CHATEAU CHAPARRAL OWNERS ASSOCIATION

Wastewater Treatment Facility Feasibility Study

JULY 2008

DRAFT FOR COMMENTS

SCHMUESER GORDON MEYER
ENGINEERS SURVEYORS

PO Box 3088 / 407 4th Street

Crested Butte, Colorado

970.349.5355

Table of Contents

List of Figures

List of Tables

Appendices

***** Further detailed cost sheets can be seen upon request***

References

1. Crites, Tchobanoglous
   Small and Decentralized Wastewater Management Systems
   Pages 171, 319

2. Michael Richard, Ph.D. and John McGee, P.E.
   Anaerobic Pretreatment for Municipal Wastewater Lagoons:
   Five Years of Experience in Colorado
   (Presented at the Annual Meeting of the Rocky Mountain Water Environment Federation, Vail, Colorado – September 2000)

3. Angela Helliwell
   SCG Enterprises Inc
   www.orenco.com

4. Wally Camp
   Worrell Water Technologies, LLC
   www.livingmachines.com

5. EPA Design Manual

1 Purpose and Scope

1.1 Purpose

In May of 2008, the Chateau Chaparral Owners Association (applicant) received an "Advisory of Requirements for General Permit Coverage and Explanation of Engineering Design Requirements" letter from the Water Quality Control Division of the Colorado Department of Public Health and Environment[1]. The "Compliance Advisory" letter requires that the Chateau Chaparral Owners Association do the following items:

1. Prove to the Division that your facility is designed to provide adequate treatment of effluent wastewater prior to discharge to ground water. More specifically prove that your aerated lagoon is properly sized for your flow rate and does not leak.

2. It this can not be proven, you must hire a Colorado Registered Professional Engineering consultant by November 1, 2008. This was completed by hiring Schmueser Gordon Meyer.

3. Work with your engineering consultant to prepare a proposed compliance schedule for evaluating the treatment system and developing/implementing necessary upgrades to the

[1] referred to as the "Division" or "CDPHE" in this document

treatment system to later then May 1, 2009. This item was also completed by Schmueser Gordon Meyer and submitted to the Division before May 1, 2009.

4. Complete the work established in the compliance schedule within the agreed upon timeframes.

The Chateau Chaparral Owners Association is now in the phase of work in the fourth item. As spelled out in the approve compliance schedule an feasibility analysis of the existing treatment system and site constraints must be completed in order to determine the most applicable necessary upgrades to the system from an operations, treatment , and cost standpoint.

The engineering firm of Schmueser Gordon Meyer (SGM) has been retained by the applicant to perform the site assessment and Feasibility Study (FS) for various on-site wastewater treatment solutions.

The purpose of this report is to formally state that the site can meet all requirements within section 22.4 of regulation 22 with the necessary upgrades. Additionally, this report is a Feasibility Study (FS) which evaluates different on-site wastewater treatment facility (WWTF) alternatives. The alternatives selected for analysis all have the ability to effectively treat and safely dispose of wastewater collected from the Chateau Chaparral Subdivision. The information and recommendations in this FS are to be used by the Subdivision Owners Association (OA) as guidance for selecting the preferred alternative for wastewater treatment. The selection of an appropriate WWTF is a critical step required to comply with the last step noted in the May 1, 2008 Compliance Advisory letter.

The last step of the letter also noted, "Failure to complete the work established in the compliance advisory may result in the termination of existing permit coverage and referral to enforcement." However stated earlier in the Compliance Advisory Letter, " By completing the steps in accordance with an agreement with the Division you can avoid formal action to compel you to comply and associated monetary penalties."

1.2 Problem

The existing wastewater treatment and discharge, consisting of an existing aerated unlined lagoon followed by a rapid sand infiltration basis (RIB), is in violation of the Colorado Water Quality Control Act in two areas. First, the system was designed for and received site location and design approval from the Division for no more then 4,200 gpd annual average, but currently has an annual average of close to 7,400 gpd; making the site location an design approval from the Division void. Second, based on historic recorded flows into the aerated lagoon and out of the lagoon to the RIB, also accounting for evaporation, approximately 2/3 of the wastewater is seeping of the bottom of the aerated lagoon before it has reached its full detention time in the lagoon and final treatment from the RIB.

To further complicate the situation, Chateau Chaparral is now fully developed and only has limited available space on your property for any expansions or upgrades. Therefore, the greater problem is not only that the HOA has an unapproved WWTF but that they are in need of a new WWTF or upgrades that are designed and constructed in accordance with acceptable industry standards and can fit around the site constrains on the existing system. This will insure that when a new construction, and an appropriate new discharge permit is obtained, the WWTF has the ability to meet the required effluent limitations (effluent limits are the limits the Division sets that the treated wastewater constituents must be reduced to before it is discharged to waters of the State) provided with the discharge permit.

1.3 Scope

The scope of this report assesses six (6) primary alternatives with several options under each alternative for treated effluent disposal, site location, and upgrades to the existing collection system. The primary alternatives include:

1. Expand and Line Existing Aerated Lagoon
2. Advanced Integrated Pond System (AIPS)
3. AdvanTex® Treatment System (Textile-based packed bed filter)
4. Sequencing Batch Reactor (SBR)

5 Packaged Plant Systems

6 Connection to the Buena Vista Sanitation District central sanitary sewer system

Selected alternatives and alternative options for a new WWTF and or upgrade need to meet key project goals many of which were discussed on the June 27th owners meeting.

From the meeting SGM identified the following project goals in addition to meeting State and County regulations:

7 Selected alternative shall be the most cost effective from both an initial construction and ongoing operational and maintenance standpoint.

8 The selected system should be as simple as possible to operate and maintain.

9 The selected system should be any aesthetically worse then existing from a visual and olfactory standpoint.

It should be noted that a number of other options were initially considered but rejected relatively quickly because they did not meet some or all of the above listed goals. Some of the options considered early on but eliminated from further consideration were:

10 A pump and haul system

11 Evaporative lagoon system

12 Traditional custom designed and built mechanical plant

13 Traditional constructed wetland (as primary treatment)

2 Existing Conditions and Design Constraints

2.1 Existing Conditions

The Chateau Chaparral subdivision consists of approximately 40 Acres that are divided into 307 lots. Lot sizes range from approximately 2,000 to 3,000sf with a handful of lots between 3,000 and 5,000sf. There are also a number of open space tracts spread out throughout the

subdivision that are owned by the Chateau Chaparral Owners Association ranging from .1 Acres to 6.1 Acres.

