BLUE HOLE REGIONAL PARK
"ALTERNATIVE" WATER SUPPLY FOR
NON-POTABLE WATER USES

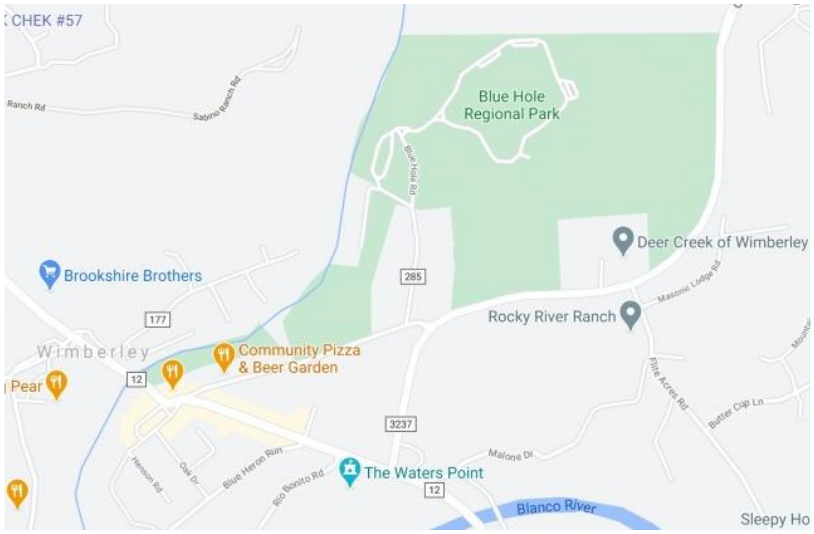
Phase 1: Background and Feasibility

Prepared for Friends of Blue Hole
by

David Venhuizen, P.E.
Planning and Engineering as if Water
and Environmental Values Matter

Blue Hole Regional Park (BHRP) in Wimberley, Texas, is owned and operated by the City of Wimberley. The Friends of Blue Hole (FoBH), a 501(c)(3) nonprofit organization dedicated to supporting BHRP, has entered into an agreement with David Venhuizen, P.E., to execute this study of how to create an "alternative" water supply to provide irrigation and toilet flush water demands on the park. A Google Earth image of the park is shown in Figure 1, on which are labeled the various facilities in the park that are referred to in this report. An outline of the property within the park boundaries and city-owned land around it is shown in Figure 2.

Blue Hole Regional Park Facilites
Figure 1



Blue Hole Park Property Boundary
Figure 2

It is desired to create a water supply for irrigation and other non-potable water uses on BHRP that would not tax the potable water supply system, and that would be as sustainable as practical and feasible. This study is being conducted to investigate options that would fulfill this desire. In this Phase 1 report, the water demands that have been identified to be provided by any “alternative” supply scheme are set forth, the irrigation water demands and flush water demands to be served are estimated, the options identified to create the water supply are generally reviewed, and the institutional/regulatory obstacles confronting those options are analyzed. FoBH will consider the options and determine which are to be pursued further in Phase 2.

1.0 POTENTIAL WATER NEEDS

In consultation with FoBH and the City of Wimberley Parks and Recreation Department (PARD), the areas it is desired to irrigate on BHRP include:

- The soccer fields.
- The “Great Lawn”.
- The grounds of the proposed Nature Center.
- Around the existing office and bathhouse building.

Other water uses that may be supplied with a source other than the potable water system include:

- A “wetlands” and a greenhouse associated with the proposed Nature Center.
- Toilet flushwater in the existing facilities and in the proposed Nature Center.

1.1 Irrigation Demands

Irrigation water demands are estimated using a calculation procedure based on evapotranspiration (ET) rates, a “crop coefficient”, a “quality factor”, and the expected irrigation efficiency of the irrigation method proposed to be used. These calculations produce an irrigation depth (inches/day), which applied over the area to be irrigated yields a daily irrigation water demand, set forth as gallons/day.

Considering the irrigation efficiency factor highlights the choice of irrigation method. If the water source were to be treated wastewater – set forth below as an option for producing this water supply – then it would be highly recommended to irrigate the grounds, in particular “active use” areas like the soccer fields, using subsurface drip irrigation, to minimize potential for contact with the reclaimed water. Drip dispersal also has the benefit of higher irrigation efficiency. Since the water is applied within the soil, in the root zone, and not subject to evaporation and wind drift, the irrigation efficiency would be high, typically in the range of 90-95%. In these analyses, 95% irrigation efficiency is assumed for subsurface drip dispersal. For spray irrigation, efficiency is typically in the range of 50-70%, depending on the quality of the design and operation. In these analyses, 70% irrigation efficiency is assumed for surface spray dispersal.

Irrigation demand calculations were done for the soccer fields, the Great Lawn, and for the grounds of the proposed Nature Center. No information was provided about the "entry garden" around the park office and bathhouse building, which it was reported is currently being irrigated with rainwater harvested off the roof of that building.

1.1.1 Soccer Field Irrigation

The area covered by the soccer fields, including sideline area, was measured off the BHRP plans to be about 162,800 sq. ft., or 3.74 acres. The "crop coefficient" is 0.8, set forth as the appropriate factor for "sports turf" by Texas A&M Extension. The plant quality adjustment factor is set at 0.6, the value for "normal" plant stress set forth by Texas A&M Extension. As noted previously, the irrigation efficiency assumed for subsurface drip dispersal is 95%, and for surface spray dispersal it is 70%. Plugging in these factors, and using the ET rates published by Texas A&M Extension for Austin, the ET-based irrigation demands for the soccer fields are shown in Table 1, for drip dispersal, and in Table 2, for spray dispersal.

Table 1

Blue Hole Regional Park Irrigation Water Requirement Estimates
for Soccer Fields

Irrigated Area:	**Soccer fields**	Area =	162,800	sq. ft. =	3.74	acres
	Crop coefficient =		0.8	"sports turf"		
	Plant quality adj. factor =		0.6	"normal"		
	Irrigation efficiency =		95%	subsurface drip dispersal		

Month	Days in Month	ETo (in/mo)	ETo (in/day)	Crop Coefficient	Plant Quality Adj. Factor	Irrigation Efficiency	Irrigation Water Demand (in/day)	Irrigation Water Demand (gal/s.f./day)	Irrigated Area (s.f.)	Total Irrigation Demand (gal/day)
January	31	2.27	0.073	0.8	0.6	95%	0.037	0.0230	162,800	3,753
February	28	2.72	0.097	0.8	0.6	95%	0.049	0.0306	162,800	4,978
March	31	4.34	0.140	0.8	0.6	95%	0.071	0.0441	162,800	7,174
April	30	5.27	0.176	0.8	0.6	95%	0.089	0.0553	162,800	9,002
May	31	6.39	0.206	0.8	0.6	95%	0.104	0.0649	162,800	10,563
June	30	7.15	0.238	0.8	0.6	95%	0.120	0.0750	162,800	12,214
July	31	7.22	0.233	0.8	0.6	95%	0.118	0.0733	162,800	11,935
August	31	7.25	0.234	0.8	0.6	95%	0.118	0.0736	162,800	11,985
September	30	5.57	0.186	0.8	0.6	95%	0.094	0.0584	162,800	9,515
October	31	4.38	0.141	0.8	0.6	95%	0.071	0.0445	162,800	7,241
November	30	2.74	0.091	0.8	0.6	95%	0.046	0.0287	162,800	4,680
December	31	2.21	0.071	0.8	0.6	95%	0.036	0.0224	162,800	3,653

Table 2

Blue Hole Regional Park Irrigation Water Requirement Estimates
for Soccer Fields

Irrigated Area:	**Soccer fields**	Area =	162,800	sq. ft. =	3.74	acres
	Crop coefficient =		0.8	"sports turf"		
	Plant quality adj. factor =		0.6	"normal"		
	Irrigation efficiency =		70%	surface spray dispersal		

Month	Days in Month	ETo (in/mo)	ETo (in/day)	Crop Coefficient	Plant Quality Adj. Factor	Irrigation Efficiency	Irrigation Water Demand (in/day)	Irrigation Water Demand (gal/s.f./day)	Irrigated Area (s.f.)	Total Irrigation Demand (gal/day)
January	31	2.27	0.073	0.8	0.6	70%	0.050	0.0313	162,800	5,093
February	28	2.72	0.097	0.8	0.6	70%	0.067	0.0415	162,800	6,756
March	31	4.34	0.140	0.8	0.6	70%	0.096	0.0598	162,800	9,737
April	30	5.27	0.176	0.8	0.6	70%	0.120	0.0750	162,800	12,217
May	31	6.39	0.206	0.8	0.6	70%	0.141	0.0881	162,800	14,336
June	30	7.15	0.238	0.8	0.6	70%	0.163	0.1018	162,800	16,576
July	31	7.22	0.233	0.8	0.6	70%	0.160	0.0995	162,800	16,198
August	31	7.25	0.234	0.8	0.6	70%	0.160	0.0999	162,800	16,265
September	30	5.57	0.186	0.8	0.6	70%	0.127	0.0793	162,800	12,913
October	31	4.38	0.141	0.8	0.6	70%	0.097	0.0604	162,800	9,826
November	30	2.74	0.091	0.8	0.6	70%	0.063	0.0390	162,800	6,352
December	31	2.21	0.071	0.8	0.6	70%	0.049	0.0305	162,800	4,958

Through the peak irrigation period of June-August, the average daily irrigation water demand for the soccer fields would be about 12,000 gallons/day if using subsurface drip irrigation dispersal, and about 16,000 gallons/day if using surface spray dispersal. These calculations do not take account of rainfall inputs defraying demand, so they are the peak daily demands. Thus they set forth the required daily flow capacity of any water supply source that would assure the soccer fields are “properly” irrigated through the peak irrigation period.

In the “off-peak” times, the demands range down from these peaks, to about 3,700 gallons/day in December-January if subsurface drip dispersal were utilized, or to about 5,000 gallons/day if surface spray dispersal were utilized. Given the likelihood of some rainfalls during these winter months, the need to irrigate through this “dormant” period for the Bermuda turfgrass is open to question.

1.1.2 Great Lawn Irrigation

Regarding the Great Lawn, the Agreement for this study states: “Identify the area(s) for which water would be provided temporarily to establish new plantings, such as the proposed Great Lawn, and/or to maintain plantings through extended drought.” This implies that it is not intended to “routinely” irrigate the Great Lawn. It has also been stated that some development on the Great Lawn is being considered, which may reduce the total area to be irrigated.

The area of the Great Lawn was measured off the BHRP plans to be 121,260 sq. ft., or about 2.78 acres. Assuming the entire area would be “routinely” irrigated, to meet “normal” plant stress, the plant quality adjustment factor is 0.6. The “crop coefficient” is 0.6, listed in the Texas A&M Extension table as being appropriate for “warm season turf”. The irrigation demands for the Great Lawn if using subsurface drip dispersal are shown in Table 3, and if using surface spray dispersal, the demands are shown in Table 4.

Table 3

Blue Hole Regional Park Irrigation Water Requirement Estimates
for Great Lawn

Irrigated Area:		**Great Lawn**	Area =	121,260	sq. ft. =	2.78	acres			
		Crop coefficient =		0.6	"warm season turf"					
		Plant quality adj. factor =		0.6	"normal"					
		Irrigation efficiency =		95%	subsurface drip dispersal					
Month	Days in Month	ETo (in/mo)	ETo (in/day)	Crop Coefficient	Plant Quality Adj. Factor	Irrigation Efficiency	Irrigation Water Demand (in/day)	Irrigation Water Demand (gal/s.f./day)	Irrigated Area (s.f.)	Total Irrigation Demand (gal/day)
January	31	2.27	0.073	0.6	0.6	95%	0.028	0.0173	121,260	2,096
February	28	2.72	0.097	0.6	0.6	95%	0.037	0.0229	121,260	2,781
March	31	4.34	0.140	0.6	0.6	95%	0.053	0.0331	121,260	4,008
April	30	5.27	0.176	0.6	0.6	95%	0.067	0.0415	121,260	5,029
May	31	6.39	0.206	0.6	0.6	95%	0.078	0.0487	121,260	5,901
June	30	7.15	0.238	0.6	0.6	95%	0.090	0.0563	121,260	6,823
July	31	7.22	0.233	0.6	0.6	95%	0.088	0.0550	121,260	6,667
August	31	7.25	0.234	0.6	0.6	95%	0.089	0.0552	121,260	6,695
September	30	5.57	0.186	0.6	0.6	95%	0.070	0.0438	121,260	5,315
October	31	4.38	0.141	0.6	0.6	95%	0.054	0.0334	121,260	4,045
November	30	2.74	0.091	0.6	0.6	95%	0.035	0.0216	121,260	2,615
December	31	2.21	0.071	0.6	0.6	95%	0.027	0.0168	121,260	2,041

The calculations show a peak period irrigation demand of about 6,700-6,800 gallons/day if subsurface drip irrigation were utilized, tapering to about 2,000 gallons/day through December-January. If surface spray dispersal were utilized, the peak period demand would be about 9,000 gallons/day, tapering to about 2,800 gallons/day in the winter. Here again it is questionable how much irrigation would actually be needed through the “dormant” winter period. And again, these demand rates do not take account of any rainfalls, so are estimates of the peak demands that may be expected, thus the daily flow capacity that would be required of any water supply source.

As noted, irrigation of the Great Lawn may actually only be required to establish the turf (and other plantings?) and to alleviate drought stress. The need for establishment irrigation would be “random”, subject to the season and happenstance of rainfall during the establishment period. But the irrigation demand to alleviate drought stress can be estimated by setting the plant quality adjustment factor at 0.4, listed in the Texas A&M Extension table as the “minimum” level of plant maintenance. Inputting that factor to the calculation table, we see the results if subsurface drip dispersal were utilized in Table 5, and the results if surface spray dispersal were utilized in Table 6.

