cant factors in the failure of wastewater treatment facilities to adequately meet the effluent limitations for which they were designed has been inferior process equipment.

Our experience indicated that there was no one best means of procurement and bidding format. During our initial stages, we evaluated five methods individually and in combination:

1. *Conventional open bid.* Competition is encouraged because the contractors are free to negotiate with all interested parties. However, this method also permits the contractor the opportunity to offer products that while complying with the salient requirements of the specifications and project intent may not be the exact equipment or process envisioned in the design. This process also encourages prebid packaging, post bid shopping, and may lead to the possibility of disputes during construction.
2. *Base bid.* Contractors are required to base their prices on equipment named on a fixed list. Competition tends to be discouraged, except among the named "base bid" manufacturers. Because the products and equipment in the base bid have been evaluated in the design process, fewer problems tend to arise during construction and start-up phases. Bid protests may occur because suppliers are not listed in the specifications or bid form.
3. *Base/substitute bid.* The contractor is allowed to enter equipment names and deduct amounts to the bid package. The bids can be evaluated either before or after the substitutions have been included. Similar to the base bid format, competition is limited and generally prebid packaging is discouraged. The concerns with bid protests are similar to the problems that could be encountered with the base bid process.
4. *Evaluated bid.* Equipment is selected based on total cost, life-cycle cost, or some other method of evaluation. This format maintains equipment selection with the owner and designer, provides for competition, tends to eliminate prebid packaging, and fulfills all the legal requirements for bidding of federally funded projects. Since the project is designed around a specific type of equipment, disputes are generally minimized during construction.
5. *Pre-selection of major equipment.* This method is very similar to the evaluation bid format since the engineer and owner play a critical role in selecting not only the type, but also the brands of equipment installed. The primary difference is that it does not generally permit competition, since the equipment has already been chosen prior to the bid; however, it leaves open the possibility for a fair competition during the equipment proposal process.

It was determined that a combination of methods 2 and 5 provided a number of advantages, such as:

1. Equipment selection decisions stay with the owner and engineer.
2. New and innovative processes and equipment are encouraged.
3. Pre-bid packaging and post-bid shopping are discouraged.
4. Disputes during construction are minimized.
5. The method is legal and enforceable.

A number of primary components of the wastewater facilities were evaluated during the pre-selection/evaluation process. The premise of the pre-selection process was to select the major pieces of equipment prior to bidding. With the bidding format process chosen, the contractor was still required to purchase the equipment and be responsible for its installation, as with typical construction contracts.

The process equipment that was determined to be the most important components of the wastewater treatment facilities to meet the effluent limitations contained in the Consent Agreement and was theref evaluated and pre-selected prior to bidd included the biological nutrient remo process, the method of filtration, and t instrumentation package. The primary a of our evaluation was the biological nutri removal wastewater treatment proce since it was the heart of the system.

A number of biological nutrient remo treatment processes were evaluated, inclu ing the Eimco 5-stage Bardenpho proce Kruger Bio-Denitpho process, Envirex Orb Simpre process, and sequential batch rea tors. Each of the process suppliers w invited to submit proposals on technic merit and cost. The criteria for the proce evaluation, identical for all proposals, i cluded influent and effluent characteri tics, operating conditions, and site consic erations.

Evaluations of technical proposals wer based on capital and operating costs, labo and maintenance requirements, operatin experience and reliability, the ability to mee the effluent criteria, performance guaran tees, and other miscellaneous items (e.g. odors, aerosols). Moreover, during the pro cess proposal stage of the project, we visitec a number of wastewater facilities that utilized the treatment processes to develop a subjective analysis of them.

It was determined that an Eimco 5-stage

Bardenpho facility was the biological nutrient removal treatment process that met the requirements for the UCCNSB.

The methods of filtration that were evaluated were travelling bridge and continuous backwash deep bed filters, and they were evaluated in a similar fashion to the biological nutrient removal processes. It was determined that the continuous backwash deep bed filters were the most appropriate method of filtration for this project and site.

The evaluation of the instrumentation package was more difficult because of the many suppliers available. Since the primary goal was to select a system that could efficiently operate with the selected biological nutrient removal process, one of the key evaluation criteria was experience with other biological nutrient removal processes. It was determined that the Kruger instrumentation package met all the requirements of the evaluation.

