

Appendix A - Relative Cost Comparison

For comparison purposes at this level of analysis, the following unit costs were used in developing opinions of probable costs. All costs shown include construction costs + “soft costs” (permitting, engineering, construction management) and a contingency.

Description	Unit	Probable Cost per Unit
Capital Costs		
Pipe Lines - no paving		
18" PVC Water Main - no paving	mile	\$ 1,490,000
24" PVC Water Main - no paving	mile	\$ 1,610,000
36" PVC Water Main - no paving	mile	\$ 1,840,000
Pipe Lines - with paving		
8" PVC Water Main - with paving	mile	\$ 1,350,000
18" PVC Water Main - with paving	mile	\$ 1,860,000
20" PVC Water Main - with paving	mile	\$ 1,910,000
24" PVC Water Main - with paving	mile	\$ 2,010,000
Pipe Crossings		
Pipe river crossing, trenched installation - 24" diameter pipe	feet	\$ 1,020
Pipe river crossing, HDD installation - 24" diameter pipe	feet	\$ 2,775
Pump Stations		
Pump Station, 2.7 MGD (3,000 AFY)	each	\$ 810,000
Pump Station, 5.7 MGD (6,300 AFY)	each	\$ 1,700,000
Storage		
Tank, Site Improvements and Appurtances	gallon	\$ 2.00
Connections		
Inteconnection Facility, 2.7 MGD	each	\$ 15,000
Inteconnection Facility, 5.7 MGD	each	\$ 30,000
CCWA Turnout	each	\$ 500,000
Intake/Discharge Structures		
Well, 0.89 MGD	each	\$ 175,000
Ocean Outfall, 2.7 MGD	each	\$ 18,900,000
Ocean Outfall, 5.7 MGD	each	\$ 21,500,000
Percolation Basin improvements (no land cost)	acre	\$ 100,000
Treatment Facilities		
Reverse Osmosis Plant, Stand Alone, 2.7 MGD (3,000 AFY)	each	\$ 15,800,000
Reverse Osmosis Plant, Stand Alone, 5.7 MGD (6,300 AFY)	each	\$ 23,000,000

Description	Unit	Probable Cost per Unit
Enlarge planned 2MGD SSLOCSD facility by 2.7 MGD	LS	\$ 12,000,000
Enlarge planned 2MGD SSLOCSD facility by 5.7 MGD	LS	\$ 18,000,000
Chloramination Facilities at existing NCSD wells	LS	\$ 1,100,000
Clorine Contact Treatment at Southland WWTP	each	\$ 2,319,000
Coag/Filt Plant, 2.7 MGD (1800 gpm) (3,000 AFY)	each	\$ 3,900,000
Coag/Filt Plant, 5.7 MGD (3900 gpm) (6,300 AFY)	each	\$ 7,800,000

O&M Costs

Electricity	kWh	\$ 0.13
Reverse Osmosis Plant, Stand Alone, 2.7 MGD (3,000 AFY)	acre-feet	\$ 1,200
Reverse Osmosis Plant, Stand Alone, 5.7 MGD (6,300 AFY)	acre-feet	\$ 1,100
Coagulation and Filtration Treatment Cost	acre-feet	\$ 200
Chloramination Treatment Costs	acre-feet	\$ 20

Appendix B – Hydrogeology Constraints Analyses

SAIC, Inc., Technical Memoranda:

June 1, 2007, Yield of State Water Project water for Central Coast Water Authority and San Luis Obispo County

June 1, 2007, Yield of Aquifer Storage and Recovery

June 5, 2007, Santa Maria River Underflow



1 **TECHNICAL MEMORANDUM**

2 **TO: Mike Nunely**

3 **FROM: Brad Newton**

4 **RE: Questions 1-6: Yield of State Water Project water for Central Coast Water**
5 **Authority and San Luis Obispo County,**
6 **SAIC Project Number: 01-0236-00-9785**

7 **DATE: June 1, 2007**

8 **INTRODUCTION**

9 On February 13, 2007, SAIC entered into a contractual agreement with Boyle Engineering
10 Corporation (Boyle) to provide hydrogeologic services related to evaluating alternative water
11 supplies to Nipomo Community Services District (the District). The District's Board would like
12 to assess, as an alternative water supply, the availability of State Water Project (SWP) water for
13 purchase or an exchange to be conveyed through the SWP pipeline. Subsequently, Boyle
14 requested SAIC address specific questions contained in a memorandum dated May 9, 2007.
15 Provided below and in the attachments hereto is a preliminary assessment of SWP water
16 deliveries based on historical hydrology and Table A amounts for the Central Coast Water
17 Authority (CCWA) and San Luis Obispo County (SLO).

18 **RESULTS**

19 The following are the questions Boyle presented regarding the yield of the State Water
20 Project water:

- 21 1. Based on past experience, what is the probability distribution of water available to
- 22 CCWA? (e.g., "There is an X% probability that during any year available water will
- 23 exceed YY acre feet.);
- 24 2. How much water will be available to CCWA annually on a long-term average basis?;
- 25 3. How much will be available in "wet" years?;
- 26 4. How much will be available in "dry" years?;
- 27 5. Same questions for the San Luis Obispo County SWP entitlement.

28 The following two sections present the answers to these questions regarding the Central
29 Coast Water Authority, and the County of San Luis Obispo.

30 **Yield of State Water Project for the Central Coast Water Authority (CCWA)**

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TO: Boyle Engineering Corporation
RE: Yield of State Water Project water for CCWA and SLO
DATE: May 22, 2007
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1 The CCWA State Water Project Table A amount is 45,486 acre-feet per year (AFY). On a
2 long-term average basis roughly 34,500 AFY of SWP water is available to the CCWA (Table 1).
3 In a "wet" year about 43,500 acre-feet (AF) of SWP water is available and in a "dry" year about
4 29,500 AF of SWP water is available to the CCWA (Table 1). There is a 50% probability that
5 during any year available SWP water will exceed 38,000 AF (Figure 1).

6 **Yield of State Water Project for San Luis Obispo County (SLO)**

7 The SLO State Water Project Table A amount is 25,000 AFY. On a long-term average
8 basis roughly 19,000 AFY of SWP water is available to SLO (Table 2). In a "wet" year about
9 24,000 AF of SWP water is available and in a "dry" year about 16,500 AF of SWP water is
10 available to SLO (Table 2). There is a 50% probability that during any year available SWP water
11 will exceed 21,000 AF (Figure 2).

12 **METHODOLOGY**

13 The Table A amounts for the Central Coast Water Authority (45,486 AFY) and San Luis
14 Obispo County (25,000 AFY) are based on the SWP Delivery Reliability Report (DWR, 2005).
15 The hydrologic water year type classification is based on the California Department of Water
16 Resources Sacramento Valley index (DWR, 2005). The simulated delivery as a percentage
17 (Column 3 in Tables 1 and 2) for Water Year 1922 through Water Year 1994 is based on Table B-
18 7 of the SWP Delivery Reliability Report (DWR, 2005). The simulated delivery in acre-feet
19 (Column 4 in Tables 1 and 2) is computed by multiplying the simulated delivery as a percentage
20 (Column 3 in Tables 1 and 2) with the Table A amount of 45,486 AFY for the CCWA and 25,000
21 AFY for SLO. The long-term average delivery is the average of simulated deliveries (as a
22 percentage) over the period from Water Year 1922 through Water Year 1994. The "dry" year
23 and "wet" year delivery is the average of the deliveries made in each respective hydrologic year
24 types. The probability distribution figures of SWP Delivery to CCWA and SLO are based on the
25 simulated deliveries in acre-feet (Column 4 in Tables 1 and 2).

