# Draft Project Report

# Woodacre – San Geronimo Wastewater Recycling Study

*Prepared for:*

***Marin County Community Development Agency***
***Environmental Health Services Division***
*3501 Civic Center Drive, Room 236*
*San Rafael, California 94903*



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QUESTA ENGINEERING CORP.

***March 2017***

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# Marin County, California

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Questa Project no. 1600073

March 2017

Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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# EXECUTIVE SUMMARY

## BACKGROUND AND INTRODUCTION

This report presents the results of a study regarding the feasibility of constructing a community sewer system and tertiary water recycling treatment facility for up to approximately 360 developed properties currently served by onsite wastewater systems (septic systems) in the San Geronimo Valley area of Marin County. The Study Area encompasses the low-lying and more densely developed portions of the communities of Woodacre and San Geronimo (**Figure ES-1**).

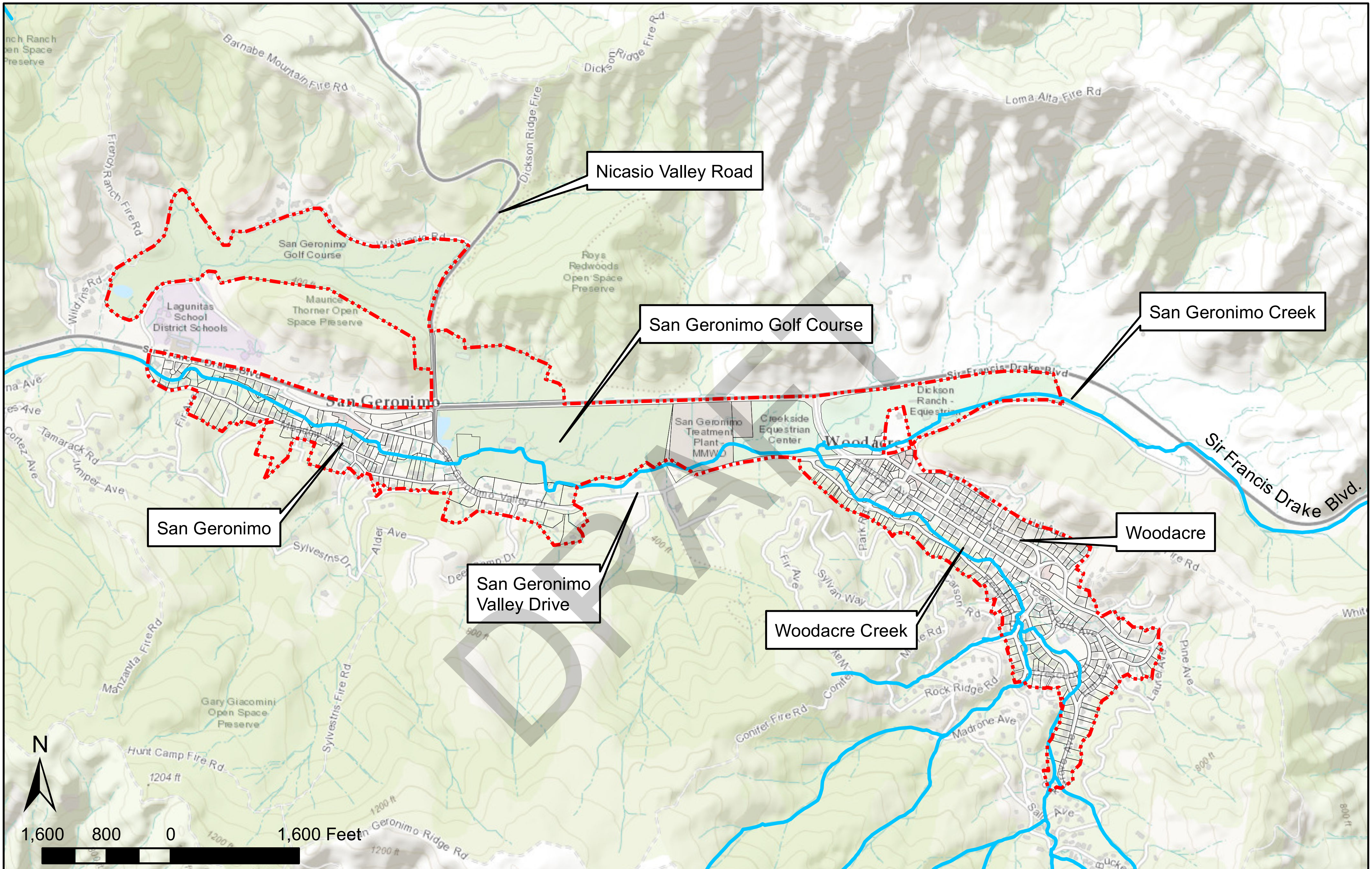
Woodacre and San Geronimo are located in the San Geronimo Creek watershed, tributary to Lagunitas Creek which is listed as impaired for pathogens, nutrients, and sediment. The Tomales Bay Pathogen TMDL of 2005 identifies lower San Geronimo Creek as the second greatest source of fecal coliforms entering Tomales Bay, after Walker Creek, and requires the County of Marin to take action to address failing septic systems.

Inspections of existing septic systems in the winters of 2004-05 and 2007-08 in Woodacre found a high percentage (77%) of homes had marginal or failing systems. Water quality monitoring in Woodacre Creek by the Tomales Bay Watershed Council (TBWC) during the same time period found generally high levels of total and fecal coliform, nitrates and ammonia, as well as methylene blue active substances (MBAS), a component of detergents. This led to their identification of Woodacre as a high priority for correction of failing septic systems, the formation of a local homeowner steering group (Woodacre Flats Wastewater Group), and eventually the initiation of a wastewater feasibility study for the “Woodacre Flats” area sponsored by the County of Marin with funding from the local community, the County, the U.S. EPA.

The “Woodacre Flats Wastewater Feasibility Study” was completed by Questa Engineering Corporation in July 2011, identifying and evaluating wastewater improvement alternatives for approximately 150 parcels in the most problematic areas of the community affected by high groundwater, drainage, clayey soils, small parcel size and age of systems. The study identified two promising options: (1) a local community leachfield option with limited capacity for properties in Woodacre; and (2) a wastewater recycling alternative centered around the San Geronimo Golf Course that could potentially support a larger number of homes, including and extending beyond Woodacre. The water recycling alternative was favorably received by the community and forms the basis for this follow-on study of a project that could serve homes in both the Woodacre and San Geronimo communities.

## EXISTING WASTEWATER DISPOSAL PRACTICES

There are no public sewers serving the Woodacre-San Geronimo study area or other parts of the San Geronimo Valley. All properties in the study area rely on individual onsite septic systems for sanitary waste treatment and disposal. This typically includes a septic tank for collection and settling of solids, with some type of leaching system for disposal (percolation) of the liquid into the soil. Most of the properties in the area were developed prior to the adoption of current County Codes. Gravity systems are most common, although more recent development has included the use of alternative systems, such as mounded and pressure distribution dispersal fields and advanced treatment units.

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| DATE: | 12/12/2016 |
| PROJECT: | WOODACRE WW |
| PROJECT NO.: | 1600073 |
| DRAWN: | DD |
| APPROVED: | NH |

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## STUDY AREA

**FIGURE ES-1**

There are many existing septic systems in the Woodacre and San Geronimo communities with unknown construction features, indicating the likelihood of an antiquated or questionable design that differs significantly from modern codes and practices. Review of County records shows less than half of the developed properties have septic system permit information on file with Marin County EHS. In 2004-2005 voluntary (confidential) septic system inspections conducted as part of a County-wide outreach effort ("Septic Matters Program") found roughly two-thirds of the systems inspected in Woodacre to have marginal to unacceptable operating conditions due to many of the following conditions and factors:

- System age, pre-dating modern standards and codes
- Small systems, undersized for current uses
- Additional living units, placing increased demand on sewage disposal systems
- Small parcel size with high intensity of development and limited remaining area for sewage disposal
- Restricted access to yard areas for system maintenance and repair
- Unpermitted repairs and greywater systems
- Shallow depth to groundwater, including seasonal saturation at or near ground surface
- Shallow soils and marginal soil permeability
- Close proximity to streams and local drainages

File and field reviews conducted as part of the 2011 study of Woodacre Flats revealed information consistent with the above findings. Additional review of septic system file information and site conditions for the properties in the San Geronimo portion of the study area showed many of the same septic system constraints and practices.

Although not located within the Woodacre-San Geronimo study area, it is important to note that there are some existing larger-flow wastewater systems, in the range of 5,000 to 10,000 gpd design capacity, providing onsite wastewater treatment and disposal for development on properties bordering or near the study area. These wastewater systems, which employ advanced/secondary treatment and onsite disposal using pressure distribution and/or drip dispersal methods, include Spirit Rock Meditation Center, Lagunitas School, and French Ranch development. These systems are regulated under waste discharge requirements issued by the Regional Water Board and operating permits issued by the Marin County EHS.



## SERVICE AREA

Wastewater improvement projects are planned and developed around a given geographical area termed the "service area". The service area provides the basis for estimating wastewater facility requirements, project alternatives and costs. Delineating the service area is often an iterative process, whereby initial boundaries are assumed for feasibility analysis, and subsequently adjusted in response to findings, recommendations and other factors, which is the case for this project.

### 2011 Woodacre Flats Study Area

The 2011 Wastewater Feasibility Study for Woodacre Flats addressed a service area encompassing approximately 150 mostly residential parcels in the low-lying portions of the community of Woodacre. Out of the study came the identification of a wastewater recycling alternative centered around the San Geronimo Golf Course that could potentially support a larger service area, which was favorably received by the community.

### Woodacre-San Geronimo Service Areas

The current study was undertaken to evaluate the feasibility of a community wastewater system to serve a larger study area, including additional homes in Woodacre Flats plus homes in a portion of San Geronimo located in similar valley areas near the Golf Course. The study area encompasses developed properties believed to be in most need of wastewater improvements and where residents have expressed the greatest level of interest in studying possible sewerage alternatives. There are a total of approximately 360 developed parcels within the larger study area, with about two-thirds in Woodacre and one-third in San Geronimo.

The approach to this project does not anticipate a condition or requirement for mandatory connection to community wastewater facilities for all properties in the study area or for any particular properties. It does, however, include the limitation that the facilities be planned and implemented to serve existing developed properties, with allowance for a modest amount of expansion for low-incoming housing, child day care facilities or similar community needs.

There is varied property owner interest in connection to community wastewater facilities, as well as differing wastewater improvement needs from property to property. Although not economically most efficient, the types of wastewater collection systems evaluated for the project lend themselves to providing service to a mix of "connected" and "non-connected" properties along the sewer route.

Based on the above, feasible project alternatives were formulated with different configurations and capacities to serve all or portions of the 360 developed properties in the study area as discussed further in the description of alternatives and estimation of wastewater flows.



### Expanded Service Area Alternative

Additionally, in the course of the study and in response to community input, an "Expanded Project Alternative 6" was identified that could provide capacity for extension of sewer service to other existing developed properties lying beyond the study area boundaries. This would entail integrating the existing wastewater flows and facilities serving the French Ranch subdivision and Lagunitas School into the water recycling system through tie-in at the west end of the San Geronimo collection system. It would take advantage of surplus wet weather storage/disposal capacity provided by existing leachfields adjacent to the golf course, and increase the amount of recycled water produced. It would also provide capacity for wastewater service to be extended to approximately 80 to 100 additional residential properties in nearby areas (to be determined) beyond the study area boundaries.

## ESTIMATED WASTEWATER FLOWS

Information regarding wastewater flows is important for assessing the required capacity of collection, treatment, storage and disposal facilities for community wastewater alternatives. Estimated wastewater flows for the study were developed based on the assumed number of parcels to be served, the type of development on the those parcels, and review of typical reference data and monitoring information from other small community wastewater facilities.

The Woodacre and San Geronimo service areas consist mainly of single family residential parcels, with a small amount of commercial uses. The commercial uses are mainly the types that generate wastewater volumes similar to or less than single family residences (e.g., offices, shops, Post Office, small apartments). Noted exceptions are two commercial uses: (1) Two Bird Café, a small restaurant; and (2) the San Geronimo Golf Course Clubhouse, which includes a restaurant, bar and banquet facilities in addition to restroom use for employees and golfers. The estimation of wastewater flows were developed by applying a typical unit wastewater flow for residential use for all properties, with an added allowance for the Two Bird Café and Golf Course Clubhouse based their respective food service activities and higher volume of wastewater generation.

Unit wastewater flows in gallons per day (gpd) per single family residence (or equivalent) were developed from review of daily and monthly flow data for the past six years for three small community wastewater systems: (1) French Ranch development, (2) Marshall Community Wastewater Facility, and (3) Lake Canyon Community Services District near Los Gatos in Santa Clara County. Taking into account an allowance for infiltration/inflow (I/I) associated with conventional gravity sewers, the following estimated unit wastewater flows were selected for assessing community wastewater alternatives:

- 30-day Average Daily Flow, Wet Weather: 120 gpd/parcel
- 30-day Average Daily Flow, Dry Season: 100 gpd/parcel
- Peak Daily Flow Wet Weather: 150 gpd/parcel

The Average Daily Flows are pertinent to the sizing and design of a community wastewater treatment system, wet weather storage facilities (ponds), and estimation of annual volumes of recycled water produced. The Peak Daily Wet Weather Flow value is pertinent to: (a) sizing of flow equalization and emergency storage for the community wastewater facility; and (b) sizing of community leachfield facilities, where applicable. For Alternative 6, which provides for integration of existing wastewater flows/facilities for the golf course clubhouse, French Ranch and Lagunitas Schools, additional wastewater flow contribution was based system design and operating data.

Based on the above, the estimated wastewater flows assigned to different levels of wastewater service/alternatives are shown in **Table ES-1**.



**Table ES-1. Estimated Wastewater Flows, gpd**

| Factor | Alternative 4 | Alternative 5a | Alternative 5b | Alternative 6 |
|---|---|---|---|---|
| Residential Connections (ESDs) | 210[1] | 270[2] | 360[3] | 420+[4] |
| Ave Wet Weather Flow | 26,000 | 33,200 | 44,000 | 53,300 |
| Ave Dry Weather Flow | 22,000 | 28,000 | 37,000 | 43,500 |
| Peak Daily Wet Weather Flow | 35,000 | 45,000 | 60,000 | 70,000 |

[1] Woodacre parcels only
[2] 75% of Woodacre/San Geronimo
[3] 95-100% of Woodacre/San Geronimo
[4] 100% of Woodacre/San Geronimo, Golf Course Clubhouse, French Ranch and Lagunitas School; potential capacity for further expansion up to approximately 500 total connections.

## PROJECT ALTERNATIVES

Project alternatives were formulated in consultation with Marin County and Regional Water Board staff, utilizing the results of the 2011 Woodacre Flats study as well as input from members of the community and San Geronimo Golf Course. To provide continuity and a frame of reference, the current study includes Non-Water Recycling project alternatives (updated) from the 2011 study along with several Water Recycling alternatives consistent with the project objectives. Project alternatives are illustrated in **Figure ES-2**.

### Non-Water Recycling Alternatives

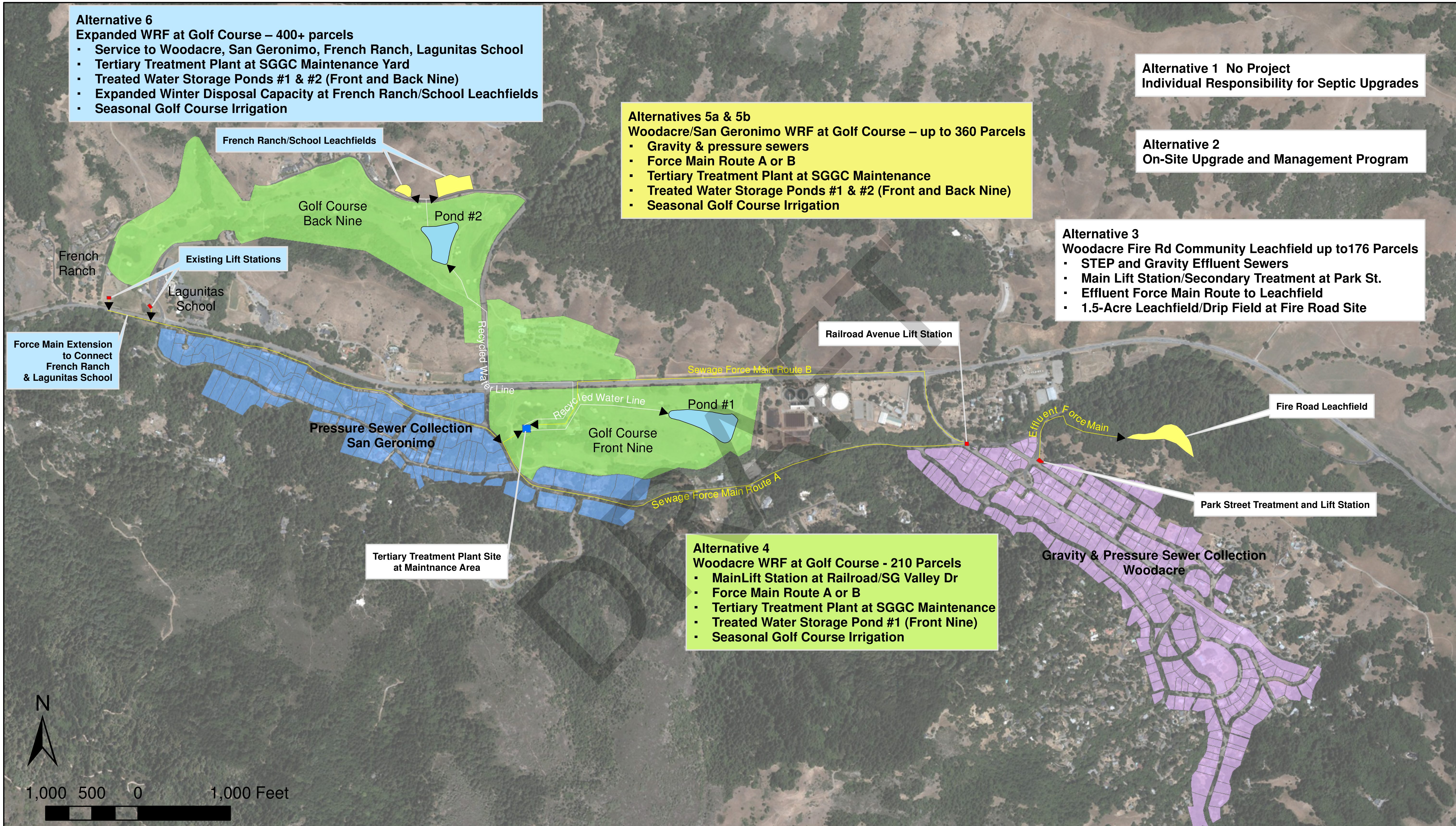
- **Alternative 1 - No Project**. This would involve maintaining the status quo, where individual property owners would be responsible for maintaining and upgrading their own onsite systems, and abatement of septic system failures as directed by Marin County EHS and/or the San Francisco Bay Regional Water Board.

- **Alternative 2 - Onsite Wastewater Management Program**. This alternative considers the upgrade of onsite systems in conjunction with the formation of a local septic system maintenance and inspection program. The program would be operated under the authority of a wastewater maintenance district, County Service Area or similar public entity covering the boundaries of the selected service area. Financing of individual septic system improvements would be accomplished with grant and/or loan assistance to bring all currently developed properties into conformance with minimum acceptable "repair" standards.

- **Alternative 3 - Community Leachfield – Woodacre Only (176 parcels)**. This alternative would provide for the construction of a central wastewater collection system for properties in the Woodacre Flats area only, leading to a community a leachfield system located on nearby wooded open land. The area identified for a potential community leachfield site is a wooded knoll along the Fire Road ridgeline northeast of Woodacre on property which is part of the Dickson Ranch. The preferred configuration of this alternative (Option 3B) from the 2011 study included a secondary wastewater treatment system located in the community (Park Street), with a shallow pressure distribution leachfield. For the current study, this Alternative 3 has been modified to include a dual (200%) capacity leachfield system with capacity to serve up to an estimated 176 existing residential connections in the Woodacre Flats service area. This would cover about 70% of the developed properties in the Woodacre portion of the study area. No comparable community leachfield facility alternative to serve the San Geronimo portion of the study area was identified.

### Water Recycling Alternatives

- **Alternative 4 – Water Recycling System at San Geronimo Golf Course – Woodacre Only (210 parcels)**. This closely matches Alternative 4 from the 2011 study, the only difference being an expanded capacity to serve up to an estimated 210 parcels in the Woodacre portion of the study area. This would be achieved by expanding the size of the proposed storage Pond #1 on the front nine of the golf course. It would entail the construction of a central wastewater collection system in the Woodacre service area, a wastewater transmission line to the San Geronimo Golf Course (via San Geronimo

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| PROJECT: | WOODACRE WW |
| PROJECT NO: | 1600073 |
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# PROJECT ALTERNATIVES

FIGURE ES-2

Valley Dr. or Sir Francis Drake Blvd), a tertiary treatment plant (30,000 gpd capacity) located in the golf course maintenance area, a holding pond on the southeastern portion of the golf course (near green #2) for winter storage of recycled water, and seasonal reuse of the recycled water for spray irrigation of the golf course turf grass. The wastewater would be treated to meet State requirements for disinfected tertiary recycled water, and would be integrated into the existing golf course irrigation system to reduce the amount of raw water currently supplied from MMWD.

- **Alternative 5a –Water Recycling System at San Geronimo Golf Course –Woodacre & San Geronimo, Partial Capacity (270 parcels).** This alternative would be an expansion of Alternative 4, including wastewater service to approximately 75% of the developed properties in both Woodacre and San Geronimo. It would include wastewater collection facilities throughout both communities, with the assumption that approximately 75% of the property owners would opt to connect to the system. Those not connecting would continue to be served by their existing/improved onsite septic systems. Compared with Alternative 4, the additional facilities under Alternative 5a would include: (a) wastewater collection system in San Geronimo consisting of pressure sewers with individual grinder pumps at each residence; (b) network of pressure sewer lines connecting at San Geronimo Valley Drive and the western driveway entrance into the golf course maintenance area; (c) expansion of the tertiary treatment plant capacity to 35,000 gpd; (d) construction of holding Pond #2 (lower section only) located adjacent to #18 fairway on the back nine of the golf course; and (e) recycled water transmission line and pumping facilities from the treatment plant to Pond #2.

- **Alternative 5b – Water Recycling System at San Geronimo Golf Course – Woodacre & San Geronimo, Full Capacity (360 parcels).** This alternative is an expanded version of Alternative 5a, with facilities sized to provide service to essentially all developed properties in the Woodacre and San Geronimo communities. The expanded capacity would be achieved by constructing Pond #2 to full (maximum) size and expanding the tertiary treatment plant capacity to 50,000 gpd. This alternative maximizes the system capacity that can be provided based on largest feasible sizing of Ponds #1 and #2 for wet season holding capacity in conformance with required 100-yr design rainfall criteria.

- **Alternative 6 – Expanded Water Recycling System at San Geronimo Golf Course – Woodacre, San Geronimo & Additional Areas.** This alternative would include all features of Alternative 5b and would be expanded further to provide capacity to serve existing developed properties located outside of the project study area boundaries. The tertiary treatment plant capacity would be 60,000 gpd. The key to this alternative would be the integration of Lagunitas School and French Ranch wastewater facilities into the water recycling system. Both presently operate independent wastewater treatment and disposal facilities, approximately 10,000 gpd capacity each. They have treatment and pumping facilities located near the west end of the San Geronimo portion of the study area, and large capacity leachfields located adjacent to the San Geronimo Golf Course a short distance from proposed Pond #2.

  Alternative 6 would provide for the school and French Ranch to: (a) decommission their existing treatment systems; (b) modify their effluent pumping stations for connection to the west end of the proposed San Geronimo sewage force main; and (c) execute an agreement(s) to make their respective leachfields near proposed holding Pond #2 available for dispersal of recycled water, as needed. With these measures, all wastewater from Lagunitas School and French Ranch would become part of the flow treated at the tertiary water recycling facility and add to the annual volume of recycled water available for golf course irrigation. The ability to divert recycled water to the leachfields would supplement the wet weather storage/flow capacity of the recycled water system by as much as 20,000 gpd or more, more than compensating for the average wet weather flow contribution of about 7,500 gpd from these two systems. Surplus capacity would potentially be available for other connections. The leachfields would normally be dormant, likely put to use only in very wet rainfall years, e.g., 10-yr to 100-yr events.

## ESTIMATED RECYCLED WATER VOLUMES

The volume of recycled water that will be produced for irrigation uses at the golf course varies among Alternatives 4 through 6 based on number of parcels served and the corresponding wastewater flows collected and processed through the treatment system. Since the recycled water will be stored in open ponds subject to rainfall additions and evaporation losses, the recycled water volume with also fluctuate from year-to-year according to prevailing weather conditions. Annual water balance analysis using monthly time steps was conducted for the ponds to estimate the annual volume of recycled water produced under each alternative and for a range of annual rainfall volumes – average year, 10-year and 100-year recurrence. The results are presented in **Table ES-2**. The 100-yr rainfall conditions would be a very rare occurrence, but are included for reference as they are the regulatory design standard for the storage ponds.



**Table ES-2. Estimated Annual Recycled Water Production**

| Alternative | No. of Connections (ESDs) | Average Rainfall (41.6”) | | 10-yr Rainfall (61.3”) | | 100-yr Rainfall (75.3”) | |
|---|---|---|---|---|---|---|---|
| | | Acre-feet | Million Gals | Acre-feet | Million Gals | Acre-feet | Million Gals |
| Alternative 4 | 210[1] | 28.3 | 9.2 | 31.0 | 10.1 | 33.1 | 10.8 |
| Alternative 5a | 270 | 37.6 | 12.3 | 41.8 | 13.6 | 45.1 | 14.7 |
| Alternative 5b | 360 | 50.0 | 16.3 | 55.9 | 18.2 | 60.6 | 19.7 |
| Alternative 6 | 420[2] | 56.0 | 18.3 | 61.6 | 20.1 | 63.9 | 20.8 |

[1] Woodacre parcels only
[2] 375 Woodacre/San Geronimo, plus Golf Course(5), French Ranch (30), Lagunitas School (10)

The annual irrigation water demand for the golf course varies between approximately 47 and 53 million gallons, depending on weather conditions. Based on average conditions, recycled water would be able to supply from about 18 to 37 percent of the irrigation demand for the range of alternatives evaluated.

## ESTIMATED PROJECT COSTS

**Table ES-3** presents a summary of estimated capital costs and annual operation and maintenance (O&M) costs for various project alternatives, along with the estimated cost per residential connection (parcel) served by the system.

### Capital Costs

The estimated capital costs include facilities construction as wells as the necessary engineering and environmental studies, project administration, district formation and financing costs. A 15% contingency allowance is also included. Not included are: (a) allowances for land/easement costs for the treatment plant, storage ponds, pipelines and appurtenances that would be located on Golf Course property, applicable to Alternatives 4 through 6; and (b) allowances for an easement(s) to integrate the French Ranch and Lagunitas School leachfield systems into the project under Alternative 6. It is anticipated that these costs would be determined buy-in agreements with the various parties, also addressing wastewater service provided and recycled water production benefits.

### Annual Operation and Maintenance Costs

The estimated annual O&M costs include costs for administration, labor, equipment, materials, and other expenses required to perform the necessary inspections, treatment plant operation (as applicable), water quality sampling, data analysis, report preparation, pump-outs, and routine maintenance for wastewater facilities. The level and nature of required O&M activities vary according to the wastewater facilities and operating requirements under each alternative. The estimated O&M costs for the recycled water alternatives (4 through 6), do not include the activities required of the Golf Course to manage and apply the recycled water for irrigation uses in accordance with State requirements for use of recycled water. The cost estimates also do not include the projected value of the recycled water that would be provided to the Golf Course by the operation of the project. As noted, under Alternative 6 the per parcel cost includes the assumption that costs would be shared on a proportionate basis among all users, including the Golf Course, French Ranch and Lagunitas School based on their respective volume of wastewater contribution ("equivalent single-family dwelling" factor).

**Table ES-3: Summary of Estimated Costs**

| Alternative | | No. of Equivalent Connections | Capital Costs ($) | | Annual O&M Costs ($) | |
|---|---|---|---|---|---|---|
| | | | Total | Per Parcel | Total | Per Parcel |
| Non-Water Recycling Alternatives | | | | | | |
| 1 | **No Project** | - | - | 35,000 to 70,000 | - | 1,000 to 1,500 |
| 2 | **Onsite Upgrades & Management Program** | 363 | 19,306,430 | 53,186 | 350,790 | 966 |
| 3 | **Woodacre Fire Road Community Leachfield** | 176 | 6,629,839 | 37,670 | 155,760 | 885 |
| Golf Course Water Recycling Alternatives | | | | | | |
| 4 | **Woodacre Only (1) Storage Pond** | 210 | 9,563,777 | 45,542 | 291,540 | 1,356 |
| 5a | **Partial (75%) Woodacre-San Geronimo** | 270 | 12,652,447 | 46,861 | 346,564 | 1,260 |
| 5b | **Full (95%+) Woodacre-San Geronimo** | 360 | 14,323,558 | 39,788 | 366,465 | 1,004 |
| 6 | **Expanded Service Area[1]** | 420+ | 14,962,670 | 39,900[2] | 440,920 | 1,050[3] |

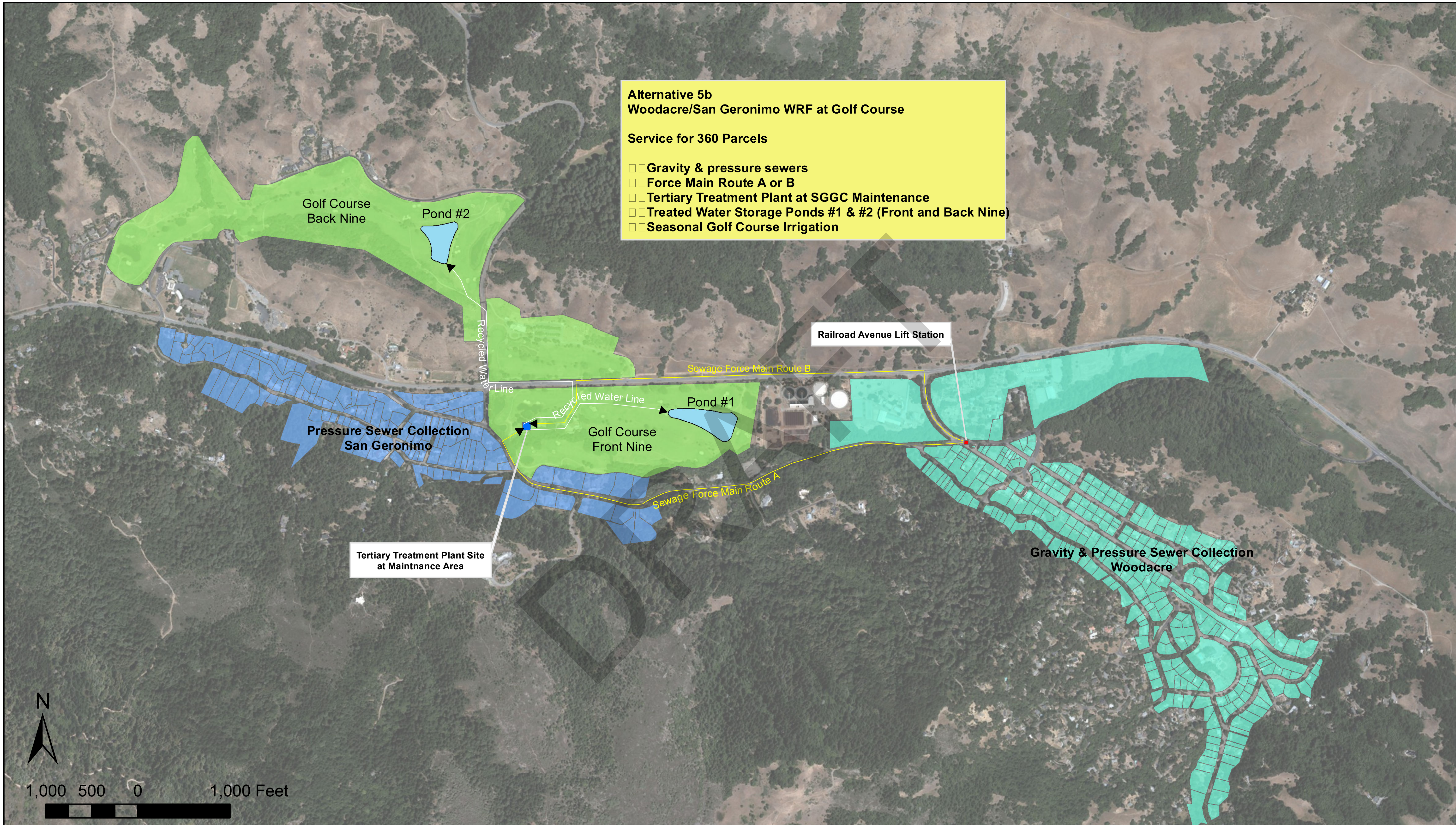
[1] includes integration with French Ranch & Lagunitas School wastewater facilities plus service to golf course
[2] Cost share for Woodacre-San Geronimo properties; Golf Course, French Ranch, Lagunitas School to be determined through
agreement for buy-in/integration of existing facilities.
[3] Costs shared among all users, based on total 420 ESDs (equivalent single-family dwelling): Woodacre/SG (375, Golf Course (5); French Ranch (30); Lagunitas School (10).



## COMPARATIVE REVIEW AND RECOMMENDED PROJECT

A comparative review was made of the advantages and disadvantages of the various project alternatives with respect to regulatory compliance, environmental impacts, reliability, energy use, water conservation/water recycling, land use, and costs. Based on this review, Alternative 5b was determined to be the "apparent best alternative" and the recommended project. Alternative 5b would include collection, treatment, and recycling of wastewater for turf irrigation at the San Geronimo Golf Course, with capacity to serve up to approximately 360 parcels in the Woodacre-San Geronimo study area. The system would have a capacity to accommodate an estimated average daily flow of approximately 44,000 gpd and peak flow of 60,000 gpd. Under average year rainfall conditions, the project would produce approximately 50 acre-feet (16.3 million gallons) of recycled water for golf course irrigation, allowing about an approximate 33% reduction in raw water obtained from MMWD.

The main facilities include: (a) wastewater collection systems extending throughout the Woodacre and San Geronimo service areas using a combination of conventional gravity sewers and pressure sewers; (b) sewage force mains from Woodacre and San Geronimo areas to the treatment plant location in the golf course maintenance area; (c) tertiary recycled water treatment plant located in an approximately 10,000 $ft^2$ area on the west side of the golf course maintenance yard; (d) two holding ponds, #1 on the front nine and #2 on the back nine of the golf course, for storage of up to approximately 12.4 million gallons of tertiary recycled water (plus rainfall); and (e) seasonal reuse of the recycled water for spray irrigation of the golf course, integrated into the existing irrigation system. **Figure ES-3** is a map showing the location and layout of key facilities for the recommended project, Alternative 5b.

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# RECOMMENDED PROJECT ALTERNATIVE 5b

FIGURE
ES-3

# SECTION 1: INTRODUCTION AND BACKGROUND

This report presents the results of a study regarding the feasibility of developing a community sewer system and tertiary water recycling treatment facility for properties currently served by onsite wastewater systems (septic systems) in the San Geronimo Valley area of Marin County (**Figure 1-1**). The particular geographical focus of the study ("Study Area") are the low-lying and more densely developed portions of the communities of Woodacre and San Geronimo, including up to approximately 360 existing developed properties, primarily single family residences. The aim of the project is to remedy public health and environmental pollution problems while providing a local source of recycled water for water conservation. The recycled water would be incorporated into the existing San Geronimo Golf Course irrigation system, replacing potentially up to approximately 50 acre-feet per year of raw water currently supplied by Marin Municipal Water District.

Woodacre and San Geronimo are located in the San Geronimo Creek watershed, tributary to Lagunitas Creek which is listed as impaired for pathogens, nutrients, and sediment. The Tomales Bay Pathogen TMDL of 2005 identifies lower San Geronimo Creek as the second greatest source of fecal coliforms entering Tomales Bay, after Walker Creek, and requires the County of Marin to take action to address failing septic systems.

Inspections of existing septic systems in the winters of 2004-05 and 2007-08 in Woodacre found a high percentage (77%) of homes had marginal or failing systems. Water quality monitoring in Woodacre Creek by the Tomales Bay Watershed Council (TBWC) during the same time period found generally high levels of total and fecal coliform, nitrates and ammonia, as well as methylene blue active substances (MBAS), a component of detergents. This led to their identification of Woodacre as a high priority for correction of failing septic systems, the formation of a local homeowner steering group (Woodacre Flats Wastewater Group), and eventually the initiation of a wastewater feasibility study for the "Woodacre Flats" area sponsored by the County of Marin with funding from the local community, the County, the U.S. EPA.



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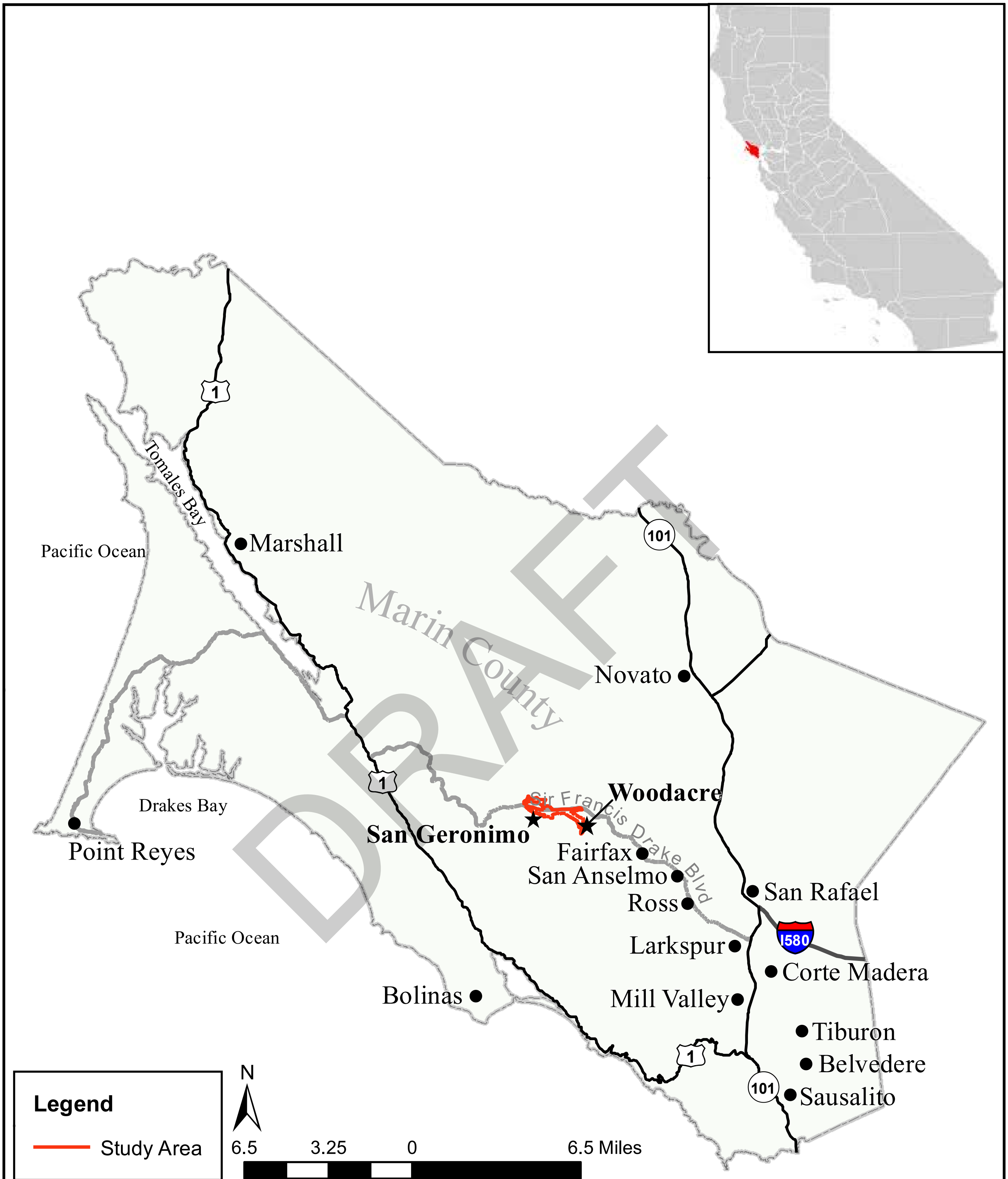
This community-based project is sponsored and managed by the County of Marin, with public input from a local community steering group (Woodacre/San Geronimo Flats Wastewater Group) with funding assistance provided by a grant from the State Water Resources Control Board (SWRCB) and the County of Marin.

In terms of the organization of this report, following the Introduction, background information on the general study area conditions, existing wastewater practices and concerns are covered in **Sections 2** and **3**. **Section 4** describes the boundaries and wastewater characteristics of the

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**Woodacre - San Geronimo Wastewater Recycling Study**

Marin County, California

**Figure 1-1**

Location Map

service area covered by the study. **Section 5** summarizes the key regulatory requirements applicable to the wastewater treatment, disposal and recycling alternatives evaluated in the study. The community wastewater and recycling alternatives are presented and described in **Section 6**, including facility requirements and estimated costs for construction and ongoing operation and maintenance. This is followed by a comparative analysis and review of the alternatives in **Section 7,** including identification of the "apparent best alternative". **Section 8** presents the recommended facilities project plan, including description of wastewater-water recycling facilities, project implementation plan, and operational plan.

# SECTION 2: STUDY AREA CONDITIONS

## GEOGRAPHICAL SETTING

The Study Area comprises a portion of the unincorporated communities of Woodacre and San Geronimo and the San Geronimo Golf Course , located in the center and eastern end of the San Geronimo Valley in western Marin County (**Figure 2-1**).

The Woodacre portion is roughly defined as the area bordered by and adjacent to San Geronimo Valley Drive on the north, Taylor and Central Avenues on the northeast, Redwood Drive on the southwest, and Oak Grove and Elm Avenues on the southeast. The Woodacre area includes 250 developed parcels, primarily the low-lying and most densely developed portions of the community. The developed properties are primarily single family residences, with a small number of commercial occupancies. There are also a small number of undeveloped (vacant) parcels within the boundaries of the Study Area.

The San Geronimo portion encompasses 113 developed residential parcels along San Geronimo Valley Drive, Meadow Way and Sir Francis Drake Boulevard, stretching over a distance of approximately one mile from the San Geronimo Golf Course to the San Geronimo Valley Community Center.

The 158-acre San Geronimo Valley Golf Course occupies the central part of the Study Area, with portions of the course located on both the south and north sides of Sir Francis Drake Boulevard. The Golf Course is integral to the wastewater study, as it represents the area under consideration for locating the wastewater treatment, storage and use area for recycled water. Other notable features in the study area include the Marin Municipal Water District's Treatment Plant and two equestrian facilities near Woodacre.

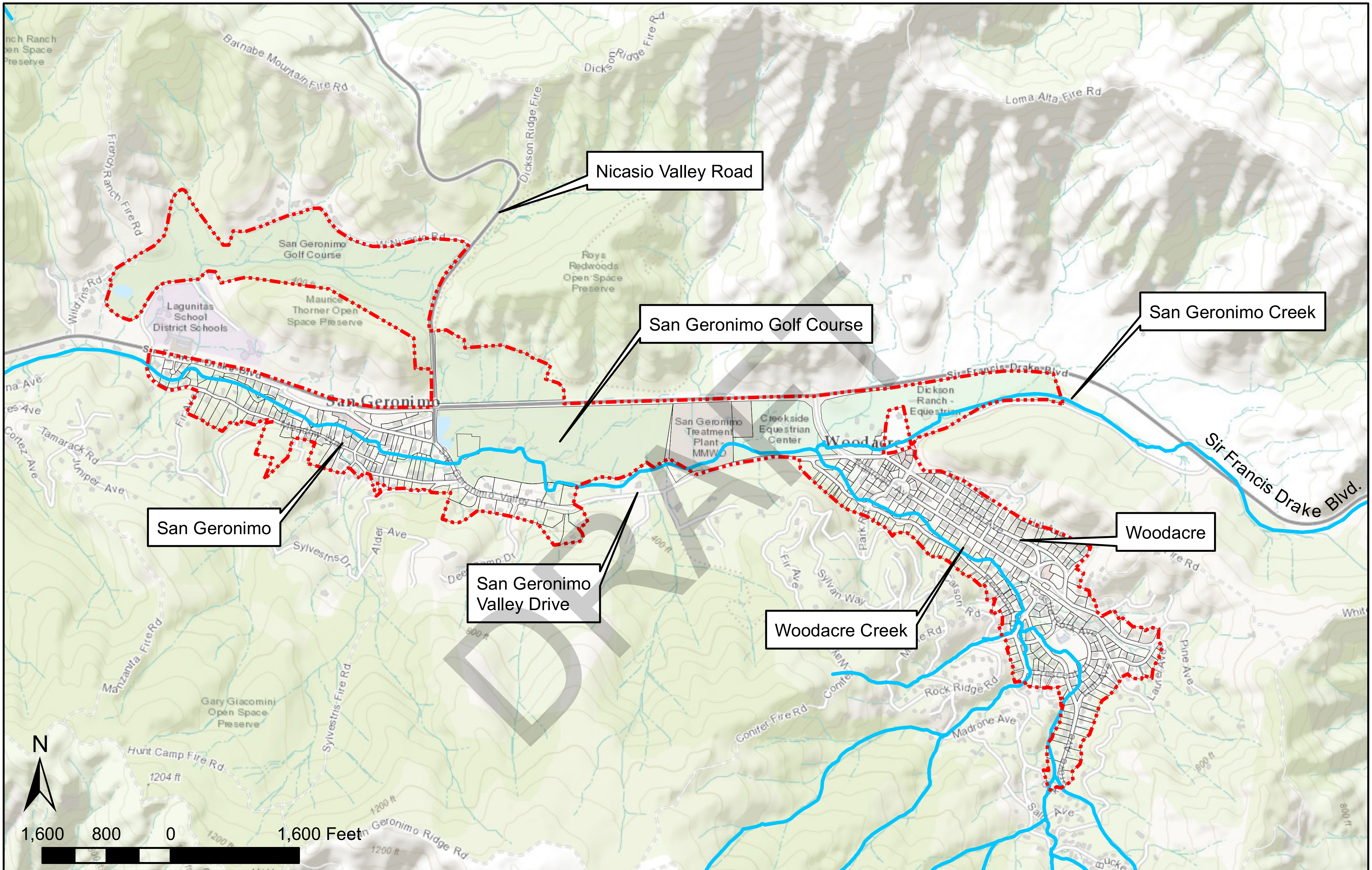


## HYDROLOGY

Woodacre and San Geronimo lie within the watershed of San Geronimo Creek, a year-round stream tributary to Lagunitas Creek and eventually into Tomales Bay (**Figure 2-2**). Woodacre Creek flows through the study area parallel to Redwood Drive, in a southeast-to-northwest direction. Woodacre Creek receives surface runoff and drainage from several small tributary branches and a network of storm drainage channels in the community. The San Geronimo portion of the study area is bisected by San Geronimo Creek.

The ground elevations in the study area range from about 270 to 300 feet above mean sea level (AMSL) in San Geronimo, to about 370 to 400 feet AMSL in the Woodacre area. The surrounding upland portions of Woodacre occupy steeper terrain, with elevations up to about 700 feet AMSL.

In Woodacre, the local hydrology is strongly influenced by the relatively flat gradients (2 to 3 percent in the Flats), concentrated runoff and drainage from the surrounding steep hills, and alteration of local drainage patterns by roads, the former railroad grade, and development of individual lots. Localized soil saturation and ponding of surface waters is common during the wet season. This has prompted many property owners to install various drainage mitigation measures in yards and around buildings, including curtain drains, sumps, and drainage ditches. San Geronimo experiences some of the same localized surface water ponding and drainage

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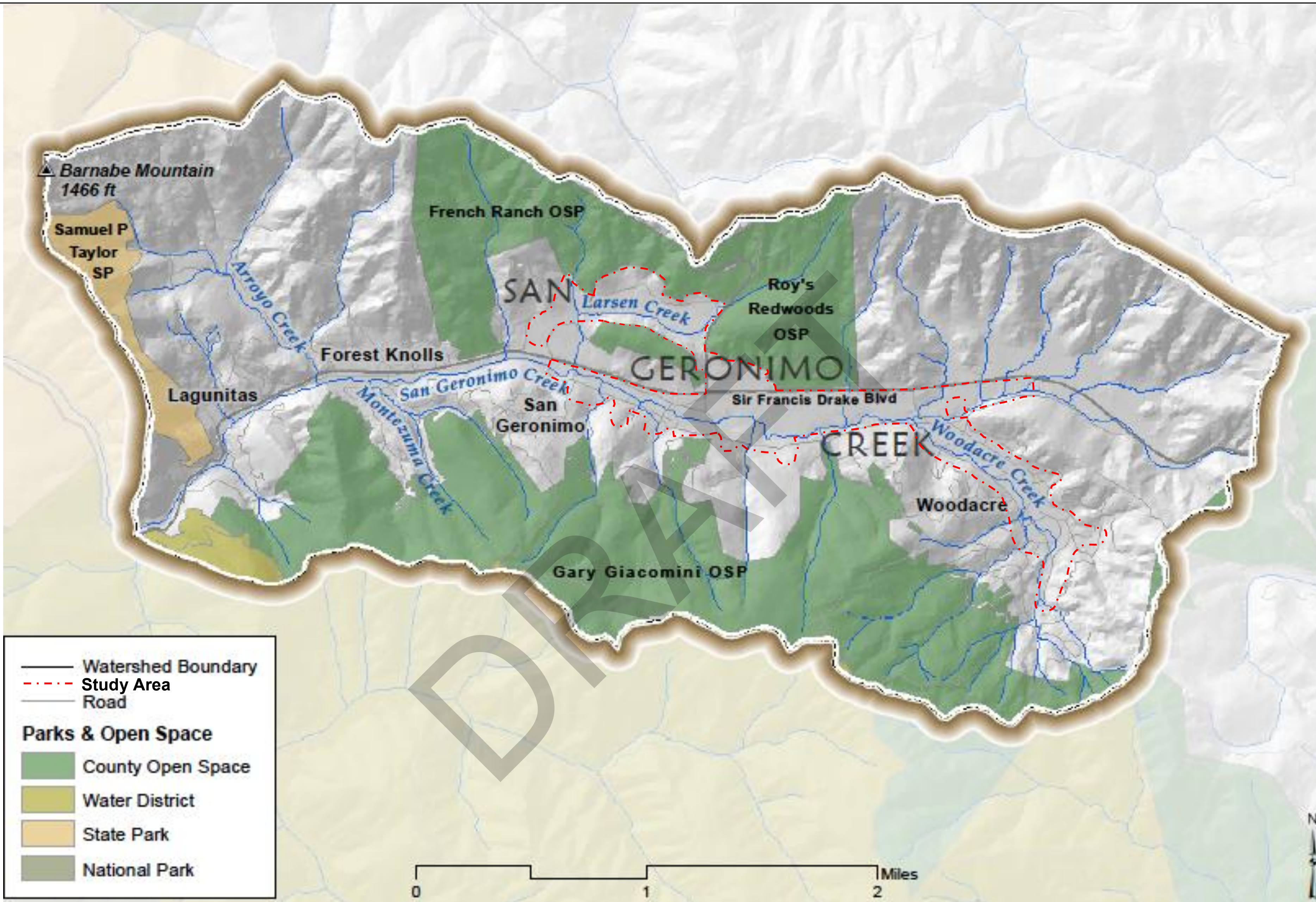
**STUDY AREA**

**FIGURE 2-1**

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| SOURCE: | MARIN COUNTY DPW |

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**SAN GERONIMO CREEK WATERSHED**

FIGURE

**2-2**

issues as Woodacre, but to a much lesser degree due to the more narrow landscape configuration along San Geronimo Creek.

Like most of the California coastal areas, the climate is Mediterranean, with wet winters and dry summers. The annual average rainfall for the area is approximately 42 inches, with 85 percent of the annual total typically occurring during the months of November through April. **Table 2-1** presents average monthly rainfall amounts for the Woodacre area based on rainfall measurements at Woodacre Fire Station, located within the study area. Also shown in **Table 2-1** are monthly rainfall estimates for 10-year and 100-year frequencies determined statistically from long-term rainfall records at San Rafael and Kentfield (see Appendix F).

**Table 2-1: Monthly Rainfall for Woodacre, California (inches)**

| Month | Average Year | 10-Year | 100-Year |
|---|---|---|---|
| January | 5.13 | 7.56 | 9.28 |
| February | 8.01 | 11.81 | 14.49 |
| March | 9.39 | 13.84 | 16.99 |
| April | 7.53 | 11.10 | 13.62 |
| May | 5.29 | 7.79 | 9.57 |
| June | 2.40 | 3.54 | 4.34 |
| July | 1.03 | 1.51 | 1.86 |
| August | 0.28 | 0.41 | 0.51 |
| September | 0.05 | 0.07 | 0.08 |
| October | 0.09 | 0.13 | 0.15 |
| November | 0.39 | 0.58 | 0.71 |
| December | 2.05 | 3.02 | 3.70 |
| **Total** | **41.6** | **61.3** | **75.3** |



# GEOLOGY AND SOILS

## Geology

The regional geology consists of the folded, faulted, and sheared bedrock of the Franciscan Complex, which is an accretionary mélange comprised of greywacke, chert, serpentine, schist, greenstone, and other rock types. The Franciscan Complex was formed 65 to 190 million years ago by the subduction of the Farallon Tectonic Plate and the northwest movement of the Pacific Plate to the North American Plate. Subsequent compression, uplift and faulting occurred during the Miocene and Pliocene epochs of the Tertiary Period (between 5 and 15 million years ago). The current tectonic setting is related to the movement along the northwest-southeast trending faults such as the San Andreas and Hayward Faults.

Locally, the Woodacre area consists of a valley with ridges rising up on both the northeast and southwest sides, and at the southeasterly end. Along the western side, the ridge is formed mainly of sandstone. In contrast, the eastern ridge (Fire Road area) and the uplands in the southern end of the valley consist of Franciscan Melange, including a mixed composition of serpentine, greenstone, chert, shale and sandstone blocks in a clayey/shale matrix. A sizeable sandstone block has been identified along the northern end of the eastern ridge. The San Geronimo portion of the study area lies almost entirely in the San Geronimo Valley floor, bounded by wooded uplands along the southern side.

## Soils

Soils in Woodacre and San Geronimo are derived from the accumulation of materials that have washed into the valley from the surrounding upland slopes and ridges. The soils are deep in some areas, but are generally somewhat poorly to very poorly drained, with seasonal groundwater levels less than 3 feet from ground surface. Deeper, sandy alluvial soils occur along the drainageways.

According to the Soil Survey of Marin County, soils in the Woodacre and San Geronimo area are primarily Blucher-Cole Complex, 2 to 5 percent slope, which occur in basins and alluvial fans. The distribution of soils in this complex is roughly as follows:

- **40% Blucher Silt Loams**. Blucher soils occur near drainageways and are deep and somewhat poorly drained, with seasonal high water table normally between 3.5 to 5 feet below ground surface. Permeability is typically moderate in near surface soils (to about 2-feet deep), and slow at deeper depths.

- **30% Cole Clay Loam** – Cole soils occur on basin rims and depression areas; they are very deep and somewhat poorly drained, with seasonal high water table normally between 1.5 to 3 feet below ground surface. Permeability is typically slow in Cole soils.

- **30% Clear Lake Soils** – Clear Lake soils occur in depressions and slopes less than 2%pp they are similar to Cole soils, but more clayey and with slow permeability.

- **Cortina Soils** - Cortina soils are deep, gravelly sandy loams that have developed from alluvial deposits along streams.

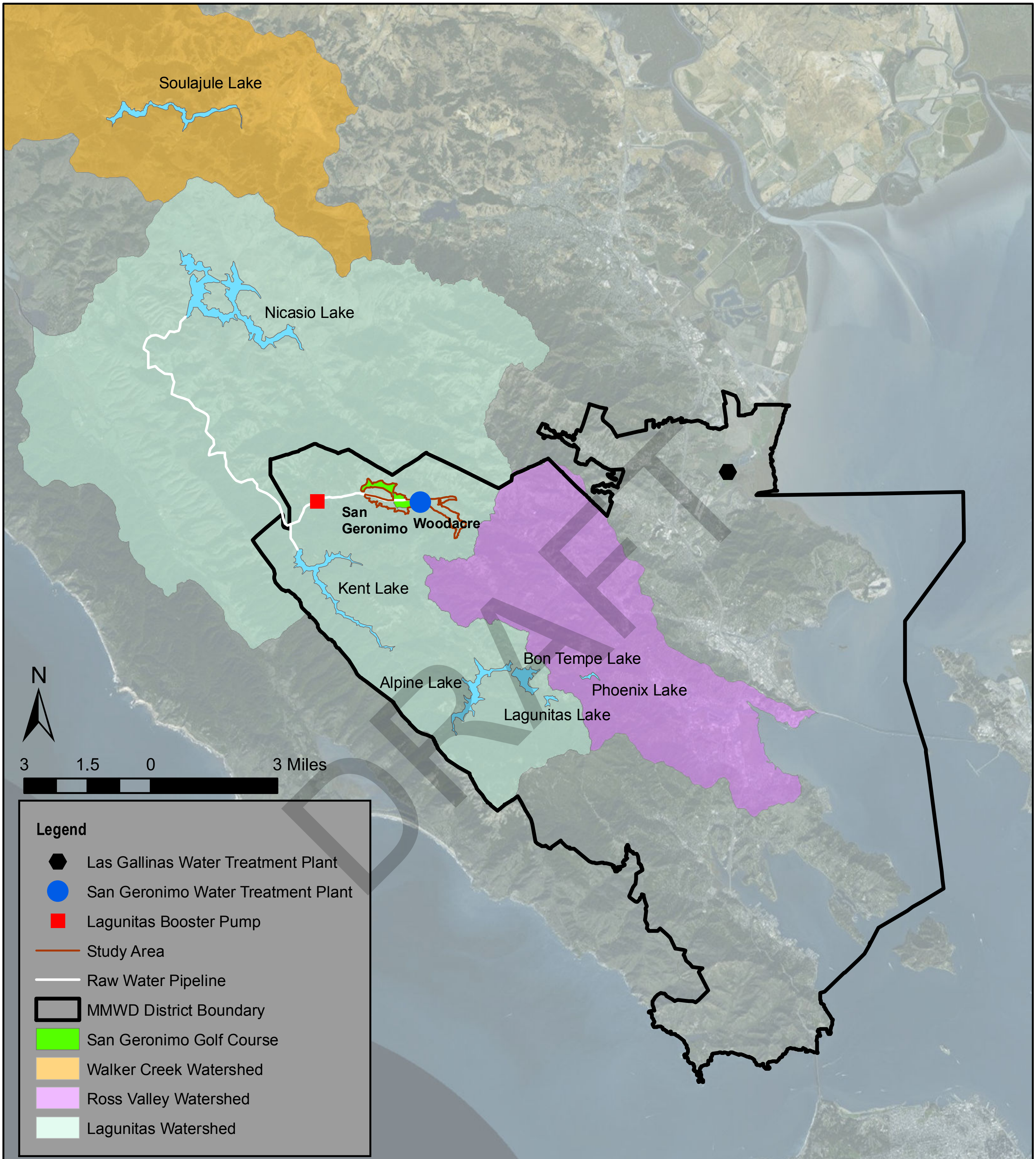
Soils in the adjacent hills and uplands along the edges of the study area, e.g., along Redwood Drive in Woodacre and south of Meadow Way, are mapped as Dipsea-Barnabe gravelly loams and clay loams. These soils are derived weathering of sandstone and shale, well drained, varying from shallow to moderately deep over bedrock, typically on steep to very steep slopes, approaching 50% or greater.

# WATER SUPPLY

The San Geronimo Valley is provided water service by the Marin Municipal Water District (MMWD). The District provides drinking water to nearly 200,000 customers in Central and Southern Marin County, as well as raw water for irrigation uses. The District also operates the Las Gallinas Valley Water Recycling Facility which serves up to 2 million gallons of recycled water per day to 350 customers in northern San Rafael. **Figure 2-3** shows District boundaries and location of some of the major facilities in the vicinity of the project.

Seventy-five percent of the district's water comes from the local watersheds, and the rest comes from the Russian River through a contract with the Sonoma County Water Agency. MMWD has seven reservoirs that store local watershed runoff - Lagunitas, Phoenix, Alpine, Bon Tempe, Kent, Nicasio, and Soulajule. Water is treated at three treatment plants - Ignacio, Bon Tempe and San Geronimo Valley.

The San Geronimo Water Treatment Plant is located within the project study area adjacent to the east end of the San Geronimo Golf Course. The San Geronimo Plant receives water from

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**KEY WATER SUPPLY FACILITIES (MMWD)**

**FIGURE 2-3**

Kent Lake and Nicasio Reservoir via raw water pipelines and booster pump station located on Sir Francis Drake Boulevard.

The San Geronimo Golf Course, one of two large raw water users in MMWD service area, is supplied approximately 150 acre-feet per year of raw water for golf course irrigation, taken from the raw water main at two intake points along Sir Francis Drake Boulevard. Current MMWD base water rates for raw water and recycled water are $1,655 and $1,202 per acre-foot, respectively.

There are no known domestic water supply wells in Woodacre or San Geronimo; however, there are known to be a few scattered agricultural wells in surrounding areas.

## WATER QUALITY

Monitoring and protection of water quality in Tomales Bay and tributary watersheds, including Lagunitas Creek and its tributary streams, falls under the authority of the San Francisco Bay Regional Water Quality Control Board (Regional Water Board.) The Regional Water Board is charged with the responsibility of ensuring maintenance of water quality conditions at levels that are protective of the beneficial uses in the Bay and tributary streams, which include shellfish harvesting, water contact recreation, and noncontact water recreation, as well as aquatic habitat uses.

Many years of monitoring results have shown that Tomales Bay and its main tributaries, Lagunitas Creek, Walker Creek and Olema Creek, are impaired by pathogens, as reflected by high fecal coliform bacteria concentrations (Regional Water Board, July 2005). The presence of pathogens in the Bay and tributary streams poses potential health risks to shellfish consumers, recreational users and other water uses. Because of these conditions, these waters have been formally "listed" in accordance with Section 303(d) of the Federal Clean Water Act (CWA) as impaired water bodies. Septic systems in the Tomales Bay watershed are a potential contributor to the water quality impairment.

Water quality sampling of Woodacre Creek and local storm drains in recent years has shown elevated levels of coliform bacteria, nitrate, ammonia and surfactants, in some cases exceeding receiving water quality standards. These influences on water quality may be attributable to the high density of older septic systems combined with the difficult drainage and soil conditions in Woodacre, especially in the Flats. Impacts on water quality locally can be carried downstream to San Geronimo Creek, Lagunitas Creek and eventually to Tomales Bay.

The Regional Water Board and Marin County EHS are committed to eliminating faulty septic systems and implementing various onsite wastewater management programs and projects to address the water quality concerns in the Tomales Bay watershed. Under the CWA, the State is required to establish Total Maximum Daily Load (TMDLs) for those pollutants causing water quality impairments to ensure that impaired water bodies attain their beneficial uses. In compliance with the requirements of the CWA, in March 2005, the RWQCB issued its report *"Pathogens in Tomales Bay – Total Maximum Daily Load, Proposed Basin Plan and Staff Report".* The report: (a) documents the basis for the impairment finding: (b) establishes numeric targets for water quality needed to protect beneficial uses; (c) identifies the actual and potential pathogen sources in the watershed; (d) proposes a loading allocation amongst the various contributing pathogen sources to achieve the TMDL; (e) evaluates the linkage between sources and water quality targets; and (f) proposes an implementation plan for achievement of the TMDL goals. The pathogen limits for Tomales Bay and its tributaries are listed in **Table 2-2** below:

**Table 2-2: Tomales Bay TMDL Pathogen Limits**

| WATERBODY | INDICATOR PARAMETER | TMDL[a,b] | |
|---|---|---|---|
| | | Median/Log Mean | 90th Percentile |
| Tomales Bay [c] | Fecal coliform | Median < 14 MPN/100mL | <43 MPN/100mL |
| Tomales Bay Tributaries [c] | Fecal coliform | Log mean <200 MPN/100 mL | < 400 MPN/100mL [c] |

*a. Based on a minimum of no less than five samples equally spaced over a 30-day period.*
*b. Most Probable Number (MPN) is a statistical representation of the coliform test results.*
*c. All samples should be collected at knee-high depth*

The TMDL sets a target of zero discharge of human waste to the waters of Tomales Bay and its tributaries. This is based on the knowledge that human waste can be a significant source of pathogenic organisms, including viruses. Prohibition of human waste discharges into surface waters is consistent with existing water quality plans and policies.

In terms of implementation, the TMDL finds that septic systems that discharge to land in a manner consistent with accepted design standards (for new systems) or according to specific performance standards (for existing systems) would be considered acceptable, providing that they are properly operated and maintained. Compliance with performance standards would also be expected to assure protection of groundwater resources (e.g., drinking water supplies), which can be impacted by improper siting, design, or operation of onsite sewage disposal systems.

# SECTION 3:
# EXISTING WASTEWATER TREATMENT AND DISPOSAL PRACTICES

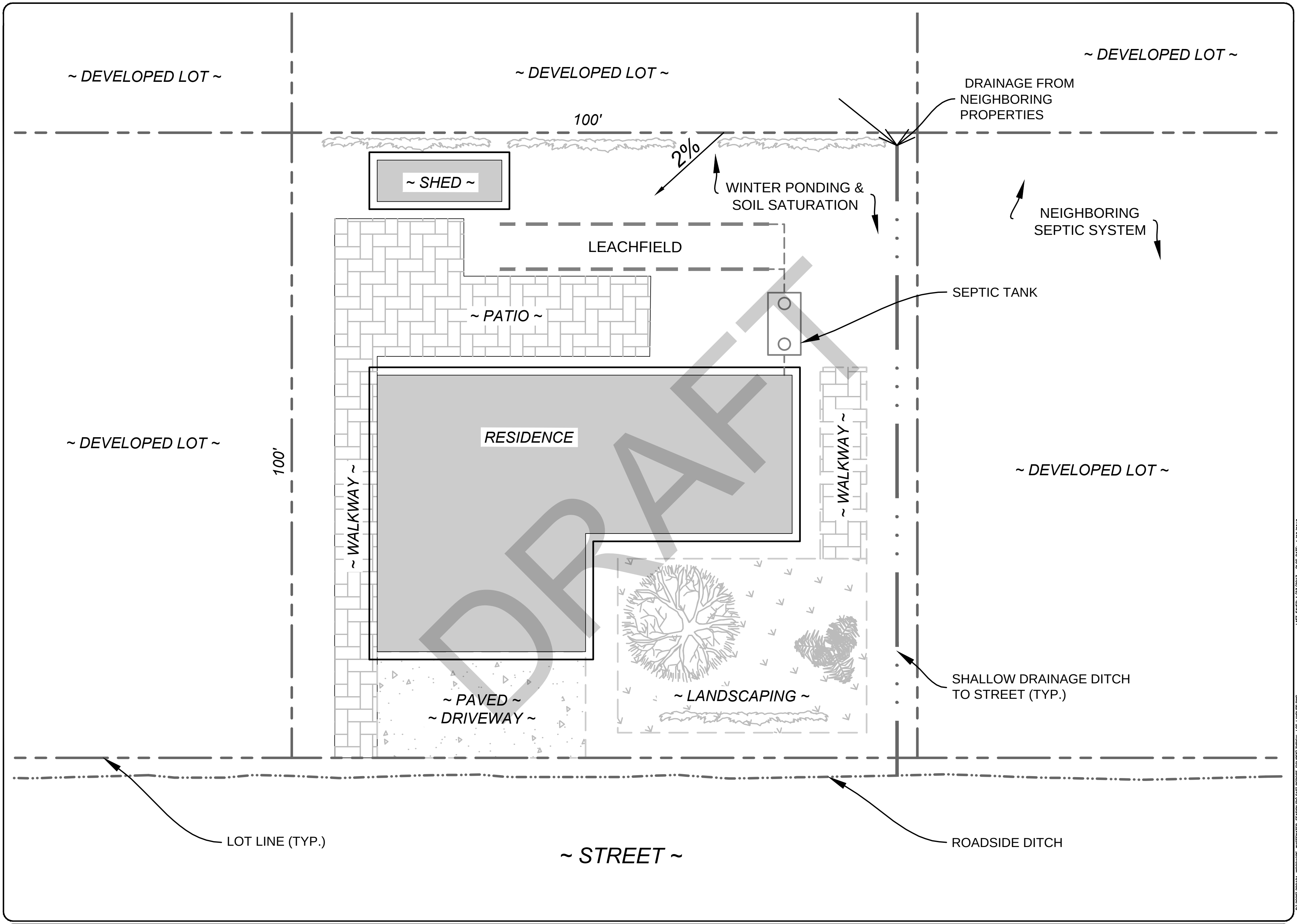
## OVERVIEW

There are no public sewers serving the Woodacre-San Geronimo study area or other parts of the San Geronimo Valley. All properties in the study area rely on individual onsite septic systems for sanitary waste treatment and disposal. This typically includes a septic tank for collection and settling of solids, with some type of leaching system for disposal (percolation) of the liquid into the soil. Most of the properties in the area were developed prior to the adoption of current County Codes. Gravity systems are most common, although more recent development has included the use of advanced systems installations, such as mounded and pressure distribution disposal fields and advanced treatment units.

There are many existing septic systems in the Woodacre and San Geronimo communities with unknown construction features, indicating the likelihood of an antiquated or questionable design that differs significantly from modern codes and practices. Review of County records shows less than half of the developed properties have septic system permit information on file with Marin County EHS. In 2004-2005, voluntary (confidential) septic system inspections conducted as part of a County-wide outreach effort ("Septic Matters Program") found roughly two-thirds of the systems inspected in Woodacre and San Geronimo have marginal to unacceptable operating conditions due to many of the following conditions and factors:

- System age, pre-dating modern standards and codes
- Small systems, undersized for current uses
- Additional living units, placing increased demand on sewage disposal systems
- Small parcel size with high intensity of development and limited remaining area for sewage disposal
- Restricted access to yard areas for system maintenance and repair
- Unpermitted repairs and greywater systems
- Shallow depth to groundwater, including seasonal saturation at or near ground surface
- Shallow soils and marginal soil permeability
- Close proximity to streams and local drainages

Many of the properties in the study area have very serious constraints for onsite sewage disposal. **Figure 3-1** illustrates the development conditions and associated sewage disposal constraints typical for most of the properties in the Woodacre Flats area. As indicated, the lot sizes are relatively small (generally about 10,000 square feet), with limited area available for septic system placement between buildings, driveways, walkways, landscaping and patio areas. The ground slopes are flat to gently sloping with relatively shallow soils, contributing to poor drainage and seasonal high groundwater conditions. Many property owners have installed drainage ditches, curtain drains and sumps to rid their yards of water ponding during the rainy season. These drainage systems provide a potential avenue for short-circuiting of sewage effluent into the local storm drain system (and subsequently downstream receiving waters) during certain times of the year. The close proximity between neighboring properties further complicates the local drainage situation and often presents additional setback conflicts for sewage disposal systems.




**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**

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**TYPICAL ONSITE CONDITIONS**
***RAILROAD/CENTRAL AREA***

**FIGURE 3-1**

Another area of special concern is the group of homes that border local streams, including Woodacre Creek and San Geronimo Creek. These properties typically have better soil and drainage conditions than the Flats area of Woodacre. However, in many cases the ability to provide suitable horizontal setback distance between the septic system and the edge of the creek is severely limited. **Figure 3-2** illustrates common creekside situations in both Woodacre and San Geronimo, where small gravity flow systems (often seepage pits/beds) are located between the building and the creek and may provide setback distances of as little as 25 to 50 feet between the disposal area and the edge of the creek bank. Some creekside properties have other available land that could be used effectively for sewage disposal with alternative/pumping systems in a way that would meet standard (100-foot) creek setback requirements; however, some properties lack sufficient and suitable land area to meet all setback requirements.

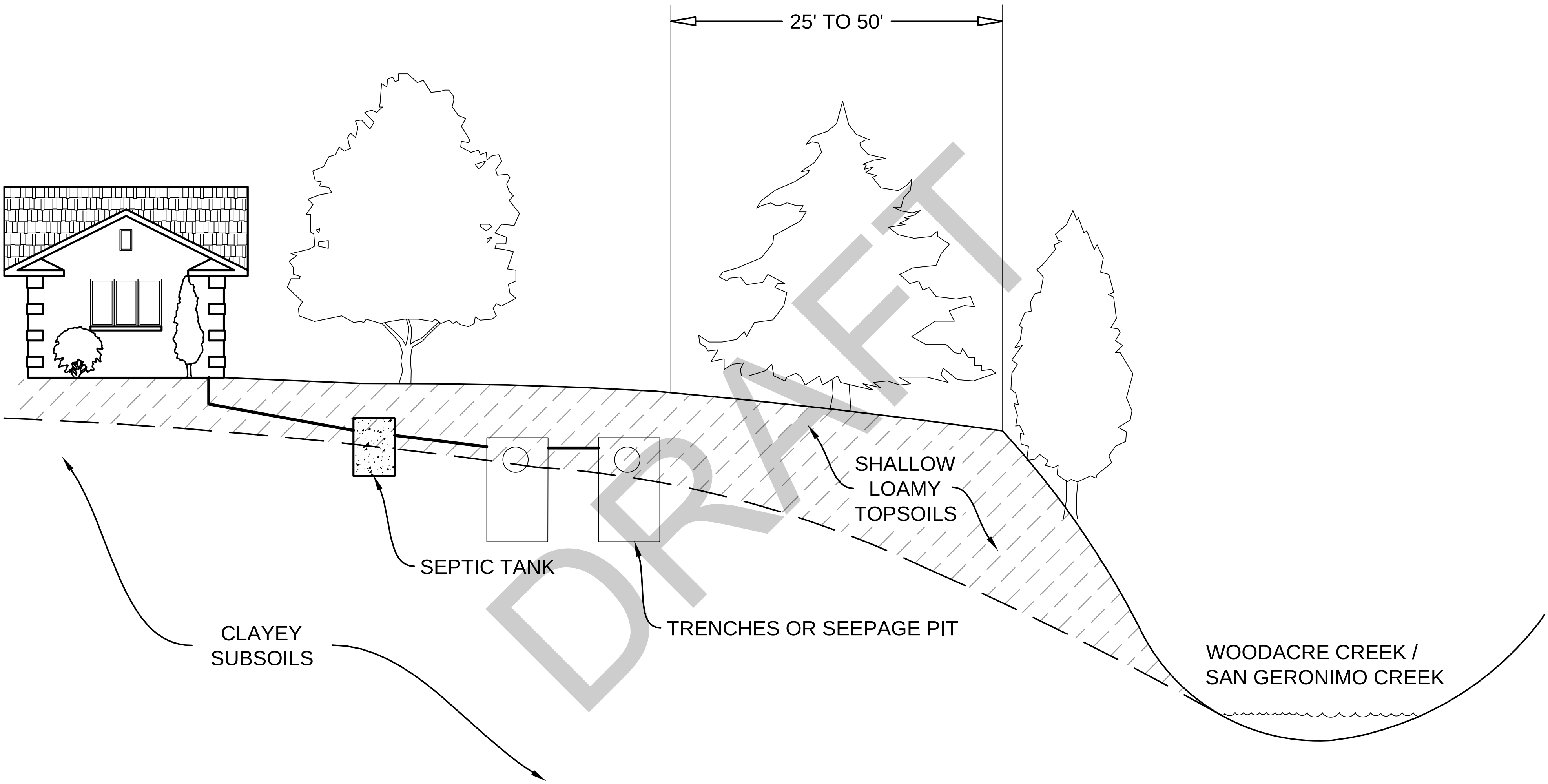
A third example on onsite wastewater conditions, typical of some parts of San Geronimo, is illustrated in **Figure 3-3.** This typifies those properties located a further distance from San Geronimo Creek at the base of the adjacent hillslopes. In these situations the constraints for onsite wastewater systems are mainly related to shallower soil depths over clayey subsoils, adjacent steep slopes, and limited land area to accommodate shallow dispersal designs dictated by these soil conditions.

## "SEPTIC MATTERS PROGRAM"

Individual septic system inspections were conducted in various parts of Marin County in the period of January 2004-August 2005 (by Kit Rosefield) and in winter of 2007-2008 (by Mike Treinen). A large number of these inspections were done in the Woodacre and San Geronimo areas. This work was funded by the County of Marin through grants received from the State Water Resources Control Board and the California Coastal Commission, and was termed the "Septic Matters Program". The overall goal of the program was to provide community education to homeowners through the completion of free and confidential third-party inspection and testing of septic systems.

The inspections were conducted on a voluntary basis, at the request of individual property owners, and the resulting information particular to any given property was kept confidential (between the inspector and the property owner). A total of 135 inspections were conducted County-wide, with more than half (70) being in the Woodacre and San Geronimo areas. The greatest number of inspections (62) were conducted in the Woodacre community. The large number of inspections in Woodacre was as a result of active local encouragement to participate in the program. The inspections in Woodacre included many systems in the Flats area, but also other properties located in the upland areas, outside the limits of the current wastewater feasibility study.

The septic system inspections were conducted to assess the functioning status of individual systems following the general methodology contained in Marin County's "Septic System Performance Evaluation Guidelines". The work included review of permit file information, field inspection and measurements of the septic tank, leachfield system and key site features, and hydraulic load testing of the system. While the location and owners of inspected properties remained anonymous, the overall results of the inspections were compiled and presented to the County by Rosefield and Treinen, and provide a general overview of the functioning status and condition of septic systems in different parts of the County.




**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**

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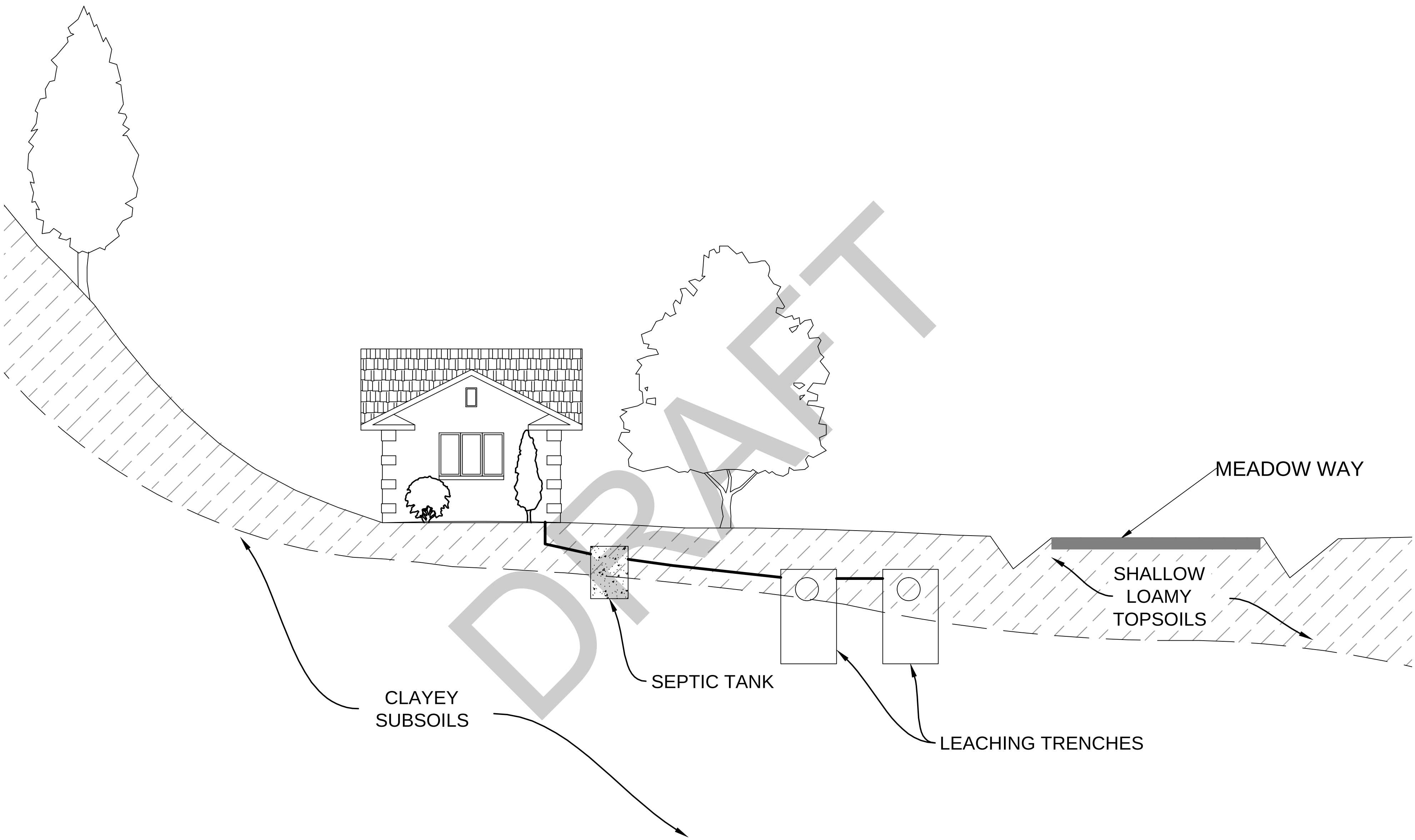
**TYPICAL ONSITE CONDITIONS**
***CREEKSIDE AREA***

FIGURE 3-2

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**TYPICAL ONSITE CONDITIONS**
***MEADOW WAY SLOPED SITES***

FIGURE 3-3

**Table 3-1** presents a summary of the key findings as reported by Treinen (2008) for the County as a whole. A copy of the full report can be found in the 2011 *Woodacre Flats Wastewater Feasibility Study*. In the Woodacre and San Geronimo areas Rosefield and Treinen encountered most of the problem conditions and issues noted in **Table 3-1**. In particular, they found many cases of marginal soils, high groundwater conditions, old and undocumented systems, gray water discharges, and a preponderance of small, “overdeveloped” lots, with minimal area provided for adequate onsite wastewater disposal. **Table 3-2** summarizes the information generated from the voluntary septic system inspections in Woodacre and San Geronimo. Overall, the Rosefield/Treinen surveys showed marginal to unacceptable operating conditions for about half to two-thirds of the septic systems inspected in these areas.

### Table 3-1: Summary of Septic System Inspection Findings, Septic Matters Program*

| Issue | Findings and Observations |
|---|---|
| **1. System Age** | Most systems estimated to be 30-50 years old. Many owners noted repairs had been done, most often without permits. |
| **2. Small Parcels** | In general, lot sizes were small, often ranging from 8,000 to 15,000 square feet. Many lots often overdeveloped with homes, garages, driveways, decks, pools and other hardscape, with limited space allowed for the septic system. |
| **3. High Groundwater (GW)** | Valley floor and flatter areas (such as Railroad Avenue in Woodacre) tend to have high seasonal GW, observed as high as 4 inches, and commonly 16-18 inches; pose flooding threat for septic tanks and leachfields that may be 3 to 6-feet deep. |
| **4. Small Systems** | Many systems smaller or substantially smaller than required under today's more scientifically based standards. Can contribute to faster accumulation of clogging bio-mat, reduced system lifespan and greater potential for hydraulic overload. |
| **5. Marginal or Shallow Soils** | Soils in many areas shallow or with marginal percolation, poorly suited for gravity systems, which is most commonly in use. |
| **6. Additional Living Units** | Secondary living units observed at 10- 20% of the residences inspected, some existing without permits. This increases wastewater volume and stresses on existing systems. |
| **7. Proximity to Waterways** | Many systems closer to waterways than permitted by current code, with increased potential for contaminant transmission. |
| **8. Graywater Discharges** | Many homes found to have separate graywater discharges (laundry, showers, sinks) to the ground surface, ditches, or to unpermitted gravel filled sumps. This is done to relieve pressure on marginal or failing septic systems or occasionally by owners pro-actively reducing the load on their systems. |
| **9. Limited or No Fail Safe Area** | Most properties have limited or no system replacement area, especially if current set backs from wells, waterways and structures were to be enforced. |
| **10. Restricted Access to Tanks** | Development such as decks and pavement stones restrict to some tanks for pumping and diagnosis; may contribute to less frequent or no pumping and diagnostic checks of those tanks. |
| **11. Mosquito Breeding** | Mosquito breeding noted in tanks and pump tanks with inadequate or poorly fitting concrete, fiberglass or wooden lids. |
| **12. Unpermitted Repairs** | High percentage of repairs (Kit Rosefield estimated 60%) have been made without permits, leading to questions of the adequacy of repair work and the maintenance of reasonable setbacks. |
| **13. Pre-code Tanks** | Some sub-standard septic tanks found, including redwood construction and bottomless tanks (e.g., function like cesspools). |
| **14. Types of Repairs** | Most common type of repair has been standard gravity leach lines, not necessarily suited to the soil and other site constraints. Some instances of non-standard systems, such as bottomless sand filters, mounds or advanced treatment units with subsurface drip dispersal (usually on steeper slopes). Non-standard systems generally appeared to be functioning properly and more appropriate for the observed site constraints. Non-standard repairs generally not favored by homeowners due to higher costs and large amount of space required; typically installed in connection with real estate transfer, refinancing, or home remodeling project. |

*Trienen, 2008

**Table 3-2: "Septic Matters" Inspection Results for Woodacre & San Geronimo***

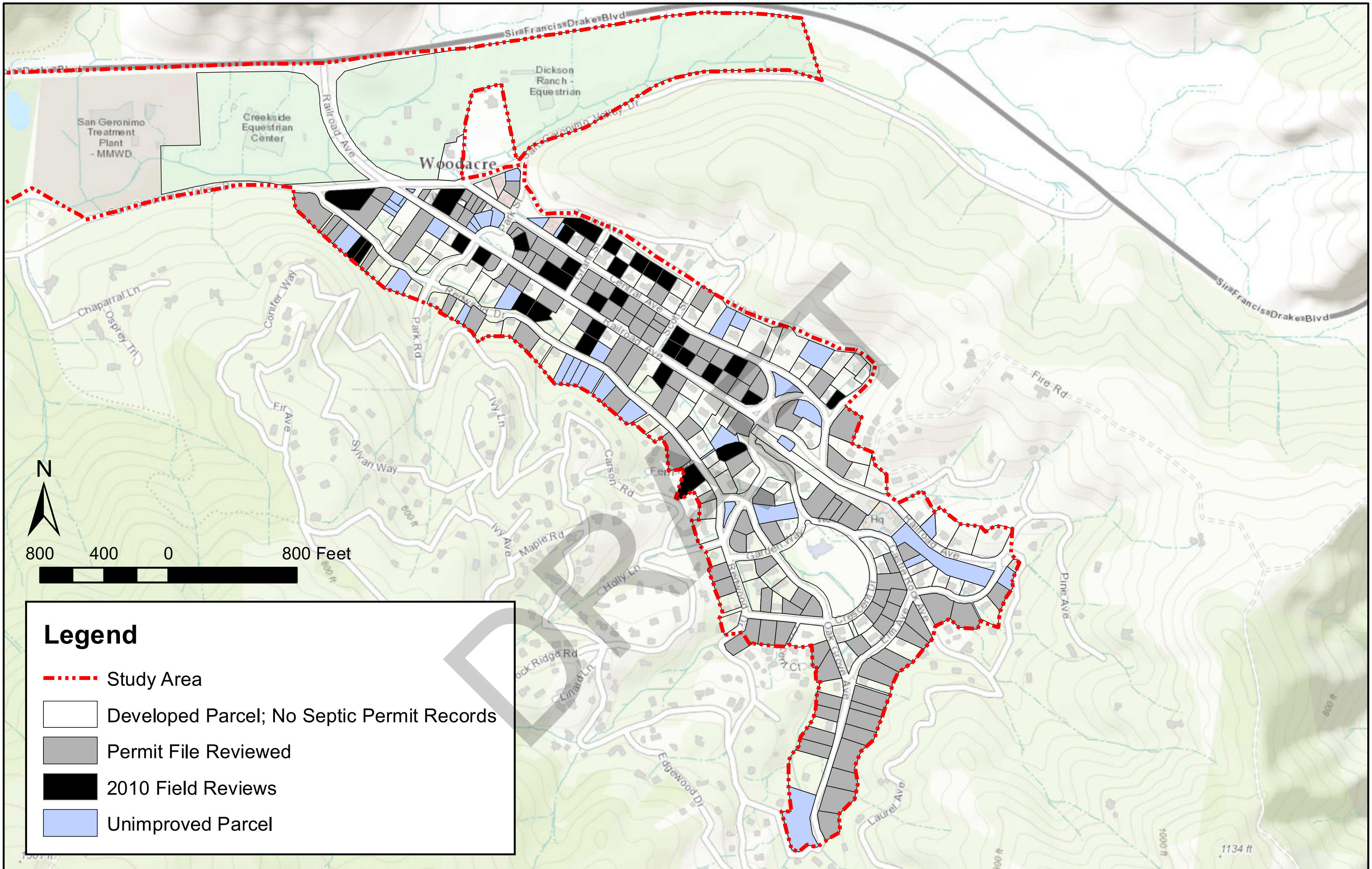
| Category | Septic System Evaluation Factors | Results | |
|---|---|---|---|
| | | # of Systems | % of Systems Inspected |
| **Overall Status & Site Conditions** | **Total systems inspected** | **70** | - |
| | Systems < 100 feet from a watercourse | 63 | 90% |
| | Systems with "satisfactory" or "good" overall rating | 23 | 33% |
| | Systems exhibiting one or more problem conditions | 46 | 66% |
| | Systems exhibiting high groundwater conditions | 15 | 21% |
| | Systems incorporating alternative treatment/dispersal | 9 | 13% |
| | | | |
| **Septic Tank Status** | Acceptable | 40 | 57% |
| | Unacceptable | 18 | 26% |
| | Unknown/ not Accessible | 12 | 17% |
| | | | |
| **Disposal System Status** | Acceptable | 37 | 53% |
| | Unacceptable | 22 | 31% |
| | Unknown/ not Accessible | 12 | 17% |
| | | | |
| **Hydraulic Load Test Results** | Good or Excellent | 26 | 37% |
| | Satisfactory or Marginal | 8 | 11% |
| | Poor or Failing | 29 | 41% |
| | Unknown/Not Accessible | 7 | 10% |

*2004/05 and 2007/08



## PERMIT FILE REVIEWS

As part of the 2011 wastewater study, Questa Engineering with assistance of Marin County EHS staff researched and reviewed septic system and related parcel information on file with Marin County for approximately 150 properties within the Woodacre Flats area. For the current study, additional permit file reviews were completed to encompass the additional 200+ properties added to the study area in Woodacre and San Geronimo. System permits, design drawings, correspondence and other file information were reviewed to determine the date of installation or of last repair, the technology or components of each system, compliance with County codes, and size of the residence or facility served. Out of approximately 360 developed properties in the Study Area permit files were found for 174 parcels (about half the total), including 108 in Woodacre and 66 in San Geronimo. **Figures 3-4** and **3-5** show, respectively, the location of the properties in the Woodacre and San Geronimo portions of the study area for which septic system records were found and reviewed. **Figure 3-4** also shows the locations of other properties in the Woodacre Flats area where field reviews were conducted as part of the 2011 wastewater study (see subsequent discussion in this section).

