Section 4 – Physical Environmental Characteristics

The only update to Section 4 is a reiteration of the public health hazard presented by onsite septic systems in high groundwater conditions. As stated in Section 3, the County applied a residential Land Use Overlay (LUO) that does not allow residential parcels larger than two acres to be partitioned. The LUO was a direct result of the health hazard concerns as well as the negative impacts resulting from onsite systems in a high groundwater area.

SECTION 4
PHYSICAL ENVIRONMENTAL CHARACTERISTICS

4.1 GENERAL

The following information concerns physical environmental characteristics in the planning area. Much of the information was taken directly from the 1983 wastewater facilities plan for the Crescent Sanitary District.

4.2 PUBLIC HEALTH HAZARDS

Any area where high groundwater is common and onsite septic systems are used for wastewater treatment and disposal has the potential to develop into a public health hazard. When groundwater reaches a high enough level, the wastewater doesn't stay in the soil long enough to be adequately treated. Septic tank drainfields in highly-permeable soil can also create a potential health hazard, since the wastewater can rapidly percolate through the soil and reach the groundwater aquifer before the wastewater is sufficiently treated.

Crescent has both high groundwater and permeable soil, which indicates there is a high probability of groundwater contamination occurring from septic tank drainfields. Depending on the time of year (and location), groundwater levels in Crescent range from 2 to 7 feet deep. Surface soils in the area consist primarily of pumice and are very permeable. LaPine, located 16 miles north of Crescent, has similar conditions and was found to have contaminated groundwater.

Due to these concerns, a groundwater testing program was conducted as part of this wastewater facilities plan update. A report summarizing results of the study is included in Appendix A.

4.3 GEOLOGY AND SOILS

The following description is taken directly from the 1983 wastewater facilities plan:

> *Surface soils of the area consist of coarse to fine pumice which resulted from the volcanic eruption of Mount Mazama. Soils are coarse textured pumice soils and are unsuited for cultivation of crops and are used almost entirely for the production of Ponderosa pine, grazing, and wildlife habitat. In the Crescent vicinity, the permeable pumice soil is underlain at a depth of 6 to 7 feet by a black and impervious layer of soil believed to be the remains of a former marshy area adjacent to the original position of the Deschutes River and below the present level of the river. The high permeability of the pumice soil underlain by the impervious layer creates a shallow basin for the accumulation of surface water adjacent to the Little Deschutes River. Water level during late spring at the Crescent Administrative Center is approximately two to three feet below the ground surface.*

In late August or early September, this water level has dropped to 6 feet or more below the ground surface. This phenomena is believed to result from the accumulation of surface originating water such as snow and rain along the natural slope toward the Little Deschutes River. As the water surface of the Little Deschutes River rises during spring runoffs, groundwater level in the adjacent soils rises correspondingly.

4.4 WATER RESOURCES/QUALITY

The following information on water resources/quality was taken directly from portions of the Report on the Condition of Water Resources in Klamath County (1995), for the upper Deschutes River sub-basin.

Surface Water

The Little Deschutes River originates near Burn Butte and flows north out of Klamath County above Gilchrist. Five flow measurements recorded in 1991 near Chemult indicate a relatively constant flow of between 37.4 cfs in April to 22.9 cfs in July. A longer period of record exists for the river near LaPine, Oregon in Deschutes County. Average discharge at the LaPine gaging station over a period of 69 years was 202 cfs (USGS 1993).

Surface waters in this sub-basin are very cold due to groundwater inflow, and most streamflow originates from deep-seated springs. Conditions of water resources are generally good, however, water quality impairments of the type associated with much of Klamath County are present. The Oregon Department of Environmental Quality (ODEQ) identifies the Little Deschutes River and Crescent Creek as having severe adverse impacts on fish life, aquatic habitat, water contact recreation, and water quality conditions.

The Oregon Department of Fish and Wildlife has delineated Odell Creek, Crescent Creek, Little Deschutes River, and a portion of Big Marsh Creek to be key fisheries habitat. The significance of this designation further highlights the importance of protecting these water resources for aquatic life beneficial uses.

Crescent Creek, Little Deschutes River, and Big Marsh Creek are all federally designated wild and scenic rivers.

Groundwater

The Oregon Water Resources Department, the U.S. Geological Service, and others are currently modeling the groundwater in the Deschutes Basin. These studies will eventually yield quantitative information about this resource. At the present time, however, little quantitative information exists regarding groundwater in the Upper Deschutes Sub-Basin. A pilot watershed analysis on the Odell and Davis Lakes *area was completed by the Deschutes National Forest in 1994. The report concluded that, due to porosity of the area, the Odell-Davis Basin functions as a sponge, absorbing water from precipitation and releasing it throughout the year via springs (USFS 1994).*

The "Meadows" area, located in the northeast corner of the County, has been identified as a problem area due to failing onsite septic systems (Bagget, personal communication). This area has rapidly draining pumice soils and high groundwater, which limits the effectiveness of onsite treatment. Residents rely on groundwater wells for drinking water and many are less than 50 feet deep. There is, therefore, a potential for bacterial contamination in these wells from inadequately treated septic discharge.

Crescent Water Association obtains its water supply from three wells. Water rights applications for the wells were filed in 1989, and issuance of the water rights is pending (Gorman, personal communication). The projected water requirement of 4.07 cfs (at ultimate buildout) is much greater that the 1.8 cfs requested on the water right application. The 1.8 cfs withdrawal would support, at current use rates, approximately 2,840 people (estimated 750 people currently served). It is unlikely that such rapid growth will occur due to economic conditions in that area.

Groundwater sampling was conducted as apart of this wastewater facilities plan update. Nitrate concentrations as high as 13 mg/l were measured. The maximum contaminate level established by EPA for drinking water is 10 mg/l. A copy of the report on groundwater testing is included in the appendix.

4.5 CLIMATE

The following information is taken from the 1983 wastewater treatment facility plan.

Based on climatological data collected at the Wickiup Dam Station, the annual mean evaporation is 37 inches, annual mean precipitation is 21 inches, and the annual mean temperature is 42 degrees F. Weather in the area is characterized by warm, dry summer days and cool evenings, and by crisp, cool winter days and sub-freezing winter nights.

4.6 FLORA AND FAUNA

Pumice soils in the upland areas generally limit the vegetation to Ponderosa pine, and related types of flora and fauna. Areas along the river include significant wetland habitat, including areas of open meadow.

4.7 AIR QUALITY

There is limited data available on air quality in Crescent because there are no monitoring stations in the study area. Air quality is assumed high due to the low density of development and lack of sources of air pollution in the area. Design and location of wastewater facilities need to consider prevailing wind directions and minimizing objectionable odors.

4.8 ENERGY PRODUCTION AND CONSUMPTION

Available energy sources include electricity and natural gas. No energy is produced locally within the study area.

4.9 ENVIRONMENTALLY SENSITIVE AREAS

Due to the natural resources and wildlife habitat within the study area, the entire area is considered to be environmentally sensitive.

4.10 HISTORIC AND ARCHAEOLOGICAL SITES

A cultural resource study was conducted on-site and in cooperation with the State Historic Preservation Office in August 1982 (1983 wastewater facilities plan). No impacts on historical and archeological sites were found for the wastewater project proposed at that time. An updated A-95 review (relevant regulatory agencies are given opportunity to review project and potential impacts) would be conducted as part of the funding application process for the updated project.

4.11 ENDANGERED SPECIES ACT

During the A-95 review process for the project proposed in the 1983 wastewater facilities plan, the only project component of concern was the possible biological impacts of any stream crossings. Again, an updated A-95 review would be conducted as part of the funding application process for construction of the updated facilities.

4.12 WILD AND SCENIC RIVER SYSTEM

The Little Deschutes River has been designated a wild and scenic river. This makes discharge of treated wastewater effluent into the river an unlikely option.

Section 5 – Socioeconomic Environment

5.1 Land Use

Table 5.1 lists the revised acreages for preliminary planning. The zoning designations are updated to reflect the consolidation of General, Recreational and Transportation Commercial to Rural Community Commercial (RUC-C). Industrial zoning was consolidated to Rural Community Industrial (RUC-I). The acreages listed in the 1999 study are still used and only consolidated to reflect the new zoning classifications.

Table 5-1 Approximate Acreages for Zoning Designations by Study Area

Abbreviations	Zoning Designations	Crescent Sanitary District	Westside Crescent	Other	Gilchrist	Total
RI	Rural Residential	374	358	0	0	732
RUC-C	Rural Community Commercial	74	0	0	98	172
RUC-I	Rural Community Industrial	12	0	16	19	47
F	Forestry	50	0	0	-	50
Total (acres)		510	358	16	117	1,001

5.2.1 Planning Period

The three critical time frames for planning are unchanged except for the year they represent as follows:

1. Present
2. 25 Years (Year 2032): a 25 year projection is the typical basis for sizing pump stations and treatment based on an assumed 20 year life for most of the mechanical components and a five year period for planning, funding and construction.
3. Ultimate buildout: the buried pipelines are generally planned to have a life of 50 years or more due to the expense and disruption to replace these components.

