Final report:

Fiock Pump

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Great Northern Corp.

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ABSTRACT

Both an "off the shelf" self-cleaning screen, and later a rock infiltration gallery were used with an electric pump to replace a gravity diversion dam on the Shasta River, Siskiyou County, California to improve water quality and fish passage for anadromous salmonids. Grant funding paid for both power costs and hardware purchase. The self-cleaning screen failed to clean itself satisfactorily, and the gallery failed due to congestion with fine particles. Efforts are now underway to replace both systems with a conventional brush-cleaned flat plate screen.

INTRODUCTION

The Fiock Pump project was undertaken as a replacement for a flashboard irrigation diversion dam used on the Shasta River since 1889 by the Fiock family. They customarily installed flashboards seasonally to raise the surface elevation of the water in order to divert it into their irrigation ditch. The diversion structure and shallow pond created upstream of it constrained anadromous fish passage and impaired water quality. This grant was intended to replace that dam with a lift pump for 4 years, and also pay the costs of operating that pump.

DESCRIPTION OF STUDY AREA

The Shasta River located in Siskiyou County, California flows out of the Mount Eddy and Mount Shasta areas northward into the Klamath River approximately twenty miles south of the Oregon border. Basin area is approximately 800 square miles and mean annual unimpaired runoff is approximately 162,300 acre-feet. Key features of the Shasta River include significant spring flow in the upper reaches, increased water development in the middle reaches, river inflows and outflows of variable quantity and temperature, and various states of riparian vegetation throughout the system. Elevated water temperature and reduced dissolved oxygen levels have placed Shasta River on the 303 (d) list of impaired waterbodies. Anadromous fish using the system include fall chinook salmon (Onchorynchus tshawytscha), coho salmon (Onchorynchus kisutch), and steelhead trout (Onchorynchus mykiss).

METHODS AND MATERIALS

The initial installation utilized consisted of a 10 hp low lift pump with a capacity of 1200 gpm, connected to a flexible suction line and a Lakos-Plum Creek style self-cleaning screen Model TB 1500 with an internal rotating backwash arm. The pump discharged directly into the original ditch customarily used to transport irrigation water when the dam was utilized. The water then flowed down that ditch to the point of use. The system also included a 3-hp pressure pump to supply pressurized water to the backwash system on the screen via a flexible 1.5-inch hose. A cable and arm assembly could raise the entire screen out of the water for additional cleaning, observation or maintenance. After several years of struggling unsuccessfully to keep this system meeting the Fiock's irrigation needs (essentially 7 days per week, 24 hours per day), it was abandoned in favor of a rock and gravel infiltration gallery.

The infiltration gallery was constructed during the low flow period in 1998 along an outside bend of approximately 50-ft. of streambank to supply water to the same 10 hp electric pump used previously. The pump utilized an 8-in. diameter steel suction line and foot valve welded to 1/2 in. steel plate sitting on top of a 6 ft. diameter, 12 ft. long vertical corrugated steel culvert. Attached to the bottom of the vertical culvert were two 24-in. diameter, 20-ft. long horizontal culverts radiating up and down stream parallel to the river's edge. All the culverts were perforated below the water line and surrounded by a porous matrix of rocks, which included a barrier of 3/4-in. leach line rock to exclude juvenile fish. The entire apparatus sat back about 12 feet from the edge of the river, and was fronted by a line of large (3-4 foot diameter) rocks.

RESULTS AND DISCUSSION

The initial pump installation was intended to be temporary, with a permanent installation to be designed and built later. The permanent system would have to be designed to mesh with a modern flashboard dam structure that the Fiocks intended to build with design and financial assistance from the Natural Resources Conservation Service. That new dam structure could then be used if funding were discontinued for the operation of the lift pump we were providing.

Multiple efforts were made by NRCS staff to gather the site information needed to create a suitable design; fortunately that process drew out over several years, until a change of personnel within NRCS resulted in an internal re-evaluation of the likelihood of successfully designing a dam in a river with ESA listed salmon, and the project was dropped. At that point we could consider designing a stand-alone system without needing to interface with a possible dam structure.

Since the initial pump installation was intended to be temporary, and not expected to need to function for more than 1-2 years, it was installed on a side channel where installation was relatively easy and cheap, rather than in the main channel where water would be more readily available, particularly in low water years. As the years dragged on, that decision proved to be increasingly faulty. Over time the side channel filled in with gravel from upstream, and had to be re-opened each year as the water dropped. Each year more gravel moved into the area, increasing the magnitude of the work required to re-open the channel.

