Testimony Before the State Water Resources Control Board
Jack S. Safely, Water Resources Manager, Western Municipal Water District
Water Right Application Nos. 31165 and 31370

Summary of Testimony

1. The purpose of my testimony is to describe how the San Bernardino Valley Municipal Water District (Muni) and the Western Municipal Water District of Riverside County (Western) can beneficially use water diverted from the Santa Ana River. Analysis indicates that, using existing and planned facilities, all of the water diverted from the Santa Ana River can be beneficially used in the Muni/Western service area within a 12-month period assuming a repeat of the historically wet hydrologic conditions that occurred during the 1968-69 water year. (A portion of these amounts of water may be utilized through future exchange arrangements between Muni, Western and The Metropolitan Water District of Southern California, although State Water Resources Control Board approval of such exchange arrangements is not being sought at this time.) Using the 1968-69 water year yields the greatest quantity of water that could be expected to be diverted from the Santa Ana River, based on the 39 year hydrologic record used in the analysis for Water Right Application Nos. 31165 and 31370. During a repetition of WY 1969 hydrology, the amount of water available for diversion from the Santa Ana River is estimated to be 198,319 acre-feet.

Background and Qualifications

2. I have 19 years of professional engineering experience working in the water resources field. I have completed numerous water resource planning studies, master plans and engineering feasibility studies for water supply projects. My employers have included James M. Montgomery Consulting Engineers, The Metropolitan Water District of Southern California ("Metropolitan"), and Western Municipal Water District. I am familiar with the operation of Metropolitan's water distribution system from my 15 years of service to that organization and with the planning and operation of Western's system, having completed the Integrated Regional Water Management Plan in 2006.

Demands in the Muni/Western Service Areas

3. In 2006, Western completed an Integrated Regional Water Management Plan, which projected future water demands. Muni is currently in the process of completing an Integrated Regional Water Management Plan and has completed the portion of the plan that projects future water demands. Based upon these two planning efforts, the ultimate or build-out demands for water in the two districts are projected to increase from 563,096 acre-feet in 2010 to 793,582 acre-feet as shown below in Table 1.

Table 1

Projected Annual Water Demand (acre-feet)

Agency	2010	2015	2020	2025	2030	Ultimate
Muni	265,374	297,495	319,394	337,478	351,269	356,496
Western	297,722	331,853	358,292	380,717	398,728	437,086
Total	563,096	629,348	677,686	718,195	749,997	793,582

4. Water diverted from the Santa Ana River under Muni/Western's Water Right Application Nos. 31165 and 31370 (the "Project") will offset demands for water imported from the State Water Project and the Colorado River. The amount of imported water needed to meet projected demands, with the Project, is estimated to increase from 174,715 acre-feet in 2010 to 249,820 acre-feet, and is shown in Table 2 below. Without the Project, the amount of imported water climbs to 276,820 acre-feet as shown on Table 3.

Table 2

Projected Imported Water Demand with the Project (acre-feet)

Agency	2010	2015	2020	2025	2030	Ultimate
Muni	26,148	41,215	44,623	57,673	67,147	71,176
Western	148,567	135,807	140,061	155,489	174,838	178,644
Total	174,715	177,022	184,684	213,162	241,985	249,820

Table 3

Projected Imported Water Demand without the Project (acre-feet)

Agency	2010	2015	2020	2025	2030	Ultimate
Muni	26,148	51,215	66,023	79,073	88,547	92,576
Western	148,567	141,407	145,661	161,089	180,438	184,244
Total	174,715	192,622	211,684	240,162	268,985	276,820

Facilities Used to Deliver Water

5. Water deliveries to Muni and Western would be accomplished using existing pipelines, spreading grounds, treatment facilities owned by Muni/Western and their member agencies, and pipeline, storage and treatment facilities owned by Metropolitan that serve Western, who is a member agency of MWDSC. The major conveyance and treatment facilities that would be used to transport this water and their design capacities are summarized in Tables 4 through 6 below, and are shown on Figure 1. Two planned facilities, the Riverside-Corona Feeder and the Lake Mathews Water Treatment Plant, are included in the analysis because they are planned for construction under Western's capital improvement program and are included in the Integrated Regional Water Management Plan, which was adopted by Western's Board of Directors in October 2006. A Final Programmatic EIR for the Riverside-Corona Feeder has been certified that identifies the pipeline alignment shown on Figure 1. Western staff is proposing to include approximately $4.5 million in Western's capital budget for fiscal year 2007-08 to continue design and implementation the Riverside-Corona Feeder. Western has also received a $4.3 million grant from the State Water Resources Control Board for implementation of the Riverside-Corona Feeder project, as shown in the attached news release. Western has purchased the site for the Lake Mathews Water Treatment Plant and staff is proposing to include approximately $1.25 million in Western's capital budget for fiscal year 2007-08 to conduct pilot testing, preliminary design and preparation of environmental documentation for the Lake Mathews Water Treatment Plant.

Table 4

Conveyance Facilities Used to Deliver Water to Muni/Western Service Area

Facility	Design Capacity	Owner	Existing/Planned
Inland Feeder	1,000 cfs	Metropolitan	Existing
Colorado River Aqueduct	1,605 cfs	Metropolitan	Existing
San Diego Canal	1,700 cfs	Metropolitan	Existing
Lower Feeder	750 cfs	Metropolitan	Existing
Box Springs Feeder	500 cfs	Metropolitan	Existing
Foothill Pipeline	300 cfs	Muni	Existing
Auld Valley Pipeline	340 cfs	Metropolitan	Existing
San Diego Pipeline No. 4	425 cfs	Metropolitan	Existing
Riverside-Corona Feeder	100 cfs	Western	Planned

Table 5

Water Treatment Facilities Used to Deliver Water in Western's Service Area

Facility	Design Capacity	Owner	Existing/Planned
Mills WTP	160/326 mgd*	Metropolitan	Existing
Skinner WTP	630 mgd	Metropolitan	Existing
Lake Mathews WTP	40 mgd	Western	Planned
Chase & Lester WTP	20 mgd	Corona	Existing
Sierra Del Oro WTP	10 mgd	Corona	Existing

*Expansion to 326 mgd under way

Table 6

Surface Storage Facilities Used to Hold Water for Delivery to Western's Service Area

Facility	Capacity	Owner	Existing/Planned
Seven Oaks Dam	50,000 acre-feet*	SBCFCD	Existing
Diamond Valley Lake	800,000 acre-feet	Metropolitan	Existing
Lake Mathews	182,800 acre-feet	Metropolitan	Existing
Lake Skinner	44,400 acre-feet	Metropolitan	Existing

*Conservation pool only

Analysis of Water Use During Maximum Diversion Year

6. Water diverted from the Santa Ana River would be delivered to Muni/Western through a combination of direct delivery to water treatment facilities, spreading to recharge groundwater basins, and conservation storage in surface reservoirs that serve the Muni/Western service area.

Delivery Priority

7. The allocation model developed to analyze delivery of water from the Santa Ana River assumes that water is delivered under four priorities. The first three priorities are to Muni and the fourth priority is to Western. Priority 1 water is for direct use by Muni, priority 2 deliveries are for San Bernardino Basin Area spreading, priority 3 deliveries are for spreading outside of the San Bernardino Basin Area but within the Muni/Western service areas, and priority 4 deliveries are to Western for both direct use and groundwater basin recharge.

8. Western would utilize a number of facilities to take delivery of Priority 4 water when available. Under Priority 4, Western would first spread water in the San Bernardino Basin Area, then deliver water to the Lake Mathews WTP, then to the Mills WTP, then to the Skinner WTP, and finally to the Corona WTPs. The analysis assumed that all water delivered through these facilities would be directly used by Western within 12 months of when the water was diverted.

