Technical Memorandum

Alternatives Evaluation for the City of Pasadena Treatment Plant
National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California

Final June 16, 2006

This technical memorandum documents the results of the evaluation of alternative locations considered for the proposed groundwater treatment system associated with four City of Pasadena wells (Arroyo Well, Well 52, Ventura Well, and Windsor Well) located in the Monk Hill Subarea of the Raymond Basin. The wells are located within the groundwater chemical plume that originates from the Jet Propulsion Laboratory (JPL).

This technical memorandum supports a Proposed Plan[1] the National Aeronautics and Space Administration (NASA) prepared as part of its Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Program at JPL. The Proposed Plan outlines NASA's Preferred Alternative to conduct a remedial action for cleaning up the off-facility groundwater, which is the deep groundwater outside the JPL fenceline. Although this technical memorandum only addresses the proposed treatment system for the four City of Pasadena wells, NASA's Preferred Alternative consists of two separate actions:

1. Work closely with the City of Pasadena and fund the construction and operation of a treatment system for groundwater from the four City drinking water wells located just east of JPL near the Arroyo Seco. Although NASA proposes to provide the funding, given the nature of how the system would operate, NASA would not be directly operating the treatment system proposed for this remedial action. Rather, the City of Pasadena would be funded by NASA to lease treatment equipment and operate the system. Only this action is addressed in this technical memorandum.

2. Continue to fund treatment of groundwater from two Lincoln Avenue Water Company (LAWC) drinking water wells at an existing treatment facility. The Lincoln Avenue Water Company system is currently funded by NASA as a CERLCA removal action. The Proposed Plan includes this treatment system as part of the remedial action for off-facility groundwater.

Groundwater from four City of Pasadena drinking water wells would be cleaned in a new treatment facility using a liquid-phase granular activated carbon (LGAC) system to remove volatile organic compounds (VOCs), and an ion exchange system to remove perchlorate. Both technologies are proven approaches for treating these chemicals and have widespread application for remediation and drinking water treatment[2,3,4]. The system is proposed to be located on property owned by the City of Pasadena and adjacent to the Windsor Well and Windsor Reservoir (see Figure 1).

Liquid-phase granular activated carbon and ion exchange are proven technologies for treating volatile organic compounds and perchlorate, and have widespread application for drinking water treatment.

[1] NASA. 2006. *Proposed Plan To Fund Construction and Operation of Treatment Systems for Groundwater from Drinking Water Wells Located near the National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California*. April.
[2] Williams, R.B., C.L. Culp. 1986. *Handbook of Public Water Systems*. Van Nostrand Reinhold. New York.
[3] EPA. 1996. *Presumptive Response Strategy and Ex Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites*. Final Guidance. Office of Solid Waste and Emergency Response. EPA 540/R-96/023. October.
[4] EPA. 2005. *Perchlorate Treatment Technology Update*. Federal Facilities Forum Issue Paper. Office of Solid Waste and Emergency Response. EPA 542-R-05-015. May.

