Date	Flow (gpd)						Rainfall (inches)
	Flow	Non-Rainfall Day	Rainfall Day	Base Flow Day	Peak Infiltration Day	Peak I/I Day	
09/11/11	41,330	41,330		41,330			0.00
09/12/11	47,540	47,540		47,540			T
09/13/11	35,450	35,450		35,450			0.00
09/14/11	41,490	41,490		41,490			0.00
09/15/11	57,860		57,860				0.24
09/16/11	37,750	37,750		37,750			0.00
09/17/11	33,050	33,050		33,050			0.00
09/18/11	31,930	31,930		31,930			0.00
09/19/11	39,210		39,210				0.46
09/20/11	36,470	36,470		36,470			T
09/21/11	90,990		90,990				1.22
09/22/11	69,940	69,940		69,940			0.00
09/23/11	66,220	66,220		66,220			T
09/24/11	43,310	43,310		43,310			0.00
09/25/11	43,580	43,580		43,580			0.00
09/26/11	88,110		88,110				0.47
09/27/11	71,053	71,053		71,053			0.00
09/28/11	61,160	61,160		61,160			0.00
09/29/11	57,890	57,890		57,890			0.00
09/30/11	65,910	65,910		65,910			0.00
10/01/11	65,910	65,910		65,910			0.00
10/02/11	43,160	43,160		43,160			0.00
10/03/11	49,610	49,610		49,610			0.00
10/04/11	45,400	45,400		45,400			0.00
10/05/11	38,930	38,930		38,930			0.00
10/06/11	38,060	38,060		38,060			0.00
10/07/11	34,660	34,660		34,660			0.00
10/08/11	29,860	29,860		29,860			0.00
10/09/11	28,890	28,890		28,890			0.00
10/10/11	28,040	28,040		28,040			0.00
10/11/11	43,730	43,730		43,730			T
10/12/11	49,720		49,720				0.20
10/13/11	40,580		40,580				0.78
10/14/11	54,250		54,250				0.13
10/15/11	34,650	34,650		34,650			0.00
10/16/11	76,100	76,100		76,100			0.00
10/17/11	37,940	37,940		37,940			0.00
10/18/11	44,140	44,140		44,140			0.00
10/19/11	210,960		210,960				1.78
10/20/11	221,960		221,960				0.18
10/21/11	148,810	148,810					0.00
10/22/11	30,670	30,670		30,670			0.00
10/23/11	77,560	77,560		77,560			0.00
10/24/11	69,550	69,550		69,550			T
10/25/11	60,620	60,620		60,620			0.00
10/26/11	52,880		52,880				0.47
10/27/11	86,600		86,600				0.42
10/28/11	53,470		53,470				0.29

Date	Flow (gpd)						Rainfall (inches)
	Flow	Non-Rainfall Day	Rainfall Day	Base Flow Day	Peak Infiltration Day	Peak I/I Day	
10/29/11	44,500	44,500		44,500			T
10/30/11	105,160	105,160					0.00
10/31/11	93,550	93,550					0.00
11/01/11	86,450	86,450					0.00
11/02/11	80,450	80,450					0.00
11/03/11	105,400		105,400				0.54
11/04/11	154,040		154,040				0.12
11/05/11	37,560	37,560		37,560			0.00
11/06/11	95,030	95,030		95,030			0.00
11/07/11	90,090	90,090		90,090			0.00
11/08/11	78,000	78,000		78,000			0.00
11/09/11	82,900	82,900		82,900			0.00
11/10/11	88,440	88,440		88,440			0.00
11/11/11	85,980	85,980		85,980			0.00
11/12/11	65,680	65,680		65,680			0.00
11/13/11	60,630	60,630		60,630			0.00
11/14/11	54,750	54,750		54,750			0.00
11/15/11	86,130		86,130				1.22
11/16/11	268,540		268,540			268,540	1.43
11/17/11	299,130	299,130			299,130		0.00
11/18/11	192,530	192,530			192,530		0.00
11/19/11	126,610	126,610					0.00
11/20/11	129,330		129,330				0.46
11/21/11	168,160		168,160				0.36
11/22/11	271,910		271,910			271,910	0.61
11/23/11	338,720	338,720			338,720		T
11/24/11	245,610	245,610			245,610		0.00
11/25/11	182,100	182,100			182,100		0.00
11/26/11	141,460	141,460					0.00
11/27/11	169,280		169,280				0.57
11/28/11	347,910		347,910			347,910	1.43
11/29/11	376,820		376,820			376,820	0.58
11/30/11	332,510	332,510			332,510		T
12/01/11	230,120	230,120			230,120		0.00
12/02/11	171,400	171,400			171,400		0.00
12/03/11	145,080	145,080					0.00
12/04/11	125,380	125,380					T
12/05/11	117,540		117,540				0.39
12/06/11	251,260		251,260			251,260	0.50
12/07/11	365,400		365,400			365,400	0.22
12/08/11	301,600	301,600			301,600		0.00
12/09/11	215,440	215,440			215,440		0.00
12/10/11	166,300	166,300			166,300		0.00
12/11/11	142,900	142,900					0.00
12/12/11	138,560	138,560					0.00
12/13/11	114,400	114,400					0.00
12/14/11	169,280	169,280			169,280		T
12/15/11	99,170	99,170					T

Date	Flow (gpd)						Rainfall (inches)
	Flow	Non-Rainfall Day	Rainfall Day	Base Flow Day	Peak Infiltration Day	Peak I/I Day	
12/16/11	131,790	131,790					T
12/17/11	127,650	127,650					0.00
12/18/11	97,380	97,380					0.00
12/19/11	97,070	97,070					0.00
12/20/11	125,110	125,110					T
12/21/11	81,870	81,870					T
12/22/11	176,050		176,050				0.57
12/23/11	282,200	282,200			282,200		T
12/24/11	197,590	197,590			197,590		0.00
12/25/11	166,520	166,520			166,520		0.00
12/26/11	148,520	148,520					0.00
12/27/11	314,030		314,030			314,030	0.88
12/28/11	343,960	343,960			343,960		0.00
12/29/11	216,340	216,340			216,340		0.00
12/30/11	167,130	167,130			167,130		0.00
12/31/11	143,540	143,540					0.00
Average	99,000	90,000	126,000	50,000	235,000	278,000	
Maximum	409,000	**Statistical values are rounded to the nearest 1,000 gpd.**					
97.5th %-ile	314,000						
99.2th %-ile	361,000						

Avg Infiltration: avg non-rainfall day - avg base flow day =	40,000	gpd
Avg Inflow: avg daily flow - avg non-rainfall day =	9,000	gpd
Peak Infiltration: avg peak infiltration day - avg base flow day =	185,000	gpd
Peak Inflow: avg peak I/I day - peak infiltration day =	93,000	gpd
Equivalent residential customers (capita) - See Table 7-1	1,039	
Average daily flow per capita	95	gpdc
Peak I/I day per capita	268	gpdc
Maximum monthly flow	179,696	gpd
Maximum monthly flow per capita	173	gpdc
Maximum montly flow/ average daily flow ratio	1.82	

Notes:

1. Flow data is recorded at the McKee WWTP at the effluent.
2. Rainfall data is recorded by a local rain gage at the McKee WWTP.
3. Non-Rainfall Day occurs if the total rainfall for the day is 0.1 inches or less.
4. Base Flow Day represents days during a dry spell when the groundwater table is low, and therefore, minimal
5. Peak Infiltration Day represents zero-rainfall days during wet season conditions such that flow levels are
6. Peak I/I Day represents high-rainfall days with excessively high flow rates.

