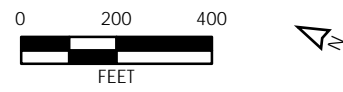
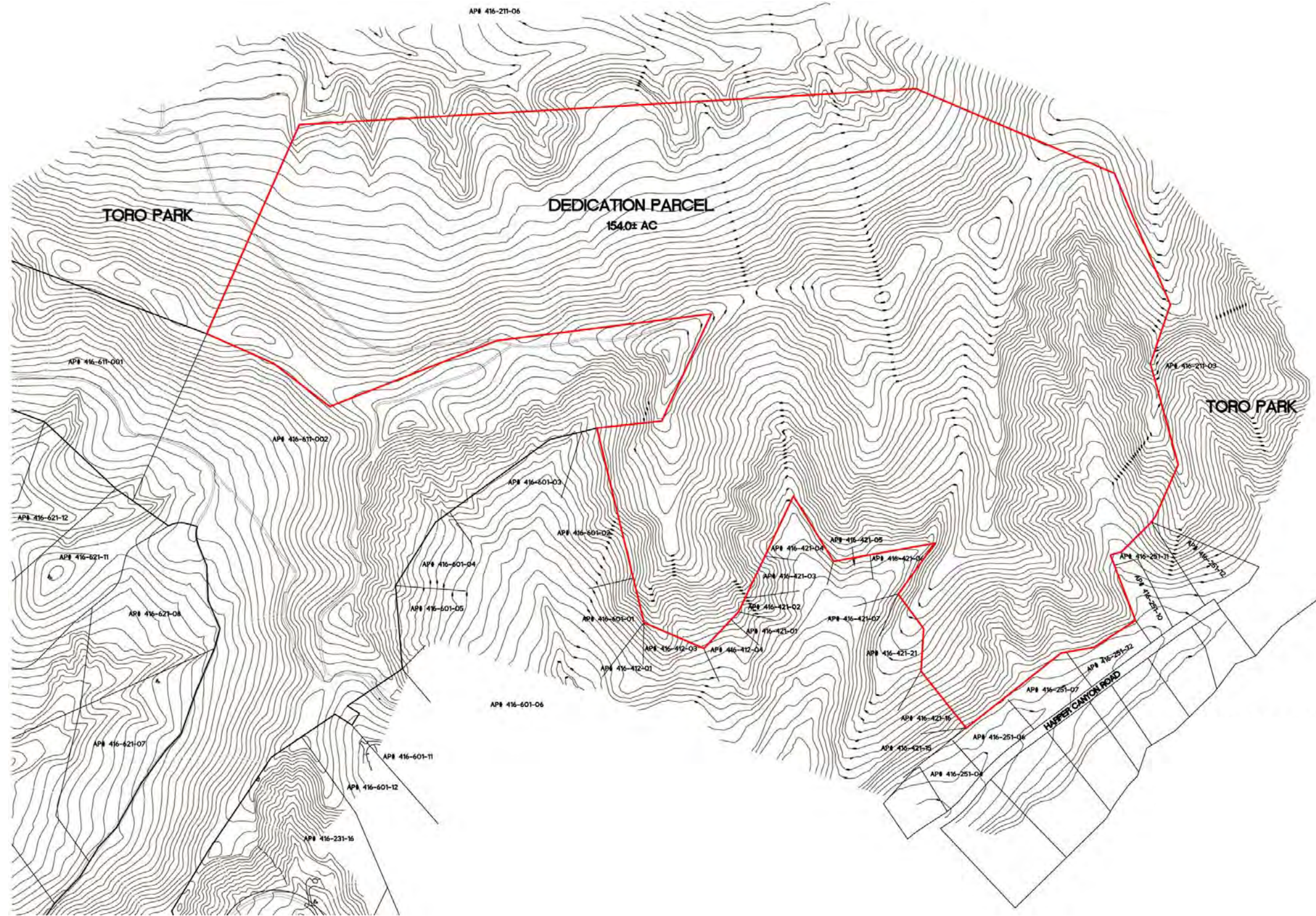


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## EXHIBITS

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T:\Harper Canyon (Encina Hills)\Figures

Source: Whitson Engineers



**AMBAG**

ASSOCIATION OF MONTEREY BAY AREA GOVERNMENTS

March 6, 2009

Pamela Lapham  
Associate Planner  
Pacific Municipal Consultants  
585 Cannery Row, Suite 304  
Monterey, CA 93940

Dear Ms. Lapham:

This letter is in response to your December 12, 2008 request for a re-determination of consistency of the Harper Canyon Subdivision in the County of Monterey with the *Air Quality Management Plan for the Monterey Bay Region (AQMP)*.

