high on the alluvial fans of Parker and Walker creeks. Prior to 1948, these channels conveyed "withering streams" that lost water to the highly permeable gravels, cobbles, and boulders of the fan apices. We believe that the single most influential factor in the near-extinguishment of the springs on the west side of the bottomlands was not the cessation of irrigation (in fact, large amounts of water continued to be spread for irrigation throughout the last several decades, during which time flows from the springs remained meager), but rather the artificial closure of the withering distributaries.

Within the next 7 weeks the State Water Resources Control Board will produce an order that will dictate the future flow regimes of Parker and Walker creeks. Depending on its details, the order could have a profound impact on springflow in the bottomlands. While no one can predict these details, one management option (indeed, one option suggested by the Los Angeles Department of Water and Power) is to cease diversion of Parker and Walker creeks. This would result in all of the water from these two streams flowing over- and underground toward Rush Creek and Mono Lake. If this comes to pass, it would be highly advisable to rewater the distributaries on the Parker and Walker creek fans, not only because it would likely contribute to spring flows in the Rush Creek bottomlands, but because directing all runoff down a single channel (a condition that did not exist naturally) would result in higher-than-natural peak flows, and a high likelihood of channel damage.

With the overall management plan for Parker and Walker creeks (and thus springflow in the bottomlands) likely to be changed in one way or another in the coming weeks, it seems advisable to wait for the Water Board's order before moving forward on springs rejuvenation. In fact, the very nature of the task is likely to be altered by the Board's order. Only after it is issued will we have a clear idea of how much the springs will need to be augmented, if at all. For that reason, this report should be considered a preliminary document. If necessary, a supplement will be produced after the Water Board issues its order.

In what follows we provide a summary of the geology, hydrology, and history of the springs, and we outline a course of action that, based on our present understanding, should be taken to rejuvenate the springs. Finally, we outline some implications of spring rejuvenation for fishery flows on Parker and Walker creeks.

Geology, Hydrology, and History of the West-Side Springs

Between ~30,000 and ~10,000 years ago (the late-glacial period), Mono Lake occupied elevations of between ~6700 feet and 7170 feet, far higher than the levels of the past 10,000 years (i.e. the Holocene, during which the lake has fluctuated between elevations of ~6368 feet and 6499 feet). During the late glacial, fine sediment (mainly glacial silt) was deposited on the lake bottom. When the lake rose to its highest levels, the lake-bottom silt was deposited to elevations approaching 7000 feet; when the lake declined from these highest stands to the more moderate or low levels, the highest-elevation deposits of silt were covered with beach sand and/or stream gravel. Late-glacial fluctuations of the lake thus produced an alternating sequence of coarse and fine sediments that today encircles Mono Lake. This sequence is illustrated in Figure 1 below.

