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Use of Produced Water in Recirculating Cooling Systems at Power Generating Facilities

Deliverable Number 6
Cost/Benefit Analysis

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Disclaimer

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Abstract

The purpose of this study is to evaluate produced water as a supplemental source of water for the San Juan Generating Station (SJGS). This study incorporates elements that identify produced water volume and quality, infrastructure to deliver it to SJGS, treatment requirements to use it at the plant, delivery and treatment economics, etc.

SJGS, which is operated by Public Service of New Mexico (PNM) is located about 15 miles northwest of Farmington, New Mexico. It has four units with a total generating capacity of about 1,800 MW. The plant uses 22,400 acre-feet of water per year from the San Juan River with most of its demand resulting from cooling tower make-up. The plant is a zero liquid discharge facility and, as such, is well practiced in efficient water use and reuse.

For the past few years, New Mexico has been suffering from a severe drought. Climate researchers are predicting the return of very dry weather over the next 30 to 40 years. Concern over the drought has spurred interest in evaluating the use of otherwise unusable saline waters.

The costs and benefits of gathering, conveying and treating produced water for use at SJGS are presented and assessed in this deliverable. Life-of-project projections are developed for the produced water resource in the Study Area and a number of scenarios are assessed to determine reasonable recoverable volumes of water. A likely range of produced water recovery was established to estimate capital and operating costs for the project. PNM and producer revenue sharing, in the form of reduced produced water disposal costs, is also incorporated into the economic analysis to determine life-of-project water costs.

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Executive Summary

The purpose of this study is to evaluate produced water as a supplemental source of water for the San Juan Generating Station (SJGS). This study incorporates elements that identify produced water volume and quality, infrastructure to deliver it to SJGS, treatment requirements to use it at the plant, delivery and treatment economics, etc.

SJGS, which is operated by Public Service of New Mexico (PNM) is located about 15 miles northwest of Farmington, New Mexico. It has four units with a total generating capacity of about 1,800 MW. The plant uses 22,400 acre-feet of water per year from the San Juan River with most of its demand resulting from cooling tower make-up. The plant is a zero liquid discharge facility and, as such, is well practiced in efficient water use and reuse.

For the past few years, New Mexico has been suffering from a severe drought. Climate researchers are predicting the return of very dry weather over the next 30 to 40 years. Concern over the drought has spurred interest in evaluating the use of otherwise unusable saline waters.

There is minimal gathering infrastructure in place in the San Juan Basin. Almost all of the gathering is accomplished by transporting produced water by tanker truck from well head to SWD for disposal via deep well injection. Also, oil and gas production is highly dispersed – one well per 160 to 320 acres. A handful of energy companies represent the majority of production in the San Juan Basin. Seven producers (large and small) represent almost 95 percent of produced water generation in the Tri-City, Fairway and Close-in areas.

Produced water from the Tri-City, Fairway and Close-in areas could supply 8.8 to 10.0 percent of plant needs and could prevent SJGS from reaching the take-or-pay coal contract threshold.

SJGS has a take-or-pay coal contract. If the plant has to reduce load for significant periods of time because of reduced water supply and if the reduction in load is large enough, PNM must pay for fuel it regardless. Since fuel is the largest expense for SJGS, this is considered a credible worst-case economic scenario given the strong inevitability of drought. PNM has determined that a one-year 30-percent shortage in regional water supply would be significantly more costly in fuel contract penalties and lost generation than the entire capital investment in the produced water project.

Producers would provide gathering infrastructure to deliver water to either the Collection Center in Bloomfield or along the Bloomfield-to-SJGS pipeline. In doing so, producers would benefit by minimizing their disposal costs. The PNM-producer relationship is structured in this analysis to provide financial benefits to PNM and producers that materially participate. In the Tri-City and Fairway areas, produced water gathering would involve BR and PNM and would be segmented into following areas of responsibility:

- BR would build infrastructure by modifying the Hart Canyon Line and CO_2 Gas Line to gather produced water in the Tri-City and Fairway areas.
- BR would deliver the gathered water via an extension of either the Hart Canyon Line or CO_2 Gas Line to the PNM Collection Center in Bloomfield.

- BR would build satellite collection stations along the Hart Canyon Line and CO_2 Gas Line to receive-for-fee produced water from other producers.
- PNM would build a Collection Center at the headworks of the pipeline to receive and pretreat gathered water in the Tri-City and Fairway areas.
- PNM would convey gathered water to SJGS for treatment and use.

The investment in BR gathering infrastructure would be paid by their avoided costs of disposal and fees generated by the receiving water from other producers. BR would share with PNM:

- Avoided costs of disposal of BR produced water
- Fees from other producers for receiving produced water
- BR's avoided costs associated with building new or replacement injection wells and injection well facilities (SWDs).

Close-in producers – Dugan and Richardson would also inject filtered produced water directly into the conveyance line. Dugan and Richardson would share with PNM cost savings associated with avoided disposal of produced water (via deep well injection).

The PNM share of BR, Dugan and Richardson avoided costs and fees would be treated as project revenue against the cost of conveyance and treatment of produced water.

The total water resource for the Study Area is a combination of produced water from the Fairway, Tri-City, and Close-in production areas, backflow from three to four SWD wells and other non-production sources of water – cooling tower blowdown from Prax Air, BHP Billiton mine water and SO_2 absorber Purge Water. Refer to the following table (next page) for a summary of the possible resource in 2006.

Life-of-project recoverable water will be dependent on initial sustained growth as a result of infill well installation followed by a gradual decline in produced water generation as fields mature. In this analysis, it was assumed that growth is sustained at two percent per year until 2008 (five years of growth from expanded production starting in 2004). Three life-of-project declination scenarios were evaluated – two, four and six percent along with five recovery cases – 50, 60, 70, 80 and 90 percent.

Total Water Resource – 2006

	BPD	gpm	AF/yr
Fairway	22,600	659	1060
Tri-City	3,020	88	142
Close-in	13,680	399	644
Backflow	10,000	292	470
Total Produced Water	49,300	1,438	2,316
Prax Air – Cooling Tower Blowdown	300	9	14
BHP Billiton – Mine Water	1,700	50	80
Purge Water – SO_2 Absorber Bleed Stream	3,430	100	161
Total Other Water	5,430	159	255
Total Water Resource	54,730	1,597	2,571

Given the high density of produced water in the Tri-City, Fairway and Close-in areas among only seven producers, it is reasonable to assume that 75 to 85 percent of the water resource could be recoverable in the Study Area. It was also assumed that six-percent declination would be a prudent choice of the three scenarios because resource decline is the least understood recovery parameter and is difficult to predict.

BR estimated that it would cost $5 million to develop the gathering system. Costs for Dugan and Richardson (estimated at $100,000 each) would be minimal since the Bloomfield-to-SJGS pipeline passes both of their operations. PNM capital expenditure would be $37.9 million and would include the Collection Center in Bloomfield, the Bloomfield-to-SJGS pipeline and the produced water treatment system. Produced water would be treated at SJGS using Alternative 10 – the HERO® process and refurbished BC 3. All of the recovered water could be used as supplemental make-up to the cooling towers, SO_2 absorbers and ash system. Refer to the following cost summary:

Total Project Capital Costs

BR	Gathering system to Collection Center	$5,000,000
Dugan	Inject into pipeline	$100,000
Richardson	Inject into pipeline	$100,000
PNM	Collection Center, pipeline & treatment	$37,900,000
Total Project		$43,100,000

If the tax credit were enacted in the 2005 legislative session (in the form proposed in the 2004 session), the following would be provided:

- A credit of $1,000/AF of produced water delivered to SJGS
- Credits cannot exceed $3 million annually
- A life-of-the-project cap equal to 50 percent of the capital cost of the project.

Since the capital budget for PNM would be $37,900,000, the life-of-the-project cap would be equal to $18,950,000 (50 percent of the capital budget).

Two levels of revenue sharing were evaluated:

- 50:50 Split – PNM and the producers would split the revenue evenly.
- 75:25 Split – PNM would receive the greater share.

With a 50:50 share of revenues, the life-of-project net cost of water would vary between $620 to $1,000/$AF_{Net}$ with the tax credit and $1,200 to $1,520/$AF_{Net}$ without the tax credit. With a 75:25 share (PNM to producer), the cost of water would vary from -$300 to -$30/AF_{Net} with the tax credit (indicating possible net revenue under these circumstances) and $200 to $500/$AF_{Net}$ without the tax credit. Clearly, both revenue sharing and the tax credit have a significant effect on the life-of-project net cost of water with an overall range of -$300 to $1,520/$AF_{Net}$ (a cost spread of $1,820/$AF_{Net}$) to collect, convey and treat produced water for reuse at SJGS.

Depending on how revenues are shared with PNM and the extent of produced water recovery, BR could recoup their total investment in gathering system development in 2.8 to 5.0 years. Given the revenue projections for Dugan and Richardson their investment should payout in less than 4 to 6 months.

6.1 Introduction

The costs and benefits of gathering, conveying and treating produced water for use at San Juan Generating Station (SJGS) are presented and assessed in this deliverable. Life-of-project projections are developed for the produced water resource in the Study Area and a number of scenarios are assessed to determine reasonable recoverable volumes of water. A likely range of produced water recovery was established to estimate capital and operating costs for the project. Public Service of New Mexico (PNM) and producer revenue sharing, in the form of reduced produced water disposal costs, is also incorporated into the economic analysis to determine life-of-project water costs.

6.1.1 Project Setting

There is minimal gathering infrastructure in place in the San Juan Basin. Almost all of the gathering is accomplished by transporting produced water by tanker truck from well head to SWD (salt water disposal facility) for disposal via deep well injection[1]. Also, oil and gas production is highly dispersed – one well per 160 to 320 acres. Recently, Bureau of Land Management (BLM) permitted infill drilling to allow one well every 80 acres on BLM land. Production in 2003 generated 45,240 BPD of water in the Study Area[2] which covers 1,500 square miles (38 townships).

A handful of energy companies represent the majority of production in the San Juan Basin. Seven producers (large and small) represent almost 95 percent of produced water generation in the Tri-City, Fairway and Close-in areas. PNM has discussed the produced water project (in varying degrees) with four of these producers.

The San Juan Basin is currently experiencing a period of accelerated development because of increased demands for natural gas and new well installation in the region is currently limited by the availability of drilling equipment. In 2003, the San Juan Basin had 19,090 active wells – 8,500 in the Study Area (almost all of which are gas wells). Also, as a result of infill drilling, produced water injection in the Study Area increased 26 percent from 2002 to 2003 and by 34 percent in the Tri-City, Fairway and Close-in areas.

6.1.2 The Need to Work with Producers

The lack of infrastructure and the size of the Study Area make gathering and delivering produced water to SJGS costly. The cost/benefit analysis recognizes this and incorporates producer involvement on the gathering side to reduce PNM's cost exposure to a collection point, pipeline and treatment plant. Producers would provide gathering infrastructure to deliver water to either the Collection Center in Bloomfield or along the pipeline. In doing so, producers would benefit by minimizing their disposal costs. The

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[1] Based on 2003 OCD (Oil Conservation Division of New Mexico) production data, there were 44 injection wells in the Study area that were used solely for produced water disposal. Of the 44 wells, one took industrial wastewater in addition to produced water.

[2] The Study Area at this point in the report has been reduced from 2,400 square miles as described in Deliverable 1, Produced Water Assessment, to 1,500 square miles. The Study Area is delineated by townships – 32N5W (northeast corner) to 29N14W (southwest corner) and encompasses the Tri-City, Fairway and Close-in areas identified in Deliverable 2, Infrastructure Availability and Transportation Requirements, Figure 2.4.

PNM-producer relationship is structured in this analysis to provide financial benefits to PNM and producers that materially participate[3].

Gathering strategies for the Tri-City and Fairway areas and Close-in production are discussed next.

Gathering in the Tri-City and Fairway Areas

The Tri-City and Fairway areas present the greatest challenge to gathering produced water. Burlington Resources (BR) has an extensive production network in the Study Area with existing infrastructure that could be modified for gathering purposes (discussed in Deliverable 2, Infrastructure Availability and Transportation Requirements). Produced water gathering would involve BR and PNM and would be segmented into following areas of responsibility:

- BR would build infrastructure by modifying the Hart Canyon Line and CO_2 Gas Line to gather produced water in the Tri-City and Fairway areas.
- BR would deliver the gathered water via an extension of either the Hart Canyon Line or CO_2 Gas Line to the PNM Collection Center in Bloomfield.
- BR would build satellite collection stations along the Hart Canyon Line and CO_2 Gas Line to receive-for-fee produced water from other producers.
- PNM would build a Collection Center at the headworks of the pipeline to receive and pretreat[4] gathered water in the Tri-City and Fairway areas.
- PNM would convey gathered water to SJGS for treatment and use.

The investment in BR gathering infrastructure[5] would be paid by their avoided costs of disposal and fees generated by the receiving water from other producers. BR would share with PNM:

- Avoided costs of disposal of BR produced water
- Fees from other producers for receiving produced water
- BR's avoided costs associated with building new or replacement injection wells and injection well facilities (SWDs).

Close-in Gathering

Close-in producers – Dugan Production Corporation (Dugan) and Richardson Operations Company (Richardson) – would inject filtered produced water directly into the conveyance line. Dugan and Richardson would share with PNM cost savings associated with avoided disposal of produced water (via deep well injection).

The PNM share of BR, Dugan and Richardson avoided costs and fees would be treated as project revenue against the cost of conveyance and treatment of produced water.

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[3] The PNM-producer project relationship presented in this deliverable was developed with three producers.

[4] Pretreatment at the Bloomfield Collection Center would consist of oil and grit removal via gravity separation, flotation and media filtration and is discussed in detail in Deliverable 3, Treatment & Disposal Analysis.

[5] Burlington Resources developed a cost analysis (with PNM) to determine the economic benefits of a gathering system owned and operated by them.

6.1.3 Legislative Initiatives

PNM endeavored to address regulatory issues associated with produced water by supporting a bill in the New Mexico legislature that would specifically allow the disposal of produced water at electric generating facilities. The bill consisted of two elements:

- It would allow producers to dispose of produced water at SJGS. This would eliminate a number of regulatory and jurisdictional problems associated with beneficial use of a water resource.
- Acknowledging the high cost of this project, PNM would receive a tax credit from the state to compensate for the cost of conveying and treating produced water. The amount of the proposed tax credit would be $1,000 per acre-foot (AF) of produced water delivered to SJGS. The credit would be limited to $3 million annually. Also, there would be a maximum payable life-of- project cap equal to 50 percent of the capital cost of the project.

The bill was introduced into the January-February 2004 state legislative session and the provision allowing produced water disposal at electric generation facilities such as SJGS was signed into law March 2004. The tax credit was not included in the bill. PNM plans to support tax credit legislation in the next state session in 2005.

6.1.4 Benefit of the Project to PNM

Power generation is directly proportional to water supply at SJGS, e.g. a five percent reduction in annual water supply would result in a five percent reduction in annual power generation. As discussed in Deliverable 3, Treatment & Disposal Analysis, SJGS treats and recycles a significant amount of its wastewater, and as a result, there are no opportunities for additional water savings to preserve generation capacity. Climate studies conducted by researchers at the University of Arizona (Cavazos et al, 2002) predict that New Mexico is entering a period of extended drought – possibly lasting 60 to 80 years (wet-to-dry-to-wet cycle). For the past two years, water supplies in the Four Corners area have been strained and the plant has guaranteed its supply through one-year purchase agreements with local tribal entities. At some point in the future, these agreements may not be possible to obtain because of dramatically reduced regional water supply.

SJGS has a take-or-pay coal contract, i.e. a fixed amount is paid for fuel annually whether it is used or not. If the plant has to reduce load for significant periods of time because of reduced water supply and if the reduction in load is large enough, PNM must pay for fuel regardless. Since fuel is the largest expense for SJGS, this is considered a credible worst-case economic scenario given the strong inevitability of drought. PNM has determined that a one-year 30-percent shortage in regional water supply would be significantly more costly in fuel contract penalties and lost generation than the entire capital investment in the produced water project[6].

Produced water from the Tri-City, Fairway and Close-in areas could supply 8.8 to 10.0 percent of SJGS's needs and could prevent SJGS from reaching the take-or-pay coal contract threshold.

[6] PNM preferred to keep fuel penalty contract information confidential.

6.1.5 Evaluation Basis

Five produced water cases are assessed in this deliverable. The cases represent a range of the produced water recovery in the Tri-City, Fairway and Close-in areas – from 50 to 90 percent (in 10-percent increments) of total produced water generated in the Study Area. Also, as oil and gas fields mature, produced water generation will decline (especially true for CBM production). Three declination scenarios – two, four and six percent – were evaluated for each produced water recovery case for a total of fifteen economic assessments. The assessments are used to evaluate a range of project economics to cover the uncertainty associated with supply.

6.2 Life-of-Project Produced Water Generation

The project would have an operating life of 20 years. The first five years would represent the development of producer-side infrastructure to gather BR water and attract other producers. It is anticipated that BR, Dugan and Richardson would participate at the outset of the project.

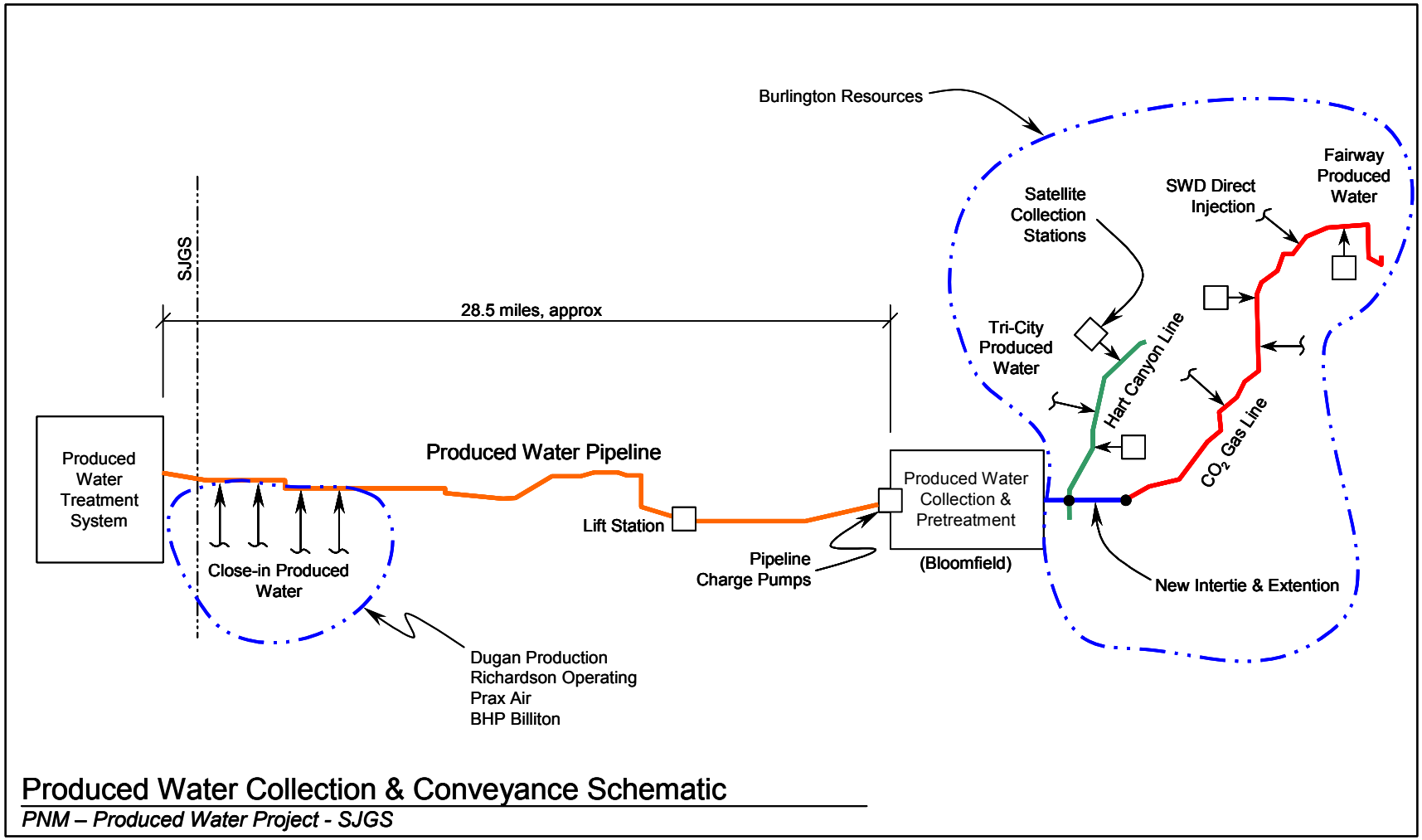
The success of the project is highly dependent on the development and utilization of a well designed produced water gathering system. A system designed to minimize transportation time from wellhead to disposal would attract producers because it could significantly reduce their operating costs. Trucking produced water represents 50 to 80 percent of the disposal costs for many producers. BR would develop and operate the gathering side of the project by extending the Hart Canyon Line and CO_2 Gas Line to a common point and onto the Collection Center in Bloomfield.