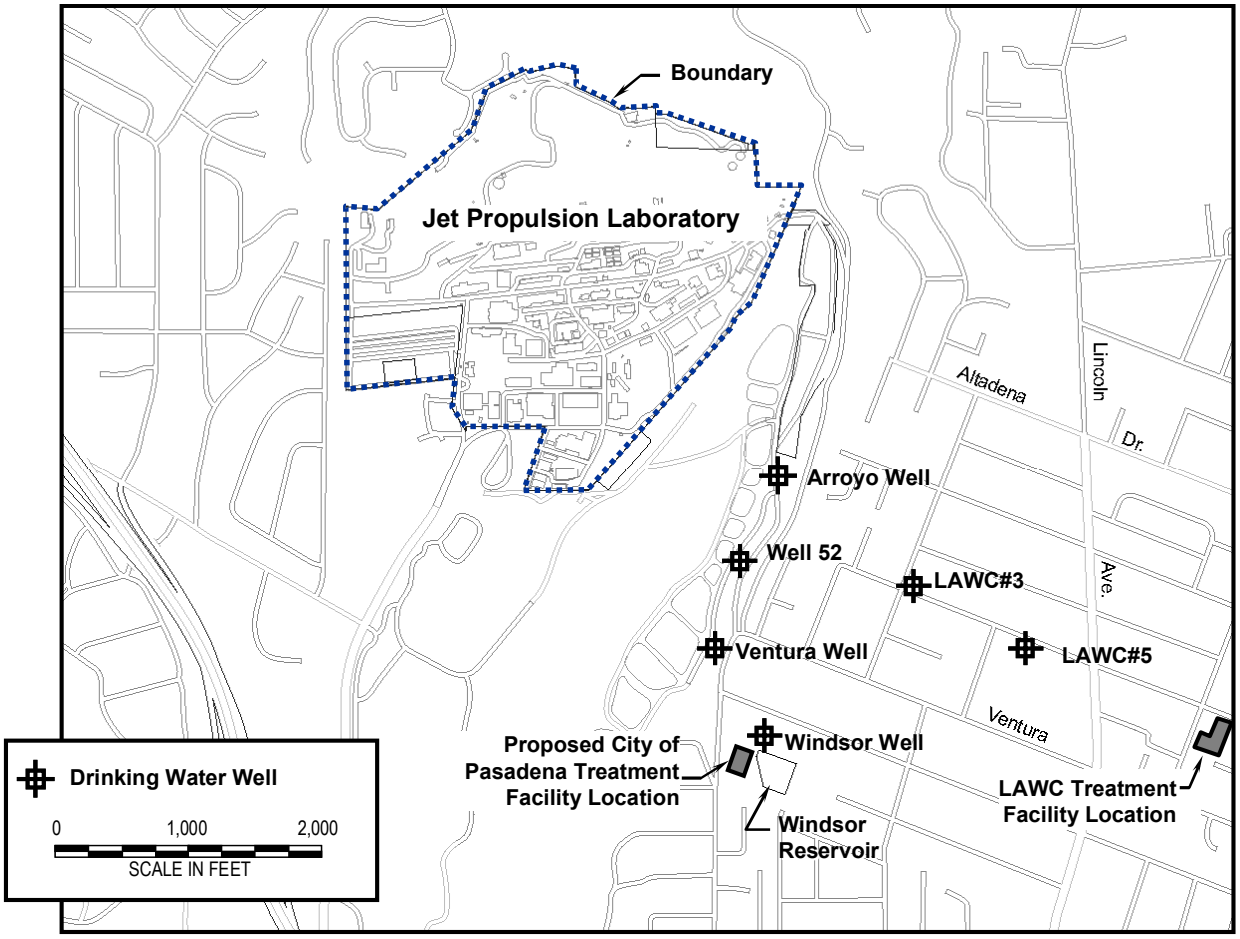

Figure 1. Location Map

APPROACH: CENTRALIZED TREATMENT VS. ON-FACILITY EXTRACTION AND REINJECTION

NASA has implemented several actions to clean up the source area groundwater[5] and soils[6] at JPL, as well as the leading edge of the groundwater chemical plume (i.e., the Lincoln Avenue Water Company treatment system). Although these activities appear effective for both the source area and leading edge, NASA needs to address the mid-plume area, which has impacted the four City of Pasadena Monk Hill Subarea drinking water wells. The mid-plume is the area in between the source area treatment system and the LAWC wells. Mid-plume cleanup is necessary for timely restoration of the plume. To accomplish mid-plume cleanup, NASA evaluated two separate approaches:

a) *Centralized Treatment* – Centralized treatment refers to using the location of the four City of Pasadena Monk Hill Subarea drinking water wells, which are currently not in operation, to extract groundwater that would then be treated. This option would extract water from the mid-plume area and offers the added benefit of restoring the use of the four City of Pasadena Monk Hill Subarea wells because the extracted water would be treated and made available by the City of Pasadena for drinking water purposes.

b) *On-Facility Extraction and Reinjection* – On facility extraction and reinjection refers to installing new extraction and injection wells just inside the JPL fenceline and reinjecting the treated

[5] NASA. 2005. *Proposed Plan For Source Area Groundwater Cleanup at the NASA Jet Propulsion Laboratory, Pasadena, California*. November.
[6] NASA. 2002. *Record of Decision and Remedial Action Plan for Operable Unit 2, NASA Jet Propulsion Laboratory, Pasadena, California*.. September.

water back into the aquifer near the southern portion of the JPL facility. This action would be completely separate from the extraction, treatment, and reinjection activities associated with source area cleanup[7].

