Placer Mining in the Waldo Mining District

by

Ward Tonsfeldt

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The following section provides a developmental history of the mining technology used from the earliest discoveries of gold in the Waldo Mining District in the 1850s and 1860s, when primitive panning techniques were used, through the several important stages of hydraulic mining between the 1870s and 1930s. The discussion provides specific context for understanding the significance of numerous mining related features and sites located throughout the project survey area.

PROSPECTING AND PLACER MINING TECHNOLOGY 1850s to 1860

During the first decade of activity in the Waldo District, mining was confined to prospecting and relatively primitive placer mining. In most other mining districts in the American West, miners located gold through the process of prospecting stream bed deposits of sand and gravel. These "prospects," or traces of alluvial gold, could be followed up the watercourse to higher elevations, where the metal could be mined from the lode or vein of ore at its source in solid rock. Prospecting generally meant washing alluvial materials in a gold pan to separate the metal from dirt. The process is laborious and tended not to recover all the gold present in the sample (Young 1970). As long as the prospecting was thought of as testing, however, and seen as a necessary prelude to the real work of mining, the labor and inefficiency were acceptable to the early gold-seekers.

In the Waldo District, unlike most other areas of the West, there was no vein or lode of gold in rock to reward the prospector?s efforts. Gold was available in the extensive gravel deposits of the Llano de Oro formation, and especially abundant in the gulches where the streams had washed the metal down from the higher gravel benches (Shenon 1933c). Hence, gold mining in the Waldo District was confined to various methods of washing the metal from the gravel where it was deposited. To a certain extent, this same set of circumstances prevailed in the extensive placer districts on the western slopes of the Sierra Nevada mountains of California. The technologies developed there spread to the Waldo District and other districts in southwestern Oregon.

As Young (1970) and others point out, when the first of the 49ers reached California, they really knew very little of mining. Americans had some experience with gold in the southern states, but most Americans had no tradition of gold mining to draw upon. In Latin America, the situation was different, since precious metal extraction was deeply embedded in the technology and economics of the Spanish colonial culture. As early as 1848, thousands of experienced gold miners were arriving in California from Mexico, Peru, and Chile and they were bringing their gold mining sophistication with them (Paul 1963), but the average Euro-American immigrant from the eastern or mid-western US had few resources beyond common sense and ingenuity in the goldfields.

One such immigrant, Herman Francis Reinhart, left us an extensive account of his activities in the Waldo District during the 1850s. Reinhart fits the pattern of a typical Euro-American immigrant rather well. He left his home in rural Illinois in April of 1851 to seek his fortune in the gold fields of California. His background was in farming, where he displayed an aptitude for working with machinery and horses. He prospected around Siskiyou County in northern California for several months, then moved north into southwestern Oregon. He then took a donation land claim on Cow Creek, a tributary of the Umpqua River in Douglas County. In the autumn of 1852, Reinhart traveled south from Cow Creek into the valley of the East Fork of the Illinois River, where he worked for the next several years on Sailor's Diggings and on Althouse Creek.

Reinhart's tools were a pick and shovel, a bucket or hand barrow, and a gold pan. He also used a rocker or cradle, which was a wooden box fitted with a mechanism to rock or shake the contents so that the gold could be separated by mechanical agitation as well as the washing (Figure 21). More sophisticated placer mining equipment, especially the long tom or the riffle box, were all too often beyond Reinhart's reach, since they required more capital than Reinhart had, and a steady supply of running water.

Reinhart refers to his method of mining or prospecting as "washing dirt." He describes his three basic technologies as follows:

> **[Panning]**
> I commenced to dig. After getting down about two or three feet, I washed out a pan of dirt and got a good prospect of coarse gold...We kept bailing out the water and digging down to about three and a half feet. It was so good a prospect that I concluded to stake off our claims (Reinhart 1962:60).
>
> **[Rocker]**
> One day we again went to work, it being about our 6th day's work in the claim. We worked the biggest part of the day in a crevasse and at night weighed our day's work and found we had made $154 in nice coarse bright gold. We kept our gold in a pan. I done the rocking and carrying the dirt in buckets; George Fetterman worked in the hole digging the dirt, and shoveled it into my two buckets. Sometimes I would have to help bail out the hole, it (i.e., water) came in so very fast in the crevasse, which was very rich, and the water bothered us a great deal (Reinhart 1962:62).
>
> **[Sluice Box and Long Tom]**
> We carried our dirt in hand barrows some fifty to seventy-five yards to the creek where we had two sluice boxes and a long tom to wash the gold. One dug down the dirt and helped carry the barrow, the other helped carry the barrow and washed the dirt. We made from $4 to $6 or $7 per day, each of us and if we had known how to wash with sluices and brought water in, we could have made $15 to $30 per day easier than with barrows (Reinhart 1962:33).

All three methods required Reinhart to dig up the gold-bearing dirt or gravel and then carry it by hand to a place on a creek where there was water to wash it. As he mentions in the last passage, this is a tedious process that could have been made easier--and significantly more profitable--by bringing the water to the dirt rather than by bringing the dirt to the water.

Another significant gap in Reinhart's education was using mercury to amalgamate the fine gold dust. Where the gold was available as nuggets or "coarse gold" pellets the size of rice grains, the prospectors could see it and capture it. The fine or "flour" gold was difficult to capture, however, and usually escaped in the pan or wash water. Metallic mercury could catch this gold, forming an amalgam in the pan or on the riffles, and this could be reduced by roasting to "gold sponge." In placer areas like the Waldo District, a large percentage of the metal was distributed as fine gold and could not be captured without mercury. Yet, amazingly, Reinhart and his associates did not know about mercury amalgamation. As he comments, "In 1854 or 1855, I saw how they worked quicksilver [mercury]. I saw how if we had known how to work it in 1852, we would have made a good thing for us all" (Reinhart 1962:50).

