CHAPTER 9

Outlying Facilities' Strategic Management Plan

Chapter 9 - Non-Metro Facilities' Strategic Management Plan

9.1 Introduction

The PCRWRD currently operates and maintains eight Non-Metro wastewater treatment facilities. This chapter draws upon preceding conveyance system evaluation (Chapter 6) and Non-Metro facility overviews (Chapter 8), as the basis for recommending flow management for the Non-Metro regions. The recommended flow management plan for the Non-Metro areas are in support of the recommended overall treatment strategy and recommended treatment plan. This chapter discusses the following topics.

- Current and future influent flows, biosolids, and effluent
- Current treatment technologies and future requirements
- Non-Metro facility treatment technology options and recommendations
- Non-Metro facility layout recommendations

Descriptions of the Non-Metro facilities are provided in Chapter 8. The Non-Metro facilities include:

- Arivaca Junction WRF
- Avra Valley WRF
- Corona de Tucson WRF
- Green Valley WRF
- Marana WRF
- Mt. Lemmon WRF
- Pima County Fairgrounds WRF
- Rillito Vista WRF

9.2 Current and Future Influent Flows, Biosolids, and Effluent

Treatment technology selection requires an understanding of the influent flows and characteristics, desired level of biosolids treatment, effluent quality, client needs, and existing treatment technologies. The Non-Metro region's growth projections were obtained and reviewed to assist in determining the optimal treatment process for the Non-Metro facilities. The recommendation draws upon information gathered from a series of facilitated workshops consisting of PCRWRD staff, consultants and other stakeholders, as well as several previous planning and engineering efforts performed for or by the PCRWRD. This chapter discusses:

- Influent flows and characteristics
- Biosolids handling, treatment, and disposal
- Effluent quality and water reuse

9.2.1 Influent Flows and Characteristics

Future wastewater flows for the Non-Metro facilities were based on population projections obtained from the PCRWRD Facility Plan and PAG TAZ data. This data was agreed upon between the City of Tucson and

Pima County Wastewater Management's Resolution of Population and Effluent Variances (Joint Memorandum). Population projections examined the current population on septic systems and assumed these populations would continue their septic service. All new population would be sewered (wastewater flow transported to a PCRWRD operated treatment facility) unless they were located in areas of sparse development where service by PCRWRD would be economically infeasible. Flow was then calculated for five year increments using the sewered population and multiplying by the gallon per capita per day factor of 85.

Facility influent flows are currently increasing for nearly all the Non-Metro facilities. Projected flow increases at these facilities range from 250 to nearly 3,000 percent. Many of the Non-Metro facilities will be treating over one mgd by 2010 with all facilities (excluding Mt. Lemmon WRF) treating more than one mgd by 2020. 2030 flow projections for these Non-Metro facilities range from 2.1 to 10.5 mgd (excluding Mt. Lemmon WRF). The future dry weather flow projections calculated from the population projections are presented in **Table 9-1**.

Table 9-1
Non-Metro Facility Average Daily Dry Weather Flow Projections (mgd)[1]

Facility	2006	2010	2015	2020	2025	2030	% Increase
Avra Valley WRF [2]	1.08	1.4	1.8	2.2	2.6	3.0	280
Corona de Tucson WRF [2]	0.14	0.5	0.9	1.3	1.7	2.1	1500
Green Valley WRF [3]	1.76	2.7	3.1	3.6	4.0	4.4	250
Marana WRF [2]	0.15	1.6	2.3	3.0	3.7	4.4	2900
Mt. Lemmon WRF [4]	0.013	0.013	0.013	0.013	0.013	0.013	-
Southlands WRF [2]	-	1.2	3.6	6.0	8.2	10.5	875

1. Flow from Arivaca Junction WRF, Pima County Fairgrounds WRF, and Rillito Vista WRF lagoon facilities' will be conveyed to Non-Metro facilities at a later date and future flow projections for these areas are included in the Non-Metro facilities' future flow projections
2. Future flows from PCRWRD's Facility Plan (TAZ)
3. Future flows from PAG
4. Future flow projection is assumed to be constant due to the agreement between PCRWRD, the County Department of Environmental Quality (DEQ), and the USFS

Future flow projections, developed in PCRWRD's Metro Area Facility Plan Update (Facility Plan) and discussed in Chapter 8, for Non-Metro facilities are summarized in **Table 9-2**.

Table 9-2
Non-Metro Facility Flow Projections (mgd)*

Facility	2010	2015	2020	2025	2030
Avra Valley WRF	1.4	1.8	2.2	2.6	3.0
Corona de Tucson WRF	0.5	0.9	1.3	1.7	2.1
Green Valley WRF	2.7	3.1	3.6	4.0	4.4
Marana WRF	1.6	2.3	3.0	3.7	4.4
Southlands	1.2	3.6	6.0	8.2	10.5

Determination of future Non-Metro influent design wastewater characteristics allows for the selection of a treatment alternative with the capabilities of properly treating the range of loadings the wastewater treatment facility may experience.

For purposes of wastewater treatment system evaluation for the Non-Metro facilities, influent wastewater characteristics were developed based on the Roger Road WRF, Ina Road WRF and Non-Metro facility influent wastewater characteristics. The influent wastewater characteristics used for evaluation of the Non-Metro facilities are listed in **Table 9-3**.

Table 9-3
Non-Metro Facility Influent Wastewater Characteristics

Characteristic	Non-Metro Facility Influent Concentrations (mg/L)
BOD_5	300
$sBOD_5$	125
COD	590
TSS	270
VSS	220
TKN	57
TP	10

9.2.2 Biosolids Handling, Treatment, and Disposal

The Non-Metro facilities store their biosolids before transporting it to one of the regional facilities, except Green Valley WRF provides on-site biosolids treatment and disposal. At Green Valley WRF sludge from the secondary clarifiers is sent to two gravity thickeners before being dried on sludge drying beds to produce Class A biosolids. Class A biosolids can be used for a number of different options, including cover material for landfills or for mine tailings reclamation. Currently, Green Valley WRF, Pima County,

and the University of Arizona have entered into an agreement with Asarco Mines to use biosolids for reclamation of its mine tailings.

Biosolids from Mt. Lemmon WRF and Marana WRF are stored and transported to the influent of the Ina Road WRF. Biosolids from Avra Valley WRF is mixed with the sewage tributary to Roger Road WRF to be treated and digested before being transferred to Ina Road regional processing facility for transfer to a disposal site. Biosolids from Rillito Vista WRF, Corona de Tucson WRF, and Pima County Fairgrounds WRF are dried, scraped, and hauled to a landfill as necessary.

Non-Metro facility biosolids production is approximated by assuming 2,800 dry pounds per day of raw biosolids produced per mgd flow treated. Current tpd produced and handling, processing, and disposal methods for each Non-Metro facility are shown in **Table 9-4**.

Table 9-4
Current Non-Metro Facilities' Biosolids Production/Handling, Processing, Disposal

Current Biosolids		
Location	**Produced (tpd)**	**Handling, Processing, Disposal**
Arivaca Junction WRF	0.09	Dried, Scraped, Hauled to Landfill
Avra Valley WRF	2.20	Storage, hauled and transported to conveyance system
Corona de Tucson WRF	0.16	Dried, Scraped, Hauled to Landfill
Green Valley WRF	5.70	GBTs, Aerobic Digesters, BFPs, Drying, Sent to Asarco Mines
Marana WRF	0.28	Storage, hauled and transported to conveyance system
Mt. Lemmon WRF	0.02	Storage, hauled and transported to conveyance system
PC Fairgrounds WRF	0.004	Dried, Scraped, Hauled to Landfill
Rillito Vista WRF	0.01	Dried, Scraped, Hauled to Landfill
Total	**8.46**	

Chapter 5: Biosolids provides information regarding existing Class B regional biosolids processing and disposal methods, Class B and Class A biosolids requirements, available markets, process alternatives for Class A production at the regional facilities, and biosolids processing recommendations in more detail.

The current recommendation for biosolids handling, processing, and disposal at the Non-Metro facilities is for thickening and hauling of biosolids to continue until an extensive market study is completed producing an optimal biosolids processing strategy as discussed in the biosolids chapter of this study. The future Non-Metro facilities' biosolids production and handling, processing, and disposal recommendation are shown in **Table 9-5**.

Table 9-5
Future Non-Metro Facilities' Biosolids Production/Handling, Processing, Disposal

Future Biosolids*						
Location	Produced (tpd)					Handling, Processing, Disposal (2030)
	2010	2015	2020	2025	2030	
Arivaca Junction WRF	-	-	-	-	-	Flow transferred to Green Valley WRF
Avra Valley WRF	1.96	2.52	3.08	3.64	4.20	Thicken/haul to interceptor for discharge
Corona de Tucson WRF	0.70	1.26	1.82	2.38	2.94	Store/haul to interceptor for discharge
Green Valley WRF	3.78	4.34	5.04	5.60	6.16	GBTs, Aerobic Digesters, BFPs, Drying, Sent to Asarco Mines
Marana WRF	2.24	3.22	4.20	5.18	6.16	Thicken/haul to Ina Road Digester for processing
Mt. Lemmon WRF	0.003	0.003	0.003	0.003	0.003	Thicken/haul to interceptor for discharge
PC Fairgrounds WRF	Current practice until flow is transferred					Flow transferred to SEI
Rillito Vista WRF	Current practice until flow is transferred					Flow transferred to Marana WRF
Southlands WRF	1.68	5.04	8.40	11.48	14.70	Master plan is under development
Total	**10.36**	**16.38**	**22.54**	**28.28**	**34.16**	

*Market study will determine future plans for all facilities' biosolids handling, processing, and disposal

9.2.3 Effluent Quality and Water Reuse

Pima County's treated effluent is increasing in value. Due to the large population growth and a limit to the amount of available water, communities are interested in water reuse programs as a means to augment their potable water consumption. Some Non-Metro communities have shown interest in obtaining the rights to their wastewater via purchase and operation of the local wastewater treatment facility and this could be a future trend in Pima County. Current and future effluent quality and water reuse for the area is discussed below to assist in determination of the optimal Non-Metro system configuration.