5.2.2 Crescent Residential Population

The 2000 census provided an update on the general County household size. The 1999 Study used 2.54 people per household in Klamath County and that number has dropped in the 2000 census to 2.48. Since the change was so minimal, the 1999 estimate of 2.54 is being used for this update. Records from the Crescent Water Association for 2007 indicated exactly the same number of residential water meters as was used in 1999. Therefore the estimated population is still 450 residents (177 accounts times 2.54 residents per account). Westside Crescent appears to have grown by one account and the 1999 population estimate of 254 people will be used for the present population in the updated study.

Since a regional facility is not anticipated at this time, an update of the Gilchrist population has not been completed.

5.2.3 Planning Growth Rate

The planning growth rate of 3 percent per year developed in the 1999 Study will be used for this update. The primary assumption in selecting this growth rate is that a community sewage system is in operation, otherwise the estimated growth will not occur. It appears that the lack of a community sewage system is the reason anticipated growth in the 1999 Study has not occurred.

Although the growth since 1999 has not followed the rate estimated in the 1999 Study, there are potential developments being planned that could allow a 3 percent growth rate to be reached and exceeded with a community sewage system. First is the annexation requested by the Gisler and Ward parcels totaling approximately 297 acres. An even larger development for a proposed destination resort within a few miles of Crescent could result in additional service related employment in Crescent along with the related housing growth that would result. It is also believed that when a community sewage system is operational, there are 95 existing residential lots that could quickly develop. Associated with the potential residential growth is an increased level of commercial growth to support the new residential growth.

5.2.4 Equivalent Dwelling Units (EDU's)

Crescent Water Association billing records are not significantly changed from the data shown in Table 5.2 of the 1999 Study with the exception of the increased water use for the user group classified as "other". The water user the accounted for the increased water use in the "Other" category was the two Forest Service accounts. Additional detail of the water use must be analyzed when it is available to determine how much of the water use will actually result in increased wastewater flows. For planning purposes, the EDU's used in the 1999 Study will be used for the estimate of present conditions.

Classification	Number of Accounts	Number of Dwelling Units	Annual usage (gallons) 1999	Annual usage (gallons) Present	Number of EDU's 1999
Residential	180	210	19,340,534	19,690,885	210
Commercial	23	-	4,527,232	4,923,701	49
Other	7	-	2,663,721	4,582,728	29
Total	210	210	26,531,487	29,197,314	288

The water use records are based on total annual meter readings. To get the most accurate water use that will actually correlate to wastewater flows, the water use from November through March over several years must be evaluated. Using these months will eliminate water use that is applied as irrigation and any other outside water use that will not result in wastewater flows.

5.2.5 Ultimate Buildout

The 1999 Study estimate of Ultimate Buildout is still valid. Although the zoning classifications have

been changed as discussed in Section 5.1, the total acreage available for development is essentially unchanged. In addition, the estimated population and EDU's have remained essentially unchanged.

The most significant issue that could impact growth rates and overall development density is unknown impacts that will result with the proposed destination resort planned on nearby Cascade Timberlands, LLC property is developed.

Table 5.4 Ultimate Buildout Computations

Zoning	Crescent Sanitary District - Acres	EDU's per Acre	Total EDU's	Residential Population
RI	374	4.35	1,627	4,132
RUC-C	74	5.6	414	-
RUC-I	12	34.4	413	-
F	50	0	0	-
Total (acres)	510	358	2,454	4,132

5.3 Public Facilities

This section of the 1999 Study is unchanged.

5.4 Economics

The updated Median Household Income (MHI) estimated for 2004 from the US Census is $33,765. A special survey to determine community income will need to be completed to determine the percentage of low and moderate income households. Data from the low and moderate income survey will be used to determine eligibility for public works grants and loans.

SECTION 5
SOCIOECONOMIC ENVIRONMENT

5.1 LAND USE

A land use zoning map was prepared by HGE using tax assessors maps. A zoning map for the study area is included as Figure 3-1.

Acreages shown in Table 5.1 are approximate and should be used for preliminary planning purposes only. Note that approximately 16 acres of land zoned IH appears to fall outside the sanitary district boundaries and is referred to as other.

Table 5-1. Approximate Acreages for Zoning Designations by Study Area

Abbreviation	Zoning Designations	Crescent Sanitary District	Westside Crescent	Other	Gilchrist	Total
RI	Rural Residential	374	358	0	0	732
RCR	Rural Community	0	0	0	89	89
CT	Commercial Transportation	67	0	0	9	76
CG	Commercial General	7	0	0	0	7
IL	Light Industrial	1	0	0	0	1
IH	Heavy Industrial	11	0	16	19	46
F	Forestry	50	0	0		50
Total (acres)		510	358	16	117	1,001

5.2 POPULATION AND EQUIVALENT DWELLING UNITS

Two population indicators will be utilized for planning purposes:

1. Resident population
2. Equivalent dwelling units (EDU)

5.2.1 Planning Period

Three critical time periods will be used when evaluating wastewater planning needs:

1. Present
2. 25 years: 20 years is the assumed life of most mechanical/electrical equipment. Typically, 25 year projections are the basis for sizing infrastructure such as pump stations and treatment plants, allowing 5 years for planning, funding, and construction.

3. Ultimate buildout: buried sewer lines are generally assumed to have a life expectancy of 50 years or more. It is disruptive and expensive to dig up undersized lines for replacement with larger pipes, therefore, buried sewer lines are typically sized for ultimate buildout.

5.2.2 Present Residential Population

Residential populations are available for incorporated areas from the US Census. However, since neither Crescent or Gilchrist are incorporated, residential populations must be estimated.

The Crescent Water Association serves a total of 277 residential accounts. Of these, 177 are located within the sanitary district boundary. The other 100 accounts are in westside Crescent. Based on information provided by the Center for Population Research and Census, Portland State University, the 1990 Census data indicates that there are 2.54 people per household in Klamath County. The residential population within the Crescent Sanitary District is estimated to be 450 people (2.54 people per household x 177 residential water accounts). Residential population in Westside Crescent is currently estimated to be 254 people (2.54 x 100).

Presently, there are approximately 120 houses connected to Gilchrist's system (personal communication with Mr. Ernst). Some of the houses are occupied by part-time residents. When all houses are occupied, the residential population is estimated at 305 people (2.54 x 120). Some commercial establishments and the school (459 students) are also connected to the wastewater system. Crown Pacific Corporation, which purchases approximately 500,000 gallons of water per month (16,700 gallons per day), is not connected to Gilchrist's wastewater system. Flows measured at the Gilchrist lagoons consistently average 21,000 gallons per day (gpd). At a per capita flow of 100 gpd, the flows measured at the lagoon indicate a residential population of approximately 210 people. Therefore, the residential population in Gilchrist is estimated to be in the range of 200 to 300 people, considerably less than the population of 500 people estimated in the "Report on the Condition of Water Resources in Klamath County."

5.2.3 Twenty-five Year Planning Growth Rate

For planning purposes, the annual rate of increase in population has been assumed to be 3 percent, based on recent growth trends in Klamath County. This results in the population approximately doubling during the 25-year planning period.

5.2.4 Equivalent Dwelling Units (EDUs)

An EDU is defined as using the same (equivalent) amount of wastewater as a residential dwelling unit. EDUs are the basis for computing system development charges (SDCs), and also are useful for planning purposes since EDUs give an indication of the impacts of nonresidential development.

The Crescent Water Association provided water billing records for accounts located within the boundary of the Crescent Sanitary District. Billing information (12 months) and EDU computations for the sanitary district are summarized in Table 5.2.

Table 5.2 Annual Water Billing and EDU Computations for Accounts Located Inside Crescent Sanitary District

Classification	Number of Accounts	Number of Dwelling Units	Annual Usage (gallons)	Average Daily Usage per Dwelling Unit (gpd)	Number of EDUs
Residential	180	210	19,340,534	258	210
Commercial	23	---	4,527,232	---	49
Other	7	---	2,663,721	---	29
Total	210	210	26,531,487	---	288

There are approximately 100 water customers in westside Crescent. It is assumed that all the water customers outside the sanitary district boundary are residential (all land is zoned residential in Westside Crescent), and therefore, 100 EDUs exist in Westside Crescent.

