BIOENGINEERING FOR EROSION CONTROL

Within areas of industrial development, exposed soils and steep banks are vulnerable to erosion from water or wind, and protection is essential to prevent undesired changes to the landscape. A variety of techniques can be used to prevent erosion, including **structural (conventional)** approaches and **bioengineering** approaches.

Structural approaches typically use permanent materials such as concrete, riprap, aggregate, geotextiles, or wire baskets or cages. In contrast, bioengineering uses living plants and plant materials to fulfill an engineering function. Some examples include wattle fences, live pole drains, brush layers or mattress, live staking, and fascines. Both approaches are useful under specific situations and can be successfully combined within a single project.

Choosing an approach

Although many techniques can be used, **no single method works everywhere**. Different techniques are better suited to specific conditions. For example, at sites where erosion is caused by groundwater slumping, bioengineering techniques that establish roots (like staking) work best. In contrast, erosion from very powerful surface flows might require a structural armouring technique like riprap. Success depends on selecting an appropriate, site-specific design. The 10 main considerations for choosing an erosion control approach include:

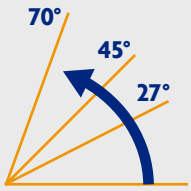
BIOENGINEERING APPROACHES ⟷ **STRUCTURAL APPROACHES**

Risks or Consequences of Failure

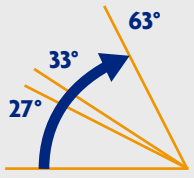
Structural approaches are less likely to fail and are preferable in situations where human safety is a risk or failure has other high consequences like damage to infrastructure. Bioengineering vegetation can also block visibility if the site requires regular inspections of assets or infrastructure. Vegetation also attracts wildlife which may be undesirable at certain locations.

Topography and Slope

Some bioengineering techniques can be used on very steep slopes with wattle fencing effective up to 70°, fascines to 45°, and brush layers to 27°. Slopes applicable for structural techniques vary with riprap armouring effective up to 27° and gabion baskets between 33 and 63°. Erosion control mats are only effective below 21°.



VERY STEEP SLOPES



LESS STEEP SLOPES

Weather and Season

Installation of structural approaches are less dependent on season. Vegetation for bioengineering approaches needs to be collected or planted at specific times of year to increase success.

SEASON DEPENDANT

LESS SEASON DEPENDANT

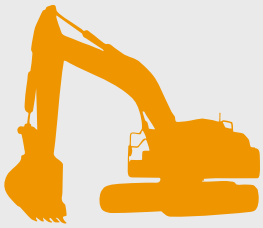
BIOENGINEERING

MORE MANUAL LABOUR

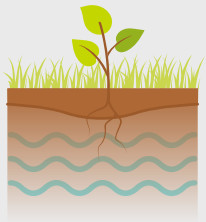
Accessibility

Bioengineering approaches are more dependent on manual labour whereas structural approaches often require access with machines. Maintenance requirements should also be considered for remote sites. Bioengineering can sometimes involve small-scale maintenance more frequently whereas structural approaches can involve large-scale but infrequent maintenance.

STRUCTURAL



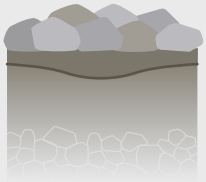
MORE MACHINES



NEEDS SOIL AND MOISTURE

Soil Characteristics and Moisture

Since bioengineering approaches rely on vegetation growth, they require specific moisture conditions. They are most effective where plant roots can reach the water table but are not inundated for long periods of time. Bioengineering at dry sites might require watering to keep plants alive. Choosing plants that do well in the soil conditions of the site can increase bioengineering success. Sites with poor or non-soil conditions might require structural approaches.

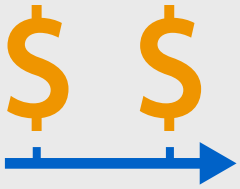


CAN BE USED ON ANY SOIL

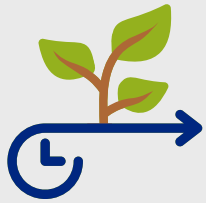
FREQUENT SMALL COSTS

Cost

Bioengineering approaches cost less overall, but they require more frequent small expenses for monitoring and maintenance and tend to be more labour intensive. In contrast, structural approaches have high initial and replacement costs but minimal maintenance in-between.



