

Artificial Wetland Creation – Purpose, Design and Construction

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A Canadian environmental technologies company:

- Based in Calgary, Alberta.
- Founded in 1998.
- Specializes in providing environmental services to the commercial/industrial and upstream oil and gas industry in Western Canada.
- Team of environmental consultants consisting of professional agrologists, biologists, chemists, ecologists, engineers, geoscientists, soil scientists, plant scientists, aquatic specialists, and foresters.
- Co-developed commercial phytoremediation systems to treat contaminated soil in an eco-friendly and responsible manner.

Site Details



Site was located in:

- Limited access
- Wooded poor fen

Surrounding area was forested:

- Labrador tea/black spruce
- Wildfire burnover in 2011

Required remediation due to:

- Pipeline release
 - Oil emulsion
- Contaminants
 - Salt & PHC
- Dead vegetation
- Volume soil removed
 - 2,500 m³ in 2015
 - Site left as open hole



Site Details



Site Details



Site Details



Remediation / Reclamation Goals

- Confirm complete remediation of site, soil and water,
- Compare reclamation options,
- Construct a fully functional wetland microcosm compatible with the adjacent ecosystem,
- Establish a self-sustaining plant community where wildlife and waterfowl can continue to succeed without human interaction,
- Maintain equivalent land capability.

Design Details

Based on:

General Design Guidelines for a Constructed ‘Habitat’ Wetland – Boreal Forest Natural Region of Alberta.

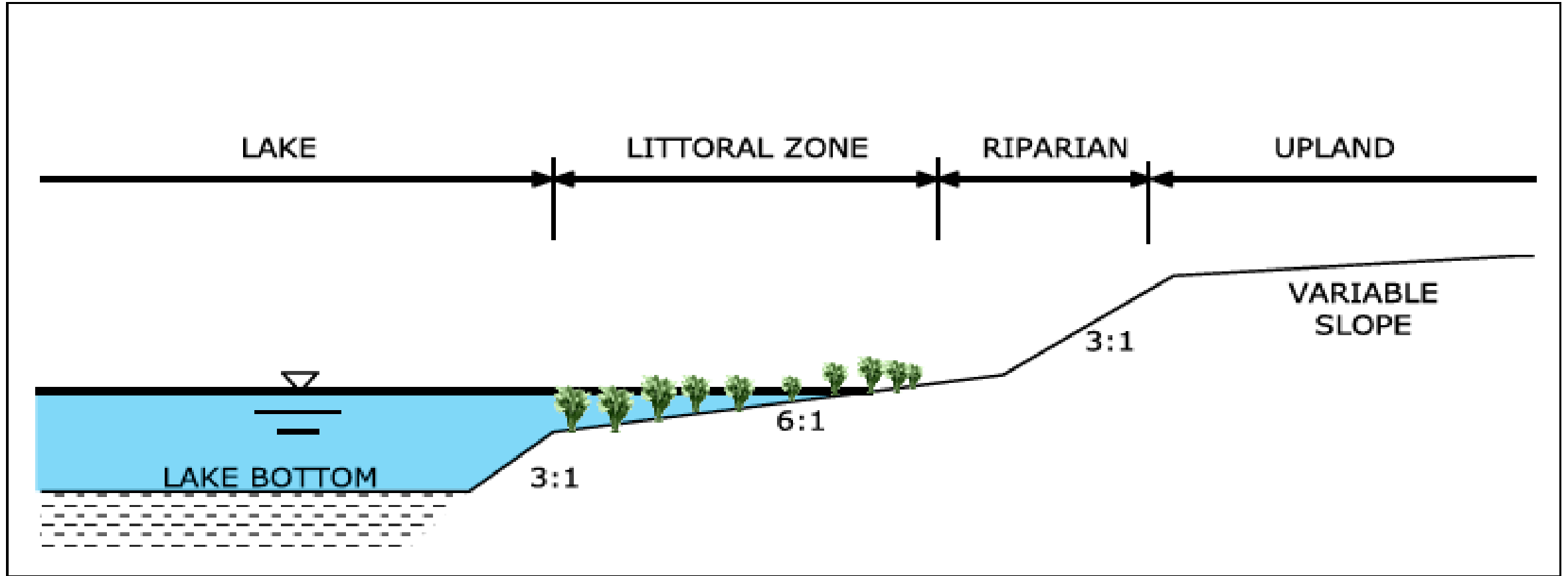
Government of Alberta (2014).

Species Name*	Common Name	Type of Microhabitat	Reclamation Techniques
<i>Equisetum arvense</i>	Common horsetail	Moist woods, swamps, fens, meadows	–
<i>Equisetum pratense</i>	Meadow horsetail	Moist thickets and meadows	–
<i>Phalaris arundinacea</i>	Reed canary grass	Lake margins, upper marsh zone, wet meadows; tends to be invasive, competing with other species	Sod forming grass that spreads by rhizomes or creeping rootstocks. Moderate seed production.
<i>Phleum pratense</i>	Timothy	Upland banks, moist meadows	Seed. Natural reseeding ability considered moderate. Displays no apparent ability to reproduce vegetatively.
<i>Agrostis scabra</i>	Rough hair grass	Wet meadows, shoreline of ponds	Seeds
<i>Calamagrostis canadensis</i>	Marsh reedgrass	Marshes, fens, shores, low meadows, temporarily flooded (wet meadows)	Seeds and rhizomes. Seed yields are low but seed has high viability
<i>Calamagrostis inexpansa</i>	Northern reed grass	Marshes, fens, shores, low meadows, temporarily flooded (wet meadows)	By seeds; spreads vegetatively
<i>Deschampsia caespitosa</i>	Tufted hairgrass	Wet meadows with high water level fluctuation	Seeds or plugs; donor wetland
<i>Equisetum palustre</i>	Marsh horsetail	Wet meadows, fens, muddy river flats	–
<i>Juncus nodusus</i>	Knotted rush	Moist ground, marshes and shores	–
<i>Lycopus asper</i>	Water horehound	Pond edges, marshes, wet meadows, thickets	–
<i>Mentha arvensis</i>	Wild mint	Lakeshores, wet meadows	Seeds and rhizomes; donor wetland
<i>Poa palustris</i>	Fowl bluegrass	Moist meadows and woods, shores	Seeds or plugs; intolerant of saline conditions.
<i>Potentilla palustris</i>	Marsh cinquefoil	Around fens, swamps, marshes, wet meadows; flooded.	Rhizomes/seeds; donor wetland
<i>Rumex maritimus</i>	Golden dock	Marshes and wet meadows; saline places	Rhizomes/seeds; donor wetland. Aggressive
<i>Rumex occidentalis</i>	Western dock	Marshes and wet meadows	Seeds
<i>Scutellaria galericulata</i>	Marsh skullcap	Wet meadows, thickets, streambanks, and lakeshores	Rhizomes/seeds; donor wetland