An economic impact analysis report was completed in 1996 for the collection and treatment system proposed in the 1983 study. Separate costs for a collection system serving the "core" area were given. The purpose of this section is to delineate and estimate flows from the core area. Figure 3-1 shows the assumed boundary. Table 5.3 gives a list of nonresidential accounts within the boundary and their metered water usage for a twelve-month period. This water usage was used to estimate the number of EDUs from nonresidential accounts. The number of residential accounts was estimated from the aerial photograph (Figure 3-2).

Table 5.3 Estimate of EDUs Within Crescent's Core Area

Estimated Flows From Core Area of Crescent	
Non-Residential Accounts	
Name	Water Usage (gal.)
Crescent Motel	403,800
Woodsman Motel	810,000
Mohawk Restaurant	423,064
Crescent Tavern	122,180
Apache Tears OUT OF BUSINESS	127,920
Starlight Café OUT OF	4,130
Crescent RV Park	357,700
Ken's Gun Shop	39,040
Young's Cut Stock	199,020
Crescent Oil Co.	18,840
Crescent ~~Texaco~~ SHELL	152,350
Crescent Fire Prot. (2 METERS)	15,027
First Baptist Church	143,442
Postmaster	9,930
Deschutes Natl. Forest	2,383,400
Total	5,451,663
Number of EDUs	60
Residential Accounts/Number of EDUs	80
Total Number of EDUs (1998)	140

CRESCENT SEWING
[illegible] MORRIS

The current number of 150 EDUs in Gilchrist has been estimated based on 120 residential dwelling units, and estimates of 20 EDUs for the school and approximately 10 EDUs for the commercial businesses.

5.2.5 Ultimate Buildout

Ultimate buildout (UBO) estimates are used for sizing sewer collection piping, and also compared with 25-year planning projections to determine if enough buildable lands are available to support the expected growth during the planning period. The UBO population and EDUs are computed based on land use zoning.

After a public sewer is constructed in Crescent, it is likely that the residential zoning will be converted from R1 (1-acre lot minimum) to RCR (minimum lot size of 5,000 square feet). For computing UBO values in residential zoning, a RCR zoning designation has been assumed, so that 8.7 EDUs can be constructed on each acre of buildable land. It has also been assumed that 50 percent of the residential zoned land is buildable, and that 50 percent will be required for street right-of-ways, existing lots and other physical building limitations. This reduces the number of EDUs to 4.35 per acre for residential zoned property. Estimated residential population at buildout is computed for 2.54 people per EDU. The recently annexed 140 acre parcel is currently zoned forest land, which allows minimum residential construction, and therefore was not included in the analysis.

Commercial and light industrial zoned land is assumed to have 5.6 EDUs per acre at ultimate buildout. This is based on a design flow of 1,500 gpd per acre (Wastewater Engineering, Treatment, Disposal and Reuse, Metcalf & Eddy, Inc.), and 268 gpd per EDU.

Heavy industrial is assumed to have 37 EDUs per acre at ultimate buildout, based on a design value of 10,000 gpd per acre (typical value) and 268 gpd per EDU.

Ultimate buildout computations are summarized in Table 5.4.

Table 5.4 Ultimate Buildout Computations

Crescent Sanitary District

Zoning	Acres	EDUs per acre	Total EDUs	Residential Population
RI	374	4.35	1,627	4,132
RCR	0	4.35	0	0
CT	67	5.6	375	0
CG	7	5.6	39	0
IL	1	5.6	5.6	0
IH	11	37	407	0
F	50	0	0	0
Total	510		2,454	4,132

Table 5.4 Ultimate Buildout Computations Continued...

Outside Sanitary District, Westside Crescent and Outside Industrial Land

Zoning	Acres	EDUs per acre	Total EDUs	Residential Population
RI	358	4.35	1,557	3,956
RCR	0	4.35	0	0
CT	0	5.6	0	0
CG	0	5.6	0	0
IL	0	5.6	0	0
IH	16	37	592	0
F	0	0	0	0
Total	374		2,149	3,956

Gilchrist

Zoning	Acres	EDUs per acre	Total EDUs	Residential Population
RI	0	4.35	0	0
RCR	89	4.35	387	983
CT	9	5.6	0	0
CG	0	5.6	0	0
IL	0	5.6	0	0
IH	19	37	703	0
F	0	0	0	0
Total	16		1,090	983

5.2.6 Population and EDU Summary

Population and EDU estimates are summarized in Table 5.5 for existing conditions, 25-year projections, and ultimate buildout.

Table 5.5 Summary of Population and EDU Projections

Description	Crescent Sanitary District	Westside Crescent	Other	Gilchrist	Total
Current Population	535	254	0	210	999
25-Year Population	1121	532	0	439	2092
UBO Population	4132	3,956	0	983	9071
Current EDUs	288	100	----	150	538
25-Year EDUs	603	209	----	314	1126
UBO EDUs	2454	1,557	592	1,090	5693

The "Report on the Condition of Water Resources in Klamath County (June 1995)" estimated the population in Crescent at 750 people, and the ultimate buildout population at 4,150 people. Population estimates for Gilchrist in the water resources study were 500 people in 1995, and an ultimate buildout population of 600 people.

Current population estimates, in the water resources study and Table 5.5, are similar for Crescent (sanitary district plus westside equals 789 people in Table 5.5). The ultimate population estimate in Table 5.5 for Crescent is about twice as high as the estimate in the water resources study, since it is assumed in Table 5.4 that all residential zoning will eventually be converted from R1 to RCR. The wastewater facilities plan estimates (Table 5.5) for Gilchrist are felt to be reasonable based on the number of existing dwellings and land use zoning.

Currently, it is estimated that there are 140 EDUs located within the Crescent core area (approximately 50 percent of the total within the sanitary district boundary). It is assumed that the core area will grow at the same rate as the rest of the sanitary district, and that in 25 years there will be approximately 290 EDUs located in the core area.

5.3 PUBLIC FACILITIES

Public facilities of primary importance for wastewater planning are sewer, water, storm drainage, and streets.

Crescent currently has private onsite septic systems. The community sewer system in Gilchrist is presently privately owned.

Drinking water in Crescent is supplied by the Crescent Water Association with three wells. Gilchrist is supplied by a privately owned water system which also includes three groundwater wells.

There is very limited storm drainage facilities in Crescent, these primarily consist of roadside ditches and culverts.

Highway 97 is a state highway. Other streets in Crescent are county streets. Most of the streets are not paved.

5.4 ECONOMICS

Median household income (MHI) and the percentage of low and moderate income persons are the two primary criteria used by the funding agencies to determine eligibility for public works grants and loans. Crescent is not incorporated. The MHI would be based on the Crescent Lake division of Klamath County, which, based on the 1990 US Census Data, has a MHI of $21,050. Based on personal communication with Oregon Economic Development staff, an income survey would be required to determine the percentage of low and moderate income persons.

Section 6 – Wastewater Facility Planning Considerations.

All but one subsection in this Section are still valid for this update, with the primary update directed to current construction cost trends.

Sections 6.1, 6.2 and 6.3 have no changes necessary for this update.

Section 6.4 Facilities Planning Opinions of Probable Cost is updated below, primarily to bring the Engineering News Record (ENR) Construction Cost index to the year 2007. Table 6.3 illustrates the ENR Construction Cost index from August 1998 to August 2007.

Table 6.3
ENR Construction Cost Index

Year	20-City ENR	% Change
1998	5,928	-
1999	6,091	2.7%
2000	6,233	2.3%
2001	6,233	2.5%
2002	6,389	3.2%
2003	6,733	2.1%
2004	7,188	6.8%
2005	7,479	4.0%
2006	7,723	3.3%
2007	8,007	3.7%
Average % Change		**3.1%**

Construction of the Crescent Sanitary District wastewater improvements is estimated to begin by May 2009. Based on Table 6.3, the ENR index has increased at a rate of 3.1% over the last 10 years. Applying this annual rate of increase to the current index (August 2007) of 8,007, the rate for May 2009 can be derived as follows:

$$8{,}007\ [1 + 0.031\ (21 \text{ months} / 12 \text{ months per year})] = 14{,}446$$

The costs that are brought forward from the 1999 Study will be updated based on the ENR Construction Cost Index estimated to be 14,446 in May 2009.

Section 6.4.1 Present Worth Analysis

The only change to this section is that an interest rate 6.5 % and an ENR Construction Cost index of 14,446 will be used for present worth analysis.

SECTION 6
WASTEWATER FACILITIES PLANNING CONSIDERATIONS

6.1 WASTEWATER DISPOSAL CRITERIA

Effluent from wastewater treatment plants must be disposed of in such a manner that beneficial usage of the waters of the state and the public health are protected. Government regulations stipulate quality requirements for effluent and receiving water.

