Table 9.5 Preliminary Opinion of Probable Cost for Proposed Septic Tank Effluent Collection System

			Entire CSD		Core Service Area		West Crescent		All Areas	
Description	Unit	Unit Cost ($)	Quantity	Extension ($)	Quantity	Extension ($)	Quantity	Extension ($)	Quantity	Extension ($)
Septic Tank *	EA	$1,750	288	$504,000	160	$280,000	100	$175,000	388	$679,000
Septic Tank Pumping System	EA	$1,800	30	$54,000	15	$27,000	10	$18,000	40	$72,000
10" Sewer main	LF	$30	1,038	$31,140	1,038	$31,140	-	$0	1,038	$31,140
8" Sewer main	LF	$25	2,421	$60,525	2,220	$55,500	-	$0	2,421	$60,525
6" Sewer main	LF	$22	6,577	$144,694	720	$15,840	5,730	$126,060	12,307	$270,[illegible]
4" Sewer main	LF	$20	23,788	$594,700	10,500	$262,500	11,000	$220,000	34,788	$695,760
Manholes	EA	$2,000	2	$4,000	1	$2,000	1	$2,000	3	$6,000
Cleanouts	EA	$250	35	$8,750	23	$5,750	10	$2,500	45	$11,250
Junction Wyes (10"x8")	EA	$60	1	$60	1	$60	-	$0	1	$60
Junction Wyes (10"x4")	EA	$55	2	$110	2	$110	-	$0	2	$110
Junction Wyes (8"x6")	EA	$50	2	$100	1	$50	-	$0	2	$100
Junction Wyes (8"x4")	EA	$48	4	$192	3	$144	-	$0	4	$192
Junction Wyes (6"x4")	EA	$45	6	$270	4	$180	3	$135	9	$405
Junction Wyes (4"x4")	EA	$40	12	$480	6	$240	10	$400	22	$880
Manual Air Release Valve	EA	$200	22	$4,400	10	$2,000	6	$1,200	28	$5,600
Automatic Air Release Valve	EA	$2,000	2	$4,000	-	$0	1	$2,000	3	$6,000
Boring (10" Main) and Casing	LF	$400	60	$24,000	60	$24,000	-	$0	60	$24,000
Boring (4" Main) and Casing	LF	$300	240	$72,000	60	$18,000	-	$0	240	$72,000
Bridge Crossing (6" Gravity)	LF	$100	-	$0	-	$0	100	$10,000	100	$10,000
Service Wyes (10"x2")	EA	$60	5	$300	5	$300	-	$0	5	$300
Service Wyes (8"x2")	EA	$50	10	$500	8	$400	-	$0	10	$500
Service Wyes (6"x2")	EA	$40	18	$720	-	$0	-	$0	18	$720
Service Wyes (4"x2")	EA	$35	177	$6,195	110	$3,850	100	$3,500	277	$9,6[illegible]
4" Service Laterals	LF	$20	10,500	$210,000	6,150	$123,000	5,000	$100,000	15,500	$310,[illegible]
Air Release Valve and Manhole	EA	$4,000	1	$4,000	1	$4,000	-	$0	1	$4,000
Rock Excavation	CY	$100	25	$2,500	10	$1,000	12	$1,200	37	$3,700
Gravel Surface Replacement	CY	$15	300	$4,500	120	$1,800	150	$2,250	450	$6,750
Asphalt Surface Replacement	TON	$75	200	$15,000	80	$6,000	95	$7,125	295	$22,125
Concrete Surface Replacement	SY	$25	20	$500	10	$250	10	$240	30	$740
Seeding	SQ	$10	1,000	$10,000	400	$4,000	480	$4,800	1,480	$14,800
Compaction Testing	EA	$200	10	$2,000	2	$400	4	$800	14	$2,800
Construction Subtotal				$1,763,636		$869,514		$677,210		$2,321,906
Construction Contingencies				$176,364		$86,951		$67,721		$232,191
Engineering and Construction Observation				$352,727		$173,903		$135,442		$464,381
Legal and Administrative				$88,182		$43,476		$33,861		$116,095
Easement Acquisition and Right of Way				$15,000		$5,000		$5,000		$20,000
TOTAL				$2,395,909		$1,178,844		$919,234		$3,154,573

