STRATEGIES FOR MANAGEMENT OF HIGH-DENSITY SEPTIC SYSTEM DEVELOPMENTS IN WASHOE COUNTY

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and

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EXECUTIVE SUMMARY

The Western Regional Water Commission (WRWC) initiated the *Strategies for Management of High-Density Septic System Developments in Washoe County* project to evaluate alternative methods to address the degradation of groundwater quality caused by septic system effluent discharge. This document contains a summary of the findings of this project. The various Project Reports listed at the end of this document are available from the Document Library at the WRWC website (www.WRWC.us).

Project Task Reports

The following tasks were indentified in the Lombardo Associates, Inc. (LAI) Scope of Work and prepared as part of this study on *Strategies for Management of High-Density Septic System Developments in Washoe County*:

- *Task 1 - Review of Existing and Projected Conditions*
- *Task 2 - Technical & Economic Evaluation of Nitrogen Removal Alternatives*
- *Task 3 - Financing Alternatives*
- *Task 4 - Institutional and Management Alternatives*
- *Task 5 - Case Studies*

The Task 1 report provides analysis and assessment of the existing and projected conditions. Task 2 presents a technical and economic evaluation of nitrate removal alternatives. Information gathered in Task 5 (Case Studies) shaped much of the approach and alternatives in the Task 2 report. Similarly, information gathered and the analysis documented in the Task 4 report (Institutional and Management Alternatives) was used in the final analysis described in the Task 2 report. The case studies (Task 5) shaped the assessment and feasibility of the alternatives analyzed.

Task 1 Report - Review of Existing and Projected Conditions

There are an estimated 16,840 Individual Sewage Disposal Systems (ISDS) in Washoe County, of which approximately 14,200 are in the Truckee Meadows Service Area (TMSA). The TMSA (as illustrated in Figure 1) is the area defined by Truckee Meadows Regional Planning as the geographic area within which municipal services are planned to serve Reno, Sparks and Washoe County. Systems within this area discharge treated effluent, which contains elevated levels of nitrate, into the soil where it is free to percolate into the groundwater. The United Stated Environmental Protection Agency (U.S. EPA) established a Maximum Contaminant Level (MCL) of nitrate nitrogen in drinking water of 10 milligrams per liter (mg/L). Drinking water with concentrations higher than the MCL may cause adverse health effects.

The *Phase I Prioritization of Study Areas & Assessment of Data Needs Report* ("Phase I Report", Kropf, 2007) identified 16 separate areas of concern based on nitrate levels in groundwater and the relative density of residential septic systems. The report also included a prioritized list of "Project Areas" that exhibit a high likelihood of septic systems degrading water quality (with respect to nitrate contamination). These 16 study areas and the data listed in the Phase I Report were used in this analysis and shown graphically in Figure 1.

Review of the Phase I Report and the map shown in Figure 1 showing the locations of the Project Areas suggests that a "one-size-fits-all" approach for managing ISDS nitrate degradation of groundwater quality may not be the most effective approach. As such, the WRWC commissioned Lombardo Associates, Inc. (LAI) and AMEC for this study to provide a summary and evaluation of potential:

- Nitrate removal technologies;
- Financing alternatives,
- Nitrate management strategies; and
- Summary of case studies describing how other communities have addressed similar nitrate issues.

The primary goal of this project was to identify nitrate reduction technologies that could be used to mitigate nitrate contamination of groundwaters due to high density ISDS. To accomplish this goal, several treatment technologies were identified and evaluated. Order of magnitude cost estimates were developed for each treatment option that was considered technically and economically feasible.

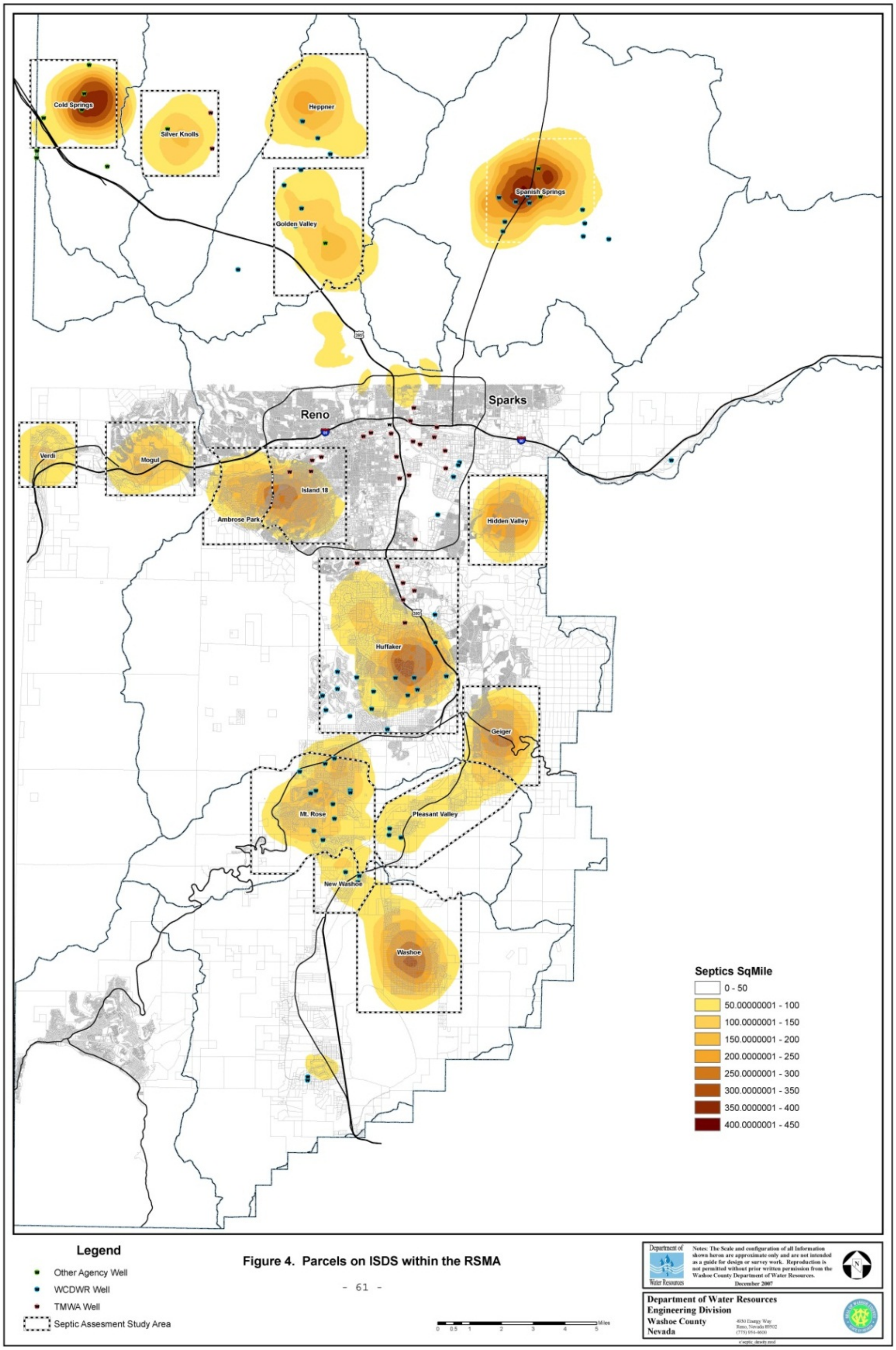

Figure 1 Septic System Densities and Study Areas

The intent of this project was not to recommend specific solutions, but to offer decision makers technical and financial information to facilitate future decision making. The challenges associated with implementing a particular technology or corrective measures for the areas discussed in this study are as much financial as they are technical. Any solution that is ultimately proposed will require the buy-in of decision makers and the public they represent. In this report, the causes and extent of the nitrate problem, the range of potential solutions and the order of magnitude costs are presented for future reference, comparative analysis and decision making purposes only.

Task 2 - Technical & Economic Evaluation of Nitrogen Removal Alternatives

Combined in this report is the analysis, findings and conclusions of the study. Results from Tasks 3, 4 and 5 contributed to the summary and analysis. A summary of the Task 2 report is provided below.

Treatment Alternatives Evaluated

The alternatives evaluated fall into the following categories:

- Individual, single family nitrogen removal systems
- Neighborhood / small community (cluster) wastewater collection, treatment and disposal / reuse systems
- Connection to existing, centralized treatment facility
- Connection to new, centralized treatment facility

Collection system options considered:

- Conventional gravity
- Septic tank effluent – gravity & pressure
- Grinder pump – low pressure
- Vacuum system

Wastewater treatment technologies considered:

- Fixed film systems
- Suspended growth – activated sludge (AS) systems
- Integrated fixed film and suspended growth systems (IFAS)
- Active or passive carbon feed (denitrification)

Nitrate Removal Required for Groundwater Protection

To compare alternatives to reduce nitrate loading from ISDS in the study areas, the level of necessary treatment (i.e., degree of nitrogen removal) was estimated using a simple, conservative mass balance approach. The estimated level of nitrate removal required was used to evaluate treatment process viability or the number of ISDS requiring removal (sewered with out-of-basin transfer). Table 1 summarizes the number and percent of existing properties (parcels with ISDS) that would need to achieve 100% nitrate removal to meet the water quality goals. These values were calculated assuming ISDS removes 25% of effluent nitrate and that sewering removes 100%. The values shown in Table 1 assume that the target recharge nitrate concentration is 5-mg/L, a level considered protective of groundwater resources.

Table 1 Number of Properties Requiring 100% Nitrate Removal to Maintain Groundwater Quality (5 mg/L Nitrate-Nitrogen)

Basin Name (number)	Project Area	2007 Report Priority Ranking	Number of ISDS		Properties Requiring 100% Removal[1]	
			Basin	Proj. Area	(%)	(#)
Truckee Meadows (87)	Ambrose	**7**	5,870	475	78%	372
	Island 18	**12**		907	82%	745
	Hidden Valley	**8**		780	81%	633
	Huffaker	**9**		1,764	77%	1,358
	Geiger	**11**		858	82%	705
Lemmon Valley (92A & 92B)	Silver Knolls	**14**	2,670	529	78%	413
	Heppner	**4**		954	80%	766
	Golden Valley	**6**		845	78%	658
Pleasant Valley (88)	Mt. Rose	**5**	1,665	1,026	78%	803
	Pleasant Valley	**15**		535	75%	399
Washoe Valley (89)	Washoe	**3**	1,852	1,296	80%	1,042
	New Washoe	**16**		197	75%	148
Truckee Canyon (91)	Mogul	**13**	1,020	544	79%	428
	Verdi	**10**		341	79%	271
Cold Springs (100)	Cold Springs	**2**	1,397	1,325	84%	1,112
Spanish Springs (85)	Spanish Springs	**1**	2,346	1,848	84%	1,546
	Total		**16,820**	**14,224**	**Avg=80%**	**11,397**

[1] 100% Nitrogen removal achieved via sewering and out-of-basin treatment / discharge or by using a higher percentage/number of nitrogen removal systems within the basin

Examination of Wastewater Treatment Plant Capacity

If ISDS are connected to a municipal sewer system and sent to the regional wastewater treatment facility (WWTF), excess capacity must either exist or be added to accommodate the flow increase. Assuming 230 gallons per day (gpd) per ISDS, the required capacity was estimated using the number of ISDS in the Project Areas within the projected service areas of each of the WWTFs (Table 2). As can be seen from the data presented in Table 2, additional capacity is required at the Lemmon Valley WWTP and likely at the Cold Springs WWTF to accommodate peak flows. The total wastewater flow from ISDS in the Project Areas is estimated to be around 3.27 million gallons per day (MGD).

Table 2 Study Area WWTFs with 2009 Average and Permitted Flow Rates

Facility Name	2009 Avg. Flow (MGD)	Permitted Flow (MGD)	Maximum Excess Capacity (MGD)	Estimated Req. Capacity for Local ISDS (MGD)
Truckee Meadows WRF	26.5	44	17.5	1.29
South Truckee Meadows WRF	2.65	4.1	1.45	1.14
Reno-Stead WRF	1.4	2.35	0.95	0.12
Lemmon Valley WWTP	0.2	0.3	0.1	0.41
Cold Springs WWTF	0.28	0.7	0.42	0.31
Total	**31.03**	**51.45**	**20.42**	**3.27**

Source WRWC, 2011

Estimated Nitrate Removal Costs

The following order of magnitude costs were estimated for each treatment option that is considered technically and economically feasible:

- Total capital costs (including design, construction, land acquisition, etc., as appropriate);
- Annual operating, maintenance, repair and replacement costs;
- Life cycle costs;
- Anticipated levels of nitrogen reduction; and
- Cost / pound of nitrate reduction/year.

Table 3 presents a summary of the estimated costs on a per Equivalent Dwelling Unit (EDU) basis for each nitrate removal technology evaluated. The highest cost alternative was connection to the existing sewer system with full street width repaving. The least expensive alternative identified was the collection of ISDS effluent (ISDSE) and connection to the existing sewer system with partial paving.

Summarized in Table 4 is the number of systems requiring 100% nitrate removal with out-of-basin discharge and 93% removal with in-basin discharge. Listed are the estimated costs associated with conventional sewer extensions (trench width paving, out-of-basin discharge) and ISDSE cluster systems (trench width paving and in-basin discharge). The cost estimates combined with the number of each type of system defines the relative scale of the anticipated capital improvement program required to achieve drinking water quality protection. Potential financing options and techniques are described in the Task 3 report.

Table 3 Summary of Alternative Nitrate Removal Costs per EDU

WW Mgmt. Option			% Nitrate Reduction	Capital Cost	Annual O&M Cost	Life Cycle Cost per EDU	Savings Compared to Conv. Sewering w/full Width Paving
1	Onsite[1]		93%	$22,000	$540	$31,283	20.8%
2	Cluster[2]	ISDSE Collection[3]	93%	$23,900	$574	$36,881	14.5%
		Conventional – Gravity Collection	93%	$26,700	$574	$39,681	5.3%
		Conventional – Pressure Collection	93%	$26,700	$574	$39,681	5.3%
3	Connection to Existing Centralized System[4]	ISDSE Collection	100%	$17,400	$645	$32,000	38.5%
		Conventional – Trench Width Paving	100%	$21,400	$600	$35,000	24.4%
		Conventional – Full Width Paving	100%	$28,300	$600	$41,900	0.0%

[1] Onsite system costs assume economies of scale are achieved
[2] Carbon Feed and Pretreatment system achieving 93% of nitrogen removal used for this analysis
[3] No drain field attenuation is assumed to occur with wastewater treated to advanced tertiary standards
[4] Sewer system costs are based upon only one engineer's estimate of sewer extensions costs in Spanish Springs. Lower density developments will have higher costs. Areas are assumed to be adjacent to existing sewered areas; therefore, no transmission cost was provided. If transmission piping is needed, costs for this option will increase.

Table 4 Capital Improvement Program for Required Nitrate Removal in Project Areas

Priority Level	Number of Properties Req. 100% Removal	Number of Properties Req. 93% Removal w/In-Basin Discharge	Total Capital Cost – 100% Removal w/Out-of-Basin Discharge[1]	Total Capital Cost 93% Removal w/In-Basin Discharge[2]
Scenario 1 (Phase 1 Areas Only)	1,546	1,656	$45,100,000	$52,500,000
Scenario 2 (Phase 1 & 2 Areas)	5,926	6,349	$150,900,000	$179,400,000
Scenario 3 (Phase 1, 2 & 3 Areas)	10,836	11,610	$269,500,000	$321,500,000

[1] Please note for 100% nitrogen removal with out-of-basin discharge, costs are based on conventional sewer system with trench-width paving and out-of-basin discharge based upon only one engineer's estimate of sewer extension costs in Spanish Springs. Lower density developments will have higher costs. Areas are assumed to be adjacent to existing sewered areas; therefore, no transmission cost is provided. If transmission piping is needed, costs for this option will increase.

[2] Costs based on septic tank effluent collection cluster systems achieving 93% nitrogen removal discharging within the basin.

Task 3 – Financing Alternatives

The objective of this task was to evaluate financing options associated with the alternatives for management of groundwater quality impacted by high density ISDS development in the TMSA.

Alternatives identified and discussed in this report included:

- Practical grant and loan funding sources
- Affordability analysis
- Fee collection mechanisms
- The financial sustainability of a Responsible Management Entity (RME) that would manage On-site Wastewater Treatment and Disposal/Reuse Systems (OSTDS)

The results of this analysis were largely used in the analysis presented in the Task 2 report (and included in Table 4 above).

Summarized in Tables 5 and 6 are the results of the U.S. EPA Financial Capability-Affordability Analysis for the proposed septic nitrogen removal systems and proposed user charges for the In-Basin Discharge Option Capital Improvement Program (CIP) cost estimates. The affordability analysis indicates that financial affordability increases from a low to high burden as more phases are implemented. The analysis assumes, as a first approach, that all properties on septic systems or connected to a sewer system pay the same annual cost, whether or not they have a new wastewater system. There are numerous user charge approaches that are possible and will need to be publicly discussed to determine the appropriate user charge system for Washoe County.

Table 5 Financial Capability Score (As of Summer 2012)

Financial Capability Indicators	Rating	Score*
Bond Rating (S&P)	AA	3
Overall net debt (as % of full market value of taxable property)	2.33%	2
Unemployment as compared to National Average	11.4%	1
Mean Household Income as % of National Average	107%	2
Property Tax Revenues as % of Full Market Property Value	3.31%	2
Property Tax Revenue Collection Rate	99%	3
* 1 = Weak; 2 = Mid Range; 3 = Strong	**Average =**	**2.17**

Table 6 Projected Sustainable User Charge Estimates Based Upon In-Basin CIP

Estimated Cost and Relative Affordability	All Properties with Same O&M & CIP Charge[1]		
	Phase 1 – Priority Area 1 Only	Phase 2 – Priority Areas 1 & 2 Only	Phase 3 – Priority Areas 1, 2 & 3
Capital Improvement Program (CIP	$52,500,000	$179,400,000	$321,500,000
Number of Parcels with Nitrate Removal Systems in Basin Discharge	1,656	6,349	11,610
Percent of the Total	12%	45%	82%
Annual O&M	$206	$383	$509
OSTDS[2] & ISDS Replacement Fund	$58	$108	$164
CIP Debt Service[1]	$180	$617	$1,105
Total Annual Cost	$444	$1,107	$1,778
Total Monthly Cost	$37	$92	$148
% of MHI – Washoe County	0.76%	1.90%	3.06%
User Charge Burden	Low	Medium	High

[1] Financing Rate of 4.00% and a Term of 30 years assumed
[2] OSTDS On-Site Treatment and Disposal System
[3] percent of median household income

Task 4 – Institutional and Management Alternatives

All remaining ISDS within the different study area basins in addition to any new on-site and cluster / neighborhood systems will need to be actively managed. For any future upgrades that involve connection to an existing WWTF, the owner of the WWTF and associated collection system would be the Responsible Management Entity (RME).

For on-site and cluster/neighborhood systems with advanced nitrogen removal, a RME should be established for their funding, implementation, operation and maintenance, and long-term sustainability. Potential RME candidates include:

- Existing agency such as the Central Truckee Meadows Remediation District (CTMRD) established via Section 318 of Nevada State Law
- Adopt Special Legislation to create a new agency to manage nitrogen pollution of the TMSA groundwater

Task 5 – Case Studies

The objective of this task was to review selected histories and examine common attributes and lessons learned from communities addressing similar septic system nitrate issues. Case studies were prepared for the following areas:

- Fairfax County, Virginia
- Suffolk County Long Island, New York
- La Pine, Oregon, Deschutes County
- Peña Blanca, New Mexico
- Phelps County, Missouri

After a review of each case history, the following common attributes were noted:

- Leadership and vision are needed for positive outcomes
- Strong resistance to financial costs was a common element
- Conventional solutions are usually proposed and often not affordable
- Conventional, high price solutions are defeated when votes for bond authorizations are required

Affordability and related financing issues were the dominant theme in the histories reviewed. Key lessons learned were:

- Proactive engagement of the broad stakeholder groups is critical
- Validate the science that is the basis for the corrective actions
- Identify low cost solutions and perform ongoing testing / evaluations
- Provide solutions for all stakeholders so that commonality of purpose is achieved
- Use Adaptive Management whereby the understanding of science and viability of lower cost options is continually re-evaluated and improved
- Look for opportune events to require upgrades

It is LAI's opinion that by implementing programs that incorporate the above lessons learned, community support will be engendered and the probability of success will be maximized.

TASK 1 REPORT

REVIEW OF EXISTING & PROJECTED CONDITIONS

STRATEGIES FOR MANAGEMENT OF HIGH-DENSITY SEPTIC SYSTEM DEVELOPMENTS IN WASHOE COUNTY

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ACRONYM LIST

ATU	Aerobic Treatment Unit
DF	Drainfield
EDU	Equivalent Dwelling Unit
EPA	United States Environmental Protection Agency
F/M	Food to Microorganism Ratio
GW	Groundwater
IFAS	Integrated Fixed Film and Activated Sludge System
ISDS	Individual Sewage Disposal System
LAI	Lombardo Associates, Inc.
MBR	Membrane Bioreactor
MCL	Maximum Contaminant Level
MGD	Million Gallons per Day
MLSS	Mixed Liquor Suspended Solids
NNWPC	Northern Nevada Water Planning Commission
O&M	Operations and Maintenance
OSTDS	Onsite Treatment and Dispersal System
PBTS	Performance Based Treatment System
PRB	Permeable Reactive Barrier
RAS	Return Activated Sludge
RBC	Rotating Biological Contactor
RMF	Recirculating Media Filter
RWPC	Regional Water Planning Commission
SBR	Sequencing Batch Reactor
STE	Septic Tank Effluent
STEG	Septic Tank Effluent Gravity
STEP	Septic Tank Effluent Pressure
TN	Total Nitrogen
WAS	Waste Activated Sludge
WCDWR	Washoe County Department of Water Resources
WRWC	Western Regional Water Commission

1.0 INTRODUCTION

Recent studies show that the nitrate concentrations in groundwaters throughout the country have steadily increased over the past 25 years (Lindsey and Rupert, 2012). Many studies present evidence that on-site wastewater treatment and disposal systems (i.e., septic tanks and their associated leach fields) are the dominant anthropogenic nitrogen source (Morgan et al., 2007). Several localized groundwaters within the Truckee Meadows follow this same nationwide trend. (Note: the term "nitrate" used in this report refers to the NO_3^- ion expressed as nitrogen [mg-N/L]. The terminology used throughout this document is simply nitrate in mg/L).

In 2007, staff from the Washoe County Department of Water Resources (WCDWR) conducted a Septic Nitrate Baseline Data and Risk Assessment Study, Phase I: Prioritization of Study Areas and Assessment of Data Needs (Kropf, 2007). The Phase 1 Report found that factors such as population and septic system density, shallow groundwater, fast percolating soils, and limited groundwater recharge (i.e., low rainfall rates) collectively exacerbate localized high nitrate concentrations. In several areas, groundwater nitrate concentrations have been confirmed to be either approaching or exceeding the drinking water Maximum Contaminant Level (MCL) of 10 mg/L (Kropf, 2007).

Summarized in this report is the identification and analysis of potential alternatives for the management and mitigation of shallow groundwater nitrate contamination in the area caused by septic discharges. Included in this report is a discussion of the resources used in this analysis, an overview of nitrate removal or mitigation alternatives, assumptions of the removal necessary to meet water quality goals, a financial analysis of the alternatives (Appendix C) and a summary of findings. References are included in Appendix A and sample dilution calculations are in Appendix B.

1.1 Background

Following one of the recommendations made in the Phase I Report, the Western Regional Water Commission (WRWC) engaged Lombardo Associates, Inc. (LAI) and AMEC to perform an analysis to identify alternatives for the management of groundwater quality impacted by high density septic systems within the greater Truckee Meadows Service Area (TMSA).

1.2 Study Goals and Objectives

The primary goal of this project was to identify nitrate reduction technologies for mitigating nitrate contamination of shallow groundwater systems due to individual sewage disposal systems (ISDS) within the TMSA. To accomplish this goal, numerous treatment technologies were identified and evaluated. For each treatment option that was considered technically and economically feasible, the cost of implementation was estimated.

The intent of this project was not to provide or recommend solutions, but to provide decision makers with technical and financial information to facilitate future decision making. There are numerous wastewater treatment technologies and collection system improvements that are capable of reducing nitrate loads to the shallow groundwaters. The challenges associated with implementing these technologies and corrective measures for many of the areas discussed in this study are as much financial as they are technical. Any solution that is ultimately proposed will require the buy-in of the decision makers and the public. In this report, the causes and extent of the nitrate problem, the range of potential solutions and the anticipated costs are presented for future reference, comparative analysis and decision making.

2.0 SUMMARY OF EXISTING REPORTS AND PROBLEM DEFINITION

The 2007 Phase I Report (Kropf, 2007) and the 2011-2030 Comprehensive Regional Water Management Plan (WRWC, 2011) were the two primary references used in this analysis. Critical data, conclusions and assumptions from these documents used in this analysis are summarized in this section.

2.1 2007 Phase I Prioritization of Study Areas & Assessment of Data Needs

The goals of the Washoe County Phase I study were to investigate the potential for septic nitrate contamination in the metropolitan and suburban areas of the TMSA and to provide recommendations for prioritizing additional study of areas potentially contaminated by septic system nitrate. The project examined the location and density of ISDS, their proximity to sensitive receptors (water supply wells, creeks, rivers, and lakes), and the concentration of nitrate in groundwater. Relative septic tank densities are shown in Figure 1-1. Approximately 14,244 septic systems were identified in and immediately adjacent to the TMSA boundaries. Collectively, these septic systems were estimated by Kropf (2007) to:

- Discharge approximately 3.20 million gallons per day (MGD) of septic tank effluent to the groundwater
- Discharge approximately 1,200 lb/day of nitrate to the groundwater (with the primary assumption that septic tank effluent nitrate concentration is 60 mg/L and that a 25% reduction occurs in the drainfield, soil and subsurface environment before reaching the groundwater)

The Phase I report identified 16 separate areas within the TMSA based on water quality data and relative density of residential septic systems. Water quality degradation was ranked on numerous factors, with septic tank and population density factors and their proximity to sensitive receptors being the most important. During this analysis, data gaps (lack of groundwater nitrate data) became more apparent and were noted as important for future investigations. Finally, a prioritized list of Project Areas that exhibit a high likelihood (relative to other Project Areas) of septic systems degrading water quality (with respect to nitrate contamination) was developed, along with recommendations for further study and analysis.

Of the 16 Project Areas identified in the Phase I report, where potential conditions for septic tank nitrate contamination of groundwater was likely to exist, a total of five (5) were found to have sufficient supporting water quality data to indicate that management action was necessary to mitigate existing and potential nitrate contamination of groundwater. Other areas were identified as having the potential for nitrate contamination, but insufficient data exist to confirm that the shallow groundwater was impacted. Areas with the highest septic system densities and sufficient groundwater quality data (i.e., nitrate) to confirm an impact were ranked as "high priority" areas (i.e., Spanish Springs and Cold Springs). Nine (9) additional areas were found to have suspected impacts; however, the water quality was insufficient to recommend or rank the area as requiring immediate management action. Presented in Table 1-1 is the Phase I prioritization of Project Areas (Kropf, 2007). This prioritization and associated Study Areas are used and noted in this analysis without change and redefinition.

Figure 1-1 Septic System Densities and Study Areas within the TMSA

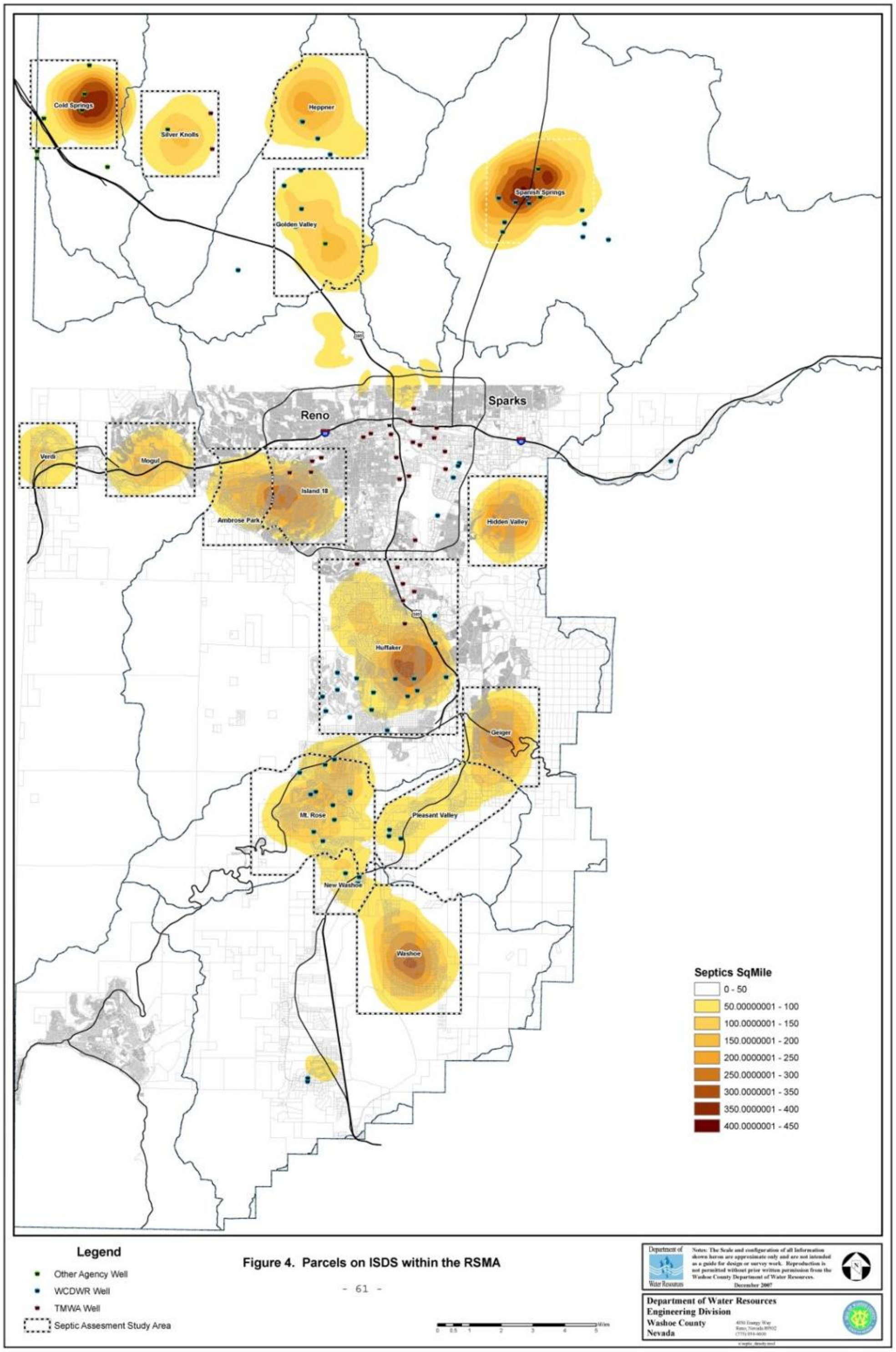


Table 1-1 Ranking of Priority Areas (as Impacted by Septic Tank Effluent and/or Known or Potential Groundwater Nitrate Impacts, WCDWR, 2007)

Project Area	Final Rank
Spanish Springs[1]	1
Cold Springs[1]	2
Washoe[1]	3
Heppner[1]	4
Mt. Rose[2]	5
Golden Valley[1]	6
Ambrose[2]	7
Hidden Valley[2]	8
Huffaker[2]	9
Verdi[2]	10
Geiger[2]	11
Island 18[2]	12
Mogul[2]	13
Silver Knolls[3]	14
Pleasant Valley[2]	15
New Washoe[3]	16

Notes:

[1] Sufficient data exist to show this study area is presently impacted with respect to known elevated nitrate-nitrogen concentrations (in well water samples), known high density septic tanks and soil conditions.

2 All implications are that this study area is vulnerable to nitrate contamination (i.e., high septic tank density, soil conditions and dept to groundwater are significant factors) but the existing water quality data record is insufficient to list this area as impaired or impacted.

3 This area is known to be an area with a high density of septic tanks, but the existing water quality data record and other circumstances (soil permeability, depth to shallow groundwater, soil texture, clay layers, etc.) are Insufficient to list this area as impacted with respect to nitrate. More data are needed.

Specific data for each of the Project Areas can be found in Table 1-2 (Table 6 in the Phase I Report). Project area, hydrographic basin and the number of ISDS are listed in the upper portion of Table 1-2 for each of the 16 study areas. The Phase I Report identified that the total number of ISDS in the 16 Project Areas is 14,244, with an additional 2,596 within the basins but outside the individual Project Areas. The total number of ISDS in the basins is 16,840. Also shown in Table 1-2 is the estimated nitrate concentration in the recharge water for each of the 16 study areas. Very little precipitation ends up recharging the groundwater on an annual basis. Overall, recharge from ISDS effluent (assumed as 230 gal/day/home) is significant, compared to recharge from precipitation. Using some simple assumptions, a ratio of ISDS effluent recharge to precipitation recharge occurring over the Project Area was developed (in the Phase I report).