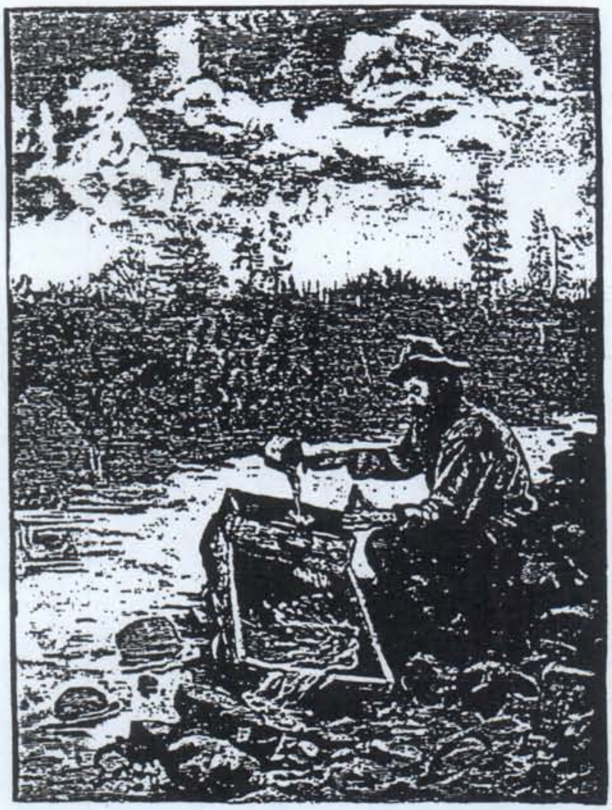

Figure 21. Rendering of prospector with cradle;
from Evans (1883).

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Figure 22. Unknown location in Waldo district, showing miner's working gravels with sluice boxes by the "shovelling in" method, ca. 1870-1880; from Reinhart (1962).

Sluicing, the third technology of "pick and shovel" placer mining, is more productive than panning or rockering, but requires significantly more water and a larger installation (Figure 22). Unlike panning or rockering, sluicing moves enough material to leave evidence on the ground long after the activity has ended. This technology diverts a stream of water through an area of gravel that has been tested by panning and proven rich enough to justify the expense and labor of setting up the sluice. In the simplest operations, ground sluicing is employed. Here the water is diverted over bedrock. Gold-bearing gravel is shoveled into the sluice stream, and the gold is washed into natural irregularities in the bedrock. After several days, the stream is diverted and the miners remove the gold from the bedrock.

In places like the Waldo District where the gravel deposits were deep, bedrock was not always convenient and sluicing was conducted with a sluice box or trough. These were wooden boxes built in sections 12' long, 24" to 72" wide, called sluice boxes. The sections were bolted together end-to-end into strings of 10 to 20 boxes. The sluice boxes had wooden or steel cleats in their bottoms to trap the gold. The longer the sluice, the more men were required to feed gravel into it, and the more efficient it was (McClelland 1918). The slope of the sluice must be carefully chosen and must remain constant, and there must be sufficient room to remove rocks and worked-out gravel from the sluice. The sluices that Reinhart describes were fed by men shoveling gravel into them, a method that McClelland calls "shoveling-in."

In practice, the sluice would be set up on a slope with water running through it. Miners would shovel gravel into the sluice and then remove rocks and gravel from the box, depositing them on ground previously worked. When the distance from the edge of the excavation to the sluice exceed a shovel's reach, the sluice would be moved and the process would begin again. Archaeological evidence of sluicing will be found as parallel rows of low rock piles cleared from the sluicing channel. Depressions between rock piles are the trenches from which gravel was shoveled into the sluice. The trench was then partially re-filled with worked-out gravel removed from the sluice after it had given up its gold.

With a sluice, the miner's productivity increased to an average of >5 cubic yards of gravel/10-hour day. Sluices examined by McClelland (1918) required 50 to 100 miner's inches of water to operate. It is significant that the water requirements were constant whether one miner was shoveling gravel into the sluice, or many were feeding it (Table 3).

Table 3. Comparison of Hand Placer Mining Methods

Method	**Water Requirements in Miner's Inches per Cubic Yard**	**Productivity in Cubic Yards of Gravel per Man Day**
Pan	n.m.	1 cubic yard/day
Rocker	>1 miner's inch/cubic yard	>2 cubic yards/day
Sluice	1 miner's inch/3.5 cubic yards	5 cubic yards/day

All figures from McClelland (1918)

The three ditches in the Waldo Mining District had a combined capacity of 2,368 miner's inches.[1] This volume of water would have met the needs of many miners using pans or rockers. If we assume that each miner needed the traditional measure of a miner's inch, then the ditches could support over 2000 miners. If we assume 1000 of these miners were panning 1 yard/day and 1000 miners were rockering 2 yards/day, the total productivity would be 3000 yards of gravel washed each day. For sluicing, however, the three ditches would meet the requirements of less than 50 sluice operations. If 20 miners worked on each sluice, the total productivity would be 100 yards/day for each sluice, or as much as 5000 yards/day for the 50 sluices. In practice, of course, the technologies were mixed. Yet, the superior productivity of the sluice could not have gone unnoticed, especially as the richest gravel was worked out and the gold content of the remaining gravel was lower. By the 1870s the individual prospectors must have seen that they were working at a disadvantage with their pans and rockers. Joining together with others to work sluices offered them a significantly higher rater of productivity.

Reinhart's account offers us insight into the working relationships of the miners. The men joined together into a Byzantine profusion of partnerships, shares, leases, sales of claims, and other business arrangements that allowed them to cooperate on specific jobs, then cash out, regroup, and move on to the next job. This fluid working arrangement bridged the gap between the individualistic pre-industrial pattern of the first prospectors in the 1850s and the large industrial-scale placer mining that was to follow in the 1880s and later decades. Reinhart's companions were independent prospectors--they were unwilling to work for wages, but they could cooperate on projects that provided them with a share of the profits and the potential to "strike it rich." The generation that followed Reinhart's was willing to accept a wage, and these men became the employees of the industrial-scale mining projects in the 1880s and later years. Table 4 summarizes the historical changes in technology from this early era through subsequent developments in hydraulic mining from about 1870 to the late 1930s.