9. The analysis includes the use of the Seven Oaks Conservation pool and/or the use of Metropolitan reservoirs. The two Metropolitan reservoirs considered under this analysis were Diamond Valley Lake and/or Lake Mathews. Given the use of the Metropolitan reservoirs, Muni and Western can use all of the diverted water within a 12 month period. The maximum utilization of Diamond Valley Lake and Lake Mathews would be 66,637 acre-feet. If the Seven Oaks conservation pool is utilized, the maximum utilization of Diamond Valley and/or Lake Mathews drops to 22,161 acre-feet and the maximum use of the conservation pool is 44,476 acre-feet.

Western Demands in Mathews/Mills Load Area and Skinner Load Area

10. Western's service area can be divided into "load areas", or areas within the service territory that are served by certain facilities. For this analysis, Western's territory is divided into two load areas, the Lake Mathews/Mills load area and the Skinner load area. The Lake Mathews/Mills load area is served through the Mills Water Treatment Plant, Lake Mathews, various pipelines, and the Corona water treatment plants. In the future, the Riverside-Corona Feeder and Lake Mathews Water Treatment Plant will serve the Lake Mathews/Mills load area. The Skinner load area is served through the Skinner Water Treatment Plant and treated and raw water delivery facilities near Lake Skinner.

11. The majority of imported water demand in Western's service area is contained in the Lake Mathews/Mills load area. Table 7 contains a summary of imported water demands for each load area.

Table 7

Imported Water Demands by Load Area

Agency	Imported Demand (AF)	Mathews/Mills Load Area (AF)	Skinner Load Area (AF)
Box Springs	120	120	-
Corona	39,879	39,879	-
Norco	-	-	-
Riverside	9,800	9,800	-
Eagle Valley	1,025	1,025	-
EVMWD	48,806	24,403	24,403
EWD	800	400	400
Home Gardens	491	491	-
Lee Lake	8,082	8,082	-
RCWD	10,350	-	10,350
Western Retail	55,491	55,491	-
Murrieta Division	4,400	-	4,400
Jurupa	5,000	5,000	-
Riverside Highland	-	-	-
Rubidoux	-	-	-
Total	**184,244**	**144,691**	**39,553**

Delivery of Water to the Muni/Western Service Area

12. Western would deliver water to its service area through a combination of facilities listed in Tables 4 through 6. There are four general routes the water could take to be delivered to Western's service area. First, water could be delivered to the San Bernardino Basin Area where it could be pumped and conveyed through the Riverside-Corona Feeder for use in the Mathews/Mills load area; however, use of the Riverside-Corona Feeder is not necessary to deliver the water made available under the water right applications. The Riverside-Corona Feeder would be used to help control high groundwater levels in the San Bernardino Basin Area. Second, water could be delivered to the Inland Feeder, Colorado River Aqueduct to Lake Mathews, then through the Lower Feeder to the Lake

Mathews WTP, Chase & Lester WTP and the Sierra Del Oro WTP for use in the Mathews/Mills load area. Third, water could be delivered through the Inland Feeder to Diamond Valley Lake for storage and later use, or continue further south through the San Diego Canal to the Skinner complex where it could be delivered to the Skinner load area via the Auld Valley Pipeline and San Diego Pipelines. Fourth, water could be delivered through the Foothill Pipeline to the Santa Ana Valley Pipeline and the Mills WTP for use in the Mathews/Mills load area or further south to Diamond Valley Lake or Skinner complex. The routes of delivery are shown on the attached Figure 1.

13. The following three cases were analyzed:

Case No.	Seven Oaks Conservation Pool (50,000 acre-feet)	Diamond Valley Lake and Lake Mathews	Lake Mathews Water Treatment Plant
1	YES	YES	NO
2	NO	YES	YES
3	YES	YES	YES

14. A summary of the beneficial use of Santa Ana River diversions in the Muni/Western service territory is shown below in Table 8.

Table 8

Beneficial Use of Diversions for the Maximum Capture Year (Water Year 1968-69)

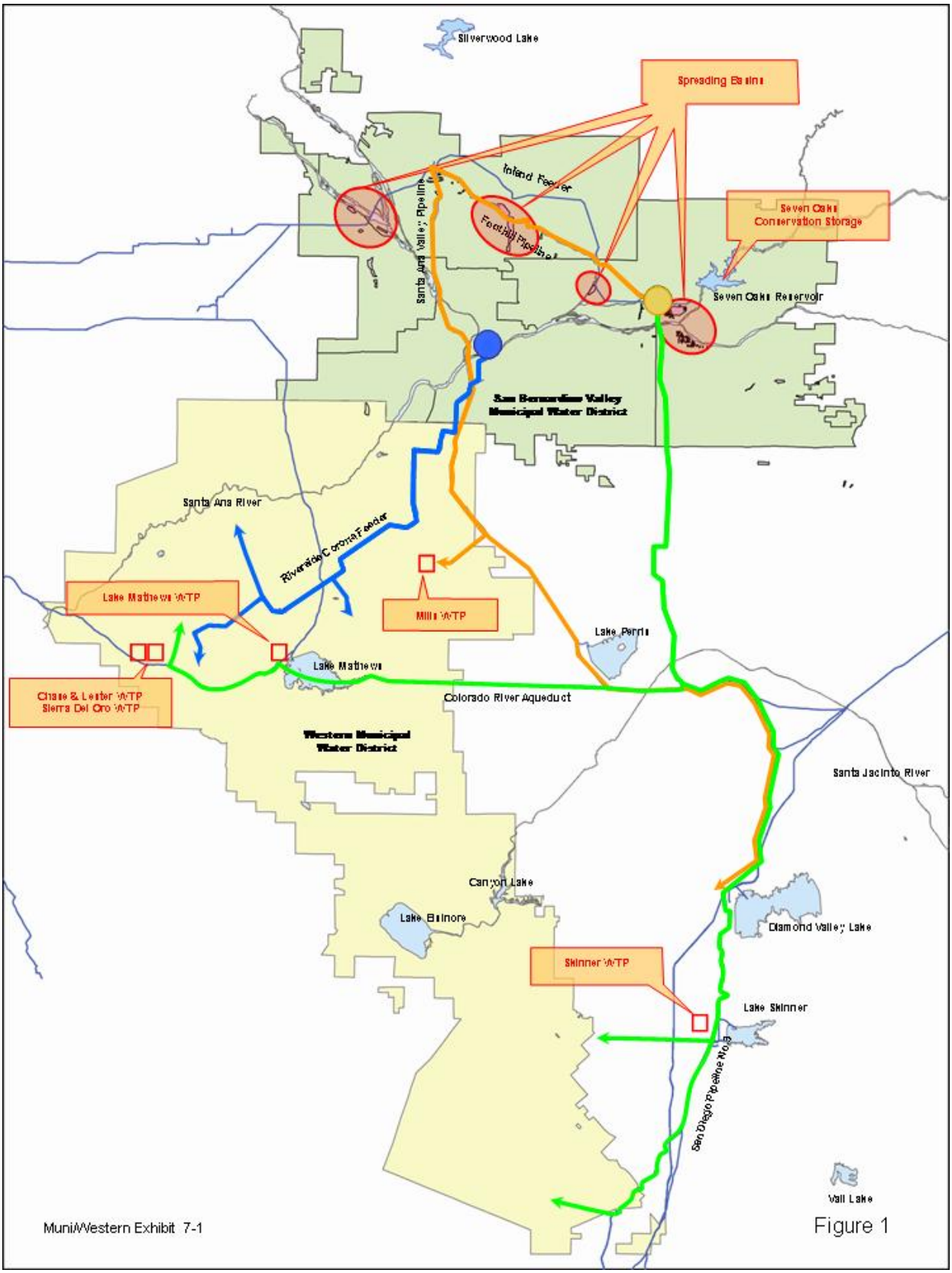
Case No.	Seven Oaks Conservation Pool (50,000 acre-feet)	Diamond Valley Lake/ Lake Mathews	Lake Mathews Water Treatment Plant	Use in Muni/Western Service Areas (12 month period), acre-feet					
				Direct Use		Via	Via		
				Muni	WMWD	Seven Oaks	DVL/LM	Total	Use - Available
1	YES	YES	NO	51,065	79,891	38,867	14,672	184,495	(13,824)
2	NO	YES	YES	51,065	80,616	0	66,637	198,319	(0)
3	YES	YES	YES	51,065	80,616	44,476	22,161	198,319	(0)

(1) Based on Allocation Model output for Project Scenario A

15. A detailed summary of the delivery of water to various facilities in the Muni/Western service territory is included as Table 9 at the end of this testimony. Graphic summary representations of deliveries to and from storage facilities for the three cases analyzed are included in Figures 2 through 6.