The 307 lots are all privately owned lots that are set up for mobile/modular and recreational vehicle use. Approximately have of the lots have a full time unit on them, primarily single wide mobile homes, but a few double wide homes and a few full time stationary recreational vehicles. The remaining lots are set up temporary/part time recreational vehicles to be parked and connected to utilities. No lots are rented for nightly/weekly for profit "camping" use as would be done in a recreational vehicle campground.

Chateau Chaparral obtains its drinking water from two wells located on the northern side of the development more then 1000 feet away from the wastewater treatment facility site. This is a public water system with an active PWID number. Drinking water is then collected in a tank and distributed through a piped distribution system to the lots. There are a number of bath houses in the subdivision that are used primarily by the part time residences (Not sure how many bath houses, I assume one with Male and Female). The subdivision also has a clubhouse/lodge that contains a full kitchen and bathrooms.

Due to the demographics of the subdivision the wastewater flows vary significantly seasonally. On average there are about 250 residence at a time in the summer and a maximum of about 70 residence that live there full time. The current annual average flow rate is 7,400 gallons pre day, with monthly averages around 5,000 gallons per day in the winter and 10,000 gallons per day in the summer. The recorded extreme flow days are around 2,000 gallons per day at low flow and 16,000 gallons per day at peak day. Aside from the flow rate changes, the composition of the wastewater is very typical of residential wastewater. Chateau Chaparral does not anticipate any higher use of the subdivision in the future and so far flow in 2009 have been less then in 2008 (see 2008 flows and discharge monitoring report summary table bellow).

Wastewater from the Chateau Chaparral subdivision flows by gravity pipes connected by manholes to the low point of the subdivision on the southern end of the subdivision (I don't think there are any lift stations). There is a 1.9 Acre track owned by the Owners Association

that contains the existing WWTF that consists of an aerated lagoon that discharges to a rapid sand infiltration basin that discharges to groundwater. This track is the most suitable track for a WWTF that the Owners Association has as any other track would require wastewater pumping and all the existing piping flow to this point.

The Plat show a portion of this southern most track touching Chalk Creek. Currently however, the closest Chalk Creek gets to the Chateau Chaparral is about 40-50 feet south of the property line. The south adjacent property that Chalk Creek is located on, is privately owned designated as being owned by Brown on the Plat. Chateau Chaparral is also has the Arkansas River that flows north south on the western side of the property. The existing WWFT is approximately 400' west of the River. Although there are many lots is Chateau Chaparral that border the Arkansas River, the WWTF track does not touch the but is blocked by a small stretch of BLM land before the River. The Plat does show 16' general utility on all rear lot lines making it possible for the wastewater to be discharged to the Arkansas River by pumping the effluent. This is discussed more in the Discharge Options Discussion section.

The existing lagoon has an area of approximately 4,500sf with two floating mechanical aerators. It is unlined and has an unknown depth but based on adjacent topography is estimated to be between 6-8 feet deep. The lagoon is allowed to fill up and is then aerated, is allowed to settle and then discharged to the rapid sand infiltration basin (RIB) about once a month, every other month in the winter. The RIB is about 5,000sf in size and usually takes less then 24 hours to infiltrate the monthly discharge.

The existing WWTF was designed for received site application approval in June 1989 for an annual average daily flow capacity of 4,200 gallons per day. Since the current flow annual average is 7,400 gallons per day the previous site application approval is no longer valid. Also by subtracting the annual flow from the aerated lagoon to the RIB and the theoretical evaporation rate for the pond area from the flow into the aerated lagoon it can be calculated that approximately 2/3 of the wastewater seeps from the bottom of the aerated lagoon before it reaches its full treatment.

Aside from occasional odor complaints the owners, in general, do not have any opposition to

the type and location of the existing WWTF as long a it can properly treat the wastewater.

2.2 Existing Design Constraints

It is anticipated that the flows from 2008 are going to be very typical of flows in the future and there is no reason to think flow rates will change at all. Annual average flow rate of 7,400 gallons per day will be used for design with a peak day of 16,000 gallons per day. Having low flow days of 2,000 gallons per day in the winter at times is also an important factor is design and treatment type selection. Not all treatment options can handle such varying flow rate.

There are no commercial or industrial wastes connected to the system and average domestic residential wastewater constituents were assumed for this FS. The 2008 discharge monitoring reports verify this assumption.

The largest existing design constraint is physical location of the WWFT. Primarily that the best location has the existing facility on it and keeping the existing facility operation during construction of anything new is a challenge. It is also important to note effluent, treated wastewater can not gravity flow to a surface water source on the property.

3 Operational and Added Benefit Considerations Discussion

Reports and cost analysis documents are good at analyzing the hard costs for the system under analysis. Placing costs on the operations and maintenance for a particular system is a little more difficult, but yet commonly done. The challenge, in our opinion, is to be able to articulate the non monetary advantages and disadvantages of an alternative. An example of this would be in evaluating evaporative lagoons. If one had the space and accommodating topography fully evaporating wastewater effluent is a very effective way to dispose of an effluent – both ground water and surface water is protected. You can put a cost on the land consumed by the lagoons and you can put a cost on the operational and maintenance savings. However, it is very difficult to place a comparable monetary value on the benefit

obtained by protecting ground and surface water. Conversely, these types of lagoons can, at times, produce objectionable odors in addition to being somewhat unsightly. Again, it would be a difficult task to place a comparable monetary value on these elements.

For each alternative we will identify the non monetary advantages and disadvantages of each option. Also, for each alternative SGM has created preliminary budgetary type cost estimates. The cost estimates are to be used for comparative purposes between each alternative. The ultimate system owner will have to evaluate this information and utilize it in their decision making process.