Consistency of housing projects with the AQMP is analyzed by comparing the total potential population growth accommodated by the project with the forecasted growth for the unincorporated County of Monterey. The *2008 Population, Housing Unit, and Employment Forecasts* adopted by the AMBAG Board of Directors on June 11, 2008 has been incorporated into the 2008 Air Quality Management Plan for the North Central Coast Air Basin (August 2008), which is the document used project consistency.

The California Department of Finance estimates there were 39,571 housing units in the unincorporated County of Monterey as of 1/01/08. AMBAG staff surveyed the County of Monterey to determine the number of housing units that have received a building permit since 1/01/08. 195 housing units have received building permits between January 2008 and December 2008. Combined, there are 39,766 existing, and or permitted housing units in the unincorporated County of Monterey as of January 1, 2009. The California Department of Finance as of 1/1/08 estimates there to be 2.58 persons per housing unit in unincorporated County of Monterey giving a total population of 101,801.

The Harper Canyon Subdivision consists of a total of 17 residential units to be build by 2010. At the Department of Finance average of 2.58 persons per housing unit the Harper Canyon Subdivision will potentially add 42 people to the unincorporated Monterey County giving a total of 101,843. The *2008 Population, Housing Unit, and Employment Forecast*, puts the total population of the unincorporated County of Monterey by the year 2010 to be 109,509.

The population from the combination of the existing and permitted housing units in the unincorporated County of Monterey (39,766) plus the 17 housing units in the Harper Canyon Subdivision is less than the regional population forecast for the unincorporated County of Monterey. Therefore the Harper Canyon Subdivision is **consistent** with the 2008 regional forecast and the Air Quality Management Plan.

Please feel free to contact me if you have any questions about this determination.

Sincerely,

David Roemer  
Associate Planner

cc: Jean Getchell, MBUAPCD

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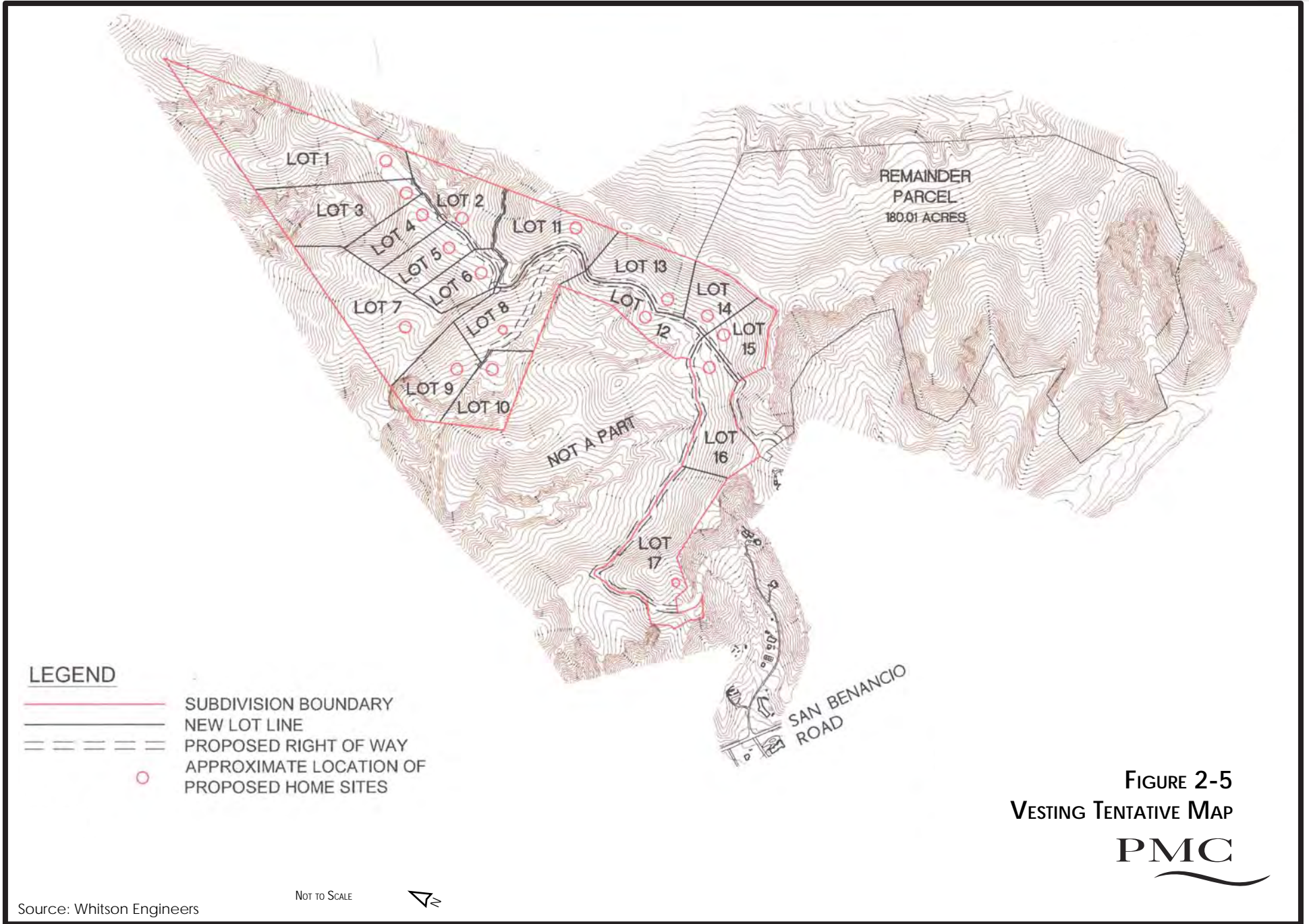