Conclusion

16. There is sufficient capacity to deliver and use within the Muni/Western service areas all of the water that could be captured from the Santa Ana River within a 12 month period under the highest flow hydrology anticipated to occur. Water diverted from the Santa Ana River would offset the need for imported from the State Water Project and from the Colorado River. Figure 7 illustrates in graphic form the significant benefit derived from project when comparing the amount of imported water required for the No Project and with Project alternatives.


Silverwood Lake
Spreading Basins
Inland Feeder
Santa Ana Valley Pipeline
Foothill Pipeline
Seven Oaks Conservation Storage
Seven Oaks Reservoir
San Bernardino Valley Municipal Water District
Santa Ana River
Riverside Corona Feeder
Lake Mathews WTP
Mills WTP
Lake Perris
Lake Mathews
Chase & Lester WTP
Sierra Del Oro WTP
Colorado River Aqueduct
Western Municipal Water District
Santa Jacinto River
Canyon Lake
Lake Elsinore
Diamond Valley Lake
Skinner WTP
Lake Skinner
San Diego Pipeline No 3
Vail Lake
Muni/Western Exhibit 7-1
Figure 1

WESTERN MUNICIPAL WATER DISTRICT

NEWS RELEASE

For Release: Immediate

Contact: Michele McKinney Underwood
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Western Municipal Water District's drought-proofing project, the Riverside-Corona Feeder, gains $4.3 million in funding

Riverside, CA – April 12, 2007 – The Riverside-Corona Feeder, Western Municipal Water District's drought-proofing project, was recently infused with $4.3 million from a State Water Resources Control Board grant providing greater regional water supply reliability.

The R-C Feeder is designed to deliver water conserved and stored in wet years in San Bernardino County groundwater basins to communities throughout western Riverside County in dry water years. "Linking surface water supplies to groundwater storage is what conjunctive use is all about. The R-C Feeder is a prime example of conjunctive use," said John V. Rossi, Western's general manager.

Competitive grant funding for the R-C Feeder is generated from the 2002 voter-approved Proposition 50 section that aims to integrate regional water resource solutions. "This state grant award launches Western's regionally-beneficial water resource management project," added Rossi. The $250 million project would allow Western to reduce its reliance on imported water during dry years or during catastrophic failure of the imported water systems. Water users elsewhere in Southern California who are unable to practice conjunctive use will benefit from the increased flexibility of imported water systems in dry years as a result of Western's created ability to reduce its share of demand for imported water.

"The R-C Feeder is the first major conjunctive use project to integrate the needs and benefits of water consumers in three major Southern California counties with significant state and federal entities," remarked Western's board president, Donald D. Galleano.

The State Water Resources grant couples perfectly with the Feb. 16 introduction of federal congressional bill HR 1139 (Calvert), the Riverside-Corona Feeder Water Supply Act, that will provide budget authority for the Secretary of the Interior in the amount of $50 million for planning, design and construction of Western's R-C Feeder. The bill will be considered in the federal House Resources and the Subcommittee on Water and Power, chaired by Congresswoman Grace Napolitano, a co-sponsor of HR 1139.

The R-C Feeder will include 20 wells and 28 miles of pipeline capable of moving 40,000 acre-feet of groundwater annually. New wet year water will come from local runoff, including regulated releases from Seven Oaks Dam and the State Water Project. The water will be stored in San Bernardino Valley groundwater basins. To deliver the stored water to consumers, the project will provide for new groundwater pumping capacity and delivery pipeline capacity. The R-C Feeder will provide the means to control water tables, thereby reducing liquefaction dangers in the Colton and San Bernardino communities. Additionally, the project improves local water quality as perchlorate and other constituents would be removed from the basin when water is extracted from the well heads via the R-C Feeder.

(more)

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Beneficiaries include the cities of Riverside, Corona and Norco; Elsinore Valley Municipal Water District; Home Gardens County Water District; Jurupa Community Services District; Lee Lake Water District; Rubidoux Community Services District; Colorado River water users; water-dependent environments in Northern California; imported water users; residents of San Bernardino Valley; as well as Western Municipal Water District.

Western Municipal Water District provides water supply, wastewater disposal and water resource management to the public in a safe, reliable, environmentally sensitive and financially responsible manner within a 527-square mile area of western Riverside County.

# # #

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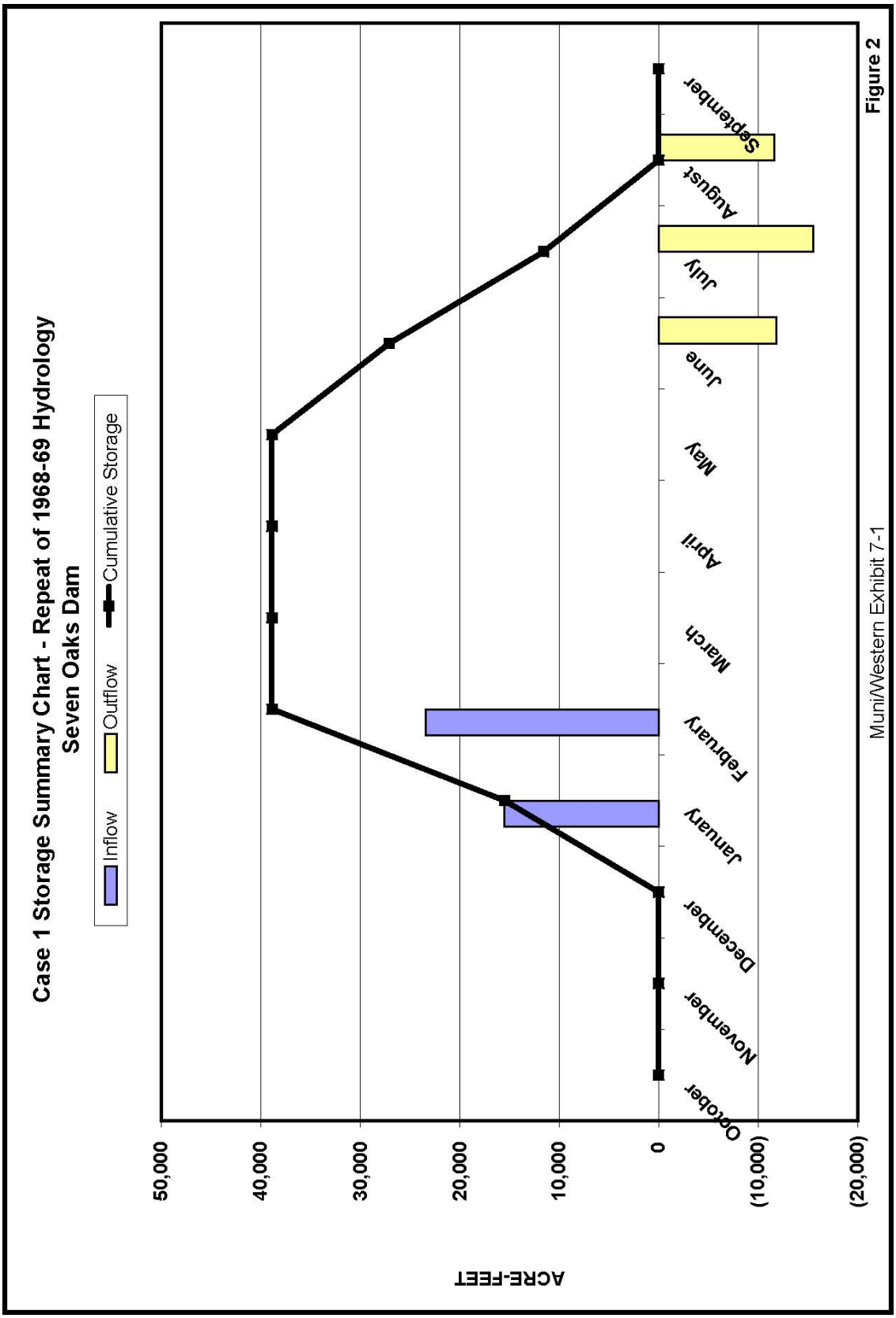
Case 1 Storage Summary Chart - Repeat of 1968-69 Hydrology
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Muni/Western Exhibit 7-1
Figure 2