4 Discharge Options Discussion

One common entity between all of the WWTF alternatives is that they treat the wastewater but they do not get rid of the treated water (effluent). Regardless of which alternative is selected, the OA will have to submit for a discharge permit through the Division. The Division has a number of discharge permits which all fall into one of two categories: *Surface Water Discharge Permit* or *Ground Water Discharge Permit*.

4.1 Surface Water Discharge Permits

Although there is no flowing surface water on Chateau Chaparral subdivision, discharging the effluent from the WWTF into the dry ravine that makes it to Chalk Creek could be considered by the Division to be a discharge to surface water, although it would require an agreement with the adjacent land owner. In general, when a treated effluent is discharged to surface water, the dilution of the effluent by the surface water is taken into account when the Division sets their effluent limit requirements. For example, if the effluent were to be discharged to the Arkansas River, the effluent limits would not be as strict because the considerable flow of the Arkansas would immediately dilute the remaining wastewater constituents. Discharging into a dry ravine, however, means that there is no surface water flow to immediately dilute the effluent and therefore the effluent limits required by the District would be more restrictive. Other factors that are taken into account in determining the effluent limits is the discharge of

other treatment facilities into the same surface water source nearby, such as Buena Vista's.

An agreement with the adjacent property owner could be reached for an easement for a gravity sewer pipe to discharge to Chalk Creek is also an option. This is something the Owners could delegate to a someone with good relations with the adjacent property owner as it was stated above it would only have to be 40-50 feet long. The adjacent property owner may want to be cooperative if helps neighbor to have a better WWTF then they currently do. The same approach could be taken with the BLM and an easement to the Arkansas River, although it is our experience that easements on Federal properties are very difficult to obtain. As mentioned above with utilizing the 16' wide utility easement at the back of the lots a pipe could be placed form the WWTF to the Arkansas River on Chateau Chaparral property across the back of lots 272, 273, and 274 (see Plat in Appendix). Do to topography this would require a small pump station but it would open up additional wastewater treatment options. Particularly if new construction could take place on top of where they existing RIB is located as it would no longer be needed.

Another option that would fall into the surface water discharge category would be to discharge into an irrigation ditch. This does not seem to be an option for Chateau Chaparral and so we will not discuss in detail the requirements but we want to look at all options.

4.2 Ground Water Discharge Permits

When discharging to ground water, the treated effluent could be going directly into ground water. Therefore, in general, the Division required effluent limits are stricter for ground water than surface water. The CDPHE allows for five different types of groundwater discharges in accordance to the following permits. The following information has been taken directly from the CDPHE web site[2].

---

[2] www.cdphe.state.co.us/wq/PermitsUnit/Domestic/GW_Permitting_Overview.pdf

General Permit 631000 - Land Disposal of Effluent from Domestic Wastewater Treatment Works (WWTWs): This permit covers wastewater treatment systems where effluent limitations and ground water standards are met *prior to* effluent discharge to an unlined impoundment [i.e., an infiltration basin or any lagoon or impoundment for which the Permittee has not adequately demonstrated that the seepage rate is less than 10^{-6} centimeters per second (cm/sec)] and/or a land disposal site. Compliance monitoring is required at the point of effluent discharge. Ground water monitoring wells are not required.

General Permit 632000 – Land Treatment of Effluent from Domestic Wastewater Treatment Works (WWTWs): This permit covers wastewater treatment systems where ground water standards are met *subsequent to* discharge to an unlined impoundment [i.e., an infiltration basin or any lagoon or impoundment for which the Permittee has not adequately demonstrated that the seepage rate is less than 10^{-6} centimeters per second (cm/sec)] and/or a land treatment site. Compliance monitoring is required at the point of effluent discharge and at ground water monitoring wells located hydraulically down-gradient of the treatment system. In some cases, lysimeters may be required in addition to, or in lieu of, ground water monitoring.

General Permit 633000 – Land Treatment of Effluent at Agronomic Rates from Domestic Wastewater Treatment Works (WWTWs): This permit covers wastewater treatment systems that discharge to ground water solely through land treatment at Division-approved agronomic rates and that are not covered under Regulation No. 84 – Reclaimed Water Control Regulation. To apply for this permit, you must include a copy of the facility's *Land Application Management Plan* with the permit application. Compliance monitoring is required at the point of effluent discharge. Ground water monitoring wells are not required.

General Permit 621000 – Domestic Wastewater Treatment On-site Systems with Design Capacity Equal or Greater than 2,000 Gallons per Day (GPD). This permit covers domestic wastewater treatment on-site systems, including septic and advance treatment systems that discharge to leach fields/absorption fields. Compliance monitoring is required at the point of effluent discharge and at ground water monitoring wells located hydraulically down-gradient of the WWTW.

General Permit 622000 – Domestic Wastewater Treatment On-site Systems with Design Capacity Between 2,000 and 10,000 Gallons per Day (GPD with No Ground Water Monitoring Requirements. This permit covers domestic wastewater treatment on-site systems, including septic and advance treatment systems that discharge to leach fields/absorption fields, which have adequately demonstrated to the Division, and have received Division-approval, that ground water monitoring is not required to ensure the protection of State waters. To apply for this permit, you must include a copy of the facility's site-specific risk based evaluation with the complete permit application. This permit does not require ground water monitoring, but does emphasize the use of best management practices.

One of the options "*Land Treatment of Effluent at Agronomic Rates from Domestic Wastewater Treatment Works*" would require Chateau Chaparral to store their treated wastewater during

the winter months.

Two of the four options involve discharging to groundwater through an unlined impoundment (percolation pond or unlined subsurface constructed wetland) just as is currently being done. These two options are then divided between two factors: whether or not the effluent limits are met prior to the effluent discharge to the unlined impoundment or if additional treatment is required by filtering the effluent through the ground as it is being discharged. If the Division required effluent limits can be met before the effluent goes to the unlined impoundment, the unlined impoundment is simply considered a disposal method and nothing more needs to be done. If the Division required effluent limits can not be met prior to going to the unlined impoundment as is the current case, then compliance monitoring is required at the point of discharge from the WWTF and also through ground water monitoring wells located hydraulically down-gradient of the treatment system.