Wetland Design Details

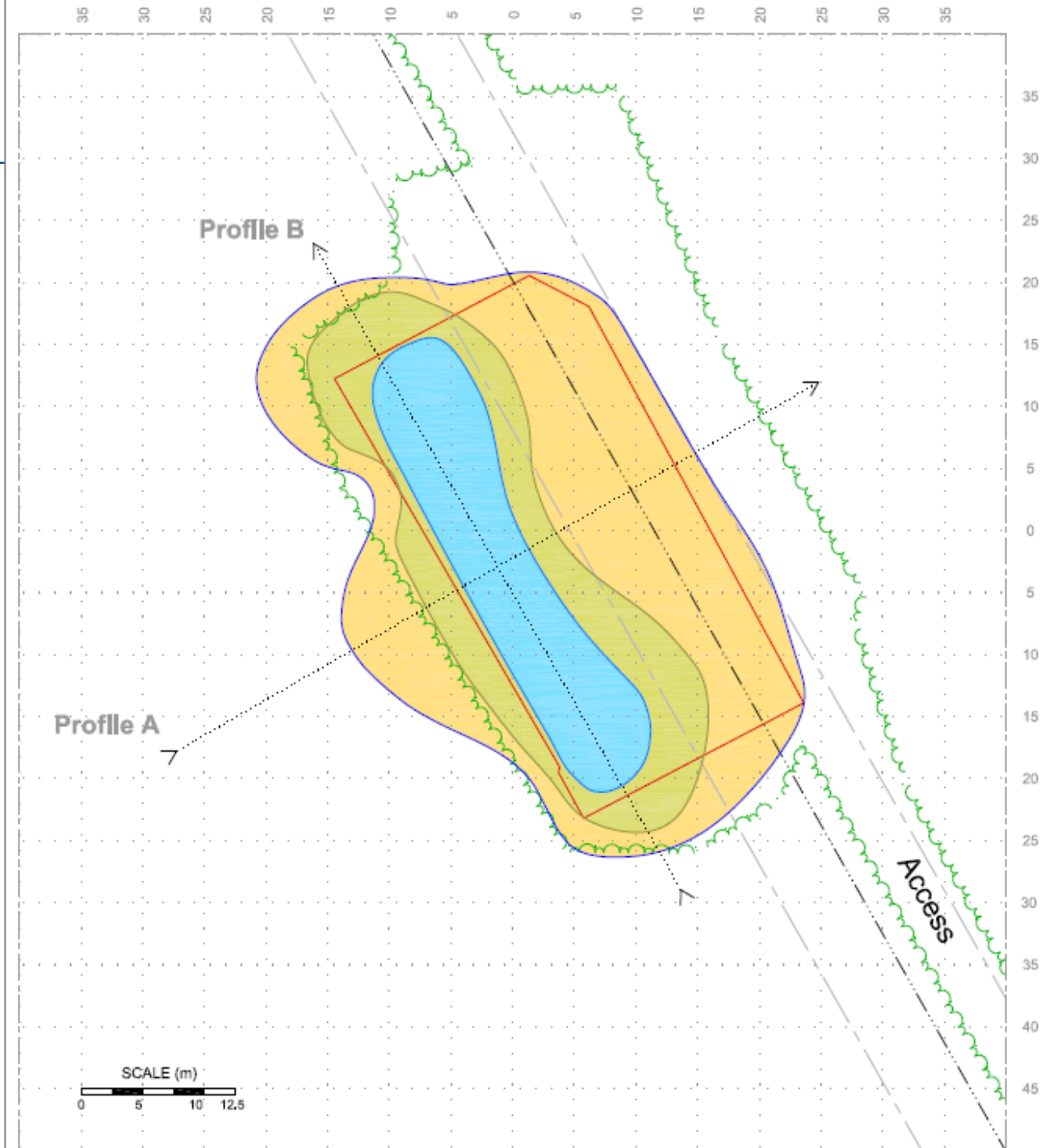
- Natural water table fluctuations: account for the natural variation in a fluctuating water table
- Bathymetric contours: provide different littoral zones with areas of deep, shallow, and open water
- Organic soil: provide stable and suitable root and rhizome penetration
- Mineral soil: added to increase the littoral surface area
- Substrate: required for wetland function and revegetation
- Shoreline: irregular shape and a variety of slopes
- Depth: irregular to allow for a variety of habitat
- Water recharge and discharge: allow precipitation and groundwater flow to enter and exit the wetland
- Accessibility: allow easy access to and exit from the wetland

Design Details



Design Details

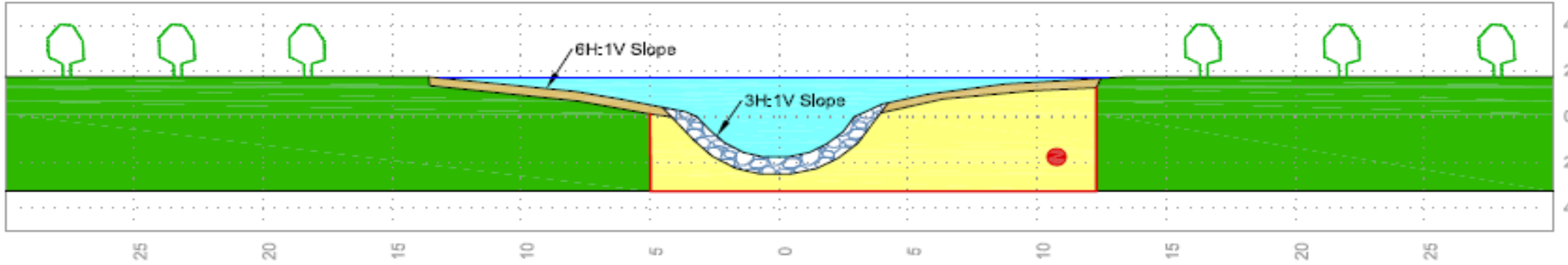
- The shallow littoral zone represents 694 m² (53%) of wetland habitat
- The deep littoral zone represents 345 m² (26%) of wetland habitat
- Mineral soil from a local source to fill the perimeter of the existing excavation and maintain the 6H:1V slope.



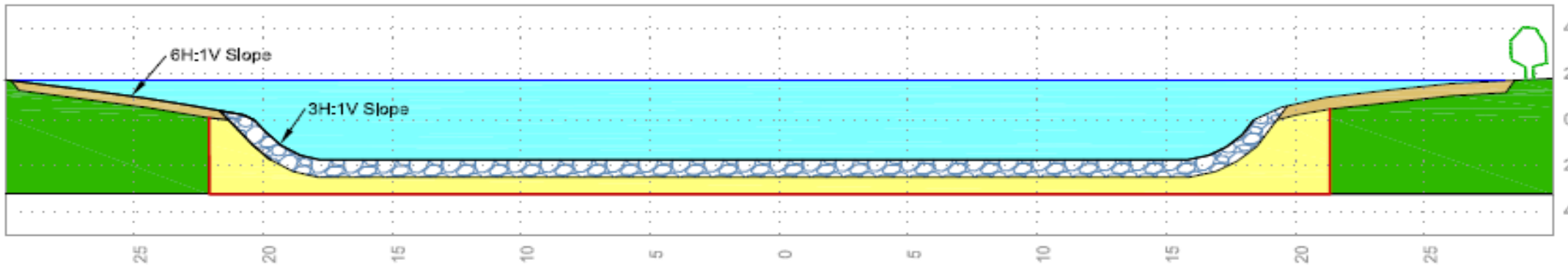
Design Details



Profile A



Profile B



Construction Details



Construction Details



Construction Details



Construction Details



Construction Details



Construction Details



Construction Details



Monitoring Requirements

- Annual reporting to regulator
- Site visits with regulator
- Monitor until equivalent land capability is reached
- Monitor and manage weeds
- Document wildlife sightings
- Document plant species ingress and diversity
- Allow for natural ingress



Mid-Season Site Visit



Mid-Season Site Visit



Mid-Season Site Visit



Vegetation Assessment – 7 Months

Area was divided into 6 strata:

- Background Treed Fen
- Background Littoral
- Constructed Wetland
- Constructed Littoral
- Backfill Clay
- Cleared Tree Fen

Established 115 randomized plot locations:

- Each plot was assessed for:
 - Bryophytes: Sphagnum, red stem, nights plume etc.
 - Herbaceous/Forbs: Marsh reed, smooth brome etc.
 - Shrubs: Labrador tea, highbush cranberry etc.
 - Trees: Black spruce, larch etc.
 - Undesirables: Sweet clover, thistle etc.
- % cover and height were measured by visual area
- Each plot 1x1m square

Vegetation Assessment



Identification of Strata

Strata were identified based on vegetation and classified as:

- Background (undisturbed) consisting of:
 - Treed fen – characterized by Labrador tea
 - Natural littoral – characterized by sedges and bullrush
- Reclamation (reclaimed land areas) consisting of:
 - Backfill clay – characterized by weeds
 - Clear fen – characterized by marsh reed grass
- Reclaimed wetland (created new) consisting of:
 - Constructed fen – characterized by sedges
 - Constructed littoral zone – characterized by sedges