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Table 1. Estimated SWP Deliveries to CCWA (Water Years 1922-1994)

Year of Simulation (Water Year) 1	Hydrologic Year Type 2	Simulated Delivery (% of Full Table A) 3	Simulated Delivery to CCWA (Acre-Feet) 4
1922	AN	98%	44,576
1923	BN	89%	40,483
1924	C	24%	10,917
1925	D	35%	15,920
1926	D	69%	31,385
1927	W	98%	44,576
1928	AN	79%	35,934
1929	C	26%	11,826
1930	D	66%	30,021
1931	C	28%	11,826
1932	D	45%	20,469
1933	C	48%	21,833
1934	C	38%	17,285
1935	BN	90%	40,937
1936	BN	89%	40,483
1937	BN	77%	35,024
1938	W	100%	45,486
1939	D	83%	37,753
1940	AN	96%	43,667
1941	W	99%	45,031
1942	W	100%	45,486
1943	W	87%	39,573
1944	D	84%	38,208
1945	BN	88%	39,118
1946	BN	92%	41,847
1947	D	63%	28,656
1948	BN	63%	28,656
1949	D	64%	29,111
1950	BN	70%	31,840
1951	AN	97%	44,121
1952	W	100%	45,486
1953	W	95%	43,212
1954	AN	93%	42,302
1955	D	43%	19,559
1956	W	100%	45,486
1957	AN	74%	33,660
1958	W	98%	44,576
1959	BN	84%	38,208
1960	D	49%	22,288
1961	D	68%	30,930
1962	BN	76%	34,569
1963	W	98%	44,576
1964	D	74%	33,660
1965	W	78%	35,479
1966	BN	93%	42,302
1967	W	98%	44,576
1968	BN	87%	39,573
1969	W	99%	45,031
1970	W	95%	43,212
1971	W	99%	45,031
1972	BN	66%	30,021
1973	AN	89%	40,483
1974	W	100%	45,486
1975	W	99%	45,031
1976	C	67%	30,476
1977	C	20%	9,097
1978	AN	95%	43,212
1979	BN	85%	38,663
1980	AN	84%	38,208
1981	D	82%	37,299
1982	W	100%	45,486
1983	W	100%	45,486
1984	W	99%	45,031
1985	D	80%	36,389
1986	W	73%	33,205
1987	D	69%	31,385
1988	C	24%	10,917
1989	D	70%	31,840
1990	C	28%	12,736
1991	C	24%	10,917
1992	C	28%	12,736
1993	AN	97%	44,121
1994	C	74%	33,660
Long-term Average (1922-1994)		76%	34,488
Sacramento Valley Water Year Hydrologic Classification:		Average Simulated Delivery for Year Type Water Years 1922 through 1994 (% of Full Table A)	Average Simulated Delivery for Year Type Water years 1922 through 1994 (Acre-feet)
W	Wet year type	96%	43,645
AN	Above normal year type	90%	41,028
BN	Below normal year type	82%	37,266
D	Dry year type	65%	29,680
C	Critical year type	36%	16,185

Figure 1 - Probability of SWP Delivery - CCWA

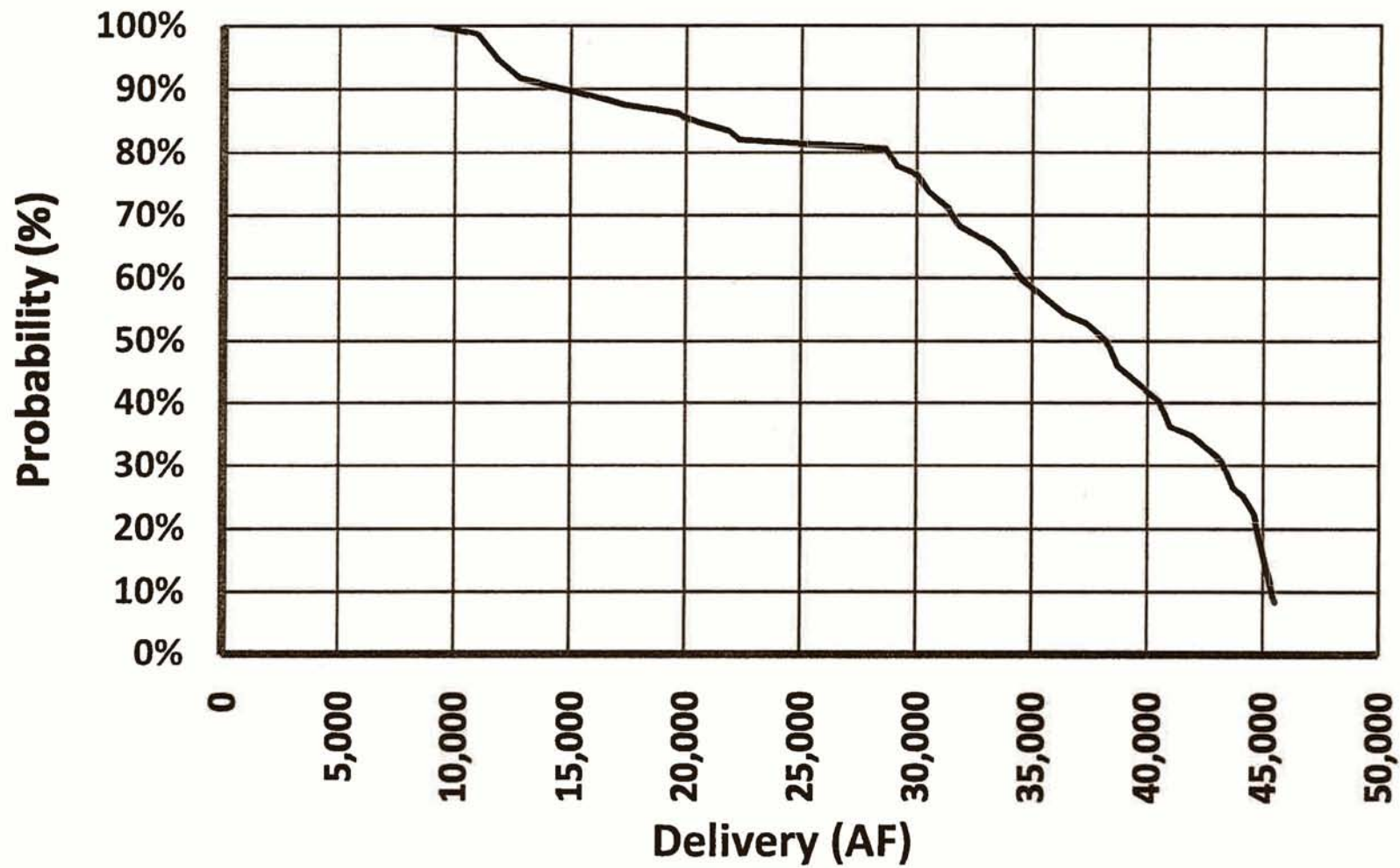
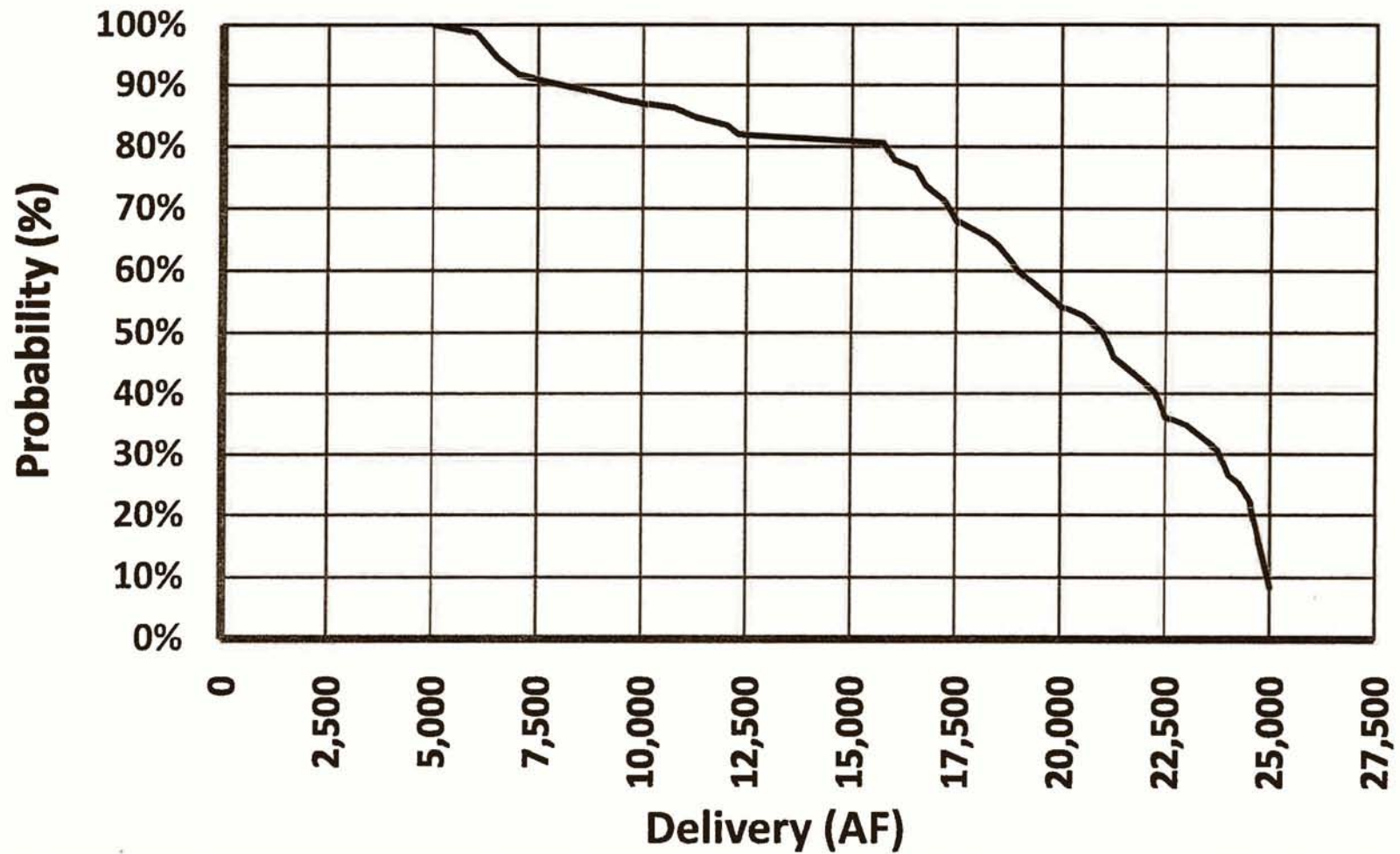