Commercial businesses will have different sized septic tanks. For estimating purposes, costs have been estimated on an EDU basis with one 1,000 gallon tank per EDU. Cleaning of a septic tank usually cost about $200 and overhaul of pumping equipment is assumed to cost $170. Estimates of yearly costs of owning a septic tank and pumping system are $70 per year per EDU and $24 per year per EDU respectively. Annual O&M costs for STEP/STEG collection system are shown below:

a)	General collection system maintenance	$	50 * 288 EDUs
b)	Septic tank pumping	$	40 * 288 EDUs
c)	Septic tank pump repair	$	30 * 30 EDUs
	Total Annual O&M (288 initial EDUs)	$26,820	

9.4 PRESENT WORTH ANALYSIS

A present worth analysis is necessary in order to make an equitable comparison of the long term cost of the conventional system and STEG alternatives. Initial capital costs, annual expenses for operation and maintenance, and salvage value must be considered. This is accomplished by a present worth analysis wherein all of the applicable costs, minus salvage value, over the design life of the facility are reduced to a comparable present worth value. An interest rate of 7.0% and a design period of 20 years were used for the present worth comparison. Table 9.6 gives a comparison of present worth values for two alternatives.

Table 9.6 Comparison of Present Worth Values

Alternative	Capital Costs	Annual O&M	Present Worth
Convention Gravity	$ 2,393,295	$ 14,400	$ 2,545,849
STEG/STEP	$ 2,395,909	$ 26,820	$ 2,680,040

The difference in costs between the two systems is within the level of accuracy expected for planning purposes (essentially the costs are the same). Therefore, the selection of the type of collection system should be based on considerations other than cost.

District must own system from S.T. downstream.

Section 10 – Detailed Development of Treatment and Disposal Options.

10.1 General

The goals for the treatment system expressed in the 1983 Study and carried forward in the 1999 Study are still valid for the current conditions. Selection of facultative lagoons and aerated lagoons is appropriate for the Crescent Sanitary District.

10.2 Design Conditions

Table 10.1 summarizes the design conditions for the entire Crescent Sanitary District and the Core of the District.

Table 10.1 Current and 25 Year (Design Year) Flows and Loadings

10.1.a Crescent Sanitary District

Parameter	Current	25-Year
Population	533	1,117
EDU's	288	603
ADF (gpd)	70,400	147,400
MMF (gpd)	126,700	265,400
PDF (gpd)	197,100	412,800
PIF (gpd)	253,500	530,700
Ave. BOD (ppd)	120	250

10.1.b Core Area - Crescent Sanitary District

Parameter	Current	25-Year
Population	200	426
EDU's	140	295
ADF (gpd)	34,200	71,500
MMF (gpd)	61,500	128,700
PDF (gpd)	95,600	200,300
PIF (gpd)	123,000	257,500
Ave. BOD (ppd)	75	165

SECTION 10
DETAILED DEVELOPMENT OF TREATMENT AND DISPOSAL OPTIONS

10.1 GENERAL

The method of effluent disposal is the most important issue in evaluating options for Crescent. There are three general options in the study area: surface discharge to the Little Deschutes River, moderate rate infiltration, and summer irrigation with winter holding. The Little Deschutes River is listed as water quality limited for summer temperature and any discharge that raises the stream temperatures would be prohibited. There are also concerns over nutrient and bacteria loading. Another influential factor will be public opinion regarding the discharge of wastewater effluent into the river. In considering these issues, surface discharge is not a practical option. The 1983 facilities plan recommended infiltration as a method of disposal, but it is unlikely that an infiltration system will meet current groundwater protection regulations. Winter holding with summer irrigation at agronomic rates eliminates any groundwater discharge and is considered a beneficial usage of wastewater effluent.