Table 1-2 ISDS Maximum and Allowable Densities for Study Area Basins

Basin Name	Truckee Meadows (87)					Lemmon Valley (92A & 92B)			Pleasant Valley (88)		Washoe Valley (89)		Truckee Canyon (91)		Cold Springs (100)	Spanish Springs (85)
Project Areas	**Ambrose**	**Island 18**	**Hidden Valley**	**Huffaker**	**Geiger**	**Silver Knolls**	**Heppner**	**Golden Valley**	**Mt. Rose**	**Pleasant Valley**	**Washoe**	**New Washoe**	**Mogul**	**Verdi**	**Cold Springs**	**Spanish Springs**
#ISDS – Project Area	475	907	780	1,764	858	529	954	845	1,026	535	1,296	197	544	341	1,325	1,848
#ISDS – Project Areas Subtotal 1	4,784					2,328			1,561		1,493		885		1,325	1,848
% of Total Septics	34%					16%			11%		10%		6%		9%	13%
#ISDS – Basin	5,870					2,670			1,665		1,852		1,020		1,397	2,346
% of ISDS in Basin included within Project Area	81%					87%			94%		81%		87%		95%	79%
Project Areas																
Project Area (mi^2)	5.8	7.0	6.9	24.0	6.6	6.5	9.4	10.7	12.5	8.8	12.6	3.1	6.4	3.7	7.5	11.1
Recharge Nitrate based on ISDS Density																
ISDS Recharge – Project Area (MGY)	39.9	76.1	65.5	148.1	72.0	44.4	80.1	70.9	86.1	44.9	108.8	16.5	45.7	28.6	111.2	155.1
Precip. Recharge – Project Area (MGY)	40.3	48.7	48.0	166.8	45.9	45.2	65.3	74.4	86.9	61.2	87.6	21.5	44.5	25.7	52.1	77.2
Recharge to GW – Septic to Precip Ratio	1.0	1.6	1.4	0.9	1.6	1.0	1.2	1.0	1.0	0.7	1.2	0.8	1.0	1.1	2.1	2.0
ISDS % of ISDS + Precip Recharge[1]	50%	61%	58%	47%	61%	50%	55%	49%	50%	42%	55%	43%	51%	53%	68%	67%
ISDS + Precip Recharge Nitrate Conc. (mg/L)[2]	22.5	27.6	26.1	21.3	27.6	22.4	24.9	22.1	22.5	19.2	25.0	19.7	22.9	23.8	30.7	30.1

Table 1-2 ISDS Maximum and Allowable Densities for Study Area Basins - Continued

Groundwater Depth and Measured Nitrate																
Basin Name	**Truckee Meadows (87)**					**Lemmon Valley (92A & 92B)**			**Pleasant Valley (88)**		**Washoe Valley (89)**		**Truckee Canyon (91)**		**Cold Springs (100)**	**Spanish Springs (85)**
Project Area	**Ambrose**	**Island 18**	**Hidden Valley**	**Huffaker**	**Geiger**	**Silver Knolls**	**Heppner**	**Golden Valley**	**Mt. Rose**	**Pleasant Valley**	**Washoe**	**New Washoe**	**Mogul**	**Verdi**	**Cold Springs**	**Spanish Springs**
Avg. Depth to Water in Project Area (ft)	147.6	69.0	97.7	177	130	94.5	78.4	102.4	136	76.5	83.3	67.8	105.1	83.0	35.3	61.4
Avg Depth to Water in 150 SD contour (ft.)	No wells	No wells	No wells	125	300 75	98.5	89.9	78	153.8	56.6*	82.3	52.5*	116.8	44.3**	21.9	56.4
Avg. GW Nitrate in Project Area (ppm)	1.1	4.0	0.3	2.2	1.2	1.7	3.4	11.9	2.1	2.0	5.3	1.9	1.0	0.6	4.5	11.2
Avg GW Nitrate in 150 SD contour (ppm)	No wells	No data	0.4	3.3	1.5	2.5	3.3	7.4	No wells	2.0*	4.8	1.9*	1.2	0.28**	8.5	12.9
Max GW Nitrate in Project Area (ppm)	5	26	0.5	12.5	7.3	27	20	36	12.7	17.0	49.2	5.9	6.9	11	24.5	63.9
Max GW Nitrate in 150 SD contour (ppm)	No wells	No data	0.4	12.5	7.3	7.7	15.7	16.0	No wells	17.0*	44.1	5.9*	6.9	2.6**	18.3	63.9

* Row added
* Assumes septic tank effluent TN of 60 mg/L with 25% reduction in subsurface and rain TN of 0.25 mg/L (assumes 100% of ISDS discharge is nitrate)

The ISDS effluent recharge rate (inches per year per Project Area) was calculated from all ISDS within each Project Area at a rate of 230 gal/day/home for one year over the areal extent of the Project Area. Precipitation recharge was estimated at 0.4 inches per year per Project Area. Any Project Area with a value of 1 or higher means that there is at least as much recharge from ISDS effluent as there is from precipitation. It is noted that ISDS effluent must be below 22% of recharge to be diluted from 45 mg/L to the drinking water standard of 10 mg/L and must be below 11% of recharge to achieve a 5 mg/L nitrate concentration (see Appendix B).

A review of Table 1-2 suggests that all Project Areas have ISDS recharge as a percentage of septic and precipitation driven recharge at ± 50% and estimated ISDS + Precipitation recharge nitrate concentration of ± 25 mg/L, which indicates that there will likely be localized groundwater exceedance of the drinking water nitrate standard of 10 mg/L.

2.2 Distribution of ISDS and Existing WWTFs

Figure 1-2 shows the locations of ISDS within Washoe County. As can be seen, a large percentage of the total ISDS in Washoe County are located in highly concentrated areas. Locations of existing WWTFs in Washoe County are shown on Figure 1-3, which includes the permitted capacity for each facility (inset table). The color coded areas in Figure 1-3 illustrate the WWTF service areas. Shown in Figure 1-4 are the parcels on septic systems and the locations of the WWTFs. As can be seen on Figure 1-4, the vast majority of ISDS are either within, or adjacent to, existing WWTF sewer service areas.

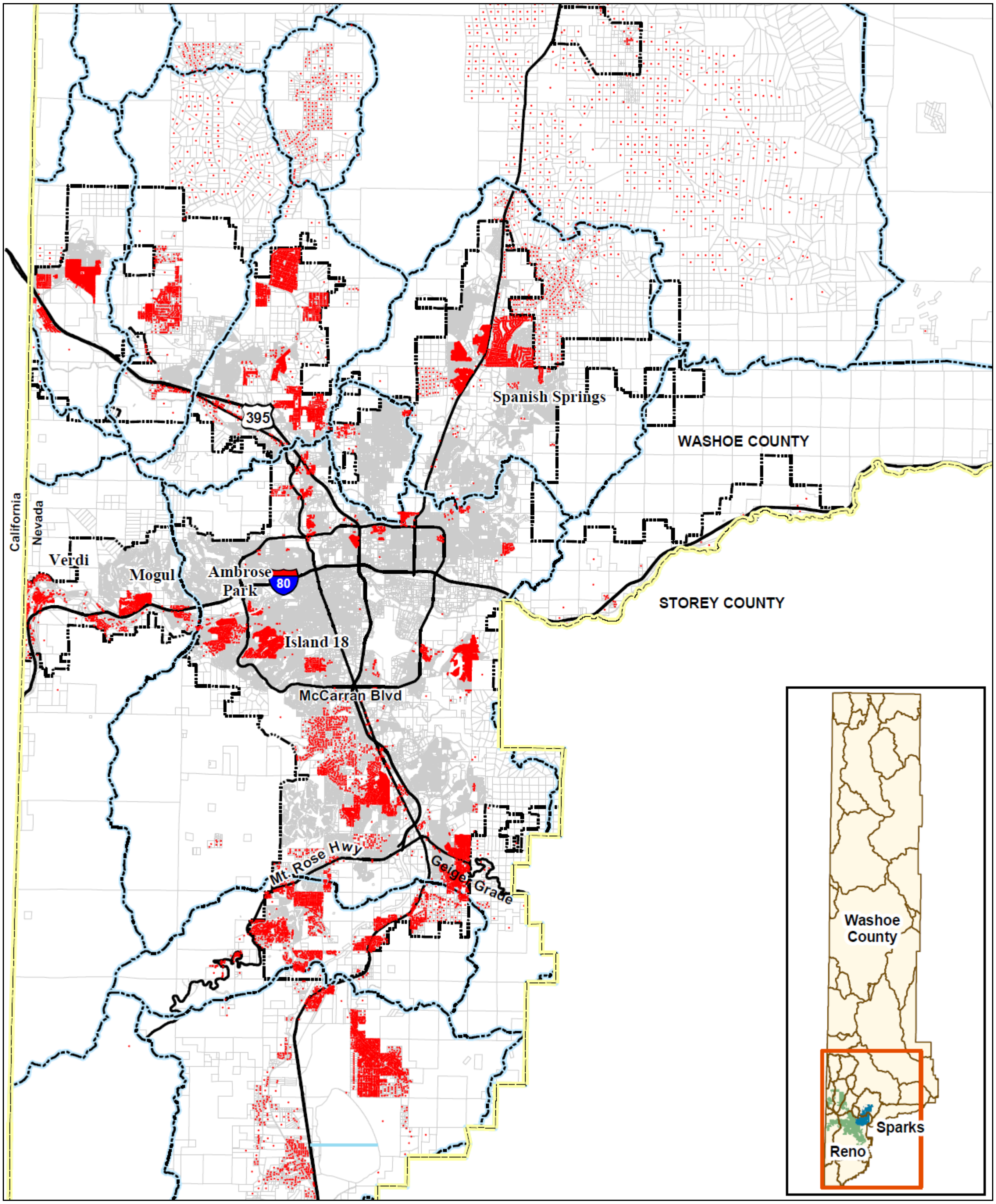
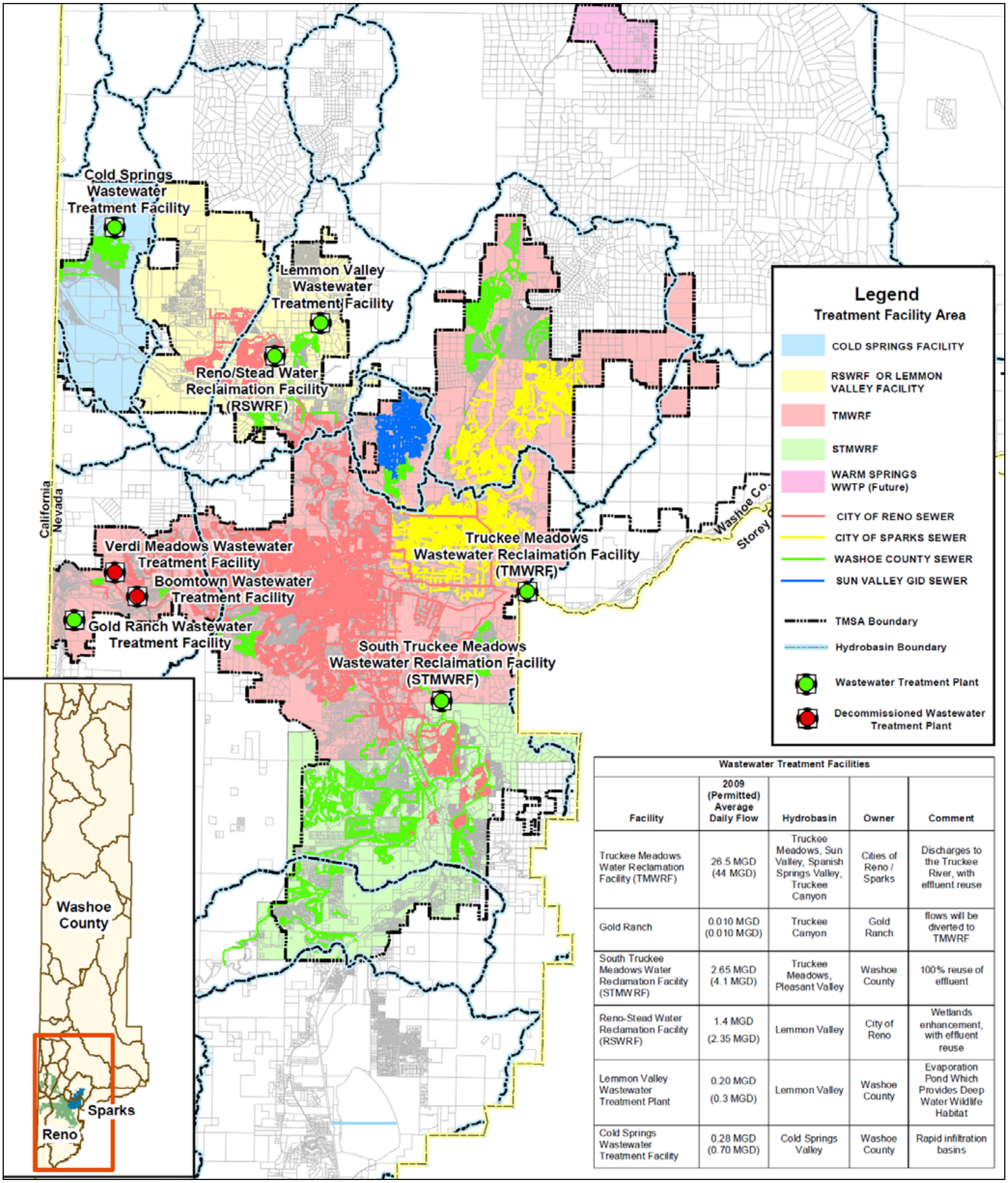


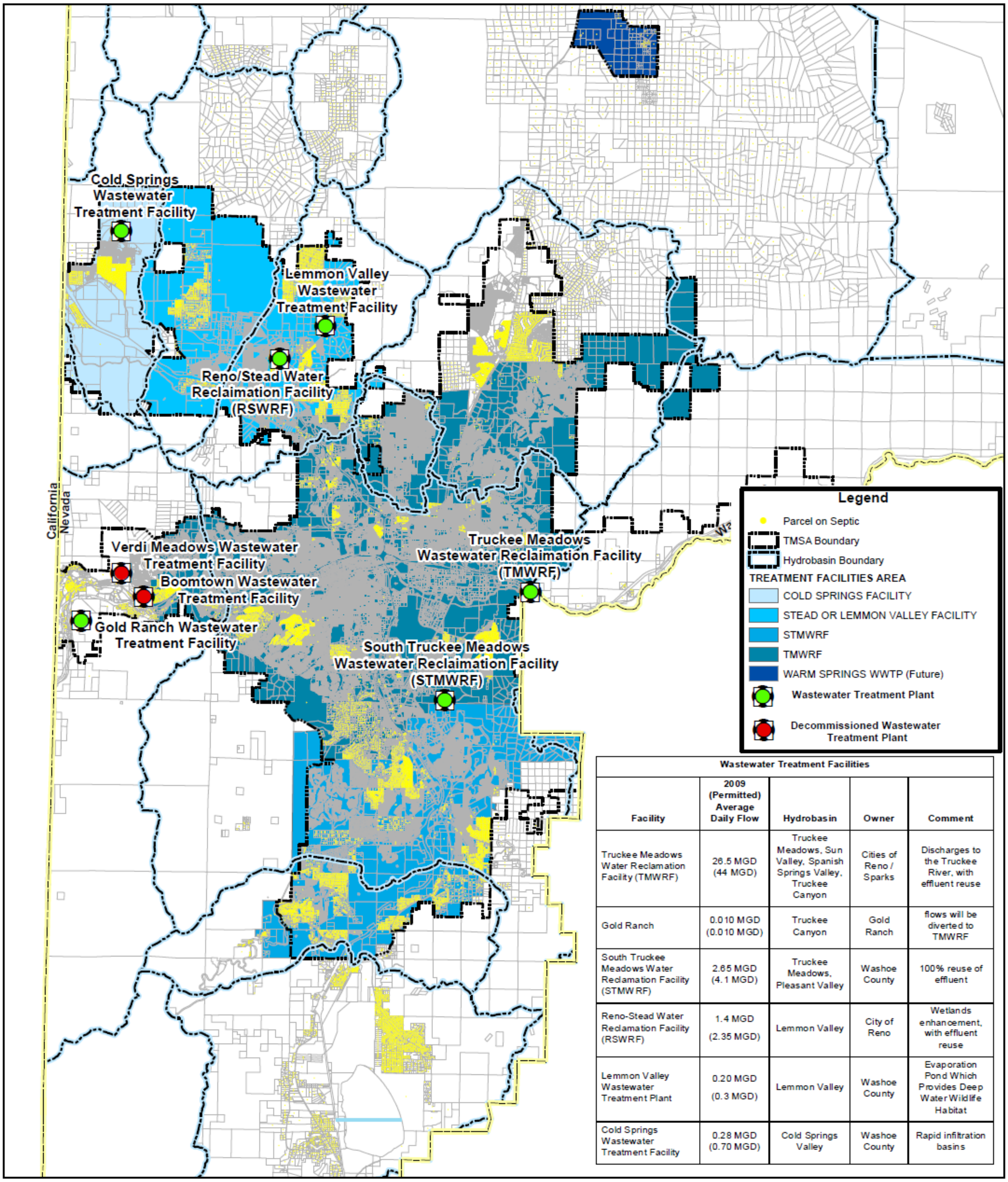
Figure 1-2 ISDS Locations in Washoe County (WRWC, 2011)



Wastewater Treatment Facilities

Facility	2009 (Permitted) Average Daily Flow	Hydrobasin	Owner	Comment
Truckee Meadows Water Reclamation Facility (TMWRF)	26.5 MGD (44 MGD)	Truckee Meadows, Sun Valley, Spanish Springs Valley, Truckee Canyon	Cities of Reno / Sparks	Discharges to the Truckee River, with effluent reuse
Gold Ranch	0.010 MGD (0.010 MGD)	Truckee Canyon	Gold Ranch	flows will be diverted to TMWRF
South Truckee Meadows Water Reclamation Facility (STMWRF)	2.65 MGD (4.1 MGD)	Truckee Meadows, Pleasant Valley	Washoe County	100% reuse of effluent
Reno-Stead Water Reclamation Facility (RSWRF)	1.4 MGD (2.35 MGD)	Lemmon Valley	City of Reno	Wetlands enhancement, with effluent reuse
Lemmon Valley Wastewater Treatment Plant	0.20 MGD (0.3 MGD)	Lemmon Valley	Washoe County	Evaporation Pond Which Provides Deep Water Wildlife Habitat
Cold Springs Wastewater Treatment Facility	0.28 MGD (0.70 MGD)	Cold Springs Valley	Washoe County	Rapid infiltration basins

Figure 1-3 WRFs Locations and Service Areas (WRWC, 2011)



Wastewater Treatment Facilities

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Cold Springs Wastewater Treatment Facility	0.28 MGD (0.70 MGD)	Cold Springs Valley	Washoe County	Rapid infiltration basins

Figure 1-4 WRF Service Areas and ISDS Locations (WRWC, 2011)

Presented in Table 1-3 is the 2009 average daily flow and the permitted maximum flow for each of the WWTFs in the Project Areas. The maximum excess capacity is the difference between the 2009 average flow and the permitted flow. Not all of the maximum excess capacity is available for ISDSs and future growth, as capacity for peak flows is necessary.

If ISDS are converted to sewer and sent to the regional WWTF, excess capacity must either exist or be added to accommodate the flow increase. Assuming 230 gpd per ISDS, the required capacity was estimated using the number of ISDSs in the Project Areas within the service areas of each of the WWTFs listed in Table 1-3. As can be seen from the data presented in Table 1-3, additional capacity is required at the Lemmon Valley WWTP and likely at the Cold Springs WWTF to accommodate peak flows. The total wastewater flow from ISDS in the Project Areas is estimated to be around 3.27 MGD.

Table 1-3 Study Area WWTFs, 2009 Average and Permitted Flow Rates

Facility Name	2009 Avg. Flow (MGD)	Permitted Flow (MGD)	Maximum Excess Capacity (MGD)	Estimated Req. Capacity for Local ISDS (MGD)
Truckee Meadows WRF	26.5	44	17.5	1.29
South Truckee Meadows WRF	2.65	4.1	1.45	1.14
Reno-Stead WRF	1.4	2.35	0.95	0.12
Lemmon Valley WWTP	0.2	0.3	0.1	0.41
Cold Springs WWTF	0.28	0.7	0.42	0.31
Total	**31.03**	**51.45**	**20.42**	**3.27**

Source WRWC, 2011

2.3 Nitrate Concentrations in Groundwater Recharge

To illustrate the impact of rainfall infiltration on groundwater recharge quality, presented in Table 1-4 is a calculation of the average recharge nitrate concentration across the Spanish Springs Project Area as a function of different rainfall infiltration rates. Table 1-5 shows the same calculation for sub-areas with different ISDS densities, including the State of Nevada limit of 118 ISDS/mi^2 and the existing maximum density of 300 ISDS/mi^2 for Spanish Springs.

Table 1-4 Recharge Nitrate Concentration Calculation for Spanish Springs

Spanish Springs Project Area				Precipitation Driven Infiltration (in.)		Recharge Nitrate Conc. (mg/L)
Project Area (acres)	**# of ISDS**	**ISDS Flow (mg/year)**	**Nitrate Mass (lb/yr)**	**Inches / Year**	**MG / Year**	
7,104	1,848	155	58,259	0.2	39	36.0
				0.4	77	30.1
				0.6	116	25.8
				0.8	154	22.6

Note: All calculated nitrate concentrations exceed the water quality standard of 10 mg/L

Table 1-5 Recharge Nitrate Concentration as a Function of ISDS Density

ISDS Density[1,2]			Recharge Nitrate Conc. @ Varying Annual Rainfall (mg/L)			
# / mi^2	# / acre	Acre / Lot	Rain = 0.2 in/yr	Rain = 0.4 in/yr	Rain = 0.6 in/yr	Rain = 0.8 in/yr
118	0.18	5.42	33.3	26.4	21.9	18.7
200	0.31	3.20	37.3	31.8	27.8	24.6
300	0.47	2.13	39.5	35.3	31.8	29.0
400	0.63	1.60	40.8	37.3	34.3	31.8

Note: All calculated nitrate concentrations exceed the water quality standard of 10 mg/L

[1] Maximum allowable density for Spanish Springs = 118 / mi^2

[2] Maximum density identified within Spanish Springs = 300 / mi^2

APPENDIX A - REFERENCES

1. Kropf, Christian A. and Thomas, Brent, "Septic Nitrate-N Baseline Data and Risk Assessment Study for Washoe County Phase I: Prioritization of Study Areas & Assessment of Data Needs", 2007.
2. Western Regional Water Commission, "2011 – 2030 Comprehensive Regional Water Management Plan", January 14, 2011.

TASK 2 REPORT

TECHNICAL & ECONOMIC EVALUATION OF NITROGEN REMOVAL ALTERNATIVES

STRATEGIES FOR MANAGEMENT OF HIGH-DENSITY SEPTIC SYSTEM DEVELOPMENTS IN WASHOE COUNTY

Prepared for:

Western Regional Water Commission

and

Northern Nevada Water Planning Commission

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Table of Contents

1.0 OVERVIEW OF NITROGEN REMOVAL AND ALTERNATIVES

Presented in this section is a summary of nitrogen removal mechanisms, wastewater nitrogen sources and an overview of wastewater and groundwater nitrogen removal alternatives.

1.1 Nitrogen Removal – Treatment Processes

Nitrogen removal from wastewater is a two-stage biological process. During the first stage, ammonification, organic nitrogen is converted into ammonia (NH_3), and nitrification whereby ammonia is converted into nitrite (NO_2) and then nitrate (NO_3). Ammonification and nitrification occur in aerobic environments where organic matter, alkalinity and a neutral pH (6.0-8.5) exist for the appropriate ammonification, (*Bacillus*, *Clostridium*, *Proteus*, *Pseudomonas*, and *Streptomyces* - called ammonifying bacteria) and nitrification bacteria, *Nitrosomonas and Nitrobacter,* to grow.

The reactions for these biological processes are described as follows:

Organic Nitrogen $\rightarrow$ NH_4^+ by ammonifying bacteria

$NH_4^+ + 1.5\ O_2 \rightarrow 2\ H^+ + H_2O + NO_2^-$ *by Nitrosomonas bacteria*

$NO_2^- + 0.5\ O_2 \rightarrow NO_3^-$ *by Nitrobacter bacteria*

Ammonification and nitrification occur in an aerobic environment such as a single pass or recirculating media filter, an aeration tank (in which activated sludge type microorganisms grow), or a septic system drainfield (which can be conceptualized as a single-pass media filter). The nitrification reaction consumes 7.1 mg of alkalinity for each milligram of ammonia nitrified and therefore has the potential to lower the pH of the treated wastewater (U.S. EPA, 1993). Nitrification will stop occurring if the pH drops significantly below 6.0.

As can be seen in the above reactions, nitrogen has not been removed from wastewater – it has been transformed to nitrate. To remove nitrogen from wastewater, nitrate must be reduced (converted) to nitrogen gas (N_2), which is harmlessly released to the atmosphere. This natural process is called denitrification. Denitrification occurs in an anaerobic environment that has sufficient available carbon. The denitrification reaction is generally described as follows (methanol shown as the carbon source):

$$6NO_3^- + 5CH_3OH + H_2CO_3 \rightarrow 3N_2 + 8H_2O + 6HCO_3^-$$

Denitrification requires a carbon source following the nitrification step. This can be achieved by recycling sludge or by adding a carbon source via active or passive carbon feed approaches, as discussed in Appendix C.

1.2 Wastewater Nitrogen Sources

A number of techniques are used to estimate total wastewater nitrogen and its components. The range of assumed average nitrogen loads generated from single family dwellings varies depending on the source referenced. Previous investigations used the following values, which LAI has used for consistency:

Flow/Concentration Based = 230 gpd x 60 mg/L x 365 x conversion factor (0.003044) = 40 lbs./yr

In LAI's opinion, average flows per property tend to be closer to 170 gpd, resulting in a flow/concentration mass loading of 30 lbs/year per property. Factors used by regulatory agencies include:

State of Maryland = 30 lbs/yr / dwelling unit
Suffolk County, NY = 10 lbs/yr per person = 4,536 grams/yr = 12.4 grams/day

According to Valiela et al., 1997, typical total N excretion rates per capita is 4.82 kg N/yr - equal to 10.6 lb N/yr-capita. According to the U.S. EPA Onsite Wastewater Treatment Systems Manual (2002), nitrogen contributions by source are presented on Table 2-1.

Table 2-1 Wastewater Nitrogen Contributions by Source (U.S. EPA, 2002)

Residential Wastewater Nitrogen Contributions by Source (U.S. EPA, 2002)			
Source	**TN (grams/capita/day)**	**TN (lbs./capita/year)**	**% of Total**
Garbage Disposal	0.6	0.5	5%
Toilet	8.7	7.0	78%
Bathing, sinks, appliances	1.9	1.5	17%
Approximate Total	**11.2**	**9.0**	**100%**

Numerous researchers (WERF, 2011 and U.S. EPA, 2010) have estimated/determined that urine accounts for 80–85% of the nitrogen in wastewater. According to references cited by WERF (2011), an adult produces 0.8 – 1.5 liters/day of urine and a child produces approximately half this amount. Furthermore, researchers have determined that 4 kg of N/person per year (10.96 grams/day) is associated with urine.

1.3 Overview of Wastewater Treatment Alternatives

The wastewater treatment alternatives being evaluated fall into the following categories:

- Source Separation – via urine diversion toilets. Compost toilets would also be effective.
- Individual, single family nitrogen removal systems
- Neighborhood / small community (cluster) wastewater collection, treatment and disposal/reuse systems

- Connection to existing, centralized treatment facility
- Connection to new, centralized treatment facility

Figure 2-1 illustrates the range of wastewater generation, collection, treatment and disposal/ reuse alternatives available for decentralized and centralized systems. In the following sections the various nitrate removal alternatives will be discussed, along with advantages, disadvantages and concerns with using each alternative. Issues associated with scalability and locations where these options have been implemented will be discussed. For each treatment option that is considered technically and economically feasible, the following costs will be developed with consideration of local factors:

- Total capital costs (including design, construction, land acquisition, etc., as appropriate)
- Annual operating, maintenance, repair and replacement costs
- Life cycle cost analysis
- Anticipated levels of nitrogen reduction
- Cost/pound of nitrate reduction/year

1.4 Nitrogen Removal Following Dispersal

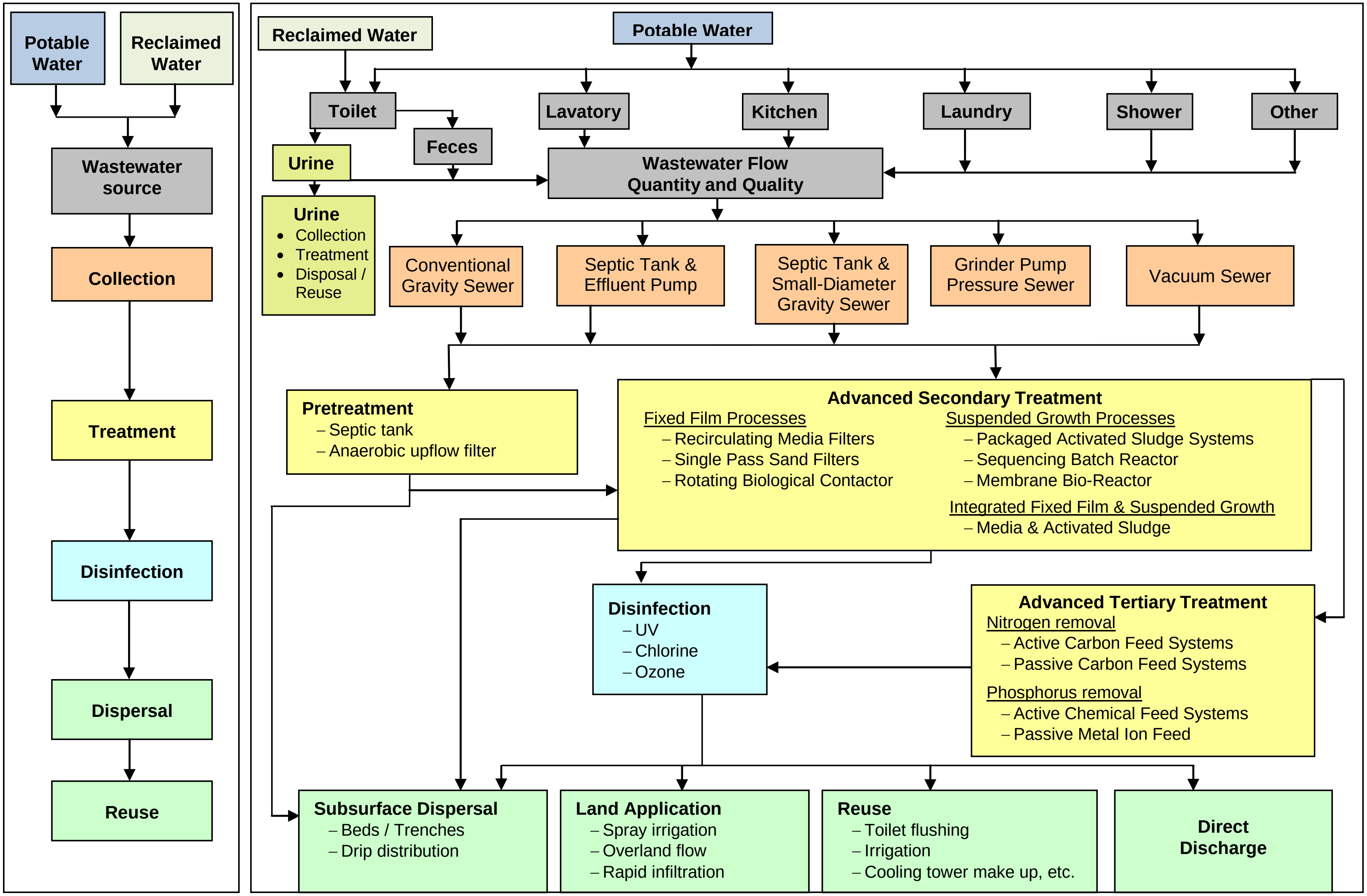
Nitrogen removal is achieved primarily in the wastewater treatment units. Nitrogen removal has also been shown to occur, in varying degrees, in the following zones:

- The drainfield
- The unsaturated soils between drainfield and groundwater
- The interface between saturated / unsaturated soils
- Within the groundwater aquifer
- At / near the interface of groundwater / surface water (the hyporheic zone)

The mechanisms through which nitrogen may be removed in these zones include the following:

- Denitrification in carbon-rich soils
- Ammonia adsorption to soils (limited to carrying capacity of the soils), nitrification and then denitrification. Very little of this process is expected in the TMSA.
- Ammonia volatilization in unsaturated soils

Figure 2-1 Range of Wastewater Collection, Treatment and Reuse / Disposal Options



Assigning nitrogen removal values within zones beyond the treatment facility requires site specific information. Literature values range between 25% and 50% for removal in the septic system drainfield. The Phase I Study assumed a 25% nitrogen removal in the drainfield. For the purposes of this Study, the following nitrogen removal percentages should be used/ assumed:

- Drainfield: 25% - as estimated in the Phase I Study and consistent with the range reported 25% – 40% from other studies (Katz et. al., 2010; USGS, 2010; USGS, 2007)
- Unsaturated soils: 0%
- Saturated / unsaturated soils interface: 0%
- Groundwater: 0%

Other factors affecting groundwater nitrogen concentration include:

- Dilution from infiltrating rainwater
- Dilution of nitrogen by the groundwater aquifer
- Nitrogen mass leaving the aquifer for aquifers that are not closed systems

Although some wastewater nitrogen after treatment is in the organic form, the amount is small. Consequently to be conservative, and as practiced by a number of regulatory agencies (i.e. Suffolk County, NY), all wastewater nitrogen is assumed to be 100% in nitrate form prior to entering the groundwater aquifer (USGS, 2007; USGS, 2010; Caraco and Cole, 2001; Walker et al., 1973; Cape Cod Commission, 1992; Katz, 2010).