Table 4

Blue Hole Regional Park Irrigation Water Requirement Estimates
for Great Lawn

Irrigated Area:	**Great Lawn**	Area =	121,260	sq. ft.	=	2.78	acres
	Crop coefficient =		0.6	"warm season turf"			
	Plant quality adj. factor =		0.6	"normal"			
	Irrigation efficiency =		70%	surface spray dispersal			

Month	Days in Month	ETo (in/mo)	ETo (in/day)	Crop Coefficient	Plant Quality Adj. Factor	Irrigation Efficiency	Irrigation Water Demand (in/day)	Irrigation Water Demand (gal/s.f./day)	Irrigated Area (s.f.)	Total Irrigation Demand (gal/day)
January	31	2.27	0.073	0.6	0.6	70%	0.038	0.0235	121,260	2,845
February	28	2.72	0.097	0.6	0.6	70%	0.050	0.0311	121,260	3,774
March	31	4.34	0.140	0.6	0.6	70%	0.072	0.0449	121,260	5,439
April	30	5.27	0.176	0.6	0.6	70%	0.090	0.0563	121,260	6,825
May	31	6.39	0.206	0.6	0.6	70%	0.106	0.0660	121,260	8,008
June	30	7.15	0.238	0.6	0.6	70%	0.123	0.0764	121,260	9,260
July	31	7.22	0.233	0.6	0.6	70%	0.120	0.0746	121,260	9,049
August	31	7.25	0.234	0.6	0.6	70%	0.120	0.0749	121,260	9,086
September	30	5.57	0.186	0.6	0.6	70%	0.095	0.0595	121,260	7,213
October	31	4.38	0.141	0.6	0.6	70%	0.073	0.0453	121,260	5,489
November	30	2.74	0.091	0.6	0.6	70%	0.047	0.0293	121,260	3,548
December	31	2.21	0.071	0.6	0.6	70%	0.037	0.0228	121,260	2,770

Table 5

Blue Hole Regional Park Irrigation Water Requirement Estimates
for Great Lawn - Drought Stress Irrigation Only

Irrigated Area:	**Great Lawn**	Area =	121,260	sq. ft.	=	2.78	acres
	Crop coefficient =		0.6	"warm season turf"			
	Plant quality adj. factor =		0.4	"minimum"			
	Irrigation efficiency =		95%	subsurface drip dispersal			

Month	Days in Month	ETo (in/mo)	ETo (in/day)	Crop Coefficient	Plant Quality Adj. Factor	Irrigation Efficiency	Irrigation Water Demand (in/day)	Irrigation Water Demand (gal/s.f./day)	Irrigated Area (s.f.)	Total Irrigation Demand (gal/day)
January	31	2.27	0.073	0.6	0.4	95%	0.018	0.0115	121,260	1,398
February	28	2.72	0.097	0.6	0.4	95%	0.025	0.0153	121,260	1,854
March	31	4.34	0.140	0.6	0.4	95%	0.035	0.0220	121,260	2,672
April	30	5.27	0.176	0.6	0.4	95%	0.044	0.0276	121,260	3,353
May	31	6.39	0.206	0.6	0.4	95%	0.052	0.0324	121,260	3,934
June	30	7.15	0.238	0.6	0.4	95%	0.060	0.0375	121,260	4,549
July	31	7.22	0.233	0.6	0.4	95%	0.059	0.0367	121,260	4,445
August	31	7.25	0.234	0.6	0.4	95%	0.059	0.0368	121,260	4,463
September	30	5.57	0.186	0.6	0.4	95%	0.047	0.0292	121,260	3,543
October	31	4.38	0.141	0.6	0.4	95%	0.036	0.0222	121,260	2,697
November	30	2.74	0.091	0.6	0.4	95%	0.023	0.0144	121,260	1,743
December	31	2.21	0.071	0.6	0.4	95%	0.018	0.0112	121,260	1,361

Table 6

Blue Hole Regional Park Irrigation Water Requirement Estimates
for Great Lawn - Drought Stress Irrigation Only

Irrigated Area:	**Great Lawn**	Area =	121,260	sq. ft.	=	2.78	acres
	Crop coefficient =		0.6	"warm season turf"			
	Plant quality adj. factor =		0.4	"minimum"			
	Irrigation efficiency =		70%	surface spray dispersal			

Month	Days in Month	ETo (in/mo)	ETo (in/day)	Crop Coefficient	Plant Quality Adj. Factor	Irrigation Efficiency	Irrigation Water Demand (in/day)	Irrigation Water Demand (gal/s.f./day)	Irrigated Area (s.f.)	Total Irrigation Demand (gal/day)
January	31	2.27	0.073	0.6	0.4	70%	0.025	0.0156	121,260	1,897
February	28	2.72	0.097	0.6	0.4	70%	0.033	0.0207	121,260	2,516
March	31	4.34	0.140	0.6	0.4	70%	0.048	0.0299	121,260	3,626
April	30	5.27	0.176	0.6	0.4	70%	0.060	0.0375	121,260	4,550
May	31	6.39	0.206	0.6	0.4	70%	0.071	0.0440	121,260	5,339
June	30	7.15	0.238	0.6	0.4	70%	0.082	0.0509	121,260	6,173
July	31	7.22	0.233	0.6	0.4	70%	0.080	0.0497	121,260	6,032
August	31	7.25	0.234	0.6	0.4	70%	0.080	0.0500	121,260	6,058
September	30	5.57	0.186	0.6	0.4	70%	0.064	0.0397	121,260	4,809
October	31	4.38	0.141	0.6	0.4	70%	0.048	0.0302	121,260	3,660
November	30	2.74	0.091	0.6	0.4	70%	0.031	0.0195	121,260	2,366
December	31	2.21	0.071	0.6	0.4	70%	0.024	0.0152	121,260	1,847

Presuming these calculations represent irrigating only as required to alleviate drought stress, they still show significant irrigation demand. Through the peak period, the requirement would be about 4,500 gallons/day if subsurface drip irrigation were utilized, and would be about 6,000 gallons/day if surface spray dispersal were utilized. Noting again, these calculations do not account for any rainfall; they are the peak daily flow rates that any water supply would have to provide.

1.1.3 Nature Center Grounds Irrigation

While the Nature Center is only “conceptual” at this point, PARD advised to presume total area of native plant landscaping on the Nature Center grounds would cover about 0.7 acres, or about 30,500 sq. ft. Research into the expected irrigation demand for native plant landscapes indicated that a “landscape coefficient” of about 0.3 is deemed appropriate. Presuming that this is the same as a “crop coefficient”, that is set at 0.3 in the calculation table. Because native plant landscapes can accommodate some drought stress – indeed they can be left largely un-irrigated and still survive, so the amount of irrigation to provide basically comes down to the aesthetics that are to be maintained – the plant quality adjustment factor is presumed to be 0.5, listed in the Texas A&M Extension table as maintaining “low” plant quality. With these inputs, the ET-based irrigation demands on the proposed Nature Center grounds are shown in Table 7, presuming application by subsurface drip dispersal, and in Table 8, presuming application by surface spray dispersal.

Table 7

Blue Hole Regional Park Irrigation Water Requirement Estimates
for Nature Center grounds

Irrigated Area:		**Nature Center**	Area =	30,500	sq. ft. =	0.70	acres			
		Crop coeficient =		0.3	native plantings estimate					
		Plant quality adj. factor =		0.5	"low"					
		Irrigation efficiency =		95%	subsurface drip dispersal					
Month	Days in Month	ETo (in/mo)	ETo (in/day)	Crop Coefficient	Plant Quality Adj. Factor	Irrigation Efficiency	Irrigation Water Demand (in/day)	Irrigation Water Demand (gal/s.f./day)	Irrigated Area (s.f.)	Total Irrigation Demand (gal/day)
January	31	2.27	0.073	0.3	0.5	95%	0.012	0.0072	30,500	220
February	28	2.72	0.097	0.3	0.5	95%	0.015	0.0096	30,500	291
March	31	4.34	0.140	0.3	0.5	95%	0.022	0.0138	30,500	420
April	30	5.27	0.176	0.3	0.5	95%	0.028	0.0173	30,500	527
May	31	6.39	0.206	0.3	0.5	95%	0.033	0.0203	30,500	618
June	30	7.15	0.238	0.3	0.5	95%	0.038	0.0234	30,500	715
July	31	7.22	0.233	0.3	0.5	95%	0.037	0.0229	30,500	699
August	31	7.25	0.234	0.3	0.5	95%	0.037	0.0230	30,500	702
September	30	5.57	0.186	0.3	0.5	95%	0.029	0.0183	30,500	557
October	31	4.38	0.141	0.3	0.5	95%	0.022	0.0139	30,500	424
November	30	2.74	0.091	0.3	0.5	95%	0.014	0.0090	30,500	274
December	31	2.21	0.071	0.3	0.5	95%	0.011	0.0070	30,500	214

Table 8

Blue Hole Regional Park Irrigation Water Requirement Estimates
for Nature Center grounds

Irrigated Area:		**Nature Center**	Area =	30,500	sq. ft. =	0.70	acres			
		Crop coeficient =		0.3	native plantings estimate					
		Plant quality adj. factor =		0.5	"low"					
		Irrigation efficiency =		70%	surface spray dispersal					
Month	Days in Month	ETo (in/mo)	ETo (in/day)	Crop Coefficient	Plant Quality Adj. Factor	Irrigation Efficiency	Irrigation Water Demand (in/day)	Irrigation Water Demand (gal/s.f./day)	Irrigated Area (s.f.)	Total Irrigation Demand (gal/day)
January	31	2.27	0.073	0.3	0.5	70%	0.016	0.0098	30,500	298
February	28	2.72	0.097	0.3	0.5	70%	0.021	0.0130	30,500	396
March	31	4.34	0.140	0.3	0.5	70%	0.030	0.0187	30,500	570
April	30	5.27	0.176	0.3	0.5	70%	0.038	0.0235	30,500	715
May	31	6.39	0.206	0.3	0.5	70%	0.044	0.0275	30,500	839
June	30	7.15	0.238	0.3	0.5	70%	0.051	0.0318	30,500	970
July	31	7.22	0.233	0.3	0.5	70%	0.050	0.0311	30,500	948
August	31	7.25	0.234	0.3	0.5	70%	0.050	0.0312	30,500	952
September	30	5.57	0.186	0.3	0.5	70%	0.040	0.0248	30,500	756
October	31	4.38	0.141	0.3	0.5	70%	0.030	0.0189	30,500	575
November	30	2.74	0.091	0.3	0.5	70%	0.020	0.0122	30,500	372
December	31	2.21	0.071	0.3	0.5	70%	0.015	0.0095	30,500	290

The calculations show a peak period demand of about 700 gallons/day if subsurface drip dispersal were utilized, and of about 950 gallons/day if surface spray dispersal were utilized. Again these volumes are the peak daily flow rate that any water supply would have to provide, not accounting for any rainfall. Demand tapers to about 220 gallons/day in the winter if subsurface drip dispersal were utilized, and to about 300 gallons/day if surface spray dispersal were utilized. Especially for this native plant landscape, the need for irrigation through the winter “dormant” period is questionable.

1.2 Other Water Demands

As noted, other water demands that might be provided by an “alternative” supply source include the maintenance of a wetland on the Nature Center grounds, “misting” in a greenhouse to be part of the Nature Center, and toilet flush water supply. The former two demands cannot be characterized without further information on size of the wetland and details of the “misting” operation. The Nature Center design being conceptual at this point, that work will hinge on FoBH choosing to pursue it in Phase 2 of this study.

As for toilet flush supply, it was stated that rainwater harvested off the roof of the pavilion is used to provide flush water supply to toilets in the pavilion building. No volume of flush water supply provided by the rainwater harvesting (RWH) system at the pavilion has been reported, as this flow is not metered. No information has been provided on whether the harvested rainwater is always a sufficient source to fulfill the flush water demand at this facility, or if makeup water must be provided, or how much makeup water, or the source of any makeup water. Lacking information to use to project toilet flush water demands, in the section of this report reviewing potential water sources, an RWH modeling procedure will be executed to review the amount of demand it may be expected the existing RWH system at the pavilion would be able to carry.

It has also been stated that rainwater is harvested off the rooftop of the office and bathhouse building, but that water is not used to provide toilet flush water in the bathhouse, rather it is used only to irrigate the “entry garden” around that building. With the amount of water being harvested and used not being quantified, any evaluation of whether that RWH system could be expanded or optimized to also provide toilet flush water supply must await further information on that irrigation operation, if FoBH determines to pursue that option in Phase 2 of this study.

A third set of bathrooms are in the “playscape restroom” building. It appears that these restrooms have water supplied by the potable water system. With the roofprint of this building reported to be only 691 sq. ft., and the flush water use in this facility undefined, further evaluation of using RWH for this supply awaits FoBH deeming it relevant to consider in Phase 2 of this study.

1.3 Summary of Water Demands

The peak daily flow rate of water from an “alternative” source that may be needed to satisfy the anticipated water uses on BHRP is summarized below. As noted, no accounting of the “entry garden” and toilet flush supply has been provided, so this review considers only the irrigation demands for the soccer fields, for the Great Lawn, and for the proposed Nature Center grounds.

If all irrigation were to be executed using subsurface drip dispersal:

- Soccer field peak water demand rate = 12,000 gpd
- Great Lawn peak water demand rate (routine irrigation) = 6,800 gpd
- Great Lawn peak water demand rate (drought stress irrigation only) = 4,500 gpd
- Nature Center grounds peak water demand rate = 700 gpd
- ➔ Total peak water demand rate = 19,500 gpd, if Great Lawn is to be routinely irrigated
- ➔ Total peak water demand rate = 17,200 gpd, if Great Lawn is to be drought stress irrigated only

If all irrigation were to be executed using surface spray dispersal:

- Soccer field peak water demand rate = 16,000 gpd
- Great Lawn peak water demand rate (routine irrigation) = 9,000 gpd
- Great Lawn peak water demand rate (drought stress irrigation only) = 6,000 gpd
- Nature Center grounds peak water demand rate = 950 gpd
- ➔ Total peak water demand rate = 25,950 gpd, if Great Lawn is to be routinely irrigated
- ➔ Total peak water demand rate = 22,950 gpd, if Great Lawn is to be drought stress irrigated only

2.0 POTENTIAL WATER SOURCES

Per the terms of the Agreement for this study, the water sources to be considered include:

- Treated wastewater.
- Hauled in water.
- Rainwater collected off rooftops.
- Stormwater runoff from paved areas.
- Withdrawal from Cypress Creek.

2.1 Treated Wastewater (Reclaimed Water) Supply

It is likely that the most "sustainable" water supply source, and the one with the lowest long-term cost, would be treated wastewater (reclaimed water), if that water could be "scalped" from the sewer system on or near BHRP, so that the cost of delivering the reclaimed water to the park would be relatively "minimal". If on the contrary that reclaimed water would have to be transported from the treatment plant to which that wastewater would otherwise flow, the plant owned by Aqua America/Aqua Texas (Aqua) located in Woodcreek, the costs of the pipeline to get the water to BHRP would no doubt be prohibitive. So the reclaimed water option considered here is to install a sewer "scalping" plant on or very near BHRP.

As reviewed in the next section, a scalping plant is "normally" permitted through the Texas Commission on Environmental Quality (TCEQ) under the provisions of TAC 321, Subchapter P. To gain approval through 321P, Aqua would have to be engaged, since that rule requires the owner of a scalping plant to be the owner of the treatment plant to which that water would otherwise flow. But in discussion with TCEQ, it has been determined that the City of Wimberley may be able to adapt its own permit, that had been obtained in anticipation of treating the wastewater run into its own sewer system but which is now being sent to the Aqua plant for treatment. This may allow the city to create and run a scalping plant itself. This is discussed further in section 3.

The most likely source of wastewater to be treated to create a water supply for BHRP is a lift station that is on or near the park – see Figure 1 – which intercepts wastewater flows generated in the park and in the nearby Deer Creek nursing home. While this remains to be verified, it is expected that the total flow through that lift station would routinely be in excess of 25,000 gpd, so that it could provide adequate supply for the maximum projected rate of demand reviewed above. If this were found not to be so, some point along the sewer system where more flow is collected, from which the flow could be extracted, would have to be found.

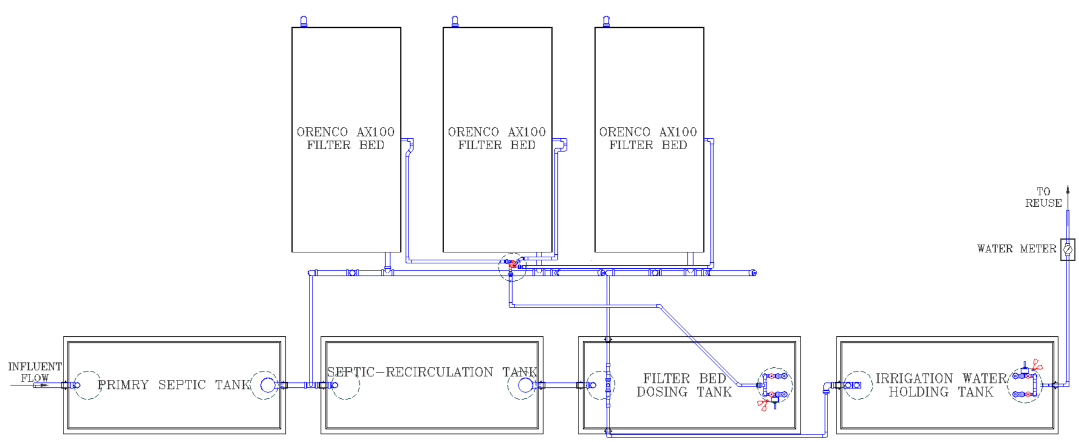
A pump unit would be installed in the lift station chamber to pump wastewater to a treatment plant, which would be optimally located as close as practical to both the lift station and the points of water use on BHRP. This pump system would be run on a timer, so that the total daily flow could be delivered to the treatment unit in "slugs", to equalize the flow through the treatment unit through the day, and to allow the solids in each slug to settle as it passes through the septic tank that would be the first stage of the treatment unit. This timer would be adjusted seasonally as needed to match the daily flow run into the treatment unit to the seasonal demands for the reclaimed water. The treatment unit capacity would have to accommodate the peak irrigation season flow, but would also have to be able to "ramp down" in the fall and back up the next spring. This flow variability has implications for the type of treatment unit that is recommended.