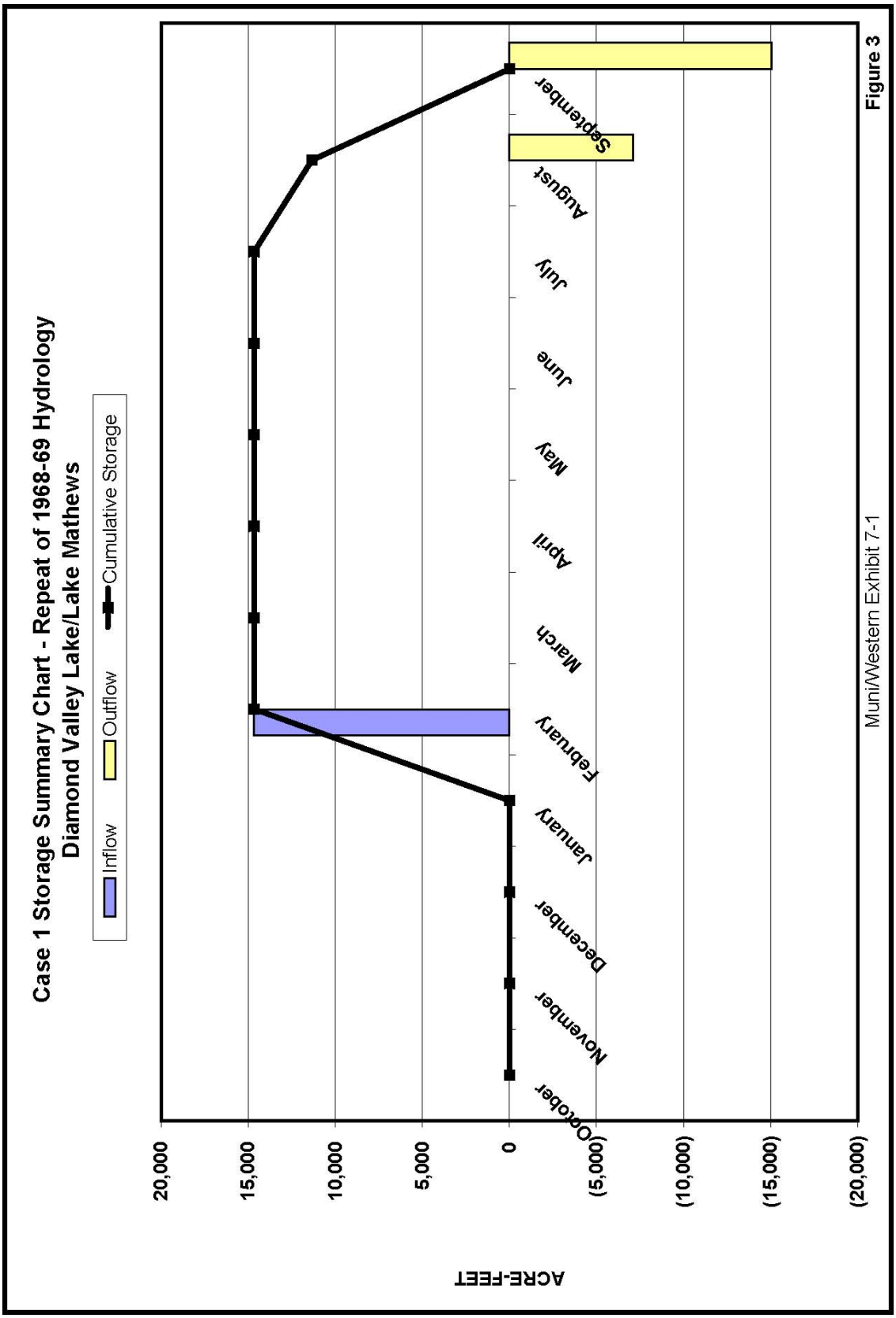
Case 1 Storage Summary Chart - Repeat of 1968-69 Hydrology
Diamond Valley Lake/Lake Mathews
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Figure 3