Since Kruger and Eimco are competitors in the marketing of biological nutrient removal process equipment, it was thought that integrating the Kruger instrumentation package with the Eimco equipment would be difficult. It was quite the contrary, since both organizations, along with the project team, worked effectively together to develop a successful instrumentation package that met the needs of the project.

This was the first project in the United States to successfully integrate the Eimco Bardenpho treatment technology with the Kruger controls and instrumentation system in a bidding package.

We believe that this method of pre-selection of the major process equipment enabled the city and the project team to select the most appropriate equipment for the project. It also enabled the project design team to work with the city and the various suppliers and determine what will work best for the facility. Since the project required the selection of specialized equipment, it was determined that this method of pre-selection was useful.

At the preliminary and 60-percent-final design stages, the project underwent an intensive value engineering study to identify potential savings in capital and/or operating costs. A savings of approximately $540,000 was realized.

When the design was completed the engineering drawings were forwarded to five major general contractors for a feasibility and constructability review. Additionally, the review process provided information regarding special construction techniques, alternative layouts, and other cost saving measures. The information from the five reviews was evaluated and, where possible, incorporated into the final bidding documents.

Results

The project went out for bid in September 1997. Nine bids, ranging from $16,156,705 to $18,725,000, were received. The low bid by Indian River Industrial Contractors, Inc., of Jacksonville resulted in a cost per gallon of $2.69. As of September 1998, the project is approximately 70 percent complete. It has had one change order—to add two additional filters to enable the treatment of an additional 1.0 MGD from the cooling tower of a proposed new electrical power plant that will be constructed adjacent to the project site. The $214,882 cost of the change order will be borne by the owner of the power plant. The wastewater treatment facility is currently in the process of being repermitted to treat an average daily flow of 7.0 MGD. Using the rerated flows and the additional costs from the change order, the cost per gallon was now $2.33.

The design and bidding format allowed the owner and engineer to implement a program that meets project needs, will minimizes disputes during construction, and is cost effective. Compared to recent bids from similar sized and type facilities in Florida, savings of at least $4,000,000 were realized. ■

United States
Environmental Protection
Agency

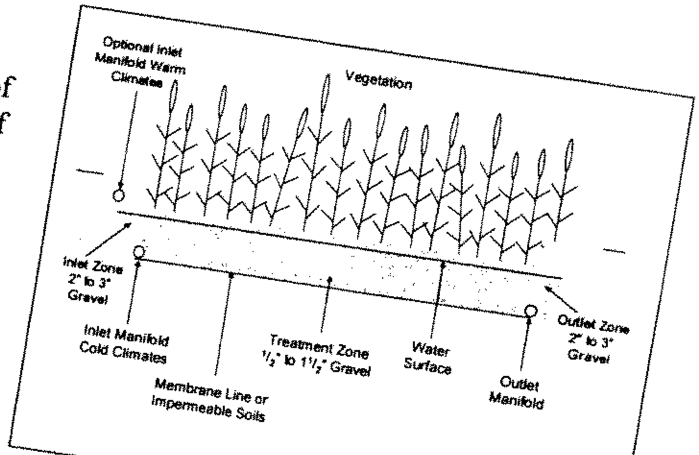
Office of Water
Washington, D.C.

EPA 832-F-00-
September 200

Wastewater Technology Fact Sheet
Wetlands: Subsurface Flow

DESCRIPTION

Wetland systems are typically described in terms of the position of the water surface and/or the type of vegetation grown. Most natural wetlands are free water surface systems where the water surface is exposed to the atmosphere; these include bogs (primary vegetation mosses), swamps (primary vegetation trees), and marshes (primary vegetation grasses and emergent macrophytes). A subsurface flow (SF) wetland is specifically designed for the treatment or polishing of some type of wastewater and are typically constructed as a bed or channel containing appropriate media. An example of a SF wetland is shown in Figure 1. Coarse rock, gravel, sand and other soils have all been used, but a gravel medium is most common in the U.S. and Europe. The medium is typically planted with the same types of emergent vegetation present in marshes, and the water surface is designed to remain below the top surface of the medium. The main advantages of this subsurface water level are prevention of mosquitoes and odors, and elimination of the risk of public contact with the partially treated wastewater. In contrast, the water surface in natural marshes and free water surface (FWS) constructed wetlands is exposed to the atmosphere with the attendant risk of mosquitoes and public access.