Quality

Determining the desired effluent quality is an important component for selection of a proper treatment technology. Effluent quality is determined by government regulations, existing permits, and the County's desired level of treatment. Government regulations have become increasingly more stringent with respect to effluent quality. The Non-Metro areas are required to follow the regulations set forth in the AAC Title 18 Chapter 9 Part B and the rules of the individual facility's respective permits. An evaluation of the

Non-Metro facilities' current permits has been summarized in Chapter 2. PCRWRD desires wastewater treatment quality standards for all facilities that will meet current and future regulations at each facility.

The recommended Non-Metro treatment alternative must comply with future government regulations, improve the discharged effluent quality, and standardize wastewater effluent quality for all facilities. Neither current nor future (2014/2015) PCRWRD Pima County AZPDES Permits require phosphorus removal. However, PCRWRD's commitment to provide a higher quality effluent has prompted PCRWRD to include the goal of a total phosphorus (TP) limit of < 1 mg/L as a part of the Regional Optimization Master Plan. Effluent quality parameters are summarized in **Table 9-6**.

Table 9-6
Effluent Quality Parameters

Parameter	Effluent Quality
BOD_5	< 6 mg/L
TSS	< 10 mg/L
Ammonium as Nitrogen (NH_4-N)	< 1 mg/L
TN	< 10 mg/L; Design <8mg/L
TP	< 1 mg/L
Pathogen removal	No detect in 4 of 7 samples per week. None exceeding 23 cfu/100ml
pH	6.8 – 7.2

Water Reuse

Currently, PCRWRD operated facilities have varying classes of treated effluent and various disposal and delivery methods. **Table 9-7** summarizes the current permitted effluent utilization for the Non-Metro facilities.

Table 9-7
Summary of the Non-Metro Facilities' Current Permitted Water Reuse*

Current Water Reuse		
Facility	**Permit**	**Use**
Arivaca Junction WRF	Class C	Reventone Ranch (Agriculture)
Avra Valley WRF	Class B+	Spray Field Disposal
Green Valley WRF	Class A+	Robson/Quail Creek, Inc. (Turf Irrigation)
Marana WRF	Class B+	Santa Cruz River Discharge and Plant Turf Irrigation
Mt. Lemmon WRF	USFS Permit	Spray Field Disposal

*Non-Metro facilities not mentioned here do not currently utilize effluent

Future prediction of water reuse begins by identifying the type(s) of uses that will be pursued and the types of customers. A reclaimed water system may grow as a way to augment the potable water supply with non-potable water. As Pima County's Non-Metro population continues to grow and the supply of potable water stays constant or possibly diminishes, water reuse will become necessary. Popular water reuse ideas for this area include turf irrigation and riparian restoration.

Turf Irrigation

Turf irrigation includes irrigation for areas such as golf courses and public/private parks. The Water Conservation in Pima County document states City of Tucson, Pima County, Marana, and Oro Valley have ordinances requiring the use of reclaimed water on new golf courses where feasible. The ability to use reclaimed water depends on the ability to connect to the reclaimed water distribution system. An existing reclaimed water piping system delivers reclaimed water to many areas of the eastern Pima County region. Golf courses outside of the existing reclaimed water distribution area would need to connect to the system at their cost.

Riparian Restoration

An element of the Sonoran Desert Conservation Plan includes riparian restoration. The City of Tucson and Pima County have come to the agreement to reserve up to 10,000 acre-feet of treated effluent per year for approved riparian projects.

9.3 Current Treatment Technologies and Future Requirements

Treatment technologies for the existing Non-Metro facilities include lagoons, oxidation ditches, closed loop reactors, and package plants. PCRWRD desires to replace primary wastewater treatment via land intensive lagoons and shift towards a technology that will comply with BADCT rules and relieve pressures due to population growth and loadings exceeding those acceptable for the lagoon technologies (BADCT rules are discussed further in Chapter 2 of this study).

Marana WRF, Avra Valley WRF, Corona de Tucson WRF, and Mt. Lemmon WRF are typically operated and maintained by a staff only present from Monday through Friday on either eight or ten hour daily shifts. Arivaca Junction WRF, Pima County Fairgrounds WRF, and Rillito Vista WRF have operations staff visits each facility approximately once per week. The projected increase in wastewater flow at Marana WRF, Avra Valley WRF, and Corona de Tucson WRF locations has prompted PCRWRD's desire for a highly efficient, low maintenance treatment technology.

Where the Non-Metro areas are experiencing rapid population expansion, populations are encroaching upon these historically remote treatment facilities driving up the price of available land. In an effort to eliminate odor complaints, eliminate potential community eye-sores, meet setback requirements, and eliminate additional land purchases, the selected treatment technology must have odor control technology implementation capabilities, be aesthetically pleasing, and be able to fit within setback buffers on PCRWRD's currently owned parcels.

Below the 0.5-mgd design capacity, treatment needs can be met by package or pre-engineered plants when operated properly. Package plants at Marana WRF used to meet the Non-Metro facility treatment needs. When capacities grow beyond 0.5 mgd, the addition of extra package plants can create a

cumbersome treatment operation and an alternative treatment facility should be determined. Marana WRF and Corona de Tucson WRF currently fall into the small capacity range (0 – 0.5 mgd) but are projected to transition into the medium capacity range (0.5 – 10 mgd) by 2010. In this range, package plants are generally no longer appropriate because as flows increase, the complexity of treatment increases significantly, well beyond the simplistic designs typical of package plants. All 2030 projected flows for the Non-Metro facilities are greater than 2.5 mgd. The proposed Southeast Non-Metro plant is projected to treat over 10 mgd by 2030.

Under the U.S. Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (PL 107188), drinking water utilities serving more than 3,300 customers were required to conduct vulnerability assessments (VAs) of their water systems. While similar requirements for wastewater utilities have yet to be promulgated, similar approaches have been promoted by the USEPA for the protection of wastewater facilities. During the design and retrofitting of PCRWRD's infrastructure, PCRWRD is encouraged to refer to the guidelines presented in *Guidelines for the Physical Security of Wastewater/Stormwater Utilities* "in an effort to delay or detect malevolent parties whose actions may otherwise defeat the mission of the utility."

9.4 Non-Metro Treatment Technology Options and Recommendations

There are many wastewater treatment technologies available. PCRWRD is interested in providing its customers and the environment with the highest quality treated effluent practical through the use of enhanced nutrient removal processes in addition to removals of the conventional pollutants of oxygen-demanding organics, suspended solids and ammonia. This chapter aims at examining and evaluating five treatment technology alternatives believed to provide a high quality effluent at reasonable cost and provide recommendations for the Non-Metro facilities.

9.4.1 Evaluation Criteria

Various treatment alternatives exist and must be analyzed using both monetary and non-monetary criteria. Monetary criteria include capital, operations and maintenance, and life cycle costs. Monetary and non-monetary criteria are analyzed using weighted rankings. This chapter discusses the evaluation criteria used to assist in treatment technology selection.

Monetary Criteria

Monetary criteria consider construction, operations and maintenance, and life cycle costs for each treatment alternative for comparative purposes only.

It is assumed that all treatment processes will need screening and grit removal and disinfection and that these costs are equally applicable to all alternatives and thus do not influence comparisons of alternatives.

Non-Monetary Criteria

Non-monetary criteria are described below. The values in parenthesis adjacent to the criteria indicate the weighting factor for that criterion (A weighting factor of 1 being low and 5 being high).

- ***Environmental Impact***: The treatment process introduces little or no negative environmental impacts during construction, start-up, regular operations, maintenance, expansion, etc. and has the potential to constantly meet and exceed current and future regulations regarding ground and surface water quality and quantity discharges. (4)

- ***Feasibility***: The treatment process meets the feasibility criteria for converting from the existing facilities to a preferred alternative process and following conversion is readily and reliably operable. (3)

- ***Operational Capability***: The treatment process meets the operational capability requirement by having the ability to modify process configurations during operations to accommodate abnormal conditions such as radical changes in influent wastewater characteristics, major maintenance activities, changes in permit requirements, changes in appropriate technology, requirements for expansion, discharge and reuse requirements and biosolids handling regulations. (4)

- ***Land Required***: The treatment process meets the land required criteria efficiently utilizes the available land. (2)

- ***Maintenance***: The treatment process meets the maintenance criteria of requiring a minimum amount of time and frequency of on-site operator attention, and that the routine preventative maintenance activities are easy to perform. (4)

- ***Public Acceptability***: The treatment process meets the public acceptability criteria in being aesthetically unobtrusive and provides effective odor and noise control. (5)

- ***Reliability***: The treatment process meets the reliability criteria by providing dependable, uninterrupted compliant service during construction, startup, operations and maintenance, and throughout its service life. (4)

- ***Sludge Production***: Current sludge processing for many of the Non-Metro facilities occurs at Ina Road WRF (a more detailed discussion of sludge processing occurs in Chapter 5). This requires transporting the sludge via pipeline or truck to a drop-off point along the conveyance system or to Ina Road WRF itself. Shipment by truck requires sludge holding facilities at the site of biosolids generation and shipment by pipeline requires construction of a pipeline specifically for the sludge produced. The treatment process would ideally produce the least amount of sludge to be processed. (1)

- ***Water Reuse Potential***: The treatment process meets the water reuse potential criteria by constantly providing the quantity and quality of reuse water demanded. (4)

- ***Odor Control***: The treatment process meets the odor control criteria by eliminating or reducing odor emissions through process components or additional external odor control structures could be added in a simple cost effective manner. (5)