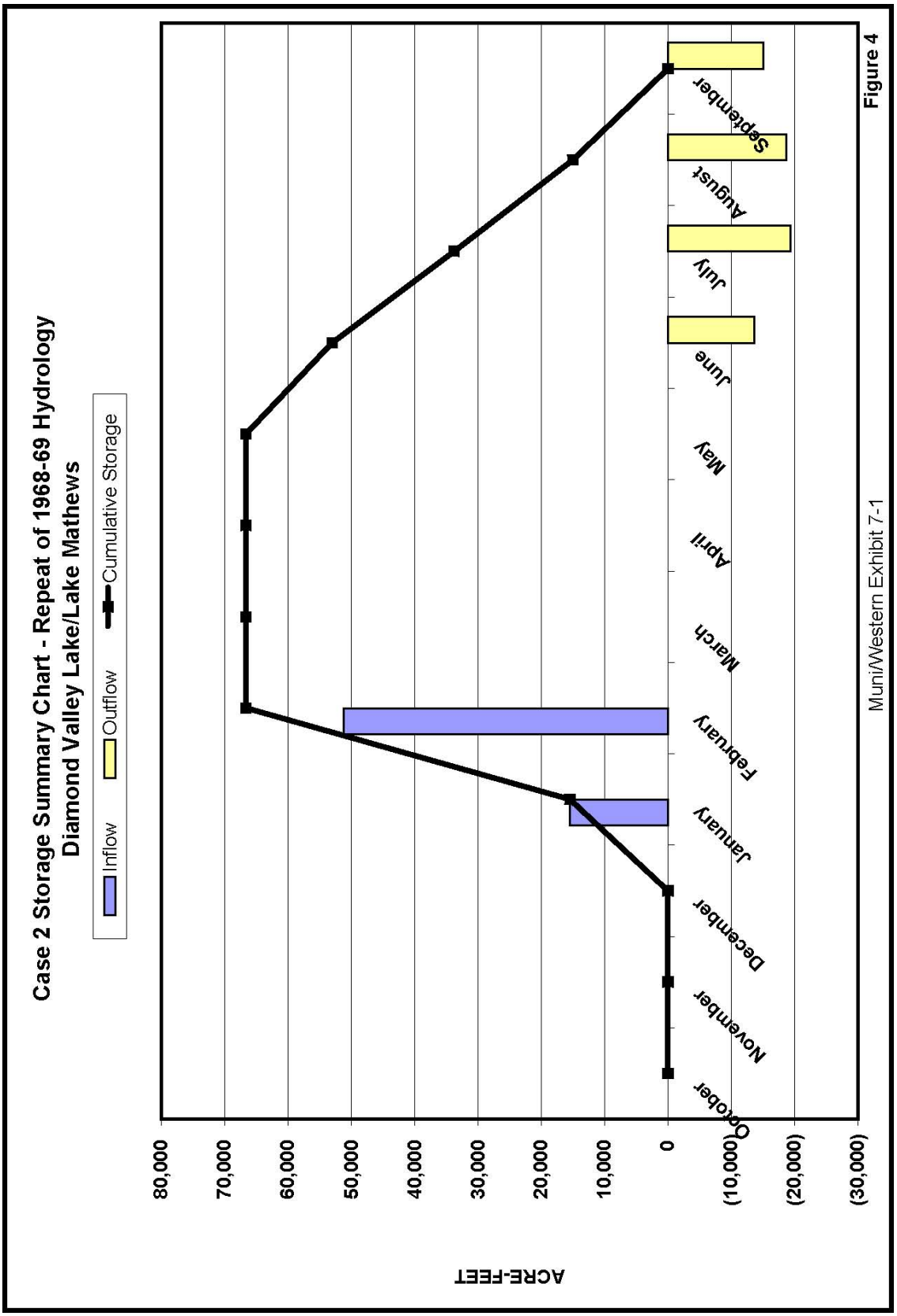
Case 2 Storage Summary Chart - Repeat of 1968-69 Hydrology
Diamond Valley Lake/Lake Mathews
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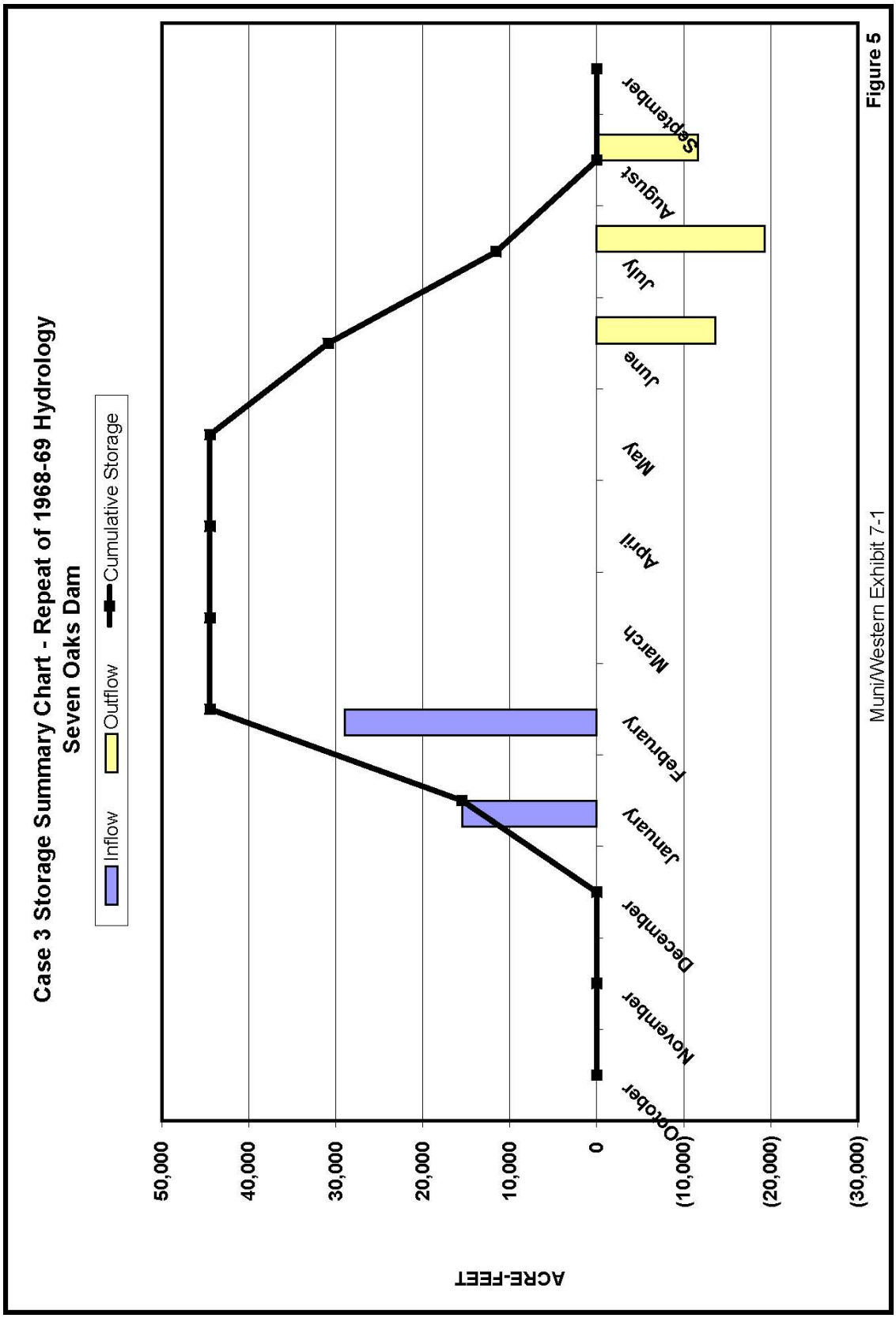
Figure 4


Case 3 Storage Summary Chart - Repeat of 1968-69 Hydrology
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Muni/Western Exhibit 7-1