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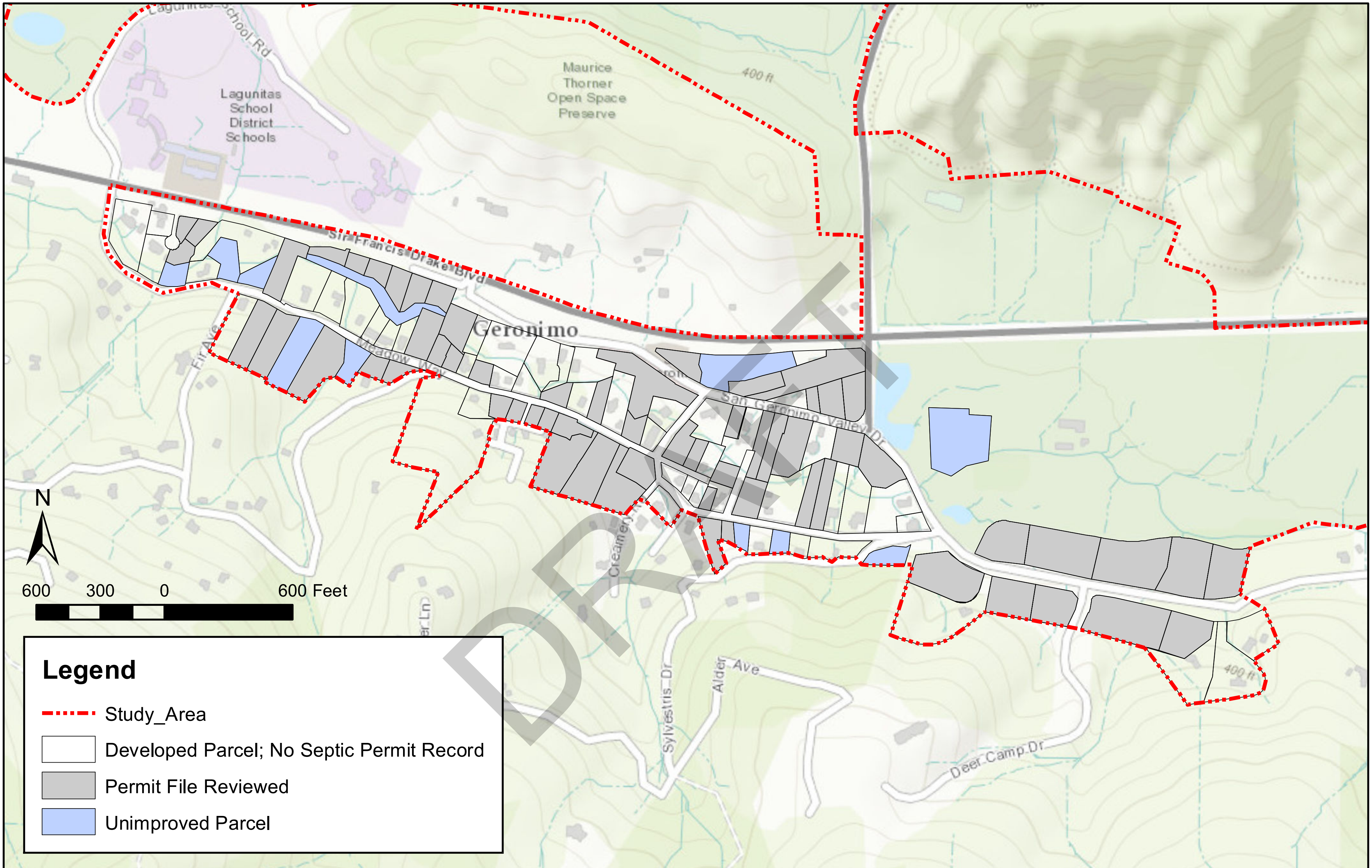
**WOODACRE SEPTIC SYSTEM PERMIT AND FIELD REVIEWS**

**FIGURE 3-4**

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**SAN GERONIMO SEPTIC SYSTEM PERMIT REVIEWS**

**FIGURE 3-5**

Information regarding the age of septic systems and an indication of new and repair system permitting work is summarized in **Table 3-3**, showing data for Woodacre and San Geronimo areas separately as well as the combined totals for entire study area. The data show the following:

- **Repairs.** The permit data show about 56% of the septic systems permit work in Woodacre (60 of 108) has been for system repairs, compared with about 30% in San Geronimo.

- **System Age.** The permit data show generally a greater proportion of septic systems being more than 30 years old in San Geronimo (77%) as compared with Woodacre (48%), which reflects a greater amount of repair activity in Woodacre in the past 30 years. Overall, nearly 60% of the septic systems for the 50% of properties for which permit information is available in the study area are more than 30 years old. A high percentage of septic systems for those properties without permit information are also likely more than 30 years old.

- **Prevailing Code.** Permit information indicates about 40 percent of the septic systems (new and repair) were constructed under the County septic regulations that underwent major update in 1984; the remaining 60 percent (with permit information) occurred under previous regulation. A high percentage of septic systems for those properties without permit information were likely installed in accordance with current (1984) regulations.

**Table 3-3: Septic System and Installation Permitting Summary**

| Age Grouping (years in service) | Original Installation | Repair System | Total # of Systems | Percent of Total Systems |
|---|---|---|---|---|
| **Woodacre** | | | | |
| <10 | 3 | 7 | 10 | 9% |
| 11-25 | 10 | 15 | 25 | 23% |
| 26-30 | 9 | 12 | 21 | 19% |
| >30 | 26 | 26 | 52 | 48% |
| **Total** | **48** | **60** | **108** | **-** |
| **San Geronimo** | | | | |
| <10 | 0 | 0 | 0 | 0% |
| 11-25 | 3 | 6 | 9 | 14% |
| 26-30 | 4 | 2 | 6 | 9% |
| >30 | 39 | 12 | 51 | 77% |
| **Total** | **46** | **20** | **66** | **-** |
| **Combined Woodacre and San Geronimo** | | | | |
| <10 | 3 | 7 | 10 | 6% |
| 11-25 | 13 | 21 | 34 | 20% |
| 26-30 | 13 | 14 | 27 | 16% |
| >30 | 65 | 38 | 103 | 59% |
| **Total** | **94** | **80** | **174** | **-** |

**Table 3-4** summarizes the wide range in the types and number of septic system technologies and designs have been used in the Woodacre and San Geronimo areas as determined from review of permit information. About 75% of systems are standard gravity-fed leachfields and seepage pits/beds. About 20% consist of alternative treatment/disposal systems and 5% are unknown from permit data. Additionally, the remaining (approximately half of total) septic systems for properties in the study are where permit files are lacking would fall in the category “unknown”, but likely consist of some type of gravity leachfield or seepage pit.

**Table 3-4: Types of Onsite Wastewater Systems in Use**

| System Type | | Number of Systems | | |
|---|---|---|---|---|
| | | Woodacre | San Geronimo | Total |
| Gravity Leachfield | | 56 | 46 | 102 |
| Seepage Pit/Seepage Bed | | 20 | 7 | 27 |
| Alternative Systems | Mound System | 8 | 3 | 11 |
| | Pressure Distribution (PD) Leachfield | 8 | 4 | 12 |
| | Sand Filter/PD Leachfield | 3 | 3 | 6 |
| | Open Bottom Sand Filter | 2 | - | 2 |
| | PD Sand Trenches | 1 | - | 1 |
| | Supplemental Treatment w/PD Leachfield | 2 | - | 2 |
| | Supplemental Treatment & Drip Dispersal | - | 1 | 1 |
| Unknown | | 8 | 2 | 10 |
| Total | | 108 | 66 | 174 |

## ONSITE FIELD REVIEWS

As part of the 2011 wastewater study field reviews were conducted by Questa for 33 properties in the Woodacre Flats area to assess the conditions and options for upgrading existing septic systems to an acceptable repair standard. The following briefly summarizes the work and findings from these onsite field reviews. Additional details can be found in the 2011 project report for the *Woodacre Flats Wastewater Feasibility Study*.

The field reviews were arranged (voluntarily) with willing property owners to make site-specific assessments of constraints and options for onsite system repair and upgrade on a representative number of properties in the study area. As previously noted, the parcels where field reviews were conducted are indicated in **Figure 3-4**.

The field reviews involved mapping and measuring various property features along with hand-auger borings for soil/groundwater observations. From this an assessment was made of the apparent available area for onsite septic system upgrade on each parcel, and to identify and evaluate some of the main construction issues and constraints that would be involved with the implementation of onsite system upgrades. Air photos and Assessor Parcel Maps were used in some cases to supplement field observations regarding property size, boundaries between parcels and setbacks to various landscape features.

The results from the field reviews along with other background information on existing conditions and practices provided the basis for evaluating the feasibility and requirements for the onsite system upgrade and management program under consideration as an alternative in the 2011 study. Based on 33 properties reviewed, the results indicated the following categories of expected septic system upgrade, with respective percentages in each category noted:

- **Low Level** – This was assigned to properties having an existing Class 1 or Class 2 code system, where little or no repair or upgrade work would be anticipated. This included properties with mound systems, sand filters and pressure distribution leachfields, mostly permitted and installed within the last 10 to 15 years. Upgrade work for these situations might include repair or replacement of various mechanical and electrical components and possibly drainage mitigation work. It would not include major changes to the existing system. (15% of properties)

- **Moderate Level** – This was assigned to properties having sufficient area and reasonably good soil and groundwater conditions that could accommodate relatively straight forward upgrades to either the treatment or disposal system, such as: (a) addition of a supplemental treatment unit along with drainage mitigation measures; or (b) expansion of disposal capacity with shallow pressure distribution trenches along with drainage mitigation measures. (12% of properties)

- **High Level -** This was assigned to properties having severe space limitations along with shallow soil/high groundwater conditions and/or drainage setback constraints requiring considerable work to implement a satisfactory onsite upgrade/repair. The type of upgrade/repair likely to be required for most of these situations would include: (a) supplemental/advanced treatment unit, often with UV disinfection; (b) drip dispersal, often with imported soil cover fill or raised beds; and (c) surface and subsurface drainage mitigation measures. Variances to standard setback requirements would be required for most properties in this category. (73% of properties)

Additional onsite field reviews were not conducted as part of the current wastewater study for the expanded number of properties in Woodacre and San Geronimo study area. However, based on prevailing site conditions and review of permit information, the findings regarding the expected level of septic system upgrade requirements cited above were deemed a reasonable basis for estimating onsite system upgrade feasibility factors for the expanded study area.

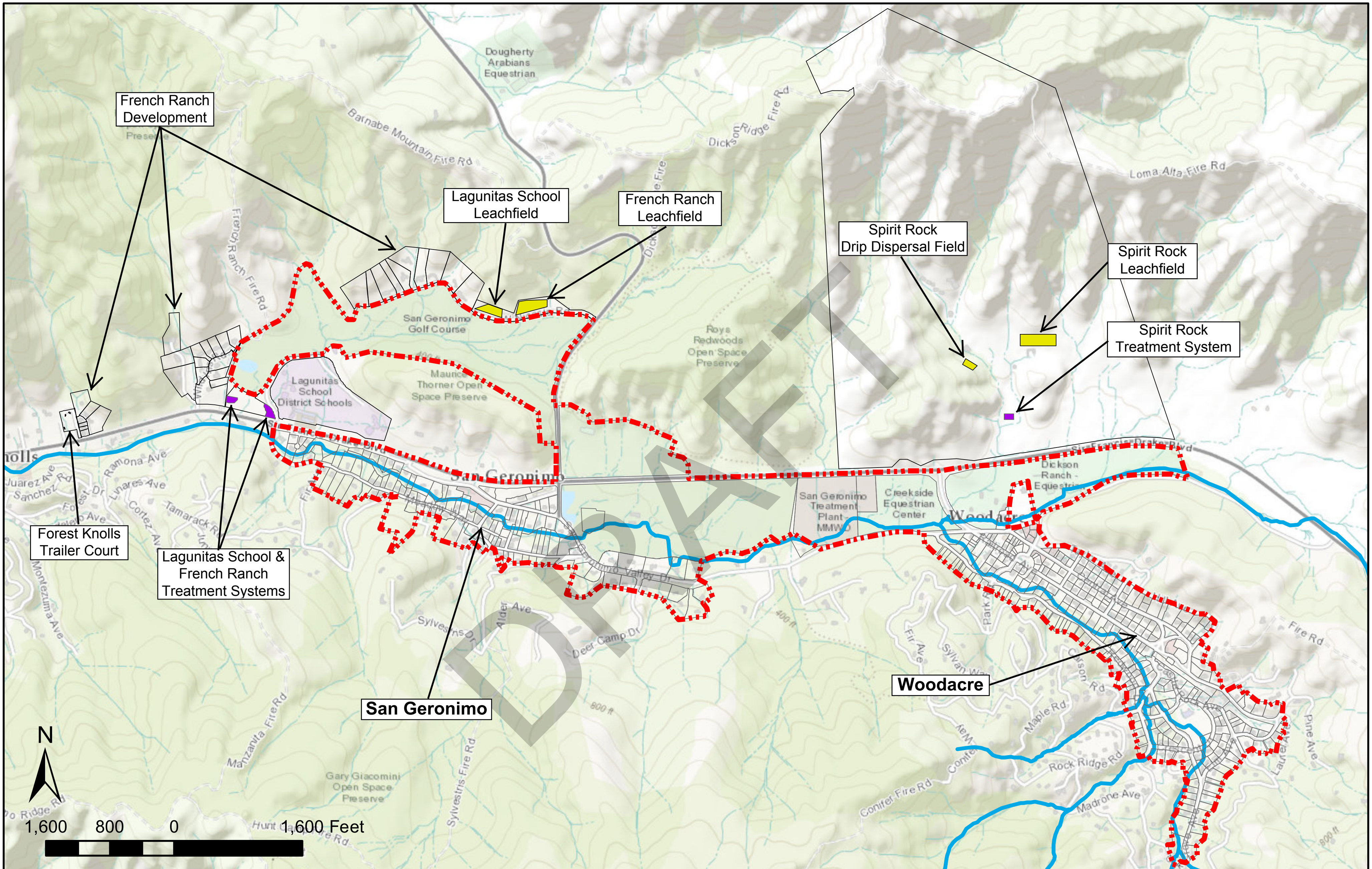


## NEARBY LARGE-FLOW WASTEWATER SYSTEMS

Although not located within the Woodacre-San Geronimo study area, there are a few existing large-flow, community-type wastewater systems providing onsite wastewater treatment and disposal for development on properties bordering or near the study area (**Figure 3-6**). These wastewater systems, which employ advanced/secondary treatment and onsite disposal using pressure distribution and/or drip dispersal methods, include the following:

- Spirit Rock Meditation Center. 7,500 gpd AdvanTex recirculating textile filter with multiple pressure distribution leachfields and drip dispersal fields for residences, overnight retreats, and day use activities.

- Lagunitas School. 10,000 gpd recirculating sand filter and dual, pressure distribution leachfields serving approximately 400 students and staff.

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| PROJECT NO.: | 1600073 |
| DRAWN: | DD |
| APPROVED: | NH |

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# NEARBY LARGE-FLOW WASTEWATER SYSTEMS

FIGURE 3-6

- French Ranch Development. 11,200 gpd recirculating sand filter and dual, pressure distribution leachfields for up to 32 single-family residences (28 presently developed).

These systems are regulated under waste discharge requirements issued by the Regional Water Board and operating permits issued by the Marin County EHS.

# SECTION 4:
# SERVICE AREA CHARACTERISTICS

## SERVICE AREA

Wastewater improvement projects are planned and developed around a given geographical area termed the "service area". The service area provides the basis for estimating wastewater facility requirements, project alternatives and costs. Delineating the service area is often an iterative process, whereby initial boundaries are assumed for feasibility analysis, and subsequently adjusted in response to findings, recommendations and other factors. **Figure 4-1** shows the Woodacre-San Geronimo study area and service area considerations discussed below.

### *2011 Woodacre Flats Study*

The 2011 Wastewater Feasibility Study for Woodacre Flats addressed a service area encompassing approximately 150 mostly residential parcels in the low-lying portions of the community of Woodacre. Out of the study came the identification of a wastewater recycling alternative centered around the San Geronimo Golf Course that could potentially support a larger service area, which was favorably received by the community.

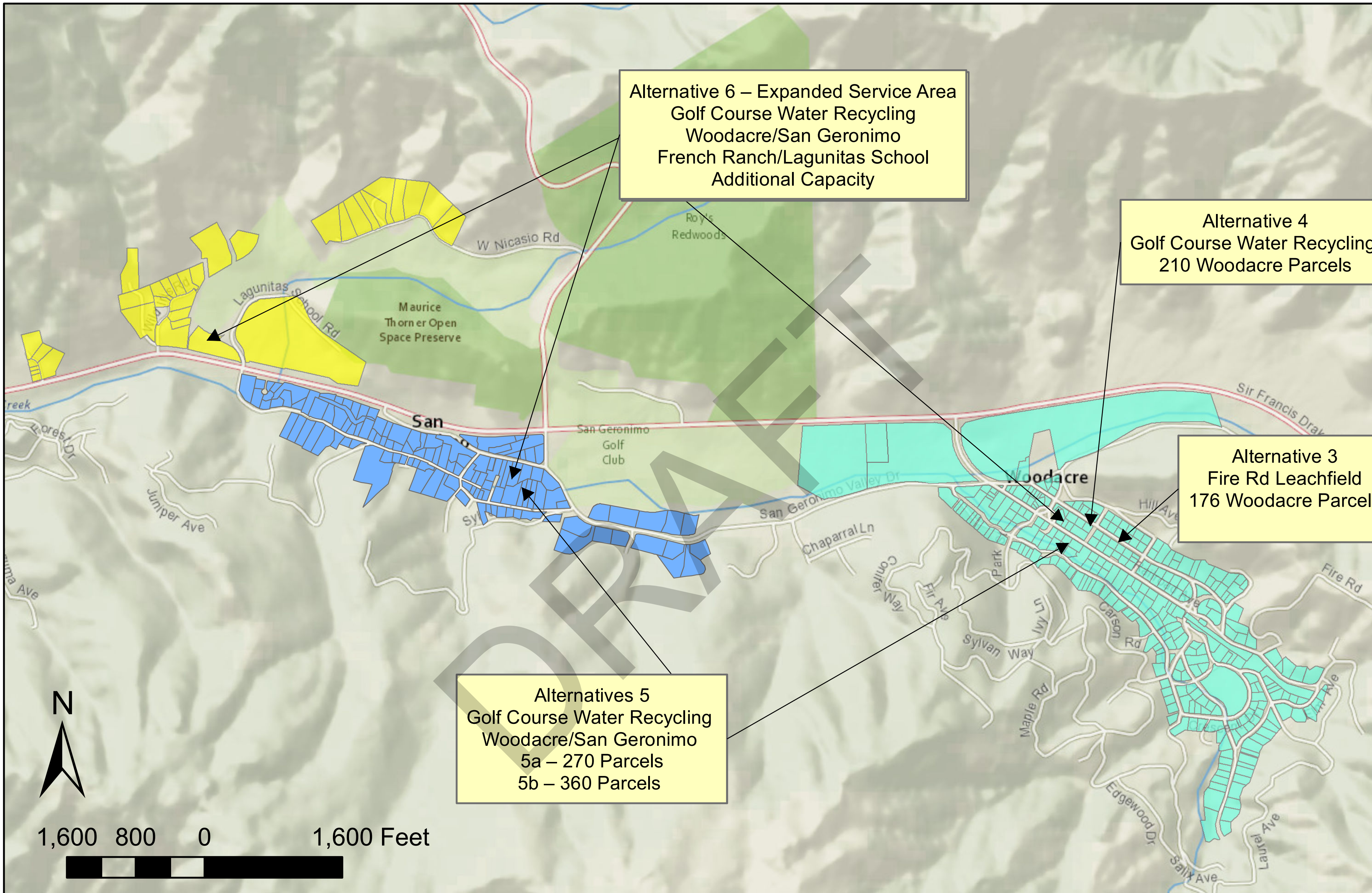
### *Woodacre-San Geronimo Service Areas*

The current study was undertaken to evaluate the feasibility of a community wastewater system to serve a larger study area, including additional homes in Woodacre Flats plus homes in a portion of San Geronimo located in similar valley areas near the Golf Course. The study area encompasses developed properties believed to be in most need of wastewater improvements and where residents have expressed the greatest level of interest in studying possible sewerage alternatives. There are a total of approximately 360 developed parcels within the larger study area, with about two-thirds in Woodacre and one-third in San Geronimo.

The approach to this project does not anticipate a condition or requirement for mandatory connection to community wastewater facilities for all properties in the study area or for any particular properties. It does, however, include the limitation that the facilities be planned and implemented to serve existing developed properties,with allowance for a modest amount of expansion for low-incoming housing, child day care facilities or similar community needs.

There is varied property owner interest in connection to community wastewater facilities, as well as differing wastewater improvement needs from property to property. Although not economically most efficient, the types of wastewater collection systems evaluated for the project lend themselves to providing service to a mix of "connected" and "non-connected" properties along the sewer route.

Based on the above, feasible project alternatives were formulated with different configurations and capacities to serve all or portions of the 360 developed properties in the study area as discussed further in the description of alternatives and estimation of wastewater flows.

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| PROJECT: | WOODACRE WW |
| PROJECT NO: | 1600073 |
| DRAWN: | MF |
| APPROVED: | NH |

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# SERVICE AREAS

**FIGURE 4-1**

### *Expanded Service Area Alternative*

In the course of this study and in response to community input, an "Expanded Service Area Alternative 6" was identified that could provide capacity for extension of sewer service to other existing developed properties lying beyond the study area boundaries. This would entail integrating the existing wastewater flows and facilities serving the French Ranch subdivision and Lagunitas School into the water recycling system through tie-in at the west end of the San Geronimo service area. It would take advantage of surplus wet weather storage/disposal capacity provided by existing leachfields adjacent to the golf course, and increase the amount of recycled water produced. It would also provide potential capacity for wastewater service to be extended to approximately 80 to 100 additional residential properties in nearby areas (to be determined) beyond the study area boundaries.

# ESTIMATED WASTEWATER FLOWS

## Wastewater Flow Factors

Information regarding wastewater is important in the assessment of required capacity of collection, treatment, storage and disposal facilities for community wastewater systems.

- Collection system design requires consideration of peak flow conditions during the day, which may include infiltration and inflow, particularly for conventional gravity sewers.

- Wastewater treatment system design is based primarily on average daily flow, with hydraulic capacity for peak flows; fluctuations from day to day and during the day are normally addressed with flow equalization facilities.

- Wastewater storage facilities, such as wet weather storage ponds, are designed on the basis of average monthly wastewater flows.

- Land application-disposal facilities design varies depending on the method used. For example, leachfields that operating continuously throughout the year must be designed to handle peak flows during the period of maximum occupancy, usually determined on a weekly basis, and may be moderated by incorporation of flow equalization. Systems using irrigation for wastewater disposal/recycling are designed to regulate the daily discharge using storage reservoirs or the like, with the discharge matched to the vegetation requirements, soils and climatic conditions; the accumulated flow on a monthly or seasonal basis is typically the determining factor for irrigation systems.

Sewer systems are subject to infiltration of groundwater and inflow of surface water through joints and cracks in pipes and manholes. The amount of infiltration/inflow (I/I) depends on the groundwater and drainage conditions, the age and condition of the sewers, and the type of sewer design. Older sewers are most notorious for experiencing high amounts of I/I; in the worst cases the I/I component may equal or exceed the sewage component. However, in newer installations I/I is more typically maintained below 10% of the sewage flow, and may be essentially nil for pressure sewer and effluent (STEP) systems that don't include manholes, utilize more shallow pipe installation and tightly sealed (or heat-fused) pressure pipe connections. Portions of the service area, especially Woodacre Flats, experience high groundwater conditions that must be accounted for where gravity sewers are used. However, overall the recommended collection systems in all community wastewater alternatives includes substantial use of pressure sewers, and should result in a relatively low I/I contribution. We included a 25% I/I factor as a reasonable allowance for peak wet weather flow estimates to be on the safe side.

## Unit Wastewater Flows

Estimated wastewater flows for the study were developed based on the assumed number of parcels to be served, the type of development on the those parcels, and review of typical reference data and monitoring information from other small community wastewater facilities.

Unit wastewater flows in gallons per day (gpd) per single family residence (or equivalent) were developed from review of daily and monthly flow data for the past six years for three small community wastewater systems: (1) French Ranch development, (2) Marshall Community Wastewater Facility, and (3) Lake Canyon Community Services District near Los Gatos in Santa Clara County. The wastewater flow information for these three facilities is summarized in **Table 4-1**, including average annual and average winter unit flows, expressed as gallons per day (gpd) per residential parcel.

**Table 4-1: Unit Flow Reference Data for Community Wastewater Facilities[1]**

| Community System | Number of Parcels | Years of Operation | Annual Ave. Daily Flow (gpd/parcel) | Winter Ave. Daily Flow (gpd/parcel) | Notes |
|---|---|---|---|---|---|
| Lake Canyon CSD (Santa Clara Co.) | 51 | 19 | 58 | 57 | Old homes; effluent (STEP) collection system to community leachfield |
| French Ranch (Marin Co.) | 28 | 15 | 121 | 140 | New subdivision with gravity sewers; peak flows affected by rainfall inflow to sand filter bed |
| Marshall Phase 1 (Marin Co.) | 32 | 8 | 79 | 80 | Old homes; some rental and seasonal occupancies; effluent (STEP) sewers to community leachfield |

[1] *Source: Self-Monitoring Reports on file with RWQCB; average flows for 2009-2015*

Taking into account the data in **Table 4-1** and an allowance for infiltration/inflow (I/I) as discussed above, the following estimated unit wastewater flows were selected for assessing community wastewater alternatives. **Figure 4-2** provides a graphical plot of the comparative data and proposed assumptions.

- 30-day Average Daily Flow, Wet Weather: 120 gpd/parcel
- 30-day Average Daily Flow, Dry Season: 100 gpd/parcel
- Peak Daily Flow Wet Weather: 150 gpd/parcel (minimum)

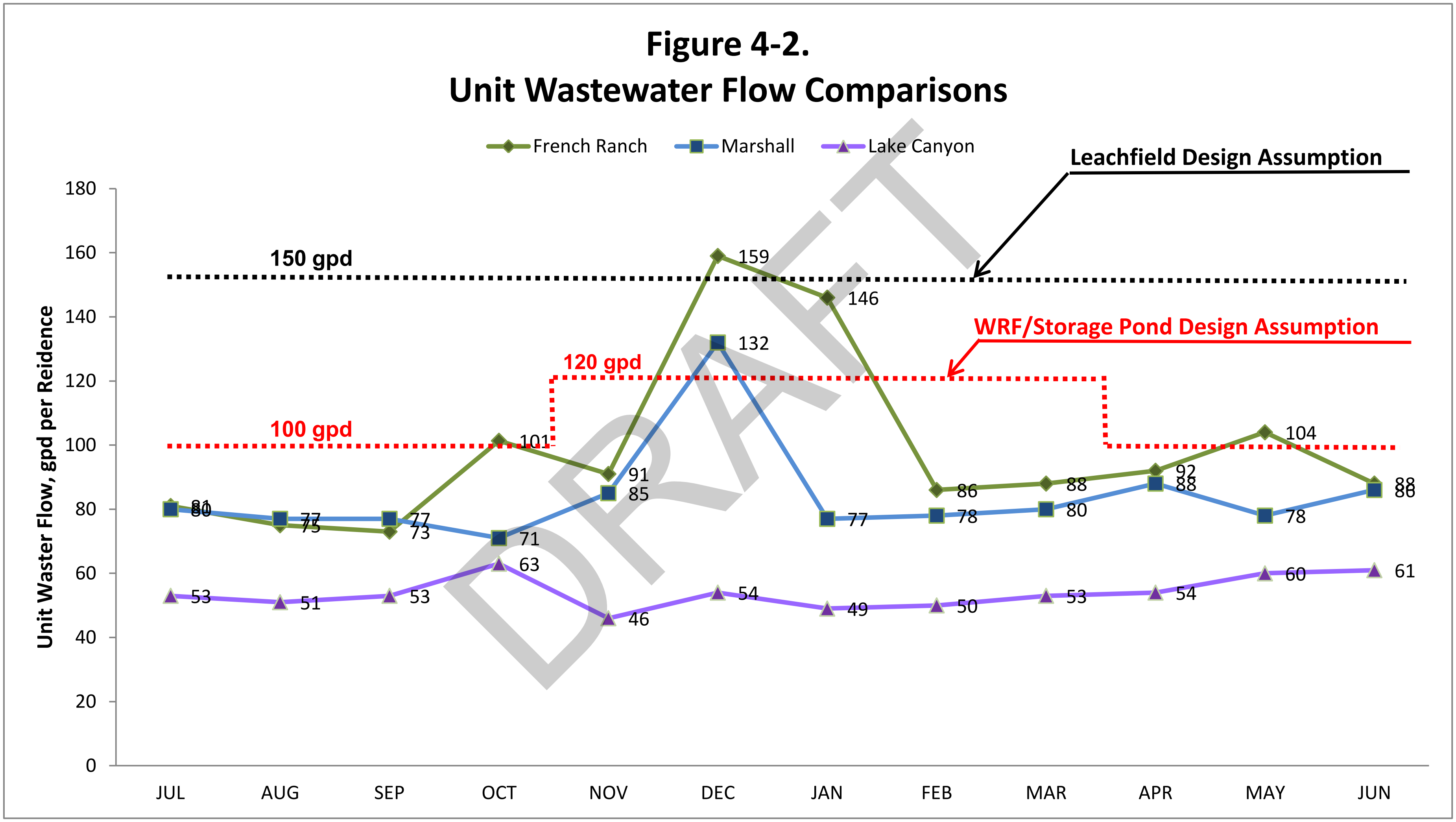


Figure 4-2.
Unit Wastewater Flow Comparisons
French Ranch
Marshall
Lake Canyon
Leachfield Design Assumption
150 gpd
WRF/Storage Pond Design Assumption
120 gpd
100 gpd
Unit Waster Flow, gpd per Reidence
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
DRAFT

## Estimated Wastewater Flows for Project Alternatives

Woodacre and San Geronimo service areas consist mainly of single family residential parcels, with a small amount of commercial uses. The commercial uses are mainly the types that generate wastewater volumes similar to or less than single family residences (e.g., offices, shops, Post Office, small apartments). The noted exceptions are two commercial uses: (1) Two Bird Café, a small restaurant; and (2) the San Geronimo Golf Course Clubhouse, which includes a restaurant, bar and banquet facilities in addition to restroom use for employees and golfers. The estimation of wastewater flows were developed by applying the above unit wastewater flow assumptions for residential and small commercial properties, with an added allowance for the Two Bird Café and Golf Course Clubhouse based their respective food service activities and higher volume of wastewater generation. The resulting wastewater flow estimates for the different project alternatives are presented in **Table 4-2**.

**Table 4-2 Estimated Wastewater Flows, gpd**

| **Community Wastewater Alternative** | | **ESDs** | **Unit Wastewater Flows, gpd** | | | **Estimated Wastewater Flow (gpd)** |
|---|---|---|---|---|---|---|
| | | | **Per ESD** | **Golf Course** | **Lagunitas School & French Ranch** | |
| 3 | Fire Road Community Leachfield<br>▪ Ave Wet Weather<br>▪ Ave Dry Weather<br>▪ Peak Daily Flow | 176 | 150<br>150<br>170 | - | - | 26,400<br>26,400<br>30,000 |
| 4 | Woodacre Only<br>▪ Ave Wet Weather<br>▪ Ave Dry Weather<br>▪ Peak Daily Flow[1] | 210 | 120<br>100<br>- | 800<br>1,000<br>- | - | 26,000<br>22,000<br>35,000 |
| 5a | Partial (75%) Woodacre-San Geronimo<br>▪ Ave Wet Weather<br>▪ Ave Dry Weather<br>▪ Peak Daily Flow[1] | 270 | 120<br>100<br>- | 800<br>1,000<br>- | - | 33,200<br>28,000<br>45,000 |
| 5b | Full Woodacre-San Geronimo<br>▪ Ave Wet Weather<br>▪ Ave Dry Weather<br>▪ Peak Daily Flow[1] | 360 | 120<br>100<br>- | 800<br>1,000<br>- | - | 44,000<br>37,000<br>60,000 |
| 6 | Expanded Service Area<br>▪ Ave Wet Weather<br>▪ Ave Dry Weather<br>▪ Peak Daily Flow[1] | 375[2] | 120<br>100<br>- | 800<br>1,000<br>- | 7,500<br>5,000<br>- | 53,300<br>43,500<br>70,000 |

[1] Peak daily flow estimated at 1.3 times wet weather flow, rounded up.
[2] Includes all developed Woodacre-San Geronimo parcels at 1.0 ESD, plus additional allowance of 12 ESDs for existing commercial occupancies and limited affordable housing and day care uses

# SECTION 5:
# WASTE DISCHARGE AND RECYCLING REGULATORY REQUIREMENTS

## ONSITE WASTEWATER TREATMENT SYSTEMS (OWTS)

Criteria governing the siting and design of onsite wastewater treatment systems (OWTS) in the project area are contained in Marin County Code Chapters 7.36 and 18 and *Marin County Regulations for Design, Construction and Repair of Individual Sewage Disposal Systems*. The Regulations have been adopted in accordance with provisions of Code Chapters 18.06 and 18.07, respectively, which govern the use of Standard OWTS and Alternative OWTS in the county. These requirements apply to OWTS having wastewater design flows of up to 10,000 gpd. Systems with flows greater than 10,000 gpd are regulated by the Regional Water Board.

Additionally, in 2012 the State Water Board adopted the *Water Quality Control Policy for the Siting, Design, Operation, and Management of Onsite Wastewater Treatment Systems,* also known as the State OWTS Policy. The State OWTS Policy sets minimum standards that go beyond the established County requirements in some instances, such as for OWTS located near public water supply wells, water supply intakes, and impaired water bodies.

Some of the key regulatory provisions contained in Marin County regulations for OWTS are reviewed here.

### *Soil Depth*

A minimum of 3 feet of soil depth is required below the leaching trenches (or bed). The soil within and below the leaching trenches must be permeable and of a suitable texture and structure for absorption of sewage effluent. Coarse sand and gravels are unacceptable due to the lack of fine soil particles for filtration and treatment; heavy clay soils, on the other hand, are generally unsuitable due to inadequate permeability.

### *Percolation Rates*

The percolation rate for conventional leachfields and alternative dispersal systems is required to be within the range of 1 to 120 minutes per inch (MPI). The percolation rate is used to establish an appropriate wastewater loading rate, which is then used for sizing the dispersal field.

### *Depth to Groundwater*

The required depth to groundwater, below the bottom of the leachfield trench varies according to the percolation rate and soil characteristics and system type. For percolation rates of 5 to 60 MPI or where the soils have more than 15 percent silt plus clay fraction (“fines”), the required depth to groundwater is 3 feet (below trench bottom). A greater depth to groundwater is required for rapidly permeable soils where the soil texture lacks sufficient “fines” for treatment. For soils with a percolation rate between 1 and 4 MPI, the required depth to groundwater is 10 feet where there are 10 to 15% fines, and 20 feet where there are less than 10% fines. These depth requirements apply to disposal of septic tank effluent through conventional leaching trenches, and may be reduced (to a minimum of two feet) if additional treatment or alternative dispersal system design (e.g., mounds) are provided.

### *Setbacks from Wells and Watercourses*

Required minimum setback distances between wastewater disposal fields and various water features are as follows:

| | |
|---|---|
| • Water Wells | 100’ |
| • Public Water Supply Wells | 150' |
| • Springs | 100' |
| • Natural Lake or Water Supply Reservoir | 200' (from high-water line) |
| • Perennial Watercourses | 100' (from top of bank) |
| • Seasonal Streams and Wetlands | 75' (from top of bank) |
| • Intermittent/Ephemeral Streams | 50' (from top of bank |
| • Public water supply intakes | 200’ to 400’ from applicable water body |

Marin County Regulations also specify minimum setback distances for other site features such as property lines, buildings, paved areas, cuts and embankments, and water lines. Variations in setback requirements are permitted in conjunction with certain alternative systems (e.g., sand filters), for system repairs, and under formal variance provisions.

### *Disposal System Design*

The standard disposal field design in Marin County is a trench system, 18-inches wide and ranging in depth from 2 to 8 feet. The system is sized according to the trench sidewall area and the wastewater loading rate determined from the percolation test results (see above). The design wastewater flow for a residential system is based on the number of bedrooms in the house, and a standard flow criterion of 150 gpd/bedroom, which may be reduced to 105 gpd/bedroom with the incorporation of low-flow plumbing fixtures.

### *Dual System Capacity*

Individual wastewater disposal systems are required by Marin County Regulations to have dual fields; i.e., a primary and back-up disposal field, each with 100% capacity, that operate on an alternating basis. The purpose is to extend the life of the disposal field. Normally, in such a system the flow is alternated between leachfields every six months. In many repair situations, dual capacity (and sometimes 100% capacity) cannot be provided; in such instances the disposal system is often designed to make maximum use of available suitable area.

### *Cumulative Impact Assessment*

High-density development using OWTS and/or larger flow systems can contribute to elevated nitrogen concentrations in the groundwater and/or a general rise or mounding of the water table. County Regulations require completion of cumulative impact assessments for nitrate loading and groundwater mounding for certain OWTS, based on the size (design flow) of the wastewater system or other factors on a case-by-case basis. The results of the may be the basis for denial, modification or imposition of specific conditions for the OWTS proposal, in addition to other siting and design criteria.

### *Operations and Monitoring*

Alternative wastewater systems require monitoring of system operations, and submission of periodic reports to the County. The monitoring is intended to keep track of such things as wastewater flow rates and volumes, treatment effectiveness, disposal field performance and conditions, and downstream/downgradient water quality measurements at monitoring wells or surface drainage points. Quarterly monitoring and annual reporting requirements are typical for the first few years of system operation, declining to semi-annual or annual monitoring in subsequent years depending upon successful system performance.

### *Repair System Requirements*

For repair of existing septic systems, Marin County EHS attempts to achieve compliance with current regulations to the maximum extent practicable. However, full compliance with all code requirements is generally not possible. Heavy emphasis is given to case-by-case evaluation to achieve the best repair possible, considering the site limitations and environmental resources and public health issues at risk. Evaluation and approval of OWTS repairs is guided by criteria contained in the County's "Remodel & Additions Policy".

### *Impaired Water Bodies*

Several water bodies in Marin County are listed as impaired under Section 303(d) of the Federal Clean Water Act for different water quality constituents. Additional requirements may apply to OWTS located adjacent to or within the contributing watershed of impaired water bodies as a result of the provisions of the State OWTS Policy or in connection with Total Maximum Daily Load (TMDL) requirements adopted by the Regional Water Board for specific bodies.

There are no impaired water bodies within the study area. However, Woodacre Creek and San Geronimo Creek are within the watersheds of Tomales Bay and Lagunitas Creek, which are both listed as impaired. The following statutory requirements pertain to the impaired status of these water bodies:

- Tomales Bay is listed as impaired for pathogens and nitrogen. In 2005, the Regional Water Board adopted the Pathogens TMDL for Tomales Bay, which found that OWTS that discharge to land in a manner consistent with accepted design standards (for new systems) or according to specific performance standards (for existing systems) would be considered acceptable, providing that they are properly operated and maintained. The Tomales Bay TMDL for nitrogen has not been completed; it is unknown when the TMDL will be completed and whether or not the TMDL will contain any requirements applicable to OWTS located in San Geronimo Valley.

- Lagunitas Creek is listed as impaired for nitrogen, but the TMDL has not been completed. It is not known when the TMDL will be completed and whether or not it will contain any requirements applicable to OWTS located in San Geronimo Valley.

## TITLE 22 - WATER RECYCLING CRITERIA

Water quality standards and treatment reliability criteria for water recycling are set forth in Title 22, Division 4, Chapter 3 of the California Code of Regulations (Title 22). Requirements for a specific use of recycled water that are not covered by the uniform statewide criteria are established by State Water Board, Division of Drinking Water on a case-by-case basis. Uniform statewide criteria include bacteriological water quality standards which are based on the expected degree of public contact with recycled water. Title 22 Water Recycling Criteria were last updated in June 2014 and include new requirements pertaining to use of recycled water for ground water replenishment/reuse.

### *Treatment Level and Reuse Applications*

For water reuse applications with a high potential for public contact with recycled water, Title 22 standards require disinfected tertiary treatment. For applications with a lower potential for public contact, Title 22 allows for secondary treatment with different levels of disinfection (bacteriological limits) depending on the particular recycling use. Allowable uses for disinfected tertiary recycled water include:

- Irrigation of food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop;
- Irrigation at parks and playgrounds, school yards, residential landscaping, and unrestricted access golf courses;
- Industrial cooling water that involves use of a cooling tower;
- Flushing toilets and urinals, priming drain traps, industrial process that may come in contact with workers, structural firefighting, decorative fountains, commercial laundries, consolidation of backfill around potable water pipelines, and car washes; and
- Any other irrigation uses not specifically prohibited.

According to Title 22, recycled water used for unrestricted golf course and landscape irrigation must meet requirements for “disinfected tertiary recycled water”. Among other things, this requires that the wastewater must be oxidized and filtered to a tertiary level, followed by disinfection using an approved process and meets the following requirements:

- **Total Coliform.** Median concentration of total coliform bacteria measured in the disinfected effluent not exceeding a most probable number (MPN) of 2.2 per 100 mL utilizing the results of the last seven days for which analyses have been completed, not exceeding 23 MPN per 100 mL in more than one sample in any 30 day period, and no sample exceeding 240 MPN per 100 mL.
- **Turbidity.** The filtered effluent prior to disinfection and following passage through a microfiltration, ultrafiltration, nanofiltration, or reverse osmosis membrane does not exceed a turbidity of (1) 0.2 nephalometric turbidity units (NTU) more than 5 percent of the time in a 24-hr period; and (2) 0.5 NTU at any time. Turbidity shall be continuously monitored, with the capability to automatically divert the wastewater should above limits be exceeded.

Title 22 includes various provisions related to sampling and analysis to verify compliance with the above effluent quality requirements. The sampling requirements are established to assure protection of the public health because there is potential risk of human exposure to the recycled water. Standard sampling provisions normally include continuous turbidity monitoring and daily coliform sampling.

### *Reliability and Storage*

Title 22 also includes provisions for short-term emergency storage (minimum one day of design flow) and redundancy in various treatment processes to ensure continuous and reliable operation. Additionally, Title 22 requires provisions for long-term storage (minimum of 20 days) or an alternate method of disposal for periods when recycling is not possible, e.g., due to the lack of irrigation demand during rainy periods or when/if the treated effluent fails to meet bacteriological limits. Long-term storage/disposal is commonly provided by holding pond(s), but may also include alternate means for disposal such as percolation ponds, leachfields, or diversion to municipal sewer system, where available.

### *Use Area Requirements*

Title 22 contains the following requirements pertaining to the areas where tertiary recycled water would be applied:

- No application of tertiary recycled water shall occur within 50 feet of a domestic well, unless supported by a geological investigation;
- No impoundment of tertiary recycled water shall occur within 100 feet of any domestic water well;
- No runoff of irrigation water from the recycled use areas shall occur unless determined not to pose a public health threat and authorized by the regulatory agency;
- No spray, mist or runoff shall enter dwellings, designated outdoor eating areas, or food handling facilities;
- Drinking water fountains shall be protected against contact with recycled water spray, mist or runoff;
- Standard warning signs shall be posted where recycled water is uses that are accessible to the public;
- No physical connection shall be allowed between recycled water systems and potable water systems; and
- No hose bibs shall be allowed in the recycled water system in areas accessible to the public; quick couplers shall be used instead.

Project facilities and areas using recycled water would be developed and maintained to meet all of the above requirements.

### *Engineering Report*

Any project proposing water recycling is required to submit for review and approval to the Water Recycling Unit of the State Water Board, Division of Drinking Water (DDW), an Engineering

Report in compliance with the provisions of Title 22, Section 60323 of the California Code of Regulations. This report is required to follow the document titled “Guidelines for the Preparation of an Engineering Report for the Production, Distribution, and Use of Recycled Water”, issued by State Water Board, DDW. This report is normally completed prior to, or in conjunction with, the filing of a Report of Waste Discharge with the Regional Water Board.

# WASTE DISCHARGE REQUIREMENTS (WDR)

## General WDRs for Small Domestic Wastewater Systems - Order WQ 2014-0153-DWQ

Community wastewater facilities for the Woodacre-San Geronimo study area, whether they include leachfields (Alternative 3) or water recycling (Alternatives 4 through 6), would be regulated by the San Francisco Bay Regional Water Board through the issuance of Waste Discharge Requirements. Based on the size (design flow) of the facilities, the system would most probably be regulated under the State Water Board’s *General Waste Discharge Requirements for Small Domestic Wastewater Systems - Order WQ 2014-0153-DWQ.* This is a general permit applicable to small, community-type wastewater systems such as the projects under study for the Woodacre-San Geronimo area. Facilities with average monthly wastewater flows of 100,000 gpd or less are eligible for coverage under this General Order. The San Francisco Bay Regional Water Quality Control Board has applied Order WQ 2014-0153-DWQ to other community wastewater projects in the region, including the Marshall Community Wastewater System in Marin County.



The provisions under Order WQ 2014-0153-DWQ cover the entire wastewater system, which is defined in the Order as including “… the collection system, treatment equipment, pumping stations, treatment ponds, clarifiers, and/media filters, disinfection systems, recycled water systems (including distribution systems), storage ponds, land application areas, and other systems associated with the collection, treatment, storage, and disposal of wastewater”. The Order contains requirements for various types of wastewater treatment and disposal systems, including water recycling facilities. In addition to general provisions for water quality protection, it includes performance standards, effluent limitations, and setback criteria applicable to different treatment, storage and disposal methods. The Order incorporates directly or by reference Title 22 requirements for any water recycling facility. Attachment C of Order provides a “Model Monitoring and Reporting Program”, which sets forth the standard scope and details normally applied, with provisions for project-specific requirements assigned by the Regional Water Board as deemed necessary.

Noteworthy requirements contained in the Order pertinent to the Woodacre-San Geronimo wastewater alternatives include setbacks, effluent limitations, and wastewater pond sizing criteria.

### *Wastewater System Setbacks*

**Table 5-1** presents the setback requirements contained in Table 3 of the Order, including requirements applicable to various types of treatment components, leachfields, land application areas, and wastewater storage ponds that have applicability to project alternatives under

**Table 5-1: Summary of Wastewater System Setbacks**
(per Table 3, General Order WQ 2014-0153-DWQ)

| Equipment or Activity | Domestic Well | Flowing Stream [a] | Ephemeral Stream Drainage [b] | Property Line | Lake or Reservoir [d] |
|---|---|---|---|---|---|
| Septic Tank, Aerobic Treatment Unit, Treatment System, or Collection System [e] | 150 ft. [y]<br>100 ft.[o]<br>50 ft.[c] | 50 ft.[c] | 50 ft. | 5 ft.[c] | 200 ft.[w]<br>50 ft.[c] |
| Leach Field [f] | 100 ft.[o,c] | 100 ft.[c] | 50 ft. | 5 ft.[c] | 200 ft.[w]<br>100 ft.[c] |
| Seepage Pit | 150 ft.[o,c] | 150 ft.[c] | 50 ft. | 8 ft.[c] | 200 ft.[w]<br>150 ft.[c] |
| *LAND APPLICATION AREA REQUIREMENTS* | | | | | |
| LAA (disinfected tertiary recycled water) [g] | 50 ft.[m] | 25 ft. | 50 ft. | 25 ft. | 200 ft. |
| LAA (disinfected sec-2.2 or sec-23 recycled water) [h] | 100 ft.[r] | 50 ft. | 50 ft. | 100 ft.[x]<br>50 ft.[p] | 200 ft. |
| LAA (undisinfected secondary recycled water) [i] | 150 ft.[s] | 100 ft. | 100 ft. | 100 ft.[x]<br>50 ft.[p] | 200 ft. |
| Spray Irrigation (disinfected tertiary recycled water) [k] | No spray irrigation of any recycled water, other than disinfected tertiary recycled water, shall take place within 100 feet of a residence or a place where public exposure could be similar to that of a park, playground, or school yard. | | | | |
| *WASTEWATER STORAGE AND/OR TREATMENT PONDS* | | | | | |
| Impoundment (disinfected tertiary recycled water) [g] | 100 ft.[t] | 100 ft. | 100 ft. | 50 ft. | 200 ft. |
| Impoundment (disinfected sec-2.2 or sec-23 recycled water) [h] | 100 ft.[r] | 100 ft. | 100 ft. | 50 ft. | 200 ft. |
| Impoundment (undisinfected secondary recycled water) [i] | 150 ft.[s] | 150 ft. | 150 ft. | 50 ft. | 200 ft. |



LAA denotes Land Application Area. Sec denotes secondary.

[a] A flowing stream shall be measured from the ordinary high water mark established by fluctuations of water elevation and indicated by characteristics such as shelving, changes in soil character, vegetation type, presence of litter or debris, or other appropriate means.

[b] Ephemeral Stream Drainage denotes a surface water drainage feature that flows only after rain or snow-melt and does not have sufficient groundwater seepage (baseflow) to maintain a condition of flowing surface water. The drainage shall be measured from a line that defines the limit of the ordinary high water mark (described in “a” above). Irrigation canals are not considered ephemeral streams drainage

## Table 5-1 Cont'd

features. The ephemeral stream shall be a "losing stream" (discharging surface water to groundwater) at the proposed wastewater system site.

[c] Setback established by California Plumbing Code, Table K-1.

[d] Lake or reservoir boundary measured from the high water line.

[e] Septic Tank, Aerobic Treatment Unit, Treatment System, or Collection System addresses equipment located below ground or that impedes leak detection by routine visual inspection.

[f] Leach Field includes all subsurface dispersal systems, including mound systems except seepage pits.

[g] Disinfected tertiary recycled water is defined in California Code of Regulations, title 22, section 60301.230.

[h] Disinfected secondary-2.2 recycled water is defined in California Code of Regulations, title 22, section 60301.220. Disinfected secondary-23 recycled water is defined in California Code of Regulations, title 22, section 60301.225.

[i] Undisinfected secondary recycled water is defined in California Code of Regulations, title 22, section 60301.900.

[k] Additional restrictions for spray irrigation of recycled water are contained in California Code of Regulations, title 22, section 60310(f)

[m] Setback established by California Code of Regulations, title 22, section 60310(a). A reduced setback is allowed as described in California Code of Regulations, title 22, section 60310(a) if all the conditions in the section are met and compliance is documented in the ROWD and NOA.

[o] California Well Standards, part II, section 8. Site-specific conditions may allow reduced setback or require an increased setback. See discussion in Well Standards.

[p] Setback for drip or flood application methods. Spray irrigation is subject to additional setbacks and restrictions. (See footnote k.)

[r] Setback established by California Code of Regulations, title 22, section 60310(c).

[s] Setback established by California Code of Regulations, title 22, section 60310(d).

[t] Setback established by California Code of Regulations, title 22, section 60310(b).

[w] Setback established by the Onsite Wastewater Treatment System Policy, section 7.5.5.

[x] Setback established by California Code of Regulations, title 22, section 60310(f).

[y] Setback established by Onsite Wastewater Treatment System Policy, section 7.5.6.

consideration for Woodacre-San Geronimo. The setbacks reflect a compilation of requirements from Title 22, State Water Well Standards, the State OWTS Policy, California Plumbing Code.

### *Effluent Limitations*

**Table 5-2** lists the effluent limitations contained in Table 4 of the Order for different types of secondary and tertiary wastewater treatment systems. “Step 2” in the table addresses nitrogen effluent limitations which apply to wastewater systems with design flows greater than 20,000 gpd. The Order includes a process for assessing the level of nitrogen threat posed by the wastewater system based on the receiving environment and other factors in order to determine the appropriate effluent standard, which may be either (a) 50% removal or (b) a specific concentration limit that may be as low as 10 mg-N/L.

### *Wastewater Pond Sizing*

The Order requires that wastewater pond sizing must be sufficient to: (1) accommodate the design wastewater flow plus precipitation based on water balance calculations incorporating 100-year frequency annual total precipitation value distributed monthly in accordance with average (mean) precipitation values; and (2) maintain two feet of freeboard.

## Statewide General WDRs for Sanitary Sewers (SWRCB Order No. 2006-0003-DWQ)

This is a general permit pertaining to the management of sanitary sewer systems of more than one mile in length that are owned or operated by a municipality, sanitary district or other public authority. This would apply to any of the community wastewater alternatives (3 through 6) under consideration for the Woodace-San Geronimo study area. For new facilities, enrollment under the General Permit must occur at least three months prior to start of operations. The Order requires the public authority to develop and implement a written Sewer System Management Plan (SSMP), including provisions to provide proper and efficient management, operation, and maintenance of sanitary sewer systems, while taking into consideration risk management, costs and benefits. Additionally, an SSMP must contain a spill response plan that establishes standard procedures for immediate response to a sanitary sewer overflow in a manner designed to minimize water quality impacts and potential nuisance conditions. The Order also contains spill notification, monitoring and reporting requirements.

**Table 5-2: Effluent Limitations for Wastewater Treatment Systems**
(per Table 4, General Order WQ 2014-0153-DWQ)

| **Step 1 - Effluent Limitations Based on Technology Performance** | | |
|---|---|---|
| Activated Sludge, MBR, or similar (not including residential aerobic treatment units) | | |
| Constituent | Units | Limit |
| BOD | mg/L | 30 (monthly average), 45 (7-day average) |
| TSS | mg/L | 30 (monthly average), 45 (7-day average) |
| Wastewater Pond or Trickling Filter [1] (not including residential recirculating sand filters) | | |
| Constituent | Units | Limit |
| BOD | mg/L | 90 [2] |
| TSS | -- | Not Applicable |

| **Step 2 - Effluent Limits Based on Low/High Threat Situation (flow rate >20,000 gpd)** | | |
|---|---|---|
| Constituent | Units | Limit |
| Total N | mg/L | -- |
| Low Threat | mg/L | 50 % [3] |
| High Threat | mg/L | 10 |

BOD denotes biochemical oxygen demand; TSS denotes total suspended solids; MBR denotes membrane biological reactor. Residential denotes a single family home, property caretaker's home, a home with an associated residence (e.g. mother in law unit), or similar, with a flow rate less than 400 gpd. "—" denotes not applicable.

1. Limit applies when treated wastewater is applied to an LAA or to a subsurface disposal system.
2. The limit is based on a 65-percent reduction of incoming BOD. An incoming BOD of 250 mg/L was used to calculate the value.
3. The value represents the minimum percent reduction compared to the untreated wastewater value. Reduction shall be calculated on an annual basis. In no case shall the reduction result in an effluent limit lower than 10 mg/L total nitrogen.

# SECTION 6: PROJECT ALTERNATIVES

## INTRODUCTION

This section presents an analysis of each of the identified alternatives for the Woodacre – San Geronimo Study Area. To provide continuity and a frame of reference, the current study includes Non-Water Recycling project alternatives (1, 2 and 3), which are updated from the 2011 Woodacre Flats study along with several Water Recycling alternatives (4, 5a, 5b and 6) consistent with the project objectives. The analysis incorporates the results of field investigations and engineering studies from the 2011 study, along with additional data and analysis for the expanded project scope and service area. The project alternatives are illustrated in **Figure 6-1** on an annotated map of the study area.

For each alternative, maps and other reference materials are provided, along with a description of key facilities, engineering feasibility, estimation of construction costs and a discussion of on-going operation and maintenance requirements and costs. Supporting technical information is provided in the appendices. **Section 7** presents a comparative review of the various treatment and disposal alternatives and identifies the "apparent best alternative(s)".

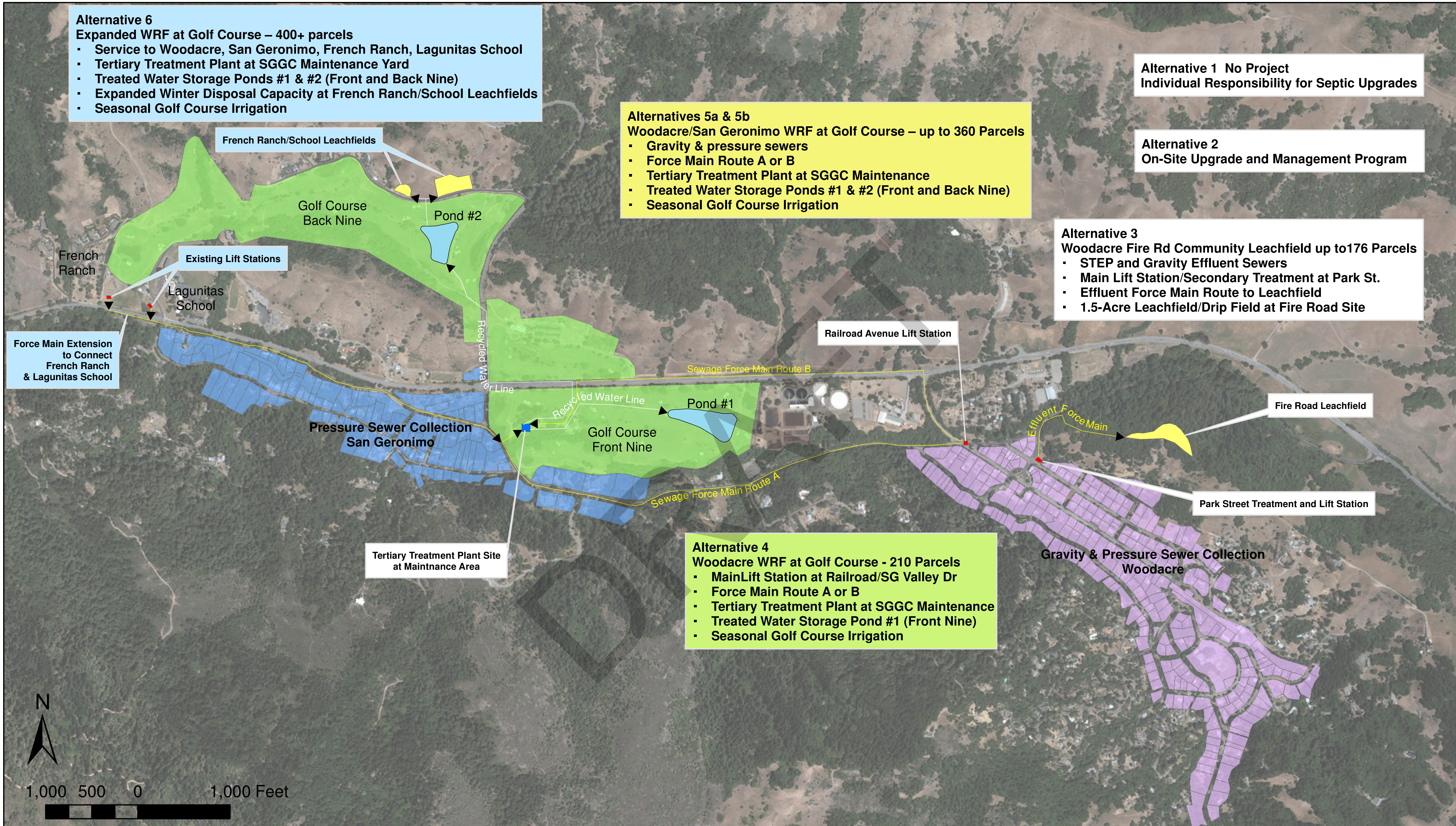
## ALTERNATIVE 1 – NO PROJECT

### *Description*

The No Project alternative, or status quo, is presented as a base case condition against which to judge other alternatives; however, no specific engineering evaluation has been made of this alternative. This alternative would provide for the continued use of onsite septic systems, with individual property owners responsible for maintenance and repair of their own systems. Permitting and regulatory responsibility would remain with the Marin County EHS and include oversight from the Regional Water Board. Correction of failing septic systems would normally be expected to occur under the following circumstances:

- As a direct result of abatement action taken by EHS for individual properties, in response to complaints;
- As a condition of sale at the time of property transfers;
- In connection with permits for building modifications; or
- By individual property owners on their own initiative.

Septic system repair work expected under this alternative might include, for example, replacement of existing substandard or failing septic systems with a new septic tank and disposal system. In most cases, an alternative system, such as a mound or advanced ("supplemental") treatment unit with drip dispersal or pressure distribution leachfield, would likely be required because of particularly poor site conditions for standard septic tank/leachfield systems. These conditions include the shallow soil depths, seasonal high groundwater, setback constraints, and limited available land area on mostly small parcels. Retrofitting houses with ultra-low flush toilets and other water conserving plumbing devices would also be a necessity for many houses to reduce the volume of wastewater to be disposed. New residential construction, building additions and second units would not be permissible except where site conditions can




| | |
|---|---|
| DATE: | 2/9/2017 |
| PROJECT: | WOODACRE WW |
| PROJECT NO: | 1600073 |
| DRAWN: | MF |
| APPROVED: | NH |

QUESTA ENGINEERING CORP

# PROJECT ALTERNATIVES

FIGURE 6-1

support the installation of an onsite system that conforms to current code requirements and/or the County's Remodel & Additions Policy.

### *Discussion*

Over some period of time, the above-described efforts may lead to improved water quality and public health conditions in the community. But it is unreasonable to expect that the existing threat of water quality impact to Woodacre Creek, San Geronimo Creek and downstream receiving waters would be satisfactorily corrected. Under the No Project alternative, the possibility exists that the County EHS and/or Regional Water Board would find it necessary at some point to undertake a systematic lot-by-lot inspection and abatement effort to mandate an upgrading of all septic systems to acceptable, modern standards. This could occur as a result of the implementation of the Tomales Bay Pathogens TMDL.

The TMDL requires that there be no discharge of human pathogens to Tomales Bay or its tributaries from septic systems. The TMDL further specifies that compliance with this requirement can be achieved by either: (a) documenting or bringing the septic system into conformance with Regional Water Board and County regulations for new construction; or (b) monitoring the septic system to verify compliance with the above "no pathogen discharge" performance standard. For existing septic systems in the watershed area found (or suspected) to be failing, the TMDL would require substantial upgrading (per Marin County Class 2 Repair Criteria), and ongoing monitoring of the new/replacement system under a County operating permit. However, the timing for implementing such corrective action is presently not specified.

### *Costs*

Costs for the No Project alternative are best estimated from the existing expenses incurred by individual property owners in connection with upgrades or repair of their onsite wastewater systems in connection with building remodel project, property transfers or repairs. Typical installation costs range from about $35,000 on the low end up to as much as $70,000, including soils testing, surveys, design, permitting and construction. Assuming most all systems require some alternative treatment components, the ongoing operation and maintenance requirements include service inspections, monitoring and reporting under the conditions of an County-issued Operating Permit, plus electrical usage, routine septic tank pump-outs, and replacement of parts and system components over the life of the system. Average annual operating maintenance costs are typically in the range of $1,000 to $1,500 for alternative onsite wastewater treatment systems, including the above items and annual County permit fees.

## ALTERNATIVE 2 - ONSITE SYSTEM UPGRADE AND MANAGEMENT PROGRAM

### *Description*

This alternative would provide for inspection and as-needed upgrading of existing septic systems in some portions or all of the study area, and formation of a septic system management authority to perform ongoing inspection, monitoring, and maintenance of these systems. Septic systems would need to be upgraded to a minimum set of standards, or determined to be in compliance with a minimum performance standard that would assure proper functioning and elimination of public health and water quality problems. The current standards of the Marin County EHS and the Regional Water Board would apply, with the possibility of adopting certain local modifications with concurrence by both of these agencies. In general, all applicable siting criteria (i.e., soil depth, percolation, groundwater, slope requirements, etc.) would be considered to the greatest extent possible in evaluating and designing septic system upgrades.

On-lot septic system improvements under this alternative would be similar to those for the No Project alternative; i.e., it would include replacement of substandard systems with new septic tanks, supplemental treatment units (e.g., sand filter or other supplemental treatment unit) and new disposal fields, most likely using pressure distribution or drip dispersal. Other alternative technologies might also be considered on a case-by-case basis, typically requiring demonstration to EHS of successful operation in other similar circumstances. Retrofitting houses with ultra-low flush toilets and other water conserving plumbing devices would also be a necessity for many houses to reduce the volume of wastewater to be disposed. The specific siting and design criteria for each alternative technology would have to be in accordance with currently adopted standards of the County and Regional Water Board, or based on criteria developed and agreed upon by both agencies specifically for this Project. In the course of developing this alternative during the 2011 Woodace Flats study, appropriate criteria were determined in consultation with these agencies. The same criteria remain valid for the expanded Woodacre-San Geronimo study area, and are presented and used in the evaluation that follows.

Following septic system upgrading, a continuing inspection and monitoring program would be carried out by a public management authority. This would entail regular inspection of each septic system, water quality sampling of treatment systems as well as Woodacre Creek and San Geronimo Creek, possibly other local drainages, and groundwater monitoring wells, with periodic reporting to the County and Regional Water Board on the inspection results and overall compliance with system performance, water quality and public health standards.

### *Design Requirements*

Criteria governing the siting and design of onsite sewage disposal facilities in the project area are described in **Section 5** of this report and cover such items as minimum soil depth, percolation rates, separation to groundwater, system design and sizing, and operation and maintenance. The standards are established to guide the installation of new systems. As previously noted, for repair of existing septic systems, Marin County EHS attempts to achieve compliance with current regulations to the maximum extent practicable. However, full compliance with all code requirements is generally not possible. Heavy emphasis is given to case-by-case evaluation to achieve the best repair possible, considering the site limitations and environmental resources and public health issues at risk. **Table 6-1** lists the repair criteria and design assumptions that were developed during the 2011 wastewater study for application in an onsite wastewater management program, at that time considering only the Woodacre Flats area. These were developed in consultation with EHS staff and the Regional Water Board staff in 2010. They have been reviewed and found still valid and equally applicable to the expanded service in the current study covering additional properties in Woodacre and San Geronimo.

## Table 6-1: Repair Criteria - Onsite Wastewater Management Program

| ITEM | CRITERIA / DESIGN ASSUMPTION |
|---|---|
| **Wastewater Design Flow** | ▪ Property owners responsible for installing ultra-low flush toilets and low flow fixtures;<br>▪ Assume design flow of 105 gpd/bedroom;<br>▪ Design flow of <105 gpd/bedroom if necessary due to dispersal area limitations and with additional monitoring requirements (per below). |
| **Septic Tanks** | ▪ Existing concrete/fiberglass tanks of 1,200 gal or greater may be retained if found to be structurally sound, watertight and are upgraded with code compliant access risers.<br>▪ Effluent filters required for all new and upgraded tanks<br>▪ Setbacks to water and landscape features to be maintained as close as possible to code requirements;<br>▪ Setbacks to wells and springs - 50-ft minimum with variance from code. |
| **Supplemental Treatment Units** | ▪ NSF Certification or equivalent technology verification required.<br>▪ Performance standard: Per standard EHS protocol*; for special/extreme creek encroachment situations, TMDL receiving water standard for fecal coliform at end of supplemental treatment process (i.e., dosing tank) or at groundwater monitoring wells adjacent to disposal field. 50% nitrogen removal may be required per future Tomales Bay or Lagunitas Creek TMDLs. |
| **Dispersal System** | ▪ All reasonable dispersal technologies may be considered, including trenches, beds, mounds, drip dispersal;<br>▪ Design capacity – 100% of daily sewage flow; provide reserve area as feasible;<br>▪ Design loading rate: per soil characteristics and percolation rate; treatment credit for supplemental treatment OK per established sand filter design criteria;<br>▪ Setbacks to water and landscape features to be maintained as close as possible to code requirements;<br>▪ Setbacks to wells and springs - 100-ft minimum |
| **Site Modifications** | ▪ Utilize curtain drains and surface drainage alteration wherever needed and feasible without impacts to/from other onsite systems or to surface waters;<br>▪ Soil excavation and replacement with sand fill – not normally allowed but may be considered case-by-case, e.g., for removal improvement of compacted fill area. |
| **Performance Monitoring** | ▪ Wastewater flow: Monitor from pump operations and/or water meter; require flow meter (or comparable device) and data logging for systems without 100% disposal capacity;<br>▪ Monitoring: water quality sampling required for coliform for special case systems at pump basin (following supplemental treatment), once/year;<br>▪ Visual inspection and maintenance once per year minimum;<br>▪ Remote alarm monitoring for identified high risk systems, e.g., creek encroachment with less than 100% disposal capacity. |
| **Other Alternatives** | ▪ Holding tanks: May be required case-by-case to overcome extreme site limitations, such as soil/groundwater/drainage conditions or water course setbacks;<br>▪ Composting toilets: Not anticipated to be feasible or acceptable in high density residential area such as Woodacre and San Geronimo.<br>▪ Greywater Systems: Case-by-case evaluation based on State and County Greywater Standards |

**Includes operating permit with standard and site specific inspection, testing, and reporting requirements*

### *Discussion*

An assessment of onsite wastewater disposal feasibility for lots within the Woodacre and San Geronimo Study Area was completed utilizing the repair criteria listed in **Table 6-1**. Background file information, to the extent available, was utilized and combined with a field reconnaissance review of a representative cross-section of properties conducted during the 2011 Woodacre Flats study for this assessment. **Section 3** provides a description and summary of findings of the permit records and field reviews; additional details are provided in the 2011Woodacre Flats project report.

Briefly, the objective of the permit records and onsite field reviews was to: (a) assess the apparent available area for onsite septic system upgrade: (b) identify and evaluate some of the main construction issues and constraints that would be involved with the implementation of onsite system upgrades; and (c) assess and categorize the properties according to potential options for implementing an onsite system upgrade in accordance the basic repair criteria outlined in **Table 6-1.** This resulted in establishment of three upgrade/repair categories based on the level of difficulty and associated work required, as described previously in Section 3 under Onsite Field Reviews, briefly as follows:

- **Low Level** – This was assigned to properties having an existing Class 1 or Class 2 code system, where little or no repair or upgrade work would be anticipated.
- **Moderate Level** – This was assigned to properties having sufficient area and reasonably good soil and groundwater conditions that could accommodate relatively straight forward upgrades to either the treatment or disposal system.
- **High Level -** This was assigned to properties having severe space limitations along with shallow soil/high groundwater conditions and/or drainage setback constraints requiring considerable work to implement a satisfactory onsite upgrade/repair.

Literature on some of the onsite wastewater treatment technologies commonly used for system upgrades in area with difficult siting constraints is provided in **Appendix A**. Generic examples of tyical repair and upgrade options representative of Moderate and High level categories are illustrated in **Appendix B.**



The 2011 Woodacre Flats study estimated the percentage of properties in each septic system upgrade level to be as follows:

- Low Level: 15%
- Moderate Level: 12%
- High Level: 73%

For the current study, the same percentages were used to estimate the probable septic system upgrade requirements for the total expanded number of properties in Woodacre and San Geronimo communities, which are presented in **Table 6-2**.

**Table 6-2: Onsite System Upgrade Assessment Needs Summary**

| Area | Total Properties | Estimated Level of Upgrade (# of properties) | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| Woodacre Subarea | 250 | 38 | 30 | 181 |
| San Geronimo Subarea | 113 | 17 | 14 | 83 |
| Total | 363 | 55 | 44 | 264 |
| Percent of Total | 100% | 15% | 12% | 73% |

### *Operation and Maintenance Needs*

Following septic system upgrading, a continuing inspection and monitoring program would be carried out by a public maintenance authority; this is assumed to be a requirement of both the County and the Regional Water Board for implementation of the Tomales Bay Pathogens TMDL. This would be expected to entail the following routine items:

- Inspection of each system, normally once per year;
- Water quality sampling of the effluent from a representative number of treatment units; assume 20 percent of systems sampled each year and all systems sampled at least once every five years;
- Groundwater and surface water quality monitoring;
- Reporting water quality failures or malfunction of systems;
- Annual reporting to the County and Regional Water Board on the inspection results and overall compliance with water quality and system performance standards; and
- Periodic cleaning and pumping of septic tanks/treatment units, usually every 3 to 5 years;

There would be electrical costs associated with the operation of the advanced treatment systems, any UV disinfection units, and the pump systems used for dosing the pressure distribution and drip dispersal fields. Each property owner would be responsible for providing and maintaining electrical service. From time-to-time, various system components (such as valves, UV light bulbs, pumps and float controls) would require repair or replacement. The need for this work would be determined by the maintenance authority; depending upon the complexity, the actual repair/replacement work could be done by the maintenance authority, a contractor or, possibly, the property owner.

To facilitate system maintenance and oversight, it is assumed that a telemetry control system would be included in the system design, so that alarm conditions at individual systems can be relayed and monitored at a remote location by the responsible maintenance authority or contractor.



### *Estimated Costs*

#### *Capital Costs*

**Table 6-3** summarizes the estimated range in cost that would be anticipated for an individual system upgrade within Low, Moderate and High upgrade categories, as discussed above. Supporting cost estimation details and assumptions are provided in **Appendix B.** The costs were developed based on Questa's experience with these types of onsite system projects in

Marin County, and included consultation with local contractors, manufacturers, and equipment suppliers. In addition to new construction items, the upgrade costs also include allowance for abandonment of the existing system (as required), electrical work, site restoration, permitting, and testing. The costs do not include an allowance for retrofitting of buildings with low-flow plumbing fixtures or appliances, which would be a homeowner responsibility and likely has already been done in many instances. Cost allowances for contingencies, engineering, environmental, and related project implementation activities are accounted for as lump sum items for this project alternative as a whole, rather than for individual systems (see below).

**Table 6-3: Estimated Individual Onsite System Upgrade Costs**

| Item | Low Estimate ($) | High Estimate ($) | Average ($) |
|---|---|---|---|
| Low Level Upgrade | 1,500 | 4,500 | 3,000 |
| Moderate Level Upgrade | 27,500 | 30,000 | 28,750 |
| High Level Upgrade | 36,000 | 51,000 | 43,500 |

Using the estimated number of upgrades by level of work provided in **Table 6-2** and the estimated average per system upgrade costs in **Table 6-3,** overall cost estimates for this alternative were developed. The overall project costs are summarized in **Table 6-4**. As indicated, in addition to individual system construction, the total project cost estimate includes other allowances as follows: (a) 15% contingency; (b) 15% for engineering and environmental studies; (c) 10% for construction management; and (d) 5% for project administration, district formation and financing. As indicated, the total estimated capital costs for Alternative 2 would be on the order of about $19.3 million for all 363 developed properties in the combined Woodacre and San Geronimo service areas. The corresponding average cost per parcel is estimated to be approximately $53,000.

*Operation and Maintenance Costs*

Annual operation and maintenance costs for the onsite management alternative are summarized in **Table 6-5**. The estimates are based on best professional judgment and experience with onsite system monitoring activities in Marin County and with other onsite wastewater management programs. As indicated, O&M costs for this alternative include district and program administration costs, labor and expenses to perform the necessary system inspections and reporting, an allowance for equipment and material costs associated with system maintenance and replacement, laboratory costs for water quality sampling and analysis, electrical costs for individual treatment/disposal system equipment (directly absorbed by property owners), and routine septic tank pump-outs. An allowance of 10% is included as a contingency. As indicated, the total annual O&M cost for Alternative 2 is estimated to be approximately $350,800 for the full Woodacre-San Geronimo service area. The corresponding annual cost per parcel would be approximately $966.

**Table 6-4: Estimated Capital Costs for Onsite Upgrade and Management Program**

| Upgrade Work Category | Number of Systems | Average Cost per System | Total Cost ($) |
|---|---|---|---|
| Low Level | 55 | 3,000 | $165,000 |
| Moderate Level | 44 | 28,750 | $1,265,000 |
| High Level | 264 | 43,500 | $11,484,000 |
| **Subtotal** | | | **$12,914,000** |
| **Contingency @ 15%** | | | $1,937,100 |
| **Subtotal** | | | **$14,851,100** |
| **Engineering and Environmental Studies @ 15%** | | | $2,227,665 |
| **Construction Management @ 10%** | | | $1,485,110 |
| **Project Administration, District Formation and Financing @ 5%** | | | $742,555 |
| **TOTAL** | | | **$19,306,430** |
| **Average Cost Per Connection (363 parcels)** | | | **$53,186** |

**Table 6-5: Estimated Annual O&M Costs, Onsite Management Program**

| Items | Assumptions | Estimated Annual Cost ($) |
|---|---|---|
| District/Program Administration | Insurance, legal, financial, permits @ $150/parcel | $ 54,500 |
| On-lot System Inspection, Monitoring & Reporting | Annual inspection of all systems, remote monitoring, data compilation, annual reporting, as-needed engineering consultation @ $300 ea | $108,900 |
| Maintenance | Equipment, materials, maintenance & replacement @ $200/yr each | $72,600 |
| Laboratory & Expenses | Sampling 20% of individual treatment systems annually, surface and groundwater sampling, travel expenses and supplies | $36,000 |
| Electrical* | Property owner expense for treatment & dispersal pumps and other electro-mechanical items @ $30/yr | $10,900 |
| Septic Tank Pumping* | 25% of tanks pumped annually @ $400 each | $36,000 |
| **Subtotal** | | **$318,900** |
| **Contingencies (@ 10%)** | | $31,890 |
| **TOTAL** | | **$350,790** |
| **ANNUAL COST PER PARCEL** | | **$966** |

**Individual property owner cost, varies according to system type, occupancy and use.*



### *Summary*

The onsite upgrade and management alternative would substantially reduce present water quality and public health problems, bring more (as opposed to the No Project option) of the existing onsite systems into conformance with accepted practices, and would do so in a timely manner. The primary shortcoming of this alternative is the heavy reliance on advanced treatment systems and the substantial variances to normal siting and design standards – especially in regard to soil conditions and setbacks from watercourses. This alternative will require on-going care, maintenance, and monitoring of each onsite wastewater system.

The septic system upgrade efforts, along with establishment of an onsite management program, would largely eliminate the public health hazards and water quality threat from septic systems in the local community, and contribute to improvement in conditions in downstream receiving waters. Existing seepage pits and other disposal systems that drain directly into groundwater or periodically experience surface failures would be eliminated in favor of advanced treatment units, disinfection in some cases, and upgraded dispersal systems, including raised drip disposal beds and other similar alternative technologies. The institution of an onsite wastewater management program would provide the means for monitoring the performance of all upgraded systems, as well as the local environment, for possible wastewater impacts. Potential negative aspects of this plan would be the land disturbance required on individual properties to upgrade on-lot disposal systems, and probable conflicts with other existing or potential uses of the limited yard areas. The septic system upgrades may interfere with parking in some cases, and require changes to landscaping.

This alternative represents a substantial improvement in reliability over existing conditions, through the proposed implementation of an onsite inspection and maintenance program. Alternative 2 would also introduce some additional flexibility for septic system management, by providing for the use of holding tanks (if needed in special cases), and perhaps other design alternatives that would not be approved for operation by individuals outside of a septic system management program, e.g., under the No Project Alternative.

Alternative 2 would not bring about any significant land use/development changes in the study area; however, an onsite wastewater management program could make it possible for house remodeling and some amount of additions to existing structures. There would be no assurance that undeveloped properties could be developed, or that house additions/remodeling could be undertaken without restrictions and conformance with Marin County EHS Remodel Policy.

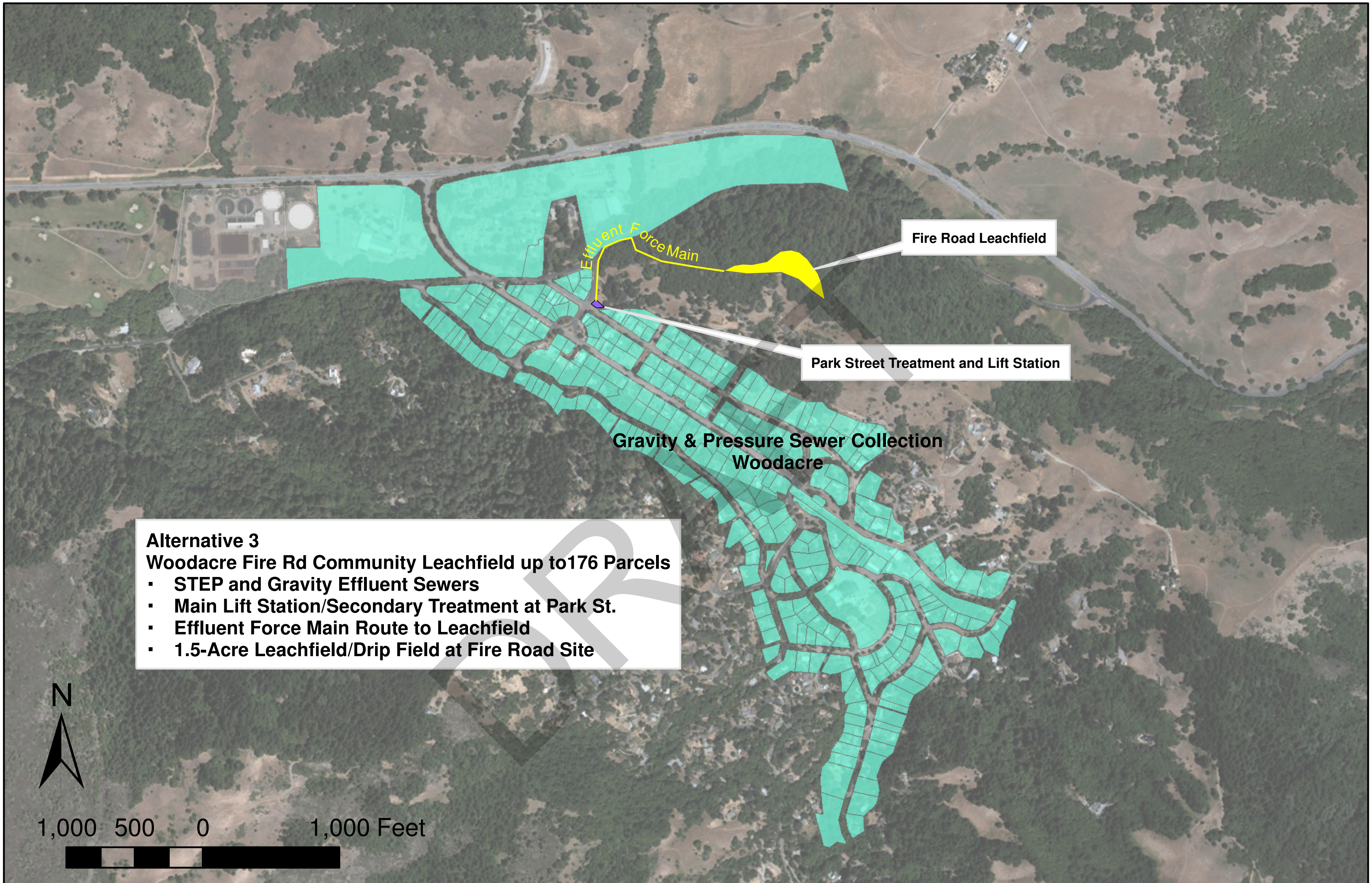


## ALTERNATIVE 3 – FIRE ROAD COMMUNITY LEACHFIELD (WOODACRE ONLY)

### *Description*

This alternative provides a potential community wastewater solution to serve a portion (roughly 70%) of the properties in the Woodacre service area. It does not offer capacity to serve properties in San Geronimo or identification of an alternate similar community leachfield-type facility that could potentially serve San Geronimo.

This alternative was developed in the 2011Woodacre Flats study and provides for the construction of a central wastewater collection system in the Flats area, leading to a community leachfield system located on nearby forested lands (**Figure 6-2**). The area identified as a potential community leachfield site is a wooded knoll along the Fire Road ridgeline northeast of Woodacre on property owned by Dickson Ranch. During the 2011 study, the property owners granted access to Questa Engineering staff for field studies to evaluate various locations on the Dickson Ranch for potential use as a community wastewater treatment and disposal site for

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| PROJECT NO: | 1600073 |
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| APPROVED: | NH |

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# ALTERNATIVE 3

FIGURE 6-2

Woodacre Flats. Three different community leachfield options were formulated and evaluated, with the preferred option consisting of a secondary treatment system (AdvanTex textile filter) with a shallow pressure distribution leachfield, which is presented here as Alternative 3 for the current study.

The main differences in Alternative 3 as compared with the information presented in the 2011 study are: (a) revised capacity to serve 176 rather than 150 properties; (b) revisions to treatment system configuration to meet current manufacturer recommendations for nitrogen removal; and (c) installation of a dual (200%) capacity leachfield, rather than a 100% field with 100% designated reserve area. The treatment and disposal facilities would be designed for a daily wastewater flow of 26,400 gpd.

Details and supporting background information for Alternative 3 are provided in **Appendix C** and in the 2011 Woodacre Flats project report. Key elements of this alternative include the following:

**Collection System.** Sewage collection would be provided by a combination of septic tank effluent pump (STEP) and small diameter (4-inch) gravity effluent sewers. This includes the continued use of existing or upgraded on-lot septic tanks, cluster tanks for multiple properties in some cases, and a system of 2-inch to 4-inch diameter pressure piping to bring the septic tank effluent to a central treatment plant location at Park Street.

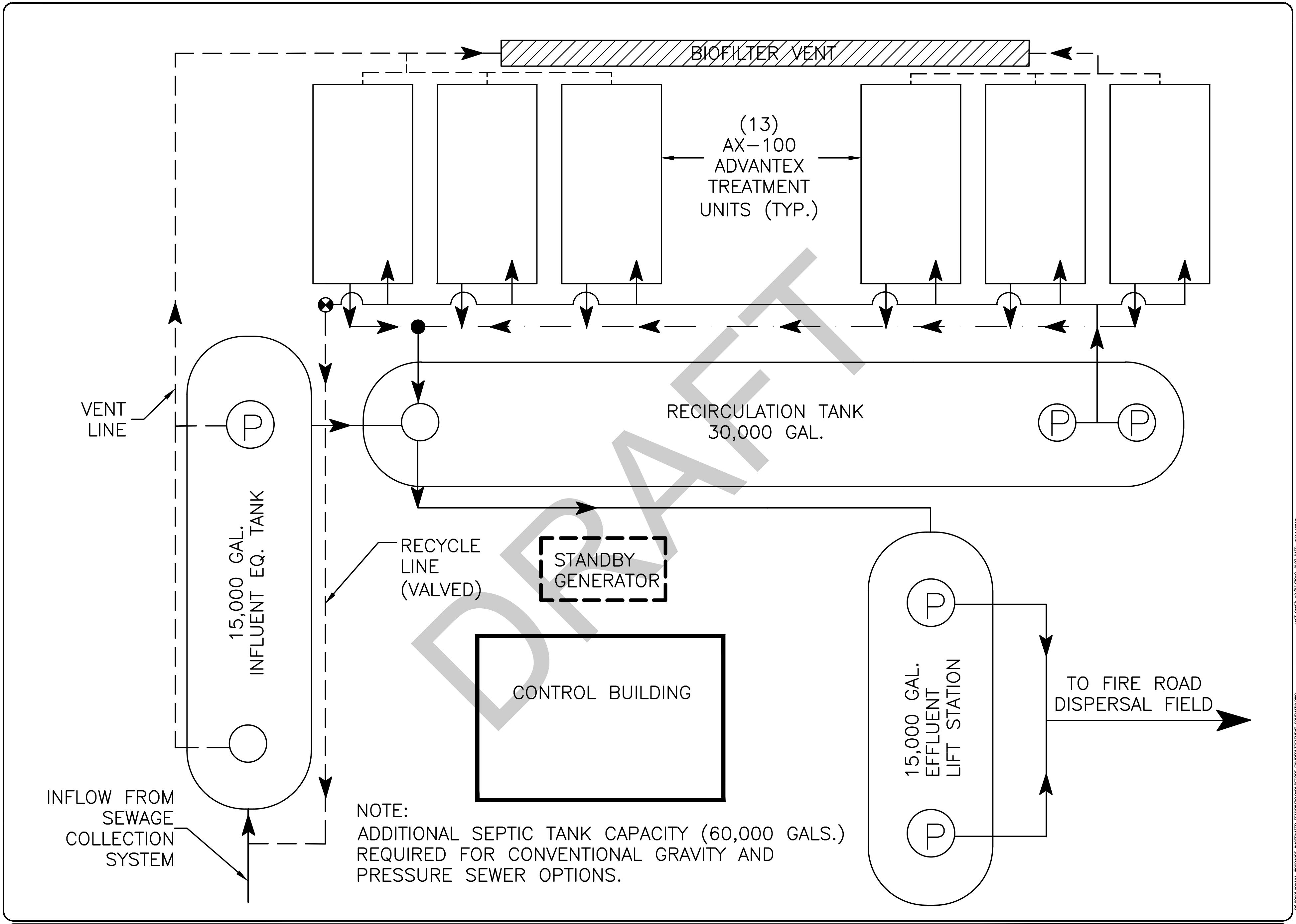
**Wastewater Treatment.** Advanced secondary treatment, including nitrogen removal, would be provided for all effluent prior to dispersal to the community leachfield.

- **Primary Treatment.** Septic tanks at individual properties (possibly some cluster locations) would provide primary treatment. Some existing tanks may continue to used, as is, and others would be upgraded or replaced with new water-tight tanks, typically 1,200-gallons capacity.

- **Secondary Treatment**. A secondary treatment system would be provided and is proposed to be located in County-owned right-of-way in at the intersection of Park Street and Central Avenue in Woodacre, occupying an area of approximately 10,000 $ft^2$. Various treatment system types are available for this application. For feasibility analysis, the recommended system best meeting project requirements would be an AdvanTex recirculating textile filter, including provisions for enhanced nitrogen removal (>50% removal rate). This type of system is recognized in County Regulations and in use locally at Spirit Rock Center, the Marshall Community Wastewater System, and others places in the County. A schematic layout of the wastewater treatment facilities is provided in **Figure 6-3**. Key features would include:

    - o Flow equalization tank – 10,000 gallons
    - o Pre-anoxic tank – 30,000 gallons
    - o AdvanTex recirculation-blend tank – 30,000 gallons
    - o AdvnTex treatment "pods" – 11 units @ 2,500 gpd/each, total 27,500 gpd
    - o Effluent Lift Station – 15,000 gallons
    - o 250 $ft^2$ control building, telemetry system, emergency generator, fencing and landscaping

**Wastewater Disposal.** Wastewater disposal would be provided by a dual (200% capacity) pressure distribution system located on an approximately 1.5-acre wooded knoll on Dickson




**WOODACRE/SAN GERONIMO**
**WASTEWATER RECYCLING STUDY**
WOODACRE, CALIFORNIA

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Design: NH/PP
Drawn: ML
Checked: PP
Appr'd: NH

**SECONDARY TREATMENT SCHEMATIC**

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Ranch property located along the Fire Road ridgeline. Description of soil investigations and findings area provided in **Appendix C** and in the 2011 Woodacre Flats project report. All test pits showed similar soil conditions, consisting of loam and sandy loam topsoils underlain by highly weathered sandstone to the depth explored. No groundwater or evidence of seasonal saturation was observed in any of the profiles.