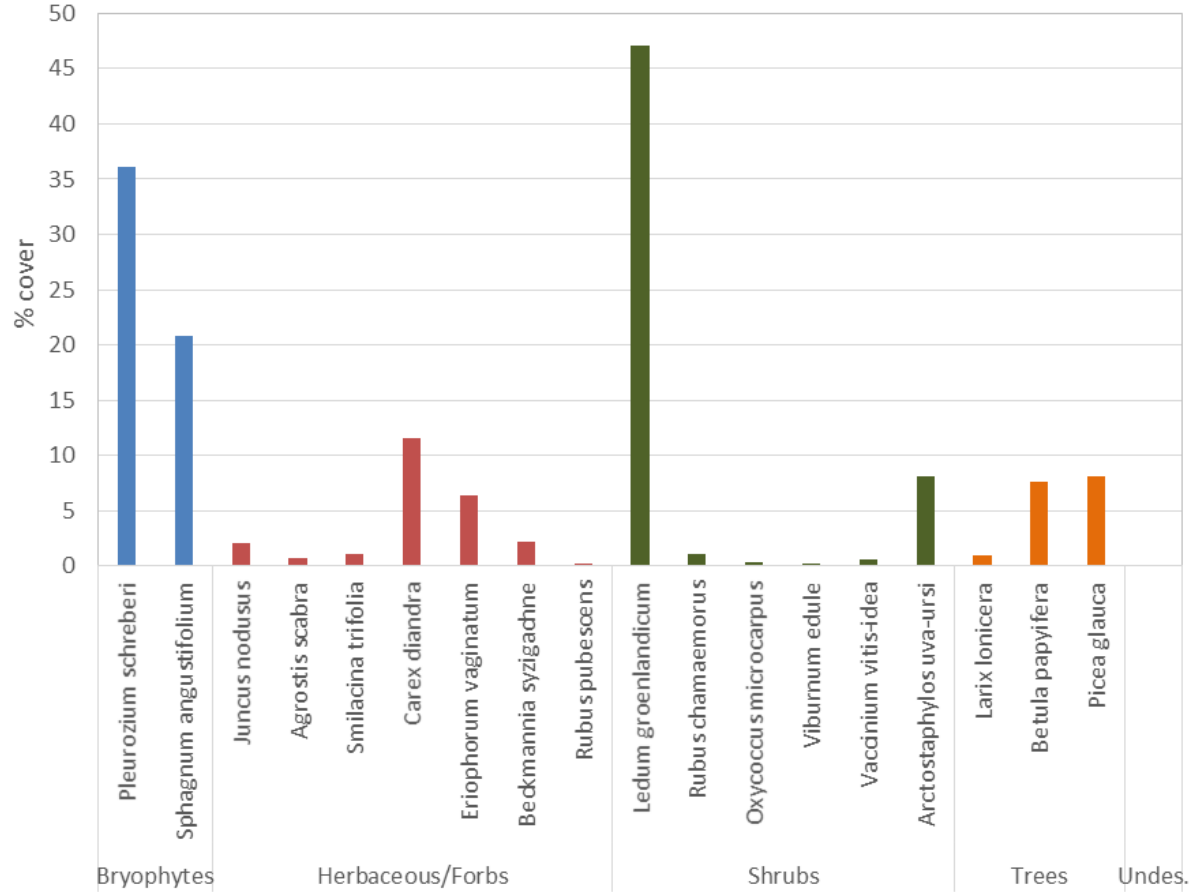
Treed Fen - Background



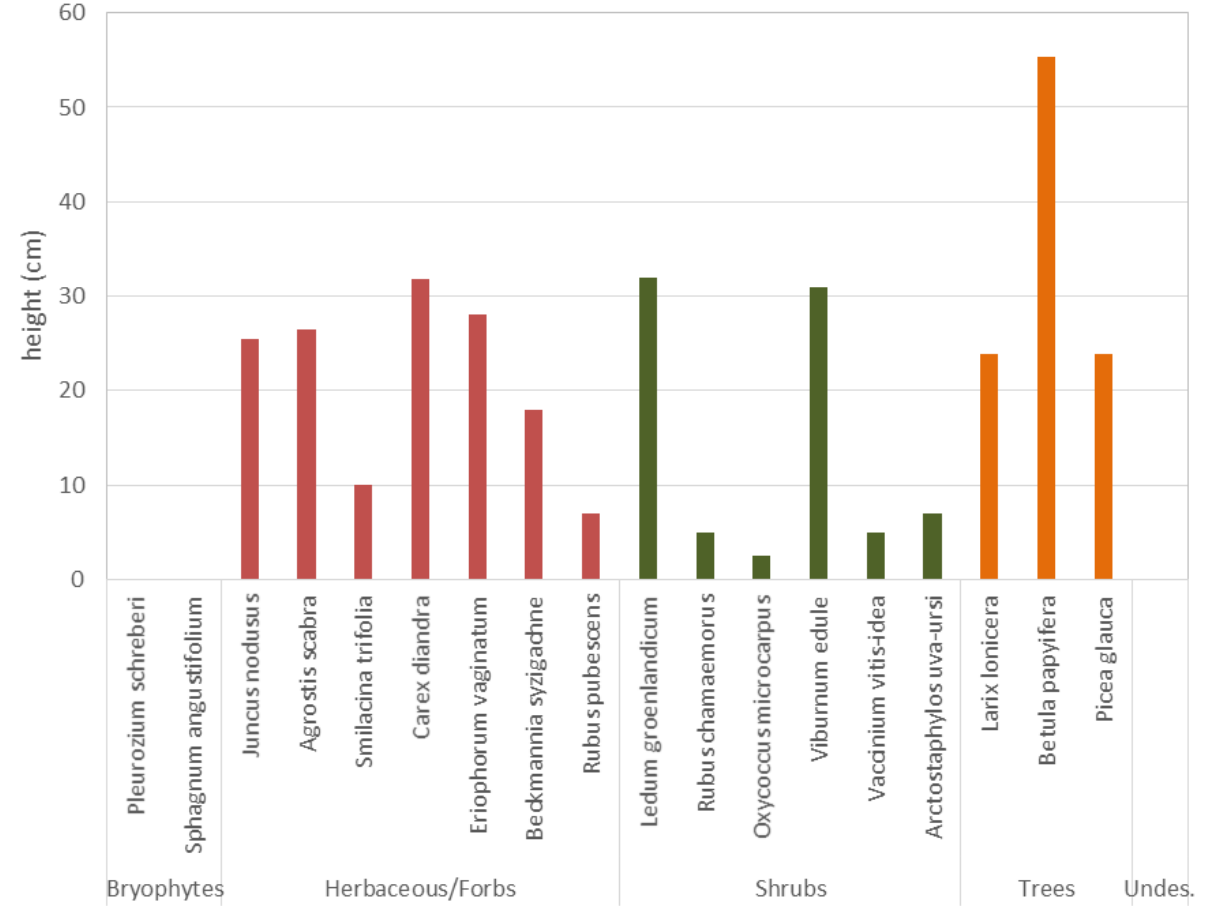
Treed Fen - Background



% Cover Treed Fen - Background



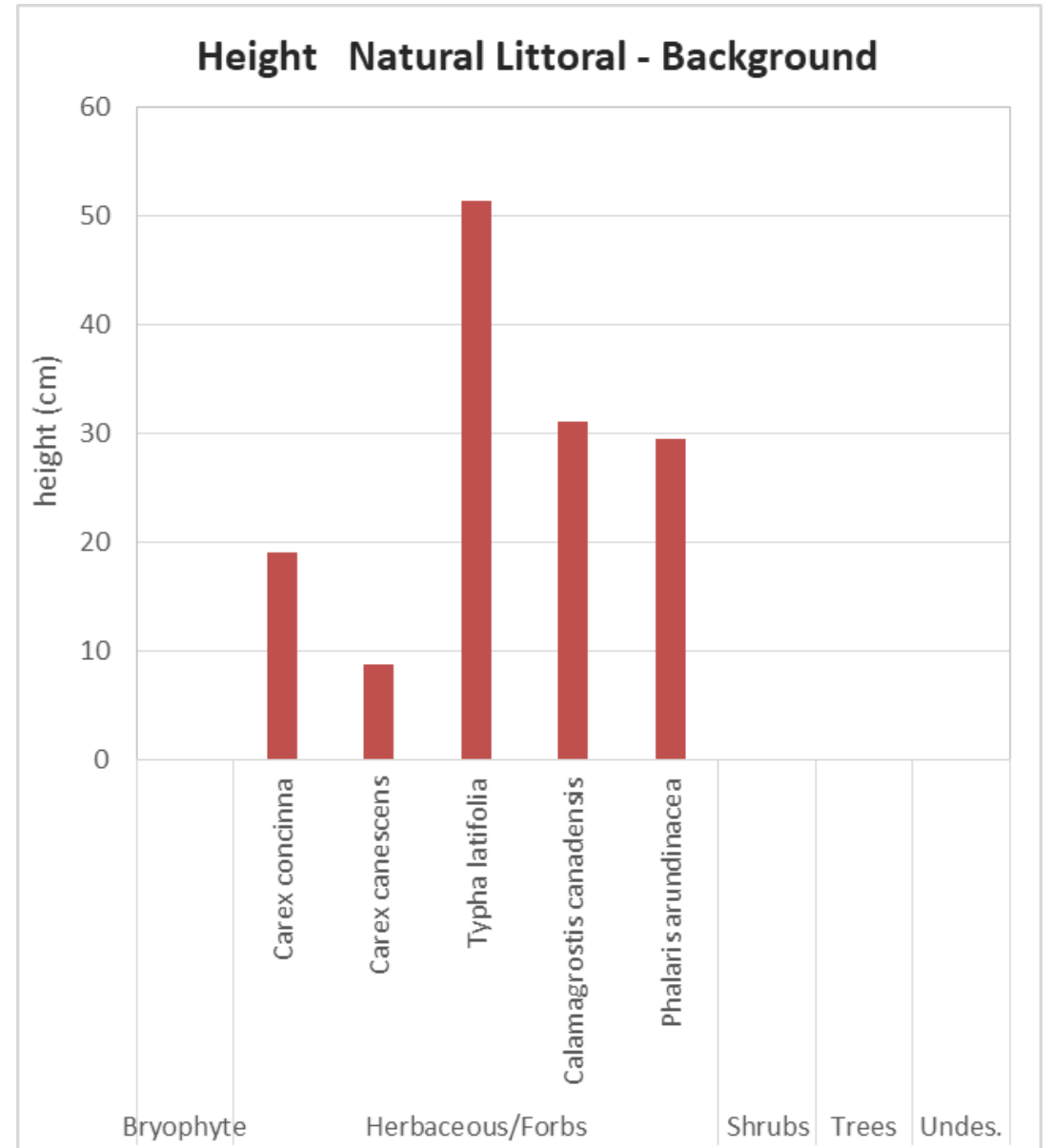