9.4.2 Alternative Treatment Method Examination

This chapter reviews the five most likely treatment processes needed by PCRWRD to meet the regulatory effluent requirements for the existing Non-Metro facilities, which are:

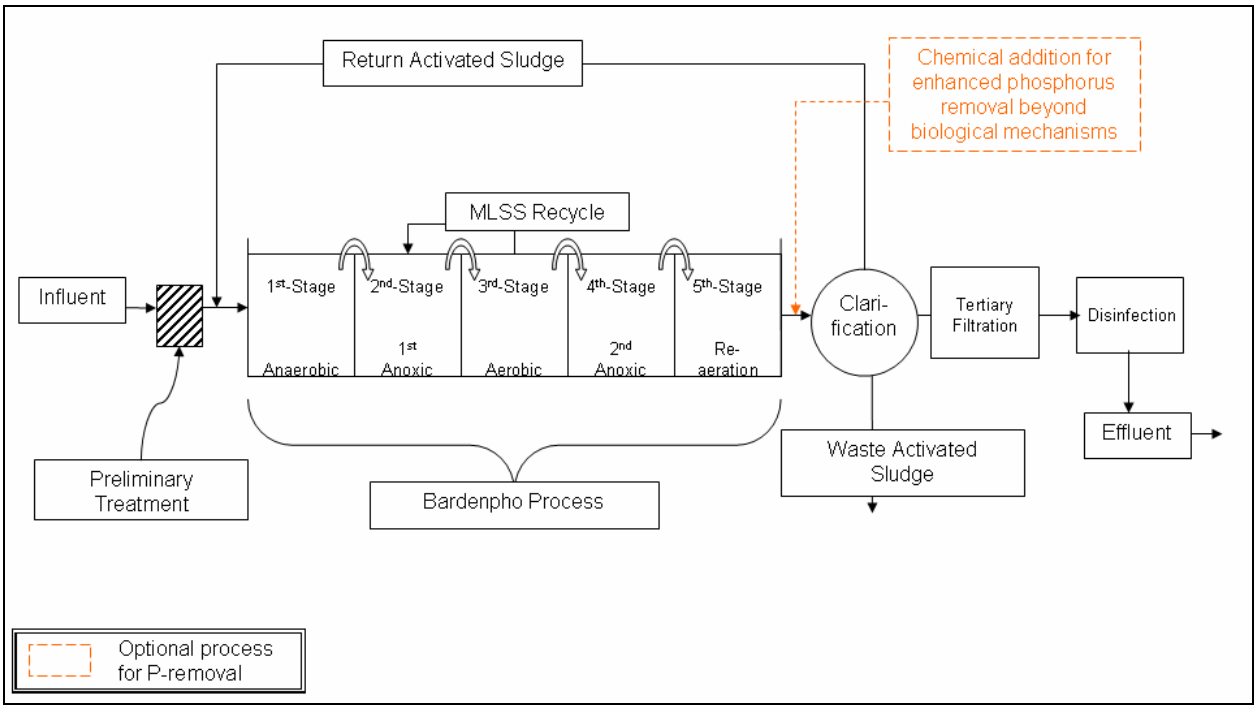
- Bardenpho (five stage)
- Biological nutrient removal oxidation ditch
- Membrane bioreactor
- Moving bed bioreactor
- Sequencing batch reactor

9.4.2.1.1 Bardenpho (Five Stage)

Process

The five stage Bardenpho process is a modification of the activated sludge process consisting of a multi-stage biological reactor. The mixing of influent with activated sludge and passing the mixture through a sequence of alternating environments of variable oxygen concentration allows removal of nitrogen from the wastewater. These alternating environments are termed anoxic and aerobic depending on the amount of oxygen available for metabolism. The five-stage process adds an anaerobic zone ahead of the anoxic/aerobic sequences of the four-stage process to create conditions amenable for the removal of phosphorus. Nitrogen is removed by metabolic processes performed by the active bacteria present in the bioreactor tanks, while phosphorus is removed by accumulating in specific species of bacteria in amounts in excess of metabolic requirements and removed from the system as these bacteria are removed from the system as part of the sludge wasting procedures. The general process flow for a typical five stage Bardenpho is shown on **Figure 9-1**. This figure also shows where additional components would be added for enhanced phosphorus removal and where disinfection would be located.

Figure 9-1
Five-Stage Bardenpho Process Diagram



Benefits and Drawbacks

The five-stage Bardenpho process is capable of consistent high levels of BOD removal, suspended solids, nitrogen, and phosphorus with little or no use of chemicals. Compared to other biological nutrient removal processes, the five-stage Bardenpho provides excellent nitrogen removal and good phosphorus removal. Nitrogen is removed via anoxic, aerobic, anoxic stages of the process. Though biological nitrogen removal is generally capable of meeting total nitrogen (TN) levels less than 5 mg/L, reaching very low levels could require the addition of a supplemental carbon source such as methanol or some other highly degradable source to drive the denitrification reactions to completion. The removal of phosphorus biologically is a sensitive process. The efficiency of removal of the phosphorus is dependent on the quantity and quality of the readily degradable carbon in the anaerobic zone. To improve reliability, the inclusion of primary clarification with the concomitant fermentation of settled primary sludge to supplement the amount of readily degradable carbon can be very effective. A metal salt addition will most likely be required in order to reduce total phosphorus levels to below one mg/L.

Additional Components

The five-stage Bardenpho process requires five separate tanks followed by final clarifiers. The return activated sludge, mixed liquor suspended solids, and waste activated sludge requires piping and pumps for operation. All stages require mixing equipment and oxygen must be introduced in the third and fifth stages of the Bardenpho sequence.

9.4.2.1.2 Biological Nutrient Removal Oxidation Ditch (BNROD)

Process

An oxidation ditch is a modified activated sludge biological treatment process that utilizes long solids retention times to remove biodegradable organics and ammonia. Multiple reactors can be operated in series or parallel, depending on configuration, also allowing a reactor to be taken out of service for inspection or repairs. Oxidation ditches are designed to carry mixed liquor suspended solid concentrations of 3000-8000 mg/L. HRT is generally between 18-30 hours. Design SRTs can be selected for a high degree of nitrification. PCRWRD currently uses BNROD at its Avra Valley and Green Valley facilities. Additionally, an anoxic tank is currently being installed ahead of the BNROD at Avra Valley WRF to enhance total nitrogen removal.

Benefits and Drawbacks

The oxidation ditch is considered an economical, highly efficient, and simple waste treatment process. Oxidation ditches are able to withstand shock and peak loads, and can be operated continuously or intermittently. The BNROD system is noted as being "operator-friendly" according to PCRWRD staff and is currently in use at the Avra Valley and Green Valley WRFs for reduction of total nitrogen concentrations in effluent. It has been reported by PCRWRD staff that Avra Valley WRF's BNROD is treating approximately 1.3 mgd to a TN below 3 mg/L. This is being achieved by alternating aerators on and off, creating alternating aerobic and anoxic environments. Large areas of level land are needed for facility construction and to meet setback requirements set in the AAC Title 18 Chapter 9. This process can not meet phosphorus limits without addition of chemicals or construction of additional anaerobic tankage volume in front of the oxidation ditch.

Additional Components

liminary treatment usually precedes the oxidation ditch but primary settling prior to the oxidation ditch is rare. Influent is aerated and mixed with return activated sludge from the final clarifiers. An anaerobic tank may be added prior to the oxidation ditch to enhance biological phosphorus removal. An anoxic tank may be added upstream of the oxidation ditch for enhanced nitrogen removal (known as the Modified Ludzack-Ettinger or MLE process) along with mixed liquor recirculation from the aerobic zone to the anoxic tank. Tertiary filters may be required after clarification to polish the effluent prior to disinfection. Tertiary filtration is effective for reducing the effluent suspended solids significantly allowing the effluent turbidity goal to be achieved consistently. The general process flow sheet for a typical BNROD process is shown on **Figure 9-2** and the MLE on **Figure 9-3**. These figures also show where additional components would be added for enhanced nitrogen and phosphorus removal and where disinfection would be located.