The last two ground water discharge permits are very similar to the previous; however, instead of discharging to an unlined impoundment, they discharge to a leach field, or absorption field. Modifying the existing RIB into an absorption field with pipes that is covered can also open up additional treatment options. The last ground water discharge permit has an additional requirement which involves meeting Division required effluent limits prior to discharging to the leachfield/absorption field, but the WWTF design capacity must be less then 10,000gpd in order to not require ground water monitoring.

5 Effluent Limits Discussion

Depending upon the selected effluent discharge type and location, the allowable effluent quality being discharged from the WWTF could vary. Upon selection of a discharge, a request to the Division is made for Preliminary Effluent Limits (PEL's). PEL's are site and discharge option specific. The Preliminary Effluent Limits are then used to proceed in the design for the WWTF. There are a number of effluent limits in which different constituents must be reduced to before discharge, but the main three represent the three types of constituents found in wastewater, physical, chemical, and organic. Total Suspended Solids (TSS) represents the

physical constituent. The organic constituent is represented by Biological Oxygen Demand (BOD, a measurement of how much oxygen is required to stabilize a waste biologically). The chemical constituents are a little more difficult to summarize but consist of free ammonia, organic and inorganic nitrogen, nitrites and nitrates as well as organic and inorganic phosphorus.

5.1 Nitrogen Removal

It is important to briefly discuss total nitrogen removal (organic nitrogen, inorganic nitrogen and ammonia nitrogen) because nitrogen in various forms is toxic to aquatic life. It can lead to an increase in chemical nutrients in the environment leading to algae blooms and loss of oxygen in aquatic environments. Similarly, in terrestrial environments, nitrogen-saturated soils can contribute both inorganic and organic nitrogen to the groundwater. Traditionally, WWTFs remove approximately 40% of nitrogen and discharge 60% of the incoming nitrogen. Recently the wastewater treatment industry, as well as the State of Colorado, have been trying to change this. The Division has started a process of further restricting the effluent limits of total nitrogens. Because this is the area where most new WWTFs in Colorado will struggle to meet the effluent limits, it is important to briefly discuss this process.

Nitrogen is removed from wastewater through two primary mechanisms, by assimilation and by the nitrification-denitrification process. *Assimilation*[3] is the process by which microorganisms (and plants if part of the WWTF) take up the nitrogen into their cell mass. *Nitrification-denitrification* is a very complex chemical process with a long series of chemical reactions. With the use of oxygen, ammonia is converted to nitrite, and then nitrite is converted to nitrate. In an oxygen deprived environment, denitrification uses organic carbon to remove both nitrite and nitrate with nitrogen gas as the byproduct. Nitrogen gas is then released to the atmosphere replenishing nitrogen levels (ambient air is composed of 78% nitrogen gas, 21%

---

[3] The conversion of nutrient into the fluid or solid substance of the body, by the processes of digestion and absorption.

oxygen gas, 1% other).

6 WWTF Alternatives Discussion

There are many different ways to treat domestic wastewater, the following alternatives best match the required goals and design constrains of the project. Because of the close proximity to a residential area and the strict effluent limits that we expect to result from a groundwater discharge or surface water discharge with no dilution, it is strongly recommended to have a form of disinfection at the end of all the WWTF alternatives. It is our recommendation to utilize ultra-violet (UV) disinfection for all alternatives. Since the disinfection component is the same for all alternatives, it will be left out of the discussion for each alternative.

The primary alternatives discussed are Expanding/Modifying the Existing Aerated Lagoon system, the Advanced Integrated Pond System (AIPS), AdvanTex® Treatment System, a Sequencing Batch Reactor System, Packaged Plant Systems, and finally connection to the Buena Vista Sanitation District central sanitary sewer system will be analyzed.

6.1 Expansion/Modification of the Existing Aerated Lagoon System

Wastewater treatment lagoons were very popular in the western United States and the primary choice of treatment in the middle of the 20th century. The primary reason for so many of them being installed in rural areas is that they are a tradeoff of cost for land. The are a low cost alternative both from an installation standpoint and an operating standpoint, but they take up more land space then any other treatment option. Lagoons are primarily focused and sized for treatment of BOD and TSS and when sized and operated correctly can be very effective in removing them.

Most all lagoons can be fit into one of four different categories, Fully Aerobic, Fully Anaerobic, Facultative and Partial-Mix Aerated. Both Fully Aerobic and Fully Anaerobic lagoons target specific portions of the wastewater treatment process and are not used by themselves as the primary treatment of wastewater, but rather in a combination with other treatment process.

Aerobic lagoons are shallow and take advantage of the treatment that takes in an environment rich in dissolved oxygen. Anaerobic lagoons are deep and take advantage of the treatment that takes place in an oxygen free environment breaking down the organic carbon. Facultative lagoons are some of the more common lagoons seen in Western United States. They are approximately 5-8 feet deep and take advantage of both an aerobic (oxygen rich environment) near the surface of the lagoon, and an anaerobic (oxygen deprived environment) near the bottom of the lagoon and when sized and operated correctly can be an effective primary treatment option.

Chateau Chaparral's existing lagoon would be categorized as a Partial-Mix Aerated Lagoon. They are typically deeper and more heavily loaded organically then facultative lagoons. Mechanical aerators are used to meet the higher oxygen requirements for BOD removal and to some extent nitrification. They are deeper then the facultative lagoons, 6-20 feet deep, and still maintain an anaerobic zone or sludge layer. In general they have the same advantages as a facultative lagoon but do not require quite as much land space. (***see Figure 1***).

