Multiple pipelines are inspected for physical damage and supported as required.

The Old Question Remains: Replace Or Rehabilitate?

by **Les Thompson**,
Executive Vice President and General Manager,
Ercon, Inc. Houston, TX

On the cofferdam, a water pump package was sized to displace all of the water. Only a few pumps were later required to maintain the water level during construction.

A pipeline system, in place and operating for many years, requires maintenance and inspection to satisfy regulatory guidelines and more importantly, ensure a safe facility.

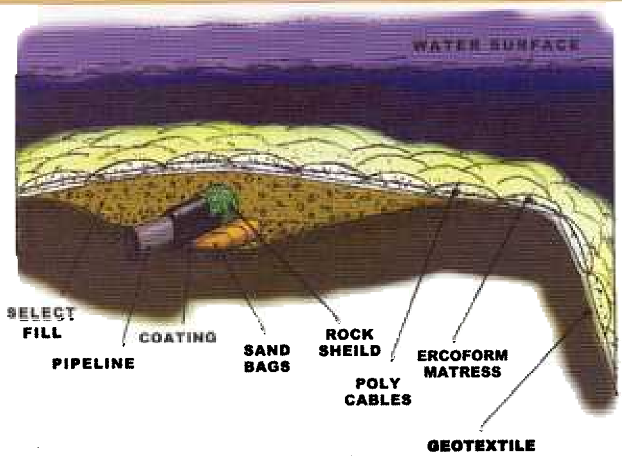
Pipeline operators all understand that an installed pipeline requires ongoing attention and that the condition of a pipeline remains dynamic. Many operators take comfort from the thought that at least the Earth that contains the line remains constant. Once safely buried to an appropriate depth and backfilled, that part of the job is supposedly done. Unfortunately, this is simply not so. In most cases, the pipeline will generally stay where it was. The Earth, however, does not.

Just like the dynamic nature of operating a pipeline with all its variables, nature and our environment are dynamic and in a constant state of change.

Without the influence of man, rivers and streams migrate naturally in the lateral or horizontal direction. River bottom degradation, due to ever increasing water runoff, results in a continual deepening of channels.

Lines Under Rivers Are Threatened

Inevitably, pipelines which had been safely buried, become threatened. Pipeline exposure—resulting in coating or mechanical damage to the line itself - is less significant than the prospect of spans which trap debris or in the worst case, exceed the structural limits of the pipe. These conditions worsen rapidly, particularly in wet seasons. The frequency and extent of high flow periods, not time, dictate the evolution of the problem.



A sure solution to the problem is to replace the river crossing, although it is seldom the most cost-effective strategy. Even with a costly total replacement of the line, there are many examples of a new crossing becoming threatened or re-exposed within a few years due to a lack of insight regarding the direction and extent to which a waterway may continue to migrate.

The rehabilitation of an existing water crossing is frequently overlooked as a technically valid and very cost-effective option. As with any good technology, everything has reasonable limits, so therefore it is critical that trained and experienced professionals with a thorough understanding of pipeline operations and most importantly, a superior knowledge of hydrology, geomorphology, and hydraulics, be involved in the review. Last, but not least, a current knowledge of all regulatory and environmental criteria will avoid a lengthy planning process that is ultimately frustrated by an inability to secure the appropriate permits.

A variety of factors will always determine whether a particular location is a candidate for rehabilitation. Water depth, line size, distance from top of pipe to the existing streambed, hydrology, geottechnical, and regulatory issues must all be considered and each location is very site specific.

Five Pipelines Below River

In this example, five pipelines crossed a large stream in a 100-foot right of way. The stream was approximately 150 feet wide with a maximum depth of 10 feet. Due to the age of the lines and uncertainty concerning the time of pipeline exposure to the elements, it was determined that the river would be bypassed, then dewatered, and held dry for inspection of the pipeline and its coating. During this time, any required upgrades were performed to establish a like-new condition. In many such cases, a bypass scenario is preferred while in some low-flow conditions, a total isolation of the work area can be accomplished while all of the stream flow is pumped past the site.

Clean upland fill was used to construct cofferdams upstream and downstream of the right of way. The cofferdams were set apart at a predetermined distance in order to correspond with the requirements of the protection system. This would be the final phase of the upgrade project. A third cofferdam was constructed perpendicular to the first two. It joined the ends of the first two cofferdams, leaving the minimum distance required, between the third cofferdam and the stream bank, for a small channel to bypass the stream flows anticipated during the two-week project.