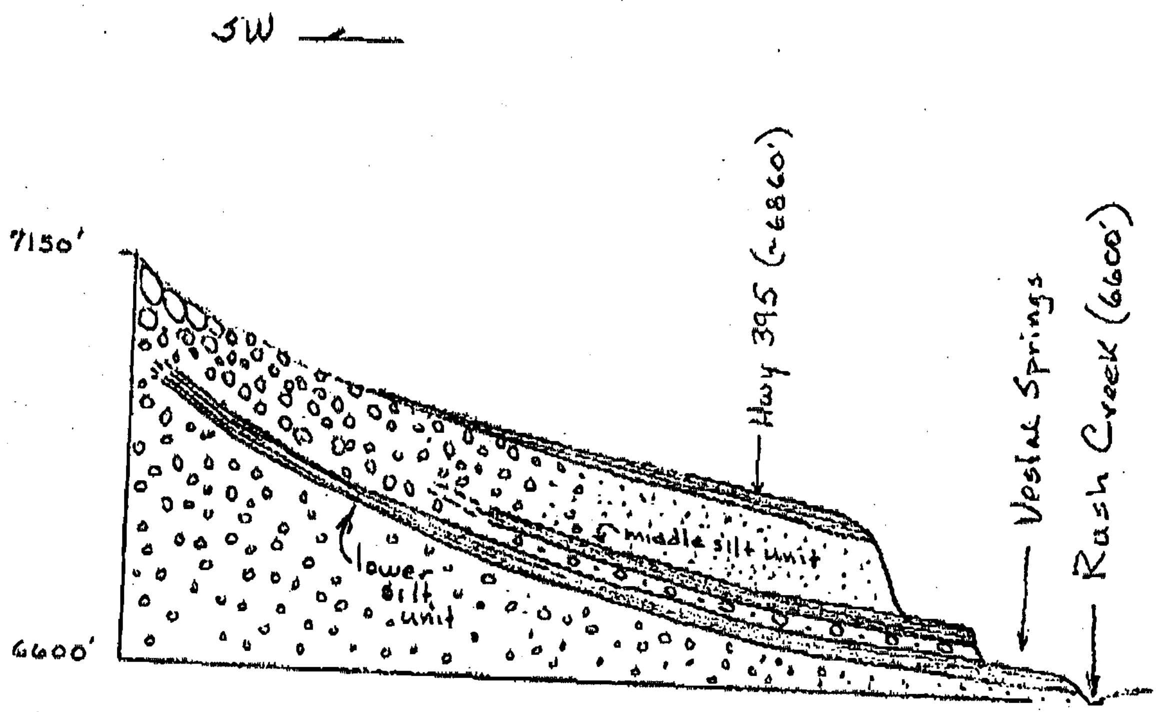

Figure 1. Schematic diagram of the Parker/Walker lands between the DWP diversion ponds (elevation ~7150 feet) and Rush Creek immediately below the narrows (elevation ~6600 feet). Not drawn to scale.

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This sedimentary sequence is important in understanding the west-side springs of the Rush Creek bottomlands because it determines the points of spring discharge, as well as the areas of spring recharge. Discharge along the west side of the bottomlands occurs in association with two of the silt units that act as aquitards (Figure 1). The lowest of these constitutes the zone of greatest spring discharge. Springs emanate from immediately above this lowest aquitard along a stretch of Rush Creek that extends from Parker Creek at the upstream end, to immediately below the narrows on the downstream end. It was on this lowest unit, immediately below the narrows on the west side of Rush Creek, where Vestal observed trout rearing and feeding in the extensive system of rills. Hereafter this rilled, lower tier of springs immediately below the narrows is referred to as "Vestal Springs".

Recharge of the west-side springs occurred on the alluvial fans of Walker and Parker creeks, where the streams crossed the fan sediments. The sedimentary composition of the fans dictated the areas of greatest permeability. The surface sediments are coarsest (dominated by gravels and boulders), and thus most permeable, near the fan heads. They become finer (and thus less permeable) toward lower elevations. The finest (therefore least permeable) sediments on the fans are found blanketing its surface at elevations below approximately 7000 feet (see Figure 1). These are the lake-bottom silts that were deposited on the fan during the last of the particularly high stands of Mono Lake, approximately 13,000 years ago.

Under natural conditions, Parker and Walker creeks crossed their fans in multiple distributaries. Early on in the Holocene, these distributaries incised below the uppermost unit of lake-bottom silt. The uppermost silt unit thus does not impede infiltration of water from the distributaries.

By late in the 19th century water was being diverted from the distributaries and spread across the fans in a series of irrigation ditches. By far the greatest lineal footage of ditch occurs below an elevation of 7000 feet. The ditches are shallow, and therefore do not penetrate the uppermost silt unit on the fans. Indeed, it was the relative impermeability of the fans below ~7000 feet that made them a desirable area for irrigated pasture.

Because of the differences in permeability, certain areas of the fan surfaces were more important than others in the natural recharge of springs. Maximum recharge was likely found on the fan apices, at elevations of between ~7150 feet (the elevation at which Parker and Walker creeks debouch from their morainal canyons and bifurcate into distributaries) and ~6900 feet (the very approximate elevation at which boulders and cobbles become rare in the floors of the distributaries). At lower elevations the distributaries likely lost less water to the ground, not because of the blanket of lake-bottom silts (the distributaries had cut through this blanket, rendering it irrelevant to distributary infiltration) but because of the general fining of fan sediments in the downslope direction.

The advent of irrigation altered the recharge of the springs, though the change was likely minor. Flow remained in the distributaries, and so recharge continued. Most of the water that was diverted from the natural channels was spread through shallow ditches over the lake silts, contributing relatively little to the springs of the bottomlands.