In addition, the screen was not oriented parallel to the flow, and as a result filamentous algae tended to wrap it on the upstream side, and the backwash system was unable to lift it sufficiently for it to wash away. Periodically the screen would be sufficiently blocked to cause the pump to cavitate and loose prime. Slight changes in the side channel over time made this problem get increasingly worse.

Had this been a single year installation as intended, the ongoing attention required would have been tolerable. Unfortunately, as the years went by the problems grew worse, and the Fiocks began to suffer economic losses due to insufficient water for their crops, and we eventually reached a point where the Fiocks no longer had any confidence that a self cleaning screen of this design could met their needs. We were faced with the need to devise an entirely new system that would work well enough that its ongoing maintenance could be transferred to the Fiocks.

At that point, in the summer of 1998, a local pump contractor convinced the Fiocks that an infiltration gallery could work well for them, so we embarked on that path. During construction, substantial unexpected problems arose when we discovered that there was a layer of saturated very fine sand several feet below the water level, and that sand layer flowed out into the excavation area continuously as we dug. The banks of the excavation would then become undermined and cave in. That caved in material could be removed, but the process would then repeat. Eventually we had to greatly oversize the excavation, line its perimeter with rocks, and try to muck out its center with the excavator bucket. That mucking out process proved virtually impossible to accomplish completely.

The infiltration gallery failed to provide a sufficient amount of water immediately post construction; the probable cause was presumed to be that the fine sand brought into suspension during construction was congesting the interstitial spaces of the rock matrix. The matrix was removed, cleaned and rebuilt, after which the system functioned adequately to meet the demand generated by the design pump and a portable test pump capable of drawing an additional 2000 gallons per minute.

The project functioned adequately for the remainder of the 1998 irrigation season, a period of approximately 5 weeks, and into the beginning of the 1999 season while stream level remained relatively high. However as the stream level dropped, the infiltration gallery eventually failed to meet the demand, causing the pump to suck air and loose prime.

At that point our only option was to immediately install the old self-cleaning screen, and pump through it while we examined our options. We did that adjacent to the infiltration gallery site, where we could install the screen in the main channel, and it would be properly oriented to the flow to facilitate self-cleaning. Despite those improvements, the screen continued to be unable to successfully shed the filamentous algae, and required excessively frequent attention to keep up with irrigation demand.

As the irrigation season drew to an end, we began construction of a partially pre-fabricated concrete vault to serve as the housing for a conventional flat plate screen to be cleaned with brush wipers. That apparatus is located in the area of the rock matrix of the infiltration gallery, and will utilize much of the infiltration gallery hardware. At the time of this report the remaining concrete for that vault has been poured, the area behind it filled, and the area re-seeded. Screen construction will need to be done during the winter of 1999-2000 in order to be in place for the 2000 irrigation season.

Throughout this entire process we continued to pay for the electrical costs of whichever system was lifting the irrigation water out of the river and discharging it into the ditch.

SUMMARY AND CONCLUSIONS

In a nutrient-rich system like the Shasta, with heavy growth of filamentous algae, it appears unlikely that a self-cleaning screen with an internal rotating bar can be relied on to function well, particularly where it must operate flawlessly 24 hours per day, and 7 days per week.

The infiltration gallery failed due to congestion of the interstitial spaces with fine sediment during the winter when fine particles carried in suspension settled out in the low velocity areas of the rock matrix. The gradient of the blockage allowed the project to function until the water level reached a point at which insufficient water could pass over the blockage and the system failed. While this result was not wholly unexpected, it was thought that it would take many years, and that much of the fine materials could be removed by the pump over the course of the summer. Apparently, without a more positive mechanism to purge the fines from the rock matrix it too cannot be relied upon for a reasonable length of time.

The above efforts stretched out over 4+ years. During that time there has been an evolution in the thinking of the Fiocks, and we have been able to arrive at a new approach in which they are willing take over the costs and ongoing maintenance of the system we are now building. That system will include relocating one of their existing pumps to the edge of the river, eliminating the irrigation ditch with its inherent maintenance, and finishing the construction of the wiper type fish screen.

While it has been a long and painful process, it appears likely that the final outcome is going to be the best that could be expected.

Summary of expenditures

Volunteer contributions:

Lost hay production, 1998 and 1999: $4,000

Ongoing babying of self cleaning screen--832 hours @ $20/hr = $16,640

Total contributions $20,640

Grant Expenditures:

Salaries/Benefits	$ 2,620
Non-Expendable Eq	$ 8,600
Expendable Mtrls	$ 5,400
Operating Exp	$ 4,300
G/A	$ 3,138
Total	**$ 24,058**