BR would install satellite collection stations along both lines at the intersections of heavily traveled disposal truck routes. BR would utilize the stations to reduce their hauling costs and offer the service (for fee) to others as a more cost effective disposal option. The Hart Canyon Line and CO_2 Gas Line will also be designed to take direct (piped in) deliveries from SWDs. There are four SWDs immediately near the CO_2 Gas Line alignment. Direct disposal to the gathering system would extend SWD injection well life, and in many cases, could eliminate to need to replace wells[7]. Refer to Figure 6.1 for an overall project schematic (showing areas of project responsibility). For additional water, many SWDs could be retrofitted with a well pump to backflow previously-injected produced water.

Dugan and Richardson would inject filtered produced water directly into the Bloomfield-to-SJGS pipeline (just east of SJGS). Prax Air and BHP Billiton would inject cooling tower blowdown and mine water, respectively into the line in the same vicinity. Eventually, produced water gathering would likely involve seven or more producers (large and small).

[7] SWD injection wells can last from three to as many as ten years. Most last five years and then must be replaced at significant cost. Also, injection well maintenance can be costly if a well experiences problems such as plugging or wall failures.

Figure 6.1



Produced Water Collection & Conveyance Schematic

PNM – Produced Water Project - SJGS

The sources of water would include:

- Tri-City and Fairway produced water gathered via the Hart Canyon Line and CO_2 Gas Line using satellite collection stations and accepting direct flow from SWDs.
- Backflow water (from retrofitted SWDs) gathered via the Hart Canyon Line and CO_2 Gas Line.
- Close-in produced water
- Cooling tower blowdown from Prax Air
- BHP Billiton coal mine water
- Purge Water from the SO_2 absorbers at SJGS (collected onsite at the plant)

6.2.1 Study Area Resource Estimates

The San Juan Basin is currently experiencing a period of increased development because of market demands for natural gas. It was assumed that the first five years of the project would see growth in gas development (and as well as increased producer involvement in the project). After that, as resources decline, produced water generation would fall. Daily produced water generation for Fairway, Tri-City and Close-in areas is based on 2003 production data (refer to Figure 2.4 in Deliverable 2, Infrastructure Availability and Transportation Analysis). These values are escalated by three percent through 2006 to reflect growth in production (new wells). There was actually a 34.7 percent increase of produced water from 2002 to 2003 in the Fairway, Tri-City and Close-in areas. This increase was a result of infill drilling to meet the increased demand for natural gas. The three-percent escalation factor was used because infill drilling will not proceed at this pace in the long term. Also, since there is uncertainty in predicting water production (especially CBM), a three-percent escalation factor was considered a more conservative approach to planning.

For the purposes of this analysis, this would establish a project start date in 2006. The following table presents assumed produced water generation for each area:

Production Area	Produced Water 2003 BPD	Produced Water 2006 BPD
Fairway	20,680	22,600
Tri-City	2,760	3,020
Close-in	12,520	13,680
Total	35,960	39,300

In addition to the above estimates, it was also assumed that a total of 10,000 BPD could be extracted (backflow) from formations currently or previously used for deep well disposal of produced water. This would likely require the retrofitting of three to four SWD injection wells with pumps.

The total water resource for the Study Area is a combination of produced water from the Fairway, Tri-City, and Close-in production areas, backflow from three to four SWD wells and other non-production sources of water – cooling tower blowdown from Prax Air, BHP Billiton mine water and SO_2 absorber Purge Water. Refer to Table 6.1 for a summary of the possible resource in 2006 (expressed in three different units of measure).

Table 6.1

Total Water Resource – 2006

	BPD	gpm	AF/yr
Fairway	22,600	659	1060
Tri-City	3,020	88	142
Close-in	13,680	399	644
Backflow	10,000	292	470
Total Produced Water	49,300	1,438	2,316
Prax Air – Cooling Tower Blowdown	300	9	14
BHP Billiton – Mine Water	1,700	50	80
Purge Water – SO_2 Absorber Bleed Stream	3,430	100	161
Total Other Water	5,430	159	255
Total Water Resource	54,730	1,597	2,571

Table 6.1 represents all of the water in the resource plus water from other sources previously discussed. Produced water recovery, however, would be limited to effective infrastructure gathering improvements. Other water (non-produced water) can be obtained with much less effort.

Life-of-project recoverable water will be dependent on initial sustained growth as a result of infill well installation followed by a gradual decline in produced water generation as fields mature. In this analysis, it is assumed that growth is sustained at two percent per year until 2008 (five years of growth from expanded production starting in 2004). Three declination scenarios are evaluated – two, four and six percent[8]. Declination is based on a compounding formula as follows:

$$DF = (1 - r)^{n-1}$$

Where: *DF* *Declination Factor*
r *Declination (expressed as percent)*
n *Year*

Refer to Figure 6.2 for declination rate versus time assumptions for the three scenarios and Figure 6.3 for the total water resource versus time used for each scenario. The water resource increases to 2,700 AF/yr in 2010 and falls to 2,200, 1,900 and 1,600 AF/yr, respectively for Scenarios 1 (2% decline), 2 (4% decline) and 3 (6% decline).

Depending on the declination scenario, the water resource as defined in Table 6.1 could loose up 40 percent of its capacity in 25 years. Life-of-project water resource predictions for each declination scenario can also be found in Table A.1 in Appendix A.

[8] Declination is difficult to predict because producing formations (including coal seams) have varied water-release characteristics.

Figure 6.2

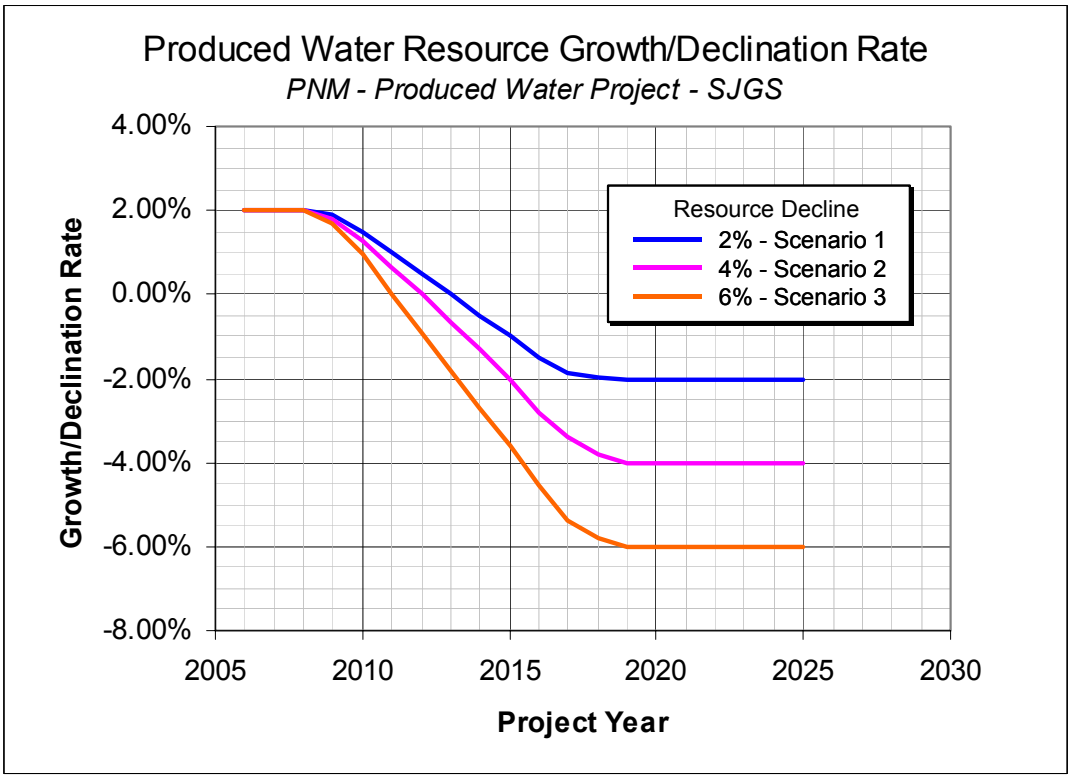
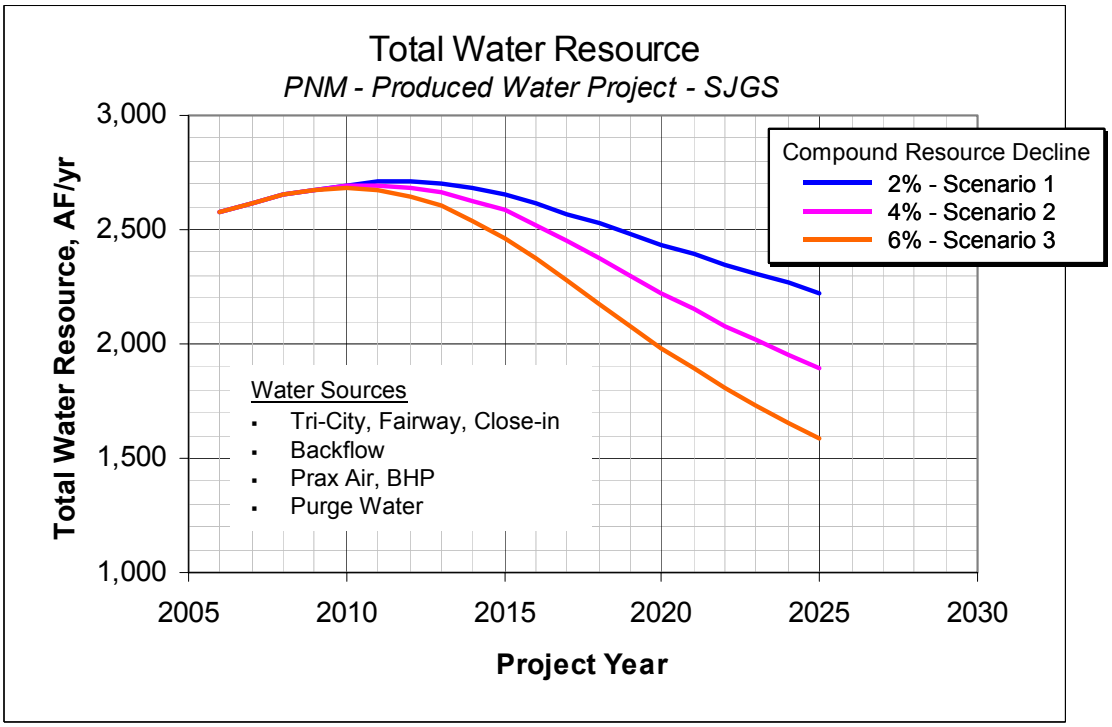


Figure 6.3



Backflow decline (backflow is included in the above resource predictions) was adjusted differently, because previously-injected water is independent of the current infill expansion. Backflow capacity was reduced by two percent per year starting in the fourth project year. Lastly, calculations used to develop resource capacity assume the supply of water from Prax Air, BHP Billiton and SO_2 absorber (Purge Water) remains constant throughout the life of the project.

Again, Figure 6.3 represents all the water in the resource. Recoverable water, which is a function of gathering efficiency, is discussed next.

6.2.2 Recoverable Volume Estimates

At the outset of project implementation, it is assumed that recoverable volume would be limited to produced water provided by BR, Dugan and Richardson. Other producers would likely participate in the project shortly after implementation and recoverable volume would increase accordingly using the infrastructure developed by BR.

In all cases, the first year starts with half of the potential recoverable daily volume followed by rapid growth in the second and third years, then slowly peaking at the fifth year. Refer to Figure 6.4 for water recovery cases and declination scenarios[9]. After five years, the fraction of recoverable water levels off to 50, 60, 70, 80 and 90 percent of the total resource, respectively for Cases 1 through 5.

Year-to-year volume recovery for each declination scenario (five recovery cases per declination scenario) can be found in Table A.2 in Appendix A.

6.2.3 Likely Recovery

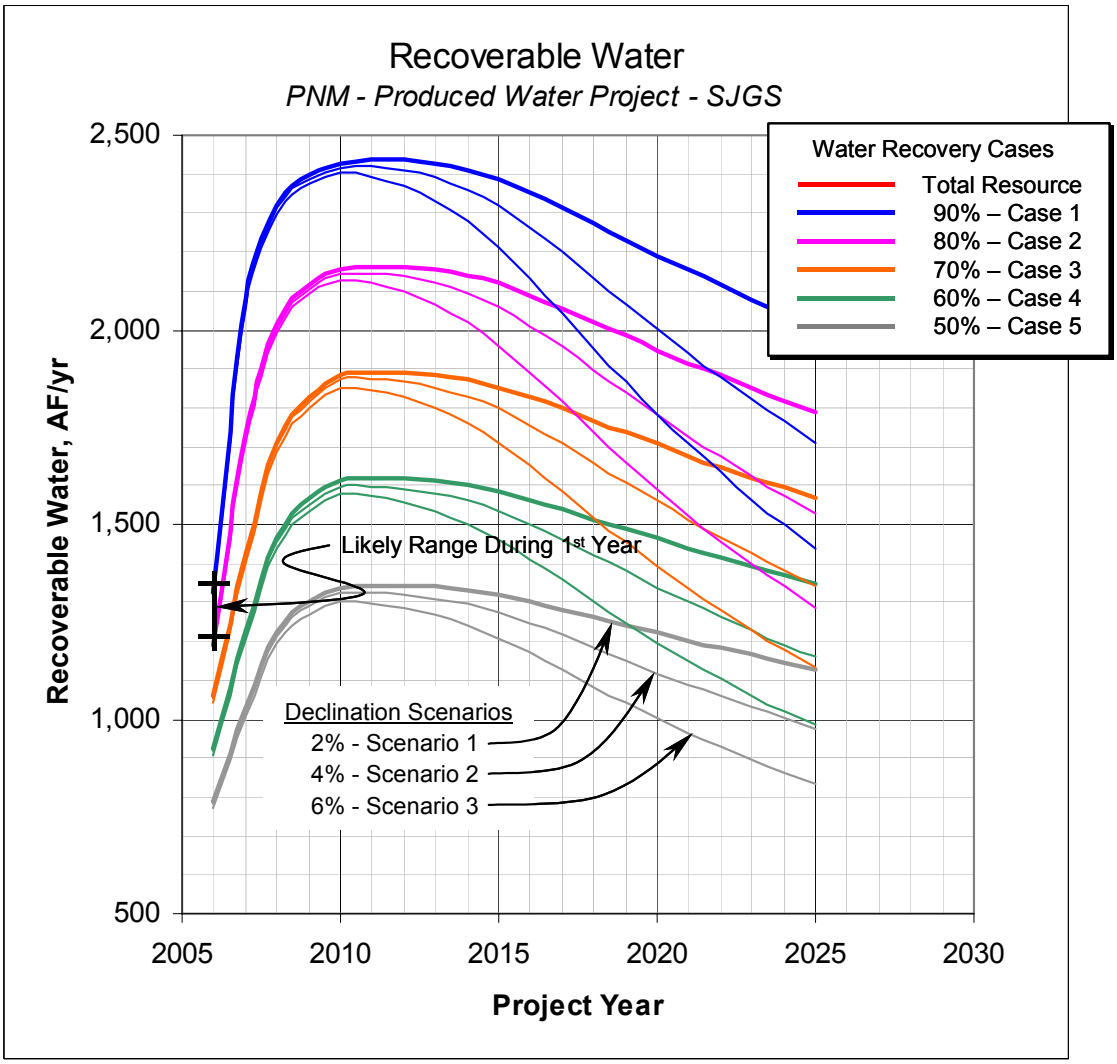
Recovery of produced water in the Study Area (38 townships north of Highway 64) will be a function of the design of the gathering system and the degree of producer involvement.

<u>First Year of Operation</u>

During the first year of the project, 46 to 49 percent of the produced water in the Study Area – 17,380 to 18,380 BPD – could be recovered. Refer to Table 6.2. This would include BR, Dugan and Richardson produced water as well as 2,000 to 3,000 BPD from a major producer with an SWD next to the CO_2 Gas Line (there are four SWDs immediate to the CO_2 Gas Line). BR would also backflow the McGrath SWD injection well for an additional 3,000 to 5,000 BPD. Prax Air, BHP Billiton and Purge Water from SJGS would generate an additional 5,430 BPD of water. During the first year of operation, 25,810 to 28,810 BPD of water (1,214 to 1,355 AF/yr) would likely be delivered to SJGS. Refer again to Figure 6.4. After treatment at SJGS, 95.3 percent of the recovered water – 1,161 to 1,295 AF/yr – would be made available for reuse at the plant.

[9] Annual recoverable water in Figure 6.4 represents water delivered to SJGS.

Figure 6.4



Long Term Produced Water Recovery

In 2003, seven producers – BR, Dugan, Richardson, BP America, Conoco Phillips Company, Williams Production Company and XTO Energy Inc. – generated:

- 89 percent (40,150 BPD) of the produced water in the Study Area
- 95 percent (34,280 BPD) of the produced water in the Tri-City, Fairway and Close-in areas

Dugan and Richardson generated almost all of the produced water in the Close-in area in 2003.

Table 6.2

Likely Recovery During First Year – 2006

Produced Water Resource (1)	
Study Area – All Producers (3)	49,450 BPD
Tri-City, Fairway, Close-in – All Producers	43,870 BPD
Tri-City, Fairway, Close-in – Seven Largest Producers	37,470 BPD
Produced Water Project	
Tri-City, Fairway, Close-in – BR, Dugan & Richardson	15,380 BPD
Direct Feed from SWD	2,000 – 3,000 BPD
Subtotal	17,380 – 18,380 BPD
Fraction of Resource at Start Up	46.4% – 49.1%
McGrath Backflow	3,000 – 5,000 BPD
Prax Air, BHP Billiton, Purge Water	5,430 BPD
Total Likely Flow at Start Up	25,810 – 28,810 BPD
First Year Delivery to SJGS	1,214 – 1,355 AF/yr
First Year Treated Water for Reuse at SJGS (2)	1,161 – 1,295 AF/yr

Notes.....

1. Produced water volumes are escalated 3% annually from 2003 to 2006.
2. Treatment at SJGS would recover 95.3% of feed water.
3. Production from 38 townships north of Highway 64. Refer to Figure 2.4.
4. One producer will likely direct feed to the CO_2 Gas Line at the outset.