Although both centralized treatment and on-facility extraction and reinjection would address chemicals in the mid-plume area, they are not equally effective in restoring the aquifer. Use of centralized treatment at the four City of Pasadena Monk Hill Subarea wells restores the use of the aquifer much more rapidly. Groundwater modeling indicates that using on-facility extraction and injection to address the mid-plume area would result in the area of the aquifer between the JPL fenceline and the LAWC wells having chemical concentrations above cleanup levels for at least a decade or two after initiating treatment. This is due to the natural groundwater flow, which prevents on-facility extraction and reinjection from being able to remove the plume in the area beneath the Arroyo Seco and West Altadena. That would leave only the LAWC system to contain this large plume. Overall, the likelihood for the plume to escape containment and migrate to impact other drinking water wells could be increased with the on-facility extraction and reinjection approach.

Using on-facility extraction and reinjection as the cleanup action to address the mid-plume area would result in the area of the aquifer in between the JPL fenceline and the LAWC wells having chemical concentrations above cleanup levels for at least a decade or two.

Use of centralized treatment at the four City of Pasadena Monk Hill Subarea wells (Arroyo Well, Well 52, Ventura Well, and Windsor Well) would restore the use of the aquifer much more rapidly than on-facility extraction and reinjection, and would result in these wells being available for use by the City once the facility is constructed and permitted. Reinitiating the use of these four drinking water wells as quickly as possible is extremely important to the City, as the wells are an important part of the City's drinking water supply, historically having provided as much as 10 million gallons per day (i.e., approximately 7,000 gallons per minute). These wells were typically used during the warmer months when the demand for water is higher.

Considering the importance of restoring the aquifer and the location of the City of Pasadena wells within the mid-plume, centralized treatment using these wells is the proposed approach for the cleanup action to address the mid-plume area. As such, NASA determined that the most appropriate approach to consider further was centralized treatment, thus on-facility extraction and reinjection was not evaluated further.

REMEDIAL ACTION OBJECTIVES

Following extensive investigation[8] to identify the source, nature, and extent of chemicals present at the site, the U.S. Environmental Protection Agency's (EPA's) CERCLA process requires the development of remedial action objectives. These objectives provide a general description of what the cleanup action must accomplish, a basis for evaluating the cleanup options, and an understanding of how identified existing or future potential site risks will be addressed by the cleanup action. The remedial action objectives for NASA's Proposed Plan were developed in cooperation with the EPA Region 9; California Department of Health Services (DHS); California Department of Toxic Substances

[7] NASA. 2005. *Proposed Plan For Source Area Groundwater Cleanup at the NASA Jet Propulsion Laboratory, Pasadena, California*. November.

[8] Foster Wheeler Environmental Corporation. 1999. *Final Remedial Investigation Report for Operable Units 1 and 3: On-Site and Off-Site Groundwater*. Prepared for the National Aeronautics and Space Administration Jet Propulsion Laboratory. August.

Control (DTSC); and California Regional Water Quality Control Board (RWQCB), Los Angeles Region. The remedial action objectives are to:

- Remove target chemicals from the aquifer by treating water pumped from specified drinking water wells in the Monk Hill Subarea of the Raymond Basin. This is referred to as centralized treatment.
- Prevent further migration of the chemicals in groundwater.
- Provide additional data to assess possible long-term cleanup remedies for groundwater both on and off the JPL facility.

EVALUATION OF TREATMENT FACILITY LOCATIONS

The Proposed Plan presented the rationale for the technologies proposed for treating perchlorate and VOCs (i.e., ion exchange and LGAC) and to a lesser degree the decision to use centralized treatment (see above). The following describes in detail the various locations considered for the City of Pasadena treatment facility and why the Windsor Reservoir site was identified as the preferred location. NASA considered the following six locations (see also Figure 2) for centralized treatment of groundwater extracted from the four City of Pasadena Monk Hill Subarea wells:

- Location 1: Behner Surface Water Treatment Facility
- Location 2: JPL East Parking Lot
- Location 3: Windsor Reservoir
- Location 4: Existing Air Stripping Treatment Facility
- Location 5: JPL South Parking Lot
- Location 6: Sheldon Reservoir (added based on comment from May 3 Public Meeting).

This technical memorandum describes the evaluation conducted to determine the preferred location using the nine criteria for evaluating alternatives required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)[9]. The nine criteria are categorized into three groups:

Threshold Criteria (an alternative must meet these otherwise it cannot be selected)

- Overall Protection of Human Health and the Environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Primary Balancing Criteria (these are used to identify the best alternative among those that meet the threshold criteria)

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume of Contaminants
- Short-Term Effectiveness
- Implementability
- Cost.