FIGURE 2-5  
 VESTING TENTATIVE MAP  
 PMC

T:\Harper Canyon (Encina Hills)\figures

Source: Whitson Engineers

NOT TO SCALE







Road Segment	Type	Direction	LOS Std.	Existing Conditions										Background Conditions						Background + Project Conditions						Cumulative + Project Conditions					
				AM Peak Hr					PM Peak Hr					AM Peak Hr			PM Peak Hr			AM Peak Hr			PM Peak Hr			AM Peak Hr			PM Peak Hr		
				Volume	Speed	LOS	Speed	LOS	Volume	Speed	LOS	Speed	LOS	Volume	Speed	LOS	Volume	Speed	LOS	Volume	Speed	LOS	Volume	Speed	LOS	Volume	Speed	LOS	Volume	Speed	LOS
1 Highway 68 Between Highway 218 and York Rd.	2-Lane Arterial 2-Lane Rural Highway Widened to 4 Lanes	EB WB	C/D	1,432	37.0	E	39.2	E	1,067	39.0	E	38.8	E	1,612	36.6	E	1,224	38.8	E	1,613	36.6	E	1,228	38.8	E	2,010	39.0	E	1,594	38.5	E
				1,345	34.0	E	34.4	E	1,726	42.0	D	41.8	D	1,464	33.5	E	1,951	36.8	E	1,468	32.9	E	1,953	36.7	E	1,862	14.9	F	2,353	15.6	F
2 Highway 68 Between York Rd. and Boots Rd.-Pasadera Dr.	2-Lane Arterial 2-Lane Rural Highway Widened to 4 Lanes	EB WB	C/D	788	40.0	E	39.6	E	1,133	23.0	F	23.3	F	869	39.9	E	1,296	22.2	F	870	40.1	D	<b>1,300</b>	<b>22.2</b>	F	1,261	33.5	E	1,757	14.2	F
				1,415	39.0	E	39.0	E	1,205	51.0	B	47.1	C	1,548	34.1	E	1,323	46.9	C	1,552	33.9	E	1,325	46.9	C	2,069	20.6	F	1,779	36.2	E
3 Highway 68 Between Boots Rd.-Pasadera Dr. and Laureles Grade Rd.	2-Lane Arterial 2-Lane Rural Highway Widened to 4 Lanes	EB WB	C/D	772	40.0	E	39.6	E	1,090	11.0	F	11.2	F	858	41.7	D	1,242	10.9	F	859	41.7	D	<b>1,245</b>	<b>10.8</b>	F	1,236	25.8	E	1,694	7.6	F
				1,351	40.0	E	40.0	E	1,102	40.0	E	39.6	E	1,472	26.8	E	1,223	34.9	E	1,476	28.8	E	1,225	34.8	E	2,003	13.7	F	1,673	15.9	F
4 Highway 68 Between Laureles Grade Rd. and Corral de Tierra Rd.	2-Lane Arterial 2-Lane Rural Highway Widened to 4 Lanes	EB WB	C/D	876	44.0	D	44.0	D	1,309	21.0	F	21.2	F	967	38.7	E	1,483	15.7	F	977	38.0	E	<b>1,487</b>	<b>15.6</b>	F	1,366	19.3	F	1,976	10.8	F
				1,373	35.0	E	35.4	E	1,074	52.0	B	51.9	B	1,508	28.8	E	1,218	51.6	B	1,512	28.6	E	1,220	51.5	B	2,034	15.6	F	1,640	33.8	E
5 Highway 68 Between Corral de Tierra Rd. and San Benancio Rd.	2-Lane Arterial 2-Lane Rural Highway Widened to 4 Lanes	EB WB	C/D	1,020	26.0	E	26.3	E	1,365	21.0	F	21.7	F	1,125	36.1	E	1,536	20.3	F	1,126	35.5	E	<b>1,540</b>	<b>19.9</b>	F	1,556	13.2	F	2,065	12.0	F
				1,305	31.0	E	30.9	E	1,149	28.0	E	27.6	E	1,444	14.9	F	1,296	16.4	F	<b>1,448</b>	<b>14.5</b>	F	<b>1,298</b>	<b>15.4</b>	F	1,985	7.8	F	1,791	5.0	F