Section 7: Forecasts of Flows and Waste Loads in the Planning Area

1. Current and Projected Flows

The City of McKee currently has 275 customer connections, 249 of which are currently active. 164 are single family residential homes. The remaining 111 are commercial/institutional, most of which are small to medium establishments. There are some dry process industries that do not discharge industrial waste, and therefore for these purposes, are treated as commercial. Table 7-1 itemizes the current active customer list and identifies the significant commercial/ institutional contributors.

Table 7-1
Flow Basis, Existing McKee Service Area

Description	units	persons per unit	total population	gpd per person	total gpd
Residental inside city (IC)	134	2.37	318	50	15,879
Residental outside city (OC)	9	2.37	21	50	1,067
Jackson Valley Apt	88	2	176	50	8,800
Rocky Hill Apt	64	2	128	50	6,400
Jackson Manor Apt	60	2	120	50	6,000
Park Ridge Apt	30	2	60	50	3,000
McKee Elementary	1	342	342	10	3,420
Jackson County MS	1	505	505	10	5,050
Jackson County HS	1	628	628	10	6,280
Vocational School	1	80	80	20	1,600
Small/Medium Commercial IC	96	20	1920	20	38,400
Small/Medium Commercial OC	2	20	40	200	8,000
Total					103,896
Equivalent Population			1,039	100	
10-Year Projection			1,071	100	107,055
20-Year Projection			1,071	100	107,055

Notes:
1. 2.37 persons per household in Jackson Co., per 2010 Census.
2. Flow basis for each source is based on KY DOW table of Design Criteria for Sizing Pump Stations and Wastewater Treatment Plant.
3. Assumed average occupancy per apartment is 2.
4. Commercial flows vary. For purposes of estimation, it is assumed 20 persons per business.
5. GPD per person is adjusted by trial and error to reasonably match the total flows from actual billing records.

Section 7: Forecasts of Flows and Waste Loads in the Planning Area

The 2010-2011 two-year flow analysis in Chapter 6 determined a long-term average historical flow of 98,850 gpd, or 95 gpdc (gallons per day per capita). For purposes of planning, the more conservative flow per capita of 100 gpdc shall be used. Flows generated by sewer extensions are shown in Table 7-2.

Table 7-2
Flow Basis, Sewer Extension Phases 1-3

Planning Phase		units	persons per unit	total population	gpd per person	total gpd
1A	Residental	51	2.37	120.87	100	12,087
	Small/Medium Commercial	5	20	100	20	2,000
1B	Residental	70	2.37	165.9	100	16,590
	Small/Medium Commercial	8	20	160	20	3,200
1C	Residental	69	2.37	163.53	100	16,353
	Small/Medium Commercial	17	20	340	20	6,800
	Sandgap Elementary Sch.	1		N/A		7,500
2A	Residental	72	2.37	170.64	100	17,064
	Small/Medium Commercial	4	20	80	20	1,600
2B	Residental	36	2.37	85.32	100	8,532
	Small/Medium Commercial	5	20	100	20	2,000
2C	Residental	61	2.37	144.57	100	14,457
	Small/Medium Commercial	5	20	100	20	2,000
	Tyner Elementary Sch.	1		N/A		10,000
2D	Residental	151	2.37	357.87	100	35,787
	Small/Medium Commercial	8	20	160	20	3,200
	Jackson Co. Regional Ind.Pk.	1		N/A		10,000
	Annville Institute	1		N/A		20,000
	Jackson Manor	1		N/A		15,000
2E	Residental	51	2.37	120.87	100	12,087
	Small/Medium Commercial	14	20	280	20	5,600
3A	Residental	54	2.37	127.98	100	12,798
	Small/Medium Commercial	2	20	40	20	800
3B	Residental	20	2.37	47.4	100	4,740
Total						240,195
Equivalent Population				2,402	100	
10-Year Projection				2,475	100	247,499
20-Year Projection				2,475	100	247,499

Section 7: Forecasts of Flows and Waste Loads in the Planning Area

Note: Flow for institutions with existing WWTP's is either the historical average daily flow, or the permitted design capacity, whichever is greater.

Table 7-3 summarizes flows for all phases.

Table 7-3
Estimated Flow, All Proposed Phases

Planning Phase	average daily flow (gpd)		maximum monthly flow (gpd)	
	present	20-yr	present	20-yr
WWTP	103,896	107,055	189,090	194,840
1A	14,087	14,515	25,638	26,418
1B	19,790	20,392	36,018	37,113
1C	30,653	31,585	55,788	57,485
2A	18,664	19,232	33,968	35,001
2B	10,532	10,852	19,168	19,751
2C	26,457	27,262	48,152	49,616
2D	83,987	86,541	152,856	157,504
2E	17,687	18,225	32,190	33,169
3A	13,598	14,011	24,748	25,501
3B	4,740	4,884	8,627	8,889
Total	344,091	354,554	626,245	645,288

As shown on Table 6-1, the 2010-2011 maximum monthly average daily flow was 179,696 gpd. Thus the historical ratio of long-term average daily flow to maximum monthly average flow is 179,696/98,850 = 1.82. For purposes of planning, this ratio is multiplied by the average daily flows to calculate a conservative design basis for wastewater treatment. 20-year flows projections are based on the population projections discussed in Chapter 4, namely a 0.3% annual increase for the first ten years, and then no increase thereafter.

2. Wastewater Treatment Capacities

A. Initial Phase

The initial phase will consist of the following:

Section 7: Forecasts of Flows and Waste Loads in the Planning Area

- Construct a new 0.50 MGD wastewater treatment plant adjacent to the existing 0.17 MGD WWTP. The new WWTP will be designed to easily facilitate doubling the treatment capacity, if needed some day. It will also be designed to operate under reduced flow conditions, as will initially be the case.

- Reroute flow from the existing WWTP to the new WWTP. Upgrade the pump station feeding the existing WWTP to meet the hydraulic conditions of the new force main.

B. Future Phases

- Extend sewers from McKee to adjacent communities in need of sewage treatment. Work will be accomplished in multiple phases as funds become available. Eventually, it may be necessary to expand the McKee WWTP to accommodate all of the projected sources of flow.

3. Waste Load Allocation

A copy of a Waste Load Allocation Letter, issued by the Division of Water on July 2, 2012 is provided in at the end of this Section as Exhibit 7-1. This applies to the proposed McKee WWTP.

Waste load allocation limits for the proposed McKee WWTP are shown in Table 7-4. These limits can be met through a secondary treatment process.

Table 7-4
Waste Load Allocation Limits for the Proposed McKee WWTP

Parameter	5/1 - 10/31 (mg/l)	11/1 - 4/30 (mg/l)
CBOD5	10	10
Total Suspended Solids	30	30
Ammonia Nitrogen	4	10
Dissolved Oxygen	7	7
Total Phosphorus	monitor	monitor
Total Nitrogen	monitor	monitor
Total Residual Chlorine	0.011	0.011

Reliablility Classification: C

Section 7: Forecasts of Flows and Waste Loads in the Planning Area

Exhibit 7-1

Kentucky Division of Water

Waste Load Allocation
July 2, 2012
(2 pages)

STEVEN L. BESHEAR
GOVERNOR

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER
200 FAIR OAKS LANE
FRANKFORT, KENTUCKY 40601
www.kentucky.gov

LEONARD K. PETERS
SECRETARY

July 2, 2012

Mark H. Feibes, P.E.
Project Manager
Nesbitt Engineering, Incorporated
227 North Upper Street
Lexington, Kentucky 40507-1016

Re: Waste Load Allocation (WLA) Update Request
City of McKee Wastewater Treatment Plant (WWTP)
KPDES No.: KY0034444
Jackson County, Kentucky

Dear Mr. Feibes:

This is in response to your June 22, 2012 letter, requesting an update to effluent limitations provided in Division of Water (DOW) correspondence dated March 12, 2009. A new 0.5 MGD WWTP is proposed to discharge into Indian Creek (Rockcastle River) near mile point (mp) 68.2 (longitude 84°00'42.9"W and latitude 37°25'50.7"N), segment 02024. Per your correspondence, the WLA information provided will be utilized in preparation of a Regional Wastewater Facilities Plan Update.