In the 1983 study, treatment system goals were clearly stated as follows:

a. Employ processes which require a minimum of operator time
b. Provide relatively maintenance free equipment
c. Operate efficiently through a wide range of loadings
d. Use minimum energy
e. Meet emergencies without damage to receiving water or land
f. Conserve and improve environmental factors and natural resources

These goals are generally best met with wastewater treatment lagoons. Ponds or lagoons might not achieve the treatment required for moderate rate infiltration under current regulations, but with crop irrigation they will meet all of the goals stated above. Therefore, the following treatment and disposal options will be evaluated in more detail:

1. Summer irrigation and winter holding with:
    a) facultative lagoons
    b) aerated lagoons

10.2 DESIGN CONDITIONS

Wastewater hydraulic, biological and loading conditions were developed in Section 7. Alternatives for regionalization and staging were discussed in Section 8. Table 10.1 summarizes the design conditions for these options.

Table 10.1 Current and Design Year Flows and Loadings for various service areas

10.1.a CSD

Parameter	Current	25-Year
Population	533	1,117
EDUs	288	603
ADF (gpd) MMF (gpd) PDF (gpd) PIF (gpd)	70,400 126,700 197,100 253,500	147,400 265,400 412,800 530,700
Average BOD_5 (ppd)	120	250

10.1.b Crescent Core Area

Parameter	Current	25-Year
Population	200	426
EDUs	140	295
ADF (gpd) MMF (gpd) PDF (gpd) PIF (gpd)	34,200 61,500 95,600 123,000	71,500 128,700 200,300 257,500
Average BOD_5 (ppd)	75	165

10.1.c Gilchrist

Parameter	Current	25-Year
Population	210	440
EDUs	150	304
ADF (gpd) MMF (gpd) PDF (gpd) PIF (gpd)	21,000 37,800 58,800 75,600	44,000 79,100 123,100 158,300
Average BOD_5 (ppd)	45	95

10.1.d CSD and Gilchrist

Parameter	Current	25-Year
Population	753	1,577
EDUs	438	943
ADF (gpd) MMF (gpd) PDF (gpd) PIF (gpd)	91,000 164,500 255,900 329,100	191,400 344,500 535,900 689,000
Average BOD_5 (ppd)	170	350

10.1.e Core Area and Gilchrist

Parameter	Current	25-Year
Population	410	858
EDUs	290	635
ADF (gpd) MMF (gpd) PDF (gpd) PIF (gpd)	55,200 99,300 154,400 198,600	115,500 207,600 323,400 415,800
Average BOD_5 (ppd)	120	265

10.3 SUMMER IRRIGATION AND WINTER HOLDING

This option requires a site with sufficient land to accommodate both storage of approximately 6 to 8 months of accumulated flow and the disposal (irrigation) of the total annual flow with allowances for rainfall accumulation and pond evaporation. Effluent quality requirements are not stringent and treatment lagoons integrate well with this system. Facultative lagoons and aerated lagoons have advantages and disadvantages over each other and both systems will be evaluated.

Treatment with Facultative Lagoons

Water in the facultative lagoon naturally stratifies into zones with particular characteristics and treatment functions. The surface zone is aerobic, with oxygen levels that can exceed saturation during sunny days. Oxygen is generated by algae in the near surface zone and by surface reaeration. Aerobic bacteria utilize the oxygen to stabilize organic materials. The lowest layer is anaerobic. Larger solids settle and form a sludge layer where anaerobic bacteria thrive and decompose the accumulated solids. This middle layer is termed "facultative" and is characterized as partly aerobic and partly anaerobic. Facultative bacteria decompose organic wastes entering this zone. Multiple cells are typically used to achieve the desired level of treatment, minimize short circuiting, and facilitate maintenance. Treatment is "natural" and requires no mechanical equipment or chemicals.