- Notes:
- Levels of service in **BOLD** represent significant project impacts.
  - Segments were analyzed using the Synchro traffic analysis software. The segment speeds in the Synchro model were calibrated with the existing segment speeds, which were obtained in the field using GPS speed data. The projected speeds in subsequent scenarios were obtained by adding the projected traffic volumes in future scenarios to the existing calibrated speeds in Synchro. The levels of service are based speeds in Table A obtained from the 2000 Highway Capacity Manual for Two-Lane Highways.
  - Mitigated levels of service were analyzed using planning level threshold volumes for a 4-lane expressway divided arterial, shown in Table B.

LOS	Average Travel Speed (mph)
A	> 55
B	50.1 - 55
C	45.1 - 50
D	40.1 - 45
E	25.1 - 40
F	<= 25

LOS	Volume	Volume
A	<=1,800	<=2,200
B	2,700	2,500
C	3,600	2,900
D	4,500	3,260
E	5,000	3,600
F	>5,000	>3,600

EXHIBIT 6  
ROAD SEGMENT LEVELS OF SERVICE



Intersection					Existing Conditions	Background Conditions	Background + Project Conditions	Cumulative + Project Conditions	
N-S Street	E-W Street	Existing Lane Configuration	Existing Intersection Control	LOS Standard					
1	Highway 218	Highway 68	NB 1-L, 1-T/R SB 2-L, 1-T, 1-R EB 1-L, 1-T, 1-T/R WB 1-L, 2-T, 1-R	Signal	C/D (Caltrans)	None Recommended	None Recommended	None Recommended	RI #6 1. Widen and restripe NB Monterra to 1-L, 1-T, 1-R 2. Widen and restripe EB Hwy 68 to 2-L, 1-T, 1-T/R 3. Convert Hwy 218 SBR to RTO
2	York Road	Highway 68	SB 1-L, 1-R EB 1-L, 1-T WB 1-T, 1-R	Signal	C/D (Caltrans)	RI #1 1. Add 2nd Hwy 68 WBT	Same As Existing	Same As Existing	RI #7 1. Existing Improvements AND 2. Add 2nd Hwy 68 EBT 3. Add 2nd Hwy 68 EBL
3	Pasadera Drive-Boots Road	Highway 68	NB 1-L, 1-T/R SB 1-L/T, 1-R EB 1-L, 1-T, 1-R WB 1-L, 1-T, 1-R	Signal	C/D (Caltrans)	RI #2 1. Add 2nd Hwy 68 WBT	Same As Existing	Same As Existing	RI #8 1. Existing Improvements AND 2. Add 2nd Hwy 68 EBT
4	Laureles Grade Road	Highway 68	NB 1-L, 1-R EB 1-T, 1-R WB 1-L, 1-T	Signal	C/D (Caltrans)	RI #3 1. Add 2nd Hwy 68 EBT 2. Add 2nd Hwy 68 WBT	Same As Existing	Same As Existing	RI #9 1. Existing Improvements AND 2. Convert Laureles Grade NBR to RTO
5	Corral de Tierra Road	Highway 68	NB 1-L, 1-R EB 1-T, 1-R WB 1-L, 1-T	Signal	C/D (Caltrans)	RI #4 1. Add 2nd Hwy 68 EBT 2. Add 2nd Hwy 68 WBT	Same As Existing	Same As Existing	RI #10 1. Existing Improvements AND 2. Convert Corral de Tierra NBR to RTO
6	San Benancio Road	Highway 68	NB 1-L/T, 1-R SB 1-L/T, 1-R EB 1-L, 1-T, 1-R WB 1-L, 1-T/R	Signal	C/D (Caltrans)	RI #5 1. Add 2nd Hwy 68 EBT 2. Add 2nd Hwy 68 WBT	Same As Existing	Same As Existing	Same As Existing
	San Benancio Road	Meyer Road	NB 1-T/R SB 1-L/T WB 1-L/T/R	Stop Sign	C (Mon. Co.)	None Recommended	None Recommended	MM #1. Pay TAMC Fee <sup>See note 6</sup> MM #2. Trim Vegetation MM #3. Widen & Resurface Meyer Road MM #4. Provide Right-Turn Tapers MM #5. Add Southbound Left-Turn Lane MM #6. Pay TAMC Fee <sup>See note 7</sup>	Same As Background + Project