Effluent limitations applicable to the subject facility are stated below. The requirements specified are essentially the same as those previously provided, with the following exceptions:

- Monitoring for total nitrogen and total phosphorus has been added.
- The Reliability Classification has been changed from Grade 1 to Grade C, based on revised requirements specified in 401 KAR 5:005, Section 13.

Design Capacity = 0.5 MGD / Discharge to Indian Creek near mp 68.2

Parameter	May 1 - October 31	November 1 - April 30
$CBOD_5$	10 mg/l	10 mg/l
Total Suspended Solids	30 mg/l	30 mg/l
Ammonia Nitrogen	4 mg/l	10 mg/l
Dissolved Oxygen	7 mg/l	7 mg/l
Total Residual Chlorine	0.011 mg/l	0.011 mg/l
Total Phosphorus	Monitor (mg/l)	Monitor (mg/l)
Total Nitrogen	Monitor (mg/l)	Monitor (mg/l)

Reliability Classification = Grade C

In addition to the above limits, the monthly average and maximum weekly average values of Escherichia coli shall be at or below 130 colonies per 100 milliliters or 240 colonies per 100 milliliters, respectively, the year around. Additional effluent limits and water quality standards are contained in 401 KAR Chapter 5 and 401 KAR Chapter 10.

These preliminary design effluent limitations are valid for one (1) year from the date of this letter, and are subject to change as a result of additional information which may be presented during the public notice phase of the KPDES permitting process.. Please note that this letter does not convey authorization or approval to proceed with the construction or operation of the proposed wastewater treatment facilities. Construction and KPDES permit applications must be submitted to request such authorization. Nor does this letter ensure the issuance of either permit. During the review processes of these permits the Division of Water will further evaluate the viability of the project.

Should you have any questions regarding this correspondence, please contact me at (502) 564-8158, extension 4914 or E-mail at Courtney.Seitz@ky.gov.

Sincerely,

Courtney Seitz

Courtney Seitz, WLA Coordinator
Wet Weather Section
Surface Water Permits Branch
Division of Water

CS

c: Anshu Singh, Water Infrastructure Branch
Compliance and Technical Assistance
Branch, London Section
Division of Water Files

Section 8: Evaluation of Alternatives

1. Alternatives

   A. No-Action

   As noted earlier in this report, the existing wastewater treatment plant (WWTP) is nearing the end of its useful life, and due to the piecemeal manner in which it has been constructed, it is difficult to operate. Expending additional funds to expand the current WWTP would only exacerbate the current operational and maintenance difficulties, and therefore, this option is not considered viable.

   B. Optimization of Existing Facilities

   The core of the existing wastewater treatment plant consists of two parallel package wastewater treatment plants. There is not much flexibility in design or operation of these units that could optimize the system beyond current conditions.

   C. Regionalization

   - Interconnection with Other Systems
     There are no other municipal sewer systems within a reasonable pumping distance to the City of McKee. This option is therefore, not viable.

   - Centrally Managed Small Clusters or Individual Facilities
     The existing sewage collection system, which has about eight miles of sewers, covers a relatively small area, namely, the city of McKee. The entire system is within a single drainage basin, and feeds to one pump station near the existing WWTP. Given the size and configuration of the collection system, this option makes little sense and would be costly, and is therefore, is not considered viable.

   - Construction of a New Centralized Facility
     The City of McKee has a collection system in place that already discharges to an existing municipal wastewater treatment plant. As noted elsewhere, the existing WWTP needs to be replaced. Adjacent to the existing WWTP is a site acquired in 2009 for the express purpose of constructing a new plant. The new WWTP will have plenty of reserve capacity for additional flow, and is centrally located between the two largest nearby population centers: Sand Gap to the northwest, and Annville to the south. Neither of those two communities have public sewer, nor have they any plans on record to construct any. Given these considerations, a new WWTP with capacity to serve the region is the most viable option.

2. Alternatives Analysis

A. Treatment Alternatives

Several approaches to treatment were considered.

1) Decentralized Treatment Facilities

For reasons discussed in Part 1 of this Section, for this situation, centralized treatment is recommended over decentralized treatment.

2) No Discharge Treatment Technologies

Land application of treated wastewater works best with deep well drained soil, which is atypical in this area. Furthermore, it requires large areas of land, thereby substantially increasing the cost of disposal. Finally, public perception of land application could be a substantial obstacle to overcome. Thus, given these factors, and the availability of a receiving stream with secondary treatment level discharge limits (based on the Waste Load Allocation), land application technologies were not considered favorable for this project.

3) Conventional Treatment Technologies

Numerous treatment approaches were considered prior to a cost analysis. As per the flows estimated in Section 7, the initial design phase will require a minimum treatment capacity of 0.24 mgd (average max monthly flow from the existing collection system). To accommodate future extensions, monthly maximum flows are estimated to be as high as 0.70 mgd. Therefore, to address the immediate flow demand and to accommodate several years-worth of sewer extensions to outlying communities, a design treatment capacity of 0.5mgd was selected Three treatment alternatives were considered in detail:

- Extended Aeration Package Plant - One of the City's primary goals with respect to a new wastewater treatment plant, it to build structures that will last upwards of fifty years. Steel package wastewater treatment tanks typically are designed for a 20-year life, and therefore, are not a good choice in this case. Precast concrete package wastewater treatment plants address the longevity concern, however, they are constructed of modular units that become difficult operate much beyond 0.2 mgd, and therefore, are also not suitable for this application.

- Extended Aeration Poured in Place Concrete – This option is effectively the same as the package plant, with the exception that the tanks are poured-in-place concrete, thus longer lasting and not requiring periodic sandblasting and coating. The process, however, works best with flow equalization (particularly given the flow history of McKee), which adds a treatment tank and pumping system to the process. Therefore, given the additional capital and operational cost associated

with flow equalization, and as it presents no apparent advantage, no further consideration was given to this process.

- Complete Mix Conventional Aeration treatment process and Contact Stabilization treatment process – These well-proven technologies utilize smaller reactors than the extended aeration process, and are best suited to large WWTP's. In smaller systems, they can be very sensitive to variations in flow and loading. Furthermore, the extended aeration process provides a greater degree of nitrification (ammonia reduction) than do these processes. Finally, given the flow history of McKee, this process would best operate with flow equalization. Therefore, these technologies were not given any further consideration.

- Oxidation Ditch – The oxidation ditch is one of the most common wastewater treatment processes used for moderately sized WWTP's in Kentucky. It is easy to operate, performs well and can handle brief periods of high flow. Given these considerations, the oxidation ditch was evaluated.

- Sequencing Batch Reactor (SBR) – The SBR is a well-established process that in recent years has gained in popularity in the state of Kentucky. The SBR is particularly well adapted to handling brief periods of peak flows. Given these considerations, the SBR was evaluated.