Facultative lagoons are much larger than aerated lagoons for treatment; however, with winter holding, the treatment and holding functions can be integrated into a single 3-cell (minimum) lagoon. Maximum lagoon depths for treatment are 6 to 8 feet in the primary cell with greater depths permissible for the secondary cells. Effluent quality is adequate for irrigation of crops, such as sugar beets, that are highly processed prior to human consumption. O&M costs are less than other treatment methods because of the lack of mechanical equipment.

Facultative lagoons are the most economical treatment systems available under the following circumstances:

- Need for winter effluent holding- a facultative lagoon can be designed to integrate both holding and treatment functions into a single facility.

- Low organic loadings- since sizing of the ponds includes holding capacity, resulting organic loadings are very low on a per acre basis. (Higher loadings would be the basis for consideration of more sophisticated and costly treatment options.)
- High groundwater table- facultative lagoons are shallower than aerated lagoons, lower dikes require less fill to be imported or excavated.
- Less stringent discharge requirements- irrigation of pasture or hay crops does not require the higher water quality produced by more sophisticated treatment facilities, or the higher water quality that would be needed to consistently meet stream discharge requirements.

The most important feature of facultative lagoons is relatively low O&M requirements, needing less operator attention and lab testing. Utility and chemical costs are largely limited to that required for the effluent irrigation system and disinfection needs.

Treatment with Aerated Lagoons

Aerated lagoons utilize deeper (10-15 feet) water depths to better optimize oxygen transfer from air provided by mechanical equipment. The increased oxygen content allows for much smaller treatment cells than those required for a facultative lagoon and aerated lagoons can produce a higher quality of effluent than a facultative lagoon. Aerated lagoons are often used where influent BOD is relatively high in relation to flow.

Pond dike construction is ideally accomplished by using excavated on-site materials. Excavated material should equal placed fill material to minimize the overall quantity of fill material and to avoid the need for more costly imported fill material. Excavated pond bottoms, however, should be above the seasonal high groundwater table. Potential treatment/holding/irrigation sites in the vicinity of Crescent have seasonal high groundwater at levels of approximately 1 to 3 feet below the surface. For planning purposes, it is assumed that a site with groundwater at approximately 3 feet will be obtained and the excavated pond bottom will be 2 feet deep. Increased dike height, while reducing total acreage requirements, would nevertheless require considerably more imported fill. The relatively high groundwater sets a practical limit on dike height- a height more amenable to facultative lagoon requirements (6-8 foot water depth plus 3 foot freeboard) then for aerated lagoon requirements (10-15 foot water depth plus 3 foot freeboard). Land costs are low ($1,000-$2,000 per acre); consequently, construction of deeper ponds will not significantly reduce property costs.

In addition, costs for an aerated lagoon (with holding) in Crescent would be higher than a comparable facultative lagoon because of the additional equipment and utility costs. Higher quality effluent that an aerated facility could provide is not needed. Facultative lagoons are best suited for the environmental conditions and treatment and storage needs; this will be the recommended treatment system unless there are restrictions on land acquisition. When the amount of available land is limited, aerated lagoons will also be considered.

Irrigation Crop Requirements

Effluent, in general, can only be spray irrigated when there is a deficiency of water, i.e., when the amount of water consumed by vegetation and lost to evaporation exceeds precipitation. Also, the potential nutrient uptake of the crop must exceed the nitrate content of the treated effluent.

The Department of Bioresource Engineering, Oregon State University published "Oregon Crop Water Use and Irrigation Requirements," in June 1992. Included in the publication are growing seasons for selected crop by region, and the net irrigation requirements for different recurrence intervals.