The State of Oregon Environmental Quality Commission (EQC) meets periodically to determine policies for maintaining or improving water quality in Oregon. The Oregon Department of Environmental Quality (DEQ) is responsible for administering these policies. EQC's general policy calls for increased efficiency and effectiveness when implementing additional wastewater treatment requirements caused by growth and development throughout the community. This policy insures that future wastewater discharges will not exceed the currently allowed discharge limit. In addition if it is determined that the receiving stream or water body is water quality limited, the EQC may require a reduction in the current permitted wastewater discharge level. A reduction may be necessary in order to restore and maintain water quality in the receiving water body at a level needed to protect public health and provide beneficial uses of the water. It is also a policy of the EQC to encourage the use of wastewater effluent for beneficial purposes such as crop or golf course irrigation. Methods are used that insure protection of public health and the environment. The use of wastewater effluent enhances water quality by reducing discharges of treated effluent to surface waters, and potentially by conserving streamflows through reduced demand for withdrawals for out-of-stream use.

The water quality management program in Oregon has undergone considerable change in the last few years. One major program change involves DEQ's shift from technology based permit decisions to water quality based permit decisions. In other words, the emphasis has shifted from the discharging facility to the receiving water. As wastewater discharge restrictions increase, new permits are becoming more and more difficult to obtain.

6.1.1 Regulatory Authority

Wastewater discharges in the state of Oregon must meet the requirements of the Oregon Department of Environmental Quality (DEQ) and the United States Environmental Protection Agency (EPA). DEQ is responsible for administering the applications of federal standards in Oregon, and for implementing the policies established by EQC. More stringent treatment requirements can be established by DEQ, when appropriate, to protect the public health and beneficial uses of water of the state. DEQ's requirements regarding wastewater treatment and disposal are set forth in Oregon Administrative Rules Chapter 340. When expected sewage flows are less than 2,500 gpd, policies are administered by the Klamath County sanitarian's office. When flows are anticipated to exceed 2,500 gpd, policies are administered by DEQ.

6.1.2 On-Site Systems

Drainfield requirements are based on considerations such as type of soil, depth of groundwater, impermeable soil layer (clay), rock, and "effective depth" of suitable soil for effluent disposal. Prior to the advent of sand filters, approximately 30 percent of construction applications for septic tank installation were approved nationwide (personal communication, Klamath County sanitarian's office). Utilization of sand filters has significantly reduced the percentage of permit denials for septic system installation. Approximately 70 percent of applications for septic systems are currently approved in Klamath County. Many of the new approvals include sand filter systems, which are expensive (average of $12,000 per residential installation) and require a relatively large land area (1/2 acre per 450 gpd of wastewater).

On-site systems are approved on a case-by-case basis. Test hole pits dug with a backhoe are inspected by either county or DEQ staff.

New septic tank drainfields must be separated from wells by a minimum distance of 100 feet (Oregon Health Division Requirements). This construction standard can have a significant impact on the minimum size of buildable lots.

6.1.3 Deschutes Basin Standards for Discharge to Receiving Stream

At a minimum, treated wastewater from a new facility that discharges into a receiving stream must meet the Deschutes Basin Standards, as defined by OAR Chapter 340, Division 41, paragraph 575. The applicable standards are summarized in the following subsections.

<u>Effluent Discharge Limits</u>

Based on OAR Chapter 340, Division 41, the minimum design criteria for treatment and control of wastewater in Deschutes Basin includes the following limits.

a.) Metolius River Subbasin and Deschutes River Basin above Bend Diversion Dam (river mile 165): treatment resulting in monthly average effluent concentrations not to exceed 5 mg/l BOD_5 and 5 mg/l of TSS.

<u>Effluent Dilution</u>

Effluent BOD concentrations in mg/l, divided by the dilution factor (ratio of receiving stream flow to effluent flow) shall not exceed one, unless otherwise approved by the EQC. For example, if the BOD_5 concentration is 20 mg/l, then the stream flow would need to be at least 20 times greater than the quantity of effluent discharged into it.

<u>Effluent Disinfection</u>

Subsequent to treatment, sewage waste shall be disinfected at a level equivalent to a thorough mixing with chlorine to sufficiently provide a residual of 1 mg/l after 60 minutes of contact time, unless otherwise specifically authorized by permit.

Effluent Toxicity

In order to prevent lethal conditions in the regulatory mixing zone, OAR 340-41-325 states that water within the mixing zone shall not be acutely toxic to aquatic life. Acute toxicity is defined as the lethal concentration that causes 50 percent mortality of organisms within a 96 hour test period. Chronic toxicity is defined as the concentration that causes long-term, sub-lethal effects, such as significantly impaired growth or reproduction during a testing period based on the test species life cycle. It is implied within the OAR requirement that acute toxicity is not permitted at the end of the outfall, thus requiring that the undiluted effluent cannot contain acute toxicity concentrations. DEQ recognizes that this requirement may be impractical and unnecessary for most wastewater treatment plants.

Due to rapid dilution at the outfall diffuser, DEQ has recommended adopting the use of a "zone of immediate dilution," in which acute toxicity concentrations may be exceeded. One approach suggested for delineating the zone of immediate dilution is that it extend 10 percent of the distance to the edge of the mixing zone. EPA's recommendations for delineating the zone of immediate dilution are listed in Table 6.1. OAR 340-41-325 also states that chronic toxicity limits are not to be exceeded outside the mixing zone. The compounds in wastewater treatment plant effluent of greatest concern with regards to acute and chronic toxicity are ammonia and chlorine. Toxicity limits expected for the Deschutes Basin are presented in Table 6.2.

Table 6.1 EPA Recommendations for Delineating Zone of Immediate Dilution.

1	10 percent of distance from the edge of outfall structure to the edge of the regulatory mixing zone.
2	50 times the discharge length scale, where discharge length scale = square root of the cross-sectional area of the discharge outlet.
3	5 times the local water depth.

Note:
a. Most restrictive conditions should be met.
b. Reference: EPA-440/4-85-032, technical support document for water quality-based toxic control.
c. Recommended outfall discharge velocity is 10 feet per second (fps) or great enough to provide turbulent mixing while minimizing organism exposure time.

Table 6.2 Anticipated Deschutes Basin Toxicity Limits

1	Chlorine - Acute 0.019 mg/l - Chronic 0.011 mg/l Reference: OAR 340-41, Exhibits, Table 20, DEQ Water Quality Summary Criteria
2	Ammonia - Total Ammonia - Acute 6.9 mg/l (pH = 8.0, T = 15° C) - Chronic 1.33 mg/l (pH = 8.0, T = 15° C) - Unionized Ammonia - Acute 0.0129 mg/l (pH = 6.5, T = 5° C) - Chronic 0.009 mg/l (pH = 6.5, T = 5° C) Reference: (AR 340-41, DEQ Document, Salmonids and other cold water species
3	BOD - BOD/DF < 1.0 DF = Dilution Factor (Wastewater flow divided by river flow) Reference: OAR 340-41-575
4	DO - 90% saturation- summer - 95% saturation- fall, winter, and spring
5	pH - 6.5 to 8.5 Reference: OAR 340-41-575

6.1.4 Water Quality Limited Water Bodies

Based on the water quality status summary, Oregon 305 (b) report for the Deschutes Basin, the only measured parameter not fully supported in the upper reaches of the Deschutes is pH. The pH parameter is partially supported in summer, but fully supported in fall, winter and spring.

6.1.5 Solids Disposal

Land application and disposal of sewage treatment plant solids and sludge derived products including septage, must comply with OAR 340-50 and satisfy the new 503 standards.

The beneficial use of solids as a fertilizer is encouraged. Restrictions have been developed in order to prevent health hazards, and the contamination of both surface and groundwater sources from nitrates and heavy metals.

Use limitations depend on the degree of treatment the solids have received prior to disposal. Limitations would be increasingly restrictive for the following types of solids:

a. Compost
b. Secondary treatment plants which provide either anaerobic digestion or aerobic digestion
c. Lagoon sludge
d. Septage

6.1.6 Protection of Groundwater

Mandatory minimum groundwater quality protection requirements for federal and state agencies, cities, counties, industries, and citizens are outlined in Oregon Administrative Rules, Division 40.

Groundwater, once polluted, is difficult and sometimes impossible to clean up. Therefore, EQC has employed an anti-degradation (zero-degradation) policy to emphasize the prevention of groundwater pollution, and to control discharges to groundwater so that the highest possible water quality is maintained.

Treated wastewater effluent, whether treated with a septic tank or other treatment system, is generally of worse quality than the natural groundwater. For small wastewater discharges, such as from single-family household septic tanks, the overlaying soils can sometimes provide enough filtration and biological treatment to prevent any degradation to natural groundwater quality.