Under natural conditions the total amount of water available on the Parker and Walker creek lands averaged the equivalent of approximately 25 cfs. (This includes the surface and sub-surface flows on Walker, Parker, South Parker, East Parker, Sawmill, and Bohler creeks, as well as precipitation on the fans.) Early this century water was added to the fans from beyond the watershed, first from the Farrington diversion off Lee Vining Creek, and later from Rush Creek (by way of C-ditch). The C-ditch diversion added an average of approximately 6 cfs to the Parker and Walker watershed, though much of the water was spread low on the fans, and so likely contributed little to spring recharge. The C-ditch diversion ceased when the DWP began to build new Grant Dam in 1935, and so is irrelevant to all of Vestal's springs observations, which began in the late 1930s. The Farrington diversion began in the late 19th century, and contributed the equivalent of perhaps 1 cfs per year to the Walker/Parker watershed. As with the C-ditch diversion, the contribution to the springs was minor at most.

Flow measurements on the springs themselves are lacking, though it is possible, using the Rush Creek records, to deduce the overall spring discharge that occurred between Parker Creek and "the ford" (the upper road crossing on Rush Creek, low in the bottomlands). (This overall discharge includes the contribution of both the east-side and west-side springs.) As detailed elsewhere (Stine, 1991, 1992), spring contribution between 1930 and 1934 amounted to roughly 7 cfs between Parker Creek and the narrows, and increased to an average of roughly 32 cfs at the ford. (Total springflow ranged from ~18 cfs to ~52 cfs, with the bulk of the variation likely a result of fluctuations in the east-side contribution.) According to Vestal, "conservatively half" of the average-level springflow issued from the west-side springs. In estimating the spring discharge that occurred in the west-side springs immediately below the narrows (the focus of the springs-rejuvenation effort), we have assumed that approximately half of the average spring contribution (thus, 32/2 = 16 cfs) emanated from the west side; that all but approximately 4 cfs of this average west-side total (16 - 4 = 12 cfs) issued from the springs immediately below the narrows; and that the bulk of this (8-10) issued from Vestal Springs).

The Department of Water and Power began diverting the Mono Basin streams in November of 1940, though for the next 7 years they took relatively little water--and most of the time no water from Parker or Walker creeks. With the exception of a few months, these two streams continued to flow as they had during the previous decades. Full-scale diversion of Parker and Walker creeks, and cessation (or near-cessation) of irrigation on the Parker/Walker lands, began in 1948. It was this change that led to the diminution, and in short order the demise, of the springs. According to Vestal, the minimum flow in Rush Creek at the ford (and thus the maximum possible spring contribution) had declined from 24 cfs in 1927 to 12 cfs by 1948, and to just 2 cfs by 1950 and '51.

In 1952 the DWP resumed irrigation of the Parker/Walker lands, though from that year through the early 1990s the natural distributaries were not used in the spreading system. Water was dispersed almost solely through the shallow ditches, minimizing the amount of infiltration losses, and thus the amount of spring recharge. Despite the resumption of irrigation in 1952, then, flow from the west-side springs never rebounded to anything approximating its pre-1948 level.

When we began doing field work in the Mono Basin in 1980, flow from the west-side springs was negligible, though the lands at Vestal Springs were saturated. Over the next dozen years, the only known change at this site was noted during an RTC field visit in the fall of 1992, when Stine, as well as Mr. G. Smith of Cal Fish and Game and Mr. J. Cain of the Mono Lake Committee, observed that saturated ground around Vestal Springs had widened, and that the flow from individual orifices had increased. A flow increase the prior year was observed at the west-side springs immediately downstream of Parker Creek by employees of Marzano Sand and Gravel. These flow increases were noted shortly after the court-ordered fishery restoration on Parker and Walker creeks, and the resultant rewatering of the main channel on each of the fans.

The positive relationships noted above (the decrease in spring flow coinciding with the dewatering of the natural channels of the Parker and Walker creek fans, and the increase in spring flow following the rewatering of the natural channels of the fans), and the negative relationship noted above (the failure of the springs to rebound despite the resumption of Parker- and Walker-land irrigation beginning in 1952), together with the antiquity of the spring system (> 600 years) and the above-noted spatial relationships between distributaries, ditches, and fan permeability, lead us to the following conclusions:

• Recharge of the west-side springs occurs largely along the upper reaches of the natural distributaries, where coarse sediments favor infiltration. Recharge is likely less, though is still appreciable, along the middle reaches of the distributaries, where the channel-bottoms are composed of coarse sands. Below some elevation on the fans (perhaps ~6800 feet) infiltration of the distributary water reaches only the middle silt unit, and contributes little to the west-side springs. On the matter of the geography of recharge, therefore, we conclude that rewatering the distributaries beginning at their heads high on the fans will provide the most benefit to a spring-rejuvenation effort.