Figure 9-2
Biological Nutrient Removal Oxidation Ditch

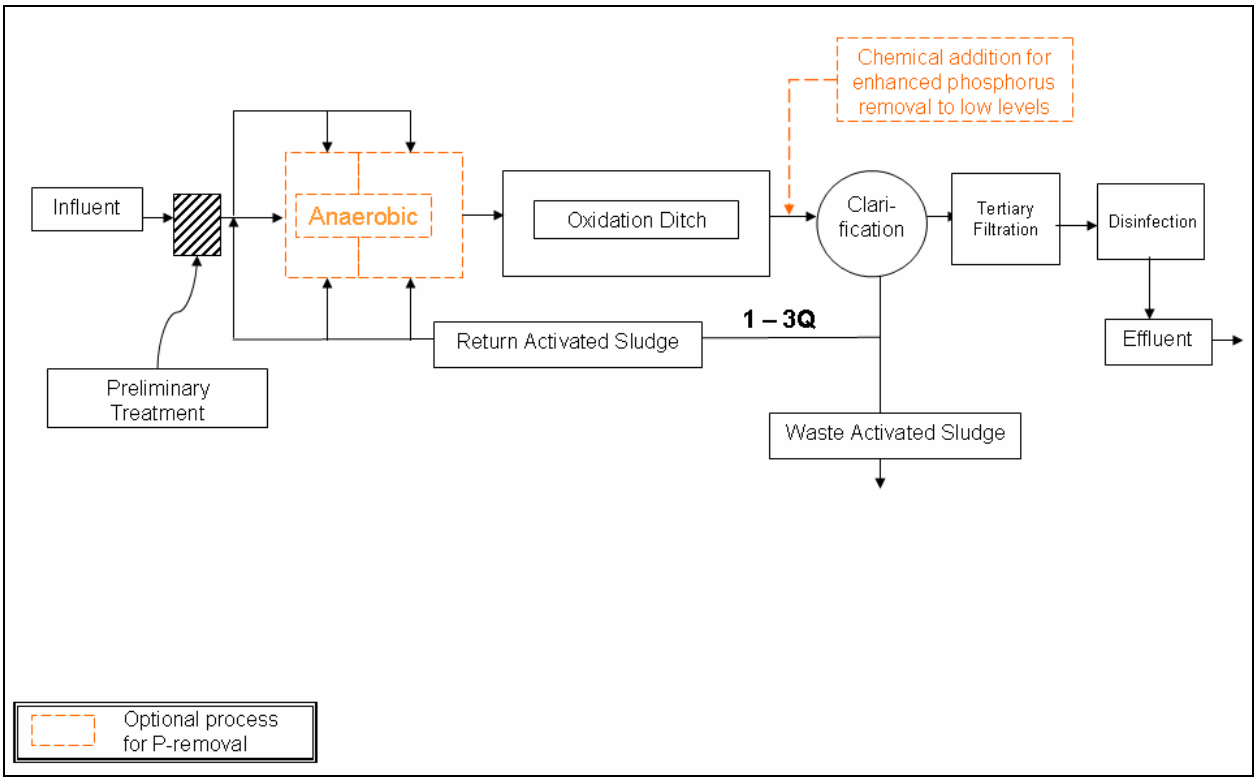
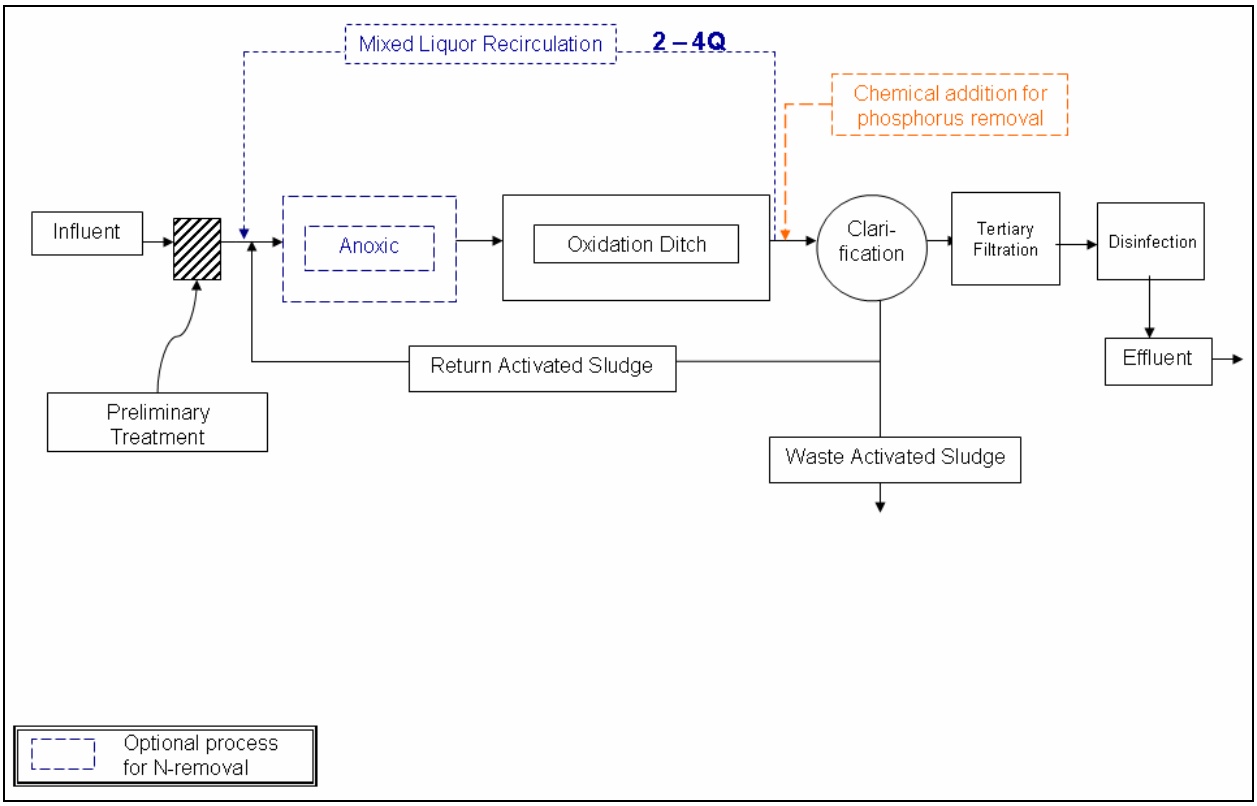


Figure 9-3
Modified Ludzack-Ettinger



9.4.2.1.3 Membrane Bioreactor (MBR)

Process
The MBR is an activated sludge process in which microfiltration through a synthetic membrane is used in place of secondary clarification. The membrane separation occurs in a separate, final stage activated sludge tank. Essentially all suspended solids and bacteria are retained in the aeration tank due to the small pore size of the separation membrane. The membrane provides both solids removal and filtration. Sludge is directly wasted from the aeration tank to maintain the desired Solids Retention Time. With membrane separation a much higher MLSS concentration (7-15,000 mg/L) can be used in the activated sludge process, reducing tank volume requirements. The MLSS concentration that can be achieved is limited by the oxygen transfer capacity of the aeration system and the fouling properties of the membranes.

Benefit and Drawbacks
A major advantage of this process is a smaller footprint and increased capacity for existing aeration tanks. Disadvantages are high energy demand, high capital and operation and maintenance costs and an unknown life expectancy of the membranes. There is the possibility for the need of a high dose of methanol as a

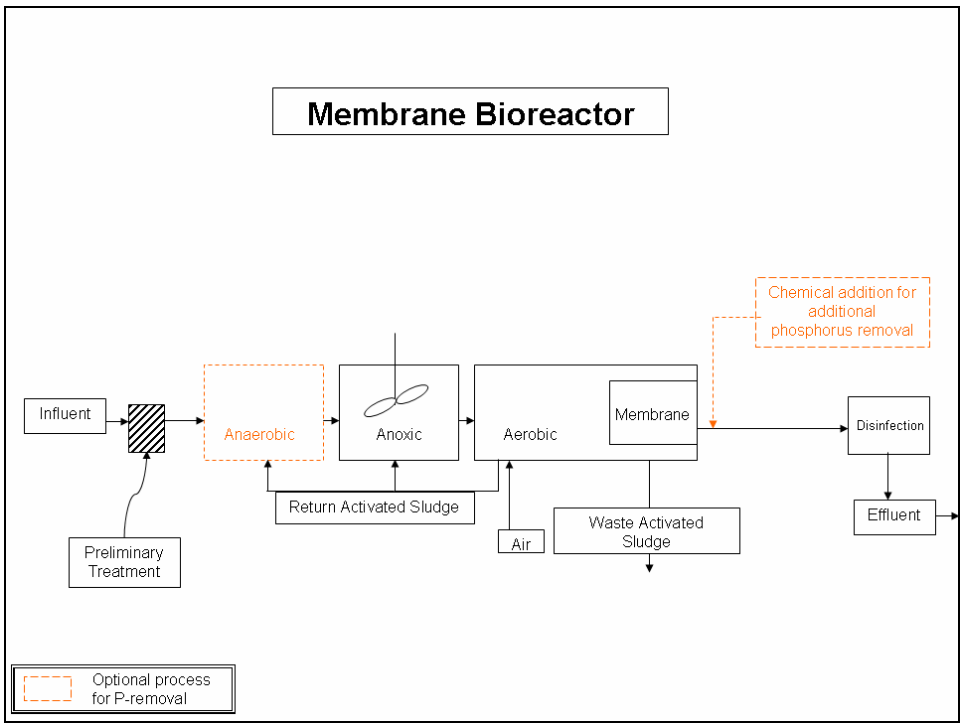
carbon source. In addition there would be no commonality of the processes at the other Non-Metro treatment plants which could require more operational training and a higher inventory of spare parts.

This process combines an ultrafiltration membrane system for solids separation with an activated sludge reactor eliminating the need for separate clarification. Wastewater is screened before entering the biological treatment tank where aeration within this aerobic zone provides the oxygen required for biological respiration and maintains solids in suspension. MLSS in the bioreactor are maintained at high levels (1% - 3%) allowing high levels of organic loading to the reactor. All solids are retained within the reactor, thus requiring no return activated sludge system. The process runs at a high solids retention time and nitrifiers are easily maintained within the system. The process is capable of achieving low levels of effluent BOD, suspended solids, nitrogen, and phosphorus.

Additional Components

Aggressive preliminary treatment usually precedes MBR. Influent is mixed with return activated sludge from the aerobic tank in an anoxic zone. An anaerobic tank may be added prior to the oxidation ditch to enhance biological phosphorus removal. Tertiary filters are not required prior to disinfection due to the membranes ability to produce very low turbidity effluent. The general process flow sheet for a typical MBR process is shown on **Figure 9-4**. This figure also shows where additional components would be added for enhanced phosphorus removal and where disinfection would be located.

Figure 9-4
Membrane Bioreactor



9.4.2.1.4 Moving Bed Bioreactor (MBBR)

Process

The MBBR system is a modification of the activated sludge process. It utilizes an attached growth or fixed film biological process instead of the suspended growth process in the conventional activated sludge systems. The MBBR includes small, plastic (usually polyethylene) carrier elements placed in a continuously mixed basin to provide surface area for the growth of attached biomass. The MBBR system does not incorporate return sludge flow nor backwashing of the screens used to retain the plastic media within the continuously mixed basin. As with other processes, the MBBR can be configured with alternating environments to gain efficiencies in nutrient removals. Either coarse bubble aeration or a mechanical mixer can be used for continuous mixing depending on whether the zone is anoxic, anaerobic, or aerobic. The media can be provided by a number of manufacturers and a 2000 Water Environment Research Foundation (WERF) report concluded that the media's effective surface area is a key design parameter and the shape and size of the media is of less importance.

