Aerated lagoon #1

Aerated lagoon #2

Subsurface Flow Wetland Cell

Hi-Land Acres Facility Statistics	
Nearest Town:	**Brighton**
County:	**Adams**
River Basin:	**Upper South Platte**
Receiving Water Body:	**Todd Creek**
Year Operational:	**1998**
Population:	**300**
Elevation (feet):	**5144**
Design Flow (mgd):	**0.055**
Average Flow (mgd):	**0.022**
Size (acres):	**0.21**

Facility Description

The Hi-Land Acres Water and Sanitation District wastewater treatment facility is a minor municipal lagoon system. The facility consists of two completely mixed aerated lagoons and one settling pond followed by a subsurface flow treatment wetland and gas chlorination. The influent flow is measured by a 6-inch Parshall flume with a continuous recorder and totalizer. The effluent flow is measured by a 90° v-notched weir with a continuous recorder and totalizer.

The two aerated cells are equipped with four aspirating aerators, that apply approximately 27 percent more energy than is recommended in the 1983 USEPA design manual for complete mix aerated lagoon systems. The goal of using high energy mechanical mixers coupled with long residence times is to achieve complete nitrification.

Effluent from the aerated cells flows into a quiescent pond. Suspended solids, particularly algae, will settle out in the settling pond. The wetland cell will then intercept most of the remaining suspended solids before discharge to the chlorine facility and ultimately final discharge to the receiving water body.

Lagoons

The Hi-Land Acres lagoon system consists of 2 completely mixed aerated cells followed by 1 settling cell. Some features of the lagoon system are detailed in the table below.

Lagoon Information			
Cell No.:	**1**	**2**	**3**
Surface Area (sq. ft.)	**9,840**	**9,840**	**9,753**
Avg. Depth (ft)	**12**	**12**	**8**
Avg. Volume (Million gallons)	**0.40**	**0.40**	**0.23**
Detention time (days)	**6.6**	**6.6**	**4.0**
Aerator size (hp)	**30**	**30**	**NA**

Background Information

The Hi-Land Acres District has operated a wastewater treatment facility since 1964. Numerous violations of the permit effluent parameters during the period from 1987 to 1992 have been recorded. In the fall of 1995 the system was in “Significant Noncompliance” due to exceeding effluent limitations for BOD_5 and TSS. In addition, the facility has had a history of numerous pH violations. The District undertook several system modifications to improve the effluent quality. In November of 1998, the aerated lagoon was divided into two smaller cells to reduce the hydraulic retention time. Pontoon supported aspirating mechanical aerators replaced the failing synthetic membrane diffusers. In addition new outlet control structures were added to allow flexibility in the operating water level in each lagoon cell. The subsurface wetland system was added to polish the lagoon effluent prior to chlorine disinfection and final discharge to Todd Creek.

Energy Analysis

The Hi-Land Acres system utilizes 4-7.5 hp motors in its aerated lagoon system. The aerators are operated full-time with 39 hp per million gallons of mixing power. This results electrical consumption of 640 kW per day.

Construction, Maintenance and Operational Cost

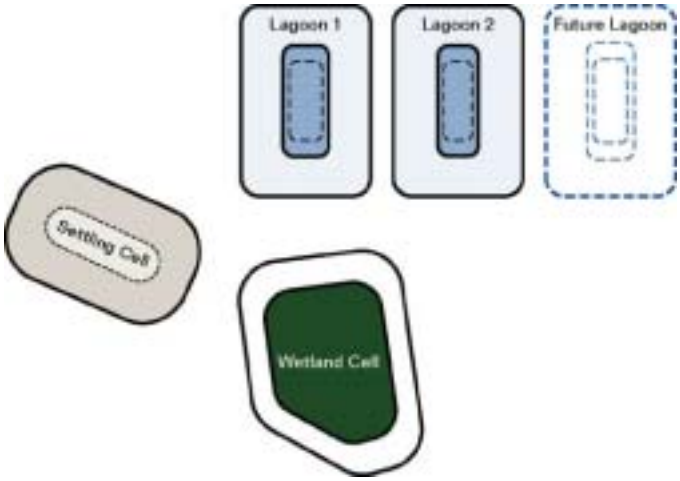
The approximate construction costs for this system were $250,000. The wetland was installed in an abandoned lagoon, so earthwork was minimized. Annual maintenance and operational costs are approximately $20,000.