1.5 Individual, Cluster and Centralized Treatment Systems Overview

For the purpose of this report, Individual Sewage Disposal Systems (ISDS) refer to a typical residential conventional septic tank and drain/leach field. Individual systems that incorporate treatment and potentially even reuse / dispersal will be referred to as onsite **treatment** and dispersal systems (OSTDS).

Decentralized treatment systems consist of the following techniques:

1. ISDS
2. Individual OSTDS, serving a single family dwelling
3. Cluster Systems, serving localized areas of development of ≥ 2wastewater generators

Wastewater treatment technologies are commonly grouped according to the following performance categories with respect to effluent total nitrogen:

Category	*Expected Effluent TN*
1. Secondary Treatment	< 30 mg/L
2. Advanced Secondary Treatment	< 20 mg/L
3. Tertiary Treatment	
a. Biological Nutrient Removal	<8-10 mg/L
b. Enhanced Nutrient Removal	<3-5 mg/L – considered to be the Limits of Technology by U.S. EPA

Collection system options are:

1. Conventional gravity
2. Septic Tank effluent – gravity & pressure
3. Grinder Pump – low pressure
4. Vacuum system

Wastewater treatment technologies fall within one of the following categories:

1. Fixed Film Systems
2. Suspended Growth – Activated Sludge (AS) Systems
3. Integrated Fixed Film and Suspended Growth Systems (IFAS)
4. Active or Passive Carbon Feed with Denitrification Filter after Pretreatment. While other techniques exist for providing the electron donor needed for denitrification, carbon feed systems are the simplest and most widely used.

Table 2-2 presents examples of each category along with representative effluent quality. The nitrogen removal values in Table 2-2 are comparable to the U.S. EPA Chesapeake Bay Program values as described in their "Update on Onsite Wastewater Treatment Systems Expert Review Panel" estimates, published July 10, 2012.

Disposal/Reuse system options consist of:

1. Drainfield with various options, including drip irrigation, drainfields and seepage pits
2. Land Application
3. Reuse

Table 2-2 Representative Effluent Quality for ISDS, OSTDS and Advanced Wastewater Treatment Systems

System Type		Effluent TN (mg/L)					
		Individual and Small Cluster			Larger Cluster and Centralized		
		End of Pipe	To Ground water	% Removal	End of Pipe	To Ground water	% Removal
Individual Sewage Disposal System (ISDS)							
Septic Tank + Drainfield		60	45	25%	n/a		
Representative Fixed Film Systems							
Single Pass Media Filter	Intermittent Sand Filter (ISF)	50	45	25%	n/a		
	Peat Systems	50	45	25%	n/a		
Recirculating Media Filters (RMF)	Advantex™, Waterloo™, RSF[2], SeptiTech®	19	19	68%	19	19	68%
Representative Suspended Growth Systems							
Conventional & Modified Activated Sludge Processes		25	25	58%	3	3	95%
Sequencing Batch Reactor (SBR)[1]		16	16	73%	3	3	95%
Membrane Bioreactor (MBR)[1]		10	10	83%	3	3	95%
Representative IFAS Systems							
FAST®		25	25	58%	n/a		
Modified Activated Sludge		n/a			3	3	95%
Representative Passive Carbon Feed Systems							
Nitrex™		3	3	95%	3	3	95%
Representative Active Carbon Feed Systems							
Methanol, Micro C		3	3	95%	3	3	95%

[1] Not typically used for individual systems
[2] Recirculating Sand Filter
n/a = not applicable

2.0 NITRATE REMOVAL REQUIRED FOR GROUNDWATER QUALITY PROTECTION

To compare alternatives to reduce nitrate loading from septic tank systems in the study areas, the level of necessary treatment (i.e., degree of nitrogen removal) needs to be quantified. For this study, a mass balance approach was used to estimate the average amount of nitrogen removal required to ensure groundwater is in compliance with drinking water standards. The analysis presented should be verified with site specific field data to ensure that the analytical procedure is appropriate. This mass balance approach is conservative in that it assumes only rainfall recharge contributes to the dilution of nitrates in ISDS effluent and that rainfall and ISDS effluent are completely mixed. Groundwater recharge flowing into a sub-area has the potential to further dilute nitrates.

It is recommended that a goal of 5 mg/L nitrate be used to provide for a margin of safety, address uncertainties associated with the analysis, and to address the variability of rainfall recharge. For reference purposes, the State of Oregon, by statute, can use a nitrate concentration of 7 mg/L as the value at which action may be taken to control water quality degradation by regulatory means (Morgan et al, 2007). The Cape Cod Commission (1992) adopted a 5 mg/L guideline based upon work performed on Long Island, NY where it was determined that wells with a mean nitrate concentration of 6 mg/L would violate the 10 mg/L drinking water standard 10% of the time and a mean of 3 mg/L would violate the standard 1% of the time. Cape Cod's standard of 5 mg/L has the objective to keep violations of the drinking water standard < 10% of the time and to provide a margin of safety during times of high loading and low rain recharge.

The following terms are used throughout the description of the mass balance:

Rainfall Recharge (RR) – Precipitation reaching groundwater (assumed to be 0.4 in/yr)

ISDS Recharge (ISDS-R) – ISDS flow reaching groundwater (assumed to be 100% of ISDS effluent, or 230 gpd/system based on previous assumptions)

Rainfall Recharge + ISDS Recharge (RR+ISDS) – The combined ISDS and rainfall flow and load reaching groundwater

The estimated level of nitrate removal required for each Project Area was calculated using the following assumption:

- RR as the only dilution for nitrates contained in ISDS-R flow

Using this assumption, LAI calculated the required maximum RR+ISDS combined nitrate concentration and the associated nitrate removal to achieve a concentration of 10-mg/L and 5 mg/L in the combined recharge water. Example calculations used in the mass balance can be found in Appendix B.

2.1 Required Nitrate Removal

The estimated level of nitrate removal required to achieve a specific RR+ISDS recharge nitrate concentration is dependent on the following factors:

- Number of ISDS / Area (septic density), from which the following can be calculated:
  - ISDS-R flow and nitrate concentration

- ISDS-R nitrate load

- Volume of rainfall recharge reaching groundwater
- Nitrate concentration of rainfall recharge (assumed to be 0.25 mg/L)

Using the above information, the nitrate removal levels required to achieve a RR+ISDS recharge nitrate concentration of 10-mg/L and 5-mg/L can be estimated. Using the mass balance approach, Table 2-3 shows the percent of existing properties (parcels with IDDS) that need to achieve 100% nitrate removal (i.e. sewered with out-of-basin transfer). This percentage was calculated assuming ISDS remove 25% of septic tank effluent nitrate and that sewering removes 100%. The values shown in Table 2-3 assume that the target recharge nitrate concentration is 5-mg/L, a level considered protective of groundwater resources.

2.2 Implications of Nitrate Removal Requirements

The nitrogen removal requirements in any particular Project Area estimate the appropriate level of removal required to attain or maintain groundwater nitrate quality. Once the removal requirement has been set, combinations of technologies can be proposed to achieve this level of removal. As an example, if the removal requirement is 75%, then the following options are among those that may be considered:

- Convert 67% of the ISDS to sewer, which removes 100% of nitrogen by not discharging the treated wastewater to the ground, and allow 33% to remain onsite, removing 25%. The weighted average removal that results is 75%.
- Convert 74% of the ISDS to onsite or cluster systems with local groundwater discharge, each removing 95% of nitrogen, and allow the other 26% to remain with ISDS. The weighted average removal that results is 75%.
- Convert 22% to sewer, and the remaining 78% to Fixed Film technologies that remove 68% of nitrogen. The weighted average removal that results is 75%

There are many combinations of treatment technologies that could be used to achieve the necessary nitrogen removal required. The ultimate solution will depend on both economic and non-economic factors that are unique to each Project Area.

Table 2-3 Number of Properties Requiring Sewers (100% Nitrate Removal)

Basin Name (number)	Project Area	2007 Report Priority Ranking	Number of ISDS		ISDS-R /RR Ratio[1]	Properties Requiring 100% Removal[2]	
			Basin	Proj. Area		(%)	(#)
Truckee Meadows (87)	Ambrose[4]	7	5,870	475	1.0	78%	372
	Island 18[4]	12		907	1.6	82%	745
	Hidden Valley[4]	8		780	1.4	81%	633
	Huffaker[4]	9		1,764	0.9	77%	1,358
	Geiger[4]	11		858	1.6	82%	705
Lemmon Valley (92A & 92B)	Silver Knolls[5]	14	2,670	529	1.0	78%	413
	Heppner[3]	4		954	1.2	80%	766
	Golden Valley[3]	6		845	1.0	78%	658
Pleasant Valley (88)	Mt. Rose[4]	5	1,665	1,026	1.0	78%	803
	Pleasant Valley[4]	15		535	0.7	75%	399
Washoe Valley (89)	Washoe[3]	3	1,852	1,296	1.2	80%	1,042
	New Washoe[5]	16		197	0.8	75%	148
Truckee Canyon (91)	Mogul[4]	13	1,020	544	1.0	79%	428
	Verdi[4]	10		341	1.1	79%	271
Cold Springs (100)	Cold Springs[3]	2	1,397	1,325	2.1	84%	1,112
Spanish Springs (85)	Spanish Springs[3]	1	2,346	1,848	2.0	84%	1,546
	Total		**16,820**	**14,224**		**Avg=80%**	**11,397**

[1] The maximum ISDS-R / RR Ratio that is protective of drinking water quality standards is 0.2
[2] 100% Nitrogen removal achieved via sewering and out-of-basin treatment / discharge or by using a higher percentage/number of nitrogen removal systems within the basin
[3] Sufficient data and known impacts
[4] Insufficient data with suspected impacts
[5] Insufficient data with little suspected impact

Summarized in Table 2-4 are the estimated percentages of properties requiring other types of nitrate removal systems compared to sewers. Values that exceed 100% indicate nitrate removal technologies cannot meet the 5-mg/L standard even if 100% of the parcels in the Project Area are upgraded.

Table 2-4 Percent of Parcels Requiring Nitrate Removal Technologies by Project Area

Nitrogen Removal Technology	Expected Nitrate Removal (%)	Percent of Project Area Parcels Requiring Various Nitrogen Removal Technologies															
		Ambrose[2]	Island 18[2]	Hidden Valley[2]	Huffaker[2]	Geiger[2]	Silver Knolls[3]	Heppner[1]	Golden Valley[1]	Mt. Rose[2]	Pleasant Valley[2]	Washse[1]	New Washoe3	Mogul[2]	Verdi[2]	Cold Springs[1]	Spanish Springs[1]
Sewers	100%	78%	82%	81%	77%	82%	78%	80%	78%	78%	75%	80%	75%	79%	79%	84%	84%
Enhanced Nutrient Removal	95%	82%	86%	85%	81%	86%	82%	85%	82%	82%	78%	85%	79%	83%	84%	88%	88%
Advanced Secondary	68%	(>100%, i.e., Technology Insufficient to Achieve Water Quality Goal)															
Secondary	58%	(>100%, i.e., Technology Insufficient to Achieve Water Quality Goal)															

[1] Sufficient data and known impacts
[2] Insufficient data with suspected impacts
[3] Insufficient data with little suspected impact

2.3 Project Phasing

The Phase I report identified 16 separate areas within the TMSA based on water quality data and relative density of residential septic systems. Water quality degradation was ranked on numerous factors using septic tank and population density factors and the proximity to sensitive receptors being the most important. A prioritized list of Project Areas that exhibit a high likelihood (relative to other Project Areas) of septic systems degrading water quality (with respect to nitrate contamination) was developed. The State of Nevada Intended Use Plan designated Spanish Springs as a high priority area, suggesting that the phasing of improvements be implemented as listed in Table 2-5.

Table 2-5 Suggested Phasing of Improvements

Project Area	Phase I Final Rank	LAI Phasing Recommendations
Spanish Springs	1	Phase 1
Cold Springs	2	Phase 2
Washoe	3	Phase 2
Heppner	4	Phase 2
Mt. Rose	5	Phase 2
Golden Valley	6	Phase 2
Ambrose	7	Phase 3
Hidden Valley	8	Phase 3
Huffaker	9	Phase 3
Verdi	10	Phase 3
Geiger	11	Phase 3
Island 18	12	Phase 3
Mogul	13	Phase 3
Silver Knolls	14	Phase 4
Pleasant Valley	15	Phase 3
New Washoe	16	Phase 4

3.0 FINDINGS AND COSTS

For each treatment option that is considered technically and economically feasible, the following costs were developed with consideration of local factors:

- Total capital costs (including design, construction, land acquisition, etc., as appropriate);
- Annual operating, maintenance, repair and replacement costs;
- Life cycle costs;
- Anticipated levels of nitrogen reduction; and
- Cost/pound of nitrate reduction/year.

A full description of the feasible technologies and the above listed removal rates and costs can be found in Appendix C. Presented in Table 2-6 is a summary of the above costs on a per Equivalent Dwelling Unit (EDU) basis for each evaluated alternative. 1 EDU = single family house, typically 3 bedroom house with a sewer system wastewater generation rate of 230 gallons per day (gpd). This is based upon 2.52 persons per household x 70 gallons per person per day wastewater generation + safety factor. See Small and Decentralized Wastewater Management Systems (Crites and Tchobanoglous, 1998) and Gravity Sanitary Sewer Design and Construction (ASCE, 1982). Per person wastewater generation typically varies from 50 – 70 gpd per person (U.S. EPA, 2002).

The cost information summarized in Table 2-6 combined with the number of each type of system required defines the scale of the anticipated capital improvement program to achieve drinking water quality protection and that will need to be financed using techniques that will be described in the Task 3 Report. Summarized in Table 2-7 is the number of systems requiring 100% nitrogen removal with out-of-basin discharge and 93% removal with in-basin discharge. Listed in Table 2-7 are the costs associated with conventional sewer extensions (trench width paving, out-of-basin discharge) and septic tank effluent cluster systems (trench width paving and in-basin discharge).

Please note for 100% nitrogen removal with out-of-basin discharge, costs are based on conventional sewer system with trench-width paving and out-of-basin discharge based upon only one engineer's estimate of sewer extension costs in Spanish Springs. Lower density developments will have higher costs. Areas are assumed to be adjacent to existing sewered areas. Therefore no transmission cost was provided. If transmission piping is needed, costs for this option will increase. The septic tank effluent (STE) collection system holds promise for cost savings; however, the technical issues with discharging septic tank effluent into a collection system need to be assessed prior to its use, as STE will be corrosive to concrete pipes and its use with concrete pipes is not recommended. STE is assumed to be the collection system for in-basin discharge as those would be new systems and therefore would have the appropriate collection pipe material.

Table 2-6 Summary of Alternative Nitrate Removal Costs per EDU

	WW Mgmt. Option		% Nitrate Reduction	Capital Cost	Annual O&M Cost	Life Cycle Cost per EDU	Savings Compared to Conv. Sewering w/full Width Paving
1	Onsite[1]		93%	$22,000	$540	$31,283	20.8%
2	Cluster[2]	STE Collection[3]	93%	$23,900	$574	$36,881	14.5%
		Conventional – Gravity Collection	93%	$26,700	$574	$39,681	5.3%
		Conventional – Pressure Collection	93%	$26,700	$574	$39,681	5.3%
3	Connection to Existing Centralized System[4]	STE Collection	100%	$17,400	$645	$32,000	38.5%
		Conventional – Trench Width Paving	100%	$21,400	$600	$35,000	24.4%
		Conventional – Full Width Paving	100%	$28,300	$600	$41,900	0.0%

[1] Onsite system costs assume economies of scale are achieved
[2] Carbon Feed and Pretreatment system achieving 93% of nitrogen removal used for this analysis
[3] No drainfield attenuation is assumed to occur with wastewater treated to advanced tertiary standards
[4] Sewer system costs are based upon only one engineer's estimate of sewer extensions costs in Spanish Springs. Lower density developments will have higher costs. Areas are assumed to be adjacent to existing sewered areas. Thereby no transmission cost provided. If transmission piping needed, costs for this option will increase.

Table 2-7 Capital Improvement Program for Required Nitrogen Removal in Project Areas

Priority Level	Number of Properties Req. 100% Removal	Number of Properties Req. 93% Removal w/In-Basin Discharge	Total Capital Cost – 100% Removal w/Out-of-Basin Discharge[1]	Total Capital Cost 93% Removal w/In-Basin Discharge[2]
Scenario 1 (Phase 1 Areas Only)	1,546	1,656	$45,100,000	$52,500,000
Scenario 2 (Phase 1 & 2 Areas)	5,926	6,349	$150,900,000	$179,400,000
Scenario 3 (Phase 1, 2 & 3 Areas)	10,836	11,610	$269,500,000	$321,500,000

[1] Please note for 100% nitrogen removal with out-of-basin discharge, costs are based on conventional sewer system with trench-width paving and out-of-basin discharge based upon only one engineer's estimate of sewer extension costs in Spanish Springs. Lower density developments will have higher costs. Areas are assumed to be adjacent to existing sewered areas; therefore no transmission cost is provided. If transmission piping needed, costs for this option will increase.

[2] Costs based on septic tank effluent collection cluster systems achieving 93% nitrogen removal discharging within the basin.

Please note that conventional sewers with full width paving, adds approximately 33% to the capital costs of the out-of-basin discharge option.

Appendix A - References

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Appendix B - Sample Calculations

Recharge Nitrate Concentration – Rain Only

The recharge nitrate concentration is a function of the following:

Nitrate concentration in wastewater effluent, after drainfield attenuation
Nitrate concentration in rainwater
Nitrates leached from soils as recharge water flows through them

For the purposes of this simplified analysis, any contribution of nitrates leached from the soil is neglected. It is assumed that the nitrate concentration in rainfall is 0.25 mg/L and 45 mg/L in ISDS effluent. The estimated concentration of nitrate in the total recharge water is weighted average of the two waters according to:

$$\frac{(\text{NO3 Conc.in ISDS})(\text{\% of recharge from ISDS}) + (\text{NO3 Conc.in Rain})(\text{\% of recharge from Rain})}{100}$$

Using this formula the estimated nitrate concentration in the recharge water as a function of the percent of total recharge water is shown in the table below.

Table B-1 Estimated Nitrate Concentration in Recharge Water

ISDS Effluent as a Percent of the Total Recharge	Calculated Nitrate Concentration (mg/L) In the total Recharge Waters
70%	32
60%	27
50%	23
40%	18
30%	14
20%	9
11%	5

Appendix C – Treatment Alternatives

Summarized in this appendix are the details pertaining to the various nitrate removal treatment processes. Each of the alternatives is discussed, along with the pros and cons, and a cost analysis.

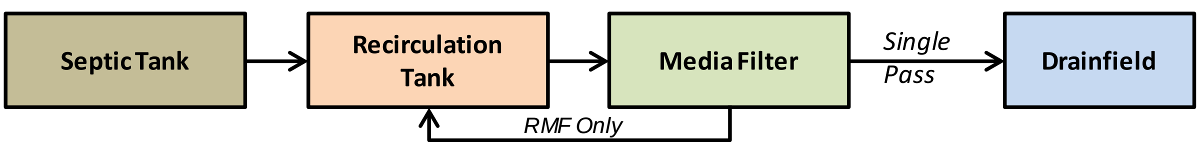
Fixed Film Systems

Fixed film technologies include:

- Single Pass Media Filters
- Recirculating Media Filters (RMF), including Rotating Biological Contactors (RBC)

The media contained within each fixed film system is typically sand, gravel, foam, peat, textile or plaster media. Figure C-1 is a process flow diagram for a typical RMF system.

Figure C-1 Typical Fixed Film Process Flow Diagram



Single pass media filters represent the simplest type of treatment; however, they are very limited when it comes to nitrogen removal. This is because they treat septic tank effluent, which has the solids separated prior to treatment. Separating the sludge prior to treatment results in a carbon-limited system. While these systems excel in nitrification (provided that sufficient alkalinity exists), denitrification is limited by the availability of carbon.

Recirculating Media Filters (RMF) utilize media with a high surface area to volume ratio as a substrate for a biofilm to grow on. Wastewater and air are mixed, using fans and/or spray heads, and contacted with the biofilm that grows on the media. The media effluent is split between recirculating and discharging to the next stage of the treatment process. Recirculation flows are directed to the recirculation tank where some denitrification (typically 50+%) and dilution of the septic tank effluent flow occurs. The primary process control on these systems is the recirculation ratio. Water is pumped in frequent short cycles, with total pump run times typically being less than an hour per day. RBCs use an engineered surface that is rotated half-submerged through the wastewater stream. A biofilm grows on the surface and aerates when the film is not submerged.

Recirculating media filters have the advantage of not needing energy intensive aeration and mixing, as compared to suspended growth systems. In addition, secondary clarifiers and return sludge pumps are not necessary, simplifying the treatment process. Fixed film processes are also more resistant to varying flows and loads than suspended growth systems. This is due to the stability of the biofilm during periods of varying loading. These systems are more reliable and require less operator involvement than processes that utilize the suspended growth technology.

Sludge production is also much lower for these systems, when compared to systems that utilize suspended growth technology. The result is simplicity and lower O&M costs, along with consistency of treatment results.

Pros of individual fixed film systems include:

- Consistent and typically complete nitrification
- Simple, stable and reliable process
- Low energy use
- Low sludge production

Cons associated with individual fixed film systems include:

- Larger footprint compared to activated sludge systems for larger conventional systems
- Carbon addition needed for complete denitrification
- Alkalinity addition may be needed

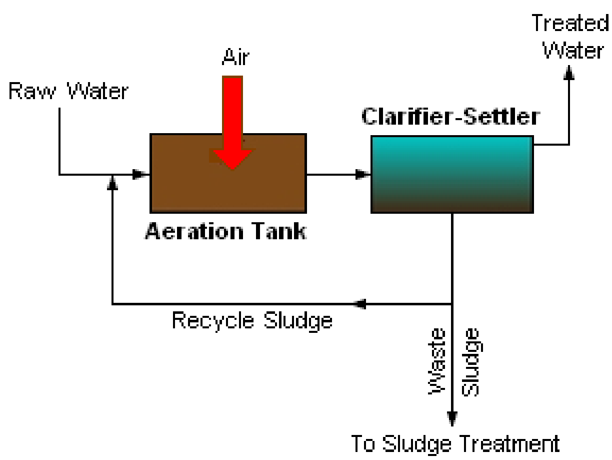
Suspended Growth – Activated Sludge (AS) Systems

The generic options for suspended growth technologies applicable to OSTDS and cluster systems include the following:

- Conventional and Modified Activated Sludge Processes
- Sequencing Batch Reactors (SBR)
- Membrane Bioreactors (MBR)

Figure C-2 is a general process flow diagram for a conventional Activated Sludge system.

Figure C-2 General Activated Sludge Process Flow Diagram



Suspended growth processes treat wastewater using the same nitrification and denitrification mechanisms as fixed film processes. The difference is that in the activated sludge process, bacteria and solids are maintained in suspension within an aeration tank. These bacteria grow as they absorb nutrients. A secondary clarifier is needed following the aeration tank to settle the biosolids into what is then called activated sludge. Suspended growth systems rely on processes that are typically monitored on a daily or even hourly basis at larger treatment facilities. In larger facilities, sludge is separated into Return Activated Sludge (RAS) and Waste Activated Sludge (WAS). In individual and small cluster systems, this is not typically done, resulting in lower levels of treatment. By maintaining the sludge within the treatment process, there is sufficient carbon to achieve high levels of denitrification, if properly configured and operated. Factors that are monitored / adjusted at larger treatment facilities include:

- WAS / RAS ratio
- Mixed Liquor Suspended Solids (MLSS)
- Food to Microorganism Ratio (F/M)
- Oxygen / redox levels
- Aeration cycles
- Recirculation ratio
- Sludge Age

All of the above factors affect nitrification (conversion of ammonia to nitrate-N) primarily and also denitrification (conversion of nitrate-N to nitrogen gas). When these factors are adjusted and monitored properly to match influent flows and loads, suspended growth systems are capable of reliably meeting advanced tertiary (<3-mg/L) standards for nitrogen removal. This process and its many variations are the standard for large-scale wastewater treatment worldwide. However, when these factors are not monitored and / or not even adjustable, as is the case with all OSTDS and many small to medium sized cluster systems, the reliability of the suspended growth process decreases dramatically.

SBRs are unique in that they utilize a batch process to combine treatment stages in a single tank. These units have great treatment potential; however, they are highly reliant on the close supervision of skilled operators. For this reason, they are not recommended for lower flows where full-time specialized operations are not required or economically feasible.

MBRs utilize the same suspended growth technology; however, replace the secondary clarifiers with membranes within the aeration tank. These processes have a range of treatment options, depending on the type of membranes used. Specialized operations and high life-cycle costs limit the feasibility of MBRs to areas with space constraints and/or a higher required treatment levels. These systems operate at a high bacteria concentration, referred to as Mixed Liquor Suspended Solids (MLSS), and a long sludge age; thereby reducing the amount of sludge production and adding stability to the process during varying flows and loads. The major concern with activated sludge processes is washout of the solids in the clarifier. By substituting membranes for the clarifier, MBRs eliminate this mode of failure. However, nitrification performance is still dependent on the same factors as conventional suspended growth systems.

Typical individual suspended growth systems do not have most of the functionality of larger systems and are packaged in a single tank. While this lack of functionality simplifies the system and reduces installation costs, the result is less operator control and generally poor performance compared to the larger centralized systems. The energy use and sludge production is higher than the fixed film systems. The economies of scale must reach a point where the higher O&M costs are offset by the lower construction costs. Typically, flows should exceed 50,000 – 100,000 gpd (depending on the type of suspended growth system) before systems that are properly designed and operated start to become competitive with fixed film systems on a total life cycle cost basis. The reliability of activated sludge systems is highly dependent on the operations staff.

Pros of individual suspended growth systems include:

- Smaller footprint due to single tank configuration
- Lower installation costs
- Generally not carbon-limited

Cons associated with individual suspended growth systems include:

- Many factors affecting performance are not monitored or adjustable
- Relative stability of biological process when faced with varying flows and loads is low
- Reliance on settling of suspended solids introduces possibility of solids carryover to the drainfield
- Inconsistent nitrification and consequently inconsistent denitrification
- Energy intensive process – property owners are able to disconnect electricity
- Higher sludge production
- High dependence on operator attention and skill

Integrated Fixed Film and Suspended Growth – Activated Sludge (IFAS) Systems

Integrated fixed film and suspended growth (IFAS) processes combine the fixed film and suspended growth technologies into one treatment process. This is achieved by adding media to the aeration tank shown previously on Figure C-2. By combining both processes, resistance to process upsets is increased over the suspended growth process alone. The addition of a fixed film media to the aeration tank in these processes increases the treatment capacity and reduces the footprint of the aeration tank. This technology has the same dependency on operator attention and skill for applications that require high levels of nitrogen removal.

Pros of individual IFAS systems include:

- Small footprint
- Lower installation costs
- Not carbon-limited
- More stable than traditional suspended growth systems

Cons associated with individual IFAS systems include:

- Many factors affecting performance are not monitored or adjustable
- Less stable and reliable than traditional fixed film processes
- Reliance on settling of suspended solids introduces possibility of solids carryover to the drainfield
- Inconsistent nitrification
- Energy intensive process
- Higher sludge production than fixed film systems

Active Carbon Feed Systems

The primary limitation on nitrogen removal in both fixed film and the simplified suspended growth systems is available carbon for the denitrifying bacteria after nitrification. If the nitrification system fully nitrifies, meaning that ammonia is less than 1 mg/L in the nitrification system, then an anaerobic environment and a carbon source (electron donor) are all that is needed to convert the nitrate to nitrogen gas. Active carbon feed systems use a chemical feed system that stores and doses a chemical carbon source into an anaerobic tank following a nitrification system that achieves complete nitrification. Examples of active carbon feed sources are:

- Methanol
- Micro C
- Glycerin / glycerol

Pros associated with active carbon feed include the following:

- Fast reaction rate minimizes retention time and associated footprint
- Low capital cost for installation if non-toxic/non-hazardous carbon source used

Cons associated with active carbon feed include the following:

- Need for chemical storage, containment
- Hazardous materials storage when methanol is used
- Generates sludge and consumes some treatment plant capacity for backwash treatment
- Requires operator attention and relies on monitoring equipment to prevent overfeed or underfeed
- Ongoing cost of chemicals

Passive Carbon Feed Systems

Passive carbon feed systems use a carbon-rich media to supply carbon for denitrification. The leaching of labile carbon from media used in passive carbon feed systems is biologically mediated. There is neither a concern with overfeeding nor underfeeding, provided the systems are appropriately sized.

The Nitrex™ system is an example of a passive carbon feed system. The Nitrex™ system is an upflow filter that contains a carbon-rich media that slowly releases labile carbon to facilitate denitrification.

Passive systems have the advantage of reliability and simplicity, inconsequential sludge production and minor increase in operator attention beyond that required for the nitrification system. The disadvantages of passive systems are larger footprints and higher construction costs than active feed systems. Passive systems have a 40 +/- year useful life, which can make them competitive on a life cycle cost basis.

Pros of passive carbon feed systems include:

- Simple, stable process
- Little/no energy use
- Inconsequential sludge production
- No chemical storage
- No ongoing chemical costs

Cons associated with passive carbon feed systems include:

- Larger footprint
- Higher installation costs
- Media replacement every 40 +/- years

For the Record, LAI is the developer of the Nitrex™ system.

Net Nitrogen Removal Performance

Presented in Table C-1 is the estimated nitrogen removal performance of the various technologies for low flow (individual or small cluster) systems. As described herein, smaller flow suspended growth / IFAS systems do not have the same functionality as larger centralized systems that can achieve Total Nitrogen (TN) < 3 mg/L. For larger cluster systems and centralized WRFs, all technology types can be designed and operated to achieve TN < 3 mg/L. Table C-1 also shows the net nitrogen load to groundwater from one equivalent dwelling unit (EDU) being served by each of the listed technology types. This number takes into account the fact that an ISDS drainfield/seepage pit removes approximately 25% of the nitrogen load from a conventional septic system's wastewater.

Table C-1 Nitrogen Removal Performance of OSTDS Treatment System Types

OSTDS Category	Flow / EDU	Effluent Quality				TN Load Reduction to Groundwater*	
		Eff. TN Conc. (Prior to drainfield attenuation	% Drainfield attenuation	TN Conc. To GW (After drainfield attenuation	TN Load Discharged to Ground Water		
	(gpd)	(mg/L)	(%)	(mg/L)	(kg/yr)	(kg/yr)	(%)
Standard ISDS							
Standard ISDS (STE + Drainfield)	230	60	25%	45	14.33	n/a	n/a
Individual and Small Cluster Advanced Secondary OSTDS							
Suspended Growth / IFAS	230	25	0%	25	7.96	6.37	44.4%
Fixed Film							
Individual and Small Cluster Advanced Tertiary OSTDS							
Carbon Feed & Pre-treatment	230	3	0%	3	0.96	13.37	93.3%
Large Cluster and Centralized Systems							
All Technologies	230	3	0%	3	0.96	13.37	93.3%

* TN Load Reduction to Groundwater based on 45 mg/L in ISDS effluent

Individual Onsite Treatment and Dispersal Systems (OSTDS)

Individual OSTDS are treatment and dispersal systems that are scaled to fit in typical residential lots with minimal disruption. As discussed in Section 3, these systems have highly variable levels of treatment and reliability with respect to nitrogen removal.

Pros and Cons of Using Individual OSTDS

The advantages of using individual systems include the following:

- Able to achieve TN 3 mg/L
- Allows targeted on-site upgrades
- Low capital cost - no collection system needed
- Can be phased in with property ownership changes

The challenges associated with using individual OSTDS include the following:

- Sampling costs can become excessive if every system is tested on a regular basis
- Numerous facilities to manage
- Susceptible to highly variable flows and loads

Further, when nitrogen removal in excess of 60% (at the receiving groundwater) is required, there are limited technology alternatives available.