Leachfield design parameters are as follows:

- Design flow: 26,400 gpd, dual alternating fields
- Pressure distribution leachfield, w/Infiltrator Chambers
- Trench depth - 30 inches
- Trench width - 36 inches
- Effective infiltrative area – 5 $ft^2$ per lf of trench, bottom area + sidewall (note: this is based on Regional Water Board onsite system minimum guidelines; Marin County regulations for systems <10,000 gpd design flow specify sizing based on sidewall only)
- Wastewater application rate – 1.6 gpd/$ft^2$ (2 x standard septic tank effluent rate); 8 gpd/lf
- Total trench length – 6,600 lf (3,300 lf primary, 3,300 lf secondary)
- Trench spacing - 10 feet, o.c.
- Total leachfield area - 1.5 acres
- Setbacks – No streams within 200+ feet; no wells within 500 feet

Other facilities required for the community leachfield would include the following:

- **Effluent Force Main.** 4-inch diameter effluent force main, approximately 2,200 feet long, to convey treated wastewater from the Park Street treatment facility to the Fire Road site. The recommended route would be via Park Street, then San Geronimo Valley Drive, and then overland through Dickson Ranch property along the ridgeline to the Fire Road leachfield site.

- **Effluent Dosing Station.** An effluent dosing (pump) station would be installed near the southerly end of the Fire Road site (high point). It would consist of a large tank (e.g., 15,000 gallon fiberglass) and multiple pumps and control system. The control panel would be housed in a small building or enclosure (e.g., <100 $ft^2$). For emergency purposes (power or pump outages), a gravity dosing tank to a series of overflow leachlines would be installed and the control system would be designed to be operated with a portable generator.

- **Electrical Power.** Electrical power from PG&E would be brought to the Fire Road site from the nearest location, estimated to be about 1,500 feet away on Fire Road; provisions for temporary operation of the dosing pumps with a portable generator will also be provided.

- **Fencing.** The 1.5-acre leachfield site, including the dosing station, would be fenced with typical farm fencing (barbed wire) to keep animals out of the site.

- **Fire Road Access Improvements.** Improvements (grading and gravel surface) would be made to Fire Road to provide all weather vehicle access to the leachfield site.

- **Land Acquisition.** The land for the leachfield and the effluent force main to the site would have to be purchased or an easement acquired from the Dickson Ranch. The property owners willingly granted access for the investigation of the Fire Road leachfield site as well as preliminary exploration of other areas of the Dickson Ranch. They indicated interest in cooperating with the community and also expressed interest in possibly being incorporated into the service area for a community wastewater system.

### *Operation and Maintenance Requirements*

The community collection, treatment and disposal facilities under Alternative 3 would be owned and operated by the wastewater district formed as part of the project. The actual operations and maintenance work would be performed or overseen by a qualified wastewater treatment plant operator. Local maintenance contractors may be hired to perform routine inspection, maintenance, and monitoring activities. Operation and maintenance activities can be expected to include the following:

- **Facility Inspections, Maintenance and Operations.** This includes routine inspections and maintenance of the individual septic tanks and STEP units, collection system pipelines and valves, lift stations, community treatment system, leachfield dosing pumps and pipelines, and leachfield piping, trenches and valves, and all electrical/mechanical control equipment. Other maintenance work includes the pump-out and hauling of sewage solids from septic tanks and other treatment units, general upkeep of the treatment plant grounds, and periodic servicing or replacement of equipment. The inspection, maintenance and operations of the facilities would be conducted on an as needed basis; it would be facilitated by remote telemetry equipment for notification of alarm conditions. Some level of onsite inspection and/or maintenance work is likely to occur on a weekly basis or a few times a week.

- **Performance Monitoring.** The waste discharge permit for the community wastewater facilities would require routine monitoring of the wastewater treatment and disposal facilities to verify compliance with performance standards and proper operation. A formal monitoring and reporting program would be established by the Regional Water Board as a permit condition. This is anticipated to include monitoring of wastewater flow (daily), influent and effluent quality, and disposal field conditions.

- **Receiving Water Quality Sampling.** There would likely be requirements for sampling and analysis of groundwater near and downgradient of the leachfield area. The expected parameters of interest would be nitrate and coliform bacteria and groundwater levels, typically on a monthly basis. There are no surface waters near the Fire Road leachfield site that would require monitoring.

- **Reporting.** The monitoring results would be summarized and submitted in monitoring reports (e.g., monthly or quarterly) to the Regional Water Board. An annual report would be prepared that presents the monitoring results, compares the results with the discharge requirements and performance objectives for the system, and discusses any problems, corrective actions, or other pertinent observations regarding to the operation of the system. It would also include results of annual tank inspections and a log of tanks that required pumping.

### ***Estimated Costs***

*Capital Costs*

The estimated capital costs for Alternative 3 are summarized in **Table 6-6** for assumed service for 176 properties in Woodacre. Itemized cost estimates including quantities and unit cost assumptions are provided in **Appendix C.** The cost assumptions were developed through discussions with manufacturers, equipment suppliers, and local contractors, and through review of recent contractor bids for similar work in Marin County, where applicable. The bottom line in the table converts the total project costs to average cost per connection, based on 176 connections.

**Table 6-6: Estimated Capital Cost - Fire Road Community Leachfield**

| Cost Item | Estimated Capital Costs ($) |
|---|---|
| Collection System (Effluent STEP/STEG)* | 2,697,175 |
| Treatment System | 735,000 |
| Disposal System | 772,500 |
| Land/Easement Costs | 100,000 |
| Mobilization/Demobilization | 100,000 |
| Permit Fees & Encroachment Fees | 30,000 |
| Subtotal | **4,434,675** |
| Contingency @ 15% | 665,201 |
| Subtotal | **5,099,876** |
| Engineering & Environmental Studies @ 15% | 764,981 |
| Construction Management @ 10% | 509,988 |
| Admin, District Formation, Financing @ 5% | 254,994 |
| **Total Estimated Cost** | **6,629,839** |
| **Estimated Cost Per Connection** | **37,670** |

*Note: does not include cost for abandonment of septic tank (where required) and any work to connect house plumbing to new facilities, which is responsibility of property owner, typical range of $1,500 to $3,000 depending on access and property conditions.



*Operation and Maintenance Costs*

The estimated annual operation and maintenance costs for Alternative 3 are presented in **Table 6-7.** Supporting itemized calculations and assumptions are provided in **Appendix C**. The O&M costs were estimated based on labor, equipment, materials and other expenses required to perform the necessary inspections, water quality sampling, data analysis, report preparation, pump-outs, and routine maintenance and equipment replacement for the community treatment and disposal facilities, as well as for the collection system and all individual STEP/STEG units served by the system. Also included are estimates of annual energy costs (electrical) for operation of the community treatment system and pumps. The electrical costs for individual STEP units at each property (estimated to be a few dollars per month) are not included. A 10% contingency allowance is also included. The cost estimates were developed based on the expected operation and monitoring needs defined above, and using data and experience from monitoring and maintenance of other similar systems in Marin County and other Northern California communities, including the Marshall Phase Community Wastewater system. As indicated, the total annual O&M costs are estimated to be $155,760, amounting to approximately $885 per parcel.

**Table 6-7: Estimated Annual O&M Costs – Fire Road Community Leachfield**

| Items | Assumptions | Estimated Annual O&M Cost ($) |
|---|---|---|
| **District/Program Admin.** | Insurance, legal, financial, permits | 28,000 |
| **Inspection, Monitoring & Reporting** | On-lot STEP/STEG systems, lift stations, treatment/disposal system; remote telemetry; monthly/annual reports; as-needed engineering | 63,600 |
| **Maintenance** | Equipment, materials, maintenance & replacement; site maintenance; sewer cleaning | 27,200 |
| **Laboratory & Expenses** | Monthly treatment system and monitoring well sampling and analysis, travel expenses & supplies | 11,400 |
| **Electrical** | Treatment plant, lift stations & leachfield dosing | 11,400 |
| **Septic Tank Pumping** | Individual owner responsibility | - |
| | Subtotal | $141,600 |
| | Contingencies (@ 10%) | $14,160 |
| | **TOTAL** | **$155,760** |
| | **ANNUAL COST PER PARCEL** | **$885** |



## ALTERNATIVE 4 –WATER RECYCLING SYSTEM – WOODACRE ONLY

### Description

This alternative corresponds with Alternative 4 from the 2011 Woodacre Flats study. It includes collection, treatment, and recycling of wastewater for turf irrigation at the San Geronimo Golf Course, with service limited to Woodacre only. It would have capacity for approximately 210 parcels, roughly 85% of the 250 total parcels in the Woodacre portion of the study area. It would not provide capacity to serve any properties in San Geronimo. The system would have a capacity to accommodate an estimated average daily flow of approximately 26,000 gpd and peak flow of 35,000 gpd. Under average year rainfall conditions, the project would produce approximately 28.3 acre-feet (9.2 million gallons) of recycled water for golf course irrigation, allowing about an approximate 18% reduction in raw water obtained from MMWD.

The main elements of this alternative include: (a) central wastewater collection system extending throughout the Woodacre service area (gravity and pressure sewers); (b) main lift station located near the intersection of Railroad Avenue and San Geronimo; (c) wastewater transmission line (force main) to the San Geronimo Golf Course (preferred route via Sir Francis Drake Boulevard); (d) tertiary recycled water treatment plant located in the golf course maintenance area; (e) an approximately 2-acre holding pond on the front nine of the golf course (near green #2) for winter storage of recycled water; and (f) seasonal reuse of the recycled water for spray irrigation of the golf course, integrated into the existing irrigation system. **Figure 6-4** is a map showing the location of key features of this alternative. **Figure 6-5** provides an overall schematic of the wastewater treatment and recycling system.

The main differences in Alternative 4 as compared with the water recycling alternative presented in the 2011 Woodacre Flats study are:

(1) Overall depth and storage capacity of the recycled water holding pond has been increased to the maximum extent practicable within the available area near green #2;

(2) Capacity of the pond has been re-calculated based on provision for storage of 100-yr seasonal rainfall, per changes in State requirements adopted in 2014 (previously 10-yr rainfall capacity was required);

(3) Pond storage capacity and recycled water production has been re-calculated based on updated/revised estimates for average unit wastewater flows during wet season and dry season (per discussion in Section 4); and

(4) Overall capacity has been increased by about 40%, from 150 up to 210 parcels. The proposed facilities would also include capacity for treatment and recycling of wastewater flows from the golf course clubhouse and maintenance area.

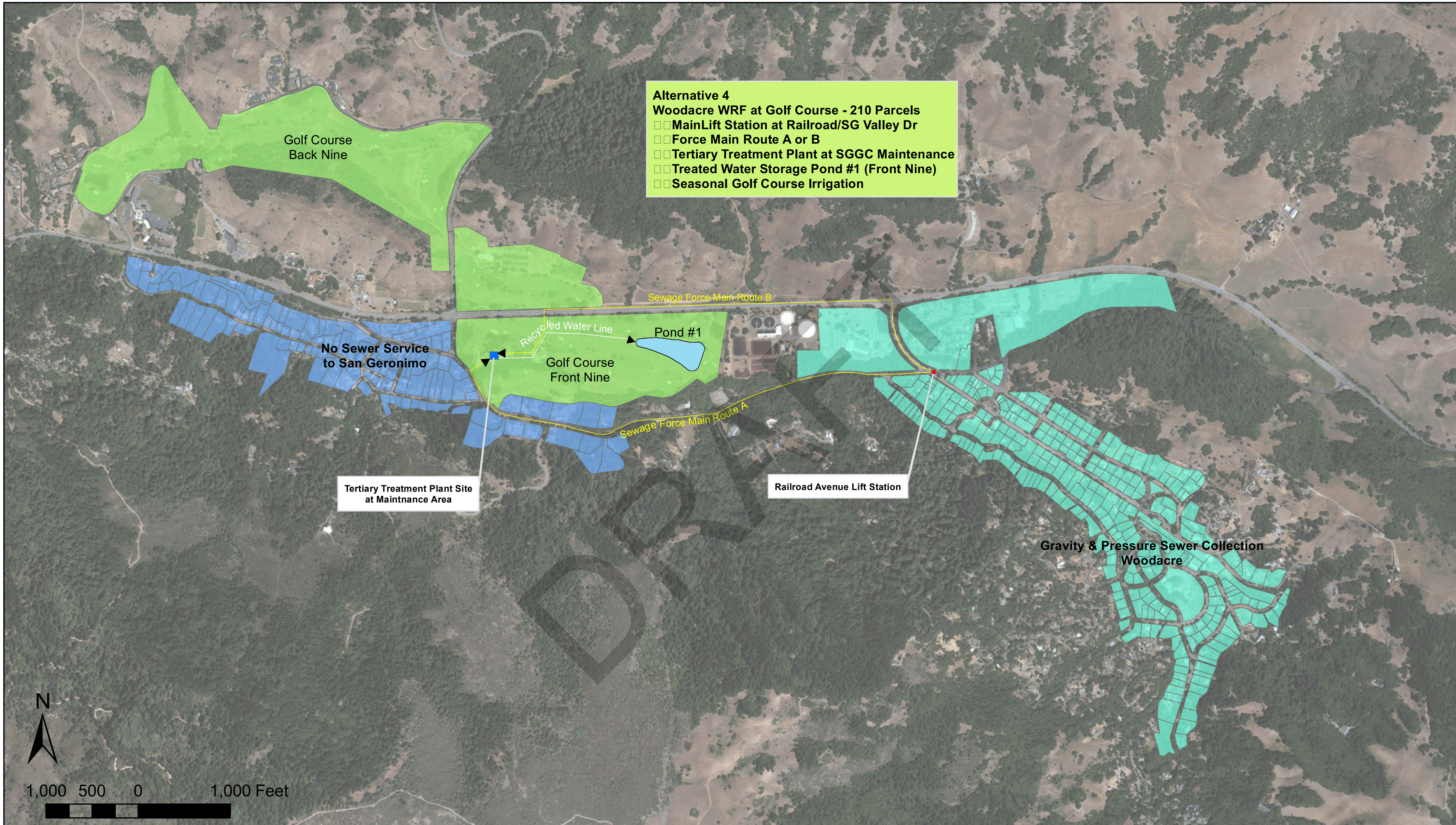
The wastewater would be treated to meet California Title 22 requirements for disinfected tertiary recycled water, and would be incorporated into the existing golf course irrigation system, reducing the amount of raw water supplied to the golf course from MMWD. The overall concept and main elements of this alternative have been developed in consultation with the golf course owners and maintenance personnel.

Key elements of this alternative are summarized below.

**Collection System.** The recommended sewage collection method for this alternative is a conventional gravity system, with a main lift station located at the northeast corner of Railroad Avenue and San Geronimo Valley Drive. Because of the undulating terrain, a pressure sewer would be used for properties along Redwood Drive, tying in at the main lift station. From the lift station, the sewage would be conveyed to the treatment plant location at the golf course maintenance area in a 4-inch diameter force main. There are two possible routes for the force main, as follows:

- **Force Main Route A.** This route would follow San Geronimo Valley Drive. The force main would be installed within the road right-of-road, either beneath or immediately adjacent to the paved roadway. The force main would enter the golf course property at the existing maintenance access road approximately 300 feet north of Meadow Way, and then follow the access road to the treatment plant site on west side of the maintenance area. The force main would cross San Geronimo Creek on the existing road bridge where a ductile iron pipe sleeve would be provided for physical protection of the pipe and prevention/capture of any leakage. The total force main length for Route A is approximately 5,360 feet.

- **Force Main Route B:** This route would run north from the main lift station within the road rights-of way of Railroad Avenue, and then westerly along Sir Francis Drake Blvd to the location of the San Geronimo Golf Course cart path undercrossing. At this point the

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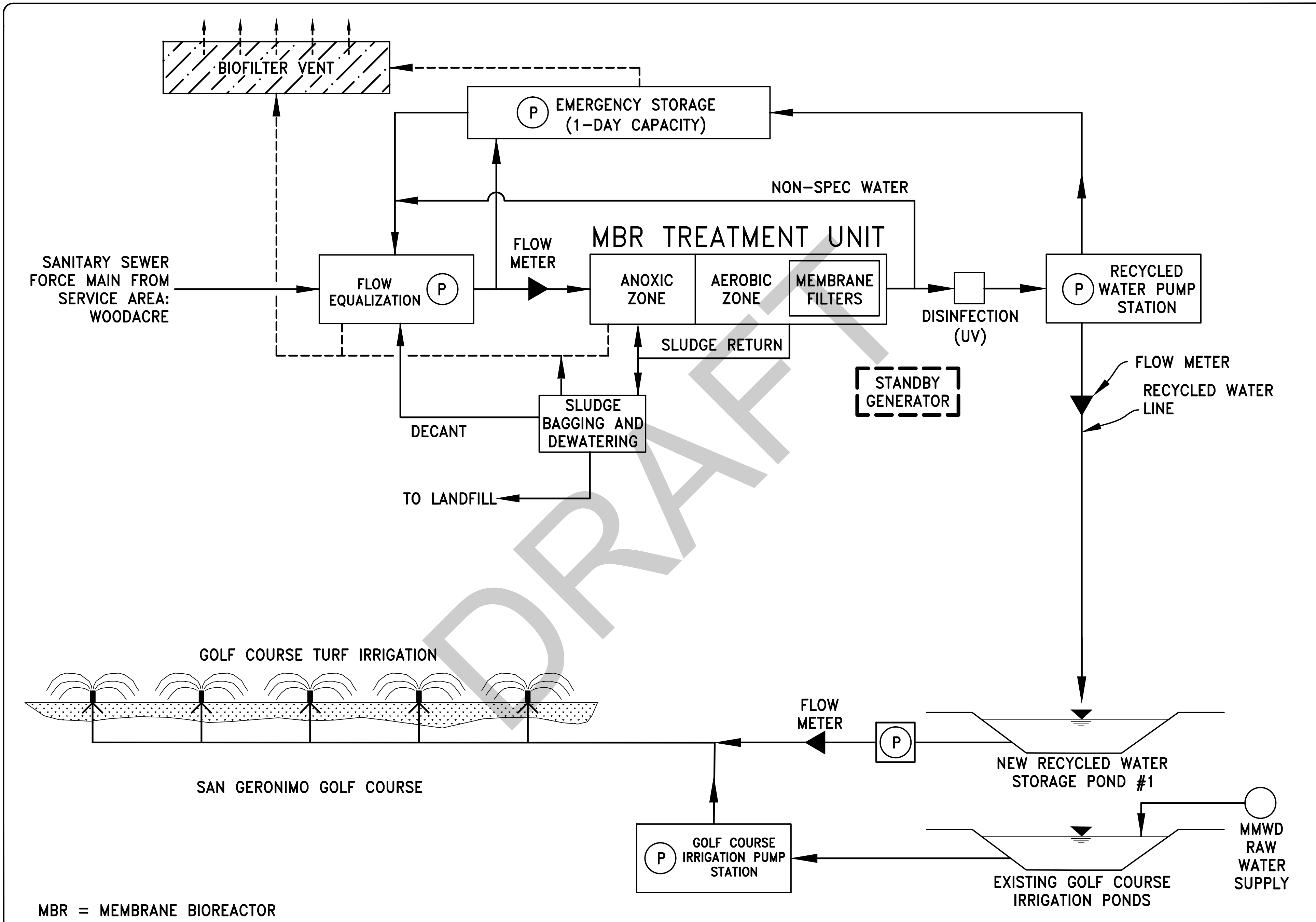
# ALTERNATIVE 4

FIGURE 6-4






**WOODACRE/SAN GERONIMO FLATS WASTEWATER RECYCLING STUDY**

WOODACRE, CALIFORNIA

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Drawn: DI
Checked: NH
Appr'd: NH

**WATER RECYCLING SYSTEM SCHEMATIC ALTERNATIVE 4**

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FIGURE: **6-5**

pipeline would be routed across the golf course near green #8 to the treatment plant site on the west side of the maintenance area. The pipeline would be buried over its entire length, including where Railroad Avenue crosses San Geronimo Creek; here the pipeline would be installed beneath the road bed, above the concrete box culvert which contains the creek flow at this location. The total force main length for Route A is approximately 5,850 feet.

Analysis indicates force main Route B would be preferred over Route A on the basis of cost (shorter distance) and reduced potential for impacts to San Geronimo Creek. Route B would put the pipeline a much greater distance from San Geronimo Creek along most of its length and would include a less vulnerable means for crossing of the creek – i.e., buried within the road bed of Railroad Avenue rather than sleeved and secured to the road bridge. For either pipeline route, the installation could be done using trenchless technology (horizontal directional drilling) to minimize traffic disruption and physical disturbance to road pavement.

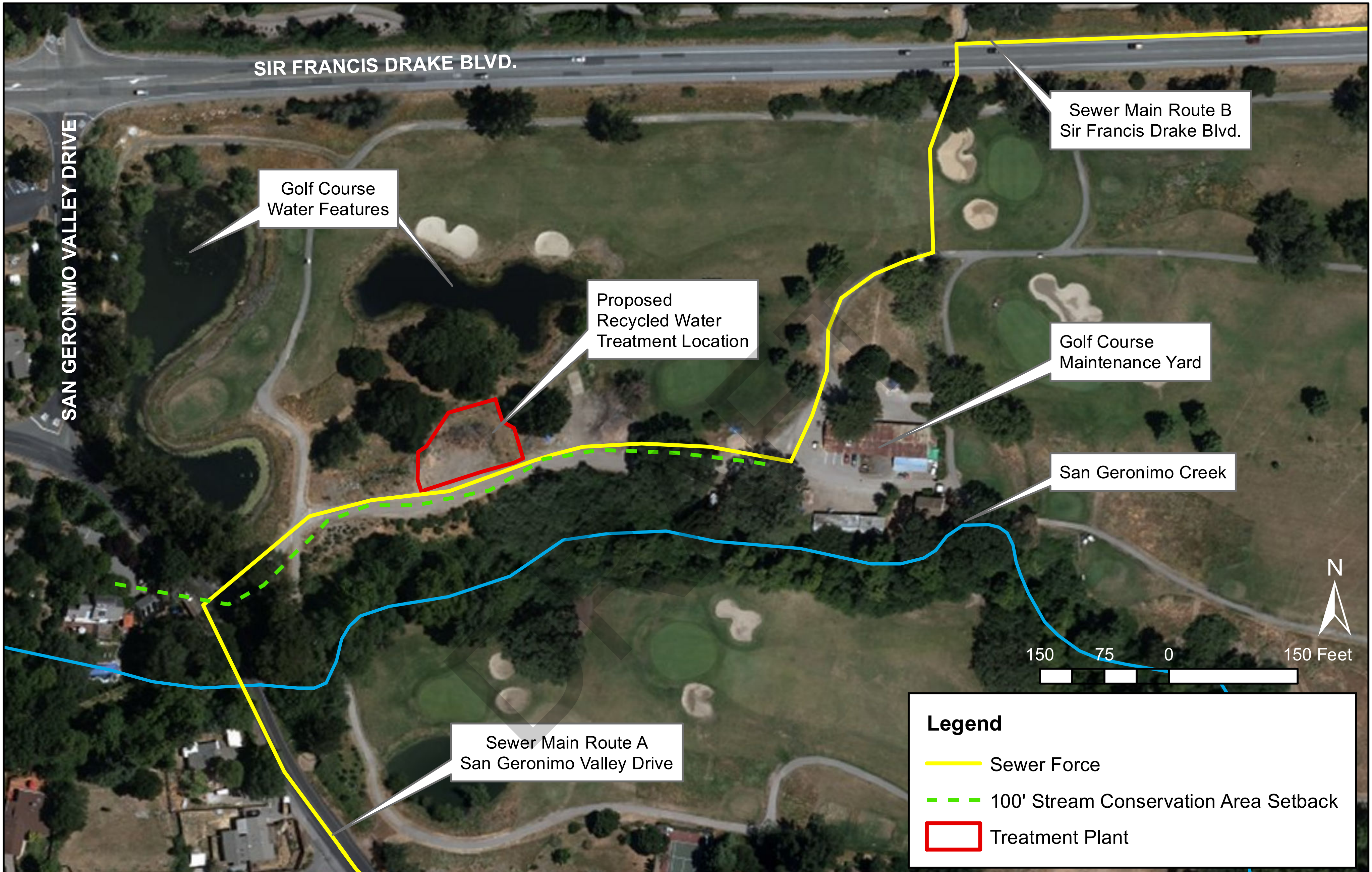
**Wastewater Treatment.** The treatment facilities under this alternative would be designed and operated to produce disinfected tertiary water meeting the requirements of California Code of Regulations, Title 22 Water Recycling Criteria (see Section 5). Recycled water meeting these standards is acceptable for unrestricted landscape irrigation, including golf course irrigation, as well as other water recycling uses. (Note: the following discussion and diagrams regarding the wastewater treatment facility are also applicable to Alternatives 5a, 5b, and 6, except as to the overall treatment system design capacity and sizing of unit processes.)



- **Treatment Plant Site. Figure 6-6** shows the location within the golf course maintenance area identified for placement of the wastewater treatment/recycling plant. It would be on the west side of the golf course maintenance yard, in an area previously graded and presently used for storage and processing of brush, cuttings and other green waste from the golf course. The proposed treatment plant site is outside of the Stream Conservation Area for San Geronimo Creek and naturally screened by several existing large trees and other vegetation, none of which would require removal. The proposed treatment plant site has good vehicular access from San Geronimo Valley Drive, and is in an area that avoids impacts to or from golf course play.

  The treatment plant would occupy an area of approximately 10,000 square feet, including above and below ground tanks, blowers, pumps, piping, covered sludge dewatering and bagging area, biofilter venting and appurtenances. There would be a control building (approximately 600 $ft^2$) to house electrical/mechanical controls, UV disinfection equipment, a small office, laboratory area, and storage space for equipment and supplies. The treatment plant area would have parking and vehicle access and would be fenced.

- **Title 22 Treatment System – Membrane Bioreactor.** Various types of treatment technologies, designs and manufacturers are available that can meet Title 22 water recycling requirements. The recommended system for this project is a membrane bioreactor (MBR), which is well suited because of the small area requirement, relatively low demands for operator control of the system (based on ease of automation), commercial availability, and acceptance of the technology by the State Water Board's Division of Drinking Water. Background information and technical details on the MBR treatment process (including advantages and disadvantages) are covered in an EPA Fact Sheet, which is provided in **Appendix E** along with example manufacturer information.

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**RECYCLED WATER TREATMENT LOCATION**

**FIGURE 6-6**

The facilities required for an MBR system to meet Title 22 water recycling criteria are diagrammed schematically in **Figure 6-5**. The MBR has small space requirements because it is designed to utilize a single complete mix reactor in which all the steps of the conventional activated sludge process occur with a membrane filter system submerged in the reactor.

Influent sewage enters the treatment plant in a flow-equalization (EQ) tank, which evens out the rate of sewage flow into the main treatment processes. From the EQ tank the raw sewage is pumped into the MBR treatment unit, consisting of an above-ground tank which includes an anoxic zone and aerated zone, pumps, electrically-actuated valves, blowers, level controls, a programmable logic controller (PLC) and ultra-filtration membrane filter. The sewage is mixed with recirculated mixed liquor in the anoxic cell and then flows to the aeration cell. In the aeration cell, the wastewater is aerated through a grid of fine bubble diffusers connected to positive displacement blowers. The ultra-filtration membranes are immersed directly in the aerated mixed liquor and are connected to the suction side of a centrifugal pump (or pumps). The clean permeate is drawn through the membranes and discharged to the disinfection system.

**UV Disinfection.** UV light disinfection is proposed and would be housed in the control building. The system would include dual units, capable of treating the entire flow with one unit out of operation. The selected equipment would be from among several types of UV systems listed and accepted by the DDW including performance validation report. Examples of approved UV systems are provided in **Appendix E**. Field testing of the UV system would be required at the time of installation to validate conformance with Title 22 disinfection/virus inactivation requirements.

**Sludge Handling.** Sludge would be withdrawn periodically from the MBR anoxic tank and collected in an adjacent, covered sludge bagging and dewatering area. Decant from the sludge dewatering tank would be collected and drained back to the EQ tank. The bagged sludge would be hauled for disposal at an approved sanitary landfill. Sludge bags, when filled, would be retained onsite in a covered area for several weeks of drying. Hauling of dry sludge (50-60 lb bags) would occur every few months.

**Odor Control.** Odor control facilities would be included, which are needed primarily in connection with the EQ tank, anoxic tank and sludge bagging/dewatering area. Odors would be controlled through capture and filtering through an organic media bed (biofilter) designed to remove volatile organic compounds, primarily hydrogen sulfide and methane. Activated carbon filters may be used at selected equipment locations, where practicable and if necessary.

**Other Facilities.** Other facilities necessary to satisfy Title 22 recycled water standards include: (a) standby emergency generator to operate the treatment plant during power outages; and (b) emergency storage sufficient to store at least one-day of incoming sewage flow from the service area. This would be provided by one or more large-capacity holding tanks (buried). Additionally, the treatment system would be equipped with automatic turbidity monitoring and control equipment that would temporarily interrupt and redirect the flow of treated water to the influent EQ tank in the event that effluent limits are exceeded or there is a malfunction of the UV disinfection system.

**Recycled Water Storage.** Alternative 4 would include the construction of a single recycled water storage pond (Pond #1), located as indicated in **Figure 6-4,** on the front nine of the golf course. The proposed location for the pond is a 2.5-acre triangular buffer area between the #2 green and #4 fairway, which was suggested and offered by the golf course owners for this purpose. All recycled water would be pumped into this pond year-round, stored throughout the rainy season (typically November through March), and fed into the existing irrigation system during the golf course irrigation season, typically April through October.

**Figure 6-7** shows a preliminary pond layout and grading plan making maximum use of the available area. The pond would be constructed through a combination of excavation below existing grade (e.g., 6 to 12-feet deep) and engineered fill embankments above grade; all cut and fill slopes would be 2:1 (horizontal:vertical). For the configuration shown in **Figure 6-7**, the overall depth of the pond would be 20 feet, including capacity for water depth of 18 feet, plus two feet of freeboard. The total internal surface area of the pond would be approximately 1.7 acres.

Soil profile observations in the proposed pond area revealed a thin topsoil layer (12 to 18 inches) underlain by stiff clayey subsoils. These soil conditions are favorable for pond construction, and may be suitable material to be used in forming the required impermeable pond liner. If not, a geosynthetic clay liner such as “BENTOMAT” would be used for the pond liner. Drainage which presently flows overland in the pond area would have to be collected and re-routed. Portions of the irrigation pipeline that crosses through the pond area may require relocation. Fencing and landscaping around the pond would be provided.

Using the assumed pond configuration in **Figure 6-7**, water balance calculations (monthly time steps) were made to estimate the storage capacity, and corresponding water depth, needed to accommodate projected recycled water volumes plus direct rainfall for average, 10-year and 100-year rainfall amounts. Through iterative calculations, maximum capacity of the pond (under 100-year conditions) was determined to be 26,000 gpd. Calculations for average rainfall conditions provide an estimate of the typical volume of water that would be available for golf course irrigation. Rainfall amounts were estimated based on data from Woodacre Fire Station combined with long-term records from Kentfield and San Rafael for statistical determination of 10-yr and 100-yr rainfall amounts. Water balance spreadsheet calculations and rainfall statistics are provided in **Appendix F.** Results are summarized in **Table 6-8.**

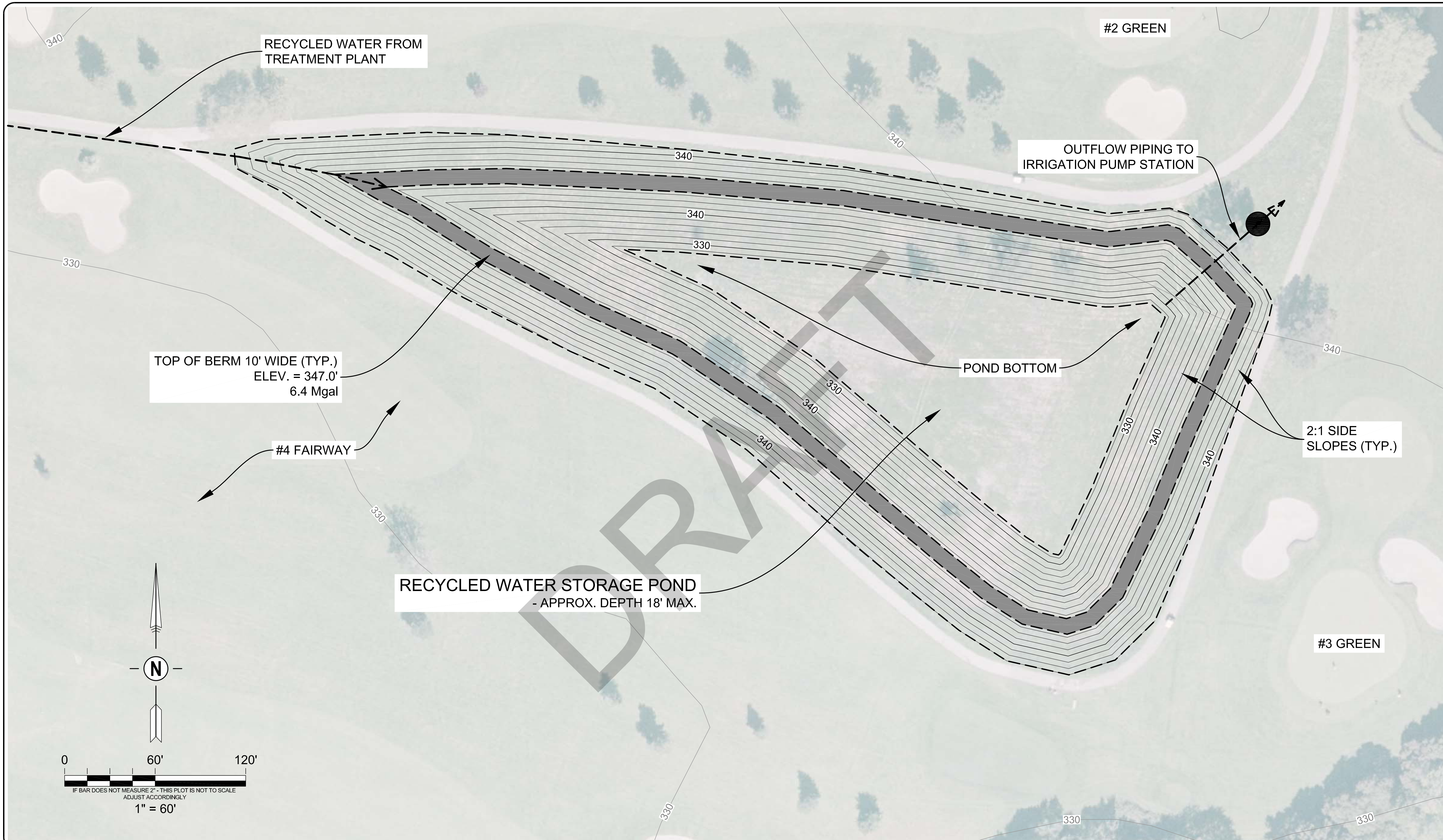


**Table 6-8: Water Balance Summary for Recycled Water Storage Pond #1**

| Ave Wet Weather Wastewater Flow (gpd) | Rainfall Scenario | Max Pond Water Depth Reached (ft) | Annual Recycled Water Produced for Irrigation | |
|---|---|---|---|---|
| | | | Million Gals | Acre-Feet |
| 26,000 | Average | 14.0 | 9.2 | 28.8 |
| 26,000 | 10-yr | 15.5 | 10.1 | 31.0 |
| 26,000 | 100-yr | 18.0 | 10.8 | 33.1 |

### *Irrigation Disposal Facilities*

During the dry season (typically April-October), the water from the storage ponds would be integrated into the main irrigation water supply for the golf course, which presently comes from




**WOODACRE -SAN GERONIMO WASTEWATER RECYCLING STUDY**

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| Appr'd: | NH |

**RECYCLED WATER STORAGE**
**STORAGE POND #1**

FIGURE
**6-7**

MMWD. The recycled water would be discharged directly into the irrigation system near the existing pump station located behind the #2 green. This irrigation pump station currently draws water from the existing golf course pond in front of the #3 tee, which is feed by a raw water pipeline from MMWD. The recycled water would not mix with the golf course pond water.

Annual irrigation water demand for the golf course varies between approximately 47 and 53 million gallons, depending on weather conditions. On average, recycled water produced under Alternative 4 would be able to supply about 17 to 20 percent of the irrigation demand.

The golf course would have to comply with recycled water use area requirements, per Title 22 requirements outlined in Section 5. These cover items such as signage and markings, protection of drinking water fountains and outdoor eating areas, setbacks from wells, prevention of runoff and spray drift, and protection against cross-connection with domestic water lines.

## Operation and Maintenance Requirements

The wastewater facilities described under this alternative would require maintenance by a California certified wastewater treatment plant operator (minimum Grade III). This would cover operation, maintenance, and monitoring responsibilities for the collection system and the treatment plant. Golf course personnel, considered the recycled water "User", would be responsible for maintenance and operation of the storage ponds, irrigation pump and distribution system and the recycled water uses areas (i.e., the golf course turf areas).

System maintenance would include regular inspection of all equipment and processes. A telemetry system would be incorporated to facilitate remote, continuous monitoring of the critical elements of the pump stations and the treatment system. Ongoing inspection and maintenance of the wastewater treatment facility and collection system is anticipated to include on-site physical work several days a week.

Effluent water quality sampling and analysis would be an important aspect of the ongoing operation and maintenance of the MBR system and would be required for permit compliance under terms of the Monitoring and Reporting Program established by the Regional Water Board. This would include daily sampling and analysis for coliform bacteria per Title 22 water recycling requirements. Contract arrangements with MMWD for coliform testing at their San Geronimo Water Treatment Plant would be an efficient way to meet this critical operating requirement. Sampling and analysis of recycled water for "Priority Pollutants"[1] would be required once every five years.

The holding ponds would be a relatively passive system requiring periodic inspection and upkeep, but little in the way of day-to-day operational requirements. The pond water levels would require management to assure suitable capacity for wet weather storage needs; pond maintenance also requires implementation of mosquito control measures, normally consisting of application of microbial larvicides that are registered and approved for use by the US EPA. Pond operation and maintenance would be handled by the golf course maintenance personnel, as would the irrigation pump station and spray operations.

Since the treated water would be incorporated into the existing golf course irrigation system for dry season application to existing managed turf areas, monitoring would primarily consist of

[1] Priority Pollutants refer to a list of 126 specific pollutants that includes heavy metals and specific organic chemicals.

visual observations of use areas, noting and correcting any evidence of ponding or runoff of irrigation water, and other abnormal conditions. Water quality sampling of the few streams that traverse the golf course may be required. Groundwater monitoring is unlikely to be required.

All flow monitoring, influent and effluent water quality data, storage pond levels and conditions, sludge hauling volumes, and wastewater treatment and water recycled water system inspection reports would be prepared and submitted to the San Francisco Bay Regional Water Board according to a schedule prescribed by the Monitoring and Reporting Program. Monthly and annual reporting frequency is anticipated. Annual monitoring data pertaining to the water recycling operations would also be submitted to the DDW.

## Estimated Costs

### *Capital Costs*

The estimated capital costs for Alternative 4 are presented in **Table 6-9**, showing the costs for the two alternate force main routes, A and B. The bottom line in the table converts the total project costs to the average cost per connection, based on 210 parcels that would be served. Detailed itemization of costs is provided in **Appendix G**, including quantities and unit cost assumptions. These assumptions were developed through discussions with manufacturers, equipment suppliers, and local contractors, and through review of recent contractor bids for similar work in Marin County, where applicable. Included are all expected costs for new gravity and pressure sewers, lift station and transmission line to the golf course, MBR treatment system, recycled water storage pond on the golf course, and connections to the golf course irrigation pumping system. Also included is a contingency 10% allowance, as well as estimated costs for engineering design, environmental studies, construction management, project administration, district formation and financing. The estimated total project cost is approximately $9.5 million with an approximate cost of $45,500 per parcel served. The cost difference between force main route A and B is negligible.



### *Operation and Maintenance Costs*

The estimated annual operation and maintenance costs for Alternative 4 are provided in Table 6-10, with supporting itemized calculations and assumptions provided in **Appendix G**. The O&M cost are estimated based on labor, equipment, materials and other expenses required to perform the necessary inspections, water quality sampling, data analysis, report preparation, sludge disposal, and routine maintenance for the collection system and MBR treatment/recycling plant. Not included are any costs associated with the storage and use of the recycled water by the golf course for turf irrigation. Also included are estimates of annual energy costs (electrical) for operation of the main lift station and the treatment system. O&M costs include an allowance for equipment repair/replacement, which would be required over the life of the system. An allowance of 10% is included as a contingency. The cost estimates were developed based on the expected operation and monitoring needs defined above, and using data and experience from monitoring and maintenance of other similar systems in Marin County and other Northern California communities. The total annual O&M cost is estimated to be about $291,500, with a per parcel annual cost of $1,356.

### Table 6-9: Estimated Capital Costs – Alternative 4

| Cost Item | Route A - Cost ($) | Route B - Cost ($) |
|---|---|---|
| Collection System (Gravity Sewer)* | 4,063,175 | 4,067,575 |
| Tertiary Treatment Plant | 1,180,000 | 1,180,000 |
| Recycled Water Storage & Transmission | 1,004,000 | 1,004,000 |
| Land/Easement Costs | 0 | 0 |
| Mobilization/Demobilization | 100,000 | 100,000 |
| Permit Fees & Encroachment Fees | 50,000 | 50,000 |
| **Subtotal** | **$6,397,175** | **$6,401,575** |
| Contingency @ 15% | $959,576 | $960,236 |
| **Subtotal** | **$7,356,751** | **$7,361,811** |
| Engr & Environ Studies @ 15% | $1,103,513 | $1,104,272 |
| Construction Management @ 10% | $735,675 | $736,181 |
| Admin, Dist Formation, Financing @ 5% | $367,838 | $368,091 |
| **Total Estimated Cost** | **$9,563,777** | **$9,570,355** |
| **Estimated Cost Per Connection** | **$45,542** | **$45,573** |

* Does not include individual property owner cost for septic tank abandonment and on-lot work to connect house plumbing to new sewer system, typical range of $1,500 to $3,000.



### Table 6-10: Estimated Annual O&M Costs – Alternative 4

| Category | Items | Cost ($) |
|---|---|---|
| **District/Program Administration** | Insurance, legal, financial, administration | 12,000 |
| | RWQCB Permits | 10,000 |
| **Labor – Collection &Treatment** | Systems Control Technician | 12,000 |
| | Grade III Operator | 46,800 |
| | Grade I Operator | 39,000 |
| | Field Technician | 31,200 |
| | Engineering Consultation | 12,000 |
| | On-call Monitoring & Response Allowance | 12,000 |
| **Sludge Handling** | Bagging, Materials and Disposal Fees | 3,600 |
| **Sewer Lines** | Maintenance Cleaning | 4,000 |
| **Equipment** | Materials & Replacement | 27,000 |
| **Vehicle** | Lease and mileage | 4,800 |
| **Laboratory and Expenses** | Laboratory | 21,600 |
| | Cleaning Chemicals & Supplies | 3,000 |
| **Electrical** | Lift Station | 660 |
| | MBR Treatment Plant | 20,188 |
| | UV Disinfection | 2,294 |
| | Treated Water Distribution | 2,294 |
| | Misc electrical, phone, internet | 600 |
| | **Sub-total** | **$265,037** |
| | 10% Contingency | $26,503 |
| | **Estimated Total Annual Cost** | **$291,540** |
| | **Estimated Annual Cost per Connection (365 ESDs[1])** | **$1,356** |

*[1] Includes additional allowance of 5 ESDs for service to golf course clubhouse*

## ALTERNATIVE 5–WATER RECYCLING SYSTEM – WOODACRE AND SAN GERONIMO

### Description

Alternative 5 would expand the water recycling system described in Alternative 4 (Woodacre Only) to include service to both Woodacre and San Geronimo. Two variations, Alternatives 5a (partial) and 5b (full), were formulated and evaluated to consider different levels of service (number of parcels) in the two communities. **Figure 6-8** is a map showing the location of key features of Alternatives 5a and 5b. **Figure 6-9** provides an overall schematic of the wastewater treatment and recycling system.

#### *Alternative 5a – Partial Service, 270 Parcels*

This alternative would be an expansion of Alternative 4, including wastewater service to approximately 75% of the developed properties in both Woodacre and San Geronimo. It would include wastewater collection facilities throughout both communities, with the assumption that approximately 270 of the property owners would opt to connect to the system. Those not connecting would continue to be served by their existing/improved onsite septic systems.

Alternative 5a would include all wastewater facilities described in Alternative 4, with the following changes and additions:

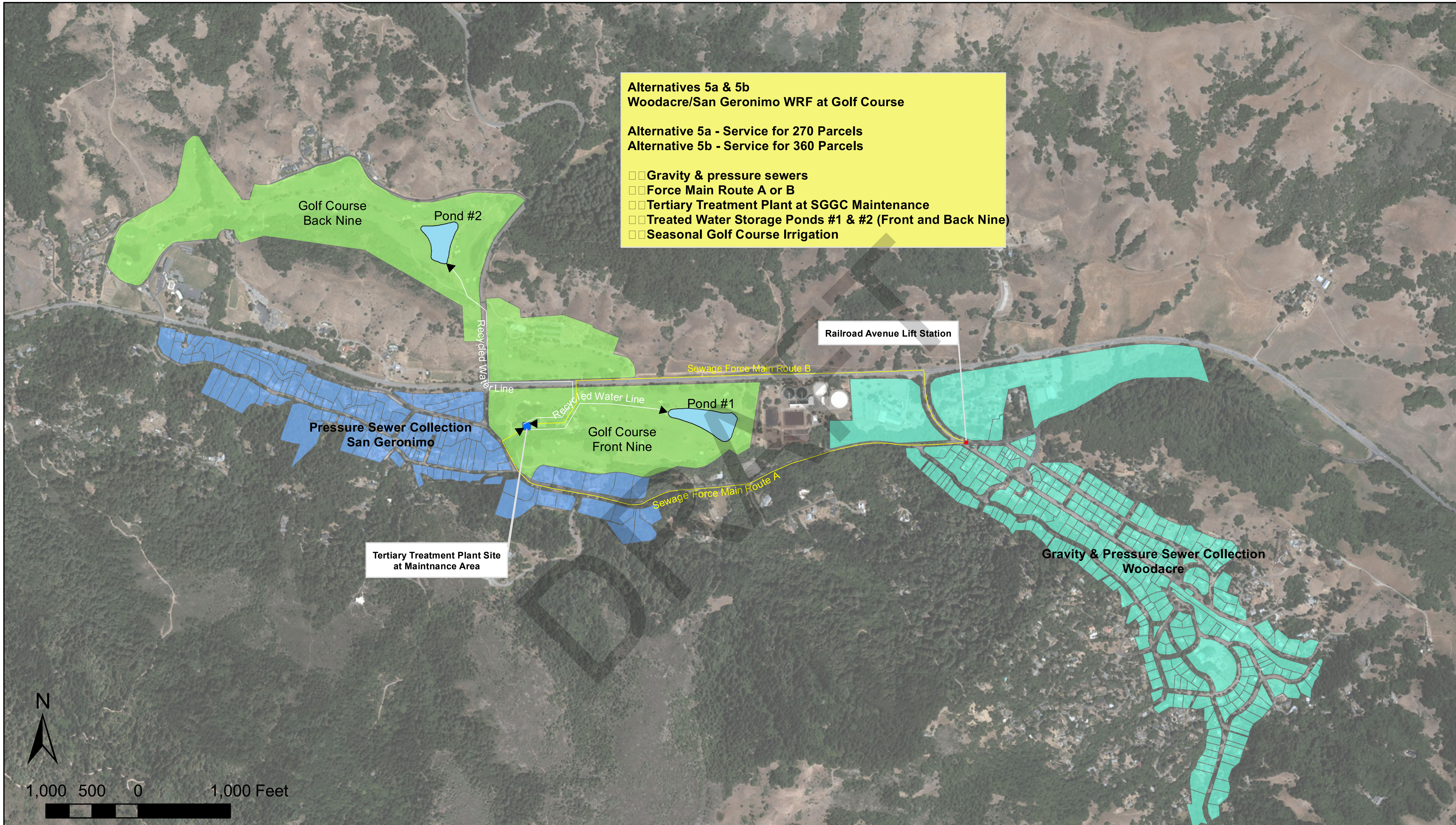
- **Collection System.** The wastewater collection system in San Geronimo would consist of (a) pressure sewers with individual grinder pumps at each property; and (b) pressure sewer force mains installed in Sir Francis Drake Blvd, San Geronimo Valley Drive and Meadow Way, connecting at the western driveway entrance into the golf course maintenance area.

- **Treatment System.** The tertiary treatment plant would be expanded to provide a nominal capacity of 40,000 gpd (45,000 gpd peak flow), including upsizing tanks, pumps and other equipment as needed. Estimated average daily wastewater flow (wet season) for this alternative is 33,200 gpd.

- **Storage Pond #2 (Lower half).** A second recycled water storage Pond #2 (Lower half) would be constructed adjacent to the #18 fairway on the back nine of the golf course.

- **Transmission Lines**. A second recycled water transmission line would be installed, running from the treatment plant to Pond #2, a distance of approximately 3,500 feet. Additionally there would be an inter-tie and pumping facilities, allowing water transfer from Pond #1 to Pond #2 for distribution into the golf course irrigation system.

- **Irrigation Pump Station.** A new irrigation pump station would be installed at Pond #2 designed to pump all recycled water directly from Pond #2 into the adjacent irrigation main line, integrated with the existing golf course irrigation control system.

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| PROJECT: | WOODACRE WW |
| PROJECT NO: | 1600073 |
| DRAWN: | MF |
| APPROVED: | NH |

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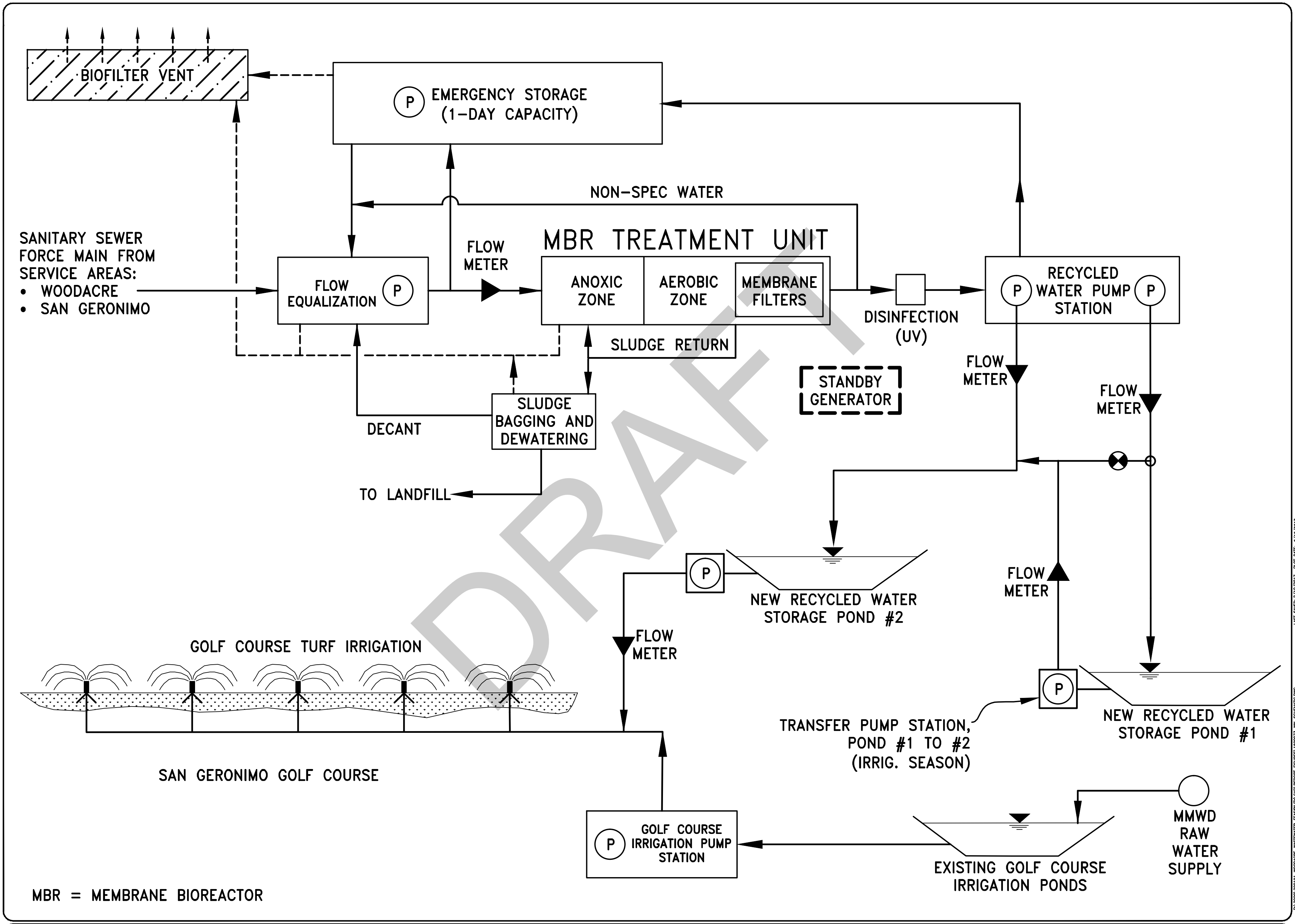
# ALTERNATIVES 5a & 5b

FIGURE 6-8




**WOODACRE/SAN GERONIMO FLATS WASTEWATER RECYCLING STUDY**
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Design: NH/MW
Drawn: DI
Checked: NH
Appr'd: NH

**WATER RECYCLING SYSTEM SCHEMATIC**
**ALTERNATIVES 5a & 5b**

Size: D
Project: 1600073
Scale: NO SCALE
FIGURE: **6-9**

### *Alternative 5b – Full Service, 360 Parcels*

This alternative is an expanded version of Alternative 5a, with facilities sized to provide service to essentially all 360 developed properties in the Woodacre and San Geronimo communities. The expanded capacity would be achieved by the following:

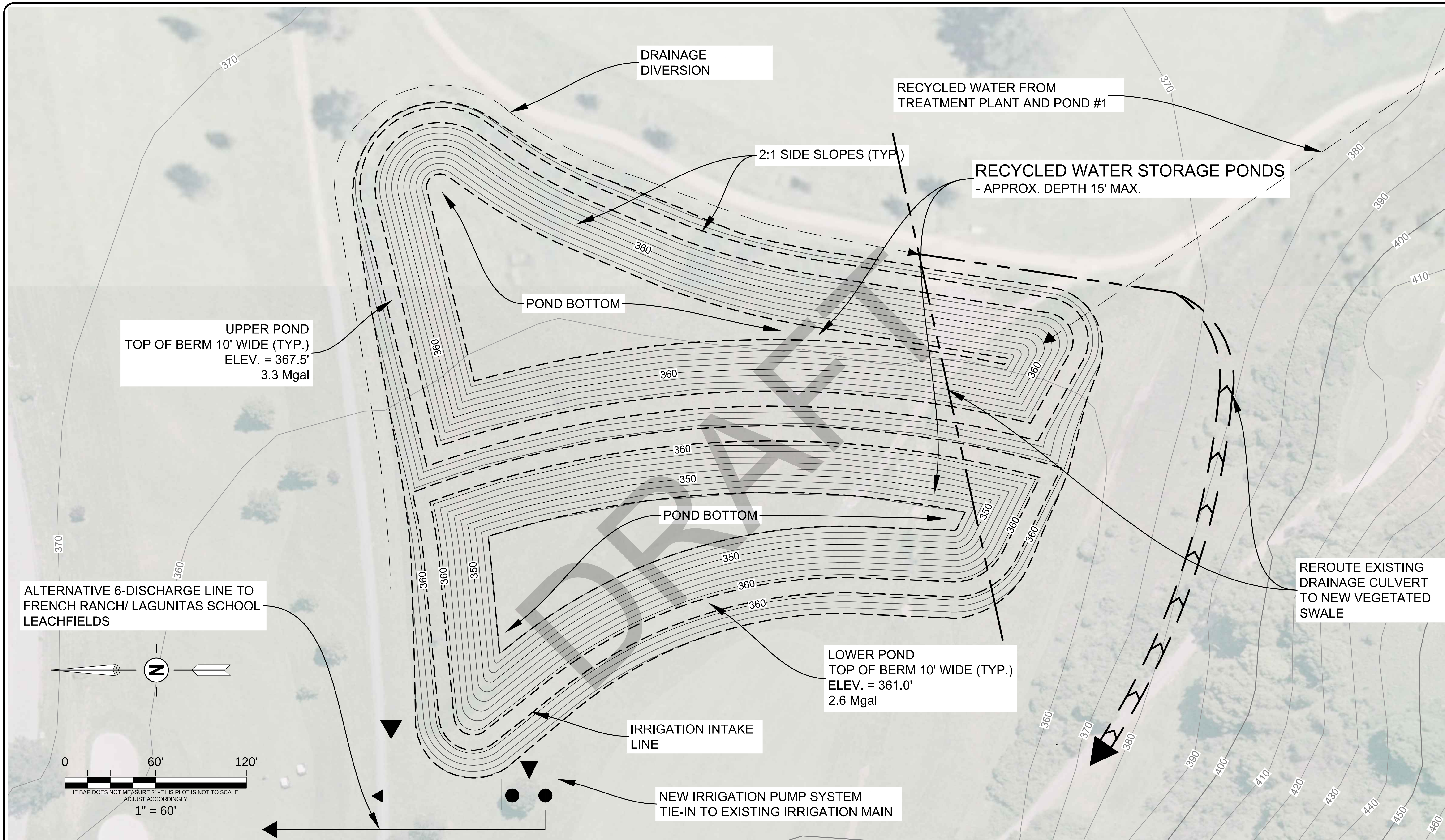
- **Treatment Plant Capacity.** The tertiary treatment plant would be expanded to provide a capacity of 50,000 gpd, including upsizing tanks, pumps and other equipment as needed. Estimated average daily wastewater flow (wet season) for this alternative is 44,000 gpd.

- **Full-size Pond #2.** Recycled water storage Pond #2 would be constructed to the full (maximum) capacity that can be accommodated in the available area.

Alternative 5b would maximize the system capacity that can be provided based on largest feasible sizing of Ponds #1 and #2 for wet season storage.

**Figure 6-10** shows a preliminary pond layout and grading plan for Pond #2, making maximum use of the available area. Pond #2 would be divided into two sections, Upper and Lower, to conform with existing topography. It would be constructed through a combination of excavation below existing grade (e.g., 6 to 12-feet deep) and engineered fill embankments above grade; all cut and fill slopes would be 2:1 (horizontal:vertical). For the configuration shown in **Figure 6-10**, the overall depth of the pond would be 15 feet, including capacity for water depth of 15 feet, plus two feet of freeboard. The total internal surface area of the pond would be approximately 2.7 acre, with an estimated storage capacity of 5.9 million gallons (18.1 acre-feet). Drainage measures would be installed to collect and re-route surface and subsurface waters around the ponds. Drainage work would require removal of an existing 18-inch storm drain culvert and smaller sub-drains, with most of the flow re-routed to a new vegetated drainage swale on the south side of the new pond. Portions of irrigation pipelines that cross through the pond areas may require relocation.

Using the assumed pond configurations for Pond #1 and Pond #2 (**Figures 6-7** and **6-10)** water balance calculations (monthly time steps) were made to estimate the storage capacity, and corresponding water depth, needed to accommodate projected recycled water volumes plus direct rainfall for average, 10-year and 100-year rainfall amounts. Through iterative calculations, maximum capacity of the ponds (under 100-year conditions) were determined and are summarized in **Table 6-11** along with respective dimensions and earthwork estimates. Calculations for average rainfall conditions provide an estimate of the typical volume of water that would be available for golf course irrigation. Rainfall amounts were estimated based on data from Woodacre Fire Station combined with long-term records from Kentfield and San Rafael for statistical determination of 10-yr and 100-yr rainfall amounts. Water balance spreadsheet calculations and rainfall statistics are provided in **Appendix F.**




**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**

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**RECYCLED WATER STORAGE**
**STORAGE POND #2**

FIGURE
**6-10**

**Table 6-11: Recycled Water Storage Ponds #1 and #2**

| Item | | Pond #1 | Pond #2 Upper | Pond #2* Lower | Total |
|---|---|---|---|---|---|
| **Overall Land Area (ft²)** | | 123,350 | 71,030 | 63,250 | 257,630 |
| **Interior Surface Area (ft²)** | | 74,650 | 49,480 | 41,100 | 165,230 |
| **Excavation (cy)** | **Cut** | 14,580 | 18,870 | | 33,450 |
| | **Fill** | 18,180 | 10,490 | | 28,670 |
| **Max. Water Depth (ft)** | | 18.0 | 15.0 | 15.0 | - |
| **Water Storage Capacity** | **Million Gals.** | 6.45 | 3.30 | 2.60 | 12.35 |
| | **Acre-Feet** | 19.8 | 10.1 | 8.0 | 37.9 |
| **100-yr Wastewater Holding Capacity, gpd** | | 26,000 | 10,200 | 7,800 | 44,000 |

** Alternative 5a includes Pond#2 Lower; Alternative 5b includes Pond #2 Upper and Lower*

For the recommended pond configurations and sizing and the estimated average wet weather wastewater flows (33,2000 Alternative 5a, 44,000 gpd Alternative 5b), water balance calculations for average year, 10-year and 100-year rainfall amounts were completed to estimate the amount of recycled water that would be produced for use by the golf course. The results for average year conditions (long-term average) are summarized in **Table 6-12**; supporting calculations are provided in **Appendix F**. As indicated, the recycled water produced by these ranges from about 23% to 31% of the annual water needed for golf course irrigation. During dry years, the recycled water volume would decline below 30%, partly due to lower rainfall addition to the storage ponds, and partly due to higher irrigation demand during dry years.

**Table 6-12: Recycled Water Produced – Average Annual Volumes[1]**

| Alternative | Recycled Water Produced per | | Percent of Golf Course Irrigation Demand[2] |
|---|---|---|---|
| | Acre-feet | Million gals | |
| **Alternative 5a** | 37.6 | 12.3 | 25% |
| **Alternative 5b** | 50.0 | 16.3 | 33% |

[1] *For average annual rainfall year (41.6")*
[2] *Based on average irrigation demand of 50 million gals/yr*

## Estimated Costs

### *Capital Costs*

The estimated capital costs for Alternatives 5a and 5b are presented in **Table 6-12,** including wastewater collection, tertiary treatment plant, water recycling storage, transmission and pumping facilities, along with a contingency factor and estimated implementation costs. As indicated, the total estimated project costs are $12.65 million Alternative 5a and $14.3 million for Alternative 5b. The bottom line in the table converts the total project costs to the average cost per connection, showing costs of about $46,900 for Alternative 5a and $39,800 for Alternative

5b. Detailed itemization of costs is provided in **Appendix G**, including quantities and unit cost assumptions.

**Table 6-12: Estimated Capital Costs - Alternatives 5a & 5b**

| Cost Item | Alternative 5a 270 Parcels | Alternative 5b 360 Parcels |
|---|---:|---:|
| Collection System – Woodacre (Route A)* | $3,921,375 | 4,224,175 |
| Collection System – San Geronimo* | $1,486,800 | 1,811,100 |
| Tertiary Treatment Plant | $1,330,000 | 1,470,000 |
| Recycled Water Storage & Transmission | $1,575,000 | 1,925,000 |
| Land/Easement Costs | - | - |
| Mobilization/Demobilization | 100,000 | 100,000 |
| Permit Fees & Encroachment Fees | 50,000 | 50,000 |
| **Subtotal** | **$8,463,175** | **$9,580,975** |
| Contingency @ 15% | $1,269,476 | $1,437,146 |
| **Subtotal** | **$9,732,651** | **$11,018,121** |
| Engineering & Environmental Studies @ 15% | $1,459,898 | $1,652,718 |
| Construction Management @ 10% | $973,265 | $1,101,812 |
| Project Admin, Dist Formation, Financing @ 5% | $486,633 | $550,906 |
| **Total Estimated Cost** | **$12,652,447** | **$14,323,558** |
| **Estimated Cost Per Connection** | **$46,861** | **$39,788** |

* Does not include individual property owner cost for septic tank abandonment and on-lot work to connect house plumbing to new sewer system, typical range of $1,500 to $3,000.

### *Operation and Maintenance Costs*

Estimated annual operation and maintenance costs for Alternatives 5a and 5b are provided in Table 6-13, with supporting itemized calculations and assumptions provided in **Appendix G**. The O&M cost are estimated based on labor, equipment, materials and other expenses required to perform the necessary inspections, water quality sampling, data analysis, report preparation, sludge disposal, and routine maintenance for the collection system and MBR treatment/recycling plant. Not included are any costs associated with the storage and use of the recycled water by the golf course for turf irrigation. Also included are estimates of annual energy costs (electrical) for operation of the main lift station and the treatment system. O&M costs include an allowance for equipment repair/replacement, which would be required over the life of the system. An allowance of 10% is included as a contingency. As indicated, the total estimated annual O&M costs are about $346,500 for Alternative 5a and $366,500 for Alternative 5b. The resulting annual cost per parcel would be approximately $1,260 for Alternative 5a and $1,000 for Alternative 5b.

**Table 6-13: Estimated Annual O&M Cost – Alternatives 5a and 5b**

| Category | Items | Alternative 5a Cost ($) | Alternative 5b Cost ($) |
|---|---|---|---|
| **District/Program Administration** | Insurance, legal, financial, administration | 12,000 | 18,000 |
| | RWQCB Permit | 10,000 | 10,000 |
| **Labor Collection &Treatment** | Systems Control Technician | 12,000 | 14,000 |
| | Grade III Operator | 46,800 | 46,800 |
| | Grade I Operator | 39,000 | 57,000 |
| | Field Technician | 45,600 | 45,600 |
| | Engineering Consultation | 12,000 | 15,000 |
| | On-call Monitoring & Response Allowance | 12,000 | 12,000 |
| **Sludge Handling** | Bagging, Materials and Disposal Fees | 3,600 | 3,600 |
| **Sewer Lines** | Maintenance Cleaning | 6,000 | 6,000 |
| **Equipment** | Materials & Replacement | 54,000 | 54,000 |
| **Vehicle** | Lease and mileage | 4,800 | 4,800 |
| **Laboratory and Expenses** | Laboratory | 24,000 | 24,000 |
| | Cleaning Chemicals & Supplies | 3,000 | 3,600 |
| **Electrical** | Lift Station | 660 | 660 |
| | MBR Treatment Plant | 23,492 | 29,365 |
| | UV Disinfection | 2,753 | 3,212 |
| | Treated Water Distribution | 2,753 | 3,212 |
| | Misc electrical, phone, internet | $600 | 600 |
| | **Sub-total** | **$315,058** | **$333,149** |
| | 10% Contingency | $31,506 | $33,315 |
| | Estimated Total Annual Cost | **$346,564** | **$366,463** |
| | **Estimated Annual Cost per Connection**[1] | **$1,260** | **$1,004** |

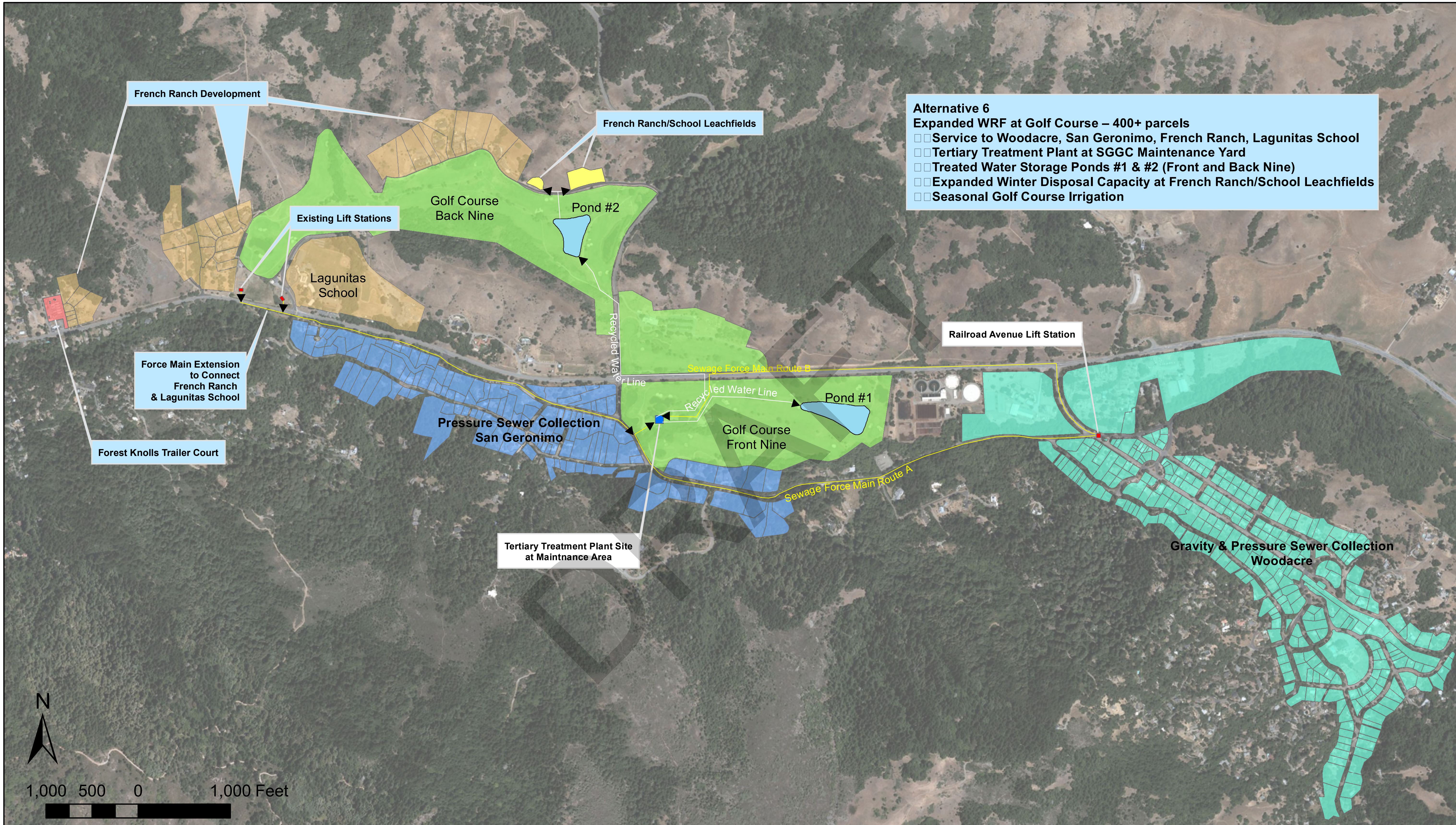
[1] *Includes additional allowance of 5 ESDs for service to golf course clubhouse*



## ALTERNATIVE 6–WATER RECYCLING SYSTEM – EXPANDED SERVICE AREA

### Description

This alternative would include all features of water recycling Alternative 5b and would be expanded further to provide capacity to serve existing developed properties located outside of the project study area boundaries to the west. The tertiary treatment plant capacity would be increased to a minimum of 60,000 gpd, with estimated average wet weather wastewater flows of approximately 53,000 gpd. The recycled water storage ponds and piping facilities on the golf course would remain the same as in Alternative 5b. The key to this alternative would be the integration of existing Lagunitas School and French Ranch wastewater facilities into the water recycling system. Both presently operate independent wastewater treatment and disposal facilities, approximately 10,000 gpd capacity each. They have treatment and pumping facilities located near the west end of the San Geronimo portion of the study area, and large capacity leachfields located adjacent to the San Geronimo Golf Course, a short distance from proposed Pond #2. **Figure 6-11** is a map showing the location of key features of Alternative 6. **Figure 6-12** provides an overall schematic of the wastewater treatment and recycling system.

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| PROJECT NO: | 1600073 |
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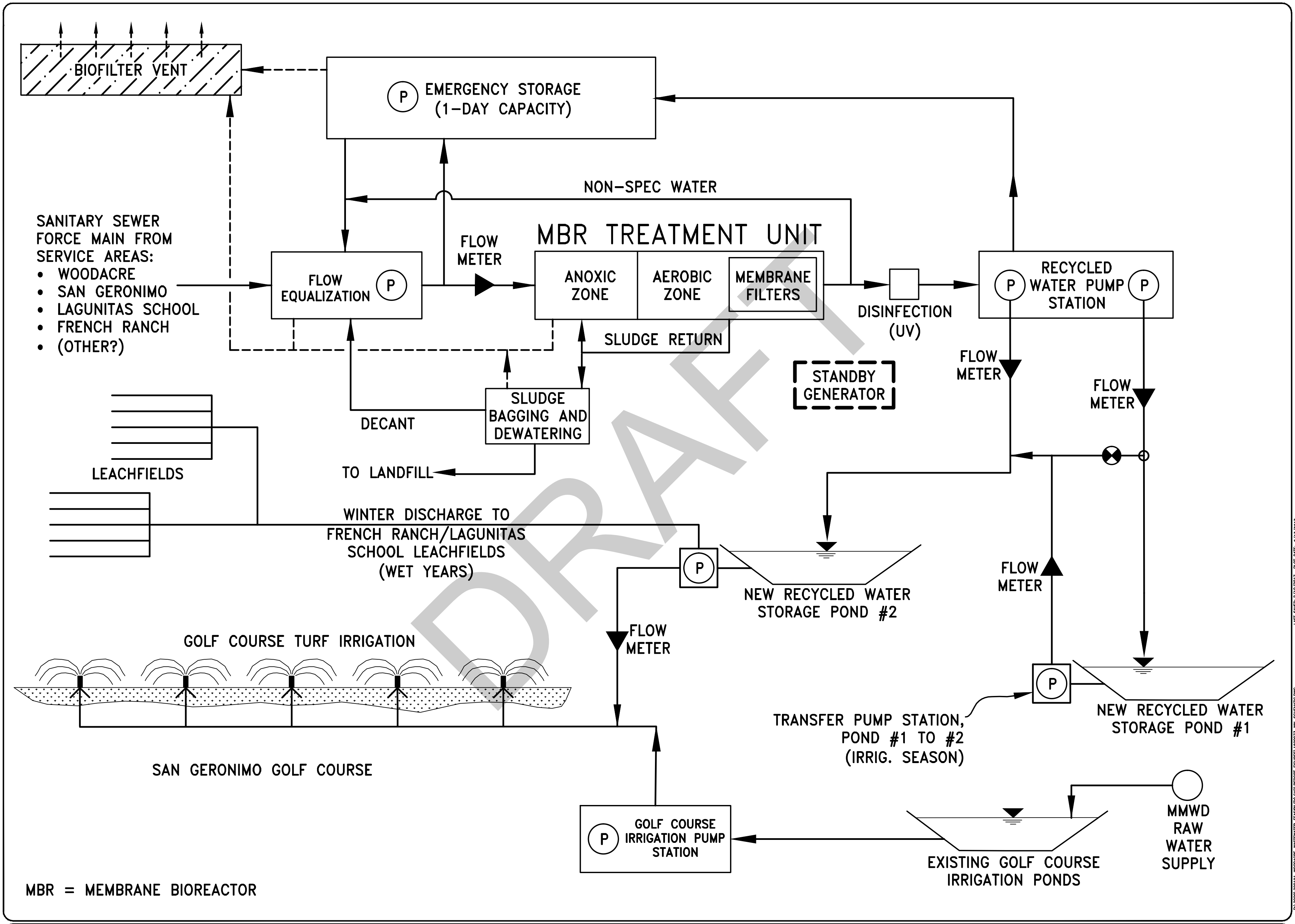
# ALTERNATIVE 6

FIGURE 6-11




**WOODACRE/SAN GERONIMO FLATS WASTEWATER RECYCLING STUDY**
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Drawn: DI
Checked: NH
Appr'd: NH

**WATER RECYCLING SYSTEM SCHEMATIC ALTERNATIVE 6**

Size: D | Project: 1600073 | Scale: NO SCALE
FIGURE: **6-12**

To implement this alternative Lagunitas School and French Ranch would do the following:

- Retain and continue to maintain their existing wastewater collection facilities, which consist of a combination of gravity sewers, septic tanks and effluent lift stations;
- Decommission and cease using their existing sand filter treatment systems;
- Modify their existing effluent pumping stations for connection to the west end of the proposed San Geronimo pressure sewer force main; convert existing treatment tanks to emergency storage/flow equalization facilities;
- Terminate current operation and use of their existing leachfields;
- Execute an agreement(s) to make their respective leachfields near proposed recycled storage Pond #2 available for as needed use and operation of the Woodacre-San Geronimo water recycling facility, in exchange for the ability to connect to the water recycling facility, including annexation or inclusion in any wastewater service district boundaries formed for the water recycling facilities;
- Pay annual operating and maintenance fees for wastewater treatment and recycling facilities operation commensurate with their wastewater flow contribution to the community system;
- Terminate their existing role as a wastewater treatment system operator and retire permits and associated monitoring and reporting obligations with the Regional Water Board and Marin County EHS.

With implementation of these measures, all wastewater from Lagunitas School and French Ranch would become part of the flow treated at the tertiary water recycling facility and add to the annual volume of recycled water available for golf course irrigation. From 15+ years of monitoring, the combined wastewater flows from Lagunitas School and French Ranch are estimated to average about 7,500 gpd during the wet weather season and 5,000 gpd during the dry season. Since their respective leachfields have a combined permitted and capacity for approximately 20,000 gpd, the leachfields would be able to handle all of the contributed flow from the school and French Ranch when needed during extreme rainfall years and, in addition, provide surplus capacity of approximately 12,500 gpd for other potential connections to the water recycling facility. Ability to discharge winter flows to these leachfields would satisfy the long-term storage/disposal requirements of Title 22 for water recycling facilities for up to 20,000 gpd beyond the capacity provided by the recycled storage ponds #1 and #2 on the golf course.

During dry, normal and most wet weather rainfall years (e.g., up to about 10-yr return frequency) the leachfields would not receive any discharge, since ponds #1 and #2 (designed for 100-yr rainfall conditions) would have surplus capacity to accept the additional flows, except during extremely wet years. Water balance analysis for Alternative 6 shows that for average year conditions, the increased wastewater flows (up to 52,000 gpd) would result in production of approximately 56 acre-feet (18.3 million gallons) of recycled water; this would be sufficient to supply approximately 37% of the average annual irrigation water demand at the golf course.

## Estimated Costs

### *Capital Costs*

The estimated capital costs for Alternative 6 are presented in **Table 6-14,** including wastewater collection, tertiary treatment plant, water recycling storage, transmission and pumping facilities, expanded over Alternative 5b to include: (a) larger treatment plant capacity; (b) allowance for San Geronimo pressure sewer force main extension to serve Lagunitas School and French Ranch; and (3) connecting transmission line from Pond #2 to the Lagunitas School and French Ranch leachfields. Cost necessary to modify the Lagunitas School and French Ranch pumping facilities are treated as a private cost that would be borne by the respective parties and accounted for in the agreement for wastewater service. Similarly, costs to the project for access and use of the Lagunitas School and French Ranch leachfields are not included, and would be accounted for in the agreement for wastewater service. As indicated, the total estimated project costs are $14.96 million, resulting in an estimated average cost per connection of $39,900. Detailed itemization of costs is provided in **Appendix G**, including quantities and unit cost assumptions.

**Table 6-14: Estimated Capital Costs - Alternative 6**

| Cost Item | Estimated Cost ($) |
|---|---|
| Collection System – Woodacre (Route A) | 4,224,175 |
| Collection System – San Geronimo | 1,849,300 |
| Lagunitas School-French Ranch Force Main Extention | 175,000 |
| Tertiary Treatment Plant | 1,635,000 |
| Recycled Water Storage & Transmission | 1,975,000 |
| Land/Easement Costs | - |
| Mobilization/Demobilization | 100,000 |
| Permit Fees & Encroachment Fees | 50,000 |
| **Subtotal** | **$10,008,475** |
| Contingency @ 15% | $1,501,271 |
| **Subtotal** | **$11,509,746** |
| Engineering & Environmental Studies @ 15% | $1,726,462 |
| Construction Management @ 10% | $1,150,975 |
| Project Admin, Dist Formation, Financing @ 5% | $575,487 |
| **Total Estimated Cost** | **$14,962,670** |
| **Estimated Cost Per Connection** | **$39,900** |

* Does not include individual property owner cost for septic tank abandonment and on-lot work to connect house plumbing to new sewer system, typical range of $1,500 to $3,000.

### *Operation and Maintenance Costs*

Estimated annual operation and maintenance costs for Alternative 6 are provided in Table **6-15**, with supporting itemized calculations and assumptions provided in **Appendix G**. The O&M cost are estimated based on labor, equipment, materials and other expenses required to perform the necessary inspections, water quality sampling, data analysis, report preparation, sludge disposal, and routine maintenance for the collection system and MBR treatment/recycling plant, plus equipment repair/replacement and electrical costs. Not included are any costs associated with the storage and use of the recycled water by the golf course for turf irrigation. Also not included are on-going costs for operation and maintenance of the wastewater collection and pumping facilities for Lagunitas School and French Ranch, which would be private costs borne by the respective parties. As indicated the total estimated annual O&M costs are about $441,000 for this alternative The resulting annual cost per parcel is estimated to be $1,050 based spreading the costs over an estimated 420 ESDs, which includes full service to Woodacre and San Geronimo, plus allowance for the golf course, Lagunitas School and French Ranch.

**Table 6-15: Estimated Annual O&M Cost – Alternative 6**

| Category | Items | Alternative 5b Cost ($) |
|---|---|---|
| **District/Program Administration** | Insurance, legal, financial, administration | 24,000 |
| | RWQCB Permit | 15,000 |
| **Labor Collection &Treatment** | Systems Control Technician | 16,000 |
| | Grade III Operator | 46,800 |
| | Grade I Operator | 57,000 |
| | Field Technician | 64,800 |
| | Engineering Consultation | 18,000 |
| | On-call Monitoring & Response Allowance | 12,000 |
| **Sludge Handling** | Bagging, Materials and Disposal Fees | 7,200 |
| **Sewer Lines** | Maintenance Cleaning | 5,400 |
| **Equipment** | Materials & Replacement | 60,000 |
| **Vehicle** | Lease and mileage | 4,800 |
| **Laboratory and Expenses** | Laboratory | 24,000 |
| | Cleaning Chemicals & Supplies | 4,200 |
| **Electrical** | Lift Station | 660 |
| | MBR Treatment Plant | 33,035 |
| | UV Disinfection | 3,671 |
| | Treated Water Distribution | 3,671 |
| | Misc electrical, phone, internet | 600 |
| | **Sub-total** | **$400,837** |
| | 10% Contingency | $40,084 |
| | Estimated Total Annual Cost | **$440,920** |
| | **Estimated Annual Cost per Connection**[1] | **$1,050** |

[1] *Based on 420 ESDs, including full service to Woodacre and San Geronimo plus additional allowance for golf course clubhouse, Lagunitas School and French Ranch.*

# SECTION 7: COMPARATIVE ANALYSIS OF PROJECT ALTERNATIVES

This section reviews the advantages and disadvantages of the various project alternatives with respect to regulatory compliance, environmental impacts, reliability, energy use, water conservation/water recycling, land use, and costs. A comparative summary and ranking is provided at the end of the section, along with identification of the “apparent best” alternative(s).

## REGULATORY COMPLIANCE

The primary goal of a wastewater facilities project in the Woodacre-San Geronimo study area is to correct existing water quality, public health and nuisance problems, and bring wastewater disposal activities into compliance with accepted sanitary practices and environmental quality standards. For project alternatives providing water recycling benefits, compliance with requirements of California Code of Regulations, Title 22 Water Recycling Criteria is applicable.

**Alternative 1** (No Project) fails to achieve water quality and public health objectives although, as property owners gradually repair or replace existing systems, improvements in local water quality, public health, and sanitation conditions would occur to some degree over a number of years. It is estimated that nearly 70% of the properties in the Woodacre-San Geronimo area are in serious conflict with current septic system standards and would have significant difficulty complying with County repair standards, particularly if requirements applicable to downstream impaired water bodies (Lagunitas Creek and Tomales Bay) are applied throughout the study area.

**Alternative 2** would substantially reduce present water quality and public health problems, and bring more (as compared with the No Project option) of the existing onsite systems into conformance with accepted practices. Where this alternative falls short of meeting environmental health/water quality requirements would be in the heavy reliance on advanced treatment systems and repair-based variances for many of the properties in the service area, along with the need for continued monitoring and surveillance to document suitable system performance and compliance with water quality objectives. The need for advanced treatment systems results from the shallow soil and groundwater conditions combined with the land area/setback constraints due to the small lot sizes and intensity of development.

**Alternative 3** would be expected to satisfy State and Regional Water Board septic system repair requirements for the limited portion of the study area served, approximately 50% of the total number of properties (176 out of 363). The system would include supplemental (secondary) wastewater treatment, nitrogen removal and a dual, 200% capacity, pressure distribution leachfield system. This would be consistent with applicable standards for small domestic wastewater treatment systems contained in State Water Board Order No. 20140-0153-DWQ, including requirements related to the impaired water body status of Lagunitas Creek and Tomales Bay. However, the approximately 50% of the study area properties not able to be served by the community wastewater system would either remain in the status quo (Alternative 1), or potentially could be addressed through implementation of an onsite system upgrade and management program per **Alternative 2**. For the overall study area, **Alternative 3** would achieve a mix of full and partial regulatory compliance per the features of **Alternatives 1, 2** and **3**.

Water recycling **Alternatives 4** through **6** would comply with California Water Recycling Criteria for disinfected tertiary recycled water, representing a higher environmental standard than that applicable to the non-recycling alternatives regarding the level of treatment and the final use and dispersal of the treated water. The water recycling alternatives differ in their capacity to serve the properties in study area, ranging from about 60% of properties under **Alternative 4** up to 100% under **Alternative 6**. Properties not able to be served would be subject to prevailing onsite septic system requirements and potentially corrective measures related to impaired water body status of Lagunitas Creek and/or Tomales Bay.

## ENVIRONMENTAL IMPACTS

A complete environmental impact report will be prepared separately as part of the overall facilities planning work. Provided here is a brief overview of the environmental issues posed by the different alternatives, other than water quality/sanitation considered to be covered under Regulatory Compliance. This review is intended to assist in assessing project feasibility and identification of the preferred alternative; it is not a substitute for the environmental documentation requirements of the California Environmental Quality Act.

**Alternative 1** would include an unknown number of new and upgraded onsite wastewater systems using conventional septic tanks and disposal systems similar to existing practices. There would be increased use of pump systems, soil fill, and drainage work, amounting to increases in the amount of land disturbance compared with current and historical practices. The general trend would be toward installing shallow disposal fields matched more closely with the limited depth of suitable soils. A negative impact of the No Project alternative would be the lack of any comprehensive plan or schedule to bring about the upgrading of onsite systems, and the continued potential for existing impacts on public health and water quality to occur. Another negative aspect of this alternative would be the possible need to revert to holding tanks and regular sewage hauling for some properties that have no acceptable on-lot options.

**Alternative 2** would largely eliminate the public health hazards from failing or poorly functioning septic systems through elimination of problematic systems, addition of individual advanced treatment units, and development of upgraded and improved means for onsite dispersal of the treated water. The institution of an onsite wastewater management program would provide the means for monitoring each system to oversee the protection of the local environment against wastewater impacts. A potential negative aspect of this plan would be the land disturbance required on individual properties to upgrade onsite systems. The importing of soil fill, removal of landscaping to make room for advanced treatment units, and raised bed dispersal systems would likely be objectionable in many instances. Conflicts with other uses of limited available land area would be a potentially significant issue. Also, similar to **Alternative 1**, there may be instances requiring holding tanks and regular sewage hauling as part of a solution for some properties.

**Alternative 3** would pose environmental impacts related to the construction of a sewer system, lift stations, treatment facilities, effluent force main and disposal field at the Fire Road site. The collection system, utilizing small diameter piping, would generate impacts during the construction phase. Also, the recommended sewer option includes the continued use of on-lot septic tanks with a combination of small diameter gravity and pressure pumping (STEP) systems. This would result in the continuing need for septic tank and pump maintenance on individual properties, along with routine septic tank cleaning. Pump failures and/or pipeline leaks or breaks would pose the potential for discharge of partially treated sewage to the environment if not properly mitigated through design and operational procedures.

Another impact of the Fire Road alternative would be posed by the conversion of the Park Street area to a site for a secondary wastewater treatment plant and effluent lift station. The treatment plant would mainly consist of below ground or low-profile tanks and submersible pumps, plus a small control building. It would be fenced and could be screened with vegetation to mitigate visual impacts. Noise levels would be low, but there would be regular activity at the site, routine maintenance and running of a standby generator. Sewage odors would be generated, but can be mitigated with appropriate odor control facilities normally part of the treatment system design.

The Fire Road leachfield site and the pipeline route to the site would involve a substantial amount of excavation and vegetation clearing, requiring mitigation for erosion control and reestablishment of native vegetation. The leachfield site and force main route were identified to avoid geologically unstable areas; however, there are steep slopes and potentially unstable lands in the vicinity, which would require evaluation to confirm avoidance of impacts or other mitigation measures. Restoration and revegetation of land areas disturbed by the leachfield and pipeline construction would be relatively straightforward. The dispersal of secondary treated effluent is compatible with the soil conditions in the identified leachfield site. However, additional soils and groundwater investigation and the potential for impacting water quality or hydrology in locations downgradient/downhill from the leachfield site would need to be considered as part of formal environmental review and system design.

Water recycling **Alternatives 4** through **6** would have environmental impacts (a) within the Woodacre and San Geronimo communities related to the construction and operation of wastewater collection systems; (b) 1-mile sewage force main from Woodacre to the golf course; (c) water recycling facilities at the golf course; and (d) irrigation of the golf course with recycled water. Between the alternatives, the level of potential impact would increase according to the service area size, treatment system capacity and level of facilities construction required.