Design Methods

The subsurface wetland system was designed to remove suspended solids and algae from the lagoon effluent prior to discharge into Todd Creek. A hydraulic residence time of 36 hours at design flows was used to size the wetland system.

Size

The wetland area is approximately 9,148 ft2. The depth of the media in the wetland cell is 4.5 feet with a porosity of 28%. This provides a water volume in the cell of approximately 1,525 cubic yards.



Shape

The subsurface flow wetland was installed by retrofitting an abandoned lagoon. The overall shape of the wetland is roughly square, with a length to width ratio of 1:1.

Hydraulics

The wetland consists of shallow earthen basin filled with ¾ - inch gravel placed to a depth of 3.5 feet. Lagoon effluent is distributed through the wetland area by a perforated pipe buried in the gravel media. The wetland effluent discharges through a perforated pipe buried in the gravel media into an outlet control structure. Aluminum stop logs in the outlet control structure form a weir to control the water surface elevation in the wetland. Stop logs can be inserted or removed to vary the water surface elevation and hydraulic retention time in the wetland.

Effectiveness

The lagoon/wetland system has shown promising results. Tests taken show that the wetland removes 53 percent of the BOD and 58 percent of the TSS remaining in the lagoon system effluent.

Treatment Goals

Permitted Discharge Limitations	
Oil and Grease:	**10 mg/l (Daily Max)**
BOD_5:	**30 mg/l (30-day ave)**
BOD_5 Removal:	**85%**
TSS:	**75 mg/l (30-day ave)**
PH, su (min – max)	**6.5 – 9.0 (Daily Max)**
Chlorine Residual:	**0.02 mg/l (Daily Max)**
Fecal Coliform Bacteria:	**1,500 organisms per 100 ml (Daily Max)**