Scalability and Relevant Comparable Installations

Scalability

Each individual OSTDS is a single treatment unit on a single property. The same technologies are used for higher flows, making these technologies scalable for decentralized treatment scenarios.

The scalability of using individual OSTDS across a neighborhood, a community and even across a watershed is very good. There is no technology limit on the extent to which areas can use individual OSTDS. The challenges with relying on individual OSTDS across large areas is primarily a management issue. Exclusive reliance on individual OSTDS to meet nitrogen removal targets requires proper management and oversight of operations and maintenance activities. A reliable monitoring program is also necessary to ensure proper performance.

Relevant Comparable Installations

Use of individual OSTDS as an area-wide solution for high levels of nitrogen removal has been required in the following areas:

- Maryland – Chesapeake Bay - although the MD Department of the Environment defines Best Available Technology as any technology achieving at least 50% TN removal, these technologies are required in the Chesapeake Bay critical areas (all lands within 1,000 feet of shoreline). Recently passed legislation requires that conventional septic systems cannot be used in a subdivision of more than 4 homes.

  http://www.mde.state.md.us/programs/Water/BayRestorationFund/OnsiteDisposalSystems/Pages/water/cbwrf/osds/brf_bat.aspx

- Wakulla County & Leon County, FL – requires Performance Based Treatment Systems that achieve TN < 10 mg/l for new development in the Wakulla Springs Protection Zones
- Suffolk County, NY - due to the groundwater being a sole source aquifer, all wastewater systems with flows greater than 1,000 gpd are required to comply with the effluent TN < 10 mg/l requirement. Nitrogen removal requirements for single family residential properties are under active consideration.
- Falmouth, MA - in the aquifer protection district, wastewater systems are required to have an effluent quality of < 12 mg/L
- Cape Cod, MA – for large projects in impaired watersheds, no net nitrogen contribution from new developments is required by the State MA DEP. Otherwise, other large projects are required to demonstrate TN < 5 mg/L at the property boundary and in some areas are required to have a no nitrogen discharge impact. This is achieved by including wastewater from existing development in the nitrogen removal system so that the net nitrogen discharge is zero or less than zero - in which case new development becomes part of the nitrogen solution mechanism.

Life Cycle Costs of Individual OSTDS

Table C-2 contains the estimated capital and O&M costs for the various individual OSTDS systems.

Table C-2 Capital and O&M Costs for Individual OSTDS

Cost Category	Suspended Growth	IFAS	Fixed Film	Carbon Feed & Pretreatment
Installation	$1,900	$2,100	$2,2350	$4,000
Subtotal	**$7,150**	**$7,350**	**$9,450**	**$18,500**
Engineering	$550	$550	$550	$900
Subtotal	**$7,700**	**$7,900**	**$10,000**	**$19,400**
Engineering	$550	$550	$550	$900
Total Capital Cost	$7,700	$7,900	$10,000	$19,400
Septic / Sludge Pumping	$63	$63	$38	$38
Pump Frequency (yr)	3	3	5	5
$ / Pumpout	$188	$188	$188	$188
Inspections – each cost	$113	$113	$113	$113
Number per year	2	2	1	1
Sampling	$225	$225	$113	$113
Electricity	$90	$90	$23	$23
kw/yr	900	900	225	225
$ / kw	$0.10	$0.10	$0.10	$0.10
Miscellaneous	$63	$63	$63	$63
Total Annual O&M Cost	**$745**	**$745**	**$541**	**$541**

Summarized in Table C-3 are the estimated life cycle costs of the various OSTDS treatment technologies. The costs are presented in terms of $/kg/yr of nitrogen removed, above that removed by a conventional ISDS. When comparing the cost of alternatives, the only relevant value is the cost per kg/yr removed above what the groundwater is currently receiving (conventional ISDS).

Table C-3 Life Cycle Costs for Typical OSTDS Types

Nitrogen Loadings and Removals		Life Cycle Cost Analysis				
				Rate 5.00%	Term 60	PW Factor – 17,159
OSTDS Category	TN Load Discharged to Groundwater (kg/yr)	Capital Cost ($)	Annual O&M Cost ($)	Present Worth of O&M	Life Cycle Cost[1] ($)	Life Cycle Costs ($/kg/yr N Removed)
Standard ISDS						
Standard ISDS (STE + Drainfield)	14.33	$3,000	$38	$643	$3,643	n/a
Advanced Secondary OSTDS						
Suspended Growth / IFAS	5.97	$7,700	$745	$12,784	$20,484	$2,450
Fixed Film	4.54	$10,000	$541	$9,283	$19,283	$1,969
Advanced Tertiary OSTDS						
Carbon Feed & PreTreat	0.72	$19,400	$541	$9,283	$28,683	$2,107

Cluster Wastewater Collection, Treatment and Dispersal Systems

Overview

Cluster systems have the advantage of being localized, minimizing piping, pump stations and other force main / transmission system costs. In areas where sewer extensions are not cost-effective, multiple small clusters serving all but the most isolated lots may prove to be the most cost effective option. This flexibility eliminates collection system pipes that traverse sparsely populated areas within the service area. By using multiple, small clusters, high density streets within otherwise low density areas may be cost-effectively served. The disadvantage to this approach, when compared to centralized alternatives, is having multiple facilities to manage; however, the internet and improved electronics has simplified this issue. Cluster system alternatives require that suitable treatment and dispersal sites exist. Cluster systems can be sited underground and under paved areas if sufficient open space is not available. This flexibility increases the number of candidate treatment sites. Dispersal can be done at multiple locations, if needed.

Pros and Cons of Using Cluster Systems

The advantages of using cluster systems include the following:

- Allows targeted sewering and minimizes undesired growth stimulation associated with large, centralized sewers
- Able to achieve advanced tertiary levels of treatment with the same reliability as centralized treatment facilities

- Eliminates long runs of sewer to connect isolated areas of development
- Regular O&M and sampling is cost-effective

The challenges associated with using cluster systems include the following:

- Multiple facilities to manage
- Cost-effectiveness declines with density - low density areas can become expensive to cluster compared to onsite options
- Subject to availability of suitable treatment and disposal locations
- Cost / logistics of acquiring treatment and dispersal sites must be considered

Scalability and Relevant Comparable Installations

Cluster systems range in scale from the very small (2 homes) to very large (>100,000 gpd). There is no strict definition for when a cluster system becomes a centralized system. In general, cluster systems serve one or more localized area of development that are not otherwise cost effective to combine into a larger, centralized area. From a technology standpoint, all cluster systems, when properly designed and operated, are capable of achieving TN < 3 mg/L.

Life Cycle Costs of Cluster Systems

Summarized in Table C-4 are the estimated life cycle costs associated with cluster systems. These costs were developed using the assumptions listed in Table C-5. Table C-6 contains details for the O&M costs associated with cluster systems.

Table C-4 Cluster System Life Cycle Costs

	Unit Pricing and Global Variables														
	Drainfield Costs	Land		STE House Lateral	STE Street Sewer	STE Inst.	STE Pump Station			Gravity House Lateral	Gravity Street Lateral	Grinder Pump Inst.	Gravity Pump Station	Grinder Force Main ($/LF)	
	$/gpd)	(ft²/gpd)	($/Acre)	($/LF)	($/LF)	($)	%	In Tank	Area	($/LF)	($/LF)	($)	($)	House	Street
	$4	0.80	$25,000	$15	$30	$2,000	15%	$3,500	$100,000	$20	$35	$5,000	$125,000	$10	$20

Collection System Type	Nitrogen Load Removed (kg/yr)	Collection System per Connection Costs – Materials & Install									WWTF Construction Costs[2]			Drainfield Cost[2]	Total Construction Costs	Development Costs			Total Development Costs	Life Cycle Cost Analysis					
		Septic Tanks	Pumps	Pump Stations	House Lateral (Length @		Street Sewer (Length @		Total Collection System Costs							Engin.	Land Acq.	Cont.					Rate	Term	PW Factor
																							4.00%	60	22.623
		Include Abandonment of Old Tank	15% Req. STEP or Grinder Pump to Connect	Area P.S.	50	100	50	100	Low	High	Materials	Install	Total WWTF Const. Costs			25%	0.80	20%		Total Capital Cost	Annual O&M Cost ($)	Useful Lifetime	Present Worth O&M	Life Cycle Cost ($)	Life Cycle Costs – Net Reduction to GW ($/kg/yr)
Septic Tank Effluent	13.37	$2,000	$525	$1,443	$750	$1,500	$1,500	$3,000	$5,693	$7,943	$5,081	$2,823	$7,904	$1,129	$14,726	$3,681	$130	$2,945	$6,756	$21,500	$550	60	$12,438	$33,938	$2,538
Conventional Gravity	13.37	$1,500	$750	$1,960	$1,000	$2,000	$1,750	$3,500	$6,210	$8,960	$5,081	$2,823	$7,904	$1,129	$15,243	$3,681	$130	$2,945	$6,756	$22,000	$550	60	$12,438	$34,438	$2,575
Grinder Pump / Pressure Sewer	13.37	$1,500	$0	$5,000	$500	$1,000	$1,000	$2,000	$8,000	$9,500	$5,081	$2,823	$7,904	$1,129	$17,033	$3,681	$130	$2,945	$6,756	$23,800	$550	60	$12,438	$36,238	$2,709
																			Max	**$25,200**	**$550**	**Max**	**$12,438**	**$36,300**	**$2,714**
																			Min	**$21,482**	**$491**	**Min**	**$11,100**	**$33,916**	**$2,536**

[1] Nitrogen Loads removed calculated using the average flow.

[2] Treatment and dispersal system costs calculated using Design WW Flow per Parcel and Global $/gpd cost factors.

Table C-5 Cluster System Assumptions

Cluster System Details								
# of Parcels			Nitrogen		Flow / Parcel		WW Flow (gpd)[1]	
Existing Development	Buildout Development	% Built Out	STE	To GW	Average	Design	Average	Design
176	276	64%	60	2.85	140	180	38,640	49.680

[1] Based on Buildout # of Parcels

Table C-6 O&M Costs for Example Cluster Systems

Cost Category	Susp. Growth	IFAS	FF & Carbon Feed
Septic / Sludge Pumping	$12,320	$12,320	$6,160
Pump Frequency (yr)	5	5	5
$ / Pumpout	$350	$350	$175
Inspections	$7,200	$7,200	$7,200
Sampling	$12,480	$12,480	$12,480
Electricity	$11,400	$11,400	$5,700
kw/yr	103,636	103,636	51,818
$/kw	$0.11	$0.11	$0.11
Chemical Feed	$1,000	$1,000	$0
Miscellaneous	$12,000	$12,000	$12,000
Collection System	$3,000	$3,000	$3,000
Administration	$12,000	$12,000	$12,000
Capital Recovery	$37,809	$37,809	$40,293
Total Annual O&M Cost	**$96,729**	**$96,729**	**$86,353**
Annual O&M per Parcel	**$550**	**$550**	**$491**

Connection to Existing Centralized Treatment Facility

Overview

Included in Section 2 of the document was information on the existing treatment facilities and their current and excess capacity (see Table 1-3). Figures 2-2 and 2-3 showed high concentrations of existing ISDS that are adjacent / near to sewered areas.

The number and location of these nearby existing facilities, along with the presence of excess capacity, may favor extension of the existing collection systems as a nitrogen removal alternative. The cost of connecting to a nearby existing facility, particularly one with excess treatment capacity, is typically lower than construction of new facilities. As such, this section will focus on utilizing any excess capacity in the nearby existing facilities.

No new centralized WRF alternatives will be examined as part of this study.

Pros and Cons of Connecting to Existing Centralized Facilities

The advantages of extending existing nearby sewers and utilizing an existing centralized treatment facility are as follows:

- Use of existing plant capacity eliminates costs associated with constructing new treatment facilities.
- Expansion of existing facilities is typically the most cost effective advanced tertiary treatment option, on a $/kg/yr nitrate-N removed basis, particularly where unused capacity exists.
- Potential to remove OSTDS nitrogen loads from subwatersheds, resulting in 100% removal of wastewater nitrogen. Groundwater aquifer impact of out-of-basin discharge needs to be evaluated and determined to be sustainable and acceptable.

Disadvantages of connection to an existing centralized facility are as follows:

- Large pump stations and force mains may be required to convey wastewater over potentially long distances.
- Energy use and other O&M costs associated with pumping water over long distances.
- Potential for unwanted growth for properties “along the way” between the new and existing service areas that were not previously buildable.
- Moving water across watershed boundaries may not be desirable.
- Concerns over sewer extensions as a nexus for annexation reportedly exist in some areas of Washoe County.

Pros and Cons of Constructing New Centralized Facilities

Given the number and location of existing facilities with excess capacity, construction of a new centralized facility is not likely to be an economically favorable alternative.

The following advantages apply to construction of new centralized facilities:

- Utilization of state of the art technology and equipment has the potential to improve efficiency and reliability of treatment process
- Ability to optimize location for the proposed service area
- Ability to optimize collection system alternatives
- Potential to remove OSTDS nitrogen loads from subwatersheds, resulting in 100% removal of wastewater nitrogen.

Disadvantages of constructing a new centralized facility are as follows:

- Large pump stations and force mains may be required to convey wastewater over long distances. Alternative low pressure and septic tank effluent sewers have cost and non-economic advantages.
- Energy use associated with pumping water over long distances.
- Potential for unwanted growth for properties that were not buildable prior to having sewer service.
- Moving water across watershed boundaries may not be desirable.

Scalability and Relevant Comparable Installations

The scalability of connection to existing WRFs is dependent on the existing excess capacity and the potential for expansion. This is a common practice for areas similar to Washoe County, where existing sewers are located near high density ISDS areas. Relevant, comparable installations are plentiful as this is generally the first alternative considered when the need for sewer service and high levels of nutrient removal is required.

Life Cycle Costs of Connection to Existing WWTF

The primary factors impacting the cost effectiveness of a centralized sewer system are as follows:

- Density of development, summarized as length of street sewer per connection
- House connection length
- Distance and elevation change from the proposed extension area to the treatment facility
- Cost of treating the additional flows
- Pipeline capacity analysis to determine if additional capacity is needed

The distance between the extension area and the existing centralized facility may require a large pump station and a significant length of pipe to convey flow to the existing sewers. However, this does not appear to be the case in Washoe County, as many of the high concentration ISDS areas are located adjacent to existing sewered areas. A pipeline capacity analysis is needed to ensure the existing infrastructure has the capacity for the additional future flows. The length of pipe connecting the house to street sewer is the same for either cluster or centralized options.

Figure C-3, prepared by Nichols Consulting Engineers for the Washoe County Department of Water Resources, lists the estimated construction costs for extending sewers into one section of Spanish Springs with full width paving of the impacted streets. Figure C-4 presents the same alternative with trench width paving only. Engineering, Legal, Administration, Special Services and contingency were estimated by LAI at 40% of construction costs. An allowance of $3,000 was added by LAI for house connections and abandonment of the existing ISDS. The 2011 - 2030 Comprehensive Regional Water Management Plan (2011) listed the Sewer Connection Fees as $5,900. Adding these costs to the Nichols estimates results in a total capital cost per connection of $28,300 and $21,400 for the full width and trench width paving options, respectively.

Use of a septic tank effluent gravity (STEG) system has the potential for significant savings over conventional gravity sewers. STEG systems use smaller diameter pipes at shallower slopes, cleanouts vs. manholes, and can be placed off pavement in road shoulders, which results in lowering the unit costs for both the installed pipe and the trench-width asphalt repair. Figure C-5 shows the adjusted costs for the same sewer extension area using a STEG system with the areas of savings highlighted in green. This analysis assumes the existing septic tanks are salvageable for future use.

No values for O&M costs were published for sewer extensions. A typical number for annual O&M is $600 - $1,000 / year. According to the 2011 – 2030 Comprehensive Regional Water Management Plan, $300/EDU per year should be collected for long-term repair / replacement (R/R) costs. The Plan states (page 13) that significant portions of these R/R costs are being collected in existing rates. For the purpose of this executive level analysis, LAI has assumed an annual O&M cost of $600 / connection. For the STEG systems, where pumping of septic tanks will be required on average every 5 years, $45 was added to the annual O&M costs. Table C-7 shows the life cycle costs for sewer extensions into this portion of Spanish Springs for both conventional gravity sewers and STEG sewers.

Figure C-3 – Cost Estimate for Sewer Extension in Spanish Springs, Full Width Paving

Washoe County Department of Water Resources

90% Engineers Estimate of Probable Construction Cost

Spanish Springs Sewer Phase IB

Nichols Consulting Engineers, Chtd.

August 1, 2011

ITEM	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	ITEM TOTAL	% of Base Bid
1	Mobilization/Demobilization	LS	1	$ 140,000.00	$ 140,000.00	6.1%
2	Storm Water Pollution Prevention Plan (SWPPP)	LS	1	$ 7,500.00	$ 7,500.00	0.3%
3	Provide Traffic Control	LS	1	$ 90,000.00	$ 90,000.00	3.9%
4	Connect to Existing Sewer	EA	2	$ 1,800.00	$ 3,600.00	0.2%
5	10-inch, SDR-35, PVC Sanitary Sewer Pipe	LF	2,959	$ 60.00	$ 177,540.00	7.7%
6	8-inch, SDR-35, PVC Sanitary Sewer Pipe	LF	6,568	$ 56.00	$ 367,808.00	16.0%
7	48-inch, Type1A, Sanitary Sewer Manhole	EA	38	$ 3,500.00	$ 133,000.00	5.8%
8	4-inch, SDR-35, PVC Sanitary Sewer Laterals	EA	167	$ 1,200.00	$ 200,400.00	8.7%
9	Place Type 1 PCC Curb and Gutter	LF	700	$ 25.00	$ 17,500.00	0.8%
10	PCC Valley Gutter	SF	1,656	$ 15.00	$ 24,840.00	1.1%
11	Place Median with Landscaping	SF	170	$ 18.00	$ 3,060.00	0.1%
12	Pulverize 9-inch Existing Composite Material	SY	45,792	$ 1.20	$ 54,950.40	2.4%
13	Pulverize 10-Inch Existing Composite Material	SY	2,781	$ 1.30	$ 3,615.30	0.2%
14	Trim and Remove Composite Material to Accommodate 3-inch Plantmix Bituminous Pavement Section	SY	45,792	$ 2.80	$ 128,217.60	5.6%
15	Trim and Remove Composite Material to Accommodate 4-inch Plantmix Bituminous Pavement Section	SY	2,781	$ 3.30	$ 9,177.30	0.4%
16	Place 3-inch PG64-28NV Plantmix Bituminous Pavement	SY	45,792	$ 14.00	$ 641,088.00	27.9%
17	Place 4-inch PG64-28NV Plantmix Bituminous Pavement	SY	2,781	$ 21.00	$ 58,401.00	2.5%
18	Place Type II Slurry Seal	SY	48,573	$ 1.65	$ 80,145.45	3.5%
19	Protect and Adjust Gas Valve Box to New Finish Grade	EA	13	$ 500.00	$ 6,500.00	0.3%
20	Protect and Adjust Water Valve Box to New Finish Grade	EA	56	$ 500.00	$ 28,000.00	1.2%
21	Protect and Adjust Manhole to New Finish Grade	EA	10	$ 700.00	$ 7,000.00	0.3%
22	Place Survey Monument Box to New Finish Grade	EA	17	$ 550.00	$ 9,350.00	0.4%
23	Place 6-Inch Solid White Pavement Marking (Paint)	LF	440	$ 0.25	$ 110.00	0.0%
24	Place 4-Inch Solid White Pavement Marking (Paint)	LF	440	$ 0.20	$ 88.00	0.0%
25	Place 4-Inch Solid Yellow Pavement Marking (Paint)	LF	679	$ 0.20	$ 135.80	0.0%
26	Place 24-inch x 10-foot White Longitudinal Crosswalk Striping (Preformed Thermoplastic)	LF	580	$ 6.00	$ 3,480.00	0.2%
27	Place 24-inch Solid White Stop Bars (Preformed Thermoplastic)	LF	82	$ 6.00	$ 492.00	0.0%
28	Place 12-inch Solid White Stop Bars (Preformed Thermoplastic)	LF	280	$ 4.50	$ 1,260.00	0.1%
29	Place White Bike Symbol and Arrow (Preformed Thermoplastic)	EA	2	$ 120.00	$ 240.00	0.0%
30	Cash Allowance	LS	1	$ 100,000.00	$ 100,000.00	4.4%
				Total Base Bid	**$ 2,297,498.85**	**100.0%**

# Connections	167	$/connection	$13,800
		Engineering / Special Services	$5,600
		House connection / ISDS Abandonment	$3,000
		Service Charge	$5,900
		Total Cost / Connection	**$28,300**

Figure C-4 – Cost Estimate for Sewer Extension in Spanish Springs, Trench Width Paving

Washoe County Department of Water Resources

90% Engineers Estimate of Probable Construction Cost

Spanish Springs Sewer Phase IB

Nichols Consulting Engineers, Chtd.

August 1, 2011

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	ITEM TOTAL	% of Total Base Bid
1	Mobilization/Demobilization	LS	1	$100,000	$100,000	6.8%
2	Storm Water Pollution Prevention Plan (SWPPP)	LS	1	$7,500	$7,500	0.5%
3	Provide Traffic Control	LS	1	$50,000	$50,000	3.4%
4	Connect to Existing Sewer	EA	2	$1,800	$3,600	0.2%
5	10-inch, SDR-35, PVC Sanitary Sewer Pipe	LF	2,959	$60	$177,540	12.0%
6	8-inch, SDR-35, PVC Sanitary Sewer Pipe	LF	6,568	$56	$367,808	24.9%
7	48-inch, Type1A, Sanitary Sewer Manhole	EA	38	$3,500	$133,000	9.0%
8	4-inch, SDR-35, PVC Sanitary Sewer Laterals	EA	167	$1,200	$200,400	13.5%
9	Place Type 1 PCC Curb and Gutter	LF	700	$25	$17,500	1.2%
10	PCC Valley Gutter	SF	1,656	$15	$24,840	1.7%
11	Place Median with Landscaping	SF	170	$18	$3,060	0.2%
12	Trench surface repair (3" AC on 4" Aggregate Base)	LF	14,050	$19	$266,950	18.0%
13	Trench surface repair (4" AC on 6" Aggregate Base)	LF	900	$25	$22,500	1.5%
14	Place Survey Monument Box to New Finish Grade	EA	8	$550	$4,400	0.3%
15	Place 24-inch Solid White Stop Bars (Preformed Thermoplastic)	LF	10	$6	$60	0.0%
16	Place 12-inch Solid White Stop Bars (Preformed Thermoplastic)	LF	30	$5	$135	0.0%
17	Cash Allowance	LS	1	$100,000	$100,000	6.8%
				Total Base Bid	**$1,479,293**	**100.0%**

# Connections	**167**	**$/connection**	**$8,900**
		Engineering / Special Services	**$3,600**
		House connection / ISDS Abandonment	**$3,000**
		Service Charge	**$5,900**
		Total Cost / Connection	**$21,400**

Figure C-5 Cost Estimate for Sewer Extension in Spanish Springs – STEG Alternative

Washoe County Department of Water Resources

90% Engineers Estimate of Probable Construction Cost

Spanish Springs Sewer Phase IB

Nichols Consulting Engineers, Chtd.

August 1, 2011

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	ITEM TOTAL	% of Total Base Bid
1	Mobilization/Demobilization	LS	1	$100,000	$100,000	8.5%
2	Storm Water Pollution Prevention Plan (SWPPP)	LS	1	$7,500	$7,500	0.6%
3	Provide Traffic Control	LS	1	$50,000	$50,000	4.3%
4	Connect to Existing Sewer	EA	2	$1,800	$3,600	0.3%
5	6-inch, SDR-35, PVC Sanitary Sewer Pipe	LF	2,959	$48	$142,032	12.1%
6	4-inch, SDR-35, PVC Sanitary Sewer Pipe	LF	6,568	$42	$275,856	23.5%
7	PVC Cleanouts	EA	38	$800	$30,400	2.6%
8	4-inch, SDR-35, PVC Sanitary Sewer Laterals	EA	167	$1,200	$200,400	17.1%
9	Place Type 1 PCC Curb and Gutter	LF	700	$25	$17,500	1.5%
10	PCC Valley Gutter	SF	1,656	$15	$24,840	2.1%
11	Place Median with Landscaping	SF	170	$18	$3,060	0.3%
12	Trench surface repair (3" AC on 4" Aggregate Base)	LF	14,050	$14	$196,700	16.7%
13	Trench surface repair (4" AC on 6" Aggregate Base)	LF	900	$20	$18,000	1.5%
14	Place Survey Monument Box to New Finish Grade	EA	8	$550	$4,400	0.4%
15	Place 24-inch Solid White Stop Bars (Preformed Thermoplastic)	LF	10	$6	$60	0.0%
16	Place 12-inch Solid White Stop Bars (Preformed Thermoplastic)	LF	30	$5	$135	0.0%
17	Cash Allowance	LS	1	$100,000	$100,000	8.5%
				Total Base Bid	**$1,174,483**	**100.0%**
		# Connections	**167**	**$/connection**	**$7,100**	
				Engineering / Special Services	**$2,900**	
				House connection	**$1,500**	
				Service Charge	**$5,900**	
				Total Cost / Connection	**$17,400**	

Table C-7 Sewer Extensions Life Cycle Costs – Spanish Springs

<table>
<tr><th colspan="2" rowspan="3">Collection System Type</th><th colspan="5">Life Cycle Cost Analysis</th></tr>
<tr><th rowspan="2">Total Capital Cost</th><th rowspan="2">Annual O&M Cost</th><th>Interest Rate</th><th>Term (years)</th><th>PW Factor O&M</th></tr>
<tr><th>4.00%
Present Worth O&M</th><th>60
Life Cycle Cost ($)</th><th>22.623
Life Cycle Costs Net Reduction to Groundwater ($/kg/yr)</th></tr>
<tr><td colspan="2">Septic Tank Effluent</td><td>$17,400</td><td>$645</td><td>$14,600</td><td>$32,000</td><td>$2,400</td></tr>
<tr><td rowspan="2">Conventional Gravity</td><td>Trench Width</td><td>$21,400</td><td>$600</td><td>$13,600</td><td>$35,000</td><td>$2,620</td></tr>
<tr><td>Full Width</td><td>$28,300</td><td>$600</td><td>$13,600</td><td>$41,900</td><td>$3,140</td></tr>
</table>

Nitrate Removal Required for Groundwater Quality Protection

As discussed in Section 4, a mass balance approach was used to estimate the average amount of nitrogen removal required for groundwater protection using very conservative assumptions. A sample calculation was provided in Appendix B. As review, the following terms were used in the mass balance:

Rainfall Recharge (RR) – Precipitation reaching groundwater (assumed to be 0.4 in/yr)

ISDS Recharge (ISDS-R) – ISDS flow reaching groundwater (100% of ISDS effluent, 230 gpd/system, per previous assumptions)

Rainfall Recharge + ISDS Recharge (RR+ISDS) – the combined ISDS and rainfall flow and load reaching groundwater

The estimated level of nitrate removal required for each Project Area was calculated using the following assumption:

- RR as the only dilution for nitrates contained in ISDS-R flow

Using this assumption, LAI calculated the required maximum RR+ISDS combined nitrate concentration and the associated nitrate removal to achieve a concentration of 10-mg/L and 5 mg/L in the combined recharge water. Summarized in Table C-8 are the estimated nitrate removal requirements for the 16 different Project Areas

Table C-8 Nitrate Removal Requirements for TMSA Project Area

	Basin Name	**Truckee Meadows (87)**					**Lemmon Valley (92A & 92B)**			**Pleasant Valley (88)**		**Washoe Valley (89)**		**Truckee Canyon (91)**		**Cold Springs (100)**	**Spanish Springs (85)**	**Total**
	Project Area	**Ambrose**	**Island 18**	**Hidden Valley**	**Huffaker**	**Geiger**	**Silver Knolls**	**Heppner**	**Golden Valley**	**Mt. Rose**	**Pleasant Valley**	**Washoe**	**New Washoe**	**Mogul**	**Verdi**	**Cold Springs**	**Spanish Springs**	
Number of Systems	#ISDS – Project Area	475	907	780	1,764	858	529	954	845	1,026	535	1,296	197	544	341	1,325	1,848	14,224
	#ISDS – Basin	5,870					2,670			1,665		1,852		1,020		1,397	2,346	16,820
	#ISDS – Basin not in Project Areas	1,086					342			104		359		135		72	498	2,596
	% of ISDS in Basin included w/Project Area	81%					87%			94%		81%		87%		95%	79%	85%
	Project Area																	
Area	Area (mi^2)	5.8	7.0	6.9	24.0	6.6	6.5	9.4	10.7	12.5	8.8	12.6	3.1	6.4	3.7	7.5	11.1	143
	Basin Area (mi^2)	195.0					96.8			39.0		82.8		83.5		29.5	80.1	607
	% of Basin Area	3%	4%	4%	12%	3%	7%	10%	11%	32%	23%	15%	4%	8%	4%	25%	14%	24%
	Recharge Flows																	
Recharge Flows ISDS Precipitation GW Recharge	ISDS Recharge (MGY)	40	76	65	148	72	44	80	71	86	45	109	17	46	29	111	155	1,194
	Precip. Recharge – Project Area (MGY)	40	49	48	167	46	45	65	74	87	61	88	22	44	26	52	77	991
	GW Recharge – Basin (MGY)	8,795					489			3,257		4,886		1,303		163	195	19,088
	GW Recharge – Prorated Based on Project Area % of Basin Area (MGY)	85	103	101	353	97	11	15	18	340	239	242	60	33	19	13	7	1,736

Table C-9 Nitrate Removal Requirements for TMSA Project Area - Continued

	Project Area	**Ambrose**	**Island 18**	**Hidden Valley**	**Huffaker**	**Geiger**	**Silver Knolls**	**Heppner**	**Golden Valley**	**Mt. Rose**	**Pleasant Valley**	**Washoe**	**New Washoe**	**Mogul**	**Verdi**	**Cold Springs**	**Spanish Springs**	
ISDS + Precipitation Recharge Only																		
RR + ISDS Recharge Nitrate Concentration	Recharge to GW – Septic to Precip Ratio	1.0	1.6	1.4	0.9	1.6	1.0	1.2	1.0	1.0	0.7	1.2	0.8	1.0	1.1	2.1	2.0	
	ISDS % Total Recharge	50%	61%	58%	47%	61%	50%	55%	49%	50%	42%	55%	43%	51%	53%	68%	67%	
	Recharge Nitrate Conc. (mg/L)	22.5	27.6	26.1	21.3	27.6	22.4	24.9	22.1	22.5	19.2	25.0	19.7	22.9	23.8	30.7	30.1	
Average Nitrate Removal Requirements by Project Area – ISDS + Precipitation Only																		
Nitrate Removal Requirements – No Consideration of GWR	Removal Target Requirement Target – 10 mg/L	67%	73%	71%	65%	73%	67%	70%	66%	67%	61%	70%	62%	68%	69%	76%	75%	70%
	Removal Requirement Target – 5 mg/L	84%	87%	86%	83%	87%	84%	85%	83%	84%	81%	85%	81%	84%	85%	88%	88%	85%
Max. End of Pipe TN Req'd (mg/L)	5	10	8	8	10	8	10	9	10	10	11	9	11	10	9	7	7	
	10	20	16	17	21	16	20	18	20	20	23	18	23	19	19	15	15	

TASK 3 REPORT

FINANCING ALTERNATIVES-SEPTIC SYSTEMS

STRATEGIES FOR MANAGEMENT OF HIGH-DENSITY SEPTIC SYSTEM DEVELOPMENTS IN WASHOE COUNTY

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and

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1.0 INTRODUCTION

The Western Regional Water Commission conducted an Analysis to Identify Alternatives for Management of Groundwater Quality Impacted by High Density Septic System Development in the Truckee Meadows Service Area (TMSA). This Task 3 Financing Alternatives Report identifies and discusses:

a. Practical grant and loan funding sources
b. Affordability analysis
c. Fee collection mechanisms
d. The financial sustainability of a Responsible Management Entity (RME) that would manage On-site Wastewater Treatment and Disposal/Reuse Systems (OSTDS)

1.1 Summary of Relevant Information from Previous Reports

The following are relevant facts/conclusions from previous Task Reports:

- There are 14,224 Individual Sewage Disposal Systems (ISDS) in the TMSA Project Areas, grouped into 16 project areas, with an additional 2,596 within the basins but outside project areas. The total number of ISDSs in the basins is 16,820.
- Five of the 16 Project Areas have documented adverse impacts to groundwater quality with respect to nitrates.
- Nine of the Project Areas are suspected of having nitrate-impacted groundwater, but further data collection activities are needed to confirm.

As described in the Task 2 Report, Table 2-2 reproduced below as Table 3-1, lists the properties requiring 100% Nitrogen Removal and associated costs for sewering assuming that sewers are installed with only trench width paving. Other techniques are projected to reduce these costs by 10% - 20%. Sewering with full width paving increases capital costs by 33%.

