Removal of Elwha and Glines Canyon Dams  
*Port Angeles, Washington*

**NAME OF NOMINATOR**  
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**BRIEF PHYSICAL DESCRIPTION OF THE PROJECT**

Described in some circles as North America’s largest ever dam removal project, the controlled deconstruction of the Elwha and Glines Canyon dams began with a Congressional act in 1992 supporting the full restoration of the Elwha River ecosystem and native anadromous fisheries through the removal of the 108-foot-tall Elwha Dam and 210-foot-tall Glines Canyon Dam and the implementation of other necessary restoration measures. The river runs out of Olympic National Park on Washington’s Olympic Peninsula and empties into the Strait of Juan de Fuca. The removal of the two dams has increased the spawning habitat on the Elwha River from 5 miles – the limit created by the dams – to over 70 miles available for steelhead and the five species of Pacific salmon to spawn after opening up the length of the river and access to its tributaries.

**THE CHALLENGE**

An estimated 16 million CY of sediment was impounded by Glines Canyon Dam in Lake Mills, 13 miles inland from the river’s mouth, with another 4 million CY impounded by Elwha Dam in Lake Aldwell. A significant portion of this sediment had to be eroded naturally by the Elwha River as a result of the dam removals to restore the riverbed and delta to re-create the natural, gravel-bed spawning habitat. The sediment release rate from the reservoirs had to be controlled by regulating the rate of reservoir drawdown and the rate of dam removal at both sites simultaneously. Barnard deconstructed the dams, powerhouses, penstocks, surge towers, intake tower, gate houses, transmission lines, and miscellaneous structures and restored the area over three years, adhering to the NPS schedule and set fish windows. Adding to the challenge was the unparalleled public interest and scrutiny that arose from a project in the planning stages for 20 years.
JUSTIFICATION FOR NOMINATION

Best use of the resource for sustainable water resources management

The Glines Canyon and Elwha dams were first constructed in 1927 and 1913, respectively. The National Park Service (NPS) was faced with a decision to either perform major upgrades/improvements to and construct fish passage structures at these hydroelectric facilities, or remove the dams. Ultimately, the decision was reached to remove the dams and restore the river to its natural habitat, most of which lies within Olympic National Park. This decision would eliminate two recreational reservoirs and an aging power generation source, but would also restore a vital resource to the local ecosystem, community and the Lower Elwha Klallam tribe, located at the mouth of the Elwha River and having a long history and culture based on the steelhead and salmon fishery. This project would receive extraordinary national and even global attention throughout the environmental community as a landmark step in achieving one of the largest environmental remediation projects in the world next to the Everglades restoration, which has stalled as this progressed. The NPS and Barnard cooperated with many media requests, accommodated documentary filmmakers, organized public tours, set up webcams, and constructed new public overlook areas so the progress could easily be viewed and followed.
All materials generated from the demolition of the two dams and associated structures were either donated to local museums or recycled. The concrete was given to Clallam County to be crushed and re-used as road base; all metals were recycled, and the wooden structures were salvaged where possible and re-purposed. In addition, bio-degradable oil was used in all construction equipment working near the river.

**Innovative design or construction techniques**

To maximize the amount of sediment eroded by the river, to assure the health of the Bull Trout that resided in the reservoirs, and to limit the disruption to the steelhead and salmon spawning seasons downstream, NPS instituted reservoir drawdown restrictions and non-drawdown “fish windows.” These restrictions limited the rate at which the dams could be removed and also confined dam demolition that resulted in reservoir drawdown to 6½ months each year. In addition, both dams were located within narrow canyons, making river diversions very challenging. At Elwha Dam, a plan was developed to drill and blast a diversion channel in the rock and systematically lower the diversion channel and demolish the dam with excavator-mounted breakers in alternating sequencing, diverting the river back and forth, effectively lowering the reservoir each time while performing the dam demolition and diversion channel blasting in the dry. Barnard developed these plans with the aid of three-dimensional modeling software, carefully laying out each river diversion, blasting and demolition plans, and access requirements.