Table 2. Estimated SWP Deliveries to SLO (Water Years 1922-1994)

Year of Simulation (Water Year) 1	Hydrologic Year Type 2	Simulated Delivery (% of Full Table A) 3	Simulated Delivery to SLO (Acre-Foot) 4
1922	AN	98%	24,500
1923	BN	89%	22,250
1924	C	24%	8,000
1925	D	35%	8,750
1926	D	69%	17,250
1927	W	98%	24,500
1928	AN	79%	19,750
1929	C	26%	8,500
1930	D	66%	16,500
1931	C	26%	8,500
1932	D	45%	11,250
1933	C	48%	12,000
1934	C	38%	9,500
1935	BN	90%	22,500
1936	BN	89%	22,250
1937	BN	77%	19,250
1938	W	100%	25,000
1939	D	83%	20,750
1940	AN	96%	24,000
1941	W	99%	24,750
1942	W	100%	25,000
1943	W	87%	21,750
1944	D	84%	21,000
1945	BN	86%	21,500
1946	BN	92%	23,000
1947	D	63%	15,750
1948	BN	63%	15,750
1949	D	64%	16,000
1950	BN	70%	17,500
1951	AN	97%	24,250
1952	W	100%	25,000
1953	W	95%	23,750
1954	AN	93%	23,250
1955	D	43%	10,750
1956	W	100%	25,000
1957	AN	74%	18,500
1958	W	98%	24,500
1959	BN	84%	21,000
1960	D	49%	12,250
1961	D	68%	17,000
1962	BN	76%	19,000
1963	W	98%	24,500
1964	D	74%	18,500
1965	W	78%	19,500
1966	BN	93%	23,250
1967	W	98%	24,500
1968	BN	87%	21,750
1969	W	99%	24,750
1970	W	95%	23,750
1971	W	99%	24,750
1972	BN	66%	16,500
1973	AN	89%	22,250
1974	W	100%	25,000
1975	W	99%	24,750
1976	C	67%	16,750
1977	C	20%	5,000
1978	AN	95%	23,750
1979	BN	85%	21,250
1980	AN	84%	21,000
1981	D	82%	20,500
1982	W	100%	25,000
1983	W	100%	25,000
1984	W	99%	24,750
1985	D	80%	20,000
1986	W	73%	18,250
1987	D	69%	17,250
1988	C	24%	8,000
1989	D	70%	17,500
1990	C	28%	7,000
1991	C	24%	8,000
1992	C	28%	7,000
1993	AN	97%	24,250
1994	C	74%	18,500
Long-term Average (1922-1994)		76%	18,955
Sacramento Valley Water Year Hydrologic Classification:		Average Simulated Delivery for Year Type Water Years 1922 through 1994 (% of Full Table A)	Average Simulated Delivery for Year Type Water years 1922 through 1994 (Acre-feet)
W	Wet year type	96%	23,988
AN	Above normal year type	90%	22,550
BN	Below normal year type	82%	20,482
D	Dry year type	65%	16,313
C	Critical year type	36%	8,896

Figure 2 - Probability of SWP Delivery - SLO



TO: Mike Nunely
RE: Yield of Aquifer Storage and Recovery
DATE: May 31, 2007
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1 Canyon supports the interpretation that a confining layer exists from the coastal dunes to the
2 east of the canyon head. Drilling logs and well casing records also support the presence of
3 confining layer from the western area of municipal production to Omiya well where the
4 confining layer abruptly thins. Additional drilling logs and casing records would be needed to
5 strengthen the confidence of the presence and extent of a regional confining layer in the western
6 half of the NMMA.

7 The proposed conceptual model of the hydrogeology within the NMMA is preliminary
8 and may be changed upon reviewing additional data. For the purposes of this constraints
9 analysis, and foregoing any additional data review, the proposed conceptual model provides
10 the context for evaluating the following questions presented in the Boyle memorandum dated
11 May 9, 2007.

12 **RESULTS**

13 12. How will the use of aquifer storage and recovery change the answers to the previous
14 questions 1-5?

15 The available space of groundwater storage in the aquifer (approximately 400,000 acre-feet
16 [AF]) is sufficient to accommodate the volume of water obtainable from the SWP to meet the
17 District's target additional maximum supply of 6,300 acre-feet per year (AFY). Therefore,
18 the answers to question 1-5 would not change.

19 13. How much water can be stored in the aquifer underlying the NMMA?