Source: Adapted from drawing by S.C. Reed, 2000.

FIGURE 1 SUBSURFACE FLOW WETLAND

The water quality improvements in natural wetlands had been observed by scientists and engineers for many years and this led to the development of constructed wetlands as an attempt to replicate the water quality and the habitat benefits of the natural wetland in a constructed ecosystem. Physical, chemical, and biochemical reactions all contribute to water quality improvement in these wetland systems. The biological reactions are believed due to the activity of microorganisms attached to the available submerged substrate surfaces. In the case of FWS wetlands these substrates are the submerged portion of the living plants, the plant litter, and the benthic soil layer. In SF wetlands the available submerged substrate includes the plant roots growing in the media, and the surfaces of the media themselves. Since the media surface area in a SF wetland can far exceed the available substrate in a FWS wetland, the microbial reaction rates in a SF wetland can be higher than a FWS wetland for most contaminants. As a result, a SF wetland can be smaller than the FWS type for the same flow rate and most effluent water quality goals.

The design goals for SF constructed wetlands are typically an exclusive commitment to treatment functions because wildlife habitat and public recreational opportunities are more li... FWS wetlands. Th...

TABLE 5 CAPITAL AND O&M COSTS FOR 100,000 GALLONS PER DAY SF WETLAND

Item	Cost $*	
	Native Soil Liner	Plastic Membrane Liner
Land Cost	$16,000	16,000
Site Investigation	3,600	3,600
Site Clearing	6,600	6,600
Earthwork	33,000	33,000
Liner	0	66,000
Gravel Media**	142,100	142,100
Plants	5,000	5,000
Planting	6,600	6,600
Inlets/Outlets	16,600	16,600
Subtotal	$229,500	$295,500
Engineering, legal, etc.	$133,000	$171,200
Total Capital Cost	**$362,500**	**$466,700**
O & M Costs, $/yr	$6,000/yr	$6,000/yr

* June 1999 costs, ENR CCI = 6039
**12,000 cy of 0.75 in. gravel

TABLE 6 COST COMPARISON SF WETLAND AND CONVENTIONAL WASTEWATER TREATMENT

Cost Item	Process	
	Wetland	SBR
Capital Cost	$466,700	$1,104,500
O &M Cost	$6,000/yr	$106,600/yr
Total Present Worth Costs*	$530,300	$2,233,400
Cost per 1000 gallons treated**	$0.73	$3.06

*Present worth factor 10.594 based on 20 years at 7 percent interest (June 1999 costs, ENR CCI = 6039).
**Daily flow rate for 365 d/yr, for 20 yr, divided by 1000 gallons

Source: WEF, 2000.

Table 6 compares the life cycle costs for this wetland to the cost for a conventional treatment system designed for the same flow and effluent water quality. The conventional process is a sequencing batch reactor (SBR).