- Lagoon – Lagoon systems, if properly designed can be one of the easiest wastewater treatment processes to operate. It is very well adapted to handling brief periods of peak flow, and has relatively low long-term solids production. Based on preliminary design calculations, using 10-States Standards, a three-cell lagoon totaling 14.5 mgal would be required to meet the treatment requirements under winter temperatures. Accounting for side slopes, approximately four acres of land would be necessary for construction of these cells. The property that the City of Mckee has purchased for the regional WWTP appears to have suitable area and topography for a lagoon system, and therefore, it was also evaluated.

4) Cost

Exhibits 8-1 through 8-3, at the end of this Section provide a detailed breakdown of costs and schematic diagrams for the three options considered. Table 8-1 below summarizes these costs. The present value, which factors in initial project costs, periodic replacement costs and operations and maintenance costs assumes a 3.2% interest rate (SRF Fund B) and a 2.49% inflation rate (2002-2011 average CPI). Costs of all three options track fairly closely.

Table 8-1
0 to 5 Year Planning Area Opinion of Probable Cost
New McKee Wastewater Treatment Plant

Alternative	Construction	Development & Contingency	Project	20-Year Present Worth
A OD	$ 3,860,000	$ 930,000	$ 4,790,000	$ 8,370,000
B SBR	$ 3,710,000	$ 890,000	$ 4,600,000	$ 8,200,000
C Lagoon	$ 4,090,000	$ 980,000	$ 5,070,000	$ 8,220,000

Notes:
OD- Oxidation Ditch
SBR – Sequencing Batch Reactor
Values are rounded to the nearest $10,000.

5) Non-Monetary Effectiveness Criteria

Evaluation of alternatives by present worth comparison is limited because the only items considered are construction costs, OM&R costs and salvage values. There are other factors not directly tied to these costs that should be considered in the selection of an alternative. These eight other factors which were used to evaluate the treatment alternative are identified and described below:

- Environmental Impact – short-and long term impacts on the environment.
- Public Acceptance – a measure of the public acceptance of the project.
- Flexibility – ability to adapt to changing conditions.
- Reliability – a measure of performance dependability.
- Operability – ease of operation
- Energy Use – energy conservation.
- Constructability – ease with which the alternative can be constructed and phased into operation.
- Expandability – ability to expand the WWTP in a cost effective manner with minimal disruption to the daily operations.

Following are some specific non-monetary considerations.

a) Oxidation Ditch

Advantages
- Designed with stormflow mode of operation to minimize solids washout.
- Flexible operations. Half the system can be easily taken off line for operation during low I/I seasons.
- Designed with biological nutrient removal (BNR) capabilities.
- Well established treatment technology with many systems operating in Kentucky.
- McKee WWTP operations staff is familiar with the oxidation ditch process.

Disadvantages
- Requires separate clarifier and RAS/WAS pump station
- Requires larger footprint that SBR alternative

b) Sequencing Batch Reactor

Advantages
- SBR can be operated in a stormflow mode to minimize solids washout.
- Clarification takes place in the reactor under completely quiescent conditions.
- Highly automated operations.
- The only mechanical component in the treatment basin is the decanter, which is a very low maintenance item.
- Smallest footprint of the three options.

Disadvantages
- Operators not familiar with the process. More so than the other treatment options, it requires the greatest understanding of process biology and kinetics to successfully operate.
- Can be susceptible to filamentous growth if not properly operated.
- Has lower flow limits of operability.
- Requires influent flow equalization or dual basin operation.
- Requires effluent flow equalization or larger UV disinfection process and post aeration tank than the other two options.

c) Aerated Lagoon

Advantages
- Large storage capacity. Discharge control can be utilized to minimize the effect of flow surges.
- Lowest waste solids production of the three options.
- Relatively easy to operate

Disadvantages
- Largest footprint of the three options that will lead to several design issues at the selected site, such as the need for retaining walls, substantial fill requirements, and floodplain encroachment.
- There may not be enough land on the proposed site for future expansion, if desired.
- Requires effluent filtration to ensure compliance with effluent TSS.
- Process can lead to severe odors if not properly operated.

Section 8: Evaluation of Alternatives

A matrix was used to evaluate each alternative based on these factors. Each factor was given a subjective weight. A total of 100 points were distributed among the seven factors based on relative importance. Each alternative was then assigned a ranking for each factor. A ranking of one represented the least favorable ranking, whereas a five represented the most favorable. Each alternative was then scored as the sum of weight factor times the assigned ranking. Totaling all of the scores for each factor produced a final score for each alternative. Table 8–2 presents the matrix indicating non-economic effectiveness factors for the treatment alternatives.

Table 8-2
Non-Economic Effectiveness Alternative Analysis
New McKee Wastewater Treatment Plant

Evaluation Criteria	Weight Factor	Alternative No.					
		Oxidation Ditch		Sequencing Batch Reactor		Aerated Lagoon	
		Rank	Score	Rank	Score	Rank	Score
Environmental Impact	3	4	12	4	12	4	12
Public Acceptance	3	5	15	5	15	4	12
Flexibility	4	5	20	4	16	3	12
Reliability	5	4	20	4	20	4	20
Operability	5	4	20	3	15	5	25
Energy Use	2	3	6	3	6	4	8
Constructability	2	4	8	5	10	4	8
Expandability	3	4	12	4	12	2	6
Total Score	27		113		106		103

The alternative with the greatest total score is the preferred alternative based on the non-economic factors. Combining this non-economic analyses with the present worth (economic analysis) should identify the "best" or the selected alternative. Table 8-3 combines these two analyses into a present worth/non-economic (PW/NE) ratio. The selected alternative is the one with the lowest PW/NE ratio.

Table 8-3
Non-Economic Effectiveness Alternative Analysis
New McKee Wastewater Treatment Plant

Alternative	Present Worth (PW)	Non-Economic Effectiveness (NE)	Comparison PW/NE Ratio	Variance from Lowest Scoring Ratio
Alternative No. 1 Oxidation Ditch	**$ 8,370,000**	**113**	**74,071**	**0.0%**
Alternative No. 2 Sequencing Batch Reactor	$ 8,200,000	106	77,358	4.4%
Alternative No. 3 Aerated Lagoon	$ 8,220,000	103	79,806	7.7%

6) Recommended Alternative

Based on the above analysis, the recommended alternative for the new McKee Wastewater Treatment is an oxidation ditch.

B. Collection Alternatives

After construction of a new wastewater treatment plant, the City of McKee plans to extend sewers into the outlying regions. The first of these sewer projects are anticipated to be at least five years in the future, and will be performed as funds become available. Sewers will first extend along US 421 northwest to Sandgap, then south along US 421 to Tyner, and from there, west along KY 30 to Annville. Finally, sewers will extend south from McKee along KY 290 south towards Annville. Exhibits 8-4 through 8-6 provide cost opinions of sequential sewer extensions broken down into projects of approximately $1.0MM each. These phased extensions are shown in Figures 3-3A and 3-3B. Costs are summarized in Table 8-4.