- **Collection System.** Collection system would include impacts related to installation of gravity sewers and pressure sewer lines in Woodacre and San Geronimo. This would include disruption of traffic, noise, and potential for soil erosion, dewatering or runoff issues. Pressure sewer installation using horizontal directional drilling methods would be less disruptive than gravity sewer construction which would be done using open cut trenching methods. Existing septic tanks and disposal fields would be decommissioned/abandoned, and replaced with a gravity connection to the sewer system where feasible. The Redwood Ave portion of Woodacre and all of San Geronimo, would be served by pressure sewers, which would include an on-lot grinder pump and pressure connection line to the pressure sewer mains in the street. This would result in the continuing need for pump servicing on these individual properties. Pump failures and/or pipeline leaks or breaks would pose the potential for plumbing backups or discharge of raw sewage to the environment if not properly maintained.

- **Woodacre–Golf Course Force Main.** There are two alternate pipeline routes from Woodacre to the golf course treatment plant site: (a) via San Geronimo Valley Drive (Route A); and (b) via Railroad Avenue and Sir Francis Drake Blvd (Route B). The two pipeline routes are very close in length and estimated costs; and both would be within public road right of ways their entire length until entering golf course property. Regardless of the route, it is likely that the pipeline would be installed for most of its length using trenchless methods (i.e., horizontal directional drilling), to minimize excavation, soil erosion hazards and impacts to road surfaces and traffic. Route A would generally run parallel to San Geronimo Creek for most of its length, eventually crossing the creek at the bridge near Meadow Way. This would be done using ductile iron pipe secured to the downstream side of the bridge deck for support, protection of the pipe and double-containment against pipe leaks. Route B would be buried in the road bed of Railroad Avenue where it crosses San Geronimo Creek; the remainder of the pipeline route would be a much greater distance from San Geronimo Creek than for Route A.

- **Recycled Water Facilities.** Impacts of the recycled water facilities would include: (a) those associated with the treatment plant (visual, odors, noise, spills) located in the golf course maintenance complex; and (b) the construction and maintenance of one or two recycled water storage ponds in currently unused parts of the golf course. The treatment plant would be of a compact design, provided with odor control facilities and located and screened to minimize visual, noise and operational impacts locally. The treatment system would be required to comply with Title 22 standards for water recycling, which are very stringent in the direction of public health and water quality protection. The storage ponds on the golf course would be designed to capture and hold rainfall as well as tertiary treated water for 100-yr seasonal rainfall occurrence (75.3 inches annual rainfall), plus freeboard allowance. The ponds would have to be managed to control mosquitoes, prevent overflows, and be maintained in a safe condition and fenced to restrict access by golfers or others.

- **Golf Course Irrigation with Recycled Water.** Final dispersal of the recycled water would be integrated into the existing golf course irrigation system and would be limited to application during the driest time of the year (August-September), at appropriate application rates and to areas where there is no threat of runoff to local drainages or San Geronimo Creek. Violation of these standard conditions of Title 22 and Regional Water Board requirements could result in recycled water runoff into San Geronimo Creek. The recycled water would amount to a relatively small percentage of the total golf course irrigation water demand (approximately 20% to 35%), and would be controlled through a separate pump station; this would allow a high degree of control and flexibility in the timing and conditions for applying recycled water.

  Application of recycled water also requires consideration of public health impacts. This is a low environmental/public health threat due the fact that the wastewater will be treated to a tertiary level, deemed by California Title 22 standards to be suitable for surface irrigation in areas where human contact with the treated water can be expected, e.g., at parks, golf courses and similar irrigated pubic areas. By regulation, signs will be posted and drinking water fountains will be isolated from irrigated areas to alert the public and minimize the chances of contact with recycled water.

## RELIABILITY

Reliability considerations relate to the ability to consistently meet wastewater treatment and disposal objectives and have adequate provisions for emergencies, malfunctions, extreme climatic conditions, or fluctuations in flow.

**Alternative 1** rates poorly in terms of reliability. Options to correct existing septic system problems would be limited and costly. Some property owners would have extreme difficulty finding solutions that can assure long-term performance reliability because of shallow soil/groundwater conditions and space limitations. Without a concerted effort to systematically assess and upgrade existing systems, many systems would remain “as is” and a source of continuing public health and water quality concerns.

**Alternative 2** represents a substantial improvement in reliability through the proposed implementation of an onsite system inspection and maintenance program. However, the need to rely on many individual advanced treatment units, although feasible, would intensify the oversight and maintenance requirements, and affect overall reliability of this alternative.

**Alternative 3** (Fire Road Leachfield) offers a high degree of reliability over present sewage disposal practices for the Woodacre properties served. The facilities would be capable of meeting accepted State standards for wastewater treatment and disposal, including built-in emergency and redundancy provisions for potential equipment failures, power outages, etc. The inclusion of secondary wastewater treatment prior to disposal reduces the amount of dependence on the soil environment for absorption and treatment of wastewater constituents, which improves the reliability of this alternative. The provision of a dual, 200% capacity, leachfield system would provide an added redundancy, also helping to preserve and extend the life of the wastewater dispersal field. The electrical and mechanical elements of the secondary treatment system, as well as the individual pump systems within the collection system, would be subject to periodic malfunction. However, these aspects of the treatment system can be routinely monitored, maintained, repaired and replaced as necessary. The types of operating issues and maintenance for wastewater facilities under **Alternative 3** would be similar to those faced by individual properties utilizing alternative onsite wastewater systems per **Alternative 2**. For the study area as a whole, since **Alternative 3** would only provide facilities to serve about half of the properties, overall reliability would be judged as a mix of reliability offered by **Alternatives 1**, **2** and **3**.

Water recycling **Alternatives 4** through **6** would all provide a higher level of reliability than the non-water recycling alternatives, as they would have to be designed and operated to comply with State standards (Title 22) for disinfected tertiary recycled water. The applicable standards for water recycling facilities have built-in redundancy and fail-safe requirements to assure against human health impacts from exposure to recycled water. These requirements include such things as automatic monitoring and control systems, duplicate unit processes, and emergency storage/holding capacity sized for 100-yr seasonal rainfall conditions (plus freeboard). The method of final dispersal of the treated water (winter storage/summer irrigation) is inherently more reliable than depending on year-round soil absorption, as per the other alternatives. Compared to one another, the reliability of the water recycling alternatives would increase in proportion to the system capacity and number of properties in the study area that could be served.

In addition to the required failsafe features, **Alternative 6** would provide surplus winter season capacity by being able to disperse treated water to the existing French Ranch and Lagunitas School leachfields. Since the storage ponds would be designed for 100-yr seasonal rainfall conditions, the leachfields would rarely be used. However, they would always be available for extreme rainfall years, and for emergencies or to facilitate pond maintenance activities, if needed, adding operational flexibility and reliability over that provided by the other alternatives.

## Energy Use

**Alternative 1** would create new energy requirements and resource demands where individual actions are taken to upgrade existing septic systems with more modern treatment devices.

**Alternative 2** would increase energy requirements in comparison with the No Project alternative, since a substantial number of properties would be served by an advanced treatment/dispersal system utilizing pumps and possibly UV disinfection and aeration units. There would also be increased usage of fossil fuels for **Alternative 2** as a result of the construction work for onsite system improvements, regular inspection and monitoring activities, and a somewhat higher rate of septic tank pump-outs that would likely occur with a management program in place.

**Alternative 3** would have increased energy requirements, in comparison with **Alternatives 1** and **2**, because of the need to pump the wastewater to offsite treatment/disposal locations and the operation of pumps, and other equipment needed for secondary treatment facilities. There would also be increased usage of fossil fuels as compared with **Alternatives 1** and **2** as a result of the more extensive construction work for the community system improvements, and ongoing inspection and monitoring activities.

Water recycling **Alternatives 4** through **6** would have substantially greater energy requirements than the non-water recycling alternatives due to: (a) the pumping requirements to bring all wastewater to the proposed treatment plant location at the golf course; (b) treatment facilities needed to produce disinfected tertiary-level recycled water; and (c) pumping requirements to distribute the recycled water to locations on the golf course for storage and integration into the golf course irrigation system. The energy requirements would increase in proportion to the treatment capacity and number of parcels severed under each recycling alternative. **Table 7-1** summarizes the estimated annual energy use for each alternative, showing the breakdown between the collection system and treatment and distribution system. For comparison, the typical annual energy use for an advanced individual residential onsite treatment system would be on the order of about 100 to 200 kW-hrs per year per system. The water recycling facilities would also entail substantially greater usage of fossil fuels for construction of the wastewater collection, treatment and storage facilities as compared with the non-recycled water alternatives. Relative to one another, usage of fossil fuels for project construction among the water recycling alternatives would be in proportion to the system capacity and number of parcels served, similar to operating energy use per **Table 7-1**. Also shown as a point of reference are the projected energy costs associated with the operation of upgraded onsite wastewater treatment systems under Alternative 2.



**Table 7-1: Estimated Annual Energy Use for Water Recycling Alternatives**

| Alternative | Treatment Capacity (gpd) | Parcels Served | Estimated Annual Energy Use (kW-hrs/yr) | | |
|---|---|---|---|---|---|
| | | | Collection System | Treatment & Distribution | Total |
| 2 | n/a | 363 | n/a | 100 to 200/parcel | 36,300 to 76,600 |
| 4 | 30,000 | 210 | 8,100 | 135,000 | 143,100 |
| 5a | 35,000 | 270 | 9,100 | 158,000 | 167,100 |
| 5b | 50,000 | 360 | 10,600 | 195,000 | 205,600 |
| 6 | 60,000 | 400+ | 12,600 | 220,000 | 232,600 |

## WATER CONSERVATION AND RECYCLING

Under **Alternatives 1** and **2** water conservation would potentially occur to a small degree to the extent that individual property owners choose to implement greywater systems as allowed under California Code Plumbing Code. Also water recycling would potentially occur where subsurface drip dispersal methods are used in a way where it can provide incidental yard irrigation benefits. Under **Alternative 3** secondary treated water would be dispersed to a leachfield, returning the water to the local watershed, but it would not provide any measureable water conservation benefit or water recycling.

Water recycling **Alternatives 4** through **6** would all provide direct, measureable water recycling benefits realized through the reduction in irrigation water supplied to the golf course from MMWD raw water supplies. **Table 7-2** summarizes the projected average annual water produced by each of the alternatives, in acre-feet and million gallons per year. As indicated, the recycled water would provide in the range from a low of about 18% (**Alternative 4**) to a high of 37% (**Alternative 6**) of the annual golf course irrigation demand.

**Table 7-2: Recycled Water Produced – Average Annual Volumes[1]**

| Alternative | Recycled Water Produced per | | Percent of Golf Course Irrigation Demand[2] |
|---|---|---|---|
| | Acre-feet | Million gals | |
| **Alternative 4** | 28.3 | 9.22 | 18% |
| **Alternative 5a** | 37.6 | 12.26 | 25% |
| **Alternative 5b** | 50.0 | 16.28 | 33% |
| **Alternative 6** | 56.0 | 18.26 | 37% |

*[1] For average annual rainfall year (41.6")*
*[2] Based on average irrigation demand of 50 million gals/yr*

## LAND AREA NEEDS

This factor considers the impact of wastewater facilities on individual properties, public areas and other lands**.** **Alternative 2** would pose the biggest impact on individual properties in the service area through the need to modify and expand onsite wastewater systems on each property, affecting existing landscaping and other property improvements and activities**.** **Alternative 1** would have a similar effect, but not to the same degree. Neither of these alternatives would impact land uses elsewhere in the Woodacre-San Geronimo area.

**Alternative 3**, serving Woodacre (176 parcels), would involve the installation of small diameter gravity and pressure (STEP) effluent sewers in the local streets, with septic tanks and STEP pumping units on individual properties. The construction impacts in the streets could be minimized with the use of horizontal directional drilling methods for most of the pipeline work. The on-lot septic tanks and STEP pumping units would utilize the existing tanks or provide new tanks in generally the same location; the existing drainfield areas could be decommissioned. A more significant land use change under **Alternative 3** would be the community wastewater treatment and pumping facilities in the Park Street area (0.25 acres), the 1.5-acre Fire Road leachfield, and the connecting 0.4-mile long effluent force main to the leachfield site.

The land use impacts of water recycling **Alternatives 4** through **6** would include effects on individual properties, within street rights-of-way, and at the golf course. On-lot impacts would include decommissioning/removal of existing septic systems and installation of new on-lot grinder pumps for a portion of the service area. Facilities in the street rights-of-way would include a combination of gravity sewers, pressure sewers, and one main lift station proposed at the intersection of Railroad Ave. and San Geronimo Valley Dr. in Woodacre. Impacts at the golf course would include land required for wastewater treatment facilities, storage ponds and transmission lines and associated pumping facilities. **Table 7-3** quantifies and compares the respective facilities and land requirements for the various alternatives, along with the estimated reduction in land area requirements associated with decommissioning of existing septic systems on individual properties served by the community facilities. The net effect on land area used for wastewater facilities is presented in the right-hand column, showing overall reductions (minus values) for all alternatives.

**Table 7-3. Land Area Impact Comparison – Water Recycling Alternatives**

| Alternative | On-lot Facilities | | Gravity & Pressure Sewers[3] | Wastewater Recycling Facilities | | | Net Land Impact (ac) |
|---|---|---|---|---|---|---|---|
| | OWTS Removed[1] | Grinder Pumps[2] | | Treatment Plant Area | Pipelines | Storage Ponds | |
| 4 | 210 | 40 | 26,565 lf | | 2,000 lf | | |
| | (-9.64 ac) | 0.09 ac | 6.10 ac | 0.2 ac | 0.46 ac | 2.8 ac | - 2.79 ac |
| 5A | 270 | 115 | 36,740 lf | | 6,000 lf | | |
| | (-12.4 ac) | 0.26 ac | 8.43 ac | 0.2 ac | 1.38 ac | 4.5 ac | -2.12 ac |
| 5B | 360 | 160 | 36,740 lf | | 6,000 lf | | |
| | (-15.53 ac) | 0.37 ac | 8.43 ac | 0.2 ac | 1.38 ac | 5.9 ac | - 6.15 ac |
| 6 | 363 | 163 | 37,490 lf | | 7,000 lf | | |
| | (-16.67 ac) | 0.37 ac | 8.61 ac | 0.2 ac | 1.61 ac | 5.9 ac | -5.88 ac |

[1] *Assumes average 2,000 $ft^2$ area per septic system*
[2] *Assumes average 100 $ft^2$ area per grinder pump unit*
[3] *Assumes average 10 $ft^2$/lf of pipeline*

## COSTS

The estimated capital cost and operation and maintenance (O&M) cost for the various wastewater project alternatives are summarized in **Table 7-4.** Supporting cost information is itemized for each alternative in preceding individual sections and in the appendices. A total project cost cannot be provided for No Project alternative. However, based on experience in Marin County with existing properties, expenses to individual property owners for upgrading and on-going maintenance of functional and compliant onsite wastewater systems (predominantly alternative systems) include typical capital costs in the range of $30,000 to $70,000, and annual costs of $1,00 to $1,500. These costs would be similar to the estimated per parcel costs developed for **Alternative 2**. The cost comparison shows **Alternative 3** (Fire Road Community Leachfield) to have the lowest projected capital and O&M cost per parcel; however, it would offer only limited capacity, serving about half of the entire study area. The most cost effective alternatives are water recycling **Alternatives 5b** and **6**, which both include service to the entire study area and compare closely in estimated capital costs (approximately $41,000/parcel) and annual O&M costs (approximately $1,000/parcel).

**Table 7-4: Project Alternatives Cost Comparison**

| Alternative | | Parcels | Capital Costs ($) | | | Annual O&M Costs ($) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Total | Per Parcel | Rank* | Total | Per Parcel | Rank* |
| 1 | No Project | - | - | 35,000 to 70,000 | 1 | 1,000 to 1,500 | n/a | 1 |
| 2 | Onsite Upgrades & Management Program | 363 | 19,306,430 | 53,186 | 1 | 350,790 | 966 | 5 |
| 3 | Woodacre Fire Road Community Leachfield | 176 | 6,629,839 | 37,670 | 6 | 155,760 | 885 | 6 |
| 4 | Woodacre Only | 210 | 9,563,777 | 45,542 | 3 | 291,540 | 1,356 | 1 |
| 5a | Partial (75%) Woodacre-San Geronimo | 270 | 12,652,447 | 46,861 | 2 | 346,564 | 1,260[2] | 2 |
| 5b | Full Woodacre-San Geronimo | 360 | 14,323,558 | 39,788 | 5 | 366,465 | 1,004[2] | 4 |
| 6 | Expanded Service Area[1] | 420+ | 14,962,670 | 39,900[3] | 4 | 440,920 | 1,050[4] | 3 |

*[1] Includes integration with French Ranch & Lagunitas School wastewater facilities plus service to golf course*
*[2] Cost share includes additional allowance of 5 ESDs for golf course clubhouse*
*[3] Cost share for Woodacre-San Geronimo properties; golf course, French Ranch, Lagunitas School to be determined through agreement for buy-in/integration of existing facilities*
*[4] Costs shared among all users, based on total estimated 410 ESDs, including Woodacre/San Geronimo, Golf Course, French Ranch, and Lagunitas School.*
**Lowest cost = Highest Ranking (6)*



# COMPARATIVE SUMMARY AND RANKING

An overall comparison is presented here between the seven (7) project alternatives, taking into consideration the various factors presented in the section. Relative numerical ratings (lowest=0 to highest=6) were assigned to each alternative for each factor as discussed below. The scoring was based on a combination of objective information (e.g., costs) and subjective best professional judgment. Results are displayed in **Table 7-5**. The cumulative scores provide the basis for overall comparative ranking of alternatives, 1 through 7, at the bottom of the table.

## Regulatory Compliance

Project alternatives were evaluated with respect to their ability to meet public health and water quality standards, along with the level of standard applicable to the project. Projects were ranked in order of increasing environmental quality standards, and points were assigned according to rank, from 0 (minimum) to 6 (maximum). The No Project alternative, which would have the greatest degree of non-compliance, was assigned the lowest ranking and point score. Increasingly higher environmental standards would be met by **Alternatives 2** through **6**, and they were ranked and scored accordingly. Higher ranking was given to water recycling alternatives (**4** through **6**) meeting tertiary treatment standards. Also between the water recycling alternatives, higher ranking was given based on the total number of properties in the study area able to be served.

## Environmental Impacts

Projects were preliminarily ranked in order of decreasing impacts on the natural environment based on best professional judgment, and assigned points according to rank. The least impact project was assigned the highest score (6). This assessment and ranking will be reviewed refined in the EIR process.

## Reliability

Projects were subjectively ranked in order of increasing operational reliability to address community wastewater needs consistent with applicable requirements, including provisions for emergencies and other reasonable contingencies. The most reliable project was assigned the highest score.

## Energy Use

Project alternatives were ranked in order of decreasing energy requirements for construction and on-going operation and maintenance. Higher points correspond to projects with lower energy use.

## Water Conservation and Recycling Benefits

All water recycling projects were scored higher than non-recycling alternatives, and between **Alternatives 4** through **6**, scores were assigned according to the projected amount of recycled water produced for replacement of raw water supplies used for golf course irrigation. Onsite management **Alternative 2** was ranked ahead of **Alternative 3** (Fire Road Leachfield) on the basis of potentially offering greater potential for water savings through effective onsite use of greywater or subsurface drip dispersal for yard irrigation.

## Land Area Needs

Project alternatives were subjectively ranked in order of decreasing impacts on land area needs, based on the amount of land that would be converted or dedicated to wastewater treatment and/or disposal uses.

## Costs

Lastly, project alternatives were ranked by costs per parcel, with separate ranking and points assigned for (a) capital costs and (b) annual operation and maintenance costs per **Table 7-4**. Highest points were given to least cost alternative. The lowest points were given to the No Project alternative. This is due to the fact that, although no information has been developed on the total cost of this alternative, there is a strong likelihood that the future cost of individual compliance for any given property owner could easily exceed the estimated per parcel costs for the any of the other community-based project alternatives.

### Table 7-5: Numerical Rating of Alternatives*

| | Non-Recycling Alternatives | | | Water Recycling Alternatives San Geronimo Golf Course | | | |
|---|---|---|---|---|---|---|---|
| | **1** No Project | **2** Onsite Mgmt | **3** Fire Road Leachfield | **4** Woodacre Only | **5a** Partial - 75% Woodacre & San Geronimo | **5b** Full Woodacre & San Geronimo | **6** Expanded Service Area |
| **Regulatory Compliance** | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| **Environmental Impacts** | 0 | 1 | 2 | 6 | 5 | 4 | 4 |
| **Reliability** | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| **Energy Use** | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| **Water Conservation** | 0 | 2 | 1 | 3 | 4 | 5 | 6 |
| **Land Area Needs** | 1 | 0 | 2 | 4 | 3 | 6 | 5 |
| **Capital Cost** | 1 | 1 | 6 | 2 | 3 | 5 | 4 |
| **Annual O&M Cost** | 1 | 5 | 6 | 1 | 2 | 4 | 3 |
| **TOTAL** | **9** | **16** | **25** | **25** | **27** | **35** | **34** |
| **RANKING**** | **7** | **6** | **4** | **4** | **3** | **1** | **2** |

**Points assigned from 0 to 6, low to high for each factor*
***Ranking with 1 as best*



## Apparent Best Alternative

The comparative analysis shows **Alternative 5b** to be the highest ranking and “apparent best” alternative. It would provide capacity to serve essentially all properties within the designated Woodacre and San Geronimo service areas (360 parcels), meeting an important project objective. Both the estimated capital costs ($39,788) and annual O&M costs ($1,004) per parcel are among the lowest of the alternatives evaluated. Projected water recycling/water conservation benefits are exceeded only by **Alternative 6**, which addresses the potential for expanding the water recycling to properties beyond the project study area. **Alternatives 5b** and **6** are not mutually exclusive. **Alternative 6** could be undertaken in a subsequent phase as an expansion of **Alternative 5b**, providing appropriate allowances are incorporated in the initial treatment plant design to accommodate future expansion.

# SECTION 8: RECOMMENDED FACILITIES PROJECT PLAN

## WATER RECYCLING FACILITIES

### Description, Layout and Preliminary Design Criteria

The recommended project ("apparent best alternative") is **Alternative 5b**, which includes collection, treatment, and recycling of wastewater for turf irrigation at the San Geronimo Golf Course, with capacity to serve up to approximately 360 parcels in the Woodacre-San Geronimo study area. The system would have a capacity to accommodate an estimated average daily flow of approximately 44,000 gpd and peak daily flow of up to 60,000 gpd. The nominal sizing of the treatment system would be 50,000 gpd. Under average year rainfall conditions, the project would produce approximately 50 acre-feet (16.3 million gallons) of recycled water for golf course irrigation, allowing about an approximate 33% reduction in raw water obtained from MMWD.

The main facilities include: (a) wastewater collection systems extending throughout the Woodacre and San Geronimo service areas using a combination of conventional gravity sewers and pressure sewers; (b) sewage force mains from Woodacre and San Geronimo areas to the treatment plant location in the golf course maintenance area; (c) tertiary recycled water treatment plant located in an approximately 10,000 $ft^2$ area on the west side of the golf course maintenance yard; (d) two holding ponds, #1 on the front nine and #2 on the back nine of the golf course, for storage of up to approximately 12.4 million gallons of tertiary recycled water (plus rainfall); and (e) seasonal reuse of the recycled water for spray irrigation of the golf course, integrated into the existing irrigation system. **Figure 8-1** is a map showing the location and layout of key facilities.

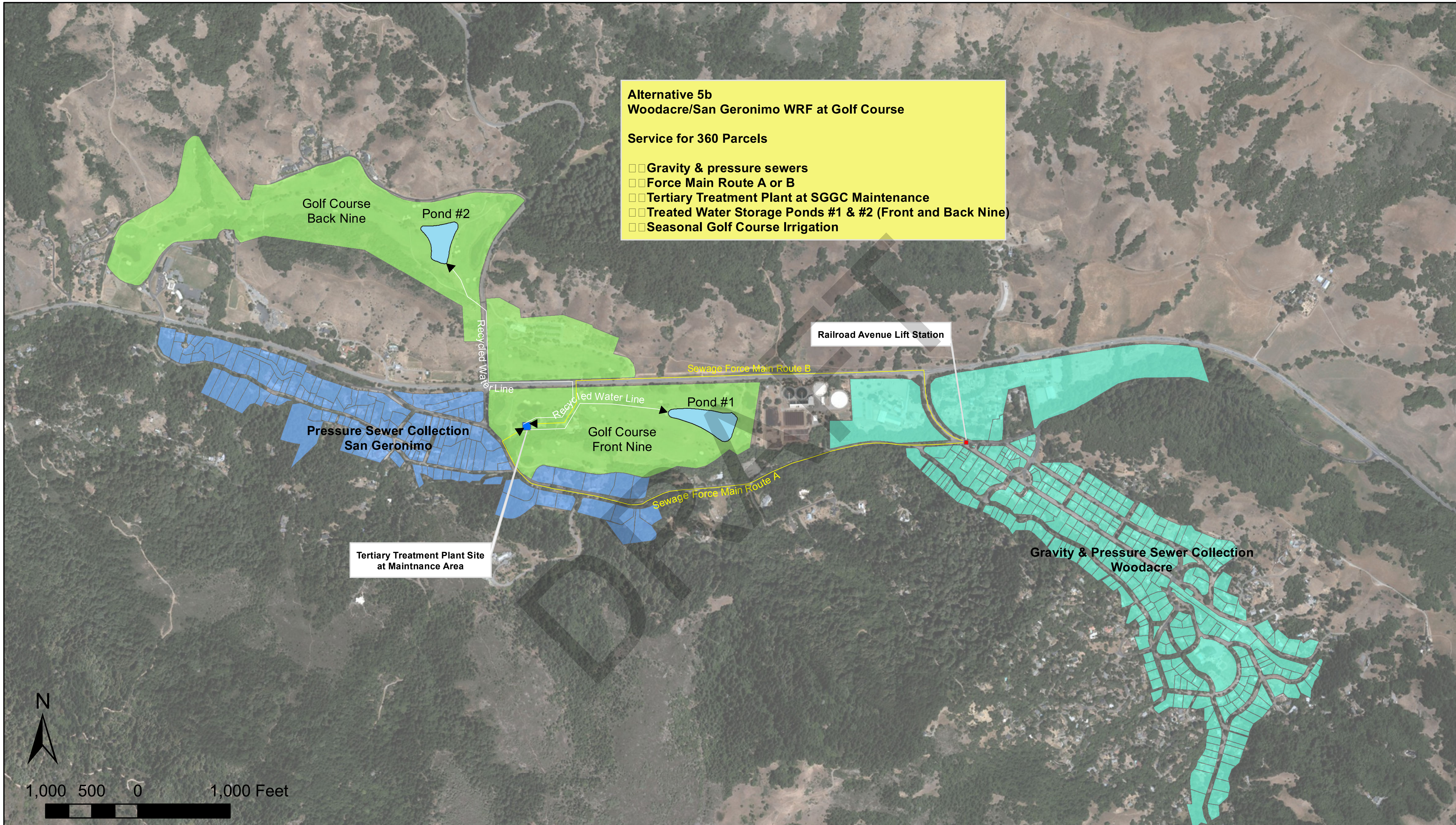
#### *Wastewater Collection*

New wastewater collection systems would be installed throughout the Woodacre and San Geronimo communities using a combination of conventional gravity sewers and pressure sewers. All existing septic tanks and disposal systems would be decommissioned and properly abandoned (by the owner) in accordance with County Regulations for septic tank abandonment. This normally includes pumping out the tank, breaking the tank bottom for drainage, and backfilling the tank with sand or soil. Sewage pipes can either be removed or abandoned in place.

The recommended features and layout of wastewater collection facilities for Woodacre and San Geronimo are shown, respectively in **Figures 8-2** and **8-3**, and summarized below.

**Woodacre.** The recommended sewage collection method for Woodacre is a conventional gravity system for most of the area, with a main lift station located at the northeast corner of Railroad Avenue and San Geronimo Valley Drive, and a force main from the lift station to the treatment plant at San Geronimo Golf Course. Because of the undulating terrain, a pressure sewer would be used for properties along Redwood Drive, tying in at the main lift station.

- **Gravity Sewers**. Properties served by gravity connections would have a 4-inch lateral extended to the front property line, and the property owner would be responsible for installing a new 4-inch house plumbing drain to the lateral provided. The gravity sewers

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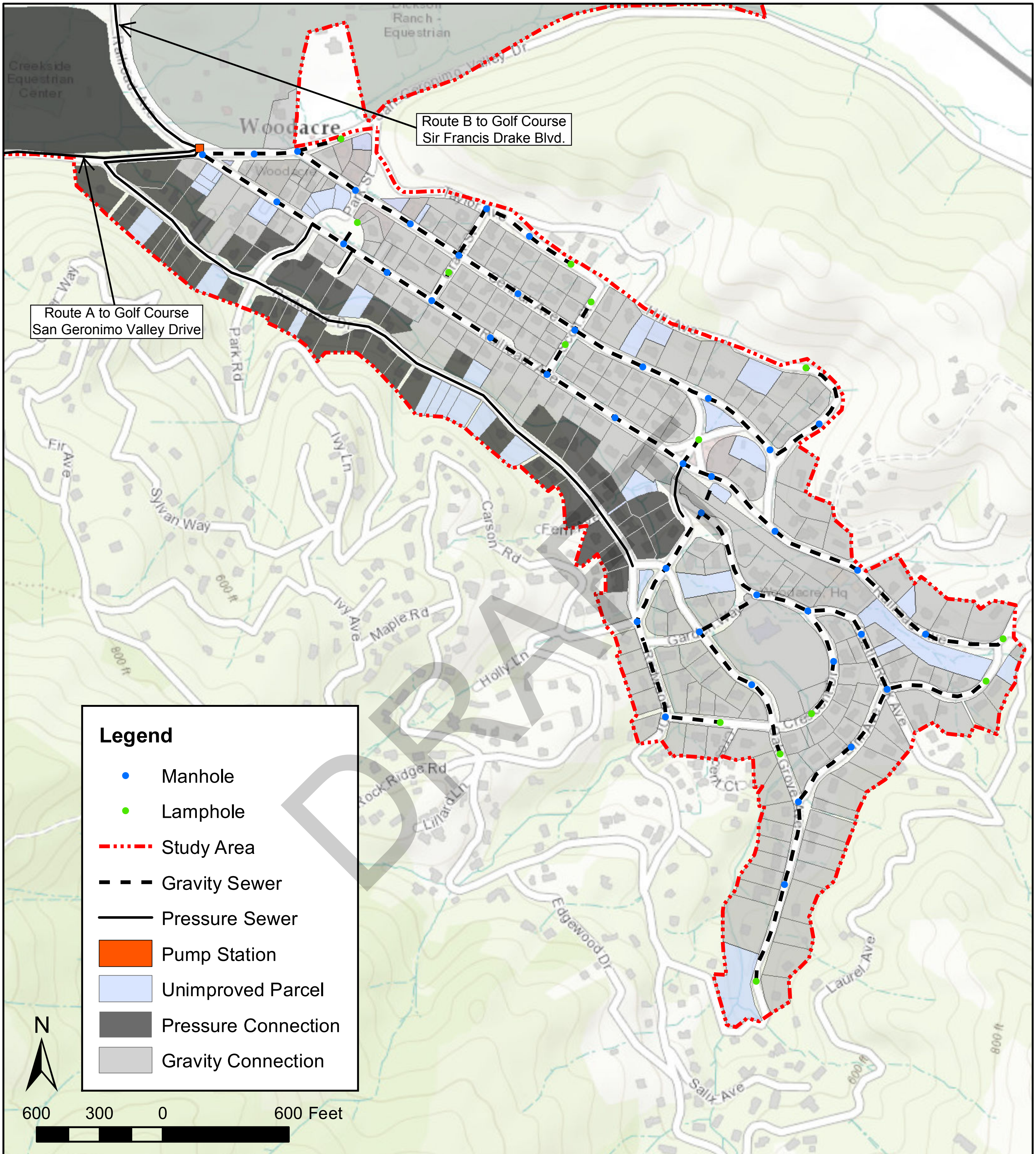
# RECOMMENDED PROJECT ALTERNATIVE 5b

FIGURE 8-1

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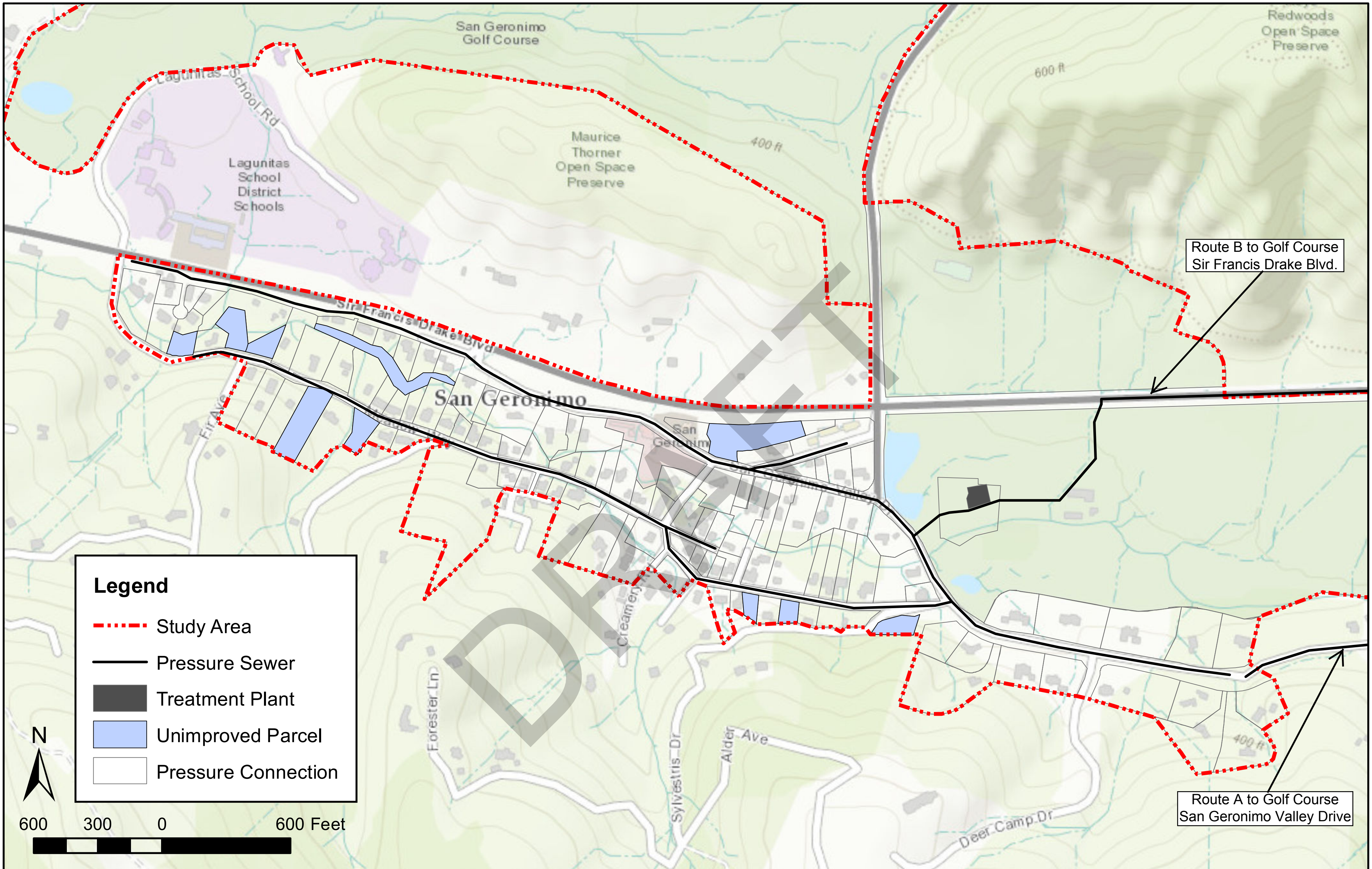
**WOODACRE GRAVITY SEWER SYSTEM PLAN**

**FIGURE 8-2**

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# SAN GERONIMO PRESSURE SEWER SYSTEM PLAN

FIGURE 8-3

in the street right-of-way would consist primarily of 6-inch diameter sewer pipes, typically 4 to 5-feet deep, with manholes located about every 400 feet and at intersections and major grade changes. There may be some use of 8-inch diameter sewers depending on the final sewer layout. Gravity sewers must maintain a constant downhill grade and would be installed using open-cut trenching methods.

- **Pressure Sewer.** A pressure sewer is a small diameter pipeline (e.g., 2 to 4 inches diameter), which is installed following the profile of the ground or street. Burial depths usually have a 30-inch minimum cover. This sewer design is the preferred approach for properties along Redwood Avenue due to the undulating grade of the street and the elevation of many properties below the street, requiring pumps to lift the sewage from the house to the sewer. Each home would have a small grinder pump unit to discharge to the pressure main via a small diameter service lateral (typically 1.25-inch diameter). The pump grinds the solids in the wastewater into slurry in the manner of a kitchen sink garbage grinder. Grinder pumps to serve individual homes would be one horsepower, and come in standard package units consisting of 30-inch diameter by 5-ft to 6-ft deep polyethylene basins (see **Appendix D**). The grinder pumps and service lateral would be provided as part of the project; the property owner would be responsible for re-routing and connecting their building sewer to the new grinder pump; they would also be responsible for providing the electrical power for pump operation.

- **Main Lift Station**. A main lift station would be located in the north end of the service area on the northeast side of the intersection of Railroad Avenue and San Geronimo Valley Drive. It would be the terminal collection point for the gravity sewer lines as well as the pressure sewer main from Redwood Avenue. The lift station would be located within County road right-of-way and would consist of a buried tank (wet well), duplex submersible pumps, electrical controls, and an emergency generator. In addition to redundant pump capacity and emergency power supply, the lift station would be designed with emergency storage capacity for minimum six hours of sewage flow and telemetry alarm and control features for remote monitoring and operation.

- **Force Main.** A 4-inch diameter force main would run from the main lift station to the proposed treatment plant location at the San Geronimo Golf Course maintenance area. Two alternate routes have been identified: (a) Route A via San Geronimo Valley Drive, approximately 5,360 feet long; and (b) Route B via Railroad Avenue and Sir Francis Drake Boulevard, approximately 5,850 feet long. Both routes are feasible and are very close in length and estimated cost. They differ mainly in the fact that Route A would parallel the San Geronimo Creek corridor for most of its length, and Route B would cross San Geronimo Creek at Railroad Avenue and then remain away from the creek for the remaining distance. Horizontal directional drilling methods would be used for either pipeline option. Selection of the preferred route should be made following completion of environmental review.

**San Geronimo.** The recommended sewage collection method for San Geronimo is a pressure sewer system. The pressure sewer network would consist of 2-inch, 3-inch and 4-inch diameter pipes, running west-to-east on Sir Francis Drake Blvd, San Geronimo Valley Dr. and Meadow Way, eventually connecting together at San Geronimo Valley Drive before entering the golf course and following the maintenance road to the proposed wastewater treatment plant. Due to the flat and undulating terrain, which slopes steadily downstream, away from the golf course, analysis shows that gravity sewers would be a significantly more expensive option for San Geronimo, requiring deep trenching and multiple lift stations in the community.

The preliminary collection system plan includes about 10,200 feet of pressure sewer mains with individual grinder pumps and pressure laterals at each property. Pressure sewer lines would be installed primarily using horizontal directional drilling methods. There would be one section of pressure sewer that crosses San Geronimo Creek; this would be at the bridge near Meadow Way. The crossing would be accomplished using a ductile iron sleeve (for support, protection and double-containment) secured on the downstream side of the bridge deck adjacent to an existing water main crossing. This is the same creek crossing required for Woodacre force main Route A; the San Geronimo and Woodacre lines would join into a single pipeline crossing if Woodacre Route A is selected.

### *Wastewater Treatment*

**Treatment Objectives.** The wastewater treatment facilities would be designed and operated to produce disinfected tertiary recycled water meeting the requirements of California Code of Regulations, Title 22 Water Recycling Criteria. Recycled water meeting these standards is acceptable for unrestricted landscape irrigation, including golf course irrigation, as well as other water recycling uses. Effluent constituent concentrations for the water recycling facility are listed in **Table 8-1,** based on Title 22 standards and effluent limitations contained in the *State Water Board Order WQ 2014-0153-DWQ (Table 4)* for MBR and similar treatment systems**.** In addition to meeting turbidity and total coliform limits set by Title 22, the selected treatment system would be designed with denitrification features to reduce final effluent nitrogen concentration by 50% compared to the influent concentration.

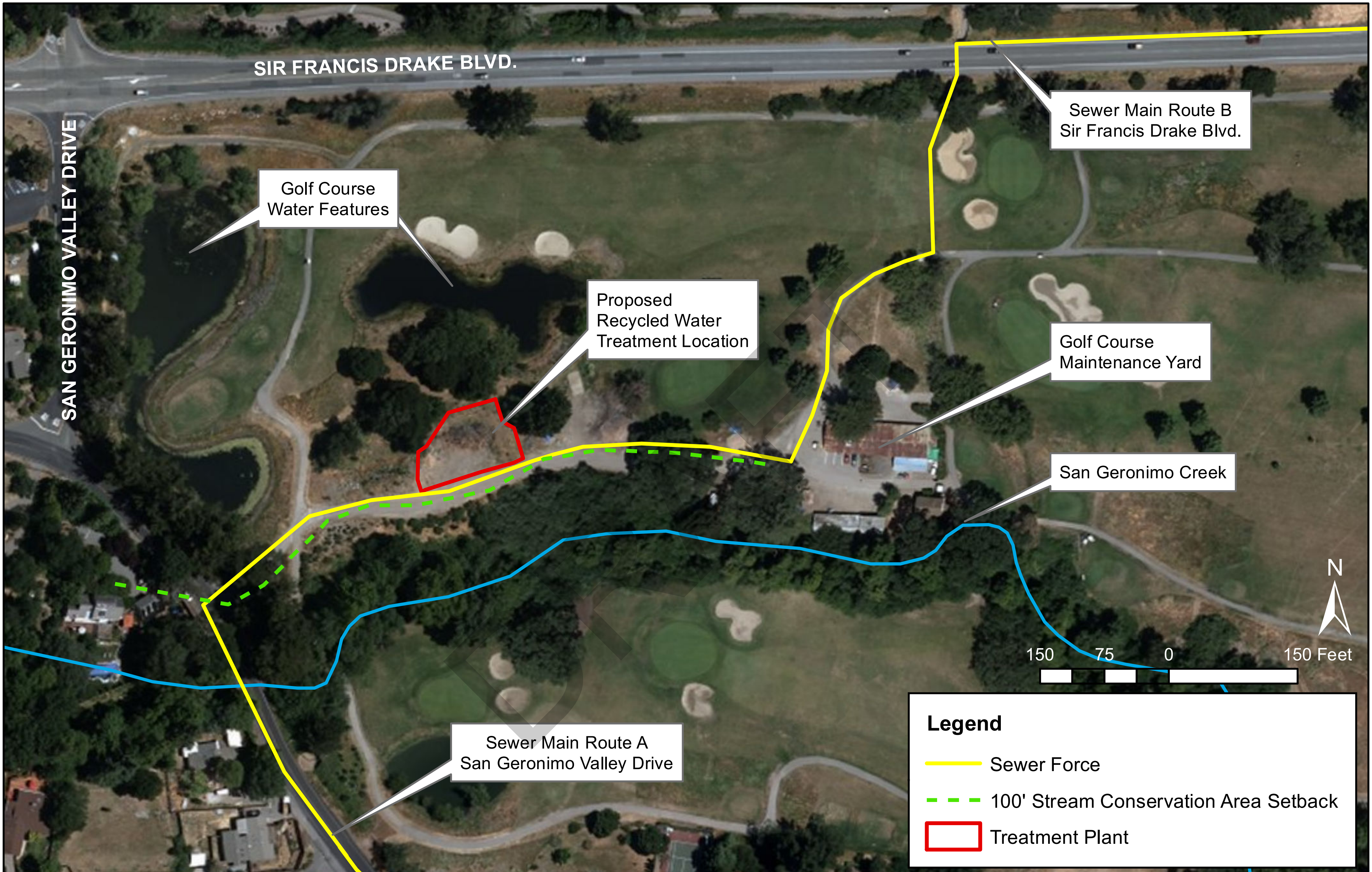
**Table 8-1: Proposed Effluent Limits**

| Constituent | Average | Maximum |
|---|---|---|
| Flow (gpd) | 44,000 gpd (monthly) | - |
| BOD (mg/L) | 30 (monthly) | 45 (7-day ave.) |
| Total Suspended Solids (mg/L) | 30 (monthly) | 45 (7-day ave.) |
| Turbidity (NTU) | 0.2[1] | 0.5[2] |
| Total Coliform (MPN/100 ml) | 2.2[3] | 23[4] |
| Total Nitrogen (mg/L) | 50% Removal | - |

[1] *Not to be exceeded more than 5% of time in 24-hr period;*
[2] *Not to be exceeded at any time*
[3] *Median for seven day period*
[4] *Not to be exceeded more than once in any 30-day period.*

**Treatment Plant Site. Figure 8-4** shows the location within the golf course maintenance area identified for placement of the wastewater treatment/recycling plant. It would be on the west side of the golf course maintenance yard, in an area previously graded and presently used for storage and processing of brush, cuttings and other green waste from the golf course. The proposed treatment plant site is outside of the Stream Conservation Area for San Geronimo Creek and naturally screened by several existing large trees and other vegetation, none of which would require removal. The proposed treatment plant site has good vehicular access from San Geronimo Valley Drive, and is in an area that avoids impacts to or from golf course play.

The treatment plant would occupy an area of approximately 10,000 square feet, including above-ground and below-ground treatment and storage tanks, blowers, pumps, piping, covered

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**RECYCLED WATER TREATMENT LOCATION**

**FIGURE 8-4**

sludge dewatering and bagging area, biofilter venting and appurtenances. There would be a control building (approximately 600 $ft^2$) to house electrical/mechanical controls, UV disinfection equipment, a small office, laboratory area, and storage space for equipment and supplies. The treatment plant area would have parking and vehicle access and would be fenced.

**Treatment Processes. Figure 8-5** shows the preliminary design layout of the treatment facilities and processes, which are described below.

- **Flow Equalization and Emergency Storage Tanks.** Influent sewage from the wastewater collection system would enter the treatment plant in a below-ground flow equalization (EQ) tank where peak surges in sewage flows that occur throughout the day are evened-out. The EQ tank also provides some settling and collection of grit and other solids. Duplex pumps, operating on timed-dosing, would deliver a steady approximately equal flow to the MBR treatment unit for optimum performance. The EQ tank would be sized equal to approximately half the daily peak flow (e.g., 30,000 gallons). The EQ tank would be aerated at a rate sufficient to keep the sewage from becoming anaerobic (septic), with the air vented to the biofilter odor control facilities.

  Per Title 22 requirements, an emergency storage tank sufficient to store at least one day of incoming sewage flow (peak of 60,000 gals.) from the service area would be provided. It would be situated and designed to take water as direct inflow from the collection system, pumped discharge from the EQ tank, or high water gravity overflow from the EQ tank.

- **Membrane Bioreactor (MBR).** From the EQ tank the raw sewage would be pumped into the MBR treatment unit, consisting of an above-ground tank which includes an anoxic zone and aerated zone, pumps, electrically-actuated valves, blowers, level controls, a programmable logic controller (PLC) and ultra-filtration membrane filter. The sewage is mixed with recirculated mixed liquor in the anoxic cell and then flows to the aeration cell. In the aeration cell, the wastewater is aerated through a grid of fine bubble diffusers connected to positive displacement blowers. The ultra-filtration membranes are immersed directly in the aerated mixed liquor and are connected to the suction side of a centrifugal pump (or pumps). The clean permeate is drawn through the membranes and discharged to the disinfection system. The dimensions of a 50,000 gpd MBR unit would be approximately 40-ft long, by 8-ft wide by 12-ft high. The MBR would be vented partially to the biofilter odor control facilities and partially to the atmosphere.

  The MBR process is well suited for the project because of the small area requirement, relatively low demands for operator control of the system (based on ease of automation), commercial availability, and acceptance of the technology by the State Water Board's Division of Drinking Water (DDW) for water recycling applications. Background information and technical details on the MBR treatment process are covered in an EPA Fact Sheet and example manufacturer information, provided in **Appendix E**.

  **UV Disinfection.** Treated water from the MBR would be passed through a UV light disinfection system housed in the control building. The system would include dual units, capable of treating the entire flow with one unit out of operation. The selected equipment would be from among several types of UV systems listed and accepted by the DDW as an approved technology under Title 22. An example of approved UV system suitable for the project are provided in **Appendix E**. Field testing of the UV system would be required at the time of installation to validate conformance with Title 22 disinfection/virus


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**TERTIARY TREATMENT FACILITY PLAN**

**FIGURE 8-5**

inactivation requirements. The proposed equipment would include sensors to continuously monitor the effluent flow rate and UV transmittance in order to control the UV dose by varying the power output (i.e., UV intensity). The UV equipment also employs a programmable automatic sleeve-wiping mechanism to regularly maintain the unit against bulb fouling.

- **Recycled Water Lift Station.** Following UV disinfection, treated water would collect in the recycled water lift station for distribution to the storage ponds located on the golf course. The preliminary design proposes a 5,000-gallon pump tank with duplex submersible pumps, and separate 4-inch distribution pipelines running respectively to Pond #1 (front nine) and Pond #2 (back nine).

- **Sludge Handling.** Sludge would be withdrawn periodically from the MBR anoxic tank and collected in an adjacent, covered sludge bagging and dewatering area. Decant from the sludge dewatering facilities would be collected and drained back to the EQ tank. The bagged sludge would be hauled for disposal at an approved sanitary landfill. Dry sludge production is estimated to be approximately 50 pounds per day. Sludge bags, when filled, would be retained onsite in a covered area for several weeks of drying. Hauling of dry sludge (50-lb bags) would occur every few months. Manufacturer information and photos of typical sludge bagging system suited to this project is provided in **Appendix E**.

- **Biofilter Odor Control.** Odor control facilities would be provided for air vented from the EQ tank, portions of the MBR unit, sludge bagging/dewatering area and emergency storage tank. Odors would be controlled through capture and filtering through an organic media bed (biofilter) designed to remove volatile organic compounds, primarily hydrogen sulfide and methane. Activated carbon filters may be used at selected equipment locations, where practicable. The odor collection system would include various piping, ductwork and fans to create a vacuum condition at each process facility and move the foul air to and through the filter ("scrubber") media, which would be located on the knoll on the north side of the treatment plant. The biofilter bed would be approximately 30 inches deep with a minimum surface area of about 300 $ft^2$. The bottom 12 inches would contain plastic pipes or chambers for air distribution, gravel bedding and packing around the chambers, covered with an 18-inch depth of organic-compost filter media. A sprinkler system would be provided to maintain adequate moisture conditions and a bottom drain provided to direct any excess water back to the treatment system (EQ tank). Preliminary sizing is based on a design rate of 3 $ft^2$/cfm for an expected air flow of 100 cfm (U.S. EPA, 2003; Cornell University, 1996).

- **Control Systems.** Key elements of the control system are would include the following:

  - **Flow Meters**. Primary flow meters would be installed: (1) following the EQ tank to measure inflow to the MBR unit; (2) downstream (discharge) side of the treatment system to monitor recycled water flows to the storage ponds. Other flow meters would be installed within the system for internal monitoring and process control.

  - **Turbidity Meters/Controls.** A continuous turbidity meter would be installed downstream of the MBR unit. If the filter influent turbidity exceeds 0.2 NTU, an electronically actuated three-way valve prior to the disinfection process would divert the flow back through the EQ tank and MBR system for additional treatment.

Otherwise, treated water would continue through the disinfection facilities and into the recycled water dosing tank for distribution to the storage ponds on the golf course.

- **Telemetry.** The treatment plant (and main lift station in Woodacre) would be equipped with a telemetry control system allowing remote monitoring and control of various mechanical and electrical equipment and tank water levels. The control system would be monitored and maintained by treatment system personnel. Although the system would require daily attendance by an operator, the telemetry system would provide for continuous (24-hour) monitoring and emergency response from a remote location. The control system would provide for logging of data on system operations (e.g., flow, turbidity readings, pump operations), and would have auto-dialer/internet notification features to page the operator(s) in the event of alarm conditions.

- **Control Building.** There would be a one-story control and operations building, approximately 600 square feet in size, to house the control and communications equipment, a small office, restroom, laboratory area, safety equipment and storage of various tools and supplies.

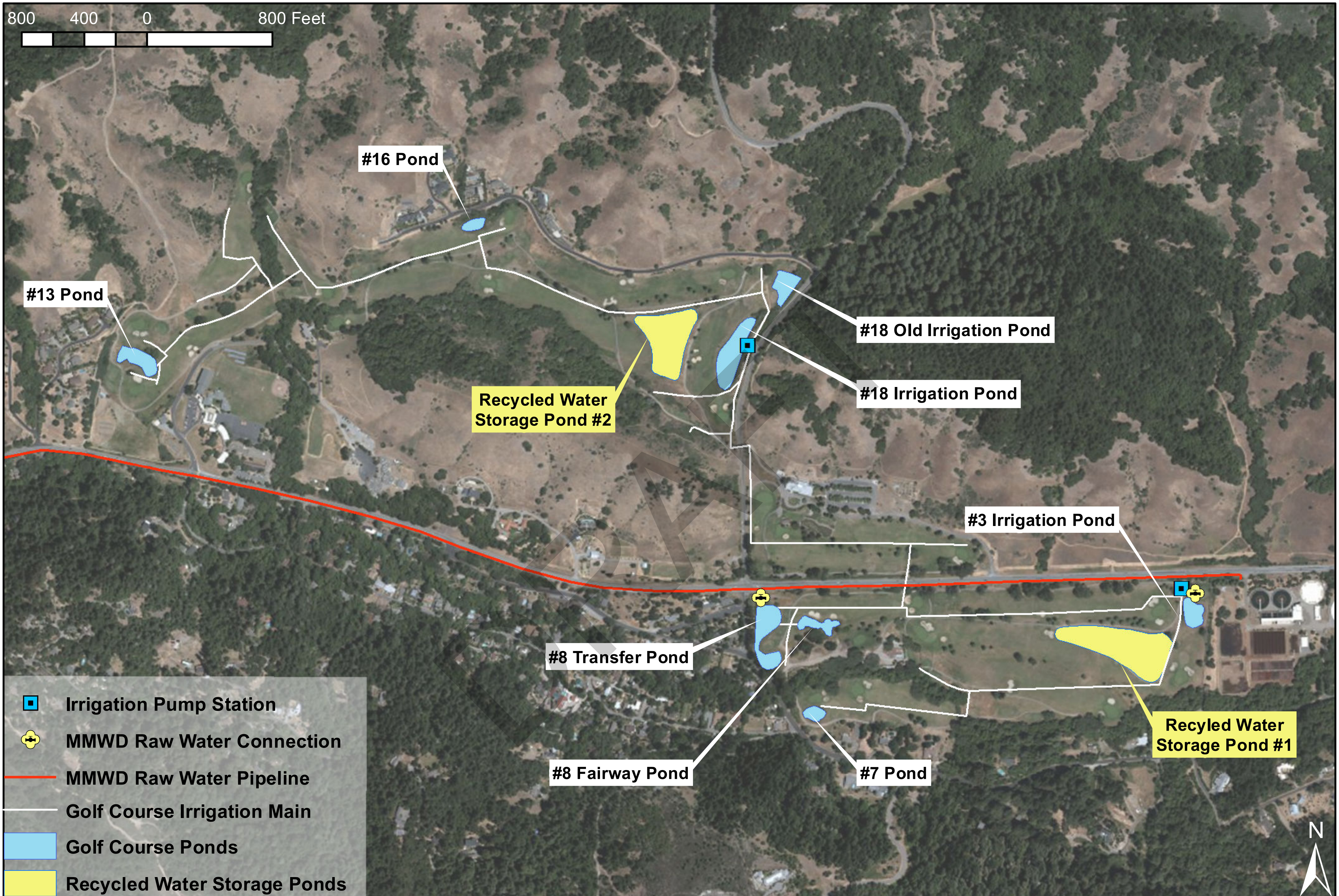
- **Emergency Power.** A standby emergency generator would be provided to ensure continuous uninterrupted operation of the treatment system.

### *Recycled Water Storage and Irrigation Use*

**Storage Ponds.** Two recycled water storage ponds would be constructed for storage and management of recycled water which would be integrated as an alternate supply of irrigation water for the San Geronimo Golf Course. All recycled water would be pumped into the two storage ponds year-round, stored throughout the rainy season (typically November through March), and fed into the existing irrigation system during periods of golf course irrigation, typically April through October. The water levels in the ponds would be drained down each year in the fall to ensure maximum available storage capacity prior to the start of the ensuing rainy season.

The ponds would be located in areas within the golf course that have been identified and offered for this purpose by the golf course owners. Pond #1 would be located on the front nine in an approximately 2.5-acre triangular buffer area between the holes #2, #3 and #4. Pond #2 would be located on the back nine of the golf course in an out-of-play area bounded by the #10, #17 and #18 fairways. The ponds would not be connected to any of the other existing ponds and water features on the golf course. **Figure 8-6** shows the proposed location of the storage ponds in relation to the other water features and main components of the golf course irrigation system.

**Figures 8-7** and **8-8** show preliminary layout and grading plans for the two ponds, making maximum use of the available area. As indicated, Pond #2 would be divided into two sections, Upper and Lower, to conform with existing topography. The ponds would be constructed through a combination of excavation below existing grade (e.g., 6 to 12-feet deep) and engineered fill embankments above grade; all cut and fill slopes would be minimum 2-to-1 (horizontal-to-vertical). The ponds would be lined with a geosynthetic clay liner such as “BENTOMAT”. Drainage measures would be installed to collect and re-route surface and subsurface waters around the ponds. Existing drainage at Pond #1 is primarily overland flow. Drainage work at Pond#2 would require removal of an existing 18-inch storm drain culvert and

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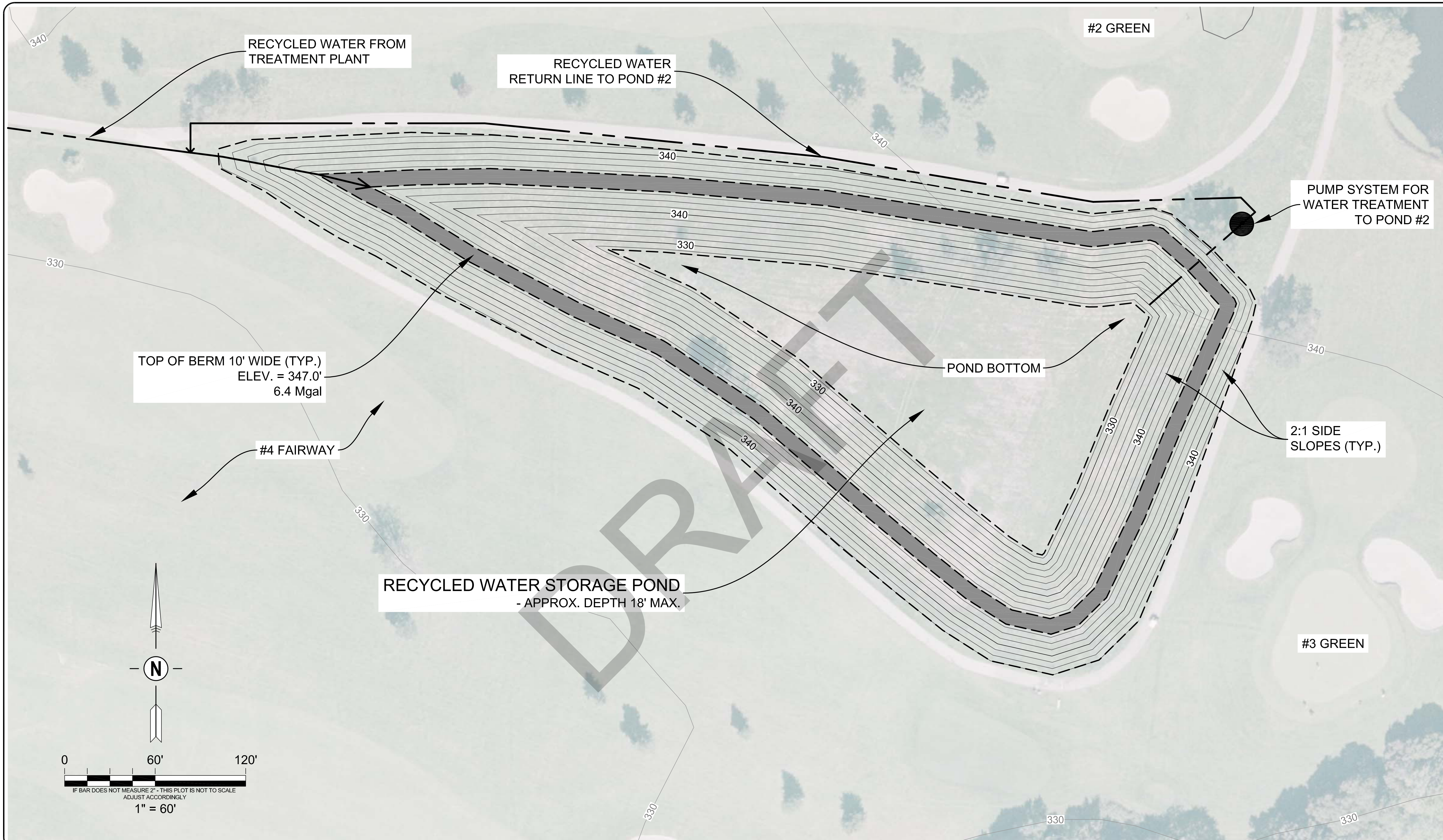
# GOLF COURSE IRRIGATION FACILITIES

FIGURE 8-6




**WOODACRE -SAN GERONIMO WASTEWATER RECYCLING STUDY**

QUESTA ENGINEERING CORP. — Civil, Environmental & Water Resources
(510) 236-6114 FAX (510) 236-2423 questa@questaec.com
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

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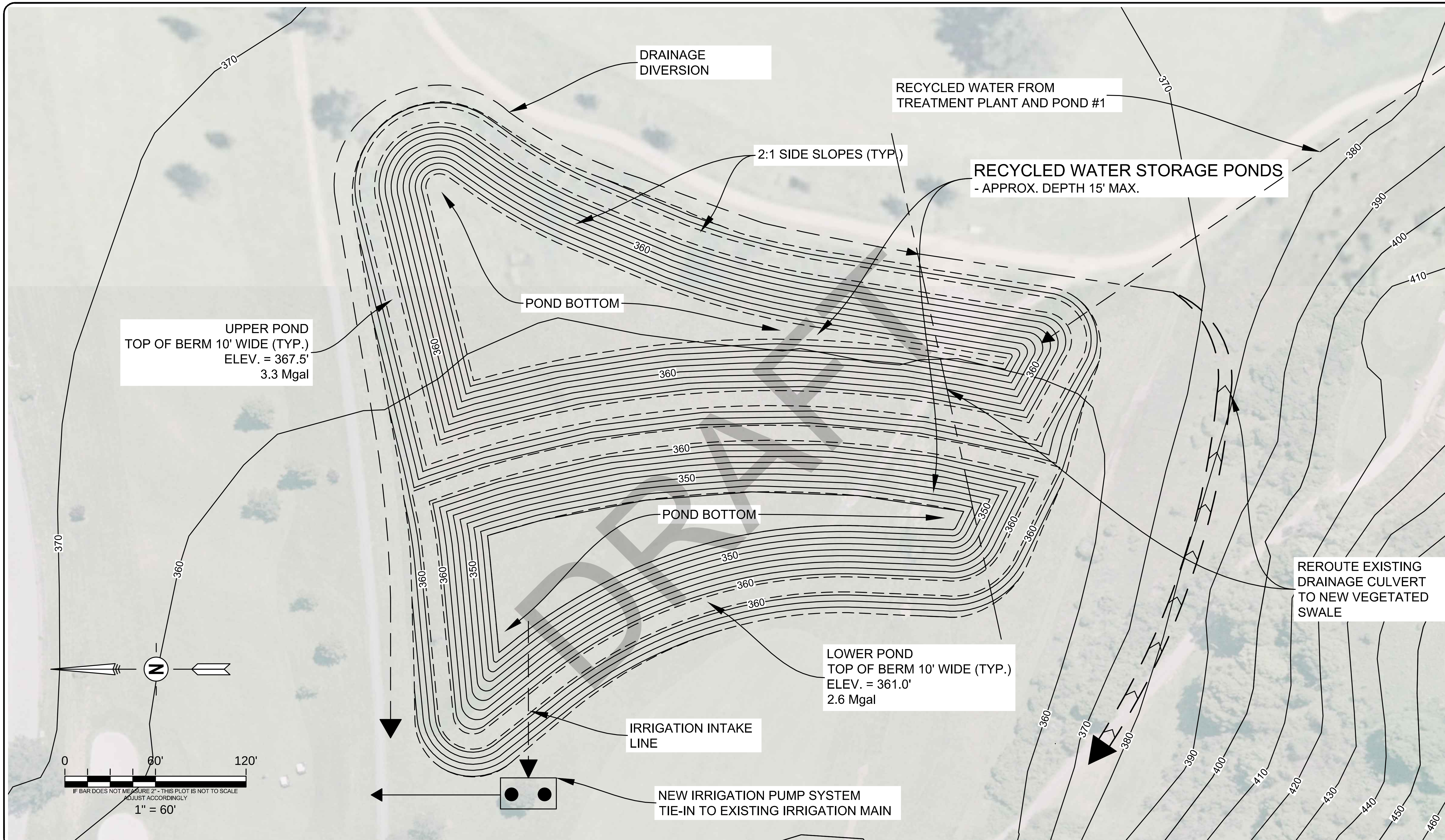
**RECYCLED WATER STORAGE STORAGE POND #1**

FIGURE 8-7

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| WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY | QUESTA ENGINEERING CORP. Civil Environmental & Water Resources (510) 236-6114 FAX (510) 236-2423 questa@questaec.com P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807 | Design: NH/MW Drawn: AM/DI Checked: NH Appr'd: NH | RECYCLED WATER STORAGE STORAGE POND #2 | FIGURE 8-8 |
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smaller sub-drains, with most of the flow re-routed to a new vegetated drainage swale on the south side of the new pond. Portions of irrigation pipelines that cross through the pond areas may require relocation. Fencing and landscaping around the ponds would be provided, coordinated with the golf course. Preliminary earthwork calculations indicate pond construction would result in a net excavation of approximately 4,800 cubic yards of soil. The earthwork, dimensions and water storage capacities of the two ponds are summarized in **Table 8-2.**

The 100-yr wastewater holding capacities for each pond were determined (iteratively) from water balance calculations (monthly time steps), using the assumed pond configurations and accounting for: (a) 100-yr monthly rainfall amounts; (b) average wastewater flow; (c) average evapotranspiration losses; and (d) provision of 2-ft freeboard at maximum water depth. Water balance calculations were also completed for average year and 10-yr rainfall conditions. Supporting calculations are provided in **Appendix F.** The 100-yr wastewater holding capacity from these analyses establishes the maximum design capacity of the water recycling system (44,000 gpd, average flow).

### Table 8-2: Recycled Water Storage Ponds #1 and #2

| Item | | Pond #1 | Pond #2 Upper | Pond #2 Lower | Total |
|---|---|---|---|---|---|
| **Overall Land Area (ft$^2$)** | | 123,350 | 71,030 | 63,250 | 257,630 |
| **Interior Surface Area (ft$^2$)** | | 74,650 | 49,480 | 41,100 | 165,230 |
| **Excavation (cy)** | **Cut** | 14,580 | 18,870 | | 33,450 |
| | **Fill** | 18,180 | 10,490 | | 28,670 |
| **Max. Water Depth (ft)** | | 18.0 | 15.0 | 15.0 | - |
| **Water Storage Capacity** | **Million Gals.** | 6.45 | 3.30 | 2.60 | 12.35 |
| | **Acre-Feet** | 19.8 | 10.1 | 8.0 | 37.9 |
| **100-yr Wastewater Holding Capacity, gpd** | | 26,000 | 10,200 | 7,800 | 44,000 |



**Distribution Pipelines and Pumping Facilities.** Recycled water would be pumped from the treatment plant to Ponds #1 and #2 via two separate 4-inch diameter transmission lines. The line to Pond #1 would be approximately 1,800-feet long, installed generally following the alignment of existing golf course maintenance roads and cart paths. The line to Pond #2 would be approximately 3,400-feet long and would cross the #8 fairway, Sir Francis Drake Blvd, and Nicasio Valley Road. The final alignment of these transmission lines would be coordinated with the golf course. The pipelines would be installed using horizontal directional drilling methods where feasible. Road crossings would require encroachment permits from Marin County Department of Public Works.

Under normal operations, recycled water would be pumped equally to the two ponds during the rainy (non-irrigation) season. During the irrigation season recycled water from the treatment plant would be directed primarily to Pond #2. A new irrigation pump system (50 hp) would be installed and connected to the existing golf course irrigation system at a point near the 17$^{th}$ fairway, and would be used solely for introduction of recycled water into the irrigation system from Pond #2. The pump system would be compatible and coordinated with the irrigation control system and main irrigation pump station near the 18$^{th}$ fairway. A smaller pump station would also be installed at Pond #1 for transfer of all recycled water from Pond #1 to Pond #2, for integration into the irrigation system during the summer and fall.

**Golf Course Irrigation.** Annual irrigation water demand for the San Geronimo Golf Course varies between approximately 47 and 53 million gallons, depending on seasonal weather conditions. Peak daily use may be as high as 200,000 to 300,000 gallons at certain times of the year. The irrigation supply comes principally from the MMWD raw water transmission line located in Sir Francis Drake Blvd, with metered connections as indicated in **Figure 8-6**. MMWD water, along with small amounts of groundwater and rainfall, is collected and stored in several golf course ponds located at holes #3 and #8 on the front nine, and hole #18 on the back nine. The main irrigation pump station (with duplex 50 hp pumps) is located adjacent to the 18$^{th}$ hole, and is capable of pressurizing nearly the entire irrigation system. A second, smaller pump station is located adjacent to the #3 tee, and supplements the main pumps during peak irrigation periods.

As noted above, the recycled water would be stored in separate ponds (#1 and #2) and would be introduced directly into the irrigation system through a new, independent pump station and piping connection. The recycled water would not enter or mix with water in any of the existing irrigation reservoirs or other golf course water features. The only potential for comingling of recycled water and other irrigation water would be within the irrigation piping and sprinkler system.

Under the recommended project, the irrigated turf areas of the golf course would become a recycled water use area and, as such, would require various measures to comply with applicable Title 22 standards, including the following:

- The system must be operated to ensure no runoff of irrigation water from the recycled water use areas;
- No spray, mist or runoff may enter dwellings, designated outdoor eating areas, or food handling facilities;
- Drinking water fountains must be protected against contact with recycled water spray, mist or runoff;
- No irrigation with disinfected tertiary water can occur within 25 feet of a perennial (flowing) stream.
- Standard warning signs must be posted on the golf course alerting the public of the use of recycled water for irrigation;
- Minimum pipe separation distances (horizontal and vertical) must be maintained between recycled water lines and potable water lines, and measures taken to ensure no cross-connections between the two water systems;
- Above-ground facilities such as irrigation valves and control boxes must be labeled or tagged as part of a recycled water system; wherever possible, new piping and fittings should be purple pipe or marked with purple tape.

- Quick couplers and sprinkler heads must be of a type, or secured in a manner that permits operation by authorized personnel only.

Implementation of the above measures would be the responsibility of the golf course as the designated water recycling user. Costs for implementing these measures would be borne by the golf course and not included as part of the project costs.

## Recycled Water Production

For the recommended pond configurations and sizing and the proposed design wastewater flow (44,000 gpd), water balance calculations for average year, 10-year and 100-year rainfall amounts were completed to estimate the amount of recycled water that would be produced for use by the golf course. The results are summarized in **Table 8-3**; supporting calculations are provided in **Appendix F**. As indicated, the recycled water produced by the project is estimated to provide, on average, about one-third of the annual water needed for golf course irrigation, and a greater percentage in wet years. During dry years, the recycled water volume could decline below 30%, partly due to lower rainfall addition to the storage ponds, and partly due to higher irrigation demand during dry years.

**Table 8-3: Estimated Recycled Water Produced for Golf Course Irrigation**

| Rainfall Scenario | Annual Rainfall (inches) | Annual Recycled Water Produced for Irrigation | | Percent of Golf Course Irrigation Demand[2] (%) |
|---|---|---|---|---|
| | | Million Gals | Acre-Feet[1] | |
| Average | 41.6 | 16.3 | 50.0 | 33 |
| 10-yr | 61.3 | 18.2 | 55.9 | 39 |
| 100-yr | 75.3 | 19.7 | 60.6 | 42 |

*[1]One acre-foot=325,851 gallons*
*[2] Based on average irrigation demand of 50 million gals/yr for ave rainfall year, and 47 million gals/yr for 10-yr and 100-yr rainfall.*

## Estimated Costs

### *Capital Costs*

The estimated capital costs for the recommended water recycling facilities are presented in **Table 8-4**. The bottom line in the table converts the total project costs to the average cost per connection, based on service to 360 parcels in the combined Woodacre and San Geronimo communities. Detailed itemization of cost is provided in **Appendix G,** including quantities and unit cost assumptions. These assumptions were developed through discussions with manufacturers, equipment suppliers, and local contractors, and through review of recent contractor bids for similar work in Marin County, where applicable.

### *Annual Operation and Maintenance Costs*

The estimated annual operation and maintenance (O&M) costs for the recommended water recycling facilities are provided in **Table 8-5**, with supporting itemized calculations and assumptions are included in **Appendix G.** The O&M costs cover estimated labor, equipment, materials and other expenses required to perform the necessary inspections, water quality sampling, data analysis, report preparation, sludge disposal, and routine maintenance for the collection system and MBR treatment/recycling plant. Also included are estimates of annual energy costs (electrical) for operation of the main lift station (in Woodacre) and the treatment system. Additionally, O&M costs include an allowance for equipment repair/replacement, which would be required over the life of the system. An allowance of 10% is included as a contingency. Not included are any costs associated with the use and management of the recycled water for golf course irrigation, which would be borne by the golf course. The cost estimates were developed based on the expected operation and monitoring needs defined above, and using data and experience from monitoring and maintenance of other similar systems in Marin County and other Northern California communities. The average annual cost per property is based on an estimated 365 ESDs (equivalent single family dwellings), which includes 360 properties in the Woodacre and San Geronimo service areas, plus an allowance of 5 ESDs for the golf course clubhouse, which would be connected to the water recycling facilities.

**Table 8-4: Capital Cost Summary**

| Cost Item | Estimated Cost ($) |
|---|---:|
| Collection System – Woodacre | 4,224,175 |
| Collection System – San Geronimo | 1,811,800 |
| Tertiary Treatment Plant | 1,470,000 |
| Recycled Water Storage & Transmission | 1,925,000 |
| Land/Easement Costs* | - |
| Mobilization/Demobilization | 100,000 |
| Permit Fees & Encroachment Fees | 50,000 |
| **Subtotal** | **$9,580,975** |
| Contingency @ 15% | $1,437,146 |
| **Subtotal** | **$11,018,121** |
| Engr & Environ Studies @ 15% | $1,652,718 |
| Construction Management @ 10% | $1,101,812 |
| Admin, Dist Formation, Financing @ 5% | $550,906 |
| **Total Estimated Cost** | **$14,323,558** |
| **Estimated Cost Per Connection (360 parcels)** | **$39,788** |

* It is assumed that the land/easement costs for locating the wastewater treatment plant, storage ponds and pipelines on golf course property would be waived by the golf course owners in exchange for use and management of the recycled water produced by the project; preliminary economic analysis indicates this is a reasonable agreement and assumption.

**Table 8-5: Estimated Annual O&M Cost**

| Category | Items | Cost ($) |
|---|---|---:|
| **District/Program Administration** | Insurance, legal, financial, administration | $18,000 |
| | RWQCB Permits | $10,000 |
| **Labor – Collection &Treatment** | Systems Control Technician | $14,000 |
| | Grade III Operator (1/4 time) | $46,800 |
| | Grade I Operator (1/3 time) | $57,000 |
| | Field Technician (1/3 time) | $45,600 |
| | Engineering Consultation | $15,000 |
| | On-call Monitoring & Response Allowance | $12,000 |
| **Sludge Handling** | Bagging, Materials and Disposal Fees | $4,800 |
| **Sewer Lines** | Maintenance Cleaning | $4,500 |
| **Equipment** | Materials & Replacement | $36,000 |
| **Vehicle** | Lease and mileage | $4,800 |
| **Laboratory and Expenses** | Laboratory | $24,000 |
| | Cleaning Chemicals & Supplies | $3,600 |
| **Electrical** | Lift Station | $661 |
| | MBR Treatment Plant | $29,365 |
| | UV Disinfection | $3,212 |
| | Treated Water Distribution | $3,212 |
| | Misc electrical, phone, internet | $600 |
| | **Sub-total** | $333,150 |
| | 10% Contingency | $33,315 |
| | Estimated Total Annual Cost | $366,465 |
| | **Estimated Annual Cost per Connection (365 ESDs)*** | **$1,004** |

*Includes assumed 5 ESDs for Golf Course



## Reliability of Facilities

**Table 8-6** provides an itemized summary of the reliability features that would be incorporated in the recommended water recycling facilities in compliance with specific requirements of Title 22. These include emergency and long-term storage, treatment system redundancies and other provisions to ensure that the system complies with all protections to public health and water quality required for approved uses of tertiary disinfected recycled water.

**Table 8-6: Water Recycling Treatment Plant Design and Reliability Features**

| **FLEXIBILITY OF DESIGN** **(CCR Title 22, Article 8, § 60333)** |
|---|
| Treatment plant design would provide flexibility of operation through:<br>1. Influent equalization tank and standby storage to regulate the flow through the treatment plant;<br>2. Provisions for internal recycling of wastewater within the plant when discharge specifications are not met or for other temporary interruption of plant operations; and<br>3. Providing 100% capacity for long-term, 5+ months of seasonal storage of treated water when irrigation with recycled water is interrupted or not needed. |
| **ALARMS** **(CCR Title 22, Article 8, § 60335)** |
| Alarm devices installed in the treatment system would provide warning of:<br>1. Loss of power from the normal power supply;<br>2. Failure of biological treatment (blower failure);<br>3. Failure of filtration process (turbidity readings), and<br>4. Failure of disinfection process (UV light sensors).<br><br>The alarm devices would be independent of the normal power supply of the treatment plant. The plant operator, superintendent, and other parties responsible for the management of the plant would be alerted of any alarm condition. A telemetry system would be employed for remote notification to the treatment operator(s) who would be on-call 24 hours per day. |
| **POWER SUPPLY** **(CCR Title 22, Article 8, § 60337)** |
| The power supply would provide the following reliability features:<br>1. Alarm and standby power source;<br>2. Automatically actuated short-term retention provisions at the influent lift station/EQ tank, and overflow to the emergency storage tank(s) if necessary. |
| **EMERGENCY STORAGE OR DISPOSAL** **(CCR Title 22, Article 10, § 60341)** |
| **Short-term.** Short-term emergency facilities would provide sufficient storage capacity at the influent flow equalization tank and supplementary emergency storage tank(s) for minimum of 24-hour storage of influent at peak flow. Standby power source (emergency generator) would be provided to assure uninterrupted operation of these units.<br><br>**Long-term.** Long-term storage capacity for wastewater to be provided by two holding pond with minimum capacity for 5 months of wastewater flow plus 100-yr rainfall. |
| **PRIMARY TREATMENT** **(CCR Title 22, Article 10, § 60343)** |
| Influent EQ and short-term emergency storage would provide redundant capacity to augment primary treatment process within the MBR unit. |
| **BIOLOGICAL TREATMENT** **(CCR Title 22, Article 10, § 60345)** |
| The biological treatment unit (MBR) would have alarm system and duplicate equipment (blowers and air diffusers) capable of producing oxidized wastewater with one unit not in operation |

| SECONDARY SEDIMENTATION (CCR Title 22, Article 10, § 60347) |
|---|
| Secondary sedimentation not applicable for MBR treatment process. |
| **COAGULATION (CCR Title 22, Article 10, § 60349)** |
| Coagulation not required; the filtration system (MBR) is provided with effluent turbidimeters and automatic bypass to satisfy coagulation waiver requirements of the California Water Recycling Criteria. |
| **FILTRATION (CCR Title 22, Article 10, § 60351)** |
| Filtration processes for MBR provides:<br>1. Alarm;<br>2. Multiple (2) filter units capable of treating the entire flow with one unit not in operation;<br>3. Automatically actuated bypass, storage and treatment of "non-spec" water.<br><br>The MBR system is capable of achieving effluent turbidity limits established in Title 22 requirements for tertiary treatment using microfiltration. |
| **DISINFECTION (CCR Title 22, Article 10, § 60353)** |
| Reliability features provided by the disinfection system:<br>1. Alarm and standby UV light and/or chlorination systems;<br>2. Short-term retention for "non-spec" water; and<br>3. Long-term (5+ months) storage provisions for treated water. |



# PROJECT IMPLEMENTATION PLAN

## Agreement with Recycled Water User

A legal agreement would be required between the County of Marin and the San Geronimo Golf Course, which is anticipated to cover the following main points:

1. Long-term lease of golf course property for placement and operation of water recycling facilities;

2. Production and delivery of disinfected tertiary recycled water for exclusive use by the Golf Course for irrigation uses;

3. Commitment of the Golf Course to use and manage the recycled water and appurtenant storage and transmission facilities in accordance with applicable State, Regional Water Board and County requirements;

4. Provision of sewer service to replace existing septic systems at the Golf Course Clubhouse and Maintenance Yard, subject to the Golf Course paying an equitable annual user fee for sewer service.

The County has met with representatives of the Golf Course on several occasions beginning during the 2011 Woodacre Flats Wastewater Study, with the last meeting being in January 2017. The intent, scope and basic terms of an agreement have been discussed at these meetings, and there is general concurrence between the parties on moving forward.

The following is a preliminary outline and list of items expected to be addressed in the agreement:

- Facts and general background information (‘recitals”), including statement of purpose and intent, interest and role of each party to the agreement, permit authorization for the water recycling facilities/operations, suitability and needs of the golf course for use of recycled water, etc.

- Definitions of terms used in the agreement, including technical, regulatory and legal

- Terms of the Agreement
  - Term/duration of the agreement
  - Description of the wastewater facilities, including map(s) and description of land area required
  - Recycled water quality and quantities
  - Applicable regulatory codes, documents and requirements
  - County operational responsibilities
  - Golf course operational responsibilities
  - Sewer service connection for golf course clubhouse and maintenance building and associated fees
  - Access provisions
  - Various legal provisions



## Governance and Financing

### *Governance*

A public entity would be required to assume responsibility for ownership and ongoing operation of any community facilities that are constructed. A public entity is also required to oversee the construction of the wastewater facility improvements, including the acquisition and management of funding for construction as well as for ongoing operation and maintenance. The public entity formed for ongoing operation and maintenance must be in place prior to initiation of project construction.

The present wastewater feasibility study and environmental studies are being conducted by the County of Marin, which has general authority for wastewater management throughout the unincorporated area of the County. Acting in this general capacity, the County has the authority to continue through the design and construction phase of the project, if this is desired.

**Appendix H** provides an overview of the potential options available along with some of the key considerations that may influence the local decision on an appropriate institutional arrangement for the community. The main options identified include: (a) creation of a new dependent district under the governing authority of the County Board of Supervisors; (b) creation of an independent district with a locally-elected board of directors; and (c) coverage/annexation under an existing independent district such as Marin Municipal Water District or Ross Valley Sanitation

District. In general, all options presented are technically viable; the ultimate decision by the community would likely focus on issues of local autonomy, economics and possibly political or personal preferences. Preliminary analysis indicates the creation of a dependent district under the County of Marin, as followed for the Marshall Community Wastewater project, as the apparent best course of action.

### *Financing*

*Construction Financing*

**Grant Funding.** Grant funds have been secured to pay for most of the engineering and environmental studies to date. Grant funds may also potentially be available to help finance a portion of project implementation. Such funds could potentially be used to pay for administration, planning and design-related services, and construction costs. However, it is likely that any grant funds would only be able to cover a portion of the total costs. For example, in the Marshall Phase Community Wastewater Project, grant funds covered roughly half of the overall project costs

**Assessment District.** The primary source of funding for implementation of the recommended water recycling project would be provided through the formation of a local assessment district. This is one of the most common methods used to finance sewer systems and other public works projects. The assessments would be secured against the properties in the project service area that receive benefits from the facilities. The funds raised through this process would then be used to support low-interest loans and/or the sale of bonds to pay for the balance of the construction costs not covered by grants.



*Ongoing Operation and Maintenance Fees*

Once constructed, the project facilities would require ongoing operation and maintenance, the costs for which would be paid through the collection of fees or user charges from all properties served by the project. These fees are normally collected as part of the annual property tax bill. Estimated annual operation and maintenance costs are summarized in **Table 8-5**, indicating an annual cost of approximately $1,000 per parcel. Further details on the estimated costs are included in **Appendix G.** As discussed below, annual O&M fees would be established by ordinance for all property owners receiving wastewater services, and would normally be updated and approved annually by the Board of Supervisors (or District Board of Directors).

## Ordinances

It is anticipated that project implementation would require adoption of two ordinances pertaining to the provision of wastewater service as noted below. Since the proposed project does not entertain the possibility of making recycled water available to multiple parties, an ordinance addressing the use of recycled water would not be necessary. Requirements related to the use of recycled water by the San Geronimo Golf Course (sole recycled water “User”) would be covered in an agreement between the County and the Golf Course.

### *Wastewater Regulations Ordinance*

The Wastewater Regulations Ordinance would be the basic document regulating the use of the community wastewater system, including such things as installation and connection of building sewers, installation of sewer laterals, permits and procedures for installation and connections to the system, discharge of waters and wastes into the system, construction standards, prohibitions, enforcement and other administrative issues.

### *Fee Ordinance*

The fee ordinance would cover the fees charged to property owners receiving wastewater services, and is normally updated and approved annually by the Board of Supervisors (or District Board of Directors). It would, for example, address the method of determining the fees related to the administration of the wastewater facilities, including operating, maintaining, managing, upgrading, and replacing components of the sewer system, treatment plant and water recycled operations. It would also address the of method fee collection, which is normally via the property tax bill.

## Tentative Water Recycling Requirements of Regional Water Board

### *General WDR for Small Domestic Wastewater Systems - Order WQ 2014-0153-DWQ*

The recommended water recycling project would qualify for coverage and would most appropriately be regulated under the State Water Board's *General Waste Discharge Requirements for Small Domestic Wastewater Systems - Order WQ 2014-0153-DWQ.* This is a general permit applicable to small, community-type wastewater systems such as the Woodacre-San Geronimo project. Facilities with average monthly wastewater flows of 100,000 gpd or less are eligible for coverage under this General Order. The San Francisco Bay Regional Water Quality Control Board has applied Order WQ 2014-0153-DWQ to other community wastewater projects in the region, including the Marshall Community Wastewater System in Marin County.

The provisions under Order WQ 2014-0153-DWQ cover the entire wastewater system, which is defined in the Order as including "… the collection system, treatment equipment, pumping stations, treatment ponds, clarifiers, and/media filters, disinfection systems, recycled water systems (including distribution systems), storage ponds, land application areas, and other systems associated with the collection, treatment, storage, and disposal of wastewater". The Order contains requirements for various types of wastewater treatment and disposal systems, including water recycling facilities. In addition to general provisions for water quality protection, it includes performance standards, effluent limitations, and horizontal siting criteria applicable to different treatment, storage and disposal methods. The Order provides a "Model Monitoring and Reporting Program" (Attachment C), which sets forth the standard scope and details normally applied, with provisions for project-specific requirements assigned by the Regional Water Board as deemed necessary.

Some of the key requirements applicable to the Woodacre–San Geronimo project would include the following:

- **Title 22 Water Recycling Criteria and Engineering Report.** The project will be expected to adhere to all applicable requirements for production, storage and use of disinfected tertiary recycled water per Title 22 Water Recycling Criteria. Compliance details will be demonstrated in an Engineering Report for the water recycling facilities, subject to review and approval by the State Water Board Division of Drinking Water

(DDW), per Article 7, Section 60323 of Title 22. The required Engineering Report will describe the details of the facilities and operations plan for the treatment, storage, distribution and use of recycled water, in order to document compliance with all relevant requirements of Title 22. The Engineering Report will be prepared in accordance with DDW guidelines.

- **Water Recycling System Setbacks.** **Table 8-7** lists the horizontal setback requirements applicable to the siting of various wastewater system components. The setbacks reflect a combination of requirements cited in the General Order, Title 22, State Water Well Standards, and California Plumbing Code plus locally adopted criteria in Marin County. Adjustment of setback distances may be made by the Regional Water Board and/or the DDW on a project-specific basis, also considering outcomes and recommendations from the EIR process.

**Table 8-7: Summary of Horizontal Setback Requirements (feet)**

| System Component | Domestic Well | Flowing Steam[1] | Ephemeral Stream[2] | Property Line | Lake or Reservoir[3] |
|---|---|---|---|---|---|
| Treatment Plant | 100 | 100 | 50 | 5 | 200 |
| Storage Ponds | 100 | 100 | 100 | 50 | 200 |
| Irrigation Use Areas | 50 | 25 | 50 | 25 | 200 |

[1] *Year-round and seasonal (intermittent) streams*
[2] *Surface water drainage features that carry runoff during and shortly following rain events.*
[3] *Natural lakes and water supply reservoirs*

- **Effluent Limitations.** Anticipated effluent limitations for the water recycling facility are listed in **Table 8-8,** based on Title 22 standards and requirements contained in the General Order for MBR treatment units. An effluent limit for total nitrogen must be considered for any wastewater system with a design flow over 20,000 gpd. The removal requirement of 50% (treated water compared to influent concentration) is the standard applicable to systems deemed to have a “low threat” of water quality impact, considering the location, site conditions, and method of dispersal or reuse. Land application for golf course irrigation fits the category of “low threat” due to the uptake and attenuation of nitrate vegetation .