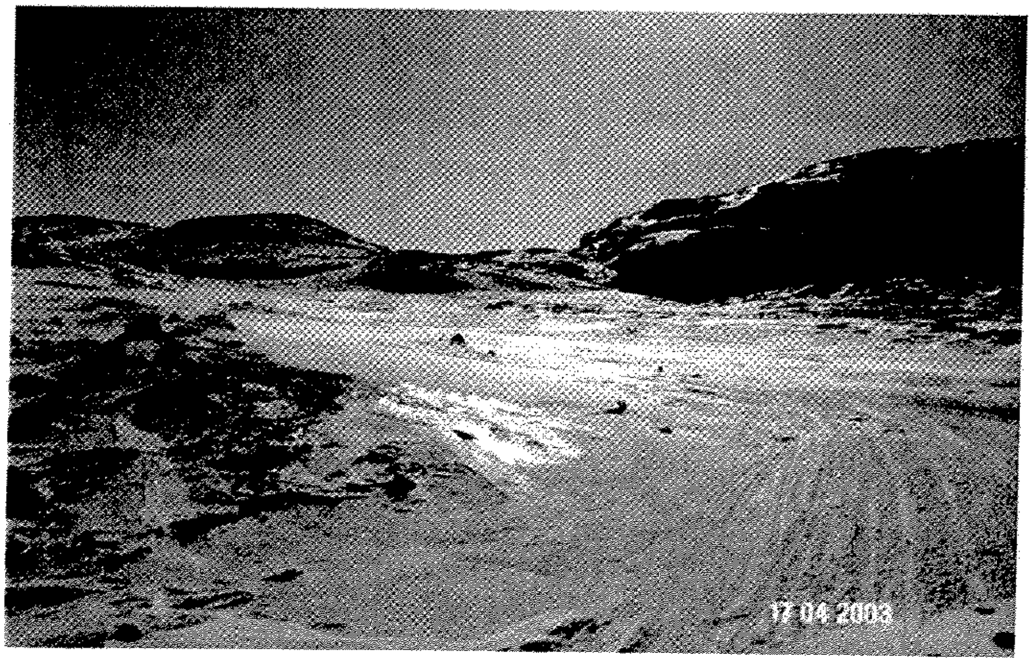
REFERENCES

Other Related Fact Sheets

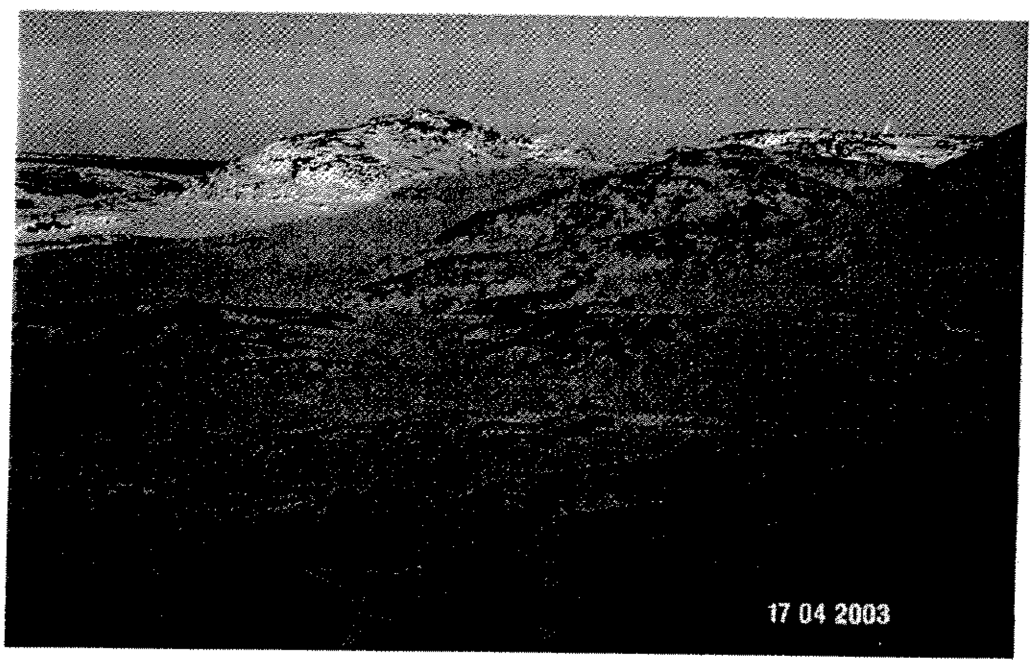
Free Water Surface Wetlands
EPA 832-F-00-024
September, 2000

Other EPA Fact Sheets can be found at the following web address:
http://www.epa.gov/owmitnet/mtbfact.htm