• Most of the irrigation on Parker and Walker creeks had little affect on the west-side springs. Only above an elevation of ~7000 feet, where the fans are characterized by relatively coarse sediments and lack a blanket of lake-bottom silts, are irrigation ditches likely to have contributed appreciably to spring recharge. Concerning the contribution of the irrigation system to the west-side springs, therefore, we conclude that spring rejuvenation can be accomplished without watering irrigation canals, though higher springflows might be achieved by diverting a portion of the Parker and Walker creek flows into the ditches (particularly the "laterals") that lie above an elevation of ~7000 feet.

• Water imported from Lee Vining and Rush creeks (by way of Farrington diversion and C-ditch) contributed little to springflows observed by Vestal. On the matter of interbasin diversions, therefore, we conclude that rejuvenation of the west-side springs will not require import from beyond the Parker/Walker/Bohler/Sawmill watershed.

Course of Action

Premises. In delineating a course of action for rejuvenating the west-side springs of the Rush Creek bottomlands, we build on these two fundamental premises:

- Prior to 1948, elements of the Parker and Walker creek systems supported the west-side springs of the Rush Creek bottomlands at a level that was of direct benefit to trout. Restoration of these same elements of the Parker and Walker systems will restore similar flows to the springs.

- While any increase in spring flow provides at least an indirect benefit to the Rush Creek fishery (by helping to stabilize stream temperatures and by increasing conductivity), a direct benefit accrues when fish are able to swim from Rush Creek into Vestal Springs. Rejuvenation of Vestal Springs to such a level should therefore be the focus of the rejuvenation effort.

Required modifications to the present-day system. From the information provided above it is clear that any effort to restore the essential pre-1948 elements of the spring-recharge system must involve rewatering the distributary channels at the heads of the alluvial fans on Parker and Walker creeks. In response to an order by the El Dorado County Superior Court, the main distributary on Parker Creek, and the main distributary on Walker Creek, were rewatered late in 1991. Rewatering the other distributaries would entail removing portions, or all, of the Parker and Walker creek diversion apparatus. Presently the dams that impound the diversion ponds prevent water from reaching some of the distributaries. These dams should be removed, or bypassed. Other distributaries are blocked by the spoils that were generated in excavating the diversion ponds. These blockages, too, would have to be removed. It seems likely, though we cannot say with surety, that the diversion ponds themselves are lined with clay to prevent percolation. To the extent that this is true, the lining should be removed so that infiltration can be maximized.

The importance of monitoring the system response. While the spring recharge-discharge system is, by natural system standards, relatively simple, the intricacies of the responses are difficult to predict. It is impossible to say, for example, that placing quantity of water $Q_{1.3}$ at Point X on the Parker Creek fan, plus placing quantity of water $Q_{2.6}$ at Point Y on the Walker Creek fan, will result in a discharge of quantity of water $Q_{3.4}$ at Vestal Springs. The springs-rejuvenation effort will need to proceed as an experiment in which responses over time are observed and noted, and adjustments are made accordingly. It is therefore essential that the effort be undertaken in a methodical order that permits the system response to monitored. We suggest the following order:

1. Establish a spring monitoring network. First and foremost, a means of monitoring the springs must be set up in the very near future (within the next several weeks, if possible) so that quantitative observations can begin. We feel strongly that this monitoring system should be in place before the Water Board issues its order, so that any changes that result from the order, and/or any seasonal changes that occur through the summer and fall, can be recorded. This data will constitute the baseline for future flow comparisons. We suggest that the monitoring system consist of small weirs or other suitable measuring devices, placed in rills at Vestal Springs; a somewhat larger weir placed in the channel that drains the spring immediately downstream of the present-day Marzano operation; and a still larger weir placed in the spring-fed rill that feeds Channel 7 in the bottomlands of Rush Creek (see Feasibility Report No. 5, "Feasibility of Rewatering Abandoned Channels in the Rush Creek Bottomlands"). We also suggest that at least qualitative observations be made at formalized stations located near the mouths of both Parker and Walker creeks, where scientists in the 1930s and '40s reported spring activity. To derive the most benefit from this effort, all of these sites should be monitored, and the observed flows recorded, weekly to semi-weekly.