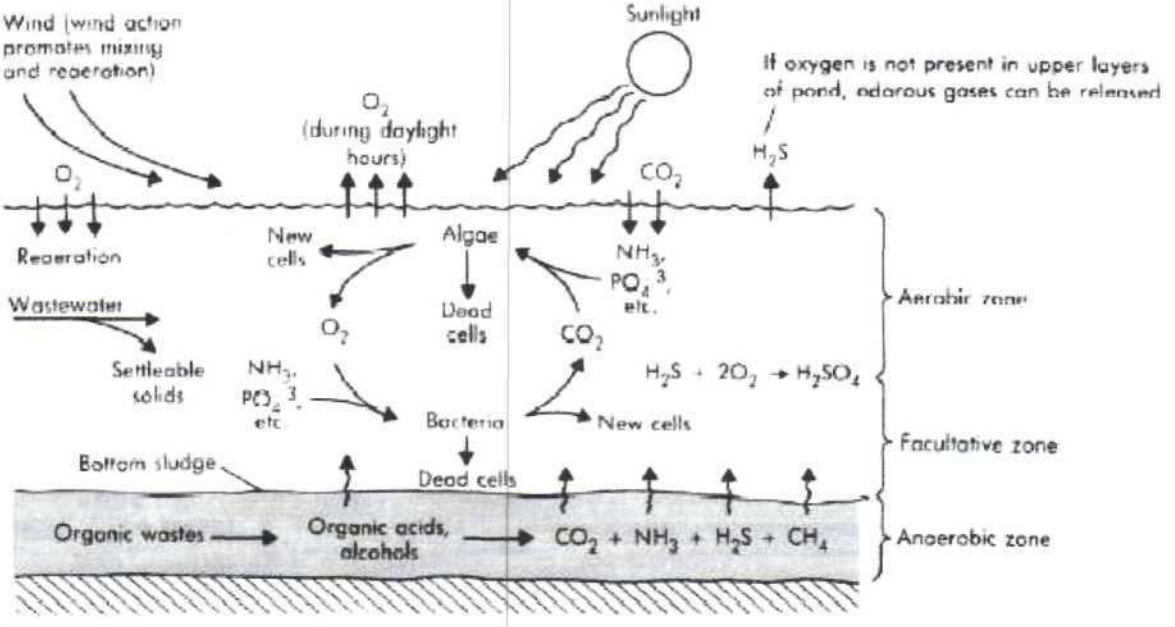


Figure 1

The actual depth on the existing partial-mix lagoon is unknown but estimated to be about 6-8 feet deep. With the depth assumption and the surveyed size about 60'X70', the existing lagoon is probably sized about right for the 4,200 gallons per day. Based on first-order reaction-rate kinetics and preliminary calculations show that an 8' deep lagoon about 70'X160' for the required 45 day hydraulic detention time. At least an additional two aerators would also be required.

Typically lagoons are the most cost effective wastewater treatment alternative even with a synthetic liner, both from an initial construction cost standpoint and long term operations and maintenance. They are not difficult to operate and do not require constant operator attention. The only energy requirements are for the aerators. Minimum maintenance and repair is required during the design life and can have a design life in excess of 20-30 years.

That does not mean significant problems can not happen to a lagoon that will undermine its ability to properly treat wastewater such as; short circuiting (solved by slug discharge and not continuous flow), significant algae blooms, and pond turn over where due to rapid temperature differences and anaerobic zone on the bottom actually flips up to the top creating many problems. They are also not well known for great nutrient removal.

Specifically for Chateau Chaparral the size of pond required would fit on the existing WWTF track but it would have to go replace the existing pond and take up the RIB space. This creates two problems. First, during the construction period of the lagoon (about 2 months) all wastewater would have to be stored and hauled to an existing facility; even at low flow 2,000 gallons per day this is approximately a $120,000 additional cost to the project. Second it removes the existing and or shrinks down the existing RIB. This is a final method of treatment to get additional removal of BOD and TSS removal in the sand filtration and some nutrient removal in plant uptake and fixed film on the sand. More importantly with out space for the RIB there is not room to discharge to groundwater on site, and without an additional "polishing" treatment step it will be difficult to meet effluent limits discharging to surface water directly after the lagoon.

Advantages:

1 Low initial construction cost

2 Extremely simple design, therefore operational and maintenance friendly and cost-effective to operate

3 Uses the same treatment process that existing operator is familiar with

4 No significant change to visual/odor impacts then existing

5 Longer design life 30+ years

Disadvantages:

1 Larger footprint 70' X 160'

2 Not as effective at nitrogen removal, particularly with out any additional "polishing" treatment

3 Additional end treatment and during construction store and haul cost offset low initial construction cost.

4 Is not the best at treating effluent to the highest level

5 Can have significant problems, such as algae blooms and turnover that takes the whole system out of compliance until the problem can be fixed.

Table 1

Need new cost table

6.2 Advanced Integrated Pond System (AIPS)

AIPS is a different approach to a traditional wastewater lagoon system, which was created by Dr. William Oswald at the University of California, Berkeley, but perfected for systems in Colorado by Dr. Michael Richard. AIPS differs from the traditional lagoons in that instead of having the first cell aerated and the last cell anaerobic (oxygen deprived), the anaerobic cell is

first. This increases the efficiency of the lagoon and decreases the hydraulic retention time (how long the water stays in the lagoons), and thus decreases the footprint.

Since the anaerobic cell is where the sludge is digested and the denitrification occurs, having it at the end lowers the water temperature and efficiency. If sludge ever builds up and over flows, it is the last step before discharge in a traditional lagoon system. By moving the anaerobic cell to the front, making it deep (12' to 15') and introducing the wastewater at the bottom of the cell the treatment process is helped in a number of ways. The wastewater has to travel from the bottom of the cell up through the sludge layer (2'-9' thick) where the temperatures stay much higher all year long increasing the microbial action for better BOD removal, and also allows denitrification to happen in a warmer carbon enriched environment. After this process, the wastewater goes through an aerated cell and a settling cell, both of which don't need to be as big in size.