Ideally the treated effluent could also "overflow" back into the lift station. Flow ***out of*** the treatment unit, to the irrigation systems, would be run by an irrigation controller, which would be independent of the pumps feeding wastewater ***into*** the treatment unit. With this overflow provision, in the event of rain, reducing the demand for irrigation water, the flow to the plant would not have to be modulated in real time, rather any "excess" reclaimed water would simply re-enter the sewer via the irrigation water holding tank overflow line, going back into the lift station to flow on to the Aqua treatment plant. With this scheme, control of flow rates into and out of the treatment unit would be relatively simple.

The optimal sort of treatment unit for this sort of variable flow situation would be what is generically called a recirculating packed-bed filter treatment system. The variant of this technology recommended here is termed the high performance biofiltration concept, which is an optimized version of that basic technology, rendering it as consistent and reliable as practical while incurring relatively minimal operations and maintenance (O&M) liabilities.

While the traditional version of this technology used sand or fine gravel as the media in the "packed beds" – simply meaning media "packed" into a containment "bed" – this technology would be implemented here using filter beds containing a geotextile fabric media, a standard product of Orenco Systems, Inc., which manufactures and vends its own version of this basic technology. These filter beds can receive a somewhat higher hydraulic application rate than can be applied to sand or gravel media, so the footprint of a treatment unit using the Orenco filter beds would be somewhat smaller.

An example of a high performance biofiltration concept treatment unit using the Orenco filter beds is the treatment plant installed at the Wimberley ISD Blue Hole Elementary School. Figure 3 shows a schematic of that installation. The design flow rate capacity of each of the Orenco AX100 filter beds used in this design is 2,500 gpd. So the treatment unit to create an "alternative" water supply for BHRP would be somewhat larger than the layout shown in Figure 3, employing perhaps 6-10 of those filter beds, and somewhat larger tanks. But the basic layout and function would be the same as it is for the Blue Hole School system.



TYPICAL TREATMENT UNIT LAYOUT PLAN
Figure 3

Reasons why this sort of treatment unit would be more "robust" and would incur lower O&M liabilities than the more common activated sludge process include:

- The activated sludge process depends for its treatment effect upon very few trophic levels of microorganisms (a "trophic level" is a rung on the food chain, microbes on a "higher" trophic level eat those on a "lower" trophic level), living in concentrations far higher than found anywhere in nature, so this process can only be kept "on track" by the input of power to keep the slurry well aerated and by withdrawal of sludge to maintain the proper food/microorganism level. Being suspended in the water column, it is rather easy for pollution to "wash out" of the treatment unit. The high performance biofiltration system depends on many trophic levels of organisms that are attached to the filter media or grow within the filter bed, so the treatment process is inherently more stable, and the microbes are not prone to washout.

- The volume of the media in a properly loaded high performance biofiltration concept treatment unit is such that the "mean cell residence time" is much longer than it is in an activated sludge unit, again imparting a more stable treatment process.
- The basic treatment process in the high performance biofiltration concept unit is passive, imparted by the biota living in the filter bed as the water flows on down through the filter bed ***by gravity***, so that power is needed only to move water to the top of the filter bed. If power is lost, or the pump malfunctions, the biota simply sits there waiting for flow to resume, and the treatment process picks up without missing a beat. This is in stark contrast to the activated sludge process, in which power input is absolutely critical to maintaining the treatment process. If power is lost, or any component of the aeration system were to fail, treatment would begin to degrade very quickly. And when power is restored or the failed component is repaired or replaced, it would typically take some time for the treatment process to get back "on track", with poorly treated water flowing on through the system in the interim.
- Sludge management in a high performance biofiltration concept treatment unit is simpler and far less time-critical than it is for an activated sludge unit. As noted, sludge must be periodically withdrawn from the activated sludge unit to keep the food/microorganism ratio "in balance", and typically that must be done on a time scale measured in hours, or days at the most. By contrast, the major mode of sludge management for a high performance biofiltration concept unit would be pumping of the septic tank(s) that, as Figure 3 shows, serves as the first stage of the treatment process. This is typically required only at ***multi-year intervals***, and timing is not at all critical. Months could pass between when measurement of sludge depth in the septic tank indicates that it should be pumped and the actually pumping without any meaningful impact on the treatment process.
- Because the high performance biofiltration concept treatment unit is so inherently stable and robust, very little routine O&M effort is required. There is nothing to adjust, rather the system just operates day to day with no intervention, so there is nothing for an operator to do on a daily basis. Basic routine maintenance would be required, but only at multi-month intervals, so the plant would not even have to be visited by an operator very often. Alarms would signal need for unscheduled maintenance, which would typically be a pump failure. In a plant this size, duplex pump sets would be used for continuous reliability, so even replacement of a failed pump would not be very time-critical.

Besides being "robust" in the face of variable wastewater loads through the year, this technology would also consume far less electricity than the more commonly used activated sludge treatment process, typically something like 1/10 as much. That makes the high performance biofiltration concept more sustainable in regard to greenhouse gas emissions than activated sludge would be.

A characteristic of the high performance biofiltration concept process is that it can be configured to remove a majority of the nitrogen in the wastewater, essentially "for free". The way this happens is not belabored here; suffice it to say that this treatment process can consistently reduce nitrogen by over 50%, typically in the range of 60-75%. Nitrogen is a problematic pollutant in the context of irrigation dispersal of treated wastewater. If overloaded relative to the uptake potential of the plants being irrigated, the excess nitrogen can readily build up in and leach out of the root zone whenever soaking rains are received, which could transport the nitrogen into environmental waters. So reducing the level of nitrogen applied to the plants to a level more in line with the uptake potential of the Bermuda turfgrass, with the water being applied at rates needed to properly irrigate the turf, would essentially eliminate the potential to shed nitrogen pollution into area waters.

This technology can consistently and reliably produce a 10/10 effluent – BOD_5 and a TSS concentrations of 10 mg/L. This would be considered quite sufficient for an effluent to be dispersed via subsurface drip irrigation, but would likely need a bit of "polishing" to be applied via surface spray dispersal, which typically requires production of what TCEQ terms a "Type I" effluent, imparting a limit of 5 mg/L of BOD_5. This betterment of the effluent quality, if deemed to be needed, might be imparted by installing a second stage filter bed, which could be loaded very heavily so could be relatively small, or by installing a slow sand filter unit behind the high performance biofiltration concept treatment unit.

A slow sand filter is a very old and well established potable water treatment process, capable of converting even heavily polluted river flows into a potable quality supply. So it is expected that a relatively lightly loaded slow sand filter installed behind a high performance biofiltration concept treatment unit would produce near-potable quality water. This technology would entail fairly little equipment and fairly little O&M liability.

In terms of overall sustainability of this water supply option, it is noted that if the wastewater were to flow on through to the Aqua treatment plant, the reclaimed water produced in that plant would be land applied. It is purported that this land application yields a reuse value because it is being applied to nominally irrigate a gold course. It is of course a value judgment if irrigating a golf course is a "higher" or "lower" value operation, in regard to moving society toward sustainable water, than would be irrigating the spaces identified on BHRP, but the efficiency in defraying potable water demands should be quantifiable.

While producing an accurate cost estimate awaits a more detailed review of the scalping plant concept that may be executed in Phase 2 of this study, a rough guess for a 20,000 gpd high performance biofiltration treatment concept plant and the pumping unit to feed it is $400,000. Over a 20-year loan period at a 2% interest rate, the annual payment on this amount would be about $24,000. A preliminary rough guess at annual operating cost is $6,000, presuming in light of the rather minimal O&M liabilities of the high performance biofiltration concept treatment unit that the City of Wimberley could assign O&M duties to existing staff. The total of $30,000 per year is offered for a rough comparison with the costs of other options.

2.2 Hauled In Water Supply

Another option would be to haul in water supplies from an available source to supply the water demands on BHRP. In terms of moving society toward sustainable water, that would depend on the source of the hauled water. If it came from a potable water supply system – the "usual" source of hauled water, e.g., by rainwater harvesters for backup supply – that supply scheme would not be any more sustainable than tapping the Wimberley Water Supply Corporation to supply this water would be. It is the aim of this study to set forth a water supply strategy for BHRP that would be more sustainable than tapping the potable water supply. So it is presumed that for this option to even be considered would require that the water source be a non-potable supply. It is unknown what such sources of supply may be, how sustainable they would be, and if any of them would have the capacity to provide the peak flow rates that would be needed on BHRP.

In any case, the cost of this option would likely be prohibitive. For example, to provide the full annual irrigation profile calculated in Table 1 for just the soccer fields, irrigated via the more efficient subsurface drip dispersal method, would nominally require 1,475 truckloads at 2,000 gallons each. The going rate for a truckload of potable supply is in the range of $120. If some non-potable supply could be obtained and hauled for half that price (which may not cover the truck operating costs much less that and the water cost too) the total annual cost of a hauled in water supply just for the soccer fields would about $89,000 per year. Then the city would still have to install, and pay for, a tank into which the tanker trucks would deliver the water and a pump system to deliver the water to the irrigation systems.

Given that this option may not be at all sustainable, and it appears it would be much more costly than other options, FoBH will judge if this option is worthy of further investigation in Phase 2 of this study.

2.3 Rainwater Harvesting

As has been noted, building-scale RWH is being practiced off the rooftops of the park pavilion and the park office-bathhouse building. Since the office-bathhouse RWH system is being used to irrigate the "entry garden", about which no information is available, there is no basis for modeling that system to see if it could also deliver a flush water supply for the bathhouse fixtures. While it may be possible to also harvest rainwater off the rooftop of the playscape restroom building, it is unknown if the plumbing in that building would allow the toilets to be supplied by rainwater. So these facilities are left to be investigated further in Phase 2, if FoBH deems that to be of interest.

For the pavilion, a basic RWH modeling analysis was conducted to arrive at a guess of how much toilet flush water could be harvested off the pavilion rooftop. PARD has informed that the pavilion roofprint is 1,994 sq. ft., and the capacity of the cistern into which the roof runoff drains is 2,900 gallons. These are input into a rainwater harvesting model, covering the years 2007-2018, using Dripping Springs rainfall data. The modeling results are shown in Table 9.

To model water demand, the volume required to supply a set number of flushes per day that might be supported by this configuration is entered for each month. The volume of water used per flush varies from 0.8 to 1.6 gallons per "full" flush, with lesser amounts required for urine only flushes, if a toilet has that feature, or to flush urinals. It is unknown how efficient the fixtures in the pavilion restroom may be, so here it is presumed a flush consumes 1.6 gallons.

Table 9

Blue Hole Regional Park
Pavilion RWH for Toilet Flush Supply
2007-2018

12-Year Summary

Copyright 2019
David Venhuizen, P.E.

System Sizing Parameters		
Collection area =	1,994	sq. ft.
Total storage =	2,900	gallons
Cistern alarm criterion:	-	days
Cistern alarm level:	-	gallons
Enhanced conservation curtailment rate:	1	

Interior Demand		
Occupancy =	N/A	persons
Usage rate =	N/A	gpcd
Irrigated area =	0	sq. ft.
Wastewater irrigated?	0	(1=yes, 0=no)

Interior Daily Demand in Each Month			No. of Days	Irrigation Rate	
January	8	gpd	31	0.00	in/week
February	8	gpd	28	0.00	in/week
March	16	gpd	31	0.20	in/week
April	16	gpd	30	0.50	in/week
May	16	gpd	31	0.75	in/week
June	32	gpd	30	1.00	in/week
July	32	gpd	31	1.00	in/week
August	32	gpd	31	1.00	in/week
September	16	gpd	30	0.75	in/week
October	16	gpd	31	0.50	in/week
November	8	gpd	30	0.20	in/week
December	8	gpd	31	0.00	in/week

Parameter	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total rainfall - inches	43.58	17.81	35.32	39.55	17.71	26.03	42.35	32.21	46.28	47.35	32.49	37.20
Total makeup demand - gallons	0	2,000	0	2,000	2,000	2,000	0	0	2,000	0	0	0
Demand provided by rainwater	100%	69%	100%	69%	69%	69%	100%	100%	69%	100%	100%	100%
Total overflow (lost supply) - gallons	44,098	16,717	35,666	42,746	16,617	26,796	43,843	31,945	50,798	50,058	32,280	37,915
Portion of rainfall lost	85%	79%	85%	91%	79%	87%	87%	83%	92%	89%	84%	86%

Average annual rainfall thru data period =	34.82	inches
Total makeup demand over 12-year period =	10,000	gallons
Maximum makeup required in any one year =	2,000	gallons
Number of years in which makeup was required =	5	
% of demand met by rainwater =	86.9%	

As Table 9 illustrates, only a very limited number of flushes could be supplied by the pavilion RWH system, configured as was reported. Assuming only 5 flushes per day (8 gallons/day) in January, February, November and December, only 10 flushes per day (16 gallons/day) in March, April, May, September and

October, and only 20 flushes per day (32 gallons/day) in June, July and August, presumably the peak park visitation period, the model shows that a little over 85% of the flush water demand could have been provided by this RWH system. This is a rather minimal level of usage, so unless the park really is visited rather infrequently, and/or very few visitors use the restroom facilities, it does not appear that the pavilion RWH system has the capacity to even cover this usage, much less to expand the capacity. To do so would require a significant increase in the roofprint and cistern volume.

Moving on to the proposed Nature Center, the prospects for covering the water demands expected to be incurred in/around that facility are much better. The irrigation demand rates shown in Table 5, converted to in/week, and an irrigated area of 30,500 sq. ft. were entered into a modified RWH model spreadsheet to calculate the average daily water demands in each month of the RWH model covering the years 2007-2018, accounting for the rainfalls received in each month. Based on the conceptual plan for the proposed Nature Center, and PARD's estimate that the conditioned space in the Nature Center buildings would be about 7,000 sq. ft., a guess of the total roofprint, including the large verandas shown in the conceptual plan drawings, is 12,000 sq. ft. As shown in Table 10, presenting the summary page of the RWH model, presuming a 30,000-gallon cistern were to be installed, RWH could have covered about 87% of the modeled irrigation demand through the 12-year modeling period.

Table 10

Blue Hole Regional Park

Nature Center Irrigation Water Supply

2007-2018

12-Year Summary

Copyright 2019
David Venhuizen, P.E.