2. Rewater one of the two stream systems. Initially, all distributary channels should be rewatered on only one of the two streams (that is, either on Parker or Walker Creek). Water should be distributed amongst the channels in such a way as to maximize water loss to the ground. Limiting the rewatering to just one of the two streams will provide a basis for isolating spring response to that one stream system. This initial rewatering will also provide an opportunity to derive the transit time of the underground flow. (Anecdotal evidence on transit time presently exists. According to employees of Marzano Sand and Gravel, springs at the Marzano quarry increased markedly approximately 6 months following the rewatering of the main channels on Parker and Walker creeks in 1990.)

3. Rewater the distributaries of the second stream system. After allowing sufficient time for the springs to respond to the rewatering of the first stream system, the distributaries of the second stream should be rewatered, and the response of the springs recorded.

4. Manipulate flow on the fans to maximize water loss to the ground. Throughout this initial rewatering stage of the springs-rejuvenation effort, every attempt should be made to maximize water loss to the ground. Ideally, except for any surface flows that are considered essential to the Parker and Walker creek fisheries (see below), all runoff on the two streams would be underground before reaching Highway 395. This may require diligent trial-and-error adjustments to the distribution of water on the fans.

5. *Determine, and then manage for, the ideal discharge at Vestal Springs.* The precise amount of flow that issued from Vestal Springs in the 1930s and early '40s is not known, though there can be little question that the amount was sufficient to directly benefit trout. As outlined above, we consider 8 to 12 cfs to be a reasonable estimate of the flows that issued from these springs over a normal year. Even 8 cfs would fill all rills of Vestal's springs area, and provide an unbroken surface-water connection to Rush Creek. As the rejuvenation effort progresses, and data from Vestal Springs accumulates, some ideal (and/or minimum beneficial) flow will become evident, and the recharge system can be managed with that flow as the goal.

6. *Redefine, to the extent necessary, the channel that linked Vestal Springs to Rush Creek.* While the rills at Vestal Springs remain intact, the channel that conveyed the spring water to Rush Creek appears to have been filled over time. (The position of the channel is still evident, but channel depth has decreased due to accumulation of sand and peat.) As the total flow from Vestal Springs increases, and the path and volume of flow toward Rush Creek becomes evident, it may be necessary to appropriately redefine this channel.

Implications for the Fisheries on Parker and Walker Creeks

We consider it highly unlikely that the springs can be restored to their pre-1948 level if the interim fish flows set in 1990 (4.5 cfs in winter, and 6 cfs in summer on Walker Creek; 6 cfs in winter, and 9 cfs in summer on Parker Creek) remain in the streams.[1] Maximizing spring flows in the bottomlands necessarily means maximizing percolation on the Parker and Walker creek fans, thus minimizing surface flows in the lower reaches of the distributary channels. Management of the Parker/Walker system to provide springs in the bottomlands as well as fisheries in the streams will require a

[1] This assumes no importation of water. It would be possible to have both interim-level flows in the streams, as well as full recharge of the west-side springs, if water was imported to the Parker and Walker creek fans from Lee Vining Creek. We consider an examination of such possibilities to be beyond the scope of this report.

balancing on the part of the RTC or some other appropriate body. While the full range of realistic management combinations will only become clear as the spring-rejuvenation effort progresses, we consider the following to be reasonable and likely elements of future management scenarios:

- In normal, and perhaps even dry years, it will be possible to provide recharge to the springs while still maintaining a minimum (fall and winter) flow of 1-2 cfs in the main distributary on Parker Creek, and in the main distributary on Walker Creek. (These are similar to the minimum flows that have characterized Parker and Walker creeks during the past several drought years.)

- With water in several distributaries on each of the fans, it may be possible to maintain a fishery in at least the upper portions of these channels.

- Flushing of the main channels will occur during peak runoff periods in those years when stream discharge exceeds the the ability of the fans to absorb all the flow.