The gathering system would likely generate produced water rapidly the first year of operation, leveling off after five years, and in the eighth year, volumetric decline would start to occur as the fields mature. The gathering system could accelerate and optimize collection because:

- There are only seven producers that generate most of the production in the area.
- The Hart Canyon Line and CO_2 Gas Line would have six to eight satellite collection stations to accept produced water along heavily traveled transportation routes.
- Four SWDs are located immediate to the CO_2 Gas Line and could provide a significant portion of the produced water resource.

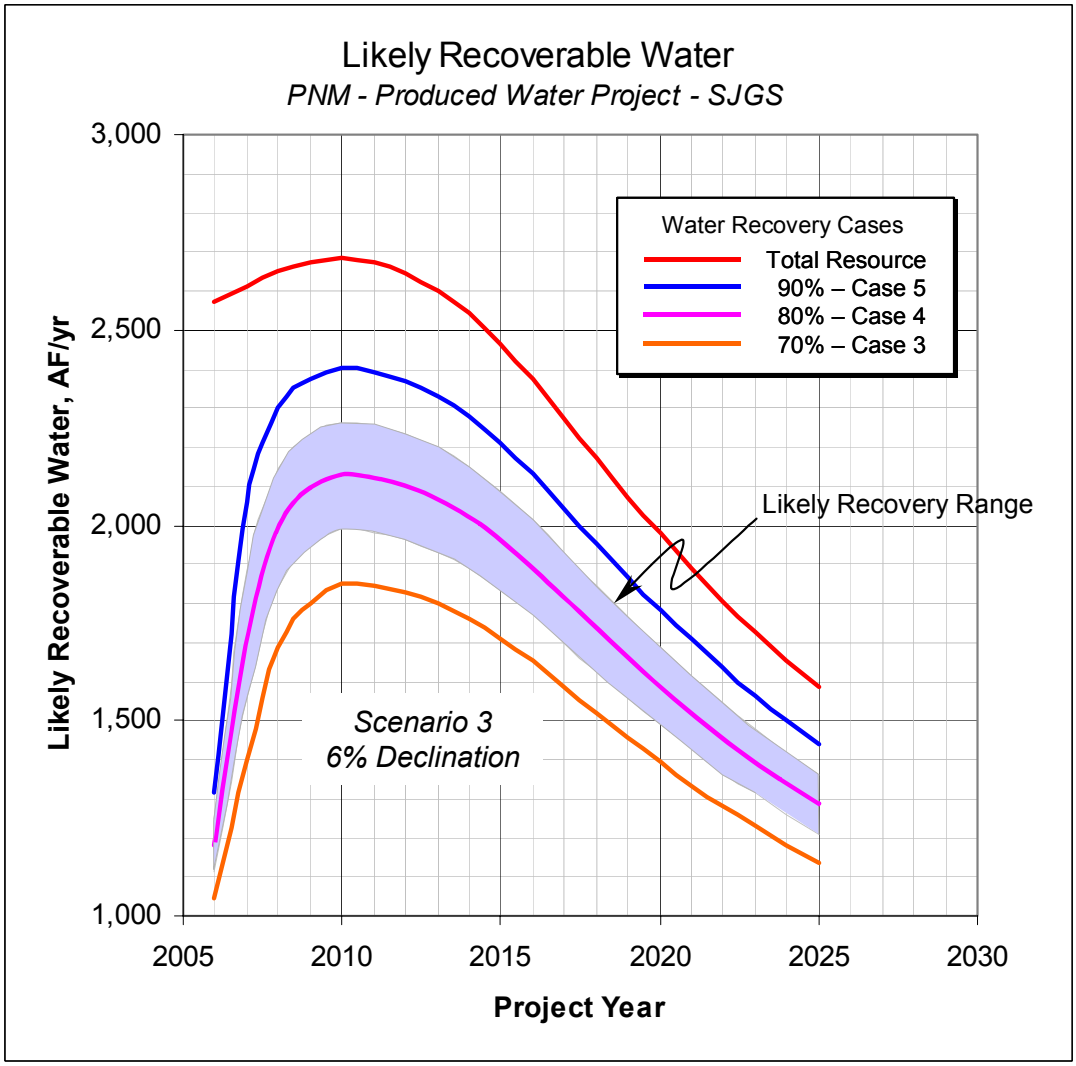
Given the high density of produced water in the Tri-City, Fairway and Close-in areas among only seven producers, it is reasonable to assume that 75 to 85 percent of the water resource could be recoverable in the Study Area. Recall that a combination of 15 recovery scenarios were evaluated (five recovery cases for each of three declination scenarios). Since the majority of produced water was generated among only seven producers (three were involved in project development), 50 percent recovery seems unrealistically small. Conversely, 90 percent recovery or more seems unrealistically high. A recovery of 75 percent is midway between these two endpoints and would appear to be very likely given volume generation patterns. The 75 to 85 percent range reflects the presumed ability of the gathering system that has been conceptually configured by BR to attract other producers.

For each recovery case, three declination scenarios were evaluated – two, four and six percent. The two-percent declination scenario would result in a 20 percent drop in produced water generation during the life of the project. The four and six percent scenarios would result in a 30 and 40 percent produced water decline, respectively. *It was assumed that six-percent declination would be a realistic choice of the three scenarios* because:

- Resource decline is the least understood recovery parameter and is difficult to predict. Therefore, a conservative approach was considered essential.
- Currently, the emphasis in the San Juan Basin is on CBM production. CBM wells typically generate water in high volumes early in their life and then drop off more quickly than conventional wells.

Using the above assumptions, Figure 6.5 presents a likely produced water recovery range (delivered to SJGS) over the life of the project.

Figure 6.5



6.2.4 Project Volume and Revenue

Produced water generated by the project would provide revenue to defray costs associated with gathering, conveying and treating produced water. Project revenue would be realized by reducing the disposal costs of BR, Dugan and Richardson and fees from receiving produced water from other producers. The tax credit (if passed) would also be tied to total produced water recovery[10].

Produced water gathering can be grouped into two categories:

- Produced water delivered to the Collection Center in Bloomfield by the gathering system designed, owned and operated by BR.
- Filtered produced water injected directly into the Bloomfield-to-SJGS pipeline by Dugan and Richardson.

The following produced water streams would determine project revenue for each gathering category:

BR Gathering System to Collection Center

BR	Produced water
Other Producers (delivery for fee)	Produced water delivered via satellite collection station
	Produced water fed directly to the Hart Canyon Line or CO_2 Gas Line

Bloomfield-to-SJGS Pipeline

Dugan	Filtered produced water fed directly to the pipeline
Richardson	Filtered produced water fed directly to the pipeline

Refer to Figure A.1 in Appendix A for Collection Center volume assumptions and calculations. Also, year-to-year volumes for revenue streams are provided in Table A.3 for each of the five recovery cases and three declination scenarios[11]. Project revenue is discussed later in this deliverable.

6.2.5 Disposition of Off-Spec Produced Water

Occasionally the Collection Center will receive water that cannot be treated, e.g. produced water with very high levels of salinity. There are provisions for holding off-spec water and blending it back into the water leaving the Collection Center, however, there will be occasions when blending is not feasible. Off-spec water will be disposed of at a licensed disposal well in the Bloomfield area. Off-spec water was assumed to be one percent of the volume received at the Collection Center for the first year of operation and tapering off to 0.2 percent by the fourth year as off-spec sources are identified and kept out of the system.

Off-spec water should not to be a problem for Close-in production, because CBM water quality is somewhat constant and there are only trace levels of petroleum byproducts.

[10] The tax credit would not include water collected from Prax Air, BHP Billiton or SO_2 absorber Purge Water.

[11] Even though an operating range and declination scenario has been assumed for resource recovery, Table A.3 presents all the cases and scenarios evaluated in this section of the report.

6.3 Capital Cost

There are three categories of capital spending involved in the project:

- Costs incurred by BR to build the gathering system
- Costs by Dugan and Richardson to connect to the Bloomfield-to-SJGS pipeline
- Costs incurred by PNM to build the Collection Center, Bloomfield-to-SJGS pipeline and treatment system at SJGS

6.3.1 Producer Costs

BR estimated that it would cost $5 million to develop the gathering system. This would include:

- Recommissioning the Hart Canyon Line and CO_2 Gas Line including integrity checks and necessary repairs.
- Building six to eight satellite collection stations – each consisting of a receiving tank, transfer pumps, cartridge filters (to remove oil and grit), instruments, valves and piping to either the Hart Canyon Line or CO_2 Gas Line. Each satellite station would use electronic card readers to permit access to a receiving tank for disposal of produced water. This tracking system will also allow BR to identify off-spec sources of water over time.
- Connecting the Hart Canyon Line and CO_2 Gas Line and building an extension to the Collection Center.
- Retrofitting two existing BR SWD injection wells for backflow conversions.
- Providing flange connections and isolation valves for direct-feed of produced water into the Hart Canyon Line and CO_2 Gas Line.

Capital cost details for the gathering system are not included at the request of BR.

Costs for Dugan and Richardson would be minimal and are not estimated[12]. The Bloomfield-to-SJGS pipeline passes both of their operations. They would use existing tanks, filters and pumps and would only have to install several hundred feet of pipeline to intercept the conveyance line.

6.3.2 PNM Costs

PNM capital expenditure would include the Collection Center in Bloomfield, the Bloomfield-to-SJGS pipeline and the produced water treatment system. Refer to Table 6.3 for a summary of capital equipment costs. Produced water would be treated at SJGS using Alternative 10 – the HERO® process and refurbished BC 3. All of the recovered water could be used as supplemental make-up to the cooling towers, SO_2 absorbers and ash system.

Refer to Deliverable 2, Infrastructure Availability and Transportation Requirements for pipeline details and costs and Deliverable 3, Treatment & Disposal Analysis, for equipment details and costs for the Collection Center and the treatment system at SJGS.

[12] Given the distance to the pipeline and the simplicity of the tie-in, connection costs for Dugan and Richardson are likely less than $100,000 each.

Table 6.3

Capital Costs Incurred by PNM

		Collection Center	14-inch Pipeline	HERO + BC 3	Total Project
Capacity, BPD		34,000	60,000	53,000	
Peak Conditions, BPD		30,670	44,710	48,130	
Equipment & Installation		$5,200,000	$12,900,000	$11,800,000	$29,900,000
Contingency	15%	$780,000	$1,940,000	$1,770,000	$4,490,000
NMGRT (1)	6.125%	$320,000	$790,000	$720,000	$1,830,000
PNM G&A (2)	5.5%	$290,000	$710,000	$650,000	$1,650,000
Total Project		$6,590,000	$16,340,000	$14,940,000	$37,870,000

Notes…..

1. NMGRT is the New Mexico Gross Receipts Tax.
2. G&A is a "general and admistrative" charge applied to all PNM projects.

Equipment capacity is based on the maximum treatment throughput that would be experienced by each equipment element during the life of the project (project years four through seven) based on the 75 to 85 percent produced water recovery operating range. The high end of the range – 85 percent – was selected for equipment sizing. Refer to Figure 6.6. The Collection Center and treatment system at SJGS are sized at 34,000 and 53,000 BPD, respectively. During peak recovery periods, this equipment would be operated at 90 percent of rated capacity. Refer to Figure 6.7. The pipeline is sized at 60,000 BPD, and at peak conditions, would be operated at 75 percent of its capacity. The pipeline is considerably oversized to deal with unexpected growth in produced water recovery. With a smaller line and unexpected growth, an additional pipeline (at significant expense) would be required to handle additional flow. Unexpected growth is not a problem with the Collection Center or the treatment system at SJGS, since additional equipment could be added for greater capacity. Lastly, equipment capacity is not optimized and capacity could vary (up or down) after closer analysis.

6.3.3 Total Project Capital Costs

The capital costs associated with the entire project including BR, Dugan, Richardson and PNM are found in Table 6.4. Capital investment would be assumed by each participant in their designated area. Costs include new equipment, upgrades or improvements to existing equipment, one-time right-of-way or land costs, erection and start-up costs.

Figure 6.6

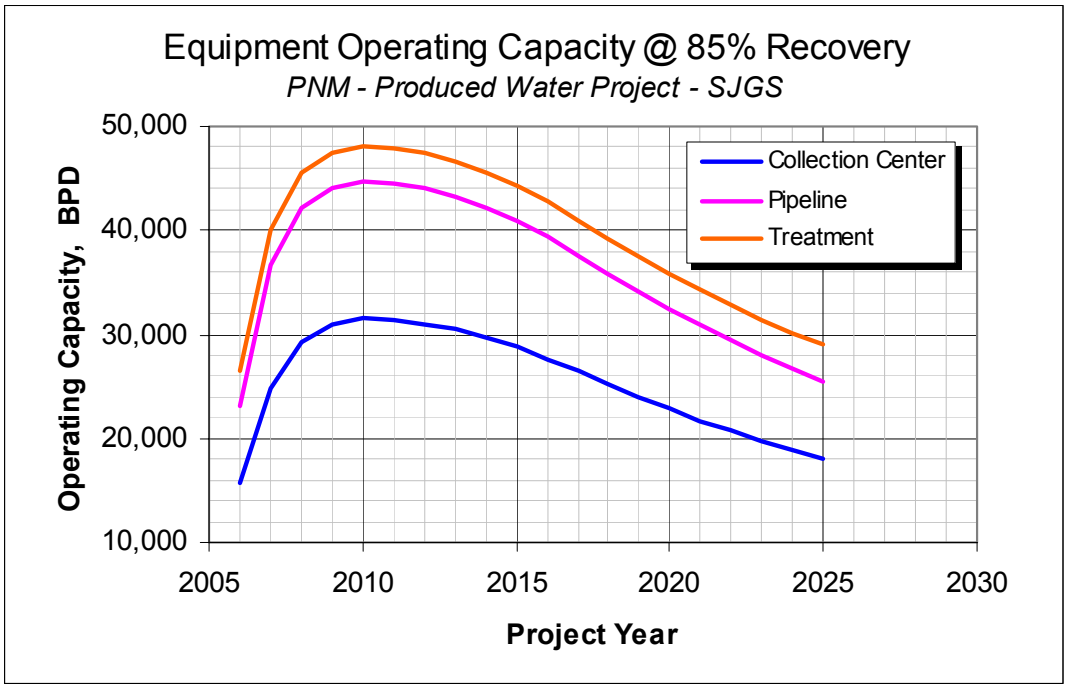


Figure 6.7

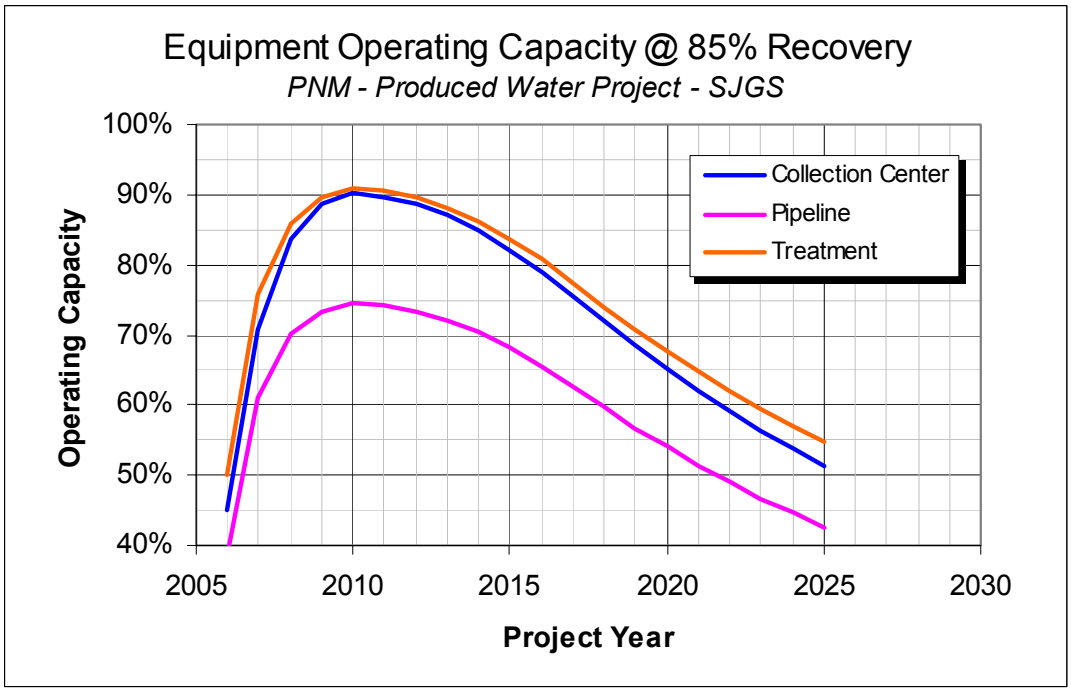


Table 6.4

Total Project Capital Costs

BR	Gathering system to Collection Center	$5,000,000
Dugan	Inject into pipeline	$100,000
Richardson	Inject into pipeline	$100,000
PNM	Collection Center, pipeline & treatment	$37,900,000
Total Project		$43,100,000

Notes.....

1. Installation costs for Dugan and Richardson are most likely high.

6.4 Operating Costs and Revenues

Operating costs and revenue are assessed in this section of the deliverable. Costs for PNM to operate the Collection Center in Bloomfield, convey produced water to SJGS and treat water for reuse at SJGS are outlined. Tax credits, project revenue and revenue sharing are also developed in this section. Project operating costs and revenue adjustments are used to determine the life-of-project cost of water for a range of produced water recoveries. BR, Dugan and Richardson returns on investment for the produced water project are inferred in this analysis[13].

6.4.1 PNM Operating Costs

PNM's operating costs include:

- Chemicals such as sulfuric acid, lime, emulsion breakers, coagulant aids, RO cleaning chemicals, etc.
- Materials include filter media, RO membranes, BC condenser tube inserts, degasifier packing, etc.
- Maintenance – materials and labor for planned and unplanned repairs and contract services such as BC cleaning
- Power to operate equipment
- Off-spec produced water disposal costs – transportation and disposal
- Labor includes PNM operators, maintenance personnel and technicians
- Backflow fees charged by BR and other producers to extract previously injected water from retrofitted SWD disposal wells
- Capital recovery (annual amortization charge assessed to the project to pay for capital equipment).
- Annual rights-of-way payments.

Refer to Tables A.1 and A.4 in Appendix A for a detailed summary of operating assumptions and unit costs, respectively.

Some oil would be recovered at the Collection Center in the gravity separator and sold to the Giant Refinery in Bloomfield. The amount of recoverable oil would be a function of the number of conventional wells that utilize the gathering system for disposal. Based on OCD data, most of the production is CBM (and that fraction is growing). CBM

[13] BR requested that their financial information to be kept confidential.

produced water contain trace levels of non-recoverable volatile petroleum byproducts such as benzene, toluene, etc. In time, less and less oil would be recovered as the number of CBM wells increases and the number of conventional wells declines. Therefore, no credit was taken for recovered oil in the operating analysis because of the uncertainty associated with predicting its volume.

Depreciation charges are not included in this analysis. Depreciation is an adjustment to gross income and is used by corporations when determining tax liability. It is designed to encourage new investment by speeding up the recovery of capital invested in a project. Many companies incorporate depreciation into financial analyses, because it reduces corporate expenses in the form of reduced taxes. No attempt was made to include depreciation in this analysis, given the number of entities in the project and the many ways depreciation can be applied. Following the same reasoning, a tax analysis was not performed either, because of the intricacies of tax law and how it can be applied by all parties.