Table 8-4
Proposed McKee Sewer Extensions
Probable Opinion of Project Costs

Phase	Description	Equivalent Population	Construction	Development & Contingency	Project
1A	US 421 - East from McKee to Sandgap	141	$ 780,000	$ 234,000	$ 1,000,000
1B		198	780,000	234,000	1,000,000
1C		307	760,000	228,000	1,000,000
2A	KY 421- South from McKee to Tyner	187	860,000	258,000	1,100,000
2B		105	740,000	222,000	1,000,000
2C	KY 30 - West From Tyner to Annville	265	850,000	255,000	1,100,000
2D		840	980,000	294,000	1,300,000
2E		177	720,000	216,000	900,000
3A	KY 290 - South from McKee to Annville	136	790,000	237,000	1,000,000
3B		47	530,000	159,000	700,000
Total		2,402			$ 10,100,000

Exhibit 8-1
Proposed McKee Wastewater Treatment Plant - Alternative A
Opinion of Probable Project Cost

0.50 MGD Oxidation Ditch System

	Description	Installed Capital Cost[1]	Service Life (Yrs)[2]	Salvage Value, Adjusted to Present Value[3]	Present Value of All Future Purchases (S.L.< 20 yr)[4]	Total Present Value
1	8" SDR 21 PVC Force Main Extension	$ 60,000	40	$ 16,000	$ -	$ 44,000
2	Existing Pump Station Upgrade	55,000	15	28,242	49,589	76,347
3	Influent Channel/ Structure	55,418	40	15,000	-	40,418
4	Influent Flow Meter	6,200	15	3,184	5,590	8,606
5	Screening/ Wash Press/Hopper	114,100	15	58,590	102,876	158,386
6	Grit Removal Structure	21,458	40	6,000	-	15,458
7	Grit Removal and Grit Washing Equipment	189,000	15	97,051	170,408	262,357
8	Oxidation Ditch Conc. Structure (3 Stages)	444,863	40	118,000	-	326,863
9	Oxidation Ditch Equip. & Ancellaries (3 Stages)	432,600	15	222,138	390,044	600,505
10	Clarifiers Concrete Structure (2)	167,552	40	45,000	-	122,552
11	Clarifiers Equipment(2)	210,000	15	107,834	189,342	291,507
12	Ultraviolet Disinfection Channel	21,333	40	6,000	-	15,333
13	Ultraviolet Disinfection Equipment	205,800	15	105,678	185,555	285,677
14	Post Aeration, Metering and PS Structure	42,000	40	11,000	-	31,000
15	Post Aeration Blowers & Diffusers	20,000	15	10,270	18,033	27,763
16	Effluent Flow Meter	6,200	15	3,184	5,590	8,606
17	Aerobic Digester Structure (2)	157,500	40	42,000	-	115,500
18	Aerobic Digester Blowers and Diffusers (2)	86,800	15	44,571	78,261	120,490
19	Sludge Drying Bed w/ Roof	175,000	30	31,000	-	144,000
20	Polymer Feed System	20,000	15	10,270	18,033	27,763
21	Sludge Feed Pumps	35,000	15	17,972	31,557	48,585
22	Piping and Valves	170,000	40	45,000	-	125,000
23	RAS/WAS Pump Station	112,440	15	57,738	101,379	156,081
24	Plant Sump	65,000	15	33,377	58,606	90,229
25	Non-Potable Water Pumps, Control and Tank	23,500	15	12,067	21,188	32,621
26	Effluent Pump Station	80,000	15	41,080	72,130	111,050
27	Bldg: Lab/ Office/Control/Electrical	240,000	40	64,000	-	176,000
28	Bldg: Screening/Solids Handling/Blower	108,000	40	29,000	-	79,000
29	Finish Grading, Macadam, Landscaping	45,000	40	12,000	-	33,000

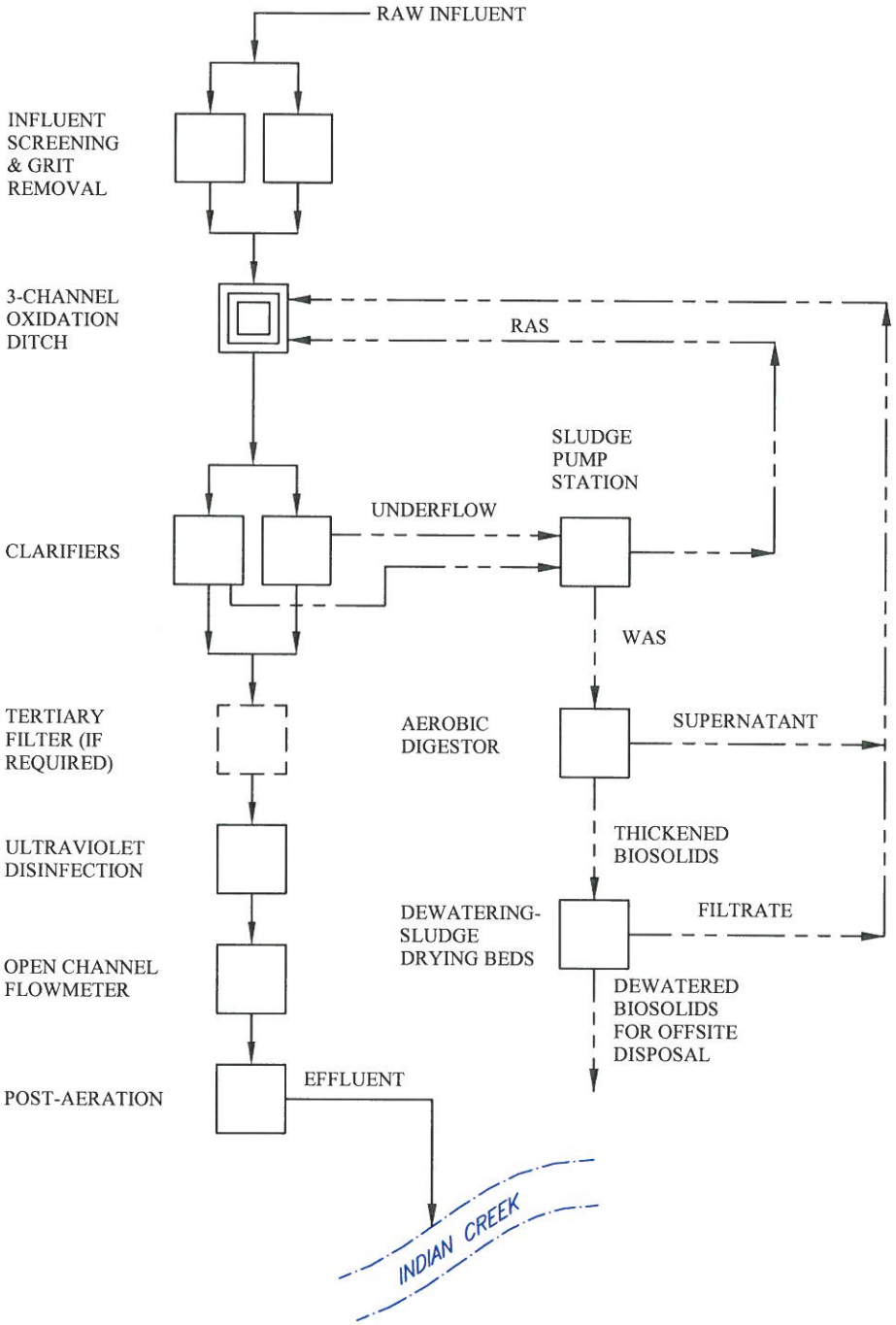
Exhibit 8-1
Proposed McKee Wastewater Treatment Plant - Alternative A
Opinion of Probable Project Cost