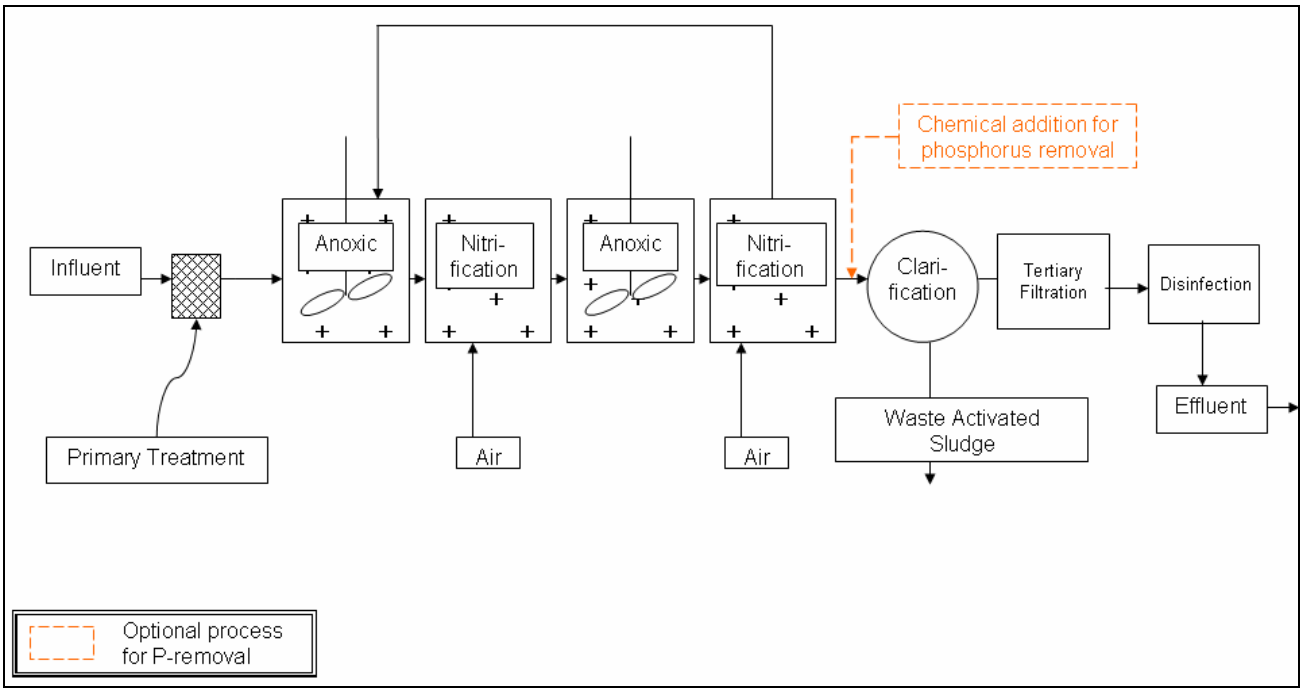
Benefits and Drawbacks

MBBR systems are less operationally complex than an activated sludge system because the MBBR system does not include return activated sludge.

Additional Components

The MBBR system requires screens, grit chambers, primary clarifiers, a reactor basin, plastic media, continuous mixing devices, a screen or sieve installed at the effluent end of the reactor basin to retain the media within the basin, and final clarifiers. The MBBR system can be retrofitted from an existing activated sludge reactor through the addition of baffle walls creating separated anoxic and aerobic zones. The amount of media required is dependent upon the organic and hydraulic loading, the temperature, oxygen transfer capability of the system, and the degree of treatment required. External chemical addition is necessary to provide a carbon source for denitrification. Retrofits of the oxidation ditches at the Avra Valley, Green Valley, and Corona de Tucson facilities to an MBBR are plausible options for PCRWRD to consider. The general process flow sheet for a typical MBR process is shown on **Figure 9-5**. This figure also shows where additional components would be added for enhanced phosphorus removal and where disinfection would be located.

Figure 9-5
Moving Bed Bioreactor



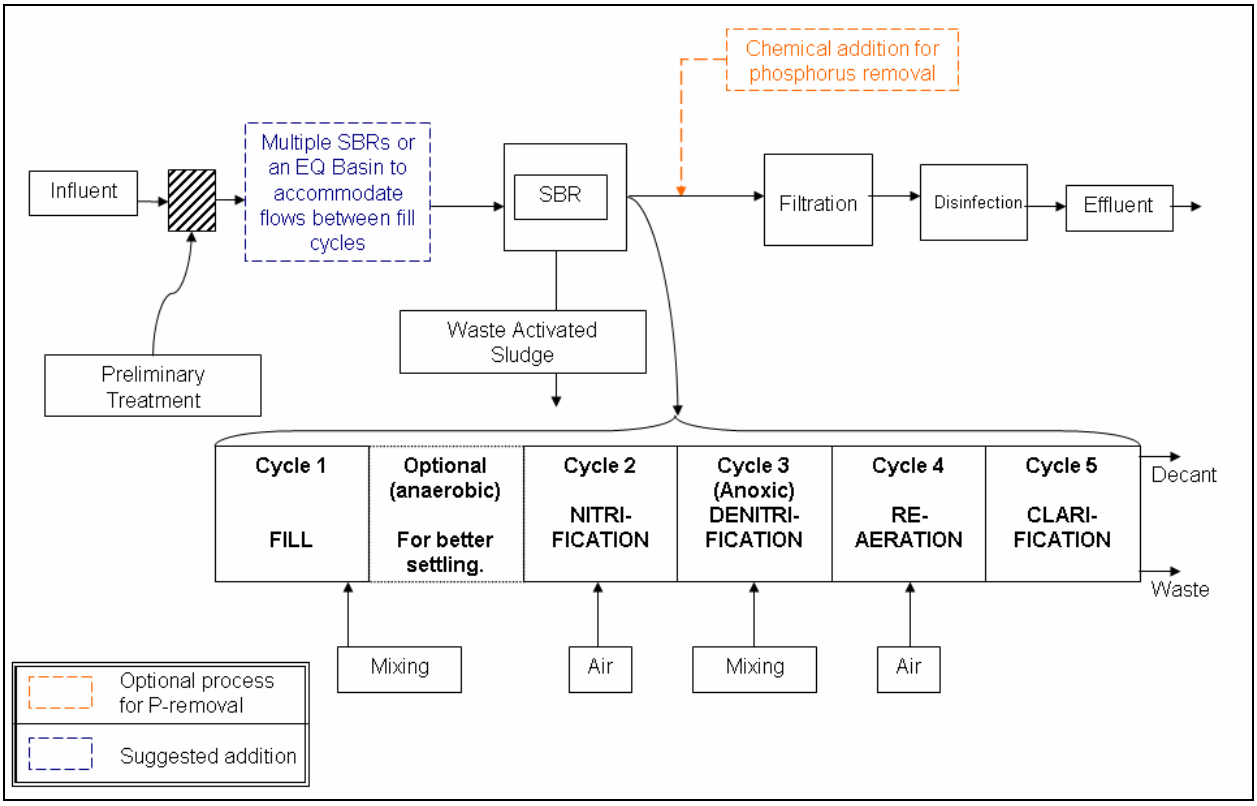
9.4.2.1.5 Sequencing Batch Reactor (SBR)

Process
Improvements in aeration devices and control systems have made sequencing batch reactors a competitive process to conventional continuous flow activated sludge systems. SBRs and conventional continuous flow activated sludge systems have essentially the same biological and physical processes, aeration and sedimentation/clarification are performed in both systems. SBRs allow these processes to be performed within in one tank, reducing the land area needed when compared to the conventional activated sludge processes. Hydraulic retention times between 21-24 hours are typical for SBRs.

Benefits and Drawbacks
SBRs need less land for reactors, but often require equalization (EQ) basins for volume balance; can be easily automated; can be operated for BNR with simple modifications to the sequencing logics; have limited capability to handle high hydraulic peaks;

Additional Components
An oxidation ditch could be retrofitted to an SBR by installing gates and a decanter mechanism and some aeration equipment in lieu of rotors. Also, mixers would be needed in order to develop anoxic/react conditions and anaerobic conditions. The general process flow sheet for a typical SBR process is shown on **Figure 9-6**. This figure also shows where additional components would be added for enhanced phosphorus removal and where disinfection would be located.

Figure 9-6
Sequencing Batch Reactor



9.4.3 Evaluations

Weighted ranks are used for evaluating treatment process alternatives with respect to the chosen criteria. A weighted rank is the product of the criteria's weighting factor (WF) and value. A weighting factor (1-5, with 5 being the highest) is given to each criterion; the higher the weighting factor, the more important the criteria. A rank (1-5, with 5 being the highest) is given to each treatment process; the higher the rank the better that treatment process satisfies the evaluation criteria. Each criterion is then given a score for a particular alternative; the weighted rank. The higher the weighted rank, the better the treatment process meets the evaluation criteria. The weighted values for each treatment process alternative are then summed and compared with the other alternatives. The highest sum of weighted ranks equates to a better treatment process alternative for the selected criteria.

Table 9-8 shows the weighted ranks for each criteria and treatment process alternative.