Refer to the Figure 6.8 for calculating "year *n*" life-of-project escalated costs for 75 to 85 percent produced water recovery and six percent declination. Materials and services were escalated annually by 1.93 percent[14] and labor by 2.71 percent[15]. Capital recovery is based on a 7.5 percent interest rate for a payout period of 20 years. Capital recovery is not escalated, rather it is a fixed charge applied annually to the project throughout its life (20 equal payments). Annual capital recovery is calculated as follows:

$$ACR = CI \frac{(1+i_C)^n i_C}{(1+i_C)^n - 1}$$

Where:	ACR	*Annual capital recovery (n equal payments)*
	CI	*Capital investment*
	n	*Investment payback period, n years*
	i_C	*Interest borrowed capital*

Operating costs are calculated using the following relationship:

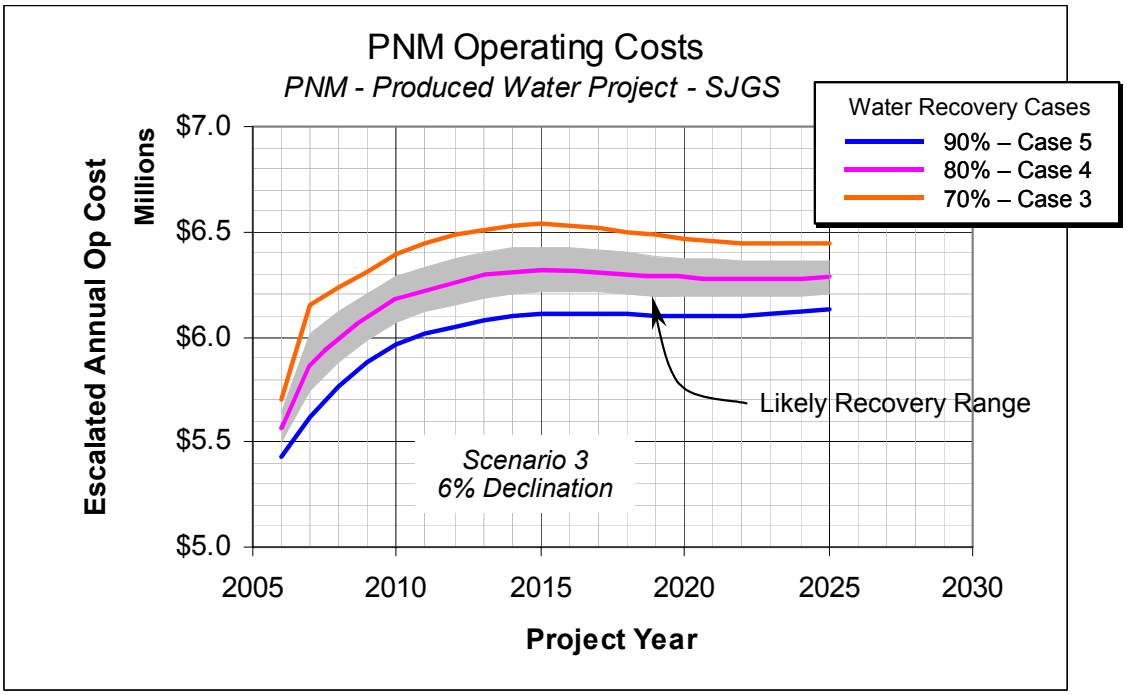
$$OC_n = (M+S)_n (1+i_{MS})^{n-1} + L(1+i_L)^{n-1} + ACR$$

Where:	OC_n	*Escalated operating cost in year n*
	$(M + S)_n$	*Costs (2006 basis) for materials and services in year n*
	$(1 + i_{MS})^{n-1}$	*Escalation factor for materials and services in year n*
	L	*Labor costs (2006 basis)*
	$(1 + i_L)^{n-1}$	*Escalation factor for labor in year n*
	ACR	*Annual capital recovery (n equal payments)*

[14] Average annual growth of producer prices of industrial chemicals from 1982 to April 2004, *Chemical Engineering Magazine*, August 2004, Vol. 111, No. 8, page 72.
[15] Average annual growth of hourly earnings in the chemical and oil-related industries from 1992 to April 2004, *Chemical Engineering Magazine*, August 2004, Vol. 111, No. 8, page 72.

Backflow charges were not included in this portion of the analysis; instead they were deducted from producer revenue (discussed later). Because of escalation, project costs appear to level off in the latter years even though volume is significantly reduced. Escalated life-of-project operating costs can also be found in Table A.4 in Appendix A.

Figure 6.8



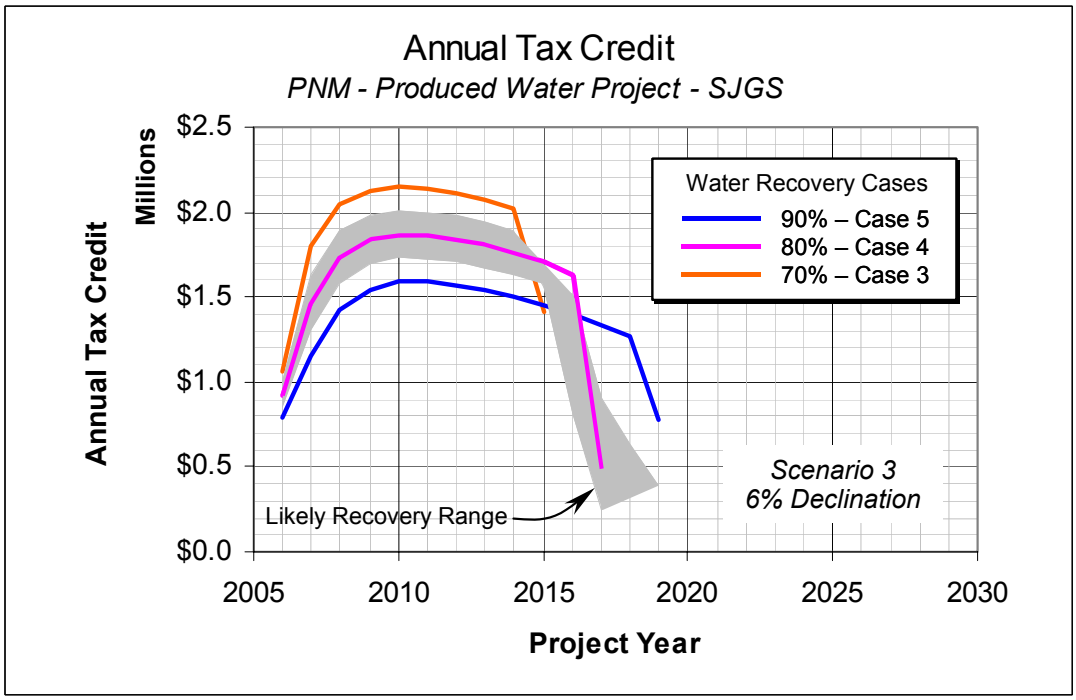
6.4.2 Tax Credit

If the tax credit were enacted in the 2005 legislative session (in the form proposed in the 2004 session), the following would be provided:

- A credit of $1,000/AF of produced water delivered to SJGS
- Credits cannot exceed $3 million annually
- A life-of-the-project cap equal to 50 percent of the capital cost of the project.

Since the capital budget for PNM would be $37,900,000, the life-of-the-project cap would be equal to $18,950,000 (50 percent of the capital budget). Refer to the Figure 6.9 for life-of-project payout of the tax credit for 75 to 85 percent produced water recovery and six percent declination. Lastly, note that the life-of-project tax credit cap would be achieved and would expire in 2017 to 2019 – six to eight years before the end of the project. Life-of-project tax credits can be found in Table A.5 in Appendix A.

Figure 6.9



6.4.3 Project Revenues

As discussed previously, project revenues would be generated by BR via their gathering system and Close-in producers Dugan and Richardson. Revenue would come in the form of reduced operating costs, avoided injection well replacement costs and fees from accepting produced water from other producers. Refer to Table 6.5 for the revenue schedule of fees used to calculate project revenue[16].

Year-to-year volumes for revenue streams are provided in Table A.3 for each of the five recovery cases and three declination scenarios.

Table 6.5

BR Gathering System to Collection Center – Revenue Schedule of Fees

BR	Produced water	$0.55/bbl
	Deferred injection well replacement (starting in year 5)	$1,200,000/year
Other Producers	Produced water delivered via satellite collection station	$0.95/bbl
	Produced water fed directly to the Hart Canyon Line or CO_2 Gas Line	$1.25/bbl

Bloomfield-to-SJGS Pipeline – Revenue Schedule of Fees

Dugan	Filtered produced water fed directly to the pipeline	$0.25/bbl
Richardson	Filtered produced water fed directly to the pipeline	$0.25/bbl

[16] The revenue schedule of fees was developed with BR, Dugan and Richardson.

By sending its produced water to the Collection Center, BR determined it would save $1.2 million per year on injection well replacements. A typical injection well costs between $2 to $3 million to install. One in four wells fail at start-up and have to be abandoned. Depending on the receiving formation and injection rates, wells can last 3 to 10 years (some longer). BR suggested a four-year grace period (to reflect the life cycle of a typical well) before this revenue stream would be implemented. Given the fact that there were 44 injection wells in the Basin in 2003, a significant amount of capital is spent annually by producers to replace (and repair/work over) wells.

As stated previously and for the purposes of this analysis, fees to backflow produced water from retrofitted injection wells are charged against the revenue stream. PNM would be charged a fee of $0.15 per barrel for backflow from BR and $0.25 per barrel for backflow from other producers. Ten cents per barrel was added to the BR unit charge for other producers because they may have to provide more infrastructure than BR to deliver the backflow.

The following relationship is used to calculate year-to-year escalated revenue. Note that the escalation factor for materials and services is used since the basis of revenue is from deferred operating costs and fees for disposal.

$$ER_n = (R_n - BF_n)(1 + i_{MS})^{n-1}$$

Where:	ER_n	*Escalated revenue in year n*
	R_n	*Revenue (2006 basis) in year n*
	BF_n	*Backflow charge (2006 basis) in year n*
	$(1 + i_{MS})^{n-1}$	*Escalation factor for materials and services in year n*

Refer to Figure 6.10 for year-to-year escalated total project revenue for 75 to 85 percent produced water recovery and six percent declination. Escalated life-of-project revenue can be found in Table A.6 in Appendix A.

6.4.4 Revenue Sharing and Cost of Recovered Water

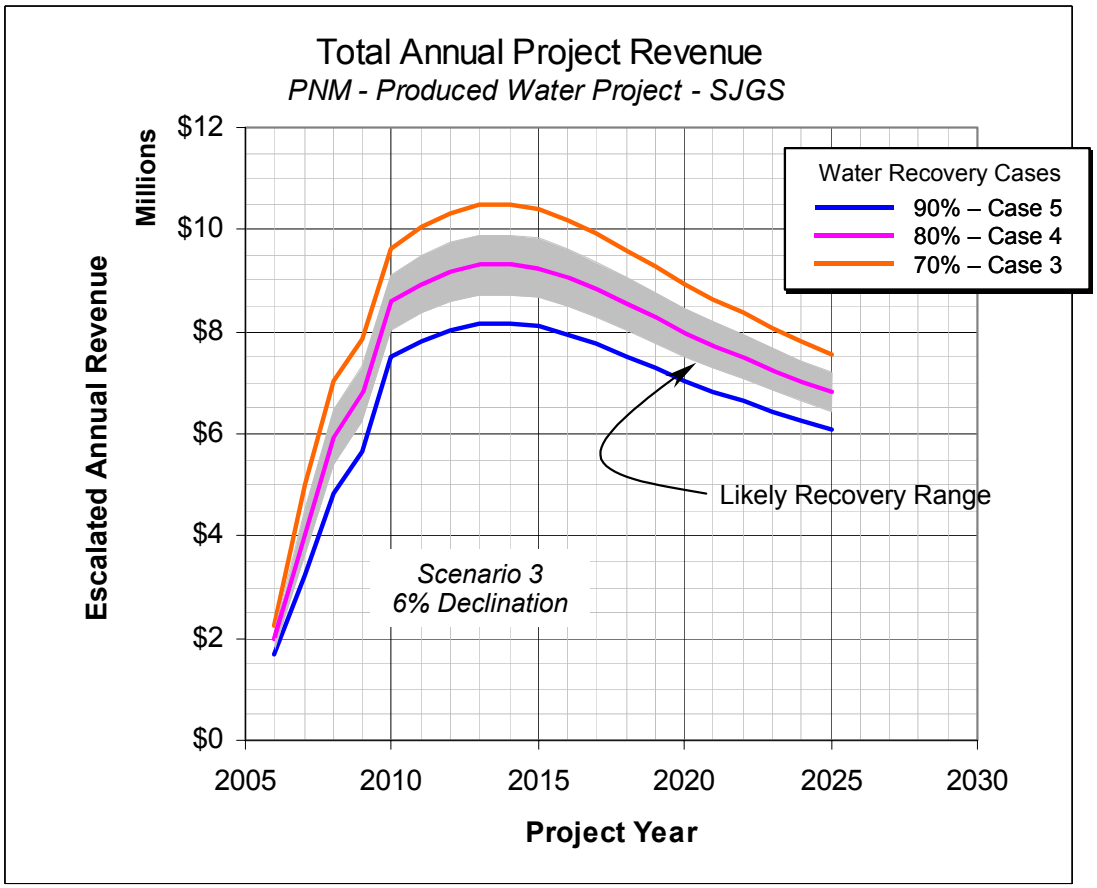
Recovering produced water for power generation will benefit PNM by ensuring power generation and avoiding fuel penalties. It will benefit BR, Dugan and Richardson by reducing their cost of operation. The project would generate $87 to $99 million in revenue (2006 dollars) over a period of 20 years (assuming 75 to 85 percent produced water recovery and six percent resource declination). The relationship among the PNM/producer group is mutually dependent, i.e. without PNM there would be no project and without the producers there would be no water. Therefore, since the project benefits all parties, all parties should share the revenue.

Two levels of revenue sharing are evaluated:

- 50:50 Split – PNM and the producers would split the revenue evenly.
- 75:25 Split – PNM would receive the greater share.

The 50:50 split is a logical allocation of revenue in a mutually dependent business relationship, i.e. all parties need each other to generate this particular revenue.

Figure 6.10



Several sound arguments support a 75:25 split:

- PNM's needs are greater because their business could be harmed financially if the project does not occur. During a prolonged drought, PNM might have to reduce load and pay significant fuel penalties. *In this scenario, the producers would continue to operate with no effect on their business*.
- By sending produced water to SJGS, the producers reduce their environmental liability. *PNM would take long-term responsibility and potential environmental liability for the water*.
- *PNM would be taking the largest financial risk by investing $37.9 million* in the project, significantly more than any of the other participants. Even with a lesser share, the *producers would payout their investment quickly* (discussed later).
- PNM would also assume some financial risk in potential damage to their equipment or unanticipated O&M costs associated with the use and disposal of this water.

Regardless of pro/con arguments, producers must meet their internal rate of return (IRR) for this and any capital investment. In the revenue sharing cases discussed here, producer IRR was met.

Using the two revenue sharing splits, an analysis was performed to determine the life-of-project net cost of water. Operating savings, deferred well installations and revenue for accepting water from other producers (as discussed in the previous section) would form the basis of the revenue stream. The revenue would be split and PNM's share would defray project operating expenses. The following relationships are used to calculate PNM's cost of collecting, conveying and treating water over the life of the project.

The following relationship is used to calculate time-corrected costs (base year 2006) for each year of the project.

PNM costs for chemicals, power, materials, services, labor, etc.

PNM's share of producer revenue

$$\left[\begin{array}{c}\textit{Time Corrected}\\ \textit{Project Costs}\end{array} = \frac{\textit{Escalated Costs} - \textit{Escalated Revenue} + \textit{Annual Capital Recovery} - \textit{Tax Credit}}{\textit{Escalation Factor}}\right]_{\textit{Year "n"}}$$

Tax credit based on recovered water

Corrected annual project costs are then summed and divided by the life-of-project net acre-feet (AF_{Net}) of water reclaimed for use at SJGS. Recall that 95.3 percent of the recovered water would be reclaimed via treatment. This calculation yields the life-of-project cost to PMN[17] for collecting, conveying and treating produced water based on 2006 dollars and expressed as dollars per net acre-foot of reclaimed water. Refer to the next relationship for calculation details.

$$CRW_{Net} = \frac{\sum_{1}^{n} \frac{(M+S)_n (1+i_{MS})^{n-1} + L_n (1+i_L)^{n-1} - (R_n - BF_n)(1+i_{MS})^{n-1} + ACR - TC_n}{(1+i_{MS})^{n-1}}}{\sum_{1}^{n} Net\ RV_n}$$

Where:	CRW_{Net}	*Cost (2006 basis) of recovered water, $/$AF_{Net}$ (net volume after treatment)*
	$(M + S)_n$	*Costs (2006 basis) for materials and services in year n*
	$(1 + i_{MS})^{n-1}$	*Escalation factor for materials and services in year n (also used to re-adjust escalated costs to 2006 basis year)*
	L	*Labor costs (2006 basis)*
	$(1 + i_L)^{n-1}$	*Escalation factor for labor in year n*
	R_n	*Revenue (2006 basis) in year n*

[17] Producer costs and revenue are not included in this analysis.

BF_n	*Backflow charge (2006 basis) in year n*
ACR	*Annual capital recovery (n equal payments)*
TC_n	*Tax Credit earned in year n*
$Net\ RV_n$	*Net Recovered Volume (95.3% of water delivered to SJGS) of water in year n,* AF_{NET}

In this analysis, the escalation factor used for materials and services (approximately 2 percent per year) is also used to adjust costs back to 2006 dollars. Capital recovery is not escalated since this cost consists of twenty equal payments paid annually throughout the life of the project. Tax credits would be earned based on the volume of recovered water for a given year.

Refer to Figure 6.11 for the life-of-project net cost of produced water for all scenarios and cases. Figure 6.11 also includes a wider range of revenue sharing possibilities – 0, 25, 50 and 75 percent PNM share of producer savings. The importance of revenue sharing and produced water recovery is evident. Without revenue sharing and under low-recovery circumstances, the life-of-project net cost of water could approach $4,500/$AF_{Net}$.

Refer also to Figure for 6.12 for a more focused analysis of the life-of-project net cost of produced water *with and without the tax credit.* The analysis is based on a 75 to 85 percent recovery range, 6% compound declination and two revenue splits – 50:50 and 75:25 (PNM to producer).

With a 50:50 share of revenues, the life-of-project net cost of water would vary between $620 to $1,000/$AF_{Net}$ with the tax credit and $1,200 to $1,520/$AF_{Net}$ without the tax credit. With a 75:25 share (PNM to producer), the cost of water would vary from -$300 to -$30/AF_{Net} with the tax credit (indicating possible net revenue under these circumstances) and $200 to $500/$AF_{Net}$ without the tax credit. Clearly, both revenue sharing and the tax credit have a significant effect on the life-of-project net cost of water with an overall range of -$300 to $1,520/$AF_{Net}$ (a cost spread of $1,820/$AF_{Net}$) to collect, convey and treat produced water for reuse at SJGS.

