Building Resilience in the Reinland Channel

For decades, the Reinland Drainage Channel suffered erosion from rain events and spring melt.

The Reinland Channel is a municipal drainage channel in Manitoba, Canada, that receives flows from the entire Pembina Valley. The channel holds and drains water from the region's spring melt and rain events. It was originally built in 1966 on shifting sandy soil that suffered from years of accelerated erosion. For more than a decade, the municipality had been working to solve this problem.

In 2010, a sheet piling drop structure reinforced with large rock riprap was installed. Later that year, damage to the side slopes and around the structure occurred after a spring flood event. Following the damage in 2010, remediation was performed to stop the progression of erosion. This included regrading and reshaping the drain as well as installing more rock riprap. Another significant flood event occurred in 2016 and caused major failures along two miles of the channel.

Due to these increasing flood events and maintenance challenges with the riprap structure, the town decided a longer-term solution to stabilize the eroded channel banks was needed. In 2018, work began to better manage the water throughout the channel and protect area farmers from losing property.

An assessment of the drain found the following characteristics:

- Erosion of the channel banks
- Drain channel bottom is 6.5 feet (2 meters); spillway channel bottom is 10-16 feet (3-5 meters)
- Drain channel side slopes to be graded to 3.5 horizontal:1 vertical (3.5H:1V)
- Spillway channel side slope range between 4H:1V to 5H:1V
- Channel bed slope of 0.0018%
- Channel consists of sandy, silty clay
- Maximum expected hydraulic flow rate of the drain is 7.6 inches (19.33 centimeters)
- Maximum expected hydraulic flow rate of the spillway is 7.4 inches (18.78 centimeters)

The construction schedule was delayed due to persistent wet weather until winter months. This delay drastically shortened the allotted construction schedule because the project had to be completed before the spring runoff began in March.

Originally, the project design called for a combination of mattress-style baskets on the bottom of the channel with rock riprap on the side slopes. Rock riprap had previously been used in the channel but failed during rain events. Another challenge of using rock was transporting it to the project site. The closest quarry was 90 minutes away, and shipping the amount of needed rock would add considerable time and cost.

When evaluating the Reinland Drainage Channel, the engineer of record considered the hydraulic flow conditions present for various flood events and the overall cost of the solution. The hydraulic design incorporated HEC-RAS modeling with flow return periods from two years up to 100 years. With each design flow, the maximum velocity, shear stress and water-surface elevation were calculated to choose the most-appropriate solution in each scenario.

The drainage channel was modeled having 3.5 horizontal to 1.0 vertical (3.5H:1.0V) side slopes and a bottom width that varied along length of the channel. The design flow of 1,345 ft^3/s for the 100-year flood event resulted in a maximum velocity of 5.8 ft/s and a maximum shear stress of 0.5 lb/ft^2. In addition to the velocities and shear stresses

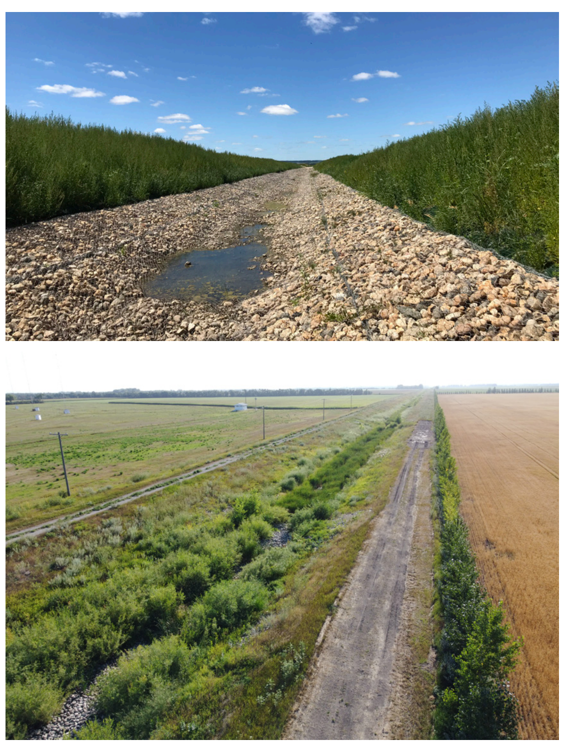
PROPEX Armormax was used to stabilize the side slopes of the channel. Due to delays in construction, project engineers had to overcome challenges such as an accelerated installation schedule and frozen soil.

generated, the 100-year flood event showed a maximum flow depth of 7.3 feet (2.2 meters). The more-frequent design flow of 170 ft^3/s for the two-year flood event resulted in a maximum velocity of 3.3 ft/s and a maximum shear stress of 0.2 lb/ft^2.

In addition to the velocities and shear stresses generated, the two-year flood event showed a maximum flow depth of 3.1 feet (0.9 meters). Due to the frequency of flood events and the somewhat constant water level in the bottom of the channel, it was determined that it would not be viable to maintain vegetation along the channel bottom. The solutions considered would have to be able to provide adequate erosion control performance in a fully unvegetated state.

Solmax worked with the project engineer to provide a nature-based solution using PROPEX Armormax in place of rock riprap. The final project design included a combination of hard armoring and PROPEX Armormax. The hard armoring along the channel bottom and up to the two-year flood event would provide protection during the more-frequent occurrences and help control erosion even if vegetation did not establish along the bottom. The Armormax was used to protect the side slopes from the two-year flood event up to 1 foot above the 100-year flood event and provide a vegetated solution with a reduced overall cost and environmental impact. The PROPEX Armormax system is composed of PROPEX Pyramat® 75 High Performance Turf Reinforcement Mat (HPTRM) and Engineered Earth Anchors that work together to lock soil in place and protect against hydraulic stresses for up to 75 years or longer with vegetation.

One truckload of 5,000 square yards of HPTRMs is equivalent to about 250 truckloads of rock.



Vegetation establishment five months after installation (top) as well as channel performance five years after installation (bottom).

For the Reinland project, this meant significantly reducing the number of trucks sent to the site. **Use of Armormax instead of rock riprap reduced Reinland's overall project cost by nearly 30 percent and lowered the carbon emissions by 90 percent. Armormax's carbon footprint has been independently verified and is up to 30 times lower than rock riprap and concrete-based solutions.**

Another challenge presented by the winter installation schedule was that the soil froze, creating a three-foot-thick section of frozen ground. To overcome this challenge, the engineer used a longer securing pin that was within the acceptable specification range in addition to 3-foot B1 earth anchors. Additionally, the contractor pre-drilled the anchor locations through the frozen soil to improve the anchor installation rate.

Once installed, Armormax is engineered to promote vegetated reinforcement. This helps decrease sedimentation and pollutants, and encourages infiltration of water back into the groundwater table. These are two reasons why the Environmental Protection Agency (EPA) identified systems that utilize HPTRMs such as Armormax as a Best Management Practice (BMP) for improving water quality. Conversely, rock does not promote vegetation and offers poor filtering and pollutant-removal capabilities. The Reinland project was hydroseeded after installation to help establish vegetation.

Within six months, the channel was vegetated. Currently, the project has been installed for five years and has experienced major weather and flood events without need for maintenance or repair. II