Net irrigation requirements in Region 17 (Bend) for alfalfa hay and pasture grass for a 5 out of 10 year event (average conditions) are listed in Table 10.2

Table 10.2 Net Irrigation Requirements

Alfalfa Hay			Pasture Grass		
Month	Net Irr (inches)	% of Seasonal Requirement	Month	Net Irr (inches)	% of Seasonal Requirement
April	1.02	5.09	April	1.02	4.60
May	2.83	14.13	May	3.07	13.85
June	3.74	18.67	June	4.02	18.13
July	5.51	27.51	July	5.91	26.66
August	4.25	21.22	August	4.53	20.43
Sept	2.68	13.38	September	2.91	13.13
			October	0.71	3.20
Total	20.03	100%	Total	22.17	100%

Sunriver Utilities Company (SRUC) currently uses National Forest land for effluent disposal. Since much of the land surrounding Crescent is a similar type of forest, this method of disposal is a possibility. Personal communication was made with staff at DEQ and the Director of SRUC regarding the use of forest land as a crop for effluent disposal. An environmental assessment (EA) was made for the Sunriver site and land application rates are limited to 300,000 gallons per acre per year (gal/ac-yr).

A detailed wastewater facilities plan was conducted by HGE for the city of Sisters in 1998. As part of the facilities planning, a soils analysis was conducted by Wert and Associates. The analysis included maximum hydraulic loading rates for existing stands of Ponderosa-Lodgepole pine, and sage-bitter brush (PLSB). The maximum loading rate is limited by nitrogen requirements and is approximately 425,000 gal/ac-yr. While average temperatures are colder and the growing season is shorter in Crescent than in Sisters, similar loading rates are used for flow balance calculations. Table 10.3 gives the estimated agronomic rates used for preliminary evaluation and estimate of land requirements. A detailed soils analysis will be necessary to establish irrigation rates used in design.

Table 10.3 Forest Land (PLSB)

Month	Net IRR (inches)	% of Seasonal Requirement
May	0.78	5
June	1.56	10
July	7.8	50
August	3.1	20
September	1.56	10
October	0.78	5
Total	15.6	100%

Acreage requirements for forest land are higher than alfalfa or pasture grass. However, irrigation of forest land is the preferred alternative for effluent disposal, since this appears to be the most common usage of land that may be available for irrigation.

Monthly Precipitation and Evaporation Data

Average monthly precipitation and evaporation data for the Crescent area was provided by the Oregon Climatology Service, Oregon State University (OSU). Average monthly values are listed below. Precipitation data is taken from the Chemult station which is 16 miles south of Crescent. The nearest station where evaporation data is available is Wickiup Dam which is 15 miles to the north. These sites have similar elevations and climates to Crescent and the data is a reasonable estimate. Monthly precipitation and evaporation estimates are summarized in Table 10.4.

Table 10.4 Monthly Precipitation and Evaporation

Month	Precipitation (inches)	Evaporation	Net
January	4.25	0	4.25
February	2.84	0	2.8
March	2.49	0	2.5
April	1.11	2.99	-1.9
May	0.82	5.15	-4.3
June	0.80	6.49	-5.7
July	0.53	8.03	-7.5
August	0.76	6.85	-6.1
September	0.86	4.68	-3.8
October	1.51	2.46	-9.5
November	3.99	0	4.0
December	4.59	0	4.6
Total	24.55	36.65	-12.1

Restrictions on Land Use

Regulations pertaining to the use of reclaimed water (treated effluent) from sewage treatment plants are stated in OAR Chapter 340, Division 55. Usage restrictions depend on the level of treatment and disinfection provided.

Facultative lagoon treatment (without effluent polishing) would generally be classified as Level I category. Size of the required buffer strip around the irrigation site is considered to be site specific, but typically would be a minimum of 70 feet. The primary reason for having more restrictions with lagoon treatment is that pathogenic organisms may be shielded from the disinfectant due to algae or other solids within the effluent. It should be noted that lightly loaded facultative lagoons naturally achieve a very high removal of pathogens.