Table 9-8
Monetary and Non-Monetary Criteria Treatment Process Alternative Weighted Ranks

Criteria	WF	Rank					Weighted Rank				
		Bardenpho	BNROD	MBR	MBBR	SBR	Bardenpho	BNROD	MBR	MBBR	SBR
Cost	5	4	4	2	3	5	20	20	10	15	25
Environmental Impact	4	4	4	3	3	3	16	16	12	12	12
Feasibility	3	3	5	3	4	3	9	15	9	12	9
Operation Compatibility	4	4	4	4	3	2	16	16	16	12	8
Land Required	2	4	3	5	4	4	8	6	10	8	8
Maintenance	4	5	5	2	3	3	20	20	8	12	12
Public Acceptability	5	3	3	5	3	5	15	15	25	15	25
Reliability	4	3	4	2	3	3	12	16	8	12	12
Sludge Production	1	3	5	3	3	3	3	5	3	3	3
Water Reuse Potential	4	4	4	4	4	4	16	16	16	16	16
Odor Control	5	4	3	4	4	3	20	15	20	20	15
Sum of Weighted Ranks							**155**	**160**	**137**	**137**	**145**

9.5 Non-Metro Facility Layout Recommendation

Application of the weighted rank method reveals BNROD and Bardenpho as the top two treatment alternatives. This chapter discusses the recommended expansion plan for each Non-Metro facility through the year 2030.

This chapter examines the general process, benefits and drawbacks, additional components necessary to meet treatment requirements, and a graphical representation of the process flow sheets of the five Non-Metro area treatment alternatives. These flow sheets reflect processes only. They are not intended to illustrate how the processes would be physically configured within the layouts of existing facilities or how a new facility would appear physically.

9.5.1 Northwest Region

Future flow projections for Marana WRF (includes Rillito Vista WRF flows) project wastewater flows of 4.4 mgd, well within BNROD's proven treatment range. PCRWRD currently has a completed 1.5 mgd BNROD system design and selecting a different process requires additional time and money investment. Therefore, Marana WRF's treatment process selection is BNROD.

Figure 9-7 presents the projected influent flow.

Figure 9-7
Marana WRF

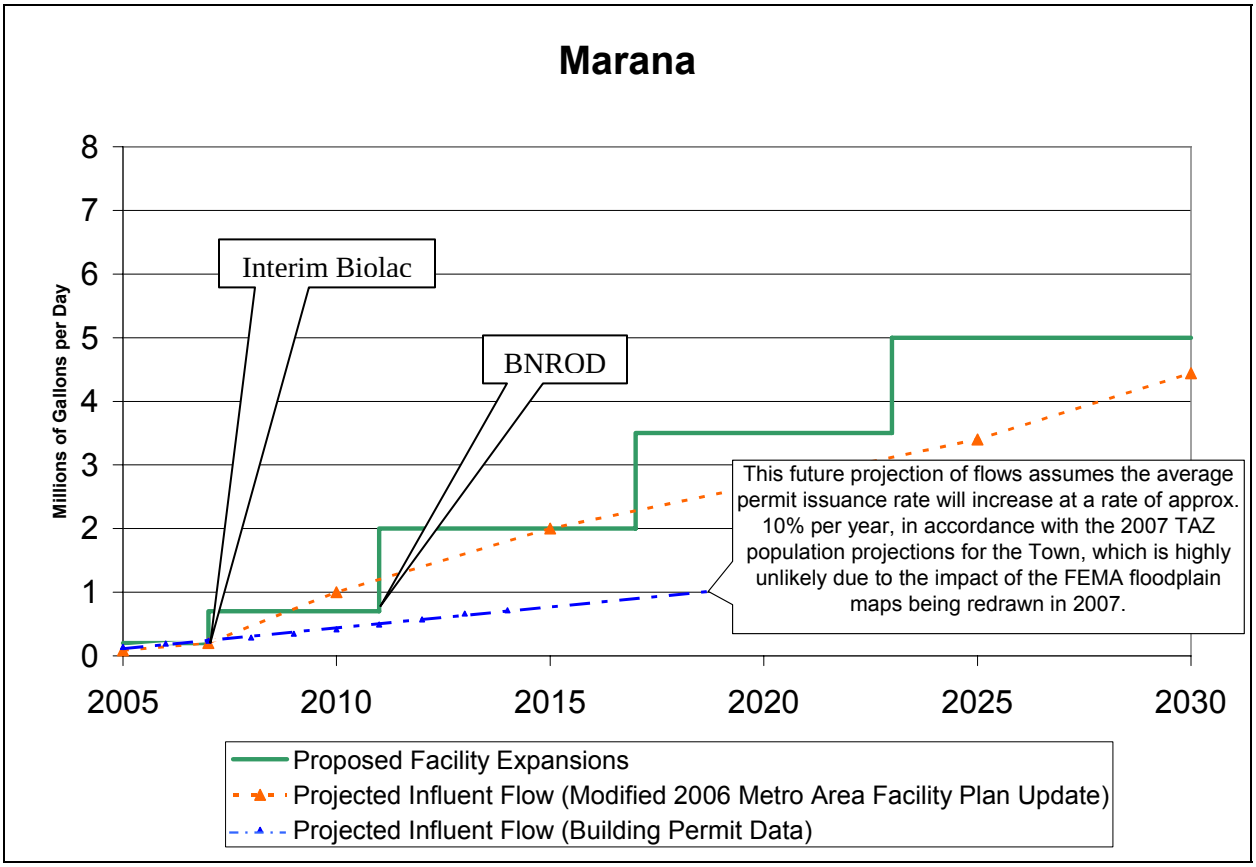
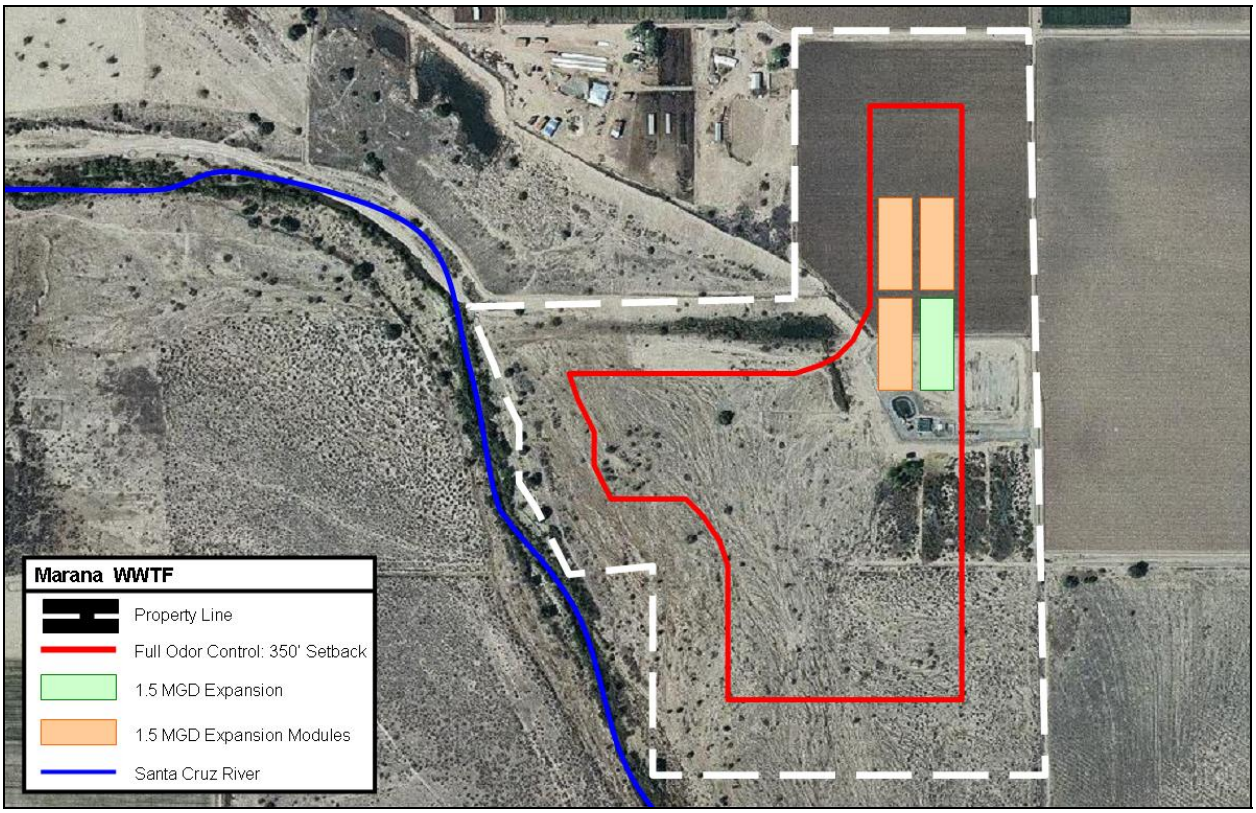


Figure 9-8 shows the possible location for siting 1.5 mgd BNROD modules within PCRWRD property and setback boundaries.