Table 3-1 Number of Properties Requiring Nitrogen Removal & Capital Improvement Program for Required Nitrate Removal in Project Area

Priority Level	Properties Req. 100% Removal		Properties Req. 93% Removal with In-Basin Discharge		Total Capital Cost – 100% Removal w/Out-of-Basin Discharge[1]	Total Capital Cost – 93% Removal w/In-Basin Discharge[2]
	#	%	#	%		
Scenario 1 (Phase 1 Areas Only)	1,546	11%	1,656	12%	$45,100,000	$52,500,000
Scenario 2 (Phase 1 & 2 Areas)	5,926	42%	6,349	45%	$150,900,000	$179,400,000
Scenario 3 (Phase 1, 2 & 3 Areas)	10,386	76%	11,610	82%	$269,500,000	$321,500,000

[1]Please note for 100% nitrogen removal with out-of-basin discharge, costs are based on conventional sewer system with trench-width paving and out-of-basin discharge based on one engineer's estimate of sewer extension costs in Spanish Springs. Lower density developments will have higher costs. Areas are assumed to be adjacent to existing sewered areas; therefore, no transmission cost is provided. If transmission piping is needed, costs for this option will increase.

[2]Costs based on septic tank effluent collection cluster systems achieving 93% nitrogen removal discharging within the basin.

The project areas were identified and prioritized in previous investigations (Kropf, 2007). The State of Nevada Intended Use Plan designated Spanish Springs as a high priority area, suggesting that the phasing of improvements to be implemented should be as follows:

Phase 1:

- Spanish Springs

Phase 2:

- Cold Springs
- Washoe
- Golden Valley
- Heppner
- Mt. Rose

Phase 3:

- All Truckee Meadows Basin Project Areas
- Pleasant Valley
- Mogul
- Verdi

Phase 4:

- Silver Knolls
- New Washoe

2.0 PROGRAM FINANCING

2.1 Government Financing Options

Grants and loans for the capital costs (construction plus development costs such as engineering and financing, not Operations & Maintenance (O&M) costs), associated with wastewater projects are available under several Nevada State and Federal programs. Major programs that are available include:

- Federal Sources
  - USDA Rural Utilities Service (RUS)
  - US EPA Nonpoint Source Section 319 Grant Program
  - HUD Community Development Block Grants
  - Department of Commerce Economic Development Administration
- US EPA Hardship Grants Program for Rural Communities
  - Federal/State Combined Sources
  - State Revolving Funds (SRF) Program with the SRF and RUS programs being the largest

With recent Federal program budget reductions, funding from these sources will become even more challenging and competitive; however, given the leadership of Washoe County and significance of the issues to the State of Nevada, communication with funding sources should be initiated as they may be interested in being partners with the County and/or provide limited funding for demonstration projects.

At this time, with interest rates at historic lows, it is LAI's opinion that the majority of project funding may be best achieved through conventional municipal financing by the County. While State and Federal grants and loans should be further investigated, they should not be relied upon as the sole focus at this time. The USDA RUS and USEPA/State 319 grant programs (requires a 40% local match which can be a SRF loan) may be the best available existing grant programs. As stated herein, forgivable loans (i.e. grants) are part of the USEPA SRF Program. USDA RUS grants are usually awarded solely for the purpose of establishing affordable user rates. The 319 Program funds are very limited and therefore should only be considered for initial and/or demonstration projects. The SRF and USDA RUS funds are the largest federal/state low interest loan programs. Efforts should always be maintained to stay in contact with the funding sources identified in this report and pursue funding sources as funding availability/appropriations and priorities change, typically on a yearly basis. Given the importance of the issues to the State of Nevada, contact with State and Federal legislature representatives for potential demonstration project(s) funding should be maintained.

The major federal programs, along with the state revolving funds, are briefly described below.

2.1.1 State Revolving Fund (SRF) Loans

Capital for state SRF programs is provided as a 20% match by the state and 80% by US EPA. States have discretion to establish program priorities and project eligibility criteria under US EPA guidelines. For FY2012, the State of Nevada was provided a $7.008 million federal capitalization grant which the NDEP was required to match with 20% of state funds. The distribution of the funds is governed by the 2012 Intended Use Plan http://ndep.nv.gov/bffwp/docs/cw_iup_draft_2012.pdf and the 2013 Year State Priority List http://ndep.nv.gov/bffwp/docs/2013_cwsrf_priority_list.pdf. It is noted that the Spanish Springs septic to sewer project with an estimated cost of $34 million, and the Verdi septic to sewer project with an estimated cost of $7 million, are number 1 and 27, respectively, on the State's Priority List.

The Clean Water State Revolving Fund (CWSRF) of the State's SRF program distributes approximately $10 million annually to public entities in Nevada. The repayment period for loans is 20 years. Interest rates are currently calculated at 62.5% of the Bond Buyers Index Rate. As of June 7, 2012, the Bond Buyers Index was 3.92%, making the SRF interest rate approximately 2.45%, which would result in an approximate 13.2% reduction in loan repayment costs as compared to a municipal bond rate of 4%; an approximate 5% reduction in loan repayment costs as compared to a municipal bond rate of 3%.

Recently, US Congress required that at least 10% of the EPA Capitalization Grant for the SRF program be used for green projects (for which decentralized systems would qualify) and 20% - 30% be used as subsidies (i.e., loan forgiveness).

The SRF program requires that projects apply for, and be placed on, the Intended Use Plan. In general, SRF funding is challenging to obtain due to high demand. In addition, such funds are typically loans, not grants, with the exception of forgivable loans. However as stated above, Spanish Springs is number 1 on the State's priority list, thus making SRF funding likely for Spanish Springs.

Local contact:

Adele Basham
Nevada Department of Environmental Protection
Office of Financial Assistance
Bureau Chief
Phone: (775) 687-9488
Fax: (775) 687-9510

2.1.2 USDA Rural Utility Service (RUS)

Communities may be able to fund projects through RUS, formerly Farmers Home Administration (FmHA). RUS offers low interest loans depending on criteria set by RUS for award. The RUS grant/loan program is a grant in conjunction with a low-interest loan. The population and the median income are two important factors used to determine pre-qualifiers for the RUS grant and low interest loan programs. The final eligibility for RUS funding depends upon the available funding in the program, the number of projects submitted, and the rankings for each project. The projects can be phased to spread the cost over a number of years in order to maximize funding.

To receive funding a community must show that it:

- Cannot obtain funding from commercial lenders at reasonable rates
- Has the capacity to borrow and repay loans and pledge security
- Can operate and maintain the affected facilities
- Has a population < 10,000 people

The maximum grant funding level is 75 percent of a project's total cost.

Interest rates for Rural Utilities Service (RUS) water and wastewater loans—issued quarterly at three different levels: the poverty line rate, the intermediate rate, and the market rate, are routinely updated. The rate applied to a particular project depends on community income and the type of project being funded.

To qualify for the *poverty line rate*, two criteria must be met. First, the loan must primarily be used for facilities required to meet health and sanitary standards. Second, the median household income of the area being served must be below 80 percent of the state's non-metropolitan median income or fall below the federal poverty level. For 2012, the federal poverty level is $23,050 for a family of four, http://aspe.hhs.gov/poverty/12poverty.shtml. To qualify for the *intermediate rate*, the service area's median household income cannot exceed 100 percent of the state's non-metropolitan median income.

The *market rate* is applied to projects that do not qualify for either the poverty or intermediate rates. The market rate is based on the average of the Bond Buyer index.

Subareas of Washoe County may qualify for the small community wastewater facilities grant program.

Current rates (http://www.rurdev.usda.gov/UWP-int-rate.htm) are:

- poverty line: 2.125 percent
- intermediate: 2.75 percent
- market: 3.5 percent

Local contact:

Sarah Adler, State Director
1390 South Curry Street
Carson City, NV 89703-9910
(775)887-1222 x103 Program telephone
sarah.adler@nv.usda.gov

2.1.3 Clean Water Act Section 319 Non-Point Source Management Program

This program provides grants through state governments. The goal of the program is to support projects nationwide that work to restore water adversely affected by non-point source pollution and to protect waters endangered by such pollution. Most states allow the use of Section 319 funds for decentralized wastewater system projects. The program has provided money to small communities and state agencies to construct decentralized wastewater systems in areas where these systems are more cost effective than centralized systems. Funds have also been used for the repair of existing decentralized wastewater systems and for decentralized system technology demonstration projects. Projects must meet a minimum set of project planning, implementation, monitoring, and evaluation requirements designed to lead to successful documentation of project effectiveness with respect to water quality protection or improvement.

Funding is limited and there is significant competition for grant funds, which require a 40% local match.

NDEP awarded $1,289,240 in December 2011 to local governments and others to implement projects designed to reduce the impacts of NPS pollution. Additional grant funding is expected to be made available to qualifying projects in July 2012. (See http://ndep.nv.gov/bwqp/nps319h.htm)

Local Contact:

Birgit Widegren
Supervisor, Nonpoint Source Program
Bureau of Water Quality Planning
Nevada Division of Environmental Protection
775-687-9550
bwidegren@ndep.nv.gov

2.1.4 HUD Community Development Block Grant (CDBG) Program

HUD provides block grants to participating states, which allocate funds to local governments that perform development activities, principally for people with low to moderate incomes. HUD requires that 70 percent of grant funds be used to benefit low and moderate-income people. Detailed eligibility requirements vary by state. Funded activities include wastewater, drinking water, and economic development projects. As of 1999, 48 states and Puerto Rico participate in the HUD CDBG program. CDBGs are available directly from HUD for communities in these states. HUD provided approximately $3 million to Nevada for FY 2010.

Contact:

Maria Cremer
600 Harrison Street, 3rd Floor
San Francisco, CA 94104
Phone: (415) 489-6572
Fax: (415) 489-6602
Maria.F.Cremer@hud.gov

2.1.5 Department of Commerce Economic Development Administration (EDA) Funding

EDA grants are intended to help distressed communities attract new industry, encourage business expansion, diversify local economies, and generate long-term jobs. Water and wastewater facilities designed primarily to serve industry and commerce are among the many projects that can be funded under this program.

Contact:

Richard Tremblay
U.S. Economic Development Administration
550 W. Fort St., Room 111
Boise, ID 83724
Phone: 208-334-1035

2.2 Local Financing Options

Local financing options include community-wide charges and those based on the service area:

- Community-Wide
  - Taxes - property and/or local assessment districts
  - Special Assessments
  - Sales tax
  - Bonding
- Service-Area-Wide
  - User-charges
  - Connection fees

2.2.1 Community-Wide

Local community-wide financing options include all financing options that are derived from the community at large through public means with fees paid by ad valorem taxes or special assessment(s).

Special assessments and associated bonding are possible through current enabling State Legislation.

For example, in 1995, the Nevada legislature enacted NRS 540A.250 et seq., through which the Washoe County Commission created the Central Truckee Meadows Remediation District (CTMRD) to impose a fee upon certain properties within the region for the purpose of remediating widespread tetrachloroethene (PCE) groundwater contamination in the central Truckee Meadows. The principal goal of the CTMRD is to prevent, protect, and mitigate PCE contamination in accordance with an adopted Remediation Management Plan (RMP). NRS 540A.260 allows the RMP to include "any action which is reasonable and economically feasible in the event of the release or threat of release of any hazardous substance into the environment which may affect the water quality in this state." The RMP defines the activities, processes, and procedures utilized to address the PCE contamination of the central Truckee Meadows.

Legal counsel for the WRWC has advised that the authority and procedures contained in the above statutes may be broad enough for use to create a new district to remediate, through various methods subject to a plan to be adopted, the groundwater contamination addressed in this Report. The boundaries of such a district and fees imposed upon beneficiaries of varying degree are issues that would require resolution.

Other potential financing alternatives are also available through existing legislation, as follows:

- Chapter 271, Nevada Revised Statutes, provides for financing of local improvements, including sanitary sewer projects, through a process for creation of special assessment districts, and the collection of assessments for such projects.
- Chapter 318, Nevada Revised Statutes, provides for financing of local improvements, including sanitary sewer improvements, through a process for creation of general improvement districts, and the imposition of rates, tolls, and charges for the services provided by the district.

Special legislation is an additional option to create a community tailored financing system.

Alternative structures are also possible, such as establishing special tax rate districts. The property tax can be used to finance all or a portion of a wastewater system. Chapter 318, Nevada Revised Statute (NRS) governs the establishment and duties of General Improvement Districts (GIDs). Pursuant to NRS 318.050, the County Board of Commissioners is vested with jurisdiction, power and authority to create districts within the county. GIDs may be established for a variety of purposes including paving, curb and gutters, sidewalks, storm drainage and sanitary sewer improvements. In the case of a GID established wholly or in part for sanitary sewer improvements (NRS 318.140), the board of trustees of the GID may construct, reconstruct, improve or extend the sanitary sewer system or any part thereof, including, collection systems, treatment and disposal plants.

Pursuant to NRS 318.100, the GID board of trustees may, except as otherwise provided in the statute, construct or acquire any improvement pertaining to the GID functions, and may finance the costs of any such improvement by any of the procedures provided in the statute. The financing can be accomplished through several mechanisms. First, pursuant to NRS 318.225, the board has the power and authority to levy and collect general (ad valorem) taxes on and against taxable property within the district. Such levies and collections are made in conjunction with the county and its officers, as outlined in the statute. Pursuant to NRS 318.230, taxes may be used for paying both operating and maintenance expenses, and the capital costs for the sewage collection, treatment and disposal systems and the repayment of principal and interest of general obligation bonds and other obligations of the district for sewage services.

Additionally, pursuant to NRS 318.275, the board has the authority to borrow monies for sewage system construction, as outlined in the statute. Allowable methods of borrowing under the statute include.

- Short-term notes, warrants and interim debentures
- General obligation bonds
- Revenue bonds
- Special assessment bonds

Pursuant to NRS 318.197, the board may fix, and from time to time increase or decrease, sewer rates, tolls or charges (other than special assessments), including, but not limited to, service charges and standby service charges (for services or facilities furnished by the district), charges for the availability of service, annexation charges, and minimum charges. The board has the ability to set forth late payment penalties, etc., within the limits of the statute. The statute outlines procedures for collection of service charges collected for the forthcoming fiscal year on the tax roll in the same manner and together with the county's general taxes. The board has the authority, within the limits of the statute, to impose a lien or other penalty on or against a served property for non-payment of rates, tolls or charges.

Various techniques have been used throughout the US to provide temporary or permanent relief of partial or all capital cost assessments to special needs groups such as low-income and elderly. Bond counsel and financing specialists will need to be relied upon should the project communities wish to utilize these techniques.

As described in EPA's comments on **Rate Options to Address Affordability Concerns for Consideration by District of Columbia Water and Sewer Authority,** http://water.epa.gov/infrastructure/sustain/upload/2009_05_26_waterinfrastructure_pricings_AffordOptions.pdf in developing an affordability program for wastewater rates, a utility will need to consider a number of aspects of the program:

- Identification of groups that are the intended beneficiary of subsidies
- Establishment of criteria and methods for assessing eligibility for participation in the program
- The objectives of the assistance program
- The particular nature and extent of subsidies
- The source of funds to pay for the subsidies

Target groups for subsidies can be:

- Elderly (specified age, typically 65 and over)
- Disabled (usually require a doctor's certification)
- Low income (criteria vary widely)
- Unemployed
- Households facing temporary financial emergencies (criteria vary widely)
- Combination (e.g., low income AND elderly, low income AND disabled)
- Owners/tenants – Programs are commonly limited to owner-occupants of single family residences or tenants of single family residences

Naturally a financing-user charge impact analysis needs to be performed to determine the impact of subsidies on other users of the system that will be paying the subsidy.

2.2.2 Service-Area-Wide

Local service-area financing options include revenues that are derived only from the property owners served by the wastewater system. These financing options can be implemented through public or private entities. They can take the following forms:

- **User-charges** are periodic (monthly, quarterly, or semiannual) fees paid by all property owners in the wastewater system. User charges can be structured as a fixed fee per connection, a fee based on actual wastewater flows (flat rate or a usage based multi-step rate structure with a minimum monthly fee), or a fee based on allocated capacity (regardless of actual usage). User-charges can be implemented to raise revenues for capital, O&M, or both.

- **Connection fees** are typically a one-time payment or assessment made at the time the wastewater system is built, when the property connects to the system, or some combination of both. The fee is the proportionate share of the capital costs. Connection fees are assessed based on the principal that the property is being improved by the wastewater system. Connection fees can be assessed based on lot size, street frontage, water demand/wastewater generation capacity, or as a fixed amount per equivalent dwelling unit (EDU), with non-residential properties assessed based upon similar capacity criteria.

A combination of property taxes, user fees, and connection fees is frequently used to finance public projects.

2.3 Financial Characteristics of Study Area

Communities fund wastewater projects through municipal (or County or other public entity) bonds. Municipal bond interest rates will depend on the community's bond rating. Current municipal bond ratings for Washoe County are:

- Washoe County AA - General Obligation Rating by Standard & Poor

As of June 2012 according to Bloomberg, municipal bond rates are approximately:

- 20-year General Obligation for AA rated Municipality 3.70%per annum
- 30-year Revenue Bonds for AA rated Municipality 4.25% per annum

According to the New York Times, July 13, 2012 edition, high quality municipal bonds are <3% for a 30-year term.

3.0 AFFORDABILITY ANALYSIS

The affordability and ability, not willingness, of the customer base to pay in accordance with the necessary fee structure is assessed in this Section using US EPA (1997) guidelines, as discussed herein.

3.1 Federal Guidelines

US EPA (1997) developed guidelines to assess the affordability of wastewater fees using a two-phased approach, (See Environmental Protection Agency, Office of Water, Office of Wastewater Management, "Combined Sewer Overflows— Guidance for Financial Capability Assessment and Schedule Development," EPA 832-B-97-004, February 1997).

Phase 1 determines the Residential Indicator using the projected fees as a percent of the local median household income (MHI). EPA's guidance on the affordability of investment in wastewater systems uses an average household rate of 2 percent of MHI. The indicator characterizes whether the costs impose a low, mid-range or high financial impact on residential users.

EPA's criteria compare the revenues collected by a water/wastewater system to the median household income (MHI) in a service area, not to individual household income, see Congressional Budget Office Study 2002 at:
http://www.cbo.gov/doc.cfm?index=3983&type=0&sequence=7

EPA's affordability assessment guidelines are the annual cost as a percentage of median household income with the following Table 3-2 benchmarks for comparison:

Table 3-2 Residential Affordability Indicators

Financial Impact	Residential Indicator (cost as % MHI)
Low	<1.0%
Mid-Range	1.0 – 2.0
High	>2.0%

The second phase analysis develops the Financial Capability Indicators using indicators to evaluate:

- Debt
- Socio-Economic conditions
- Financial conditions

All of these are used to serve as the basis for a second phase analysis to characterize the municipalities' financial capability as weak, mid-range or strong.

3.2 Federal Guidelines – Application to Washoe County

3.2.1 Phase One – Residential Indicator

The 2006-2010 median household income (MHI) for Washoe County was $55,658 in 2010 dollars per the United States Census (http://quickfacts.census.gov/qfd/states/32/32031.html). EPA (1997) states that the average Consumer Price Index (CPI) for the past five (5) years should be used for projecting costs. The CPI is used as a simple and reliable method of indexing projected wastewater treatment costs and household income. The CPI index (ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt) for the past 5 and 10 years are presented in Table 3-3.

Table 3-3 CPI Indices

Year	CPI Index
2001	2.8
2002	1.6
2003	2.3
2004	2.7
2005	3.4
2006	3.2
2007	2.8
2009	-0.4
2010	1.6
2011	3.2
Average 2007-2011	2.2
Average 2002-2011	2.42

Estimated affordability rates solely using this criteria, are presented in Table 3-4. Affordability of lower income households, especially those below the poverty level, and the unemployed will be an issue, especially due to the recession and poor economic and housing conditions of the past few years. Techniques are available to address this matter, as described in Section 2.2.1.

Table 3-4 MHI & Calculated Average Affordability User Rates

Indicators		
Median Household Income (MHI) (2006-2010)	$55,658	
2012 Projected MHI	$58,134	
User Charges as % MHI	**Annual**	**Monthly**
1.0%	$581	$48.44
1.5%	$872	$72.67
2.0%	$1,163	$96.89

3.2.2 Phase Two – Financial Capability Indicators

The six Financial Capability Indicators are:

1) Bond rating
2) Overall net debt as a percentage of full market value of taxable property
3) Unemployment rate
4) Median household income – as a percentage of state median income
5) Property tax revenue collection rate
6) Property tax revenues as a percentage of full market value of taxable property are presented on Table 3-6.

Information was derived from the Washoe County Comprehensive Annual Financial Report for fiscal year ending June 30, 2011 (http://www.co.washoe.nv.us/finance/cafr2011.htm) and the U.S. Census Bureau. For each of the indicators, a score is assigned based upon the Benchmarks described below and the following:

Table 3-5 Benchmarks

Benchmark	Score
Weak	1
Mid-Range	2
Strong	3

An overall average financial capability is determined. Although the analysis should reflect existing conditions, pending changes should be considered in the development of the second phase indicators (EPA, 1997). Comments on each indicator are as follows:

Debt

Financial data that illustrates existing and projected debt burden and remaining debt issuing capacity are also important indicators.

Bond Rating

When a Bond Rating is not available, this indicator is excluded from the analysis. The rating agency categories and associated ratings are listed below.

Table 3-6 Bond Ratings

Moody's Investor Services Category	Rating
Weak	Ba, B, Caa, Ca, C
Mid-Range	Baa
Strong	Aaa, AA, A
Standard & Poor's Investor Services Category	**Rating**
Weak	BB, B, CCC, CC, C, D
Mid-Range	BBB
Strong	AAA, AA, A

Table 3-7 Secondary Financial Health Indicators

Indicator	No.	Description	Washoe County
Debt	1	Bond rating (S&P)	AA
		Overall net debt ($ million)	$318
		Full market value of taxable property ($ million)	$13,658
	2	Overall net debt (as% of full market value of taxable property	2.33%
SocioEconomic	3	Unemployment Rate – Washoe County	11.4%
		National Rate	8.2%
		Nevada State Rate	11.7%
	4	Washoe County Median Household Income (2011)	$55,658
		National MHI (2006-2010), 2010 dollars	$51,914
		Median household income (2006-20100 – as a percentage of national MHI	107%
		Per Capita Income (2006-2010), 2010 dollars	$29,687
		Persons per household (2006-2010)	2.52
		Persons below poverty level, percent (2006-2010)	12.6%
Financial Management	5	Property tax collection rate	98.5%
		Property tax revenue ($ million)	$452
		Median Taxable Property Value (2010)	$295,700
		Per Property Taxes	$798
		Mileage Rate ($1 per thousand)	2.7002
	6	Property tax revenues (as % of full market value of taxable property	3.31%
		Sales Tax Rate	7.73%

Overall Net Debt as % of Full Market Property Value

Overall net debt is debt repaid by property taxes and excludes debt which is repaid by special user fees, with benchmarks listed below:

Table 3-8 Overall Net Debt as % of Full Market Property Value

Benchmark	Score
Weak	>5.0%
Mid-Range	2.0 – 5.0%
Strong	<2.0%

Socioeconomic

Unemployment Rate

The unemployment rate and its comparison to national average are used as a socioeconomic indicator to assess the general economic well-being of residential users in the service area. Benchmarks are presented below:

Table 3-9 Unemployment as Compared to National Average

Benchmark	Score
Weak	>1.0%
Mid-Range	+/-1%
Strong	<1.0%

Median Household Income as % of National Average

Benchmarks for MHI as compared to National averages are presented below:

Table 3-10 Mean Household Income as % of National Average

Benchmark	Score
Weak	>25% or below
Mid-Range	+/-25%
Strong	<25% or above

Property Tax Revenues as % of Full Market Property Value

This indicator is referred to as the Property Tax Burden since it indicates the funding capacity available to support debt based upon the wealth of a community. It also reflects the effectiveness of management in providing community services (EPA, 1997).

Table 3-11 Property Tax Revenues as % of Full Market Property Value

Benchmark	Score
Weak	>4.0%
Mid-Range	2.0 – 4.0%

Property Tax Revenue Collection Rate

The Property Tax Revenue Collection Rate benchmarks are as follows:

Table 3-12 Property Tax Revenue Collection Rate

Benchmark	Score
Weak	<94%
Mid-Range	94 – 98%
Strong	>98%

3.2.3 Financial Capability Matrix

The results of the Residential Indicator and Financial Capability Indicators Analysis are combined in the Financial Capability Matrix as illustrated on Table 3-13.

Table 3-13 Financial Capability Matrix

Financial Capability Indicators Average Score	Residential Indicator		
	Low (<1.0%)	Mid-Range (1.0 – 2.0%)	High (above 2.0%)
Weak (below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (above 2.5)	Low Burden	Low Burden	Medium Burden

3.2.4 Scheduling Considerations

For reference purposes, the EPA (1997) developed scheduling considerations for Combined Sewer Overflows (CSO) controls implementation are presented on Table 3-14.

Table 3-14 Financial Capability Scheduling Considerations

Financial Capability Matrix	Implementation Period
Low Burden	Normal Engineering/Construction
Medium Burden	Up to 10 years
High Burden	Up to 15 years

3.3 Affordability Analysis Application to Washoe County

Based upon the above EPA guidance and data for Washoe County, Table 3-14 presents the Financial Capability Score with the result being mid-range. With comparison of the score for Washoe County to the Capability Matrix of Table 3-15, the affordability analysis indicates that there would be medium to high burden for all areas depending on the user charge system selected, as discussed in Sections 4 and 5.

Table 3-15 Financial Capability Indicator Score

Category	Rating	Score
Bond Rating (S%P)	AA	3
Overall net debt (as % of full market value of taxable property	2.33%	2
Unemployment as compared to National Average	11.4%	1
Mean Household Income as % of National Average	107%	2
Property Tax Revenues as % of full market property value	3.31%	2
Property Tax Revenue collection rate	99%	3
Average		**2.17**

4.0 FEE COLLECTION MECHANISMS

Alternative fee collection mechanisms include property taxes, betterments and user fees. As described in NRS 318, the GIDs have the ability to set up rates, tolls and charges, and procedures for fee collection are addressed in the statute.

Annual O&M costs are typically assessed on property as a user fee. It is recommended that all or a significant portion of the replacement fund contribution be associated with the annual user fee. Deferring replacement fund contributions for a number of years (i.e. 5 years) and having "co-pays" for OSTDS replacements are options.

Grants are typically available for connection and assessment fees for low-income families and the elderly and have been funded by CDBG and State Housing Initiatives Partnership (SHIP) programs.

Developing fee deferral programs for the elderly and low-income households in which the fees accumulate and are paid when the property is sold may also be advantageous. Cash-flow financing, usually through fees on other users, will need to be provided to the ownership agency.

5.0 PRO FORMA AND SUSTAINABLITY ANALYSIS

The financial sustainability of the wastewater management plan is addressed by consideration of the initial capital costs and ongoing operating and maintenance and replacement costs. To address this issue, a preliminary financial pro forma table, presented in Appendix B for Scenario 1, illustrates the economic sustainability of a RME responsible for all OSTDS and Advanced Wastewater Treatment (AWT) upgrades, based upon the assumptions stated on the spreadsheet, with the yellowed cells indicating input variables.

For financial analytical purposes only, this report presents the two options of out-of-basin discharge with conventional sewers and trench width paving and the in-basin-discharge option, which assumes that all wastewater nitrogen removal is achieved with cluster systems with in-basin discharge having 93% nitrogen removal, which requires 107% of the number of properties requiring 100% N removal as effluent is discharged locally to groundwater and not out-of-basin. Table 3-16 presents the required Capital Improvement Program (CIP) for these two options.

Table 3-16 Number of Properties Requiring OSTDS & Capital Improvement Program for Required Nitrate Removal in Project Areas

Priority Level	Properties Req. 100% Removal		Properties Req. 93% Removal w/In-Basin Discharge		**Total Capital Cost – 100% Removal w/out of Basin Discharge[1]**	**Total Capital Cost 93% Removal w/In-Basin Discharge[2]**
	#	%	#	%		
Scenario 1 (Phase 1 Areas Only)	1,546	11%	1,656	12%	$45,100,000	$52,500
Scenario 2 (Phase 1 & 2 Areas)	5,925	42%	6,349	45%	$150,900,000	$179,400,00
Scenario 3 (Phase 1, 2 & 3 Areas)	10,836	76%	11,610	82%	$269,500,000	$321,500,000

[1] Please note for 100% nitrogen removal with out-of-basin discharge, costs are based on conventional sewer system with trench-width paving and out of basin discharge based upon only one engineer's estimate of sewer extension costs in Spanish Springs. Lower density developments will have higher costs. Areas are assumed to be adjacent to existing sewered areas. Thereby no transmission cost is provided.

[2] Costs based on septic tank effluent collection cluster systems achieving 93% nitrogen removal discharging within the basin.

Sustainable user charges are estimated in Table 3-17 for the following user charge scenarios assuming all Priority Areas are addressed:

The following assumptions have been made:

- Cluster systems with AWT have an average capital cost of $23,900 per property
- 10% of OSTDS outside the Scenario 1 area will require repair at $4,000 each. The repair is only for septic system functionality, not for AWT nitrogen removal.
- An additional 1% per year of new failures will occur. Five years of these new failures are capitalized as part of the Capital Improvement Program (CIP).

In addition to the costs of the CIP, a management allowance of 15% is used for CIP financing, land acquisition, legal and administration. As an initial executive level placeholder amount, LAI is of the opinion that a 15% CIP Management allowance is prudent. Table 3-17 costs include the 15% CIP management allowance.

Table 3-17 Capital Improvement Program

(Debt service is same for all properties with Priority 1, 2 & 3 Areas being implemented)

Septic Tank Effluent Cluster System with In-Basin Discharge			
Financing Affordability Analysis	**All Properties with same O&M & CIP Charge[1]**		
	Phase 1 – Priority Area 1 only	**Phase 2 – Priority Areas 1 & 2 only**	**Phase 3**
Capital Improvement Program (CIP)	$52,500,000	$179,400,000	$321,500,000
Number of Properties with Nitrogen Removal Systems – In-basin Discharge	1,656	6,349	11,610
% of Total	12%	45%	82%
Annual O&M	$206	$383	$509
OSTDS & ISDS Replacement Fund	$58	$108	$164
CIP Debt Service[1]	$180	$617	$1,105
Total Annual Cost	$444	$1,107	$1,778
Total Monthly Cost	$37	$92	$148
% of MHI – Washoe County	0.76%	1.90%	3.06%
User Charge Burden	Low	Medium	High

[1]Financing rate of 4.00% and term of 30 years assumed

There are many variables that need to be reviewed and discussed to refine these estimates prior to public discussion as there are numerous options available. It is not unusual to have all participants in a Plan pay the same fee using the rationale that all benefit from restored water quality as well as all are equally contributing to the water quality standard exceedance. This method avoids the disputes that will arise from different user classes.

Please note that all costs at this level of planning should be viewed with the industry standard range of -15% to +30% of the presented values.

6.0 START–UP – INITIAL CAPITALIZATION OPTION

There will be numerous additional technical, legal and financial efforts in addition to those associated with this project prior to the establishment of an On-Site Wastewater Management RME for Washoe County. Normal practice is the preparation of a detailed Engineering Plan that is then used as the basis for legal establishment of the RME, its boundaries, bonding, grant/loan applications, user charges, etc.

As the Engineering Plan and associated activities will require funding, and as it is understood that there is no current funding mechanism, it is recommended that an annual fee be adopted that could be used for planning and implementation of desired improvements.

With an initial $20 per year fee per residential septic system and with 16,800 ISDS, annual revenues would be approximately $336,000. Higher rates for commercial, industrial and institutional septic systems are recommended using the basis of residential septic system equivalency, usually referred to as Equivalent Dwelling Units (EDU). Commercial, industrial and institutional septic systems would be rated as the number of EDUs based upon their code wastewater flow divided by code flow for a residential three (3) bedroom home.

It is LAI's opinion that with the establishment of an on-site RME, the likelihood of forgivable loans, grants and/or low interest loans will be significantly improved.