System Sizing Parameters			Interior Demand		
Collection area =	12,000	sq. ft.	Occupancy =	0	persons
Total storage =	30,000	gallons	Usage rate =	0	gpcd
Cistern alarm criterion:	-	days			
Cistern alarm level:	-	gallons			
Enhanced conservation curtailment rate:	1		Irrigated area =	30,500	sq. ft.
			Wastewater irrigated?	0	(1=yes, 0=no)

Interior Daily Demand in Each Month		No. of Days	Irrigation Rate	
January	gpd	31	0.084	in/week
February	gpd	28	0.105	in/week
March	gpd	31	0.154	in/week
April	gpd	30	0.196	in/week
May	gpd	31	0.231	in/week
June	gpd	30	0.266	in/week
July	gpd	31	0.259	in/week
August	gpd	31	0.259	in/week
September	gpd	30	0.203	in/week
October	gpd	31	0.154	in/week
November	gpd	30	0.098	in/week
December	gpd	31	0.077	in/week

Parameter	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total rainfall - inches	43.58	17.81	35.32	39.55	17.71	26.03	42.35	32.21	46.28	47.35	32.49	37.20
Total makeup demand - gallons	0	0	0	0	50,000	0	0	0	22,000	0	0	0
Demand provided by rainwater	100%	100%	100%	100%	51%	100%	100%	100%	61%	100%	100%	100%
Total overflow (lost supply) - gallons	285,774	65,128	220,884	247,626	73,515	120,487	249,868	205,326	297,524	305,208	206,896	227,131
Portion of rainfall lost	91%	51%	87%	87%	58%	65%	82%	89%	90%	90%	89%	85%

Average annual rainfall thru data period =	34.82	inches
Total makeup demand over 12-year period =	72,000	gallons
Maximum makeup required in any one year =	50,000	gallons
Number of years in which makeup was required =	2	
% of demand met by rainwater =	86.8%	

The model results show that 100% of the demand could have been covered in all but 2 years – the worst year being 2011, the worst one-year drought on record here – so that most of the time, there would likely be water supply for much of the toilet flush water demand as well. The model shows that there would have been considerable volume of cistern overflows in every year. These flows could be directed to-through the proposed wetland to provide the water needed there.

These results indicate that RWH could be depended upon to largely cover the water supply to the Nature Center when it comes on line. If years like 2011 occur again, with the potable water supply line right there, providing the occasionally needed backup supply would functionally be no problem. It is recommended that the Nature Center be planned to maximize RWH supply to it, so that no other water sources, other than the occasional backup supply through an extended drought and routine supply to lavatories from the potable system, would need to be dedicated to it.

2.4 Stormwater Runoff from Paved Areas

The idea of rainwater harvesting can be extended to gather runoff from impervious surfaces on the ground, the pavement. This runoff would be more polluted than rooftop runoff, so may require some degree of treatment to be used for irrigation or toilet flush supply, and being gathered at ground level, would require any storage facilities – "cisterns" – to be dug into the ground. The simplest sort of cistern would be an open pond, but a free water surface carries the liability of breeding misquitos. This can be blunted by constantly aerating the pond, incurring a power demand, and stocking it with minnows to eat misquito larvae. While a variable depth ornamental pond – what this sort of cistern would effectively be – may be a nice water feature on the park, that would require that the pond could never be allowed to go dry, which would very likely require perhaps frequent inputs of makeup water to the pond. This is in part because an open pond would suffer high evaporative losses, being at their maximum during the summer, the peak irrigation season, when those water losses would be most impactful on supply. So perhaps an effective RWH system employing paved areas as the collection surface would need to use in-ground tanks as the cistern, an option that would be somewhat more costly.

In BHRP, however, most of the parking spaces are paved with gravel rather than impervious pavement, so only the narrow drive strips are impervious. This renders gathering of runoff from the paved areas quite problematic. It is therefore recommended that this option be omitted from further consideration.

2.5 Withdrawal from Cypress Creek

The ET-based calculations estimating irrigation water demand indicate that the peak daily demand for the soccer fields and the Great Lawn might be in the range of 20,000 gallons/day, about 0.031 cfs. Through the winter, the water demands would drop into the range of 5,000 gallons/day, or about 0.008 cfs. While the flow of Jacob's Well, the main source of water flowing down Cypress Creek, has occasionally gone to zero, the vast majority of the time those flows would be quite in excess of these projected rates of withdrawal to provide the irrigation supply. So while in simple "raw" terms, it would appear that withdrawing water from Cypress Creek would be "sustainable", it is rather open to question if this strategy should be considered.

Per information provided by the Wimberley Valley Watershed Association (WVWA), which is, so to speak, the "keeper" of Jacob's Well, there have been 5,998 recordings of Jacob's Well daily mean flow rate since the monitoring program began in 2005. Of those, 3,302 daily mean values were below 4 cfs, which is designated as the flow rate below which there would be low dissolved oxygen and thus impacts on habitats. A total of 3,887 daily mean values were below 6 cfs, designated as a trigger for drought declaration by the Hays-Trinity Groundwater Conservation District. While any withdrawals from Cypress Creek to irrigate on BHRP would be a very small fraction of these flows, and would be far down the creek from Jacob's Well, this is an ecosystem that, from all reports, local society would be loathe to risk damaging. And while the facilities – an intake structure and pump house – could likely be well "hidden" so as not to impart an aesthetic impact on the park or the creekside environment, the very idea of impacting the resource that is the centerpiece of BHRP, the Blue Hole itself, is rather antithetical to the spirit of BHRP.

Therefore, it is questionable if this option would be further considered by FoBH, even if the City of Wimberley were to possess the water rights to make the withdrawals. Queries about this have so far gone unanswered, so this remains to be determined, if FoBH chooses to further investigate this option in Phase 2 of this study.

In any case, a rough cost estimate for the intake structure and pump house is $125,000. Over 20 years at 2% interest, the annual loan payment on this amount would be about $6,400 per year. Additional cost would be incurred for a pipeline to the irrigated areas. Operating costs would include electricity and whatever maintenance the pump system were to require, and pump replacements, expected to be needed at about 7-10 year intervals.

3.0 INSTITUTIONAL AND REGULATORY ISSUES

As just noted, an institutional/regulatory question about withdrawals from Cypress Creek is whether the City of Wimberley has water rights that would allow it to make the withdrawals. As long as the rainwater harvesting options provide water only to non-potable uses, those systems would remain largely free of any regulation. With the option of hauling in water being unlikely due to costs and questions about sustainability, and the option of stormwater harvesting off pavement being unlikely due there being no large areas of impervious pavement, this leaves the wastewater scalping scheme as the only option for which institutional and regulatory issues need to be further explored.

3.1 Scalping Plant Permitted Under 321P

As was noted in section 2, the “normal” manner of implementing a treatment plant to “scalp” wastewater from the sewer system upstream of the “regular” wastewater treatment plant is though TAC 321, Subchapter P. The presumption of that rule is that the sewer system and the treatment plant would be owned by the same entity, and any water “scalped” upstream would deduct from the flow to be treated at the downstream treatment plant. Therefore, that rule specifies that the owner-operator of the scalping plant must be the owner-permitee of that downstream plant.

So to implement a scalping plant under 321P would require that Aqua be “recruited” to be at least the “nominal” owner-operator of the scalping plant. Arrangements could be made for the City of Wimberley to be the “actual” operator of the scalping plant, and of course to run the irrigation systems it feeds, but Aqua would have to be at least the “figurehead” owner. It will have to be evaluated whether dealing with Aqua would be preferable to dealing with the conditions of Wimberley’s wastewater permit, reviewed below, if FoBH determines to further explore the scalping plant option in Phase 2 of this study.

3.2 Scalping Plant Approved Under Current City of Wimberley Permit

The alternative would be for the City of Wimberley to build and operate the scalping plant under the permit it obtained from TCEQ when the plan for a Wimberley wastewater system was to build a plant in the location indicated on Figure 1. While that permit would have allowed the city to discharge the treated wastewater into Deer Creek, which runs on into the Blanco River, it was the city’s intent, per all reports, to maximize reuse of the treated effluent. The city obtained a “210 authorization” – the TCEQ vehicle to authorize diverting of reclaimed water from the permitted “use”, being stream discharge in this case, to beneficial reuse – intending to reuse this water for irrigation, and eventually to perhaps route it to other non-potable demands in the city, with discharge occurring only as a last resort; e.g, during extended wet weather.

It has been explored with TCEQ if the current permit and 210 authorization could be adapted to implementing a treatment plant that could be operated as a scalping plant, withdrawing from the Wimberley sewer system only the amount of water projected to be needed for irrigation in each season, and to allow any “excess” treated water to overflow the irrigation water holding tank back into the city sewer system. In short, it appears possible to do this, but there are some “wrinkles” to be considered.

3.2.1 Location of the Treatment Plant

One matter is the location of the scalping plant. As shown on Figure 1, there is a treatment plant on BHRP, which is to be abandoned. While it might be expected this space would be a good option for a scalping plant, it has been asserted that provisions of certain grants preclude building a new wastewater treatment plant on BHRP, so it is asserted that this space would not be available. While it has been requested that the exact boundaries of the park, the specific area where a plant could purportedly not be sited, be provided, to date that boundary has not been clarified. It appears that the land on which the city had intended to build its treatment plant, shown on Figure 1, is within the park. It has been asserted, however, that there would have been a land swap that would define this area to be out of the park, so a plant could have been built in that location. No information on those arrangements has been provided to date, so the explicit viability of that location remains unknown, in regard to the restriction noted.

The other matter potentially impacting on treatment plant location is the specification of the plant site in the city's permit. The site for both an "interim" plant – purported to be the existing treatment plant – and for the proposed new "final phase" treatment plant is listed as 333 Blue Hole Lane. On both Google Maps and Google Earth, entering that address delivers a "pin" on a site on the west edge of BHRP, next to Cypress Creek, all the way across the city-owned property shown in Figure 2 from where it was proposed to build that final phase treatment plant. This indicates that the exact location of any new treatment plant is not confined by the provisions of the permit to any given site on the city-owned land in this area. If that is not the case, any restrictions on where the treatment plant can be located imparted by the permit must be investigated. Or perhaps the permit would have to be modified to enable the plant to be more "conveniently" located.

As noted in section 2, it is to be expected that the point where wastewater would be withdrawn from the Wimberley sewer system to be treated in a scalping plant is the Deer Creek lift station, the location of which is shown on Figure 1. If that is the point of withdrawal, then the "obvious" choice for scalping plant location would be "near" that lift station. It has been asserted that this lift station is not on BHRP, rather on adjacent city-owned property. Comparing Figure 1 and Figure 2, it does appear that this lift station is within the green area denoting city-owned land, but it remains to confirm whether the lift station site is on or off the BHRP property, as that is impacted by the asserted ban on building a treatment plant on BHRP.

During a site visit to the park with FoBH and PARD, it was suggested that "near" the lift station would be the "best" location for a scalping plant, as that would minimize the run of pipeline to feed water from the lift station to the treatment plant, and this area is within "reasonable" proximity of the areas to be irrigated. This would also place the scalping plant "close" to electric power feed, since lines are already run to the lift station, although it remains to investigate if the capacity of electric feed to that site would be sufficient to run the treatment plant in addition to the lift station.

It was opined by both parties that clearing the heavy tree growth in that area for a plant site would not be favored. While, as seen on Figure 1, there is a small clearing around the lift station, more area would have to be cleared to create a space sufficient to house the treatment plant. It is roughly estimated that a space covering about 160' x 40' would be needed for a nominal 20,000 gpd plant.

An area around the maintenance buildings, shown on Figure 1, which is already cleared, currently used for materials storage, was suggested by PARD to be a better location. This location is right on the route from the lift station to the irrigated areas, so would be an expeditious location to minimize total runs of pipeline. Note however that this space is almost certainly ***on*** park land, and per the asserted ban, the treatment plant could not be sited there.

All those matters must be straightened out in order to determine a feasible site for a scalping plant. The City of Wimberley and FoBH must cooperate to determine what areas are or are not available for siting the treatment plant, and to work out the most expeditious site, in regard to access, extension of electric feed, the length of pipelines required, and where it would be allowable to site a treatment plant.

3.2.2 Level of Treatment Required

Another issue is to clarify the conditions of the city's permit for a treatment plant and of its 210 authorization, relative to the level of treatment actually needed in this case. Since the permit was issued to provide the level of protection purported to allow stream discharge, it imposes a rather stringent effluent set – 5/5/2/0.5. This is 5 mg/L BOD_5, 5 mg/L TSS, 2 mg/L ammonium nitrogen (note ***not*** total nitrogen, allowing the level of nitrates, the actually problematic nutrient in the context of land dispersal of the wastewater, and perhaps for discharge also, in the effluent to be unlimited), and 0.5 mg/L of total phosphorus. ***All*** of these measures are "excessive" for a scheme that proposes the water would only be irrigated at rates limited by the ET-based measure of irrigation demand at any given time of year, rather than being routed to stream discharge.

The 5 mg/L of BOD_5 is important for discharge in regard to dissolved oxygen depletion in the receiving water, but is rather irrelevant for the proposed irrigation scheme. The limit on BOD_5, and TSS too, if the mode of irrigation were to be subsurface drip dispersal would be "secondary" treatment, to about 20 mg/L, as required to keep emitter clogging from being a problem. If surface spray dispersal were to be the mode of irrigation, BOD_5 serves as a measure of "cleanliness", thus "disinfectability", which is important in regard to the potential for human exposure to this water.

The city's current 210 authorization, under which it had been presumed irrigation would be executed via surface spray dispersal, specifies a "Type I" effluent be produced, which indeed requires that BOD_5 be reduced to 5 mg/L, so that the irrigated areas could be "uncontrolled" in regard to human use. TCEQ can also issue a 210 authorization specifying a "Type II" effluent, with a limit of 20 mg/L of BOD_5. While as noted, this would be quite sufficient for subsurface drip dispersal, which would practically preclude ***any*** human contact, the 210 regulatory process appears to be not set up to accommodate, indeed apparently does not even recognize, the highly protective nature of subsurface drip dispersal. So it must be clarified if, under the existing city permit, 5 mg/L of BOD_5 would ***have*** to be produced, or if the permit could be "adapted" to allow a limit of 20 mg/L BOD_5 and TSS, and what institutional arrangements would be needed to do so. It has been asserted this would require a "major amendment" of the permit. As noted in section 2, a "polishing" process would have to be added onto the basic treatment unit to be able to reliably produce 5 mg/L of BOD_5, increasing the cost to no real benefit, assuming subsurface drip dispersal were employed.

The limit of 2 mg/L ammonium nitrogen is also important for discharge, as the conversion of ammonium nitrogen to nitrate nitrogen in the stream would also deplete dissolved oxygen in the water. As noted however this effluent set imposes ***no*** limit on ***total*** nitrogen, so is not actually protective against stimulation of algal growth in the stream, for which the phosphorus limit is imposed. Other sources of phosphorus in the environment could still, in the presence of sufficient nitrogen, result in problematic algal growth in otherwise "pristine" Hill Country streams.

As was noted in section 2, the type of treatment unit proposed would "automatically" reduce total nitrogen content in the wastewater, producing an effluent with a total nitrogen concentration in the range of 15 mg/L, down from a typical level of 40-60 mg/L in raw wastewater. This would basically preclude leaching of nitrogen out of the root zone of the turfgrass, particularly when the irrigation is limited to the ET-based rates in every season. So the effluent this sort of treatment plant would produce would be much more highly protective against nutrient pollution of environmental waters than the level specified in the city permit. Note that the 210 authorization does not address nutrients at all.

This leaves the most problematic aspect of the effluent set that had presumed stream discharge to be the fate of the treated wastewater, the phosphorus level. As noted, this level is set very low, at 0.5 mg/L, to blunt algal growth in the receiving waters. In a land dispersal context, the level of phosphorus in the effluent is essentially meaningless. In soils with a sufficient clay content – the soils covering the candidate irrigation areas are dominated by the Gruene clay soil series – there is practically infinite capacity to “sorb” phosphorus, binding it into the soil materials, so that little if any phosphorus would leach out of the root zone and potentially migrate into environmental waters. Indeed, removing the phosphorus from the reclaimed water would remove a nutrient that would provide fertilizer to the turfgrass, so it is actually counterproductive to the proposed irrigation usage of this water.