Reinhart's own career as a prospector was somewhat eclectic. He worked as a builder, bartender, baker, and gambler at various times in Althouse, Browntown, and Waldo. In 1858 he and some friends struck out for the Fraser River in British Columbia, but they were unable to find sufficient gold to remain there. Later, he joined with a partner to build a bowling alley in Browntown. They included a bakery in the premises, as well as a saloon and cardroom. Reinhart eventually left the frontier in 1870. He settled in Chanute, Kansas, where he owned a livery stable and other retail businesses.

[1]This assume that the Quinn and Darkes Ditch was in use in 1860 and that its adjudicated volume of 500 MI had not been assigned to one of the other two ditches.

Table 4. Placer Mining Technology Summary 1850s-1930s.

TECHNOLOGY	DATES	SITES ON WALDO	VOLUME WORKED	SOCIAL PATTERN	CAPITAL ITEMS	SUPPORT SYSTEMS
Pan (pre-industrial)	1851-	Any promising gravel	<1 cu. yd/day	Individual prospector	Modest investment- Pan, shovels, picks	None needed
Rocker or cradle (pre-industrial)	1851-	Any promising gravel	4-5 cu. yd./day	Prospectors in pairs	Modest investment Rocker, shovels	None needed
Long Tom or sluices (transition)	middle 1850s	Extensive gravel with gradual slope and water	5 cu.yds. /man 30 to 50 yds./ sluice	Prospectors in groups of 5 to 100. Some partners, some wage workers	Moderate investment- sluice boxes and ditches	Ditches
Simple hydraulic (industrial)	1880s	Gulches, Deep Gravel, High Gravel	>100 cu.yds./day	Miners employed for wages	Substantial investment- Ditches, pipe, giant, sluices, undercurrent s	Ditches, electricity
Compound hydraulic (industrial)	>1895	Deep Gravel, Llano de Oro, Carroll Slough	>500-1000 cu.yds./day	Miners employed for wages	Substantial investment- Ditches, pipe, giant, elevators, steel sluices, undercurrent s, drainage ditches, settling pond	Ditches, electricity, drainage canals.
Gravel milling (industrial)	>1900	Deep Gravel, Allen Gulch Mill	100-350 cu. yds./day	Miners employed for wages	Substantial investment- Shaft, lift, gravel cars, rails, mill with equipment or sluice	Mill with screen, gold-saving devices, cyanide tubs

HYDRAULIC MINING TECHNOLOGY

Although Wright (1915) argues for a very broad interpretation of the term "hydraulic mining," the general sense is that "hydraulicking" refers to excavating placer material by a high pressure stream of water shot from a nozzle. The technology is associated with California placer working, perhaps appearing in California's Sacramento valley as early as the 1850s (McClelland 1918). During the next decade, a substantial iron working industry began in San Francisco (Bailey 1996). The San Francisco foundries and machine shops supplied the mining industry with specialized machines they developed, including patented hydraulic nozzles. Early nozzles included such brand names as the Craig Monitor, the Fisher Knuckle-Joint, Hoskins' Dictator, Hoskins' Little Giant, and Hoskins' New Hydraulic Giant. The terms "giant" and "monitor" are now used as generic terms for the nozzles, although these were originally proprietary terms for specific designs. Most of these nozzles had an inside diameter of 4" to 8". They were designed to be fixed to concrete or timber foundations, and to be directed by a deflection plate in the stream of water. As the operator moved the deflection plate, the nozzle moved in an opposite direction, changing the course of its stream (Figure 23).

Hydraulic mining enabled miners to work large amounts of placer gravels in short time. This ability was vitally important in placer areas where the operating season was short, either because of water availability or weather conditions. Two of the most important placer areas in the world were the dry California valleys and the Alaskan tundra. A single giant could work more than 100 cubic yards of gravel each 24-hour day. This figure is a threshold estimate, however. In the winter of 1875-1876, the North Bloomfield mine in California, which was one of the largest and most productive hydraulic mines, averaged 8,000 cubic yards of gravel each 24-hour day (McClelland 1918). In 1915, in the Waldo Mining District, the Logan operations on the Llano de Oro had a maximum production of 1,000 cubic yards each day (Wright 1915).

In addition to its productivity, the hydraulic technology was inexpensive. Again, calculating the cost is complicated by innumerable variables, including all of the mining and engineering factors, plus accounting discrepancies. In the 1875-1876 working season, the North Bloomfield's costs per cubic yard were about $0.0325/yard. This included labor, water, explosives to loosen the gravel, materials, replacement riffles, and depreciation on the equipment (McClelland 1917). In Logan's operations in 1915, the costs averaged $0.0233/yard (Wright 1915). The prospectus of the Waldo Consolidated Gold Mining Company estimated the average costs of hydraulicking on the Waldo District mines at $0.05/yard, but added significantly, "The hydraulic method is the cheapest method known for mining gold bearing gravel" (Waldo Consolidated Gold Mining Company 1910).

In operation, the hydraulic mines had three basic requirements: A) a supply of water with sufficient fall, B) a means of removing the gold from the material washed out, and C) a way to dewater the site. Each of these presented challenges.

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Figure 23. Logan or Esterly Mine (Llano de Oro area), showing hydraulic giant at work, ca. 1910. Note supply pipe and runoff water. From Josephione County Historical Society Collection.

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Figure 24. Logan or Esterly Mine (Llano de Oro area), showing hydraulic elevator and riffle boxes with second elevator in background, ca. 1920s. Note the supply of smaller diameter pipe descending into the pit next to the larger diameter ascending elevator pipe. Note also the central sluice in the bottom of the pit to collect water and gravel. From Josephine County Historical Society Collection.

Supplying the Water

In the Waldo Mining District, water supply came from ditches dating back to 1852, as shown Table 5, below.