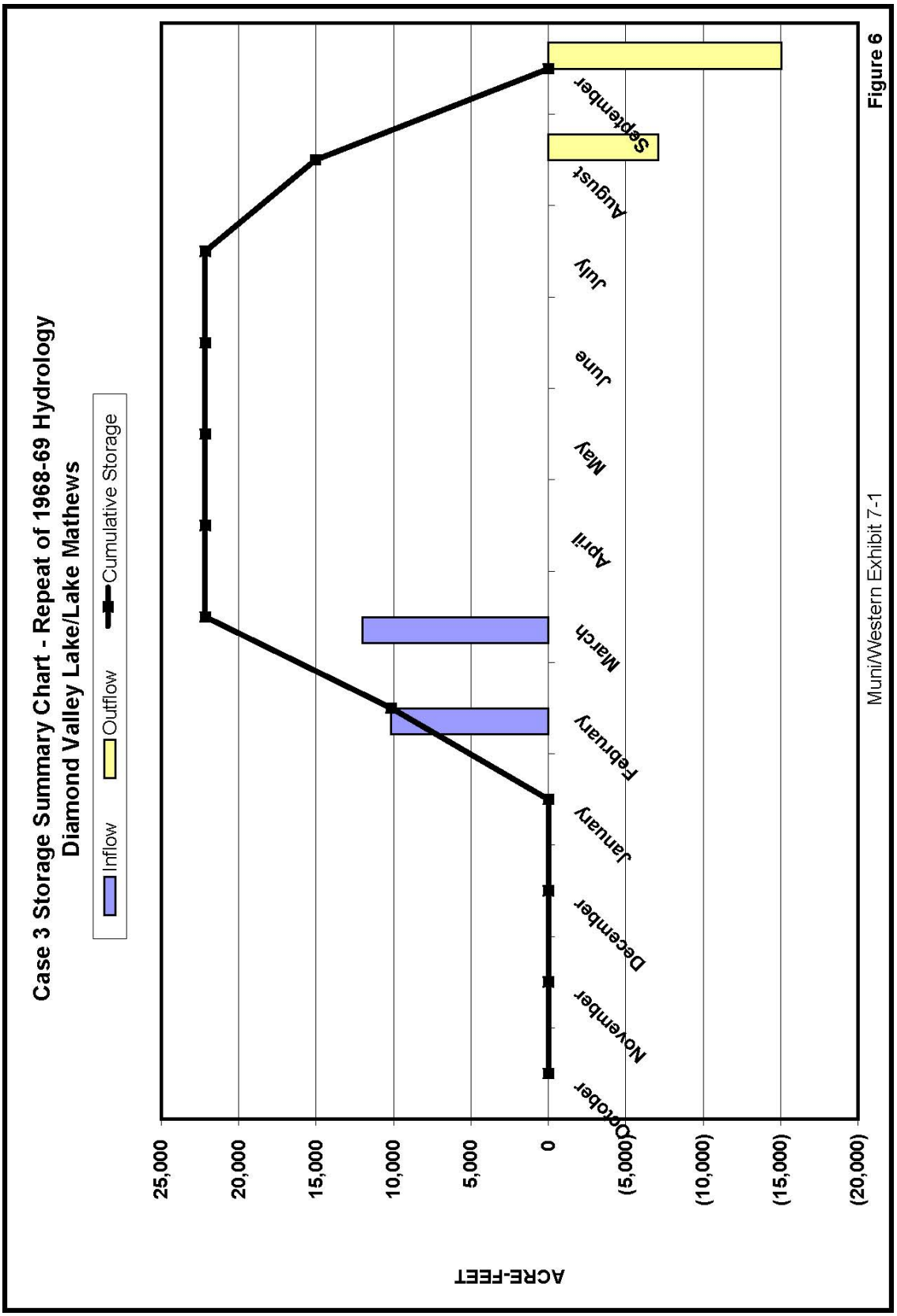
Case 3 Storage Summary Chart - Repeat of 1968-69 Hydrology
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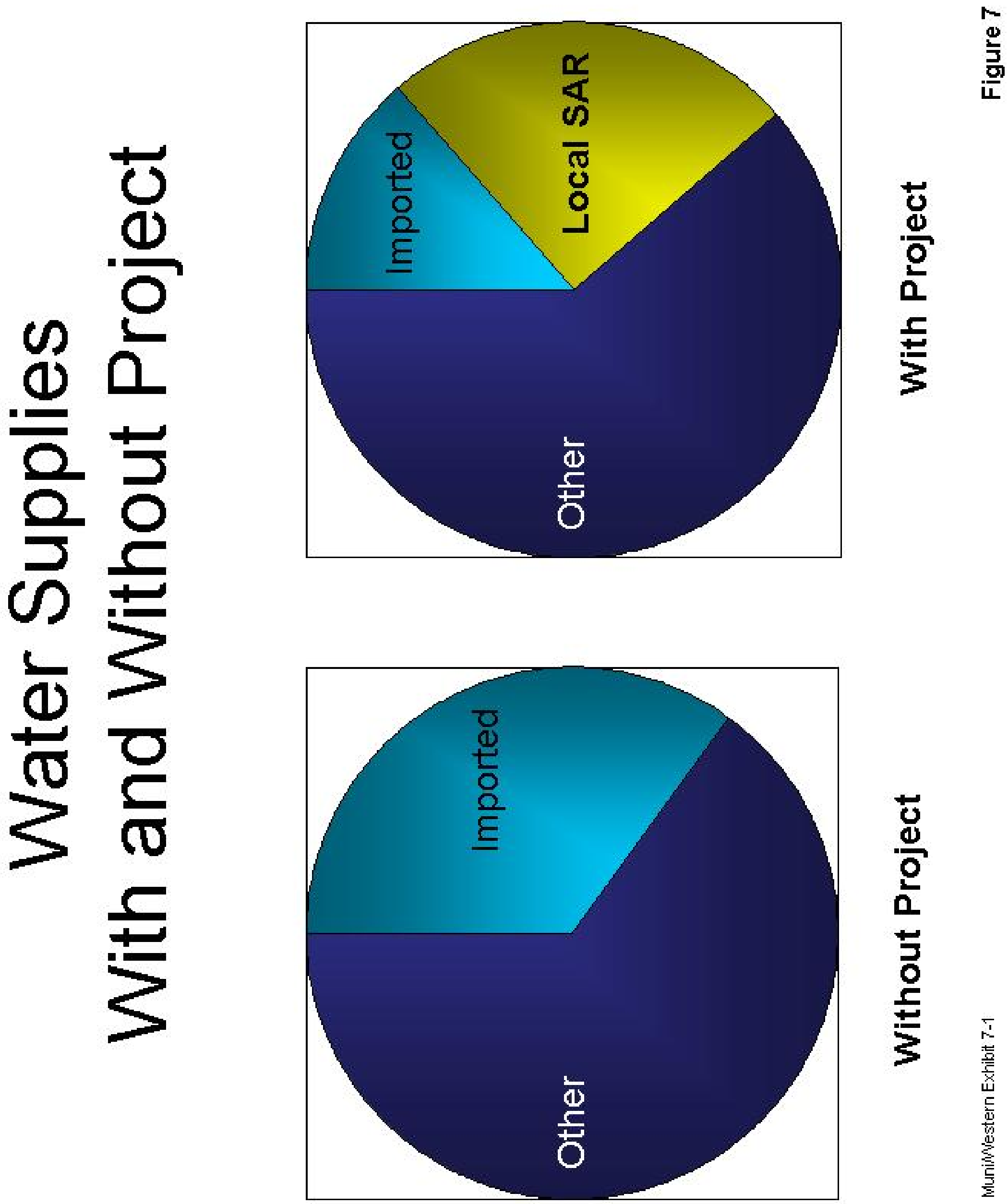
Figure 6


Water Supplies
With and Without Project
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Muni/Western Exhibit 7-1
Figure 7

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)a	)B64e)	a6a(4	)6de)	4	4	)6de)	4	4	4	4	4	4	4	4	4	4	4	4	nad	4
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)e	)46dn4	(d64so	)6de)	4	4	)6de)	4	4	4	4	4	4	4	4	s6ono	4	4	s6ono	B6ee)	4
)d	o6n(B	))6s4d	)6edB	4	4	)6edB	4	4	4	4	4	4	4	4	e6)a4	)64od	4	o6B)d	4	a6oB)
)o	a6d4n	)n6sBa	)6de)	4	4	)6de)	4	4	4	4	4	4	4	4	(6nad	)6de)	4	a6d4n	4	e6Ba4
)n	nda	)o6(aB	nda	(6doo	4	)6de)	4	4	4	4	4	4	4	4	4	nda	4	nda	4	e64a)
B4	(6(eo	))6osa	(6(eo	4	(6s4s	)6edB	4	4	4	4	4	4	4	4	4	4	4	4	4	4
B(	**aVTUMsW**	**aoVWWW**	**MaUnua**	**aLToo**	**aUsms**	**MWUuMW**	**m**	**m**	**m**	**m**	**m**	**m**	**m**	**m**	**aTUuum**	**sUoMu**	**m**	**MUUasu**	**oUsss**	**aTUUaW**
B)																				
BB																				