20 The aquifer underlying the NMMA has an estimated available storage of 400,000 AF above
21 sea level. However, the proposed conceptual model of the hydrogeology constrains the
22 available area for storage capacity to approximately one-quarter of the total 20,000 acres on
23 NMMA as the target recharge area. This target area is bound by the confining layer to the
24 west, the Black Lake Canyon to the north, the topographic boundary to the south, and the
25 Santa Maria River Fault trace to the east, although little is known regarding lateral flow
26 across the fault. The storage of 6,300 AF of water within 5,000 acres area would likely cause
27 an increase in the groundwater surface elevation by approximately 10 feet over the 5,000
28 acres.

29 14. Where are the best places to locate percolation/aquifer storage facilities?

30 The proposed preliminary target area is east of Omiya well, southwest of Santa Maria Fault,
31 and north of the mesa topographic boundary. The ideal location of recharge ponds will be
32 places with high percolation rates and no confining layer or low hydraulic conductivity
33 zones at depth. The proposed preliminary target area is bound by the confining layer to the
34 west, the Black Lake Canyon to the north, the topographic boundary to the south, and the
35 Santa Maria River Fault trace to the east.

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1 15. If percolation ponds are used, what area would be required?

2 Based on a typical percolation rate of 6 inches per day, approximately 50 acres of ponds
3 would be required to recharge 6,300 AFY.

4 16. How many new wells would be needed to recapture the stored water?

5 Based on wells currently operated by the Nipomo Community Services District (NCSD) five
6 extraction wells with a production rate of 800 gallons per minute (gpm) would be required
7 to capture 6,300 AFY of water.

8 17. Where should these wells be installed (location and depth)?

9 We recommend locating the wells east of Highway 1, south of the Black Lake Canyon, west
10 of Santa Maria River Fault, and north of the Woodlands development. This general area
11 will distribute pumping across the NMMA providing for a more even access to the water
12 resource. These wells should be screened in zones that produce large volumes of high
13 quality water, likely within the Paso Robles Formation.

14 **DISCUSSION**

15 The Paso Robles Formation is overlain by dune sands and younger alluvium, and overlies
16 the Careaga Formation, an accumulation of unconsolidated to well-consolidated, shallow-water
17 marine sands. The Paso Robles Formation is highly variable in color and texture, ranging from
18 gavel and clay, sand and clay, gravel and sand, silt and clay. Most of it is fluvial in origin and
19 in most places correlation between individual beds is not possible. The Careaga Formation is
20 the lower most fresh water bearing formation and water quality is typically poor.

21 Identifying potential recharge sites on the Nipomo Mesa is contingent upon
22 understanding the geology, the available land for recharge facilities construction, and the
23 existing conveyance facilities or the need for new facility construction. The geologic conditions
24 specific to recharge site identification on the Nipomo Mesa is poorly documented; however,
25 anecdotal information, a few well logs, and existing reports have been reviewed and
26 summarized herein to provide the basis for our current understanding. In general, recharge
27 facilities are constructed over sediments where no confining layer exists in an effort to
28 maximize percolation and therefore recharge to the groundwater aquifer. Set forth below is the
29 summary of document reviews, geologic and topographic map evaluations, site visits, and well
30 logs which indicates the likelihood of a confining layer and location of its inland margin.

31 Black Lake Canyon is an east-west trending topographic feature resulting from the erosion
32 and transport of unconsolidated sand dune sediments westward to the active dune complex at
33 the ocean. No river exists upstream of the canyon head, and the local surface drainage area at
34 the canyon head is small. Surface water exists along much of the length in the canyon bottom
35 and a terminal lake exists at the canyon mouth in the margin of the active beach dune complex.

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1 No existing reports reviewed during this investigation explained the occurrence or physical
2 processes that created the Black Lake Canyon. However, fine-grained layers in the upper
3 portion of the Paso Robles Formation beneath dune sands are reported to function as a perching
4 layer, and that some of the shallow groundwater that percolates downward within the
5 permeable Nipomo Mesa dune sands is diverted laterally along these low-permeability layers
6 and discharges into Black Lake Canyon and supports Black Lake and other systems of coastal
7 drainages and lakes west of Nipomo Mesa (Papadopolas & Associates, 2004). While not
8 specifically inferred in these reports, the laterally diverted perched shallow groundwater
9 emerging at the ground surface can cause seepage erosion and over time develop a channel
10 head which is likely to migrate up stream. This mechanism may explain the existence of Black
11 Lake Canyon, and substantiate the occurrence of a confining layer above the principle
12 production aquifer.

13 Santa Maria Valley Water Conservation District releases water stored in Twitchell
14 Reservoir to enhance groundwater recharge by optimizing percolation to the principle
15 production aquifer under the Santa Maria River. Reservoir water is released when there is no
16 water flowing in the Sisquoc River as reported at the gage near Garey. Reservoir water is
17 released at a steady flow rate, typically 300 cubic feet per second (cfs), to maximize
18 groundwater recharge. This flow rate maintains a wetted reach up to but not beyond the Bonita
19 School Road crossing. Anecdotal information suggests that a wetted reach beyond the crossing
20 does not promote groundwater recharge to the principle aquifer because of the occurrence of
21 confining layers at depth.

22 Drilling logs and well casing documentation may improve the understanding of the
23 subsurface geology. The District provided this information for seven District production wells
24 (Figure 1). Drilling logs were evaluated and correlations were made between well locations in
25 order to identify the existence of a confining layer or sequence of layers. Well completion data
26 documents the depth of the screened interval which is presumably located within the Paso
27 Robles Formation (Table 1). General trends in the lithologies of each drilling log and the
28 position of the screened interval were noted. The occurrence of a sequence of layers with a
29 greater proportion of clay was identified and is interpreted as a confining sequence (Figure 2).
30 The east-west transect of production well log data describes the presence of a confining layer
31 directly above the screened interval in each well, however, the thickness of the confining
32 sequence abruptly thins between the Omiya and Olympic wells. The occurrence of a thin clay
33 layer at the Olympic well may indicate the eastern margin location of the regional confining
34 layer that extends westerly to the ocean.

35 Drilling logs record the total drilling depth and a description of the lithology. All logs
36 report that drilling ceased upon drilling into a blue clay lithology. This lithology is interpreted
37 as the Franciscan Formation. Well casing is generally installed to total depth with the screened

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1 interval at bottom, directly above the Franciscan Formation. The elevation of the top of the
2 Franciscan Formation is 100 feet lower on the west side of the Oceano Fault relative to the east
3 side (Figure 2). The Sundale well is more consistent with the geology west of the Oceano Fault
4 than the geology on the east side of the fault. Reviewing additional drilling logs and casing
5 records may improve the understanding of the vertical offset along the Oceano Fault.

6 The principle production aquifer under the NMMA has an estimated total storage
7 capacity 500,000 AF of groundwater above sea level (DRW, 2002). Currently, generally 90,000
8 AF (SAIC, 2007) of water is stored above sea level in the aquifer. Therefore, approximately
9 400,000 AF of groundwater storage is available in the Nipomo Mesa groundwater basin. The
10 district currently is interested in obtaining at most 6,300 AFY of supplemental water from an
11 alternative water supply. Based on these estimates, there is sufficient available storage to
12 accommodate the 6,300 AFY of supplemental water supply.