Road Segment	Type	LOS Standard	Existing Conditions	Background Conditions	Background + Project Conditions	Cumulative + Project Conditions
1 Highway 68 Between Highway 218 and York Rd.	2-Lane Arterial 2-Lane Rural Highway	C/D	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*
2 Highway 68 Between York Rd. and Boots Rd.-Pasadera Dr.	2-Lane Arterial 2-Lane Rural Highway	C/D	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*
3 Highway 68 Between Boots Rd.-Pasadera Dr. and Laureles Grade Rd.	2-Lane Arterial 2-Lane Rural Highway	C/D	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*
4 Highway 68 Between Laureles Grade Rd. and Corral de Tierra Rd.	2-Lane Arterial 2-Lane Rural Highway	C/D	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*
5 Highway 68 Between Corral de Tierra Rd. and San Benancio Rd.	2-Lane Arterial 2-Lane Rural Highway	C/D	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*	Widen Highway 68 to 4 Lanes*

Notes:

- 1. L, T, R = Left, Through, Right
- 2. NB, SB, EB, WB = Northbound, Southbound, Eastbound, Westbound
- 3. RTO = Right-turn overlap phasing
- 4. RI = Recommended Improvement
- 5. MM = Project Mitigation Measure
- 6. Payment of the TAMC fee mitigates direct project impacts at intersection #'s 5 and 6 through the TAMC "SR 68 Commuter Improvements" project.
- 7. Payment of the TAMC fee mitigates cumulative project impacts on the regional road network.
- \* Or Construct Highway 68 Bypass

EXHIBIT 7  
RECOMMENDED IMPROVEMENTS AND MITIGATION MEASURES

T:\Harper Canyon (Encina Hills) Figures

Source: Hatch Mott MacDonald



## Memorandum

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To: Douglas Fraser, California American Water, Central Division  
From: Anne Prudhel, Erin Mackey, Jason Davis  
Date: December 5, 2013 Project No.: 9199D.00  
Subject: A Summary of Arsenic Removal from Drinking Water – Options and Relative Costs

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A review of the existing water quality data for the Ambler Oaks and Encina Hills wells indicate arsenic concentrations of 65 parts per billions (ppb) and silica concentrations of 70 parts per million (ppm). California American Water is evaluating the feasibility of serving both the Ambler Oaks and Encina Hills subdivision by treating water from both wells with an arsenic removal facility located at the Ambler Oaks well site. For purposes of evaluation, it is assumed a maximum of 30 lots will be served by the treatment facility at an average 500 gallons per day/lot (gpd/lot), resulting in the need for a 15,000 gpd system with a peak flow of 50 gallons per minute (gpm).

This memorandum summarizes the primary types of treatment technologies for arsenic removal from groundwater and provides some initial cost estimates for a very small system application.

Treatment technologies capable of removing arsenic from drinking water supplies include:

- Coagulation/Filtration (C/F)
- Sorptive Media, granular ferric hydroxide (SM)
- Ion Exchange (IX)
- Sorptive Media, Activated Alumina (AA)
- Coagulation/Membrane Filtration (C/MF)
- Lime Softening
- Membrane Filtration (RO/NF) and Electrodialysis Reversal (EDR)

Of these technologies, C/F, IX, SM (AA), RO, and EDR are considered Best Available Technologies (BATs) by the United States Environmental Protection Agency (USEPA). This does not imply that other technologies (i.e., C/MF or SM) cannot remove arsenic, but rather that non-BAT technologies are newer technologies that have yet to establish the historical track record necessary for designation as a BAT. Many of the media types developed for SM treatment have been developed specifically to address the Arsenic Rule. As a result, these media have had extensive testing on many types of water qualities all across the U.S. The EPA has further refined the list of technologies for arsenic removal best suited for small systems. The small system compliance technologies (SSCTs) for arsenic treatment include:

- Activated Alumina (Centralized Treatment)
- Activated Alumina (Point of Use (POU))
- Coagulation/Filtration
- Lime Softening

- Ion Exchange
- Reverse Osmosis (POU)

The small size of the treatment system required for a small subdivision application limits the practical options for treating the entire water supply under a centralized treatment option. Three of the seven potential technologies, C/F, SM (AA or granular ferric hydroxide), and IX, are the most feasible options for centralized treatment. Other treatment technologies, such as RO, become feasible when a point of use (POU) treatment approach is considered or if additional treatment goals are established (i.e., other contaminants). A POU approach only treats a portion of the water supply as it is used at the point of consumption. Both approaches are appropriate for arsenic treatment under the applicable regulations. However, this memorandum does not address the feasibility of POU treatment.

### Centralized Treatment Alternatives

The most feasible centralized treatment technologies for arsenic removal are described below and a comparison between them is provided Table 1.