	p	p	p	p	f p	f f	f P	f j	f	f	f	f	f	f	f	f	f	f	f
(										hV N av		b	h		C	smUmm	7			hV N av u u
)									w		ib				C	l	7			
B											/ b				C	l	7		Up U	
a																V	w	Δ	w w	- l w
s														P		(4d0eBB	(ad0)sa	3Bn0e) (5	MsUTST	(BB6aB4
e																(so6eno	(no6B(n | 3Bn0e) (5	MsUTST	(oa6ans
(4																				
(a																			r	(4d0eBB
(s											3s46t44 5			P 8					r	(4d0eBB
(e	P		r P P	r	r P	r		P 8	Y 7 Y			r				r				
(d	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5				
(o | 3a) 5	3aB5	3aa5	3as5	3ae5	3ad5	3ao5	3an5	3s45											
(n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
)4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
)(	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
))	4	dns	(ao	4	4	(ao	4	4	B6d4s	(s6ao)	4	(s6ao)	4	4	4					
)B	4	sBd	4	4	4	4	4	4	B64B)	) B6Bos	4	Bo6ned	(a6ed)	4	(a6ed)					
)a	4	nad	d4(	4	4	d4(	4	4	a6a(4	4	4	Bo6ned	4	4	(a6ed)					
)s	4	) 6e(a |) 6eBe	4	4	) 6eBe	4	4	((6(eo	4	4	Bo6ned	4	4	(a6ed)					
)e	4	B6ee)	B6en)	4	4	B6en)	4	4	(e64(a	4	4	Bo6ned	4	4	(a6ed)					
)d	4	a6oB)	4	a6od)	4	a6od)	((6dn(	4	o6n(B	4	3((6dn(5	) d64de	4	4	(a6ed)					
)o	4	e6Ba4	4	e6BnB	4	e6BnB	(s6ans	4	a6d4n	4	3(s6ans5	((6so(	4	4	(a6ed)					
)n	4	e64a)	4	) 6ddd	B6B(a	e64n(	((6so(	B6B(a	nda	4	3((6so(5	4	4	3B6B(a5	((6Bso					
B4	a6n4e	a6n4e	4	4	a6nad	a6nad	4	((6Bso	(6(eo	4	4	4	4	3((6Bso5	345					
B(	VtSnr	umu Ts	TuTo	aVtWVM	oUra	MSUVoa	uoubrT	aVtuTM	sVtWSW	uoubrT	QuoubrT1	pV	aVtuTM	QaVtuTM	pV					
B)																				
BB																				

n

	p	f	r	P	j																	
(		w	w		b	h		0	aSrolrS1	L	0a1									hV NM/	a	u
)																						
B																						
a																						
s																						
n																						
(B			(AP f P						) A f f p									BA				
(a																						
(s		P				r r			p	P r 8	f	r r			j r	f	r	r		8 p r	(θ) B
(e		3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5
(d	3(5	3) 5	3B5	3a5	3s5	3e5	3d5	3o5	3n5	3(45	3((5	3( ) 5	3(B5	3(a5	3(s5	3(e5	3(d5	3(o5	3(n5	3) 45	3) (5
(o		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
(n		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
)4	P	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
)(		) s6 ea	Bes	B4d	4	4	4	4	4	(6 44	d44	4	4	4	4	4	4	) 6(s)	Ben	noa	e64dd	
))		as6 noe	Be4	) do	4	4	4	4	4	4	4	4	4	4	4	4	4	(6 naa	BBB	oon	B6o4a	
)B		) n6 ((o	Bno	B4d	4	4	4	4	4	4	4	4	4	o44	o44	) ae	4	) 6(s)	Ben	noa	e64se	
)a	p	B46 sns	ao)	) no	4	4	4	4	4	4	4	4	4	4	4	(sa	4	) 64 oB	Bsd	ns)	a6B) e	
)s		) s6) BB	eB(	B4d	4	4	4	4	4	4	4	4	4	4	4	4	4	) 6(s)	Ben	noa	a6aaB	
)e		(e64 ss	d4d	) no	dda	d(a	) 6Bo4	(oe	4	4	4	4	4	4	4	4	4	) 64 oB	4	4	d6(a)	
)d		( ) 64 od	oB4	B4d	dnn	dBo	) 6ae4	n)	4	4	4	4	4	4	4	4	4	) 6(s)	4	4	d6Bdo	
)o	p	o6Bs)	one	B4d	dnn	dBo	) 6ae4	) e	4	4	4	4	4	4	4	4	4	) 6(s)	4	4	d6Bdo	
)n		s6e) n	dd(	) no	4	4	4	4	4	4	4	4	4	4	4	4	4	) 64 oB	Bsd	ns)	a6ae(	
B4		aSoluaS	sUWWm	MJTmT	MuiTM	MuiSm	TUumm	umW	m	auWmm	Tmm	m	m	omm	omm	Wmm	m	aoUSsu	MuisW	sUTWs	saumrs	
B(	A																					
B)	3(5f	p					p															

					pp	pf	pP	pj	p	p	p	p	p	p	p	p	p	p	p	p
(																			hV N Mv	M u
)																				
B																				
a																				
s																				
n																				
(B															aA		P			
(a																				
(s	V P P	w P	P p	p	p P	p	P P		P		r 7	r 7 7	r 7 P 7	r 7	P P		P		P P 9	
(e	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5
(d	3))5	3)B5	3)a5	3)s5	3)e5	3)d5	3)o5	3)n5	3B45	3B(5	3B)5	3BB5	3Ba5	3Bs5	3Be5	3Bd5	3Bo5	3Bn5	3a45	3a(5
(o	4	(e6(n(	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
(n	4	()6es4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
)4	4	((6no)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
)(	(n6(od	B6d4s	)6de)	4	4	)6de)	naB	4	4	naB	4	4	4	4	4	4	4	4	4	4
))	a)6(o)	B64B)	)6ans	4	4	)6ans	sBd	4	4	sBd	4	4	4	4	4	4	4	4	4	4
)B	)B64e)	a6a(4	)6de)	4	4	)6de)	(6eao	4	4	(6eao	4	4	4	4	4	4	4	4	4	4
)a	)e6)en	()6(do	)6edB	4	4	)6edB	B6eoB	4	4	B6eoB	4	4	4	4	B6)as	4	4	B6)as	)6sdd	4
)s	)46dn4	(d64so	)6de)	4	4	)6de)	B6o4e	4	4	B6o4e	4	4	4	4	s6ono	4	4	s6ono	B6ee)	4
)e	o6n(B	))6s4d	)6edB	4	4	)6edB	B6eoB	4	4	B6eoB	4	4	4	4	)6ssd	4	s6dd4	o6B)d	4	4
)d	a6d4n	)n6sBa	)6de)	4	4	)6de)	(6nad	4	(6osn	B6o4e	4	4	4	4	4	4	a6d4n	a6d4n	4	4
)o	nda	)o6(aB	nda	4	(6doo	)6de)	4	4	B6o4e	B6o4e	4	4	4	4	4	4	nda	nda	4	4
)n	(6(eo	))6osa	(6(eo	4	(6s4s	)6edB	4	4	B6eoB	B6eoB	4	4	4	4	4	4	4	4	4	4
B4	**aWTUWsW**	**aoWWWW**	**MaUhua**	**m**	**uUWSu**	**MWuMW**	**ar UWb**	**m**	**SuUWb**	**MsUsSr**	**m**	**m**	**m**	**m**	**aaUTmm**	**m**	**aaUWsu**	**MuUasu**	**r UWuS**	**m**
B(																				
B)																				

	p	p	p	p	f p	f f	f P	f j	f	f	f	f	f	f	f	f	f	f	f
(										hV NMv		b	h	C	I	7		hV NMv	u u
)									w		ib			C	I	7		Up U	
B															V	w	Δ	w w	- l w
a														P	( )) 6dos	(ad6) sa	3) a6aen5	uTUnSM	(sn6odd
s															(dB6os4	(no6B(n	3) a6aen5	uTUnSM	) (46na)
n																			
(B																		r	( )) 6dos
(a											3s46444 5		P	8				r	( )) 6dos
(s	P		r P P	r	r P	r		8 P	Y 7 Y			r			r				
(e	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5				
(d	3a) 5	3aB5	3aa5	3as5	3ae5	3ad5	3ao5	3an5	3s45										
(o	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
(n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
) 4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
) (	4	4	4	4	4	4	4	4	B6d4s	4	4	4	(s6ao)	4	(s6ao)				
))	4	4	4	4	4	4	4	4	B64B)	4	4	4	s(6(se	4	ee6eBd				
) B	4	4	4	4	4	4	4	4	a6a(4	4	4	4	4	4	ee6eBd				
) a	4	) 6sdd	4	4	4	4	4	4	( ) 6(do	4	4	4	4	4	ee6eBd				
) s	4	B6ee)	nB4	4	4	nB4	4	4	(d64so	4	4	4	4	4	ee6eBd				
) e	a6oB)	a6oB)	4	4	) 6nn)	) 6nn)	4	(B6sna	o6n(B	4	4	4	4	3(B6sna5	sB64aB				
) d	e6Ba4	e6Ba4	4	4	e6BnB	e6BnB	4	(n6B4(	a6d4n	4	4	4	4	3(n6B4(5	BB6da)				
) o	e64a)	e64a)	4	4	e64n(	e64n(	4	(o6d4(	nda	4	4	4	4	3(o6d4(5	(s64a(				
) n	a6n4e	a6n4e	4	4	a6nad	a6nad	4	(s64a(	(6(eo	4	4	4	4	3(s64a(5	4				
B4	**MMaMm**	**MoUusS**	**Sum**	**m**	**MnUWu**	**MaUusu**	**m**	**r r U uT**	**sr UaWT**	**m**	**m**	**p V**	**r r U uT**	**0r r U uT1**	**p V**				
B(																			
B)																			