At Glines Canyon Dam, the challenges were very different. The construction of an arch dam in a steep, narrow canyon would not allow for a diversion channel as an option. Dam demolition had to occur while working around the fluctuating and unpredictable river flows that ranged from 200 cfs to over 11,000 cfs during construction. Barnard developed a notching plan to selectively demolish notches in the dam at varied elevations and dimensions, depending on river flows, and staying within the reservoir drawdown restrictions. Access
would only be by boat and/or crane. Since the top of the dam was too narrow to safely fit construction equipment, the top one-third of the dam had to be removed using an excavator-mounted breaker situated on a barge until the dam was wide enough to fit drilling equipment. At that point, the remainder of the dam was removed with carefully designed blasts, removing portions of the dam and diverting the river back and forth, each time exposing the opposite side of the dam so the drilling and blasting process could continue.

Efficiency of design (cost, materials or time)

Prior to the Project’s commencement, NPS, Bureau of Reclamation (Design Engineer), URS (Construction Management Representative), and Barnard participated in a Partnering workshop to help build a cooperative, teamwork-oriented culture. This partnership proved invaluable in creating a truly collaborative atmosphere and led to great communication, problem-solving, and issue resolution on the Project. As is the case with any project, changed conditions were encountered, requiring all parties to develop solutions. In this particular project, the level of unknowns was extremely high given that these structures were built up to 100 years prior and also given that a dam removal project of this magnitude had never been done before. This partnership undoubtedly helped foster efficient designs and plans throughout the project, ultimately leading to its successful completion. Below are a couple of the most significant issues that arose and were solved by the Team with as minimal cost and schedule impacts to the project as possible.

Given the rich history of the Elwha River and the Lower Elwha Klallam Tribe, Barnard worked closely with NPS to preserve natural and cultural resources throughout the project. These considerations plus the unknown suitability of the preferred crane location at Glines Canyon Dam due to the presence of the reservoir at the start of the project, resulted in converting an existing onsite crane at the outset to a ringer crane. The ringer crane proved invaluable throughout the remainder of the Project, increasing the crane’s capacity and reach and maintaining our ability to service the remainder of the work. It also provided an unexpected benefit when the need arose to drill and blast boulders within the channel downstream of the dam, further described below.

The most significant impact to the Project’s schedule was realized when Glines Canyon Dam demolition reached the point where sediment trapped within the reservoir began to erode and be transported downstream. This sediment level in the river unexpectedly overloaded NPS’s downstream sediment removal plant to remove sediment before the water reaches the City of Port Angeles. It became evident that dam demolition had to be suspended while NPS made adjustments to its plant. To minimize cost impacts, Barnard and NPS developed a plan to conduct a series of demobilizations/remobilizations as conditions warranted. While this unfortunate problem extended Project Completion
by over a year, working together to develop this plan helped substantially minimize cost impacts to the project.

**Overcoming significant challenges – technical, physical, management**

At Glines Canyon Dam, a significant problem was realized when the downstream river surface elevation was found to be 25 to 30 feet above the elevation of the dam removal limits. The cause of this higher-than-expected water elevation was determined to be large rocks and boulders that had broken free from the sides of the canyon walls over time since the dam’s construction, causing constrictions in the channel floor. This caused two significant issues: first, these boulders created barriers and waterfalls during low flows, causing fish-passage concerns for the fish biologists; and second, the high water elevation greatly increased the difficulties of removing the bottom 30 feet of dam since it was completely underwater.

To solve the first problem, Barnard utilized the Manitowoc 4100 ringer crane to access and blast selected downstream boulders in an attempt to open up the channel and remove the fish barriers. To solve the second problem, Barnard solicited the services of a specialty drilling subcontractor, developed an intricate access and drilling plan involving drilling through overburden from above the water level, installed casing pipe, and successfully blasted the remainder of the dam through the casing pipe.

**RESULTING BENEFITS**

Even before the project was complete, the results of removing both dams and letting the river run freely from its headwaters to the Strait of Juan de Fuca proved very promising. Almost immediately after the last pieces of the Elwha Dam were removed, Chinook salmon made their way upstream of the dam location. Not too much later and much earlier than expected, redds (fish spawning beds) also were spotted in the tributaries upstream of the former Elwha Dam. In addition to re-establishing the fisheries, the overall ecosystem is expected to benefit. More fish, in turn, will feed more otters, bears, eagles, osprey and others. They will bring nutrients from the fish into the upper reaches of the basin, which will benefit all other parts of the plant/animal ecosystem. After 100 years, salmon are again spawning in the upper Elwha River, and long-trapped sediment is beginning to rebuild the river and shoreline habitat.

**INDIVIDUALS OR ORGANIZATIONS TO BE RECOGNIZED**

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