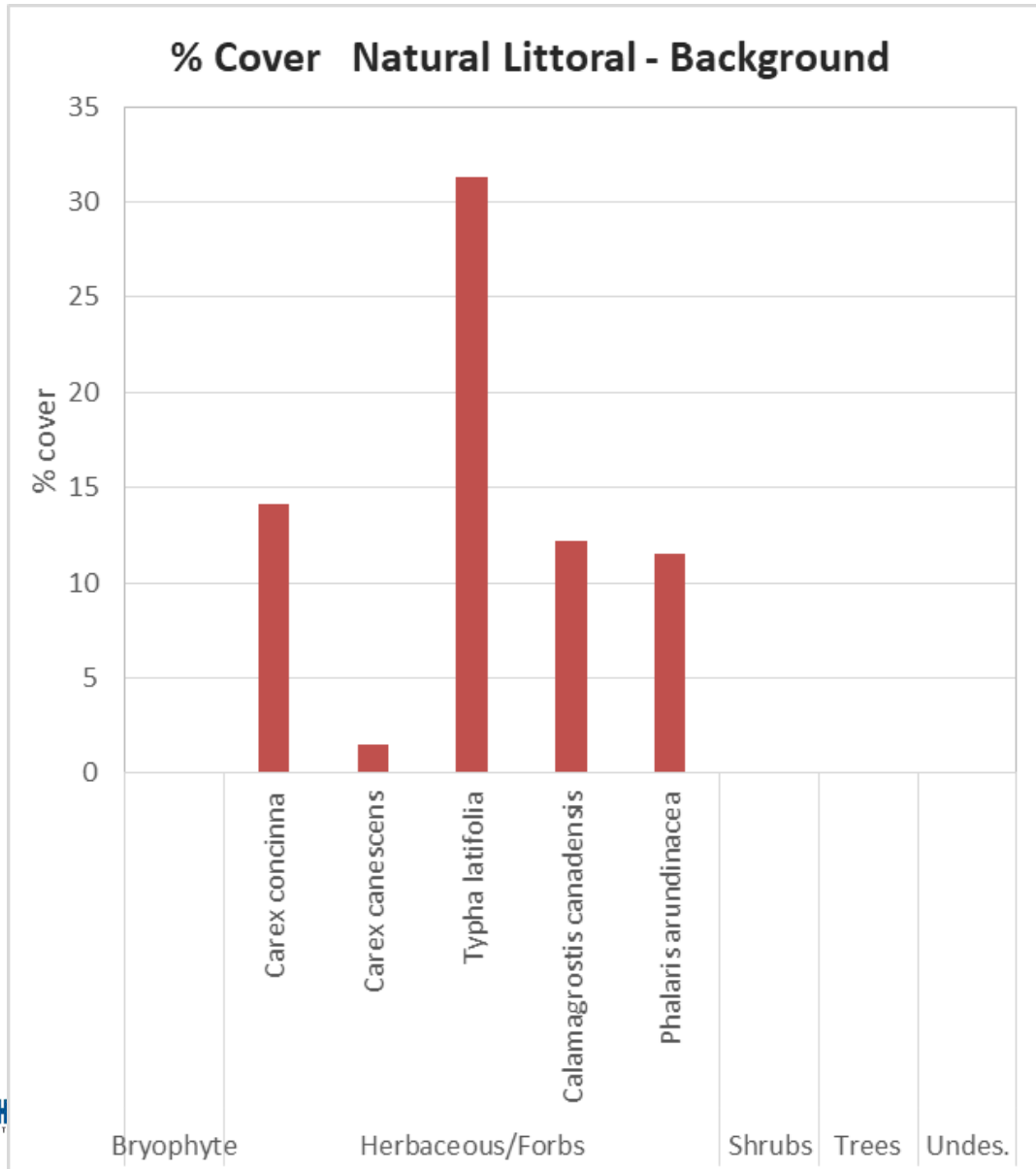
Height Treed Fen - Background



Natural Littoral- Background



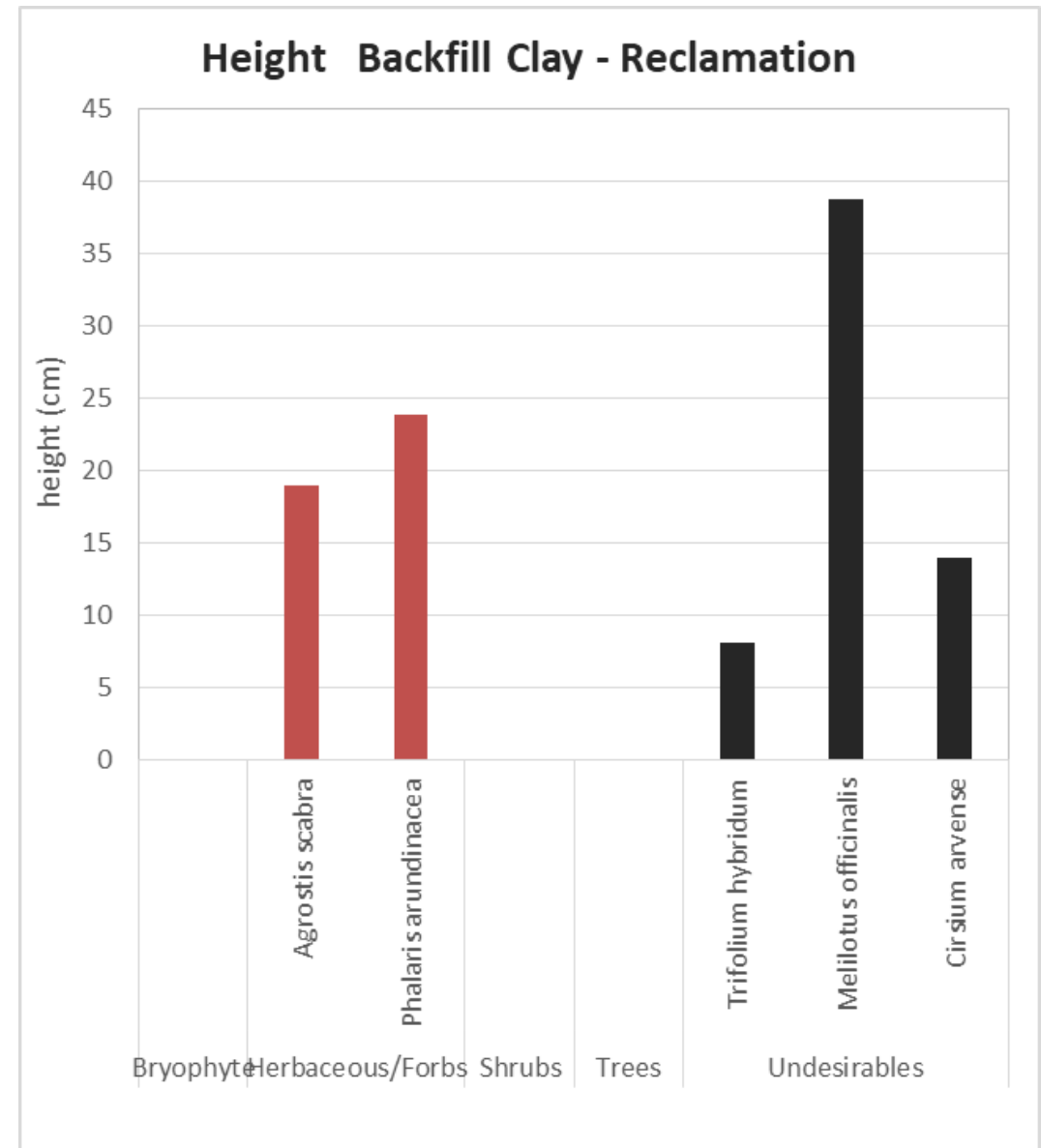
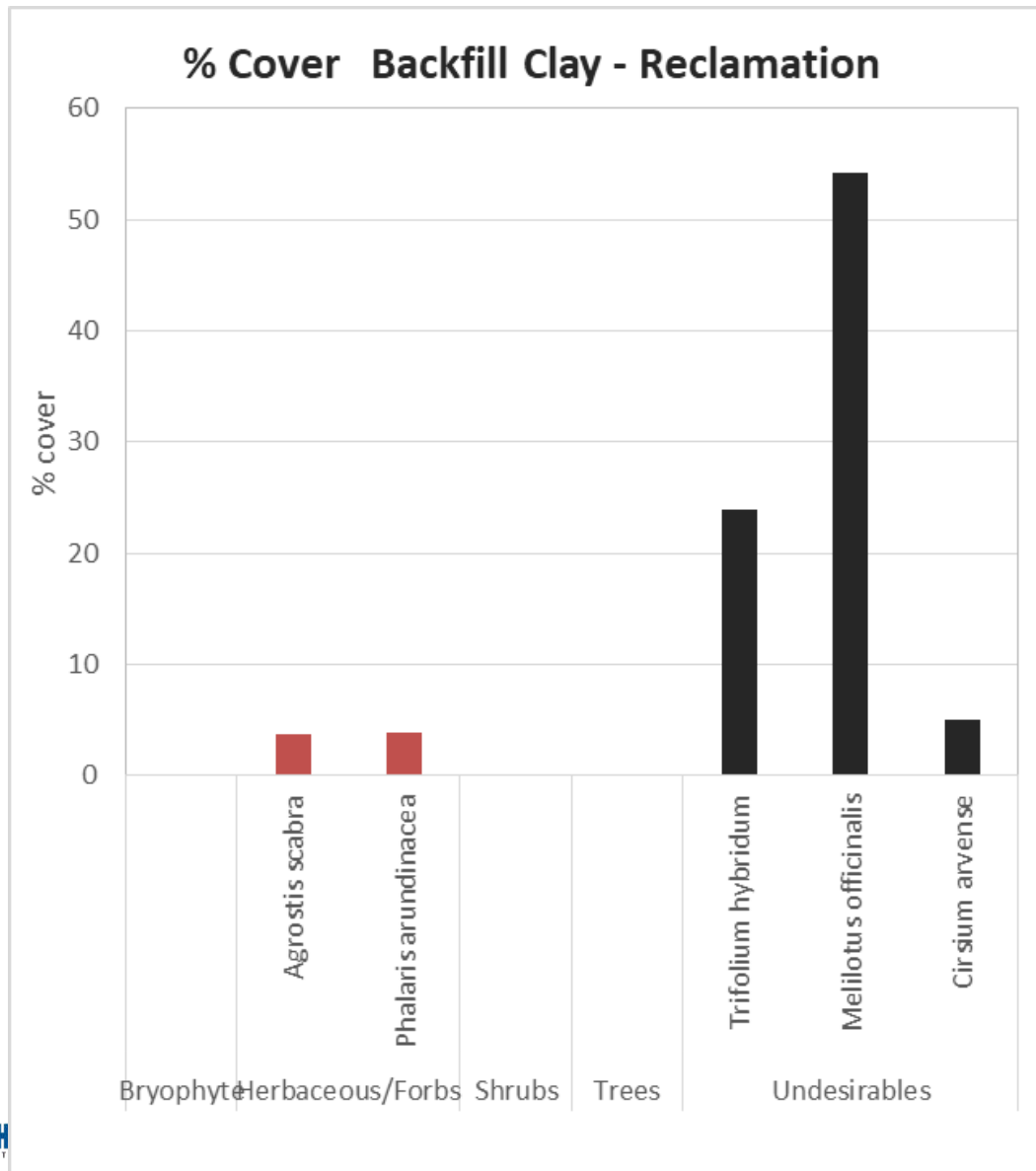
Natural Littoral- Background