Table 5. Waldo Mining District Ditches

Ditch	Date	Volume	Mines
Quinn and Darkis	c1852	500 MI	Sailors' Gulch Allen Gulch
Middle Ditch (Logan/Esterly)	1852	1330 MI	Scotch Gulch Allen Gulch Llano de Oro (later)
Upper Ditch (Logan/Esterly	1854	518 MI	Waldo Fry Gulch Deep Gravel (later)
Wimer Ditch	<1870	2,800 MI	Butcher Gulch Deep Gravel
Osgood Ditch	1901	n.a. [est. 500 MI]	High Gravel
Logan Wash Ditch	<1915	11,000 MI	Llano do Oro

Note: Volume in miner's inches (MI) from Waldo Consolidated Gold Mining Company Map (1911) and Wright (1915).

The longest ditches including the Upper and Middle ditches and the Osgood Ditch began in northern California six miles from the Waldo District at the headwaters of the East Fork Illinois River. The Wimer and the Logan Wash ditches took water from the Illinois at a lower level, near the Takilma townsite. The 1850s ditches were built to supply pre-industrial mining activities, including rockering and sluicing. With the advent of hydraulic mining in the later decades of the century, the miners built the Wimer Ditch to supply Butcher Gulch and the Deep Gravel mines, and the Osgood Ditch to supply the High Gravel mine. Although based on the same template as the earliest ditches, these were enlarged to carry greater capacity. The Wimer Ditch carried 2,800 MI, but we do not know the adjudicated volume of the Osgood ditch. The latest and largest ditch is the Logan Wash Ditch, which had a capacity of 11,000 miner's inches, or approximately 10 times the volume of the largest of the 1850s ditches.

Water requirements for the giants included the volume of water, measured in miner's inches; and the pressure of the water, measured in feet of fall, or head. The higher the head, the less volume was required to do the work (or "duty"), which was measured in cubic yards of gravel excavated each day. The head or force of the water was obtained by gravity. The ditch would be located above the working face of the mine. Water at a higher elevation would run from the ditch into a pipe and then be dropped down slope through progressively smaller pipes to the giant itself. Archaeological evidence in the Waldo District includes pipes, siphons, tunnels, flumes, and other extreme means of getting water to flow to the desired locations. The survey found no evidence of pumping water for hydraulic mining, however. The expedient of pumping the water to obtain a head was technically possible but was apparently not practiced in American hydraulic mining. "Numerous attempts to pump water for hydraulicking have nearly all been commercial failures" (McClelland 1918:899).

In practice, the larger mines used several giants at once for mining and for stacking tailings. The hydraulic elevators used in the Deep Gravel and Llano de Oro mines were similar to giants in their water requirements (Figure 24). In 1915, the Deep Gravel, High Gravel, and Llano de Oro mines were operating the following hydraulic equipment (Wright 1915):

Llano de Oro (340' head for Upper Ditch, 125' head for second, unnamed ditch)
- 2 mining giants
- 2 stacking giants
- 1 9" Hendy elevator

Deep Gravel (140' Head for Wimer Ditch, 202' Head for Middle Ditch)
- 1 #2 hydraulic elevator
- 2 #1 giants
- 1 #2 giant
- 1 #4 giant

High Gravel (125' Head for Osgood Ditch)
- 1 #2 giant
- 1 #3 giant

Data on giants manufactured by the Joshua Hendy Iron Works establishes that a #1 giant with a 4" nozzle and a 100' head requires 120 MI, a #2 giant with a 4" nozzle and a 100' head requires 226 MI, a #3 giant with a 4" nozzle and a 100' head requires 230 MI, and a #4 giant with a 6" nozzle and a 100' head requires 533 MI (McClelland 1918). If we assume that the giants were #3 units with 4" nozzles, rough calculations suggest that the Llano de Oro during J.T. Logan's ownership required about 1500 MI. The Deep Gravel would have required perhaps 2000 MI, and the High Gravel perhaps 500 MI. These add up to 4,000 miner's inches, which is well within the 4,650 MI capacity of the first five ditches built to serve the Waldo Mining District.[2]

Recovering the Gold

[2] This number (4,650 MI) does not include the unknown volume of water in the Osgood Ditch. It also assumes that the 500 MI adjudicated to the Quinn and Darkes Ditch was added to the capacity of the Wimer Ditch. If not, then the total capacity of the system in 1915 would have been closer to 6,200 MI. The physical size of the Osgood Ditch and the fact that J.P. Logan, who was leasing the property in 1915, ran only two giants suggest that the capacity of the ditch was small, perhaps <500 MI.

Once the giant had done its work and broken the gold-bearing gravel loose from the deposit, the real work of hydraulic mining began. The water shot out by the giant produced a slurry of rocks, gravel, mud, sand, and water. In the Waldo District, the gold was evenly distributed through the placer material; the size of the gold particles varied from larger "coarse gold" perhaps 1mm in diameter, to smaller "fine gold" often described as the size of flour particles (Shenon 1933c). As long as the hydraulic debris was moving, the gold was suspended, but when it stopped moving, the gold settled rapidly to the bottom of the mixture. The miners therefore needed to channel the runoff into sluices as quickly as possible, and as thoroughly as possible. Any hesitation in the flow, or escaped debris, would mean a lower recovery of the gold.

The normal means of recovering gold was to send the hydraulic debris through a sluice. This device was adapted from pre-industrial mining technology. Because the volume of debris was higher in hydraulic operations than in "shoveling in" sluicing or ground sluicing, the sluices needed to be longer and larger. The sluice on the Llano de Oro pits in 1915 was a steel fabrication 340' long and 40" wide (Wright 1915). J.T. Logan and his workers fitted steel Hungarian riffles into the bottom of this sluice. These riffles were made from angle iron bars 40" long, ½ " thick, and 2" on each flange. The riffles caught the gold as it settled out of the slurry. In most operations, the riffles were coated with mercury to amalgamate with the gold and help recover a higher percentage of the finest gold particles. Some of the gold in the Waldo District was coated with metallic oxides, however, and did not always amalgamate easily (Wright 1915). Periodically, the miners diverted the water out of the system and removed the accumulated gold from the sluices, a process known as "cleaning up."