For onsite systems of less than 2,500 gpd, Klamath County is responsible for administering groundwater protection rules and reviewing permit applications to construct septic tank and drainfield systems.

When wastewater discharge will exceed 2,500 gpd, DEQ administers the groundwater protection rules. The owner must apply for a Water Pollution Control Facilities (WPCF) permit. If design flow is 5,000 gpd or greater, a public notice of pending action must be distributed. Depending on public response, additional public involvement may be required. Typically, a hydrologic characterization is needed to document affects of wastewater discharge. Since it is rare for a wastewater discharge to cause zero degradation of the background water quality, in most instances the applicant must also request a waiver to groundwater protection rules. In order for a waiver to be granted, the applicant must demonstrate that groundwater degradation will have no negative impact on beneficial uses of groundwater, such as drinking water supply. Groundwater monitoring wells must also be installed to monitor for any future degradation of groundwater quality.

The WPCF permitting process can be time consuming and expensive, especially when a hydrologic characterization study, variance request to OARs, and groundwater monitoring wells are required. An exception can be discharge to land irrigation. If it can be demonstrated that through a combination of evaporation and plant consumption, zero wastewater will reach the groundwater table, than the permitting process is simplified.

6.2 NPDES OR WPCF WASTE DISCHARGE PERMIT

Any wastewater discharge to surface water, regardless of quantity, requires a National Pollutant Discharge Elimination System (NPDES) waste discharge permit.

Onsite systems (no surface water discharge) require a construction permit from Klamath County when flows are less than 2,500 gpd. When flows exceed 2,500 gpd, the owner must apply for a Water Pollution Control Facilities (WPCF) permit.

6.3 DESIGN CRITERIA

Design philosophies for the facilities to be developed in following chapters are discussed below. Specific design loadings and criteria will be discussed with the alternatives.

DEQ requires that facility planning for wastewater facilities be based on a 20-year planning period. They feel that this allows adequate time for adaption to future needs, while being short enough to insure that the facilities will be effectively utilized within their economic life. Trunk and interceptor sewers are typically sized for an ultimate buildout.

This report is based on the design year 2023, which provides an allowance for the time required to develop and construct facilities. Recommended treatment improvements are developed for construction in phases throughout the projected year 2023, and components that are expected to remain in service beyond the year 2023 are designed to permit future expansion. It is important to realize that if population growth develops more rapidly than projected, (Section 5) capacity may be reached at an earlier date.

6.3.1 Wastewater Treatment Plants

Major considerations in the design of a wastewater treatment plant involve the required capacity and degree of treatment. The degree of treatment is based on meeting discharge requirements. All plant designs must include enough capacity to contain peak hydraulic and peak organic loads. Other important considerations are discussed below.

Flexibility of Design

Flexibility in process design allows for modification of the treatment processes or capability to bypass or isolate individual treatment units. Flexibility in design will also allow for removal of duplicate units from the treatment process during low flow periods, scheduled maintenance, or as a means to provide an effluent quality within allowable standards during periods of mechanical failures.. Flexibility is a key factor in some instances as it allows construction and connection of new process units while the plant remains in operation. Every attempt will be made in each of the recommended alternatives to establish the maximum possible flexibility of installed process units.

Reliability

Reliability in wastewater treatment plant design is largely dependent on proper selection of unit design criteria with sufficient allowances for peak flow conditions and a conservative selection of quality equipment to provide for long life and minimum maintenance. Reliability should provide for continued operation of the developed treatment facility with process redundant units removed from the flow stream. Reliability should also allow for an effluent quality within established permit conditions. Duplicate facilities are an important facet of reliability since provisions must be made for periodic maintenance and unplanned equipment failures. The degree of duplication is a function of the degree of risk and the potential adverse impacts from a permit violation. EPA has designated three classes to identify the degree of reliability. Class I reliability is the most restrictive and includes multiple units or backup features for all treatment components.

Provisions should be made for standby power capabilities to maintain essential process functions during power outages. Location of electrical equipment, control centers, and switch gear should be strategically placed in areas not subject to flooding.

Automation

While automated controls can reduce the amount of labor required to operate the plant, they must be inspected and maintained on a routine basis to insure that they are properly calibrated and that the processes are performed as intended. Automated controls are more suitable for complex processes.

Human Factors

Wastewater facilities should be designed to allow for ease of operation and maintenance and to ensure the continued usefulness of the facility. Facilities should be properly ventilated, provide sufficient light, and be free from excessive noise. Convenient access to equipment, valves and other operating devices is imperative. Operator health and safety must be of paramount importance in the design of the facilities.

Odor Control

By their nature, wastewater treatment facilities will have some odors; however, it is possible through good design practices to minimize odors to a publicly acceptable level.

6.4 FACILITIES PLANNING OPINIONS OF PROBABLE COST

Opinions of probable cost presented in this study include four components which are discussed separately in this section. It must be recognized that these figures are preliminary, and are based on the level and detail of planning presented in this study. As projects proceed forward it may be necessary to update the opinions of probable cost from time to time, as more information becomes available.

Construction Cost

Opinions of probable cost will be based on the construction costs for similar plants when available, and from other supportable sources. It is important to note that the opinions of probable cost are for preliminary budgeting purposes, and should be updated as part of the design process when the extent and scope of work is better defined.

Future changes in the cost of labor, equipment, and materials may justify comparable changes in the costs presented herein. For this reason it is common engineering practice to relate costs to long term changes in the national economy. The Engineering News Record (ENR) construction costs index is most commonly used. It is based on a value of 100 for the year 1913, and its value for the past 12 years is shown in Table 6.3.

Table 6.3 ENR Cost Index Projection

Year	20-City ENR (August)	% Change
1988	4541	
1989	4607	1.5 %
1990	4752	3.1 %
1991	4892	2.9 %
1992	5032	2.9 %
1993	5230	3.9 %
1994	5433	3.9 %
1995	5506	1.3 %
1996	5670	1.0 %
1997	5854	1.0 %
1998	5928	1.0 %
10- year average		2.3 %

Construction of Crescent's wastewater improvements is expected to begin by June 2000. The applicable ENR is calculated based on an annual increase of 2.3 percent over the future time frame beginning in August 1998, and calculated as follows:

$$5{,}928\ [1 + .023\ (22/12)] = 6{,}178$$

The costs presented in this study are based on an ENR 20-city index of 6,178.

Engineering and Construction Observation

Engineering and construction observation costs have been assumed to be 20 percent of the construction cost. This includes costs for the engineering company to conduct preliminary surveys, perform detailed design analysis, prepare construction drawings, develop construction specifications, advertise for construction bids, conduct construction stakeout surveys, provide detailed construction observation, administer construction related activities such as change orders, and to prepare final record drawings.

Engineering and construction observation services generally are divided into the following six phases:

1. Study phase
2. Preliminary design phase
3. Final design phase
4. Bidding phase
5. Construction phase
6. Operational phase

This wastewater engineering study is being conducted as part of the study phase. Opinions of probable cost are updated during each phase. Accurate cost estimates are not available until after construction bids are opened at the end of the bidding phase. Even then, costs may change as modifications are made during the construction and operational phases.

Contingencies

A contingency factor equal to 10 percent of the estimated construction cost has been added. In recognizing that opinions of probable cost are based on preliminary design, allowances must be made for variations in final quantities, bidding market conditions, adverse construction conditions, unanticipated specialized investigation and studies, and other difficulties that cannot be foreseen at this time, but which may tend to increase final costs.

Legal and Administrative

An allowance of 5 percent of construction cost has been added for legal and administration fees. This allowance is intended to include internal project planning and budgeting, grant administration, liaison, interest on interim financing, legal services, review fees, legal advertising, and other related expenses associated with the project.

Summary

The opinions of probable cost presented in this study include a combined allowance of 35 percent for contingencies, engineering, design and legal/administrative fees.

6.4.1 Present Worth Analysis

Principal alternatives will be evaluated on a present worth basis. The analysis will be based on the following assumption:

Planning period	20 years
Service life	
treatment plant components and pump stations	20 years
pipelines	50 years
Interest rate	7%
ENR construction cost index	6,178

Section 7 – Wastewater Characteristics.

Current water use records were reviewed for the Crescent Water Association customers to use as a basis for estimating sewage flows for residential and commercial customers as shown in Section 5. The Crescent Water Association water use records had minor variations for residential and commercial users compared to the 1999 Study. The most significant variation from the 1999 Study was the "other" classification which included the Forest Service accounts. Further evaluation of the Forest Service water use is necessary to determine whether the differences will actually result in wastewater flow increases. Water use records for the Forest Service could be inflated as a result of water use for fire fighting. Based on this information, the wastewater flows and characteristics from the 1999 Study will be used for this update.