Backfill Clay - Reclamation



Backfill Clay - Reclamation

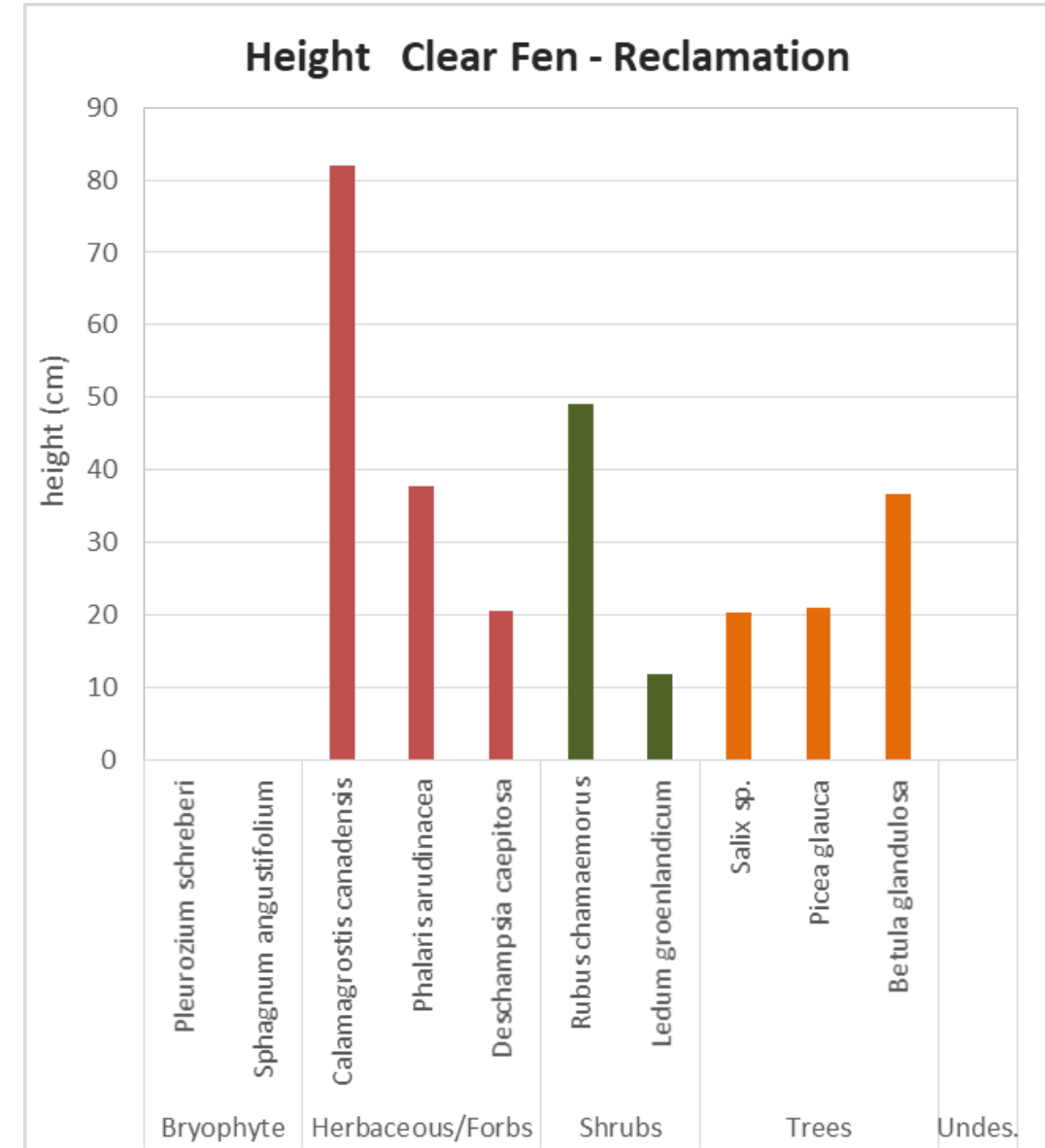
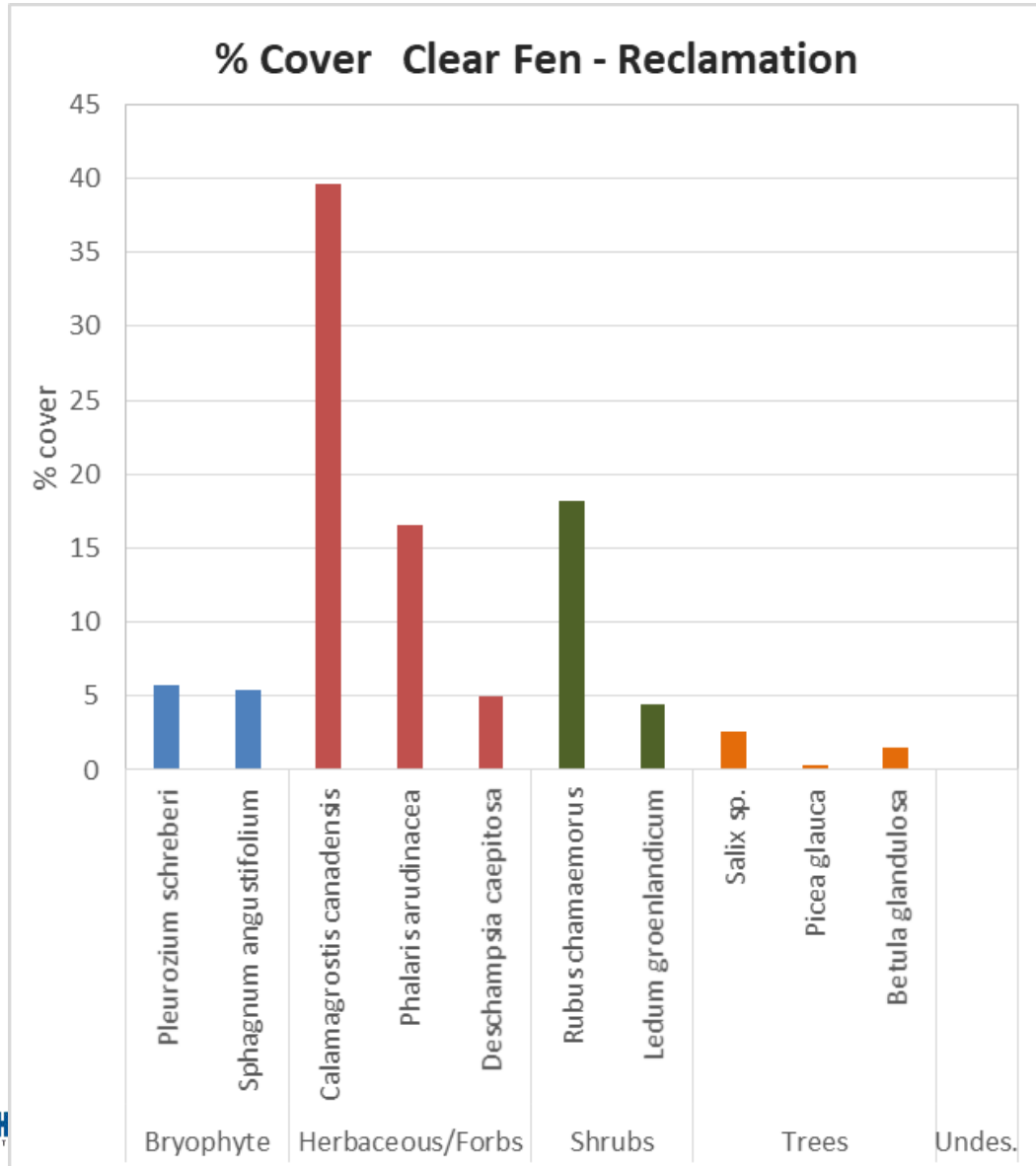