APPENDIX A: REFERENCES

1. "Cluster Wastewater Systems Planning Handbook. Project No. WU-HT-01-45", Prepared for the National Decentralized Water Resources Capacity Development Project, Washington University, St. Louis, MO, by Lombardo Associates, Inc., Newton, MA, 2004
2. "Combined Sewer Overflows — Guidance for Financial Capability Assessment and Schedule Development," Environmental Protection Agency, Office of Water, Office of Wastewater Management, EPA 832-B-97-004, February 1997
3. "Future Investment in Drinking Water and Wastewater Infrastructure", November 2002, Congressional Budget Office http://www.cbo.gov/doc.cfm?index=3983&type=0&sequence=7

APPENDIX B: PRO FORMA TABLE

Priority 1 Application - Scenario 1

All cells in yellow are input variables

Capital Cost / OSDS	$22,000	Annual Cluster Failure Rate	1.0%
Capital Cost / ISDS	$4,000	Annual OSTDS Failure Rate	1.0%
Sewer Connection	$23,900	% in Initial Failure	5%
	Annual Payment	Years of OSTDS Failure in CIP	5
Annual Debt Service / OSDS Parcel	$1,272		
Annual Debt Service / ISDS Parcel	$231		
Sewer Connection Debt Service	$1,382		

Initial CIP	# Parcels	CIP
Capital Cost - All Scenario 1 Parcels	1,656	$ 39,578,400
Capital Cost - All Non Scenario 1 Parcels	15,164	$3,033,000
Capital Cost of Years of OSTDS Failure in CIP	15,164	$3,033,000
CIP Management	15%	6,847,000
	Total CIP	$52,491,400

Cost / existing parcel	$ 3,121	Interest Rate	4.00%
Cost / buildout parcels		Term (years)	30
Annual debt payment	$ 180	Capital Amortization Factor	0.0578
Monthly debt payment	$ 15.04		

CIP Program	$ 52,500,000		$ 5,000,000	$ 15,000,000	$ 15,000,000	$ 9,000,000	$ 8,500,000	$ -
Bond Series			2013	2014	2015	2016	2017	2018
Interest Rate			4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
Term (years)			30	30	30	30	30	30
Capital Amortization Factor			0.0578	0.0578	0.0578	0.0578	0.0578	0.0578
CIP Term (Years)	6		1	2	3	4	5	6

Annual Growth Rate

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
TMSA		0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%
Compounded Growth Rate		0.35%	0.70%	1.05%	1.41%	1.76%	2.12%	2.48%	2.83%	3.19%	3.56%	3.92%	4.28%	4.65%	5.01%	5.38%	5.75%	6.12%	6.49%	6.86%	7.24%
	Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of OSTDS/Parcels																					
Priority 1	1,656	1,662	1,668	1,673	1,679	1,685	1,691	1,697	1,703	1,709	1,715	1,721	1,727	1,733	1,739	1,745	1,751	1,757	1,763	1,770	1,776
Priority 2	4,693	4,709	4,726	4,742	4,759	4,776	4,792	4,809	4,826	4,843	4,860	4,877	4,894	4,911	4,928	4,946	4,963	4,980	4,998	5,015	5,033
Priority 3	5,261	5,279	5,298	5,316	5,335	5,354	5,372	5,391	5,410	5,429	5,448	5,467	5,486	5,505	5,525	5,544	5,563	5,583	5,602	5,622	5,642
Others	5,210	5,228	5,247	5,265	5,283	5,302	5,320	5,339	5,358	5,376	5,395	5,414	5,433	5,452	5,471	5,490	5,510	5,529	5,548	5,568	5,587
Total Scenario 1	1,656	1,662	1,668	1,673	1,679	1,685	1,691	1,697	1,703	1,709	1,715	1,721	1,727	1,733	1,739	1,745	1,751	1,757	1,763	1,770	1,776
Total Scenario 2	6,349	6,371	6,394	6,416	6,438	6,461	6,484	6,506	6,529	6,552	6,575	6,598	6,621	6,644	6,667	6,691	6,714	6,738	6,761	6,785	6,809
Total Scenario 3	11,610	11,651	11,691	11,732	11,773	11,815	11,856	11,897	11,939	11,981	12,023	12,065	12,107	12,149	12,192	12,235	12,278	12,320	12,364	12,407	12,450
Total Others	5,210	5,228	5,247	5,265	5,283	5,302	5,320	5,339	5,358	5,376	5,395	5,414	5,433	5,452	5,471	5,490	5,510	5,529	5,548	5,568	5,587
Total # OSTDS	**16,820**	**16,879**	**16,938**	**16,997**	**17,057**	**17,116**	**17,176**	**17,236**	**17,297**	**17,357**	**17,418**	**17,479**	**17,540**	**17,602**	**17,663**	**17,725**	**17,787**	**17,849**	**17,912**	**17,974**	**18,037**
EXPENSES																					
CIP Debt Service																					
2013 Series	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2014 Series	$ 5,000,000		$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150
2015 Series	$ 15,000,000			$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451
2016 Series	$ 15,000,000				$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451
2017 Series	$ 9,000,000					$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471
2018 Series	$ 8,500,000						$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556	$ 491,556
2019 Series	$ -							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2020 Series	$ -								$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CIP Debt Service Total	$2,500,000	$ -	$ 289,150	$ 1,156,602	$ 2,024,053	$ 2,544,524	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080
Annual CIP Debt Service w Coverage	115%	$ -	$ 332,523	$ 1,330,092	[illegible]	$ 2,926,203	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492
Inflation on OSTDS Replacement		2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
ISDS Replacement Fund	$ 40	$ -	$ -	$ -	$ -	$ -	$ 282,541	$ 283,530	$ 284,523	$ 285,518	$ 286,518	$ 287,521	$ 288,527	$ 289,537	$ 290,550	$ 291,567	$ 292,588	$ 293,612	$ 294,639	$ 295,670	$ 296,705
Sceanrio 1 OSTDS System Replacement	$220	$ -	$ -	$ -	$ -	$ 1,421,395	$ 1,426,370	$ 1,431,363	$ 1,436,372	$ 1,441,400	$ 1,446,445	$ 1,451,507	$ 1,456,587	$ 1,461,685	$ 1,466,801	$ 1,471,935	$ 1,477,087	$ 1,482,257	$ 1,487,445	$ 1,492,651	1,497,875
(starts in year)	5																				
Annual O&M Inflation Rate		3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
ISDS		15,217	15,270	15,324	15,377	15,431	15,485	15,539	15,594	15,648	15,703	15,758	15,813	15,869	15,924	15,980	16,036	16,092	16,148	16,205	16,262

			Per Parcel	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1	27%	Contract Operations	$50	$541,144	$559,329	$578,125	$597,553	$617,634	$638,390	$659,843	$682,017	$704,936	$728,625	$753,111	$778,419	$804,578	$831,616	$859,562	$888,448	$918,304	$949,163	$981,060	$1,014,029
2	19%	**Septic Pumping**	$35	$378,801	$391,530	$404,688	$418,287	$432,344	$446,873	$461,890	$477,412	$493,455	$510,038	$527,177	$544,893	$563,204	$582,131	$601,693	$621,913	$642,813	$664,414	$686,742	$709,820
		Annual Septage Generation (gal)	200																				
		Remove-Disposal Cost ($/gal)	$0.18																				
		Pumping Freq (years)	5																				
3		**Electricity**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4	17%	**Equipment Repair**	$32	$346,332	$357,971	$370,000	$382,434	$395,286	$408,569	$422,299	$436,491	$451,159	$466,320	$481,991	$498,188	$514,930	$532,234	$550,120	$568,606	$587,714	$607,465	$627,878	$648,978
		% of Materials Costs	1.00%																				
5	16%	**Sampling**	$30	$324,686	$335,597	$346,875	$358,532	$370,580	$383,034	$395,906	$409,210	$422,961	$437,175	$451,866	$467,051	$482,747	$498,969	$515,737	$533,069	$550,982	$569,498	$588,636	$608,417
		# of samples per location	3																				
		# of locations to be sampled	1																				
		# of sampling trips per year	0.50																				
		Sample Cost ($/sample)	$20																				
6	11%	**Administration**	$20	$216,458	$223,732	$231,250	$239,021	$247,054	$255,356	$263,937	$272,807	$281,974	$291,450	$301,244	$311,368	$321,831	$332,646	$343,825	$355,379	$367,322	$379,665	$392,424	$405,611
7	9%	**Annual Misc. O&M Costs**	$16	$173,166	$178,985	$185,000	$191,217	$197,643	$204,285	$211,150	$218,245	$225,579	$233,160	$240,995	$249,094	$257,465	$266,117	$275,060	$284,303	$293,857	$303,732	$313,939	$324,489
		% of Materials Costs	0.50%																				
	100%	**TOTAL ONSITE O&M COST**	$183	$1,980,587	$2,047,144	$2,115,939	$2,187,045	$2,260,540	$2,336,506	$2,415,024	$2,496,181	$2,580,065	$2,666,768	$2,756,385	$2,849,013	$2,944,754	$3,043,713	$3,145,997	$3,251,718	$3,360,992	$3,473,938	$3,590,680	$3,711,345

Priority 1 Application - Scenario 1

All cells in yellow are input variables

Capital Cost / OSDS	$22,000	Annual Cluster Failure Rate	1.0%
Capital Cost / ISDS	$4,000	Annual OSTDS Failure Rate	1.0%
Sewer Connection	$23,900	% in Initial Failure	5%
	Annual Payment	Years of OSTDS Failure in CIP	5
Annual Debt Service / OSDS Parcel	$1,272		
Annual Debt Service / ISDS Parcel	$231		
Sewer Connection Debt Service	$1,382		

Initial CIP	# Parcels	CIP
Capital Cost - All Scenario 1 Parcels	1,656	$ 39,578,400
Capital Cost - All Non Scenario 1 Parcels	15,164	$3,033,000
Capital Cost of Years of OSTDS Failure in CIP	15,164	$3,033,000
CIP Management	15%	6,847,000
	Total CIP	$52,491,400

Cost / existing parcel	$ 3,121		Interest Rate	4.00%
Cost / buildout parcels			Term (years)	30
Annual debt payment	$ 180		Capital Amortization Factor	0.0578
Monthly debt payment	$ 15.04			

CIP Program	$ 52,500,000		$ 5,000,000	$ 15,000,000	$ 15,000,000	$ 9,000,000	$ 8,500,000	$ -	
Bond Series			2013	2014	2015	2016	2017	2018	
Interest Rate			4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	
Term (years)			30	30	30	30	30	30	
Capital Amortization Factor			0.0578	0.0578	0.0578	0.0578	0.0578	0.0578	
CIP Term (Years)	6		1	2	3	4	5	6	

Annual Growth Rate		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
TMSA		0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%	0.35%
Compounded Growth Rate		0.35%	0.70%	1.05%	1.41%	1.76%	2.12%	2.48%	2.83%	3.19%	3.56%	3.92%	4.28%	4.65%	5.01%	5.38%	5.75%	6.12%	6.49%	6.86%	7.24%
	Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of OSTDS/Parcels																					
Priority 1	1,656	1,662	1,668	1,673	1,679	1,685	1,691	1,697	1,703	1,709	1,715	1,721	1,727	1,733	1,739	1,745	1,751	1,757	1,763	1,770	1,776
Priority 2	4,693	4,709	4,726	4,742	4,759	4,776	4,792	4,809	4,826	4,843	4,860	4,877	4,894	4,911	4,928	4,946	4,963	4,980	4,998	5,015	5,033
Priority 3	5,261	5,279	5,298	5,316	5,335	5,354	5,372	5,391	5,410	5,429	5,448	5,467	5,486	5,505	5,525	5,544	5,563	5,583	5,602	5,622	5,642
Others	5,210	5,228	5,247	5,265	5,283	5,302	5,320	5,339	5,358	5,376	5,395	5,414	5,433	5,452	5,471	5,490	5,510	5,529	5,548	5,568	5,587
Total Scenario 1	1,656	1,662	1,668	1,673	1,679	1,685	1,691	1,697	1,703	1,709	1,715	1,721	1,727	1,733	1,739	1,745	1,751	1,757	1,763	1,770	1,776
Total Scenario 2	6,349	6,371	6,394	6,416	6,438	6,461	6,484	6,506	6,529	6,552	6,575	6,598	6,621	6,644	6,667	6,691	6,714	6,738	6,761	6,785	6,809
Total Scenario 3	11,610	11,651	11,691	11,732	11,773	11,815	11,856	11,897	11,939	11,981	12,023	12,065	12,107	12,149	12,192	12,235	12,278	12,320	12,364	12,407	12,450
Total Others	5,210	5,228	5,247	5,265	5,283	5,302	5,320	5,339	5,358	5,376	5,395	5,414	5,433	5,452	5,471	5,490	5,510	5,529	5,548	5,568	5,587
Total # OSTDS	16,820	16,879	16,938	16,997	17,057	17,116	17,176	17,236	17,297	17,357	17,418	17,479	17,540	17,602	17,663	17,725	17,787	17,849	17,912	17,974	18,037
EXPENSES																					
CIP Debt Service																					
2013 Series	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2014 Series	$ 5,000,000		$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150	$ 289,150
2015 Series	$ 15,000,000			$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451
2016 Series	$ 15,000,000				$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451	$ 867,451
2017 Series	$ 9,000,000					$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471	$ 520,471
2018 Series	$ 8,500,000						$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558	$ 491,558
2019 Series	$ -							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2020 Series	$ -								$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual CIP Debt Service Total	$2,500,000	$ -	$ 289,150	$ 1,156,602	$ 2,024,053	$ 2,544,524	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080	$ 3,036,080
Annual CIP Debt Service w Coverage	115%	$ -	$ 332,523	$ 1,330,092	$ 4,048,107	$ 2,926,203	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492	$ 3,491,492
Inflation on OSTDS Replacement		2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
ISDS Replacement Fund	$ 40	$ -	$ -	$ -	$ -	$ -	$ 282,541	$ 283,530	$ 284,523	$ 285,518	$ 286,518	$ 287,521	$ 288,527	$ 289,537	$ 290,550	$ 291,567	$ 292,588	$ 293,612	$ 294,639	$ 295,670	$ 296,705
Sceanrio 1 OSTDS System Replacement	$220	$ -	$ -	$ -	$ -	$ 1,421,395	$ 1,426,370	$ 1,431,363	$ 1,436,372	$ 1,441,400	$ 1,446,445	$ 1,451,507	$ 1,456,587	$ 1,461,685	$ 1,466,801	$ 1,471,935	$ 1,477,087	$ 1,482,257	$ 1,487,445	$ 1,492,651	$ 1,497,875
(starts in year)	5																				
Annual O&M Inflation Rate		3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
ISDS		15,217	15,270	15,324	15,377	15,431	15,485	15,539	15,594	15,648	15,703	15,758	15,813	15,869	15,924	15,980	16,036	16,092	16,148	16,205	16,262
	Per Parcel	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1 27% Contract Operations	$50	$541,144	$559,329	$578,125	$597,553	$617,634	$638,390	$659,843	$682,017	$704,936	$728,625	$753,111	$778,419	$804,578	$831,616	$859,562	$888,448	$918,304	$949,163	$981,060	$1,014,029
2 19% Septic Pumping	$35	$378,801	$391,530	$404,688	$418,287	$432,344	$446,873	$461,890	$477,412	$493,455	$510,038	$527,177	$544,893	$563,204	$582,131	$601,693	$621,913	$642,813	$664,414	$686,742	$709,820
Annual Septage Generation (gal)	200																				
Remove-Disposal Cost ($/gal)	$0.18																				
Pumping Freq (years)	5																				
3 Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4 17% Equipment Repair	$32	$346,332	$357,971	$370,000	$382,434	$395,286	$408,569	$422,299	$436,491	$451,159	$466,320	$481,991	$498,188	$514,930	$532,234	$550,120	$568,606	$587,714	$607,465	$627,878	$648,978
% of Materials Costs	1.00%																				
5 16% Sampling	$30	$324,686	$335,597	$346,875	$358,532	$370,580	$383,034	$395,906	$409,210	$422,961	$437,175	$451,866	$467,051	$482,747	$498,969	$515,737	$533,069	$550,982	$569,498	$588,636	$608,417
# of samples per location	3																				
# of locations to be sampled	1																				
# of sampling trips per year	0.50																				
Sample Cost ($/sample)	$20																				
6 11% Administration	$20	$216,458	$223,732	$231,250	$239,021	$247,054	$255,356	$263,937	$272,807	$281,974	$291,450	$301,244	$311,368	$321,831	$332,646	$343,825	$355,379	$367,322	$379,665	$392,424	$405,611
7 9% Annual Misc. O&M Costs	$16	$173,166	$178,985	$185,000	$191,217	$197,643	$204,285	$211,150	$218,245	$225,579	$233,160	$240,996	$249,094	$257,465	$266,117	$275,060	$284,303	$293,857	$303,732	$313,939	$324,489
% of Materials Costs	0.50%																				
100% TOTAL ONSITE O&M COST	$183	$1,980,587	$2,047,144	$2,115,939	$2,187,045	$2,260,540	$2,336,506	$2,415,024	$2,496,181	$2,580,065	$2,666,768	$2,756,385	$2,849,013	$2,944,754	$3,043,713	$3,145,997	$3,251,718	$3,360,992	$3,473,938	$3,590,680	$3,711,345

TASK 4 REPORT

INSTITUTIONAL AND MANAGEMENT ALTERNATIVES

STRATEGIES FOR MANAGEMENT OF HIGH-DENSITY SEPTIC SYSTEM DEVELOPMENTS IN WASHOE COUNTY

Prepared for:

Western Regional Water Commission

and

Northern Nevada Water Planning Commission

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1.0 INTRODUCTION

The Western Regional Water Commission conducted an Analysis to Identify Alternatives for Management of Groundwater Quality impacted by High Density Septic System Development in the Truckee Meadows Service Area (TMSA). This Task 4 Report identifies and discusses options for institutional ownership and program management of the permitting, operations and maintenance of privately-owned and publicly-owned decentralized wastewater management systems including:

- Responsibilities and service levels, such as for EPA Management Levels 4 and 5
- Projected annual costs – See Task 3 Report
- Pros, cons and considerations regarding each management option, including relevant, comparable locations where these options have been implemented, are being considered, and/or are proposed – See Task 5 Report.

The focus of this report is on the management of the operations and maintenance (O&M), repair and replacement of privately and publicly owned wastewater treatment systems, from the perspective of achieving sufficient nitrogen removal to restore and protect groundwater quality in the project areas. Management services would be performed by one or more Responsible Management Entity (RME), depending on the selected alternative. Management of the needed capital improvements could be addressed as a separate activity or as part of the RME.

1.1 Summary of Relevant Information from Previous Reports

The following are relevant conclusion from previous Task Reports:

- There are 14,220 Individual Sewage Disposal Systems (ISDS) in the Project Areas, grouped into 16 project areas, with an additional 2,596 within the basins but outside project areas. The total number ISDS in the basins is 16,820.
- Five of the 16 Project Areas have documented adverse impacts to groundwater quality with respect to nitrates
- Nine of the Project Areas are suspected of having impact-impacted groundwater, but further data collection activities are needed to confirm

Per the Task 2 Report, the Project Areas were prioritized based upon previous investigations (Kropf and Thomas, 2007). In addition, the State of Nevada Intended Use Plan designated Spanish Springs as a high priority area. Based on this information, the prioritization of improvements should be as follows:

Priority 1:

- Spanish Springs

Priority 2:

- Cold Springs
- Washoe
- Golden Valley
- Heppner

- Mt. Rose

Priority 3:

- All Truckee Meadows Basin Project Areas
- Pleasant Valley
- Mogul
- Verdi

The Task 3 Financing Report considered the following scenarios for the purpose of determining sustainable user charges required to finance the Capital Improvement Program (CIP):

- Upgrading the required number of properties in the Priority 1 Area only;
- Upgrading the required number of properties in the Priority 1 and Priority 2 Areas only;
- Upgrading the required number of properties in all Priority Areas

Table 4-1 presents the Capital Improvement Program (CIP) required for either Out-of-Basin Discharge or In-Basin Discharge.

Table 4-1 Capital Improvement Program for Required Nitrogen Removal in Project Areas

Priority Level	Properties Req. 100% Removal		Properties Req. 93% Removal w/In-Basin Discharge		Total Capital Cost – 100% Removal w/out of Basin Discharge[1]	Total Capital Cost 93% Removal w/In-Basin Discharge[2]
	#	%	#	%		
Scenario 1 (Phase 1 Areas Only)	1,546	11%	1,656	12%	$45,100,000	$52,500
Scenario 2 (Phase 1 & 2 Areas)	5,925	42%	6,349	45%	$150,900,000	$179,400,00
Scenario 3 (Phase 1, 2 & 3 Areas)	10,836	76%	11,610	82%	$269,500,000	$321,500,000

[1] Please note for 100% nitrogen removal with out-of-basin discharge, costs are based on conventional sewer system with trench-width paving and out of basin discharge based upon only one engineer's estimate of sewer extension costs in Spanish Springs. Lower density developments will have higher costs. Areas are assumed to be adjacent to existing sewered areas. Thereby no transmission cost is provided.

[2] Costs based on septic tank effluent collection cluster systems achieving 93% nitrogen removal discharging within the basin.

1.2 Current Practice

Currently, all on-site disposal systems in Washoe County fall either under the administrative purview of Nevada Division of Environmental Protection Bureau of Water Pollution Control (NDEP) or Washoe County District Health Department (WCDHD). WCDHD administers all new construction, repair and replacement of on-site ISDS for individual homeowners. Applications for construction repair or replacement are submitted to WCDHD for review and must be approved prior to the commencement of construction activities. Monitoring of effluent quality is not required, and WCDHD does not require the homeowner to submit records of preventive maintenance (records of pumping, etc.). Regulatory authority is given in the District

Board of Health Regulations Governing Sewage, Wastewater, and Sanitation, as revised and approved on January 26, 2006. Individual homeowners retain ownership of the ISDS.

NDEP regulates discharges to groundwater via Nevada Administrative Code (NAC) 445A, Water Controls. NDEP does not regulate septic systems serving individual homes. NDEP administers a general permit, GNEVOSDS09, which oversees all on-site disposal systems (OSDS) for treatment of domestic/sanitary wastewater generated in commercial applications in Washoe County. The general permit is for all commercial systems up to 15,000 gallons, and applies to standard systems. Standard systems include all standard septic tank/leach field systems, mechanical/aerobic systems, including multiple pass filtration systems, single pass bed filters, etc, and denitrification systems. Industrial and hazardous wastes are prohibited, as are other non-domestic discharge streams such as excess amounts of fats, oil, or high organic loads, etc. Quarterly monitoring is required for mechanical/aerobic and denitrification systems. Commercial OSDS systems greater than 15,000 gallons require individual permits.

Under the OSDS (OSDS includes both ISDS and OSTDS) regulations promulgated in NAC 445A, individual discharge permits are required for discharges that:

- Handle more than 15,000 gallons of flow per day
- Receive flows other than domestic sewage
- Use surface disposal
- Serve a cluster system

Multi-home or user OSDS, referred to as cluster treatment systems, are addressed in NAC 445A.9694. Cluster Systems require issuance of individual discharge permits by NDEP, and application and renewal fees are based on effluent flow. For cluster systems, regulations require that the local governing agency or its recognized entity take responsibility for the operation and maintenance of a cluster system, and be named as the responsible party in the permit. Cluster systems are limited to a maximum of 25,000 gallons per day (gpd).

OSDS do not include mechanical package plants, as defined in Nevada Revised Statute (NRS) 445A.380. There has been precedent within the State of Nevada for the issuance of individual permits for mechanical package plants serving a cluster of residences with discharge of treated effluent to groundwater via surface infiltration. These permits have been written for systems serving small subdivisions in outlying areas of Clark County, with the homeowners association or other legal entity being the RME. This mechanism may be an option for areas of residences within Washoe County that would exceed the 25,000 gpd limit applied to cluster systems. Quarterly monitoring of effluent is required for package treatment systems. Package treatment plants must have a Nevada certified operator in charge of the operation of the facility.

1.3 Scope of Management

Prior to discussing management options, a definition of what is to be managed is needed. The following two management categories for septic systems are considered:

- *Conventional ISDS*

  This category applies to the existing ISDS that are located within the basins of concern and the defined project areas. As seen in Table 1-1, not all ISDS require upgrades to OSTDS. The systems shown as Long Term ISDS on Table 1-1 do not need to upgrade their systems to achieve groundwater drinking water quality compliance. These properties will remain on ISDS.

- *Upgrades to OSTDS to achieve Enhanced Tertiary Treatment (AWT)*

  Management of the onsite and/or cluster enhanced tertiary upgrades, for the Priority Project Areas as described in the Task 2 Report. Properties connected to an existing sewer would be managed by the sewer system owner, not the OSTDS and cluster wastewater systems management entity, i.e. RME.

The estimated total number of properties in each of the two management categories described above is shown in Table 1-1. These priority categories and the number of OSTDS within each category may change based on subsequent studies that define the nitrogen removal requirements for each project area. As improvements are made and additional data is collected, the number and location of properties in each of the two management categories may change. An adaptive management program is recommended to update management categories based on an improved understanding of the impact of ISDS on drinking water quality.

1.4 Management Alternatives

Achievement of the necessary nitrogen removal with OSTDS and/or cluster systems can be accomplished by one of the following two management alternatives:

Alternative 1- ISDS Upgrade Requirements by Ordinance

Compelling Project Area ISDS to upgrade to systems capable of 95% removal of discharged nitrates, individually, or in some type of cluster or centralized sewer system with no County funding. In this case, user costs would be dictated by property location and associated AWT upgrade requirements. This could be performed by Ordinance or through a RME, with the homeowner paying the costs associated with the upgrades and ongoing O&M costs.

Alternative 2- ISDS Upgrade Requirements Achieved Through Financing Solutions

RME provides funding of OSTDS upgrades (regardless of solution type) by amortizing the costs of Nitrogen-removal systems over all members of a RME that would govern properties currently, and in the future, with ISDS or enhanced tertiary OSTDS systems. The benefit of this approach is to lower the user costs and provide "sewer equivalency" service to all members of the RME, where, similar to sewer systems, maintenance and repairs are not the responsibility of the property owners. The financial aspects of this option are addressed in the Task 3 Financing Alternatives Report.

Initial capital costs could be paid for in part or whole by:

- Ad Valorem
- Fee on a uniform basis – such as equivalent dwelling unit (EDU)

Where connection to an existing sewer system is the preferred option, the wastewater service for those properties would be managed by the sewer system owner. The philosophical basis of Alternative 2 is that the aquifers have a finite capacity to accept ISDS effluent, all discharges are contributing to its impairment and therefore all ISDS owners should equally pay for its remediation, whether or not the solution connects their property.

Key management issues for an ISDS/OSTDS/Cluster System RME are:

- Ownership
- Administration
- Operations & Maintenance, including repair & replacement
- Use Fees

In Alternative 1, described above, ownership can be public or private (i.e. property owner), with private being the typical approach. In Alternative 2, described above, ownership can be public or private, with funding sources dictating which options are allowed.

The public ownership options include:

- A single Washoe County entity
- Multiple separate entities for each project or basin area

The private options are:

- Maintain ownership with property owner
- Privatization whereby a private entity could own and operate ISDS and OSTDS systems. Although this has not been done previously, LAI is of the opinion that private firms are interested and capable. Many details will need to be addressed.

2.0 RESPONSIBILITIES & SERVICE LEVELS

2.1 Ownership & Management Options and Responsibilities

The ownership and management options for decentralized wastewater systems consist of:

- Public
- Private
  - o Property Owner
  - o Other
    - ▪ Private for-profit RME
    - ▪ Private non-profit RME

Management responsibilities for wastewater system ownership include:

- Administration
  - o Program management for implementation of capital improvements
  - o Use regulation
  - o Regulatory compliance reporting
  - o Customer service, billing and collections
  - o User-charge system
  - o Financial
- Operations
  - o Monitoring
  - o Maintenance and routine repair
  - o Major repair/replacement

2.1.1 Ownership

Ownership refers to the entity that has legal responsibility, liability, and authority regarding all aspects of a wastewater system. Ownership is sometimes referred to as the institutional structure of a wastewater system, and generally falls into the following categories:

- Public - Municipal
- Property Owner
- Outsourced to:
  - o Private For-Profit
  - o Public (such as a cooperative)
  - o Private Non-Profit Entity

The ownership options in Nevada are defined by existing enabling legislation that defines the responsibilities, authorities, composition, and functioning of the ownership entity. Additionally, the State legislature can be petitioned to establish a wastewater management entity with unique, locally desired features. Naturally, these desired features must be constitutional and endorsed by the will of the community. Public options can be within each of the various jurisdictions or a joint entity.

It is assumed that no measures will be taken to attain ownership of ISDS within any of the priority areas, and that private homeowners will maintain autonomy over their existing systems. For those areas targeted as high priority, and where centralized (nearby sewer main) or decentralized wastewater/sewage services (nearby cluster treatment system or neighborhood package plant) are readily available, the County may require through ordinance that the ISDS owner connect to the appropriate system at the time that their ISDS fails. The framework for this requirement appears to be in place in Washoe County, through the permit application system.

Traditionally, centralized wastewater systems have been owned and managed publicly, while onsite and cluster systems have been owned and managed privately with public oversight. Pursuant to NAC 445A.9694, regulations regarding cluster treatment systems require that the local governing agency or its recognized entity assume responsibility for the operation and maintenance of the system, and that an individual discharge permit be obtained from the appropriate authority. Pursuant to NRS 704.6674, the Board of County Commissioners of any County may regulate by ordinance any entity furnishing sewer services, except those entities under the purview of the Public Utilities Commission, the services furnished to its residents by a political subdivision, and services furnished to its members by a nonprofit association in which the rights and interests of all its members are equal, such as a homeowners association. Thus, the county has oversight through its ordinances of the sewage treatment RMEs operating within its boundaries, including any RMEs overseeing OSDS.

As the potential use of decentralized cluster treatment systems is a new development in the State of Nevada and in Washoe County, it is unknown at this point what would be considered a recognized entity with respect to responsibility. Sewage treatment services may also be provided by public utilities, as defined in NRS 704.020-021, which are under the purview of the Public Utilities Commission. As previously stated, the Nevada legislature may be petitioned to establish a wastewater management entity.

These are not the only options, as decentralized wastewater systems have successfully been implemented using other innovative ownership structures. Table 4-2 describes the range of potential ownership structures.

Table 4-2 Matrix of Decentralized Wastewater Systems Ownership Options

Ownership Institution	Infrastructure
Public	Added to existing unit
	Independent public entity
Private	Property owner
	Special purpose entity
	For-profit corporation
	Non-profit corporation

The ownership of a wastewater system may constrain the available financial and institutional management system options available. For example, privately owned systems are unable to obtain public funding in the form of grants, whereas publicly owned systems are eligible. Low interest septic system rehabilitation loan programs under the EPA/State Revolving Fund Program (SRF) can be used for private and public systems.

The administration and monitoring, maintenance, and repair (MMR) options are discussed in the following sections. An owner can either perform some or all of these activities internally or have them performed by others, i.e. outsourced.

2.1.2 Administration

Administrative functions include:

- Ownership Management
- Program Management for Capital Improvements
- Use Regulation
- Regulatory Compliance Reporting
- Customer Service, Billing, and Collections
- User-Charge System
- Financial

Ownership Management

The ownership management function can consist of:

- Oversight of the outsourced entity's activities
- Performance of all activities by the owner's manager directly or within a Responsible Management Entity (RME)
- Combination of above

At a minimum, ownership management (directly or through its agent) maintains records on the wastewater system and submits required compliance performance reports to regulatory agencies, and educates system users.

Ownership administration management costs include:

- General administration
- Professional services for engineering, legal, and accounting
- Insurance
- Office space and other overhead
- Customer service, billing, and collection

Program Management for Capital Improvements

For capital improvement projects, there is a significant need for management of the proposed system's capital facilities planning and implementation. These activities are usually outsourced to an experienced engineering or program management-type firm, with the public entity defining what is performed internally.

Use Regulation

Onsite Sewage Treatment and Disposal Systems for individual homes are regulated by the Washoe County Department of Health. Permits must be obtained from the local health department to install or make repairs to these systems.

All commercial OSDS systems in Washoe County are regulated by the Nevada Department of Environmental Protection (NDEP). These systems are usually Septic Tanks, Aerobic Treatment Systems, or special Performance Based Treatment Systems that are used for homes and small residential units, or small commercial or industrial sites, which only produce domestic or commercial type wastes. General permits for construction and operation of OSDS for commercial installations are issued by NDEP. Systems under 5,000 gallons per day (gpd) in size are not subject to the permitting fee. The maximum size of an OSDS under the general permit is 15,000 gallons. Systems larger than 15,000 gallons may be permitted under an individual discharge permit.

Regulatory Compliance Reporting

As decentralized wastewater systems increase in size and proximity to environmentally sensitive areas, their regulatory reporting requirements generally increase. Owners must provide for gathering and transmission of the required regulatory compliance reporting information. Currently, Washoe County does not require periodic monitoring of ISDS discharges for individual residences. Conventional septic systems serving commercial installations, as permitted under the NDEP Commercial OSDS general permit are not required to submit monitoring data other than pumping records annually, describing compliance with biennial pumping requirements. Systems permitted under the general permit that include mechanical/aerobic processes or that denitrify effluent are required to submit quarterly effluent monitoring reports, as well as records of pumping. Monitoring requirements for systems with individual NDEP discharge permits would vary depending on the system and receiving water, but could reasonably be expected to be at least on an annual basis.

Customer Service, Billing, and Collections

Customer service issues range from responding to odor complaints to change of use, including service termination and the addition of new service connections. Billing and collections are vital functions of any RME/business. Many private and public utilities provide this service for other utilities. A key issue is the ability of the RME to take enforcement action for non-payment of fees.