13 The Southland Wastewater Treatment Facility (WWTF) operated 3 recharge basins
14 covering 2.8 acres during the period of 1988 to 1992. The aggregate percolation during this 5
15 year period was 760 AFY (Lawrance, 1993). This is equivalent to 53.6 AFY per acre or 1.8 inches
16 per day per acre. This includes rotation of the ponds between filling, percolating and drying.
17 Typical long-term percolation rates are on the order of 6 inches per day. It is reasonable to
18 expect effective percolation rates for a recharge facility to be less when considering pond
19 rotations for drying and maintenance, typically 2 of 3 ponds are wet at any time.
20 Approximately 50 acres of recharge ponds would be required in order to bank 6,300 AFY.
21 However, this is programmatically less efficient than to firstly utilize the 6,300 AFY of water in
22 direct deliveries, while reducing pumpage, then secondly, to recharge the un-deliverable water
23 in percolation ponds.

24 The number of wells needed to capture this volume of water can be estimated from
25 current production data. The three most productive wells operated by the NCSD are the
26 Eureka Well, Sundale Well and the Via Choncha Well. The respective capacity of these wells is
27 850 gpm, 1000 gpm and 700 gpm (Boyle 2002). Assuming an average capacity per well of 850
28 gpm, it is expected that a properly install production well will produce 1370 AFY. This value
29 takes into account normal well operations such as downtime and maintenance. It is assumed
30 that similar pumping operations would be implemented. To capture 6,300 AFY of water would
31 require approximately 5 wells.

32 Geologic features present in the basin will dictate the optimal locations for new
33 extraction wells. The wells should be located seaward of the recharge areas with sufficient
34 distance to allow for mixing and natural filtration of the recharged water. However, wells
35 should be placed far enough away from the coast to avoid causing seawater intrusion. We
36 recommend locating the wells in areas where little pumping currently exists, east of Highway 1,

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1 south of the Black Lake Canyon, west of Santa Maria River Fault, and north of the Woodlands
2 development. This general area will distribute pumping across the NMMA providing for a
3 more even access to the water resource. These wells should be screened in zones that produce
4 large volumes of high quality water, likely within the Paso Robles Formation.

5

6 **REFERENCES:**

7 Boyle Engineering Corporation, (Boyle, 2002), Water and Sewer System Master Plan 2001,
8 prepared for Nipomo Community Services District, update, March 2002.

9 Department of Water Resources, (DWR, 2002), Water Resources of the Arroyo Grande -
10 Nipomo Mesa Area, 2002.

11 Lawrance, Fisk & McFarland, INC., (Lawrance, 1993), Engineering Considerations of
12 Groundwater Yields and Rights on the Nipomo Mesa Sub-Area, San Luis Obispo,
13 California, October 20, 1993.

14 Science Application International Corporation, (SAIC, 2007), Technical Memorandum #4
15 Update to Groundwater in Storage NMMA, May 23, 2007.

16 S.S. Papadopolas & Associates, INC., (Papadopoulos et al. 2004), Nipomo Mesa Groundwater
17 Resources Capacity Study, San Luis Obispo County, California, prepared for the County of
18 San Luis Obispo, 2004.

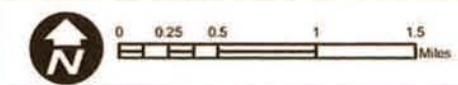
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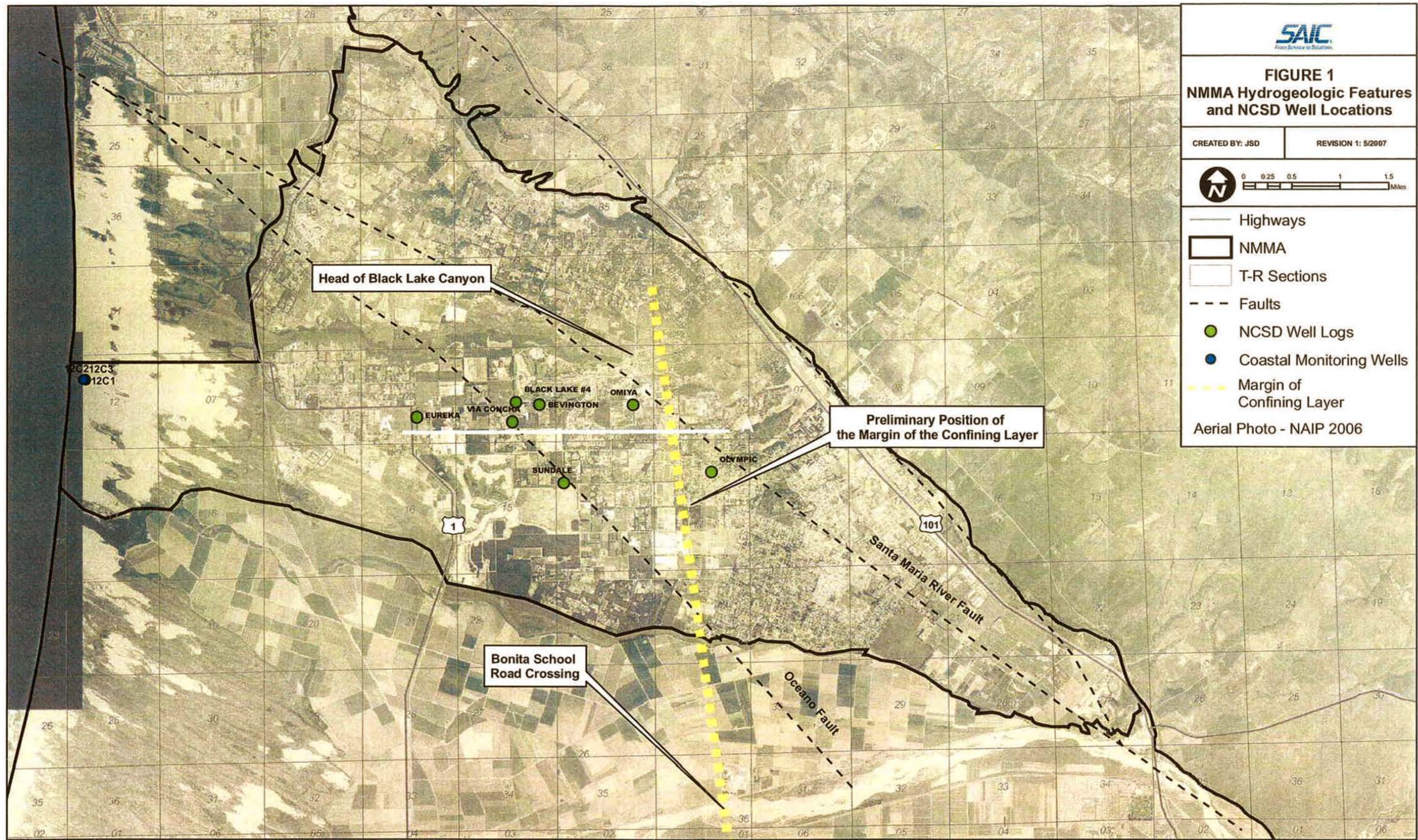
FIGURE 1
NMMA Hydrogeologic Features
and NCSW Well Locations

CREATED BY: JSD

REVISION 1: 5/2007



- Highways
 - ▭ NMMA
 - ▭ T-R Sections
 - - - Faults
 - NCSW Well Logs
 - Coastal Monitoring Wells
 - - - Margin of Confining Layer
- Aerial Photo - NAIP 2006