0.50 MGD Oxidation Ditch System

	Description	Installed Capital Cost[1]	Service Life (Yrs)[2]	Salvage Value, Adjusted to Present Value[3]	Present Value of All Future Purchases (S.L.< 20 yr)[4]	Total Present Value
30	Emergency Generator and Transfer Switch	80,000	40	21,000	-	59,000
31	Electrical/Controls/Instrumentation	414,000	20	-	-	414,000
	Subtotal (Construction Costs)	**$ 3,863,763**		$ 1,314,246	$ 1,498,180	**$ 4,047,697**
	Project Dev. (~14 % of Initial Construction Costs)	540,927				1,004,578
	Contingency (~10% of Initial Construction Costs)	386,376				193,188
	Total Project Cost (Const., Proj. Dev. and Con	**$ 4,791,066**				**$ 5,245,464**
	Operations and Maintenance, First Year Annual Cost				214,000	
	Operations and Maintenance, Present Value[7]					3,125,697
	TOTAL OPINION OF PRESENT WORTH, (Rounded to nearest $10,000)					**$ 8,370,000**

Notes:

1) Prices are projected to 2013 construction.
2) For purposes of this analysis, items with no salvage value are given a 20-year service life.
3) Salvage value is for the most recent purchase of the given item, if replaced in less than 20 years. Future cost is based on an assumed 2.49% inflation rate (2002-2011 average CPI), adjusted to a present worth, using a 3.2% interest rate (SRF
4) If an item is purchased more than once over the 20-year planning cycle, the present value of each purchase is calculated and totaled in this column. Present value is based on a 3.2% interest rate. Future purchases are calculated on an
5) This estimate is preliminary without final design being completed. Miscellaneous includes items such as laboratory and safety equipment, furniture, fencing, and an allowance for change orders, etc. These items will be quantitatively
6) Project development includes: engineering design and project management, resident project representative, administrative and legal, land and ROW, interim financing, environmental assesment (if applicable) surveying, etc.
7) Operations and Maintenance present value is based on a 20-year, 5.1% equal-payment series present worth factor of 12.3
8) Structure costs include associated earthwork. Equipment costs include installation.



OXIDATION DITCH WWTP
PROCESS FLOW SCHEMATIC

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FIGURE 8-1

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Exhibit 8-2
Proposed McKee Wastewater Treatment Plant - Alternative B
Opinion of Probable Project Cost

0.50 MGD Sequencing Batch Reactor System

	Description	Installed Capital Cost[1]	Service Life (Yrs)[2]	Salvage Value, Adjusted to Present Value[3]	Present Value of All Future Purchases (S.L.< 20 yr)[4]	Total Present Value
1	8" SDR 21 PVC Force Main Extension	$ 60,000	40	$ 16,000	$ -	$ 44,000
2	Existing Pump Station Upgrade	55,000	15	28,242	49,589	76,347
3	Influent Channel/ Structure	55,418	40	15,000	-	40,418
4	Influent Flow Meter	6,200	15	3,184	5,590	8,606
5	Screening/ Wash Press/Hopper	114,100	15	58,590	102,876	158,386
6	Grit Removal Structure	21,458	40	6,000	-	15,458
7	Grit Removal and Grit Washing Equipment	189,000	15	97,051	170,408	262,357
8	Influent Equalization Structure	303,800	40	81,000	-	222,800
9	Influent Equalization Equipment & Ancellaries	75,000	15	38,512	67,622	104,110
10	Sequencing Batch Reactor Conc. Structure (2)	469,000	40	125,000	-	344,000
11	SBR Equipment & Ancellaries (2)	385,000	15	197,696	347,126	534,430
12	Ultraviolet Disinfection Channel	21,333	40	6,000	-	15,333
13	Ultraviolet Disinfection Equipment	205,800	15	105,678	185,555	285,677
14	Post Aeration, Metering and PS Structure	42,000	40	11,000	-	31,000
15	Post Aeration Blowers & Diffusers	20,000	15	10,270	18,033	27,763
16	Effluent Flow Meter	6,200	15	3,184	5,590	8,606
17	Aerobic Digester Structure (2)	157,500	40	42,000	-	115,500
18	Aerobic Digester Blowers and Diffusers (2)	86,800	15	44,571	78,261	120,490
19	Sludge Drying Bed w/ Roof	175,000	30	31,000	-	144,000
20	Polymer Feed System	20,000	15	10,270	18,033	27,763
21	Sludge Feed Pumps	35,000	15	17,972	31,557	48,585
22	Piping and Valves	168,000	40	45,000	-	123,000
23	Plant Sump	65,000	15	33,377	58,606	90,229
24	Non-Potable Water Pumps, Control and Tank	23,500	15	12,067	21,188	32,621
25	Effluent Pump Station	80,000	15	41,080	72,130	111,050
26	Bldg: Lab/ Office/Control/Electrical	240,000	40	64,000	-	176,000
27	Bldg: Screening/Solids Handling/Blower	108,000	40	29,000	-	79,000
28	Finish Grading, Macadam, Landscaping	45,000	40	12,000	-	33,000
29	Emergency Generator and Transfer Switch	80,000	40	21,000	-	59,000

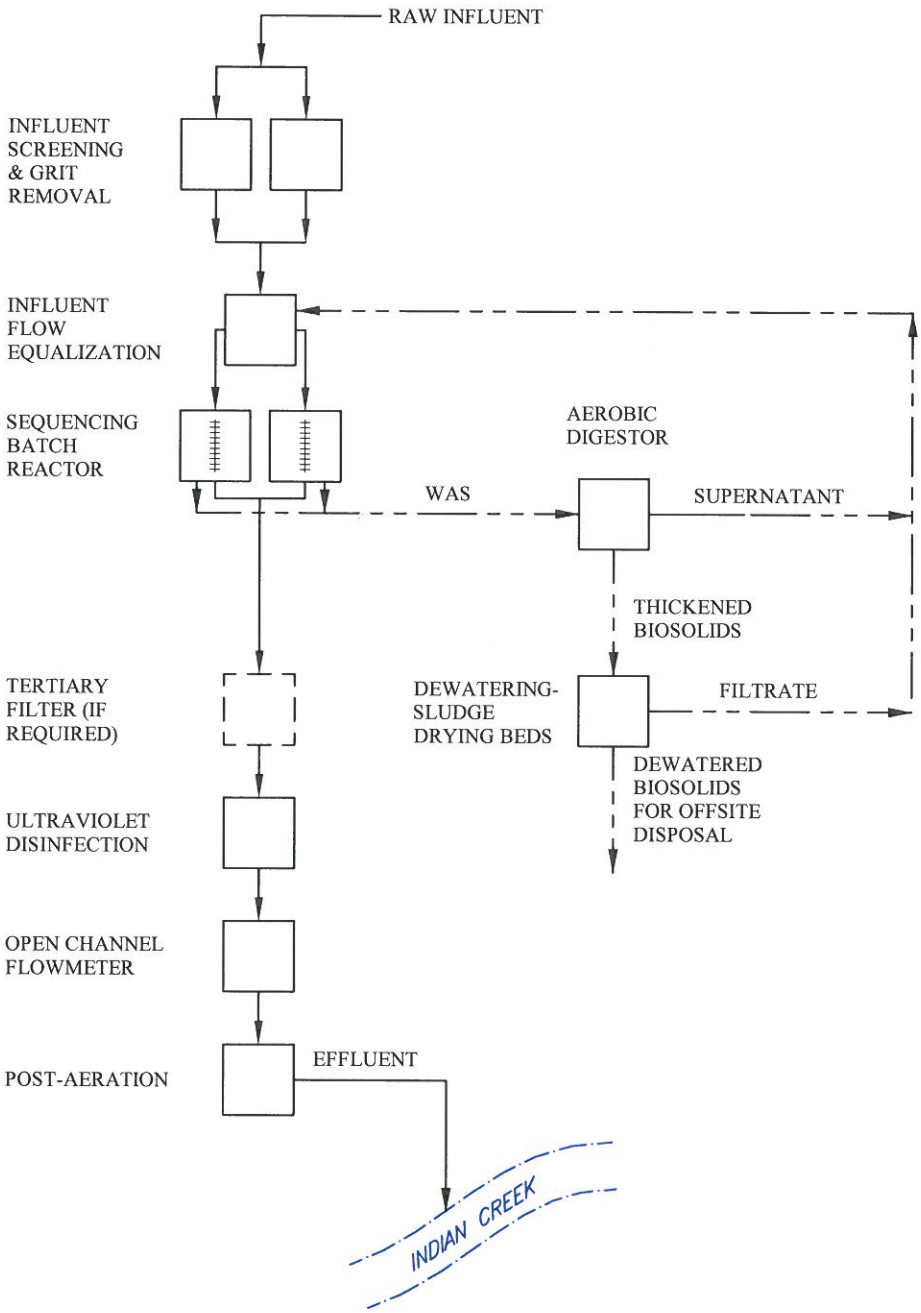
Exhibit 8-2
Proposed McKee Wastewater Treatment Plant - Alternative B
Opinion of Probable Project Cost