In addition to the sluices, hydraulic miners also employed undercurrents. These were recovery devices required to remove fine gold that could not otherwise settle in the high-volume sluices used in hydraulicking (Figure 25). Various commentators describe the undercurrents differently, but the logic of all the versions of this device remains consistent. The undercurrent is basically a wooden pool in the sluice, perhaps 20' x 40' x 6' deep, where the current stops and the finest gold can settle to the bottom. Water runs over the top edge of the pool. Along one side of the pool is a thin opening at the bottom. The lowest sediment in the pool is sucked into this opening and deposited in a wide, shallow riffle where the gold can be recovered. Evans (1883) remarks that undercurrents in the California placer mines saved more gold than "miles of sluices" that would have been required to replace them. Wright (1915) notes that both the Deep Gravel and Llano de Oro mines were provided with undercurrents. The High Gravel presumably was not so provided during the years that Logan operated it.

Removing the Water

After hydraulic technology came of age in the 1880s, the volume of water flowing from each giant averaged from 200 to 1000 miner's inches. This translates to 3.25 million gallons/day for a small giant, and 16.2 million gallons for the largest giants. When we consider that the Llano de Oro and the Deep Gravel were operating multiple pieces of equipment and cycling through 1500 to 2000 miner's inches or 24.3 million to 32.4 million gallons each day, the dimensions of the water problem become more apparent.

On the High Gravel mine, the auriferous gravel was deposited on the top of a ridge with clear access to Allen Gulch to the east and Fry Gulch to the west. The slopes on either side were steep enough that the water could run off the surface and be collected into sluices by gravity. The volume of water on the High Gravel was also significantly less than the two larger mines. With only two giants operating in 1915, the daily run-off would not have exceeded 8 million gallons/day. Despite the relative ease with which the High Gravel could be dewatered, it was not considered an easy property to mine. The problem apparently lay in intercepting the run-off water and debris so that the gold could be recovered. Wright (1915) remarks that "Mr. Logan reports greatest difficulty in saving it [i.e., the gold], which, however, he is successfully doing."

The other two hydraulic mines in the Waldo District used a different technology for removing water and debris. These properties, the Deep Gravel and the Llano do Oro, had gravel deposits exceeding 50' deep below a relatively flat terrain. The volume of water associated with hydraulic technology in these mines was considerably more than natural runoff could distribute. As a result, the mines required drainage canals. The Logan Cut was a canal which provided drainage for the Carroll Slough mines and later for the mines on the Llano de Oro plateau near present Esterly Lakes. This cut was three and one-half miles long and from 40 to 70 feet deep. Located in Butcher Gulch, the Deep Gravel mine had a better natural drainage than the Llano de Oro mines, but the depth of the gravel deposits required a canal to augment natural drainage. This was provided by a 7000' canal draining the mine water into the West Fork Illinois River (Wright 1915).

Perhaps the most striking feature of these deeper mines was their use of hydraulic elevators (see Figure 24). These devices, manufactured by the Joshua Hendy Company in San Francisco and other firms, provided a means to blow water, gravel, and rocks 6" in diameter out of the pits where the giants were working. The elevator consisted of an inclined pipe 9"-16" in diameter running at a slant from the bottom of the pit to the surface. At the base of the pipe or elevator was a nozzle fed by 100 to 500 MI of water with as much head as could be obtained (Figure 26). Above the nozzle was a Venturi. The vacuum formed downstream of the Venturi was ported to admit water and debris. The result was that the water and auriferous debris was literally jetted out of the pit to the surface, where it ran into a long sluice box fitted with undercurrents. The elevator was an added capital item, and elevators consumed additional water, but they increased the mines' efficiency in recovering gold since all the debris and water had to pass through them and all of it was deposited into the long sluice systems. In a mine without elevators, like the High Gravel, a higher percentage of the gold, especially the finest particles, would inevitably be lost.

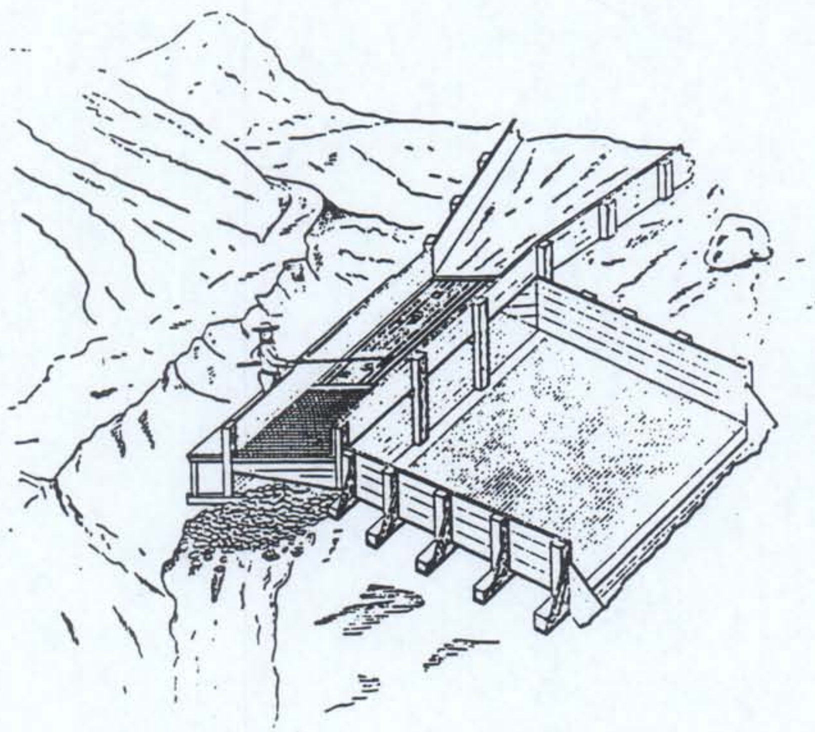

Figure 25. Rendering of an undercurrent device; from McClelland (1918).