**Table 8-8: Proposed Effluent Limits**

| Constituent | Average | Maximum |
|---|---|---|
| BOD (mg/L) | 30 (monthly) | 45 (7-day ave.) |
| Total Suspended Solids (mg/L) | 30 (monthly) | 45 (7-day ave.) |
| Turbidity (NTU) | 0.2[1] | 0.5[2] |
| Total Coliform (MPN/100 ml) | 2.2[3] | 23[4] |
| Total Nitrogen (mg/L) | 50% Removal[5] | - |

[1] *Not to be exceeded more than 5% of time in 24-hr period*
[2] *Not to be exceeded at any time*
[3] *Median for seven day period*
[4] *Not to be exceeded more than once in any 30-day period*
[5] *May be calculated on an annual basis*

- **Storage Ponds.** Requirements applicable to the storage ponds include:
  - Pond sizing shall be sufficient to accommodate the design wastewater flow plus precipitation based on water balance calculations incorporating 100-year return annual total precipitation value distributed monthly in accordance with average (mean) precipitation values; a maintain two feet of freeboard must also be provided.
  - Ponds shall be managed to mitigate breeding of mosquitoes, including control of weeds, debris, algae, shoreline irregularities, and other methods coordinated with the local mosquito abatement and vector control district.
  - Objectionable odors shall not create nuisance conditions affecting the public.
  - Control of burrowing animals, as applicable.
- **Irrigation with Recycled Water.** Requirements applicable to the golf course irrigation operations include:
  - No irrigation is permitted within 24 hours of forecasted precipitation with a greater than 50-percent probability of occurring, during precipitation events, or when the irrigation area soils are saturated.
  - No irrigation is permitted when the wind speed exceeds 30 miles per hour.
  - Surface runoff of recycled water from the irrigation area is prohibited.
  - Mosquito breeding shall be mitigated by ensuring no standing water more than 48 hours after application of irrigation water.
  - Compliance with all requirements for limiting public exposure to recycled water as contained in Title 22 Water Recycling Criteria and the required Engineering Report.
- **Required Technical Reports.** Within 90 days following the Regional Board's issuance of coverage under the General Order, submission of the following reports will be required:
  - *Spill Prevention and Emergency Response Plan* that describes operation and maintenance activities to prevent accidental releases of wastewater and to effectively respond to such releases to minimize environmental impacts.
  - *Sampling and Analysis Plan (SAP)* describing the procedures that will be followed to comply with the required sampling and testing requirements of the Order.
  - *Sludge Management Plan* which contains estimates of sludge volumes generated by the treatment plant and describes the equipment, processes and procedures that will be followed for collection, dewatering, drying and disposal of the sludge.

### *Statewide General WDRs for Sanitary Sewers (SWRCB Order 2006-0003-DWQ)*

In addition to the General Order WQ 2014-0153-DWQ, the project will also be required to comply with the Statewide General WDRs for Sanitary Sewers. This is a general permit pertaining to the management of sanitary sewer systems of more than one mile in length that are owned or operated by a municipality, sanitary district or other public authority. Enrollment under the General Permit must occur at least three months prior to start of operations. The Order will require the County (District) to develop and implement a written Sewer System Management Plan (SSMP), including provisions to provide proper and efficient management, operation, and maintenance of sanitary sewer systems, while taking into consideration risk management, costs and benefits. Additionally, an SSMP must contain a spill response plan that establishes standard procedures for immediate response to a sanitary sewer overflow in a manner designed to minimize water quality impacts and potential nuisance conditions. The Order also contains spill notification, monitoring and reporting requirements.

## Permits, Right-of-Way, Design, Construction & Community Outreach

### *Permits*

In addition to the Waste Discharge Requirements issued by the Regional Water Board, he following is a list of the permits anticipated to be required for project implementation:

- General Construction Stormwater Permit for land disturbance of one acre or more
- General WDRs for Sanitary Sewers (SWRCB Order No. 2006-0003-DWQ)
- Streambed Alteration Agreement for pipeline creek crossings - California Department of Fish and Wildlife
- Air quality permit - Bay Area Air Quality Management District
- Encroachment permits for sewers, force mains, and lift stations within road rights-of-way; Marin County Department of Public Works (DPW)
- Grading, drainage, building and electrical permits; Marin County DPW and Building Department

### *Utilities*

Utility requirements for the project are expected to include:

- PG&E – treatment plant and pump stations
- MMWD – potable water supply to treatment building
- AT&T – telephone and internet service

### *Facilities Design*

Design of the wastewater collection, treatment and recycling facilities is expected to include the following elements:

- Surveying
- Geotechnical investigation
- Collection system design
- Treatment plant design
- Civil engineering -including grading, drainage, utilities, storage ponds, pumps, piping etc.

- Electrical engineering
- Design reports, plans, specifications, engineers estimate

### *Construction Management*

Construction management would include:

- Bidding assistance
- Services during construction:
  - RFIs, change orders, submittals, payment requests, etc
  - Construction inspection and testing
  - Daily logs and photo documentation
  - Utilities and coordination
  - As-built Drawings
- O&M Manual(s)
- Start-up Assistance

### *Community Outreach*

Community outreach would be an on-going activity during project implementation including: (a) public meetings with the affected property owners in the service area and other interested parties; (b) executing access agreements with various property owners for design work and construction access in some cases; (c) obtaining easements, if necessary; and (d) ongoing announcements, FAQs and other communications with members of the community and neighborhood steering committee(s).

## Schedule – To Be Determined



# OPERATIONAL PLAN

The following summarizes the operational plan for the recommended wastewater collection, treatment and water recycling facilities, including responsible parties, operation and maintenance activities, and monitoring and reporting requirements.

## Responsible Parties

### *County*

The County would be the owner and responsible party for operation and maintenance of the wastewater collection facilities, recycled water treatment plant, and recycled water transmission lines.

It is anticipated that the operations would be performed by a qualified and properly certified wastewater facilities contractor. The contractor would be required to be a California certified wastewater treatment plant operator Grade III, minimum. Preliminary estimates of staffing for contract O&M services include:

- Chief Operator, Grade III
- Grade I Operator

- Field Technician
- Systems Control Technician

The County would also retain the services of an engineering consultant for oversight of operations, engineering analysis and other technical assistance as needed. The County may also establish a contractual arrangement with Marin Municipal Water District for additional support services, such as laboratory analytical work, emergency response, or other technical assistance.

### *San Geronimo Golf Course*

The San Geronimo Golf Course would be the Recycled Water User. They would be responsible for maintenance and operation of the storage ponds, irrigation pump and distribution system and the recycled water uses areas (i.e., the golf course turf areas). They would carry-out their responsibilities in accordance with the terms of an operating/lease agreement with the County and in accordance with all State and Regional Water Board requirements for use of recycled water.

The Golf Course will designate a Use Area Supervisor, who shall be the person having responsible charge for: (a) operation and maintenance of recycled water storage and irrigation facilities within the golf course use area; (b) prevention of potential hazards; (c) implementing and complying with applicable permit conditions and best management practices for use of recycled water on the golf course; (d) coordination with any cross-connection control programs for the golf course facilities, as applicable; (e) control of onsite piping to prevent any cross connections with potable water supplies; and (f) day-to-day communications and coordination with the County Water Recycling Facility operators.

## Operation and Maintenance

Operation and maintenance (O&M) guidelines will be provided in an O&M Manual for covering the wastewater collection, treatment and recycling facilities. This document will incorporate the WDRs and Monitoring and Reporting Program (MRP) requirements issued by the RWQCB along with specific operation and maintenance instructions for all system components and equipment at the time of project facilities construction. A summary of anticipated operation and maintenance activities is presented below.

### *Wastewater Collection System*

Gravity Sewers
Operation and maintenance activities for a conventional gravity sewer system consist of cleaning the sewers, monitoring sewers for illegal inflow connections, and pump station operation and maintenance. Access for cleaning is provided by manholes (6-inch and 8-inch gravity sewers) and by clean-outs (for 4-inch laterals). Cleaning of gravity sewers may require removal of obstructions from time to time, as well s flushing. Video inspection of sewer lines would typically be performed from time-to-time as a preventative measure and/or to investigate specific sections of sewer lines.

Main pump station O&M would involve routine onsite inspections (e.g., weekly) to observe pump station operations and conditions, as well as on-going monitoring of operations remotely via telemetry. Major inspections and servicing would be conducted quarterly or as needed, including evaluation and serving of all major pumping components, valves, piping, controls, alarms, structural elements and other mechanical/electrical equipment. The emergency generator would be tested and operated during these quarterly inspections. Repair and/or replacement of equipment components would be performed, as needed. Operator(s) would be tasked with the responsibility to respond to alarms or other emergency conditions typically within 2 to 4 hours.

*Pressure Sewers*

On-lot grinder pumps require periodic maintenance and cleaning, which are normally handled by the sewer district; the associated electrical energy costs are absorbed directly by the property owner. Annual inspection of all grinder pumps is recommended. High-pressure flushing of the pressure sewer lines may be required every few years to scour slime and solids buildup. A full walk-through inspection of the pressure sewer alignments is recommended yearly, accessing all valve boxes, exercising valves, and other visual inspections. Visual inspection of pressure lines at creek crossings is recommended to be done at least quarterly.

### *Treatment System*

System maintenance would include regular inspection of all equipment and processes. A telemetry system would be incorporated to facilitate remote, continuous monitoring of the critical elements of the pump stations and the treatment system. Ongoing inspection and maintenance of the wastewater treatment facility and collection system is anticipated to include on-site physical work several days a week.

### *Storage Ponds*

The holding ponds would be a relatively passive system requiring periodic inspection and upkeep, but little in the way of day-to-day operational requirements. The pond water levels would require management to assure suitable capacity for wet weather storage needs; pond maintenance also requires implementation of mosquito control measures, normally consisting of application of microbial larvicides that are registered and approved for use by the US EPA. Pond operation and maintenance would be handled by the golf course maintenance personnel, as would the irrigation pump stations and spray operations.

The integration of recycled water into the golf course is proposed to occur from a new dedicated pump system (50 hp pump) drawing water from the Lower Pond #2 on the back nine. The new pump system will be integrated into the existing irrigation controller, with all operations managed by the golf course superintendent/use area supervisor. The irrigation operations will take place normally during July-September. All water collected and stored in front nine Pond #1 will be transferred to the Pond #2 during the end of the irrigation season for application to the golf course via the Pond #2 irrigation pump station.

### *Golf Course Irrigation with Recycled Water*

Since the treated water would be incorporated into the existing golf course irrigation system for dry season application to existing managed turf areas, monitoring would primarily consist of visual observations of use areas, noting and correcting any evidence of ponding or runoff of irrigation water, and other abnormal conditions. The golf course irrigation system is operated with the assistance of a modern weather-based computerized controller, which will also be used to govern the application of recycled water. Additionally, permit requirements will dictate adherence to the following minimum irrigation practices for use of recycled water:

- Avoid wastewater spraying with 24 hours of forecasted rainfall with greater than 50% probability of occurring, during rainfall event, or if surface soil is saturated;
- Avoid wastewater spraying when wind speeds exceed 30 miles per hour; and
- Limit irrigation to avoid ponding, soil saturation or creation of runoff.

**Table 8-9** provides a summary listing of management and operation requirements regarding golf course irrigation that would be incorporated in the recycled water use agreement between the
golf course and the County.

**Table 8-9: Management and Operation Requirements for Golf Course Water Recycling**

- *Designate a Use Area Supervisor, who shall be the person designated by the Golf Course owner(s) to have responsible charge for: (a) operation and maintenance of recycled water storage and irrigation facilities within the golf course use area; (b) prevention of potential hazards; (c) implementing and complying with applicable permit conditions and best management practices for use of recycled water on the golf course; (d) coordination with any cross-connection control programs for the golf course facilities, as applicable; (e) control of onsite piping to prevent any cross connections with potable water supplies; and (f) day-to-day communications and coordination with the County Water Recycling Facility operators.*
- *Comply with use area conditions per Title 22, WDRs and project-specific BMPs.*
- *Maintain a copy of use area requirements, BMPs and other relevant documents golf course personnel and for inspection by County, Regional Water Board and DDW staff.*
- *Submit onsite observation reports and use data to the County for inclusion in required reports to the Regional Water Board and DDW.*
- *Ensure that golf course personnel receive training to assure proper operation of recycling facilities, worker protection, and compliance with applicable requirements.*
- *Maintain in good working order and operate as efficiently as possible any facility or control system to achieve compliance with applicable requirements for use of recycled water.*
- *Implement and adhere to the following general management practices for use of recycled water for golf course irrigation:*
  *a) application of recycled water at reasonable agronomic rates considering soil, climate, and nutrient demand;*

> *b) management of recycled water to prevent nuisance conditions or breeding of mosquitoes;*
> *c) conduct irrigation during periods lowest public use, with consideration to allow maximum drying time prior to subsequent public use;*
> *d) perform required inspections, reporting and regular maintenance of areas irrigated with recycled water;*
> *e) manage operations to minimize worker contact with recycled water.*
>
> - *Implement other best management practices as specifically adopted for the facility, including measures identified in the Title 22 Engineering Report, Waste Discharge Requirements, Environmental Impact Report mitigation measures, or, as applicable, BMPs identified in State Water Board Order No. 2009-0006-DWQ – General Permit for Landscape Irrigation Uses of Municipal Recycled Water:* http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/wqo_2009_0006_general_permit.pdf

## Monitoring and Reporting

The wastewater system will be monitored to verify compliance with performance objectives and to ensure safe and proper operation of the collection, treatment, storage and disposal facilities. Specific monitoring requirements will be established as permit conditions by the Regional Water Board in the MRP. They are anticipated to include the following.

### *Wastewater Flow*

Wastewater flows will be monitored at the treatment plant at two primary locations: (1) influent EQ tank; and (2) recycled water pumping station. Flows will be monitored to determine the total daily flow in the system, as well as the distribution of flow to the two recycled water ponds. Flows will be measured using in-line flow meters and/or pump event counts, dose volume and pump run-time data. Flow monitoring will also be conducted on at the Pond #2 irrigation pump station to measure and record the volume of recycled water pumped into the golf course irrigation system.

### *Wastewater Influent and Effluent Sampling*

Wastewater effluent will be sampled routinely to monitor and assess the performance of various components of the treatment system and to verify conformance with performance requirements (e.g., effluent limits). Wastewater effluent will be sampled at the dosing tanks prior to discharge to the storage ponds, and in accordance with requirements established by the Regional Water Board. Recommendations for sampling parameters and frequency are listed in **Table 8-10**. Analyses may be made from time to time for other parameters as diagnostic tools to assist in system operations and maintenance. A critical task will be daily sampling and analysis for coliform bacteria per Title 22 water recycling requirements. Contract arrangements with MMWD for coliform testing at their San Geronimo Water Treatment Plant would be an efficient way to meet this critical operating requirement. Sampling and analysis of recycled water for "Priority Pollutants"[2] would be required once every five years.

[2] Priority Pollutants refer to a list of 126 specific pollutants that includes heavy metals and specific organic chemicals.

**Table 8-10: Recommended Monitoring Schedule**

| Wastewater Parameter | Measurement Units | Anticipated Frequency | |
|---|---|---|---|
| | | Influent | Effluent |
| Flow | gallons per day | Daily | Daily |
| BOD | mg/L | Monthly | Monthly |
| Total Suspended Solids (TSS) | mg/L | Monthly | Monthly |
| Turbidity | NTU | N/A | Continuous |
| Total Coliform | MPN/100 mL | N/A | Daily |
| Total Kjeldahl Nitrogen (TKN) | mg/L | Monthly | Monthly |
| Nitrate-Nitrogen | mg/L | Monthly | Monthly |
| Priority Pollutants | | - | Every 5 years |

### *Recycled Water Storage Ponds*

Monitoring of recycled water storage ponds is anticipated to include:

- Dissolved oxygen concentration (grab sample, monthly)
- Water level and freeboard to nearest 0.1 ft (staff gauge, monthly)
- Odors (observation, monthly)
- Berm conditions (observation, monthly)

### *Golf Course Irrigation*

Monitoring of the recycled water discharge to the golf course irrigation system is anticipated to include the following items during periods when irrigation water is applied:

- Recycled water applied for irrigation (metered, monthly)
- Acreage irrigated (calculated, monthly)
- Local rainfall amounts (from weather station, monthly)
- Application rate (calculated, gal/acre/month)
- Golf course irrigation area observations for soil erosion, containment of applied water, soil saturation/ponding, nuisance odors or vectors, off-site discharge of applied wastewater (monthly during recycled water use period)

### *Surface Water and Groundwater Monitoring*

Surface water and groundwater monitoring requirements may be established by the Regional Water Board as permit conditions for the water recycling facilities. Specific monitoring recommendations (constituents, locations, frequency) should be developed following the completion of and utilizing information from the environmental review of the project. Preliminary recommendations for consideration include:

- **Surface Water Monitoring.** Establish surface water monitoring locations ("upstream" and "downstream") on the year-round (flowing) streams that lie within 100 feet of the golf course irrigation areas, and conduct monthly sampling during the portion of the irrigation season when recycled water is applied.

- **Groundwater Monitoring.** Install a minimum of three monitoring wells around both recycled water storage ponds (#1 and #2) and conduct routine sampling on a quarterly basis for observation of changes in water levels and water quality as a check on potential leakage of recycled water from either of the ponds.

### Reporting

Routine reporting of monitoring results will be required for the facility in accordance with a schedule included as a condition of the WDRs and Monitoring and Reporting Program issued by the Regional Water Board. Quarterly and Annual monitoring reporting is anticipated.

*Quarterly Monitoring Reports*

Quarterly reports are due on the first day of the second month after the quarter ends and will ordinarily include:

- Results of all required monitoring.
- Comparison of monitoring data to the discharge specifications, applicable effluent limits, Title 22 requirements, and disclosure of any violations along with an explanation of any violation of those requirements.
- If requested by staff, copies of laboratory analytical report(s) and chain of custody form(s).

*Annual Report*

Annual Reports are due by March 1st of the following monitoring year and will ordinarily include:

- Tabular and graphical summaries of all monitoring data collected during the year, with a section devoted specifically to recycled water monitoring and compliance per Title 22.
- Evaluation and discussion of the performance of the wastewater treatment facility and recycling operations, including capacity issues, nuisance conditions, problems, and forecast of any anticipated changes in the next year.
- Description of ultraviolet light disinfection system maintenance activities performed, addressing inspections performed, lamp bulb replacement, lamp sleeve cleaning, and manufacturer recommended maintenance activities.
- Discussion of compliance and the corrective action taken, as well as any planned or proposed actions needed to bring the discharge into compliance with requirements.
- Discussion of any data gaps and potential deficiencies/redundancies in the monitoring system or reporting program.

- Name and contact information for the wastewater operator responsible for operation, maintenance, and system monitoring.

- If required, groundwater monitoring report prepared by a California licensed professional containing an analysis of groundwater data collected during the year and a general evaluation of any impacts the wastewater discharge is having on groundwater quality.

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# Appendix A

# Onsite Wastewater Treatment Literature

- AdvanTex Packed Bed Filter
- UV Disinfection
- Geoflow Drip Dispersal

# AdvanTex® Treatment Systems

# AX-RT

Manufactured by **Orenco Systems®, Inc.**

*A number of vacation homes along beautiful Smith Mountain Lake in Virginia treat their wastewater – and protect the lake – with AdvanTex® AX-RT Treatment Systems.*

## Dependable, Affordable Treatment For Residential & Small Commercial Wastewater

**Orenco Systems®, Inc.**
814 Airway Avenue, Sutherlin, Oregon, USA 97479
Toll-Free: 800-348-9843 • +1-541-459-4449 • www.orenco.com

**Applications:**

- 1-6 bedroom homes
- Small commercial properties
- New construction, repairs
- Tight lots, other site constraints
- Poor soils, shallow bury
- Stringent permit requirements
- Nitrogen reduction, disinfection
- Surface discharge

# AdvanTex® – AX-RT Treatment System

## Dependable, Affordable Wastewater Treatment, Anywhere!

The AdvanTex® AX-RT Wastewater Treatment System is the latest residential (and small commercial) treatment system in Orenco's AdvanTex line.

AdvanTex systems consistently produce clear, odorless effluent ... effluent that meets the most stringent permit limits and is ideal for subsurface irrigation and other water-saving uses. That's one reason why AdvanTex won the Water Environment Federation's "2011 Innovative Technology Award." It also won for its low power costs and low operating & maintenance costs. Plus AdvanTex is easy to install, too. Here's why:

### Pre-Plumbed Treatment System Saves On Excavation, Installation, O&M

The AX-RT is a compact "plug and play" wastewater treatment system. It can be shallowly buried and installed right behind a septic tank, as easily as a septic tank, so contractors can schedule more jobs in a single day.

The AX-RT unit includes the following functional areas of the treatment process:

1. Textile media for advanced treatment
2. Recirculation/blending chamber
3. Gravity or pump discharge to final dispersal
4. Optional Orenco UV unit when disinfection is required

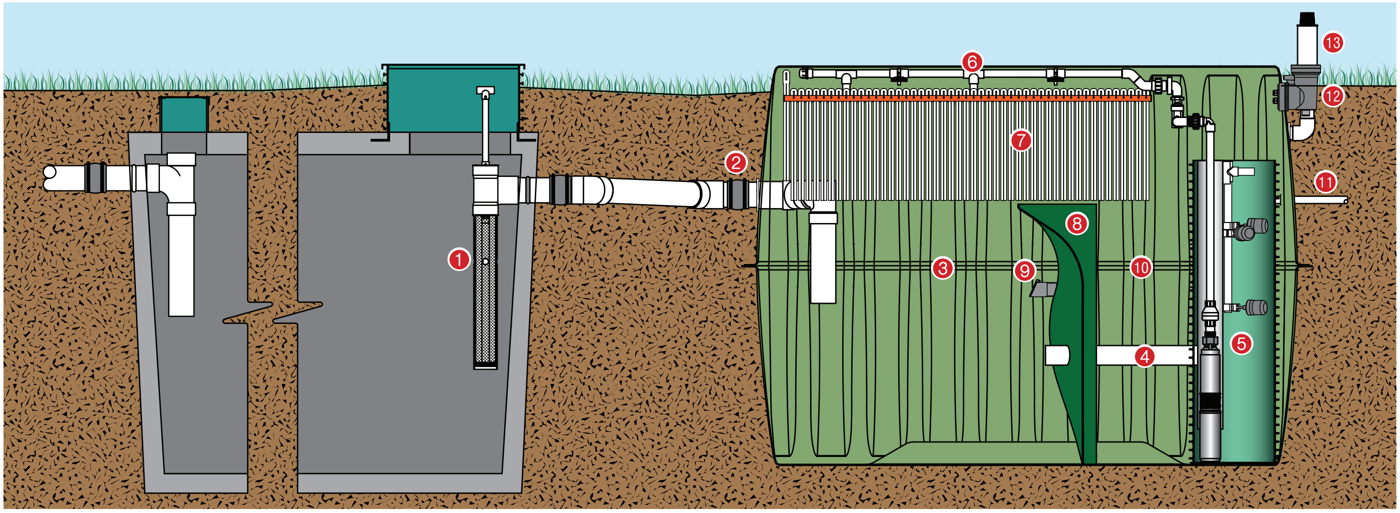
This simple design fits on the smallest lots and reduces costs for excavation, installation, and O&M. That means property owners can buy AdvanTex quality at a competitive price.

*Since 2003, 116 AdvanTex Treatment Systems have been installed in Sunset Bay, a lakefront subdivision in northeast Tennessee, and 23 have been AX-RTs. According to **Arthur Helms, Helms Construction**, the RT's are "a lot easier to install. This one only has a few connections, so you can't hardly screw it up." Even better, Helms says that the RT "saves about 8 hours labor and saves on fittings ... I make more money with the RT. I can do it and go on to the next one."*



### Components

1. *Biotube® effluent filter*
2. *Inlet*
3. *Treatment tank – recirc/blend chamber*
4. *Recirc transfer line*
5. *Recirc pumping system (discharge pumping system not visible)*
6. *Manifold and spin nozzles*
7. *Textile treatment media*
8. *Tank baffle*
9. *Recirc return valve*
10. *Treatment tank – recirc/filtrate chamber*
11. *Outlet*
12. *Splice box*
13. *Passive air vent*
14. *Control panel (not shown)*



*The AX-RT is a completely prepackaged "plug & play" wastewater treatment system that can be quickly installed right behind an existing (or new) watertight septic tank. The AX-RT serves 1-6 bedroom homes.*

# AdvanTex® – AX-RT Treatment System

## Low Power Costs, Low Maintenance Costs

No blowers. No odors. The AX-RT is passively vented and uses only \$2-\$3 per month in electricity.[1] Other products can use anywhere from ten to twenty times more! AX-RT customers also have low lifetime costs. The AX-RT is easily maintainable with an annual service call, thanks to its accessible, cleanable filters and media. And the AX-RT's high-quality, high-head pumps last 20 years or more!

***Homeowner Nancy Smith** was the first person to receive a \$400 cash incentive from Energy Trust of Oregon for buying an energy-efficient wastewater system: an AX-RT. Smith's drainfield failed the day before Thanksgiving and she immediately started researching replacement systems. "My determining factor was the electric use," said Smith. "Incomes are going down, expenses are going up ... I have to know going forward what things are going to cost." Smith chose the AX-RT because the annual cost for electricity runs less than \$40; other systems can run as high as \$500 or more.*

## Consistent, Reliable Performance

Stringent testing programs consistently show that AdvanTex Treatment Systems produce effluent with $BOD_5$/TSS at or below 10 mg/L and nitrogen reduction of 60-70+%. In fact, the Maryland Department of the Environment has rated AdvanTex as tops among all "Best Available Technologies" for nitrogen-reduction.[2]




[1] *Assumes electricity costs of \$0.10 per kWh and 3-4 occupants*

[2] *http://www.state.md.us/programs/Water/BayRestorationFund/OnsiteDisposalSystems/Pages/Water/cbwrf/osds/brf_bat.aspx*

## The AdvanTex Advantage:

- Reliable, reputable
- Clear, re-usable effluent
- No noise or odors
- Complete "plug & play" package
- Easy to install and maintain
- Energy efficient
- Competitively priced
- For 1-6 bedroom homes

### Textile Treatment Media

*Spin nozzles microdose wastewater effluent onto highly absorbent textile filters at regular intervals, optimizing treatment.*

### Ultraviolet Disinfection

*Our optional UV unit reduces bacteria by 99.999%, allowing wastewater re-use for irrigation, toilet flushing, etc. It uses no chemicals and has no moving parts. The UV unit is protected in its own chamber inside the AX-RT and just needs a lamp replacement every other year.*

### Smart Controls

*The AX-RT comes standard with Orenco's Veri-Comm™ remote telemetry control panel and monitoring system. That means service providers can oversee the system, from office or home. (Non-telemetry "smart" controls also available.)*

# AdvanTex® – AX-RT Treatment System

## Carefully Engineered by Orenco

Orenco Systems has been researching, designing, manufacturing, and selling leading-edge products for decentralized wastewater treatment systems since 1981. The company has grown to become an industry leader, with about 300 employees and more than 300 points of distribution in North America, Australasia, Europe, Africa, and Southwest Asia. Our systems have been installed in about 70 countries around the world.

*AdvanTex® Treatment System AXN Models meet the requirements of NSF-ANSI Standard 40 for Class I Systems.*

NSF/ANSI STANDARD 40

Certified Product Australian Standard

c UL us LISTED

Powered by Franklin Electric

# Use the AX-RT for Applications Like These ...

### Small Lots

In 2011, Mike Madson, a septic system installer in Oregon, replaced a failing system along the beautiful North Umpqua River with an AX-RT. “That particular situation was really, really confining,” says Madson. “There was a high bank to the river about 25 feet away and roots everywhere; we had to get things in there in compact fashion. We even had to add a drainfield to the site; the old one was bootlegged in, cedar trees had grown into it, and the leach line was plugged up.” The AX-RT incorporates the recirc and discharge processes right within the RT unit, so its smaller footprint made this installation possible.

### Nitrogen Reduction


Bob Johnson of Atlantic Solutions has sold (and services) more than 325 AX-RTs, mostly in Maryland, for the state’s aggressive nutrient-reduction program. Maryland requires Total Nitrogen of less than 20 mg/L to protect the Chesapeake Bay. After a year of testing 12 RTs under Maryland’s BAT (Best Available Technologies) Program, Johnson reports that TN averaged just 14.6 mg/L, while $BOD_5$/TSS averaged <5 mg/L. Says Johnson, “When you look at life cycle costs and percent of nitrogen reduction, the AX-RT costs less than other technologies for every pound of nitrogen removed.”

### Strict Permit Limits, Including Surface Discharge

*Photo courtesy of Kevin Davidson*

Kevin Davidson, an engineer with Agri-Waste Technology, designed the first AX-RT in North Carolina to replace a failing system under North Carolina’s “Surface Discharge” permit. According to Davidson, the property had poor soil conditions, plus there was no room for a new drainfield. The state allowed the AX-RT for surface discharge because it produces such outstanding effluent that it could meet the required permit limits. And, with UV disinfection, it could meet the limit for fecals, too. Consequently, treated and disinfected effluent could then be discharged to a ditch.

Davidson was able to use the existing septic tank, and the RT’s configuration eliminated the need for a discharge tank, separate UV basin, and several risers and lids, reducing costs. On the O&M side, he appreciates having the UV sensors integrated into the control panel, especially the one that allows the service provider to know the bulb is working, without having to pull it out. Says Davidson, “I think the RT is the best unit, when you look at aesthetics, installation cost, ability to treat waste, and support from Orenco. Compared to other technologies, I would grade Orenco at the top.”



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**ABR-ATX-AXRT-1**
**Rev. 1.3,** 

# AdvanTex® AX100 Treatment Systems

## For Onsite Treatment of Commercial and Multi-Family Wastewater




Ideal for:

- Multi-family residential properties
- Cluster systems, community systems
- Subdivisions, resorts, golf course developments
- Mobile and manufactured home communities
- Parks, RV parks, rest areas
- Truck stops, restaurants, casinos
- Schools, office buildings

OSI
Orenco Systems® Incorporated
*Changing the Way the World Does Wastewater®*

**800-348-9843**
**orenco.com**

# We've Written the Blueprint for the Decen

## The Product

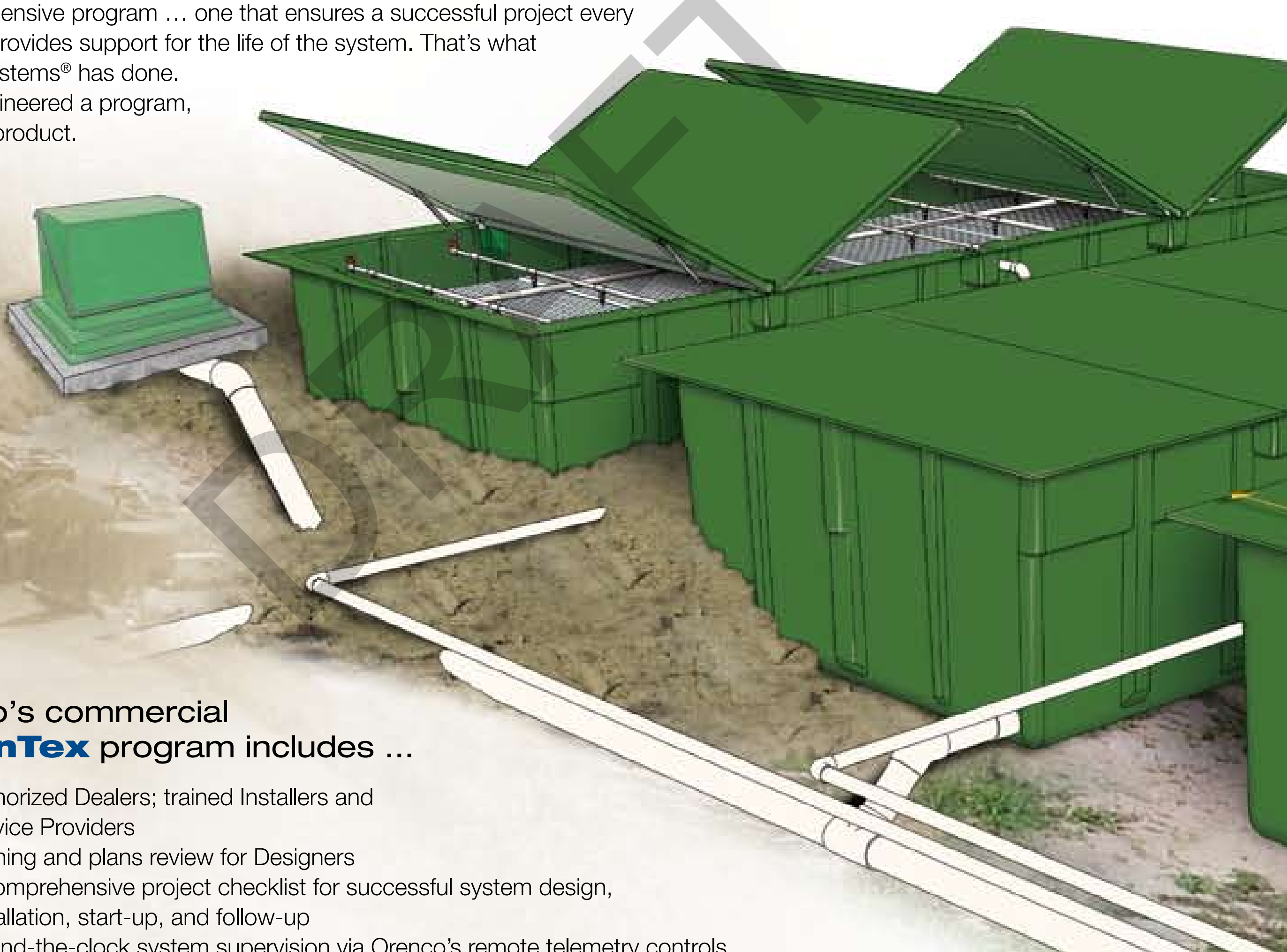
Orenco's AdvanTex® Treatment Systems utilizing the commercial-sized AX100 can make raw wastewater up to 98% cleaner, meeting stringent regulatory requirements. It can also reduce nitrogen significantly, depending on influent and configuration. And the AX100 offers all the benefits of Orenco's residential-sized AdvanTex Treatment Systems:

- Consistent, reliable treatment, even under peak flows
- Compact package, small footprint, for small sites
- Premanufactured package, including textile medium, for quality control
- Low maintenance requirements; low life-cycle costs
- Production of clear, odorless effluent that's ideal for reuse

## The Program

It takes more than a product, however, to solve onsite wastewater problems. It takes a comprehensive program … one that ensures a successful project every time and provides support for the life of the system. That's what Orenco Systems® has done. We've engineered a program, not just a product.





### Orenco's commercial **AdvanTex** program includes …

- Authorized Dealers; trained Installers and Service Providers
- Training and plans review for Designers
- A comprehensive project checklist for successful system design, installation, start-up, and follow-up
- Round-the-clock system supervision via Orenco's remote telemetry controls
- A commitment to ongoing O&M, signed by system owners
- Web-based tracking of site and performance data on Dealer extranet
- Ongoing manufacturer support through Orenco's Engineering Department

*AX100 filter pods can be installed above ground or partially bermed, depending upon site conditions.*

* NOTE: Covered by U.S. patent numbers 6,540,920; 6,372,137; 5,980,748; 5,531,894; 5,492,635; 5,480,561; 5,360,556; 4,439,323

# Decades of Research, Thousands of Installations

Orenco's patented* AdvanTex Treatment System is a recirculating filter that's configured like a recirculating sand filter — a packed bed filter technology that Orenco engineers have helped to perfect since the 1970s. Like recirculating sand filters, AdvanTex is reliable and low-maintenance. It is superior to other packed bed filters, however, in its serviceability and longevity.

It is also superior in its treatment media. AdvanTex uses a highly efficient, lightweight textile that has a large surface area, lots of void space, and a high degree of water-holding capacity. Consequently, AdvanTex Treatment Systems can provide treatment equivalent to that of sand filters at loading rates as high as 25-50 gpd/ft$^2$ (1000-2000 L/d/m$^2$). That means AdvanTex can treat high volume commercial and multi-family flows in a very compact space.

Our textile-based, multi-pass treatment technology has undergone third-party testing and evaluation to ANSI Standards. About 20,000 residential-sized AdvanTex filters have been installed since 2000. And more than 2,500 commercial-sized AX100 units are now in operation, including the installations described on the back page.




**Textile Media**
*The treatment medium is a uniform, engineered textile, which is easily serviceable and allows loading rates as high as 50 gpd/ft$^2$ (2000 L/d/m$^2$).*

**Spray Nozzles**
*Efficient distribution is accomplished via specially-designed spray nozzles.*

**Laterals and Lids**
*Isolation valves, flushing valves, and hinged lids with gas springs allow easy access and servicing by a single operator.*

**Telemetry Controls**
*Orenco's telemetry-enabled control panels use a dedicated phone line and ensure round-the-clock system supervision and real-time, remote control.*

# AdvanTex® AX100 Treatment Systems

## Carefully Engineered by Orenco

Orenco Systems has been researching, designing, manufacturing, and selling leading-edge products for small-scale wastewater treatment systems since 1981. The company has grown to become an industry leader, with about 250 employees and 150 distributors and dealers representing most of the United States, Canada, Mexico, Australia, New Zealand, and parts of Europe. Our systems have been installed in more than 60 countries around the world.

Orenco maintains an environmental lab and employs dozens of civil, electrical, mechanical, and manufacturing engineers, as well as wastewater treatment operators. Orenco's systems are based on sound scientific principles of chemistry, biology, mechanical structure, and hydraulics. As a result, our research appears in numerous publications and our engineers are regularly asked to give workshops and offer trainings.

## Oregon Riverside Community

Since 2003, twelve AX100s have been providing advanced secondary wastewater treatment in Hebo, Oregon, for a small community collection system that discharges directly into Three Rivers, after UV disinfection. The average annual design flow is 17,000 gpd (64,400 L/d) with a peak daily design flow of 80,000 gpd (303,000 L/d) to account for I&I contributions from the collection system. Effluent $BOD_5$ and TSS are averaging 4.4 and 4.5 mg/L, respectively.

## Malibu, California Restaurant

Ten AX100s at the top of a Malibu bluff are treating high-strength waste from a large (200+ seat) beachfront restaurant, 100 feet (30 m) below. This high-visibility tourist destination requires reliable, odor-free operation. Effluent sampling indicates excellent treatment, including nitrogen reduction. At an adjacent residential community, another system, consisting of 20 AX100s capable of treating up to 60,000 gpd (227,000 L/d) peak flows, has also been installed.

## Mobile, Alabama Utility-Managed Subdivisions

*Champion Hills is one of the many subdivisions in rural Mobile County served by Orenco's effluent sewers and treatment systems.*

South Alabama Utilities (SAU) in Mobile County, Alabama, has become the subject of nationwide classes, presentations, and tours because of its ambitious and innovative solution for serving nearly 4,000 new customers in 47 new subdivisions (as well as a number of new schools and commercial properties) northwest of Mobile. How? By installing more than 60 miles (96.5 km) of interconnected Orenco Effluent Sewers that are followed by 141 AdvanTex AX100s to treat nearly half a million gpd (1.9 million L/d) of effluent, at better than 10 mg/L.

Under SAU's program, developers, builders, homeowners, and the utility all share the cost of extending wastewater infrastructure. Overall costs vary by development, but SAU currently charges each homeowner about $2,000 to provide and install the on-lot equipment. Overall costs are about half the cost of conventional sewers.

*To order a complete design/engineering package for Orenco's Commercial AdvanTex Treatment Systems, contact your local Commercial AdvanTex Dealer. To find a Commercial Dealer, go to www.orenco.com/systems and click on "Locate a Dealer." Or call 800-348-9843 and ask for Systems Engineering.*

**Orenco Systems®** Incorporated

*Changing the Way the World Does Wastewater®*

**814 Airway Avenue**
**Sutherlin, OR 97479**

**T • 541-459-4449**
**800-348-9843**

**F • 541-459-2884**

**www.orenco.com**

ABR-ATX-AX100-1
Rev. 1.6, 

# Orenco® UV and AXUV Disinfection Units

## Applications

The Orenco® UV and AXUV Disinfection Units provide UV disinfection in residential applications after advanced secondary treatment (10 mg/L $cBOD_5$/TSS), when disinfection is required before dispersal. Treated effluent flows by gravity through the contact chamber and around the UV lamp where it is disinfected in a 360-degree contact zone.

Orenco UV units dramatically reduce bacteria and viruses. In side-by-side NSF® testing, they reduced bacteria by 99.999% (5 logs), meeting or exceeding the performance of other residential UV disinfection units.

Both the Orenco UV and AXUV Disinfection Units require installation inside a pump or gravity discharge basin or in a separate tank following advanced secondary treatment. Both are gravity-flow units.

The AXUV is specifically designed to follow AdvanTex® Treatment Systems. It can be also be mounted inside of the AX20-RT Treatment System.

*The Orenco® UV Disinfection Unit is unlike any other disinfection unit on the residential wastewater market. It dramatically reduces bacteria and viruses, when used as directed.*

*Warning: UV radiation burns retinas and skin! Do not look directly at an operating UV lamp or expose skin to UV lamp light!*



## Standard Features & Benefits

### Better Product

- UL-recognized
- NSF® equivalency tested
- Fecal coliform reduction of 99.999% (5 logs)
- Flow path designed to maximize contact time between effluent and lamp
- Unit comes fully-assembled
- Components designed to work together; no piecemeal disinfection units and wiring
- Quick-disconnect coupling makes unit easy to remove for inspection and cleaning
- Teflon® sleeve ...
  - – protects lamp
  - – reduces breakage
  - – minimizes buildup
  - – minimizes service intervals
  - – makes cleaning easy
- Yearly service interval and lamp replacement

### Better Controls

- Power ballast and lamp current sensor housed in control panel (not a tank or wet well) to minimize corrosion and failure due to environmental exposure
- Panel prevents discharge of non-disinfected effluent due to lamp failure or control panel failure[1]
- Audible and visible alarm activated if lamp fails[2]
- E-mail alert sent if lamp fails[3]
- For more information, call Orenco at 800-348-9843 or 541-459-4449

[1] *AXUV only*
[2] *AXUV or UVIB panel only*
[3] *AXUV with VCOM® panel only*

## To Order

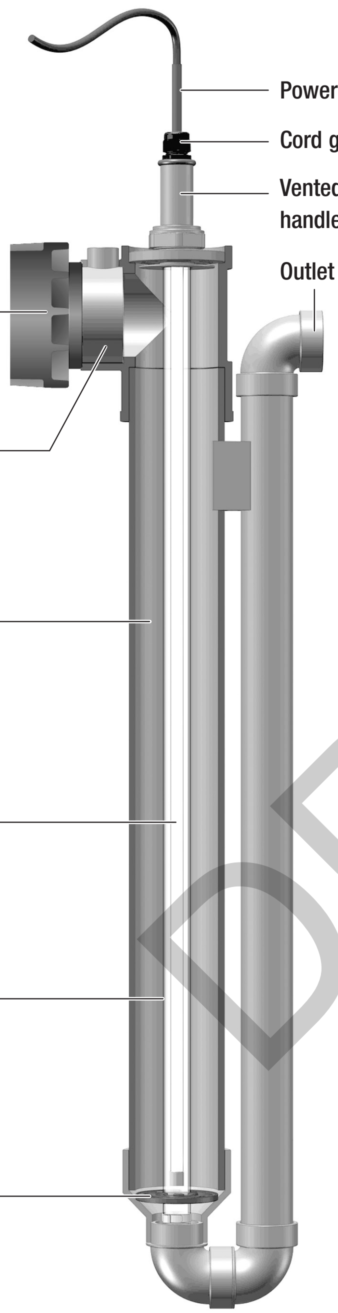
Call your nearest Orenco Systems®, Inc. Distributor. For nearest Distributor, call Orenco at 800-348-9843, or visit www.orenco.com and click on "Where to Buy."

**Orenco**
**Orenco Systems®**, Incorporated



**Orenco Systems® Inc. , 814 Airway Ave., Sutherlin, OR 97479 USA**
**800-348-9843 • 541-459-4449 • www.orenco.com**

## UV Disinfection Unit Components




UL-recognized

## Performance

| | |
|---|---|
| Typical contact chamber UV dose (65% transmittance, 20% lamp degradation) | 276,000 μW·s/cm² at 1 gpm (0.06 L/sec)<br>55,000 μW·s/cm² at 5 gpm (0.32 L/sec)<br>28,000 μW·s/cm² at 10 gpm (0.63 L/sec) |
| Minimum target dose | 30,000-38,000 μW·s/cm². |
| Lamp | 31 in. (787 mm), 92 VAC, 50 or 60 Hz, 425 mA, 38 W; 254 nm UVC intensity at 1m is 125 μW/cm². |
| Power cord length | 600V, 18/2 UL Type TC, 25 ft (7.62 m) std |
| Cord plug | UL listed four-pin connector, lamp-holder, electric discharge, 1000 V or less |
| Ballast | 120 VAC, 50 or 60 Hz, located in UL listed Orenco® control panel |
| Circuit breaker | 10 A, OFF/ON switch; Single-pole 120 V*, DIN rail mounting with thermal magnetic tripping characteristics |
| Audible alarm* | 95 dB at 24 in. (610 mm), warble-tone sound |
| Visual alarm* | ⅞-in. (22-mm) diameter red lens, "Push-to-silence," UL Type 4X rated, 1 W LED light, 120 V |

** Standard on VeriComm, MVP, and UVIB panels. Not available with UVIBSUB panels.*

## Model Codes for Ordering

**UV - 125/31 - [ ] - [ ]**

- Power cord length: Blank = 25 ft (7.62 m); 50 = 50 ft (15.2 m)
- Control panel options: UVIB = panel with audible and visible alarms; UVIBSUB = sub-panel for use with separate control panel
- Lamp length: 31 = 31 in. (787 mm)
- Lamp output at 1 meter: 125 = 125 μW/cm²
- Orenco UV disinfection unit

**AXUV - 125/31 - [ ]**

- Power cord length: Blank = 25 ft (7.62 m); 50 = 50 ft (15.2 m)
- Lamp length: 31 = 31 in. (787 mm)
- Lamp output at 1 meter: 125 = 125 μW/cm²
- AdvanTex™ UV disinfection unit





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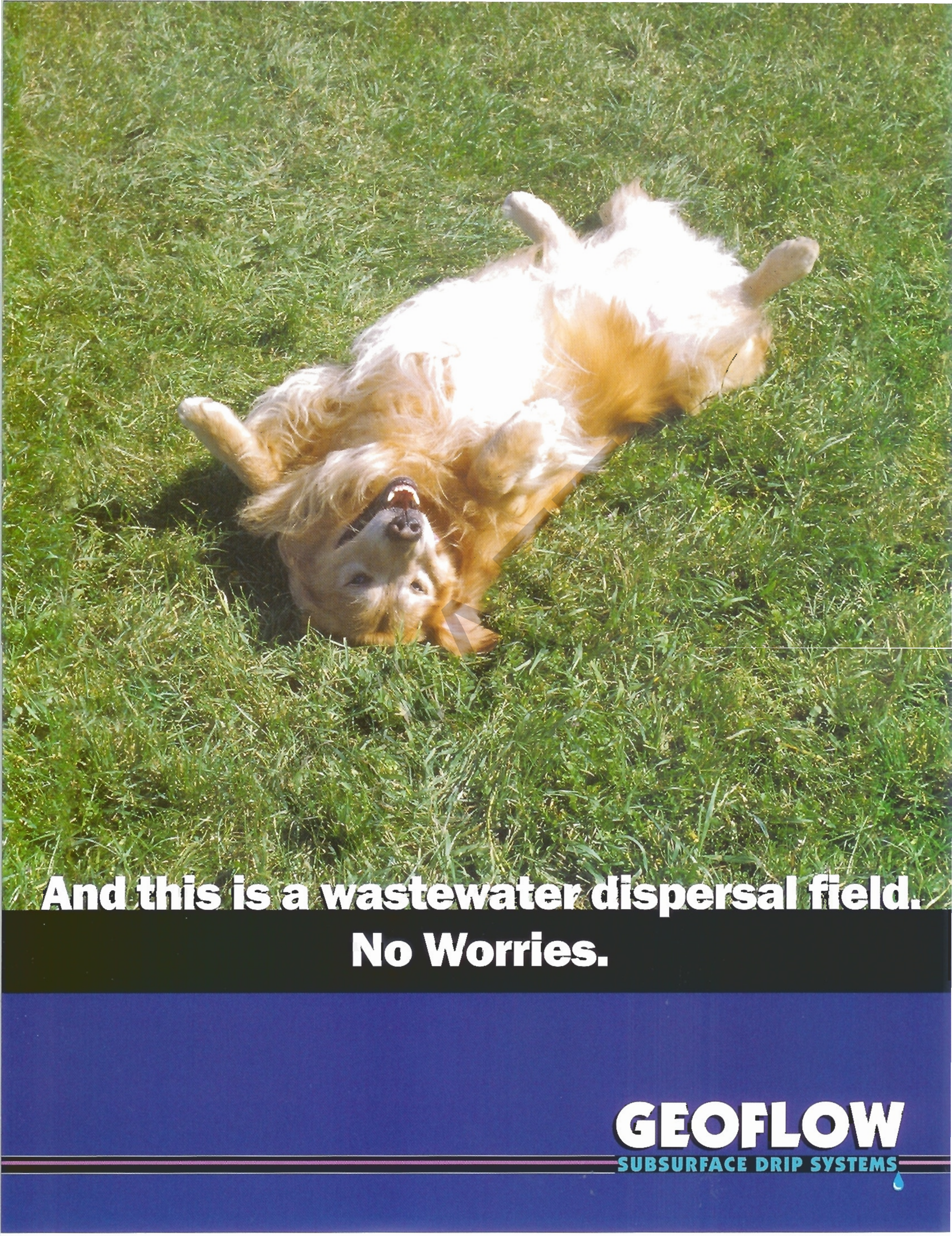

And this is a wastewater dispersal field.
No Worries.
GEOFLOW
SUBSURFACE DRIP SYSTEMS

## Geoflow WASTEFLOW®

Geoflow's subsurface drip systems solve many of the problems that plague traditional methods of wastewater dispersal. Since the effluent is dispersed underground where it is absorbed in the biologically active soil layer, there is no surface contamination, no ponding, no run-off problems, no bad smells.

Issues such as overspray and aerosol drift are eliminated, dose scheduling is unaffected by land use or weather, and it is a politically and environmentally favorable means of dispersing wastewater.

With subsurface drip, secondary reclaimed wastewater can be used, eliminating the ongoing cost of additional effluent treatment.

Geoflow drip dispersal is recommended for commercial, municipal, industrial, residential and agricultural applications.

Subdivision in Minnesota.

## How It Works

The WASTEFLOW dripline has factory-installed emitters evenly spaced along the tubing. The dripline is usually installed six to ten inches below the surface, directly into the biologically active soil horizon where the treated effluent can be absorbed by the plants, animal life, and soil.

Wastewater is pumped to the dripfield on a time-activated dose cycle. The slow, even application of effluent with resting periods is key to the drip system's success.

## Easy To Install — New or Retrofit

Geoflow subsurface systems are simple to install. The tubing can be laid on a graded parcel then covered with topsoil or installed using a tubing plow or trencher.

Subsurface drip also solves the problem of small or odd-shaped areas, such as property edges and around buildings and other structures. The flexible tubing can easily be fit to uneven spaces. Since the wetted area is within close proximity of each emitter, run-off problems are easily eliminated.



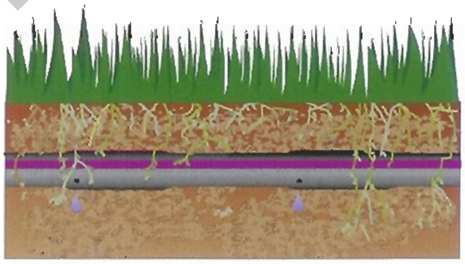
Plow single or multiple driplines at a time.

## But What About...?

**Clogging** — Geoflow drip systems are installed with self-cleaning filters to keep large particles from entering the drip field.

WASTEFLOW emitters are also self-cleaning and have been used for over 15 years in actual onsite applications. They are made with large orifices, raised entry ports, and turbulent flow paths to keep smaller particles from collecting in the emitters.

**Root intrusion** — Each emitter features ROOTGUARD®, patented protection against roots entering the emitters. The non-toxic active ingredient, Treflan®, directs root growth away from the emitters. Treflan is impregnated into the emitters during the molding process.



Rootguard keeps roots from penetrating and clogging the emitters.

**Bacterial growth** — Geoflow's WASTEFLOW dripline is coated inside with the anti-bacterial, *Ultra-Fresh®* to inhibit bacterial growth on the walls of the tube and in the emitters. *Ultra-Fresh* has been found to be effective in preventing slime build-up inside the tube, even with effluent that has very high BOD.

Look for the anti-bacterial turquoise lining.

This eliminates the need to scour the dripline with high flush velocities.

There is virtually no discharge into the environment because the active ingredient, TBT-maleate, does not migrate readily through plastic (Note: Ultra-Fresh does not treat the water flowing through the tube.)

**Freezing climates** — Geoflow systems can be used year round, even in freezing conditions. The polyethylene dripline is flexible enough so as not to crack when it freezes. The dripline self-drains through the emitters every time the system is turned off, and will not hold water. Sound design, including drainback of the system, air vacuum breakers and insulation of the more rigid parts of the system keep the system working even in the coldest climates.

**Difficult sites** — Geoflow systems can be effective in areas with

- tight soils,
- rocky terrains,
- steep slopes,
- high water tables.

Design guidelines are available directly from Geoflow and at www.geoflow.com.

## Testimonials

### Higgins Corner Retail Development
### Nevada County, California

"The Geoflow dripline system proved to be successful in four areas: Foremost, there was a tremendous cost saving in installing the Geoflow system. Secondly, the time and effort saved in installing Geoflow as compared to the construction of deep absorption trenches was also a benefit. Thirdly, one and a half acres of land could be used for other monetary-inducing projects; and fourth, the final disposal site looks like the original untouched property. Neighbors are pleasantly surprised at the final effluent disposal field."

***Mark Kahl, Design Engineer***
***7H Technical Services Group Inc.***

Higgins Corner, Nevada County, CA.

### Ocala Airport
### Ocala, Florida

"The [44-acre] site has operated successfully at an average of 500,000 gpd over a three-year period. Monitoring data reveals that groundwater quality has not been adversely effected despite high loading rates... The cost to operate and maintain a subsurface reuse system is much less than a conventional irrigation system..."

***Ed T. Earnest, P.E. Utility Engineer.***
***City of Ocala Engineering Dept.***

Ocala Airport.

A steep slope installation in California — 65% slope.

### Omaha Beach Golf Course
### Matakana, New Zealand

"As part of the construction of the new 9-holes the developer installed a new subsurface drip irrigation system on some of the new fairways to act as part of the overall community treated effluent disposal system... We are extremely pleased with the system, which gives a very even deep green appearance to the fairways where it was been installed. The fairways that are irrigated with the subsurface drip system are in better condition than those that do not yet have the system."

***Allan Anderson,***
***Head Greenkeeper***

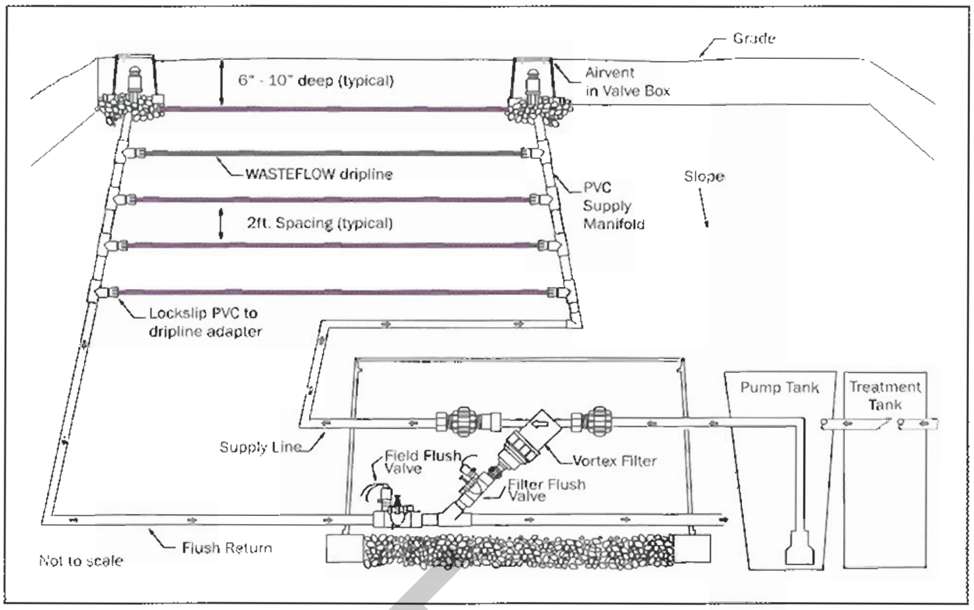
Omaha Beach Golf Course, N.Z.

## Typical Layout

WASTEFLOW dripline is made of flexible ½" polyethylene tubing coated on the inside with an anti-bacterial lining to inhibit bacterial growth. The factory-installed emitters are spaced evenly along the tubing.

The dripline is placed six to ten inches below the surface, directly into the biologically active soil horizon. Effluent is pumped on a time-activated dose cycle through a self-cleaning filter out to the dripfield, providing slow, even application of effluent.

The system returns back to the pump tank or treatment tank in a closed loop, and is kept clean with regular flushing.



Typical disposal field elements and layout

## The Drip Emitters

**Geoflow offers two different emitters, the Classic and the PC.**


**WASTEFLOW Classic**


**WASTEFLOW PC**

**Each dripper has a filter built in at the entry port to to keep particles out.**


**Turbulent flow path**

**Effluent travels through a turbulent flow path that helps keep any fine particles from settling inside the dripper.**

**CUTAWAY OF THE PC EMITTER**


**Dose mode – When pressurized, the rubber diaphragm flexes across the compensating chamber to regulate flow across 7 to 60 psi.**


**Flushing mode – As the pump is powered on and off again, the rubber diaphragm relaxes across the exit hole enabling the dripper to self-flush every cycle.**



## Geoflow Team

The people at Geoflow are the subsurface drip *experts*. We offer training, answers to your questions, and support every step of the way from concept through design and installation.

***Geoflow dripline comes with an unprecedented 10-year limited warranty for root intrusion, workmanship and materials.***

**GEOFLOW, INC.**
506 Tamal Plaza
Corte Madera, CA 94925
**www.geoflow.com**

Tel: (800) 828-3388
Fax: (415) 927-0120

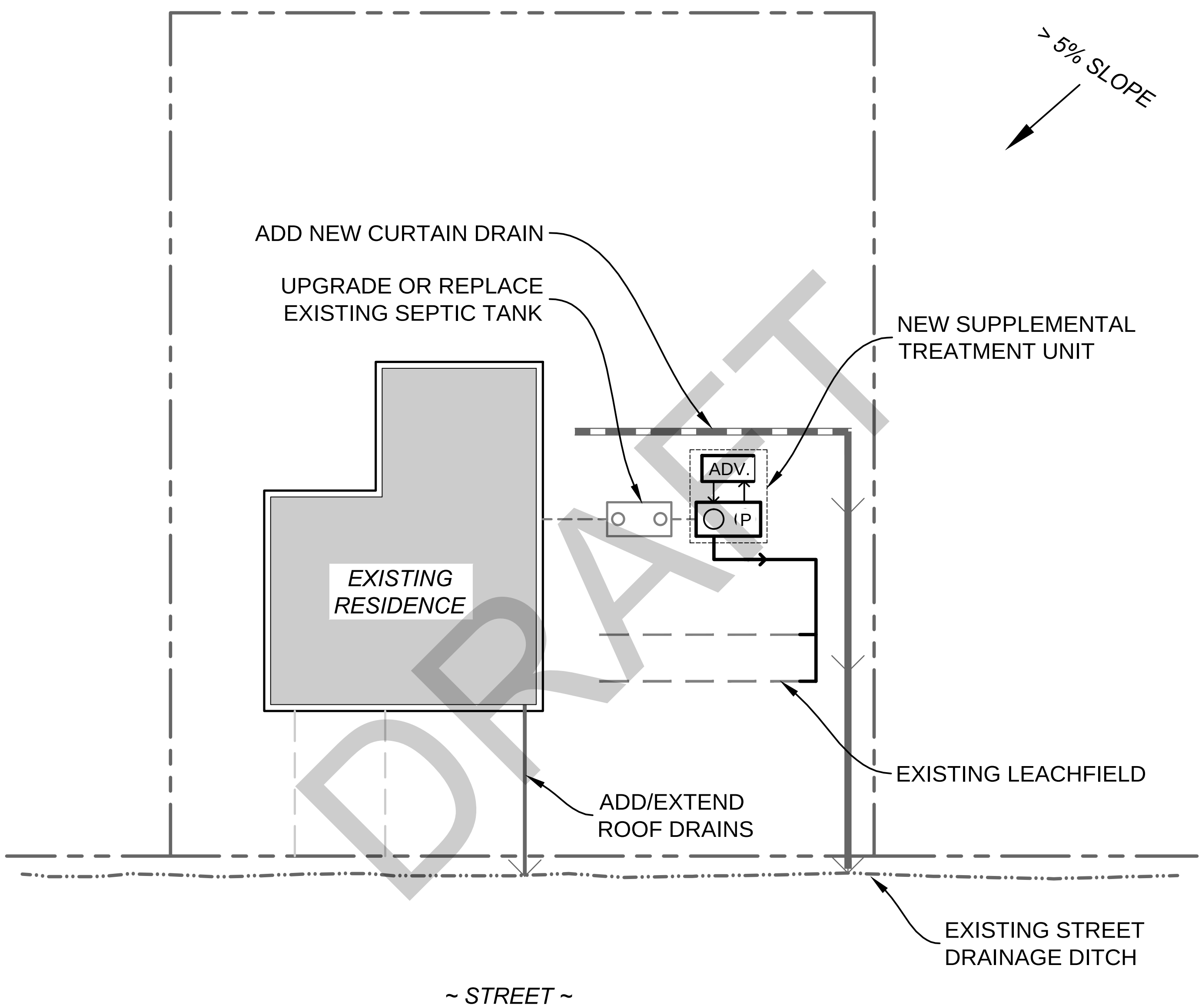


GEOFLOW
SUBSURFACE DRIP SYSTEMS

*Look for the purple stripe on the tubing to be sure you are getting Geoflow!*

Appendix B

# Onsite System Upgrade Options and Cost Estimates




**WOODACRE/SAN GERONIMO FLATS WASTEWATER FEASIBILITY STUDY**

WOODACRE, CALIFORNIA


QUESTA ENGINEERING CORP.
Civil, Environmental & Water Resources
(510) 236-6114
FAX (510) 236-2423
questa@questaec.com
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807


| Sht: | Rev: | Date: | By: | Description: | App'd: |
| --- | --- | --- | --- | --- | --- |

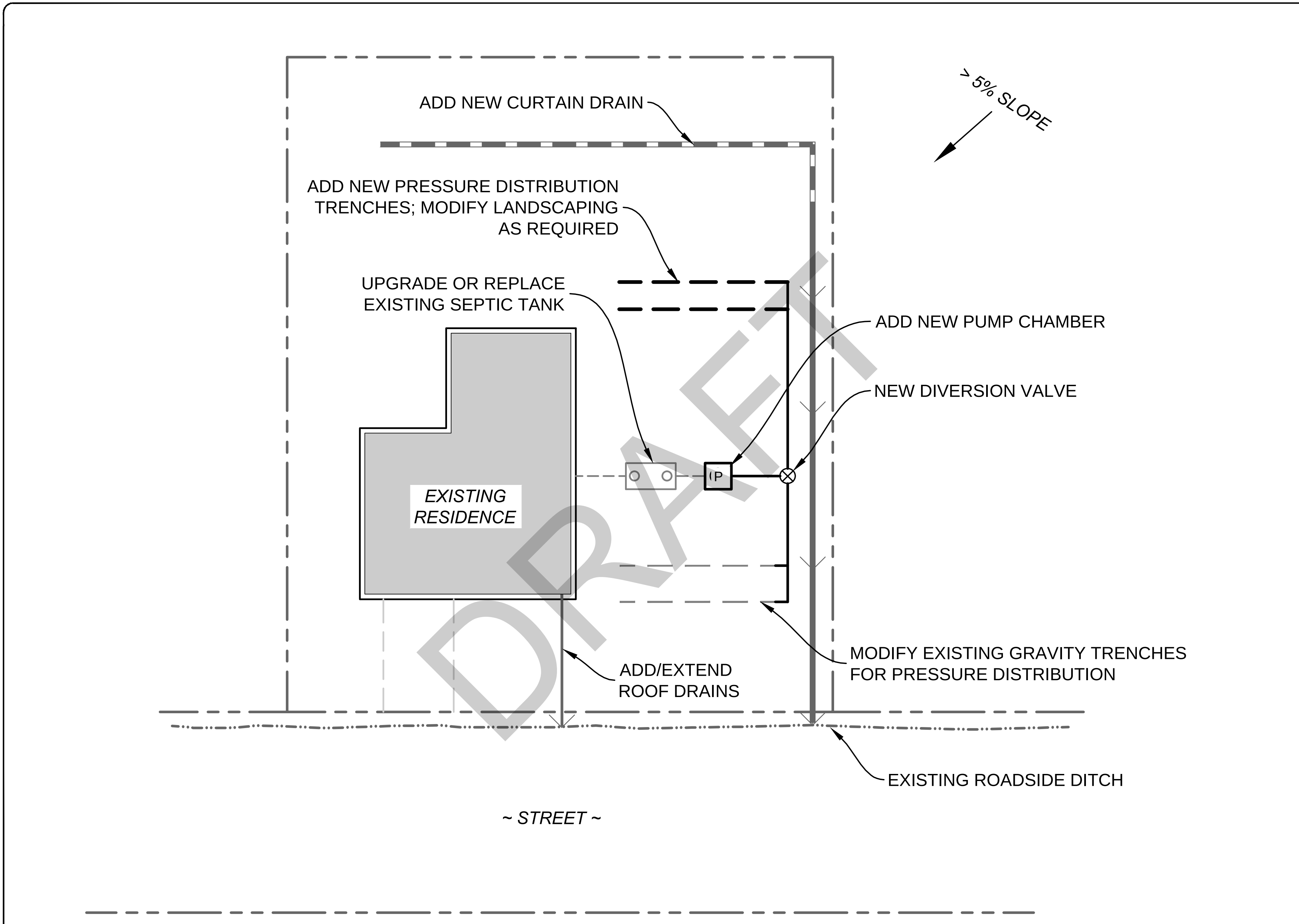
Design: NH/PP
Drawn: ML
Checked: PP
Appr'd: NH

**ON-SITE UPGRADE EXAMPLE**

***TREATMENT AND DRAINAGE***

Size: D
Project: 1600073
Scale: AS NOTED
FIGURE: B-1


LAST SAVED: 3/6/2017 PLOT DATE: 3/6/2017
P:\2016\1600073_WOODACRE_WASTEWATER\CAD\MODEL\TYPICAL LOT LAYOUTS.DWG

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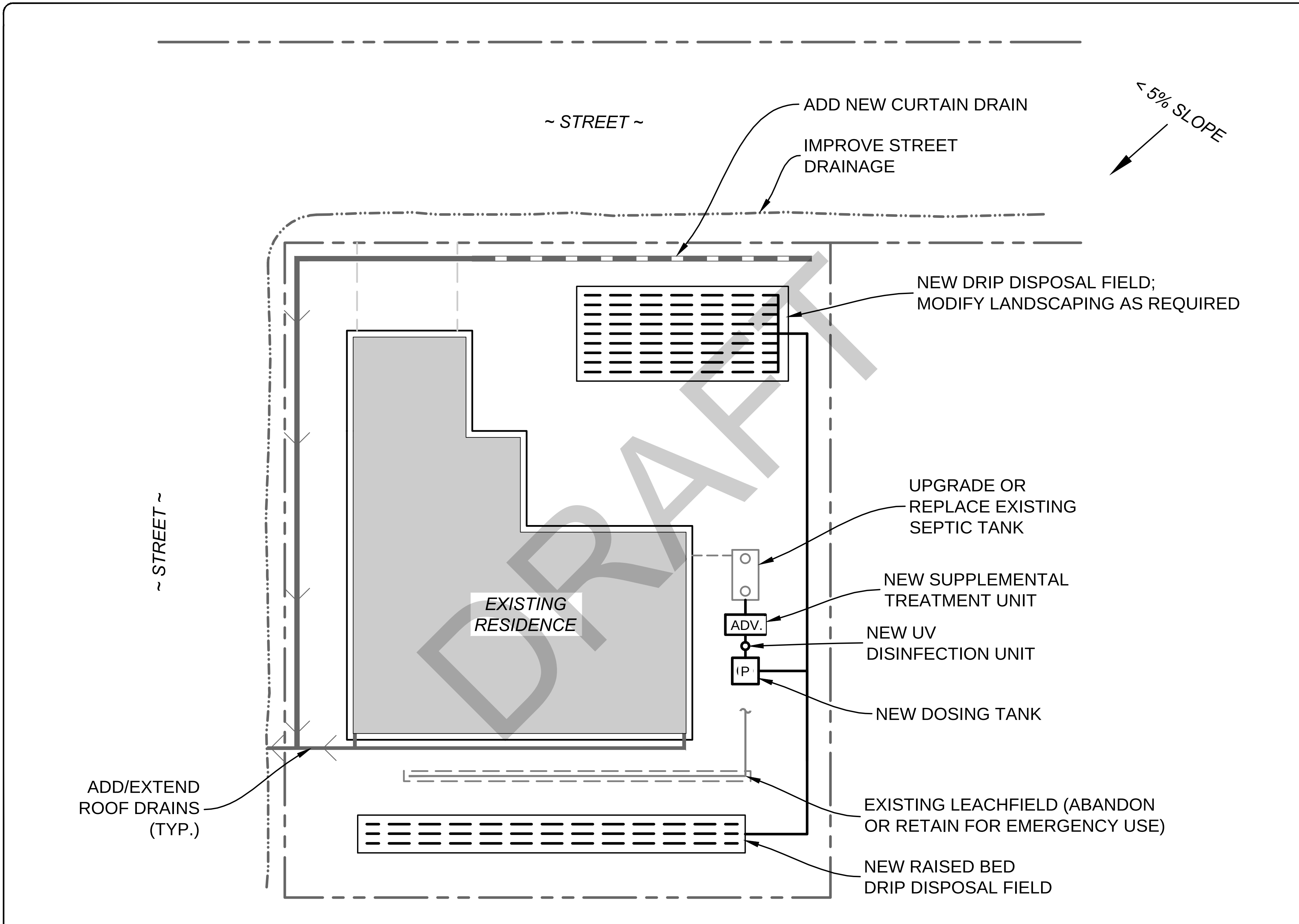
| --- | --- | --- | --- | --- | --- |
| | | | | | |

Design: NH/PP
Drawn: ML
Checked: PP
Appr'd: NH

**ON-SITE UPGRADE EXAMPLE**
***DISPOSAL FIELD AND DRAINAGE***

Size: D
Project: 1600073
Scale: AS NOTED
FIGURE: B-2

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| Sht: | Rev: | Date: | By: | Description: | App'd: |
|---|---|---|---|---|---|
| | | | | | |

Design: NH/PP
Drawn: ML
Checked: PP
Appr'd: NH

**ON-SITE UPGRADE EXAMPLE**

***TREATMENT, DISPOSAL FIELD, & DRAINAGE***

Size: D
Project: 1600073
Scale: AS NOTED
FIGURE: B-3

## Preliminary Construction Cost Estimate
## Alternative 2 - Onsite Upgrades & Management Program

### MODERATE LEVEL WORK
### Add Supplemental Treatment & Drainage Improvements

| ITEM | UNIT | QTY | UNIT COST ($) | TOTAL COST ($) |
|---|---|---|---|---|
| **I. SITE PREPARATION & MOBILIZATION** | LS | 1 | | $1,500 |
| | | | | |
| **II. SEPTIC TANK** | | | | |
| Inspect, waterproof, upgrade risers, inlet & outlet | LS | 1 | | $1,000 |
| | | | | |
| **III. SUPPLEMENTARY TREATMENT** | | | | |
| Install AdvanTex & Controls | LS | 1 | | $9,500 |
| | | | | |
| **IV. DISPERSAL SYSTEM - EXISTING GRAVITY** | | | | |
| Inspect, add observation wells, pipe connections | LS | 1 | | $1,000 |
| | | | | |
| **V. DRAINAGE IMPROVEMENTS** | | | | |
| Install new curtain drain | LF | 100 | 75 | $7,500 |
| Surface drainage improvments | LS | 1 | | $1,500 |
| | | | | |
| **VI. ELECTRICAL** | LS | 1 | | $1,500 |
| | | | | |
| **VII. SITE RESTORATION & DEMOBILIZATION** | LS | 1 | | $1,500 |
| | | | | |
| **VII. INSPECTION/TESTING** | LS | 1 | | $500 |
| | | | | |
| **IX. PERMITTING** | LS | 1 | | $2,000 |
| | | | **TOTAL** | $27,500 |

**Preliminary Construction Cost Estimate**
**Alternative 2 - Onsite Upgrades & Management Program**

**MODERATE LEVEL WORK**
**Add PD Leachfield & Drainage Improvements**

| ITEM | UNIT | QTY | UNIT COST ($) | TOTAL COST ($) |
|---|---|---|---|---|
| **I. SITE PREPARATION & MOBILIZATION** | LS | 1 | | $1,500 |
| | | | | |
| **II. SEPTIC TANK** | | | | |
| Inspect, waterproof, upgrade risers, inlet & outlet | LS | 1 | | $1,000 |
| | | | | |
| **III. CONVERT/ADD NEW PD LEACHFIELD** | | | | |
| New dosing tank | LS | 1 | | $5,000 |
| Dosing pump & controls | LS | 1 | | $2,500 |
| New PD leachfield | LF | 100 | 50 | $5,000 |
| Modify existing leachfield piping | LS | 1 | | $500 |
| | | | | |
| **V. DRAINAGE** | | | | |
| Install new curtain drain | LF | 100 | 75 | $7,500 |
| Surface drainage improvements | LS | 1 | | $1,500 |
| | | | | |
| **VI. ELECTRICAL (UPGRADE)** | LS | 1 | | $1,500 |
| | | | | |
| **VII. SITE RESTORATION & DEMOBILIZATION** | LS | 1 | | $1,500 |
| | | | | |
| **VII. INSPECTION/TESTING** | LS | 1 | | $500 |
| | | | | |
| **IX. PERMITTING** | LS | 1 | | $2,000 |
| | | | **TOTAL** | $30,000 |

**Preliminary Construction Cost Estimate**
**Alternative 2 - Onsite Upgrades & Management Program**
**HIGH CONSTRAINTS AND WORK LEVEL**

**Add Treatment, Drip Field & Drainage Improvements**

| ITEM | COST RANGE ($) | |
|---|---|---|
| | Low Estimate | High Estimate |
| **I. SITE PREPARATION & MOBILIZATION** | $1,500 | $1,500 |
| | | |
| **III. SEPTIC TANK** | | |
| Inspect, waterproof, upgrade risers, inlet & outlet | $1,000 | |
| Abandon existing septic tank | | $1,500 |
| Install new septic tank | | $5,500 |
| | | |
| **IV. SUPPLEMENTARY TREATMENT** | | |
| AdvanTex & Controls | $9,500 | $9,500 |
| UV Unit | | $1,000 |
| | | |
| **IV. DRIP DISPERSAL SYSTEM** | | |
| Dosing Tank | $4,500 | $5,000 |
| Pump and Controls | $2,500 | $2,500 |
| Drip Piping and Valves | $2,500 | $3,500 |
| Raised Bed Soil Fill | | $5,000 |
| | | |
| **V. DRAINAGE IMPROVEMENTS** | | |
| Install new curtain drain | $7,500 | $7,500 |
| Surface drainage improvements | $1,000 | $1,500 |
| | | |
| **VII. ELECTRICAL (UPGRADE)** | $1,500 | $1,500 |
| | | |
| **VIII. SITE RESTORATION & DEMOBILIZATION** | $1,500 | $2,500 |
| | | |
| **VIIII. INSPECTION/TESTING** | $1,000 | $1,000 |
| | | |
| **IX: PERMITTING** | $2,000 | $2,000 |
| **TOTAL** | $36,000 | $51,000 |

## Estimated Capital Costs
## Alternative 2 - Onsite System Upgrade and Management Program

| Upgrade Work Category | Number of Systems | Average Cost per System | Total Cost ($) |
|---|---|---|---|
| Low Level | 55 | $3,000 | $165,000 |
| Moderate Level | 44 | $28,750 | $1,265,000 |
| High Level | 264 | $43,500 | $11,484,000 |
| | | **Subtotal** | **$12,914,000** |
| | | **Contingency @ 15%** | $1,937,100 |
| | | **Subtotal** | **$14,851,100** |
| | | **Engineering and Environmental Studies @ 15%** | $2,227,665 |
| | | **Construction Management @ 10%** | $1,485,110 |
| | | **Project Admin, District Formation and Financing @ 5%** | $742,555 |
| | | **TOTAL** | **$19,306,430** |
| | | **Average Cost Per Connection (363 parcels)** | **$53,186** |

## Estimated Annual Operation and Maintenance Costs

## Alternative 2 - Onsite System Upgrade and Management Program

| Items | Assumptions | Estimated Annual Cost ($) |
|---|---|---|
| District/Program Administration | Insurance, legal, financial, permits @ $150/parcel | $54,500 |
| On-lot System Inspection, Monitoring & Reporting | Annual inspection of all systems, remote monitoring, data compilation, annual reporting, as-needed engineering consultation @ $300 ea | $108,900 |
| Maintenance | Equipment, materials, maintenance & replacement @ $200/yr each | $72,600 |
| Laboratory & Expenses | Sampling 20% of individual treatment systems annually, surface and groundwater sampling, travel expenses and supplies | $36,000 |
| Electrical* | Property owner expense for treatment & dispersal pumps and other electro-mechanical items @ $30/yr | $10,900 |
| Septic Tank Pumping* | 25% of tanks pumped annually @ $400 each | $36,000 |
| | **Subtotal** | **$318,900** |
| | Contingencies (@ 10%) | $31,890 |
| | **TOTAL** | **$350,790** |
| | **ANNUAL COST PER PARCEL (363)** | **$966** |

* Direct cost to property/system owner, varies according to system use

Appendix C

# Fire Road Community Leachfield Information

# APPENDIX C

# FIRE ROAD COMMUNITY LEACHFIELD - ALTERNATIVE 3

The following information regarding site conditions and community leachfield options at the Fire Road site is from the 2011 Woodacre Flats Wastewater Feasibility Study.

## Fire Road Site Conditions

As part of the 2011 Woodacre Flats Wastewater Feasibility Study, field reconnaissance investigations were conducted on several large properties in the Woodacre area to identify sites that might be suitable and of sufficient size to accommodate a community wastewater disposal system. A few potential sites were located on the Dickson Ranch property and on lands owned by the Tamalpais Union High School District, east of Woodacre. Based on the amount of area, soil conditions, and land owner interests and concerns, the most promising site identified was an approximately 1.5-acre wooded knoll on Dickson Ranch property located along the Fire Road ridgeline. This is referred to as the Fire Road Site and, from preliminary analysis, was estimated to have sufficient capacity to accommodate a community leachfield system of the size required to serve the Woodacre Flats area.

The Fire Road Site was initially identified as a potential area of interest from review of air photos, and topographic and geologic maps. It lies on a portion of the ridgeline composed of sandstone. The area considered suitable for a community leachfield a 1.5-acre knoll, extending approximately 1,000-feet along the ridgeline in a southeast-northwest direction, sloping predominantly to the north and northeast at grades varying from about 5 to 20 percent. A small portion of the site (estimated 5 to 10 percent) drains in a southwesterly direction toward Woodacre. Immediately north of the knoll, the slopes steepen considerably to greater than 30%, which continue downhill to San Geronimo Valley Drive. The knoll is wooded, mostly with bay trees, a few oaks and Douglas fir, and two distinct clusters of redwoods. There is a limited amount of understory vegetation. The steeper hillslopes to the north and northeast are densely wooded, with predominantly with redwoods and Douglas fir. There is no development on the site or on any lands between the site and San Geronimo Valley Drive.



As a result of its topographically high position, there are no watercourses on or within 200 to 300 feet of the Fire Road site. Runoff from the site is dispersed by sheet flow, and is slowed by the gentle slopes, vegetative cover, and sandy soil conditions. Farther down the hillslope to the north and northeast, swales form which eventually become seasonal drainages at the base of the hillslope near San Geronimo Valley Drive. There are no known wells on the site or in the immediate vicinity. The nearest well an agricultural supply well located approximately 600 feet to the southeast.

Following initial hand-auger soils inspection, four exploratory test pits were excavated in the Fire Road site by Questa on June 4, 2010, to evaluate soil suitability for wastewater disposal. Test pit locations are shown in **Figures C-1, C-2** and **C-3**. All test pits showed similar soil conditions, consisting of loam and sandy loam topsoils underlain by highly weathered sandstone to the depth explored. No groundwater or evidence of seasonal saturation was observed in any of the profiles. **Table C-1** summarizes the soil profiles logs.

**Table C-1: Soil Profile Summary, Fire Road Site**

| Test Pit # | Depth (inches from surface) | Soil Description |
|---|---|---|
| T-1 | 0 - 21 | Loam |
| | 21 - 66 | Very weathered sandstone |
| | 66 - 90 | Very weathered sandstone, increasing density |
| | | |
| T-2 | 0 – 24 | Fine sandy loam |
| | 24 – 66 | Highly weathered sandstone; textures to sandy clay loam |
| | 66 - 78 | Weathered sandstone, very soft and friable |
| | | |
| T-3 | 0 - 16 | Loam to sandy loam |
| | 16 – 72 | Weathered sandstone, variable from sandy loam to sandy clay |
| | | |
| T-4 | 0 – 28 | Sandy loam |
| | 28 - 60 | Very weathered sandstone; textures to sandy loam |



No percolation testing conducted; however, based on the observed sandy soil conditions and experience with other similar soils in the Woodacre area, soil percolation rates are estimate to be in the range of 5 to 15 minutes per inch (MPI), with faster rates in the upper 2 to 3 feet and becoming slower with depth. These percolation rates would be suitable for disposal of either primary/septic tank effluent or secondary treated wastewater effluent, making the site feasible for a variety leachfield designs, including standard and pressure distribution trenches (2 to 5-feet deep), mound systems, or subsurface drip dispersal. Formal percolation testing in accordance with standard Marin County procedures should be conducted prior to final project selection and design to verify percolation rates and leachfield sizing for the service area and wastewater flows to be accommodated.

**Community Leachfield Options**

Based on the favorable soil and site conditions along with the amount of available land area, several different design options and configurations were considered for the Fire Road site. This resulted in the development of three different community leachfield options, identified as Alternatives 3A, 3B and 3C, and illustrated in **Figures C-1, C-2** and **C-3**, respectively. The following briefly describes these alternatives.

- **Alternative 3A.** The first Fire Road option is a shallow pressure distribution leachfield system for disposal of septic tank effluent. The trenches would be constructed with the use of Infiltrator Chambers to eliminate the need for hauling large quantities of drain rock to the Fire Road site. The trenches would be 30-inches deep and 36-inches wide, with an effective wastewater application area of 5 ft$^2$ per lineal foot. This is based on the combination of 3-ft wide bottom area plus 12 inches sidewall area (two sides), following sizing criteria contained in the RWQCB Minimum Guidelines. Minimum trench spacing would be 6 feet (on centers); however a spacing of 10 feet was assumed to provide a reasonable margin of safety for avoidance of trees and other local incongruities in the topography. Using an average percolation rate of 10 minutes per inch (MPI) would give a wastewater loading rate of 0.8 gpd/ft$^2$, or 4.0 gpd/lineal foot of trench. Although the use of Infiltrator Chambers is recommended, if rock-filled trenches are preferred from a regulatory standpoint or for other reasons, the trench dimensions and overall sizing would be the same as presented above. No extra capacity credit is assumed for the use of Infiltrator Chambers in this analysis. The costs for rock-filled trenches and rock-hauling impacts would be greater than for the recommended Infiltrator Chamber design.

The available disposal area at the Fire Road site is estimated to be approximately 65,000 to 66,000 square feet, which would accommodate approximately 6,500 to 6,600 lineal feet of trench at 10-foot o.c. trench spacing. At the above wastewater loading assumptions, leachfield capacity could be provided up to approximately 26,400 gpd.

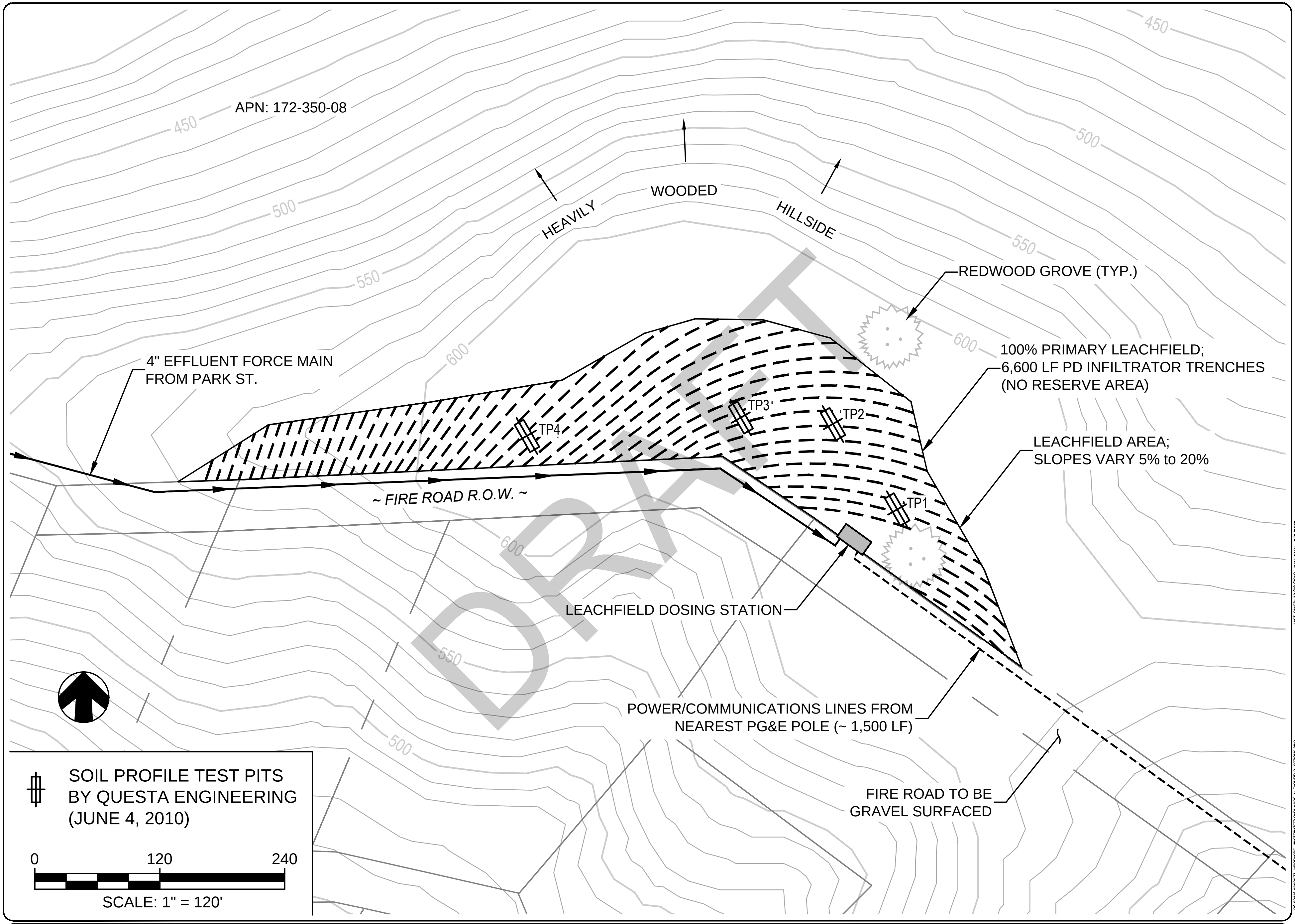
- **Alternative 3B.** The second option considered for Fire Road included a secondary treatment system that would have the effect of reducing the required leachfield area by one-half compared with Alternative 3A. Using the same pressure distribution system design as for Alternative 3A (including Infiltrator Chambers), the wastewater loading rate would increase two-fold from 0.8 to 1.6 gpd/ft$^2$. This would increase the loading rate to 8 gpd/ft$^2$, and increase the overall disposal capacity of the site. Using the same trench spacing of 10 feet o.c., the leachfield would occupy approximately half of the available disposal area, leaving enough unused area to serve as a 100% replacement area.

  The assumption of a higher wastewater loading rate for dispersal of secondary treated water is derived from Marin County regulations (in effect since 1996) and is supported in technical literature (e.g., U.S. EPA Onsite Wastewater Treatment Systems Manual, 2002). Marin County regulations authorize increased leachfield loading rates (as compared with standard septic tank effluent) for systems that include advanced treatment using either an intermittent sand filter, recirculating sand filter, or packed bed filter such as AdvanTex. For soils with percolation rates up to 90 minutes per inch, the application rate may be increased up to two times the standard rate for septic tank effluent. The scientific rationale is that wastewater with low organic strength (low BOD) reduces the amount of organic material delivered to the soil absorption field, and promotes the maintenance of aerobic soil conditions and microbial populations that are more efficient (as compared with anaerobic bacteria) in assimilating the organic materials in the effluent. The net result is reduced soil clogging and better water transmission through the soil.

- **Alternative 3C.** Using the same secondary treatment system as 3B, Alternative 3C would include a subsurface drip dispersal system in lieu of the shallow pressure distribution leachfield system included in the other two Fire Road alternatives.

  The drip dispersal system uses a specially manufactured dripline, such as Geoflow Wasteflow™, developed for wastewater applications. Technical literature describing subsurface drip dispersal equipment and design/installation procedures is provided in **Appendix A.** In brief, the dripline consists of 1-inch diameter polyethylene tubing with pressure-compensating emitters spaced 12 to 24 inches apart. The driplines are typically installed at a depth of 6 to 12 inches in below ground surface, and up to 18 inches in wooded areas. Spacing between driplines depends is typically 24 inches, although it can be varied around vegetation. The drip dispersal system would be organized into a series of zones (of roughly equal disposal capacity) to be dosed from the central wastewater effluent dosing station at the disposal site.

The sizing and design of the drip field would follow criteria contained in Marin County sewage disposal regulations and manufacturer recommendations. The sandy/loamy soil conditions at the site would warrant a wastewater application rate in the range of 0.6 to 1.0 gpd/$ft^2$, based on the surface area of the disposal field. Using an average value of 0.8 gpd/$ft^2$, the required disposal area for a design flow of 26,400 gpd would be about 33,000 square feet. Including an additional 100% reserve field, the required area would be double, or about 66,000 square feet. The estimated 65,000 to 66,000 square feet at the Fire Road site would accommodate both a 100% primary and 100% reserve drip field, or dual alternating fields.