It would be expensive to install equipment to remove phosphorus down to a level of 0.5 mg/L. Preliminary queries to a company that produces a “package” unit for this purpose, no doubt the type of equipment that would best serve this sort of small flow system, have not been answered to date, so the level of cost remains to be defined. Then too phosphorus reduction processes typically produce a sludge flow, which must be managed, so would increase the on-going O&M costs of the scalping plant as well. But again note that functionally whatever these costs may be would be wasted money, as phosphorus removal would serve no purpose, and would actually reduce the fertilizer value of the reclaimed water.

However, TCEQ has stated that, as long as none of the water produced by the treatment plant were actually discharged directly into a stream, the phosphorus removal process would not have to actually operate. TCEQ stated that the city’s obligation would be to report the pounds of phosphorus ***discharged***, so if there were no stream discharge, there would be no permit violation, without any regard to the actual phosphorus concentration of the effluent that is produced. It is not clear if that means a phosphorus reduction unit would not have to even be installed. So at present it is unknown what additional costs to remove phosphorus may be incurred in order for any proposed scalping plant to be implemented. That is a level of investigation that must be done if FoBH determines to further consider the scalping plant option in Phase 2 of this study.

3.2.3 Permitted Flow Rate of the Treatment Plant

Discussion with TCEQ indicates that, whatever the findings in regard to nutrient reduction, the City of Wimberley would have to submit a “minor amendment” to set the design flow rate for a scalping plant to something less than the final phase flow rate of 75,000 gpd listed in the current permit. A minor amendment was characterized as a rather “easy” regulatory process, so it is presumed that this would not present any significant barrier to using the current permit as the vehicle for approving a scalping plant.

3.2.4 Treatment Plant Operational Scheme

Regarding the operation of this treatment plant, the “normal” expectation is that a treatment plant would be fed and would treat ***all*** the wastewater running to it, or in this case to the lift station that routes wastewater into the treatment plant. As has been reviewed, in this case only a set amount, expected to be somewhat less than the flow running through the lift station, would be treated, and further that amount would be changed through the seasons, to match reclaimed water production required to provide irrigation demands in each season. Also, it is to be expected that a practical control system for this whole operation would allow “excess” reclaimed water to gather in and overflow the irrigation water holding tank at the end of the treatment unit, which may occur in any season when rainfalls reduce the demand for irrigation water. It would be proposed that this “excess” reclaimed water be allowed to flow back into the lift station, and so to flow along with the untreated water to the Aqua treatment plant.

It is important to understand that none of these arrangements violate the provisions of the agreement between the City of Wimberley and Aqua governing the delivery of wastewater from the City of Wimberley sewer system to the Aqua system, and on to its treatment plant. Aqua is committed to take a certain amount of wastewater that is classified as “domestic wastewater”, basically limiting the organic strength – BOD_5 concentration – of the wastewater. Clearly, any amount of water scalped and used to irrigate on BHRP could only ***reduce*** the total amount of wastewater delivered to Aqua, and if any “excess” reclaimed water were to drain back into the lift station, this could only ***reduce*** the organic strength of the whole wastewater flow running on by the lift station, so could only ***reduce*** the organic strength of the wastewater delivered to Aqua.

Still these arrangements are "strange" to TCEQ, so it remains to confirm that it would approve a treatment plant under a "regular" permit to operate as a scalping plant rather than in the manner "normally" expected. In discussion with TCEQ, it was acknowledged that these arrangements do not appear to explicitly violate any permit provisions. So it is expected that, upon further investigation, implementing a scalping treatment plant permitted under the City of Wimberley's current permit would be approvable. It is left to FoBH to determine whether to clarify this matter and pursue a scalping plant to be approved under the city's current permit in Phase 2 of this study.

4.0 SUMMARY OF FINDINGS

This Phase 1 report has reviewed the projected irrigation water demands that any "alternative" supply may have to provide, by what means that supply may be provided, and the institutional/regulatory matters that may impact on implementing any such supply. The findings are summarized below:

- Projected irrigation water demands calculated for the soccer fields, the Great Lawn, and the grounds of the proposed Nature Center show that the peak daily flow of an "alternative" water supply would have to be about 20,000 gallons/day if using subsurface drip dispersal, and about 26,000 gallons/day if using surface spray dispersal, presuming that the Great Lawn would be "routinely" irrigated.
- If it were presumed that the Great Lawn would be irrigated to alleviate drought stress only, the peak daily flow would have to be about 17,000 gallons/day if using subsurface drip dispersal, and about 23,000 gallons/day if using surface spray dispersal.
- Preliminary analysis indicates that the water needs of the proposed Nature Center could be met with a robust rainwater harvesting system off the rooftops of the Nature Center buildings. The projected peak daily irrigation demand for the Nature Center grounds is about 700 gallons/day if using subsurface drip dispersal – likely the choice for native landscaping – and about 950 gallons/day if using surface spray dispersal. Providing this flow with rainwater harvesting would reduce the peak daily flow volumes listed above that would need to be produced for irrigation of the soccer fields and Great Lawn from another source.
- It is likely that much of the toilet flush water demand in the proposed Nature Center could also be supplied by that rainwater harvesting system, and cistern overflows could replenish the proposed wetland on the Nature Center grounds, leaving only lavatory supply and the occasional backup water supply to be derived from the potable water system to fully supply the Nature Center's water demands.
- Toilet flush water in the pavilion restroom is currently being supplied by rainwater harvested off the pavilion roof, but no information was provided to evaluate the sufficiency of this practice, or if it may be extended or optimized to increase the rainwater supply.
- Rainwater harvesting off the rooftop of the office-bathhouse building is currently being used to irrigate the "entry garden" around that building, but no information was provided to evaluate the sufficiency of this practice, or if it may be extended or optimized to increase the rainwater supply, either to "better" irrigate the garden or to supply flush water in the bathhouse.
- The playscale restroom is presently supplied flushwater by the potable water system. No information on the volume of supply needed was provided, but it could be evaluated if rainwater harvesting could be implemented there to provide some of that supply.
- A reclaimed water supply could be created that would have sufficient capacity to supply the projected irrigation demands. It might be permitted under 321P, which would entail Aqua being at least the "figurehead" owner of the treatment plant to produce that water supply, or it might be covered by the current permit owned by the City of Wimberley.

- A reclaimed water supply system would entail significant investment for:
    - Installing facilities to draw water from the City of Wimberley sewer system and run it into the treatment plant;
    - Installing the treatment plant;
    - Installing the pipelines to run the reclaimed water to the points where irrigation is needed;
    - Installing the irrigation systems;
    - On-going O&M and electricity costs for the reclaimed water operation.
- Implementing the reclaimed water plant under the City of Wimberley permit would entail some uncertainties, which remain to be worked through, including:
    - Where the treatment unit may be located;
    - What quality of water the treatment unit would have to produce;
    - Modifying the permitted flow rate;
    - Clarifying if the operational scheme to run the system as a “sewer scalping” operation could be allowed.
- The degree of sustainability a reclaimed water system implemented at the park would impart rests on an evaluation of how efficiently this water would defray demands on the potable water system if this water were to flow on to the Aqua treatment plant, to be land applied there, vs. the projected amount this water would defray potable water demands at the park.
- A hauled in water supply might provide sufficient supply, but this option would be rather expensive, and it is unknown if that supply would be “sustainable”, or would simply be withdrawn from some other potable water supply system.
- Harvesting of rainwater at ground level off pavements appears not attainable because most of the parking lots are “paved” with gravel rather than impervious pavement, so gathering any appreciable volume of water appears to be infeasible.
- Withdrawing water from Cypress Creek to provide the irrigation water (and flush water?) supplies would put a relatively small dent in the creek flow under most conditions, but tapping the creek seems rather antithetical to the spirit of Blue Hole Regional Park, the centerpiece of which is the “Blue Hole”, which is Cypress Creek. It is also unknown if the City of Wimberley has water rights so that it could withdraw the water in any case. These are “waters of the state”, flowing into the Blanco River, which recharges the Edwards Aquifer, so all this water may already be “spoken for”.

FoBH is requested to review this information and determine which options for creating an “alternative” water supply to provide non-potable water supply to Blue Hole Regional Park are to be further evaluated in Phase 2 of this study.

BLUE HOLE REGIONAL PARK
"ALTERNATIVE" WATER SUPPLY FOR
NON-POTABLE WATER USES

Phase 2: Review of Options

Prepared for Friends of Blue Hole

by

David Venhuizen, P.E.
Planning and Engineering as if Water
and Environmental Values Matter

Upon reviewing the Phase 1 report, the Friends of Blue Hole (FoBH) directed that Phase 2 consider two options to provide irrigation water on Blue Hole Park:

1. Implement a treatment plant that would be installed by the City of Wimberley under the permit it currently has in hand, which was intended for a treatment plant to serve the broader community.
2. Implement a treatment plant that would be, nominally at least, owned by Aqua America/Aqua Texas (Aqua) under the program outlined in section 321P of the Texas Administrative Code.

Under either approach, a number of matters would need to be resolved in order to understand how a treatment plant would be practically implemented and operated. These matters are first reviewed, including a rundown on the status of the information needed to evaluate them. Then a "best guess" of how to proceed is laid out, and cost estimates for that course of action are offered. A review of the two regulatory pathways completes this report.

1.0 BASIC INFORMATION/DECISIONS

1.1 Treatment Unit Capacity

A most basic choice is the peak daily flow which the treatment unit would be designed to accommodate. Estimates of daily irrigation water demand for various areas on the park, based on ET rates, plant factors, and mode of irrigation, were set forth for each month in the Phase 1 report. FoBH has directed that the treatment unit is to be sized to provide irrigation water for the soccer fields and for the Great Lawn, and also added on that water to irrigate about 100 trees should also be considered. This usage had not been set forth to be evaluated in the Phase 1 effort, so there are no irrigation demand estimates for those trees. The peak rates calculated for the soccer fields and the Great Lawn are reviewed below:

If all irrigation were to be executed using subsurface drip dispersal:

- Soccer field peak water demand rate = 12,000 gpd
- Great Lawn peak water demand rate (routine irrigation) = 6,800 gpd

- Great Lawn peak water demand rate (“drought stress” irrigation only) = 4,500 gpd
- ➔ Total peak water demand rate = 18,800 gpd, if Great Lawn is to be routinely irrigated
- ➔ Total peak water demand rate = 16,500 gpd, if Great Lawn is to be “drought stress” irrigated only

If all irrigation were to be executed using surface spray dispersal:

- Soccer field peak water demand rate = 16,000 gpd
- Great Lawn peak water demand rate (routine irrigation) = 9,000 gpd
- Great Lawn peak water demand rate (“drought stress” irrigation only) = 6,000 gpd
- ➔ Total peak water demand rate = 25,000 gpd, if Great Lawn is to be routinely irrigated
- ➔ Total peak water demand rate = 22,000 gpd, if Great Lawn is to be “drought stress” irrigated only

Subsequent to further discussion, it was determined that soccer field irrigation would utilize subsurface drip irrigation, since in addition to imparting a significantly lower peak flow rate requirement the source water would be reclaimed water, and drip dispersal would sequester the water underground and so avoid potential for human contact. This would also allow the treatment quality to be what will routinely be produced by the type of treatment unit proposed, typically about 10 mg/L of BOD_5 and TSS, while also reducing the concentration of nitrogen in the effluent by more than half. While not explicitly noted, given the very same concern, it is presumed for this analysis that any irrigation on the Great Lawn would also be executed through subsurface drip irrigation.

Therefore, the preliminary estimate of the required peak capacity of the treatment unit as listed above is in the range of 16,500 to 18,800 gpd. While the ET-based estimates of irrigation demand for the soccer field are an accurate reflection of that peak flow requirement, the situation on the Great Lawn is less clear cut, and the additional irrigation requirements for the trees noted above are undefined.

In the agreement for this investigation, FoBH stated this requirement for irrigation relating to the Great Lawn: “Identify the area(s) for which water would be provided temporarily to establish new plantings, such as the proposed Great Lawn, and/or to maintain plantings through extended drought.” And in setting forth its expectations of irrigation water needs, the City of Wimberley Parks and Recreation Department (PARD) stated: “Great Lawn – for 2022, native sod.” That implies the turf would be a seed mix like Habiturf, created and vended by the Lady Bird Johnson Wildflower Center, or Native Sun Turf or Thunder Turf, available from Native American Seed. These seed mixes are dominated by buffalo grass, which is widely reputed to be able to thrive with less irrigation than more “traditional” turfgrasses. Native American Seed asserts in its catalog that their turfs require “NO extra watering once established”, noting there is no definition of what “extra” means.

These stipulations and understandings appear to leave it rather open whether it is intended that the Great Lawn is to be “routinely” irrigated, thus the estimates of peak demand set forth above would be the best estimate of the need, or “drought stress” irrigated only, in which case lesser amounts of irrigation water may be demanded, expected to be lower than the “drought stress” peak flow calculated in Phase 1. The intentions here have not been clarified.

In any case, regarding plant establishment irrigation, planting in central Texas, for turf and ornamental plants, “should” be done mid-fall to mid-spring, so getting the plants initially established would require irrigation supply outside of the peak irrigation season, when irrigation requirements for the soccer fields would be well below the peak demand. So irrigation for initial plant establishment only would not impact on the peak capacity required for any treatment unit.

It was also asserted that some “development” is planned on the Great Lawn, including an “amphitheater”. It is called to question if such development would reduce the area needing irrigation, and to what degree. This has not been clarified.

Regarding the 100 or so trees noted above, no information was provided on what size(s) of trees are to be planted, and only a general idea of where they would be planted. As the amount of water needed for establishment irrigation would vary with tree size, and the siting of the trees may impact on their irrigation needs, the amount of water needed for tree establishment irrigation is indeterminate. Guidance indicates that establishment irrigation for new trees is expected to be required for the first 2-3 years after planting, so establishment irrigation would be needed through the peak irrigation period for 2-3 years, thus adding to the peak period treatment plant capacity that would be required over that time period. Then too the actual irrigation water demand would depend on rainfalls during the peak period, further calling to question what amount of peak capacity should be available for tree establishment irrigation. Note again this is a demand that will “go away” after the first 2-3 years.

As to the volume of water that tree establishment irrigation might require, first understand that the preferred time to plant a tree in central Texas is during the late fall to early spring, which is outside the period when the treatment unit would need to produce the peak irrigation water supplies. A City of Austin document sets forth that after the first couple weeks, trees would require something like 5 gallons per week per inch of trunk diameter, with the recommended watering frequency being once every two weeks in the “growing season”. As noted, with no size(s) of the trees to be installed having been specified, any estimate of total water demand for tree establishment irrigation is rather indeterminate.

However, it is clear that, relative to the other irrigation demands being considered, the peak daily requirement for tree establishment irrigation would be very low. For example, assuming all the trees have a 2-inch diameter trunk, the water requirement would be 10 gallons per week per tree, or less than 1.5 gpd per tree. So for 100 trees, the daily water demand would be only about 150 gpd. However, as each tree would nominally be watered biweekly, the peak flow required on any given day may be more like 15 gpd, assuming watering would be conducted on the ten weekdays only. Given that this irrigation would need to be regularly done for only 2-3 years, it may be called into question if installing an irrigation water distribution system to get water to these trees, rather widely dispersed over a part of the park, is merited. Rather, it may be that “hand watering” would be the cost efficient course of action over that 2-3 year establishment period, even though that would entail a labor cost.