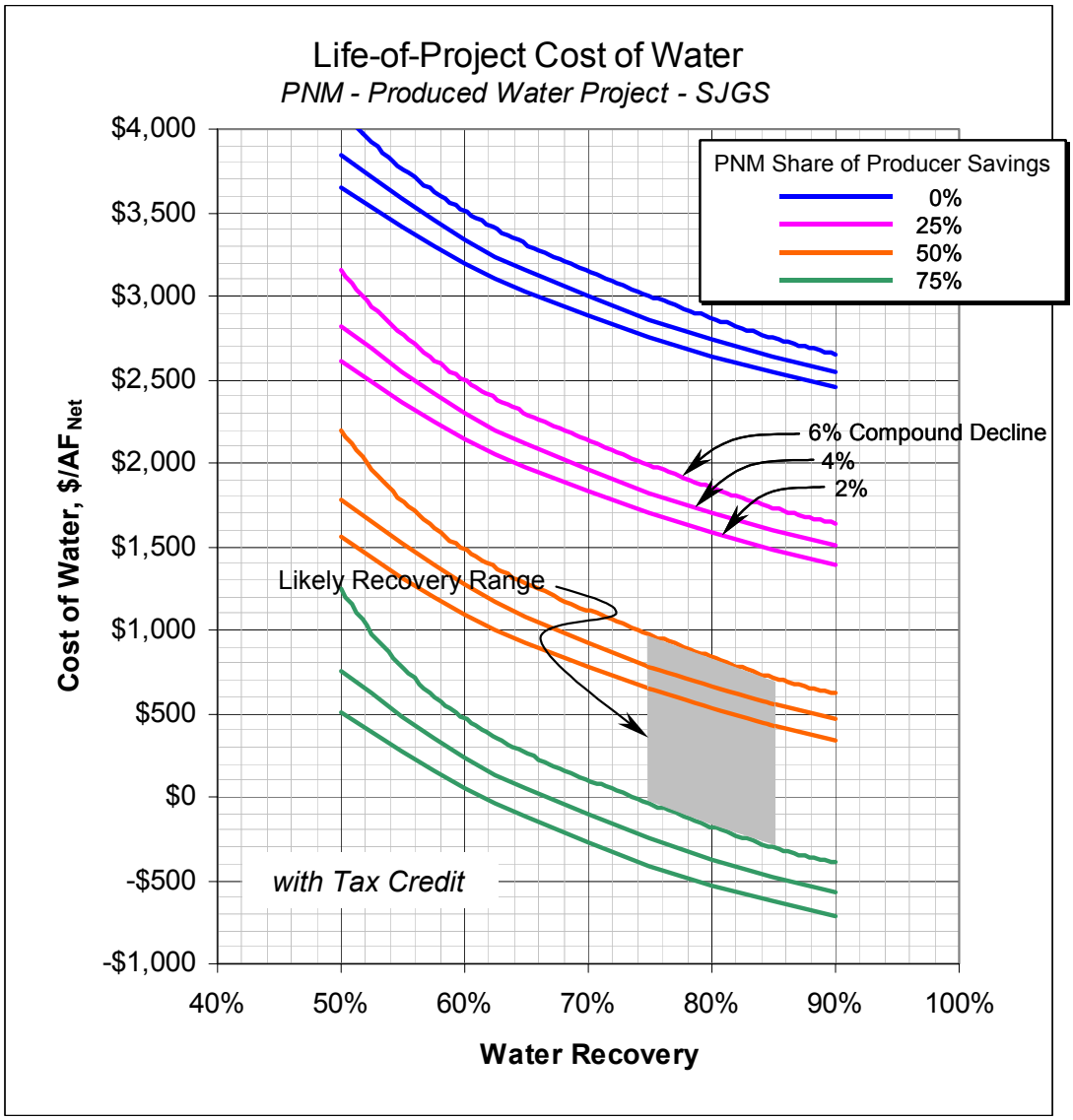
6.4.5 Impact on the Cost of Water at SJGS

At present, PNM has rights to divert 24,200 AF/yr of water from the San Juan River via two contracts:

- United States Bureau of Reclamation (USBR) provides rights for 16,200 AF/yr at a contract rate of $9/AF. The water right is granted from the Navajo Reservoir, which is upstream of SJGS.
- The San Juan coal contract (through BHP Billiton) provides run-of-the-river rights for 8,000 AF/yr at no cost to PNM as long as the fuel contract is in effect. This type of water right is the most susceptible to being reduced dramatically during long-term shortages.

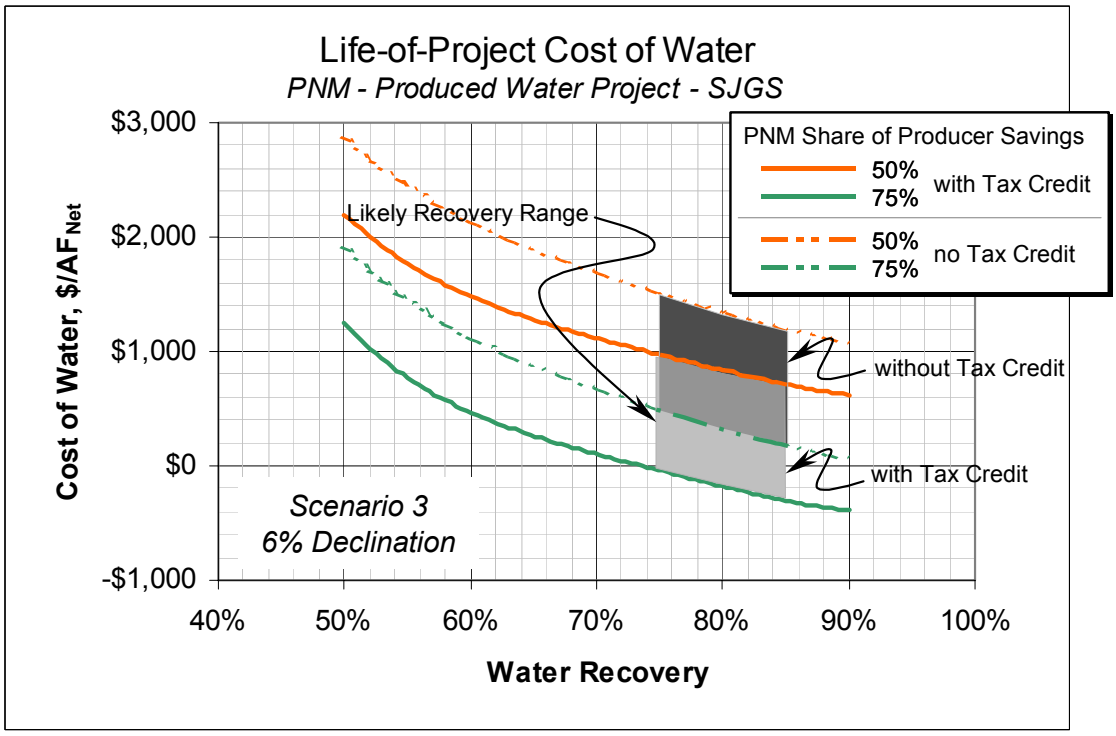
USBR managed water will be provided through a tribal entity in 2006. PNM expects water prices to increase from $9 to $70/AF[18]. The weighted[19] cost of water from the San Juan River to SJGS will rise from its current cost of $6.50 to $47/AF. On this basis, the annual cost of freshwater at SJGS will increase from $146,000 to $1,053,000 in 2006.

Figure 6.11



[18] The water will likely cost between $60/AF to $70/AF. The higher cost, $70/AF, was used in the analysis.
[19] Weighting is based on 66.9 percent of water rights from USBR (Navajo Reservoir) and 33.1 percent from run-of-the-river through BHP Billiton.

Figure 6.12



To put the produced water project in perspective, refer to Tables 6.6 and 6.7 for an analysis of the blended unit cost and annual cost of water to SJGS, respectively. Note that life-of-project water costs include capital recovery, operating expenses and shared revenue associated with the produced water project. The overall cost impact of the produced water project to the cost of water at SJGS is relatively small. Depending on circumstances such as achievable recovery, passage of the tax credit and the PNM-producer revenue share, the unit cost of blended San Juan River water and produced water would range from –9$ to $155/AF_{Net}$.

The life-of-project cost of water (2006 basis) *could be reduced by $1.2 million per year* at SJGS with 85 percent recovery of the produced water resource (6 percent decline), a 75:25 (PNM to producer) revenue sharing agreement and the tax credit. Under these circumstances, the produced water project would generate net revenue. Conversely, the cost of water at the plant *could be increased by $2.5 million per year* with 75 percent recovery (6 percent decline), a 50:50 revenue sharing agreement and no tax credit.

As a point of comparison, in California where water resources have been strained for decades, retail water costs range from $200 to $1,200/AF[20]. These are rates that recently-built combined cycle power plants pay for water. Most plants, which must compete with residential and agricultural demands, are paying between $400/AF to

[20] These costs were taken from a survey done in support of an as yet unpublished study for the California Energy Commission on the use and cost of water in power plants.

$500/AF for water. Reclaimed water is mandated[21] if the plant is reasonably close to a large source of treated municipal effluent. Reclaimed water is typically priced at 90 percent of freshwater costs, i.e. $350 to $450/AF.

Table 6.6

Blended Life-of-Project Unit Cost of Water
San Juan River & Treated Produced Water
PNM - Produced Water Project – SJGS

		75% Recovery 6% Declination		85% Recovery 6% Declination	
PNM Revenue Share	Tax Credit Yes/No	Blended Cost $/AF	Additional Cost $/AF (1)	Blended Cost $/AF	Additional Cost $/AF (1)
50%	Yes	$91	$44	$79	$32
75%	Yes	$14	-$33	-$9	-$56
50%	No	$155	$108	$144	$97
75%	No	$81	$34	$60	$13

Notes.....

1. The cost basis for San Juan River Water will be $47/AF in 2006.

Table 6.7

Blended Annual Cost of Water (1)
San Juan River & Treated Produced Water
PNM - Produced Water Project - SJGS

PNM Revenue Share	Tax Credit Yes/No	75% Recovery 6% Declination	85% Recovery 6% Declination
50%	Yes	$2,042,000	$1,774,000
75%	Yes	$315,000	-$196,000
50%	No	$3,469,000	$3,236,000
75%	No	$1,806,000	$1,341,000

Notes.....

1. The cost basis for San Juan River Water will be $1,053,000 per year in 2006.

Relatively speaking, the unit cost (per acre-foot) of blended San Juan River and treated produced water would be significantly less than that paid by power plants in other areas where the market value of water is high. On the other hand, the $37.9 million capital cost of the produced water project, which would supply 8 to 10 percent of the SJGS's water during peak recovery years, is quite prohibitive.

Finally, the project investment would have to be weighed against the possibility of a one-year 30-percent shortage in regional water supply. PNM determined that it would be

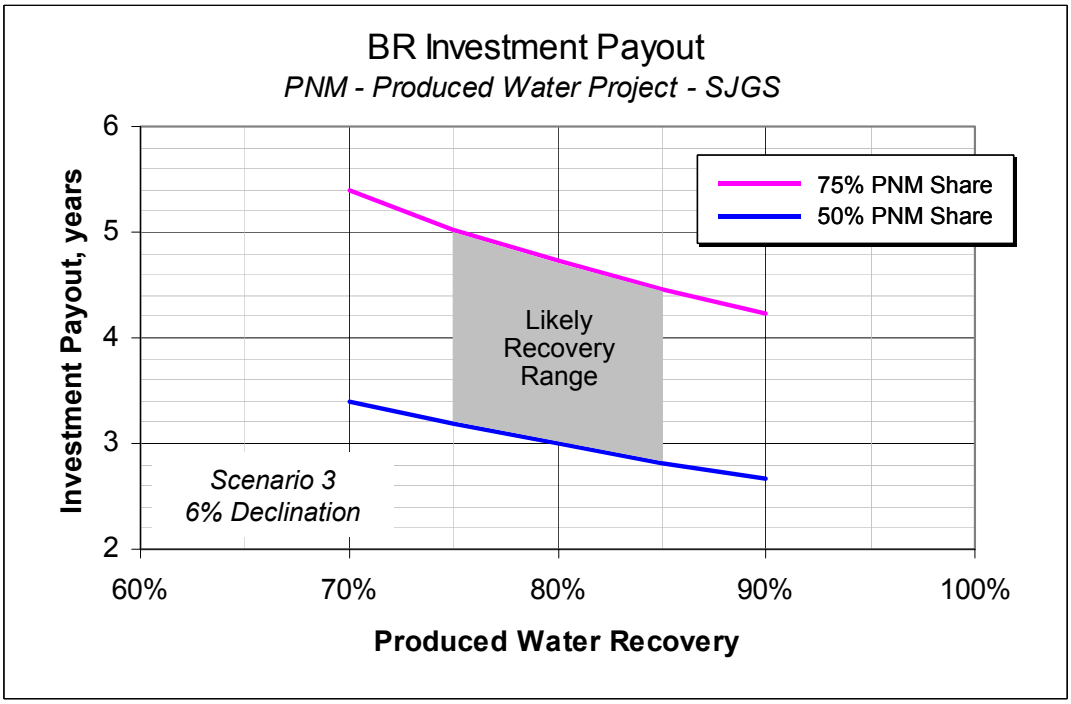
[21] There are no legal requirements for using treated municipal effluent for power plant cooling, but state water policy prioritizes this resource. Power plant developers must consider this resource when proposing a project to the California Energy Commission.

significantly more costly in fuel contract penalties and lost generation than the entire capital investment in the produced water project[22].

6.4.6 Producers Return on Investment

Burlington resources would invest $5 million to develop a gathering system for the project. Revenue in the form of reduced operating costs, avoided well replacement costs and fees from receiving produced water from other producers would be generated at the outset of the project. Refer to Figure 6.13. Depending on how revenues are shared with PNM and the extent of produced water recovery, BR could recoup their total investment in gathering system development in 2.8 to 5.0 years. Given the revenue projections for Dugan and Richardson their investment should payout in less than 4 to 6 months.

Figure 6.13



6.5 Summary

There is minimal gathering infrastructure in place in the San Juan Basin. Almost all of the gathering is accomplished by transporting produced water by tanker truck from well head to SWD for disposal via deep well injection. Also, oil and gas production is highly dispersed – one well per 160 to 320 acres. A handful of energy companies represent the majority of production in the San Juan Basin. Seven producers (large and small) represent almost 95 percent of produced water generation in the Tri-City, Fairway and Close-in areas.

[22] As noted previously, PNM preferred to keep fuel penalty contract information confidential.

Climate studies conducted by researchers at the University of Arizona (Cavazos et al, 2002) predict that New Mexico is entering a period of extended drought – possibly lasting 60 to 80 years (wet-to-dry-to-wet cycle). An extended drought is possible and could affect generation at SJGS.

SJGS has a take-or-pay coal contract. If the plant has to reduce load for significant periods of time because of reduced water supply and if the reduction in load is large enough, PNM must pay for fuel it regardless. Since fuel is the largest expense for SJGS, this is considered a credible worst-case economic scenario given the strong inevitability of drought. PNM has determined that a one-year 30-percent shortage in regional water supply would be significantly more costly in fuel contract penalties and lost generation than the entire capital investment in the produced water project.

Produced water from the Tri-City, Fairway and Close-in areas could supply 8.8 to 10.0 percent of plant needs and could prevent SJGS from reaching the take-or-pay coal contract threshold.

Producers would provide gathering infrastructure to deliver water to either the Collection Center in Bloomfield or along the Bloomfield-to-SJGS pipeline. In doing so, producers would benefit by minimizing their disposal costs. The PNM-producer relationship is structured in this analysis to provide financial benefits to PNM and producers that materially participate. In the Tri-City and Fairway areas, produced water gathering would involve BR and PNM and would be segmented into following areas of responsibility:

- BR would build infrastructure by modifying the Hart Canyon Line and CO_2 Gas Line to gather produced water in the Tri-City and Fairway areas.
- BR would deliver the gathered water via an extension of either the Hart Canyon Line or CO_2 Gas Line to the PNM Collection Center in Bloomfield.
- BR would build satellite collection stations along the Hart Canyon Line and CO_2 Gas Line to receive-for-fee produced water from other producers.
- PNM would build a Collection Center at the headworks of the pipeline to receive and pretreat gathered water in the Tri-City and Fairway areas.
- PNM would convey gathered water to SJGS for treatment and use.

The investment in BR gathering infrastructure would be paid by their avoided costs of disposal and fees generated by the receiving water from other producers. BR would share with PNM:

- Avoided costs of disposal of BR produced water
- Fees from other producers for receiving produced water
- BR's avoided costs associated with building new or replacement injection wells and injection well facilities (SWDs).

Close-in producers – Dugan and Richardson would also inject filtered produced water directly into the conveyance line. Dugan and Richardson would share with PNM cost savings associated with avoided disposal of produced water (via deep well injection).

The PNM share of BR, Dugan and Richardson avoided costs and fees would be treated as project revenue against the cost of conveyance and treatment of produced water.

The total water resource for the Study Area is a combination of produced water from the Fairway, Tri-City, and Close-in production areas, backflow from three to four SWD wells and other non-production sources of water – cooling tower blowdown from Prax Air, BHP Billiton mine water and SO_2 absorber Purge Water. Refer to the following table (next page) for a summary of the possible resource in 2006.

Life-of-project recoverable water will be dependent on initial sustained growth as a result of infill well installation followed by a gradual decline in produced water generation as fields mature. In this analysis, it was assumed that growth is sustained at two percent per year until 2008 (five years of growth from expanded production starting in 2004). Three life-of-project declination scenarios were evaluated – two, four and six percent along with five recovery cases – 50, 60, 70, 80 and 90 percent.

Total Water Resource – 2006

	BPD	gpm	AF/yr
Fairway	22,600	659	1060
Tri-City	3,020	88	142
Close-in	13,680	399	644
Backflow	10,000	292	470
Total Produced Water	49,300	1,438	2,316
Prax Air – Cooling Tower Blowdown	300	9	14
BHP Billiton – Mine Water	1,700	50	80
Purge Water – SO_2 Absorber Bleed Stream	3,430	100	161
Total Other Water	5,430	159	255
Total Water Resource	54,730	1,597	2,571

Given the high density of produced water in the Tri-City, Fairway and Close-in areas among only seven producers, it is reasonable to assume that 75 to 85 percent of the water resource could be recoverable in the Study Area. It was also assumed that six-percent declination would be a prudent choice of the three scenarios because resource decline is the least understood recovery parameter and is difficult to predict.

BR estimated that it would cost $5 million to develop the gathering system. Costs for Dugan and Richardson (estimated at $100,000 each) would be minimal since the Bloomfield-to-SJGS pipeline passes both of their operations. PNM capital expenditure would be $37.9 million and would include the Collection Center in Bloomfield, the Bloomfield-to-SJGS pipeline and the produced water treatment system. Produced water would be treated at SJGS using Alternative 10 – the HERO® process and refurbished BC 3. All of the recovered water could be used as supplemental make-up to the cooling towers, SO_2 absorbers and ash system. Refer to the following cost summary:

Total Project Capital Costs

BR	Gathering system to Collection Center	$5,000,000
Dugan	Inject into pipeline	$100,000
Richardson	Inject into pipeline	$100,000
PNM	Collection Center, pipeline & treatment	$37,900,000
Total Project		$43,100,000

If the tax credit were enacted in the 2005 legislative session (in the form proposed in the 2004 session), the following would be provided:

- A credit of $1,000/AF of produced water delivered to SJGS
- Credits cannot exceed $3 million annually
- A life-of-the-project cap equal to 50 percent of the capital cost of the project.

Since the capital budget for PNM would be $37,900,000, the life-of-the-project cap would be equal to $18,950,000 (50 percent of the capital budget).

Two levels of revenue sharing were evaluated:

- 50:50 Split – PNM and the producers would split the revenue evenly.
- 75:25 Split – PNM would receive the greater share.

With a 50:50 share of revenues, the life-of-project net cost of water would vary between $620 to $1,000/$AF_{Net}$ with the tax credit and $1,200 to $1,520/$AF_{Net}$ without the tax credit. With a 75:25 share (PNM to producer), the cost of water would vary from -$300 to -$30/AF_{Net} with the tax credit (indicating possible net revenue under these circumstances) and $200 to $500/$AF_{Net}$ without the tax credit. Clearly, both revenue sharing and the tax credit have a significant effect on the life-of-project net cost of water with an overall range of -$300 to $1,520/$AF_{Net}$ (a cost spread of $1,820/$AF_{Net}$) to collect, convey and treat produced water for reuse at SJGS.