0.50 MGD Sequencing Batch Reactor System

	Description	Installed Capital Cost[1]	Service Life (Yrs)[2]	Salvage Value, Adjusted to Present Value[3]	Present Value of All Future Purchases (S.L.< 20 yr)[4]	Total Present Value
30	Electrical/Controls/Instrumentation	398,000	20	-	-	398,000
	Subtotal (Construction Costs)	**$ 3,711,109**		$ 1,205,744	$ 1,232,164	**$ 3,737,529**
	Project Dev. (~14 % of Initial Construction Costs)	519,555				964,888
	Contingency (~10% of Initial Construction Costs)	371,111				185,555
	Total Project Cost (Const., Proj. Dev. and Con	**$ 4,601,775**				**$ 4,887,973**
	Operations and Maintenance, First Year Annual Cost				227,000	
	Operations and Maintenance, Present Value[7]					3,315,576
	TOTAL OPINION OF PRESENT WORTH, (Rounded to nearest $10,000)					**$ 8,200,000**

Notes:

1) Prices are projected to 2013 construction.
2) For purposes of this analysis, items with no salvage value are given a 20-year service life.
3) Salvage value is for the most recent purchase of the given item, if replaced in less than 20 years. Future cost is based on an assumed 2.49% inflation rate (2002-2011 average CPI), adjusted to a present worth, using a 3.2% interest rate (SRF
4) If an item is purchased more than once over the 20-year planning cycle, the present value of each purchase is calculated and totaled in this column. Present value is based on a 3.2% interest rate. Future purchases are calculated on an
5) This estimate is preliminary without final design being completed. Miscellaneous includes items such as laboratory and safety equipment, furniture, fencing, and an allowance for change orders, etc. These items will be quantitatively
6) Project development includes: engineering design and project management, resident project representative, administrative and legal, land and ROW, interim financing, environmental assesment (if applicable) surveying, etc.
7) Operations and Maintenance present value is based on a 20-year, 5.1% equal-payment series present worth factor of 12.3
8) Structure costs include associated earthwork. Equipment costs include installation.



SEQUENCING BATCH REACTOR PROCESS FLOW SCHEMATIC

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FIGURE 8-2

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Exhibit 8-3
Proposed McKee Wastewater Treatment Plant - Alternative C
Opinion of Probable Project Cost

0.50 MGD Aerated Lagoon System

	Description	Installed Capital Cost[1]	Service Life (Yrs)[2]	Salvage Value, Adjusted to Present Value[3]	Present Value of All Future Purchases (S.L.< 20 yr)[4]	Total Present Value
1	8" SDR 21 PVC Force Main Extension	$ 60,000	40	$ 16,000	$ -	$ 44,000
2	Existing Pump Station Upgrade	55,000	15	28,242	49,589	76,347
3	Influent Channel/ Structure	55,418	40	15,000	-	40,418
4	Influent Flow Meter	6,200	15	3,184	5,590	8,606
5	Screening/ Wash Press/Hopper	114,100	15	58,590	102,876	158,386
6	Grit Removal Structure	21,458	40	6,000	-	15,458
7	Grit Removal and Grit Washing Equipment	189,000	15	97,051	170,408	262,357
8	Lagoon Earthwork, subgrade prep	353,000	100	150,000	-	203,000
9	Lagoon Lining	395,000	40	105,000	-	290,000
10	Lagoon Aerators (14 total)	350,000	15	179,724	315,569	485,846
11	Lagoon Inf & Dischg Structures, curtain baffles	137,500	20	-	-	137,500
12	Rapid Sand Filters, pumps and ancellaries	140,000	15	71,889	126,228	194,338
13	Structures: Filter, Clearwell, Mudwell	257,250	40	69,000	-	188,250
14	Filter Building	192,000	40	51,000	-	141,000
15	Piping and Valves	137,000	40	36,000	-	101,000
16	Ultraviolet Disinfection Channel	21,333	40	6,000	-	15,333
17	Ultraviolet Disinfection Equipment	205,800	15	105,678	185,555	285,677
18	Post Aeration, Metering and PS Structure	42,000	40	11,000	-	31,000
19	Post Aeration Blowers & Diffusers	20,000	15	10,270	18,033	27,763
20	Effluent Flow Meter	6,200	15	3,184	5,590	8,606
21	Sludge Drying Bed w/ Roof	175,000	30	31,000	-	144,000
22	Polymer Feed System	20,000	15	10,270	18,033	27,763
23	Sludge Feed Pumps	35,000	15	17,972	31,557	48,585
24	Sludge Thickening Tank	56,000	40	15,000	-	41,000
25	Plant Sump	65,000	15	33,377	58,606	90,229
26	Non-Potable Water Pumps, Control and Tank	23,500	15	12,067	21,188	32,621
27	Effluent Pump Station	80,000	15	41,080	72,130	111,050
28	Bldg: Lab/ Office/Control/Electrical	240,000	40	64,000	-	176,000
29	Bldg: Screening/Solids Handling	72,000	40	19,000	-	53,000