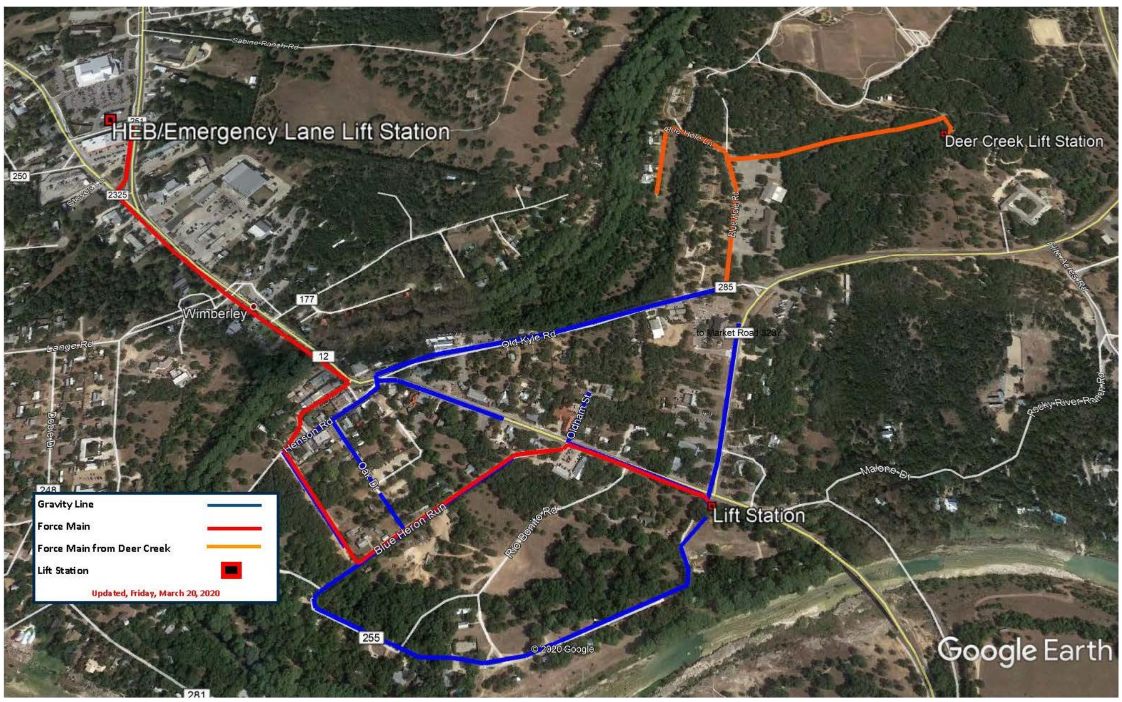
Returning to the determination of peak daily flow to be provided, the irrigation demand estimates for the soccer fields presumed a crop coefficient of 0.8 for “sports turf”, which provides a level of maintenance “higher” than for “normal” warm season turf, for which the crop coefficient would be 0.6. Those estimates also presumed a plant quality adjustment factor of 0.6, imparting a “normal” quality of turf maintenance. Clearly there is ample “space” to reduce the irrigation demands on the soccer fields, to allow the turf quality to degrade some, if the water were to be needed during the peak irrigation period to provide water for “drought stress” irrigation of other areas. Changing the crop coefficient from “sports turf” to “normal” warm season turf would reduce the peak period irrigation demand for the soccer fields from about 12,000 gpd to about 9,000 gpd. Reducing in addition the plant quality adjustment factor to 0.5, reflecting “low” quality maintenance, would reduce the peak period demand for the soccer fields to about 7,500 gpd. This indicates that, depending on how high a quality it will be desired to maintain the soccer field turf, there may be considerable “slack” in the irrigation water requirements through the peak irrigation period.

Taking all these factors into account, it is suggested that the nominal capacity of the treatment unit be 15,000 gpd. This provides capacity to “fully” irrigate the soccer fields through the peak irrigation season with 3,000 gpd “left over” to provide drought stress irrigation over other areas through the peak irrigation season. As noted, if found to be critically needed, the soccer field turf could be left to “stress” a little more, freeing considerable flow to blunt drought stress over the Great Lawn, or other areas.

Complicating this matter, this study was belatedly informed that the total wastewater flow through the Deer Creek lift station, the “nominal” extraction point to feed wastewater to the treatment unit, does not exceed 10,000 gpd. So a strategy would be to size the treatment unit for that flow rate and obtain whatever irrigation benefit can be derived from it. As just reviewed, if the soccer field turf quality were allowed to “degrade” some, 10,000 gpd would cover soccer field irrigation through the peak irrigation season, with some water available for drought stress irrigation in other areas. This strategy will be explored in Section 2.

1.2 <u>Point of Wastewater Extraction</u>

As just noted, the presumed point where wastewater would be extracted from the City of Wimberley sewer system, to be treated to provide irrigation water supply, is the Deer Creek lift station, which lies just to the north of the Deer Creek Nursing Home, as shown on Figure 1. It has not been clarified if this lift station lies on park property, but since it is in place, it is presumed there would be no issues installing equipment at that site to extract wastewater and pump it to a treatment unit. As also just noted, however, daily flow through this lift station is currently insufficient to provide the flow rate set by the suggested peak capacity of the treatment unit, 15,000 gpd.



City of Wimberley Sewer System
Figure 1

While the operator of the current treatment plant that receives flow from the Deer Creek lift station has stated that in his experience the flow rate has not exceeded 10,000 gpd – it has been in the range of 8-10 thousand gpd, per his report – investigation of the Deer Creek Nursing Home informs that it has a bed (person) capacity of 122, but that it currently serves only 70 nursing home residents. This implies that, in the future, the flow produced from the nursing home could increase. If it were to increase in proportion to the number of beds occupied, the flow might increase by as much as ~75% (122/70) if the nursing home were to operate at full occupancy. This would provide sufficient flow for the suggested treatment unit capacity of 15,000 gpd. The nursing home operator should be queried about its business prospects, thus the prospect that the flow it routes through the lift station may be expected to increase.

If the flow rate through the Deer Creek lift station does remain at the current/historic level, and that is deemed inadequate to “properly” irrigate the soccer fields and Great Lawn (and perhaps provide for tree establishment), it is an open question where an extraction point where sufficient flow occurs may be. Examining the City of Wimberley sewer system map in Figure 1, no “obvious” location where the extraction could occur “near” Blue Hole Park can be seen. It would remain for the City of Wimberley to identify any other suitable extraction point.

1.3 <u>Location of the Treatment Unit</u>

During the initial reconnoiter of the park with PARD, the parks director identified an area near the maintenance buildings as a candidate for the treatment unit location. This area is on grounds presently being used for materials storage, so which are already somewhat “disturbed”. That site is shown on the park map in Figure 2. This location is a short distance from the Deer Creek lift station, and right along a route from the lift station to the soccer fields and Great Lawn, so appears to be a very expeditious choice.

Blue Hole Regional Park Facilities
Figure 2

FoBH has asserted that the conditions of a grant preclude locating a new wastewater treatment plant on the Blue Hole Park property. While no explicit showing of the park property boundary has been provided, it is rather sure that the site by the maintenance facilities is on that property. The City and FoBH are therefore urged to investigate the conditions of the grant purported to impart the restriction noted. It may be speculated that the purpose of such a prohibition would have been to prevent park property from being co-opted to house a treatment plant that would serve the broader community, perhaps perceiving that the activated sludge plant being contemplated as the City of Wimberley treatment plant would be noisy, odiferous, and otherwise obtrusive, a detriment to the park experience. In this case, however, the treatment plant would be dedicated to providing irrigation water on the park only, and as reviewed in the Phase 1 report, would be of a type that would not be obtrusive, producing no noise or odors, and having a rather “minimal presence”, with the only facilities in view above the ground surface being tank hatches and the sealed filter bed units.

Two other locations were suggested for the treatment unit: (1) The area where it was proposed to house the City of Wimberley treatment plant, seen as the denuded area toward the right side of Figure 2, or (2) Where an existing treatment plant, to be abandoned, is sited, also shown on Figure 2. FoBH asserted that some land swap was, or was to be, executed so that one of these areas would no longer be on park property. It has not been made clear if this swap occurred, or which property does/did lie on park property before the swap.

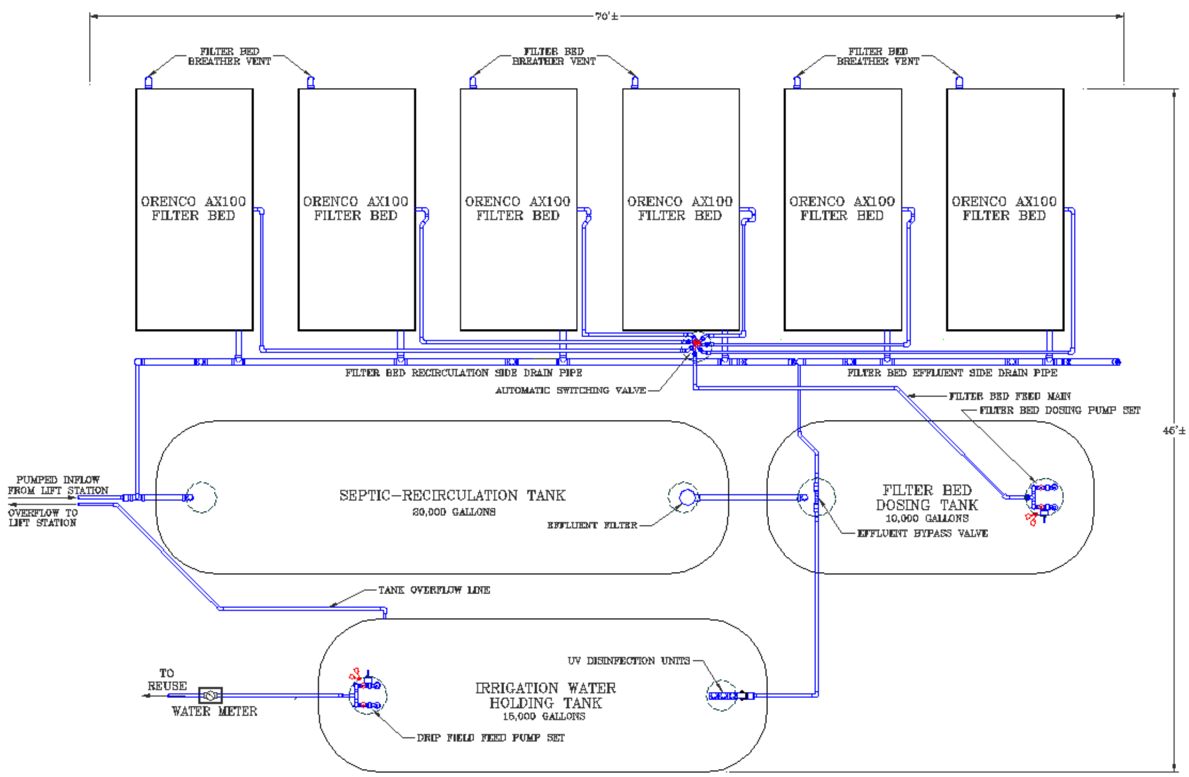
As Figure 2 shows, neither of these other sites is as conveniently located as is the site by the maintenance buildings, presuming that the lift station would be the point of extraction. But indeed, if the point of extraction were to be somewhere further "down the line" in the Wimberley sewer system, both of these sites would be a further distance from any such point than would be the site by the maintenance buildings. In either case, these other locations would create the need for a somewhat longer pipe to feed the wastewater from the extraction point to the treatment plant site, and for a somewhat longer "overflow" pipe to drain water back to the extraction point – see explanation of that pipe in the following section.

1.4 Treatment Unit Design

As reviewed in the Phase 1 report, the best choice for treatment unit technology is a variant of the recirculating packed-bed filter system labeled the high performance biofiltration concept. The layout of that sort of treatment unit, sized for the initially suggested peak flow rate capacity of 15,000 gpd, is illustrated in Figure 3. The unit would consist of:

- A septic-recirculation tank, preliminarily sized at 20,000 gallons;
- A filter bed dosing tank, preliminarily sized at 10,000 gallons;
- An irrigation water (final effluent) holding tank, preliminarily sized at 15,000 gallons;
- Six Orenco AX100 filter beds, each having a design flow rate capacity of 2,500 gpd, for a total capacity of 15,000 gpd.

As Figure 3 shows, the footprint of this treatment unit would be about 70 feet by 45 feet. This could be fit generally in the clearing where materials are presently being stored just to the east of the maintenance buildings. It would also readily fit on either the site intended for the City of Wimberley treatment plant or the site of the existing treatment plant that is being abandoned.

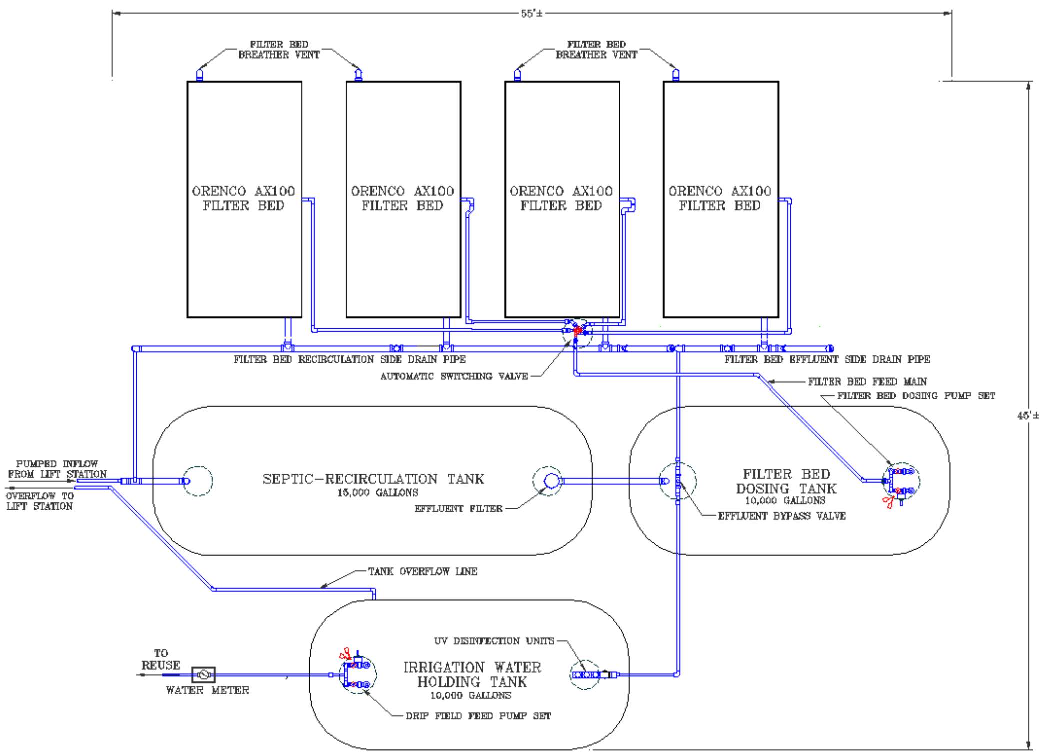


15,000 GDP Treatment Unit General Layout Plan
Figure 3

In the event it is determined to “mine” the Deer Creek lift station for whatever flow could be obtained from it, it appears that the “appropriately” sized treatment unit would be a capacity of 10,000 gpd. The layout for a treatment plant of that size is shown in Figure 4. The unit would consist of:

- A septic-recirculation tank, preliminarily sized at 15,000 gallons;
- A filter bed dosing tank, preliminarily sized at 10,000 gallons;
- An irrigation water (final effluent) holding tank, preliminarily sized at 10,000 gallons;
- Four Orenco AX100 filter beds, each having a design flow rate capacity of 2,500 gpd, for a total capacity of 10,000 gpd.

As Figure 4 shows, the footprint of this treatment unit would be about 55 feet by 45 feet. This could be even more readily fit into the area near the maintenance buildings, or into either of the other two locations identified as potential treatment unit locations.