n

	p	f	r	P	j																
(		w	w		b	h		0	aSrolrS1	L	0a1								hV Nuv	a u	
)																					
B																					
a																					
s																					
n																					
(B			(AP f P						) A f f p									BA				
(a																					
(s		P				r r			p	P r 8	f	r r			j r	f	r	r		8 p r	(θ) B
(e		3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5
(d	3(5	3) 5	3B5	3a5	3s5	3e5	3d5	3o5	3n5	3(45	3((5	3( ) 5	3(B5	3(a5	3(s5	3(e5	3(d5	3(o5	3(n5	3) 45	3) (5
(o		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
(n		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
)4	P	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
)(		) s6 ea	Bes	B4d	4	4	4	4	4	(6 44	d44	4	4	4	4	4	4	) 6 s)	Ben	noa	e64dd
))		as6 noe	Be4	) do	4	4	4	4	4	4	4	4	4	4	4	4	4	(6 naa	BBB	oon	B6o4a
)B		) n6 (o	Bno	B4d	4	4	4	4	4	4	4	4	4	o44	o44	) ae	4	) 6 s)	Ben	noa	e64se
)a	p	B46 sns	ao)	) no	4	4	4	4	4	4	4	4	4	4	4	(sa	4	) 64 oB	Bsd	ns)	a6B) e
)s		) s6 BB	eB(	B4d	4	4	4	4	4	4	4	4	4	4	4	4	4	) 6 s)	Ben	noa	a6aaB
)e		(e64 ss	d4d	) no	dda	d(a	) 6Bo4	(oe	4	4	4	4	4	4	4	4	4	) 64 oB	4	4	d6(a)
)d		( ) 64 od	oB4	B4d	dnn	dBo	) 6ae4	n)	4	4	4	4	4	4	4	4	4	) 6 s)	4	4	d6Bdo
)o	p	o6Bs)	one	B4d	dnn	dBo	) 6ae4	) e	4	4	4	4	4	4	4	4	4	) 6 s)	4	4	d6Bdo
)n		s6e) n	dd(	) no	4	4	4	4	4	4	4	4	4	4	4	4	4	) 64 oB	Bsd	ns)	a6ae(
B4		aSoluaS	sUWm	MJTmT	MuiTM	MuiSm	TuImm	umW	m	auWmm	Tmm	m	m	omm	omm	Wmm	m	aouSsu	MuisW	sUWs	saumrs
B(	A																				
B)	3(5f	p					p														

					pp	pf	pP	pj	p	p	p	p	p	p	p	p	p	p	p	p
(																			hV Nuv	M u
)																				
B																				
a																				
s																				
n																				
(B															aA	P				
(a																				
(s	V P P	w P	P p	p	P p	p	P P		P		r 7	r 7 7	r 7 7 P	r 7	P P		P		P P 9	
(e	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5
(d	3))5	3)B5	3)a5	3)s5	3)e5	3)d5	3)o5	3)n5	3B45	3B(5	3B)5	3BB5	3Ba5	3Bs5	3Be5	3Bd5	3Bo5	3Bn5	3a45	3a(5
(o	4	(e6(n(	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
(n	4	()6es4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
)4	4	((6no)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
)(	(n6(od	B6d4s	)6de)	4	4	)6de)	naB	4	4	naB	4	4	4	4	4	4	4	4	4	4
))	a)6(o)	B64B)	)6ans	4	4	)6ans	sBd	4	4	sBd	4	4	4	4	4	4	4	4	4	4
)B	)B64e)	a6a(4	)6de)	4	4	)6de)	(6eao	4	4	(6eao	4	4	4	4	4	4	4	4	4	4
)a	)e6)en	()6(do	)6edB	4	4	)6edB	B6eoB	4	4	B6eoB	4	4	4	4	B6)as	4	4	B6)as	)6sdd	4
)s	)46dn4	(d64so	)6de)	4	4	)6de)	B6o4e	4	4	B6o4e	4	4	4	4	s6ono	4	4	s6ono	B6ee)	4
)e	o6n(B	))6s4d	)6edB	4	4	)6edB	B6eoB	4	4	B6eoB	4	4	4	4	)6ssd	s6dd4	4	o6B)d	4	a6oB)
)d	a6d4n	)n6sBa	)6de)	4	4	)6de)	(6nad	(6osn	4	B6o4e	4	4	4	4	4	a6d4n	4	a6d4n	4	e6Ba4
)o	nda	)o6(aB	nda	(6doo	4	)6de)	4	B6o4e	4	B6o4e	4	4	4	4	4	nda	4	nda	4	s64(B
)n	(6(eo	))6osa	(6(eo	4	(6s4s	)6edB	4	4	B6eoB	B6eoB	4	4	4	4	4	4	4	4	4	4
B4	**aWTUsW**	**aoWWWW**	**MaUhua**	**aUToo**	**aUsms**	**MWUMW**	**ar UWb**	**sUrs**	**uUou**	**MsUsSr**	**m**	**m**	**m**	**m**	**aaUTmm**	**aaUWsu**	**m**	**MuUasu**	**r UWuS**	**ar Uaos**
B(																				
B)																				

	p	p	p	p	f p	f f	f P	f j	f	f	f	f	f	f	f	f	f	f	f
(										hV N uv		b	h	C	snUmm	7		hV N uv u u	
)									w		ib			C	l	7		Up U	
B															V	w	Δ	w w	- l w
a													P		( )) 6dos	(ad6 sa	3) a6aen5	uTuhSM	(sn6odd
s															(dB66s4	(no6B(n	3) a6aen5	uTuhSM	) (46na)
n																			
(B																		r	( )) 6dos
(a											3s46t44 5		P 8					r	( )) 6dos
(s	P		r P P	r	r P	r		P 8	Y 7 Y			r			r				
(e	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5	3p 5				
(d	3a) 5	3aB5	3aa5	3as5	3ae5	3ad5	3ao5	3an5	3s45										
(o	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
(n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
)4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4				
)(	4	4	4	4	4	4	4	4	B6d4s	(s6ao)	4	(s6ao)	4	4	4				
))	4	4	4	4	4	4	4	4	B64B)	) o6nns	4	aa6ade	(46(se	4	(46(se				
) B	4	4	4	4	4	4	4	4	a6a(4	4	4	aa6ade	( ) 644e	4	)) 6(e(				
) a	4	) 6sdd	4	4	4	4	4	4	( ) 6(do	4	4	aa6ade	4	4	)) 6(e(				
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) e	4	a6oB)	4	) 6nn)	4	) 6nn)	(B6sna	4	o6n(B	4	3(B6sna5	B46oo)	4	4	)) 6(e(				
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B4	slUsus	MbulsS	Sum	Sulos	aaluhuo	Maulisu	VWWTr	MMdra	srdaVT	VWWTr	OVWWTr1	pV	MMdra	OVMdra1	pV				
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