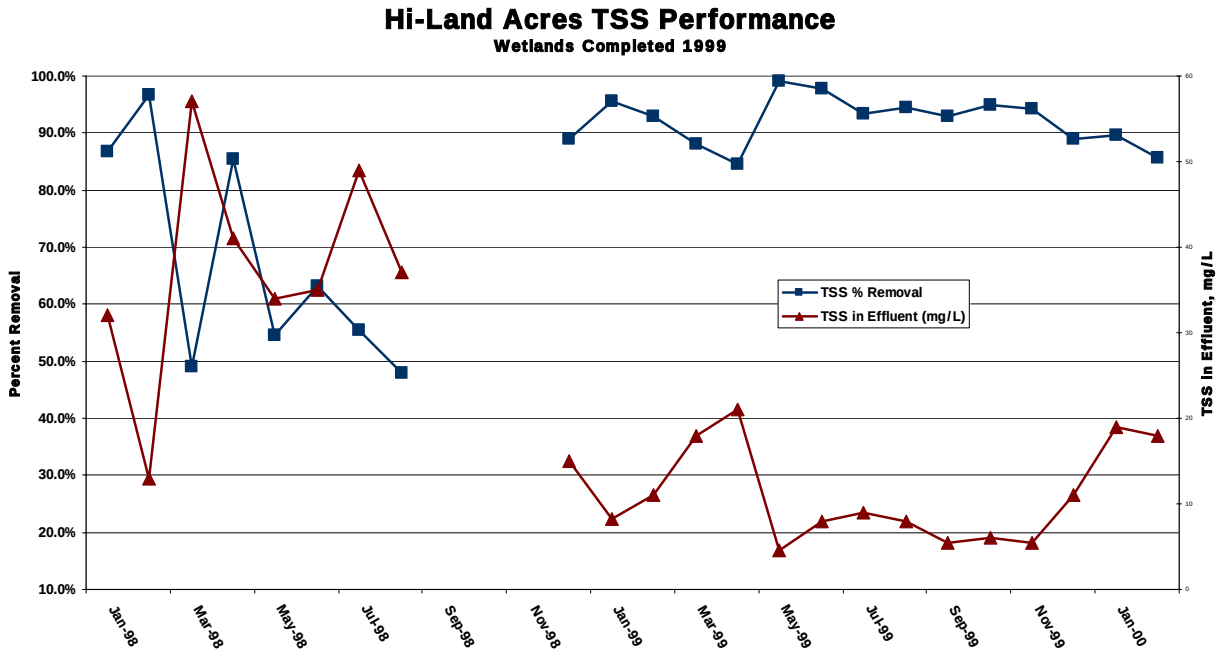
Water Quality Data

Water quality data was obtained from CDPHE permit files. The data indicate that within a year of implementing the wetlands, permit limitations have been consistently met.

TSS Data

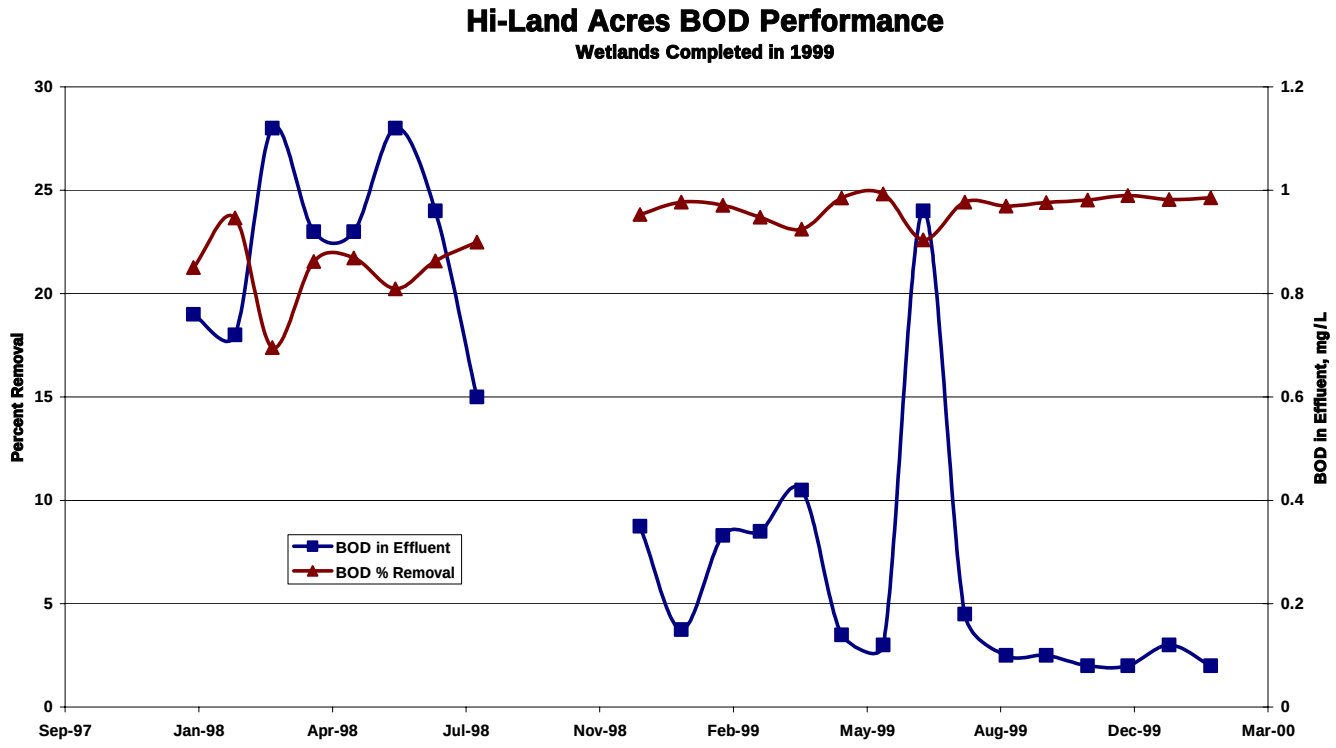
Some general observations can be made by reviewing the plotted 30-day average TSS data. The TSS graph plots the percent removal on the left axis and TSS in mg/l in the effluent on the right axis. In the months before the wetland was implemented, there was no discharge from the treatment facility. Since no discharge was occurring, data for this period were not reported. Trends in the TSS data indicate that TSS in the effluent has consistently been below permit limitations.