Well Completion Table

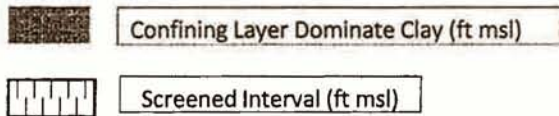
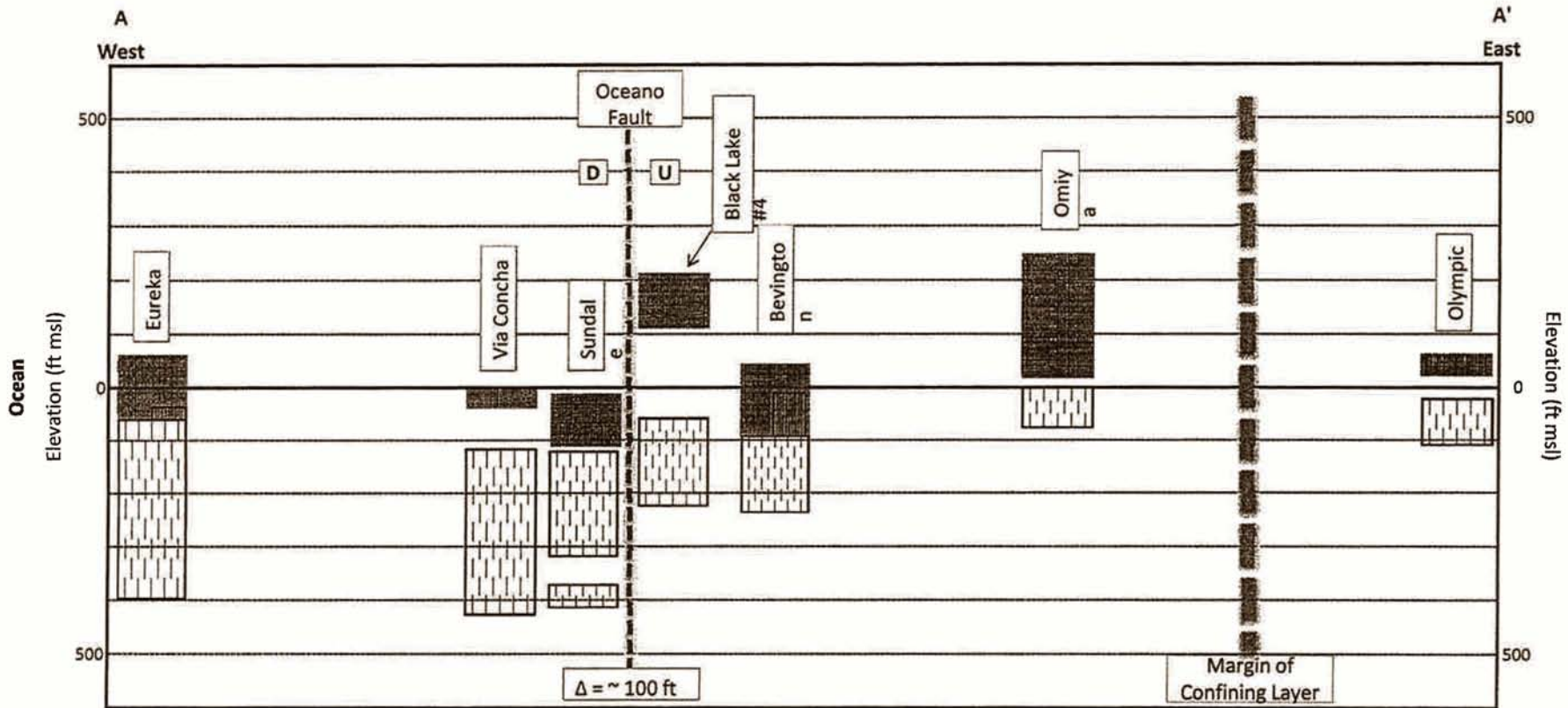
Nipomo Mesa Management Area

Well ID	Latitude	Longitude	Ground Surface Elevation (ft msl)	Total Depth (ft msl)	Screen (ft msl)		Screen Interval (ft)	Comments		
					Top	Bottom		Confining Layer (ft msl)		Confining Layer Interval (ft)
								Top	Bottom	
Eureka 11N35W09K05	35° 02' 44.20"	120° 34' 04.93"	174	-546	-46	-401	355	31	-71	102
Via Concha 11N35W10L01S	35° 02' 40.61"	120° 33' 02.26"	264	-464	-126	-426	300	-4	-54	50
Sundale 11N35W15H01S	35° 02' 07.01"	120° 32' 29.11"	251	-459	-129	-329	200	-19	-119	100
					-379	-419	40			
Black Lake #4	35° 02' 51.19"	120° 32' 59.53"	301	-299	-59	-219	160	207	111	96
Bevington #2 11N35W10J02S	35° 02' 49.57"	120° 32' 43.93"	317	-329	-13	-253	240	47	-93	140
Omiya #2 11N35W11J02S	35° 02' 11.17"	120° 30' 52.05"	390	-260	0	-75	75	255	10	245
Olympic 11N35W13G01S	35° 02' 48.30"	120° 31' 42.57"	346	-129	-19	-109	90	46	28	18

Notes:

Information based on review of driller logs provided by NCSD

Hydrogeology of Nipomo Mesa Mangement Area Conceptual Model



Note:
All well data is projected to line (Figure 1)

SAIC
From Science to Solutions

**FIGURE 2
DRAFT**



1 **TECHNICAL MEMORANDUM**

2 **TO:** Mike Nunley
3 **FROM:** Nivan Bhuta, Brad Newton
4 **RE:** Response to Boyle Engineering Questions 6-11 - Santa Maria River Underflow
5 SAIC Project Number: 01-0236-00-9785
6 **DATE:** June 5, 2007

7 **INTRODUCTION**

8 On February 13, 2007, SAIC entered a contractual agreement with Boyle Engineering
9 Corporation (Boyle) to provide hydrogeologic services related to evaluating alternative water
10 supplies to Nipomo Community Services District (the District). The District's Board requested
11 an assessment of the Santa Maria River underflow as an alternative water supply.
12 Subsequently, Boyle requested SAIC address specific questions contained in a memorandum
13 dated May 9, 2007. Provided below is a preliminary assessment of Santa Maria River underflow
14 and Santa Maria groundwater basin characteristics.

15 **FINDINGS**

16 Santa Maria River underflow recharges the Santa Maria groundwater basin. The Santa
17 Maria groundwater basin is currently undergoing adjudication. The District must enter into an
18 agreement with the parties entitled to receive water from the Santa Maria groundwater basin in
19 order to obtain additional water supply from Santa Maria River underflow.

20 **RESULTS**

21 6. What are the typical depths to groundwater and the range of depths observed in the
22 relevant record?

23 Data showing the depth to groundwater and range of depths to groundwater are not
24 available for Santa Maria River underflow. The average depth to groundwater for the entire
25 basin is 281 feet (ft) with a range of 16 ft to 1,220 ft based on domestic wells (DWR, 2002).

26 7. What is the quantity of water available?

27 The quantity of Santa Maria River underflow is not known. Estimates of annual
28 streamflow loss for the Santa Maria River are provided in question number 10. As indicated in
29 the Santa Maria Groundwater Adjudication the native yield of the entire Santa Maria
30 groundwater basin was estimated by GEOSCIENCE to be 60,000 acre-feet per year (AFY) before
31 implementation of the Twitchell Reservoir Project in 1960. This estimate of native yield

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TO: Mike Nunley

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DATE: June 5, 2007

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1 includes 47,300 AFY of streamflow loss, 12,500 AFY of recharge from rainfall and 200 AFY of
2 subsurface inflow to the Santa Maria groundwater basin.

3 8. What is the quality of water available?