Clear Fen - Reclamation



Add picture

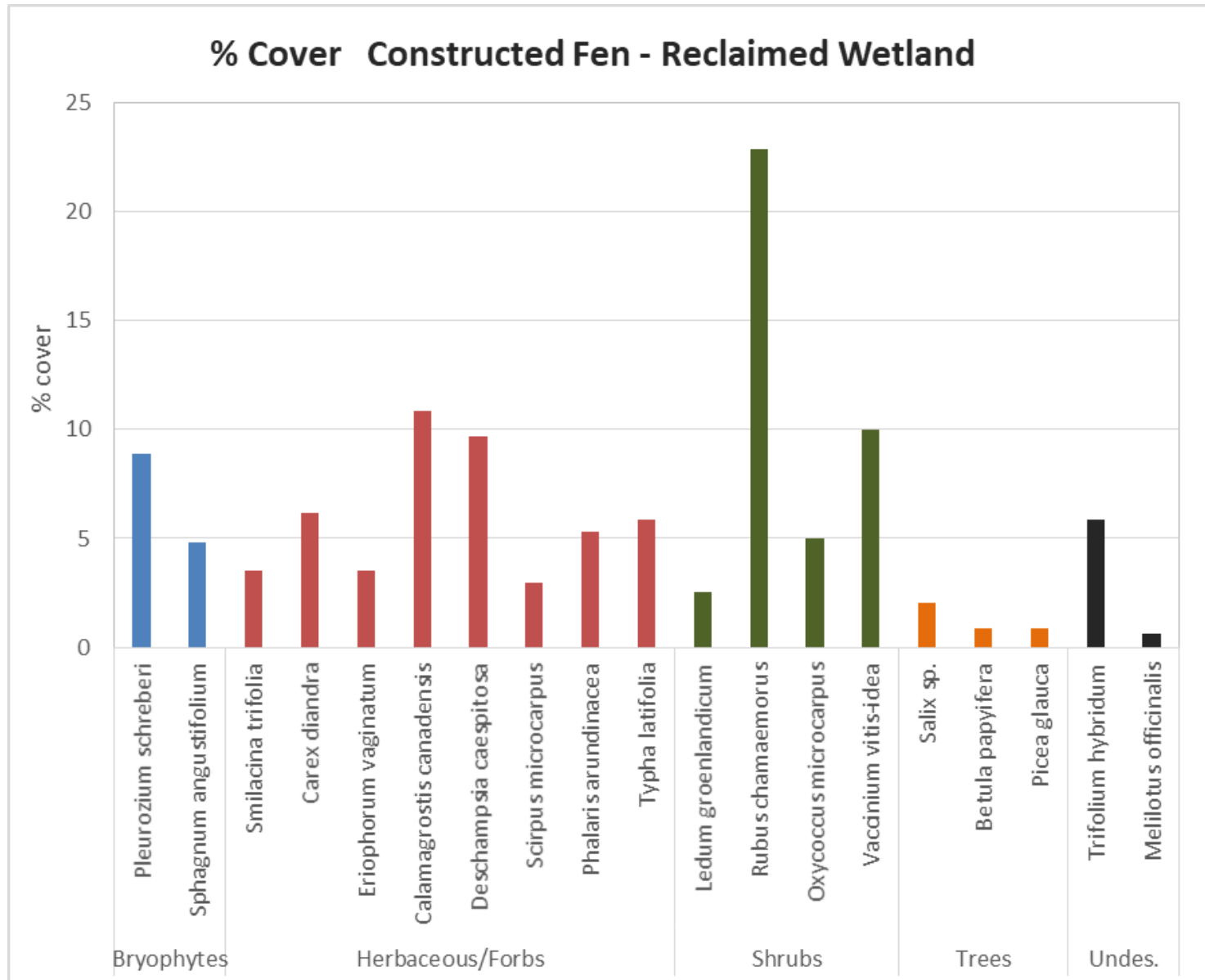
Clear Fen - Reclamation



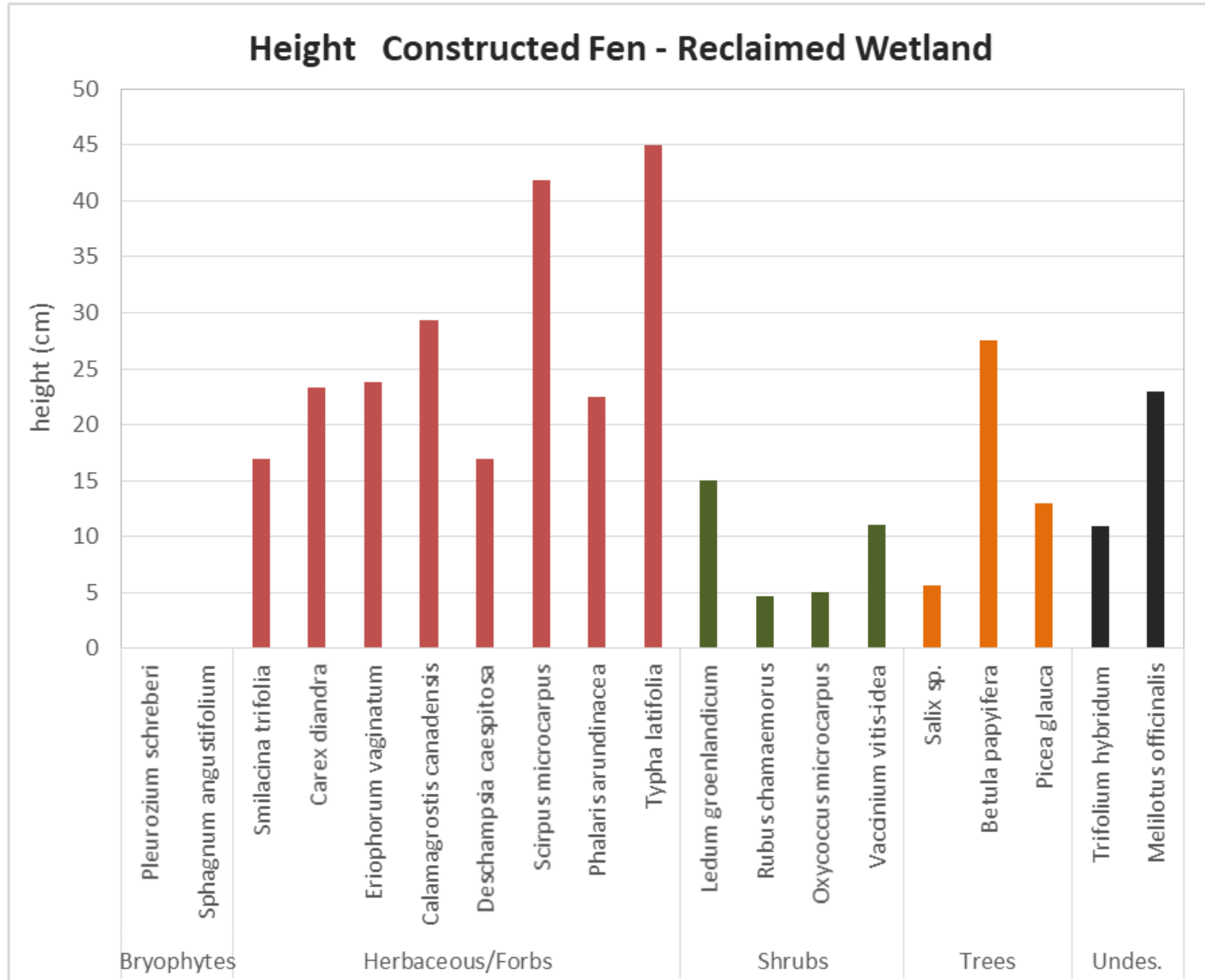
Constructed Fen – Reclaimed Wetland