INFREQUENT LARGE COSTS



CAN STAY FOREVER

Permanency of Techniques

Since bioengineering uses natural materials, it can be permanently left on the landscape and incorporated into closures. Structural approaches can degrade over time and may require removal at closure.

MAY REQUIRE REMOVAL

Availability of Materials

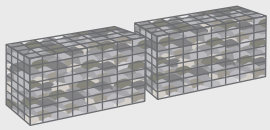
Both bioengineering and structural approaches can be impacted by availability of materials depending on the techniques chosen and location of the site.

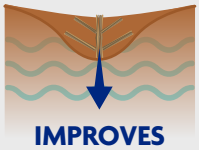
TAKES TIME TO GROW

Need for Immediacy

Vegetation takes time to grow. Bioengineering approaches can take months to fully establish and often require longer planning phases to obtain plant material. Most structural approaches can be rapidly installed.

EFFECTIVE IMMEDIATELY

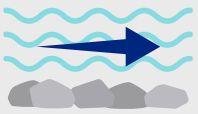




IMPROVES DRAINAGE

Water Flow and Velocity

Structural approaches are better able to withstand the shear forces when water moves at high velocities. Bioengineering approaches, like live pole drains, are more effective at improving drainage and moving excess water away from a site.



WITHSTANDS HIGH FLOW

Best of both

A combination of both structural and bioengineering techniques can be used at a single site. Using a combined approach can be more cost-effective (by minimizing the use of structural techniques) and can take advantage of the benefits of both approaches. For example, where water flows too quickly for bioengineering alone, short sections of structural techniques can be used to create longer sections where flow is slow enough for bioengineering. Bioengineering can also be used to provide habitat and promote revegetation amongst structural techniques to reduce environmental impact.

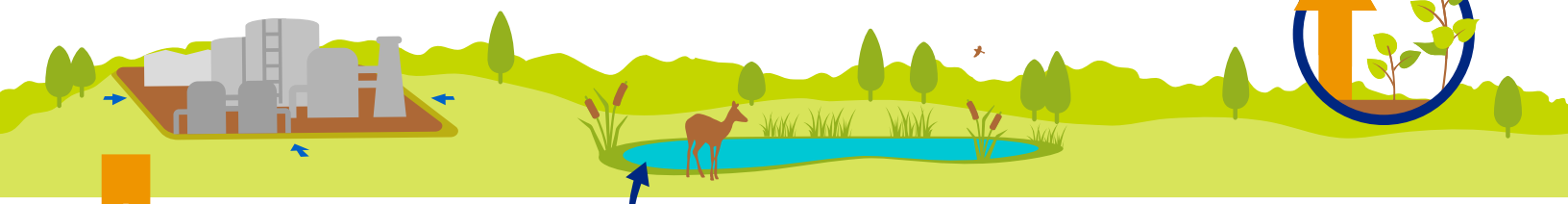
Prioritizing bioengineering

Where possible, it is preferable to prioritize bioengineering over structural approaches as they have fewer negative ecological impacts, blend in with the natural environment, and can help meet other environmental goals. These techniques:

Reduce intensity of industrial development footprints

Provide biodiversity benefits through creation of habitat diversity

Help rapidly re-establish vegetation (especially through phased closures)



Are more cost effective during operations due to lower material maintenance costs. There is also no requirement to remove synthetic materials or structures at closure

Can be used as a natural treatment for low-level contamination through applications such as treatment wetlands

Help create self-maintaining and self-healing ecosystems that grow stronger with time and can adapt to environmental changes

However, bioengineering is a relatively new practice and does not have the same history of research that structural approaches have. Many practitioners are well trained in structural approaches but lack understanding of many bioengineering techniques. Moving towards using more bioengineering approaches requires:

Increase of available training on techniques and installation

Production of live plants to reduce pressure on wild collecting

Expansion of research to improve confidence in techniques

To learn more visit:
cclmportal.ca/resource/bioengineering-and-conventional-erosion-and-sediment-control-solutions-oil-sands

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