Marmot Dam has operated in the northwest United States for nearly 100 years. Now, a team of experts is taking it out. They've got just four months to break down 25,000 tons of concrete and steel and clear a million cubic yards of sand, gravel, and boulders so endangered species of salmon can return to their spawning ground. Pulling this off will take a radical and unproven plan. They'll use 21st-century science and technology to harness the force of a perfect storm without losing any lives along the way. Big dams are as commonplace as epic rivers in the northwestern United States. Here, among Oregon's Cascade Mountains, Marmot Dam has tapped the Sandy River's hydropower for almost 100 years, but the dam is old and tough on migrating fish. The power company, Portland General Electric, has decided to retire this expensive structure and replace it with other sources of energy such as wind power. John Essler is a PGE manager overseeing this project. His job is about difficult choices.

Our customers expect us to do the right thing, and if a project cannot be run economically and protect the salmon, they expect us to remove the project.

But deconstructing a dam of this size and age is a major engineering challenge.

There's a lot of things that we don't know that we'll learn as we actually see it take place.

This dam removal, a grand experience.

PGE has assembled a topnotch team to help them. Engineers, explosive experts, scientists, and even weather forecasters. If their plans are successful, the Swill run free again, from its head waters on the slopes of volcanic Mount Hood to its confluence with the Columbia River 50 miles away, but it won't be easy. Marmot dam looms 5 stories high and nearly 200 feet across. A canal sits on one side, and an old fish ladder allowing salmon a way to cross on the other. The dam itself is constructed of 25,000 tons of concrete and 200,000 pounds of reinforcing steel. To break it down, the deconstruction crew must first divert the river with a temporary dam to create a dry, safe work area. Next, they'll use explosives to crumble the old dam, then remove the concrete and steel for recycling. Finally, with marmot gone, the team will take on their biggest challenge. Removing the sediment that's built up behind the dam for almost 100 years; 18 million tons of bolders, gravel, and sand forming a backward doorstop stacked right up to the lip of the dam. Even with marmot gone, this massive clog could continue to block the river, but removing this much debris with backhoes and dump trucks is not an option. Contractors have just four months to safely complete the project because another clock is ticking. A biological clock for wild salmon returning to their river.

Salmon are a real symbol to people in the northwest. It's a symbol of the recreation and the cultural resources we've had and want to continue to have in spite of a strongly growing population.

The salmon are born in the Sandy River's fresh water, then travel downstream to the Pacific Ocean. Once they reach maturity, the fish travel thousands of miles back to the Sandy in a race to spawn before they die. Many have to climb the dam's outdated fish ladder to get to their native habitat. Over the decades, the fish population has dropped from as many as 20,000 to around 5000. Some species, like the Chinook and coho, have even made it on to the endangered species list. To minimize the project's impacts on fish, removing the dam can only occur while the river is at its lowest and before the biggest runs return. Contractor Nat McDougal is in a tight spot.

We basically have to do this job in about half the time that it normally would take and under normal conditions. It'll take six and seven days a week and some long hours to get finished and meet the deadline.

With no minutes to waste, the project launches promptly on July 1. Stage 1. Nat McDougal's crew starts building a gravel and clay structure upstream of Marmot. Known as a cofferdam, this will hold back the river during Marmot's deconstruction. They'll build the specially designed cofferdam on top of five stories of sediment. Inside it, drillers will thread wells and pumps down to the river bed. The pumps will extract water from the sediment making it part of the protective structure. The cofferdam will also include a steel bridge so heavy equipment can cross the diversion canal. Once they complete the project, crews

will stop the pumps allowing water to resaturate the sediment. Then the gravel and clay dam will dissolve harmlessly into the water, but until then, it will have to hold.

We're working behind a temporary dam, and if any kind of failure were to occur it would be a fairly major catastrophe.

The cofferdam is designed to hold back flows of 850,000 gallons a minute. That's enough in summer when the river is low, but this region gets more than 37 inches of rain every year, and after the storm season starts in the fall, the river can crest at over eight times that amount. Far more than the cofferdam can withstand. The team must complete the project before summer ends. In the meantime, keeping the river out of the work area is the contractor's top priority. Lives depend on it.

Trying to pump the water out and control that water. That is the biggest single risk we have. We run the risk of the river rising and coming into our work, and that would not be good.

Crews work around the clock to complete the cofferdam. Well drillers bore 60 feet through the sediment trapped behind marmot, then lower well casings into the holes. Inside these wells go the pumps that'll serve as their life support system. The pumps must operate 24 hours a day to keep the river from

dissolving the temporary dam. With construction under way on the cofferdam, research hydrologist Gordon Grant tackles the project's biggest challenge. Working out how to remove the silt and debris that's built up behind the old dam for nearly 100 years.

We pull the dam, there's gonna be sand everywhere through here. It's gonna end up in all these kinds of nooks and crannies.

His biggest concern is that the freed sediment could clog the river, blocking fish or burying their eggs.

There's never been a human-constructed dam coming off a river that has involved this much release of sediment. We've never seen what happens when a million cubic yards of sediment comes down a river all at once.

PGE has decided on a radical scheme, to wash the debris away in one bold move, but it's a method that's never been attempted on this scale, so Gordon Grant is being sent on assignment to see if the plan will work. Portland General Electric has asked researchers at the University of Minnesota's Center for Earth Surface Dynamics to create a scale model of the dam deconstruction project. It's 45 feet long with a replica Marmot Dam in the middle and a mile of the Sandy River represented below and above it. Engineer Jeff Marr designed the model based on laser measurements taken from the field.

The red lines are cross sections that we use to construct the model. They actually tell us what shape to form the concrete.

It even has scaled down sand and gravel sediment packed to the lip of the dam. They've built this model in order to test PGE's plan for flushing away the sediment in the real world. The concept is simple. Once contractors remove the old dam, they'll wait for a fall rainstorm to fill the river behind the cofferdam to its bursting point. Then they'll release the water directing the flow to wash away the mountain of sediment, but controlling the storm flood with manpower and machinery is an ambitious and potentially dangerous operation. Researchers hope their miniature Marmot Dam will help them learn how to manage this dynamic process. The model is ready for a test drive. First, they build the cofferdam, including a pump system. Next, they remove the old dam. Now the researchers simulate a series of events that will happen in the field. Fall storms arrive.

Of course, we have the luxury of being able to turn the river off and on. The chaps who have to do this in the field, they have to do it with a live river. I see water coming. It's starting to rain.

Pumps in their cofferdam are turned off and removed. Most importantly, a notch is cut to guide the water flow. In the field, this will have to be done by men and machinery. Then they block the canal diverting the water around the site.

The diversion canal's blocked. Here we go.

And the scale model river rises.

Alright. So we're going up to 2500. We're getting erosion here.

Within minutes, the water starts to cut through the notch and begin scouring away the sediment behind the cofferdam.

Look at it! Look at it!! Underneath! There it goes. There it goes. Wow. Look at that thing go! I would not want to be down in the hole with big slumps like that coming off. I'm not that brave.

The equivalent of 18 million tons of material moves safely downstream. In this room at least, the plan is a success, but how model time translates to real time is anyone's guess.

It's one thing to scale dimensions of things; the size of the grains, the depth of the flow, the width of the channel. It's a little trickier to scale time in a model.

Over the next few weeks, researchers will try subtle variations to determine exactly how much water flow they'll need and where and how they should cut the notch to direct the river's energy against the sediment. The model proves the plan could work.