SECTION 7
WASTEWATER CHARACTERISTICS

7.1 GENERAL

The wastewater management plan completed for Crescent in 1979 developed estimates for wastewater flow and BOD_5 loadings. These estimates were made from standard design values and estimates of septage wastes from Forest Service facilities and campgrounds. Since then, the Crescent Water Association (CWA) has installed meters on all accounts. With this data, a more accurate estimate of wastewater generation can be made.

7.2 TERMINOLOGY

The following terms are used to define seasonal differences in wastewater flow characteristics:

Dry-Weather (Low Streamflow) Period: Generally defined as the period when precipitation is limited and stream flows are low. This period is specifically defined by Oregon Administrative Rules (OAR) 340-41-575 as April 1 through October 31 for the Deschutes River Basin above the Bend Diversion Dam

Wet-Weather (High Streamflow) Period: Generally defined as the period when precipitation is greatest and stream flows are highest. This period is specifically defined by Oregon Administrative Rules (OAR) 340-41-575 as November 1 through March 31.

The following terms are used to characterize wastewater flows:

Average Daily Flow (ADF): Total wastewater flow for one year, divided by the number of days in that year.

Maximum Monthly Flow (MMF): Total wastewater flow for the month with the highest wastewater flow during the year, divided by the number of days in that month.

Peak Daily Flow (PDF): Total flow for the day with the highest wastewater flow during the year.

Peak Hourly Flow (PHF): A diurnal peak sustained for one hour during the year. May also be called Peak Instantaneous Flow (PIF)

7.3 WASTEWATER FLOWS AND LOADINGS

7.3.1 Crescent

Wastewater flows must still be conservatively estimated since there is not an existing sewer system in Crescent. The CWA provided metered water usage for all accounts within the Crescent Sanitary District (CSD). Water usage for a period of twelve months was divided into categories based on the type of institution (Table 7.1). Approximately 60-85 percent of per capita consumption generally becomes wastewater, so a reduction factor within the higher end of this range was assumed based on characteristics of water use, such as amount of landscaping. Wastewater generation may be more accurately determined from water usage during the non-irrigating months of November and March. However, many of the March readings appear to be estimated and are not useful for this purpose.

The calculated average flow rate is 132 gallons per capita-day (gpcd). A total dry weather base flow rate of 120 gpcd has been established by EPA as a historical average where infiltration is not excessive (Metcalf & Eddy). The city of Chiloquin, which has a similar population and environmental conditions, uses a per capita flow of 156 gpcd (HGE, 1996). Chiloquin also has significant I/I and a school which would increase per capita flows. Therefore, a design flow of 132 gpcd is reasonable.

Due to the shallow groundwater depths in the area, infiltration can be expected to produce a significant impact. After per capita wastewater flows were estimated from water consumption, an additional 20% was added to account for I/I. It has been specified (Ten State Standards) that the I/I in new collections systems should not exceed 200 gpd per in-mile of pipe. From the preliminary layout of the collection system (Section 9), there is about 62 in-mile of pipe. The added I/I (20% of per capita flow) back calculates to 190 gpd per in-mile. From this, it appears that the estimate of I/I is reasonable.

Hydraulic design flows are shown in Table 7.2. Peaking factors were based on HGE's experience with similar systems and standard design values. Note that flows during the dry-weather and wet-weather period have been assumed equal. Current average daily flow (ADF) is calculated from an average rate of 132 gpcd and an estimated population of 533 (210 households * 2.54 people/household). This per capita flow includes infiltration and commercial usage. From Table 7.1 it can be seen that non-residential customers are estimated to contribute approximately 40 percent of the domestic flow and the residential contribution alone is approximately 80 gpcd. The 1983 facilities plan used a unit design flow of 170 gpcd for Crescent.

Computed breakdown for the average daily per capita flow in the sanitary district is as follows:

Residential	82 gpcd
Nonresidential	30 gpcd
I/I	20 gpcd
Total	132 gpcd

Solids and BOD_5 loadings are based on standard design values (Metcalf & Eddy) and are listed in Table 7.2. Total suspended solids (TSS) have been assumed equal to BOD_5. Current BOD loading is calculated with the estimated current population of 533.

Wastewater flows from Crescent's core area are estimated from the unit flow per EDU calculated in Table 7.1. The current average daily flow from the core area is 34,160 gpd (140 EDUs * 244 gpd/EDU). Flows from the area west of the river are calculated in a similar manner using per capita unit values. Note that the flow and loading per EDU is different in westside Crescent, since there are no nonresidential customers in this area. Flows for the sanitary district, core area, and westside Crescent are summarized in Table 7.3.

Table 7.1 Development of Unit Flow Rates and Loadings

User Category	Annual Usage (gallons)	Average Daily Flow (gpd)	Assumed Reduction Factor	Average Daily WW Flow (gpd)
Single Family Residential	19,340,534	52,843	80%	42,274
RV Parks	1,424,180	3,891	85%	3,308
Motels	1,213,800	3,316	85%	2,819
Restaurants	677,294	1,851	100%	1,851
Misc. Commercial	1,211,958	3,311	85%	2,815
Churches	235,772	644	85%	548
Public	44,549	122	80%	97
Forest Service	2,383,400	6,512	75%	4,884
Totals (no I/I)				
(gpd)				58,595
(gpcd)				110
(gpm)				41
(gpd/EDU)				203
Totals (with 20% I/I)				
(gpd)				70,300
(gpcd)				132
(gpm)				49
(gpd/EDU)				244

Table 7.2 Crescent Design Flows and Loadings

Design Parameter	Current	2023	UBO
Population	533	1,117	4,132
Flow (mgd)[1]			
Average Daily Flow (ADF)	0.070	0.148	0.546
Maximum Monthly Flow (MMF)	0.127	0.267	0.982
Peak Daily Flow (PDF)	0.197	0.415	1.527
Peak Hourly Flow (PHF)	0.253	0.533	1.964
MMF/ADF Ratio		1.8	
PDF/ ADF Ratio		2.8	
PHF/ADF Ratio		3.6	
BOD Loadings (ppd)[2]			
Average	117	246	909
Maximum Monthly	199	418	1,545
Peak Daily	293	614	2,273
Avg/Avg		1	
MM/Avg		1.7	
PD/Avg		2.5	

[1] Based on ADF unit loading of 132 gpcd or 245 gpd per EDU.

[2] Based on average unit loading of 0.22 ppcd or 0.41 ppd per EDU.

Table 7.3 Current and Projected Flow Rates for Crescent Sanitary District, Core Area and Westside

7.3.a Crescent Sanitary District

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

7.3.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

7.3.c Westside Crescent

Parameter	Current	25-Year
Population	254	531
EDUs	100	209
ADF (gpd) MMF (gpd) PDF (gpd) PIF (gpd)	33,500 60,300 93,900 120,700	70,200 126,400 196,600 252,700
Average BOD_5 (ppd)	40	85

7.3.2 Gilchrist

The average daily flow for Gilchrist is based on daily monitoring records from January 1993 to July 1998. With the exception of a sharp decline for several months in 1996, flows are consistently in the range of 21,000 gpd. The wastewater flow per EDU is less than that used for projections in Crescent. However, this is explained by the fact that not all of the houses are occupied and there is less commercial impact in Gilchrist. The per capita flow in Gilchrist has been assumed to be 100 gpcd. Table 7.4 gives the design flow rates and loadings for Gilchrist.

Table 7.4 Projected Flows for Gilchrist (all flows in gallons per day)

Gilchrist

Parameter	Current	25-Year
Population	210	439
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

Section 8 – Preliminary Development of Wastewater Collection, Treatment and Disposal Options.

The discussion of options in Sections 8.1 through 8.8 are unchanged from the 1999 Study with the exception that a Membrane Bioreactor (MBR) was briefly reviewed as treatment option. It is expected that the use of a MBR would still require effluent storage to allow for effluent application during the irrigation season since effluent discharge to either groundwater or surface water are not acceptable solutions primarily due to the resulting nutrient loadings to the water resources. The MBR is at least the same cost as a lagoon and requires a Level III operator versus a Level I or II operator for a lagoon treatment option. Based on these considerations, the use of a MBR will not be considered further at this time.

8.9 Regionalization and Staging of Improvements

The options listed in Table 8.1 of the 1999 Study consider either independent systems for Crescent and Gilchrist or a regional system that combines the two communities. An independent system for Crescent is the only option being considered with this update. From Table 8.1 the two options to be considered are:

Option IA.1 - Provide service to the entire district initially

Option IA.2 - Provide service to the core area initially and phase in service to the remainder of the District.

Option IA.1 is to provide service to the entire District at the outset. Treatment and effluent disposal systems will be sized for the design population of 2029. The cost estimates are based on acquiring Site 2 that was discussed in previous studies.