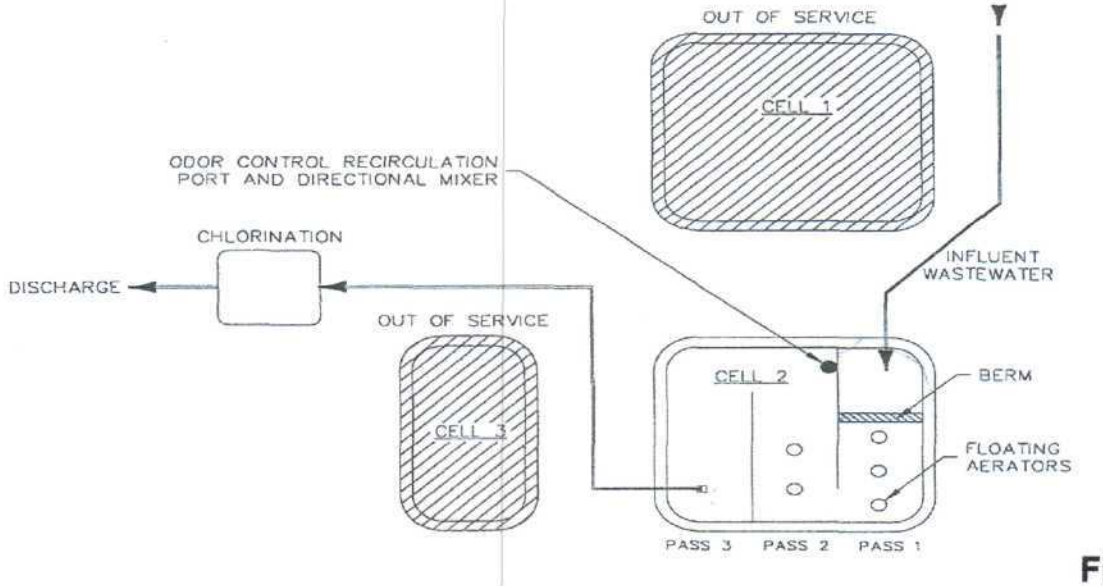


Figure 2

Specifically for Chateau Chaparral the whole system would take up a footprint only slightly larger then the existing lagoon 65' X75' with a similar configuration to the figure above. The figure above was a retrofit to the WWTF in Mead Colorado that had three larger cells and after the AIPS was implemented the footprint could fit into one of the existing cells. Therefore the AIPS system could fit in the same location as the existing lagoon and still utilize the RIB for

discharge. This would cause the same store and haul constructability problems as the partial mix lagoon. Or the new AIPS system could be construction on top of the existing RIB during the two month off season period (February/March) where there is no discharge to the RIB. Switch the flow to the AIPS and replace the existing lagoon with a new RIB. Also the AIPS has better treatment abilities and has a much better ability to meet surface water discharge requirements without any additional treatment.

BOD, TSS and nitrogen removal does not end up on the Advantage or Disadvantage list because although it is much better then a traditional lagoon system, it is not excellent and would depend on the effluent limits provided by the Division to know if an additional "polishing" treatment would be required but not anticipated.

Advantages:

1 Relatively low construction cost for AIPS if self

2 Very simple low-tech operations and maintenance.

3 Surface water or Groundwater discharge

4 Could remove need for construction store and haul cost

5 Not the smallest footprint but would fit on the existing tract

6 Longer design life, 30+ years depending on liner condition

Disadvantages:

1 Construction juggling with moving around existing facilities

2 May need one additional aerator

3 Visual impact but not much different then existing

4 Odor, although the proponents of AIPS in Colorado brag about having no odors, we feel there will most likely be times when mild odors are produced.

Table 2 (not fully refined with all details)

ADVANCED INTEGRATED POND SYSTEM (AIPS) COST				
$41,050	$446,000	$8,700	$495,750	$746,119

6.3 AdvanTex® Treatment System

The AdvanTex® Treatment System operates on the same principals as a traditional packed bed filter; however, instead of a natural granular material for the filter, AdvanTex® uses their own engineered fabric to filter the wastewater. The AdvanTex® Treatment System would come as a complete package including 5 AX100 filtration units, new septic tanks (AdvanTex® requires that use of their septic tanks need fit with their STEP system pumps and filters), recirculation tank, dosing tank, pumps, tank anchors, flow meter and custom TCOM control panels. All AdvanTex® equipment could be supplied through SCG Enterprises, Inc. out of Conifer, Colorado. There is also a more local Valley Precast in Buena Vista that supplies AdvanTex® equipment but we have not yet received a quote from them.

Although this WWTF would still require a licensed operator because it has a larger capacity then 2,000gpd, SCG Enterprises could help locate an Operator in the area if needed. Operation and Maintenance manuals are provided, as well as start up assistance. They are also available for troubleshooting and technical assistance for the life of the system. Round-the-Clock system supervision is available via Orenco's® telemetry controls. Although the system gets more complicated with pumps, recirculation, and telemetry controls, there is a lot of assistance available for a fee.

The system does require solids to be removed first and would require common septic tanks to be installed around the subdivision or possibly one or two larger ones near the WWTF track.

They then have their own maintenance and pumping requirements. The AX100 units themselves could be placed on top of the existing RIB with the existing RIB being modified into a buried absorption field.

After treatment, the effluent would need to be disinfected and pumped to the discharge location. Similar to the packed bed filter, the AdvanTex® system also has trouble reducing the nitrogen levels. AdvanTex® has tried to add additional components to the system (additional tanks and different circulation) to try to improve nitrogen removal but this is an additional cost that is not included and it is unsure how well it works. Additional treatment from the infiltration basin would be required and therefore monitoring wells used.

Figure 3

Figure 4

Advantages:

1 Initial construction cost

2 Good telemetry and technical assistance

3 Effectively removes BOD and TSS to less the 10mg/l

4 Small foot print allows for it to be placed on site and work around existing lagoon

5 Comes in packages for quicker less obtrusive construction

6 Minimal visual and odor impacts

Disadvantages:

1 More advanced operations and maintenance

2 Annual Maintenance cost $5,000 in power consumption and part replacement

3 Maintenance agreement for technical assistance and monitoring $250 per year per house - $10,000 per year for whole system.