Appendix I
P-Lake Access Road Route Photographs

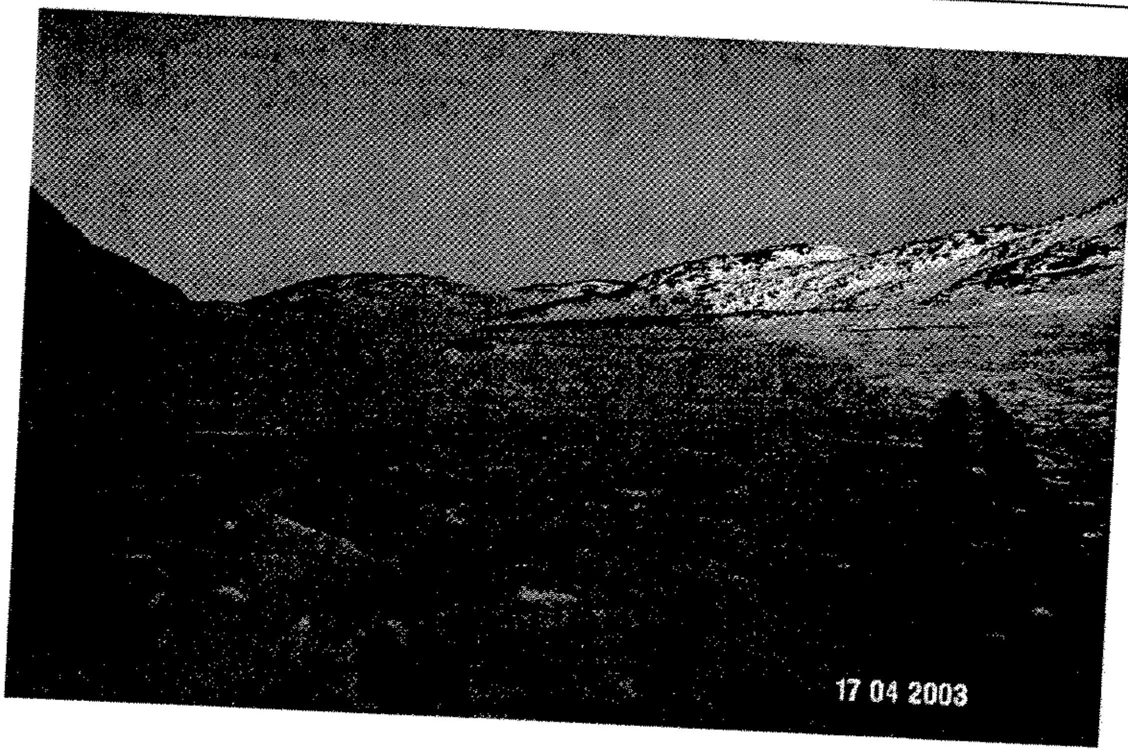


View of Existing Road Looking Toward Saddle. Wetland / Lagoon Location at Top Of Saddle.