Option IA.2 is to provide service to the entire District in phases. However, the purpose of phasing construction is solely to reduce initial costs. Service to the District core area would be provided initially and the remainder of the District would be served in phases.

Availability of funding may be a key factor in determining whether phasing construction is a desirable and possible option. For example, a funding agency may not have sufficient funds allocated to finance the entire District construction in one or two fiscal years and the result may be that phasing is necessary.

SECTION 8
PRELIMINARY DEVELOPMENT OF WASTEWATER COLLECTION, TREATMENT AND DISPOSAL OPTIONS

8.1 GENERAL

There are many different ways to collect, treat, and dispose of wastewater. The purpose of this section is to provide a broad overview of feasible possibilities.

8.2 ON-SITE SYSTEMS

Currently all wastewater treatment in Crescent is provided by onsite (septic tanks) systems. Septic tanks are designed for rural areas with lot sizes of one acre or more. Due to soil and groundwater conditions, and population density, these systems are contributing to excessively high nitrate concentrations in the area, as demonstrated by recent groundwater testing (report included in Appendix A). Continued usage of onsite systems will lead to increased nitrate levels in the groundwater. It is important to recognize that nitrate accumulates in the groundwater over a long period of time, and it can take a correspondingly long time for nitrate levels to decrease after the source of contamination has been eliminated.

8.3 COLLECTION SYSTEM

When onsite systems are not acceptable, wastewater must be collected for treatment at a centralized location. Collection systems can be divided into two categories, conventional and alternative. Conventional collection transports raw wastewater, primarily by gravity, through relatively large diameter (generally 8-inch diameter and greater) pipelines. Alternative systems primarily consist of three classes: septic tank effluent pumping (STEP), grinder pumps, and vacuum sewers. Crescent's population could be served by either conventional or alternative system.

With a STEP system, each customer uses a separate tank. Since most of the solids are removed in the septic tank, sewer clogging typically is not a problem, even in low spots. Small diameter (typically 3 inch to 6 inch) pipes can be installed at shallow depths, and may generally follow the contour of the land. In most cases cleanouts can be installed rather than manholes. The smaller diameter piping and elimination of manholes can decrease costs, depending on density of development. These savings are often offset by the cost of septic tank installation. In some instances, it is possible to gravity flow out of the septic tank, eliminating the requirement for pumping. This type of system can be referred to as septic tank effluent gravity (STEG) or small diameter gravity sewer (SDGS). The topography in Crescent is well suited for gravity flow and a combination STEP/STEG system will be further evaluated.

Grinder pump systems do not use a septic tank to store solids, but grind up these solids and pump them into the sewer. These pumps can be plugged or damaged by certain waste products, such as rags or cat litter. Generally, each individual customer has their own grinder pump. This helps discourage customers from disposal of improper materials that may interfere with pump operation. The system may require more sewer line cleaning and customer education. The grinder pumps themselves may require more maintenance than STEP system pumps. Due to these additional maintenance concerns, grinder pumps will be eliminated from further consideration.

In vacuum sewer systems, no septic tanks or grinder pumps are used. Instead, wastewater gravity flows from each customer, or group of customers, to a valve station. From the valve stations, wastewater then flows by vacuum through special valves into small diameter pipes and then to a central vacuum station. Wastewater is then pumped by conventional means to another collection system or treatment site. The vacuum system allows the use of small diameter pipes without the need for septic tanks or pumps. Vacuum sewage is also aerobic and mixes easily with conventional sewage. A disadvantage is that specially trained personnel must be on call and readily available in the event of a problem. This type of system would be considered as new and innovative technology. However, since there are no existing systems in Oregon to provide historical performance information, and because of concerns about additional O&M, vacuum systems have been eliminated from further consideration.

8.4 CLUSTER SYSTEMS

In a cluster system, alternative sewers collect wastewater and transport it a short distance to what is generally a larger version of an onsite drainfield. Cluster systems typically serve small subdivisions or mobile home parks in rural settings. This type of system works best for a cluster of homes that do not have proper conditions for individual drainfields, but a suitable drainfield can be located a short distance away.

Klamath County uses a design guideline of 450 gpd for each single-family household. A cluster of more than five homes would need to apply through DEQ for a WPCF permit (or when total design flow exceeds 2,500 gpd). Due to the existing concerns related to contamination of groundwater from onsite systems, cluster systems are not a likely solution to the wastewater problems within the Crescent Sanitary District.

8.5 CENTRALIZED TREATMENT

Centralized treatment is necessary when conditions do not allow for onsite treatment or cluster systems. Centralized treatment can consist of a number of processes with increasing removal of solids and BOD. However, as better treatment is achieved, the costs of operation and maintenance of these systems also increases.

Stages of treatment are divided into three categories: primary, secondary and tertiary. Primary treatment is a physical settling process which removes most of the settleable solids. Secondary treatment includes biological treatment in addition to primary settling. Biological processes are used to reduce the suspended and soluble organic material in the wastewater. Federal law requires that all publicly owned wastewater plants provide at least secondary treatment. Generally, effluent concentrations of BOD_5 and TSS are expected to be less than 30 mg/l, and average concentrations of 20 mg/l can consistently be provided with some secondary treatment processes.

Advanced or tertiary treatment is used to further reduce specific components remaining in the wastewater after secondary treatment. Additional removal of suspended solids by filtering the effluent is an example of advanced treatment. After filtration, effluent BOD_5 and total suspended solids (TSS) concentrations of less than 5 mg/l can be expected. Removal of nutrients such as nitrogen can be achieved through different means of chemical and biological treatment. These processes can be complex and expensive and are only implemented where the most stringent conditions require nutrient removal.

After treatment, effluent is disinfected to remove disease causing organisms. Disinfection with the addition of chemicals, such as chlorine, is the most common method in the United States. Chlorine can be added in several different forms. A physical means of disinfection that is gaining popularity is ultraviolet (UV) light. UV disinfection leaves no toxic residual like chlorine and is gaining popularity in the United States. Selection of a disinfection method is determined on a case-by-case basis.

A facultative pond or lagoon is one of the simplest systems considered to provide secondary treatment. Solids settle out in the lagoon, aerobic (need oxygen) and anaerobic (do not need oxygen) bacteria reduce the organic matter in the wastewater. There is very little control over the biological process and effluent TSS concentrations commonly exceed 30 mg/l.

Aerated ponds are supplied with oxygen through mechanical means of mixing or diffused aeration. Land requirements can be reduced since aerated ponds can be deeper and have less surface area, but these cost saving may be offset by operation and maintenance (O&M) requirements of aeration equipment.

Secondary treatment plants, which generally are considered to be the modern method of treatment, utilize the same biological processes which occur in a lagoon, but provide a much greater degree of control over the process. The main advantages are better treatment and smaller land requirements. Disadvantages are higher operational costs, complexity of operation and greater risk of equipment malfunction. There are limits to the degree of treatment which is feasible and can reasonably be achieved. Typically, good secondary treatment plants are expected to reduce average BOD_5 and TSS concentrations to 20 mg/l.

A wide variety of proven secondary treatment options exist that use different methods to control the settling and biological processes. Some common concepts include:

a) Trickling Filter
b) Rotating Biological Contactor (RBC)
c) Activated Sludge
d) Oxidation Ditch
e) Sequencing Batch Reactor (SBR)

Each of these concepts have different modes of operation to meet specific treatment needs.

Septic tank effluent is commonly treated with a recirculating sand filter. This system looks to probably be a simple, inexpensive method of treatment. However, the level of nitrate removal required will not be achieved with this system. DEQ approval is doubtful since this system will essentially move the problem (groundwater degradation), not solve it.

Depending on the discharge location and time of year, the state regulatory agency (Oregon DEQ) which administers federal policies may require a higher degree of treatment than 30 mg/l. This is the case in Crescent, where average monthly concentrations of BOD and TSS must be less than 5 mg/l (both summer and winter) for discharge into the Little Deschutes. This requirement potentially eliminates any proposed system which consists of surface discharge (discharge to stream), unless tertiary treatment and reliable nutrient removal are provided.

8.6 SLUDGE DISPOSAL

Treated sludge will be a byproduct of the treatment process. In some communities the sludge is disposed of in a landfill. However, this practice is presently being discouraged and may no longer be feasible with new regulations impacting landfill use.

State and federal regulatory agencies strongly encourage the beneficial usage of sludge. This basically means that the sludge will ultimately be applied to the land for use as fertilizer. When regulatory guidelines are followed, sludge from secondary treatment plants can be applied directly to land. Settleable solids in a treatment plant system are piped to a tank where they are either aerobically or anaerobically digested to decompose the sludge in a controlled environment. Then the sludge will most likely be hauled by truck to a land application site. Hauling of sludge often makes it economically feasible to de-water the sludge by means of drying beds or another mechanical process.