Figure 9-8
Marana WRF – 1.5-mgd Expansions without CRRPS Flow



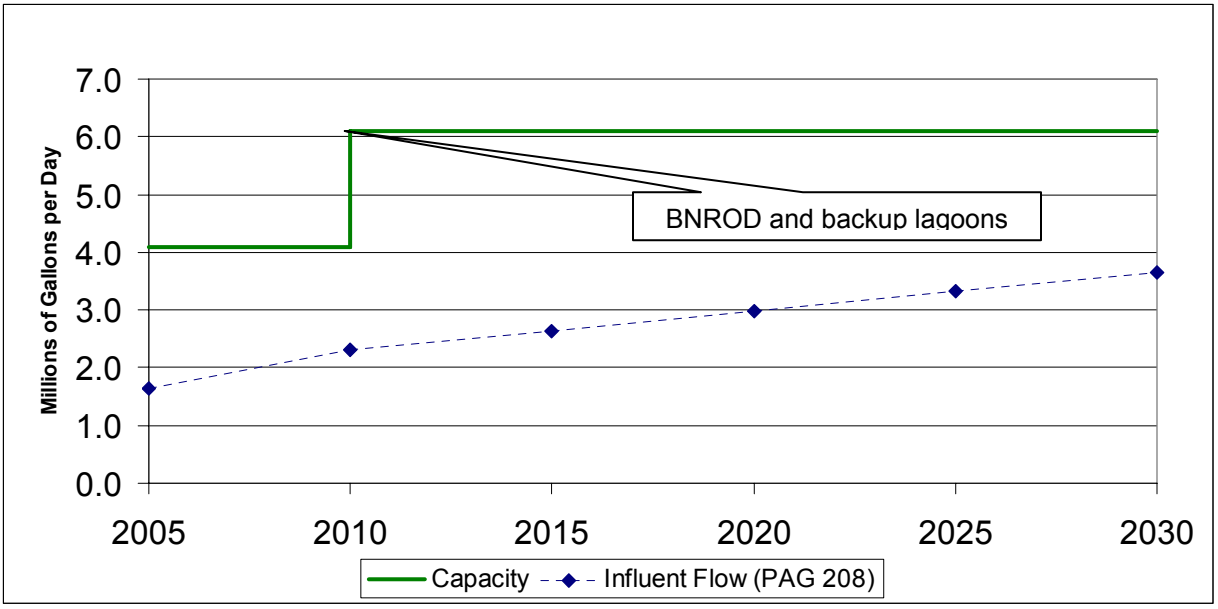
Marana WRF flow projections do not include flows originating within the Continental Ranch Regional Pump Station (CRRPS) service area. The CRRPS resides within the boundaries of the town of Marana and is located up-gradient of the Marana WRF and would best be served by the Marana WRF if economically feasible. On June 23, 2005 a Continental Ranch Regional Pump Station Strategic Plan Memorandum was issued. The memorandum determined that construction of an additional 24" force main is not required to handle flows through the 20-year planning period. The CRRPS Strategic Plan stated the long range plan (2005-2015) is to convey flow from the pump station to the Marana WRF via gravity within the 2012-2015 timeframe. This would give the County adequate time to complete the project before flows approach the pumping station's capacity and to relieve the emergency back-up pumping system. The CRRPS Strategic Plan projects a peak wet weather flow of 6.7 mgd by 2025. Ultimately, if the CRRPS flow is conveyed to the Marana WRF, the facility will need to be expanded to accept CRRPS flow.

An economic evaluation should be conducted before the pipeline capacity is modified determining the feasibility of phasing out the pump station and conveying the flow to the Marana WRF or constructing a parallel pump station/pipeline to continue to pump flow up-gradient to Ina Road WRF. Additionally, an economic evaluation determining the feasibility for Marana WRF's processing of the CRRPS's flow as opposed to pumping this flow to Ina Road WRF should be performed before expansion at Marana WRF occurs. It should be noted that allowing wastewater to flow by gravity from Continental Ranch to the Marana WRF will require expansion of the facility's capacity to accommodate the additional hydraulic loading.

9.5.2 South Region

Future flow projections for Green Valley WRF predict wastewater influent flows slightly above 3.5 mgd and are well within BNROD's proven treatment capability. Current combined BNROD/aerated lagoon capacity can provide sufficient treatment for flows through the year 2030. PCRWRD's environmental stewardship and foresight of residential encroachment includes in its CIP elements the construction of an additional 2.0-mgd BNROD facility in 2010 increasing its total capacity to 4.0 mgd. Introducing a different process to the Green Valley facility introduces complexity and therefore BNROD is the recommended treatment process for this Non-Metro facility. Green Valley WRF's projected flow and expansion are shown on **Figure 9-9**.

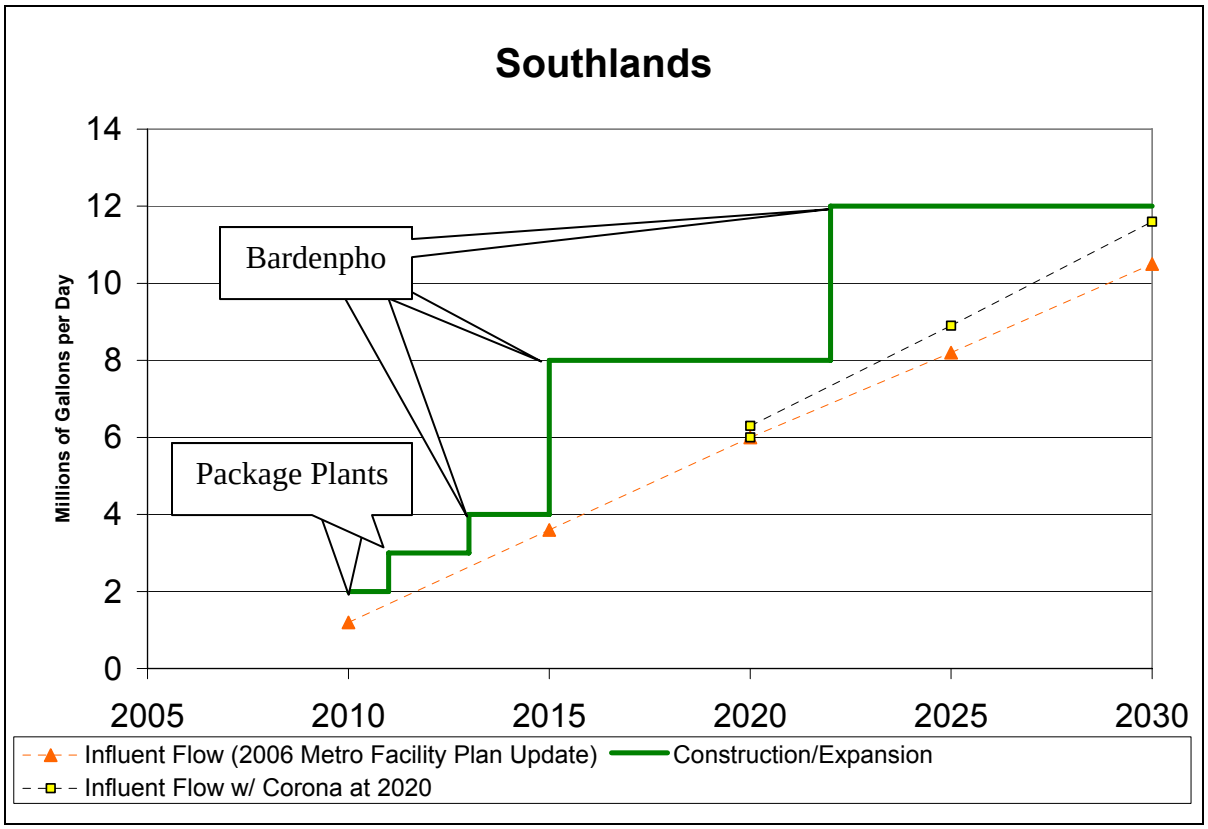
Figure 9-9
Green Valley WRF



9.5.3 Southeast Region

Future flow projections for the Southlands facility (excluding Corona de Tucson WRF flows) forecast flows greater than 10 mgd by 2030. Inclusion of Corona de Tucson WRF's flow, Southlands projected flows are above 13 mgd by 2030. At these capacities, the Bardenpho treatment process is recommended over a BNROD process. The Southlands flow projection (including Corona de Tucson WRF by 2020) and proposed construction/expansion are shown on **Figure 9-10**.

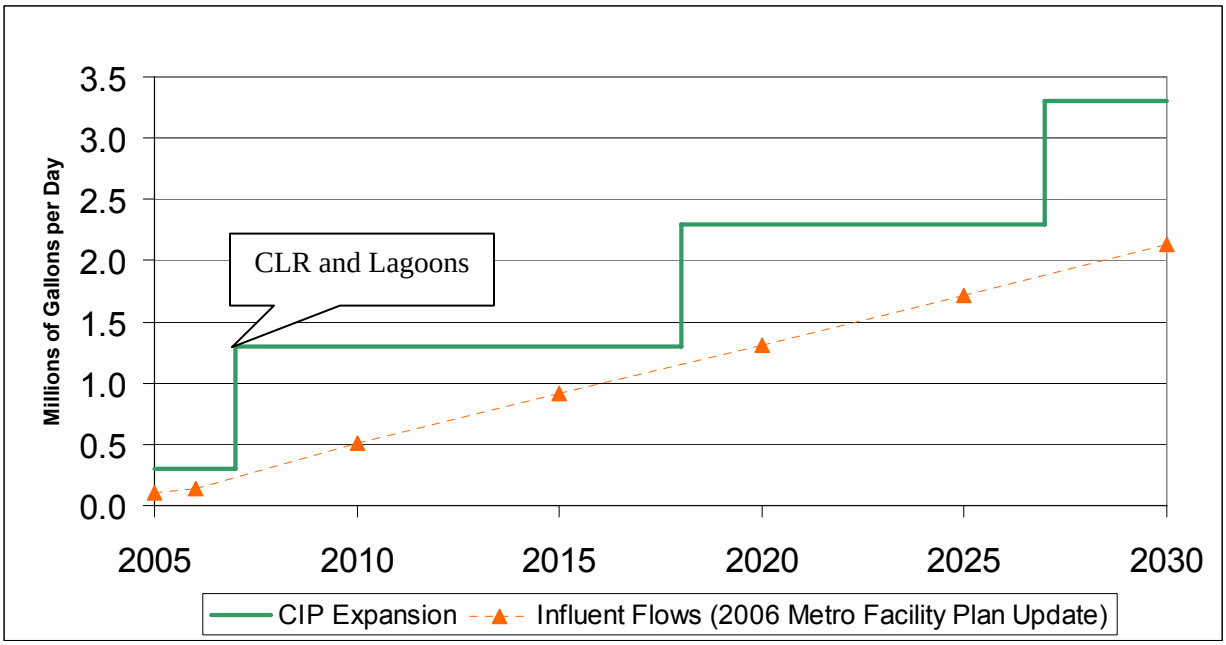
Figure 9-10
Southlands



While flow projections suddenly show influent flows of 1.2 mgd in 2010, no Southlands facility or expansion plan exists. Facility siting, design, and construction of this facility must start now to provide treatment service for the rapid population growth projected for this area. In an effort to provide treatment as rapidly as possible, package treatment plants provided by developers should be permitted and located to treat the flow until design, construction, and startup of a 4.0 mgd Bardenpho can be completed. Concurrent to package plant selection, siting, permitting, and startup, design of the Bardenpho module should begin. Construction of additional 4.0 mgd Bardenpho expansion modules will need to be completed by 2015 and 2022 providing the Southlands area with a total capacity of 12.0 mgd by the year 2030.