Constructed Fen – Reclaimed Wetland



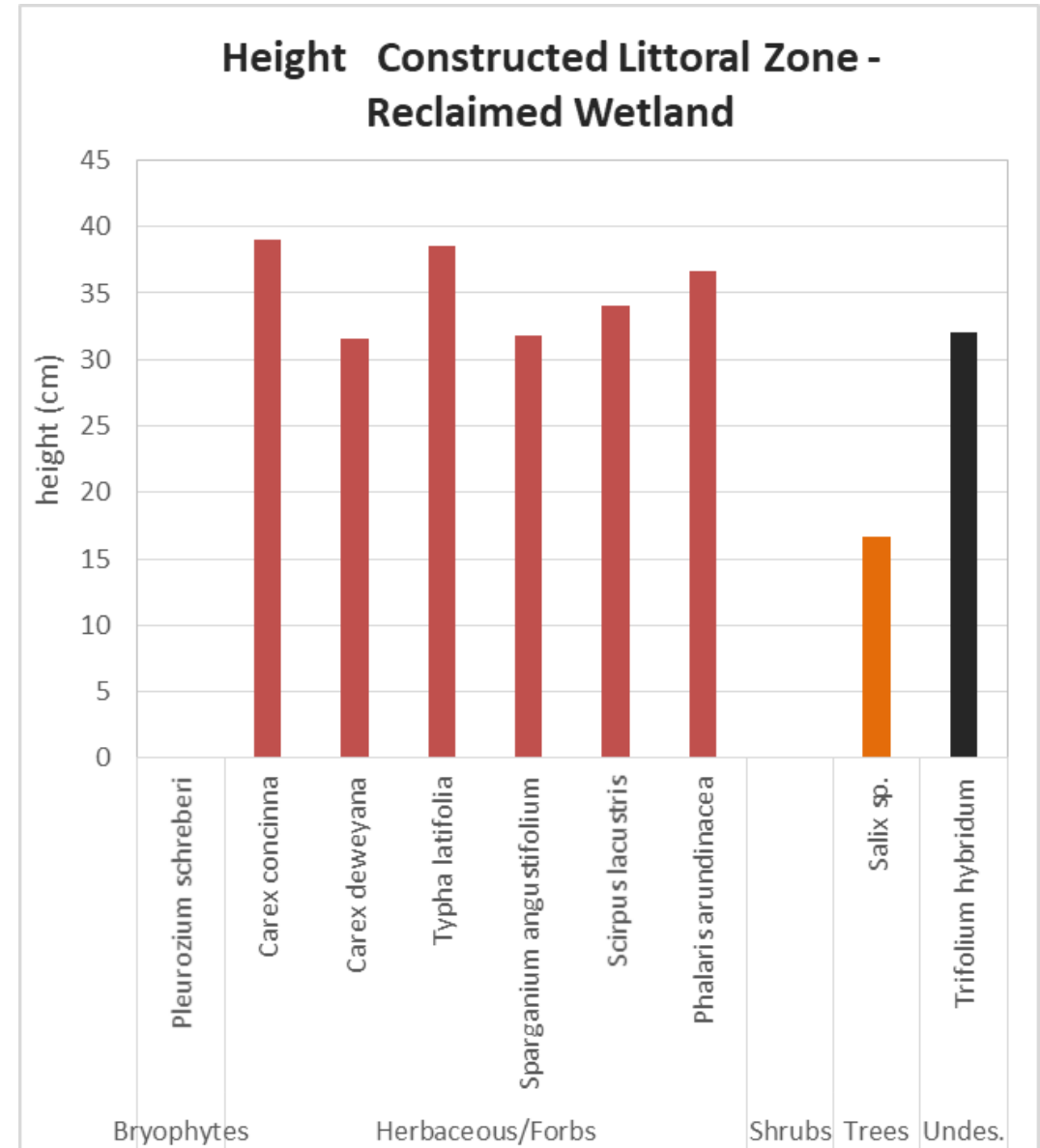
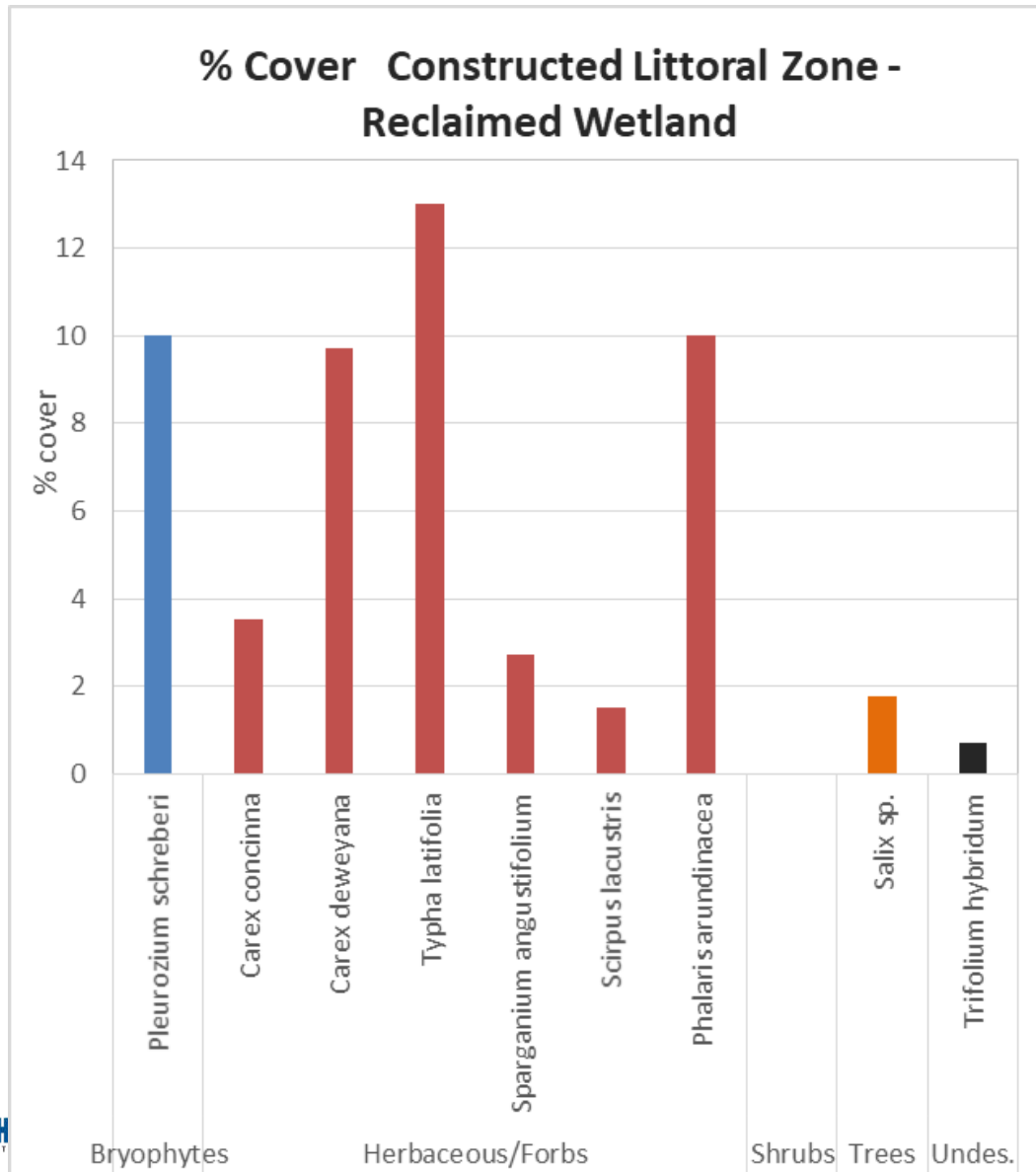
Constructed Fen – Reclaimed Wetland