10.4 PROJECT OPTIONS FOR SUMMER IRRIGATION AND WINTER HOLDING

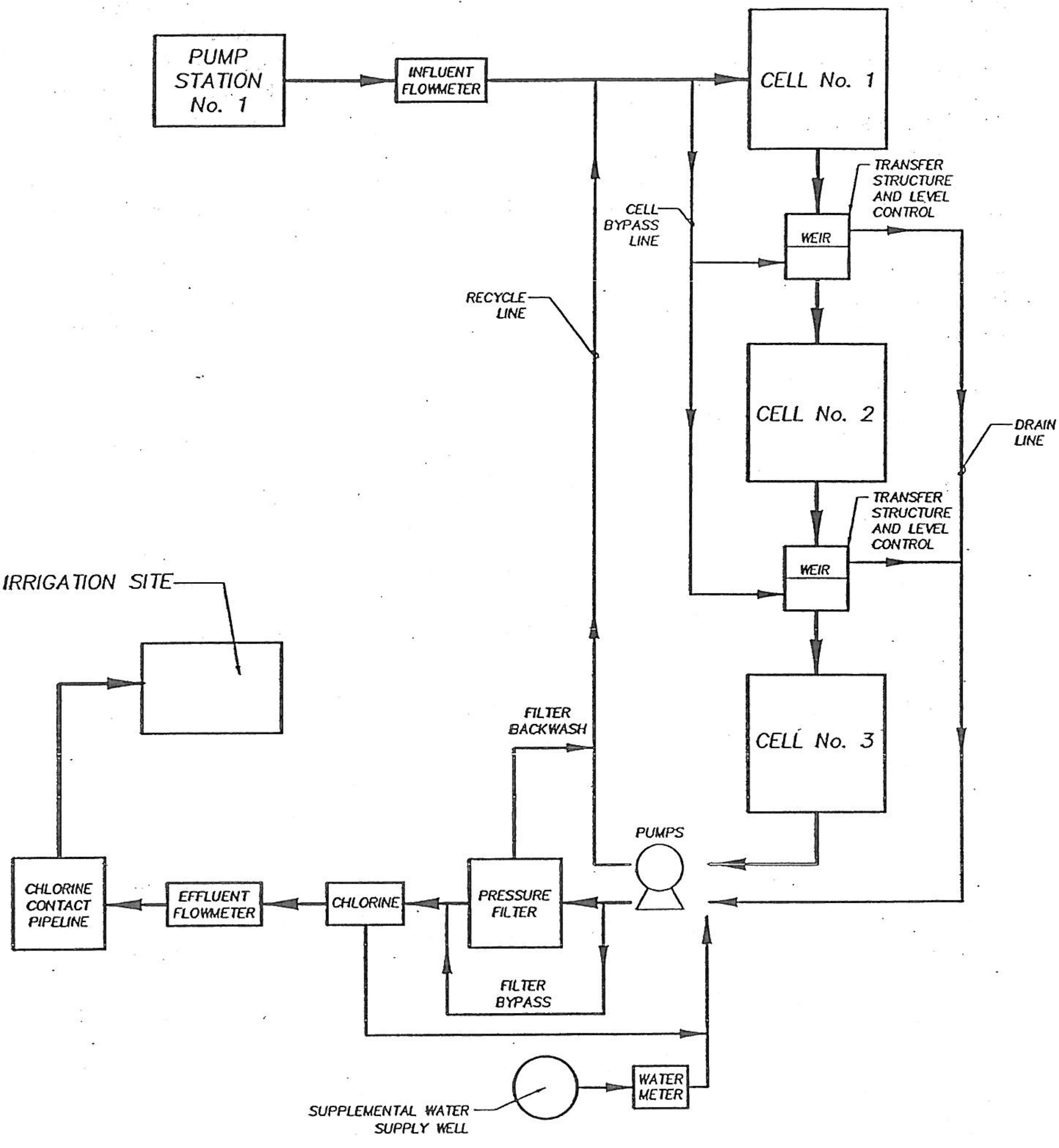
In Section 10.3, it was established that the preferred method of treatment, storage and disposal was through the use of lagoons and irrigation of forest land. Still, there are many alternatives to consider for determining the scope of the project which will determine the total cost and economic impact of the project on district and/or Gilchrist customers. The following is a list of six potential project options.