Investment in Corona de Tucson WRF's 1.0 mgd closed loop reactor and 0.3 mgd aerated lagoon system will provide sufficient capacity through the year 2020. The facility should continue with its 1.3 mgd total permitted capacity until a Southlands facility and conveyance structure transporting flows beyond Corona's 1.0 mgd closed loop reactor capacity can be sited, designed, and constructed. Flow beyond Corona de Tucson WRF's capacity can then be conveyed to Southlands for treatment and Corona de Tucson WRF could continue as a wastewater treatment facility or be upgraded to provide reclaimed water service. Converting Corona de Tucson's wastewater treatment facility to a facility that provides reclaimed water would require a feasibility study be completed. The Corona de Tucson WRF projected flow and expansion without diverting flow to Southlands WRF is shown on **Figure 9-11**.

Figure 9-11
Corona de Tucson WRF



Expansion at the Corona de Tucson facility should only occur if the Southlands Non-Metro facility and conveyance structure are not constructed to accept flow beyond Corona de Tucson WRF's 1.3 mgd capacity. Flows beyond Corona de Tucson's 1.3 mgd capacity should be conveyed to the Southlands facility for treatment.

9.5.4 Southwest Region

PCRWRD's Avra Valley WRF Expansion Plan recommends having a dual oxidation ditch online and permitted to treat 4.0 mgd by January 2008. **Figure 9-12** and **Figure 9-13** show the projected flow and expansion for Avra Valley WRF, respectively.

Figure 9-12
Avra Valley WRF

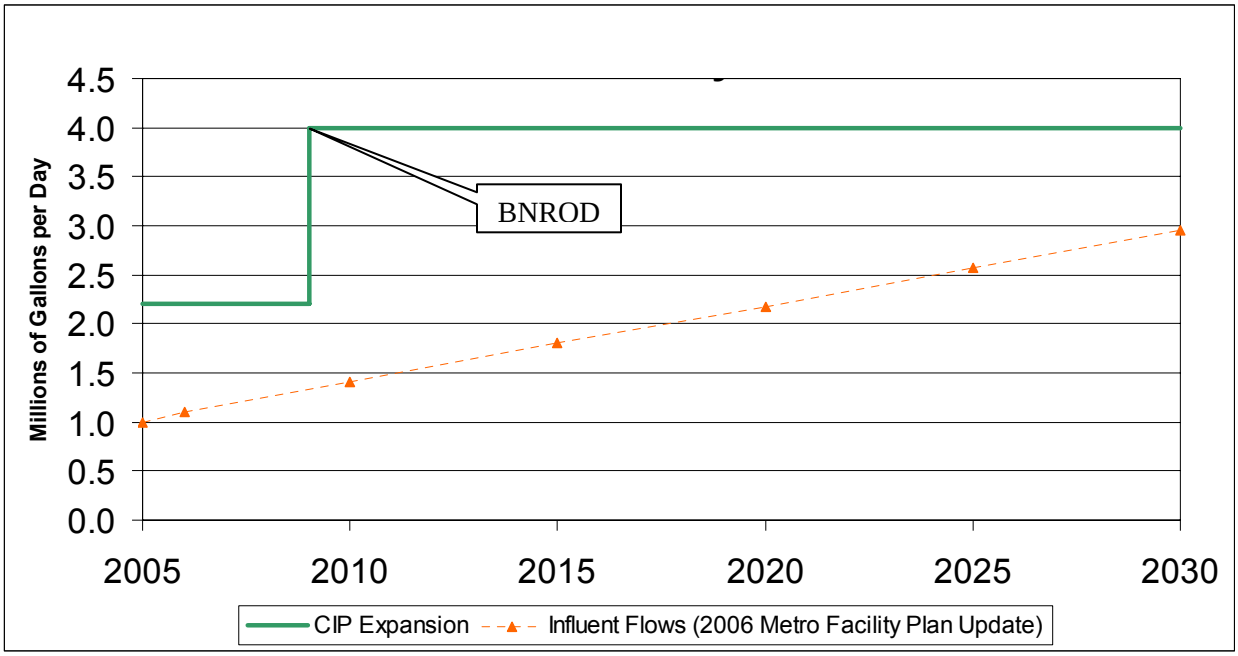
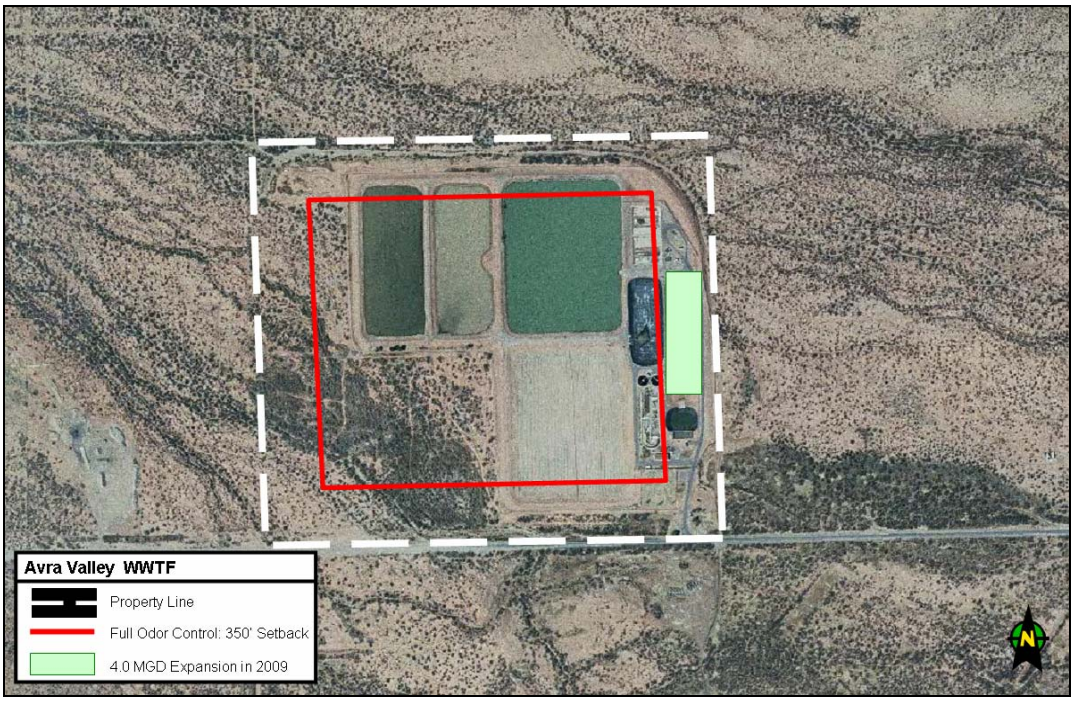


Figure 9-13
Avra Valley WRF



9.5.5 Mount Lemmon Region

The Mount Lemmon WRF is currently in the process of negotiating service area expansion with the USFS. Future flow projection should refer to the agreement contracted between PCRWRD and the USFS. Future recommendation for this facility includes the development of a contingency plan for emergencies due to weather, facility malfunction, or routine maintenance.

9.6 Summary

Establishing regional treatment facilities does carry some pragmatic challenges. Obviously, large tracts of undeveloped land exist throughout the Non-Metro area and are significant distances from the any PCRWRD facility. Development in some separated areas would require long conveyance structures to transport sewage from the new developments to regional treatment plants. These lines would have significant excess capacity for years to come until build-out is achieved. Additionally, demand for water in these Non-Metro areas is likely to require the availability of treated effluent to supplement other water sources. (A satellite facility could ultimately be converted to a water reclamation plant to help relieve local water demands.) Such conditions generally pose significant economic disincentives for establishing centralized wastewater treatment on a regional level, and solutions, such as satellite plants constructed within the newly developed area typically result.

However, satellite facilities may not be an appropriate solution for the long term. Owning multiple facilities would require Pima County to budget annually for operations and maintenance for several different facilities. Critical to successful operation of several satellite facilities is finding and retaining skilled operators and maintenance personnel. Secondly, multiple facilities require multiple operating permits, none of which will remain static in respect to their regulatory compliance standards. Thirdly, as populations increase in these areas, there will be needs for upgrading and expanding these satellite facilities. Finally, as development progresses, on-going public acceptance of the treatment facilities in their neighboring areas cannot be guaranteed.

Aligning regional treatment facilities provides Pima County with an opportunity to establish a model for how it will support development for years to come. This model incorporates the interests of stakeholders ranging from developers to environmental groups to local residents. It promotes Pima County as a proactive leader in managing rapid growth pressures to improve quality of life for generations.

Balancing the economics necessary to shape the Non-Metro facilities into regional facilities will require some type of mechanism for generating a consistent revenue stream to fund the conveyance and treatment infrastructure. Since many facilities are already under design and/or expansion, these revenues would initially focus on the installation of regional interceptor sewers that tie the developing areas to the Non-Metro facilities. Options include development reimbursement agreements, impact fees on new residential and commercial construction, revenue bond sales, general obligation bonds, economic development income tax revenues, or tax incremental financing districts.