4 Not as effective at nitrogen removal effluent at 25mg/l or worse during cold temperatures

5 Requires new septic tanks, about $5,000 per year to pump septic tanks

6 Because of pumps – power outages/failures require immediate attention by technician.

Table 3 (not yet including cost for septic tanks and modifications to RIB)

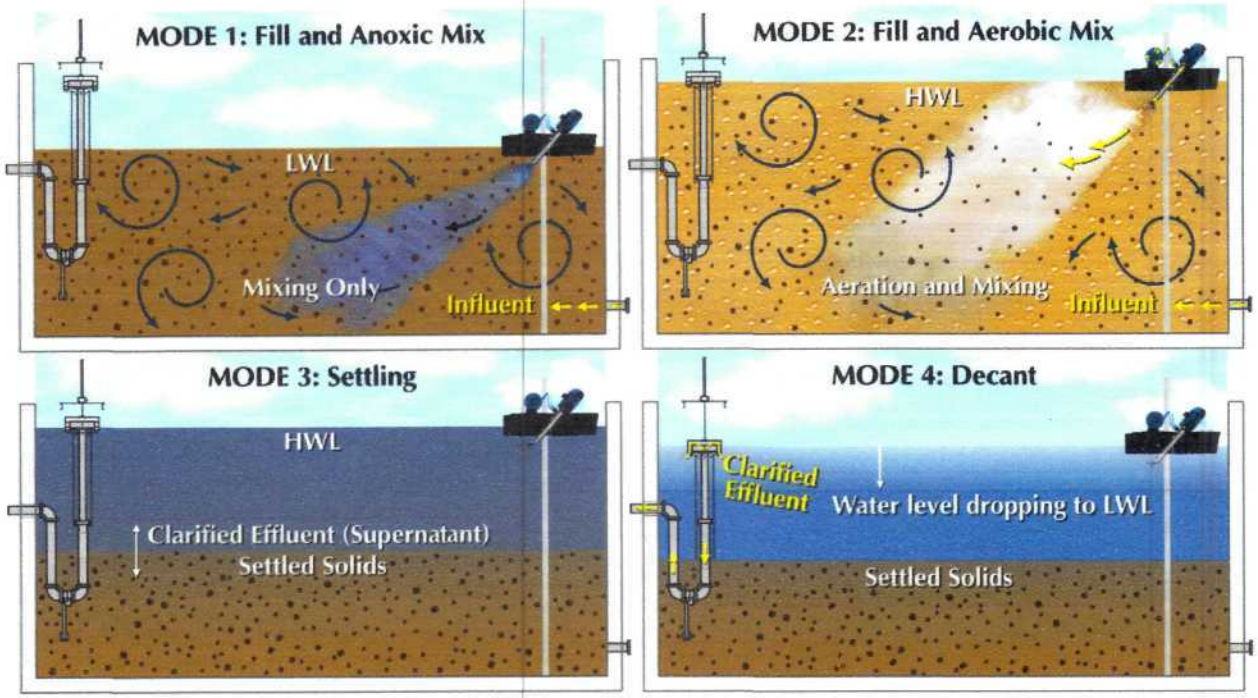
ADVANTEX® SYSTEM COST				
$38,850	$359,500	$30,200	$428,550	$1,297,648

6.4 Sequencing Batch Reactor (SBR)

Packaged system from Aeration Industries, still waiting for preliminary design cost and submittal package from them.

Similar to how existing lagoon is operated but with two different basins, one fills as the other mixes and aerates just more efficient. Aeration Industries provides a packaged system that can treat BOD, TSS and nutrients to a high level as it has all treatment phases in it, anaerobic, aerobic mix with high levels of dissolved oxygen, clarification and decant all in the same basin but at different time intervals. Installation would be quick and simple between Oregon Street and existing lagoon so as to not effect the operations of existing ponds. Then the SBR would utilize the existing RIB as is.

Figure 5



Advantages:

1 Medium level of operations and Maintenance.

2 Relatively low operations and maintenance cost

3 Good telemetry and technical assistance

4 Effectively removes BOD, TSS and nitrogen to levels less than regulatory requirements.

5 Small foot print allows for non obtrusive construction

6 No additional sludge removal

7 No changes to discharge process

Disadvantages:

1 Slightly higher total initial cost? Not yet finalized

2 Slightly more difficult operations requirements with more controls

Table 4

6.5 Package Plant

There are many different types of package plants and while simple from a designer and installation perspective, many prove to be expensive and problematic. One package plant that has been proven in the state of Colorado to be relatively cost effective (compared to other package plants and mechanical plants) and effective at treating wastewater is the Ecolo Chief out of Grand Island, Nebraska.

The Ecolo Chief is an Activated Sludge, Extended Aeration package plant. The principal structures include a flow equalization tank, one primary separation tank, one anoxic tank, two aeration tanks, one final settling tank (clarifier) and one aerobic digester. The treated effluent is finally treated through disinfection and piped to a disposal option (ground or surface). The Ecolo Chief historically has been able to meet the Division's effluent limits at other locations in Colorado, which should be able to discharge directly to ground water, surface water or both at

different times of year.

All tanks are eleven feet tall and will be equipped with guardrails and installed in the ground with 12 to 18-inches above finish grade. The tanks are buried to retain as much heat as possible during the winter months, therefore, keeping the process working efficiently. Cathodic protection using magnesium anodes will be installed to prohibit corrosion. The footprint is also relatively small (60' X 30') and could be located at the same three locations as the previous alternative.