Special attention was given to the area where the third cofferdam crossed the pipelines in order to protect the lines as well as maintain a seal against a 10-foot head pressure along the lines. Pumps were sized to evacuate water from the work area. Sumps were developed in the center of the work area to control any seepage and keep moisture away from the lines. This required far less pump capacity than to dry the work area initially. However, full pump capacity was maintained at the site in case the work area would have to be flooded and de-watered again during the course of the project. The site was pumped dry within eight hours and the rehabilitation work began.

After the initial inspection, the lines were sandblasted to "near white" and minor repairs were made to the lines themselves. Two-part coal tar epoxy was used to complete the pipeline rehabilitation. The lines were then supported across their full length and an appropriate rock shield was used as an added measure of protection to ensure that no coating damage could occur during the reburial process. The entire work area was thoroughly cleaned of any debris or foreign material related to the work, and the lines were re-bedded and buried, using the clean fill previously used for cofferdams. The small area, used as a bypass channel, adjacent one stream bank, was treated in an identical manner while 95 percent of the channel was returned to normal flow.

While all elements of this project are important to its overall success, nothing is more critical than how the newly renovated lines are protected and prevented from becoming re-exposed.

A cable-reinforced, grout-injected system is most often the system of choice for inland rivers and streams. For many years, quarry run stone or "rip-rap" was used to prevent erosion. This technique is non-contiguous and individual stones can move in bed load as the river velocity increases. In nearly every case, rip-rap will require ongoing maintenance as a percentage of rock material is carried downstream every year. This is neither technically nor environmentally acceptable.

Individual pipelines are sandblasted and recoated to operation specifications.

Material Choices

Poured concrete is a poor choice as it cannot differentially settle to compensate for minor further compaction of fill and it also exhibits a very low "Manning n factor." This is a measure of friction, which in the case of slick concrete, allows for locally accelerated velocities well beyond what is found in the natural environment. Higher velocities are the root cause of soil erosion and a system which exhibits a surface roughness similar to, or greater than the natural environment, is preferred. The large variety of pre-cast concrete mats have their place but there are several inherent technical deficiencies which make these systems a poor choice. The economic disadvantage of moving heavy mats hundreds of miles to a remote pipeline site also needs to be a consideration.

The highly touted characteristic of articulation or flexibility when describing any protective cap is generally misunderstood. An appropriately designed protective cap should be capable of bending and flexing to cater to some differential settlement. In many cases, a small degree of this is unavoidable, especially if the fill and compaction is accomplished in the wet. A high degree of flex at the edges, and most notable at the downstream end, should never be required and is indicative of a poor design from a hydraulic point of view.

More importantly, if downstream bed scour is allowed to occur, a flexible cap made contiguous through the use of internal cables will most often be held suspended by the cables and adjacent mat, and bridging will occur. An appropriate design will always address the hydraulic issues in a manner that prevents downstream scour in the first place.

Individual block weight, weight per square foot, and footprint are other major factors of a mat system appropriate for inland streams and rivers. A block weight of a minimum 100 pounds—the largest

Cost-effective construction techniques allowed for a rapid isolation of the work site. A small bypass channel was left open to allow for nominal river flow.

No Single Solution

P&GJ

Eco-Flexª Grout Mat Protective System

Ercon, Inc. understands the importance of our natural environment and designs every project for the lowest environmental impact possible. Because of this philosophy, our patented Eco-Flex Grout Mat is used in many of our designs. This special mat allows for native vegetation to establish in spaces in the mat, allowing the area to return to very close to pre-construction environmental conditions.

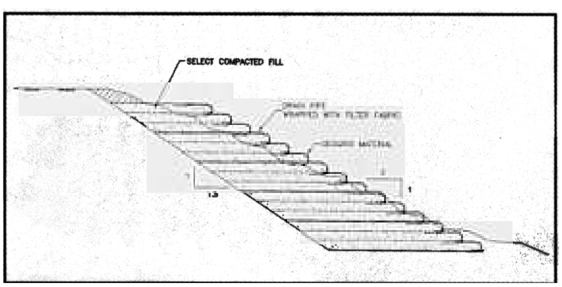
Palisadeª River Training System

Ercon's patented technology is second to none. In this situation, lateral migration threatened pipelines running parallel to this river. Ercon has installed a Palisade System to prevent further migration and stabilize the bank by manipulating the river's natural processes to protect the pipeline.

Flexible Concrete Revetmentª System

Near vertical erosion with complex exposures are a common problem. Ercon's Flexible Concrete Revetments are designed for these tough situations. These systems can be grid reinforced and remain flexible, allowing for hydrostatic venting.

Grid Reinforced Stabilization System



Using state of the art synthetics, Grid Reinforcement successfully stabilizes difficult embankments. Properly designed and installed grid reinforcement is a widely accepted and environmentally friendly alternative to engineered retaining structures that has the added benefit of 20% to 50% less cost.