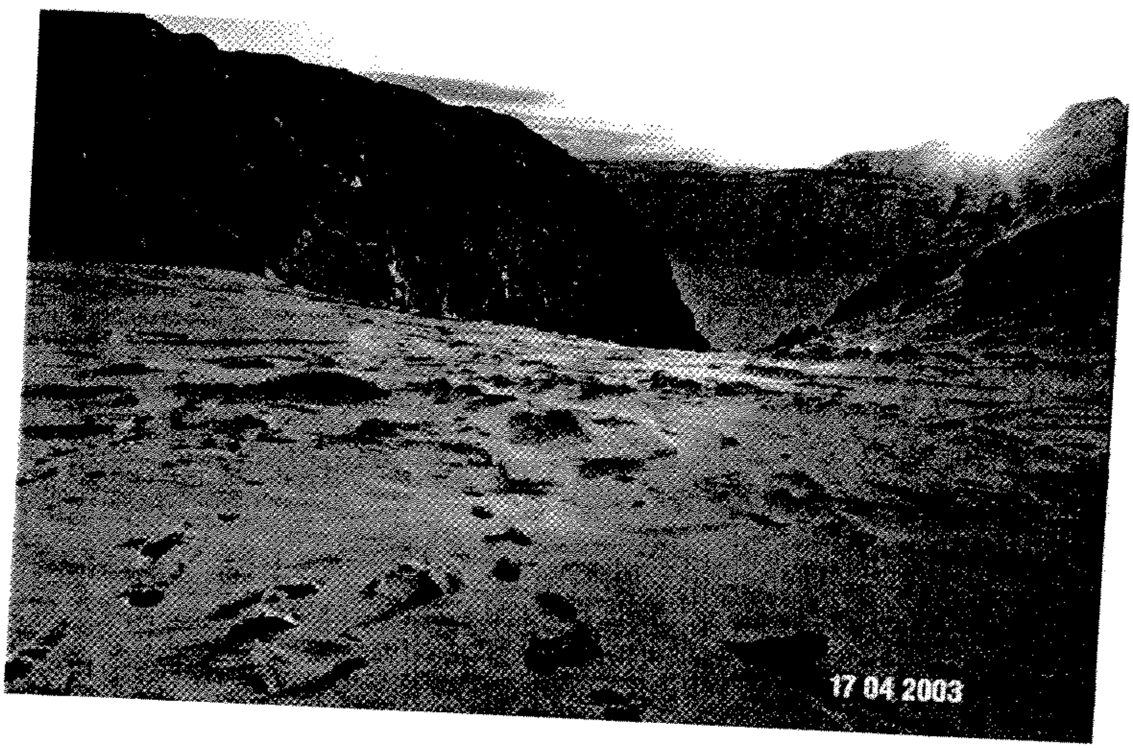


View From Top of Saddle Looking Toward Possible Road Route.

DILLON CONSULTING	PROJECT Cape Dorset Sewage Management Review	PROJECT NO. 031943-1000
		DATE July 2003
	TITLE	FIGURE NO.



View of Wetland and Possible Lagoon Location



View of Wetland Outlet To Ocean

DILLON CONSULTING

PROJECT	Cape Dorset Sewage Management Review
PROJECT NO.	031943-1000
DATE	July 2003
TITLE	
FIGURE NO	

Dillon Consulting Limited
Cape Dorset Sewage Options
File: 031943-1000

Access Road Assumptions

Road Length	850	m
Excavated Road Width	16	m
Fill Road Width	10	m
Excavated Slope	0.5 H:1V	
Fill Slope	3H:1V	

Access Road			
	Volume	**Unit Rate**	**Cost**
	(m3)		
Road - Cut	12,000	$100	$1,200,000
Road - Fill	43,000	$40	$1,720,000
Road Base	7,500	$40	$300,000
Total Road			**$3,220,000**
		say	$3,200,000

Lagoon Assumptions

Lagoon Constructed in Flat Ground

Total Volume (2 Cells)	96,725	m3
Cell Width	110	m
Cell Length	214	m
Berm Width	2	m
Inside Slope	2H:1V	
Outside Slope	3H:1V	
Berm Height	3.3	
Liquid Level	2.0	m
Freeboard	1.3	m

Lagoon			
	Quantity	**Unit Rate**	**Cost**
Earthworks (m3)	39,000	$40	$1,560,000
Site Preparation and Drainage	1	$25,000	$25,000
Fencing (m)	1100	$250	$275,000
Inlet and Outlet Controls	1	$25,000	$25,000
Total Lagoon			**$1,885,000**
		say	**$1,900,000**

Note:

Costs do not include any Environmental Assessments and Permitting, Sealift, and Taxes.
Costs do not include any geosynthetic liner.

Dillon Consulting Limited
Cape Dorset Sewage Options
File: 031943-1000

P - Lake Sewage Lagoon and Access Road - NPV

Item	Cost
Access Road	$3,200,000
Sewage Lagoon	$1,900,000
Total Capital Cost	**$5,100,000.00**
Engineering and Geotechnical @ 10%	$510,000.00
Contingency @ 25%	$1,275,000.00
Total	**$6,885,000.00**
Operating Cost @ 2.0% of Lagoon Cost	$38,000
say	$40,000

Note:
Costs Do Not Include Taxes, Sewage Collection and Haulage, Road Maintenance, and Snow Clearing

NPV ANALYSIS

	Sewage Lagoon
Construction Year	$6,885,000.00
1	$40,000
2	$40,000
3	$40,000
4	$40,000
5	$40,000
6	$40,000
7	$40,000
8	$40,000
9	$40,000
10	$40,000
11	$40,000
12	$40,000
13	$40,000
14	$40,000
15	$40,000
16	$40,000
17	$40,000
18	$40,000
19	$40,000
20	$40,000
NPV @ 2%	**$7,539,057**
NPV @ 4%	**$7,428,613**
NPV @ 8%	**$7,277,726**