Typical enforcement options include:

- Property liens
- Water shut-off, when central water is available
- Civil actions (small claims court)

Owners must ensure that all stakeholders understand the legal mechanisms and proper notification procedures, as well as the impact of non-payments of fees on the financial viability of the RME. Owners can contract with private organizations that guarantee user-charge payments. These organizations provide the revenue cash flow and will place liens (or use other legal instruments) on the property of non-paying users for a fee.

User-Charge System

In Nevada, private ownership user rates for large flow systems are regulated by the Public Utilities Commission of Nevada (PUCN). The PUCN has extensive approval requirements for setting and raising rates to end users.

Pursuant to NRS 704.673-675, cooperatives, non-profit corporations and associations that supply services both to the public and to its members are considered public utilities and are therefore under the purview of the PUCN. Cooperatives, nonprofit corporations and associations supplying services only to members are considered public utilities over which the PUCN has limited jurisdiction, and which does not oversee the setting or raising of rates to member customers.

The primary cost categories for user-charges associated with decentralized wastewater systems are:

- Capital Costs Amortization
- Administration Costs
- Operation and Maintenance Costs
- Repair Funds
- Replacement-Depreciation Funds

Capital costs are the total installed costs of the wastewater system, including engineering (planning, design and construction management), land, financing, administration, etc. and construction costs. Capital costs for decentralized systems can be paid for in one or more of the following ways:

- Federal or state grants and loans
- User-charges, in which a portion or all of the capital costs are amortized over a fixed term (such as 20-30 years)
- Connection charges, in which users pay a fee when the decentralized system is constructed or when users connect
- Property taxes in which all property owners in an entire community, regardless of whether the property owners are served by the decentralized system or a special tax district, finance some or all of the wastewater system’s capital cost
- Nevada State Laws Chapter 318 provides the mechanisms for the establishment of Improvement Districts and fee collection options. NRS 318.140 provides for sanitary sewer improvements and NRS 318.170 provides for water, drainage, sewerage and disposal of garbage and other refuse.
- Unique taxing mechanisms, such as dedicated sales tax, in which revenues are restricted for payment of capital costs

- Private entity building the decentralized system, as in a new parcel development
- Private entity providing design, build, own, operate and finance services
- Establishment of Remediation Districts similar to the Central Truckee Meadows Remediation District (CTMRD), which charges residents and business owners fees for remediation of contaminant plumes within the area

A key determinant of which financing options are available is the ownership of the system, as many public funding sources are restricted from being used for private property.

O&M costs include the annual cost of operating and maintaining the system arising from:

- Labor
- Electricity use
- Chemicals
- Equipment servicing
- Residuals removal and ultimate disposal
- Routine repair and replacement (R&R) for equipment with useful life < 10 years
- Equipment and major component replacement

A repair and replacement (R&R) fund should be established for equipment with a useful life of less than 10 years. This fund is used to pay for small equipment repair/replacement when it fails or on a scheduled basis (to avoid damaging impacts). Establishing an annual repair fund contribution ensures that funds are available when needed. A repair fund also levels impacts on necessary user-charge rates.

A major challenge with decentralized wastewater systems is the funding for future major asset replacements of major capital equipment. This funding is sometimes referred to as a depreciation fund.

Therefore, user-charge systems need to be established to cover:

- Amortization of capital costs, if any
- Annual actual O&M costs
- Repairs, when needed (R&R account)
- Major asset replacement, when needed (Depreciation account)

Typically, funding of future major equipment replacement has been a challenge for RMEs. Inclusion of replacement-depreciation fund contributions in user-charge systems is essential so that funds are available when major repairs are required. An affordability challenge exists when the user-charge includes significant capital amortization for upgrades. To mitigate the user charge impact, initiation of depreciation funding could be delayed a few years.

Some states require that privately owned cluster systems maintain the replacement-depreciation fund (sometimes referred to as the reserve fund) with the regulatory authority having access to those funds, should the private entity not repair/replace the system when necessary to maintain permit compliance. In addition to actual fund contributions, numerous financial instruments (such as bonds or letters of credit) provide equivalent financial assurances.

Depreciation funding is recommended to be included in the RME structure to ensure that funds exist to replace major equipment at the end of its useful life.

GASB 34 (Government Accounting Standards Board 2000) requires replacement-depreciation funding of municipal systems, for proper asset management.

Financial

The financial issues associated with decentralized systems are:

- Budgeting, cash flow management, accounts payable, and accounts receivable, as with any business operations
- Capital resources procurement

The owner will need to establish a budget for any decentralized system, in particular for user-charge determination. Projected revenues will need to provide excess amounts (usually 115%-125%) of expenses, for unforeseen conditions, revenue shortfalls, and to maintain a good credit rating. Cash flow difficulties arise when the timing of expenses outpaces revenue receipts. In part for this reason, capitalizing the first year, or preferably two, of operating expenses is typically performed.

The procurement of capital resources for decentralized systems is a significant issue, with the options discussed in the Task 3 Financing Report.

2.1.3 Operations

The maintenance, monitoring, and repair (MMR) activities required for decentralized wastewater systems are heavily influenced by system capacity and effluent requirements. Maintenance and repair activities are dictated by the equipment, while monitoring requirements are dictated by permits and environmental setting. Table 4-3 presents typical MMR responsibilities for the OSTDS, medium and large cluster systems.

A monitoring program, specific to the proposed OSTDS improvements in the TMSA study areas will need to be developed and will need to demonstrate compliance with public health and water quality requirements. Such a monitoring program should be integrated into the planning process to ensure that implemented improvements are resulting in the expected nitrate reductions.

Table 4-3 Typical MMR Responsibilities for the Range of Decentralized Systems

MMR Activity	Conventional OSTDS	Medium AWT Cluster	Large AWT Cluster
Maintenance	Residuals removal every 5-7 years	Treatment, collection, dispersal system maintenance activities	Ongoing treatment, collection, dispersal system maintenance activities
Monitoring	Inspections every 3-5 years	Monthly inspections / Operation activities	Daily inspections / Operation activities
		Monthly sampling	Daily sampling
	Remote monitoring systems available	On-call personnel	Full-time personnel
		SCADA system	SCADA system
Repair	Component repair, as needed	Preventative repair and replacement program	Preventative repair and replacement program
			Full-time personnel
		On-call personnel	Redundant systems
Administration	Varies by degree of oversight (Education, Permit applications, Inspections, etc.)	Discharge permit	Discharge permit
		Compliance reporting	Compliance reporting
	System use regulation through Washoe County	Moderate customer service	Full customer service
		System use regulation	System use regulation

3.0 LOCAL WASTEWATER MANAGEMENT OPTIONS

3.1 EPA Options

The United States Environmental Protection Agency (U.S. EPA) recommends five model management programs for decentralized systems:

1. System inventory (awareness of maintenance needs)
2. Management through maintenance contracts
3. Management through operating permits
4. Responsible Management Entity (RME) operation and maintenance
5. RME ownership and management

Each of these model management programs is summarized in Table 3-1, with full descriptive reports at www.epa.gov/owm/mtb/decent/index.htm.

A mixture of ownership and management options is not uncommon. Many publicly owned systems are managed in varying degrees by private entities, commonly referred to as public-private partnerships. An owner can outsource any or all of the management activities for a cluster system. Ownership can be held by a public utility, a private for-profit or non-profit entity.

3.2 Current Management Options Used in Washoe County

Section 1.2 describes the existing practices, which would be classified as Level 1 of the various U.S. EPA Management Levels, listed in Table 4-4.

Washoe County does not require inspections of ISDS maintained by private homeowners. NDEP requires that OSDS be pumped by the operator at least biannually, and more frequently if it is shown that mechanical/aeration or denitrification OSDS cannot meet effluent quality limitations. NDEP does not issue general permits for OSDS that would discharge excessive amounts of fats, oils or greases, and would require that these facilities obtain an individual discharge permit. Individual permits include operator inspections that are site specific and dependent on the discharge and the receiving water. Typically, individual dischargers are inspected by NDEP every five years.

Table 4-4 Overview of U.S. EPA Management Level Options

Management Model	Objectives	Basic Features
Management Model 1 **Inventories and Maintenance Reminders**	• Owner awareness of permitting program, installation and O&M needs • Compliance with codes, regulations • Maintain prescriptive program for sites that meet code criteria (MP 1)	• Only conventional onsite systems • Prescriptive design/site requirements • Owner education to improve O&M • Inspections only during construction and complaint evaluations • Create and maintain system inventory • Allowances for specified alternatives where code is not met
Management Model 2 **Maintenance Contracts**	• Permit only approved alternative systems on sites not quite meeting criteria	• O&M contracts and reporting required for alternative systems • Inspections and owner education as in MP 1 • Create and maintain inventory
Management Model 3 **Operating Permits**	• Onsite system designs based on site conditions and performance requirements • System performance assumed by O&M task completion and verified through permit renewal inspections	• Wider variety of designs allowed • Performance of required O&M tasks governs operating permit renewal • Onsite Wastewater Treatment System (OWTS) monitoring/ inspections required • Property sale and change-of-use compliance-assurance inspections • Create and maintain inventory
Management Model 4 **Responsible Management Entity Operation and Maintenance**	• Responsible public or private entity assumes O&M and inspection/monitoring responsibilities for all systems in management area	• Performance governs acceptability • Operating permits ensure compliance • All systems are inspected regularly • Monthly/yearly fees support program • Owner responsible for all costs • Create and maintain inventory
Management Model 5 **Responsible Management Entity Ownership**	• Public or private RME owns and operates all systems in management area • Similar to centralized sewer system service approach	• Performance governs acceptability • All systems are inspected regularly • Monthly/yearly fees support program • Users relieved of all O&M responsibilities • RME funds installation and repairs • Create and maintain inventory

Source: Cluster Wastewater Systems Planning Handbook, 2004

4.0 MANAGEMENT MODEL COST ANALYSIS

For decentralized wastewater systems the capital costs are usually apportioned into the following components:

- Connect fee
- Assessment fee (in some areas referred to as a betterment fee)
- Amortized (usually 20 – 30 years) capital portion with annual payment added to O&M
- Other and non-user sources
  - Property assessment
  - Special/innovative taxes
  - Grants/loans

The Task 3 Report provides alternative financing and implementation options and their implications on user fees, which include management/administrative costs.

5.0 EVALUATION OF MANAGEMENT OPTIONS

An evaluation of management options needs to be preceded by a definition of what is being managed. The following preliminary plan is proposed:

Existing ISDS Management

Management for the ISTDS systems that will not require upgrade to OSTDS

OSTDS Upgrades to AWT

Management of OSTDS upgraded to AWT and/or cluster systems

The existing management structure is presented in Table 4-5. To achieve the nitrate reduction levels described on Table 4-1, LAI recommends the management structure presented in Table 4-6.

Table 4-5 Existing Management Structure

Management of Decentralized Wastewater Systems Status in Washoe County, NV as of 2012		
Component	**Washoe County**	
	On-Site	**Cluster**
Ownership	Property Owner	Private
Management	Property Owner	Private Owner or Private Utility
Operations & Maintenance	Property Owner	Private
Permitting	Washoe County Health Dept.	NDEP

Table 4-6 Lombardo Associates, Inc. Recommended Management Structure

Recommended Management Structure for Decentralized Wastewater Systems		
Component	**Washoe County**	
	On-Site	**Cluster**
Ownership	RME or Private	RME or Private
Management	RME	RME
Operations & Maintenance	RME	RME
Permitting	Washoe County Health Dept.	NDEP
Designated Responsible Management Entity	TBD	TBD

REFERENCES

1. Cluster Wastewater Systems Planning Handbook. Project No. WU-HT-01-45. Prepared for the National Decentralized Water Resources Capacity Development Project, Washington University, St. Louis, MO, by Lombardo Associates, Inc., Newton, MA, 2004.
2. Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems, US EPA, EPA No. 832-B-05-001, 2005, updated 2010.
3. Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems, US EPA, EPA 832-B-03-001), 2003.
4. Septic Nitrate-N Baseline Data and Risk Assessment Study for Washoe County Phase I: Prioritization of Study Areas & Assessment of Data Needs, prepared for Regional Water Planning Commission, Kropf, Christian A. and Thomas, Brent, December 7, 2007.

TASK 5 REPORT

CASE STUDIES

STRATEGIES FOR MANAGEMENT OF HIGH-DENSITY SEPTIC SYSTEM DEVELOPMENTS IN WASHOE COUNTY

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and

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1.0 INTRODUCTION

The Western Regional Water Commission (WRWC) conducted an Analysis to Identify Alternatives for Management of Groundwater Quality impacted by High Density Septic System Development in the Truckee Meadows Service Area (TMSA).

This Task 5 Case Studies Report presents five (5) case studies of communities addressing septic system nitrogen removal requirements. The case studies were selected from candidate communities as listed on Table 5-1 and from the recent U.S. EPA Report on Management of Decentralized Wastewater Systems (2012). Case study candidates span the spectrum of communities that are implementing solutions, to those debating/struggling with gaining consensus/commitments on problem definition and appropriate solution(s).

Table 5-1 Summary of Candidate Case Studies

#	Case Study	Description of Issue	Proposed/ Implemented Action	Driver for Action: Groundwater Drinking Water Quality – Public Health Protection	Driver for Action: Surface Water Quality Protection	Approximate Number of Septic Systems
	Reno-Sparks Metropolitan Area			✓	---	15,000 +/-
1	Bend, OR	Goundwater drinking water contamination caused by septic systems.	Properties required to upgrade to OSTWS that achieve TN <10 mg/l. County requirements to implement requirements have been stymied due to public opposition. Location similar to Reno-Sparks area.	✓	---	
2	Los Osos, CA	Goundwater drinking water contamination caused by septic systems. Community required to install a sewer system.	Significant community opposition to conventional sewer. Sewers being installed by County with monthly fees of $200+/- per property.	✓	---	
3	Mobile, AL	Decentralized systems being managed by large metropolitan utility as a technique to minimize impacts on Combined Sewer Overflow (CSO) problems.	Actively managed utility in major metropolitan area.			
4	Leon and Wakulla Counties, FL	Septic system impact on world famous Wakulla Springs and TMDL compliance requirements.	Under consideration. LAI performed study estimating program costs of $300 +/- million to achieve TMDL compliance.	---	✓	50,000 +/-
5	Suffolk County, NY	Sole source drinking water aquifer contamination from septics and surface water quality degradation.	Studies underway. Costs are huge multi-billion $. County assesses ¼% sales tax for wastewater systems subsidies.	✓	✓	x00,000
6	Electric Co-Operatives	Own & Operate cluster systems as an alternative to centralized sewer				
7	Cape Cod	Septic system impact predominately on receiving water bodies	$3 to $5 billion costs.	---	✓	50,000+
8	Chesapeake Bay	Septic system impacts on Chesapeake Bay	MD has toilet tax that provides grants for treatment plant upgrades and septic system upgrades for nitrogen removal.	---	✓	50,000+
9	Seattle Metro Area - Hood Canal	Septic nitrogen contamination of surface waters causing excessive algal growth.		---	✓	

Groundwater Drinking Water Quality Standard – Nitrate-N of 10 mg/l
Surface Water Quality Standard for Water Quality Protection – TMDL compliance = 0.3 to 0.5 mg/l TN

Table 5-2 presents the case studies reviewed in this analysis.

Table 5-2 Case Studies

Case Study Communities	U.S. EPA Management Model
Fairfax County, VA	1
Suffolk County, NY	1
Bend, OR	1
Pena, NM	4
Phelps County, MO	5

The U.S. EPA developed five Management Models for addressing issues related to ISDS. These models are described in Table 5-3.

Table 5-3 U.S. EPA Management Models

Management Model	Objectives	Basic Features
Management Model 1 **Inventories and Maintenance Reminders**	• Owner awareness of permitting program, installation and O&M needs • Compliance with codes, regulations • Maintain prescriptive program for sites that meet code criteria (MP 1)	• Only conventional onsite systems • Prescriptive design/site requirements • Owner education to improve O&M • Inspections only during construction and complaint evaluations • Create and maintain system inventory • Allowances for specified alternatives where code is not met
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Source: Cluster Wastewater Systems Planning Handbook, 2004

2.0 OVERVIEW OF COMMUNITIES ADDRESSING SEPTIC NITROGEN

The basis for regulation of septic system densities has been:

- **Groundwater Drinking Water Quality - Public Health Protection** based upon the drinking water standard Maximum Contaminant Level (MCL) of 10 mg/L of nitrate where septic systems are discharging to a drinking water aquifer.

- **Surface Water Quality Protection** where septic discharges to groundwater have a hydrologic connection to surface waters. The surface water quality criteria vary depending on the water body; however, is generally 0.35 mg/L to 0.5 mg/L total nitrogen.

2.1 Drinking Water Quality Protection

States with communities with sole source aquifers or with septic systems discharging to drinking water aquifer recharge areas have used nitrogen dilution from rainfall groundwater recharge models as the basis for establishing maximum septic system densities for drinking water quality protection.

As illustrated by the Bend, OR case study, getting communities to adopt capital improvement programs to correct legacy septic system densities that have caused violations of drinking water standards has been very difficult and has likely not occurred without legal action. The community of Los Osos, CA has such a situation and implementation of corrective actions has occurred only after State orders were issued and years of controversy.

2.2 Surface Water Quality Protection

There are many locations with surface water quality degradation due to septic system nitrogen contributions, predominately in coastal areas, but also in inland waters, where nitrogen is the limiting nutrient for algae growth. Significant efforts are underway in many communities on the East Coast, due to its geography and numerous coastal embayments and estuaries, to address this issue. A smaller number of communities are addressing this issue on the west coast. Septic system phosphorus contribution to surface waters is a water quality challenge in many inland waters, as phosphorus is typically the limiting nutrient in freshwaters.

Requiring improvements to septic systems to reduce their nitrogen contributions to surface waters has been dictated by Total Maximum Daily Load (TMDL) determinations. In many coastal watersheds, septic nitrogen contributions represent +/-70% of the nitrogen load. Legal efforts are underway to force EPA to require National Pollutant Discharge Elimination System (NPDES) permits for septic systems “discharging” (via groundwater connection) to surface waters. Regarding its regulatory authority, EPA stated in its February 13, 2012 letter to U.S. Representative John Mica, Chairman of the House Committee on Transportation and Infrastructure that “although the U.S. EPA does not consider a groundwater aquifer to be a water of the United States under the Clean Water Act and groundwater is not regulated by the Clean Water Act, EPA has a longstanding and consistent interpretation that the Clean Water Act may cover discharges of pollutants from point sources to surface water that occur via groundwater that has a direct hydrologic connection to the surface water.

Whether or not such a hydrological connection exists, and the need for a NPDES permit for any given source, is highly dependent on the facts and circumstances surrounding each permitting situation. A number of factors are relevant in evaluating the connection between groundwater and surface water, such as geology, flow and slope. A fact-specific evaluation could support a determination that an NPDES permit is required or a determination that one is not required."

2.3 Common Attributes and Lessons Learned

Following are common attributes and lessons learned from communities addressing excessive septic system densities that are causing groundwater and surface water degradation:

Common Attributes

1. Leadership and vision is needed for positive outcomes. Examples include "toilet tax" fee in MD to fund septic system improvements and Suffolk County sales tax funding of measures for groundwater quality protection.

2. Due to virtually no federal/state grants, strong resistance to financial costs of required / needed improvements is common. First the science that forms the basis for any requirement for septic system nitrogen reduction is questioned along with attempts to discredit the science.

3. Conventional solutions are usually proposed and many times are not affordable. Creative thinking and innovative approaches are needed and usually not sought until there is strong political leadership or public outcry at the cost of conventional systems.

4. Conventional, high price solutions are defeated when votes for bond authorizations are required, in some cases after millions of dollars have been spent on the detailed design of facilities that were simply not affordable.

As can be deduced from the above, affordability/financial issues are the core issue that needs to be addressed/solved.

Lessons Learned

A number of communities are working somewhat successfully, although many are in process, to address the significant financial implications of septic nitrogen control. Key lessons learned where progress is occurring includes:

1. **Proactive engagement of the broad stakeholder groups is critical**

   In Falmouth MA, the conventional solution that would have resulted in a $600 million project has been revised by an appointed Citizens Committee of respected scientists, engineers, regulators and general public to a $300 million project. Additionally the Town has appropriated $2.2 million to evaluate alternative and leading edge approaches for septic nitrogen management. http://www.falmouthmass.us/depart.php

   In Leon County, FL, citizens and scientific committees have endorsed a long-term comprehensive septic management plan that was initially resisted by County staff due to concern over the fear of public reaction to costs.

2. **Validate science that is the basis for the corrective actions**

   Computer models and **continual** water quality / hydrology data collection are needed to improve the understanding of the natural system so that appropriate solutions are implemented and faith in the science is maintained. Unfortunately, the lack of transparency of the science of TMDL determinations associated with the Massachusetts Estuary Project has caused great skepticism in many communities.

3. **Use Adaptive Management whereby the understanding of science and viability of lower cost options is continually improved**

   This means maintain the maximum flexibility possible when solutions are being implemented so that costs can be minimized as improved understanding of the environmental response to corrective measures is made. Inappropriate planning or poor adaptive management is when large treatment plants are built and sewer expansion over 20 years is planned.

4. **Identify low cost solutions and perform ongoing testing/evaluations**

5. **Provide solutions for all stakeholders so that commonality of purpose is achieved**

6. **Look for opportune events to require upgrades**

   As an example, in 1995 Massachusetts updated its Title V regulations governing onsite treatment and disposal systems. As part of this update, Title V now requires septic systems to be upgraded to meet current code requirements as part of any property transfer. This approach assumes that the majority of properties will change hands within a seven year period. Although this policy was not implemented specifically for nitrate removal purposes and primarily is applied to failing or inferior systems, property transfer is an opportune time to require necessary upgrades. Suffolk County, NY is currently considering requiring upgrades as a part of any property transfer and is expected to make a decision by the end of 2012.

By implementing programs that incorporate the above lessons learned, community support will be engendered and the probability of success will be maximized.

3.0 CASE STUDY – FAIRFAX COUNTY, VIRGINIA

3.1 Project Background & Septic System Water Quality Issues

3.1.1 Project Background

Fairfax County, Virginia is located in the northeastern part of the State, adjacent to Washington, DC and is approximately 400 square miles, as shown on Figure 3-1. The County is adjacent to the State of Maryland along the Potomac River to the north and east. It lies in the northern parts of the Piedmont and Coastal Plane physiographic regions. Soils are generally well draining, with percolation rates of 10 to 30 minutes per inch. The climate is typical mid-Atlantic, with normal average rainfall of about 40 inches per year. The County lies within two major watersheds. The Occoquan Watershed drains into a drinking water reservoir, and the Dulles Watershed drains to the Potomac River, which in turn flows to Chesapeake Bay. Groundwater wells for drinking water are abundant.

Since the early part of the last century, the County has changed from a largely rural area to an urban suburb of Washington, DC. The onsite disposal systems management programs have historically been a function of the local health department, in conjunction with the State Health Department, and ordinances were originally put in place regarding on-site sewage disposal systems as early as 1928. The County has known very marked growth since the 1970s, with population growing from less than 500,000 in 1970 to over 1 million by 2000. With sanitary sewers at or near capacity, the number of individual wastewater systems began to multiply, eventually rising to more than 24,000. Inappropriately sited, improperly designed, and/or poorly managed individual systems have the potential to contribute to the pollution and degradation of the county's 900 miles of perennial and intermittent streams and a number of freshwater lakes and ponds. Additionally, portions of the County are within a watershed draining to Chesapeake Bay, which is subject to regulations promulgated under the Chesapeake Bay Preservation Act to in part protect the Bay from contamination due to septic system issues.

3.1.2 ISDS Related Groundwater Quality Issues

Groundwater in the County is a source of drinking water. The high concentration of individual on-site disposal systems (24,000 systems in 400 square miles total area) discharging to soil absorption beds poses a potential threat to groundwater quality. High nitrogen and bacterial levels in groundwater could be encountered in areas of high concentration of on-site disposal systems.

3.1.3 ISDS Related Surface Water Quality Issues

Because of the plentiful rainfall and the location of the County near the Potomac River, numerous streams and rivers tributary to the Potomac traverse the County. Groundwater contributions to the surface waters in areas of high ISDS concentration has the potential to carry pollutants from inadequate or inappropriately sited absorption fields into these surface water streams, and ultimately into the Potomac River. The Potomac flows to the Chesapeake Bay, the subject of the Chesapeake Bay Preservation Act. The Act seeks to improve water quality and habitat in the Bay, and imposes particular requirements on ISDS which may introduce pollutants into the Bay tide waters.

Figure 3-1 Location Map for Fairfax County, VA

3.2 Proposed Actions

As part of the adoption of the Chesapeake Bay Preservation Act, all counties located in the Chesapeake Bay tide waters are required to adopt local codes that affect onsite sewage disposal systems. In 1992, Fairfax County adopted an ordinance requiring routine pumping of septic tanks every five years and required alternating drainfields and drainfield reserve areas to ensure system performance. Further, in 1999, the County began to explore the concept of

Onsite Management Systems and Onsite Management Districts. Currently, the Fairfax County Health Department (FCHD) serves as the RME for the ISDS management system.

Alternating Drainfields and Reserve Area: As the RME, the FCHD issues permits and provides inspections and evaluations for new and existing individual wastewater system repairs and expansions. All new and repaired systems are designed with a flow diversion valve to allow portions of the drainfield to dry out; this improves treatment and avoids soil saturation problems. A suitable reserve area is required in the event the system needs to be repaired or replaced.

Five-Year Pump-out and Manifest System: An ordinance specifies that septic tanks must be pumped every five years. The service provider and the system owner both provide copies of the pump-out manifests to the FCHD, which tracks maintenance. The information is maintained in a database and is used to track compliance with the local ordinance. The database generates five-year pump-out reminder notices that the FCHD mails to system owners. The FCHD also offers $200 individual system inspections if required by a mortgage lender at the time of property transfer.

3.3 Community Reaction / Acceptance

A study, http://www.nesc.wvu.edu/nodp/pdf/ffva.pdf, found that the average malfunction rate for systems in the county was only 2.1% of the 15,401 systems reviewed. In addition, many systems thought to have outlived their life expectancy are still functioning satisfactorily.

The creation of a database for system inventory has allowed the County to track septic tank pump-outs and categorize all systems according to system type, greatly assisting the enforcement of existing codes and regulations. The use of alternating drainfields has increased the average lifespan of sewage disposal systems.

The five-year pump-out requirement has resulted in better maintained systems and the identification of system malfunctions that would otherwise go undetected. As a result of these measures, fewer owners are facing costly major repairs or system replacements.

Through its program, Fairfax County now better understands and manages its many onsite systems even in light of a fast- growing population.

3.4 Implementation Status

The FCHD serves as the RME for this program which has been in place for about four years.

3.5 User Costs

Fairfax County sustains its annual $1.5 million onsite program through user fees and dedicated funds. The fees cover approximately 30% of the program costs. The remainder is financed through dedicated state and local funds.

3.6 Lessons Learned

Proactive management of septic systems minimizes septic system failure rates.

References and Resources

1. Fairfax County Stream Quality Assessment Program. **www.fairfaxcounty.gov/dpwes/stormwater/streams/assessment.htm**.

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3. Hill, D. 1999. Onsite Waste Management—A Case Study, Fairfax, Virginia. **www.nesc.wvu.edu/nodp/pdf/ffva.pdf**.

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4.0 SUFFOLK COUNTY LONG ISLAND, NEW YORK

4.1 Project Background & Septic System Water Quality Issues

4.1.1 Project Background

Suffolk County is located in the central and eastern portion of Long Island, NY, above a sole source aquifer used for drinking water supply. There are approximately 1,000 miles of coastline supporting tourism and fisheries industries that support the local economy. The population is approximately 1.5 million people, with approximately 25% of the community connected to centralized sewage collection, treatment and disposal facilities. The majority of the population relies on individual sewage disposal systems (ISDS).

A 208 Study was conducted in 1977 that identified ISDS as a major source of hazards to groundwater quality in Suffolk County. The relationship between housing density and groundwater quality was established and became the basis for density based sewering requirements in Article 6 of the Suffolk County Sanitary Code.

4.1.2 ISDS Related Groundwater Quality Issues

The Clean Water Act 208 Water Quality Planning Study identified ISDS as a primary source of nitrogen and VOCs (from organic cesspool cleaners), threatening groundwater quality in Suffolk County. With a projected buildout population of over 3 million people, there was the potential for significant impacts on groundwater quality in the sole source aquifer.

The recent 2010 Suffolk County Comprehensive Water Resources Plan (SCCWRP), (CDM, 2010) updated the 208 Planning Study and developed an improved understanding of the groundwater aquifer and its water quality. The SCCWRP addressed the nitrogen issues as well as other issues such as VOCs and pharmaceutical contaminants.

4.1.3 ISDS Related Surface Water Quality Issues

In addition to the potential groundwater contamination associated with widespread ISDS use, there are a significant number of coastal embayments in Suffolk County that are experiencing moderate to severe water quality degradation as a result of increasing nitrogen loads. Numerous 303(d) listed impaired water bodies due to septic system nitrogen exist in Suffolk County. The Town of Southampton has estimated the cost of implementing nitrogen removal measures at $1 billion for the Town alone (http://www.peconicestuary.org/pep-admin/reports/7a07778087fb622b8d5aaea1d65da526d83ec0e3.pdf). Given the area's reliance on its coastal waterways for the tourism and fisheries industries, this is a critical resource that Suffolk County residents are very concerned with preserving.

4.2 Proposed Actions

As a result of the 208 Planning Study, organic cesspool cleaners were banned and density requirements were created. The projected population for Suffolk County dropped from around 3 million to fewer than 2 million after density requirements were implemented.

Groundwater protection zones were created, presented on Figure 4-1, that delineated areas of restricted densities due to their sensitivity with respect to potential groundwater contamination.

Density restrictions established a minimum lot size of 40,000-ft^2 in Zones III, V and VI. Zones I, II, IV, VII and VIII have a minimum lot size requirement of 20,000-ft^2.

The Suffolk County Drinking Water Protection Program was approved in 1987, and then extended in 1999 and 2007. The program created a ¼% sales tax to generate revenue for the following purposes:

- 42.85% of revenues to the Suffolk County Environmental Programs Trust Fund for:
    - 31.1% for acquisition of environmentally sensitive lands
    - 11.75% for environmental programs / projects related to pollution abatement and water quality protection
- 32.15% of revenues to the Suffolk County Taxpayers Trust Fund, proceeds of which are used for stabilization of the County's general property taxes and/or police/public safety property taxes for the subsequent year
- 25% of revenues to the Suffolk County Sewer Assessment Stabilization Fund, proceeds of which are used to offset any sewer assessment fee increase in excess of 3%.

4.3 Community Reaction / Acceptance

As evidenced by the extension / modification the Suffolk County Drinking Water Protection Program and the associated ¼% sales tax in 1999 and 2007, this program has the support of the community. In general, the people of Suffolk County understand the issues and the need for protection of resources the entire community relies upon.

4.4 Implementation Status

The Suffolk County Drinking Water Protection Program has been extended through 2030.