<b>Technology</b>	<b>Key Implementation Considerations</b>	<b>O&amp;M Requirements</b>	<b>Removes other Contaminants of Potential Concern?</b>
C/F	<ul style="list-style-type: none"> <li>- Non-proprietary equipment/media.</li> <li>- Backwash waste must be properly treated/disposed of.</li> </ul>	Moderate	No
IX	<ul style="list-style-type: none"> <li>- Potential to “leak” arsenic due to chromatographic peaking.</li> <li>- Waste stream from media regeneration.</li> <li>- May require pre-oxidation step.</li> <li>- Potential NDMA formation and competition from other anions for sorption sites (e.g., sulfate).</li> </ul>	Moderate	Cr(VI)
RO	<ul style="list-style-type: none"> <li>- Generates large volumes of high-TDS waste.</li> <li>- High silica (&gt;30 mg/L) necessitates pretreatment prior to RO process</li> </ul>	Highest	TDS, Cr(VI)
SM (AA)	<ul style="list-style-type: none"> <li>- Minimal waste generated.</li> <li>- Optimum at pH &lt; 6.5.</li> <li>- Small systems typically use once (no regeneration).</li> </ul>	Lowest	F

<b>Table 1 Summary of Centralized Treatment Options</b>			
<b>Technology</b>	<b>Key Implementation Considerations</b>	<b>O&amp;M Requirements</b>	<b>Removes other Contaminants of Potential Concern?</b>
SM (Fe media)	<ul style="list-style-type: none"> <li>- Minimal waste stream generated.</li> <li>- Small systems typically use once (no regeneration).</li> </ul>	Lowest	No

### **Coagulation Filtration (C/F)**

C/F treatment functions by converting soluble arsenic into a particulate form that is readily filtered by granular media (i.e., anthracite and/or sand media). Coagulating (ferric sulfate) and possibly oxidizing chemicals (e.g., chlorine or potassium permanganate) are required as part of the C/F process. When solids accumulate to the point of excessive headloss through the filter media, the media must be backwashed. Filtered water or raw water, routed in reverse direction through the pressure vessel, is used to flush solids out of the filter and prepare the filter for the next production cycle. The need for additional chemical feed equipment, increased operating requirements, and the storage and waste disposal requirements associated with backwashing operations may make this alternative less attractive than other options.

### **Ion Exchange (IX)**

This process removes arsenic by absorption to a specially engineered resin. As arsenic is absorbed, chloride is released or “exchanged” and transferred to the treated water. Over time, the ability of the resin to remove arsenic is reduced. At this point, the pressure vessel is taken off-line and soaked in a concentrated sodium chloride brine solution. This soaking step is called “regeneration.” Regeneration is a reversal of normal operation: chloride is exchanged back onto the resin and arsenic is desorbed back into the water. The resulting brine solution would then contain arsenic and could be classified as hazardous if the arsenic concentration exceeds 5 mg/L; and therefore, must be disposed of properly. The brine solution could be monitored and disposed prior to it becoming toxic and transported to a centralized facility for treatment. Alternatively, it may be possible to contract with a vendor to perform regeneration offsite.

The resins used for arsenic removal are not only selective for arsenic, but will also remove ions with similar properties. These similar or “competitive” ions can impact the useful life of ion exchange resins, and they have additional impacts on treated water quality. For example, sulfate, also present in the groundwater may compete for ion exchange sites. When the sulfate concentration is high, sulfate may displace previously adsorbed ions (such as arsenate) from the resin bed, thereby causing higher arsenic concentrations in the effluent than in the influent. This phenomenon is called chromatographic peaking and requires the resin bed to be monitored and regenerated well in advance of its onset.

Ion exchange does not readily remove arsenite (As(III)). If present, either the use of an oxidizing chemical (i.e., chlorine) to convert the arsenite to arsenate (As(V)) or pH adjustment to greater than 9.2 is needed. However, the use of chlorine upstream of the ion exchange units is undesirable as it can potentially cause N-Nitrosodimethylamine (NDMA) to leach from the resin. NDMA is a probable carcinogen though an MCL has not yet been established. NDMA can form when residual chlorine in water comes in contact with ion exchange media. For this reason, the recommended process layout uses GAC contactors to quench the residual chlorine so that feed water to the IX contactor does not have any chlorine.

The challenges with brine disposal, the potential of NDMA formation, and high sulfate concentrations in the source water may make this alternative less attractive than other options.

### **Reverse Osmosis (RO)**

RO is a pressure-driven membrane separation process capable of removing arsenic from water by means of particle size, dielectric characteristics, and hydrophilicity/hydrophobicity. In addition to arsenic, RO also effectively removes other constituents from water, including hexavalent chromium (Cr(VI)), organic carbon, salts, dissolved minerals, and color. It is well established that RO typically requires higher operating costs than other technologies due to higher power and chemical consumption. Costs associated with membrane module replacement, maintenance of pumping systems other process equipment are also significantly higher than for other suitable processes. High silica (>35 mg/L) would also necessitate pretreatment. In addition, RO processes typically achieve between 70 and 80 percent recovery, depending on raw water characteristics. This results in significant volumes of liquid waste water that may contain high levels of arsenic and other constituents rejected from the source's water. In waters with high contaminant levels, like arsenic, the concentrate would be considered hazardous waste that must be properly disposed of. The Resource Conservation and Recovery Act (RCRA) considers the waste hazardous if it contains greater than 5 mg/L of arsenic or if the liquid extraction of the Toxicity Characteristic Leaching Procedure (TCLP) contains more than 5.0 mg/L of arsenic. Due to these constraints, an RO treatment approach would likely be impractical and expensive. Consequently, RO was precluded from further consideration.