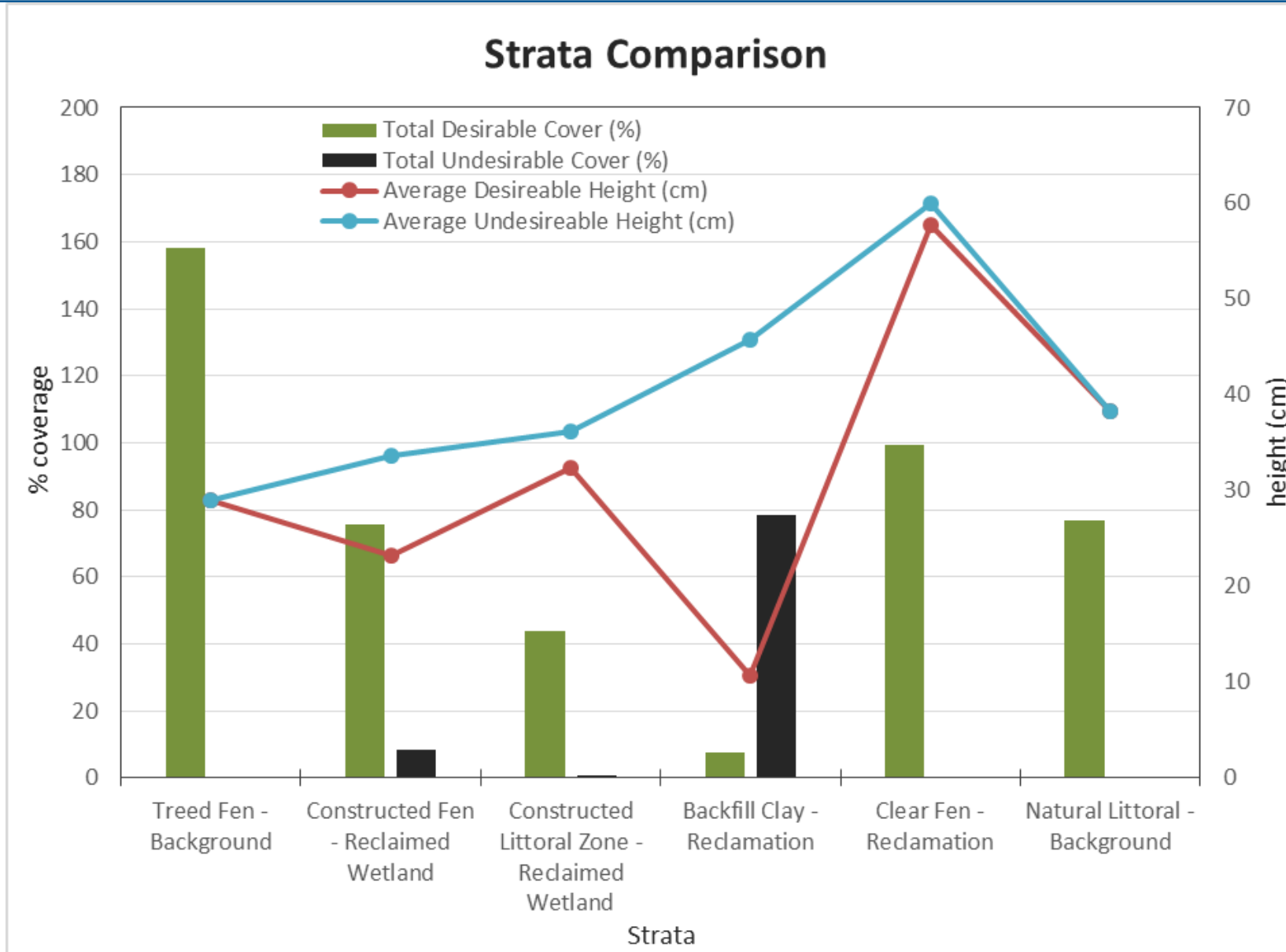
Constructed Littoral Zone – Reclaimed Wetland



Constructed Littoral Zone – Reclaimed Wetland



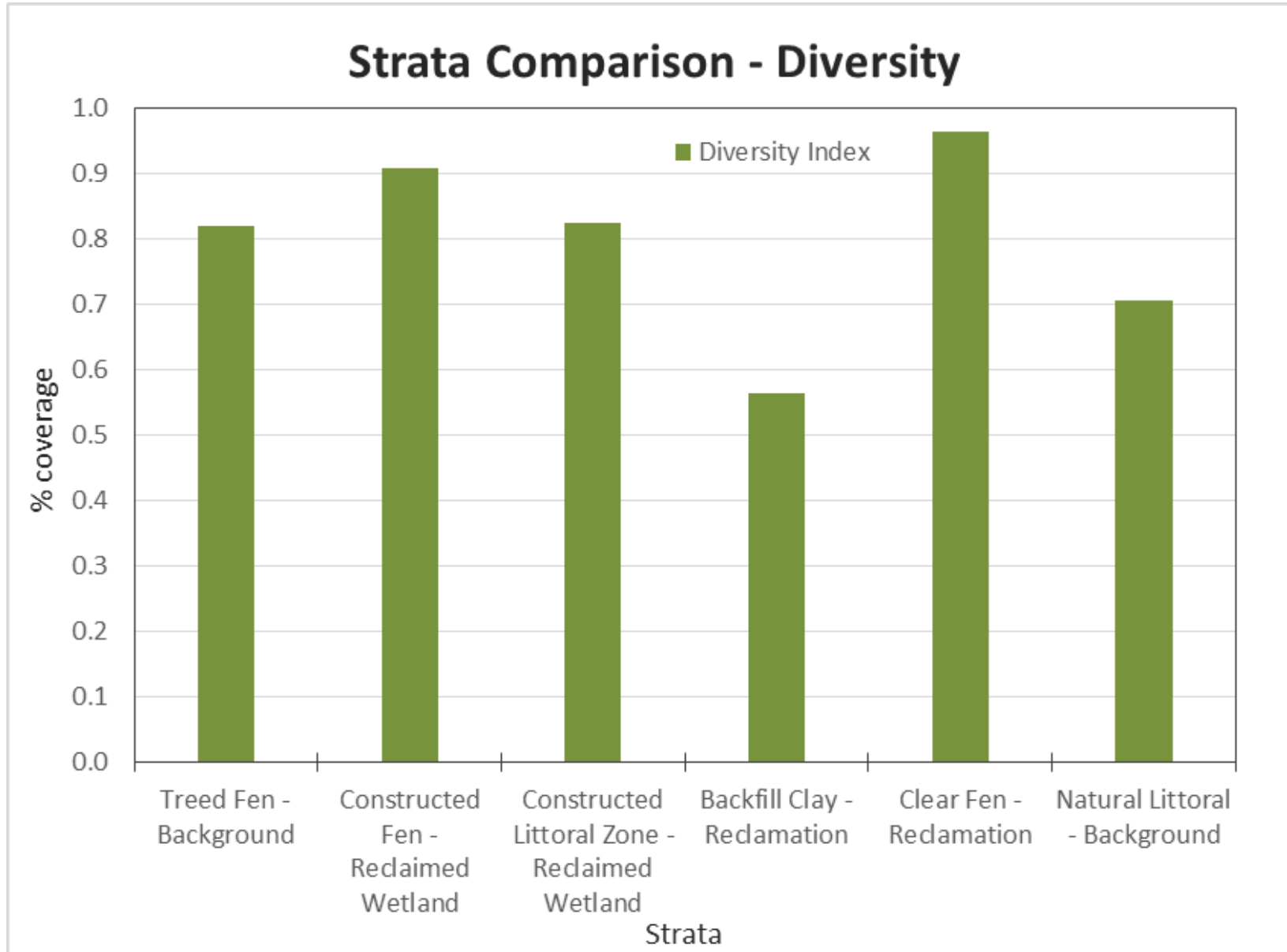
Strata Comparison



Simpsons Diversity Index

Compare diversity of each strata as an indication of ecosystem recovery.

Simpson Diversity Index Comparison



Monitoring Requirements - Future

- Continue to monitor establishment for another growing season
- Hope to have closure next winter
- Regulator is pleased to receive annual reports
- Compare backfill scenario to constructed wetland features

Lessons Learned

- The Good: Utilization of existing organic soils
- The Bad: Prefer not to undertake this activity over an abandoned pipeline
- The Ugly: Winter work highly recommended

Translating Lessons Learned to Native Prairie

Mineral vs Organic Wetlands...

- Weedy backfill can be suppressed in littoral zones
- Utilization of surface soils with natural revegetation and seed banks
- Minimized disturbance through seasonal variations
- Monitoring requirements may differ due to annual precipitation amounts
- Encourage the establishment of native habitat for critters

Thank You