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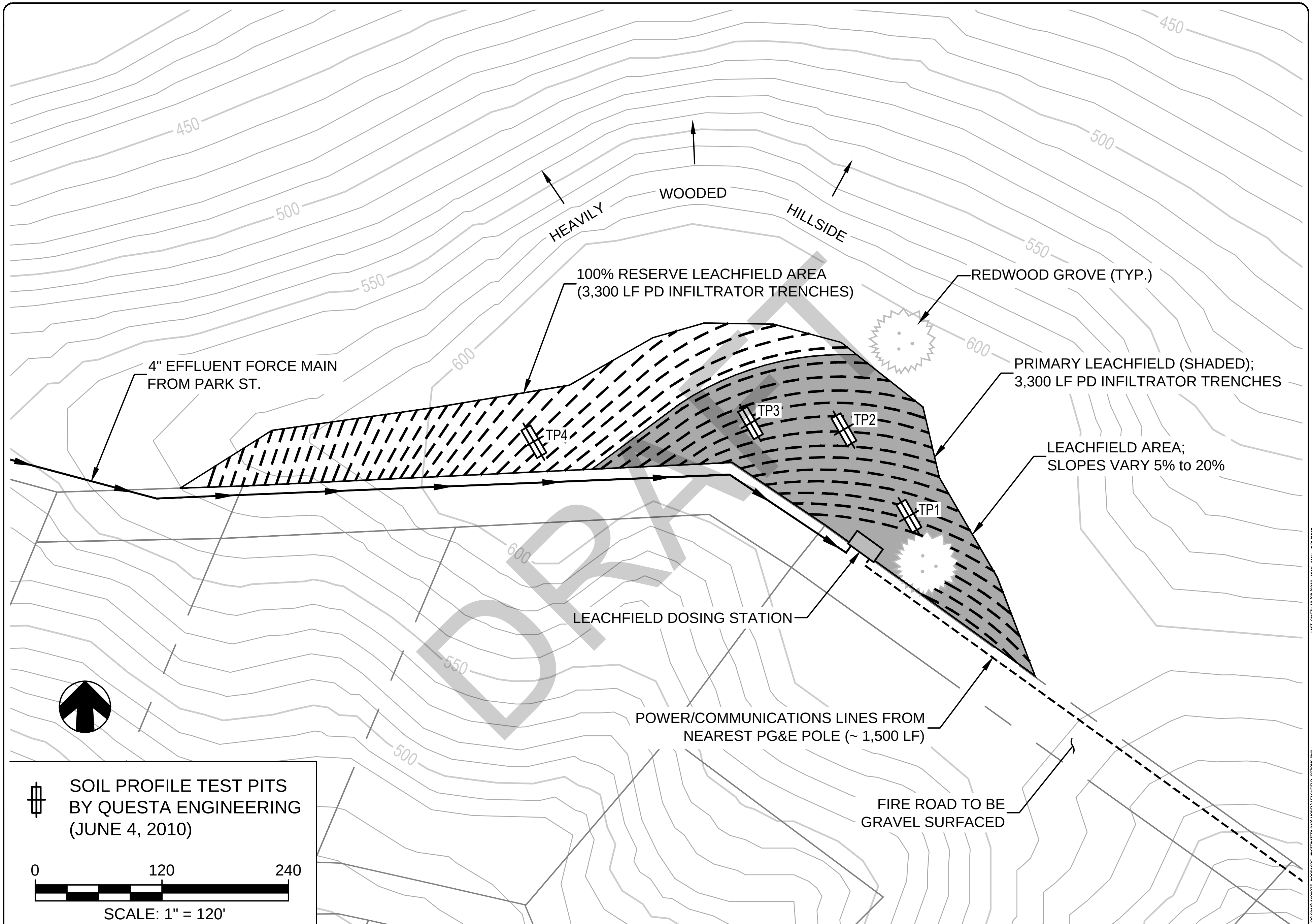
**ALTERNATIVE 3A - FIRE RD LEACHFIELD**
***PRIMARY TREATMENT - PD LEACHFIELD***

Size: D
Project: 1600073
Scale: AS NOTED
FIGURE: C-1

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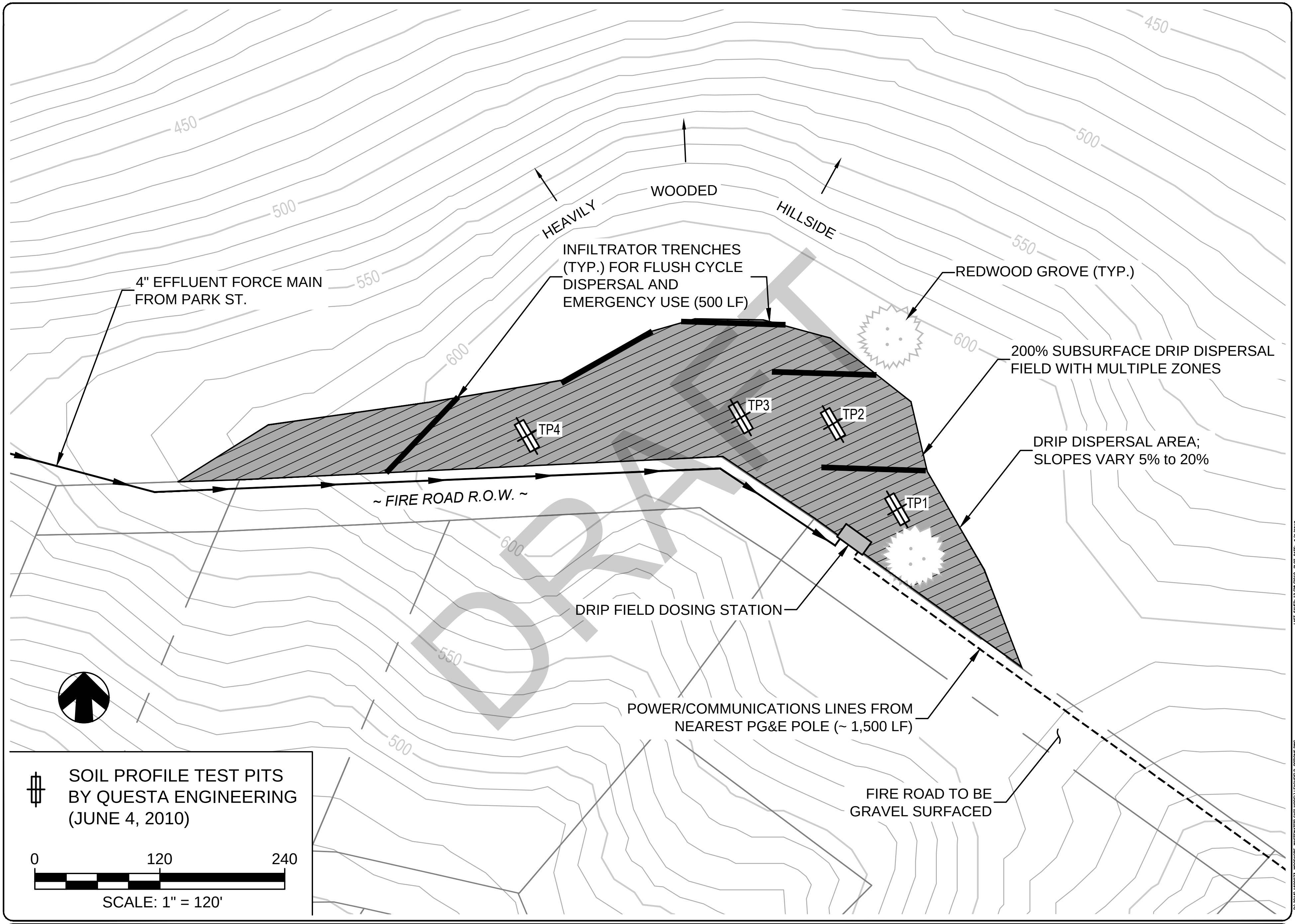
**ALTERNATIVE 3B - FIRE RD LEACHFIELD**
***SECONDARY TREATMENT - PD LEACHFIELD***

Size: D
Project: 1600073
Scale: AS NOTED
FIGURE: C-2

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Appr'd: NH

**ALTERNATIVE 3C - FIRE RD LEACHFIELD**

***SECONDARY TREATMENT - DRIP DISPERSAL***

Size: D
Project: 1600073
Scale: AS NOTED
FIGURE: C-3

# Appendix D

# Wastewater Collection Systems

# APPENDIX D
# WASTEWATER COLLECTION SYSTEMS

## 1.0 INTRODUCTION

Provided here is a review of different methods of sewage collection for use in connection with a community wastewater system for the Woodacre-San Geronimo Flats study area. The basic types of sewage collection methods reviewed include:

- Conventional Gravity Sewers
- Pressure Sewers, with individual grinder pumps
- Small Diameter Effluent Sewers, including Septic Tank Effluent Pump (STEP) and Gravity (STEG).

Included are a general overview of each type of sewage collection system, along with typical advantages, disadvantages and operation and maintenance for each method. Preliminary layouts of collection system options for Woodacre and San Geronimo sub-areas are provided based on review of topographic mapping of the service area, supplemented with field reconnaissance inspections. These represent best professional judgement of the range of options for sewage collection suitable for feasibility analysis. Further study during project design could reveal changes in alignments or other refinements that may result in improvements or cost savings. The collection system layouts provide the information needed to define the expected routing of sewer lines, estimation of the need for individual pump systems, and the probable locations of sanitary lift station(s). The information also provides basic data for preliminary hydraulic analysis of pumping requirements and an estimation of pipe sizes and corresponding costs.

## 2.0 CONVENTIONAL GRAVITY SEWERS

### General Description

In a conventional gravity sewer, untreated wastewater travels through a system of sewer pipes installed at a minimum grade to maintain gravity flow. Sewer pipes are usually six or eight-inch minimum diameter, with four-inch diameter lateral connections from buildings, and typically require a minimum of 4.5 feet of backfill cover. Pipe and fitting material can be PVC, ABS, high density polyethelyene (HDPE) or ductile iron. Conventional gravity sewers require manholes generally: (a) at all intersections of sewer lines other than side sewer connections less than six inches in diameter; (b) at all vertical or horizontal angle points; and (c) at intervals not greater than 400 feet. Manholes provide access for maintenance and cleaning. Since conventional gravity sewers require a constant downhill grade, gravity sewer mains may need to be installed at considerable depths where the terrain is flat or undulating.

## Advantages and Disadvantages

***Advantages***

Conventional sewers are normally cost effective and appropriate in densely developed areas. The primary advantage of conventional sewers is the proven long-term reliability, long service life, and relatively low operation and maintenance (O&M) costs. Maintenance requirements for gravity sewers consist of routine cleaning of the sewer pipes and maintenance of lift stations. Another advantage is that construction techniques for conventional gravity sewers are familiar to most construction contractors and maintenance personnel.

***Disadvantages***

The typical disadvantages of conventional gravity sewers include costly and infeasible construction due to sparse population, flat terrain, high groundwater, shallow bedrock, or unstable soils. Infiltration from groundwater leaking into the sewers and inflow from direct storm water runoff into the sewers are an almost unavoidable component of conventional gravity sewers. Infiltration and inflow (I/I) may burden the treatment facility with sewage flows beyond capacity during wet weather. However, I/I can be at mitigated by using high-quality pipe materials and construction along with an ongoing preventative maintenance program.

## Operation and Maintenance

Operation and maintenance activities for a conventional gravity sewer system consist of cleaning the sewers, monitoring sewers for illegal inflow connections, and pump station operation and maintenance. Pump station O&M involves repair and maintenance of mechanical, electrical and structural equipment. Access for cleaning is provided by manholes (6-inch and 8-inch gravity sewers) and by clean-outs (for 4-inch laterals). Cleaning of gravity sewers may require removal of obstructions from time to time, as well as flushing. Video inspection of sewer lines is also typically performed periodically as a preventative measure and/or to investigate specific sections of sewer lines.



# 3.0 PRESSURE SEWERS

## General Description

Pressure sewers are one of the most popular and successful alternatives to conventional gravity sewers. A pressure sewer is a small diameter pipeline, which is installed following the profile of the ground. Typical main diameters are 2 to 6 inches, and PVC and HDPE are the usual piping material. Burial depths usually have a 30-inch minimum cover.

In residential areas served by a pressure sewer, each home uses a small grinder pump to discharge to the main line (**Figure D-1**). A typical grinder pump and connection detail is provided in **Figure D-1**. The pump grinds the solids in the wastewater into slurry in the manner of a kitchen sink garbage grinder. Grinder pumps to serve individual homes usually range from one to two-horsepower in size. Installations using duplex (2) pumps and/or large horsepower motors can be used to serve several homes with one pumping unit. Multifamily and commercial properties may make use of duplex pump stations designed for larger flows.

The service line leading from the pumping unit to the main is usually 1.25-inch diameter PVC or HDPE. A check valve on the service line prevents backflow, which is insured with a redundant check valve at the pumping unit. If a malfunction occurs, a high liquid level alarm is activated. This alarm may be a light mounted on the outside wall of the home, or it may be an audible alarm that can be silenced by the resident. In the instance of an activated alarm, the resident would notify the sewer service district, which would respond to make the necessary repair.

Where the terrain and land area favorable, pressure sewer systems can also be designed in a “cluster” configuration, where small groups of houses have gravity sewers leading to a common grinder pump unit/station for each “cluster”. The cluster grinder pump units all discharge into the pressure sewer main, which may also have connections from individual grinder pump units.

## Advantages and Disadvantages

***Advantages***

With a typical pipe depth of about 36 inches, pressure sewers eliminate the need for the deep excavation, multiple lift stations, and groundwater dewatering and shoring involved in the installation of conventional gravity sewers. The shallow depth, positive pressure, and tight-glued PVC joints or fused HDPE joints also prevent groundwater infiltration and exfiltration, and substantially reduce the potential for stormwater inflow. In many instances, small diameter HDPE pipe can be installed using Horizontal Directional Drilling (HDD) methods, which is typically much less expensive than open-cut trench installation, and greatly reduces the impacts to road pavement, traffic interruption, and hauling requirements for trench bedding material and excvated soils.



***Disadvantages***

The main disadvantage of pressure sewers is the added complexity of the large number of pumps and controls that would have to be installed and maintained at the individual residences. Most modern grinder pump units are very reliable, have a relatively long service life, and include built-in alarms to alert the homeowner in the event of a pump failure. Nevertheless, the impact during extended power outages is much greater with pressure sewers due to limited reserve storage at individual pump units and lack of readily available back-up power. Grinder pump units normally provide emergency storage capacity of about 50 to 100 gallons, unless an additional storage tank is added. Some sanitary districts require grinder pumps to be installed with a transfer switch to allow pump operation using a portable generator. Larger commercial or multi-family complexes can be equipped with an automatic backup generator.

Another disadvantage of pressure sewers is the greater reliance upon on-lot facilities. The facilities located on private property require access easements for system maintenance or repair, and much more ongoing interaction with property owners and attention to public relations by the sewer district personnel.

## Operation and Maintenance

On-lot grinder pumps require periodic maintenance and cleaning, which are normally handled by the sewer district; the associated electrical energy costs are absorbed directly by the property owner. Additionally, high-pressure flushing of the pressure sewer lines may be required every few years to scour slime and solids buildup.

# 4.0 SMALL DIAMETER EFFLUENT SEWERS – PUMP (STEP) AND GRAVITY (STEG)

## General Description

Small diameter, septic tank effluent pump (STEP) and gravity (STEG) sewers are a popular alternative, especially for low density areas and to minimize sewer pipe sizes and deep trench construction. Unlike conventional sewers, primary treatment is provided at each connection by a septic tank, and only the settled wastewater is collected. Where the terrain is appropriate, the septic tank effluent can be collected by gravity flow (STEG system) in a common small diameter collection main. Where the terrain is flat or undulating individual pumping units (STEP) can be used. In these cases, each connection includes one or more effluent pumps located either in the septic tank or in a separate pump chamber. The septic tank effluent is then pumped into a small diameter force main (2 to 4-inch PVC or HDPE). Grit, grease, and other troublesome solids which might cause obstructions in the pumps or collector mains are separated from the waste flow and retained in septic tanks installed upstream of each connection. With the solids removed, the collector main need not be designed to carry solids, unlike conventional sewers. **Figure D-3** illustrates typical STEP/STEG sewer layout; **Figure D-4** provides details of a typical STEP unit.

Where the terrain and land area favorable, STEP/STEG systems can also be designed in a “cluster” configuration, where small groups of houses have gravity sewers leading to a common septic tank and pumping unit for each “cluster”. The cluster STEP units all discharge into the STEP pressure main, which may also have connections from individual STEP units.

## Advantages and Disadvantages

### *Advantages*

Effluent STEP/STEG sewers have many of the same advantages cited for pressure sewers. An added advantage is the absence of solids in the sewer lines, since the solids are retained in septic tanks. This reduces the stress on pumping facilities and eases the passage of wastewater through the system. The removal of solids from the waste flow also significantly reduces the load on the treatment plant. Because of their smaller size, reduced gradients and lack of manholes, STEP/STEG systems can also have a distinct cost advantage over conventional gravity sewers where adverse conditions create excavation problems or where roadway restoration costs in developed areas can be excessive.

### *Disadvantages*

STEP/STEG sewers usually are not well suited in high-density developments because of the cost of installing and maintaining the septic tanks. Since sewage is maintained in an anaerobic or septic state in STEP/STEG systems, nuisance gases are produced that may cause odor problems at individual connections. However, the venting of odors is no different from the conditions with individual septic systems; odors are vented through the house plumbing stacks. Another disadvantage of STEP/STEG sewers is the reliance on septic tank pump-outs and disposal of septage. Accumulated digested sludge and scum must be removed from the septic tank and disposed of on a periodic basis (every three to five years, on average). Although this is no different from existing conditions where onsite septic systems used.

The main disadvantage of STEP sewers is the added complexity of the large number of pumps and controls that would have to be installed and maintained at the individual residences. Most modern STEP units are very reliable, have a relatively long service life, and include built-in alarms to alert the homeowner in the event of a pump failure. Nevertheless, the impact during extended power outages can be a concern with STEP sewers depending on the amount of reserve storage capacity provided at the STEP unit and lack of readily available back-up power. STEP units are normally configured to provide emergency storage capacity of about 100 to 200 gallons in the septic tank or a separate pump basin, which should normally be sufficient for a one to two-day power outage. Some sanitary districts require STEP units to be installed with a transfer switch to allow pump operation using a portable generator. Larger commercial or multi-family complexes can be equipped with an automatic backup generator.

Finally, as noted previously under the discussion of pressure sewers, STEP/STEG sewers require easements for maintenance and repair of on-lot facilities along with greater attention to public relations and considerable interaction between the district personnel and property owners.



## Operation and Maintenance

Operation and maintenance activities for a STEP/STEG sewer system consist mainly of septic tank pump-outs and maintenance, annual inspection and repair, and cleaning out of individual on-lot pump facilities, as needed. Because STEP collection lines are pressurized and do not transport any solids, solids accumulation and associated cleaning of the sewer lines are not normally required to the same degree as for conventional sewers.

# 5.0 COLLECTION SYSTEM LAYOUTS AND RECOMMENDATIONS

### Preliminary Collection System Layouts

The attached figures show the layout of various collection system options for Woodacre and San Geronimo service areas as follows.

- Figure D-5
- Figure D-6
- Figure D-7

- Figure D-8
- Figure D-9

## Recommendations

Following are recommended methods for sewage collection systems for Woodacre and San Geronimo service areas for different community wastewater system alternatives.

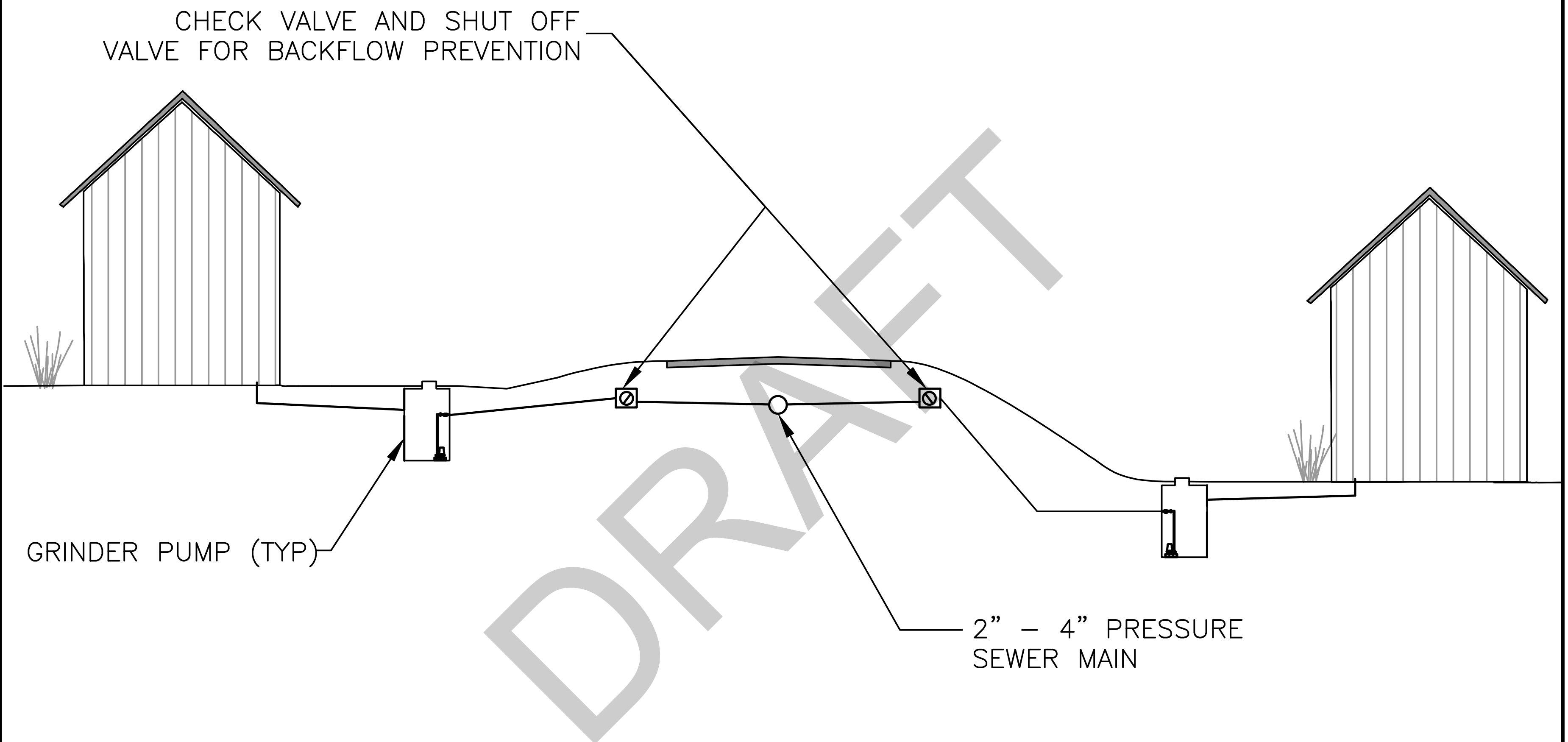
### *Project Alternative 3 – Fire Road Community Leachfield*

Sewage collection would be provided by a combination of septic tank effluent pump (STEP) and small diameter (4-inch) gravity effluent sewers. This would include the continued use of existing or upgraded on-lot septic tanks, cluster tanks for multiple properties in some cases, and a system of 2-inch to 4-inch diameter pressure piping to bring the septic tank effluent to a central treatment plant location at Park Street.

### *Water Recycling Alternatives 4 through 6*

**Woodacre.** The recommended sewage collection method for Woodacre is a conventional gravity system for most of the area, with a main lift station located at the northeast corner of Railroad Avenue and San Geronimo Valley Drive, and a force main from the lift station to the treatment plant at San Geronimo Golf Course. The force main would follow one of two alternative routes: (a) via San Geronimo Valley Drive to the west entrance to the Golf Course maintenance yard; or (b) via Railroad Avenue and Sir Francis Drake Boulevard. Because of the undulating terrain, a pressure sewer would be used for properties along Redwood Drive, tying in at the main lift station. The pressure sewer would eliminate the need for deep sewer construction and/or multiple lift stations that would be needed for a gravity sewer line in this area. The properties along the Redwood Avenue pressure sewer branch would all have individual on-lot grinder pumps.

**San Geronimo.** The recommended sewage collection method for San Geronimo is a pressure sewer system. The pressure sewer network would consist of 2-inch, 3-inch and 4-inch diameter pipes, running west-to-east on Sir Francis Drake Blvd, San Geronimo Valley Dr. and Meadow Way, eventually connecting together at San Geronimo Valley Drive before entering the golf course and following the maintenance road to the proposed wastewater treatment plant. Due to the flat and undulating terrain, which slopes steadily downstream, away from the golf course, analysis shows that gravity sewers would be a significantly more expensive option for San Geronimo, requiring deep trenching and multiple lift stations in the community.

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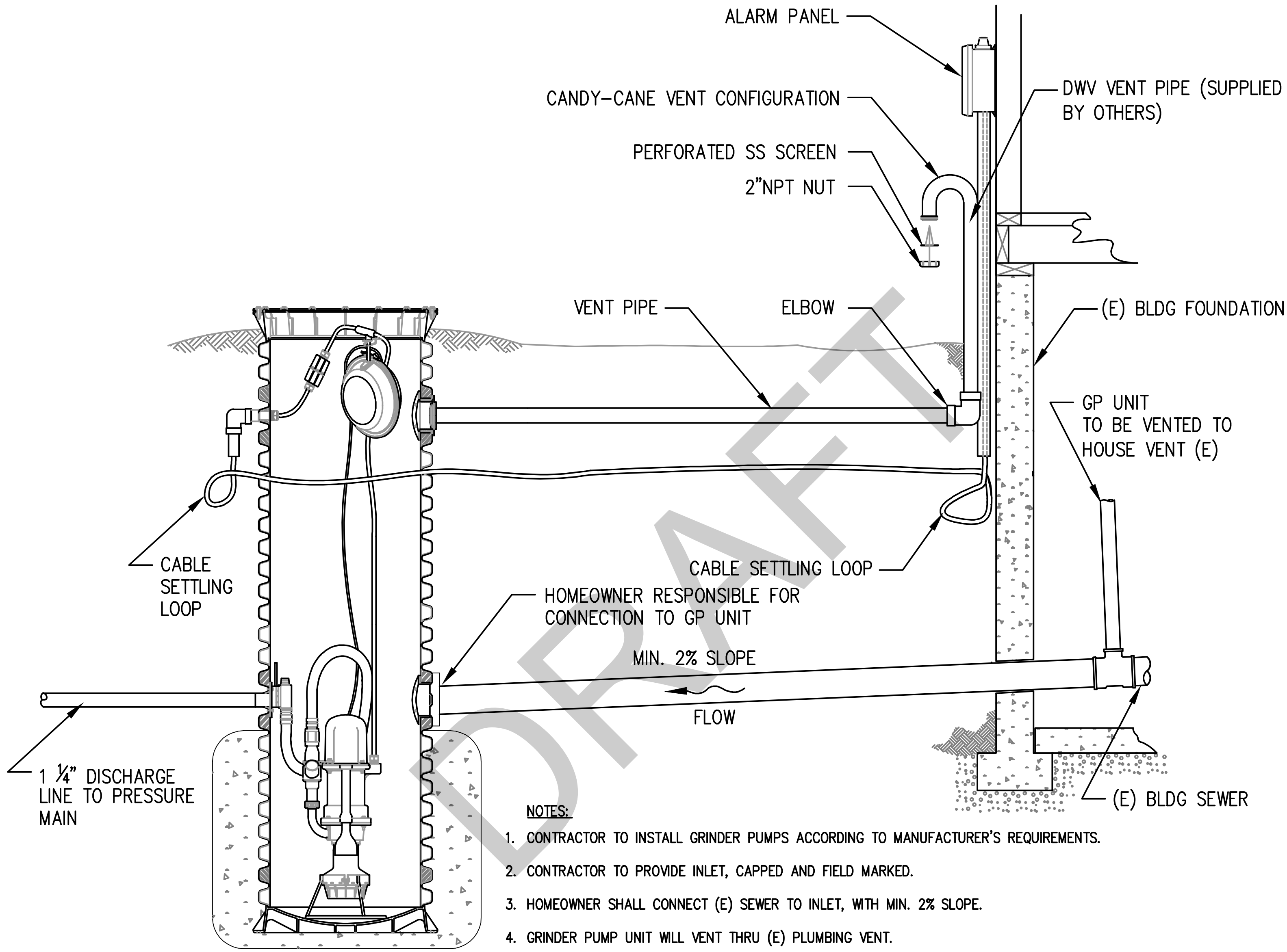
**TYPICAL PRESSURE SEWER**

**WOODACRE/SAN GERONIMO WASTEWATER FEASIBILITY STUDY**

**FIGURE**

**D-1**






NOTES:

1. CONTRACTOR TO INSTALL GRINDER PUMPS ACCORDING TO MANUFACTURER'S REQUIREMENTS.
2. CONTRACTOR TO PROVIDE INLET, CAPPED AND FIELD MARKED.
3. HOMEOWNER SHALL CONNECT (E) SEWER TO INLET, WITH MIN. 2% SLOPE.
4. GRINDER PUMP UNIT WILL VENT THRU (E) PLUMBING VENT.
5. IF (E) PLUMBING VENTILATION IS NOT PER 1997 UPC, CONTRACTOR SHALL CONNECT OPTIONAL 2" VENT PIPE TO EXTERIOR OF BUILDING.

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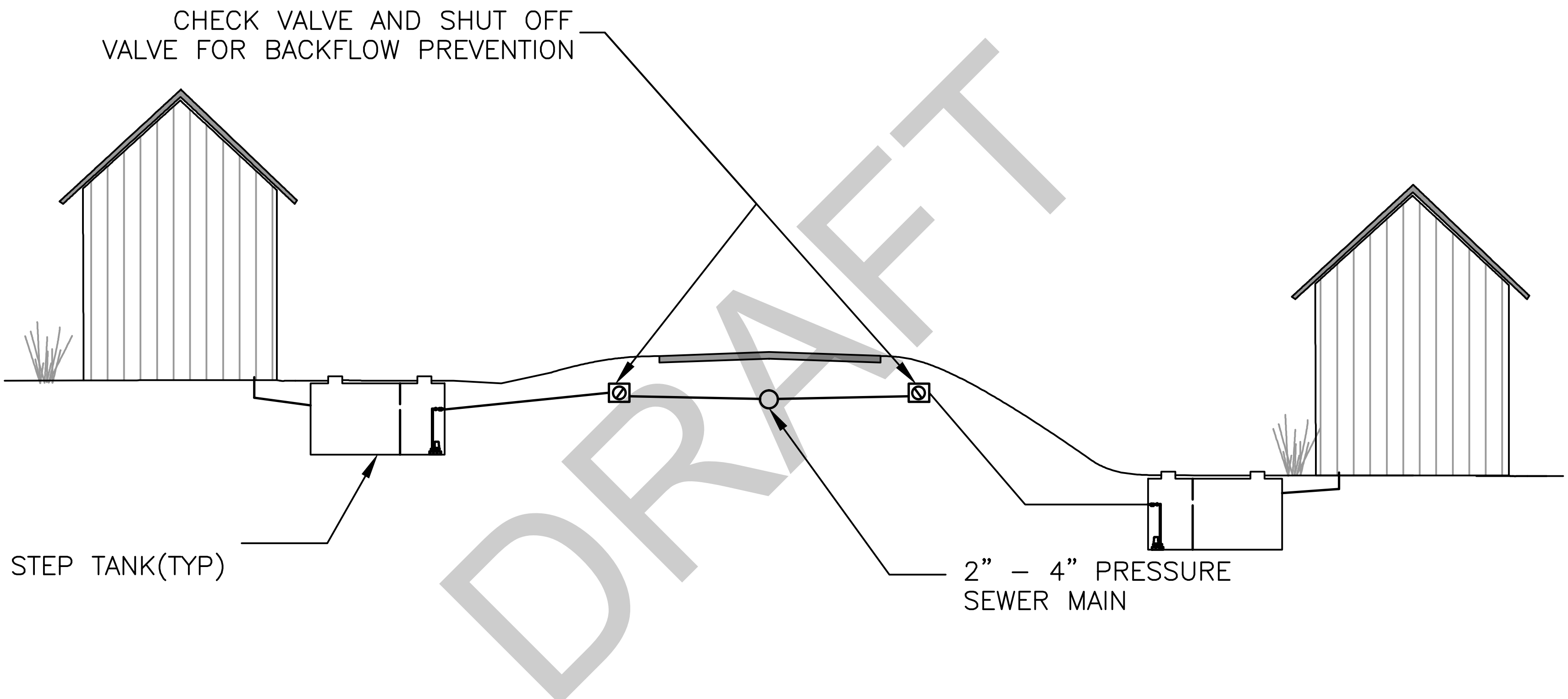
**TYPICAL GRINDER PUMP UNIT**

**WOODACRE/SAN GERONIMO WASTEWATER FEASIBILITY STUDY**

**FIGURE D-2**

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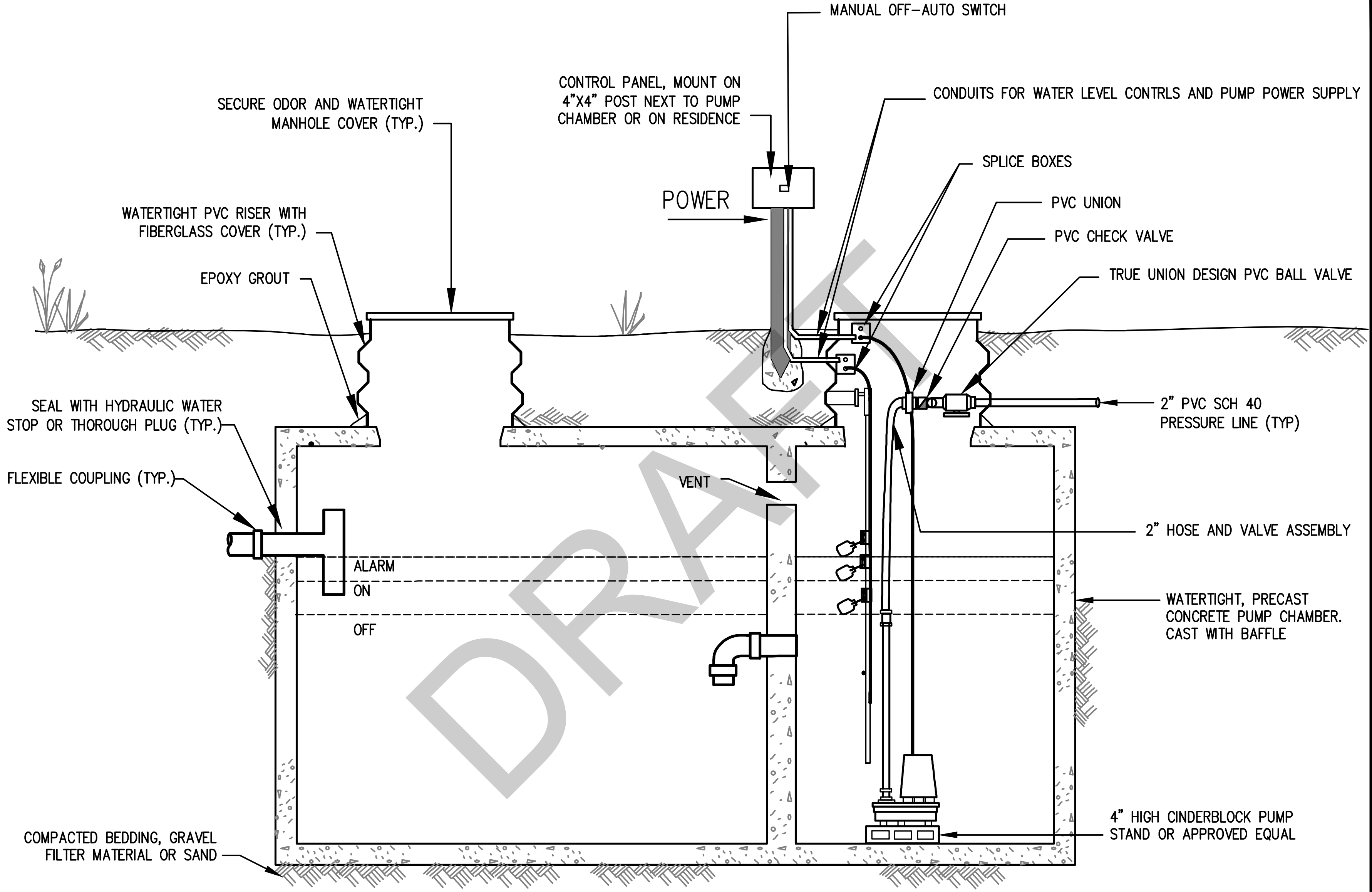
**TYPICAL STEP SYSTEM**

**WOODACRE/SAN GERONIMO WASTEWATER FEASIBILITY STUDY**

**FIGURE**

**D-3**

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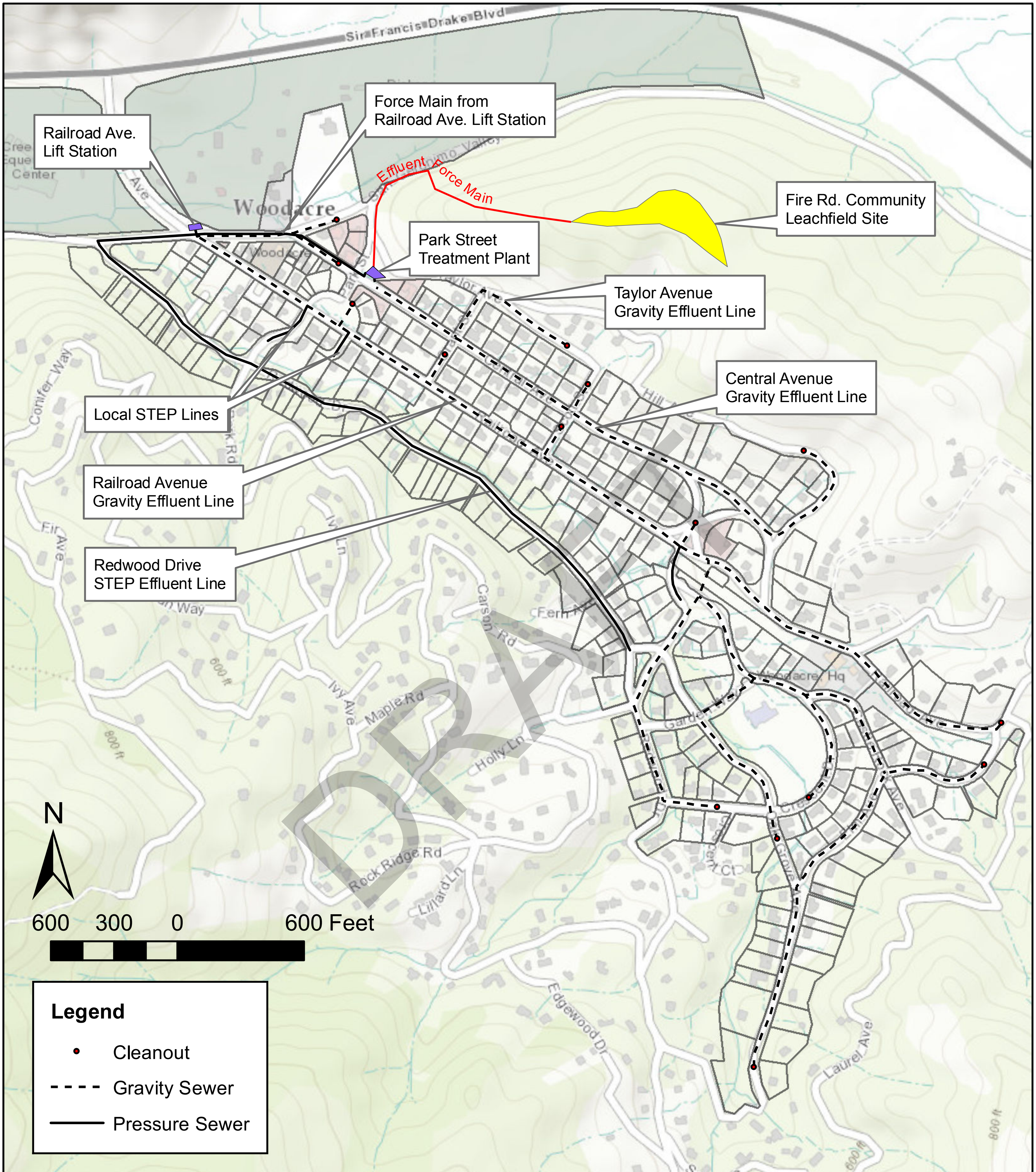
# TYPICAL SEPTIC TANK WITH EFFLUENT PUMP (STEP)

## WOODACRE/SAN GERONIMO WASTEWATER FEASIBILITY STUDY

FIGURE

D-4

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| APPROVED: | NH |

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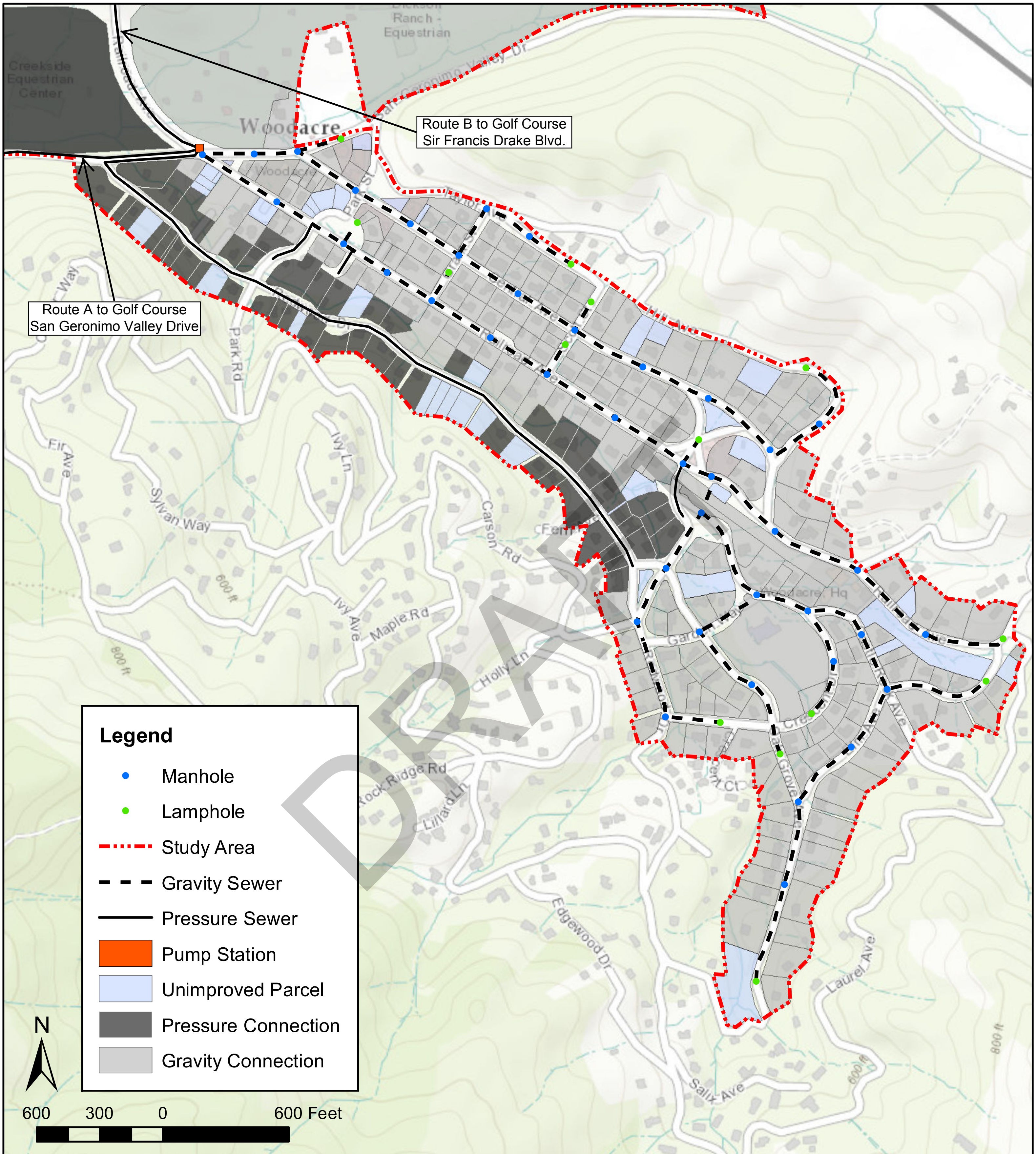
**FIRE ROAD LEACHFIELD ALTERNATIVE EFFLUENT STEP/STEG SYSTEM**

**FIGURE D-5**

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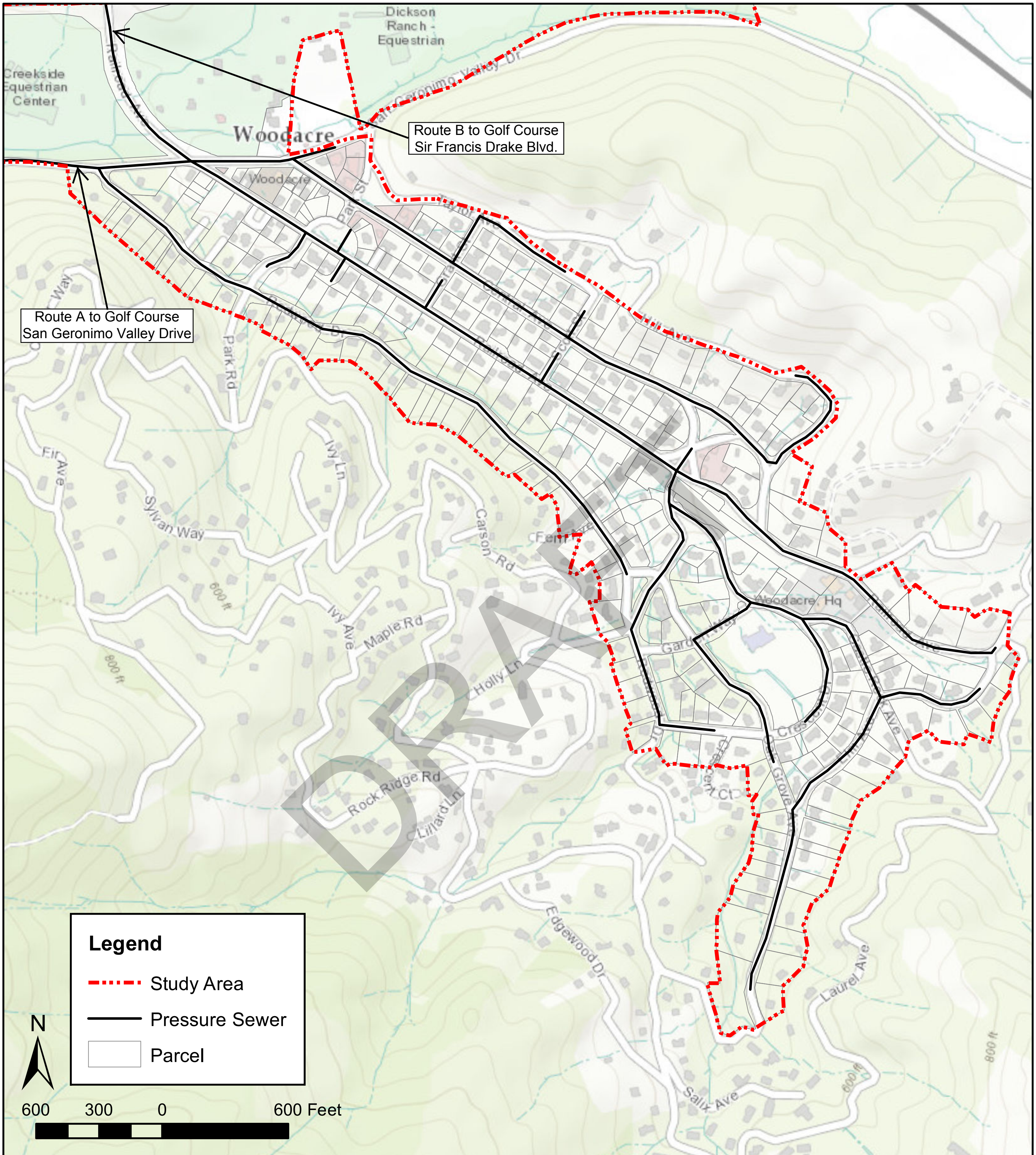
# WOODACRE GRAVITY SEWER SYSTEM PLAN

**FIGURE D-6**

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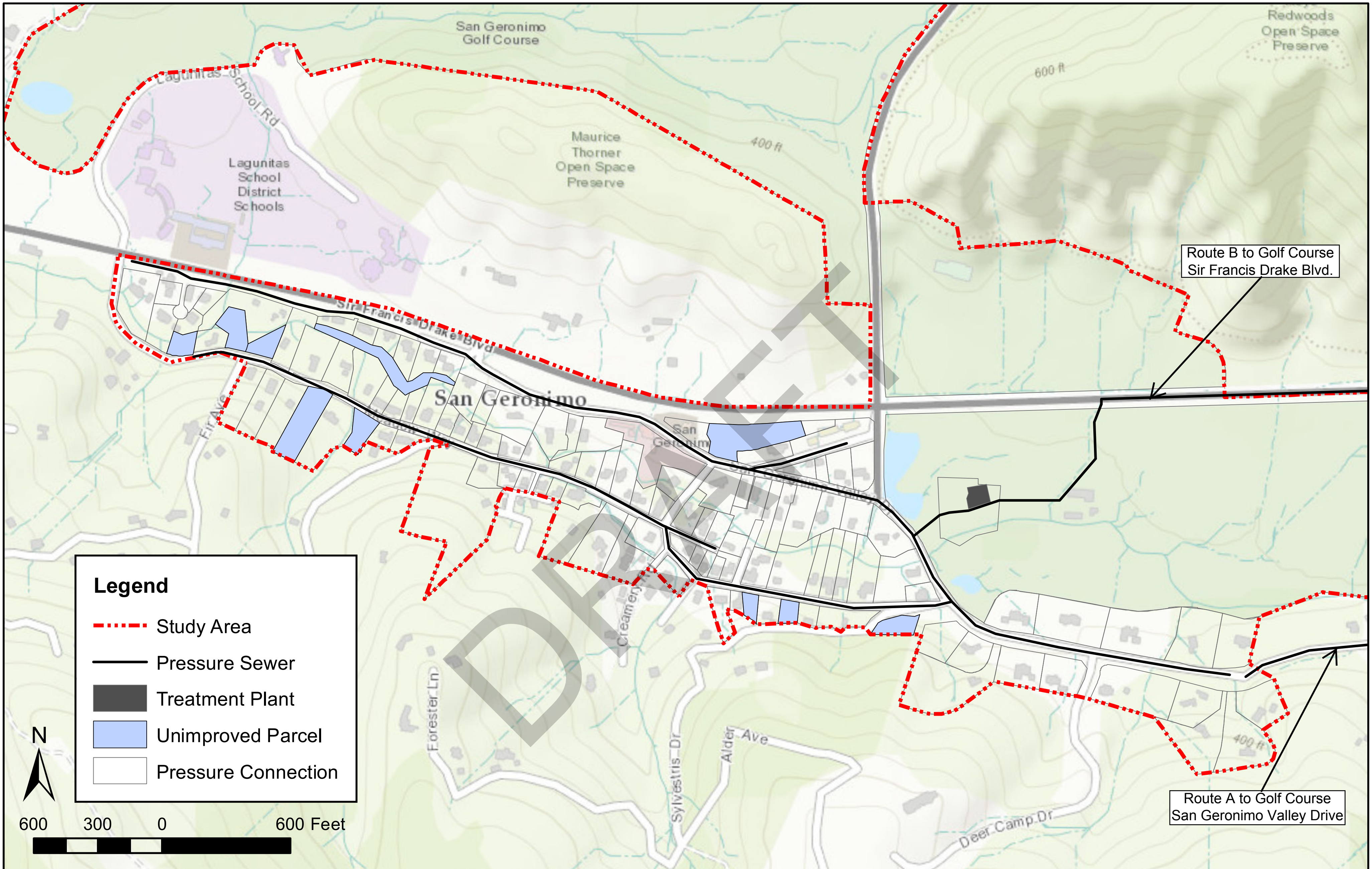
# WOODACRE PRESSURE SEWER SYSTEM PLAN

FIGURE D-7

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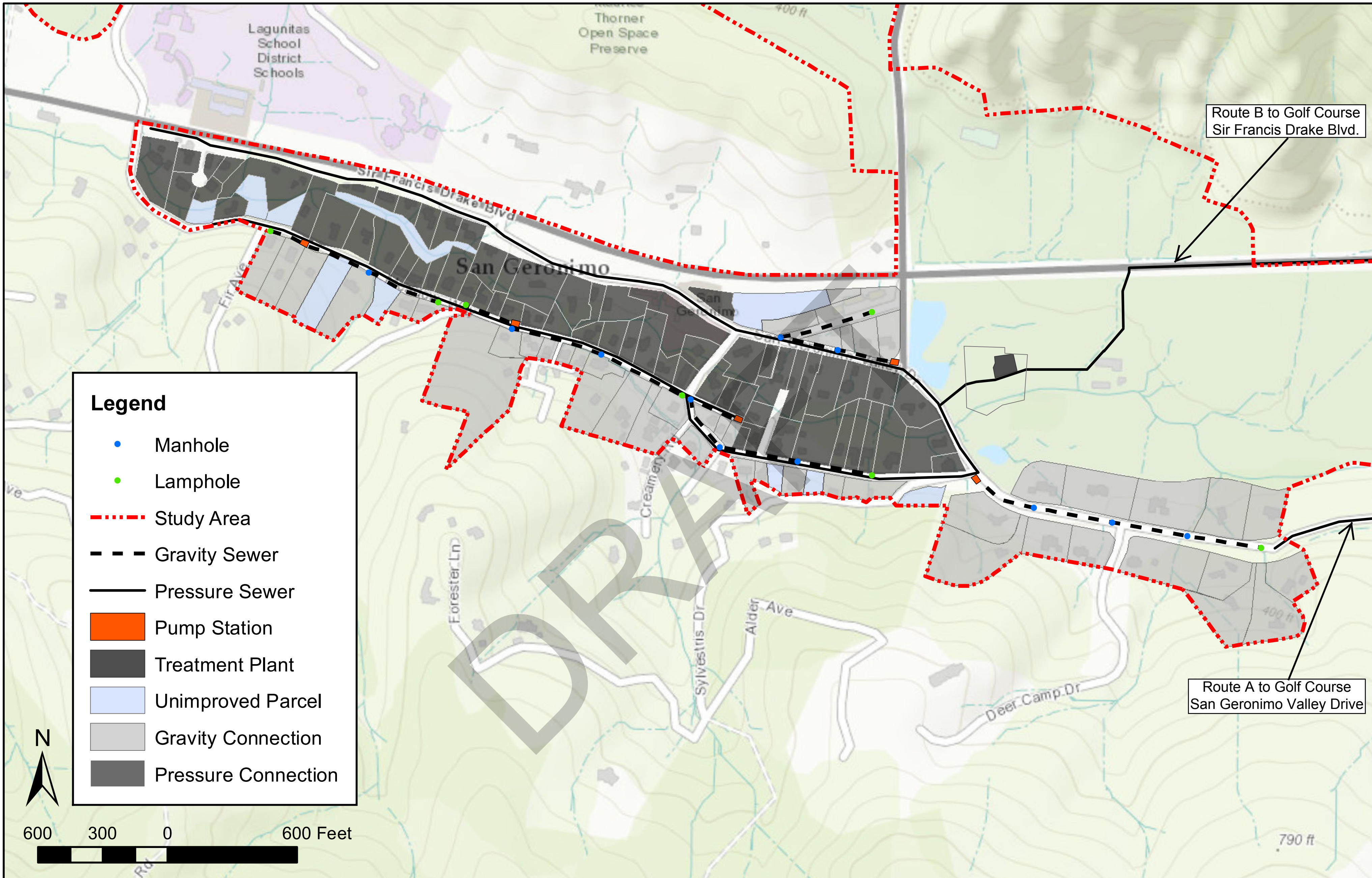
# SAN GERONIMO PRESSURE SEWER SYSTEM PLAN

**FIGURE D-8**

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**SAN GERONIMO CLUSTER SEWER SYSTEM PLAN**

**FIGURE D-9**

## Appendix E

# Wastewater Treatment Literature

- Membrane Bioreactors (MBR)
- UV Disinfection
- Sludge Bagging

# Wastewater Management Fact Sheet

## Membrane Bioreactors

## INTRODUCTION

The technologies most commonly used for performing secondary treatment of municipal wastewater rely on microorganisms suspended in the wastewater to treat it. Although these technologies work well in many situations, they have several drawbacks, including the difficulty of growing the right types of microorganisms and the physical requirement of a large site. The use of microfiltration membrane bioreactors (MBRs), a technology that has become increasingly used in the past 10 years, overcomes many of the limitations of conventional systems. These systems have the advantage of combining a suspended growth biological reactor with solids removal via filtration. The membranes can be designed for and operated in small spaces and with high removal efficiency of contaminants such as nitrogen, phosphorus, bacteria, biochemical oxygen demand, and total suspended solids. The membrane filtration system in effect can replace the secondary clarifier and sand filters in a typical activated sludge treatment system. Membrane filtration allows a higher biomass concentration to be maintained, thereby allowing smaller bioreactors to be used.

## APPLICABILITY

For new installations, the use of MBR systems allows for higher wastewater flow or improved treatment performance in a smaller space than a conventional design, i.e., a facility using secondary clarifiers and sand filters. Historically, membranes have been used for smaller-flow systems due to the high capital cost of the equipment and high operation and maintenance (O&M) costs. Today however, they are receiving increased use in larger systems. MBR systems are also well suited for some industrial and commercial applications. The high-quality effluent produced by MBRs makes them particularly applicable to reuse applications and for surface water discharge applications requiring extensive nutrient (nitrogen and phosphorus) removal.

## ADVANTAGES AND DISADVANTAGES

The advantages of MBR systems over conventional biological systems include better effluent quality, smaller space requirements, and ease of automation. Specifically, MBRs operate at higher volumetric loading rates which result in lower hydraulic retention times. The low retention times mean that less space is required compared to a conventional system. MBRs have often been operated with longer solids residence times (SRTs), which results in lower sludge production; but this is not a requirement, and more conventional SRTs have been used (Crawford et al. 2000). The effluent from MBRs contains low concentrations of bacteria, total suspended solids (TSS), biochemical oxygen demand (BOD), and phosphorus. This facilitates high-level disinfection. Effluents are readily discharged to surface streams or can be sold for reuse, such as irrigation.

The primary disadvantage of MBR systems is the typically higher capital and operating costs than conventional systems for the same throughput. O&M costs include membrane cleaning and fouling control, and eventual membrane replacement. Energy costs are also higher because of the need for air scouring to control bacterial growth on the membranes. In addition, the waste sludge from such a system might have a low settling rate, resulting in the need for chemicals to produce biosolids acceptable for disposal (Hermanowicz et al. 2006). Fleischer et al. 2005 have demonstrated that waste sludges from MBRs can be processed using standard technologies used for activated sludge processes.

## Membrane Filtration

Membrane filtration involves the flow of water-containing pollutants across a membrane. Water permeates through the membrane into a separate channel for recovery (Figure 1). Because of the cross-flow movement of water and the waste constituents, materials left behind do not accumulate at the membrane surface but are carried out of the system for later recovery or disposal. The water passing through the membrane is called the *permeate*, while the water with the more-concentrated materials is called the *concentrate* or *retentate*.

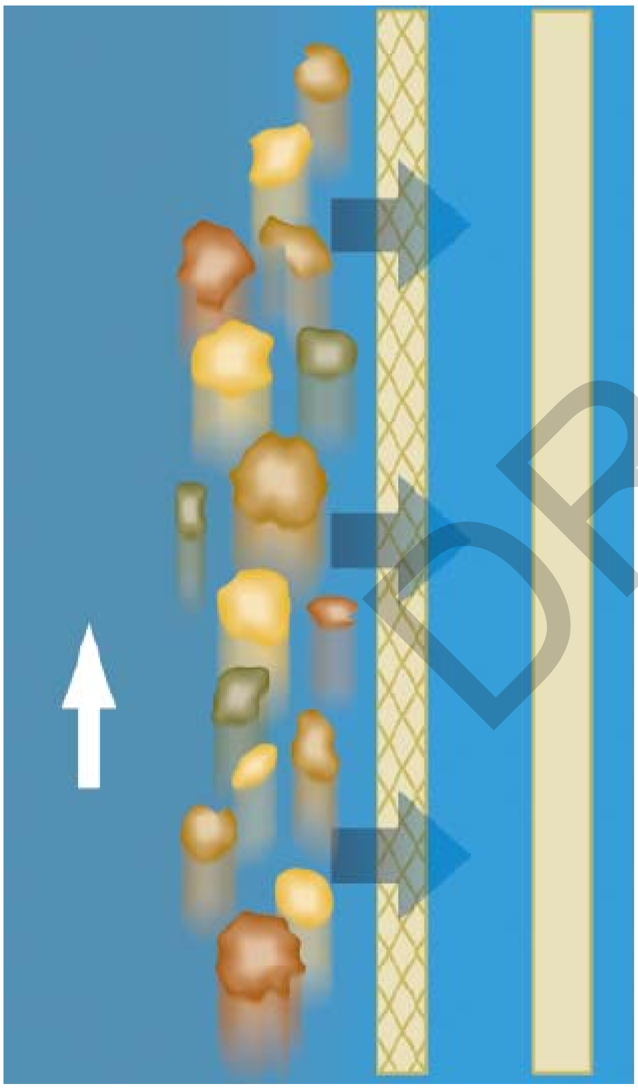

**Figure 1. Membrane filtration process (Image from Siemens/U.S. Filter)**

Membranes are constructed of cellulose or other polymer material, with a maximum pore size set during the manufacturing process. The requirement is that the membranes prevent passage of particles the size of microorganisms, or about 1 micron (0.001 millimeters), so that they remain in the system. This means that MBR systems are good for removing solid material, but the removal of dissolved wastewater components must be facilitated by using additional treatment steps.

Membranes can be configured in a number of ways. For MBR applications, the two configurations most often used are hollow fibers grouped in bundles, as shown in Figure 2, or as flat plates. The hollow fiber bundles are connected by manifolds in units that are designed for easy changing and servicing.

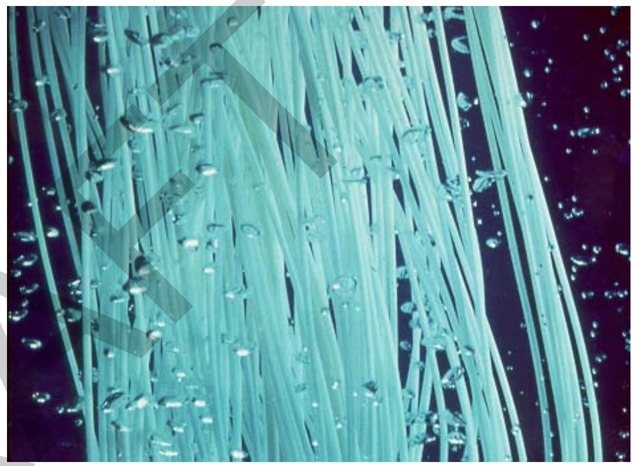

**Figure 2. Hollow-fiber membranes (Image from GE/Zenon)**



## Design Considerations

Designers of MBR systems require only basic information about the wastewater characteristics, (e.g., influent characteristics, effluent requirements, flow data) to design an MBR system. Depending on effluent requirements, certain supplementary options can be included with the MBR system. For example, chemical addition (at various places in the treatment chain, including: before the primary settling tank; before the secondary settling tank [clarifier]; and before the MBR or final filters) for phosphorus removal can be included in an MBR system if needed to achieve low phosphorus concentrations in the effluent.

MBR systems historically have been used for small-scale treatment applications when portions of the treatment system were shut down and the wastewater routed around (or bypassed) during maintenance periods.

However, MBR systems are now often used in full-treatment applications. In these instances, it is recommended that the installation include one additional membrane tank/unit beyond what the design would nominally call for. This “N plus 1” concept is a blend between conventional activated sludge and membrane process design. It is especially important to consider both operations and maintenance requirements when selecting the number of units for MBRs. The inclusion of an extra unit gives operators flexibility and ensures that sufficient operating capacity will be available (Wallis-Lage et al. 2006). For example, bioreactor sizing is often limited by oxygen transfer, rather than the volume required to achieve the required SRT—a factor that significantly affects bioreactor numbers and sizing (Crawford et al. 2000).

Although MBR systems provide operational flexibility with respect to flow rates, as well as the ability to readily add or subtract units as conditions dictate, that flexibility has limits. Membranes typically require that the water surface be maintained above a minimum elevation so that the membranes remain wet during operation. Throughput limitations are dictated by the physical properties of the membrane, and the result is that peak design flows should be no more than 1.5 to 2 times the average design flow. If peak flows exceed that limit, either additional membranes are needed simply to process the peak flow, or equalization should be included in the overall design. The equalization is done by including a separate basin (external equalization) or by maintaining water in the aeration and membrane tanks at depths higher than those required and then removing that water to accommodate higher flows when necessary (internal equalization).

## DESIGN FEATURES

### Pretreatment

To reduce the chances of membrane damage, wastewater should undergo a high level of debris removal prior to the MBR. Primary treatment is often provided in larger installations, although not in most small to medium sized installations, and is not a requirement. In addition, all MBR systems require 1- to 3-mm-cutoff fine screens immediately before the membranes, depending on the MBR manufacturer. These screens require frequent cleaning. Alternatives for reducing the amount of material reaching the screens include using two stages of screening and locating the screens after primary settling.

### Membrane Location

MBR systems are configured with the mem-

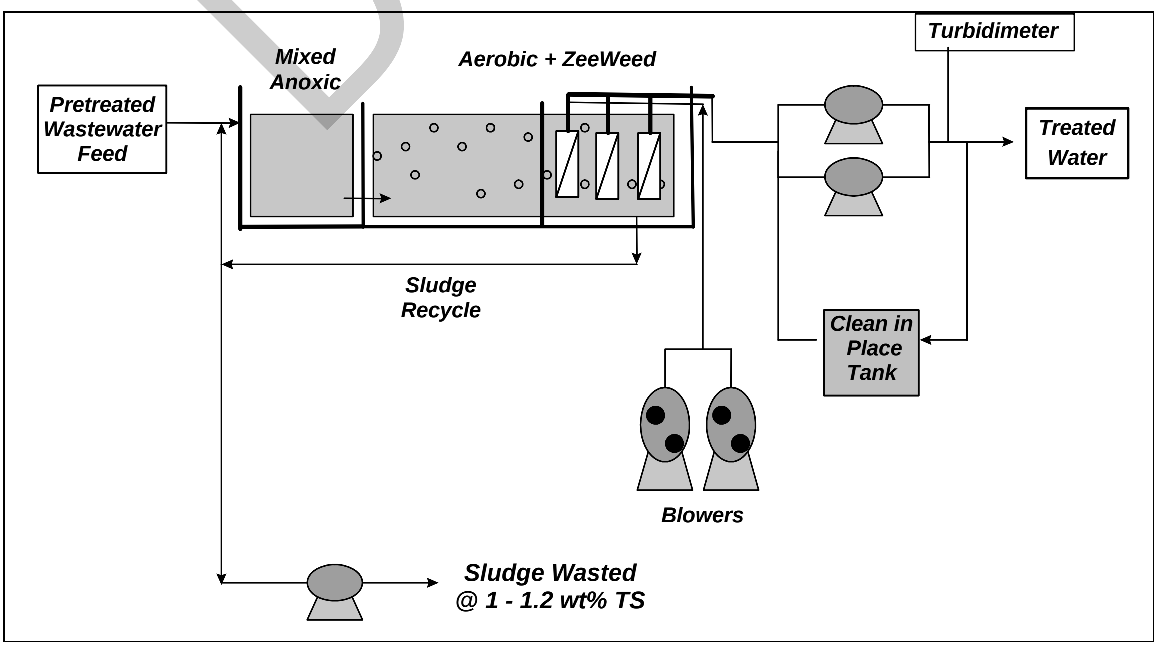


**Figure 3. Immersed membrane system configuration (Image from GE/Zenon)**

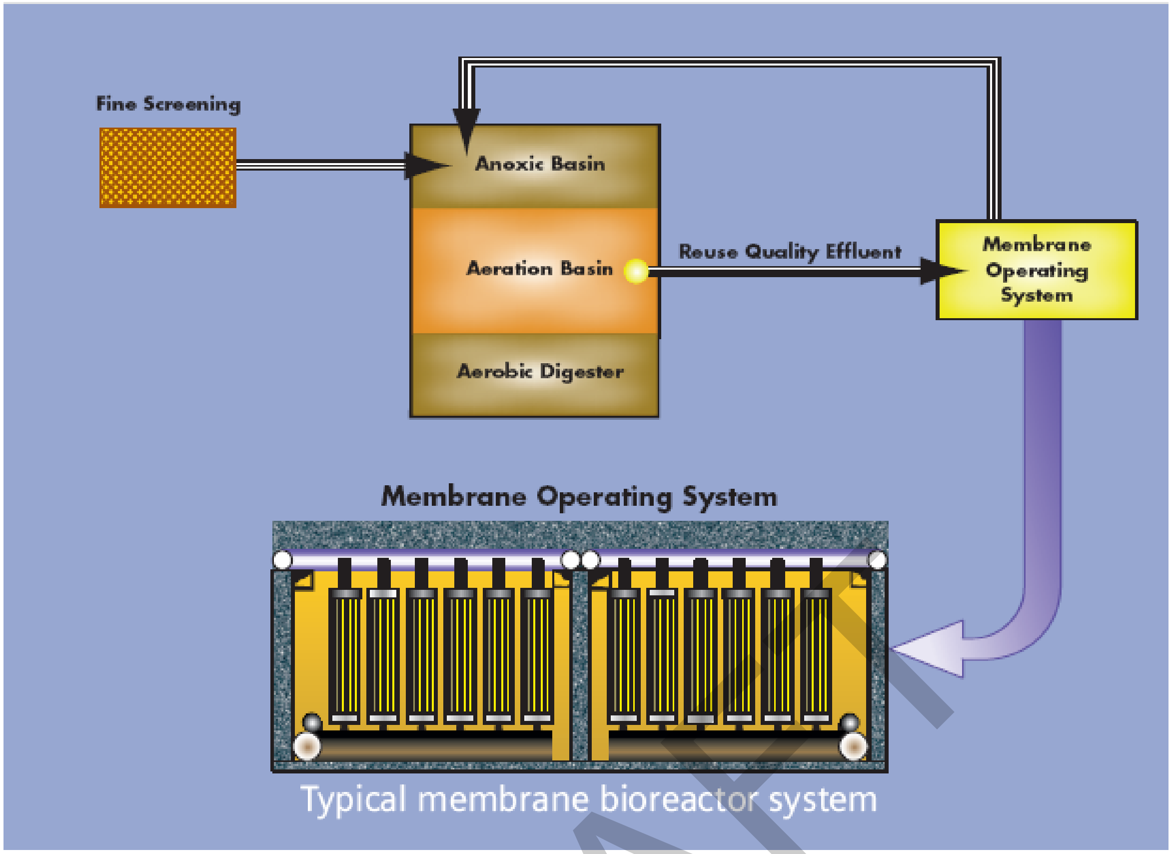


**Figure 4. External membrane system configuration (Image from Siemens/U.S. Filter)**



branes actually immersed in the biological reactor or, as an alternative, in a separate vessel through which mixed liquor from the biological reactor is circulated. The former configuration is shown in Figure 3; the latter, in Figure 4.

### Membrane Configuration

MBR manufacturers employ membranes in two basic configurations: hollow fiber bundles and plate membranes. Siemens/U.S.Filter's Memjet and Memcor systems, GE/Zenon's ZeeWeed and ZenoGem systems, and GE/Ionics' system use hollow-fiber, tubular membranes configured in bundles. A number of bundles are connected by manifolds into units that can be readily changed for maintenance or replacement. The other configuration, such as those provided by Kubota/Enviroquip, employ membranes in a flat-plate configuration, again with manifolds to allow a number of membranes to be connected in readily changed units. Screening requirements for both systems differ: hollow-fiber membranes typically require 1- to 2-mm screening, while plate membranes require 2- to 3-mm screening (Wallis-Lage et al. 2006).

### System Operation

All MBR systems require some degree of pumping to force the water flowing through the membrane. While other membrane systems use a pressurized system to push the water through the membranes, the major systems used in MBRs draw a vacuum through the membranes so that the water outside is at ambient pressure. The advantage of the vacuum is that it is gentler to the membranes; the advantage of the pressure is that throughput can be controlled. All systems also include techniques for continually cleaning the system to maintain membrane life and keep the system operational for as long as possible. All the principal membrane systems used in MBRs use an air scour technique to reduce buildup of material on the membranes. This is done by blowing air around the membranes out of the manifolds. The GE/Zenon systems use air scour, as well as a back-pulsing technique, in which permeate is occasionally pumped back into the membranes to keep the pores cleared out. Back-pulsing is typically done on a timer, with the time of pulsing accounting for 1 to 5 percent of the total operating time.

### Downstream Treatment

The permeate from an MBR has low levels of suspended solids, meaning the levels of bacteria, BOD, nitrogen, and phosphorus are also low. Disinfection is easy and might not be required, depending on permit requirements..

The solids retained by the membrane are recycled to the biological reactor and build up in the system. As in conventional biological systems, periodic sludge wasting eliminates sludge buildup and controls the SRT within the MBR system. The waste sludge from MBRs goes through standard solids-handling technologies for thickening, dewatering, and ultimate disposal. Hermanowicz et al. (2006) reported a decreased ability to settle in waste MBR sludges due to increased amounts of colloidal-size particles and filamentous bacteria. Chemical addition increased the ability of the sludges to settle. As more MBR facilities are built and operated, a more definitive understanding of the characteristics of the resulting biosolids will be achieved. However, experience to date indicates that conventional biosolids processing unit operations are also applicable to the waste sludge from MBRs.

### Membrane Care

The key to the cost-effectiveness of an MBR system is membrane life. If membrane life is curtailed such that frequent replacement is required, costs will significantly increase. Membrane life can be increased in the following ways:

- Good screening of larger solids before the membranes to protect the membranes from physical damage.

- Throughput rates that are not excessive, i.e., that do not push the system to the limits of the design. Such rates reduce the amount of material that is forced into the membrane and thereby reduce the amount that has to be removed by cleaners or that will cause eventual membrane deterioration.

- Regular use of mild cleaners. Cleaning solutions most often used with MBRs include regular bleach (sodium) and citric acid. The cleaning should be in accord with manufacturer-recommended maintenance protocols.

### Membrane Guarantees

The length of the guarantee provided by the membrane system provider is also important in determining the cost-effectiveness of the system. For municipal wastewater treatment, longer guarantees might be more readily available compared to those available for industrial systems. Zenon offers a 10-year guarantee; others range from 3 to 5 years. Some guarantees include cost prorating if replacement is needed after a certain service time. Guarantees are typically negotiated during the purchasing process. Some manufacturers' guarantees are tied directly to screen size: longer membrane warranties are granted when smaller screens are used (Wallis-Lage et al. 2006). Appropriate membrane life guarantees can be secured using appropriate membrane procurement strategies (Crawford et al. 2002).

## SYSTEM PERFORMANCE

### Siemens/U.S. Filter Systems

Siemens/U.S.Filter offers MBR systems under the Memcor and Memjet brands. Data provided by U.S. Filter for its Calls Creek (Georgia) facility are summarized below. The system, as Calls Creek retrofitted it, is shown in Figure 5. In essence, the membrane filters were used to replace secondary clarifiers downstream of an Orbal oxidation ditch. The system includes a fine screen (2-mm cutoff) for inert solids removal just before the membranes.

The facility has an average flow of 0.35 million gallons per day (mgd) and a design flow of 0.67 mgd. The system has 2 modules, each containing 400 units, and each unit consists of a cassette with manifold-connected membranes. As shown in Table 1, removal of BOD, TSS, and ammonia-nitrogen is excellent; BOD and TSS in the effluent are around the detection limit. Phosphorus is also removed well in the system, and the effluent

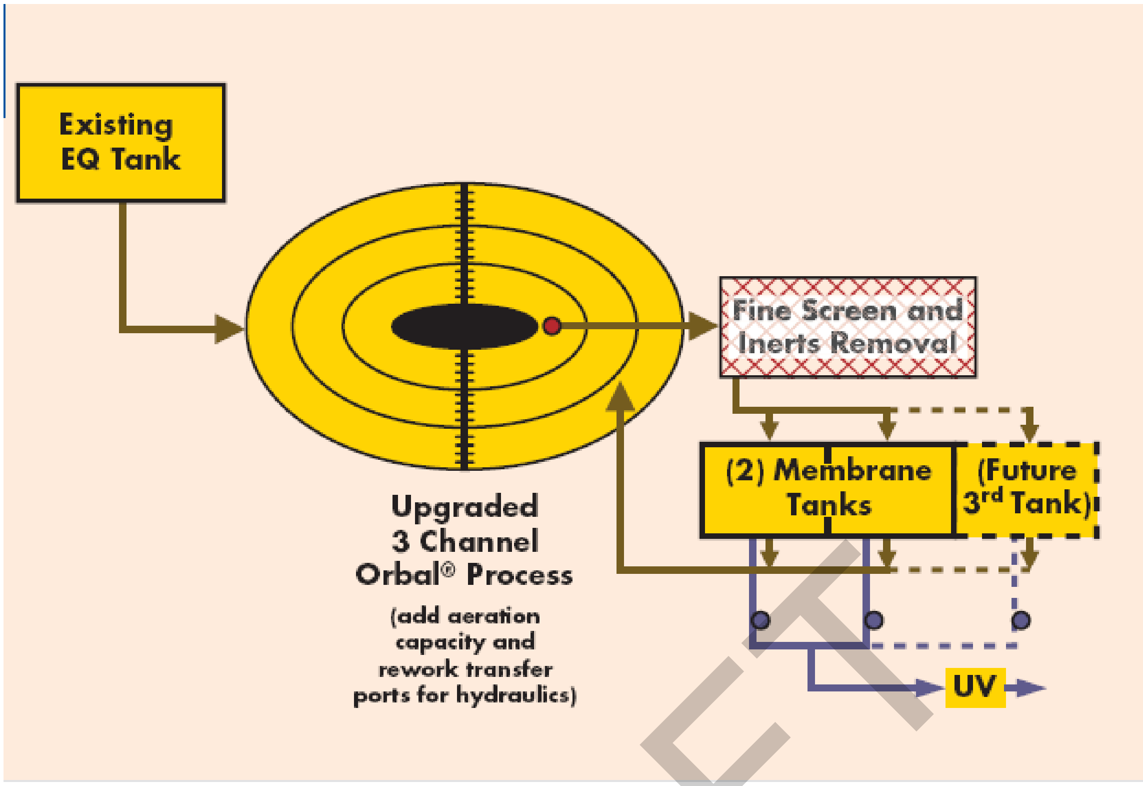


**Figure 5. Calls Creek flow diagram (courtesy of Siemens/U.S. Filter)**



**Table 1.**
**Calls Creek results 2005**

| Parameter | Influent | Effluent | | |
|---|---|---|---|---|
| | Average | Average | Max Month | Min Month |
| Flow (mgd) | 0.35 | -- | 0.44 | 0.26 |
| BOD (mg/L) | 145 | 1 | 1 | 1 |
| TSS (mg/L) | 248 | 1 | 1 | 1 |
| Ammonia-N (mg/L) | 14.8 | 0.21 | 0.72 | 0.10 |
| P (mg/L) | 0.88 | 0.28 | 0.55 | 0.12 |
| Fecal coliforms (#/100 mL) | -- | 14.2 | 20 | 0 |
| Turbidity (NTU) | -- | 0.30 | 1.31 | 0.01 |

has very low turbidity. The effluent has consistently met discharge limits.

## Zenon Systems

General Electric/Zenon provides systems under the ZenoGem and ZeeWeed brands. The ZeeWeed brand refers to the membrane, while ZenoGem is the process that uses ZeeWeed.

Performance data for two installed systems are shown below.

**Cauley Creek, Georgia.** The Cauley Creek facility in Fulton County, Georgia, is a 5-mgd wastewater reclamation plant. The system includes biological phosphorus removal, mixed liquor surface wasting, and sludge thickening using a ZeeWeed system to minimize the required volume of the aerobic digester, according to information provided by GE. Ultraviolet disinfection is employed to meet regulatory limits. Table 2 shows that the removal for all parame-

**Table 2.**
**Cauley Creek, Georgia, system performance**

| Parameter | Influent | Effluent | | |
|---|---|---|---|---|
| | Average | Average | Max Month | Min Month |
| Flow (mgd) | 4.27 | -- | 4.66 | 3.72 |
| BOD (mg/L) | 182 | 2.0 | 2.0 | 2.0 |
| COD (mg/L) | 398 | 12 | 22 | 5 |
| TSS (mg/L) | 174 | 3.2 | 5 | 3 |
| TKN (mg/L) | 33.0 | 1.9 | 2.9 | 1.4 |
| Ammonia-N (mg/L) | 24.8 | 0.21 | 0.29 | 0.10 |
| TP (mg/L) | 5.0 | 0.1 | 0.13 | 0.06 |
| Fecal coliforms (#/100 mL) | -- | 2 | 2 | 2 |
| NO3-N (mg/L) | -- | 2.8 | | |

ters is over 90 percent. The effluent meets all permit limits, and is reused for irrigation and lawn watering.

**Traverse City, Michigan.** The Traverse City Wastewater Treatment Plant (WWTP) went through an upgrade to increase plant capacity and produce a higher-quality effluent, all within the facility's existing plant footprint (Crawford et al. 2005). With the ZeeWeed system, the facility was able to achieve those goals. As of 2006, the plant is the largest-capacity MBR facility in North America. It has a design average annual flow of 7.1 mgd, maximum monthly flow of 8.5 mgd, and peak hourly flow of 17 mgd. The membrane system consists of a 450,000-gallon tank with eight compartments of equal size. Secondary sludge is distributed evenly to the compartments. Blowers for air scouring, as well as permeate and back-pulse pumps, are housed in a nearby building.

Table 3 presents a summary of plant results over a 12-month period. The facility provides excellent removal of BOD, TSS, ammonia-nitrogen, and phosphorus. Figure 6 shows the influent, effluent, and flow data for the year.

Operating data for the Traverse City WWTP were obtained for the same period. The mixed liquor suspended solids over the period January to August averaged 6,400 mg/L, while the mixed liquor volatile suspended solids averaged 4,400 mg/L. The energy use for the air-scouring blowers averaged 1,800 kW-hr/million gallons (MG) treated.



## COSTS

### Capital Costs

Capital costs for MBR systems historically have tended to be higher than those for conventional systems with comparable throughput because of the initial costs of the membranes. In certain situations, however, including retrofits, MBR systems can have lower or competitive capital costs compared with alternatives because MBRs have lower land requirements and use smaller tanks, which can reduce the costs for concrete. U.S. Filter/Siemen's Memcor package plants have installed costs of \$7–\$20/gallon treated.

Fleischer et al. (2005) reported on a cost comparison of technologies for a 12-MGD design in Loudoun County, Virginia. Because of a chemical oxygen demand limit, activated carbon adsorption was included with the MBR system. It was found that the capital cost for MBR plus granular activated carbon at \$12/gallon treated was on the same order of magnitude as alternative processes, including multiple-point alum addition, high lime treatment, and post-secondary membrane filtration.

### Operating Costs

Operating costs for MBR systems are typically higher than those for comparable conventional systems. This is because of the higher energy

**Table 3.**
**Summary of Traverse City, Michigan, Performance Results**

| Parameter | Influent | Effluent | | |
|---|---|---|---|---|
| | Average | Average | Max Month | Min Month |
| Flow (mgd) | 4.3 | -- | 5.1 | 3.6 |
| BOD (mg/L) | 280 | < 2 | < 2 | < 2 |
| TSS (mg/L) | 248 | < 1 | < 1 | < 1 |
| Ammonia-N (mg/L) | 27.9 | < 0.08 | < 0.23 | < 0.03 |
| TP (mg/L) | 6.9 | 0.7 | 0.95 | 0.41 |
| Temperature (deg C) | 17.2 | -- | 23.5 | 11.5 |

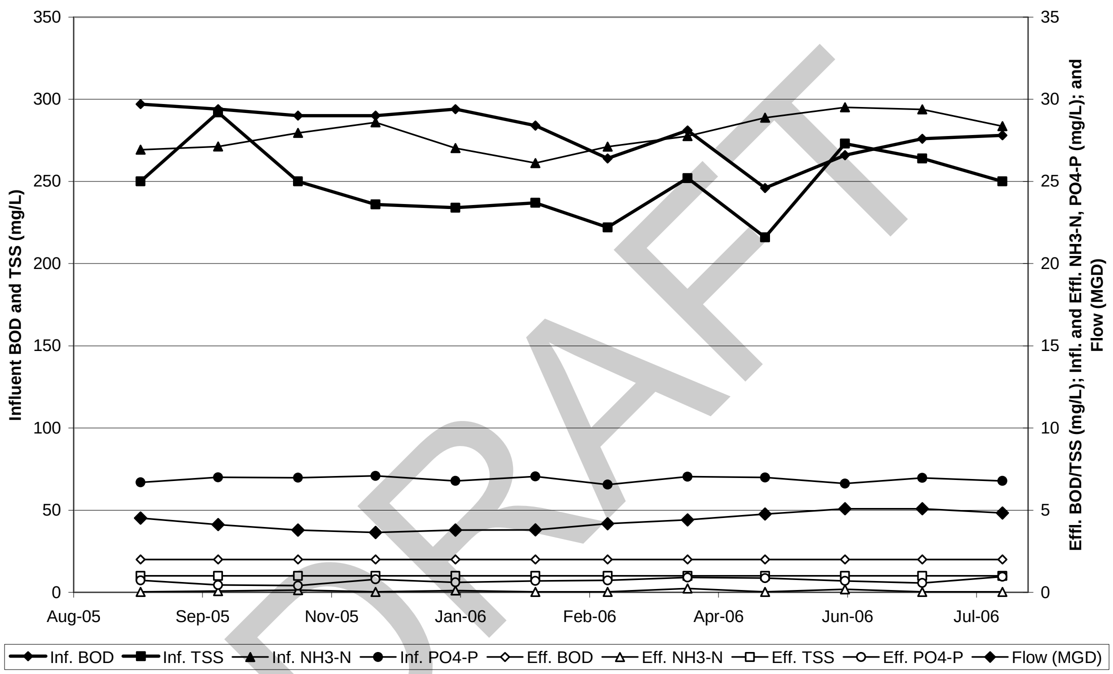


**Figure 6. Performance of the Traverse City plant**



costs if air scouring is used to reduce membrane fouling. The amount of air needed for the scouring has been reported to be twice that needed to maintain aeration in a conventional activated sludge system (Scott Blair, personal communication, 2006). These higher operating costs are often partially offset by the lower costs for sludge disposal associated with running at longer sludge residence times and with membrane thickening/dewatering of wasted sludge.

Fleischer et al. (2005) compared operating costs. They estimated the operating costs of an MBR system including activated carbon adsorption at $1.77 per 1,000 gallons treated. These costs were of the same order of magnitude as those of alternative processes, and they compared favorably to those of processes that are chemical-intensive, such as lime treatment.

## ACKNOWLEDGMENTS

The authors acknowledge Dr. Venkat Mahendraker, GE/Zenon, Mr. John Irwin, Siemens/U.S. Filter, and Mr. Scott Blair and Mr. Leroy Bonkoski of the Traverse City WWTP for their assistance in obtaining data and system information. EPA acknowledges external peer reviewers Pat Brooks, Alan Cooper, and Glenn Daigger for their contribution.

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**TITAN MBR™**

**Marin Co., CA**
**Woodacre / San Geronimo**

**December 13, 2016**

**AN INTRODUCTION TO SMITH & LOVELESS, INC.**

Located in Lenexa, Kansas, Smith & Loveless is a leading U. S. manufacturer of water and wastewater treatment and pumping equipment. With its equipment utilized by municipalities and industries in the U.S. and around the world, the Smith & Loveless product line includes:

**Wastewater Pumping Equipment up to 100,000 GPM**
The Smith & Loveless Non-Clog Pump was the first wastewater pump to use a mechanical seal and a 100% factory-built pump station. Since its invention, the Smith & Loveless pump has proven its reliability in more than 21,000 separate pumping installations worldwide. Smith & Loveless also developed the station that mounts directly on top of a wet well, pumping up to 7,500 GPM.

**PRE-ENGINEERED TREATMENT PLANTS**
Smith & Loveless developed the market for smaller treatment plants designed for schools, subdivisions, hotels, hospitals, offshore drilling rigs, resorts, various industrial applications and municipalities. These plants have major advantages, which include proven design, lower cost installation and reduced construction time. Our treatment plants range in flow capacity from 1,000 GPD to 5 MGD in single units, with seven (7) separate product lines, including the **TITAN MBR™**.

**WASTEWATER TREATMENT EQUIPMENT**
Smith & Loveless offers a complete line of wastewater treatment equipment for the larger component-type municipal and industrial systems. It is highlighted by the **PISTA®** Grit Removal System. Other well-known Smith & Loveless component products are the LOOP Brush Aerator, the Kraus-Fall peripheral-feed clarifier, the **PACE®** oil/water separator, the **DI-SEP®** SX Filter and the Marine **FAST®**.

**Water Treatment Equipment**
Smith & Loveless also has a complete line of water treatment equipment. Included are the **FIBROTEX®**, the **IMF PROTECTOR™** Ultrafiltration System, the **IRONMAN™** System, the **SCIENCO®** Brinemaker, the **DI-SEP®** Nitrate Removal Filter, the **SCIENCO®** Sodium Hypochlorite Generator, the **CLAR-I-VATOR®** and more. This line encompasses both component equipment and package treatment plants from 10 GPD (0.6 lps).

**COMPANY PROFILE**
Smith & Loveless was founded in 1946 by B. Alden Smith and Compere Loveless as a Sales Engineering Firm representing several manufacturers in the wastewater industry. Early in their association, Smith & Loveless recognized the need for complete factory-built wastewater pump stations and began manufacturing this equipment. Their first three stations were built for the municipal wastewater system of Salina, Kansas. These units were fabricated in a converted barn less than three miles from the present plant location.

As demand for this equipment grew, Smith & Loveless built their first manufacturing plant – a modest structure a few miles from the present plant site. Sales increased rapidly and within a short time, Smith & Loveless had sales representatives throughout the United States and Canada. Because of this rapid growth, it was necessary to expand the plant five times in four years.

The present site in Lenexa, Kansas (a Kansas City suburb) was selected in 1957. By 1958, the new manufacturing facility was ready for production. This present plant has been expanded several times, more than tripling the original manufacturing and office space (over 100,000 square feet of manufacturing space).