### **Sorptive Media (SM)**

Activated alumina (AA) is a sorption process that uses porous, granular material with ion exchange properties. In drinking water treatment, packed-bed AA adsorption is commonly used for the removal of natural organic matter and fluoride. The removal of As(V) by adsorption can be accomplished by continuously passing water under pressure through one or more beds. AA media can either be regenerated or disposed and replaced with fresh media. The efficiency and economics of the system are contingent upon several factors: pre-oxidation of As(III) to As(V), if necessary, constituent(s) interference with the adsorption process, and the need for pH adjustment to <6.5. If the location's natural pH is below this value pH adjustment would likely not be needed (no acid storage and feed system would be required). However, activated alumina strongly sorbs silica and fluoride, which are both assumed present in high



concentrations based on the Ambler Oaks data. This precludes the use of AA unless fluoride removal is also a treatment goal. Acid and base would both need to be stored on-site to regenerate the media, which is more complex than would be appropriate for this application. Also, there is only one supplier (ALCOA) which makes it difficult to competitively bid. Consequently, AA was precluded from further consideration.

Alternative sorptive medias have also been developed. These media may be made of iron, titanium, or synthetic materials and are capable of converting arsenite (As III) into arsenate (As V) without the need to add chlorine. Studies have shown that relative to AA these media have strong affinities for arsenic under natural pH conditions. While SM treatment is most cost effective for waters with a pH between 5.5 and 7, SM treatment can be used in waters with pH values of up to 8.5. Iron-based media is sensitive to silica and vanadium. The ions compete with arsenic for sorption sites on the media reducing the number of bed volumes that can be treated before arsenic breakthrough. The number of bed volumes that can be treated is dependent on the water quality and the media type. Based on the available water quality data and a 15,000 gpd system, the bed volumes to arsenic breakthrough would be approximately 57K for granular ferric hydroxide (GFH) media. At this rate, estimated media life would be approximately one year.

Unlike IX treatment, SM treatment is typically not “regenerated” (the one exception being regenerable activated alumina). When the SM treatment can no longer remove arsenic, the media is removed from the vessel and replaced with fresh media. Filtration upstream of SM and occasional backwashing of the sorptive media bed removes sand and grit that may accumulate in the treatment process. Additionally, when it comes time to remove the exhausted media, often the media supplier provides this service as part of the media exchange, resulting in a simple and effective solution for waste disposal. Several constituents found in the groundwater, such as vanadium and silica, may limit the life of iron based SM.

These factors combined with the minimal operation and maintenance requirements associated with the implementation of this technology may make this alternative the most attractive option.

## Conceptual Costs

Five technologies, C/F, IX, SM (AA), RO, and SM (Fe), are BATs by the USEPA. Two, RO and AA, were excluded from further consideration based on operational complexity (RO) and interference from co-occurring ion minerals (silica in the case of both RO and AA, and fluoride in the case of AA) which would both complicate operation and significantly reduce system performance. The assumed system size is an average flow of 10.4 gpm and a peak demand (design size) of 50 gpm. The capital costs presented in Table 2 below are based on cost estimates for a very small system with similar water quality and engineering judgment. It includes the following assumptions:

- Costs are for “custom” layout.
- No post treatment (e.g., caustic or chlorination) is included.

- The iron and turbidity concentrations are high, so pretreatment with cartridge filters is required for SM and C/F. This additional cost is included in the capital cost below.
- SM would be a lead-lag scenario to get full use of the media before replacing it.
- No sanitary sewer is available near the site, all waste generated by the treatment facility will need to be processed on site to form a slurry or sludge to be trucked off site and disposed of.
- All equipment (excluding some tankage, solids' thickening bin container, and recycled pump) will be housed in a CMU building which is included in the cost.
- Minimal grading associated with excavation for building and tank pads and civil sitework, including paving is included in the capital cost.
- Capital cost includes treatment facilities and onsite piping only. Piping to connect to the distribution system is not included.
- There will be washdown water in the facility. No costs were developed for any onsite storage or treatment of washdown water. It is assumed that this water will be discharged to daylight outside the facility.
- All chemical related spills from the bulk storage tanks are contained in the storage areas and will be pumped and transported off-site for proper disposal.