Depending on how revenues are shared with PNM and the extent of produced water recovery, BR could recoup their total investment in gathering system development in 2.8 to 5.0 years. Given the revenue projections for Dugan and Richardson their investment should payout in less than 4 to 6 months.

Appendix A

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Table A.1 (1 of 3)

Life-of-Project Produced Water Resource Summary - Scenario 1

San Juan Generating Station

Project Year	Prod Water Volume Increase Over Prev Year	Backflow Volume Decline Over Prev Year	Tri-City BPD	Fairway BPD	Close-in BPD	Potential Produced Water BPD	Potential Backflow Water BPD	BHP Mine Water BPD	Prax Air CT Blowdown BPD	Purge Water BPD	Potential Water BPD	Potential Water AF/yr
2006	2.0%	0.0%	3,016	22,598	13,681	39,294	10,000	1,700	300	3,429	54,723	2,575
2007	2.0%	0.0%	3,076	23,050	13,955	40,080	10,000	1,700	300	3,429	55,509	2,611
2008	2.0%	0.0%	3,138	23,511	14,234	40,882	10,000	1,700	300	3,429	56,311	2,649
2009	1.9%	-2.0%	3,197	23,957	14,504	41,659	9,800	1,700	300	3,429	56,887	2,676
2010	1.5%	-2.0%	3,245	24,317	14,722	42,284	9,604	1,700	300	3,429	57,316	2,696
2011	1.0%	-2.0%	3,278	24,560	14,869	42,706	9,412	1,700	300	3,429	57,547	2,707
2012	0.5%	-2.0%	3,294	24,683	14,943	42,920	9,224	1,700	300	3,429	57,572	2,709
2013	0.0%	-2.0%	3,294	24,683	14,943	42,920	9,039	1,700	300	3,429	57,388	2,700
2014	-0.5%	-2.0%	3,278	24,559	14,868	42,705	8,858	1,700	300	3,429	56,992	2,681
2015	-1.0%	-2.0%	3,245	24,314	14,720	42,278	8,681	1,700	300	3,429	56,388	2,653
2016	-1.5%	-2.0%	3,196	23,949	14,499	41,644	8,508	1,700	300	3,429	55,580	2,615
2017	-1.9%	-2.0%	3,137	23,506	14,231	40,874	8,337	1,700	300	3,429	54,640	2,571
2018	-2.0%	-2.0%	3,075	23,040	13,949	40,064	8,171	1,700	300	3,429	53,664	2,525
2019	-2.0%	-2.0%	3,014	22,580	13,670	39,263	8,007	1,700	300	3,429	52,699	2,479
2020	-2.0%	-2.0%	2,953	22,128	13,397	38,478	7,847	1,700	300	3,429	51,754	2,435
2021	-2.0%	-2.0%	2,894	21,685	13,129	37,708	7,690	1,700	300	3,429	50,827	2,391
2022	-2.0%	-2.0%	2,836	21,252	12,866	36,954	7,536	1,700	300	3,429	49,919	2,348
2023	-2.0%	-2.0%	2,780	20,827	12,609	36,215	7,386	1,700	300	3,429	49,029	2,307
2024	-2.0%	-2.0%	2,724	20,410	12,357	35,491	7,238	1,700	300	3,429	48,157	2,266
2025	-2.0%	-2.0%	2,670	20,002	12,109	34,781	7,093	1,700	300	3,429	47,303	2,225

Table A.1 (2 of 3)

Life-of-Project Produced Water Resource Summary - Scenario 2

San Juan Generating Station

Project Year	Prod Water Volume Increase Over Prev Year	Backflow Volume Decline Over Prev Year	Tri-City BPD	Fairway BPD	Close-in BPD	Potential Produced Water BPD	Potential Backflow Water BPD	BHP Mine Water BPD	Prax Air CT Blowdown BPD	Purge Water BPD	Potential Water BPD	Potential Water AF/yr
2006	2.00%	0.0%	3,016	22,598	13,681	39,294	10,000	1,700	300	3,429	54,723	2,575
2007	2.00%	0.0%	3,076	23,050	13,955	40,080	10,000	1,700	300	3,429	55,509	2,611
2008	2.00%	0.0%	3,138	23,511	14,234	40,882	10,000	1,700	300	3,429	56,311	2,649
2009	1.80%	-2.0%	3,194	23,934	14,490	41,618	9,800	1,700	300	3,429	56,846	2,674
2010	1.30%	-2.0%	3,236	24,245	14,678	42,159	9,604	1,700	300	3,429	57,191	2,691
2011	0.65%	-2.0%	3,257	24,402	14,774	42,433	9,412	1,700	300	3,429	57,273	2,694
2012	0.00%	-2.0%	3,257	24,402	14,774	42,433	9,224	1,700	300	3,429	57,085	2,686
2013	-0.65%	-2.0%	3,236	24,244	14,678	42,157	9,039	1,700	300	3,429	56,625	2,664
2014	-1.30%	-2.0%	3,194	23,929	14,487	41,609	8,858	1,700	300	3,429	55,896	2,630
2015	-2.00%	-2.0%	3,130	23,450	14,197	40,777	8,681	1,700	300	3,429	54,887	2,582
2016	-2.80%	-2.0%	3,042	22,793	13,800	39,635	8,508	1,700	300	3,429	53,571	2,520
2017	-3.40%	-2.0%	2,939	22,019	13,330	38,288	8,337	1,700	300	3,429	52,054	2,449
2018	-3.80%	-2.0%	2,827	21,182	12,824	36,833	8,171	1,700	300	3,429	50,432	2,373
2019	-4.00%	-2.0%	2,714	20,335	12,311	35,359	8,007	1,700	300	3,429	48,795	2,296
2020	-4.00%	-2.0%	2,605	19,521	11,818	33,945	7,847	1,700	300	3,429	47,221	2,222
2021	-4.00%	-2.0%	2,501	18,740	11,346	32,587	7,690	1,700	300	3,429	45,706	2,150
2022	-4.00%	-2.0%	2,401	17,991	10,892	31,284	7,536	1,700	300	3,429	44,249	2,082
2023	-4.00%	-2.0%	2,305	17,271	10,456	30,032	7,386	1,700	300	3,429	42,847	2,016
2024	-4.00%	-2.0%	2,213	16,580	10,038	28,831	7,238	1,700	300	3,429	41,498	1,952
2025	-4.00%	-2.0%	2,124	15,917	9,636	27,678	7,093	1,700	300	3,429	40,200	1,891

Table A.1 (3 of 3)

Life-of-Project Produced Water Resource Summary - Scenario 3

San Juan Generating Station

Project Year	Prod Water Volume Increase Over Prev Year	Backflow Volume Decline Over Prev Year	Tri-City BPD	Fairway BPD	Close-in BPD	Potential Produced Water BPD	Potential Backflow Water BPD	BHP Mine Water BPD	Prax Air CT Blowdown BPD	Purge Water BPD	Potential Water BPD	Potential Water AF/yr
2006	2.00%	0.0%	3,016	22,598	13,681	39,294	10,000	1,700	300	3,429	54,723	2,575
2007	2.00%	0.0%	3,076	23,050	13,955	40,080	10,000	1,700	300	3,429	55,509	2,611
2008	2.00%	0.0%	3,138	23,511	14,234	40,882	10,000	1,700	300	3,429	56,311	2,649
2009	1.70%	-2.0%	3,191	23,910	14,476	41,577	9,800	1,700	300	3,429	56,806	2,672
2010	0.95%	-2.0%	3,221	24,137	14,613	41,972	9,604	1,700	300	3,429	57,005	2,682
2011	0.00%	-2.0%	3,221	24,137	14,613	41,972	9,412	1,700	300	3,429	56,812	2,673
2012	-0.90%	-2.0%	3,192	23,920	14,482	41,594	9,224	1,700	300	3,429	56,246	2,646
2013	-1.80%	-2.0%	3,135	23,490	14,221	40,845	9,039	1,700	300	3,429	55,313	2,602
2014	-2.70%	-2.0%	3,050	22,855	13,837	39,743	8,858	1,700	300	3,429	54,030	2,542
2015	-3.60%	-2.0%	2,941	22,033	13,339	38,312	8,681	1,700	300	3,429	52,422	2,466
2016	-4.55%	-2.0%	2,807	21,030	12,732	36,569	8,508	1,700	300	3,429	50,505	2,376
2017	-5.40%	-2.0%	2,655	19,894	12,044	34,594	8,337	1,700	300	3,429	48,360	2,275
2018	-5.80%	-2.0%	2,501	18,741	11,346	32,588	8,171	1,700	300	3,429	46,187	2,173
2019	-6.00%	-2.0%	2,351	17,616	10,665	30,632	8,007	1,700	300	3,429	44,068	2,073
2020	-6.00%	-2.0%	2,210	16,559	10,025	28,794	7,847	1,700	300	3,429	42,070	1,979
2021	-6.00%	-2.0%	2,077	15,566	9,424	27,067	7,690	1,700	300	3,429	40,186	1,891
2022	-6.00%	-2.0%	1,953	14,632	8,858	25,443	7,536	1,700	300	3,429	38,408	1,807
2023	-6.00%	-2.0%	1,836	13,754	8,327	23,916	7,386	1,700	300	3,429	36,730	1,728
2024	-6.00%	-2.0%	1,725	12,929	7,827	22,481	7,238	1,700	300	3,429	35,148	1,654
2025	-6.00%	-2.0%	1,622	12,153	7,358	21,132	7,093	1,700	300	3,429	33,654	1,583

Table A.2 (1 of 3)

Life-of-Project Recoverable Water by Case - Scenario 1

San Juan Generating Station

		Recoverable Water					*Fraction of Recoverable Water*				
Project Year	Potential Water AF/yr	50% Case 1 AF/yr	60% Case 2 AF/yr	70% Case 3 AF/yr	80% Case 4 AF/yr	90% Case 5 AF/yr	50% Case 1 Fraction	60% Case 2 Fraction	70% Case 3 Fraction	80% Case 4 Fraction	90% Case 5 Fraction
2006	2,575	789	923	1,057	1,191	1,325	30.6%	35.9%	41.1%	46.3%	51.5%
2007	2,611	1,033	1,229	1,424	1,737	2,081	39.6%	47.0%	54.5%	66.5%	79.7%
2008	2,649	1,225	1,468	1,712	2,013	2,319	46.2%	55.4%	64.6%	76.0%	87.5%
2009	2,676	1,303	1,566	1,830	2,118	2,396	48.7%	58.5%	68.4%	79.1%	89.5%
2010	2,696	1,339	1,611	1,883	2,156	2,428	49.7%	59.7%	69.8%	79.9%	90.0%
2011	2,707	1,343	1,616	1,890	2,163	2,436	49.6%	59.7%	69.8%	79.9%	90.0%
2012	2,709	1,343	1,617	1,890	2,163	2,437	49.6%	59.7%	69.8%	79.9%	90.0%
2013	2,700	1,339	1,611	1,884	2,156	2,428	49.6%	59.7%	69.8%	79.9%	89.9%
2014	2,681	1,331	1,601	1,871	2,141	2,411	49.6%	59.7%	69.8%	79.9%	89.9%
2015	2,653	1,318	1,585	1,852	2,119	2,386	49.7%	59.7%	69.8%	79.9%	89.9%
2016	2,615	1,301	1,564	1,826	2,089	2,352	49.8%	59.8%	69.8%	79.9%	89.9%
2017	2,571	1,281	1,539	1,797	2,055	2,312	49.8%	59.9%	69.9%	79.9%	90.0%
2018	2,525	1,261	1,514	1,766	2,019	2,271	49.9%	60.0%	70.0%	80.0%	90.0%
2019	2,479	1,241	1,488	1,736	1,984	2,231	50.1%	60.0%	70.0%	80.0%	90.0%
2020	2,435	1,221	1,464	1,706	1,949	2,192	50.2%	60.1%	70.1%	80.1%	90.0%
2021	2,391	1,202	1,440	1,677	1,915	2,153	50.3%	60.2%	70.1%	80.1%	90.0%
2022	2,348	1,183	1,416	1,649	1,882	2,115	50.4%	60.3%	70.2%	80.1%	90.1%
2023	2,307	1,164	1,393	1,621	1,849	2,078	50.5%	60.4%	70.3%	80.2%	90.1%
2024	2,266	1,146	1,370	1,594	1,818	2,041	50.6%	60.5%	70.3%	80.2%	90.1%
2025	2,225	1,128	1,348	1,567	1,786	2,006	50.7%	60.6%	70.4%	80.3%	90.1%
				Average Recovery - Starting at Year 5			50.00%	60.00%	70.00%	80.00%	90.00%

Table A.2 (2 of 3)

Life-of-Project Recoverable Water by Case - Scenario 2

San Juan Generating Station

		Recoverable Water					*Fraction of Recoverable Water*				
Project Year	Potential Water AF/yr	50% Case 1 BPD	60% Case 2 BPD	70% Case 3 BPD	80% Case 4 BPD	90% Case 5 BPD	50% Case 1 Fraction	60% Case 2 Fraction	70% Case 3 Fraction	80% Case 4 Fraction	90% Case 5 Fraction
2006	2,575	782	917	1,051	1,186	1,321	30.4%	35.6%	40.8%	46.1%	51.3%
2007	2,611	1,022	1,219	1,415	1,728	2,072	39.1%	46.7%	54.2%	66.2%	79.4%
2008	2,649	1,212	1,456	1,701	2,003	2,311	45.7%	55.0%	64.2%	75.6%	87.2%
2009	2,674	1,289	1,553	1,818	2,107	2,387	48.2%	58.1%	68.0%	78.8%	89.3%
2010	2,691	1,323	1,597	1,870	2,144	2,417	49.2%	59.3%	69.5%	79.7%	89.8%
2011	2,694	1,325	1,598	1,872	2,146	2,420	49.2%	59.3%	69.5%	79.6%	89.8%
2012	2,686	1,320	1,593	1,866	2,138	2,411	49.2%	59.3%	69.5%	79.6%	89.8%
2013	2,664	1,311	1,581	1,851	2,121	2,392	49.2%	59.3%	69.5%	79.6%	89.8%
2014	2,630	1,296	1,562	1,828	2,095	2,361	49.3%	59.4%	69.5%	79.7%	89.8%
2015	2,582	1,275	1,536	1,797	2,058	2,319	49.4%	59.5%	69.6%	79.7%	89.8%
2016	2,520	1,248	1,502	1,756	2,010	2,264	49.5%	59.6%	69.7%	79.8%	89.8%
2017	2,449	1,217	1,463	1,709	1,955	2,201	49.7%	59.7%	69.8%	79.8%	89.9%
2018	2,373	1,184	1,421	1,659	1,896	2,134	49.9%	59.9%	69.9%	79.9%	89.9%
2019	2,296	1,150	1,379	1,608	1,837	2,066	50.1%	60.1%	70.1%	80.0%	90.0%
2020	2,222	1,118	1,339	1,560	1,780	2,001	50.3%	60.3%	70.2%	80.1%	90.1%
2021	2,150	1,087	1,300	1,513	1,726	1,938	50.5%	60.4%	70.4%	80.2%	90.1%
2022	2,082	1,057	1,262	1,468	1,673	1,878	50.8%	60.6%	70.5%	80.4%	90.2%
2023	2,016	1,028	1,226	1,424	1,622	1,820	51.0%	60.8%	70.7%	80.5%	90.3%
2024	1,952	1,001	1,192	1,382	1,573	1,764	51.3%	61.0%	70.8%	80.6%	90.4%
2025	1,891	974	1,158	1,342	1,526	1,710	51.5%	61.2%	71.0%	80.7%	90.4%
				Average Recovery - Starting at Year 5			50.00%	60.00%	70.00%	80.00%	90.00%

Table A.2 (3 of 3)

Life-of-Project Recoverable Water by Case - Scenario 3

San Juan Generating Station

		Recoverable Water					*Fraction of Recoverable Water*				
Project Year	Potential Water AF/yr	50% Case 1 AF/yr	60% Case 2 AF/yr	70% Case 3 AF/yr	80% Case 4 AF/yr	90% Case 5 AF/yr	50% Case 1 Fraction	60% Case 2 Fraction	70% Case 3 Fraction	80% Case 4 Fraction	90% Case 5 Fraction
2006	2,575	771	907	1,043	1,179	1,315	30.0%	35.2%	40.5%	45.8%	51.1%
2007	2,611	1,007	1,204	1,402	1,715	2,060	38.5%	46.1%	53.7%	65.7%	78.9%
2008	2,649	1,193	1,440	1,687	1,990	2,299	45.0%	54.3%	63.7%	75.1%	86.8%
2009	2,672	1,268	1,535	1,802	2,092	2,375	47.5%	57.4%	67.4%	78.3%	88.9%
2010	2,682	1,301	1,577	1,852	2,127	2,402	48.5%	58.8%	69.1%	79.3%	89.6%
2011	2,673	1,297	1,571	1,845	2,119	2,394	48.5%	58.8%	69.0%	79.3%	89.6%
2012	2,646	1,285	1,556	1,828	2,098	2,370	48.6%	58.8%	69.1%	79.3%	89.5%
2013	2,602	1,266	1,533	1,799	2,065	2,331	48.7%	58.9%	69.1%	79.3%	89.6%
2014	2,542	1,241	1,500	1,759	2,018	2,278	48.8%	59.0%	69.2%	79.4%	89.6%
2015	2,466	1,208	1,459	1,710	1,960	2,211	49.0%	59.2%	69.3%	79.5%	89.7%
2016	2,376	1,170	1,410	1,651	1,891	2,132	49.2%	59.4%	69.5%	79.6%	89.7%
2017	2,275	1,127	1,356	1,585	1,814	2,044	49.5%	59.6%	69.7%	79.7%	89.8%
2018	2,173	1,083	1,301	1,519	1,736	1,954	49.8%	59.9%	69.9%	79.9%	89.9%
2019	2,073	1,041	1,247	1,454	1,660	1,867	50.2%	60.2%	70.1%	80.1%	90.1%
2020	1,979	1,000	1,197	1,393	1,589	1,785	50.5%	60.5%	70.4%	80.3%	90.2%
2021	1,891	963	1,149	1,335	1,521	1,707	50.9%	60.8%	70.6%	80.4%	90.3%
2022	1,807	927	1,104	1,280	1,457	1,634	51.3%	61.1%	70.9%	80.6%	90.4%
2023	1,728	893	1,061	1,229	1,397	1,565	51.7%	61.4%	71.1%	80.8%	90.5%
2024	1,654	861	1,021	1,181	1,340	1,499	52.1%	61.7%	71.4%	81.0%	90.7%
2025	1,583	831	983	1,135	1,286	1,438	52.5%	62.1%	71.7%	81.2%	90.8%
				Average Recovery - Starting at Year 5			50.00%	60.00%	70.00%	80.00%	90.00%

Table A.3 (1 of 15)