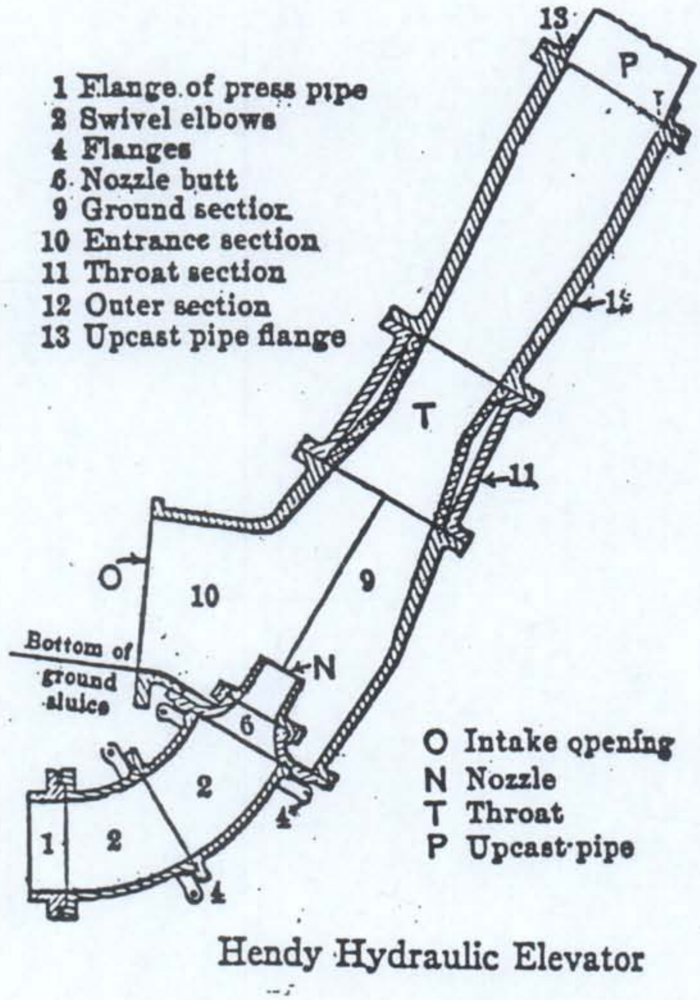

Figure 26. Rendering of a Hendy Elevator nozzle; from McClelland (1918).

Regulation of Hydraulic Mining

Hydraulic mining had some significant advantages over other placer mining technologies, but it had some negative effects on the environment. Early hydraulic mining discharged solid materials consisting of rocks, soil, gravel, and stumps down slope from the hydraulic workings. Collectively called "debris," much of this material consisted of auriferous gravel and rocks that had escaped processing. In later hydraulicking, especially with elevators, nearly all the debris would be processed through a sluice and the gravel and rocks would be deposited as tailings in mined-over areas. Wright (1915) notes that the Llano de Oro miners deposited tailings of gravel and rocks into previously mined pits. If these materials had been sent down the Logan Cut drainage canal, they would have blocked it in a short time. The same is true of the Deep Gravel and other mines employing elevators and drainage canals.

In the early 1880s, hydraulic mines in the Sacramento River drainage, especially the Yuba and Bear rivers, discharged enormous amounts of debris directly into rivers. This material washed downstream, choking the drainage and burying whole valleys. One part of the Bear River was reportedly choked with tailings deposits 97 feet deep (Wyckoff 1993). In response, Northern California landowners, farmers, and shippers formed Anti-Debris Association groups to oppose hydraulic mining. The most famous of these lawsuits pitted Col. Edward Woodruff against the North Bloomfield Mining Company, which was the largest of the hydraulic operations in the Sacramento drainage and the worst offender. The suit dragged along through the early 1880s while tempers and vandalism flared spasmodically. Finally, in January of 1884, Federal Court Judge Lorenzo Sawyer reached a decision in favor of the plaintiff. As a result, the Court issued an injunction that limited hydraulic mining to operations conducted in a manner "so as not to injure the valleys" (Wyckoff 1993:18).

The Sawyer Decision was effective in halting the abusive practice of dumping hydraulic debris into rivers in the Sacramento system. Since the Sawyer Decision and the ensuing injunctions addressed the results of poor hydraulic practices rather than the technology itself, hydraulic operations continued in other parts of California, and in the Sacramento drainage after the Sawyer Decision (Kelley 1959). Hydraulicking also continued in other areas of the US and Alaska where cleaner debris practices prevailed. As Kelley (1959) points out, hydraulicking resumed within a few years on the North Bloomfield itself, after the mines had been modified to use Evans elevators so that the debris could be controlled.

In the Waldo District, farming and navigation were not issues, so hydraulic mining escaped the outrage that it occasioned in California (Walling 1884). Also, the geography of the Waldo District is such that early hydraulic operators may not have discharged debris directly into either branch of the Illinois. It is likely, however, that the earliest hydraulicking in the lower portions of Butcher Gulch, Allen Gulch, and Fry Gulch did send tailings into the rivers. By 1915, however, as we have seen from Wright's report, the two largest operations, the Deep Gravel and the Llano de Oro, were using elevators and controlling their debris. The High Gravel was still sending debris down the hills, but we do not know how this was managed, or what effect it may have had.

In 1893, the Caminetti Act provided a mechanism for re-introducing old-style surface hydraulic operations in California. This required that the operators build a debris dam downstream of their mines to catch the debris and to provide the sediment with an opportunity to settle. Rivers were to be patrolled by the Debris Commission, which was administered by the US Corps of Engineers to ensure compliance. Some Sacramento Valley miners built debris dams and resumed hydraulicking at this time (Wyckoff 1993). Most did not, however, because a new, superior placer mining technology was available during the 1890s and this technology was unregulated. This was gold dredging, in which the miners processed the placer gravels through huge floating dredges that stacked their debris on dry land. Since this technology did not dump debris into the streams, it was not covered by the injunction following the Sawyer Decision (Miller 1998).