4.5 User Costs

During the past few years the ¼% sales tax has generated the following revenues:

2009	$59,705,154
2010	$63,799,578
2011	$65,313,029

Figure 4-1 Suffolk County Location Map & Groundwater Zones

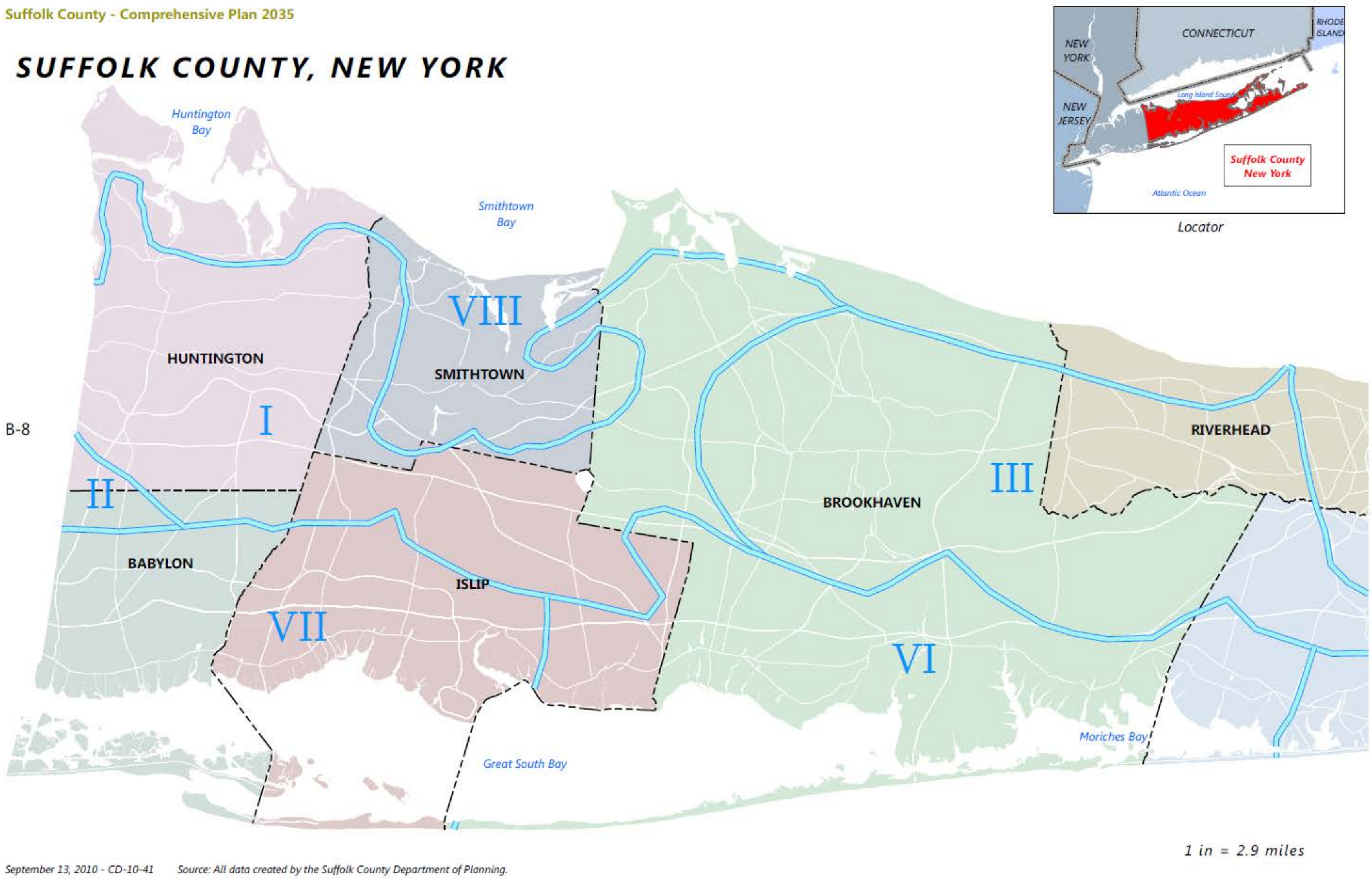
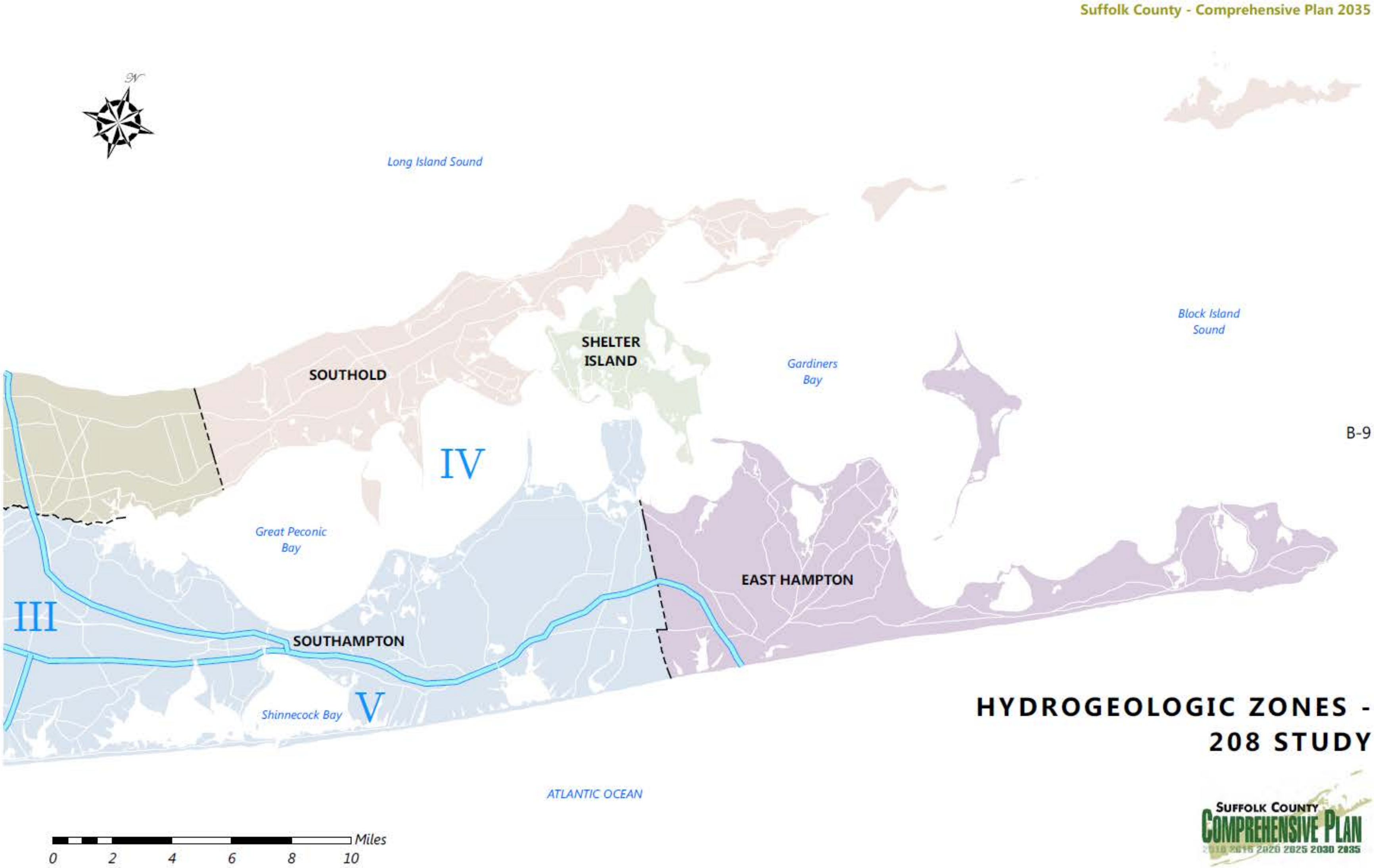


Figure 4-1 (Continued): Suffolk County Groundwater Zones



4.6 Lessons Learned

The groundwater zones and associated density requirements were based on a groundwater quality standard of 10 mg/L. The sewering requirements, and the associated NPDES discharge requirement of TN < 10 mg/L, were only applied to new development and retrofits / upgrades to existing properties. While this addresses the issue of minimizing future contamination, it does not address existing areas using ISDS with densities that, under current density requirements, would be required to install a community system meeting NPDES discharge requirements of TN<10 mg-L. In addition, groundwater quality standards are not protective of surface water quality. Suffolk County is experiencing moderate to severe surface water quality degradation due to excess nitrogen from ISDS. Groundwater nitrogen concentrations have been steadily increasing (SCDHS, 2010), causing concern that the existing density based sewer requirements may not be sufficiently protective to ensure long-term groundwater quality protection. To address the surface and groundwater quality concerns, recently the Suffolk County Department of Health Services has adopted the Best Management Practices (BMP) that when the treated wastewater is discharged in an area within the 25-year travel time to a water body or 50-year travel time to a water supply well that the effluent TN is to be < 7 mg/l.

The Suffolk County lessons learned can be summarized as follows:

- Using density based sewer requirements with a 10 mg/L threshold offers no margin of safety. Density based requirements should be based on 5 mg/L to ensure long-term water quality.
- Density based requirements only work if they are applied to existing as well as new development. Legacy issues must be addressed as part of a comprehensive plan.
- Groundwater quality based nitrogen standards are not protective of surface waters receiving groundwater contaminated with nitrogen. ISDS effluent limits that comply with TMDL standards for nitrogen loading need to be established.

5.0 CASE STUDY – LA PINE, OREGON, DESCHUTES COUNTY

5.1 Project Background & Septic System Water Quality Issues

5.1.1 Project background

Groundwater concerns in southern Deschutes County, Oregon date back to the 1960s, when land was subdivided into more than 12,000 one-half to one-acre lots and population growth led to an increasing threat of nitrate contamination from septic systems.

Nitrate levels as high as 41 mg/L, over 4 times the drinking water standard of 10 mg/L, were detected in La Pine in 1982. In 1994 the Oregon Department of Environmental Quality conducted additional sampling and created a groundwater model for the area. The model predicted that groundwater nitrate concentrations would exceed the 10 mg/L standard within 10 to 20 years under projected buildout conditions.

The water table in the La Pine area is higher than elsewhere in the County. Rainfall groundwater recharge is 2 – 3 inches/year, minimizing dilution of ISDS effluent and making the aquifer susceptible to nitrate contamination. In addition to groundwater contamination concerns, the potential for pollution of the Little Deschutes and Deschutes Rivers was also a concern.

In 2008, The Deschutes County Commission passed an ordinance that requires property owners in the southern part of the County to reduce nitrate contamination from septic systems. The ordinance requires property owners to upgrade existing ISDS to nitrate-reducing OSTDS by 2022 or take other measures to reduce nitrates, such as connecting to sewers or installing composting toilets. The vote was the culmination of a year of public hearings, and more than a decade of research on how nitrates from ISDS contaminate the aquifer in and around La Pine and Sunriver. The nitrate problem has drawn millions of dollars from federal, state and local governments to fund research (http://www.deq.state.or.us/wq/onsite/sdesch-nklam.htm and http://www.deschutes.org/Community-Development/Regional-Projects-and-Resources/Groundwater-Protection-Project/La-Pine-National-Demonstration-Project.aspx).

Voters overturned the ordinance in a special election in March 2009, citing affordability issues.

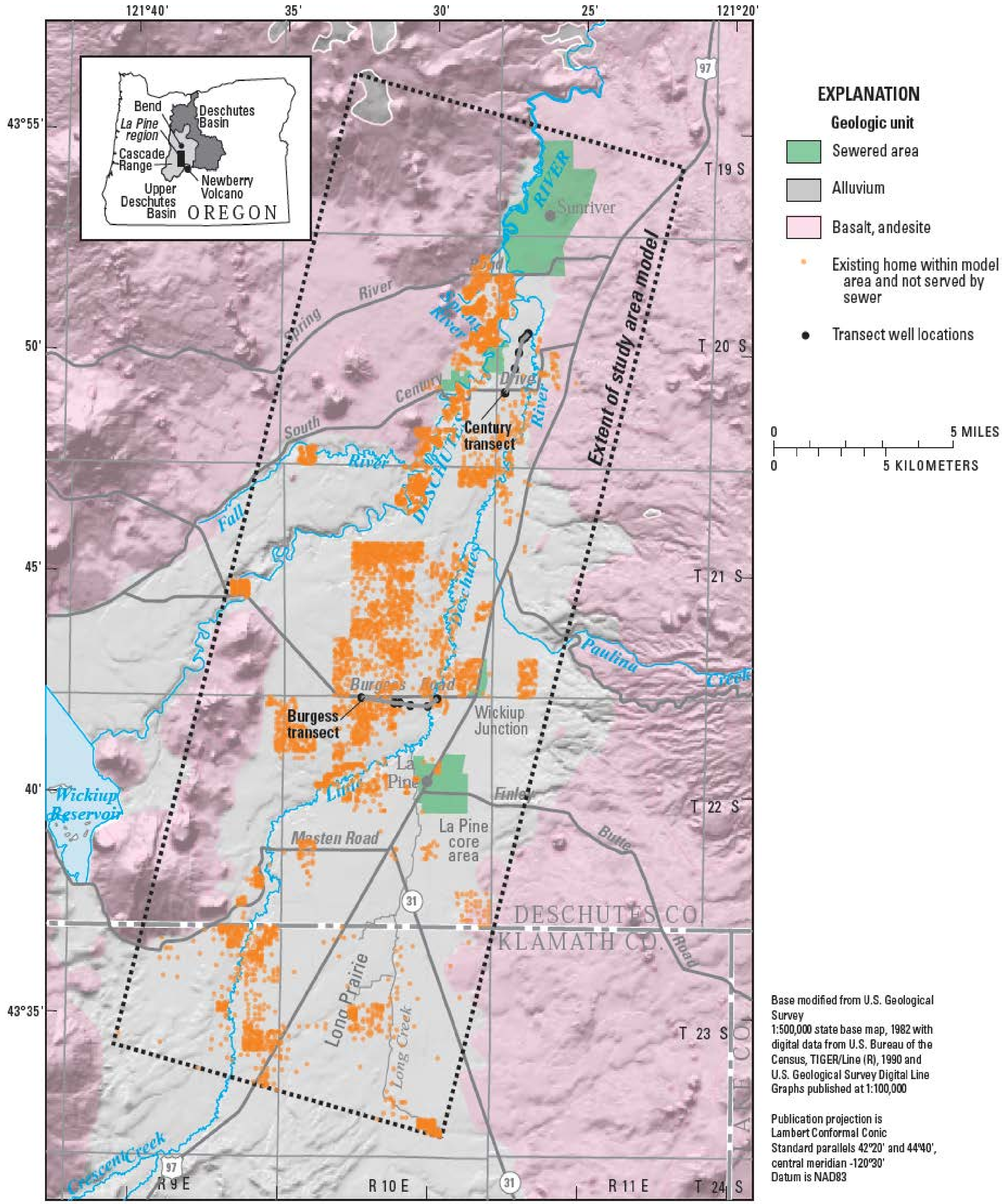
5.1.2 ISDS Related Groundwater Quality Issues

In addition to the studies referenced above, a 2007 USGS study utilized nitrogen isotopes for plume tracking as part of a model to determine the fate and transport of ISDS generated nitrates. The modeling efforts indicated that average nitrate contamination under buildout conditions will exceed the drinking water standard over areas totaling 9,400 acres. Figure 5-1 presents the area modeled by USGS.

5.1.3 ISDS Related Surface Water Quality Issues

Also raising concern was the water quality of local streams and rivers. Reports written in 2000, 2003, and 2007 indicated that the Deschutes and Little Deschutes Rivers, world class trout fisheries which flow through developed areas of La Pine, were already experiencing excessive algae in some reaches. This was likely due, in part, to nitrogen and phosphorus contributions from groundwater impacted by ISDS.

Figure 5-1 La Pine Area USGS Nitrate Model Area



5.2 Proposed Actions

Under the La Pine National Decentralized Wastewater Demonstration Project, various innovative nitrogen reducing technologies were installed and evaluated (http://www.deschutes.org/Community-Development/Regional-Projects-and-Resources/Groundwater-Protection-Project/La-Pine-National-Demonstration-Project.aspx).

The minimum on-site system performance standards for the evaluated technologies included the following:

- Total nitrogen ≤10 mg/L
- Fecal Coliform and/or E.coli levels ≤ two orders of magnitude CFU/100 ml
- Five-Day Biochemical Oxygen Demand (BOD_5) ≤10 mg/L
- Total suspended solids (TSS) ≤10 mg/L

Based on the results of the demonstration project, the Deschutes County Commission passed an ordinance in 2008 requiring property owners in the southern part of the County to upgrade existing septic systems to nitrate-reducing ones by 2022 or select an alternative method to reduce discharge of nitrogen to the groundwater. These alternate measures could include installing such technologies as composting toilets, or connecting to an available centralized treatment system.

Concurrent goals were to establish an on-site system maintenance program and to create a low interest loan fund program to assist property owners with implementation of the ordinance. The maintenance program was to include an education campaign for the public and professional groups, and to establish an advisory committee charged with defining an on-site maintenance strategy.

5.3 Community Reaction / Acceptance

Voters overturned the ordinance in a special election in March 2009, citing affordability issues. Deschutes County has asked DEQ to take the lead to resolve the issue. At a meeting in July 2009, the public raised many questions about how to best approach the issue. In July 2010, DEQ assembled a steering committee of community members to discuss and make recommendations to improve groundwater protection in South Deschutes and North Klamath counties. The Committee met for the first time in September 2010, and has been meeting monthly since. Information on topics discussed at the meetings can be found at http://www.deq.state.or.us/wq/onsite/sdesch-nklam.htm.

5.4 User Costs

A loan program is being evaluated that would provide low-interest loans to help homeowners replace or repair failing and improperly sited systems with technologies that will reduce nitrogen discharge to the groundwater. Creating an affordable user cost system is a critical component for any action requiring voter approval. Efforts to create this program are on-going.

5.5 Lessons Learned

The primary lesson learned for Deschutes County is that affordability issues need to be addressed prior to enacting legislation that requires action from residents who are either unwilling or unable to afford the cost of the required upgrades. Alternative means of financing and managing upgrades must be fully vetted to ensure the proposed upgrades are economically feasible and meet the community's needs.

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6.0 CASE STUDY – PEÑA BLANCA, NEW MEXICO

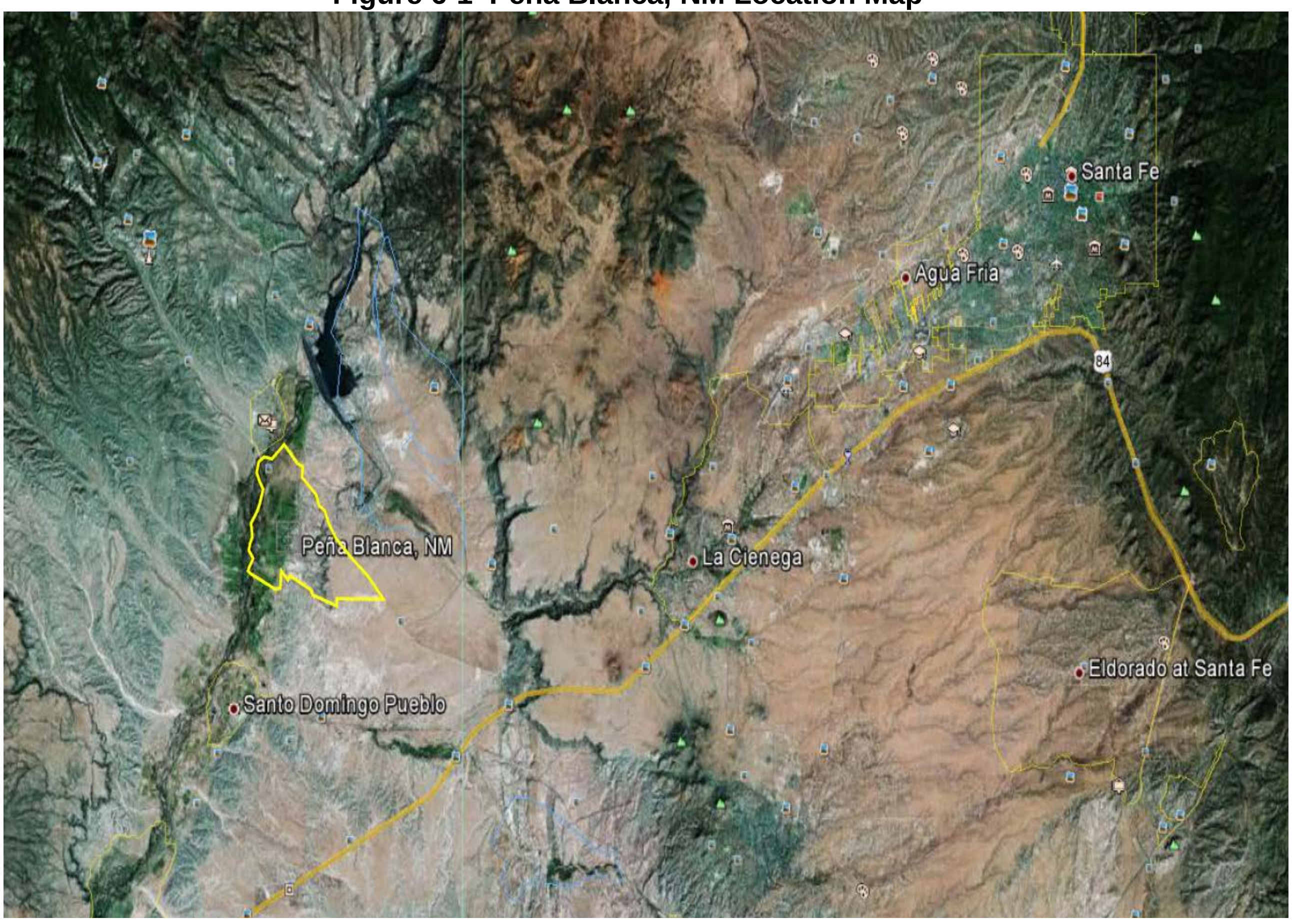
6.1 Project Background & Septic System Water Quality Issues

6.1.1 Project Background

Peña Blanca, New Mexico is located in north central New Mexico, about 25 miles southwest of Santa Fe, as presented on Figure 6-1. The town was originally established in the 1700s and is a farming community near the Rio Grande River. The community is relatively remote, with a population of 661 residents as of the 2000 census.

The community was served completely by ISDS, with many being outdated, neglected or essentially non-existent. A number of homes were served only by cesspools. Raw sewage and material from cesspools was often disposed of in irrigation ditches or on the land surface. Additionally, a number of systems were located in areas of high groundwater, creating a hydraulic connection to the Rio Grande. Residents began noticing problems with the on-site disposal systems in the 1970s and by the 1980s, the problems associated with the inadequate and/or failing systems were increasing. Residents became concerned with possible exposure to their children, and with the safety of water for drinking and bathing. Surveys revealed that 86% of the individual wastewater systems needed repair or replacement.

Figure 6-1 Pena Blanca, NM Location Map



6.1.2 ISDS Related Groundwater Quality Issues

Groundwater contamination from ISDS was evident in areas with a shallow depth to groundwater. These areas did not have the necessary unsaturated zone between the bottom of the ISDS and the seasonal high groundwater table to ensure proper removal of bacteria and virus, as well as to maximize the limited nitrogen removal associated with ISDS discharges. Additionally, high groundwater levels contribute to hydraulic failure of septic systems and cesspools, often resulting in discharge of untreated wastewater to the ground surface. Surface discharge of septic tank effluent water is a public health hazard.

6.1.3 ISDS Related Surface Water Quality Issues

The Rio Grande River, a potential source of drinking and irrigation water and a recreational resource in the arid area, is hydraulically connected to the nearby groundwater in which the failed ISDS were located. The surface water issues related to the failed and/or inadequate systems could have major repercussions, especially since the Rio Grande is interstate and an international water. Further, sewage from failed systems was often discharged into irrigation canals, from which excess irrigation water is discharged back to the river.

6.2 Proposed Actions

As a result of resident action, engineering firms were hired to evaluate the community's wastewater treatment options. In 1984, a Facilities Plan was completed outlining 10 alternatives, with a centralized alternative being selected. The cost of the selected alternative was estimated at $669,392. The State review determined that the decentralized alternative was the most cost-effective and therefore the only one eligible for EPA financial assistance.

A second Facilities Plan was completed in 1985, and it proposed installing a small-diameter pressure collection system and facultative ponds with intermittent sand filters. The cost was estimated at $3.1 million dollars. This Plan was rejected by the State on both a technical and economic basis, leading to a third Facility Plan that was completed in 1986.

The 1986 facilities Plan proposed construction of a total of 133 onsite systems. At least 39 cesspools and 20 existing septic systems were replaced with new ISDS. Additionally, the firm recommended that 23 new septic systems be installed as cluster systems to serve more than one home. Sand mounds were installed at 18 homes situated in high groundwater areas. The estimated project costs were $1,108,084, and the final construction costs were $939,700, of which $759,820 was eligible for funding through U.S. EPA Grants.

The improved ISDS were constructed / upgraded between February and September of 1990. The town has implemented an on-site system management program with the following attributes:

- Operating permit and maintenance contract requirements
- Requirement to pump tanks every two years
- Maintenance of system records and reporting requirements
- The Pena Blanca Water and Sanitation District (PBWSD) was formed in 1990, under the authority of a New Mexico State statute, to manage the onsite and cluster systems. The PBWSD adopted an ordinance addressing the operation, maintenance, and repair of ISDS. The PBWSD maintains an inventory of the

systems, collects user fees, requires pumping of all tanks at least once every two years, contracts pumping services, maintains all active systems, and coordinates with the City of Albuquerque to accept septage pumped from the tanks.

- The PBWSD ordinance serves as a maintenance contract and authorizes the District to pump septic tanks every two years. Homeowners retain the option of hiring their own pumpers but must maintain documentation of the service and pay a base fee of $4 per month. Residents installing new individual wastewater systems must sign an easement allowing for maintenance. Operating permits from the New Mexico Environment Department are required for all systems.

6.3 Community Reaction / Acceptance

Formation of the PBWSD required a petition to be signed by at least 25% of registered voters and an election. The State rejected the 1984 and 1985 Plans due to affordability concerns, which were likely shared by the majority of the residents. However, according to some officials with the PBWSD, some residents feel that the septic system upgrades are not their preferred option, and they feel that a centralized system would have been preferred.

6.4 Implementation Status

The program is in place and operational, under the authority of the PBWSD.

6.5 User Costs

According to septic tank size, the PBWSD charges a monthly service fee, which ranges from $9 to $20 per month. The PWWSD 2008–2009 operating budget was $27,000.

6.6 Lessons Learned

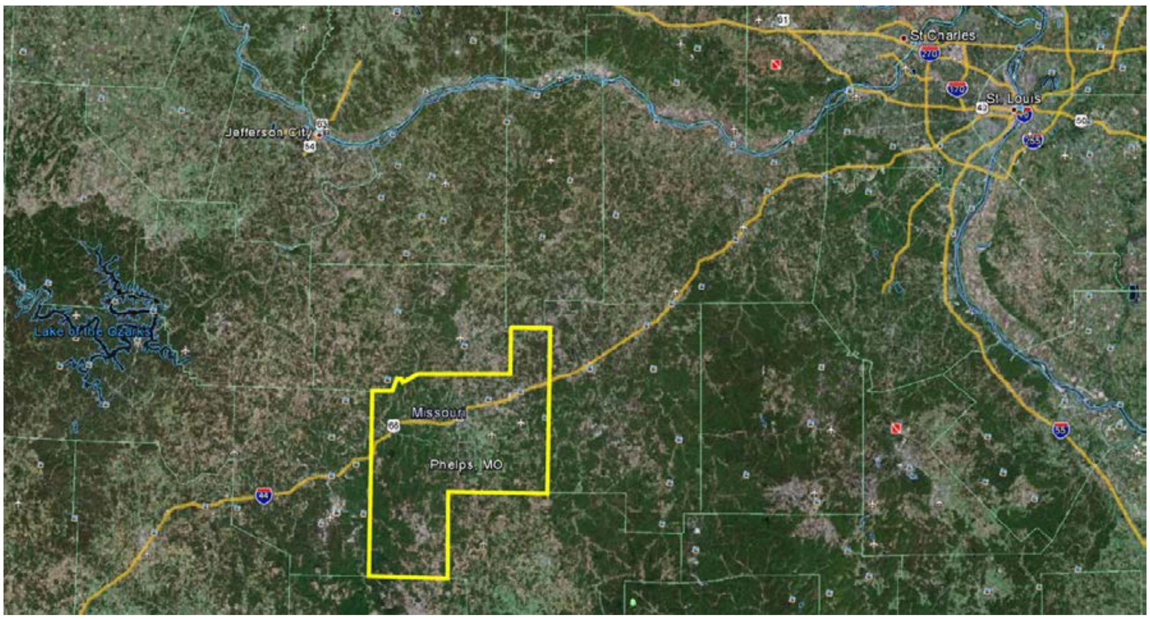
The primary lesson learned is the importance of conducting an affordability analysis with a public outreach process as part of the Facility Planning process that requires upgrades to ISDS. The 1984 and 1985 Facilities Plans were not economically feasible. The 1986 Facilities Plan was affordable, and even though some residents may prefer a centralized approach, the decentralized approach was the only feasible alternative. In addition, the decentralized alternative was the only alternative that was deemed eligible for U.S. EPA financial assistance, which ultimately paid for ~80% of the total project cost through grants.

7.0 CASE STUDY – PHELPS COUNTY MISSOURI

7.1 Project Background & Septic System Water Quality Issues

7.1.1 Project Background

Phelps County is an area of 677 square miles in the Ozark Mountains of south-central Missouri. According to the 2010 census, the County has 45,156 residents, with a density of 59 persons per square mile, county wide. A large percentage of the population resides in rural and small town settings without centralized wastewater treatment systems. As a result, the County has many ISDS.



In 1995, Missouri adopted more stringent public health regulations for individual systems on lots of three acres or less. Local banks would not provide loans on homes that could not pass a septic inspection showing compliance with those regulations. The combination of people with failing systems and people who were seeking a bank loan created a significant number of property owners who needed to upgrade their individual systems. Residents were becoming concerned about the new regulations in light of potential failure of their existing systems and the inability to repair or replace them with affordable conventional systems if their property was less than 3 acres.

The local Water Service District was a known and trusted agency with experience in providing utility service. However, the costs of traditional sewers and centralized wastewater treatment facilities were not economically feasible due to extensive open areas separating subdivisions with higher densities.

7.1.2 ISDS Related Groundwater Quality Issues

Except for occasional cisterns and springs, drinking water supplies in Phelps County are mostly groundwater wells. Groundwater studies performed in the 1970s indicated a presence of nitrate and coliform bacteria in groundwater wells in Phelps County. Areas of high nitrate and coliform bacteria concentrations in the groundwater were linked to intense agricultural usage. This was an indication that surface or near surface contamination was travelling down through the permeable soils and impacting groundwater.

7.1.3 ISDS Related Surface Water Quality Issues

Numerous streams flow through the rolling hills of Phelps County, many of which are in hydraulic connection with groundwater. Additionally, several high producing springs associated with Karst features such as caves, springs and sinkholes, are located in the area. The springs rise from groundwater and form bodies of open water. High nitrate levels in groundwater can contribute to algae blooms in the surface waters. Algal blooms can range from nuisance levels to posing a threat to fisheries.

7.2 Proposed Actions

In 1995, the general manager of Public Water Supply District #2 (PWSD2) became aware of decentralized technology and the potential to provide economically feasible wastewater service to smaller areas of more dense development – subdivisions. The technology was Septic Tank Effluent Pump (STEP) collection systems with recirculation sand filters (RSF) for treatment. The water district petitioned the local court to amend its decree of incorporation to allow them to provide wastewater service to their customers.

The initial intention was to service existing areas where the numbers of failing systems combined with the regulatory and bank requirements created a pool of customers that would make a decentralized system economically feasible. However, due to a dispute with the City of Rolla concerning PWSD2 customers that had been annexed by the City, service to existing customers was put on hold until PWSD2 could receive assurances that potential future customers would not be annexed and removed from their jurisdiction. While this dispute was being settled, a process that took over 2 years, PWSD2 was approached by a developer who was interested in developing a subdivision that was not near the areas in dispute. The developer offered to donate a lot for the treatment facility and to fund the STEP and RSF systems on the condition that the PWSD2 would construct, own and operate the systems. During construction, PWSD2 realized it had the funds to add capacity and connect nearby developments that were in need of service.

The project was a success and lead to other similar projects. For subsequent projects, the District modified the approach, partnering with developers to construct new RSFs so that both new and existing homes could be served. In return, the District agreed to own and manage the systems. The systems all utilize a STEP collection system and RSF wastewater treatment system and operate under a surface water National Pollutant Discharge Elimination System (NPDES) permit issued by the state of Missouri.

PWSD2's management program consisted of the following:

- Discharge authority under an individual NPDES permit
- District holds bonding authority to fund program
- Routine inspection requirement
- Financial incentive and low-interest loan opportunities

User Agreements and Utility Easements: Residents in new developments must sign a user agreement, connect to the system, and grant a utility easement to the PWSD2. Owners of existing homes with malfunctioning individual systems may voluntarily connect to the decentralized system at the homeowner's expense. PWSD2 offers incentives (e.g., connection fee waivers) to encourage homeowners to connect to the system during the time of construction.

7.3 Community Reaction / Acceptance

The new regulations and bank requirements created a large base of people looking for a wastewater solution. Customers were already accustomed to paying the water district for water service and having the utility own the components of the system was familiar. The prevailing sentiment was that, rather than dealing with the new regulatory requirements, customers just wanted to flush their toilets and pay a monthly bill (Dietzmann and Gross, 2003).

For new developments, the inclusion of residents into the cluster systems was done by a covenant signed at the time of lot purchase, whereby the new property owners were required to sign a user's agreement for the cluster system and grant an easement to the water district. Since the PWSD2 owned and maintained the cluster systems, homeowners were not responsible for maintenance of their own individual systems.

According to Dietzmann and Gross (2003), the public perception is that there now is a "sewer system" that they can connect to.

7.4 Implementation Status

The program is fully implemented and adding customers when opportunities arise. The District continues to partner with developers to construct new systems so that both new and existing homes can be serviced.

7.5 User Costs

PWSD2 issued revenue bonds and borrowed money to finance the start of the decentralized wastewater management program. PWSD2 charges a flat rate of $46.50 per month to fund the program. The District has the power to terminate potable water service for nonpayment of fees.

7.6 Lessons Learned

The following lessons were learned during this process:

- Regulations requiring upgraded systems create demand for RME of decentralized collection, treatment and dispersal.

- Having additional incentives, such as bank loans being conditional on systems compliant with new regulations, adds to the base of potential customers.
- PWSD2 determined that 2/3 of an existing area needed to commit to connection to make a project economically feasible, and that notarized agreements to connect need to be secured prior to construction.
- Leveraging new development to facilitate connection of nearby existing development reduces the cost to provide service to nearby existing areas of need.

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