Volume Revenue Elements - Scenario 1 (2% Decline) - Case 1 (50% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	5,936	2,318	8,253	5,092	3,162	0	0	0
2007	8,453	3,275	11,729	5,790	3,828	0	106	2,006
2008	10,282	4,017	14,299	5,614	3,966	51	490	4,178
2009	11,395	4,450	15,844	5,148	3,883	566	906	5,341
2010	11,872	4,635	16,507	4,597	3,656	979	1,309	5,965
2011	11,991	4,542	16,533	4,149	3,457	1,086	1,631	6,211
2012	12,051	4,451	16,502	3,803	3,292	1,159	1,880	6,367
2013	12,051	4,362	16,413	3,546	3,183	1,179	2,067	6,438
2014	11,990	4,275	16,265	3,396	3,110	1,165	2,191	6,403
2015	11,870	4,190	16,060	3,251	3,013	1,177	2,301	6,318
2016	11,692	4,106	15,798	3,098	2,906	1,200	2,381	6,214
2017	11,476	4,024	15,500	2,988	2,825	1,199	2,428	6,061
2018	11,249	3,943	15,192	2,893	2,757	1,186	2,457	5,899
2019	11,024	3,864	14,888	2,800	2,690	1,174	2,500	5,724
2020	10,803	3,787	14,590	2,712	2,623	1,164	2,525	5,567
2021	10,587	3,711	14,299	2,626	2,557	1,154	2,547	5,413
2022	10,376	3,637	14,013	2,543	2,493	1,144	2,561	5,271
2023	10,168	3,564	13,732	2,462	2,430	1,134	2,574	5,132
2024	9,965	3,493	13,458	2,384	2,368	1,125	2,593	4,988
2025	9,765	3,423	13,189	2,308	2,308	1,115	2,610	4,847

Table A.3 (2 of 15)

Volume Revenue Elements - Scenario 1 (2% Decline) - Case 2 (60% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	7,427	2,900	10,326	6,370	3,956	0	0	0
2007	10,576	4,098	14,674	7,244	4,789	0	132	2,509
2008	12,865	5,026	17,890	7,024	4,962	63	613	5,227
2009	14,256	5,567	19,823	6,441	4,859	708	1,133	6,682
2010	14,853	5,799	20,652	5,752	4,574	1,225	1,638	7,463
2011	15,002	5,683	20,685	5,190	4,325	1,358	2,041	7,771
2012	15,077	5,569	20,646	4,759	4,119	1,450	2,353	7,966
2013	15,077	5,458	20,535	4,437	3,982	1,476	2,585	8,054
2014	15,001	5,349	20,350	4,249	3,891	1,458	2,742	8,010
2015	14,851	5,242	20,093	4,067	3,769	1,473	2,879	7,905
2016	14,629	5,137	19,766	3,876	3,635	1,502	2,979	7,774
2017	14,358	5,034	19,392	3,738	3,534	1,500	3,037	7,583
2018	14,074	4,934	19,007	3,619	3,449	1,484	3,074	7,381
2019	13,792	4,835	18,627	3,503	3,366	1,469	3,128	7,161
2020	13,516	4,738	18,255	3,393	3,282	1,456	3,159	6,965
2021	13,246	4,643	17,890	3,286	3,199	1,444	3,187	6,773
2022	12,981	4,551	17,532	3,182	3,119	1,432	3,204	6,595
2023	12,722	4,460	17,181	3,081	3,040	1,419	3,220	6,421
2024	12,467	4,370	16,837	2,983	2,963	1,408	3,244	6,241
2025	12,218	4,283	16,501	2,888	2,888	1,395	3,266	6,065

Table A.3 (3 of 15)

Volume Revenue Elements - Scenario 1 (2% Decline) - Case 3 (70% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	8,917	3,482	12,399	7,649	4,750	0	0	0
2007	12,699	4,921	17,620	8,698	5,750	0	159	3,013
2008	15,447	6,035	21,482	8,434	5,959	76	736	6,276
2009	17,118	6,684	23,802	7,733	5,834	851	1,361	8,024
2010	17,835	6,963	24,798	6,906	5,493	1,470	1,967	8,961
2011	18,013	6,824	24,837	6,232	5,193	1,631	2,450	9,330
2012	18,103	6,687	24,790	5,714	4,946	1,741	2,825	9,565
2013	18,103	6,554	24,657	5,328	4,782	1,772	3,104	9,671
2014	18,013	6,422	24,435	5,102	4,672	1,750	3,292	9,618
2015	17,832	6,294	24,126	4,883	4,526	1,768	3,457	9,492
2016	17,565	6,168	23,733	4,654	4,365	1,803	3,576	9,335
2017	17,240	6,045	23,285	4,488	4,244	1,801	3,647	9,105
2018	16,899	5,924	22,823	4,345	4,142	1,782	3,691	8,863
2019	16,561	5,805	22,366	4,206	4,041	1,764	3,756	8,599
2020	16,229	5,689	21,919	4,074	3,941	1,749	3,793	8,363
2021	15,905	5,575	21,480	3,945	3,841	1,734	3,827	8,132
2022	15,587	5,464	21,051	3,820	3,745	1,719	3,848	7,919
2023	15,275	5,355	20,630	3,699	3,650	1,704	3,866	7,710
2024	14,970	5,248	20,217	3,582	3,557	1,690	3,895	7,493
2025	14,670	5,143	19,813	3,467	3,467	1,675	3,921	7,282

Table A.3 (4 of 15)

Volume Revenue Elements - Scenario 1 (2% Decline) - Case 4 (80% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	10,409	4,064	14,473	8,929	5,545	0	0	0
2007	16,134	5,744	21,878	10,800	7,140	0	197	3,741
2008	19,257	7,044	26,302	10,327	7,296	0	911	7,768
2009	20,506	7,803	28,309	9,198	6,939	864	1,640	9,669
2010	20,819	8,128	28,947	8,062	6,412	1,716	2,296	10,461
2011	21,027	7,965	28,992	7,275	6,061	1,904	2,860	10,891
2012	21,132	7,806	28,938	6,670	5,774	2,032	3,297	11,165
2013	21,132	7,650	28,782	6,219	5,582	2,068	3,624	11,289
2014	21,026	7,497	28,523	5,956	5,454	2,043	3,843	11,228
2015	20,816	7,347	28,163	5,701	5,283	2,064	4,036	11,080
2016	20,504	7,200	27,704	5,432	5,095	2,105	4,175	10,897
2017	20,125	7,056	27,181	5,239	4,954	2,102	4,257	10,628
2018	19,726	6,915	26,641	5,072	4,835	2,080	4,308	10,345
2019	19,332	6,777	26,108	4,910	4,717	2,059	4,384	10,037
2020	18,945	6,641	25,586	4,755	4,600	2,041	4,427	9,763
2021	18,566	6,508	25,074	4,606	4,484	2,025	4,467	9,493
2022	18,195	6,378	24,573	4,460	4,371	2,007	4,491	9,244
2023	17,831	6,251	24,081	4,318	4,261	1,989	4,513	9,000
2024	17,474	6,126	23,600	4,181	4,153	1,973	4,546	8,747
2025	17,125	6,003	23,128	4,047	4,047	1,956	4,577	8,500

Table A.3 (5 of 15)

Volume Revenue Elements - Scenario 1 (2% Decline) - Case 5 (90% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	11,900	4,646	16,546	10,207	6,339	0	0	0
2007	19,754	7,062	26,816	13,237	8,752	0	241	4,586
2008	22,729	8,502	31,231	12,262	8,663	0	1,082	9,224
2009	23,562	9,060	32,622	10,599	7,996	1,064	1,880	11,084
2010	23,800	9,292	33,092	9,216	7,330	1,962	2,625	11,959
2011	24,038	9,106	33,144	8,317	6,929	2,177	3,270	12,451
2012	24,158	8,924	33,082	7,625	6,601	2,323	3,770	12,764
2013	24,158	8,746	32,904	7,110	6,381	2,365	4,143	12,906
2014	24,037	8,571	32,608	6,809	6,235	2,336	4,393	12,836
2015	23,797	8,399	32,196	6,517	6,040	2,360	4,614	12,666
2016	23,440	8,231	31,671	6,210	5,825	2,406	4,773	12,457
2017	23,007	8,067	31,073	5,989	5,663	2,404	4,867	12,150
2018	22,551	7,905	30,456	5,799	5,527	2,378	4,925	11,827
2019	22,100	7,747	29,847	5,613	5,393	2,354	5,012	11,475
2020	21,658	7,592	29,250	5,436	5,259	2,334	5,061	11,161
2021	21,225	7,440	28,665	5,265	5,126	2,314	5,107	10,853
2022	20,800	7,292	28,092	5,098	4,997	2,294	5,135	10,567
2023	20,384	7,146	27,530	4,936	4,871	2,274	5,160	10,288
2024	19,977	7,003	26,979	4,780	4,747	2,255	5,197	10,000
2025	19,577	6,863	26,440	4,627	4,627	2,236	5,233	9,718

Table A.3 (6 of 15)

Volume Revenue Elements - Scenario 2 (4% Decline) - Case 1 (50% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	5,855	2,286	8,141	5,022	3,119	0	0	0
2007	8,339	3,231	11,569	5,711	3,776	0	104	1,978
2008	10,143	3,962	14,105	5,538	3,912	50	483	4,121
2009	11,240	4,389	15,629	5,078	3,831	558	893	5,268
2010	11,711	4,572	16,283	4,535	3,607	965	1,292	5,884
2011	11,787	4,481	16,267	4,082	3,401	1,080	1,603	6,102
2012	11,787	4,391	16,178	3,729	3,228	1,163	1,837	6,221
2013	11,710	4,303	16,013	3,460	3,105	1,198	2,005	6,245
2014	11,558	4,217	15,775	3,294	3,016	1,201	2,107	6,157
2015	11,327	4,133	15,459	3,129	2,900	1,233	2,189	6,009
2016	11,009	4,050	15,060	2,953	2,770	1,280	2,232	5,825
2017	10,635	3,969	14,604	2,815	2,662	1,307	2,237	5,584
2018	10,231	3,890	14,121	2,689	2,563	1,327	2,217	5,325
2019	9,822	3,812	13,634	2,564	2,463	1,348	2,206	5,051
2020	9,429	3,736	13,165	2,447	2,367	1,369	2,178	4,804
2021	9,052	3,661	12,713	2,335	2,273	1,388	2,149	4,567
2022	8,690	3,588	12,277	2,228	2,184	1,404	2,113	4,349
2023	8,342	3,516	11,858	2,126	2,098	1,418	2,076	4,140
2024	8,008	3,446	11,454	2,029	2,015	1,430	2,045	3,934
2025	7,688	3,377	11,065	1,936	1,936	1,440	2,013	3,739

Table A.3 (7 of 15)

Volume Revenue Elements - Scenario 2 (4% Decline) - Case 2 (60% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	7,355	2,872	10,226	6,309	3,918	0	0	0
2007	10,474	4,058	14,533	7,174	4,743	0	131	2,485
2008	12,740	4,977	17,718	6,956	4,915	63	607	5,177
2009	14,118	5,513	19,632	6,378	4,812	702	1,122	6,618
2010	14,710	5,743	20,453	5,696	4,530	1,213	1,622	7,391
2011	14,805	5,628	20,434	5,127	4,272	1,356	2,013	7,665
2012	14,805	5,516	20,321	4,684	4,054	1,461	2,308	7,814
2013	14,709	5,405	20,114	4,346	3,901	1,504	2,518	7,845
2014	14,518	5,297	19,815	4,137	3,789	1,509	2,647	7,734
2015	14,228	5,191	19,419	3,931	3,643	1,548	2,749	7,548
2016	13,829	5,087	18,917	3,709	3,479	1,608	2,803	7,317
2017	13,359	4,986	18,345	3,536	3,343	1,642	2,809	7,014
2018	12,851	4,886	17,737	3,377	3,219	1,667	2,785	6,689
2019	12,337	4,788	17,126	3,221	3,094	1,694	2,771	6,345
2020	11,844	4,692	16,536	3,073	2,973	1,720	2,736	6,034
2021	11,370	4,599	15,969	2,933	2,856	1,743	2,700	5,737
2022	10,915	4,507	15,422	2,799	2,743	1,763	2,654	5,462
2023	10,479	4,416	14,895	2,671	2,636	1,781	2,608	5,200
2024	10,060	4,328	14,388	2,549	2,532	1,796	2,569	4,942
2025	9,657	4,242	13,899	2,432	2,432	1,809	2,529	4,696

Table A.3 (8 of 15)

Volume Revenue Elements - Scenario 2 (4% Decline) - Case 3 (70% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	8,855	3,457	12,312	7,595	4,717	0	0	0
2007	12,610	4,886	17,496	8,637	5,710	0	157	2,992
2008	15,338	5,992	21,330	8,375	5,917	76	731	6,232
2009	16,997	6,637	23,635	7,679	5,793	845	1,351	7,967
2010	17,709	6,914	24,623	6,858	5,454	1,460	1,953	8,898
2011	17,824	6,776	24,600	6,173	5,143	1,633	2,423	9,228
2012	17,824	6,640	24,465	5,639	4,881	1,759	2,778	9,407
2013	17,708	6,507	24,216	5,232	4,696	1,811	3,032	9,444
2014	17,478	6,377	23,855	4,981	4,561	1,816	3,187	9,310
2015	17,129	6,250	23,378	4,732	4,386	1,864	3,310	9,087
2016	16,649	6,125	22,774	4,465	4,189	1,936	3,375	8,809
2017	16,083	6,002	22,085	4,257	4,025	1,977	3,382	8,444
2018	15,472	5,882	21,354	4,066	3,875	2,007	3,353	8,053
2019	14,853	5,765	20,617	3,877	3,725	2,039	3,337	7,639
2020	14,259	5,649	19,908	3,700	3,579	2,070	3,294	7,265
2021	13,688	5,536	19,225	3,531	3,438	2,098	3,250	6,907
2022	13,141	5,426	18,566	3,370	3,303	2,123	3,195	6,576
2023	12,615	5,317	17,932	3,215	3,173	2,144	3,140	6,260
2024	12,111	5,211	17,321	3,069	3,048	2,163	3,092	5,950
2025	11,626	5,106	16,733	2,928	2,928	2,178	3,044	5,654

Table A.3 (9 of 15)

Volume Revenue Elements - Scenario 2 (4% Decline) - Case 4 (80% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	10,353	4,042	14,395	8,880	5,515	0	0	0
2007	16,047	5,713	21,760	10,742	7,102	0	196	3,721
2008	19,153	7,006	26,159	10,271	7,256	0	906	7,726
2009	20,395	7,761	28,156	9,148	6,901	860	1,631	9,617
2010	20,706	8,084	28,790	8,018	6,377	1,707	2,284	10,404
2011	20,841	7,922	28,763	7,217	6,013	1,909	2,834	10,789
2012	20,841	7,764	28,604	6,593	5,707	2,057	3,249	10,999
2013	20,705	7,609	28,314	6,118	5,491	2,118	3,545	11,043
2014	20,436	7,456	27,892	5,824	5,333	2,123	3,726	10,886
2015	20,027	7,307	27,335	5,533	5,128	2,180	3,870	10,624
2016	19,466	7,161	26,628	5,221	4,897	2,264	3,946	10,299
2017	18,805	7,018	25,823	4,977	4,706	2,312	3,955	9,873
2018	18,090	6,878	24,968	4,754	4,531	2,347	3,921	9,415
2019	17,366	6,740	24,106	4,534	4,356	2,384	3,901	8,932
2020	16,672	6,605	23,277	4,326	4,185	2,421	3,852	8,494
2021	16,005	6,473	22,478	4,129	4,020	2,454	3,800	8,076
2022	15,365	6,344	21,708	3,940	3,862	2,482	3,736	7,689
2023	14,750	6,217	20,967	3,759	3,710	2,507	3,671	7,320
2024	14,160	6,092	20,253	3,588	3,564	2,529	3,616	6,956
2025	13,594	5,971	19,564	3,424	3,424	2,547	3,559	6,610

Table A.3 (10 of 15)

Volume Revenue Elements - Scenario 2 (4% Decline) - Case 5 (90% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	11,853	4,628	16,480	10,167	6,314	0	0	0
2007	19,675	7,034	26,709	13,185	8,717	0	240	4,567
2008	22,639	8,468	31,107	12,213	8,628	0	1,078	9,187
2009	23,468	9,024	32,492	10,557	7,964	1,060	1,872	11,039
2010	23,705	9,255	32,960	9,179	7,301	1,954	2,615	11,911
2011	23,859	9,070	32,929	8,263	6,885	2,185	3,244	12,352
2012	23,859	8,889	32,748	7,548	6,534	2,355	3,719	12,593
2013	23,704	8,711	32,415	7,004	6,286	2,424	4,058	12,642
2014	23,396	8,537	31,933	6,668	6,106	2,431	4,266	12,463
2015	22,928	8,366	31,294	6,334	5,870	2,495	4,431	12,163
2016	22,286	8,198	30,485	5,977	5,607	2,592	4,518	11,791
2017	21,529	8,035	29,563	5,698	5,388	2,647	4,527	11,303
2018	20,710	7,874	28,584	5,442	5,187	2,686	4,489	10,779
2019	19,882	7,716	27,598	5,190	4,987	2,730	4,466	10,225
2020	19,087	7,562	26,649	4,953	4,791	2,771	4,410	9,724
2021	18,323	7,411	25,734	4,727	4,602	2,809	4,351	9,246
2022	17,590	7,263	24,853	4,510	4,421	2,841	4,277	8,803
2023	16,887	7,117	24,004	4,304	4,247	2,870	4,203	8,380
2024	16,211	6,975	23,186	4,108	4,080	2,895	4,139	7,964
2025	15,563	6,835	22,398	3,920	3,920	2,916	4,075	7,568

Table A.3 (11 of 15)

Volume Revenue Elements - Scenario 3 (6% Decline) - Case 1 (50% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	5,741	2,242	7,983	4,925	3,058	0	0	0
2007	8,176	3,168	11,344	5,600	3,702	0	102	1,940
2008	9,945	3,885	13,830	5,430	3,836	49	474	4,041
2009	11,021	4,304	15,325	4,979	3,756	548	876	5,166
2010	11,483	4,483	15,966	4,446	3,536	947	1,267	5,770
2011	11,483	4,393	15,876	3,984	3,319	1,074	1,560	5,939
2012	11,379	4,305	15,685	3,615	3,129	1,176	1,770	5,994
2013	11,174	4,219	15,394	3,326	2,985	1,234	1,907	5,941
2014	10,873	4,135	15,008	3,134	2,869	1,266	1,973	5,766
2015	10,481	4,052	14,534	2,942	2,726	1,326	2,013	5,526
2016	10,004	3,971	13,976	2,740	2,570	1,401	2,012	5,252
2017	9,464	3,892	13,356	2,574	2,434	1,458	1,970	4,919
2018	8,915	3,814	12,729	2,424	2,310	1,504	1,909	4,583
2019	8,380	3,738	12,118	2,279	2,190	1,548	1,855	4,247
2020	7,877	3,663	11,540	2,145	2,075	1,588	1,789	3,944
2021	7,405	3,590	10,994	2,019	1,966	1,624	1,723	3,662
2022	6,961	3,518	10,478	1,902	1,864	1,654	1,654	3,405
2023	6,543	3,448	9,990	1,791	1,768	1,680	1,587	3,165
2024	6,150	3,379	9,529	1,688	1,677	1,702	1,526	2,936
2025	5,781	3,311	9,092	1,591	1,591	1,720	1,467	2,724

Table A.3 (12 of 15)

Volume Revenue Elements - Scenario 3 (6% Decline) - Case 2 (60% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	7,252	2,832	10,084	6,221	3,863	0	0	0
2007	10,328	4,002	14,330	7,074	4,677	0	129	2,450
2008	12,563	4,908	17,471	6,859	4,846	62	599	5,105
2009	13,922	5,436	19,358	6,290	4,745	692	1,107	6,526
2010	14,505	5,663	20,168	5,617	4,467	1,196	1,600	7,288
2011	14,505	5,550	20,055	5,032	4,193	1,357	1,970	7,502
2012	14,374	5,439	19,813	4,567	3,953	1,486	2,236	7,572
2013	14,116	5,330	19,446	4,202	3,771	1,559	2,409	7,505
2014	13,735	5,223	18,958	3,958	3,625	1,599	2,493	7,283
2015	13,240	5,119	18,359	3,716	3,444	1,675	2,543	6,981
2016	12,638	5,017	17,654	3,462	3,247	1,770	2,542	6,634
2017	11,955	4,916	16,871	3,252	3,075	1,841	2,489	6,214
2018	11,262	4,818	16,080	3,062	2,918	1,900	2,411	5,789
2019	10,586	4,722	15,308	2,879	2,766	1,956	2,343	5,364
2020	9,951	4,627	14,578	2,709	2,621	2,006	2,259	4,982
2021	9,354	4,535	13,888	2,551	2,484	2,051	2,177	4,626
2022	8,793	4,444	13,237	2,402	2,355	2,089	2,090	4,301
2023	8,265	4,355	12,620	2,263	2,233	2,122	2,005	3,998
2024	7,769	4,268	12,037	2,133	2,118	2,150	1,928	3,709
2025	7,303	4,183	11,486	2,010	2,010	2,173	1,853	3,440