Figure 9

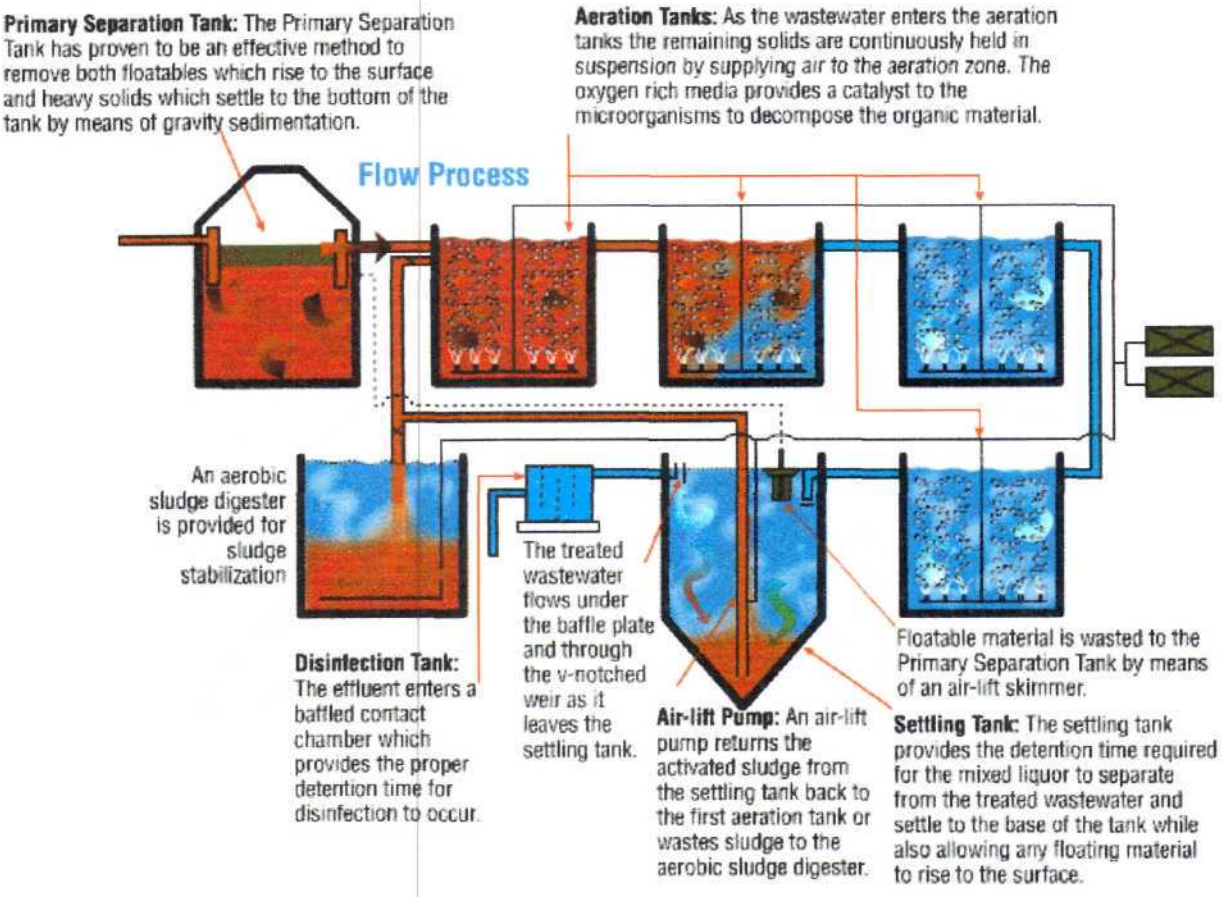


Figure 10

Advantages:

1 Small foot print allows for less obtrusive quick construction due to the packaged system

2 No changes to discharge process

3 Effectively removes BOD, TSS and nitrogen

Disadvantages:

1 Higher total initial cost

2 Requires periodic grit removal from separation tank and sludge removal from Aerobic Digester

3 Higher operational and maintenance cost

4 Much higher-tech Operational requirements.

Table 5 (have not yet received site/project specific quote but from previous project in North West Colorado)

ECOLO CHIEF PACKAGED PLANT COST				
$39,900	$691,000	$22,000	$752,900	$1,386,018

6.6 Connection to Buena Vista Sanitation District Central Sewer

One of the requirements of this FS is to evaluate the possibility of connecting Chateau Chaparral subdivision onto central sewer system. It is widely accepted that connecting to central sewer provides the greatest ground water protection. This would eliminate the WWTF at Chateau Chaparral all together and eliminate such responsibility from the Owners Association.

It would require tap fees at BVSD rates and user rates at about $100 a quarter, but no operating cost and or responsibilities. SGM looked at one possible route for a force main line along the railroad easement (***see Area Map***). This rout is 4.7 miles long and the cost for just the pipe installation would be at least $750,000.

Advantages:

1 A WWTF located within the Chateau Chaparral would be eliminated and no longer a potential pollution source and no longer the responsibility of the HOA.

2 Adjacent neighbors could tie into this line to further protect groundwater.

Disadvantages:

1 Logistical and easement challenges

2 Cost about ($750,000 for the 4.7 miles of pipe alone without easements cost, tap fees, lift station...)

Table 6

6 Conclusions and Recommendations

6.1 Conclusions

Not yet finalized

6.2 Recommendations

AIPS or SBR depending on final costs

Appendix C

NORTH VALLEY HOME OWNERS ASSOCIATION
SEWER SYSTEM ANALYSIS AND RECOMMENDATIONS
ALTERNATIVE COST ESTIMATE
SCHMUESER GORDON MEYER, INC.

	ALTERNATIVES	*TOTAL ENGINEERING & SURVEYING COST	TOTAL CONSTRUCTION COST	ANNUAL OPERATION & MAINTENACE COST	**TOTAL FIRST YEAR COST	***TOTAL 20 YEAR COST
1	PACKED BED FILTER	$41,270	$217,900	$15,200	$274,370	$711,797
2	ADVANCED INTEGRATED POND SYSTEM (AIPS)	$41,050	$446,000	$8,700	$495,750	$746,119
3	ADVANTEX SYSTEM	$38,850	$359,500	$30,200	$428,550	$1,297,648
4	TIDAL WETLAND LIVING MACHINE SYSTEM	$37,660	$388,500	$18,600	$444,760	$980,032
5	ECOLO CHIEF PACKAGED PLANT	$39,900	$691,000	$22,000	$752,900	$1,386,018
6	CONNECTION TO GUNNISON COUNTY CENTRAL SEWER	$54,930	$279,000	$5,840	$339,770	$507,834

*Alternatives 3,4 and 5 are packaged type systems and the engineering costs for the internal workings are included in the Total Construction Cost

**Total First year cost is the sum of the three first columns

***A 4% inflation rate was used on the Annual Operation and Maintenace Cost to project the 20 year cost