During the Great Depression of the 1930s, state and federal governments encouraged gold mining to provide income for displaced workers and to create hard currency. Miller (1998) chronicles the change in public sentiment about hydraulic mining in California during the 1930s. The California State Senate passed the Placer District Act (SB 480) in 1933, which allowed mining districts to form Placer Mining Districts and bond themselves for construction costs of debris dams and other abatement technology. Then, in 1934, California Senator Harry Englebright introduced in the US Senate the Englebright Amendment to the Caminetti Act, which passed on June 9, 1934. This piece of legislation provided funds from the federal Reconstruction Finance Commission to build debris dams under the supervision of the US Corps of Engineers (Miller 1998). The Joshua Hendy Company rose to the occasion by resuming manufacture and sales of the Little Giant hydraulic nozzle.

This favorable regulatory climate was too good an opportunity for the placer miners to miss. California, Idaho, and Alaska, operators resumed hydraulic mining, presumably with acceptable settling ponds and debris dams where needed. Meanwhile, in Oregon, the situation was a little different. The Waldo District miners continued hydraulicking after 1884 with little recorded conflict (*Oregon Mining Journal*, 1897; Van Wagenen 1900; Wright 1915). As we have seen, the total extent of hydraulic mining was minuscule by California or Alaska standards, and the largest mines used elevators and controlled their debris.

One early 1930s hydraulic operation in the Waldo District is well-documented through the Josephine County deed records of the sale of the Waldo Mine, at the old Waldo townsite. An equipment inventory for the sale lists the following items:

2 Hendy cutting giants, 11"
1 stacking giant, 11"
1 Hendy elevator, 9", 56" long
1 6" Hendy siphon
pipe in 10", 11",12", 15", 18", 24" diameters
1 Pelton wheel
2 electric dynamos for lighting plant
390' top sluice box
250' ground sluice box

1931 Ford truck
blacksmith shop

This equipment was probably used for mining out the Waldo townsite, which would have sent water though Fry Gulch to the West Fork Illinois. The operation used a pit and elevator strategy, and the equipment list shows that a stacking giant was used as well. This piece of equipment moved the tailings into "stacks" after they had been processed through the elevator sluices. There is some evidence on the ground of settling ponds in Fry Gulch that may have served this operation. Hyraulicking in this fashion with an elevator and stacking giant allowed the miners to control the debris.

As the level of hydraulic activity in southern Oregon increased during the Depression, or was perceived to increase, conflicts arose between fisheries interests and placer mining interests. By the mid-1930s the conflict was newsworthy, and by the late 1930s, the State Legislature was involved. This conflict did not involve debris, which was presumably controlled, but focused on the sediment and cloudy water that were released from the mines. Lawsuits against miners charged that sediment released into the Rogue and its tributaries affected the salmon fishery and made the river unsightly to wealthy tourists from California (*Oregonian*, February 5, 1937; August 1, 1937).

After considerable agitation from both sides, the Oregon Senate passed SB 385 in January of 1939. This created the Rogue River Coordination Board to "coordinate the operations of placer mining along the Rogue river and its tributaries" to maintain "suitable...conditions for angling and game fishing" (ORS 1939, Chapter 337:714). Section 5 of this act added that "the duty hereby is imposed upon every state police officer and sheriff...to cooperate with and assist the Board in enforcing the provisions of this act, and every rule, regulation, or order made pursuant thereto" (ORS 1939, Chapter 337:715).

In the Waldo District, the only large-scale hydraulic mine operating after 1939 was the Llano de Oro, then owned by the Esterly interests. There were probably other placer mining operations in the district, however, that could discharge turbid water into the Illinois. The sluice on the Esterly Mine emptied into a settling pond in French Flat and the water was then released into the Logan Canal, where it ran for four miles to the West Fork of the Illinois River, which joined the East Fork and ran for 50 miles to its confluence with the Rogue. The Esterly settling pond on French Flat controlled the turbidity of the discharge in the Logan Cut, and other mines in the Rogue watershed apparently had similar provisions. When SB 385 passed, State Senator L.W. Wipperman (R. Grants Pass) remarked that "there would be few instances where action by the Coordination Board would be necessary, since settling basins would eliminate the muddying in most instances" (*Oregonian*, February 25, 1937:10). This implies that settling basins were in place or were a simple addition to operating placer mines.

In April of 1942, however, we find C.R. Stout, PE, Manager of the Esterly Mine, reporting to Joe Madarus of the Oregon State Police. The Coordinating Board has set the limit for turbidity discharged into the Rogue and its tributaries as 1000 parts of sediment per million. Measurements of the turbidity of the discharge from the Llano de Oro through the Logan Cut for the spring of 1942 are as follows (Sprague Papers, Stout to Madarus, April 29, 1942):

March 4, 1942	33 parts per million
March 14, 1942	38 parts per million
March 26, 1942	45 parts per million
April 7, 1942	115 parts per million
April 17, 1942	155 parts per million
April 29, 1942	102 parts per million

On May 19 of 1942, Officer Madarus and Charles H. McElves of the Oregon State Police inspected placer mines discharging water into the Rogue and its tributaries. Their results were as follows:

Sterling Mine	No operator
Federal Mine	One giant, good conditions
Forest Creek	Two dredges, no muddy discharge because of settling ponds
Blue Channel Mine	One giant, no fault
McIntosh Mine	No mud whatsoever
Jumpoff Joe	One dredge, clear discharge

McElves concludes, "At no time did I observe any operations that would violate the orders of the Rogue River Coordination Board" (Sprague Papers, McElves to Headquarters, May 19, 1942).

In an undated letter to Jack Dunphy, Chairman of the Rogue River Coordination Board, State Senator Lou Wipperman summarized the thrust of the regulation. For the placer mines supplied by water from ditches, the mining season ended in June when the water ran out. Prior to this time, during the spring months, the Rogue and its tributaries were turbid from natural causes. Dredges, on the other hand, operated year-round and needed to be regulated during the summer months when natural river conditions were low and clear. "It may be well to mention...that there has been no complaint [that] placer mining affects trout fly-fishing for, as previously stated, mines do not operate during this period; and, of course, clear water is the result and [it] is essential for good fly-fishing" (Sprague Papers, Wipperman to Dunphy, n.d: 2).

