

DESIGN AND CONSTRUCTION MANAGEMENT ASPECTS OF CONSTRUCTED WETLANDS

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INTRODUCTION

Integration of constructed wetlands within land reclamation schemes afford opportunities to manage runoff, provide habitat and protect surface water quality. Constructed wetlands concepts can be applied to deal with poorly drained areas and can enhance the habitat and water quality value of post-reclamation ponds and lakes.

CONSTRUCTED WETLANDS DEFINITIONS

In considering application of wetland ecosystems for water quality enhancement, a very broad definition of "wetland" is useful.

"Wetland is defined as land having the water table at, near or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophytic vegetation and various kinds of biological activity which are adapted to the wet environment." (Tarnocai, 1979)

This definition includes a wide range of systems and land forms including ponds, marshes, sloughs, muskeg, wet meadows and floodable forests which provides an extensive palette for water management, site rehabilitation and landscape design.

Wetlands can also be distinguished by the degree of human intervention and four distinctions are commonly used (US SCS, 1992):

Natural wetlands:	no human alteration
Restored wetlands:	reconstructed on former wetland sites
Created wetlands:	constructed on sites where no wetlands existed primarily to compensate for natural wetlands lost to development
Constructed wetlands:	constructed with the intent of managing water quality

Natural wetlands are not typically used for wastewater treatment. Constructed wetlands are designed with flow paths, water depths, water distribution and vegetation compatible with the influent stream in a way which results in the desired effluent quality, aesthetics and habitat features.

CONSTRUCTED WETLANDS APPLICATIONS

Constructed wetlands have been used for a variety of water management purposes:

Municipal Wastewater Treatment: Secondary - tertiary treatment of domestic or municipal wastewater. Constructed wetlands are used to enhance removal of organic material, suspended solids and nutrients.

Agricultural Wastewater and Runoff Treatment: Constructed wetlands and wetland concepts (e.g. floodable buffer strips) are used to treat effluents from intensive livestock operations and runoff from cultivated and pasture lands.

Mine Drainage: Remove suspended solids and metals, as well as adjust pH of contaminated runoff and drainage from mine sites. If systems receive runoff from eroding sites, inlet ponds can be provided to reduce sediment loads on the marsh cells.

Industrial Wastewater Treatment: Provide secondary, tertiary and/or polishing treatment for industrial effluents and site runoff for pulp mill effluents, refinery wastewater, food processing plant discharges and runoff from industrial sites.

Leachate Treatment: Remove oxygen demand, suspended solids, metals, organics and nitrogenous compounds from municipal and industrial landfill leachates and surface runoff.

Stormwater Management: Removal of suspended solids, bacteria, organic matter and nutrients from urban runoff. Stormwater wetlands are also employed as runoff detention facilities to reduce downstream flooding risks.

MULTIPLE BENEFIT DESIGN OPPORTUNITIES WITH CONSTRUCTED WETLANDS

Among water treatment technologies, constructed wetlands concepts provide an opportunity to design with multiple values in mind incorporating engineering function, wildlife habitat, naturalized vegetation and pleasing aesthetics into a single project. In many cases the combination of these values into design can lower costs, enhance land values and increase public acceptance of related facilities.

Functional Purpose: The engineering function is usually a primary purpose for developing a facility. Such functions include contaminant removal from domestic wastewater, sediment removal from runoff and detention to control peak stormwater flows.

Aesthetic Value: Naturalized wetland sites can be aesthetically pleasing and can enhance the experience of surrounding land uses, in fact stormwater wetlands have been shown to increase the value of surrounding properties. By utilizing floodable forests and wetlands, natural appearing buffers can be established surrounding gravel operations, landfills and industrial sites. The concept transforms a regulatory necessity such as stormwater containment into an amenity which enhances the public perception of the proposed site use.

Ecological Enhancement: Constructed wetlands can provide a wide range of habitat which compensate for loss of natural areas to urban and industrial development. Designed with marsh, open water pond and upland buffer vegetation zones, these wetlands provide a diversity of micro-habitats for a wide range of wildlife. Stormwater wetlands and associated overland flow channels can form the basis of linear urban park systems which can provide important wildlife corridors in developed areas. Wetland modifications such as aquatic benches and shore fringe can improve the habitat value of lagoons and stormwater lakes by providing cover, food and nesting habitat.

Recreational Uses: Pathways and wildlife viewing points (bird watching) integrated into constructed wetland projects can provide increasingly sought after nature-centered recreation. The inclusion of naturalized vegetation (wet meadows, marsh areas, floodable forests) attracts animal life and presents a diverse, seasonally changing experience for recreational users.

Developer Benefit: Naturally vegetated systems of distributed stormwater wetland detention sites with interconnecting overland drainage channels would not only greatly enhance stormwater quality but also could reduce costs for piped stormwater systems. Park-like stormwater facilities have become perceived as amenities by consumers increasing the value of lots abutting the sites. Creation of naturalized open spaces with lower maintenance costs can appeal to municipal agencies increasing the chances for land use designations favorable to the developer.

CASE STUDIES

Calgary Constructed Wetland Pilot Project

Objectives: Evaluate water treatment capability of stormwater wetlands in Calgary climate.

Design Features: Alternating pond - marsh zones and vegetation test areas.

Ancillary Benefits: Future development as an urban park - wetland interpretive site.

Winnipeg West End Pollution Control Center Lagoon Decommissioning

Objectives: Retain obsolete lagoons for waterfowl habitat.

Design Features: Enhancement of lagoons with aquatic bench marsh zones.

Ancillary Benefits: Incremental effluent treatment and lower reclamation costs.

Bow Ridge Stormwater Wetland

Objectives: Address anticipated public and municipal objections to development.

Design Features: Reconstruction of riparian wetland area with pond and marsh zones.

Ancillary Benefits: Will provide stormwater water quality enhancement and park area.

Calgary Zoo Northern Forest Wetland

Objectives: Reduce potential contaminants in runoff and drainage from zoo exhibits.

Design Features: Floodable forest detention/treatment zone, wetland habitat exhibits

Ancillary Benefits: Wetland interpretive displays, regulatory/public acceptance.

Hobbema Correctional Facility Integrated Water Reuse Wetland

Objectives: Provide for integrated water use and domestic wastewater reuse.

Design Features: Packaged treatment unit, wetland polishing and storage ponds.

Ancillary Benefits: Landscape amenities and acceptance of on-site effluent irrigation.

Edgemont Stormwater Wetland

Objectives: Provide stormwater detention.

Design Features: Sediment forebay, passive subsurface wet meadow irrigation.

Ancillary Benefits: Park area, water quality improvement and amenity land value.

Nowicki Farm Feedlot Runoff Treatment Wetland

Objectives: Reduce contaminants in runoff from feedlot.

Design Features: Inlet pond and multiple marsh zones.

Ancillary Benefits: Improved land drainage and reduced cattle health risks

Gregg River Coal Mine Aquatic Habitat Enhancement Wetlands

Objectives: Reclamation of coal mine including end-cut lake.

Design Features: Marshes to intercept inflow and end cut lake littoral wetland zones.

Ancillary Benefits: Addition of nutrients, vegetation and detritus to enhance fishery.

CONCLUSIONS

Constructed wetlands using concepts such as marshes, ponds and floodable forests have a role in land reclamation, as well as in mitigating the impacts of development. With consideration of potential multiple values, wetlands can provide water quality improvement, hydrological control, habitat enhancement and human amenity. Early applications of constructed wetlands in Western Canada indicate the techniques are feasible and cost effective.

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