10,000 GDP Treatment Unit General Layout Plan
Figure 4

Using either treatment unit, wastewater would be fed by a duplex pump system from the Deer Creek lift station (or other suitable extraction point) into the septic-recirculation tank. The water would flow through that tank, allowing any sludge to settle, and out through an effluent filter, to minimize the carryover of solids into the filter bed dosing tank. A duplex pump system in the filter bed dosing tank would intermittently dose wastewater onto the filter beds, running through an automatic switching valve that would switch the flow among the filter beds, dose by dose.

In the 15,000 gpd treatment unit, four of the 6 filter bed units would compose the “recirculation side” of the filter bed system. In the 10,000 gpd treatment unit, 3 of the 4 filter beds would compose the “recirculation side”. Water dosed onto those filter beds would recirculate back into the septic-recirculation tank, and so run back through the system. The other 2 filter bed units in the 15,000 gpd unit, or the 4th filter bed in the

10,000 gpd unit, would compose the "effluent side" of the filter bed system. Water dosed onto those filter beds would run to the effluent bypass valve.

If the water level in the filter bed dosing tank were up into the "equalization volume" of the filter bed dosing tank – the volume reserved for storage of surge flows into the treatment unit – the effluent bypass valve would be closed, and so the flow from the effluent side filter beds would pass on through to the irrigation water holding tank. If flow into the system were lower than the design flow rate, water level in the filter bed dosing tank would drop to the point the effluent bypass valve opened, and the underflow from the effluent side filter beds would drop back into the filter bed dosing tank. By opening up this second recirculation pathway, the filter bed dosing tank could never "run out of water", so that the filter bed dosing cycle would never be interrupted. This allows the filter beds to be loaded at hydraulic steady state, receiving the same flow on the same schedule every day, regardless of how little or how much flow were to enter the system each day. This assures that the filter beds operate at high efficiency, so imparting stability to the treatment process.

It is noted that, since wastewater would be fed to the treatment unit by pumps, which may also flow at the same rate on the same schedule every day, flow into the treatment unit may already be highly flow equalized. If this were the case, little equalization volume would be required in the filter bed dosing tank, perhaps allowing it to be somewhat downsized, and minimizing the amount of time the effluent bypass valve might be open. Again, the system would operate at hydraulic steady state, imparting stability.

The treated (reclaimed) water would flow into the irrigation water (final effluent) holding tank through a UV disinfection unit, to provide enhanced bacterial/viral removal, deemed to be prudent even though the water would be dispersed subsurface in the drip irrigation fields. The water would be held in that tank until the irrigation controller turns on a drip irrigation field feed pump in the duplex pump set installed in that tank, which would run the reclaimed water into the drip field, zone by zone.

Ideally the treated effluent could also "overflow" back into the lift station. As noted, flow ***out of*** the treatment unit, to the irrigation systems, would be run by an irrigation controller, which would be independent of the controller running the pumps feeding wastewater ***into*** the treatment unit. With this overflow provision, in the event of rain, reducing the demand for irrigation water, the flow to the plant would not have to be modulated in real time, rather flow into the treatment unit could remain constant (likely set each month as required to provide the expected irrigation water demand in that month), and any "excess" reclaimed water would simply re-enter the sewer via the irrigation water holding tank overflow line, going back into the lift station to flow on to the Aqua treatment plant. With this scheme, control of flow rates into and out of the treatment unit would be relatively simple.

This highlights that another characteristic of the treatment unit location is that it "should" be at a higher elevation than the lift station, so that gravity flow from the irrigation water holding tank back to the lift station can be maintained. Visual inspection has confirmed that the location near the maintenance buildings is upslope from the lift station, and it appears that the site of the treatment plant to be abandoned is also. Lacking any elevation information over the park and environs, it cannot be determined if the site where the City of Wimberley treatment plant was to be located is at or above the lift station elevation. The City of Wimberley has asserted that it is. If it is not, and it were determined the treatment unit must be located there, the flowback would have to be actuated by a pump system in the irrigation water holding tank, an additional cost and complication.

2.0 PROPOSED COURSE OF ACTION

Taking into account all the factors bearing on this matter, to the extent they are known at this point, the recommended course of action is to "mine" the Deer Creek lift station for whatever flow could be derived from it, and to install a 10,000 gpd treatment unit, to match the currently observed flow rate through the

Deer Creek lift station. This is informed by there being no readily apparent point of extraction in the City of Wimberley sewer system downstream of this lift station, where a higher flow rate may be available for extraction, that might be within "reasonable" proximity of the optional treatment unit locations and the areas proposed to be irrigated on Blue Hole Park.

It would be a task for the City of Wimberley to propose any such other extraction point, a task it has at this point declined to take on. If such a point can be identified, and the costs of the transfer facilities from that point to the park would be deemed "affordable", then it would be recommended to install a 15,000 gpd treatment unit, to allow the soccer fields to routinely be irrigated at the "higher" level indicated by the ET-based irrigation demand calculations.

It is recommended that the management of the Deer Creek Nursing Home be queried about its future business prospects. It was noted that the current population of that nursing home is well below its listed total bed capacity, implying that this facility may generate more flow. If it were found that the nursing home's business prospects do forecast a larger resident population in the future, installation of a 15,000 gpd treatment unit may be contemplated to avail the park of that additional irrigation supply.

Regarding the treatment unit location, it is recommended that, if possible, it be installed on the site near the park maintenance buildings, as that is the most "efficient" location. As was reviewed above, this would hinge on whether the grant stipulations asserted by FoBH that prohibit locating a new wastewater treatment plant on Blue Hole Park property can be worked around.

The second choice location for the treatment unit is the site of the existing treatment plant, to be abandoned. This site would be preferred to the City of Wimberley treatment plant site, shown as the denuded area on Figure 2, because it is located closer to the areas to be irrigated, so reducing the run of pipelines to get the reclaimed water into the irrigation systems. With the existing treatment plant at that location, electric feed to that location already exists. While that cost factor is not evaluated in this report, it is sure that this would impart a cost saving of locating the treatment unit at that location. Noting the previous discussion of a land swap entailing the current treatment unit location, the ability to use that site may depend on the ownership status of that property.

The City treatment plant site would be the third choice, if circumstances eliminate the other two sites from consideration. This site is more "out of the way" than the other two options, increasing the costs of pipelines from any extraction point to this site, and the costs of pipes to feed and flush the drip irrigation systems. As just noted, extending electric feed to this site would also be somewhat more costly than it would be for either of the other two locations. However, if institutional "convenience" – e.g., the grant conditions noted previously – outweighed any of these cost factors, then the City treatment plant site may be the "best" choice.

3.0 COST ESTIMATES AND FISCAL ANALYSIS

Reviewed in this section are cost estimates to implement the extraction, conveyance, treatment and irrigation systems that would be needed to implement the "sewer scalping" strategy to provide a sustainable irrigation water supply for Blue Hole Park. Table 1 shows the cost estimate for a 15,000 gpd treatment unit, and the cost estimate for a 10,000 gpd treatment unit is displayed in Table 2.

At a bottom line price of $462,300, a 15,000 gpd treatment unit has a cost per gpd of $30.82. For a 10,000 gpd treatment unit, at a bottom line price of $340,300, the cost per gpd is $34.03. These are well above a frequently quoted figure of $25/gpd for installations of this sort of treatment unit. It is noted that the presumed installation cost is 100% of the materials costs. Orenco reports that installation cost is generally expected to be in the range of 60-80% of materials costs for this sort of treatment unit. Local experience has been quite different. The installation costs of the Wimberley ISD Blue Hole Elementary School treatment unit, for example, were well above 100% of materials costs. Given the "unsettled" nature of supply chains and labor conditions, the installation cost is somewhat of a "wild card" in these estimates.

Table 1

Cost Estimate for 15,000 gpd Treatment Unit				
Item Description	Quantity	Units	Unit Price	Total Cost
Septic-recirculation tank	20,000	gallon	$ 2.00	$ 40,000.00
Filter bed dosing tank	10,000	gallon	$ 2.00	$ 20,000.00
Irrigation water holding tank	15,000	gallon	$ 2.00	$ 30,000.00
Filter bed dosing pump system	1	L.S.	$ 7,500.00	$ 7,500.00
Effluent bypass valve assembly	1	L.S.	$ 150.00	$ 150.00
Automatic switching valve assembly	1	L.S.	$ 250.00	$ 250.00
Irrigation water feed pump system	1	L.S.	$ 7,500.00	$ 7,500.00
Orenco AX100 filter bed	6	each	$ 20,500.00	$ 123,000.00
UV disinfection unit	1	L.S.	$ 2,500.00	$ 2,500.00
Treatment unit general piping	1	L.S.	$ 250.00	$ 250.00
	Total treatment unit materials cost =			$ 231,150.00
Presume installation cost = materials cost => Installation cost =				$ 231,150.00
	Total cost of treatment unit =			$ 462,300.00

Table 2

Cost Estimate for 10,000 gpd Treatment Unit				
Item Description	Quantity	Units	Unit Price	Total Cost
Septic-recirculation tank	15,000	gallon	$ 2.00	$ 30,000.00
Filter bed dosing tank	10,000	gallon	$ 2.00	$ 20,000.00
Irrigation water holding tank	10,000	gallon	$ 2.00	$ 20,000.00
Filter bed dosing pump system	1	L.S.	$ 7,500.00	$ 7,500.00
Effluent bypass valve assembly	1	L.S.	$ 150.00	$ 150.00
Automatic switching valve assembly	1	L.S.	$ 250.00	$ 250.00
Irrigation water feed pump system	1	L.S.	$ 7,500.00	$ 7,500.00
Orenco AX100 filter bed	4	each	$ 20,500.00	$ 82,000.00
UV disinfection unit	1	L.S.	$ 2,500.00	$ 2,500.00
Treatment unit general piping	1	L.S.	$ 250.00	$ 250.00
	Total treatment unit materials cost =			$ 170,150.00
Presume installation cost = materials cost => Installation cost =				$ 170,150.00
	Total cost of treatment unit =			$ 340,300.00

Table 3 displays the cost estimates for extraction and transfer facilities from the Deer Creek lift station to a treatment unit located near the park maintenance buildings. At a bottom line price of $22,600, this would be a relatively minor contribution to the overall costs of all the required facilities. As seen in Table 3, the run-of-pipe distance from the lift station to this treatment unit site was measured at 450 l.f. Note that a feed pipe and a drainback pipe would be installed. The $25/l.f. cost factor represents the basic installed cost for trenching and installing the feed pipe. The drainback pipe would simply be a second pipe dropped into that same trench, so its installed cost estimate of $3 per l.f. is considerably lower.

Table 3

Cost Estimate for Wastewater Transfer Facilities

Item Description	Quantity	Units	Unit Price	Total Cost
Duplex pump unit & control system	1	L.S.	$ 10,000.00	$ 10,000.00
Wastewater feed pipe to treatment unit	450	l.f.	$ 25.00	$ 11,250.00
Effluent drainback pipe to lift station	450	l.f.	$ 3.00	$ 1,350.00
	Total transfer facilities cost =			$ 22,600.00

To reach the treatment unit site where the existing treatment plant sits, the measured run-of-pipe was 1,190 l.f. by the most direct route, along pathways through the woods. This would increase the price of these facilities by (1,190 – 450 =) 740 l.f. x $28/l.f. = $20,720, almost doubling the cost of this component of the facilities. If it were determined that theses pipes must run along the paved pathways rather than running “cross country”, the measured run-of-pipe length would be about 1,850 l.f. That would impart an added cost of (1,850 – 450 =) 1,400 l.f. x $28/l.f. = $39,200, close to tripling the cost of this component of the facilities.

To reach the treatment unit site that would lie upon the City of Wimberley treatment plant site, the measured run-of-pipe was 1,200 l.f. along the most direct line, and was 1,700 l.f. if it followed the paved pathway. In the former case, the additional estimated cost would be (1,200 – 450 =) 750 l.f. x $28/l.f. = $21,000, almost doubling the cost of the transfer facilities. In the latter case, the additional cost would be (1,700 – 450 =) 1,250 l.f. x $28/l.f. = $35,000, making this cost to reach this site about 2.5 times the cost to reach the recommended treatment unit location.

The cost estimate of the drip irrigation system for the soccer fields, including the facilities to deliver the reclaimed water from the treatment unit to the drip field entry, is shown in Table 4. Here too the installation costs of these facilities is guessed at equal to the total materials costs. This is the expectation offered by Geoflow, the vendor of the drip hose recommended to be used in this drip irrigation system.

Table 4

Cost Estimate for Soccer Field Drip Irrigation System

Item Description	Quantity	Units	Unit Price	Total Cost
Drip hose	110,000	l.f.	$ 0.40	$ 44,000.00
Zone entries	30	each	$ 200.00	$ 6,000.00
Flush valve assembly	30	each	$ 100.00	$ 3,000.00
Header pipe assembly	1	L.S.	$ 1,000.00	$ 1,000.00
Feed pipe to soccer fields	500	l.f.	$ 20.00	$ 10,000.00
Flush return pipe to treatment unit	750	l.f.	$ 3.00	$ 2,250.00
Irrigation controller	1	each	$ 2,500.00	$ 2,500.00
Total soccer field drip system materials cost =				$ 68,750.00
Presume installation cost = materials cost => Installation cost =				$ 68,750.00
Total installed cost of soccer field drip system =				$ 137,500.00

Note however that this expected installation cost also covers the installation of the drip field feed and flush pipes, while the cost factors in Table 4 are expected to reflect the installed cost of those components. So the bottom line price shown in Table 4 may be a bit inflated.

At a total estimated installed cost of $137,500, the installed cost works out to a price of about 85 cents per sq. ft. of field area over the estimated 162,800 sq. ft. of drip field area. As just noted, this covers the delivery pipe as well as the drip lines and their appurtenances. Given the rather "vanilla" nature of the installation, with long, uninterrupted runs of drip hose that can be readily "plowed in" over the existing field area, this is deemed to be a reasonable cost estimate for these facilities. The number of zones is a "best guess", depending on the peak flow rate that could be provided by the pumps, but as can be seen in Table 4, changing the number of zones by a few either way would have a rather small impact on the bottom line cost estimate.

The price in Table 4 reflects the estimated cost if feeding the drip irrigation field from the recommended treatment plant location, next to the park maintenance buildings. The measured length of the pipeline from that location was 500 l.f. A feed pipe from the treatment unit irrigation water holding tank to the drip field entry and a flush return pipe to the treatment unit septic tank would be required. As with the transfer pipes, a "basic" cost for trenching and installation of one pipe is reflected by the price estimate of $20/l.f., and the cost of dropping a second pipe into the same trench is estimate at $3/l.f.

For a treatment unit located at the site of the existing treatment plant, the measured run-of-pipe to and from the plant site is 1,000 l.f. This would impart a price increase of (1,000 – 500 =) 500 l.f. x $23/l.f. = $11,500. For a treatment unit located at the City treatment plant site, the measured run-of-pipe to and from the plant site is 1,400 l.f., assuming those lines could be run "cross country" in a fairly direct line to the irrigation areas. That would impart a price increase of (1,400 – 500 =) 900 l.f. x $23/l.f. = $20,700.

Due to the rather indeterminate nature of the irrigation program for the Great Lawn, no explicit estimate of the cost of an irrigation system for that area was prepared. On the basis of their proportional areas, it may be expected that a "full" drip irrigation system over the entire Great Lawn area would run about 75% of the cost of the soccer field irrigation system, yielding an estimate of about $103,000 for that installation. To reach the Great Lawn, length of the feed and flush pipes from and to the recommended treatment unit site would be increased by about 600 l.f., at an estimated cost of 600 l.f. x $23/l.f. = $13,800. For the other two potential treatment unit locations, the feed and flush pipes would already run by the Great Lawn to reach the soccer fields, so there would be no additional pipeline costs for those options.