Gravel Milling

Other placer mining technologies besides hydraulicking has some currency in the Waldo District. A gold dredge operated at the mouth of Sailor's Gulch for a few years, and the Waldo Consolidated Company proposed using a dredge on their property. A more successful, if less dramatic, technology than dredging was gravel mining, which had a long history on the Deep Gravel mine and was at least attempted at the upper end of Allen Gulch. With this technology, the gold-bearing gravel was removed from a shaft on the hillside by mechanical means then transported to a sluice or washing plant where the gold could be removed.

The Deep Gravel began mining gravel some time prior to 1910. Two shafts were sunk into the gravel deposits and the material was removed by a winch powered by a steam engine (Waldo Consolidated Gold Mining Company 1910). The volume of material excavated from the Leland shaft averaged 100 yards/24-hour day. The operators hoped to increase this to 350 yards by increasing the winch capacity. The depth of the shaft was 122 feet. Photographs of the Leland shaft show the gravel in mine cars en route to a processing plant.

We have no documentation of how the gravel was processed at the Deep Gravel mine, but it seems safe to assume that it was simply dumped into the sluice with the hydraulic slurry. Since the mine had plenty of water available, and the sluice was in place, that would seem to be the most reasonable practice.

In the years after the turn of the century, however, the advances in dredge technology provided methods of washing gravel that were more efficient than sluicing and required less water. This technology was also physically compact, since it was designed to be operated in the limited space of a gold dredge. The gravel was first fed into a rotary screening drum that separated the larger material from the fines. The gold-bearing fines were then fed onto some variety of a device known collectively as "gold-saving tables" (McClelland 1918). At this point, the gold was separated from the silt and black sand was removed. The gold-saving tables used washing, vibration, emulsification, and amalgamation to separate out the fine gold. The most successful of these devices was the Frue Vanner, which employed a huge rubber sheet that moved across the table in a belt-like fashion (McClelland 1918).

The Allen Gulch mill site was built to separate gold from gravel. On the hillside above the mill are mine cart tracks that suggest the gravel was brought to the mill by this means. The source of the gravel is unknown, but it is likely materials were derived from the vicinity of the High Gravel mine during its ownership by either the Hydroplass Mining Company between 1933-1934 or the Plataurica Mining Company after 1940. The Plataurica had several claims under operation in the bottom of Allen Gulch in the 1930s that could have provided the gravels for milling. Remaining features on the concrete foundation of the mill include concrete beds for a large machine at the topmost level. This was the logical location for the rotary screen or trommel. On the next level lower is the gold-saving table, which was not a Frue Vanner, but apparently used washing and agitation to separate the gold from the gravel. No equipment is located at the lowest level of the mill, but possibilities for this level include cyanide tubs for treating gold that would not amalgamate with mercury.

The Allen Gulch mill is a fascinating site and one that has been preserved remarkably well. Such a mill would have offered its operators a chance to work gravel without requiring much water and without discharging sediment into the Allen Gulch watershed. It would have required a significant amount of capital to build and equip the mill, the ore cart railway, and the shaft that produced the gravel. Unfortunately, at the present time we know virtually nothing about the mill's operations or even its chronology. Trommels came into use soon after the turn of the century, and they remain in use by placer miners today.

REFERENCES CITED

Bailey, Lynn R.

1996 *Supplying the Mining World: the Mining Equipment Manufacturers of San Francisco, 1850-1900.* Westernlore Press, Tucson, Arizona.

Kelley, Robert L.

1959 Gold vs. Grain: The Hydraulic Mining Controversy in California's Sacramento Valley. Arthur Clark Publishing, Glendale, California.

McClelland, James F.

1918 "Prospecting, Development, and Exploitation of Mineral Deposits." In Peel 1927(1): 405-973.

Miller, Charles W.

1998 *The Automobile Gold Rushes and Depression Era Mining.* University of Idaho Press, Moscow, Idaho.

Oregon Mining Journal

1897 Offpring "Waldo District Mines." On file Josephine County Historical Society, Grants Pass, Oregon.

Oregon Revised Statutes

1939 Chapter 377, "An Act to Provide for Establishing a System of Rotating, Alternating, and Coordinating the Operations of Placer Mining in and along the Waters of the Rogue River and its Tributaries." Pursuant to SB 385, March 15, 1939. Legislative Counsel Committee, Legislative Assembly, State of Oregon, Salem, Oregon.

Paul, Rodman W.

1963 *Mining Frontiers of the Far West.* Holt, Reinhart, and Winston, New York.

Peele, Robert

1927 *Mining Engineer's Handbook*, Two Volumes. John Wiley and Sons, New York.

Reinhart, Herman Francis

1962 *The Golden Frontier: The Recollections of Herman Francis Reinhart, 1851-1869.* Edited by Doyce B. Nunnis, University of Texas Press, Austin.

Shenon, Philip J.

1933c Geology and Ore Deposits of the Takilma-Waldo District, Oregon, including the Blue Creek District. U.S. Geological Survey Bulletin 846-B, pp. 141-194. Government Printing Office, Washington, D.C.

Sprague Papers

n.d. Administrative Correspondence of Governor Sprague, Box 6, Folder 14 in Oregon State Archives, Salem, Oregon.

Van Wagenen, Theodore F.

1900 "Southern Oregon Placer Conditions." *Mining and Scientific Press*, April 21, 1900, page 432.

Waldo Consolidated Gold Mining Company

1910 *Waldo Consolidated Gold Mining Co.* [prospectus]. New York, New York.

1911 Map of "Waldo Consolidated Gold Mining Co. of Oregon Property in Waldo Mining District, Josephine County." Southern Oregon Historical Society, Medford, Oregon.

Walling, A.G.

1884 *History of Southern Oregon*. A.G. Walling, Portland, Oregon.

Wright, W.H.

1915 Hydraulicking at Waldo, Oregon. *Mining Journal* 100 (6): 211-214.

Wycoff, Robert M.

1993 *Hydraulicking North Bloomfield and the Malakoff Diggings State Park.* Nevada City, California.

Young, Otis E.

1970 *Western Mining*. University of Oklahoma Press, Norman, Oklahoma.