4 Water quality data for Santa Maria River underflow is not available. For the entire Santa
5 Maria groundwater basin TDS concentrations increase toward the center of the basin beneath
6 the cities of Santa Maria and Orcutt and away from the recharge area of the Santa Maria River
7 (SBCWA 1999; 2001). Nitrate concentrations as high as 240 milligrams per liter (mg/L) have
8 been recorded and some wells sampled from 1990 through 2000 show nitrate concentrations
9 that exceed the minimum contaminant level (DWR, 2002).

10 9. What is the reliability of this water supply?

11 While the estimate of native yield for the entire Santa Maria groundwater basin is 60,000
12 AFY, the volume in storage is on the order of ten times the native yield, therefore providing a
13 reasonable reliability to the annual supply for any one year. The confidence in this reliability
14 estimate is predicated on the understanding that over long periods, annual rainfall totals are
15 occasionally extremely high and therefore the likelihood of replacing groundwater pumpage in
16 excess of the native yield is high.

17 Winter floodwaters are captured at Twitchell Reservoir annually. Based on USGS gage
18 data (for Water Years 1960 through 1983) releases from Twitchell Reservoir have been made in
19 all but three years since the implementation of the project in 1960. Therefore, Santa Maria River
20 underflow provides a reasonable reliability to the annual supply for any one year.

21 10. What is a reasonable estimate of its yield?

22 The estimated annual streamflow loss for the Santa Maria River downstream of the
23 confluence with the Sisquoc River Valley is 60,000 AFY since the implementation of the
24 Twitchell Reservoir Project (Scalmanini, 1997). The estimated yield of the Twitchell Reservoir
25 Project is 35,000 AFY as indicated in the Santa Maria Groundwater Adjudication. The Santa
26 Maria Groundwater Adjudication litigation has concluded, but the court has not rendered a
27 final decision. So, the numbers presented above are still preliminary.

28 11. What physical connections exist between this water source and other nearby sources
29 that may already be "spoken for"? (i.e., Who else has a reasonable chance of
30 establishing a prior claim to this water?)

31 Subsurface outflow to the west from the Santa Maria Valley enters the ocean and
32 outflow to the northwest enters the Nipomo Mesa Management Area (NMMA). Cause for
33 concern over changing the subsurface flow dynamics due to an additional pumpage of the
34 Santa Maria River underflow is warranted, specifically in that the current underflow to the
35 NMMA has been historically accounted for in the water supply estimates for the District.

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TO: Mike Nunley
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1 **METHODOLOGY**

2 The answers to the questions posed in the results section are based upon a review of
3 existing documentation related to the Santa Maria groundwater basin and to the Santa Maria
4 Groundwater Adjudication. Provided below is additional analysis and discussion of the
5 questions presented in the results section.

6 **DISCUSSION**

7 The Twitchell Reservoir Project was implemented in 1960 to regulate surface water
8 releases to the Santa Maria River system upstream of the confining layer in order to optimize
9 groundwater recharge to the Santa Maria groundwater basin (Scalmanini, 1997). The Santa
10 Maria Groundwater Adjudication indicates that only Santa Maria Valley parties have paid for,
11 managed and benefited from the Twitchell Reservoir Project. The District would need to
12 purchase a water right from the parties involved in the Twitchell Reservoir Project or make an
13 agreement with parties entitled to water from the Santa Maria groundwater basin in order to
14 access Santa Maria River underflow as an alternative water supply.

15 6. The depth to groundwater information provided is based on data for the Santa Maria
16 groundwater basin as a whole, including the Northern Cities, the Nipomo Mesa Management
17 Area and the Santa Maria Valley. Data must be collected and analyzed from wells along the
18 Santa Maria River in order to provide a range of depths to groundwater in the vicinity of the
19 Santa Maria River.

20 7. The quantity of water available (60,000 AFY) presented is for the entire Santa Maria
21 groundwater basin. Previous reports and studies of the Santa Maria groundwater basin have
22 shown varied estimates of native yield. The Santa Maria Groundwater Adjudication litigation
23 has concluded, but the court has not rendered a final decision. So, the estimated native yield for
24 the entire Santa Maria groundwater basin of 60,000 AFY is still preliminary.

25 The estimated annual streamflow loss for the Santa Maria River downstream of the
26 confluence with the Sisquoc River Valley was 26,000 AFY (for Water Years 1942 through 1959)
27 prior to the Twitchell Reservoir Project and 60,000 AFY (for Water Years 1960 through 1983)
28 after implementation of the Twitchell Reservoir Project (Scalmanini, 1997).

29 8. The groundwater quality data provided is based on data for the Santa Maria
30 groundwater basin as a whole. Water quality data of Santa Maria River flows and groundwater
31 in the vicinity of the Santa Maria River must be collected and analyzed in order to provide
32 water quality data for the Santa Maria River underflow.

33 9. The average annual release from Twitchell Reservoir is 39,000 AFY based on USGS
34 gage data (for Water Years 1960 through 1983). Releases have been made in all years since the
35 implementation of the Twitchell Reservoir Project except Water Years 1972, 1976 and 1977.

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1 10. If all releases from Twitchell Reservoir recharged the Santa Maria groundwater
2 basin, then Santa Maria River underflow would yield approximately 65,000 AFY (26,000 AFY
3 streamflow losses prior to Twitchell Reservoir + 39,000 AFY release from Twitchell Reservoir).

4 11. Geologically the quaternary alluvium that comprises the principal aquifer is
5 composed of an upper fine-grained member consisting of sand and gravel and a lower coarse
6 grained member consisting of boulders and gravel throughout the valley. The upper member
7 toward the Pacific Ocean is much finer grained and consists of predominately silt and clay.
8 This finer grained upper member (confining layer) confines groundwater to the lower member
9 in areas westward of Santa Maria's water treatment plant. Water flowing in the segment of the
10 Santa Maria River above the confining layer does not recharge into the groundwater basin and
11 wastes to the Ocean (Wort, 1951). The Twitchell Reservoir Project was implemented to regulate
12 flows along the lower reaches of the Cuyama River in order to minimize water waste to the
13 Ocean.

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Appendix C – CCAMP Data for Oso Flaco Watershed

This summary of water quality in Oso Flaco Lake and Oso Flaco Creek is based on the following studies and documents:

- Cachuma Resource Conservation District and the Dunes Center. *Draft Nitrate and Sediment Assessment, Oso Flaco Watershed, San Luis Obispo County, California, August 2004.* Report prepared for California Regional Water Quality Control Board, Central Coast Region.
- Central Coast Ambient Monitoring Program (CCAMP). *312 Santa Maria River Hydrologic Unit Draft Report for Sampling Year 2000*

CCAMP water quality data is summarized below for monitoring sites in the Oso Flaco Creek watershed. Maximum Contaminant Levels (MCLs) and Secondary MCLs are also listed for comparison.

Note that water quality standards shown below for municipal supply are in some cases based on source water quality and in other cases based on distribution system water quality. Surface water treatment must meet "performance standards", and the MCL is deemed to be a "treatment technique". For example, the performance standard for turbidity is 0.3 NTU, and the treatment technique to achieve this would be conventional treatment; however, if an alternative filtration technology is used as the treatment technique, the turbidity performance standard is typically 0.1 NTU.