Late in 1959, Smith & Loveless was acquired by Trans Union Corporation, which was based in Lincolnshire, Illinois. This acquisition complemented markets served by other divisions of that firm, as well as providing additional capital for expansion and research and development, ensuring Smith & Loveless' leadership in the wastewater industry.

In February 1981, Trans Union merged with the Marmon Group, a largely privately held corporation.

In October 1981, the management of the Smith & Loveless Division purchased the assets of the Division from the Marmon Group, and Smith & Loveless, Inc., was reborn. Smith & Loveless renewed its commitment to maintain its role as a leader in the water and wastewater treatment and pumping industry through the design and production of quality equipment, and by providing superior service.

To continue to strengthen its leadership position, Smith & Loveless, on October 1, 1984, purchased two firms: **SCIENCO®**, Inc., of St. Louis, Missouri and **DI-SEP®** Systems International, Inc., of Santa Fe Springs, California. On August 1, 1985, Smith & Loveless added another subsidiary by acquiring St. Louis Marine Systems, Inc., renamed **FAST®** Systems, Inc. – Later, **SCIENCO®**, Inc., and **FAST®** Systems, Inc. were merged into **SCIENCO/FAST®** Systems, Inc. In 1987, Smith & Loveless made another step to provide additional capabilities in water treatment by acquiring K-W Industries. K-W was previously located in Omaha, Nebraska. In 1993, the above mentioned companies and their products were all absorbed into Smith & Loveless and its product line.

In a move to both strengthen Smith & Loveless, Inc.'s water product line and expand into the European marketplace, Smith & Loveless Limited, an affiliated company of Smith & Loveless, Inc., acquired the majority interest in Kalsep Limited of Camberley, England on March 29, 1995. Licenses granted allow Smith & Loveless products to be sold by Kalsep Limited and Kalsep Limited's water products to be sold in Smith & Loveless' markets.

In June 1996, in a move to specially develop, manufacture and market wastewater treatment systems for the on-site residential marketplace, an affiliated company, Bio-Microbics, Inc., was formed.

Further international expansion occurred on March 20, 1998, when Smith & Loveless New Zealand Ltd. Was granted licenses to market and sell Smith & Loveless, Inc. technology and equipment in New Zealand and Australia. And in a strategic move in August of 1999, Smith & Loveless Limited – UK began to more actively market and sell Smith & Loveless, Inc. technology in the UK.

On the domestic front, in June of 2000, Smith & Loveless Georgia Inc. was formed. This allows the Company to provide superior pump station sales and service for its Georgia customers.

Smith & Loveless actively pursues the patents of its inventions. The Company currently owns more than 50 active U.S. patents, holds foreign patents in 15 different countries, has several patent applications pending and has more than 25 domestic and foreign trademarks.

Smith & Loveless has actively engaged in R&D. Smith & Loveless' approach to research and development is both the search for new applications of existing product lines, as well as development of completely new concepts. Through these efforts, Smith & Loveless has been able to enter previously untapped markets. The Company's products are sold mainly through manufacturers' sales representative companies, with more than 150 such contract companies located worldwide.

Smith & Loveless employs approximately 250 people direct. Approximately 65 employees are represented by the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union Local No. 13-18. The total Lenexa, Kansas facility today encompasses 115,000 square feet of manufacturing and office space.

Smith & Loveless will continue to expand and offer new and better solutions for a world of water.

# 1.0 GENERAL DESCRIPTION

One (1) Smith & Loveless **TITAN MBR™** Treatment Plant, as described herein. The plant shall include separate zones: flow equalization, sludge holding, and aeration with **TITAN MBR™**.

Advantages of the Smith & Loveless **TITAN MBR™** include:

- Simple controls provide centralized information.
- System is factory-built, eliminating concrete pour on-site.
- V-Crimp wall design provides improved coatings application and longer tank life
- Factory-built reduces time required on-site by installing contractor.
- Flat-plate membrane is *Cleaned-In-Place* during normal operation.
- Flat-plane membrane eliminates the need for backwash and associated backwash tank.
- S&L membrane is gravity fed, eliminating the need for a permeate pump and associated O&M costs.
- S&L membranes located directly in aeration basin, eliminating the need for MLSS recirculation pump and associated O&M costs.
- Membrane modules arrive installed in the tank for a shorter install-to-start up lead time.
- Title 22 approved membrane modules.

## 1.01 TITAN MBR™ Performance Requirements

Flow:

| | |
|---|---|
| **Option 1:** | 75,000 gpd (ave) |
| **Option 2:** | 50,000 gpd (ave) |

| Parameter: | Influent: | Effluent: |
|---|---|---|
| BOD: | 250 mg/L | ≤ 5 mg/L |
| TSS: | 250 mg/L | ≤ 5 mg/L |
| TKN: | 45 mg/L | ≤ 10 mg/L (expressed as TN) |
| Turbidity: | | < 2 NTU |

# 2.0 Basic Process Flow

The wastewater stream will pass through 3mm fine screen(s) prior to entering the plant.

The flow equalization zone will be equipped with an air ejector to transfer the wastewater into the membrane treatment system inside the aeration zone. Gravity will also be used to pass flow through the membranes, before exiting the MBR.

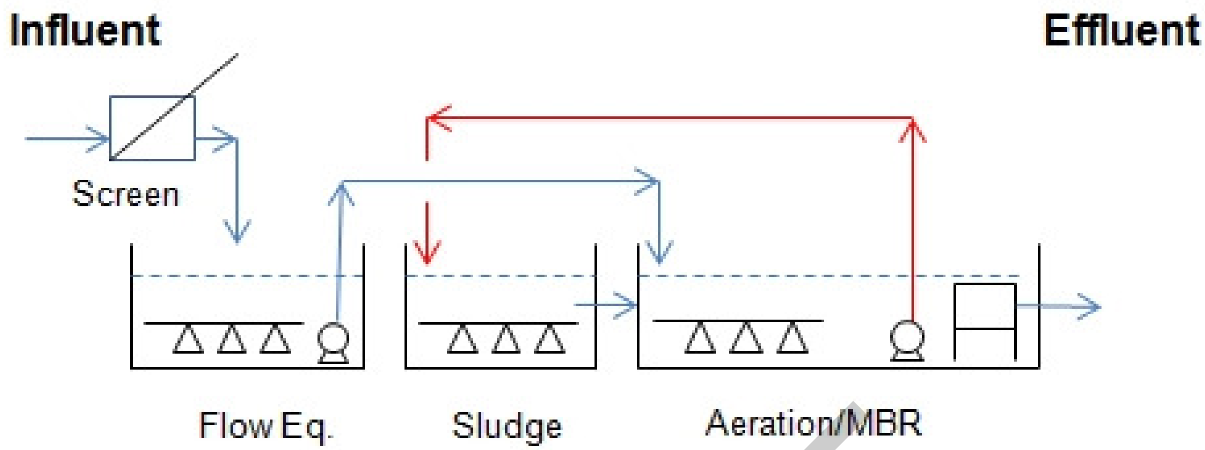
A recycle pump shall be used to send nitrified flow from the MBR/Aeration zone to the anoxic zone for denitrification.

Aeration zones will include fine bubble diffusers while coarse bubble diffusers are provided under the membrane module to for air scour of the membranes.

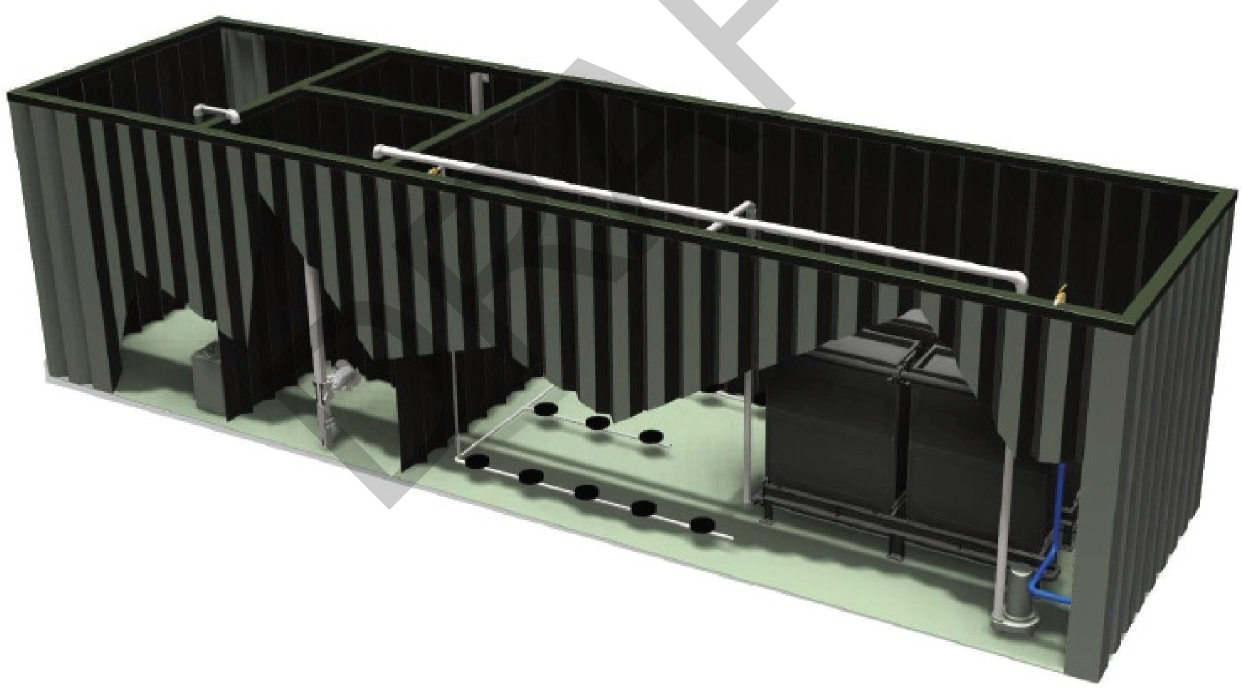
The sludge holding zone shall be used for further digestion of wasted sludge and increased operator flexibility.

The entire system will have the air supply distribution pipes inside the tank.

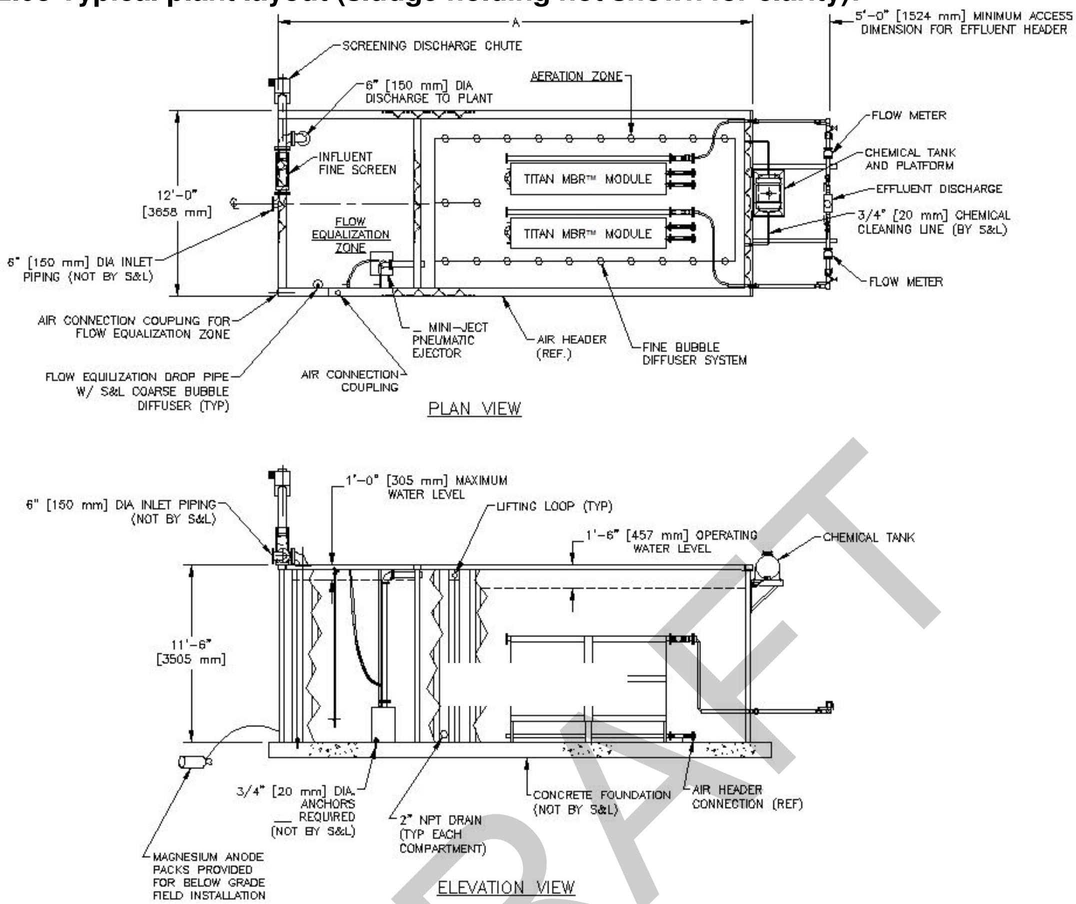
## 2.01 Basic Process Flow Diagram




Isometric view outlines typical system look and components:



**2.03 Typical plant layout (sludge holding not shown for clarity):**






**2.05 Scope of Supply**

a. 304 stainless steel, 3mm fine screen
b. Factory built, epoxy coated tankage
c. Membrane Bio Reactor modules (Title 22 Approved)
d. Fine bubble diffusers
e. Coarse bubble diffusers for flow equalization and sludge holding
f. Air headers
g. Air piping to Membrane Bio Reactor modules within tank
h. Flow equalization **MINI-JECT®** ejector and associated discharge piping
i. Wasting sludge airlift
j. Valves for diffuser drop pipes
k. Flow equalization blower
l. Main plant blowers
m. NEMA 4 Control Panel, including steel support stand and mounting hardware
n. PLC controls with HMI, VFDs, and remote monitoring
o. DO, pH, temperature, and other necessary probes
p. Flow meter
q. Chemical clean in place constant head tank and system

## 3.0 DELIVERY, TERMS, BUDGET PRICING

### 3.01 Delivery

Submittal drawings and other technical engineering details are expected to be complete in 4-6 weeks after receipt of a purchase order. After approved drawings, manufacturing would take 20-22 weeks. Depending on factory work load, lead times may be improved.

### 3.02 Payment Terms

To be determined.

### 3.03 Budget Price (fob, factory) – Offer Valid for 90 days

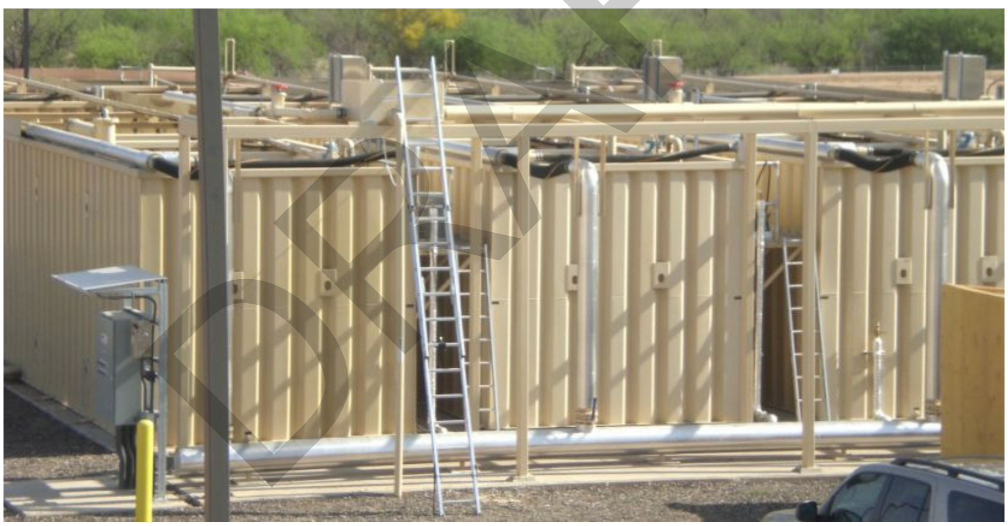
**Option 1:** 75,000 gal/day **TITAN MBR™** system ........................................ $
Freight ........................................................................ Included
Start up and Training ........................................................ Included

**Option 2:** 50,000 gal/day **TITAN MBR™** system ........................................ $
Freight ........................................................................ Included
Start up and Training ........................................................ Included

### 3.04 Items Not Included

- Interconnecting piping and wiring (outside of tanks)
- Any civil work
- Any lighting of the site
- Excavation
- Any landscaping/roads around the plant
- Any buildings (if required)

Multi-tank layouts:



TROJAN UV FIT™


WASTEWATER DISINFECTION FILTERED IN-PIPE TREATMENT

TROJANUVFIT™




# Proven TrojanUV Closed-Vessel Chambers for Reuse Disinfection.

## Validated, chemical-free disinfection from the industry leader

Around the globe, wastewater treatment plants of all sizes are responding to the water quality and quantity demands of the communities they serve. As more municipalities adopt wastewater reuse policies and practices, wastewater treatment plants are required to treat effluent to higher levels–essentially eliminating all pathogens prior to reuse or discharge.

Depending on site and design conditions, wastewater treatment plants producing filtered effluent sometimes prefer a disinfection solution using closed-vessel or pressurized UV chambers. The TrojanUVFit™ offers an effective and energy-efficient closed-vessel UV solution. This compact chamber is available in multiple configurations to treat a wide range of flow rates. The streamlined hydraulic profile of closed-vessel systems disinfect filtered effluent without breaking head in the treatment process. These benefits, along with UV's ability to provide environmentally friendly, chemical-free treatment for chlorine resistant microorganisms (such as *Cryptosporidium* and *Giardia*) make the TrojanUVFit closed-vessel solution an attractive option for wastewater disinfection.

# Key Benefits

TrojanUVFit

**Fully validated performance.** System sizing is based on actual dose delivery verified through bioassay validation. Real-world, field performance data eliminates sizing assumptions and risks associated with theoretical dose calculations.

**Compact design.** The small chamber footprint simplifies indoor retrofit installations and reduces construction costs.

**Reliable, proven components.** UV lamps, quartz sleeves, electronic lamp drivers, sensors and sleeve wiping system have been tested, proven reliable and are operating in hundreds of installations.

**Design flexibility.** Chambers can be installed in parallel or in series, making it simple to incorporate redundancy or future expansion needs.

**Wide range of flow rates.** Peak flow rates per chamber are suitable for either individual post-filter or manifold installation. Flows up to 7 MGD per chamber – the largest validated low-pressure lamp in-pipe wastewater system in the industry.

**Validated lamp performance.** Lamp output and aging characteristics validated through industry protocols and proven through years of operating experience.

**Automatic wiping.** Automatic sleeve wiping saves operator's time and money. Ensures the maximum UV output is available for disinfection and minimizes energy consumption.

**Global support. Local service.** Our comprehensive network of certified service providers offers fast response for service and spare parts.

**Guaranteed performance and comprehensive warranty.** Our systems include a Lifetime Disinfection Performance Guarantee.

# TROJANUVFIT™

Designed for efficient, reliable performance

## System Control Center (SCC)

The microprocessor or Programmable Logic Controller (PLC) based controller continuously monitors and controls UV system functions. Supervisory Control and Data Acquisition (SCADA) communication for remote monitoring, control and dose pacing is available. Programmable digital and analog input/output (I/O) capabilities can generate unique alarms for individual applications and send signals to operate valves and pumps.

## Sleeve Wiping System

Automatic sleeve wiping system operates online without interrupting disinfection. The wiping sequence occurs automatically at preset intervals without operator involvement.



## Amalgam Lamps

High-output amalgam lamps are energy-efficient and save operating costs due to reduced electrical consumption. Lamps are located within protective quartz sleeves with easy access from the service entrance.

## UV Intensity Sensor

Highly accurate, photodiode sensor monitors UV output within the chamber. The sensor ensures UV light is fully penetrating the water for complete disinfection.

*This chamber contains lamps in both ends of the chamber. Multiple inlet and outlet flange orientations are available.*


## Power Distribution Center (PDC)

The PDC panel distributes power to the chamber, UV intensity sensor and sleeve wiping system. The panel also houses high-efficiency, variable-output lamp driver (60 – 100% power) with proven performance in hundreds of installations around the world.

## End Cap

The end cap protects and isolates connections for components such as lamps, sleeves and wiping system. Power is automatically disconnected if end cap is removed thereby ensuring a safe working environment for operators.

## UV Chamber

Electropolished 316L stainless steel chamber available in multiple configurations for a wide range of flow rates. Optional flange orientations allow chambers to fit into existing piping galleries or tight spaces.

# Regulatory-Endorsed Bioassay Validation

Field testing ensures accurate dose delivery

**Benefits:**

- Validated in accordance with industry protocols established by National Water Research Institute (NWRI)
- Performance data is generated from actual field testing over a wide range of flow rates and water quality (UV transmission)
- Bioassay testing offers peace of mind and improved public and environmental safety due to verified dose delivery – not theoretical calculations

# Compact Chamber for Installation Flexibility

Efficient, cost-saving design enables retrofit or new construction

**Benefits:**

- Compact footprint simplifies installation and minimizes related capital costs – ideal for retrofit and new construction applications
- Lamps and sleeves are fully serviceable from the chamber end – allowing the system to be installed against walls, other equipment or piping
- Low head loss design simplifies integration into existing process, and avoids additional pumping and associated capital and operational costs
- Multiple flange orientations available – increasing design flexibility


*Chambers can be installed in parallel or in series for increased design and installation flexibility.*



# Amalgam Lamps Require Less Energy

Maintain maximum output and reduce O&M costs

**Benefits:**

- Each lamp draws 250 Watts
- Our amalgam lamps maintain 98% output during entire lamp life – 20% less decline than competitive UV lamps
- Validated performance provides assurance of reliable dose delivery and prolonged lamp life
- Deliver consistent and stable UV output over a wide range of water temperatures

# Built for Reliable Performance and Easy Maintenance

Designed for trouble-free operation and minimal service

**Benefits:**

- Routine procedures, including lamp change-outs are simple and require minimal time – reducing maintenance costs
- Access to internal components (lamps, sleeves, cleaning system) through service entrance at one end
- Service entrance and connections protected by end cap
- Intensity sensor continuously monitors UV output to ensure dose delivery

*The TrojanUVFit lamps are easily replaced in minutes without the need for tools.*

# Robust Sleeve Wiping System

Automatic wiping system maintains consistent dose delivery

**Benefits:**

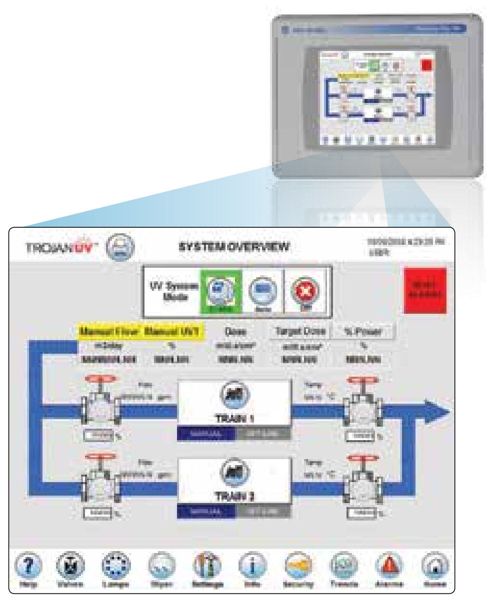
- Wiping system minimizes fouling of quartz sleeves
- Ensures consistent UV dose delivery and optimum performance
- Automatic wiping occurs while the lamps are disinfecting, reducing downtime
- Optional off-line chemical cleaning to reduce maintenance associated with manual cleaning

# User-Friendly Operator Interface

Touchscreen display allows easy operation and monitoring

**Benefits:**

- Microprocessor or PLC-based system controls all functions and dose pacing to minimize energy use while maintaining required UV dose
- Controller features intuitive, graphical display for at-a-glance system status
- Controller communicates with plant SCADA systems for centralized monitoring of performance, lamp status, power levels, hours of operation and alarm status




*The PLC-based controller combines sophisticated system operation and reporting with an operator-friendly, touchscreen display.*

TROJANUVFIT™



## System Specifications

| Model | | | 04AL20 | 08AL20 | 18AL40 | 32AL50 | 72AL75 | D72AL75 |
|---|---|---|---|---|---|---|---|---|
| Number of Lamps | | | 4 | 8 | 18 | 32 | 72 | 144 |
| Lamp Type | | | High-efficiency, High-output, Low-pressure Amalgam | | | | | |
| Sleeve Wiping | | | Automatic wiping system | | | | | |
| Lamp Driver | | | Electronic, constant output (100% power) or electronic, variable output (60 to 100% power) | | | | | |
| **Chamber** | | | | | | | | |
| Materials of Construction | | | 316L Stainless Steel | | | | | |
| Standard Flange Size (ANSI/DIN), inches (mm) | | | 6 (150) | | 10 (250) | 12 (300) | 20 (500) | 20 (500) |
| Outlet Flange Orientation | | | Multiple orientations available 3, 6, 9 or 12 o'clock position | | | | | |
| Approx. Chamber Length, inches (mm) | | | 80 (2032) | 80 (2032) | 82 (2083) | 90 (2286) | 90 (2286) | 152 (3860) |
| Max. Operating Pressure, PSI (bar) | | | 150 (10) | 150 (10) | 150 (10) | 100 (6.8) | 65 (4.5) | 65 (4.5) |
| Dry Chamber Weight, lbs (kg) | | | 107 (49) | 115 (52) | 400 (181) | 1600 (726) | 2100 (953) | 3700 (1678) |
| Wet Chamber Weight, lbs (kg) | | | 230 (105) | | 877 (398) | 2200 (998) | 3700 (1678) | 7200 (3265) |
| **Power Distribution Center (PDC)** | | | | | | | | |
| Electrical Supply | Standard: Single phase, 2 wire + gnd, 50/60 Hz L-L | 120V | N/A | N/A | N/A | N/A | N/A | N/A |
| | | 208V | √ | √ | √ | √ | N/A | N/A |
| | | 240V | √ | √ | √ | √ | N/A | N/A |
| | 3 Phase, 4 wire + gnd, 50/60 Hz | 400/230V | N/A | N/A | √ | √ | √ | √ |
| Dimensions (H x W x D) inches (mm) | | Type 12 | 30 x 16 x 10 (760 x 410 x 250) | | 36 x 30 x 10 (920 x 760 x 250) | 60 x 36 x 10 (1520 x 920 x 250) | 86 x 48 x 24 (2184 x 1219 x 610) | 86 x 96 x 24 (2184 x 2438 x 610) |
| | | Type 3R | | | | | | |
| | | Type 4X | 30 x 24 x 10 (760 x 610 x 250) | | | 60 x 36 x 12 (1520 x 920 x 305) | | |
| Material | | Type 12 | Painted Mild Steel | | | | | |
| | | Type 3R | Painted Mild Steel | | | | | |
| | | Type 4X | 304 Stainless (1.4301 in Europe) | | | | | |
| Panel Rating | | | NEMA 12, 3R or 4X | | | NEMA 12 or 4X | | |
| Network Interface | | | Modbus RTU RS485, Modbus TCP/IP, AB Ethernet I/P, ProfiNet | | | | N/A | |
| **System Control Center (SCC)** | | | | | | | | |
| Panel is Required/Optional | | | N/A (requires only PDC) | | | Optional | Required | |
| Electrical | | | N/A (see PDC) | | | Two (2) Supplies of 120 V single phase, 2 wire plus ground, 60 Hz, 1.2 kVA (one (1) for the PLC, one (1) for lights & heater) | | |
| Material | | Type 12 | Painted Mild Steel | | | | | |
| | | Type 4X | Stainless(1.4301 in Europe) | | | | | |
| Panel Rating | | | N/A (see PDC) | | | NEMA 12 or 4X | | |
| Typical Outputs Provided | | | Chamber status, common alarms and SCADA communication | | | | | |
| Network Interface | | | Modbus RTU RS485, Modbus TCP/IP, AB Ethernet I/P, ProfiNet | | | | | |

**TrojanUV is part of the Trojan Technologies group of businesses.**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TROJANUV™ WATER CONFIDENCE™

ENVIRODYNE SYSTEMS INC.

Custom Water & Wastewater Treatment Equipment - Since 1971

46 YEARS

ISO 9001:2008 CERTIFIED



# Sludge Bagging Systems



The All-American™ Sludge Bagger is an economical alternative to drying beds, liquid hauling and other technologies for small sludge flows dewatering.

The All-American™ Sludge Bagger has been featured in *Operations Forum*, a Water Environment Federation

Appendix F

# Water Balance Calculations and Reference Data

- Methodology & Summary Table
- Water Balance Worksheets
- Rainfall and Evaporation Data

# Recycled Water Storage Ponds
# Water Balance Methodology

1. Develop preliminary layout and configuration of proposed storage ponds based on available land area, site features and minimum 2:1 graded cut and fill slopes; calculate cut and fill volumes.

2. Determine volume-depth relationships (rating curve), bottom area, surface “catchment” area; determine maximum storage volume of each pond up to a depth of 2 feet below top of pond (freeboard).

3. Obtain best estimates of average monthly rainfall data for Woodacre Fire Station (41.6 inches); develop estimates of 10-yr and 100-yr seasonal rainfall amounts from statistical analysis of long-term rainfall records for San Rafael and Kentfield; apply results (“multiplier”) to average monthly values to obtain estimates of 10-yr and 100-yr rainfall for Woodacre.

4. Develop estimates of monthly water surface evaporation from MMWD data for Lake Lagunitas pan evaporation data and use of 0.8 coefficient per NOAA National Weather Service guidelines and maps.

5. Construct monthly water balance calculation worksheet covering annual cycle, November through October; assumes pond empty on November 1st of each year;

   a. **Wet weather season**: calculate net water volume additions from direct rainfall (100-yr values) plus assumed wastewater additions, minus loss of water to evaporation for each month; accumulate total volume in pond storage from month to month until maximum storage volume is reached; trial-and-error calculations adjusting the assumed daily/monthly wastewater inflow <u>to determine maximum wastewater flow capacity (gpd).</u>

   b. **Dry weather season**: continue water balance calculations through dry (irrigation) season (April-October), accounting for additional outflow of recycled water from pond for irrigation uses; trial-and-error calculations to determine <u>volume of recycled wate</u>r discharged to drain pond by end of October.

6. Run calculations for average, 10-yr and 100-yr rainfall conditions for each pond; tally results to estimate recycled water production volumes for **Alternative Projects 4, 5a and 5b**.

7. Modify and run water balance calculations for **Alternative 6**, including: (a) supplemental treated water input to storage ponds year-round (from expanded service area flows) during average and 10-yr rainfall conditions year-round; and (b) supplemental treated water during dry season only for 100-yr rainfall conditions.

## Estimated Recycled Water Production

| Alternative | Service Area | Parcels/ESDs | Estimated Average WW Flow (gpd) | Ponds/Storage | Average Rainfall Year | | 10-Yr Rainfall | | 100-Yr Rainfall | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MGAL | AC-FT | MGAL | AC-FT | MGAL | AC-FT |
| 4 | Woodacre | 210 | 26,000 | **Front** | **9,223,400** | **28.3** | **10,090,100** | **31.0** | **10,785,600** | **33.1** |
| 5A | Woodacre & San Geronimo | 270 | 33,200 | Front | 9,223,400 | 28.3 | 10,090,100 | 31.0 | 10,785,600 | 33.1 |
| | | | | Back Upper | n/a | n/a | n/a | n/a | n/a | n/a |
| | | | | Back Lower | 3,035,250 | 9.3 | 3,514,500 | 10.8 | 3,897,900 | 12.0 |
| | | | | **Total** | **12,258,650** | **37.6** | **13,604,600** | **41.8** | **14,683,500** | **45.1** |
| 5B | Woodacre & San Geronimo | 360 | 44,000 | Front | 9,223,400 | 28.3 | 10,090,100 | 31.0 | 10,785,600 | 33.1 |
| | | | | Back Upper | 4,025,700 | 12.4 | 4,600,800 | 14.1 | 5,054,490 | 15.5 |
| | | | | Back Lower | 3,035,250 | 9.3 | 3,514,500 | 10.8 | 3,897,900 | 12.0 |
| | | | | **Total** | **16,284,350** | **50.0** | **18,205,400** | **55.9** | **19,737,990** | **60.6** |
| 6 | Woodacre, San Geronimo, Lagunitas School French Ranch (Others) | 420+ | 53,300 | Front | 10,550,200 | 32.4 | 11,309,900 | 34.7 | 11,427,600 | 35.1 |
| | | | | Back Upper | 4,291,950 | 13.2 | 4,867,050 | 14.9 | 5,293,050 | 16.2 |
| | | | | Back Lower | 3,418,650 | 10.5 | 3,897,900 | 12.0 | 4,089,600 | 12.6 |
| | | | | **Total** | **18,260,800** | **56.0** | **20,074,850** | **61.6** | **20,810,250** | **63.9** |

# Pond Water Balance Worksheets

Average, 10-yr and 100-yr Rainfall

## WOODACRE-SAN GERONIMO WASTEWATER RECYCLING STUDY



## FRONT NINE POND WATER BALANCE FOR 100-YR. RAINFALL - MAX. WW FLOW, POND CAPACITY

| | | | | |
|---|---|---|---|---|
| **WASTEWATER FLOW** | 26,000 | GPD, Winter | 21,800 | GPD, Summer |
| **MAX POND SURFACE AREA** | 73,780 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **6,446,967** | GALLONS | | |
| | 861,779 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **18.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| **Month** | **Days in Month** | **Wastewater Inflow** | | **Precipitation** | | **Evaporation*** | | **Recycled Water Produced** | | **Volume Change** | **Total Balance Volume** | | **End Water Depth** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **WW** | | **P** | | **Eto** | | **Irr.** | | **ΔV** | **V** | | |
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | ft |
| NOV | 30 | 780,000 | 104,286 | 9.28 | 57,033 | 0.98 | 5,121 | 0 | 0 | 156,199 | 156,199 | 1,168,522 | 4.7 |
| DEC | 31 | 806,000 | 107,762 | 14.49 | 89,084 | 0.94 | 4,956 | 0 | 0 | 191,890 | 348,089 | 2,604,051 | 9.2 |
| JAN | 31 | 806,000 | 107,762 | 16.99 | 104,441 | 1.83 | 9,581 | 0 | 0 | 202,622 | 550,711 | 4,119,867 | 13.0 |
| FEB | 28 | 728,000 | 97,334 | 13.62 | 83,742 | 2.87 | 15,032 | 0 | 0 | 166,043 | 716,754 | 5,362,036 | 15.8 |
| MAR | 31 | 806,000 | 107,762 | 9.57 | 58,814 | 4.13 | 21,640 | 0 | 0 | 144,936 | 861,690 | 6,446,306 | 18.0 |
| APR | 30 | 654,000 | 87,440 | 4.34 | 26,708 | 4.94 | 25,935 | 50,400 | 202,154 | -113,941 | 747,750 | 5,593,914 | 16.3 |
| MAY | 31 | 675,800 | 90,354 | 1.86 | 11,407 | 5.32 | 27,917 | 50,400 | 208,893 | -135,049 | 612,701 | 4,583,615 | 14.1 |
| JUN | 30 | 654,000 | 87,440 | 0.51 | 3,116 | 4.66 | 24,448 | 50,400 | 202,154 | -136,047 | 476,654 | 3,565,851 | 11.7 |
| JUL | 31 | 675,800 | 90,354 | 0.08 | 501 | 3.53 | 18,501 | 50,400 | 208,893 | -136,539 | 340,115 | 2,544,404 | 9.0 |
| AUG | 30 | 654,000 | 87,440 | 0.15 | 946 | 2.08 | 10,902 | 50,400 | 202,154 | -124,671 | 215,444 | 1,611,739 | 6.2 |
| SEP | 30 | 654,000 | 87,440 | 0.71 | 4,340 | 1.10 | 5,782 | 50,400 | 202,154 | -116,156 | 99,288 | 742,775 | 3.1 |
| OCT | 31 | 675,800 | 90,354 | 3.70 | 22,758 | 0.72 | 3,799 | 50,400 | 208,893 | -99,580 | -292 | -2,183 | -0.1 |
| **Totals:** | | **8,569,400** | **1,145,729** | **75.3** | **462,889** | **33.1** | **173,614** | **10,785,600** | **1,435,296** | **-292** | **5,125,103** | **38,340,897** | |

| **Annual Recycled Water Volume:** | **10.79** | Mgal |
|---|---|---|
| | **33.10** | ac-ft |

Notes:

*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD

Evap calculated based on water surface area at 50% pond capacity (vol)

Pond bottom area, SQ FT: 32,632

**WOODACRE- SAN GERONIMO WASTEWATER RECYCLING STUDY** **Back NineLower Pond - 100-Year**

**BACK NINE LOWER POND WATER BALANCE FOR 100-YR. RAINFALL - MAX WW FLOW, POND CAPACITY**

| | | | | |
|---|---|---|---|---|
| WASTEWATER INFLOW | 7,800 | GPD, Winter | 6,500 | GPD, Summer |
| POND WATERSHED AREA | 40,990 | SQUARE FEET | | |
| AVERAGE BANK SLOPE | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **2,620,000** | GALLONS | | |
| | 350,221 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| Month | Days in Month | Wastewater Inflow WW (gal) | Wastewater Inflow WW ($ft^3$) | Precipitation P (in) | Precipitation P ($ft^3$) | Evaporation Eto (in) | Evaporation Eto ($ft^3$) | Recycled Water Produced Irr. (gpd) | Recycled Water Produced Irr. ($ft^3$) | Volume Change ΔV ($ft^3$) | Total Balance Volume V ($ft^3$) | Total Balance Volume V (gal) | End Water Depth (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOV | 30 | 234,000 | 31,286 | 9.28 | 31,686 | 0.98 | 2,337 | 0 | 0 | 60,635 | 60,635 | 453,611 | 4.3 |
| DEC | 31 | 241,800 | 32,329 | 14.49 | 49,492 | 0.94 | 2,261 | 0 | 0 | 79,559 | 140,194 | 1,048,794 | 8.1 |
| JAN | 31 | 241,800 | 32,329 | 16.99 | 58,024 | 1.83 | 4,372 | 0 | 0 | 85,981 | 226,175 | 1,692,016 | 11.3 |
| FEB | 28 | 218,400 | 29,200 | 13.62 | 46,525 | 2.87 | 6,860 | 0 | 0 | 68,865 | 295,040 | 2,207,193 | 13.5 |
| MAR | 31 | 241,800 | 32,329 | 9.57 | 32,675 | 4.13 | 9,875 | 0 | 0 | 55,129 | 350,169 | 2,619,611 | 15.1 |
| APR | 30 | 195,000 | 26,072 | 4.34 | 14,838 | 4.94 | 11,835 | 18,300 | 73,401 | -44,327 | 305,842 | 2,288,004 | 13.8 |
| MAY | 31 | 201,500 | 26,941 | 1.86 | 6,337 | 5.32 | 12,740 | 18,300 | 75,848 | -55,310 | 250,532 | 1,874,230 | 12.1 |
| JUN | 30 | 195,000 | 26,072 | 0.51 | 1,731 | 4.66 | 11,157 | 18,300 | 73,401 | -56,755 | 193,777 | 1,449,643 | 10.2 |
| JUL | 31 | 201,500 | 26,941 | 0.08 | 278 | 3.53 | 8,443 | 18,300 | 75,848 | -57,072 | 136,704 | 1,022,686 | 8.0 |
| AUG | 30 | 195,000 | 26,072 | 0.15 | 526 | 2.08 | 4,975 | 18,300 | 73,401 | -51,780 | 84,925 | 635,323 | 5.6 |
| SEP | 30 | 195,000 | 26,072 | 0.71 | 2,411 | 1.10 | 2,638 | 18,300 | 73,401 | -47,557 | 37,368 | 279,550 | 2.9 |
| OCT | 31 | 201,500 | 26,941 | 3.70 | 12,644 | 0.72 | 1,734 | 18,300 | 75,848 | -37,998 | -630 | -4,711 | -0.1 |
| **Totals:** | | **2,562,300** | **342,580** | **75.3** | **257,168** | **33.1** | **79,228** | **3,897,900** | **521,149** | **-630** | **2,080,731** | **15,565,949** | |

| Annual Recycled Water Volume: | | |
|---|---|---|
| | **3.90** | Mgal |
| | **11.96** | ac-ft |

Notes:

*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD

Evap calculated based on water surface area at 50% pond capacity (vol)

Pond bottom area, SQ FT: 11,200

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY** **Back Nine Upper Pond - 100-yr**

**BACK NINE UPPER POND WATER BALANCE FOR 100-YR. RAINFALL - MAX WW FLOWS AT POND CAPACITY**

| | | | | |
|---|---|---|---|---|
| WASTEWATER INFLOW | 10,200 | GPD, Winter | 8,500 | gpd, Summer |
| POND WATERSHED AREA | 48,960 | SQUARE FEET | | |
| AVERAGE BANK SLOPE | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **3,300,000** | GALLONS | | |
| | 441,117 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| Month | Days in Month | Wastewater Inflow WW | | Precipitation P | | Evaporation* Eto | | Recycled Water Produced Irr. | | Volume Change ΔV | Total Balance Volume V | | End Water Depth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | (ft) |
| NOV | 30 | 306,000 | 40,912 | 9.28 | 37,847 | 0.98 | 2,337 | 0 | 0 | 76,422 | 76,422 | 571,716 | 4.2 |
| DEC | 31 | 316,200 | 42,276 | 14.49 | 59,115 | 0.94 | 2,261 | 0 | 0 | 99,130 | 175,552 | 1,313,306 | 8.0 |
| JAN | 31 | 316,200 | 42,276 | 16.99 | 69,306 | 1.83 | 4,372 | 0 | 0 | 107,210 | 282,762 | 2,115,344 | 11.2 |
| FEB | 28 | 285,600 | 38,185 | 13.62 | 55,571 | 2.87 | 6,860 | 0 | 0 | 86,895 | 369,658 | 2,765,409 | 13.4 |
| MAR | 31 | 316,200 | 42,276 | 9.57 | 39,029 | 4.13 | 9,875 | 0 | 0 | 71,429 | 441,087 | 3,299,773 | 15.1 |
| APR | 30 | 255,000 | 34,094 | 4.34 | 17,724 | 4.94 | 11,835 | 23,730 | 95,181 | -55,199 | 385,888 | 2,886,828 | 13.8 |
| MAY | 31 | 263,500 | 35,230 | 1.86 | 7,569 | 5.32 | 12,740 | 23,730 | 98,354 | -68,294 | 317,594 | 2,375,919 | 12.1 |
| JUN | 30 | 255,000 | 34,094 | 0.51 | 2,068 | 4.66 | 11,157 | 23,730 | 95,181 | -70,176 | 247,417 | 1,850,929 | 10.2 |
| JUL | 31 | 263,500 | 35,230 | 0.08 | 332 | 3.53 | 8,443 | 23,730 | 98,354 | -71,234 | 176,183 | 1,318,025 | 8.0 |
| AUG | 30 | 255,000 | 34,094 | 0.15 | 628 | 2.08 | 4,975 | 23,730 | 95,181 | -65,435 | 110,748 | 828,505 | 5.6 |
| SEP | 30 | 255,000 | 34,094 | 0.71 | 2,880 | 1.10 | 2,638 | 23,730 | 95,181 | -60,846 | 49,902 | 373,317 | 2.9 |
| OCT | 31 | 263,500 | 35,230 | 3.70 | 15,102 | 0.72 | 1,734 | 23,730 | 98,354 | -49,756 | 146 | 1,094 | 0.0 |
| **Totals:** | | **3,350,700** | **447,989** | **75.3** | **307,171** | **33.1** | **79,228** | **5,054,490** | **675,785** | **146** | **2,633,360** | **19,700,165** | |

| **Annual Recycled Water Volume:** | **5.05** | Mgal |
|---|---|---|
| | **15.51** | ac-ft |

Notes:

*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD

Evap calculated based on water surface area at 50% pond capacity (vol)

Pond bottom area, SQ FT: 14,316

## WOODACRE-SAN GERONIMO WASTEWATER RECYCLING STUDY
## FRONT NINE POND WATER BALANCE FOR AVE-YR. RAINFALL





| | | | | |
|---|---|---|---|---|
| **WASTEWATER FLOW** | 26,000 | GPD, Winter | 21,800 | GPD, Summer |
| **MAX POND SURFACE AREA** | 73,780 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **6,446,967** | GALLONS | | |
| | 861,779 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **18.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| Month | Days in Month | Wastewater Inflow WW (gal) | (ft$^3$) | Precipitation P (in) | (ft$^3$) | Evaporation* Eto (in) | (ft$^3$) | Recycled Water Produced Irr. (gpd) | (ft$^3$) | Volume Change ΔV (ft$^3$) | Total Balance Volume V (ft$^3$) | (gal) | End Water Depth ft |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOV | 30 | 780,000 | 104,286 | 5.13 | 31,510 | 0.98 | 5,121 | 0 | 0 | 130,675 | 130,675 | 977,582 | 4.0 |
| DEC | 31 | 806,000 | 107,762 | 8.01 | 49,217 | 0.94 | 4,956 | 0 | 0 | 152,024 | 282,699 | 2,114,873 | 7.7 |
| JAN | 31 | 806,000 | 107,762 | 9.39 | 57,702 | 1.83 | 9,581 | 0 | 0 | 155,883 | 438,583 | 3,281,037 | 11.0 |
| FEB | 28 | 728,000 | 97,334 | 7.53 | 46,266 | 2.87 | 15,032 | 0 | 0 | 128,568 | 567,150 | 4,242,851 | 13.3 |
| MAR | 31 | 806,000 | 107,762 | 5.29 | 32,494 | 4.13 | 21,640 | 0 | 0 | 118,616 | 685,767 | 5,130,220 | 15.3 |
| APR | 30 | 654,000 | 87,440 | 2.40 | 14,756 | 4.94 | 25,935 | 43,100 | 172,874 | -96,613 | 589,154 | 4,407,459 | 13.7 |
| MAY | 31 | 675,800 | 90,354 | 1.03 | 6,302 | 5.32 | 27,917 | 43,100 | 178,637 | -109,897 | 479,257 | 3,585,319 | 11.7 |
| JUN | 30 | 654,000 | 87,440 | 0.28 | 1,722 | 4.66 | 24,448 | 43,100 | 172,874 | -108,161 | 371,096 | 2,776,169 | 9.6 |
| JUL | 31 | 675,800 | 90,354 | 0.05 | 277 | 3.53 | 18,501 | 43,100 | 178,637 | -106,507 | 264,589 | 1,979,393 | 7.3 |
| AUG | 30 | 654,000 | 87,440 | 0.09 | 523 | 2.08 | 10,902 | 43,100 | 172,874 | -95,814 | 168,775 | 1,262,607 | 5.0 |
| SEP | 30 | 654,000 | 87,440 | 0.39 | 2,398 | 1.10 | 5,782 | 43,100 | 172,874 | -88,818 | 79,957 | 598,159 | 2.6 |
| OCT | 31 | 675,800 | 90,354 | 2.05 | 12,573 | 0.72 | 3,799 | 43,100 | 178,637 | -79,508 | 449 | 3,359 | 0.0 |
| **Totals:** | | **8,569,400** | **1,145,729** | **41.60** | **255,740** | **33.1** | **173,614** | **9,223,400** | **1,227,406** | **449** | **4,058,151** | **30,359,027** | |

| **Annual Recycled Water Volume:** | | |
|---|---|---|
| | **9.22** | Mgal |
| | **28.31** | ac-ft |

Notes:

*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD

Evap calculated based on water surface area at 50% pond capacity (vol)

Pond bottom area, SQ FT: 32,632

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**
**BACK NINE LOWER POND WATER BALANCE FOR AVE-YR. RAINFALL**



| | | | | |
|---|---|---|---|---|
| **WASTEWATER INFLOW** | 7,800 | GPD, Winter | 6,500 | GPD, Summer |
| **POND WATERSHED AREA** | 40,990 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **2,600,000** | GALLONS | | |
| | 347,547 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| **Month** | **Days in Month** | **Wastewater Inflow** | | **Precipitation** | | **Evaporation** | | **Recycled Water Produced** | | **Volume Change** | **Total Balance Volume** | | **End Water Depth** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **WW** | | **P** | | **Eto** | | **Irr.** | | **ΔV** | **V** | | |
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | (ft) |
| NOV | 30 | 234,000 | 31,286 | 5.13 | 17,506 | 0.98 | 2,337 | 0 | 0 | 46,455 | 46,455 | 347,530 | 3.5 |
| DEC | 31 | 241,800 | 32,329 | 8.01 | 27,344 | 0.94 | 2,261 | 0 | 0 | 57,411 | 103,866 | 777,021 | 6.5 |
| JAN | 31 | 241,800 | 32,329 | 9.39 | 32,058 | 1.83 | 4,372 | 0 | 0 | 60,014 | 163,880 | 1,225,986 | 9.0 |
| FEB | 28 | 218,400 | 29,200 | 7.53 | 25,704 | 2.87 | 6,860 | 0 | 0 | 48,044 | 211,924 | 1,585,406 | 10.8 |
| MAR | 31 | 241,800 | 32,329 | 5.29 | 18,053 | 4.13 | 9,875 | 0 | 0 | 40,506 | 252,431 | 1,888,433 | 12.2 |
| APR | 30 | 195,000 | 26,072 | 2.40 | 8,198 | 4.94 | 11,835 | 14,250 | 57,157 | -34,722 | 217,708 | 1,628,674 | 11.0 |
| MAY | 31 | 201,500 | 26,941 | 1.03 | 3,501 | 5.32 | 12,740 | 14,250 | 59,062 | -41,360 | 176,348 | 1,319,260 | 9.5 |
| JUN | 30 | 195,000 | 26,072 | 0.28 | 956 | 4.66 | 11,157 | 14,250 | 57,157 | -41,286 | 135,063 | 1,010,403 | 7.9 |
| JUL | 31 | 201,500 | 26,941 | 0.05 | 154 | 3.53 | 8,443 | 14,250 | 59,062 | -40,411 | 94,652 | 708,091 | 6.1 |
| AUG | 30 | 195,000 | 26,072 | 0.09 | 290 | 2.08 | 4,975 | 14,250 | 57,157 | -35,770 | 58,882 | 440,495 | 4.2 |
| SEP | 30 | 195,000 | 26,072 | 0.39 | 1,332 | 1.10 | 2,638 | 14,250 | 57,157 | -32,391 | 26,490 | 198,174 | 2.1 |
| OCT | 31 | 201,500 | 26,941 | 2.05 | 6,985 | 0.72 | 1,734 | 14,250 | 59,062 | -26,870 | -380 | -2,840 | -0.1 |
| **Totals:** | | **2,562,300** | **342,580** | **41.60** | **142,082** | **33.1** | **79,228** | **3,035,250** | **405,813** | **-380** | **1,487,319** | **11,126,635** | |

| **Annual Recycled Water Volume:** | **3.04** | Mgal |
|---|---|---|
| | **9.31** | ac-ft |

Notes:

*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD

Evap calculated based on water surface area at 50% pond capacity (vol)

Pond bottom area, SQ FT: 11,200

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**
**BACK NINE UPPER POND WATER BALANCE FOR AVE-YR. RAINFALL**

**Back Nine Upper Pond - Ave Year**

| | | | | |
|---|---|---|---|---|
| **WASTEWATER INFLOW** | 10,200 | GPD, Winter | 8,500 | gpd, Summer |
| **POND WATERSHED AREA** | 48,960 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **3,300,000** | GALLONS | | |
| | 441,117 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| **Month** | **Days in Month** | **Wastewater Inflow** | | **Precipitation** | | **Evaporation** | | **Recycled Water Produced** | | **Volume Change** | **Total Balance Volume** | | **End Water Depth** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **WW** | | **P** | | **Eto** | | **Irr.** | | **ΔV** | **V** | | |
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | (ft) |
| NOV | 30 | 306,000 | 40,912 | 5.13 | 20,910 | 0.98 | 2,337 | 0 | 0 | 59,485 | 59,485 | 445,010 | 3.4 |
| DEC | 31 | 316,200 | 42,276 | 8.01 | 32,660 | 0.94 | 2,261 | 0 | 0 | 72,675 | 132,160 | 988,690 | 6.4 |
| JAN | 31 | 316,200 | 42,276 | 9.39 | 38,291 | 1.83 | 4,372 | 0 | 0 | 76,195 | 208,355 | 1,558,701 | 9.0 |
| FEB | 28 | 285,600 | 38,185 | 7.53 | 30,702 | 2.87 | 6,860 | 0 | 0 | 62,027 | 270,382 | 2,022,724 | 10.8 |
| MAR | 31 | 316,200 | 42,276 | 5.29 | 21,563 | 4.13 | 9,875 | 0 | 0 | 53,964 | 324,345 | 2,426,425 | 12.3 |
| APR | 30 | 255,000 | 34,094 | 2.40 | 9,792 | 4.94 | 11,835 | 18,900 | 75,808 | -43,758 | 280,588 | 2,099,075 | 11.1 |
| MAY | 31 | 263,500 | 35,230 | 1.03 | 4,182 | 5.32 | 12,740 | 18,900 | 78,335 | -51,663 | 228,925 | 1,712,587 | 9.7 |
| JUN | 30 | 255,000 | 34,094 | 0.28 | 1,142 | 4.66 | 11,157 | 18,900 | 75,808 | -51,729 | 177,196 | 1,325,604 | 8.0 |
| JUL | 31 | 263,500 | 35,230 | 0.05 | 184 | 3.53 | 8,443 | 18,900 | 78,335 | -51,364 | 125,832 | 941,349 | 6.2 |
| AUG | 30 | 255,000 | 34,094 | 0.09 | 347 | 2.08 | 4,975 | 18,900 | 75,808 | -46,343 | 79,489 | 594,658 | 4.3 |
| SEP | 30 | 255,000 | 34,094 | 0.39 | 1,591 | 1.10 | 2,638 | 18,900 | 75,808 | -42,762 | 36,727 | 274,758 | 2.2 |
| OCT | 31 | 263,500 | 35,230 | 2.05 | 8,344 | 0.72 | 1,734 | 18,900 | 78,335 | -36,495 | 232 | 1,738 | 0.0 |
| **Totals:** | | **3,350,700** | **447,989** | **41.60** | **169,708** | **33.1** | **79,228** | **4,025,700** | **538,236** | **232** | **1,923,716** | **14,391,320** | |

| **Annual Recycled Water Volume:** | **4.03** | Mgal |
|---|---|---|
| | **12.35** | ac-ft |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 14,316

# WOODACRE-SAN GERONIMO WASTEWATER RECYCLING STUDY
# FRONT NINE POND WATER BALANCE FOR 10-YR. RAINFALL



| | | | | |
|---|---|---|---|---|
| **WASTEWATER FLOW** | 26,000 | GPD, Winter | 21,800 | GPD, Summer |
| **MAX POND SURFACE AREA** | 73,780 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **6,446,967** | GALLONS | | |
| | 861,779 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **18.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| Month | Days in Month | Wastewater Inflow WW (gal) | Wastewater Inflow WW ($ft^3$) | Precipitation P (in) | Precipitation P ($ft^3$) | Evaporation* Eto (in) | Evaporation* Eto ($ft^3$) | Recycled Water Produced Irr. (gpd) | Recycled Water Produced Irr. ($ft^3$) | Volume Change ΔV ($ft^3$) | Total Balance Volume V ($ft^3$) | Total Balance Volume V (gal) | End Water Depth ft |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOV | 30 | 780,000 | 104,286 | 7.43 | 45,690 | 0.98 | 5,121 | 0 | 0 | 144,855 | 144,855 | 1,083,660 | 4.4 |
| DEC | 31 | 806,000 | 107,762 | 11.61 | 71,365 | 0.94 | 4,956 | 0 | 0 | 174,172 | 319,027 | 2,386,639 | 8.5 |
| JAN | 31 | 806,000 | 107,762 | 13.61 | 83,668 | 1.83 | 9,581 | 0 | 0 | 181,849 | 500,876 | 3,747,053 | 12.1 |
| FEB | 28 | 728,000 | 97,334 | 10.91 | 67,086 | 2.87 | 15,032 | 0 | 0 | 149,387 | 650,263 | 4,864,621 | 14.7 |
| MAR | 31 | 806,000 | 107,762 | 7.66 | 47,116 | 4.13 | 21,640 | 0 | 0 | 133,239 | 783,502 | 5,861,379 | 16.9 |
| APR | 30 | 654,000 | 87,440 | 3.48 | 21,396 | 4.94 | 25,935 | 47,150 | 189,119 | -106,217 | 677,285 | 5,066,767 | 15.2 |
| MAY | 31 | 675,800 | 90,354 | 1.49 | 9,138 | 5.32 | 27,917 | 47,150 | 195,423 | -123,847 | 553,438 | 4,140,267 | 13.1 |
| JUN | 30 | 654,000 | 87,440 | 0.41 | 2,496 | 4.66 | 24,448 | 47,150 | 189,119 | -123,631 | 429,807 | 3,215,386 | 10.8 |
| JUL | 31 | 675,800 | 90,354 | 0.07 | 401 | 3.53 | 18,501 | 47,150 | 195,423 | -123,168 | 306,639 | 2,293,966 | 8.3 |
| AUG | 30 | 654,000 | 87,440 | 0.12 | 758 | 2.08 | 10,902 | 47,150 | 189,119 | -111,824 | 194,815 | 1,457,414 | 5.7 |
| SEP | 30 | 654,000 | 87,440 | 0.57 | 3,477 | 1.10 | 5,782 | 47,150 | 189,119 | -103,984 | 90,832 | 679,513 | 2.9 |
| OCT | 31 | 675,800 | 90,354 | 2.97 | 18,231 | 0.72 | 3,799 | 47,150 | 195,423 | -90,636 | 196 | 1,464 | -0.1 |
| **Totals:** | | **8,569,400** | **1,145,729** | **60.31** | **370,823** | **33.1** | **173,614** | **10,090,100** | **1,342,742** | **196** | **4,651,534** | **34,798,128** | |

| Annual Recycled Water Volume: | | |
|---|---|---|
| | **10.09** | Mgal |
| | **30.97** | ac-ft |



Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 32,632

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLDING STUDY**
**BACK NINE LOWER POND WATER BALANCE FOR 10-YR. RAINFALL**

**Back Nine Lower Pond - 10-Year**



| | | | | |
|---|---|---|---|---|
| **WASTEWATER INFLOW** | 7,800 | GPD, Winter | 6,500 | GPD, Summer |
| **POND WATERSHED AREA** | 40,990 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **2,600,000** | GALLONS | | |
| | 347,547 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| Month | Days in Month | Wastewater Inflow WW | | Precipitation P | | Evaporation Eto | | Recycled Water Produced Irr. | | Volume Change ΔV | Total Balance Volume V | | End Water Depth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | (ft) |
| NOV | 30 | 234,000 | 31,286 | 7.43 | 25,384 | 0.98 | 2,337 | 0 | 0 | 54,333 | 54,333 | 406,464 | 3.9 |
| DEC | 31 | 241,800 | 32,329 | 11.61 | 39,648 | 0.94 | 2,261 | 0 | 0 | 69,716 | 124,048 | 928,006 | 7.4 |
| JAN | 31 | 241,800 | 32,329 | 13.61 | 46,484 | 1.83 | 4,372 | 0 | 0 | 74,440 | 198,488 | 1,484,892 | 10.3 |
| FEB | 28 | 218,400 | 29,200 | 10.91 | 37,271 | 2.87 | 6,860 | 0 | 0 | 59,611 | 258,100 | 1,930,843 | 12.3 |
| MAR | 31 | 241,800 | 32,329 | 7.66 | 26,176 | 4.13 | 9,875 | 0 | 0 | 48,630 | 306,729 | 2,294,643 | 13.8 |
| APR | 30 | 195,000 | 26,072 | 3.48 | 11,887 | 4.94 | 11,835 | 16,500 | 66,182 | -40,058 | 266,671 | 1,994,969 | 12.6 |
| MAY | 31 | 201,500 | 26,941 | 1.49 | 5,077 | 5.32 | 12,740 | 16,500 | 68,388 | -49,110 | 217,561 | 1,627,577 | 11.0 |
| JUN | 30 | 195,000 | 26,072 | 0.41 | 1,387 | 4.66 | 11,157 | 16,500 | 66,182 | -49,880 | 167,682 | 1,254,425 | 9.2 |
| JUL | 31 | 201,500 | 26,941 | 0.07 | 223 | 3.53 | 8,443 | 16,500 | 68,388 | -49,667 | 118,014 | 882,866 | 7.1 |
| AUG | 30 | 195,000 | 26,072 | 0.12 | 421 | 2.08 | 4,975 | 16,500 | 66,182 | -44,664 | 73,350 | 548,733 | 5.0 |
| SEP | 30 | 195,000 | 26,072 | 0.57 | 1,932 | 1.10 | 2,638 | 16,500 | 66,182 | -40,817 | 32,533 | 243,383 | 2.6 |
| OCT | 31 | 201,500 | 26,941 | 2.97 | 10,129 | 0.72 | 1,734 | 16,500 | 68,388 | -33,052 | -519 | -3,880 | -0.1 |
| **Totals:** | | **2,562,300** | **342,580** | **60.31** | **206,018** | **33.1** | **79,228** | **3,514,500** | **469,889** | **-519** | **1,816,992** | **13,592,921** | |

| Annual Recycled Water Volume: | | |
|---|---|---|
| | **3.51** | Mgal |
| | **10.79** | ac-ft |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 11,200

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**
**BACK NINE UPPER POND WATER BALANCE FOR 10-YR. RAINFALL**





| | | | | |
|---|---|---|---|---|
| WASTEWATER INFLOW | 10,200 | GPD, Winter | 8,500 | gpd, Summer |
| POND WATERSHED AREA | 48,960 | SQUARE FEET | | |
| AVERAGE BANK SLOPE | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **3,300,000** | GALLONS | | |
| | 441,117 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

| Month | Days in Month | Wastewater Inflow | | Precipitation | | Evaporation | | Recycled Water Produced | | Volume Change | Total Balance Volume | | End Water Depth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WW | | P | | Eto | | Irr. | | ΔV | V | | |
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | (ft) |
| NOV | 30 | 306,000 | 40,912 | 7.43 | 30,320 | 0.98 | 2,337 | 0 | 0 | 68,895 | 68,895 | 515,402 | 3.8 |
| DEC | 31 | 316,200 | 42,276 | 11.61 | 47,358 | 0.94 | 2,261 | 0 | 0 | 87,372 | 156,267 | 1,169,032 | 7.3 |
| JAN | 31 | 316,200 | 42,276 | 13.61 | 55,522 | 1.83 | 4,372 | 0 | 0 | 93,425 | 249,692 | 1,867,947 | 10.3 |
| FEB | 28 | 285,600 | 38,185 | 10.91 | 44,518 | 2.87 | 6,860 | 0 | 0 | 75,843 | 325,535 | 2,435,327 | 12.3 |
| MAR | 31 | 316,200 | 42,276 | 7.66 | 31,266 | 4.13 | 9,875 | 0 | 0 | 63,667 | 389,202 | 2,911,618 | 13.9 |
| APR | 30 | 255,000 | 34,094 | 3.48 | 14,198 | 4.94 | 11,835 | 21,600 | 86,638 | -50,181 | 339,021 | 2,536,215 | 12.7 |
| MAY | 31 | 263,500 | 35,230 | 1.49 | 6,064 | 5.32 | 12,740 | 21,600 | 89,526 | -60,971 | 278,049 | 2,080,088 | 11.1 |
| JUN | 30 | 255,000 | 34,094 | 0.41 | 1,656 | 4.66 | 11,157 | 21,600 | 86,638 | -62,044 | 216,005 | 1,615,934 | 9.3 |
| JUL | 31 | 263,500 | 35,230 | 0.07 | 266 | 3.53 | 8,443 | 21,600 | 89,526 | -62,472 | 153,533 | 1,148,579 | 7.2 |
| AUG | 30 | 255,000 | 34,094 | 0.12 | 503 | 2.08 | 4,975 | 21,600 | 86,638 | -57,017 | 96,516 | 722,039 | 5.1 |
| SEP | 30 | 255,000 | 34,094 | 0.57 | 2,307 | 1.10 | 2,638 | 21,600 | 86,638 | -52,875 | 43,641 | 326,479 | 2.6 |
| OCT | 31 | 263,500 | 35,230 | 2.97 | 12,098 | 0.72 | 1,734 | 21,600 | 89,526 | -43,931 | -290 | -2,170 | -0.1 |
| **Totals:** | | **3,350,700** | **447,989** | **60.31** | **246,076** | **33.1** | **79,228** | **4,600,800** | **615,127** | **-290** | **2,316,066** | **17,326,492** | |

| | | |
|---|---|---|
| **Annual Recycled Water Volume:** | **4.60** | Mgal |
| | **14.12** | ac-ft |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 14,316

# Pond Water Balance Worksheets

# Alternative 6 – Expanded Service Area

Average, 10-yr and 100-yr Rainfall Years

**WOODACRE-SAN GERONIMO WASTEWATER RECYCLING STUDY**
**FRONT NINE POND WATER BALANCE FOR AVE-YR. RAINFALL**

**Front Nine Pond #1 - Average Year**
**Alternative 6 -Expanded Service Area**

| | | | | |
|---|---|---|---|---|
| **WASTEWATER FLOW** | 30,500 | GPD, Winter | 24,800 | GPD, Summer |
| **MAX POND SURFACE AREA** | 73,780 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **6,446,967** | GALLONS | | |
| | 861,779 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **18.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

WW Flow Adjustments: add 4,500 gpd Winter add 3,000 gpd Summer

DRAFT

| Month | Days in Month | Wastewater Inflow WW (gal) | Wastewater Inflow WW ($ft^3$) | Precipitation P (in) | Precipitation P ($ft^3$) | Evaporation* Eto (in) | Evaporation* Eto ($ft^3$) | Recycled Water Produced Irr. (gpd) | Recycled Water Produced Irr. ($ft^3$) | Volume Change $\Delta V$ ($ft^3$) | Total Balance Volume V ($ft^3$) | Total Balance Volume V (gal) | End Water Depth ft |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOV | 30 | 915,000 | 122,336 | 5.13 | 31,510 | 0.98 | 5,121 | 0 | 0 | 148,725 | 148,725 | 1,112,611 | 4.5 |
| DEC | 31 | 945,500 | 126,413 | 8.01 | 49,217 | 0.94 | 4,956 | 0 | 0 | 170,675 | 319,400 | 2,389,431 | 8.5 |
| JAN | 31 | 945,500 | 126,413 | 9.39 | 57,702 | 1.83 | 9,581 | 0 | 0 | 174,534 | 493,934 | 3,695,124 | 12.0 |
| FEB | 28 | 854,000 | 114,180 | 7.53 | 46,266 | 2.87 | 15,032 | 0 | 0 | 145,414 | 639,348 | 4,782,964 | 14.5 |
| MAR | 31 | 945,500 | 126,413 | 5.29 | 32,494 | 4.13 | 21,640 | 0 | 0 | 137,268 | 776,616 | 5,809,863 | 16.7 |
| APR | 30 | 744,000 | 99,473 | 2.40 | 14,756 | 4.94 | 25,935 | 49,300 | 197,742 | -109,448 | 667,168 | 4,991,081 | 15.0 |
| MAY | 31 | 768,800 | 102,789 | 1.03 | 6,302 | 5.32 | 27,917 | 49,300 | 204,334 | -123,160 | 544,008 | 4,069,721 | 12.9 |
| JUN | 30 | 744,000 | 99,473 | 0.28 | 1,722 | 4.66 | 24,448 | 49,300 | 197,742 | -120,996 | 423,012 | 3,164,550 | 10.7 |
| JUL | 31 | 768,800 | 102,789 | 0.05 | 277 | 3.53 | 18,501 | 49,300 | 204,334 | -119,770 | 303,242 | 2,268,553 | 8.2 |
| AUG | 30 | 744,000 | 99,473 | 0.09 | 523 | 2.08 | 10,902 | 49,300 | 197,742 | -108,649 | 194,593 | 1,455,747 | 5.7 |
| SEP | 30 | 744,000 | 99,473 | 0.39 | 2,398 | 1.10 | 5,782 | 49,300 | 197,742 | -101,653 | 92,939 | 695,279 | 2.9 |
| OCT | 31 | 768,800 | 102,789 | 2.05 | 12,573 | 0.72 | 3,799 | 49,300 | 204,334 | -92,771 | 168 | 1,258 | -0.1 |
| **Totals:** | | **9,887,900** | **1,322,012** | **41.60** | **255,740** | **33.1** | **173,614** | **10,550,200** | **1,403,970** | **168** | **4,603,152** | **34,436,182** | |

| **Annual Recycled Water Volume:** | | |
|---|---|---|
| | **10.55** | Mgal |
| | **32.38** | ac-ft |

| **Net Discharge to Leachfields** | |
|---|---|
| **0** | **gals** |
| **0** | **gpd** |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 32,632

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**
**BACK NINE LOWER POND WATER BALANCE FOR AVE-YR. RAINFALL**

**Back Nine Lower Pond - Ave Year**
**Alternative 6 -Expanded Service Area**

| | | | | |
|---|---|---|---|---|
| **WASTEWATER INFLOW** | 9,100 | GPD, Winter | 7,400 | GPD, Summer |
| **POND WATERSHED AREA** | 40,990 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **2,600,000** | GALLONS | | |
| | 347,547 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

WW Flow Adjustments: add 1,300 gpd Winter add 900 gpd Summer

| **Month** | **Days in Month** | **Wastewater Inflow** | | **Precipitation** | | **Evaporation** | | **Recycled Water Produced** | | **Volume Change** | **Total Balance Volume** | | **End Water Depth** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **WW** | | **P** | | **Eto** | | **Irr.** | | **ΔV** | **V** | | |
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | (ft) |
| NOV | 30 | 273,000 | 36,500 | 5.13 | 17,506 | 0.98 | 2,337 | 0 | 0 | 51,669 | 51,669 | 386,539 | 3.8 |
| DEC | 31 | 282,100 | 37,717 | 8.01 | 27,344 | 0.94 | 2,261 | 0 | 0 | 62,799 | 114,468 | 856,338 | 7.0 |
| JAN | 31 | 282,100 | 37,717 | 9.39 | 32,058 | 1.83 | 4,372 | 0 | 0 | 65,402 | 179,871 | 1,345,611 | 9.7 |
| FEB | 28 | 254,800 | 34,067 | 7.53 | 25,704 | 2.87 | 6,860 | 0 | 0 | 52,911 | 232,782 | 1,741,439 | 11.5 |
| MAR | 31 | 282,100 | 37,717 | 5.29 | 18,053 | 4.13 | 9,875 | 0 | 0 | 45,894 | 278,676 | 2,084,774 | 13.0 |
| APR | 30 | 222,000 | 29,681 | 2.40 | 8,198 | 4.94 | 11,835 | 16,050 | 64,377 | -38,332 | 240,343 | 1,798,010 | 11.8 |
| MAY | 31 | 229,400 | 30,671 | 1.03 | 3,501 | 5.32 | 12,740 | 16,050 | 66,522 | -45,090 | 195,253 | 1,460,690 | 10.2 |
| JUN | 30 | 222,000 | 29,681 | 0.28 | 956 | 4.66 | 11,157 | 16,050 | 64,377 | -44,895 | 150,358 | 1,124,827 | 8.5 |
| JUL | 31 | 229,400 | 30,671 | 0.05 | 154 | 3.53 | 8,443 | 16,050 | 66,522 | -44,141 | 106,217 | 794,610 | 6.6 |
| AUG | 30 | 222,000 | 29,681 | 0.09 | 290 | 2.08 | 4,975 | 16,050 | 64,377 | -39,380 | 66,837 | 500,007 | 4.6 |
| SEP | 30 | 222,000 | 29,681 | 0.39 | 1,332 | 1.10 | 2,638 | 16,050 | 64,377 | -36,001 | 30,836 | 230,681 | 2.4 |
| OCT | 31 | 229,400 | 30,671 | 2.05 | 6,985 | 0.72 | 1,734 | 16,050 | 66,522 | -30,600 | 235 | 1,761 | 0.0 |
| **Totals:** | | **2,950,300** | **394,455** | **41.60** | **142,082** | **33.1** | **79,228** | **3,418,650** | **457,074** | **235** | **1,647,545** | **12,325,286** | |

| **Annual Recycled Water Volume:** | | |
|---|---|---|
| | **3.42** | Mgal |
| | **10.49** | ac-ft |

| **Net Discharge to Leachfields** | |
|---|---|
| **0** | **gals** |
| **0** | **gpd** |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 11,200

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**
**BACK NINE UPPER POND WATER BALANCE FOR AVE-YR. RAINFALL**

**Back Nine Upper Pond - Ave Year**
**Alternative 6 -Expanded Service Area**

| | | | | |
|---|---|---|---|---|
| **WASTEWATER INFLOW** | 11,900 | GPD, Winter | 9,600 | gpd, Summer |
| **POND WATERSHED AREA** | 48,960 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **3,300,000** | GALLONS | | |
| | 441,117 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

WW Flow Adjustments: add 1,700 gpd Winter add 1,100 gpd Summer

| **Month** | **Days in Month** | **Wastewater Inflow** | | **Precipitation** | | **Evaporation** | | **Recycled Water Produced** | | **Volume Change** | **Total Balance Volume** | | **End Water Depth** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **WW** | | **P** | | **Eto** | | **Irr.** | | **ΔV** | **V** | | |
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | (ft) |
| NOV | 30 | 357,000 | 47,731 | 5.13 | 20,910 | 0.98 | 2,337 | 0 | 0 | 66,304 | 66,304 | 496,020 | 3.7 |
| DEC | 31 | 368,900 | 49,322 | 8.01 | 32,660 | 0.94 | 2,261 | 0 | 0 | 79,721 | 146,025 | 1,092,412 | 7.0 |
| JAN | 31 | 368,900 | 49,322 | 9.39 | 38,291 | 1.83 | 4,372 | 0 | 0 | 83,241 | 229,265 | 1,715,134 | 9.7 |
| FEB | 28 | 333,200 | 44,549 | 7.53 | 30,702 | 2.87 | 6,860 | 0 | 0 | 68,391 | 297,656 | 2,226,767 | 11.6 |
| MAR | 31 | 368,900 | 49,322 | 5.29 | 21,563 | 4.13 | 9,875 | 0 | 0 | 61,010 | 358,666 | 2,683,179 | 13.2 |
| APR | 30 | 288,000 | 38,506 | 2.40 | 9,792 | 4.94 | 11,835 | 20,150 | 80,822 | -44,359 | 314,307 | 2,351,328 | 12.0 |
| MAY | 31 | 297,600 | 39,789 | 1.03 | 4,182 | 5.32 | 12,740 | 20,150 | 83,516 | -52,284 | 262,022 | 1,960,189 | 10.6 |
| JUN | 30 | 288,000 | 38,506 | 0.28 | 1,142 | 4.66 | 11,157 | 20,150 | 80,822 | -52,330 | 209,692 | 1,568,705 | 9.1 |
| JUL | 31 | 297,600 | 39,789 | 0.05 | 184 | 3.53 | 8,443 | 20,150 | 83,516 | -51,986 | 157,706 | 1,179,799 | 7.4 |
| AUG | 30 | 288,000 | 38,506 | 0.09 | 347 | 2.08 | 4,975 | 20,150 | 80,822 | -46,945 | 110,761 | 828,607 | 5.6 |
| SEP | 30 | 288,000 | 38,506 | 0.39 | 1,591 | 1.10 | 2,638 | 20,150 | 80,822 | -43,363 | 67,398 | 504,206 | 3.8 |
| OCT | 31 | 297,600 | 39,789 | 2.05 | 8,344 | 0.72 | 1,734 | 20,150 | 83,516 | -37,117 | 30,281 | 226,535 | 1.9 |
| **Totals:** | | **3,841,700** | **513,635** | **41.60** | **169,708** | **33.1** | **79,228** | **4,291,950** | **573,834** | **30,281** | **2,250,084** | **16,832,882** | |

| **Annual Recycled Water Volume:** | | |
|---|---|---|
| | **4.29** | Mgal |
| | **13.17** | ac-ft |

| **Net Discharge to Leachfields** | |
|---|---|
| **0** | **gals** |
| **0** | **gpd** |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 14,316

**WOODACRE-SAN GERONIMO WASTEWATER RECYCLING STUDY**
**FRONT NINE POND WATER BALANCE FOR 10-YR. RAINFALL**

**Front Nine Pond #1 - 10-Year**
**Alternative 6 -Expanded Service Area**



| | | | | |
|---|---|---|---|---|
| **WASTEWATER FLOW** | 29,800 | GPD, Winter | 24,800 | GPD, Summer |
| **MAX POND SURFACE AREA** | 73,780 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **6,446,967** | GALLONS | | |
| | 861,779 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **18.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

WW Flow Adjustments: add 3,800 gpd Winter add 3,000 gpd Summer

| Month | Days in Month | Wastewater Inflow WW | | Precipitation P | | Evaporation* Eto | | Recycled Water Produced Irr. | | Volume Change ΔV | Total Balance Volume V | | End Water Depth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | ft |
| NOV | 30 | 894,000 | 119,528 | 7.43 | 45,690 | 0.98 | 5,121 | 0 | 0 | 160,097 | 160,097 | 1,197,684 | 4.8 |
| DEC | 31 | 923,800 | 123,512 | 11.61 | 71,365 | 0.94 | 4,956 | 0 | 0 | 189,922 | 350,018 | 2,618,487 | 9.2 |
| JAN | 31 | 923,800 | 123,512 | 13.61 | 83,668 | 1.83 | 9,581 | 0 | 0 | 197,599 | 547,618 | 4,096,727 | 13.0 |
| FEB | 28 | 834,400 | 111,559 | 10.91 | 67,086 | 2.87 | 15,032 | 0 | 0 | 163,613 | 711,231 | 5,320,716 | 15.7 |
| MAR | 31 | 923,800 | 123,512 | 7.66 | 47,116 | 4.13 | 21,640 | 0 | 0 | 148,989 | 860,219 | 6,435,299 | 18.0 |
| APR | 30 | 744,000 | 99,473 | 3.48 | 21,396 | 4.94 | 25,935 | 52,850 | 211,981 | -117,047 | 743,172 | 5,559,671 | 16.2 |
| MAY | 31 | 768,800 | 102,789 | 1.49 | 9,138 | 5.32 | 27,917 | 52,850 | 219,047 | -135,038 | 608,134 | 4,549,453 | 14.0 |
| JUN | 30 | 744,000 | 99,473 | 0.41 | 2,496 | 4.66 | 24,448 | 52,850 | 211,981 | -134,460 | 473,674 | 3,543,555 | 11.6 |
| JUL | 31 | 768,800 | 102,789 | 0.07 | 401 | 3.53 | 18,501 | 52,850 | 219,047 | -134,359 | 339,315 | 2,538,417 | 9.0 |
| AUG | 30 | 744,000 | 99,473 | 0.12 | 758 | 2.08 | 10,902 | 52,850 | 211,981 | -122,653 | 216,662 | 1,620,848 | 6.2 |
| SEP | 30 | 744,000 | 99,473 | 0.57 | 3,477 | 1.10 | 5,782 | 52,850 | 211,981 | -114,813 | 101,849 | 761,930 | 3.2 |
| OCT | 31 | 768,800 | 102,789 | 2.97 | 18,231 | 0.72 | 3,799 | 52,850 | 219,047 | -101,827 | 22 | 163 | -0.1 |
| **Totals:** | | **9,782,200** | **1,307,880** | **60.31** | **370,823** | **33.1** | **173,614** | **11,309,900** | **1,505,068** | **22** | **5,112,010** | **38,242,950** | |

| **Annual Recycled Water Volume:** | | |
|---|---|---|
| | **11.31** | Mgal |
| | **34.71** | ac-ft |

| **Net Discharge to Leachfields** | |
|---|---|
| **0** | **gals** |
| **0** | **gpd** |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 32,632

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLDING STUDY**
**BACK NINE LOWER POND WATER BALANCE FOR 10-YR. RAINFALL**

**Back Nine Lower Pond - 10-Year**
**Alternative 6 -Expanded Service Area**

| | | | | |
|---|---|---|---|---|
| **WASTEWATER INFLOW** | 9,100 | GPD, Winter | 7,400 | GPD, Summer |
| **POND WATERSHED AREA** | 40,990 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **2,600,000** | GALLONS | | |
| | 347,547 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

WW Flow Adjustments: add 1,300 gpd Winter add 900 gpd Summer

| **Month** | **Days in Month** | **Wastewater Inflow** | | **Precipitation** | | **Evaporation** | | **Recycled Water Produced** | | **Volume Change** | **Total Balance Volume** | | **End Water Depth** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **WW** | | **P** | | **Eto** | | **Irr.** | | **ΔV** | **V** | | |
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | (ft) |
| NOV | 30 | 273,000 | 36,500 | 7.43 | 25,384 | 0.98 | 2,337 | 0 | 0 | 59,547 | 59,547 | 445,472 | 4.2 |
| DEC | 31 | 282,100 | 37,717 | 11.61 | 39,648 | 0.94 | 2,261 | 0 | 0 | 75,104 | 134,651 | 1,007,323 | 7.9 |
| JAN | 31 | 282,100 | 37,717 | 13.61 | 46,484 | 1.83 | 4,372 | 0 | 0 | 79,828 | 214,479 | 1,604,517 | 10.9 |
| FEB | 28 | 254,800 | 34,067 | 10.91 | 37,271 | 2.87 | 6,860 | 0 | 0 | 64,478 | 278,957 | 2,086,876 | 13.0 |
| MAR | 31 | 282,100 | 37,717 | 7.66 | 26,176 | 4.13 | 9,875 | 0 | 0 | 54,018 | 332,975 | 2,490,984 | 14.6 |
| APR | 30 | 222,000 | 29,681 | 3.48 | 11,887 | 4.94 | 11,835 | 18,300 | 73,401 | -43,668 | 289,307 | 2,164,304 | 13.3 |
| MAY | 31 | 229,400 | 30,671 | 1.49 | 5,077 | 5.32 | 12,740 | 18,300 | 75,848 | -52,840 | 236,467 | 1,769,006 | 11.6 |
| JUN | 30 | 222,000 | 29,681 | 0.41 | 1,387 | 4.66 | 11,157 | 18,300 | 73,401 | -53,490 | 182,977 | 1,368,849 | 9.8 |
| JUL | 31 | 229,400 | 30,671 | 0.07 | 223 | 3.53 | 8,443 | 18,300 | 75,848 | -53,397 | 129,580 | 969,384 | 7.6 |
| AUG | 30 | 222,000 | 29,681 | 0.12 | 421 | 2.08 | 4,975 | 18,300 | 73,401 | -48,274 | 81,305 | 608,245 | 5.4 |
| SEP | 30 | 222,000 | 29,681 | 0.57 | 1,932 | 1.10 | 2,638 | 18,300 | 73,401 | -44,427 | 36,879 | 275,889 | 2.8 |
| OCT | 31 | 229,400 | 30,671 | 2.97 | 10,129 | 0.72 | 1,734 | 18,300 | 75,848 | -36,782 | 96 | 721 | 0.0 |
| **Totals:** | | **2,950,300** | **394,455** | **60.31** | **206,018** | **33.1** | **79,228** | **3,897,900** | **521,149** | **96** | **1,977,219** | **14,791,572** | |

| **Annual Recycled Water Volume:** | **3.90** | Mgal |
|---|---|---|
| | **11.96** | ac-ft |

| **Net Discharge to Leachfields** | |
|---|---|
| **0** | **gals** |
| **0** | **gpd** |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 11,200

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**
**BACK NINE UPPER POND WATER BALANCE FOR 10-YR. RAINFALL**

**Back Nine Upper Pond - 10-yr**
**Alternative 6 -Expanded Service Area**



| | | | |
|---|---|---|---|
| WASTEWATER INFLOW | 11,900 | GPD, Winter | 9,600 gpd, Summer |
| POND WATERSHED AREA | 48,960 | SQUARE FEET | |
| AVERAGE BANK SLOPE | 2.00 | :1 | |
| **MAXIMUM VOLUME** | **3,300,000** | GALLONS | |
| | 441,117 | CUBIC FEET | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | |

WW Flow Adjustments: add 1,700 gpd Winter add 1,100 gpd Summer

| Month | Days in Month | Wastewater Inflow WW (gal) | Wastewater Inflow WW ($ft^3$) | Precipitation P (in) | Precipitation P ($ft^3$) | Evaporation Eto (in) | Evaporation Eto ($ft^3$) | Recycled Water Produced Irr. (gpd) | Recycled Water Produced Irr. ($ft^3$) | Volume Change $\Delta V$ ($ft^3$) | Total Balance Volume V ($ft^3$) | Total Balance Volume V (gal) | End Water Depth (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOV | 30 | 357,000 | 47,731 | 7.43 | 30,320 | 0.98 | 2,337 | 0 | 0 | 75,714 | 75,714 | 566,413 | 4.2 |
| DEC | 31 | 368,900 | 49,322 | 11.61 | 47,358 | 0.94 | 2,261 | 0 | 0 | 94,418 | 170,132 | 1,272,754 | 7.8 |
| JAN | 31 | 368,900 | 49,322 | 13.61 | 55,522 | 1.83 | 4,372 | 0 | 0 | 100,471 | 270,603 | 2,024,380 | 10.9 |
| FEB | 28 | 333,200 | 44,549 | 10.91 | 44,518 | 2.87 | 6,860 | 0 | 0 | 82,207 | 352,810 | 2,639,370 | 13.0 |
| MAR | 31 | 368,900 | 49,322 | 7.66 | 31,266 | 4.13 | 9,875 | 0 | 0 | 70,713 | 423,523 | 3,168,372 | 14.7 |
| APR | 30 | 288,000 | 38,506 | 3.48 | 14,198 | 4.94 | 11,835 | 22,850 | 91,651 | -50,783 | 372,740 | 2,788,468 | 13.5 |
| MAY | 31 | 297,600 | 39,789 | 1.49 | 6,064 | 5.32 | 12,740 | 22,850 | 94,706 | -61,593 | 311,147 | 2,327,690 | 11.9 |
| JUN | 30 | 288,000 | 38,506 | 0.41 | 1,656 | 4.66 | 11,157 | 22,850 | 91,651 | -62,646 | 248,501 | 1,859,035 | 10.2 |
| JUL | 31 | 297,600 | 39,789 | 0.07 | 266 | 3.53 | 8,443 | 22,850 | 94,706 | -63,094 | 185,407 | 1,387,029 | 8.3 |
| AUG | 30 | 288,000 | 38,506 | 0.12 | 503 | 2.08 | 4,975 | 22,850 | 91,651 | -57,618 | 127,789 | 955,988 | 6.3 |
| SEP | 30 | 288,000 | 38,506 | 0.57 | 2,307 | 1.10 | 2,638 | 22,850 | 91,651 | -53,477 | 74,312 | 555,927 | 4.1 |
| OCT | 31 | 297,600 | 39,789 | 2.97 | 12,098 | 0.72 | 1,734 | 22,850 | 94,706 | -44,553 | 29,759 | 222,627 | 1.9 |
| **Totals:** | | **3,841,700** | **513,635** | **60.31** | **246,076** | **33.1** | **79,228** | **4,867,050** | **650,725** | **29,759** | **2,642,435** | **19,768,054** | |

| **Annual Recycled Water Volume:** | | |
|---|---|---|
| | **4.87** | Mgal |
| | **14.94** | ac-ft |

| **Net Discharge to Leachfields** | |
|---|---|
| **0** | **gals** |
| **0** | **gpd** |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 14,316

## WOODACRE-SAN GERONIMO WASTEWATER RECYCLING STUDY
## FRONT NINE POND WATER BALANCE FOR 100-YR. RAINFALL - MAX. WW FLOW, POND CAPACITY

**Front Nine Pond #1 - 100-Year**
**Alternative 6 -Expanded Service Area**



| | | | | |
|---|---|---|---|---|
| **WASTEWATER FLOW** | 26,000 | GPD, Winter | 24,800 | GPD, Summer |
| **MAX POND SURFACE AREA** | 73,780 | SQUARE FEET | | |
| **AVERAGE BANK SLOPE** | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **6,446,967** | GALLONS | | |
| | 861,779 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **18.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

WW Flow Adjustments: add 0 gpd Winter add 3,000 gpd Summer

| Month | Days in Month | Wastewater Inflow WW | | Precipitation P | | Evaporation* Eto | | Recycled Water Produced Irr. | | Volume Change ΔV | Total Balance Volume V | | End Water Depth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (gal) | ($ft^3$) | (in) | ($ft^3$) | (in) | ($ft^3$) | (gpd) | ($ft^3$) | ($ft^3$) | ($ft^3$) | (gal) | ft |
| NOV | 30 | 780,000 | 104,286 | 9.28 | 57,033 | 0.98 | 5,121 | 0 | 0 | 156,199 | 156,199 | 1,168,522 | 4.7 |
| DEC | 31 | 806,000 | 107,762 | 14.49 | 89,084 | 0.94 | 4,956 | 0 | 0 | 191,890 | 348,089 | 2,604,051 | 9.2 |
| JAN | 31 | 806,000 | 107,762 | 16.99 | 104,441 | 1.83 | 9,581 | 0 | 0 | 202,622 | 550,711 | 4,119,867 | 13.0 |
| FEB | 28 | 728,000 | 97,334 | 13.62 | 83,742 | 2.87 | 15,032 | 0 | 0 | 166,043 | 716,754 | 5,362,036 | 15.8 |
| MAR | 31 | 806,000 | 107,762 | 9.57 | 58,814 | 4.13 | 21,640 | 0 | 0 | 144,936 | 861,690 | 6,446,306 | 18.0 |
| APR | 30 | 744,000 | 99,473 | 4.34 | 26,708 | 4.94 | 25,935 | 53,400 | 214,187 | -113,941 | 747,750 | 5,593,914 | 16.3 |
| MAY | 31 | 768,800 | 102,789 | 1.86 | 11,407 | 5.32 | 27,917 | 53,400 | 221,327 | -135,049 | 612,701 | 4,583,615 | 14.1 |
| JUN | 30 | 744,000 | 99,473 | 0.51 | 3,116 | 4.66 | 24,448 | 53,400 | 214,187 | -136,047 | 476,654 | 3,565,851 | 11.7 |
| JUL | 31 | 768,800 | 102,789 | 0.08 | 501 | 3.53 | 18,501 | 53,400 | 221,327 | -136,539 | 340,115 | 2,544,404 | 9.0 |
| AUG | 30 | 744,000 | 99,473 | 0.15 | 946 | 2.08 | 10,902 | 53,400 | 214,187 | -124,671 | 215,444 | 1,611,739 | 6.2 |
| SEP | 30 | 744,000 | 99,473 | 0.71 | 4,340 | 1.10 | 5,782 | 53,400 | 214,187 | -116,156 | 99,288 | 742,775 | 3.1 |
| OCT | 31 | 768,800 | 102,789 | 3.70 | 22,758 | 0.72 | 3,799 | 53,400 | 221,327 | -99,580 | -292 | -2,183 | -0.1 |
| **Totals:** | | **9,208,400** | **1,231,163** | **75.3** | **462,889** | **33.1** | **173,614** | **11,427,600** | **1,520,731** | **-292** | **5,125,103** | **38,340,897** | |

| **Annual Recycled Water Volume:** | | |
|---|---|---|
| | **11.43** | Mgal |
| | **35.07** | ac-ft |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 32,632