The discharge permit limitation for TSS in the effluent is for the 30-day average. Monthly reports submitted to the CDPHE, since the wetlands have been operating, record an average daily TSS in the influent of 172 mg/l. The average TSS in the effluent during this same time period is recorded to be 11mg/l. The removal clearly meets the discharge requirements of 105mg/l.



BOD Data

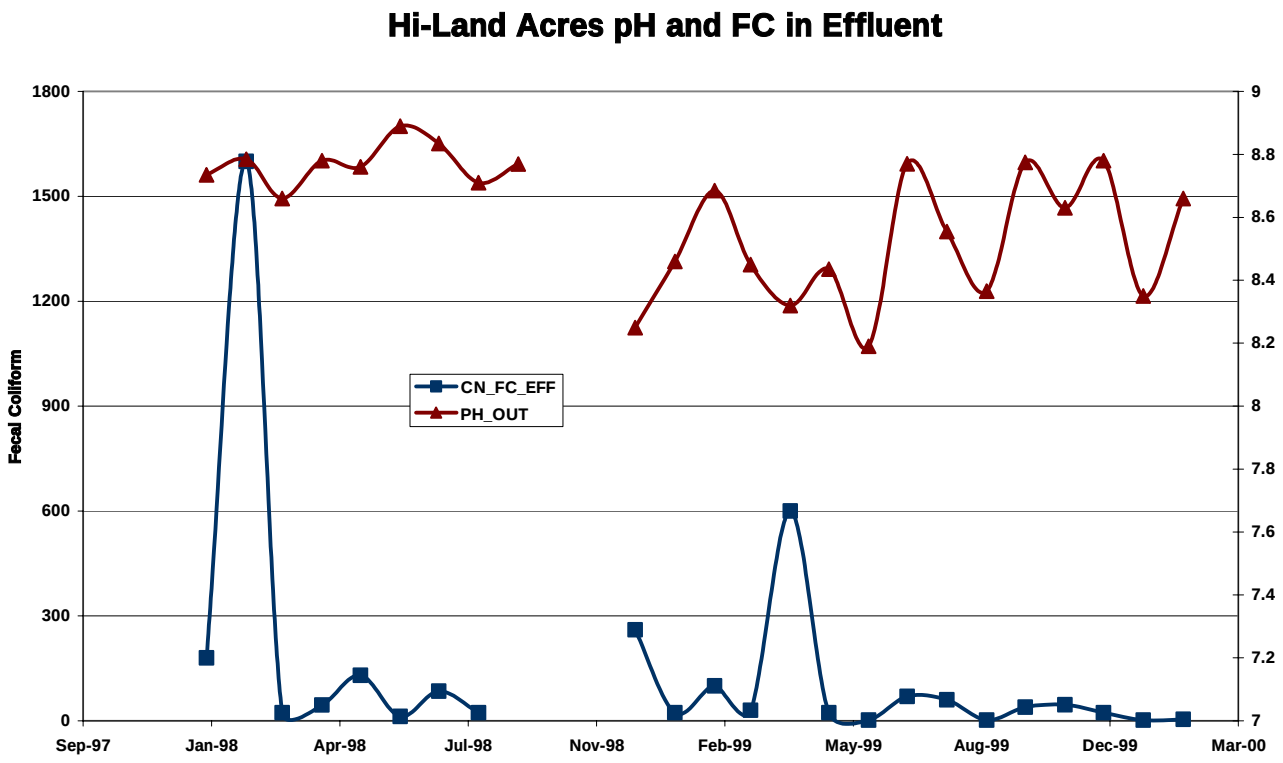
The BOD data is plotted similarly to the TSS data, with mg/l in the effluent on the right axis, and percent removal on the left axis. Since the wetland implementation, BOD in the effluent and percent removal have visibly improved. The average BOD in the influent has been 194 mg/l, since wetland implementation has been, with an average effluent amount of 6 mg/l.



pH and Fecal Coliform

Data for these two categories have been plotted on the same graph. Data reflect the quality of the effluent, no influent measurements are taken for these parameters. The pH values plotted are an average of the minimum and maximum 30-day values that are reported in the monthly reports. Previous to the wetland implementation, data indicate that average pH values in the effluent were close to the maximum daily allowable of 9. Since the wetland implementation, pH values have consistently stayed within the allowable range of 6.5 to 9.