Table C-1 Water Quality and Maximum Contaminant Levels (MCLs)

Primary Constituent	CDHS MCL	USEPA MCL	Oso Flaco Lake @ culvert (Site 312 OFL)			Oso Flaco Creek @ Oso Flaco Lake Road (Site 312OFC)			Little Oso Flaco Creek (Site 312 OFN)		
			Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Coliforms, Fecal MPN/100mL	See Note 1		1,300	20	244	35,000	1	3,586	24,000	1	2,314
Coliforms, Total, MPN/100mL			7,000	300	2,437	190,000	199	61,425	127,000	800	21,653
Nitrate as Nitrogen, mg/L		10	37.1	28	31.4	70.2	23.8	37.1	48.8	26.5	34.5
Nitrate(as NO3), mg/L	45		165	125	140	312	106	165	217	118	154
Nitrite as Nitrogen, mg/L	1	1	0.42	0.005	0.106	0.54	0.005	0.118	0.144	0.005	0.06
Nitrogen, Total, mg/L	10		37.1	28	31.3	134	26	49	45.1	26.5	32.2

Note 1: The level of pathogenic organisms present in a surface water sources will establish the degree of treatment required, as defined by the USEPA in the Surface Water Treatment Rule guidance and the Long Term 2 Enhanced Surface Water Treatment Rule.

"empty cell " means not reported / no analysis for this constituent

mg/L = milligrams per liter of sample collected = ppm

ppm = parts per million

MPN/100mL = most probable number per 100 milliliters of sample collected

Table C-2 Water Quality and Secondary Standards

Secondary Constituent	Consumer Acceptance Contaminant Levels		Oso Flaco Lake @ culvert (Site 312 OFL)			Oso Flaco Creek @ Oso Flaco Lake Road (Site 312OFC)			Little Oso Flaco Creek (Site 312 OFN)		
	CDHS	USEPA	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Chloride, mg/L	250	250	133	82	99	247	43	95	110	60	92
Conductivity, umhos/cm	900		2,763	1,830	2,128	2,820	1,595	2,010	2,350	1,680	2,007
Lab Turbidity (NTU)	5		34.5	1	9.8	526	4	190	85.1	2.1	17.3
Sulfate mg/L	250	250	740	640	678	950	440	656	730	568	633
Total Dissolved Solids, mg/L	500	500	2,040	338	1,470	2,100	387	1,445	2,080	969	1,576
Turbidity, NTU (See Note 1.)	5		34.5	1	9.8	526	4	190	85.1	2.1	17.3

Note 1: Acceptable turbidity levels for treated surface water are based on the treatment technique used, typically 0.1 to 0.3 NTU. There are no established limits for turbidity in raw surface water prior to treatment.

"empty cell " means not reported / no analysis for this constituent

mg/L = milligrams per liter of sample collected = ppm

NTU = Nephelometric Turbidity Units

ppm = parts per million

umhos/cm = millisiemens per centimeter

Additional parameters were measured under the CCAMP program for which water quality MCLs and Secondary Standards do not exist. In some cases these measured parameters indicate the presence of a water-borne contaminant. These results are summarized below:

Table C-3 Sediment Inorganic Chemistry

Inorganic Constituent in Sediment ²	Little Oso Flaco Creek (Site 312 OFN)
Antimony in Sediment (mg/kg) ²	1.50
Arsenic in sediment (mg/kg) ²	15
Barium, in sediment (mg/kg) ²	160
Beryllium in sediment (mg/kg) ²	2.70
Cadmium in sediment (mg/kg) ²	0.10
Chromium in sediment (mg/kg) ²	40.00
Copper in sediment (mg/kg) ²	33
Lead in sediment (mg/kg) ²	20
Mercury in sediment (mg/kg) ²	0.037
Nickel in sediment (mg/kg) ²	35
Selenium in sediment (mg/kg) ²	4
Thallium in sediment (mg/kg) ²	1.00
Vanadium in sediment (mg/kg) ²	78
Zinc in sediment (mg/kg) ²	110

MCL in Water	
CDHS ¹	USEPA ¹
0.006 ppm	0.006 ppm
0.05 ppm	0.010 ppm
1 ppm	2 ppm
0.004 ppm	0.004 ppm
0.005 ppm	0.005 ppm
0.05 ppm	
1.3 ppm	
0.015 ppm	
2 ppb	2 ppb
0.1 ppm	
0.05 ppm	0.05 ppm
0.002 ppm	0.002 ppm
5 ppm	5 ppm

"empty cell " means not reported / no analysis for this constituent

1 MCL applies to constituents dissolved in water

2 MCL does not apply to constituents bound to fine-grained sediment samples collected within the wetted creek channel or the tissue of fish

Table C-4 Sediment Organic Chemistry

Organic chemicals detected in the sediment sample collected at Little Oso Flaco Creek (312OFN) in June 2000. Available criteria are shown for reference. Units of measurement are ppb (ug/kg). ND is non-detect. Criteria exceedances are bold. (CCAMP, 2002, from Table 5.1.5c.)

Site Tag	DDD(p,p')	DDE(p,p')	DDT, Total	Dieldrin	Endrin	Chlorpyrifos	Total PCB
312OFN 2000	1.0	5.3	9.3	2.6	1.4	ND	ND
PEL (freshwater)	8.51	6.75	4450	6.67	62.4		277

PEL (probable effect level)

Table C-5 Metals in Fish Tissue

Site specific assessment of data used to assess impairment of aquatic life uses in the Santa Maria River Hydrologic Unit (HU312). **Yes** - evidence that a problem exists, **No** - no evidence that a problem exists. (CCAMP, 2002, from Table 5.1.5a.)

Constituent	Arsenic	Chromium	Copper	Lead	Mercury	Selenium	Zinc
Water Contact Recreation Assessment Threshold	1.5	1	20	2	0.5	2	45
Median International Standards (MIS)	1.0	1.0	20.0	2.0	0.5	0.3	70
California's Office of Environmental Health Hazard Assessment (OEHHA)	1.0				0.3	2.0	
Units	ppm	ppm	ppm	ppm	ppb	ppb	ppm
Matrix	Tis	Tis	Tis	Tis	Tis	Tis	Tis
Sites							
312OFL	No	No	No	No	No	No	No

Table C-6 Organic Compounds in Fish Tissue

Organic chemical concentrations in whole fish from Oso Flaco Lake (ng/g or ppb). National Academy of Sciences (NAS) and Food and Drug Administration (FDA) criteria for freshwater fish are shown as exceedances threshold values. Exceedances are **bold**. (CCAMP, 2002, from Table 5.1.4d.)

Site	Date	Aldrin	Chlordane	Total DDT	Dieldrin	Endrin	Heptachlor	Tot PCB	TOXAP
Oso Flaco Lake	Filet		2.2	345.1	25.5	10.5	< 2.0	NA	243.0
NAS ¹	Whole Fish	100	100	1000	100	100	100	500	100
FDA ²	Filet	300	300	5000	300	300	300	2000	5000
OEHHA ³	Filet		30	100	2	1000	4	20	30

Notes:

- (1) National Academy of Sciences guidelines
- (2) U.S Food and Drug Administration Action Levels
- (3) California's Office of Environmental Health Hazard Assessment (OEHHA) fish tissue criteria

Table C-7 Toxicity Data

Percent survival of *C. dubia* and *H. azteca* in toxicity tests conducted in the Santa Maria Hydrologic Unit July 2002 through May 2003. Bold numbers indicate survival is significantly different from the control value @ $p < 0.05$. NA=not analyzed. (CCAMP, 2002, Table 5.1.5b.) This sample contained chlorpyrifos levels that are known to exceed acute toxicity threshold for *C. dubia*.

Site	<i>C. dubia</i> survival Jul-02	<i>C. dubia</i> survival Sept-02	<i>C. dubia</i> survival Mar-02	<i>C. dubia</i> survival May-02	<i>H. azteca</i> survival June-02	<i>H. azteca</i> survival May-03
312OFC	80	100	100	30	71	N/A

Tissue Bioaccumulation

Resident fish tissue samples (from Oso Flaco Lake) did not have any metal concentrations which exceeded published Median International or OEHHA Standards.