There are more restrictions dealing with sludge removed from a lagoon since some of the solids will only have been in the lagoon for a short period of time. It is still acceptable to apply the sludge to land, but access to the site is more restrictive than sludge removed from a digester. The period of time between sludge removal projects is much greater than secondary treatment plants.

Sludge pumped from a septic tank still contains many pathogens and very few options exist. One option would be to haul it to a wastewater treatment plant. The other would be to treat with lime to a high pH for a specified detention time and land applied.

8.7 EFFLUENT DISPOSAL

Due to the sensitive environmental conditions in Crescent, effluent disposal will be the most significant factor in developing a wastewater management plan. Methods of disposal for both treatment plant effluent and septic tank effluent are discussed below.

The most common method of disposal in Oregon is direct discharge to a receiving stream. There are strict regulations controlling the acceptable quality of the treated effluent and the minimum flow required in the receiving stream to provide adequate dilution. There are also limits to the acute and chronic toxicity which may be allowed within the mixing zone of the stream before the effluent becomes diluted. The level of wastewater treatment required is normally greater during the summer months. Therefore, it is necessary to evaluate year round discharge, seasonal discharge with some other method of disposal or storage during summer months, and no discharge at all. In some cases, advanced treatment such as filtration is necessary to achieve required effluent quality. Nutrient removal is also becoming a limiting factor in effluent disposal.

Land irrigation is considered a beneficial use of wastewater effluent and is encouraged by state and federal regulatory agencies. Irrigation of wastewater effluent is only allowed when the water consumption needs of the selected crop plus evaporation, exceed the quantity of precipitation. A selected crop must be capable of utilizing all the nitrogen in the effluent to eliminate any risk of ground water contamination. The level of wastewater treatment required depends on the amount of public access to the site and the planned use of the irrigated crop.

Due to water quality concerns in the Deschutes River, discharge to a receiving stream is not considered to be a viable option, and is eliminated from further consideration. Since direct (stream) discharge (and associated higher degree of treatment) has been eliminated, and since some storage (holding ponds) will be necessary for irrigation, mechanical treatment processes have also been screened from further evaluation. Treatment processes that will be evaluated in more detail include facultative and aerated lagoons.

Treated effluent can only be used for land irrigation during months when selected crops(s) are growing and can utilize the wastewater. During the non-growing season, treated effluent must either be stored or discharged to a drainfield (infiltration system). Under today's current groundwater protection regulations, it will be difficult to receive regulatory approval for use of a drainfield with a new wastewater system. Gilchrist is currently utilizing a drainfield; however, Gilchrist is also operating under an expired permit. Communications with DEQ indicate that a condition of the renewed permit will require Gilchrist to evaluate impacts to groundwater from their effluent disposal system.

8.8 SUMMARY OF PRELIMINARY OPTIONS

A) Regional Collection System
   a) Conventional Gravity Sewer
   b) STEP/STEG

B) Pretreatment
   a) Septic Tanks

C) Treatment
   a) Facultative Ponds
   b) Aerated Ponds

D) Sludge Disposal
   a) Land Application
   b) Existing Regional Treatment Plant

E) Effluent Disposal
   a) Summer Irrigation - winter holding

8.9 REGIONALIZATION AND STAGING OF IMPROVEMENTS

Table 8.1 is an outline of options that will be considered for staging and/or regionalization.

Table 8.1 Options for Project Scope

OPTION I- Independent Systems for Gilchrist and Crescent	
A- Crescent	
Option IA.1	Provide service to entire district initially
Option IA.2	Provide service to core area initially and phase in rest of district
B- Gilchrist	Dependent on results of groundwater study
Option IB.1	No adverse impact- continue usage of drainfield
Option IB.2	Adverse impact- develop storage and irrigation
OPTION II- Regional System	
I- Utilize Existing Gilchrist Site	
Option IIA	Initially construct system to serve Gilchrist and entire sanitary district
	Results of groundwater study: Option 11A1- no adverse impact- continued use of drainfields Option 11A2- adverse impact- develop storage and irrigation
Option IIB	Phased construction and development of existing Gilchrist lagoons to serve Gilchrist and Crescent core area initially, remainder of sanitary district later
	Results of groundwater study: Option IIB1- no adverse impact- continued use of drainfields Option IIB2- adverse impact- develop storage and irrigation

Overall, there are eight different projects that Crescent can select from. Two major issues will impact the final recommendation. First, is regulatory approval of a drainfield (infiltration system). DEQ has stated (personal communication) that Gilchrist will be required to perform groundwater monitoring as a condition of their permit renewal. This may not require a full scale study; samples from the existing wells could provide an indication of the level of impact of Gilchrist's drainfield on nitrate. The second factor that will influence cost and recommendations is the availability of land. If effluent storage and irrigation is required the existing Gilchrist site is not large enough. This is not necessarily a problem if there is irrigation land available nearby. A description of the options to be considered follows.

1. **Option IA.1**: This project scope is similar to that of the 1983 study. The entire district will be served. Treatment and effluent disposal systems will be sized for the design population of 2023. It is assumed for cost estimates that the site selected in previous studies can be acquired.

2. **Option IA.2**: The goal of this option is to achieve the same system as scope 1, but to lower initial costs by staging development. Service will be initially provided to the core area, with the remainder of the district phased in as development occurs.

3. **Option IB.1**: If the drainfields have no adverse effect on the ground water, Gilchrist will be able to continue to operate as normal.

4. **Option IB.2**: If the drainfields are causing an excessive increase in nitrate concentrations, Gilchrist would develop a storage and irrigation program for effluent disposal.

5. **Option IIA.1**: A regional system between Crescent and Gilchrist on the site of the existing lagoons. Drainfields would continue to be utilized for effluent disposal if no negative impact to beneficial uses of groundwater is demonstrated.

6. **Option IIA.2**: If drainfields do have an adverse effect, then a storage and irrigation system must be developed. It is in this case that available land becomes an issue as flows approach the design limit. Most of the existing area (40 acres) will be taken up by the lagoons, and additional land for irrigation must be found immediately.

7. **Option IIB.1**: This is the same project as Option IIA.1, but with a phased approach. Collection system will serve Gilchrist and the core area of Crescent.

8. **Option IIB.2**: This is the same project as Option IIA.2, but with a phased approach. Collection system will serve Gilchrist and the core area initially.

Section 9 - Detailed Development of Collection System Options.

The underlying options of conventional gravity and STEG/STEP systems are still valid and the present worth analysis indicates the two options are essentially equal. The nearby community of LaPine has a STEP system and some indications are that the maintenance costs have exceeded estimates for pump replacement and tank pumping. Although it may be too early in the selection process to unequivocally select a collection system option, it appears that a conventional gravity collection system may provide better service for Crescent.

SECTION 9
DETAILED DEVELOPMENT OF COLLECTION SYSTEM OPTIONS

9.1 GENERAL

The Crescent Sanitary District (CSD) consists of only one basin that drains to the middle of town, just east of the Little Deschutes River. This is fortunate in that it requires only one pump station; however, depending on the selected location for treatment, a significant length of pressure sewer line may be required to pump to the treatment site. In the 1983 study, it was determined that 10,500 ft. of pressure sewer was needed from the pump station to a treatment site south of town. Pumping and pressure main costs are dependent on treatment location, and will be included with the opinions of probable cost for treatment and disposal (Section 10).

9.2 CONVENTIONAL COLLECTION

A conventional collection system is design to:

1) Gravity flow through the majority of lines (pipelines flow partially full)
2) Maintain minimum velocity of 2 feet per second (fps) to keep solids from settling in gravity lines
3) Maintain minimum velocity of 3.5 fps in pressure lines
4) Avoid anaerobic conditions that cause odor and corrosion problems

DEQ has established minimum slopes for gravity lines to maintain the 2 fps cleansing velocity. Minimum line sizes of 8 inch and 4 inch for gravity and pressure line respectively, have also been established by DEQ. Ultimate build-out populations (Section 7) were used to size the gravity lines since they have a design life of 50 years and it is very disruptive to remove sewer lines. Flows were distributed throughout the district boundary based on zoning and area served.

While the collection system pipelines were designed for ultimate build-out conditions, it is not practical to size the pumping station and pressure main based on these conditions. This type of infrastructure has a design life of twenty years and will be sized for the 2023 design year. The general criteria for pressure mains are based on velocity. A minimum of 3.5 fps must be maintained while the pumps are operating. Table 9.1 gives the capacity of a gravity pipe based on size and Table 9.2 gives design flows which the pressure main and pump station will be based on.

The previous wastewater studies developed layouts for a conventional collection system and this general layout is followed in Figure 9-1.