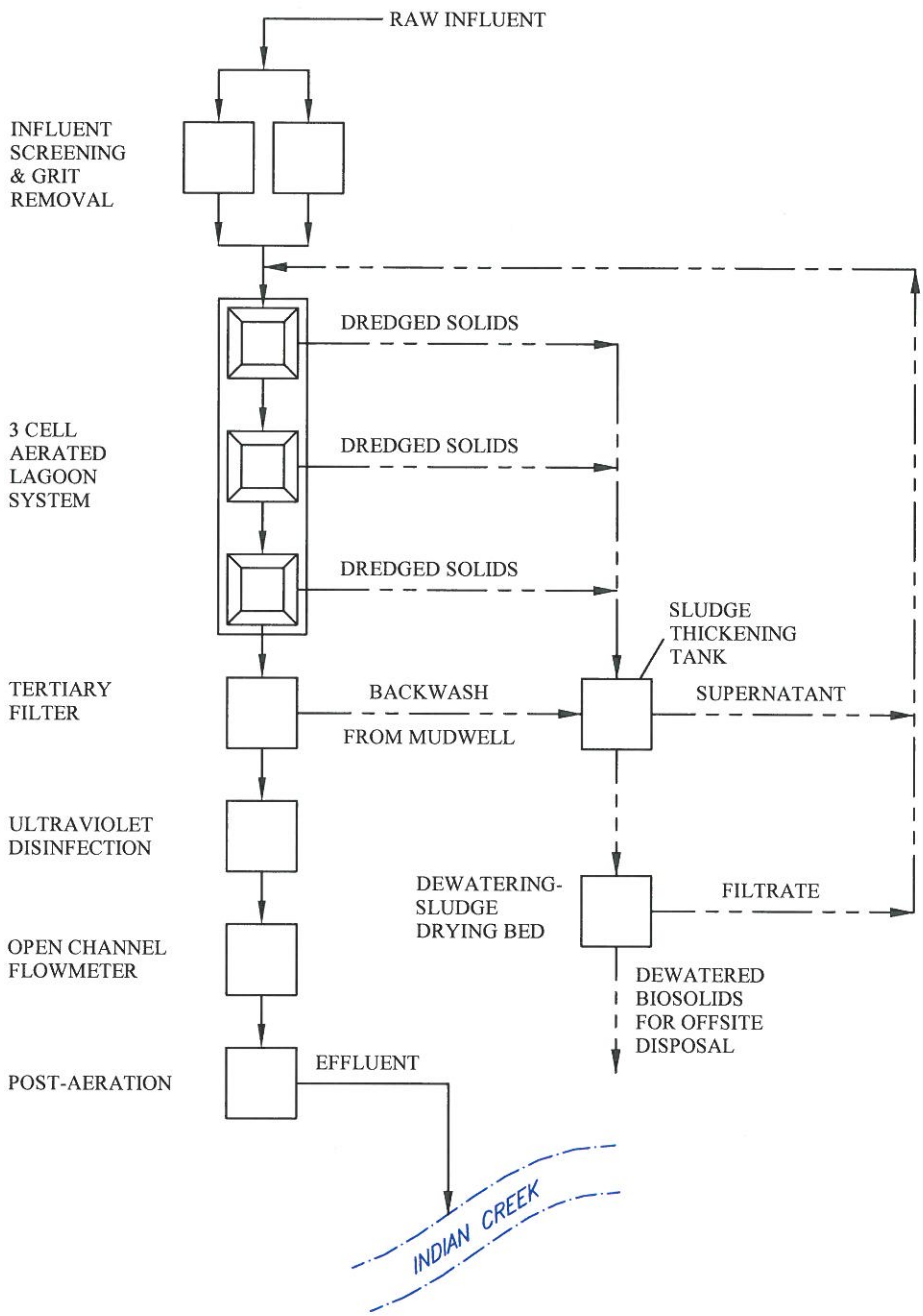
Exhibit 8-3
Proposed McKee Wastewater Treatment Plant - Alternative C
Opinion of Probable Project Cost

0.50 MGD Aerated Lagoon System

	Description	Installed Capital Cost[1]	Service Life (Yrs)[2]	Salvage Value, Adjusted to Present Value[3]	Present Value of All Future Purchases (S.L.< 20 yr)[4]	Total Present Value
30	Finish Grading, Macadam, Landscaping	45,000	40	12,000	-	33,000
31	Emergency Generator and Transfer Switch	80,000	40	21,000	-	59,000
32	Electrical/Controls/Instrumentation	438,000	20	-	-	438,000
	Subtotal (Construction Costs)	**$ 4,087,759**		$ 1,299,577	$ 1,180,951	**$ 3,969,133**
	Project Dev. (~14 % of Initial Construction Costs)	572,286				1,062,817
	Contingency (~10% of Initial Construction Costs)	408,776				204,388
	Total Project Cost (Const., Proj. Dev. and Con	**$ 5,068,821**				**$ 5,236,338**
	Operations and Maintenance, First Year Annual Cost				204,000	
	Operations and Maintenance, Present Value[7]					2,979,637
	TOTAL OPINION OF PRESENT WORTH, (Rounded to nearest $10,000)					**$ 8,220,000**

Notes:

1) Prices are projected to 2013 construction.
2) For purposes of this analysis, items with no salvage value are given a 20-year service life.
3) Salvage value is for the most recent purchase of the given item, if replaced in less than 20 years. Future cost is based on an assumed 2.49% inflation rate (2002-2011 average CPI), adjusted to a present worth, using a 3.2% interest rate (SRF
4) If an item is purchased more than once over the 20-year planning cycle, the present value of each purchase is calculated and totaled in this column. Present value is based on a 3.2% interest rate. Future purchases are calculated on an
5) This estimate is preliminary without final design being completed. Miscellaneous includes items such as laboratory and safety equipment, furniture, fencing, and an allowance for change orders, etc. These items will be quantitatively
6) Project development includes: engineering design and project management, resident project representative, administrative and legal, land and ROW, interim financing, environmental assesment (if applicable) surveying, etc.
7) Operations and Maintenance present value is based on a 20-year, 5.1% equal-payment series present worth factor of 12.3
8) Structure costs include associated earthwork. Equipment costs include installation.



AERATED LAGOON SYSTEM PROCESS FLOW SCHEMATIC

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FIGURE 8-3

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Exhibit 8-4

Proposed McKee Sewer Extension
Probable Opinion of Project Cost
Phased Projects, Appx $1.0 MM Ea.

Phase 1: US 421 - East from McKee to Sandgap

Phase 1A

Description	Unit	Quantity	Unit Cost[2]	Total Cost
4" SDR 21 PVC Pipe	LF	20,000	$ 20	$ 400,000
1.5" SDR 21 PVC Pipe	LF	2,550	16	40,800
Residential Grinder Pump Station	EA	51	6,000	306,000
Combination Air Release Valve	EA	13	2,800	36,400
Subtotal - Opinion of Probable Construction Cost (rounded to nearest $10,000)				**$ 780,000**
Project Development[1]				**$ 234,000**
Total - Opinion of Probable Project Costs[2] (rounded to nearest $100,000)				**$ 1,000,000**

Phase 1B

Description	Unit	Quantity	Unit Cost[2]	Total Cost
4" SDR 21 PVC Pipe	LF	14,000	$ 20	$ 280,000
1.5" SDR 21 PVC Pipe	LF	3,500	16	56,000
Residential Grinder Pump Station	EA	70	6,000	420,000
Combination Air Release Valve	EA	9	2,800	25,200
Subtotal - Opinion of Probable Construction Cost (rounded to nearest $10,000)				**$ 780,000**
Project Development[1]				**$ 234,000**
Total - Opinion of Probable Project Costs[2] (rounded to nearest $100,000)				**$ 1,000,000**

Phase 1C

Description	Unit	Quantity	Unit Cost[2]	Total Cost
4" SDR 21 PVC Pipe	LF	6,000	$ 20	$ 120,000
2" SDR 21 PVC Pipe	LF	8,000	20	160,000
1.5" SDR 21 PVC Pipe	LF	3,450	16	55,200
Residential Grinder Pump Station	EA	69	6,000	414,000
Combination Air Release Valve	EA	4	2,800	11,200
Subtotal - Opinion of Probable Construction Cost (rounded to nearest $10,000)				**$ 760,000**
Project Development[1]				**$ 228,000**
Total - Opinion of Probable Project Costs[2] (rounded to nearest $100,000)				**$ 1,000,000**

Total Phase 1 Opinion of Probable Project Cost	**$ 3,000,000**

Notes:

1. Project Costs include easements, engineering, resident observation, environmental, legal & administration, permitting, etc. Based on iniital cost opinion, this is 30% of the construction cost.
2. This cost opinion is based on general design assumptions using budget figures of 2013 Neither a detailed project scope nor design drawings have been prepared. The cost opinion is intended to be used as a general budget guideline for planning purposes and not for final project