1. Provide service to entire district with treatment and disposal site located south of Crescent.
2. Provide service to Crescent's core area initially; plan to phase in remainder of district later. Treatment and disposal site is the same as option 1.
3. Gilchrist remains an independent system, and adds storage and irrigation system.
4. Regional system including Crescent core area and Gilchrist; treatment site located at Gilchrist.
5. Regional system including entire district and Gilchrist; treatment site located at Gilchrist.
6. Regional system including entire district and Gilchrist; treatment site located at Gilchrist (treatment capacity staged).

Storage sizing, land requirements and preliminary opinions of probable cost will be given for each of these alternatives.

Option 1. Crescent Sanitary District, Treatment and Disposal South of Crescent

This project is also identified as Option I A.1 in Section 8. The scope of this project is to serve the entire district with the treatment, storage and disposal in approximately the same location as in the 1983 facilities plan. A schematic of the conceptual design process is shown in Figure 10-1. Detailed flow balances for each option are given in Appendix B. The computed water surface area is about 20 acres for the 3-cell lagoon, as shown on Figure 10-2. At design year conditions, BOD_5 loadings are 25 pounds per acre per day (lbs/ac-day) for the primary cell (largest) and 12.5 lbs/ac-day when averaged over all three cells. Total lagoon volume is approximately 150 acre-feet (ac-ft). This includes 85 ac-ft for six months of storage for wastewater flows, 50 ac-ft for maintaining a minimum depth of 2.5 feet, and 15 ac-ft for storage of precipitation during the holding period. Dike construction is based on a water depth of eight feet, freeboard of three feet, and slopes of 3:1.