The operation and maintenance (O&M) data is estimated from comparably-sized demonstration-scale studies published in the USEPA report *Costs of Arsenic Removal Technologies for Small Water Systems: U.S. EPA Arsenic Removal Technology Demonstration Program* (EPA/600/R-11/090, September 2011).

<b>Technology</b>	<b>Capital Cost<sup>(1)</sup> (\$)</b>	<b>Capital Cost<sup>(4)</sup> (no bin container) (\$)</b>	<b>Capital Cost<sup>(4)</sup> (no bin/no recycle pump) (\$)</b>	<b>O&amp;M Costs<sup>(2)</sup> (\$/1,000 gal)</b>
C/F (Arsenic Only)	\$750,000	\$690,000	\$660,000	\$1.90
IX (Arsenic & Chromium <sup>(2)</sup> )	\$960,000	\$880,000	\$850,000	\$1.50
SM (Fe media) (Arsenic Only)	\$650,000	\$590,000	\$560,000	\$1.00

Notes:

(1) Assumes the well casings and well pumps are already installed.

(2) Assumes media disposal and/or backwash waste disposal is handled off site.

(3) Assumes all chromium in the raw water is in the Cr<sup>6+</sup> form.

(4) If sewer is available, the bin container and possibly the recycle pump can be eliminated. The backwash tank will still be needed as an equalization tank to control the discharge rate into the

<b>Table 2 Estimated Costs for Arsenic Centralized Treatment Options</b>				
<b>Technology</b>	<b>Capital Cost<sup>(1)</sup> (\$)</b>	<b>Capital Cost<sup>(4)</sup> (no bin container) (\$)</b>	<b>Capital Cost<sup>(4)</sup> (no bin/no recycle pump) (\$)</b>	<b>O&amp;M Costs<sup>(2)</sup> (\$/1,000 gal)</b>
sewer. Up to 80% of the waste stream can be recycled if the recycle pump is included in the system. The actual percentage would either need to be confirmed through pilot testing or full-scale testing during startup.				

### Other Considerations

There is some question as to whether or not the turbidity value is accurate (given that it is a groundwater). It is possible that dissolved iron is oxidizing in the sample and registering as turbidity by the time it gets analyzed. If the turbidity value is correct, the SM process would need pretreatment, which is included in the cost.

This initial treatment and cost assessment was performed for arsenic only. If this project moves forward, it is recommended that you request detailed estimates from vendors based on the site's water quality and conduct a more detailed study of waste disposal options for IX and C/F, if these options are to be explored further. In addition, should there be interest in moving this project forward, the need for co-removal of both arsenic and hexavalent chromium should also be considered. In August 2013, the California Department of Public Health (CDPH) proposed a hexavalent chromium (Cr6+) maximum contaminant level (MCL) of 10 µg/L. However, this MCL has not yet been adopted. The Federal MCL for total Cr is 100 ppb and the current State MCL for total Cr is 50 ppb. The 2011 Ambler Oaks data included a total chrome measurement that ranged from 9 -76 µg/L. A number of recent studies show that total Cr found in groundwater is composed mostly or exclusively of Cr6+. Until the wells are tested specifically for Cr6+, it is unknown how much of the total Cr is attributed to Cr6+ or if treatment will be needed. While ion exchange and coagulation/filtration are both best available technologies (BATs) for chrome removal as well, co-removal with arsenic would not be identical and so would require further analysis. SM is not a BAT for Cr6+ removal.

### Summary

Five technologies, C/F, IX, SM (AA), RO, and SM (Fe), were evaluated for removing arsenic for a small, 15,000-gpd system with a peak flow of 50 gpm. Two, RO and SM (AA), were excluded from further consideration due to issues of operational complexity and interference from co-occurring minerals that would both complicate operation and significantly reduce system performance. Based on treatment of arsenic alone, of the three remaining options, SM, (Fe) is likely the best candidate for this application as its cost is less than C/F and is comparable to IX. Based on the water quality and a 15,000 gpd, it is anticipated that the sorptive media, for arsenic removal only, would need to be replaced every year. However, vendors should be

contacted during design to get an accurate bed volume estimate. Additionally, operation and maintenance for SM (Fe) is simple and straightforward. However, the 2011 Ambler Oaks data included a total chrome measurement of 9-76  $\mu\text{g/L}$ , indicating the Cr(VI) concentration in the local groundwater may exceed CDPH's proposed Cr6+ MCL of 10  $\mu\text{g/L}$ . Should that be the case, IX would likely be the best treatment option. Detailed estimates from vendors based on the site's water quality and a more detailed study of waste disposal options for IX and C/F, should either be explored further, are recommended if this moves forward. Conceptual layouts for SM and C/F treatment facilities to remove arsenic and an IX treatment facility to remove both arsenic and chromium are attached.