**WOODACRE- SAN GERONIMO WASTEWATER RECYCLING STUDY**
**BACK NINE LOWER POND WATER BALANCE FOR 100-YR. RAINFALL - MAX WW FLOW, POND CAPACITY**

**Back NineLower Pond - 100-Year**
**Alternative 6 -Expanded Service Area**

| | | |
|---|---|---|
| WASTEWATER INFLOW | 7,800 | GPD, Winter | 
| | 7,400 | GPD, Summer |
| POND WATERSHED AREA | 40,990 | SQUARE FEET |
| AVERAGE BANK SLOPE | 2.00 | :1 |
| **MAXIMUM VOLUME** | **2,620,000** | GALLONS |
| | 350,221 | CUBIC FEET |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET |

WW Flow Adjustments: add 0 gpd Winter add 900 gpd Summer

| Month | Days in Month | Wastewater Inflow WW (gal) | (ft$^3$) | Precipitation P (in) | (ft$^3$) | Evaporation Eto (in) | (ft$^3$) | Recycled Water Produced Irr. (gpd) | (ft$^3$) | Volume Change ΔV (ft$^3$) | Total Balance Volume V (ft$^3$) | (gal) | End Water Depth (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOV | 30 | 234,000 | 31,286 | 9.28 | 31,686 | 0.98 | 2,337 | 0 | 0 | 60,635 | 60,635 | 453,611 | 4.3 |
| DEC | 31 | 241,800 | 32,329 | 14.49 | 49,492 | 0.94 | 2,261 | 0 | 0 | 79,559 | 140,194 | 1,048,794 | 8.1 |
| JAN | 31 | 241,800 | 32,329 | 16.99 | 58,024 | 1.83 | 4,372 | 0 | 0 | 85,981 | 226,175 | 1,692,016 | 11.3 |
| FEB | 28 | 218,400 | 29,200 | 13.62 | 46,525 | 2.87 | 6,860 | 0 | 0 | 68,865 | 295,040 | 2,207,193 | 13.5 |
| MAR | 31 | 241,800 | 32,329 | 9.57 | 32,675 | 4.13 | 9,875 | 0 | 0 | 55,129 | 350,169 | 2,619,611 | 15.1 |
| APR | 30 | 222,000 | 29,681 | 4.34 | 14,838 | 4.94 | 11,835 | 19,200 | 77,011 | -44,327 | 305,842 | 2,288,004 | 13.8 |
| MAY | 31 | 229,400 | 30,671 | 1.86 | 6,337 | 5.32 | 12,740 | 19,200 | 79,578 | -55,310 | 250,532 | 1,874,230 | 12.1 |
| JUN | 30 | 222,000 | 29,681 | 0.51 | 1,731 | 4.66 | 11,157 | 19,200 | 77,011 | -56,755 | 193,777 | 1,449,643 | 10.2 |
| JUL | 31 | 229,400 | 30,671 | 0.08 | 278 | 3.53 | 8,443 | 19,200 | 79,578 | -57,072 | 136,704 | 1,022,686 | 8.0 |
| AUG | 30 | 222,000 | 29,681 | 0.15 | 526 | 2.08 | 4,975 | 19,200 | 77,011 | -51,780 | 84,925 | 635,323 | 5.6 |
| SEP | 30 | 222,000 | 29,681 | 0.71 | 2,411 | 1.10 | 2,638 | 19,200 | 77,011 | -47,557 | 37,368 | 279,550 | 2.9 |
| OCT | 31 | 229,400 | 30,671 | 3.70 | 12,644 | 0.72 | 1,734 | 19,200 | 79,578 | -37,998 | -630 | -4,711 | -0.1 |
| **Totals:** | | **2,754,000** | **368,210** | **75.3** | **257,168** | **33.1** | **79,228** | **4,089,600** | **546,780** | **-630** | **2,080,731** | **15,565,949** | |

| | | |
|---|---|---|
| **Annual Recycled Water Volume:** | **4.09** | Mgal |
| | **12.55** | ac-ft |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 11,200

**WOODACRE - SAN GERONIMO WASTEWATER RECYCLING STUDY**
**BACK NINE UPPER POND WATER BALANCE FOR 100-YR. RAINFALL - MAX WW FLOWS AT POND CAPACITY**

**Back Nine Upper Pond - 100-yr**
**Alternative 6 -Expanded Service Area**

| | | | | |
|---|---|---|---|---|
| WASTEWATER INFLOW | 10,200 | GPD, Winter | 9,600 | gpd, Summer |
| POND WATERSHED AREA | 48,960 | SQUARE FEET | | |
| AVERAGE BANK SLOPE | 2.00 | :1 | | |
| **MAXIMUM VOLUME** | **3,300,000** | GALLONS | | |
| | 441,117 | CUBIC FEET | | |
| **MAXIMUM WATER DEPTH** | **15.0** | FEET | | |
| **MAX DEPTH WITH 2-FT FREEBOARD** | **2.0** | FEET | | |

WW Flow Adjustments: add 0 gpd Winter add 1,100 gpd Summer

| Month | Days in Month | Wastewater Inflow WW (gal) | Wastewater Inflow WW (ft$^3$) | Precipitation P (in) | Precipitation P (ft$^3$) | Evaporation* Eto (in) | Evaporation* Eto (ft$^3$) | Recycled Water Produced Irr. (gpd) | Recycled Water Produced Irr. (ft$^3$) | Volume Change ΔV (ft$^3$) | Total Balance Volume V (ft$^3$) | Total Balance Volume V (gal) | End Water Depth (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOV | 30 | 306,000 | 40,912 | 9.28 | 37,847 | 0.98 | 2,337 | 0 | 0 | 76,422 | 76,422 | 571,716 | 4.2 |
| DEC | 31 | 316,200 | 42,276 | 14.49 | 59,115 | 0.94 | 2,261 | 0 | 0 | 99,130 | 175,552 | 1,313,306 | 8.0 |
| JAN | 31 | 316,200 | 42,276 | 16.99 | 69,306 | 1.83 | 4,372 | 0 | 0 | 107,210 | 282,762 | 2,115,344 | 11.2 |
| FEB | 28 | 285,600 | 38,185 | 13.62 | 55,571 | 2.87 | 6,860 | 0 | 0 | 86,895 | 369,658 | 2,765,409 | 13.4 |
| MAR | 31 | 316,200 | 42,276 | 9.57 | 39,029 | 4.13 | 9,875 | 0 | 0 | 71,429 | 441,087 | 3,299,773 | 15.1 |
| APR | 30 | 288,000 | 38,506 | 4.34 | 17,724 | 4.94 | 11,835 | 24,850 | 99,673 | -55,279 | 385,808 | 2,886,228 | 13.8 |
| MAY | 31 | 297,600 | 39,789 | 1.86 | 7,569 | 5.32 | 12,740 | 24,850 | 102,996 | -68,377 | 317,431 | 2,374,699 | 12.1 |
| JUN | 30 | 288,000 | 38,506 | 0.51 | 2,068 | 4.66 | 11,157 | 24,850 | 99,673 | -70,257 | 247,174 | 1,849,109 | 10.2 |
| JUL | 31 | 297,600 | 39,789 | 0.08 | 332 | 3.53 | 8,443 | 24,850 | 102,996 | -71,317 | 175,857 | 1,315,584 | 8.0 |
| AUG | 30 | 288,000 | 38,506 | 0.15 | 628 | 2.08 | 4,975 | 24,850 | 99,673 | -65,515 | 110,341 | 825,464 | 5.6 |
| SEP | 30 | 288,000 | 38,506 | 0.71 | 2,880 | 1.10 | 2,638 | 24,850 | 99,673 | -60,926 | 49,415 | 369,676 | 2.9 |
| OCT | 31 | 297,600 | 39,789 | 3.70 | 15,102 | 0.72 | 1,734 | 24,850 | 102,996 | -49,839 | -423 | -3,167 | -0.1 |
| **Totals:** | | **3,585,000** | **479,315** | **75.3** | **307,171** | **33.1** | **79,228** | **5,293,050** | **707,681** | **-423** | **2,631,084** | **19,683,142** | |

| Annual Recycled Water Volume: | | |
|---|---|---|
| | **5.29** | Mgal |
| | **16.24** | ac-ft |

Notes:
*Evaporation rates at 0.8*Pan A mean rate for Lake Lagunitas, 1987-1994, MMWD
Evap calculated based on water surface area at 50% pond capacity (vol)
Pond bottom area, SQ FT: 14,316

# Rainfall and Evaporation

# Reference Data

| Monthly Rainfall for Woodacre (inches) | | | | |
|---|---|---|---|---|
| **Month** | **Average[1]** | **10-year** | **50-year** | **100-year** |
| **Jan** | 5.13 | 7.43 | 8.82 | 9.28 |
| **Feb** | 8.01 | 11.61 | 13.77 | 14.49 |
| **Mar** | 9.39 | 13.61 | 16.14 | 16.99 |
| **Apr** | 7.53 | 10.91 | 12.94 | 13.62 |
| **May** | 5.29 | 7.66 | 9.09 | 9.57 |
| **Jun** | 2.40 | 3.48 | 4.13 | 4.34 |
| **Jul** | 1.03 | 1.49 | 1.76 | 1.86 |
| **Aug** | 0.28 | 0.41 | 0.48 | 0.51 |
| **Sep** | 0.05 | 0.07 | 0.08 | 0.08 |
| **Oct** | 0.09 | 0.12 | 0.15 | 0.15 |
| **Nov** | 0.39 | 0.57 | 0.67 | 0.71 |
| **Dec** | 2.05 | 2.97 | 3.52 | 3.70 |
| **Total** | **41.6** | **60.3** | **71.5** | **75.3** |
| | | | | |
| Multiplier[2] | 1.00 | 1.45 | 1.72 | 1.81 |

Notes:

1. Woodacre Fire Station

2. Based on statistical analysis of historical records for San Rafael & Kentfield



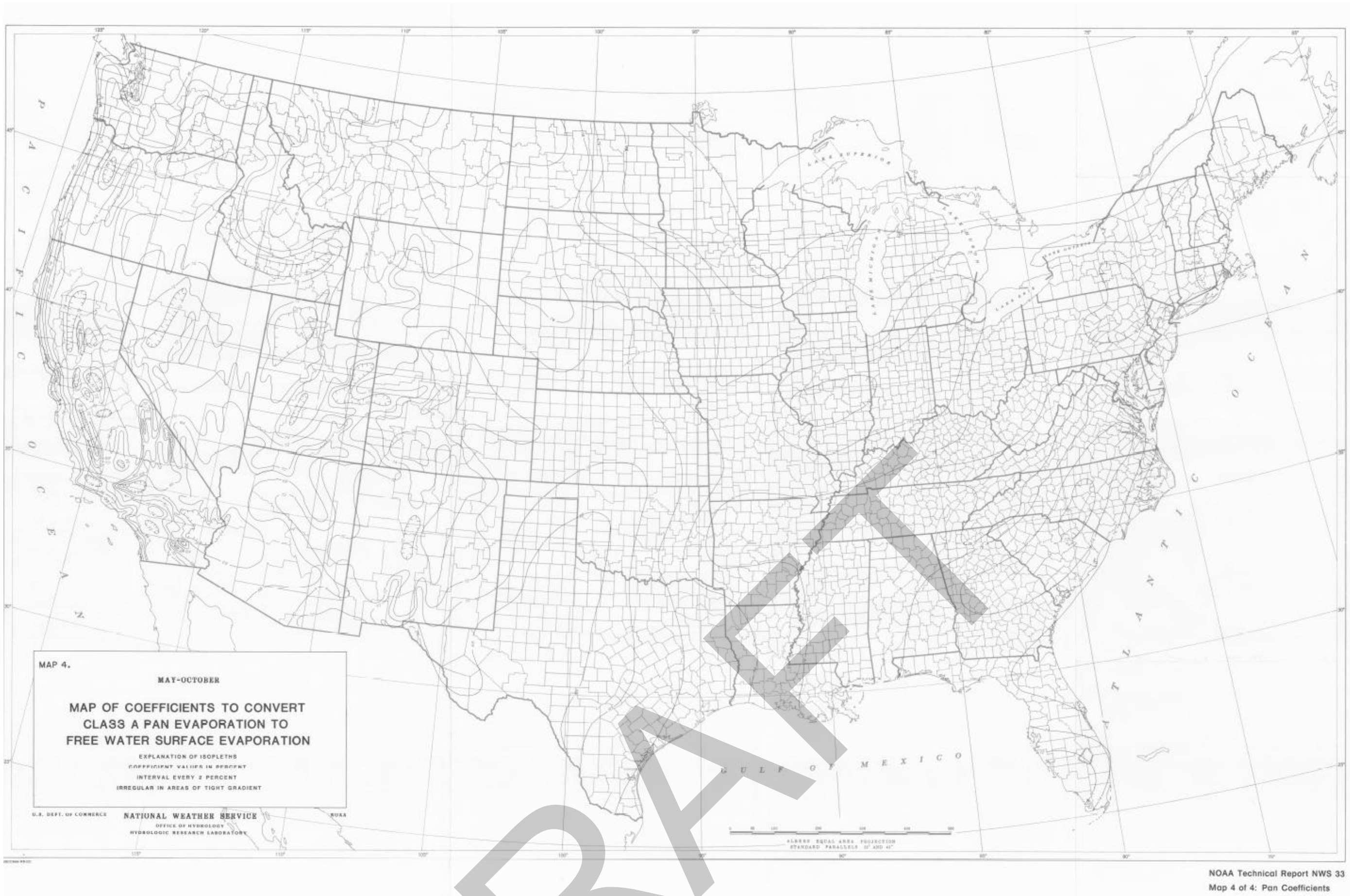
| Estimated Pond Evaporation Rates | | | |
|---|---|---|---|
| Month | Pan A Data (MMWD) | | Pond Evaporation @ 0.80 Coefficient* |
| | mm | inches | |
| Jan | 31 | 1.22 | 0.98 |
| Feb | 30 | 1.18 | 0.94 |
| Mar | 58 | 2.28 | 1.83 |
| Apr | 91 | 3.58 | 2.87 |
| May | 131 | 5.16 | 4.13 |
| Jun | 157 | 6.18 | 4.94 |
| Jul | 169 | 6.65 | 5.32 |
| Aug | 148 | 5.83 | 4.66 |
| Sep | 112 | 4.41 | 3.53 |
| Oct | 66 | 2.60 | 2.08 |
| Nov | 35 | 1.38 | 1.10 |
| Dec | 23 | 0.91 | 0.72 |
| **Total** | **1,051** | **41.38** | **33.10** |

*Per NOAA Technical Report NWS-33, Map 4 – Pan Coefficients

Table 5
**Monthly pan evaporation data provided by MMWD for two stations in the Tomales watershed; observation period is January 1987–December 1994**

| | Lake Nicasio | | | Lake Lagunitas | | |
|---|---|---|---|---|---|---|
| | Mean (mm month$^{-1}$) | SD (mm month$^{-1}$) | % SD | Mean (mm month$^{-1}$) | SD (mm month$^{-1}$) | % SD |
| January | 13 | 8 | 62 | 31 | 24 | 77 |
| February | 24 | 9 | 38 | 30 | 10 | 33 |
| March | 41 | 22 | 54 | 58 | 8 | 14 |
| April | 89 | 46 | 52 | 91 | 7 | 8 |
| May | 135 | 27 | 20 | 131 | 17 | 12 |
| June | 164 | 11 | 7 | 157 | 16 | 10 |
| July | 184 | 23 | 13 | 169 | 11 | 7 |
| August | 145 | 15 | 10 | 148 | 15 | 10 |
| September | 90 | 34 | 38 | 112 | 17 | 15 |
| October | 43 | 22 | 51 | 66 | 9 | 14 |
| November | 24 | 4 | 17 | 35 | 6 | 17 |
| December | 17 | 8 | 47 | 23 | 9 | 39 |

Source: Fischer, Douglas T., Stephen V. Smith & Robert R. Churchill. "*Simulation of a century of runoff across the Tomales watershed, Marin County, California*." Journal of Hydrology. 186 (1996) 253-273.


MAP 4.
MAY-OCTOBER
MAP OF COEFFICIENTS TO CONVERT
CLASS A PAN EVAPORATION TO
FREE WATER SURFACE EVAPORATION
EXPLANATION OF ISOPLETHS
COEFFICIENT VALUES IN PERCENT
INTERVAL EVERY 2 PERCENT
IRREGULAR IN AREAS OF TIGHT GRADIENT
U.S. DEPT. OF COMMERCE
NATIONAL WEATHER SERVICE
NOAA
OFFICE OF HYDROLOGY
HYDROLOGIC RESEARCH LABORATORY
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
NOAA Technical Report NWS 33
Map 4 of 4: Pan Coefficients


Woodacre
86
76
72
74
72
70
70
72
82
80
72
74
76
66
72
72
72
70
68
70
68
84
78
74
68

# Rainfall Frequency Distribution

# Statistical Analysis

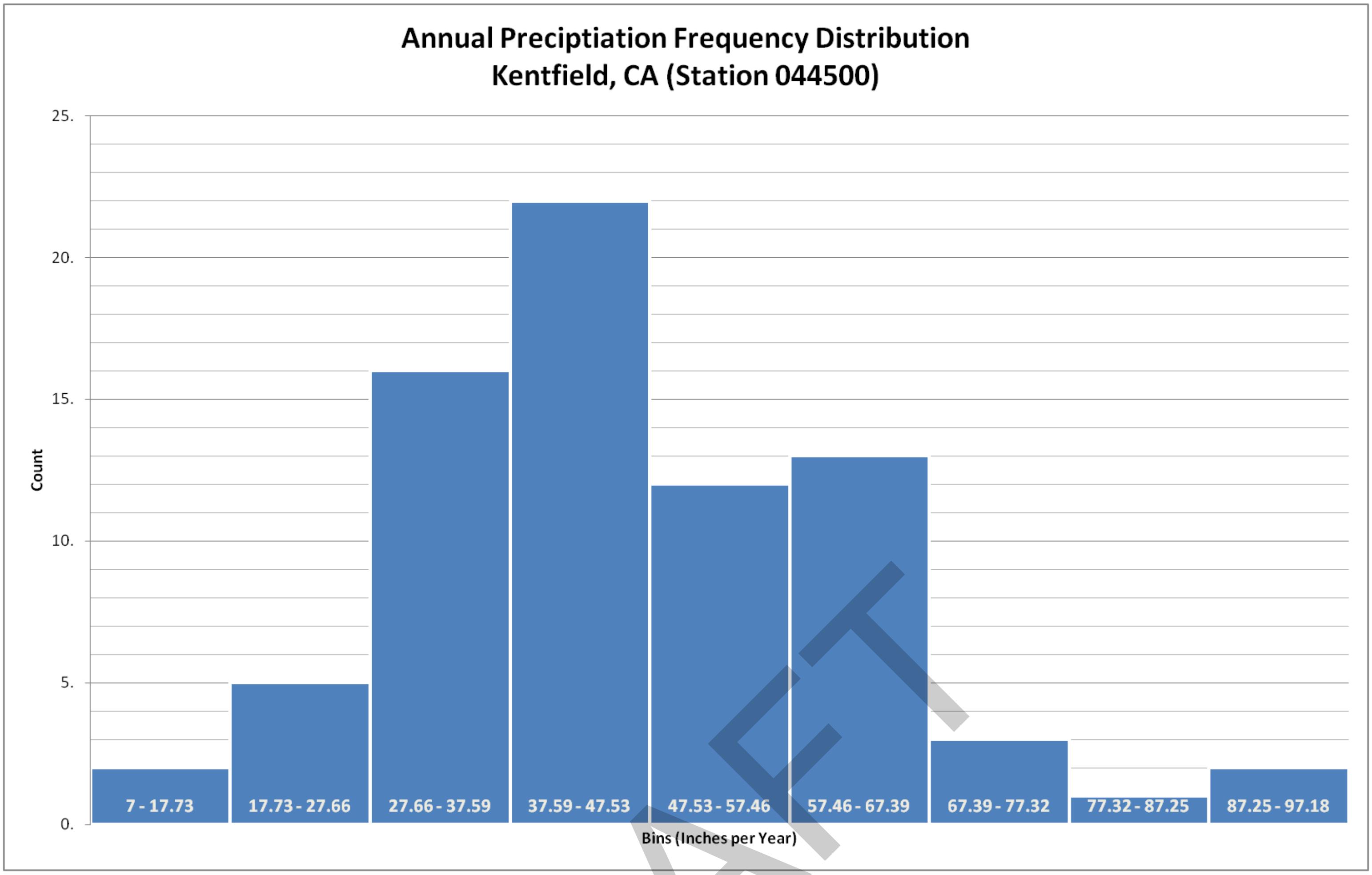
| | | | |
|---|---|---|---|
| *Alpha (for confidence interval)* | 5.% | | |

**Descriptive Statistics for Annual Precipitation Data: Kentfield, CA (Station 044500)**

| | | | |
|---|---|---|---|
| *Count* | 76 | *Mean Deviation* | 12.42 |
| *Mean* | 46.14 | *Second Moment* | 255.1 |
| *Mean LCL* | 42.47 | *Third Moment* | 2,080.76 |
| *Mean UCL* | 49.82 | *Fourth Moment* | 240,734.09 |
| *Variance* | 258.5 | | |
| *Standard Deviation* | 16.08 | *Sum* | 3,507.01 |
| *Mean Standard Error* | 1.84 | *Sum Standard Error* | 140.16 |
| *Coefficient of Variation* | 0.35 | *Total Sum Squares* | 181,217.92 |
| | | *Adjusted Sum Squares* | 19,387.41 |
| *Minimum* | 7.8 | | |
| *Maximum* | 94.38 | *Geometric Mean* | 43.12 |
| *Range* | 86.58 | *Harmonic Mean* | 39.26 |
| | | *Mode* | #N/A |
| *Median* | 44.1 | | |
| *Median Error* | 0.27 | *Skewness* | 0.51 |
| *Percentile 25% (Q1)* | 36.85 | *Skewness Standard Error* | 0.27 |
| *Percentile 75% (Q3)* | 56.56 | *Kurtosis* | 3.7 |
| *IQR* | 19.71 | *Kurtosis Standard Error* | 0.52 |
| *MAD (Median Absolute Deviation)* | 0.47 | *Skewness (Fisher's)* | 0.52 |
| *Coefficient of Dispersion (COD)* | 0.28 | *Kurtosis (Fisher's)* | 0.83 |

**Annual Precipitation Frequency Distribution: Kentfield, CA (Station 044500)**

| *Bins* | *Count* | *Cumulative Count* | *Percent* | *Cumulative Percent* |
|---|---|---|---|---|
| *7 To 17.73* | 2. | 2. | 0.03 | 0.03 |
| *17.73 To 27.66* | 5. | 7. | 0.07 | 0.09 |
| *27.66 To 37.59* | 16. | 23. | 0.21 | 0.3 |
| *37.59 To 47.53* | 22. | 45. | 0.29 | 0.59 |
| *47.53 To 57.46* | 12. | 57. | 0.16 | 0.75 |
| *57.46 To 67.39* | 13. | 70. | 0.17 | 0.92 |
| *67.39 To 77.32* | 3. | 73. | 0.04 | 0.96 |
| *77.32 To 87.25* | 1. | 74. | 0.01 | 0.97 |
| *87.25 To 97.18* | 2. | 76. | 0.03 | 1. |



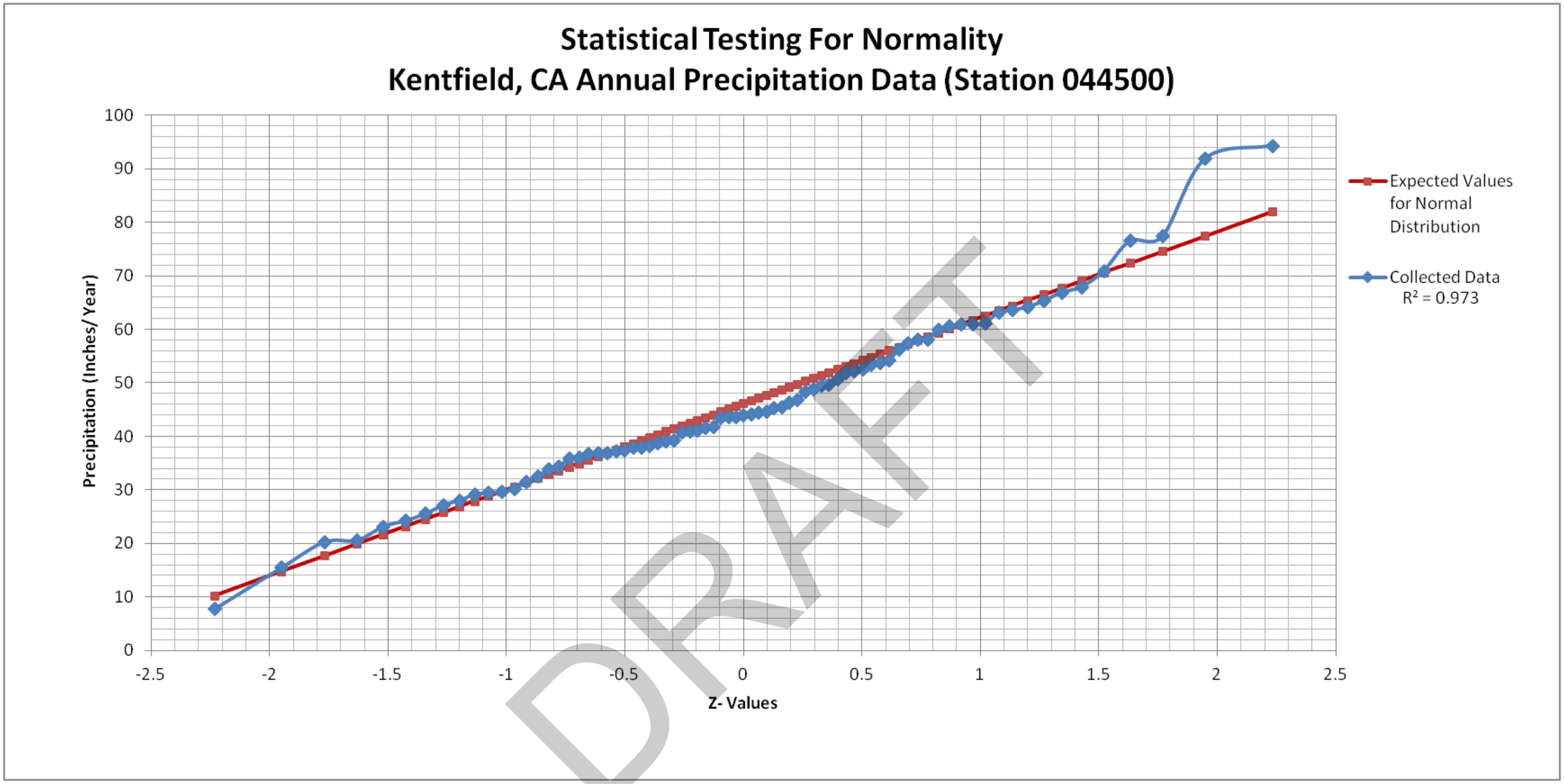



**Annual Precipitation 100 Year Analysis: Kentfield, CA (Station 044500)**

*P(X ≤ [Value]) = 0.99*

where X is a given year's precipitation value, and P is the probability of that year's precipitation totals falling under some [Value] (the 100 year exceedance value) . For these data,

**[Value] = 83.55 inches/year** (100 year high, assuming normal distribution)**.**



Statistical Testing For Normality
Kentfield, CA Annual Precipitation Data (Station 044500)
Precipitation (Inches/ Year)
100
90
80
70
60
50
40
30
20
10
0
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
Z- Values
Expected Values for Normal Distribution
Collected Data
R² = 0.973
DRAFT

*Alpha (for confidence interval)* 5.%

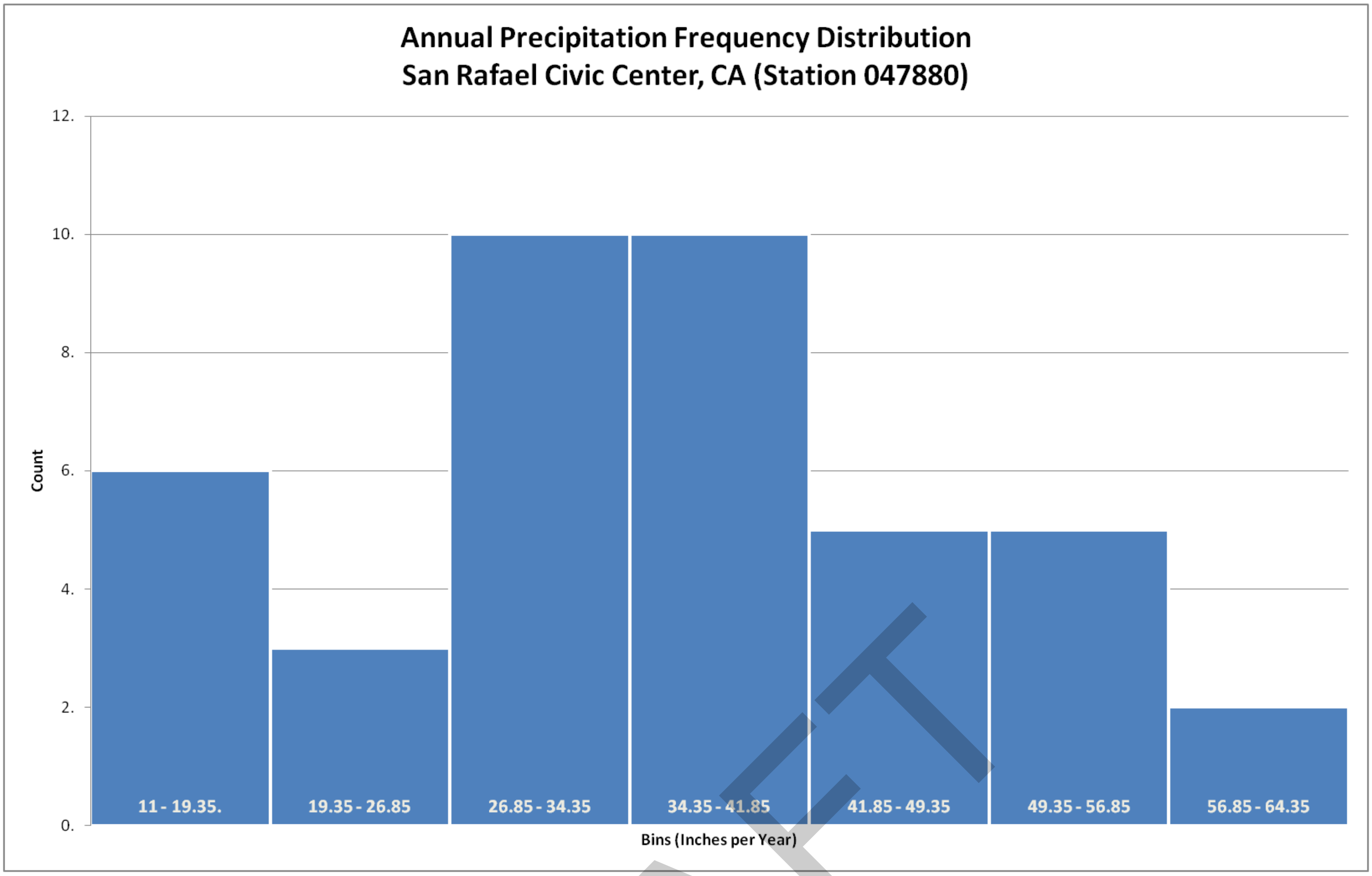
**Descriptive Statistics for Annual Precipitation Data: San Rafael Civic Center, CA (Station 047880)**

| | | | |
|---|---|---|---|
| *Count* | 41 | *Mean Deviation* | 10.22 |
| *Mean* | 35.68 | *Second Moment* | 157.68 |
| *Mean LCL* | 31.66 | *Third Moment* | 72.27 |
| *Mean UCL* | 39.69 | *Fourth Moment* | 58,119.18 |
| *Variance* | 161.62 | | |
| *Standard Deviation* | 12.71 | *Sum* | 1,462.78 |
| *Mean Standard Error* | 1.99 | *Sum Standard Error* | 81.4 |
| *Coefficient of Variation* | 0.36 | *Total Sum Squares* | 58,653.14 |
| | | *Adjusted Sum Squares* | 6,464.71 |
| *Minimum* | 11.85 | | |
| *Maximum* | 60.46 | *Geometric Mean* | 33.16 |
| *Range* | 48.61 | *Harmonic Mean* | 30.31 |
| | | *Mode* | #N/A |
| *Median* | 35.52 | | |
| *Median Error* | 0.39 | *Skewness* | 0.04 |
| *Percentile 25% (Q1)* | 27.36 | *Skewness Standard Error* | 0.36 |
| *Percentile 75% (Q3)* | 44.28 | *Kurtosis* | 2.34 |
| *IQR* | 16.92 | *Kurtosis Standard Error* | 0.67 |
| *MAD (Median Absolute Deviation)* | 20.4 | *Skewness (Fisher's)* | 0.04 |
| *Coefficient of Dispersion (COD)* | 0.29 | *Kurtosis (Fisher's)* | -0.59 |



**Annual Precipitation Frequency Distribution: San Rafael Civic Center, CA (Station 047880)**

| *Bins* | *Count* | *Cumulative Count* | *Percent* | *Cumulative Percent* |
|---|---|---|---|---|
| *11 To 19.35* | 6. | 6. | 0.15 | 0.15 |
| *19.35 To 26.85* | 3. | 9. | 0.07 | 0.22 |
| *26.85 To 34.35* | 10. | 19. | 0.24 | 0.46 |
| *34.35 To 41.85* | 10. | 29. | 0.24 | 0.71 |
| *41.85 To 49.35* | 5. | 34. | 0.12 | 0.83 |
| *49.35 To 56.85* | 5. | 39. | 0.12 | 0.95 |
| *56.85 To 64.35* | 2. | 41. | 0.05 | 1. |



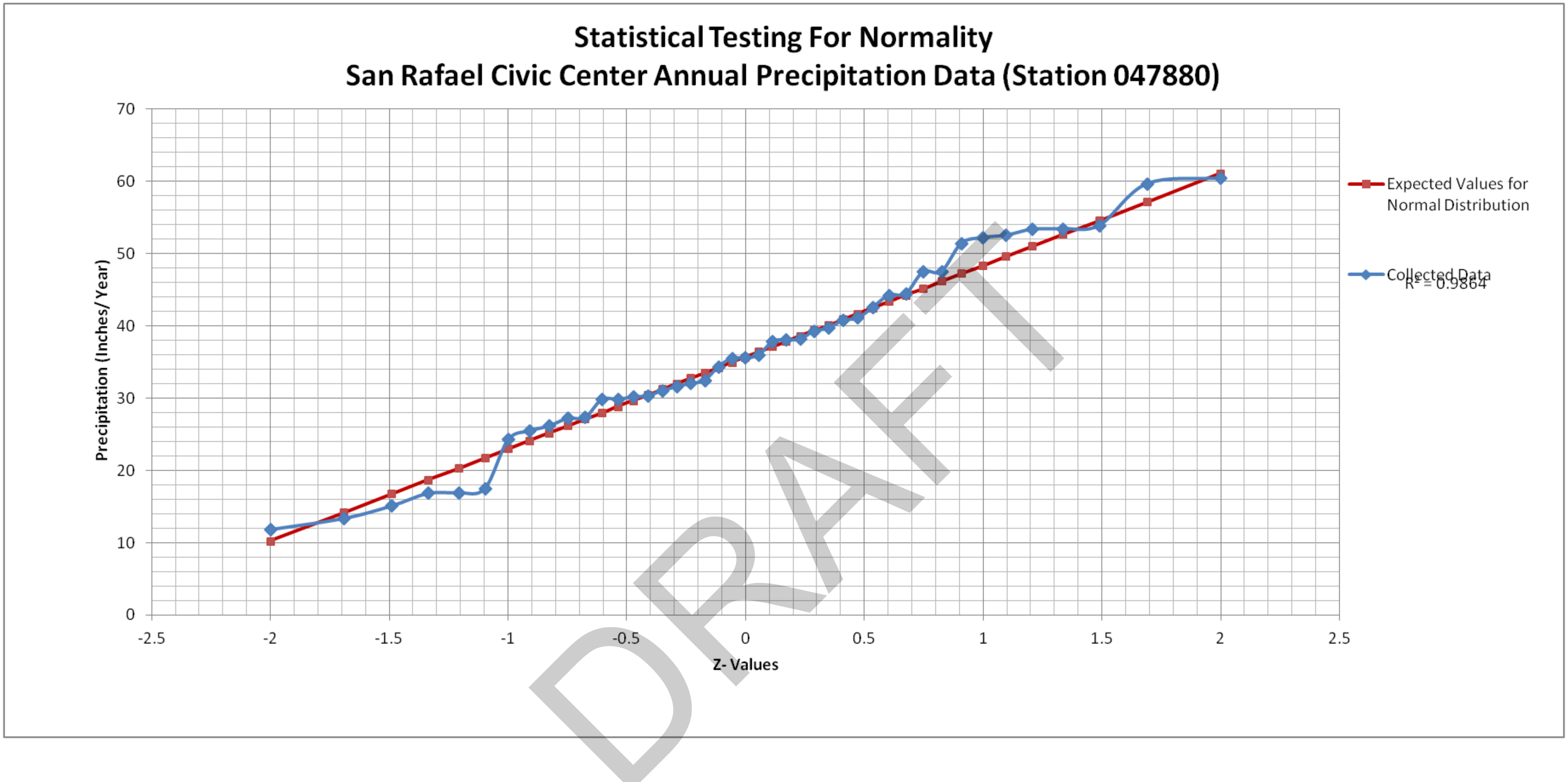



**Annual Precipitation 100 Year Analysis: Kentfield, CA (Station 044500)**

*P(X ≤ [Value]) = 0.99*

where X is a given year's precipitation value, and P is the probability of that year's precipitation totals falling under some [Value] (the 100 year exceedance value) . For these data,

**[Value] = 65.25 inches/year** (100 year high)**.**


Statistical Testing For Normality
San Rafael Civic Center Annual Precipitation Data (Station 047880)
Precipitation (Inches/ Year)
70
60
50
40
30
20
10
0
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
Z- Values
Expected Values for Normal Distribution
Collected Data
R² = 0.9864
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# Appendix G

# Recycled Water Project Cost Estimates

# Water Recycling Alternatives
# Collection System Cost Estimates

**Preliminary Construction Cost Estimate**
**Woodacre Collection System - Alternative 4 - 210 parcels**

| Combined Gravity - Pressure Sewer | | | | | |
|---|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** | **Total Cost ($)** |
| | | | | **Route A** | **Route B** |
| **On-Lot Facilities** | | | | | |
| Abandon existing septic tank (jowner cost) | EA | 170 | $ - | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 40 | $ - | $ - | $ - |
| Individual Grinder Pump | EA | 40 | $ 9,500 | $ 380,000 | $ 380,000 |
| 4" lateral to Sewer Line (20' ave distance) | EA | 170 | $ 1,200 | $ 204,000 | $ 204,000 |
| 1.25" lateral to Pressure Sewer Line (50' ave distance) | EA | 40 | $ 1,500 | $ 60,000 | $ 60,000 |
| **Collection System** | | | | $ - | $ - |
| 6" & 8" Gravity Sewer Line | LF | 15,930 | $ 140 | $ 2,230,200 | $ 2,230,200 |
| 3.0" Pressure Sewer Line | LF | 4,600 | $ 50 | $ 230,000 | $ 230,000 |
| 2.0" Pressure Sewer Line | LF | 675 | $ 45 | $ 30,375 | $ 30,375 |
| Service Connection (1.25"Isolation Valve and Traffic-Rated Box) | EA | 40 | $ 1,500 | $ 60,000 | $ 60,000 |
| 48" Dia Manhole | EA | 40 | $ 9,000 | $ 360,000 | $ 360,000 |
| Air Release Valves | EA | 3 | $ 4,000 | $ 12,000 | $ 12,000 |
| **Lift Stations (including pumps, panels, etc.)** | | | | | $ - |
| Main Lift Station at Railroad Ave | LS | 1 | $ 150,000 | $ 150,000 | $ 150,000 |
| **Transmission Line to Golf Course** | | | | | $ - |
| 4-inch HDPE Force Main, Route A, SG Valley Dr. | LF | 5,360 | $ 60 | $ 321,600 | |
| SG Creek/Bridge Crossing, Route A only | LS | 1 | $ 25,000 | $ 25,000 | |
| 4-inch HDPE Force Main, Route B, SF Drake Blvd. | LF | 5,850 | $ 60 | | $ 351,000 |
| | | | **TOTAL** | **$ 4,063,175** | **$ 4,067,575** |

## Preliminary Construction Cost Estimate
## Woodacre Collection System - Alternative 5a - 186 parcels (75%)

| Combined Gravity - Pressure Sewer | | | | | |
|---|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** | **Total Cost ($)** |
| | | | | **Route A** | **Route B** |
| **On-Lot Facilities** | | | | | |
| Abandon existing septic tank (owner cost) | EA | 186 | $ - | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 186 | $ - | $ - | $ - |
| Individual Grinder Pump | EA | 30 | $ 9,500 | $ 285,000 | $ 285,000 |
| 4" lateral to Sewer Line (20' ave distance) | EA | 156 | $ 1,200 | $ 187,200 | $ 187,200 |
| 1.25" lateral to Pressure Sewer Line (50' ave distance) | EA | 30 | $ 1,500 | $ 45,000 | $ 45,000 |
| **Collection System** | | | | $ - | $ - |
| 6" & 8" Gravity Sewer Line | LF | 15,930 | $ 140 | $ 2,230,200 | $ 2,230,200 |
| 3.0" Pressure Sewer Line | LF | 4,600 | $ 50 | $ 230,000 | $ 230,000 |
| 2.0" Pressure Sewer Line | LF | 675 | $ 45 | $ 30,375 | $ 30,375 |
| Service Connection (1.25"Isolation Valve and Traffic-Rated Box) | EA | 30 | $ 1,500 | $ 45,000 | $ 45,000 |
| 48" Dia Manhole | EA | 40 | $ 9,000 | $ 360,000 | $ 360,000 |
| Air Release Valves | EA | 3 | $ 4,000 | $ 12,000 | $ 12,000 |
| **Lift Stations (including pumps, panels, etc.)** | | | | | $ - |
| Main Lift Station at Railroad Ave | LS | 1 | $ 150,000 | $ 150,000 | $ 150,000 |
| **Transmission Line to Golf Course** | | | | | $ - |
| 4-inch HDPE Force Main, Route A, SG Valley Dr. | LF | 5,360 | $ 60 | $ 321,600 | |
| SG Creek/Bridge Crossing, Route A only | LS | 1 | $ 25,000 | $ 25,000 | |
| 4-inch HDPE Force Main, Route B, SF Drake Blvd. | LF | 5,850 | $ 60 | | $ 351,000 |
| | | | **TOTAL** | **$ 3,921,375** | **$ 3,925,775** |

# Preliminary Construction Cost Estimate

## Woodacre Collection System - Alternatives 5b and 6 - 250 parcels (100%)

| Combined Gravity - Pressure Sewer | | | | | |
|---|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** | **Total Cost ($)** |
| | | | | **Route A** | **Route B** |
| **On-Lot Facilities** | | | | | |
| Abandon existing septic tank (owner cost) | EA | 250 | $ - | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 250 | $ - | $ - | $ - |
| Individual Grinder Pump | EA | 50 | $ 9,500 | $ 475,000 | $ 475,000 |
| 4" lateral to Prop Line (20' ave distance) | EA | 200 | $ 1,200 | $ 240,000 | $ 240,000 |
| 1.25" lateral to Pressure Sewer Line (50' ave distance) | EA | 50 | $ 1,500 | $ 75,000 | $ 75,000 |
| **Collection System** | | | | | |
| 6" & 8" Gravity Sewer Line | LF | 15,930 | $ 140 | $ 2,230,200 | $ 2,230,200 |
| 3.0" Pressure Sewer Line | LF | 4,600 | $ 50 | $ 230,000 | $ 230,000 |
| 2.0" Pressure Sewer Line | LF | 675 | $ 45 | $ 30,375 | $ 30,375 |
| Service Connection (1.25"Isolation Valve & Box) | EA | 50 | $ 1,500 | $ 75,000 | $ 75,000 |
| 48" Dia Manhole | EA | 40 | $ 9,000 | $ 360,000 | $ 360,000 |
| Air Release Valves | EA | 3 | $ 4,000 | $ 12,000 | $ 12,000 |
| **Lift Stations (including pumps, panels, etc.)** | | | | | |
| Main Lift Station at Railroad Ave | LS | 1 | $ 150,000 | $ 150,000 | $ 150,000 |
| **Transmission Line to Golf Course** | | | | | |
| 4-inch HDPE Force Main, Route A, SG Valley Dr. | LF | 5,360 | $ 60 | $ 321,600 | |
| SG Creek/Bridge Crossing, Route A only | LS | 1 | $ 25,000 | $ 25,000 | |
| 4-inch HDPE Force Main, Route B, SF Drake Blvd. | LF | 5,850 | $ 60 | | $ 351,000 |
| | | | **TOTAL** | **$ 4,224,175** | **$ 4,228,575** |

**Preliminary Construction Cost Estimate**
**San Geronimo Collection System - Alternative 5a - 84 parcels (75%)**

| Pressure Sewer | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** |
| **On-Lot Facilities** | | | | |
| Abandon existing septic tank (owner cost) | EA | 84 | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 84 | $ - | $ - |
| Individual Grinder Pump | EA | 84 | $ 9,500 | $ 798,000 |
| 4" lateral to Prop Line (20' ave distance) | EA | 0 | $ 1,200 | $ - |
| 1.25" lateral to Pressure Sewer Line (50' ave distance) | EA | 84 | $ 1,500 | $ 126,000 |
| **Collection System** | | | | |
| 6" Gravity Sewer Line | LF | 0 | $ 140 | $ - |
| 4.0" Pressure Sewer Line | LF | 3,200 | $ 60 | $ 192,000 |
| 3.0" Pressure Sewer Line | LF | 1,350 | $ 50 | $ 67,500 |
| 2.0" Pressure Sewer Line | LF | 3,940 | $ 45 | $ 177,300 |
| Service Connection (1.25"Valve & Box) | EA | 84 | $ 1,500 | $ 126,000 |
| Air Release Valves | EA | | $ 4,000 | $ - |
| **Lift Stations (including pumps, panels, etc.)** | | | | |
| Cluster Lift Station | LS | 0 | $ 25,000 | $ - |
| **Transmission Line to Golf Course** | | | | |
| 4-inch HDPE Force Main to Treatment Plant* | LF | 0 | $ 60 | $ - |
| SG Creek/Bridge Crossing* | LS | 0 | $ 25,000 | $ - |
| | | | **TOTAL** | **$ 1,486,800** |

* Covered by Woodacre Force Main cost

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## Preliminary Construction Cost Estimate
## San Geronimo Collection System - Alternative 5b - 110 parcels

### Pressure Sewer

| Item | Units | No. of Units | Cost per Unit ($) | Total Cost ($) |
|---|---|---|---|---|
| **On-Lot Facilities** | | | | |
| Abandon existing septic tank (owner cost) | EA | 110 | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 110 | $ - | $ - |
| Individual Grinder Pump | EA | 110 | $ 9,500 | $ 1,045,000 |
| 4" lateral to Prop Line (20' ave distance) | EA | 0 | $ 1,200 | $ - |
| 1.25" lateral to Pressure Sewer Line (50' ave distanc | EA | 110 | $ 1,500 | $ 165,000 |
| **Collection System** | | | | |
| 6" Gravity Sewer Line | LF | 0 | $ 140 | $ - |
| 4.0" Pressure Sewer Line | LF | 3,200 | $ 60 | $ 192,000 |
| 3.0" Pressure Sewer Line | LF | 1,350 | $ 50 | $ 67,500 |
| 2.0" Pressure Sewer Line | LF | 3,940 | $ 45 | $ 177,300 |
| Service Connection (1.25"Valve & Box) | EA | 110 | $ 1,500 | $ 165,000 |
| Air Release Valves | EA | | $ 4,000 | $ - |
| **Lift Stations (including pumps, panels, etc.)** | | | | |
| Cluster Lift Station | LS | 0 | $ 25,000 | $ - |
| **Transmission Line to Golf Course** | | | | |
| 4-inch HDPE Force Main to Treatment Plant* | LF | 0 | $ 60 | $ - |
| SG Creek/Bridge Crossing* | LS | 0 | $ 25,000 | $ - |
| | | | **TOTAL** | **$ 1,811,800** |

* Covered by Woodacre Force Main cost

**Preliminary Construction Cost Estimate**
**San Geronimo Collection System - Alternative 6 - 113 parcels**

| Pressure Sewer | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** |
| **On-Lot Facilities** | | | | |
| Abandon existing septic tank (owner cost) | EA | 113 | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 113 | $ - | $ - |
| Individual Grinder Pump | EA | 113 | $ 9,500 | $ 1,073,500 |
| 4" lateral to Prop Line (20' ave distance) | EA | 0 | $ 1,200 | $ - |
| 1.25" lateral to Pressure Sewer Line (50' ave distance) | EA | 113 | $ 1,500 | $ 169,500 |
| **Collection System** | | | | |
| 6" Gravity Sewer Line | LF | 0 | $ 140 | $ - |
| 4.0" Pressure Sewer Line | LF | 3,200 | $ 60 | $ 192,000 |
| 3.0" Pressure Sewer Line | LF | 1,350 | $ 50 | $ 67,500 |
| 2.0" Pressure Sewer Line | LF | 3,940 | $ 45 | $ 177,300 |
| Service Connection (1.25" Valve & Box) | EA | 113 | $ 1,500 | $ 169,500 |
| Air Release Valves | EA | | $ 4,000 | $ - |
| **Lift Stations (including pumps, panels, etc.)** | | | | |
| Cluster Lift Station | LS | 0 | $ 25,000 | $ - |
| **Transmission Line to Golf Course** | | | | |
| 4-inch HDPE Force Main to Treatment Plant* | LF | 0 | $ 60 | $ - |
| SG Creek/Bridge Crossing* | LS | 0 | $ 25,000 | $ - |
| | | | **TOTAL** | **$ 1,849,300** |

* Covered by Woodacre Force Main cost

**Preliminary Construction Cost Estimate**
**San Geronimo Collection System**
**Collection System - 84 parcels - Alternative 5a**

| **Cluster Gravity/Pressure Sewer** | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** |
| **On-Lot Facilities** | | | | |
| Abandon existing septic tank (owner cost) | EA | 84 | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 84 | $ - | $ - |
| Individual Grinder Pump | EA | 50 | $ 9,500 | $ 475,000 |
| 4" lateral to Prop Line (20' ave distance) | EA | 34 | $ 1,200 | $ 40,800 |
| 1.25" lateral to Pressure Sewer Line (50' ave distance) | EA | 50 | $ 1,500 | $ 75,000 |
| **Collection System** | | | | |
| 6" Gravity Sewer Line | LF | 5,500 | $ 140 | $ 770,000 |
| 4.0" Pressure Sewer Line | LF | 3,200 | $ 60 | $ 192,000 |
| 3.0" Pressure Sewer Line | LF | 1,350 | $ 50 | $ 67,500 |
| 2.0" Pressure Sewer Line | LF | 3,775 | $ 45 | $ 169,875 |
| Service Connection (1.25"Valve & Box) | EA | 50 | $ 1,500 | $ 75,000 |
| Air Release Valves | EA | | $ 4,000 | $ - |
| **Lift Stations (including pumps, panels, etc.)** | | | | |
| Cluster Lift Stations | LS | 5 | $ 25,000 | $ 125,000 |
| **Transmission Line to Golf Course** | | | | |
| 4-inch HDPE Force Main to Treatment Plant* | LF | 350 | $ - | $ - |
| SG Creek/Bridge Crossing* | LS | 1 | $ - | $ - |
| | | | **TOTAL** | **$ 1,990,175** |

* Covered by Woodacre Force Main cost

**Preliminary Construction Cost Estimate**
**San Geronimo Collection System**
**Collection System -110 parcels - Alternative 5b**

| Cluster Gravity/Pressure Sewer | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** |
| **On-Lot Facilities** | | | | |
| Abandon existing septic tank (owner cost) | EA | 110 | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 110 | $ - | $ - |
| Individual Grinder Pump | EA | 65 | $ 9,500 | $ 617,500 |
| 4" lateral to Prop Line (20' ave distance) | EA | 45 | $ 1,200 | $ 54,000 |
| 1.25" lateral to Pressure Sewer Line (50' ave distance) | EA | 65 | $ 1,500 | $ 97,500 |
| **Collection System** | | | | |
| 6" Gravity Sewer Line | LF | 5,500 | $ 140 | $ 770,000 |
| 4.0" Pressure Sewer Line | LF | 3,200 | $ 60 | $ 192,000 |
| 3.0" Pressure Sewer Line | LF | 1,350 | $ 50 | $ 67,500 |
| 2.0" Pressure Sewer Line | LF | 3,775 | $ 45 | $ 169,875 |
| Service Connection (1.25" Valve & Box) | EA | 65 | $ 1,500 | $ 97,500 |
| Air Release Valves | EA | | $ 4,000 | $ - |
| **Lift Stations (including pumps, panels, etc.)** | | | | |
| Cluster Lift Stations | LS | 5 | $ 25,000 | $ 125,000 |
| **Transmission Line to Golf Course** | | | | |
| 4-inch HDPE Force Main to Treatment Plant* | LF | 350 | $ - | $ - |
| SG Creek/Bridge Crossing* | LS | 1 | $ - | $ - |
| | | | **TOTAL** | **$ 2,190,875** |

* Covered by Woodacre Force Main cost

## Preliminary Construction Cost Estimate
## San Geronimo Collection System
## Collection System -113 parcels - Alternative 6

| Cluster Gravity/Pressure Sewer | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** |
| **On-Lot Facilities** | | | | |
| Abandon existing septic tank (owner cost) | EA | 113 | $ - | $ - |
| Reroute Housing Plumbing (owner cost) | EA | 113 | $ - | $ - |
| Individual Grinder Pump | EA | 66 | $ 9,500 | $ 627,000 |
| 4" lateral to Prop Line (20' ave distance) | EA | 47 | $ 1,200 | $ 56,400 |
| 1.25" lateral to Pressure Sewer Line (50' ave distance) | EA | 66 | $ 1,500 | $ 99,000 |
| **Collection System** | | | | |
| 6" Gravity Sewer Line | LF | 5,500 | $ 140 | $ 770,000 |
| 4.0" Pressure Sewer Line | LF | 3,200 | $ 60 | $ 192,000 |
| 3.0" Pressure Sewer Line | LF | 1,350 | $ 50 | $ 67,500 |
| 2.0" Pressure Sewer Line | LF | 3,775 | $ 45 | $ 169,875 |
| Service Connection (1.25" Valve & Box) | EA | 66 | $ 1,500 | $ 99,000 |
| Air Release Valves | EA | | $ 4,000 | $ - |
| **Lift Stations (including pumps, panels, etc.)** | | | | |
| Cluster Lift Stations | LS | 5 | $ 25,000 | $ 125,000 |
| **Transmission Line to Golf Course** | | | | |
| 4-inch HDPE Force Main to Treatment Plant* | LF | 350 | $ - | $ - |
| SG Creek/Bridge Crossing* | LS | 1 | $ - | $ - |
| | | | **TOTAL** | **$ 2,205,775** |

* Covered by Woodacre Force Main cost

# Water Recycling Alternatives
# Treatment, Storage & Distribution
# Cost Estimates

## Preliminary Construction Cost Estimate
## Alternative 4 - Golf Course Water Recycling System
## Woodacre Only

| Treatment Design Flow - 30,000 gpd | Service Connections - 210 Woodacre Parcels | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** |
| | | | | |
| **Title 22 Tertiary Treatment Plant** | | | | |
| Influent EQ Tank and Pumps | Gal | 15,000 | 4.00 | $60,000 |
| 1-day Emergency Storage Tank | Gal | 35,000 | 4.00 | $140,000 |
| 30,000 GPD MBR Treatment Plant | LS | 1 | 550,000.00 | $550,000 |
| Disinfection System | LS | 1 | 75,000.00 | $75,000 |
| Odor Control | LS | 1 | 20,000.00 | $20,000 |
| Sludge Dewatering and Bagging System | LS | 1 | 40,000.00 | $40,000 |
| Effluent Pump Station | Gal | 5,000 | 4.00 | $20,000 |
| Elecrtrical Service, Wiring and Controls | LS | 1 | 60,000.00 | $60,000 |
| Standby Emergency Generator | LS | 1 | 50,000.00 | $50,000 |
| Control Building/Office, Laboratory, Equip/Mtls Storage | SF | 600 | 150.00 | $90,000 |
| Grading, Surfacing, Fencing, Site Landscaping & Restoration | LS | 1 | 75,000.00 | $75,000 |
| **Treatment Subtotal** | | | | **$1,180,000** |
| **Recycled Water Transmission & Storage** | | | | |
| Transmission Line to Storage Pond #1 | LF | 1,800 | 50.00 | $90,000 |
| Storage Pond Earthwork | CY | 22,500 | 30.00 | $675,000 |
| Storage Pond Liner | SF | 100,000 | 1.00 | $100,000 |
| Front Nine Pumping Station & Piping | LS | 1 | 75,000.00 | $75,000 |
| Fencing | LF | 1,600 | 15.00 | $24,000 |
| Turf and landscaping replanting, restoration | AC | 1 | 40,000.00 | $40,000 |
| **Disposal Subtotal** | | | | **$1,004,000** |
| | | | **Total** | **$2,184,000** |

## Capital Cost Summary
## Water Recycling Project Alternative 4
## Woodacre Only

| Treatment Design Flow - 30,000 gpd | Service Connections - 210 Woodacre | |
|---|---|---|
| **Cost Item** | **Force Main Route A** | **Force Main Route B** |
| | | |
| Collection System - Woodacre* | $4,063,175 | $4,067,575 |
| | | |
| Tertiary Treatment Plant | $1,180,000 | $1,180,000 |
| | | |
| Recycled Water Storage & Transmission | $1,004,000 | $1,004,000 |
| | | |
| Land/Easement Cost** | $0 | $0 |
| | | |
| Mobilization/Demobilization | $100,000 | $100,000 |
| | | |
| Permit Fees & Encroachment Fees | $50,000 | $50,000 |
| Sub-total | $6,397,175 | $6,401,575 |
| Contingency @ 15% | $959,576 | $960,236 |
| Sub-total | $7,356,751 | $7,361,811 |
| Engr & Environ Studies @ 15% | $1,103,513 | $1,104,272 |
| Contruction Management @ 10% | $735,675 | $736,181 |
| Admin, Dist Formation, Financing @ 5% | $367,838 | $368,091 |
| Total Estimated Cost | $9,563,777 | $9,570,355 |
| Estimated Cost Per Connection* | $45,542 | $45,573 |

* owner cost for tank abandonment & plumbing connection not included; typical range $1,500 to $3,000 per parcel

** assumes no land/eaement cost for treatment/storage in exchange for golf course use of recycled water produced

## Preliminary Construction Cost Estimate
## Alternative 5b - Water Recycling Facilities
## 75% Partial Service - Woodacre and San Geronimo

| Design Flow - 35,000 gpd | Service Connections - 270 Parcels | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Cost per Unit ($)** | **Total Cost ($)** |
| | | | | |
| **Title 22 Tertiary Treatment Plant** | | | | |
| Influent EQ Tank and Pumps | Gal | 20,000 | 4.00 | $80,000 |
| 1-day Emergency Storage Tank | Gal | 40,000 | 4.00 | $160,000 |
| 35,000 GPD MBR Treatment Plant | LS | 1 | 600,000.00 | $600,000 |
| Disinfection System | LS | 1 | 75,000.00 | $75,000 |
| Odor Control | LS | 1 | 20,000.00 | $20,000 |
| Sludge Dewatering and Bagging System | LS | 1 | 40,000.00 | $40,000 |
| Effluent Pump Station | Gal | 5,000 | 4.00 | $20,000 |
| Elecrtrical Service, Wiring and Controls | LS | 1 | 60,000.00 | $60,000 |
| Standby Emergency Generator | LS | 1 | 50,000.00 | $50,000 |
| Control Building/Office, Laboratory, Equip/Mtls Storage | SF | 600 | 150.00 | $90,000 |
| Grading, Surfacing, Fencing, Site Improvements & Restoration | LS | 1 | 75,000.00 | $75,000 |
| **Treatment Subtotal** | | | | **$1,270,000** |
| **Recycled Water Transmission & Storage** | | | | |
| Transmission Line to Storage Ponds | LF | 6,000 | 50.00 | $300,000 |
| Storage Ponds Earthwork* | CY | 27,000 | 30.00 | $810,000 |
| Storage Pond Liners | SF | 150,000 | 1.00 | $150,000 |
| Pond underdrain system, Back Nine | SF | 50,000 | 1.25 | $62,500 |
| Drainage Modifications - Back Nine Pond | LF | 700 | 75.00 | $52,500 |
| Back Nine Irrigation Pump Station | LS | 1 | 100,000.00 | $100,000 |
| Front Nine Pumping Station | LS | 1 | 20,000.00 | $20,000 |
| Turf and landscaping replanting, restoration | AC | 2.0 | 40,000.00 | $80,000 |
| **Disposal Subtotal** | | | | **$1,575,000** |
| | | | **Total** | **$2,845,000** |

* Pond #1 and Lower section of Pond #2

## Construction Cost Estimate
## Alternative 5b - Water Recycling Facilities
## Full Service - Woodacre and San Geronimo

**Design Flow - 50,000 gpd     Peak Flow 60,000     Service Connections - 360 Parcels**

| Item | Units | No. of Units | Cost per Unit ($) | Total Cost ($) |
|---|---|---|---|---|
| | | | | |
| **Title 22 Tertiary Treatment Plant** | | | | |
| Influent EQ Tank and Pumps | Gal | 30,000 | 4.00 | $120,000 |
| 1-day Emergency Storage Tank | Gal | 60,000 | 4.00 | $240,000 |
| 50,000 GPD MBR Treatment Plant | LS | 1 | 650,000.00 | $650,000 |
| Disinfection System | LS | 1 | 75,000.00 | $75,000 |
| Odor Control | LS | 1 | 30,000.00 | $30,000 |
| Sludge Dewatering and Bagging System | LS | 1 | 60,000.00 | $60,000 |
| Effluent Pump Station | Gal | 5,000 | 4.00 | $20,000 |
| Elecrtrical Service, Wiring and Controls | LS | 1 | 60,000.00 | $60,000 |
| Standby Emergency Generator | LS | 1 | 50,000.00 | $50,000 |
| Control Building/Office, Laboratory, Equip/Mtls Storage | SF | 600 | 150.00 | $90,000 |
| Grading, Surfacing, Fencing, Site Landscaping & Restoration | LS | 1 | 75,000.00 | $75,000 |
| **Treatment Subtotal** | | | | **$1,470,000** |
| **Recycled Water Transmission & Storage** | | | | |
| Transmission Line to Storage Ponds | LF | 6,000 | 50.00 | $300,000 |
| Storage Ponds Earthwork* | CY | 33,000 | 30.00 | $990,000 |
| Storage Pond Liners | SF | 200,000 | 1.00 | $200,000 |
| Pond underdrain system, Back Nine | SF | 100,000 | 1.25 | $125,000 |
| Drainage Modifications - Back Nine Pond | LF | 1,200 | 75.00 | $90,000 |
| Back Nine Irrigation Pump Station | LS | 1 | 100,000.00 | $100,000 |
| Front Nine Pumping Station | LS | 1 | 20,000.00 | $20,000 |
| Turf and landscaping replanting, restoration | AC | 2.5 | 40,000.00 | $100,000 |
| **Disposal Subtotal** | | | | **$1,925,000** |
| | | | **Total** | **$3,395,000** |

*Recyceled Water Storage Ponds #1 and #2

## Capital Cost Summary
## Water Recycling Project Alternatives 5a and 5b

| Partial (5a) and Full (5b) Service to Woodacre and San Geronimo | | | | |
|---|---|---|---|---|
| Cost Item | Alternative 5a - 270 Parcels | | Alternative 5b - 360 Parcels | |
| | Treatment Design Flow: 40,000 gpd | | Treatment Design Flow: 50,000 gpd | |
| | Pressure Sewer | Cluster Gravity | Pressure Sewer | Cluster Gravity |
| | | | | |
| **Collection System - Woodacre (Route A)** | $3,921,375 | $3,921,375 | $4,224,175 | $4,224,175 |
| **Collection System - San Geronimo** | | | | |
| **Pressure Sewer** | $1,486,800 | | $1,811,800 | |
| **Cluster Gravity/Pressure Sewer** | | $1,990,175 | | $2,190,875 |
| | | | | |
| **Tertiary Treatment Plant** | $1,330,000 | $1,330,000 | $1,470,000 | $1,470,000 |
| | | | | |
| **Recycled Water Storage & Transmission** | $1,575,000 | $1,575,000 | $1,925,000 | $1,925,000 |
| | | | | |
| **Land/Easement Costs*** | $0 | $0 | $0 | $0 |
| | | | | |
| **Mobilization/Demobilization** | $100,000 | $100,000 | $100,000 | $100,000 |
| | | | | |
| **Permit Fees & Encroachment Fees** | $50,000 | $50,000 | $50,000 | $50,000 |
| **Sub-total** | **$8,463,175** | **$8,966,550** | **$9,580,975** | **$9,960,050** |
| **Contingency @ 15%** | $1,269,476 | $1,344,983 | $1,437,146 | $1,494,008 |
| **Sub-total** | **$9,732,651** | **$10,311,533** | **$11,018,121** | **$11,454,058** |
| **Engr & Environ Studies @ 15%** | $1,459,898 | $1,546,730 | $1,652,718 | $1,718,109 |
| **Contruction Management @ 10%** | $973,265 | $1,031,153 | $1,101,812 | $1,145,406 |
| **Admin, Dist Formation, Financing @ 5%** | $486,633 | $515,577 | $550,906 | $572,703 |
| **Total Estimated Cost** | **$12,652,447** | **$13,404,992** | **$14,323,558** | **$14,890,275** |
| **Estimated Cost Per Connection*** | **$46,861** | **$49,648** | **$39,788** | **$41,362** |

* owner cost for tank abandonment & plumbing connection not included; typical range $1,500 to $3,000 per parcel

** assumes no land/eaement cost for treatment/storage in exchange for golf course use of recycled water produced

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## Preliminary Construction Cost Estimate
## Alternative 6- Water Recycling Facilities
## Expanded Service Area - Woodacre, San Geronimo, Lagunitas School, French Ranch

**Teatment Design Flow - 60,000 Service Connections - 420+**

| Item | Units | No. of Units | Cost per Unit ($) | Total Cost ($) |
|---|---|---|---|---|
| | | | | |
| **Title 22 Tertiary Treatment Plant** | | | | |
| Influent EQ Tank and Pumps | Gal | 35,000 | 4.00 | $140,000 |
| 1-day Emergency Storage Tank | Gal | 70,000 | 4.00 | $280,000 |
| 60,000 GPD MBR Treatment Plant | LS | 1 | 700,000.00 | $700,000 |
| Disinfection System | LS | 1 | 100,000.00 | $100,000 |
| Odor Control | LS | 1 | 40,000.00 | $40,000 |
| Sludge Dewatering and Bagging System | LS | 1 | 80,000.00 | $80,000 |
| Effluent Pump Station | Gal | 5,000 | 4.00 | $20,000 |
| Elecrtrical Service, Wiring and Controls | LS | 1 | 60,000.00 | $60,000 |
| Standby Emergency Generator | LS | 1 | 50,000.00 | $50,000 |
| Control Building/Office, Laboratory, Equip/Mtls Storage | SF | 600 | 150.00 | $90,000 |
| Grading, Surfacing, Fencing, Site Landscaping & Restoration | LS | 1 | 75,000.00 | $75,000 |
| **Treatment Subtotal** | | | | **$1,635,000** |
| **Recycled Water Transmission & Storage** | | | | |
| Transmission Line to Storage Ponds | LF | 6,000 | 50.00 | $300,000 |
| Storage Ponds Earthwork* | CY | 33,000 | 30.00 | $990,000 |
| Storage Pond Liners | SF | 200,000 | 1.00 | $200,000 |
| Pond underdrain system, Back Nine | SF | 100,000 | 1.25 | $125,000 |
| Drainage Modifications - Back Nine Pond | LF | 1,200 | 75.00 | $90,000 |
| Back Nine Irrigation Pump Station | LS | 1 | 100,000.00 | $100,000 |
| Back Nine Intertie to FR & Lag Sch Leachfields | LF | 1,000 | 50.00 | $50,000 |
| Front Nine Pumping Station | LS | 1 | 20,000.00 | $20,000 |
| Turf and landscaping replanting, restoration | AC | 2.5 | 40,000.00 | $100,000 |
| **Disposal Subtotal** | | | | **$1,975,000** |
| | | | **Total** | **$3,610,000** |

*Recyceled Water Storage Ponds #1 and #2

## Construction Cost Estimate
## Alternative 6- Water Recycling Facilities
## Expanded Service Area - Woodacre, San Geronimo, Lagunitas School, French Ranch

| Service Connections - 420+ | | |
|---|---|---|
| **Cost Item** | **San Geronimo Pressure Sewer** | **San Geronimo Cluster Gravity/Pressure** |
| **Collection System - Woodacre (Rte A)** | $4,224,175 | $4,224,175 |
| **Collection System - San Geronimo** | | |
| **Pressure Sewer** | $1,849,300 | |
| **Cluster Gravity/Pressure** | | $2,205,775 |
| | | |
| **Force Main Extension - Lagunitas School & French Ranch** | $175,000 | $175,000 |
| | | |
| **Tertiary Treatment Plant** | $1,635,000 | $1,635,000 |
| | | |
| **Recycled Water Storage & Transmission** | $1,975,000 | $1,975,000 |
| | | |
| **Land/Easement Costs** | $0 | $0 |
| | | |
| **Mobilization/Demobilization** | $100,000 | $100,000 |
| | | |
| **Permit Fees & Encroachment Fees** | $50,000 | $50,000 |
| | | |
| **Sub-total** | **$10,008,475** | **$10,364,950** |
| **Contingency @ 15%** | $1,501,271 | $1,554,743 |
| **Sub-total** | **$11,509,746** | **$11,919,693** |
| **Engr & Environ Studies @ 15%** | $1,726,462 | $1,787,954 |
| **Contruction Management @ 10%** | $1,150,975 | $1,191,969 |
| **Admin, Dist Formation, Financing @ 5%** | $575,487 | $595,985 |
| **Total Estimated Cost** | **$14,962,670** | **$15,495,600** |
| **Estimated Cost Per Connection** | **$39,900** | **$41,322** |

* owner cost for tank abandonment & plumbing connection not included, typical range $1,500 to $3,000 per parcel

** assumes no land/eaement cost for treatment/storage in exchange for golf course use of recycled water produced

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# Water Recycling Alternatives
# Annual O&M Cost Estimates

## Annual O&M Cost Estimate
## Alternative 4 - Water Recycyling Facility - Woodacre Only

| 84% Service Connections - 210 Woodacre Parcels | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Unit Cost** | **Cost ($)** |
| **District/Program Administration** | | | | |
| Insurance, legal, financial | Months | 12 | $1,000 | $12,000 |
| RWQCB Permit | LS | 1 | $7,500 | $10,000 |
| | | | | |
| **MBR Treatment Plant & Lift Station Operations** | | | | |
| Systems Control Technician | Hours | 120 | $100 | $12,000 |
| Grade III Operator (1/4 time) | Hours | 520 | $90 | $46,800 |
| Grade I Operator (1/4 time) | Hours | 520 | $75 | $39,000 |
| Field Technician (1/4 time) | Hours | 520 | $60 | $31,200 |
| Engineering Consultation | Hours | 80 | $150 | $12,000 |
| On-call Monitoring & Response Allowance | Months | 12 | $1,000 | $12,000 |
| | | | | |
| **Sludge Dewatering and Disposal** | Month | 12 | $300 | $3,600 |
| | | | | |
| **Sewer Maintenance Cleaning** | LS | 2 | $2,000 | $4,000 |
| | | | | |
| **Equip, Supplies, Maintenance & Replacement** | Months | 12 | $2,250 | $27,000 |
| **Vehicle - PU Truck lease & mileage** | Months | 12 | $400 | $4,800 |
| | | | | |
| **Expenses** | | | | |
| Laboratory | Months | 12 | $1,800 | $21,600 |
| Cleaning Chemicals | Months | 12 | $250 | $3,000 |
| | | | | |
| **Electrical & Utilities** | | | | |
| Collection System - Grinder pumps (owner cost) | kWhr | 4,500 | $0.000 | $0 |
| Main Lift Station | kWhr | 3,600 | $0.184 | $660 |
| Treatment Plant | kWhr | 110,000 | $0.184 | $20,188 |
| Routing to ponds, SGGC irrig system | kWhr | 12,500 | $0.184 | $2,294 |
| UV Disinfection | kWhr | 12,500 | $0.184 | $2,294 |
| Phone & misc | Months | 12 | $50.000 | $600 |
| | | | **Sub-total** | $265,037 |
| | | | **10% Contingency** | $26,504 |
| | | | **Estimated Total Annual Cost** | $291,540 |
| | | | **Estimated Annual Cost per Connection*** | **$1,356** |

* Includes 5 ESDs for Golf Course

## Annual O&M Cost Estimate

## Alternative 5A - Partial Woodacre & San Geronimo

| 75% Connections - Woodacre & San Geronimo 270 Parcels | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Unit Cost** | **Cost ($)** |
| **District/Program Administration** | | | | |
| Insurance, legal, financial | Months | 12 | $1,000 | $12,000 |
| RWQCB Permit | LS | 1 | $10,000 | $10,000 |
| | | | | |
| **MBR Treatment Plant & Lift Station Operations** | | | | |
| Systems Control Technician | Hours | 120 | $100 | $12,000 |
| Grade III Operator (1/4 time) | Hours | 520 | $90 | $46,800 |
| Grade I Operator (1/4 time) | Hours | 520 | $75 | $39,000 |
| Field Technician (1/3 time) | Hours | 760 | $60 | $45,600 |
| Engineering Consultation | Hours | 80 | $150 | $12,000 |
| On-call Monitoring & Response Allowance | Months | 12 | $1,000 | $12,000 |
| | | | | |
| **Sludge Dewatering and Disposal** | Month | 12 | $300 | $3,600 |
| | | | | |
| **Sewer Maintenance Cleaning** | LS | 3 | $2,000 | $6,000 |
| | | | | |
| **Equip, Supplies, Maintenance & Replacement** | Months | 12 | $4,500 | $54,000 |
| **Vehicle - PU Truck lease & mileage** | Months | 12 | $400 | $4,800 |
| | | | | |
| **Expenses** | | | | |
| Laboratory | Months | 12 | $2,000 | $24,000 |
| Cleaning Chemicals | Months | 12 | $250 | $3,000 |
| | | | | |
| **Electrical & Utilities** | | | | |
| Collection System - Grinder pumps (owner cost) | kWhr | 5,500 | $0.000 | $0 |
| Main Lift Station | kWhr | 3,600 | $0.184 | $660 |
| Treatment Plant | kWhr | 128,000 | $0.184 | $23,492 |
| Routing to ponds, SGGC irrig system | kWhr | 15,000 | $0.184 | $2,753 |
| UV Disinfection | kWhr | 15,000 | $0.184 | $2,753 |
| Phone & misc | Months | 12 | $50.000 | $600 |
| | | | **Sub-total** | $315,058 |
| | | | **10% Contingency** | $31,506 |
| | | | **Estimated Total Annual Cost** | $346,564 |
| | | | **Estimated Annual Cost per Connection*** | **$1,260** |

## Annual O&M Cost Estimate

## Alternative 5B - Full Woodacre & San Geronimo

| Woodacre & San Geronimo 360 Parcels | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Unit Cost** | **Cost ($)** |
| | | | | |
| **District/Program Administration** | | | | |
| Insurance, legal, financial, administration | Months | 12 | $1,500 | $18,000 |
| RWQCB Permit | LS | 1 | $7,500 | $10,000 |
| | | | | |
| **MBR Treatment Plant & Lift Station Operations** | | | | |
| Systems Control Technician | Hours | 140 | $100 | $14,000 |
| Grade III Operator (1/4 time) | Hours | 520 | $90 | $46,800 |
| Grade I Operator (1/3 time) | Hours | 760 | $75 | $57,000 |
| Field Technician (1/3 time) | Hours | 760 | $60 | $45,600 |
| Engineering Consultation | Hours | 100 | $150 | $15,000 |
| On-call Monitoring & Response Allowance | Months | 12 | $1,000 | $12,000 |
| | | | | |
| **Sludge Dewatering and Disposal** | Months | 12 | $400 | $4,800 |
| | | | | |
| **Sewer Maintenance Cleaning** | Days | 3 | $1,500 | $4,500 |
| | | | | |
| **Equip, Supplies, Maintenance & Replacement** | Months | 12 | $3,000 | $36,000 |
| **Vehicle - PU Truck lease & mileage** | Months | 12 | $400 | $4,800 |
| | | | | |
| **Expenses** | | | | |
| Laboratory | Months | 12 | $2,000 | $24,000 |
| Cleaning Chemicals | Months | 12 | $300 | $3,600 |
| | | | | |
| **Electrical** | | | | |
| Collection System - Grinder pumps (owner cost) | kWhr | 9,000 | $0.000 | $0 |
| Main Lift Station | kWhr | 3,600 | $0.183 | $660 |
| Treatment Plant | kWhr | 160,000 | $0.184 | $29,365 |
| Routing to ponds, SGGC irrig system | kWhr | 17,500 | $0.184 | $3,212 |
| UV Disinfection | kWhr | 17,500 | $0.184 | $3,212 |
| Phone & misc electrical | Months | 12 | $50.000 | $600 |
| | | | | |
| | | | **Sub-total** | $333,149 |
| | | | **10% Contingency** | $33,315 |
| | | | **Estimated Total Annual Cost** | $366,463 |
| | | | **Estimated Annual Cost per Connection*** | **$1,004** |

*Assumes % ESDs for Golf Course

## Annual O&M Cost Estimate

## Alternative 6 - Expanded Water Recycling Facility

| 100% Service Connections Woodacre and San Geronimo, Lagunitas School & French Ranch | | | | |
|---|---|---|---|---|
| **Item** | **Units** | **No. of Units** | **Unit Cost** | **Cost ($)** |
| | | | | |
| **District/Program Administration** | | | | |
| Insurance, legal, financial, administration | Months | 12 | $2,000 | $24,000 |
| RWQCB Permits | LS | 1 | $15,000 | $15,000 |
| | | | | |
| **MBR Treatment Plant & Lift Station Operations** | | | | |
| Systems Control Technician | Hours | 160 | $100 | $16,000 |
| Grade III Operator (1/4 time) | Hours | 520 | $90 | $46,800 |
| Grade I Operator (1/3time) | Hours | 760 | $75 | $57,000 |
| Field Technician (1/3 time) | Hours | 1,080 | $60 | $64,800 |
| Engineering Consultation | Hours | 120 | $150 | $18,000 |
| On-call Monitoring & Response Allowance | Months | 12 | $1,000 | $12,000 |
| | | | | |
| **Sludge Dewatering and Disposal** | Months | 12 | $450 | $7,200 |
| | | | | |
| **Sewer Maintenance Cleaning** | Days | 3 | $1,500 | $5,400 |
| | | | | |
| **Equip, Supplies, Maintenance & Replacement** | Months | 12 | $3,500 | $60,000 |
| **Vehicle - PU Truck lease & mileage** | Months | 12 | $400 | $4,800 |
| | | | | |
| **Expenses** | | | | |
| Laboratory | Months | 12 | $2,000 | $24,000 |
| Cleaning Chemicals | Months | 12 | $350 | $4,200 |
| | | | | |
| **Electrical** | | | | |
| Collection System - Grinder pumps (owner cost) | kWhr | 9,000 | $0.000 | $0 |
| Main Lift Station | kWhr | 3,600 | $0.184 | $660 |
| Treatment Plant | kWhr | 180,000 | $0.184 | $33,035 |
| Routing to ponds, SGGC irrig system | kWhr | 20,000 | $0.184 | $3,671 |
| UV Disinfection | kWhr | 20,000 | $0.184 | $3,671 |
| Phone & misc electrical | Months | 12 | $50.000 | $600 |
| | | | **Sub-total** | $400,837 |
| | | | **10% Contingency** | $40,084 |
| | | | **Estimated Total Annual Cost** | $440,920 |
| | | | **Estimated Annual Cost per Connection*** | **$1,050** |

* Based on 420 ESDs, including Woodacre, San Geronimo (375), plus golf course (5), Lagunitas School (10) and French Ranch (30)

# Appendix H

# Institutional Alternatives Review

# APPENDIX H

# INSTITUTIONAL ALTERNATIVES

## Introduction

The implementation of a community wastewater recycling project in the Woodacre-San Geronimo area would require the formation of or annexation to a public district that has suitable powers and authority for operation and management of public sewers. This is required as a matter of public policy and also to enable the community to obtain and utilize various forms of public financial assistance available from the State and Federal government.

Provided here is a brief overview of the potential options available along with some of the key considerations that may influence the local decision on an appropriate institutional arrangement for the community. In general, all options presented here are technically viable; the ultimate decision by the community would likely focus on issues of local autonomy, economics and possibly political or personal preferences.

## Existing Institutions

The present wastewater feasibility study is being conducted by the County of Marin, which has general authority for wastewater management throughout the unincorporated area of the County. Acting in this general capacity, the County has the authority to continue through the design and construction phase of the project, if this is desired. This is the approach that was followed for the Marshall Community Wastewater System, Phase1 and Phase 2. However, ultimately a district would be needed for the operation and maintenance of the facilities that are constructed or for the governance of an onsite wastewater management program, if implemented for all or any portion of the study area.

Presently, there are two local districts with sewerage powers that encompass or are in reasonable proximity to the study area: (1) Marin Municipal Water District (MMWD) and (2) Ross Valley Sanitary District (RVSD). MMWD provides water service to the area, and has the authority to expand its scope of activities to include wastewater services. However, this would be a significant departure from existing MMWD operations and, based on preliminary inquiries during the 2011 Woodacre Flats wastewater study, MMWD has not indicated strong interest in taking on sewer service responsibilities. The RVSD operates an extensive sewer collection system with sewer service boundaries that extend to Fairfax. RVSD has the capabilities to provide wastewater service for a project in Woodacre-San Geronimo; however, its boundaries would have to be extended into the San Geronimo Valley through annexation. Thus far no inquiry has been made into the potential interest of RVSD in expanding their service area and activities to encompass a community wastewater project in Woodacre-San Geronimo.

## Independent Local Districts

Independent local districts are those formed to carry out a specific local public function, where the administration and decision-making is entrusted to a locally elected Board of Directors. This board assumes the responsibility for all policy, staffing and fiscal matters for the properties within the district. The boundaries of the district are established to encompass the areas benefiting from the district facilities or activities. Common types of independent local districts pertinent to the provision of sewerage services include:

- **Community Services District (CSD)**. These districts have the authority to provide a broad range of public services, including police and fire protection, recreation and lighting, as well as water and sewer service. The formation of a CSD is initiated by local initiative; i.e., petition to the Board of Supervisors. An election is required for district formation and for election of the Board of Directors. The election can be waived if the petition includes at least 80 percent of the registered voters in the proposed district. There are no existing CSDs in the San Geronimo Valley. However, there are other CSDs in West Marin, e.g., Tomales Village CSD, which operates the community's wastewater collection, treatment and disposal facilities.

- **County Water Districts**. These local districts, authorized under the California Water Code, are formed in a similar manner to CSDs. But their powers are limited to provision of water and sewer service within their boundaries. Stinson Beach County Water District (SBCWD) is an example of this type of district. The SBCWD, with a locally elected board of directors, provides water service and also manages the onsite wastewater management program for the entire Stinson Beach community. Marin Municipal Water District is another example of a County Water District, which supplies water to the majority of the population in Marin County, including incorporated and unincorporated areas.
- **Sanitary Districts**. These districts are authorized under the Health and Safety Code specifically for the provision of sewage collection, treatment and disposal services. They can also provide water service. They are formed in a manner similar to CSDs and County Water Districts. The governing board of a Sanitary District is locally elected. Presently, there are no Sanitary Districts or County Sanitation Districts in West Marin. However, there are several sanitary districts throughout other parts of the County, such as the Ross Valley Sanitary District, Novato Sanitary District, and Las Gallinas Sanitary District.
- **Public Utility Districts.** These districts are authorized under the State Public Utilities Code and can provide a wide range of utility services, including sewer and water service. Public Utility Districts (PUD) can only be formed in unincorporated areas. They are governed by a locally elected board consisting of either three or five members. Inverness PUD and Bolinas Community PUD are local examples of PUDs in Marin County. Both of these districts provide water service within their districts; Bolinas Community PUD also owns and operates community sewerage facilities serving the downtown area of Bolinas.

Some of the common advantages of independent local districts include: (1) local autonomy in the decision-making process; and (2) local accountability and control over costs. The disadvantages of independent local districts may include: (1) limited financial resources and leverage; (2) limited economies of scale; and (3) limited resources and ability to meet public service demands. However, as in the case of MMWD and RVSD, independent water and wastewater districts can be large enough to encompass multiple jurisdictions and overcome economy of scale limitations.

## County-Dependent Districts

This category encompasses those districts formed and administered as sub-sets of County government. The County Board of Supervisors serves as the governing body or decision-maker for these districts. The Board of Supervisors acts as the Board of Directors for various dependent districts. As such, they assume responsibility for all policy, staffing, debt and rate structures within the boundaries of the district.

Marin County utilizes dependent districts to provide such things as sewer maintenance, landscape maintenance, lighting, recreation, fire protection, drainage and paramedic services. Marin County Counsel provides legal service. The Board of Supervisors typically works with a Citizen's Advisory Committee within each of the dependent districts to provide an opportunity for local input to the decision-making process.

Examples of County-dependent districts in Marin County include the following:

- **County Service Areas (CSA)**. County service areas are much the same as CSDs in their range of authority. The key distinction is the governing body, which is the Board of Supervisors for all CSAs. They can be formed by either local petition or by a resolution of the Board of Supervisors. Presently, there are 16 CSAs in Marin County providing a variety of public services, ranging from park and open space management to drainage maintenance. There are currently no existing CSAs in Marin County that provide sewer services. However, in neighboring Sonoma County, a county-wide CSA, with multiple zones of benefit, is used to provide wastewater treatment and disposal services for several unincorporated communities.

- **Sanitation Districts**. These districts are authorized under the Health and Safety Code specifically for the provision of sewage collection, treatment and disposal services. They can also provide water service. It can include unincorporated and incorporated areas; its governing board is made of County Board of Supervisors and/or City Council members, depending upon the makeup of the district. A sanitation district may be formed upon local petition and Board approval. San Rafael Sanitation District is currently the only County Sanitation District in Marin County; it was formed to manage the sewer collection system for the San Quentin area.

- **Onsite Wastewater Management Districts.** The concept of public management of onsite wastewater disposal was developed in California in the mid-1970s to expand wastewater options in rural and suburban communities, specifically by providing a means for more effective planning, operation and maintenance of onsite systems. The enabling legislation, Senate Bill 430, became law in January 1978 and was added to the California Health and Safety Code, commencing with Section 6950. This legislation enables public agencies that have powers to manage sewerage systems to form, under certain specified conditions, Onsite Wastewater Disposal Zones (Zones) in order to provide for the collection, treatment, reclamation or disposal of wastewater without the use of community-wide sanitary sewers or sewage systems. Such Zones may also manage community collection, treatment, disposal and water recycling facilities. Public agencies empowered to form such Zones include qualified special districts such as county service areas, community services districts, utility districts, sanitation districts, water districts, etc., as well as cities. The Zone formed under the Health and Safety Code is the area defined for operation and maintenance of onsite wastewater systems by the public agency. In 2007 the County of Marin formed the Marshall Onsite Wastewater Disposal Zone to serve as the governing entity for the Marshall Community Wastewater System.

The main advantages of County-dependent districts include: (1) availability of county resources and associated economies of scale; (2) financial strength and leverage for bonding and contracting. The key disadvantages of County-administered districts include: (1) reduced local control of the decision-making process; and (2) reduced ability to influence fiscal matters, e.g., through voluntary/community service or other cost reduction measures (e.g., County overhead, travel time and costs).

## LAFCO

The Local Agency Formation Commission (LAFCO) was created by the Legislature in 1963 to discourage urban sprawl and encourage the orderly formation and development of local government agencies. There is a LAFCO in each county in California except the City and County of San Francisco. LAFCO is a seven-member Commission comprised of two city council members (chosen by the Council of Mayors), two county supervisor members (chosen by the Board of Supervisors), two special district members (chosen by Independent Special District election), and one public member (chosen by the members of the Commission).

LAFCO has four major functions under State law:

1) To review and approve or disapprove proposals for changes in the boundaries or organization of cities and special districts in the county (including annexations to or detachments from cities and districts, incorporations of cities, formations of districts, and the dissolution, consolidation or merger of special districts), applications for activation of special district latent powers, and applications to provide service outside of a city or district boundary;
2) To establish and periodically update the sphere of influence or planned service area boundary for each city and special district;
3) To initiate and assist in studies of existing local government agencies with the goal of improving the efficiency and reducing the costs of providing urban services; and

4) To provide assistance to other governmental agencies and the public concerning changes in local government organization and boundaries.

With regard to the formation of County Service Areas, the Marin LAFCO implements the following policy:

> *"County Service Area (CSA) Policy*
>
> *A County Service Area may be formed when unincorporated areas that are located outside municipal sphere-of-influence boundaries desire extended urban-type services including police and fire protection from the County of Marin.*
>
> *Unincorporated lands located within a municipal sphere-of-influence boundary should not be eligible to receive extended urban-type services from the county in the form of a County Service Area except when (a) evaluation on a case-by-case basis justifies creation and (b) the affected city, by letter, expresses approval of such action. (Originally Adopted: July 13, 1977; Revised: January 13, 1983)"*

The Woodacre-San Geronimo area does not fall within the sphere-of-influence boundary of any municipality. LAFCO policy concerning the formation of County Service Areas would appear to permit the establishment of a CSA for the provision of wastewater collection and treatment services for the study area.