Fecal Coliform in the effluent is consistently well below the permit limitations of 6000 organisms per 100ml.



General Ecological Setting

Highland Acres is sited along Todd Creek, a tributary to the South Platte River in Adams County. The wastewater treatment lagoons and subsurface wetland are in an upland area where rolling hills are dominated by shortgrass prairie and other introduced grass and weed species. Todd Creek is about 300 yards downslope of the treatment facility, and it supports a narrow riparian corridor with scattered plains cottonwood trees and other shrubs.

Cell Vegetation

The Highland Acres wetland consists of one square cell, approximately ¼ acre, with two plant communities. Plant community 1, which represents 90 percent of the total cell area, is dominated by prickly lettuce (*Lactuca seriola*) and ragweed (*Amaranthus retroflexis*). Plant community 2, which represents 10 percent of the total cell area, is dominated by cattail (*Typha latifolia*) and lady's thumb (*Polygonum persicaria*)

Planting/Seeding

No wetland planting or seeding was performed at the site. Plant establishment relied on plant colonization from adjoining areas.

Weeds

A small stand of Canada thistle (*Cirsium arvense*) is located in the wetland area. Canada thistle, a State Noxious Weed, is particularly invasive in areas of recent disturbance, and spreads quickly. It prevents the establishment of or displaces native species and has low value as wildlife habitat.

Maintenance Issues

Deepening the lagoons and covering the sedimentation lagoon with a floating cover to prevent algae growth could improve wetland effectiveness.

Wildlife

Vegetative diversity and subsequent wildlife habitat value are low. Much of the subsurface wetland has not been colonized by vegetation or has been colonized by weeds only. Gravel may limit the establishment of vegetation valuable to wildlife, as. From a landscape perspective, the treatment wetland does not provide unique functions and value for wildlife, although the lagoons provide small areas of open water, which is uncommon in the area.

Wetland Biodiversity Functional Assessment

The general wildlife habitat, habitat diversity, and uniqueness of the Highland Acres constructed wetland rated low. Sediment/nutrient toxicant removal was rated moderate. Total functional points were 15 percent of the total possible, and the wetland was rated in category IV, the lowest value rating.

Wetland Biodiversity Functional Assessment.

Function and Value Variables	Functional Points (0.1 to 1)	Possible Points
General Wildlife Habitat	0.1 (low)	1
General Fish / Aquatic Habitat	NA	1
Production Export / Food Chain Support	0.1 (low)	1
Habitat Diversity	0.1 (low)	1
Uniqueness	0.1 (low)	1
Total Points	0.9 (18%)	5

Wetland Biodiversity Functional Assessment.		
Function and Value Variables	**Functional Points (0.1 to 1)**	**Possible Points**
Wetland Category (I, II, III, or IV)	**IV**	

Human Use

The wastewater wetland is part of a restricted public access area, and has never been used for educational purposes. This wetland has low aesthetic value because areas of bare gravel and weedy species dominate it.

The Hi-Land Acres wetland system was the subject of a paper presented at the October 2000 Water Environment Federation Annual Conference[1].

Overall Site Comments

While this site functions quite effectively in its intended wastewater treatment function, a large portion of the site has not developed wetland vegetation. The sewage lagoons at the site provide open water habitat for wildlife, but the treatment wetland provides only limited habitat.

[1] Lutz, Michael P., Perasso, Paul M., Yamamoto, Tom, and Watson, Roger. "Nitrification and Denitrification in Aerated Lagoons Coupled with Artificial Wetlands", presented at WEFTEC 2000.