Table A.3 (13 of 15)

Volume Revenue Elements - Scenario 3 (6% Decline) - Case 3 (70% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	8,764	3,422	12,185	7,517	4,668	0	0	0
2007	12,481	4,836	17,316	8,548	5,651	0	156	2,961
2008	15,181	5,931	21,111	8,289	5,856	75	724	6,168
2009	16,823	6,569	23,392	7,600	5,733	836	1,337	7,885
2010	17,527	6,843	24,370	6,787	5,398	1,445	1,933	8,807
2011	17,527	6,706	24,233	6,081	5,066	1,640	2,381	9,066
2012	17,370	6,572	23,942	5,518	4,777	1,795	2,702	9,149
2013	17,057	6,441	23,498	5,077	4,557	1,884	2,911	9,069
2014	16,596	6,312	22,908	4,783	4,380	1,932	3,012	8,801
2015	15,999	6,186	22,184	4,490	4,162	2,024	3,073	8,436
2016	15,271	6,062	21,333	4,183	3,924	2,138	3,071	8,017
2017	14,446	5,941	20,387	3,930	3,716	2,225	3,008	7,509
2018	13,608	5,822	19,430	3,700	3,526	2,296	2,913	6,996
2019	12,792	5,705	18,497	3,479	3,342	2,363	2,831	6,482
2020	12,024	5,591	17,616	3,274	3,167	2,424	2,730	6,020
2021	11,303	5,479	16,782	3,083	3,001	2,478	2,631	5,590
2022	10,625	5,370	15,995	2,903	2,845	2,525	2,525	5,197
2023	9,987	5,262	15,250	2,734	2,698	2,564	2,423	4,831
2024	9,388	5,157	14,545	2,577	2,559	2,598	2,329	4,482
2025	8,825	5,054	13,879	2,429	2,429	2,625	2,239	4,157

Table A.3 (14 of 15)

Volume Revenue Elements - Scenario 3 (6% Decline) - Case 4 (80% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	10,274	4,011	14,285	8,812	5,472	0	0	0
2007	15,924	5,669	21,593	10,659	7,047	0	194	3,692
2008	19,006	6,952	25,959	10,192	7,200	0	899	7,667
2009	20,239	7,701	27,940	9,078	6,848	853	1,618	9,543
2010	20,547	8,022	28,569	7,957	6,328	1,694	2,266	10,324
2011	20,547	7,862	28,409	7,129	5,939	1,922	2,791	10,628
2012	20,362	7,704	28,067	6,469	5,600	2,104	3,168	10,726
2013	19,996	7,550	27,546	5,952	5,342	2,208	3,413	10,631
2014	19,456	7,399	26,855	5,607	5,135	2,265	3,531	10,317
2015	18,755	7,251	26,007	5,264	4,879	2,373	3,602	9,889
2016	17,902	7,106	25,008	4,904	4,600	2,507	3,601	9,398
2017	16,935	6,964	23,899	4,607	4,356	2,608	3,526	8,803
2018	15,953	6,825	22,778	4,337	4,134	2,691	3,415	8,201
2019	14,996	6,688	21,684	4,078	3,918	2,770	3,319	7,599
2020	14,096	6,555	20,651	3,838	3,713	2,842	3,201	7,058
2021	13,250	6,423	19,674	3,614	3,518	2,905	3,084	6,553
2022	12,455	6,295	18,750	3,403	3,336	2,959	2,960	6,092
2023	11,708	6,169	17,877	3,205	3,163	3,006	2,840	5,663
2024	11,006	6,046	17,051	3,021	3,000	3,045	2,731	5,254
2025	10,345	5,925	16,270	2,847	2,847	3,078	2,624	4,874

Table A.3 (15 of 15)

Volume Revenue Elements - Scenario 3 (6% Decline) - Case 5 (90% Recovery)

Project Year	Produced Water BPD	BackFlow BPD	Collection Center BPD	Total BR Inj Water BPD	Total BR BF Water BPD	Other BF Water BPD	Other Producer via SWD BPD	Other Producer Satellite BPD
2006	11,785	4,601	16,386	10,108	6,277	0	0	0
2007	19,563	6,994	26,556	13,109	8,667	0	239	4,541
2008	22,509	8,420	30,929	12,143	8,579	0	1,072	9,135
2009	23,334	8,972	32,306	10,496	7,918	1,054	1,861	10,976
2010	23,570	9,202	32,772	9,127	7,259	1,943	2,600	11,843
2011	23,570	9,018	32,588	8,177	6,813	2,205	3,202	12,191
2012	23,357	8,838	32,195	7,420	6,424	2,414	3,634	12,303
2013	22,937	8,661	31,598	6,827	6,128	2,533	3,915	12,195
2014	22,318	8,488	30,805	6,432	5,890	2,598	4,051	11,835
2015	21,514	8,318	29,832	6,038	5,596	2,722	4,132	11,344
2016	20,535	8,152	28,687	5,625	5,276	2,875	4,130	10,780
2017	19,426	7,988	27,415	5,284	4,996	2,992	4,045	10,098
2018	18,300	7,829	26,128	4,975	4,742	3,087	3,918	9,407
2019	17,202	7,672	24,874	4,678	4,494	3,178	3,807	8,717
2020	16,170	7,519	23,688	4,402	4,259	3,260	3,671	8,096
2021	15,199	7,368	22,568	4,145	4,036	3,333	3,537	7,517
2022	14,287	7,221	21,508	3,903	3,826	3,395	3,396	6,988
2023	13,430	7,077	20,507	3,677	3,629	3,448	3,258	6,496
2024	12,624	6,935	19,559	3,465	3,442	3,493	3,132	6,027
2025	11,867	6,796	18,663	3,266	3,266	3,530	3,010	5,591

Table A.5

Life-of-Project Revenue Stream (1)

Scenario 3 - 6% Declination			
Project Year	70% Recovery	80% Recovery	90% Recovery
2006	$1,680,598	$1,970,153	$2,259,954
2007	$3,217,471	$4,069,988	$5,024,625
2008	$4,841,439	$5,945,112	$7,037,242
2009	$5,664,409	$6,815,281	$7,837,869
2010	$7,500,137	$8,569,176	$9,639,122
2011	$7,812,698	$8,931,282	$10,050,815
2012	$8,026,772	$9,177,849	$10,329,902
2013	$8,144,156	$9,310,982	$10,478,797
2014	$8,157,499	$9,322,062	$10,487,613
2015	$8,096,220	$9,245,575	$10,395,906
2016	$7,960,088	$9,081,249	$10,203,362
2017	$7,751,276	$8,831,629	$9,912,900
2018	$7,516,855	$8,551,896	$9,587,814
2019	$7,281,402	$8,270,857	$9,261,151
2020	$7,053,804	$7,998,929	$8,944,856
2021	$6,836,796	$7,739,317	$8,642,604
2022	$6,629,199	$7,490,638	$8,352,808
2023	$6,431,706	$7,253,700	$8,076,392
2024	$6,244,846	$7,029,122	$7,814,064
2025	$6,067,451	$6,815,535	$7,564,254

Table A.6

Life-of-Project Annual Tax Credit

Scenario 3 - 6% Declination			
Project Year	70% Recovery	80% Recovery	90% Recovery
2006	$881,843	$1,017,567	$1,153,405
2007	$1,240,881	$1,553,386	$1,898,486
2008	$1,525,251	$1,828,608	$2,137,802
2009	$1,640,317	$1,931,034	$2,213,254
2010	$1,690,508	$1,965,559	$2,240,844
2011	$1,684,083	$1,958,026	$2,232,203
2012	$1,666,309	$1,937,191	$2,208,302
2013	$1,637,392	$1,903,292	$2,169,417
2014	$1,597,840	$1,856,925	$796,286
2015	$1,548,446	$1,098,412	$0
2016	$1,489,679	$0	$0
2017	$447,453	$0	$0
2018	$0	$0	$0
2019	$0	$0	$0
2020	$0	$0	$0
2021	$0	$0	$0
2022	$0	$0	$0
2023	$0	$0	$0
2024	$0	$0	$0
2025	$0	$0	$0

Table A.7

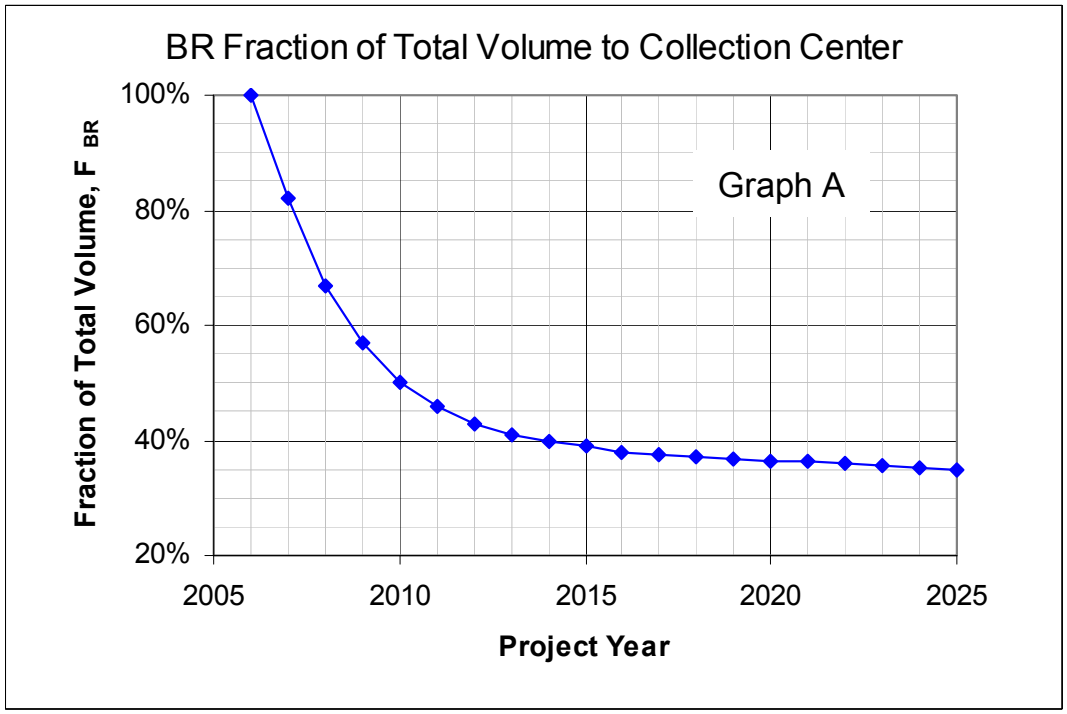
Life-of-Project Revenue Stream (1)

Scenario 3 - 6% Declination			
Project Year	70% Recovery	80% Recovery	90% Recovery
2006	$1,680,598	$1,970,153	$2,259,954
2007	$3,217,471	$4,069,988	$5,024,625
2008	$4,841,439	$5,945,112	$7,037,242
2009	$5,664,409	$6,815,281	$7,837,869
2010	$7,500,137	$8,569,176	$9,639,122
2011	$7,812,698	$8,931,282	$10,050,815
2012	$8,026,772	$9,177,849	$10,329,902
2013	$8,144,156	$9,310,982	$10,478,797
2014	$8,157,499	$9,322,062	$10,487,613
2015	$8,096,220	$9,245,575	$10,395,906
2016	$7,960,088	$9,081,249	$10,203,362
2017	$7,751,276	$8,831,629	$9,912,900
2018	$7,516,855	$8,551,896	$9,587,814
2019	$7,281,402	$8,270,857	$9,261,151
2020	$7,053,804	$7,998,929	$8,944,856
2021	$6,836,796	$7,739,317	$8,642,604
2022	$6,629,199	$7,490,638	$8,352,808
2023	$6,431,706	$7,253,700	$8,076,392
2024	$6,244,846	$7,029,122	$7,814,064
2025	$6,067,451	$6,815,535	$7,564,254

Note…..

1. Annual revenue adjusted for backflow charges.

Figure A.1 (1 of 2)
Collection Center Volume Relationships



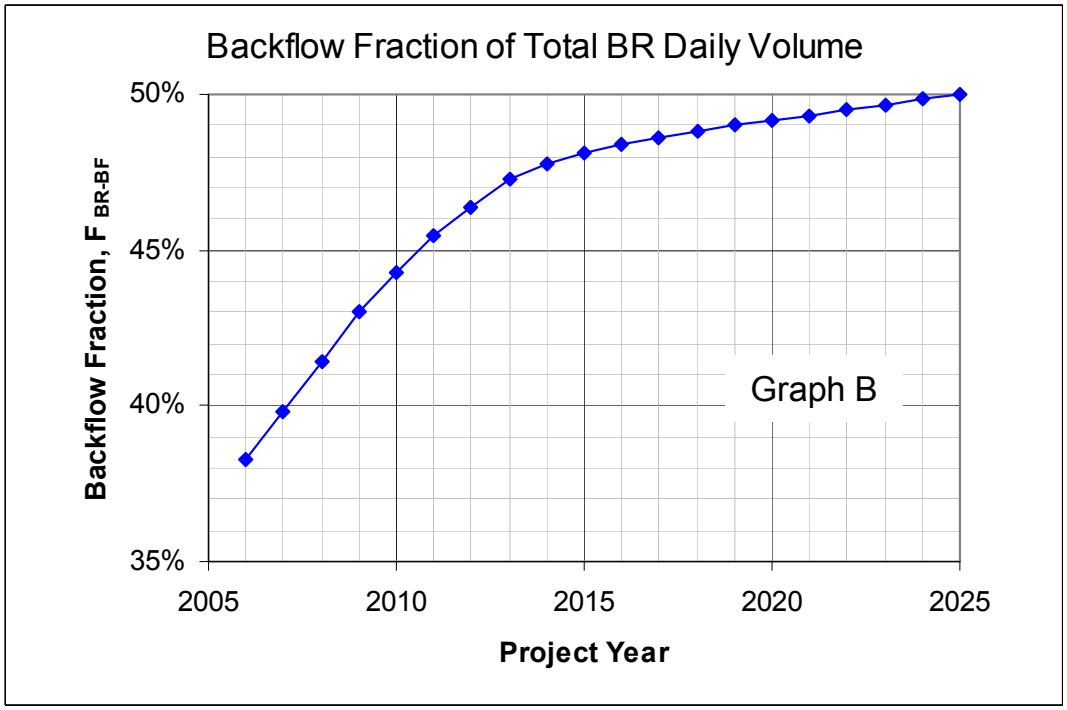
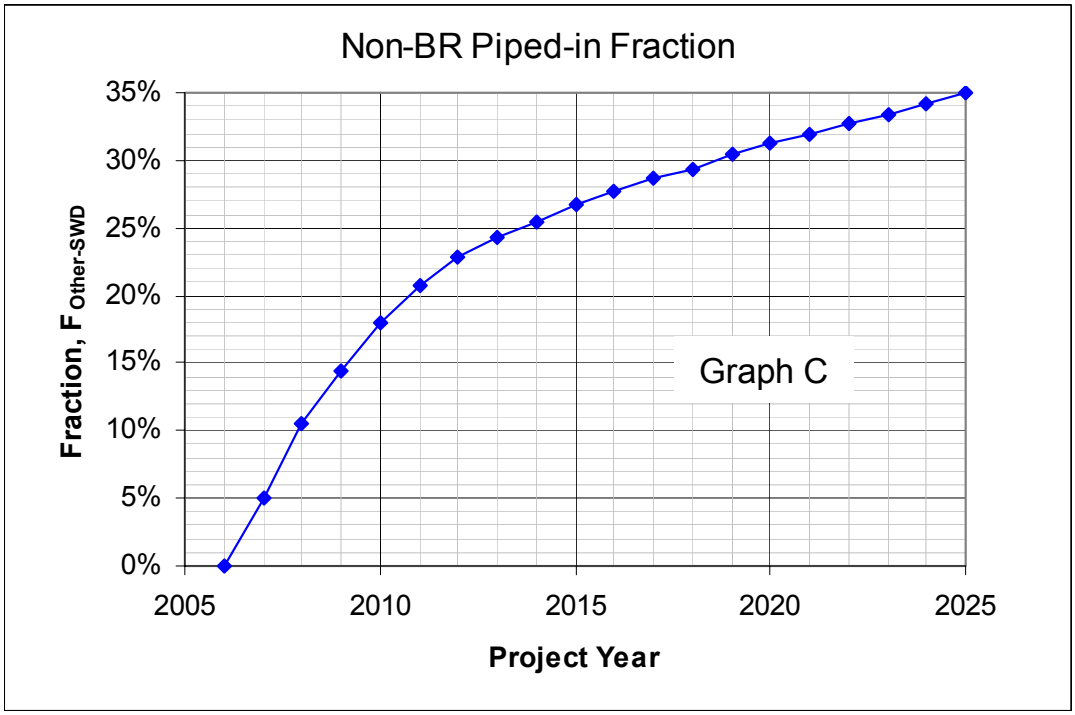


Figure A.1 (2 of 2)
Collection Center Volume Relationships



$V_{CC\text{-}BR} = V_{CC} \times F_{BR}$
$V_{CC\text{-}BR} = V_{CC\text{-}BR} \times F_{BR\text{-}BF}$
$V_{CC\text{-}Other\text{-}BF} = V_{CC\text{-}BF} - V_{CC\text{-}BR\text{-}BF}$
$V_{CC\text{-}BR\text{-}PW} = V_{CC\text{-}BR} - V_{CC\text{-}BR\text{-}BF}$
$V_{CC\text{-}Other} = V_{CC} - V_{CC\text{-}BR} - V_{CC\text{-}BF}$
$V_{CC\text{-}Other\text{-}SWD} = V_{CC\text{-}Other} \times F_{Other\text{-}SWD}$
$V_{CC\text{-}Other\text{-}Satellite} = V_{CC\text{-}Other} - V_{CC\text{-}Other\text{-}SWD}$

Collection Center Parameters

Where:	V_{CC}	Total Volume, BPD
	F_{BR}	BR Fraction (Graph A)
	$V_{CC\text{-}BF}$	SWD Backflow to Collection Center, BPD
	$V_{CC\text{-}BR}$	BR Volume, BPD
	$F_{BR\text{-}BF}$	BR Backflow Fraction (Graph B)
	$V_{CC\text{-}BR\text{-}BF}$	BR Backflow Volume, BPD
	$V_{CC\text{-}Other\text{-}BF}$	Other Producer Backflow Volume, BPD
	$V_{CC\text{-}BR\text{-}PW}$	BR Produced Water Volume, BPD
	$V_{CC\text{-}Other}$	Other Producer Volume (non-Backflow), BPD
	$F_{Other\text{-}SWD}$	Fraction Other Producers vis SWD to Pipeline (Graph C)
	$V_{CC\text{-}Other\text{-}SWD}$	Other Produced Delivery via SWD to Pipeline
	$V_{CC\text{-}Other\text{-}Satellite}$	Other Producer Delivery via Satellite Station