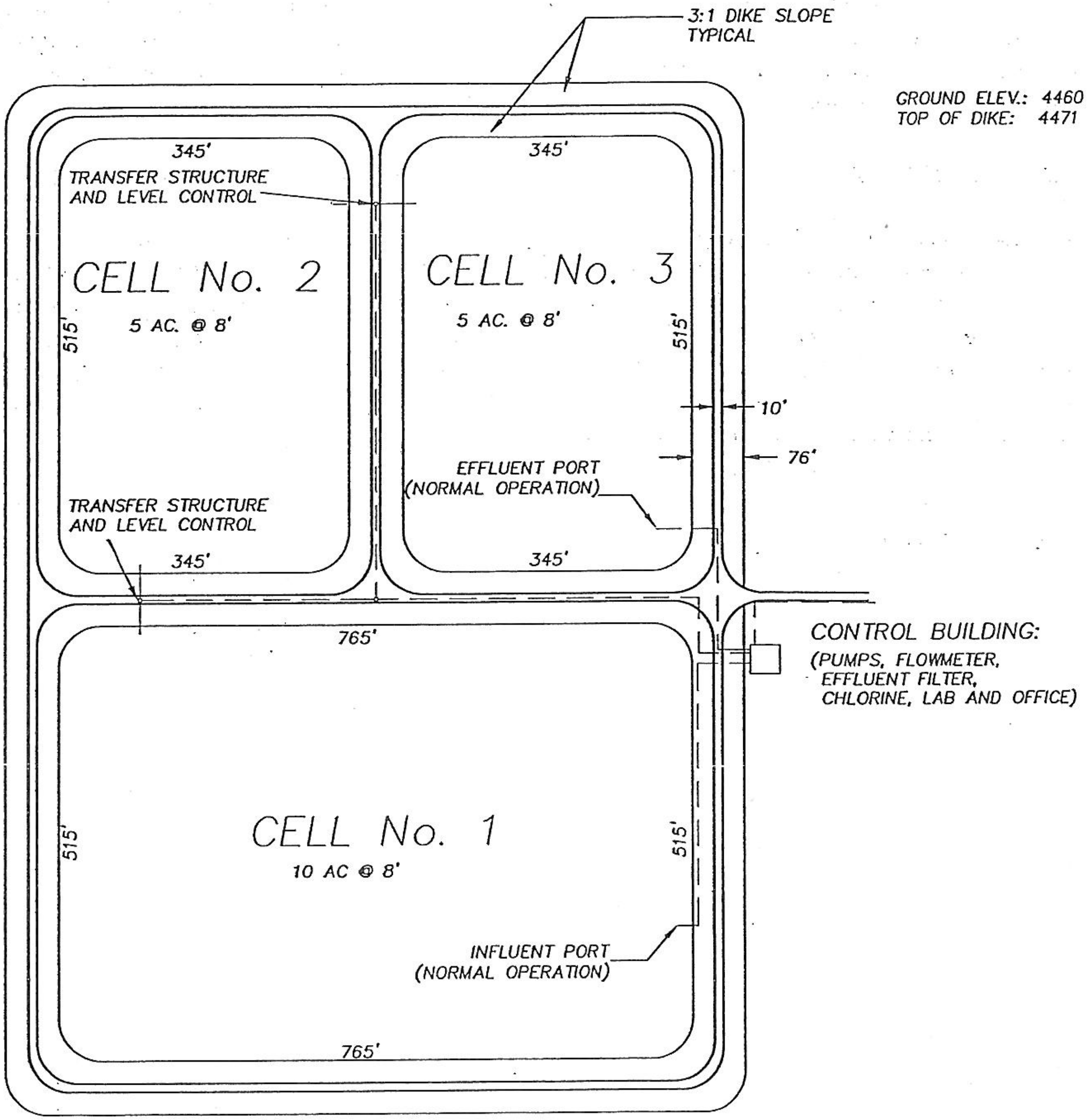


FACULTATIVE LAGOON CONCEPTUAL DESIGN SCHEMATIC

(SIMPLIFIED SCHEMATIC SHOWING GENERAL PROCESS PATHS – DETAILED PIPING AND VALVING ARE OMITTED)

FIGURE 10.1

ADKINS
CONSULTING ENGINEERS, INC.
Engineers ▲ Planners ▲ Surveyors
2950 Shasta Way - Klamath Falls, Oregon 97603 - (541) 884-4666 - FAX (541) 884-5335
Klamath Falls, OR - Medford, OR - Alturas, CA



FACULTATIVE LAGOON PLAN

SERVES ENTIRE SANITARY DISTRICT

HGE INC
ARCHITECTS, ENGINEERS,
SURVEYORS, & PLANNERS
375 Park Avenue/Coos Bay, Oregon 97420 (541) 269-1166
19 N. W. Fifth Avenue/Portland, Oregon 97209 (503) 222-1687

N.T.S.

FIGURE 10.2

The irrigation area required for design year flows is about 90 acres. Initially, only about 40 acres are required for irrigation, based on current population. To provide for the design population (25 years), a total of approximately 125 acres is needed for the lagoon, irrigation, and buffer strips. A potential site is shown in Figure 10.3 for a storage and disposal. Several potential disposal sites are located nearby, as can be seen from the aerial photo. No attempt has been made to contact property owners relative to site acquisition (purchase or lease). A preliminary opinion of probable cost for is given in Table 10.5.

Option 2. Serve Core Area of Crescent Initially, Treatment and Disposal South of Crescent

Also identified as option I A.2 in Section 8, this project would initially provide service to the core area of Crescent, with plans to phase in the rest of the district later. Design flows and loading are roughly half the amounts for project option 1 (above), and the initial costs are lower. Figure 10-4 shows that two ponds could be constructed initially, with each cell having a surface area of approximately 5 acres. Total volume of the ponds is about 75 ac-ft (includes holding storage plus volume at depth of 2.5 feet plus precipitation during holding period). Capacity is provided for the year 2023 population of the core area (population of 540).

For the first phase a total of approximately 65 acres would be needed; 15 acres for the pond, 45 acres for irrigation, and buffer strips.

Opinions of probable cost for each phase is given in Table 10.6 and 10.6.a.