Table 5 provides a summary of the installed costs of the nominally recommended system, including extraction from the Deer Creek lift station, transfer to the treatment unit site by the park maintenance buildings, a 10,000 gpd treatment unit, and subsurface drip irrigation reuse systems over the soccer fields and the Great Lawn. The basic bottom line cost for that "nominal" system is $620,200. As noted throughout this section, various add-on costs would be incurred if the treatment unit were to be located at another site, and the treatment unit cost would be considerably larger if a higher peak rate capacity were deemed to be required.

To provide a rough fiscal analysis of what the effective cost of water would be if this system were to be implemented on Blue Hole Park, the annual volume of irrigation water produced over 20 years is divided into the bottom line cost shown in Table 5. In this analysis, only the water demand for the soccer fields is considered, given that the costs in Table 5 cover only a 10,000 gpd treatment unit capacity. In determining the annual volume of water produced, the daily demands shown in Table 1 in the Phase 1 report were first limited to 10,000 gpd through the summer peak irrigation season. Then the total volume that would be produced in each month is calculated and the monthly totals added. The annual total adds up to 2,741,757 gallons. Over 20 years, the total water produced would be 54,835,140 gallons. Dividing this into $620,200, this yields a cost of this water of about 1.13 cents per gallon, or about $11.31 per thousand gallons.

Table 5

Cost Summary for Nominally Recommended System		
Item Description		Total Cost
Extraction and transfer facilities	$	22,600
10,000 gpd treatment unit	$	340,300
Soccer field effluent feed and irrigation system	$	137,500
Great Lawn effluent feed and irrigation system	$	119,800
Total installed cost of system	**$**	**620,200**

Note that this evaluation does not take account of annual O&M costs to run this system, nor does it deduct the amount of water which would ***not*** be demanded, thus would not be produced, through rainy spells. So this price of over $11 per thousand gallons is lower than what would actually be incurred. Despite that, it is considerably higher than the prevailing price of potable water in Wimberley. For example, customers of the Wimberley Water Supply Corporation are charged a “basic” block rate of $3 per thousand gallons (for up to 6,000 gallons per month), and the highest block rate (for over 36,000 gallons per month) is $7 per thousand gallons. These prices do not reflect the total cost of water, however, as there is a fixed monthly charge, based on meter size, in addition to the volumetric charges. Still the effective cost of potable water in Wimberley right now is somewhat lower than even this low estimate of the effective cost of water that would be produced by the Blue Hole Park irrigation water supply system.

Those prices of course reflect the historic cost of water, the cost of producing and delivering local groundwater. If in the future other sources of water must be developed, the price of that water is certain to be higher, perhaps much higher, than these historic costs. For example, a study done several years ago of piping in water from San Marcos indicated a water price of at least $10 per thousand gallons – which would be higher now, given inflation and the increasing cost of the basic source water – even though the cost of treating that water was not included in that price. It is therefore not at all unlikely that water that would be produced by the Blue Hole Park system would be somewhat cost competitive with the future cost of water in the Wimberley area. As reviewed in section 5, a more refined analysis is required to evaluate this.

4.0 REGULATORY PATHWAYS

As noted at the beginning of this report, there are two potential regulatory pathways for implementing this “sewer scalping” scheme. One would utilize the City of Wimberley’s existing permit, originally obtained to allow it to install a treatment plant to serve the area of Wimberley between Cypress Creek and the Blanco River. This would allow the City to unilaterally implement this strategy. The other pathway would be to use section 321P, which is aimed at exactly this sort of sewer scalping scheme, but assumes that the owner-operator of any scalping plant would be the owner-operator of the entity that holds the permit for the treatment plant to which this wastewater, if not “scalped”, would have flowed. That pathway would require that Aqua be a participant. Each of these pathways is further reviewed below.

4.1 City of Wimberley Permit

The existing City of Wimberley wastewater permit – TPDES Permit No. WQ0013321001 – contains a provision for an “Interim Phase” and a “Final Phase”. Modifying and using this permit under either of those provisions is a possibility that may be considered. The “Interim Phase”, allowing the treatment plant to produce up to 9,450 gpd of effluent, to be dispersed in a subsurface field, was intended to allow the existing treatment plant to continue to operate for a period until the “Final Phase” treatment plant could be built. That “final” treatment plant was permitted to discharge to surface waters, nominally into Deer Creek, but it was anticipated that a "210" reuse permit would also have been obtained, to allow that water to be routed to serve irrigation demands instead of being discharged.

Based on discussions with TCEQ, it is expected that to be able to adapt this permit, under either the "Interim Phase" or "Final Phase" provisions, the City of Wimberley would have to submit and get approved one or more "major amendments" to this permit. In the case of the "Interim Phase", the amendments would have to address these factors:

- Unless it were deemed "sufficient" to accept the 9,450 gpd as the peak capacity of the scalping plant, the permit would need to be amended to increase the "Interim Phase" flow limitation, to whatever the desired capacity were deemed to be.
- Unless it were deemed "okay" to continue to use the activated sludge treatment unit – presumed to be what is in place at the existing treatment plant now – the permit would need to be amended to specify the high performance biofiltration treatment unit. For the reasons reviewed in the Phase 1 report, using the activated sludge treatment process is not recommended in any case, but in this case nothing is known about the condition and longevity of the existing treatment unit, so it is anticipated that this amendment would be needed to use the "Interim Phase" provisions of this permit to implement the sewer scalping scheme.
- The permit specifies that the effluent be disinfected with chlorine. This is strongly not recommended for water that would be continuously applied to maintain turf at a good to high quality, due to the impact of chlorine in the soil. As was noted, it is recommended to employ UV disinfection of the irrigation water supply to be produced by the scalping plant. This will require a permit amendment.
- The permit specifies that the effluent is to be dispersed – dimly styled as "dispose of" in the permit – in "eleven (11) pressure dosed absorption beds with a minimum area of 94,500 square feet of non-public access land in the Interim I phase and public access land in the Interim II phase. Application rates shall not exceed 0.1 gallons per square foot per day." This entails the following factors:
    - As was reviewed under cost estimates, just the soccer field irrigation system is certain to entail more than 11 zones. So that provision would need to be modified.
    - While a subsurface drip irrigation system could quite fairly be styled as a "pressure dosed absorption bed", that term generally describes a quite different sort of dispersal system. So it is an open question if the permit would need to be amended to explicitly specify subsurface drip irrigation as the mode of dispersal of the effluent.
    - Given that the soccer fields by themselves cover an area nominally measured at 162,800 sq. ft., the specified minimum area of 94,500 sq. ft. does not appear to be an issue. However, the irrigation systems receiving the reclaimed water from a scalping plant would all be on "public access land". So it would have to be clarified what differentiates the "Interim I phase" from the "Interim II phase", and so what, if anything would need to be amended to clarify that the reclaimed water produced by the scalping plant could be dispersed on public access land.
    - While the ET-based tables estimating irrigation water demands presented in the Phase 1 report for this project show that the field loading rate would not be in excess of 0.1 gal./sq. ft./day, specified as the maximum application rate in the permit, it is understood that the plant addressed by this permit is presumed to be dispersing all of the water it is permitted to receive all throughout the year. It is expected that this 0.1 gal./sq. ft./day limitation is taken from Chapter 222, governing subsurface drip irrigation dispersal fields, based on that presumption. In this case, the aim would be to satisfy the actual irrigation demand through the year. It should be considered that this permit be amended to incorporate that understanding.

In order to use this permit under the "Final Phase" provisions, these matters would have to be addressed in the amendment process:

- The effluent set required out of the "Final Phase" treatment plant is aimed at blunting the impacts of the effluent on receiving waters if this water were to be discharged to surface waters. They are all quite "excessive" for dispersal in a subsurface drip irrigation field, especially one loaded at the ET-based irrigation demand rate throughout the year.

  - Beyond basic secondary treatment – required to protect the drip system from emitter clogging in any case – the only effluent parameter that may have any real meaning for this drip dispersal scheme would be ***total*** nitrogen, which is not even addressed in this permit. The ammonia nitrogen limit, while meaningful in regard to oxygen depletion in a stream, is totally meaningless in the soil, where most of the applied nitrogen would be readily converted to the nitrate form. Nitrate is motile in the soil, so if over-applied may leach into environmental waters. So total nitrogen is the parameter of concern, relative to environmental impact. As has been noted, the high performance biofiltration treatment unit would reduce the total nitrogen level in the effluent by over half, just as a matter of course, producing an effluent that would be better matched to the uptake potential of the turfgrass, so would be "practically superior" to what this permit specifies for nitrogen level.
  - The phosphorus limit in this permit, while meaningful in regard to blunting algae growth in surface waters, is essentially meaningless in the soil. Any soil with a sufficient clay content or other means of imparting sufficient cation exchange capacity will have a practically "infinite" capacity to sorb phosphorus, and so not allow any of the applied phosphorus to be shed into environmental waters.
  - So to be practically employed as the governing document for the scalping plant under the "Final Phase" provisions, an amendment would have to be approved to "relax" those effluent limits to a set more applicable to the actual mode of dispersal and the actual environmental impacts of that practice.
- Indeed, rerouting of the effluent from stream discharge to subsurface drip irrigation dispersal would likely require that the permit be amended to eliminate the "outfall" to surface waters altogether.
- While not a limit that might need to be changed, this permit would allow up to 75,000 gpd of effluent to be "produced" by any treatment plant covered by this permit. Practically speaking, however, it is likely that TCEQ would require the permit to be amended to specify the limit for the circumstances of the scalping plant in order to use the "Final Phase" provisions to govern that plant.
- If this permit specifies an explicit treatment unit process, that is not apparent. So it is open to question if an amendment to explicitly recognize the high performance biofiltration concept as the treatment unit technology would be required.
- This permit explicitly asserts that disinfection of the "Final Phase" effluent would be done with UV, so it appears that no amendment would be needed to use UV disinfection for a scalping plant.

It does not appear that the plant location is explicitly assigned by this permit. Both the interim plant and the final plant are addressed as 333 Blue Hole Lane. When locating that address on Google Maps or such applications, a "pin" for that address shows on the far side of the park from these two locations. So it appears that the explicit treatment unit location would not be an issue when amending this permit, so that it would be allowed to locate the treatment unit at any of the 3 optional locations under this permit.

TCEQ asserted that the sorts of amendments reviewed above would be deemed "major" amendments. This would entail opening up the whole process to a new round of public comment, and perhaps public meetings, or even regulatory hearings, if "affected persons" were to protest the permit being revised. The City of Wimberley has advised that there is some public sentiment against locating any treatment plant on or near Blue Hole Park, so that a "clean" amendment process may be unlikely. Thus it is not only the work required to prepare and submit the permit amendment(s) that would be at issue if this regulatory pathway were to be pursued, but also the prospect of encountering protests, and consequent hearings, that must be considered.

4.2 321P through Aqua

The regulatory pathway of using section 321P of the Texas Administrative Code is much "simpler" and direct, in that it would not entail the various permitting issues reviewed above – indeed, this pathway does not entail a permitting process at all. However it would entail engaging Aqua to accept at least the "nominal" role of owner-operator of the scalping plant and the reuse operation. Aqua would have to be enlisted to be the "formal" purveyor of the plans and specifications for the scalping plant, and to submit a "210" application that would govern the irrigation reuse operation.

TCEQ could identify no explicit barriers to approving either of those submittals. The review of the plans and specifications is expected to be a "rote" process, presuming that TCEQ would recognize the high performance biofiltration concept treatment process. There may be an "education" component to this, as the whole recirculating packed-bed filter technology is – quite strangely – not "mainstream", in that there is no rule set in which TCEQ explicitly recognizes this sort of treatment process and its treatment capabilities. Past experience with TCEQ, however, offers high confidence that TCEQ would accept this rational design.

The "210" permit in this case would propose that the treatment unit must produce a "Type II" effluent, which would be suitable for subsurface drip dispersal under areas that would have public access, like the soccer fields and the Great Lawn. Even though the water would be injected underground, entailing a vanishingly small potential for human contact, the Type II restrictions could be further enforced by requiring that the irrigation system be run only during hours when the park is closed, so that no one would be present while irrigation is on-going. Type II effluent has a limit of 20 mg/L of BOD_5 – readily obtainable out of the high performance biofiltration concept treatment unit, ***very*** consistently and reliably – and limits on fecal coliform/e. coli and enterococci, readily obtained with UV disinfection of that effluent, if not out of the treatment process itself. This "210" permit also appears to be a "rote" process.

It is unknown if Aqua would be amenable to cooperating in this process at all, much less what it might require as compensation for participating. Any water "scalped" for irrigation reuse out of the City of Wimberley sewer system would decrease the flow from the Wimberley sewers into the Aqua system, and thus perhaps reduce payments by the City to Aqua. So Aqua may have a fiscal incentive not to participate. In any case, FoBH has not allowed any contact with Aqua in the course of conducting this study, so the prospects for using the 321P regulatory pathway remain to be investigated.

5.0 SUMMARY

Subject to various unknowns, this report reviewed the basic strategy for creating an irrigation water supply for Blue Hole Park by tapping the City of Wimberley sewer system, "scalping" off a flow to be treated to a standard that would allow the reclaimed water to be used for irrigation on the park grounds. To briefly review, that strategy includes:

- Extracting wastewater from an appropriate/convenient point in the sewer system and pumping it into a treatment unit;
- Sizing the treatment unit either on the basis of covering a given irrigation water demand profile, or on the basis of what can be "practically" extracted from the sewer system;
- Treating this wastewater to produce a reclaimed water resource of appropriate quality to disperse it on park grounds through a subsurface drip irrigation field;
- Installing a subsurface drip irrigation field over the soccer fields and, to the extent it is intended to "routinely" or "drought stress" irrigate the Great Lawn, over some or all of that area; and
- Operating the treatment and dispersal system a rate determined by the expected irrigation demands in each month, extracting at that rate from the sewer system, allowing any "excess" reclaimed water that may be produced on any given day – e.g., due to rainfall voiding the irrigation cycle for a period of time – to flow back into the sewer system.

The nominally proposed course of action includes:

- Extract wastewater from the Deer Creek lift station, from which at present it appears no more than 10,000 gpd could be extracted;
- Install a 10,000 gpd treatment unit;
- Locate the treatment unit on the location suggested by PARD, next to the park maintenance buildings, as that location is "close" to the lift station and on the route from the lift station to the soccer fields;
- The bottom line cost estimate for the extraction and transfer facilities, the 10,000 gpd treatment unit, the conveyance pipes to the irrigation fields, and subsurface drip irrigation systems covering the soccer fields and the Great Lawn is $620,200. Note that this cost does not include addressing whatever regulatory processes that may have to be executed to allow this system to be installed.

Regarding the unknowns, if FoBH chooses to pursue implementation of the Blue Hole Park irrigation water supply system:

- It must clarify the water source/extraction point and treatment capacity to be installed;
- It must more "tightly" define the irrigation demands to be served, including the areas to be served and the quality of plant maintenance to impart;
- It must determine the quantity of effluent to be required to cover those irrigation demands, or alternatively, that can be "conveniently" extracted and routed to treatment and reuse;
- Using this information, it must determine the "best" system configuration, and so produce the best estimate of actual system cost.

Also, the City of Wimberley, presuming it would be the system operator, must determine what its operating costs would be, including electricity and manpower, and any finance costs must be clarified – e.g., if the funding would be through a loan. Further, the impact of rainfalls on the actual amount of water produced and used for irrigation must also be evaluated, so that a best estimate of actual water supply that would be produced over any given evaluation period can be derived.

Out of all this, a best estimate of the average cost of the water produced by this system would be derived, to be compared with a best estimate of the future cost of water in Wimberley. And then it could be evaluated if the value of making this water supply sustainable – by tapping wastewater as the water source, rather than an unsustainable resource like groundwater, whether produced locally or imported – would be reflected by the estimated difference in the cost of water produced by this system vs. the forecast future cost of water in Wimberley.