Modifying Criteria (state and community acceptance may modify the Preferred Alternative identified through the evaluation of the Primary Balancing Criteria).

- State Acceptance
- Community Acceptance.

[9] 40 Code of Federal Regulations (CFR) Chapter 1 Section 300.430(e)(9)(iii).

Figure 2. Aerial photograph showing six areas near Arroyo Seco considered as locations for the City of Pasadena groundwater treatment facility

The threshold criteria (i.e., Overall Protection of Human Health and the Environment and Compliance with ARARs) would be met at all of the treatment facility locations. Centralized treatment using ion exchange and LGAC would be used regardless of the facility location. This approach would be protective of human health and the environment because chemicals would be removed by proven and reliable technologies prior to distribution. Also, this approach would comply with ARARs (i.e., constructed and operated in a manner that complies with all federal, state, and local regulations).

Because the same technologies would be used regardless of the site locations, Reduction of Toxicity, Mobility, or Volume of Contaminants would not vary by site location. Therefore, **the evaluation of the preferred location depends on Long-Term Effectiveness, Short-Term Effectiveness, Implementability, Cost, and Community Acceptanc**e. These criteria are explained below.

Long-term effectiveness addresses the risk associated with the implementation of the remedial alternative and the length of time until protectiveness is achieved.

Short-term effectiveness addresses how well human health and the environment are protected from impacts during the construction and system installation activities:

- Protection of community during construction activities
- Protection of workers during construction activities
- Construction duration
- Truck traffic (considering traffic during construction and operation)
- Noise and air quality (considering noise and air quality during construction and operation)
- Environmental impacts to the Arroyo Seco, which is a sensitive ecological area.[10]

Implementability of the treatment facility location addresses the technical and administrative feasibility of implementing an alternative, including:

- Zoning
- Size of property
- Location of property in relation to existing utilities (piping, electrical, etc.)
- Truck traffic during operation
- Ease of construction
- Ease of operation and maintenance
- Ease of undertaking additional remedial actions (if necessary)
- Natural, historical, archeological resources
- Coordination with other agencies.

Cost of the treatment facility is addressed in the following categories:

- Construction
- Operation and Maintenance (O&M).

Community Acceptance deals with the general concerns of the local community in relation to the existence of the treatment plant in the community.

Each of the six locations was evaluated based on these criteria and then rated as to how well they met the criteria in comparison to the other alternatives. The comparison to other alternatives included assigning a value to each criterion as follows:

○ = Good; ◑ = Fair; ● = Poor; ⊗ = Impractical

[10] City of Pasadena, Arroyo Seco Master Plans, Hahamongna Watershed Park Master Plan, Section 2.3 The Natural Environment, pp. 2-5 et seq. September 29, 2003.

Location 1: Behner Surface Water Treatment Facility

This area is located to the west of a residential area in Altadena, below the Florecita Farms neighborhood and to the east of JPL east parking lot. The area is approximately 0.9 acres. A narrow Forest Service road (North Arroyo Seco Road) provides access to and from the site, which is currently secured with a chain link fence. This relatively narrow access road is frequently used as a trail for bicycling and jogging. A row of trees on the east side of the road blocks the view of the existing surface water treatment facility from the road and the JPL east parking lot. The existing treatment facility would have to be demolished to provide space for construction of the proposed groundwater treatment plant. Figure 3 shows an aerial map of the facility. A view of the existing facility from a nearby trail is provided in Figure 4.

Highlights of the Behner site:

- *Approximately one mile of new piping is required to transfer the water to the facility and then back to Windsor Reservoir.*
- *Limited space for construction staging and any addition to the treatment plant.*
- *Increased truck traffic on Windsor Avenue and the Windsor Avenue extension.*
- *Requires significant energy consumption for transfer of the treated water.*
- *Requires major improvement to the access road for large deliveries.*
- *Requires demolition of existing surface water treatment facility.*
- *New treatment facility incompatible with planned use of property.*
- *Construction Cost: $7.0M; Annual O&M Cost: $3.2M.*

Short-Term Effectiveness (◑): The construction activities would have limited effect on the adjacent community, as the residential area is located at a different elevation. The houses that are located closest to the Behner site are mostly located on West Altadena Drive and Crestford Drive, which are approximately 50 feet higher in elevation than the site. The workers would be subjected to the short-term health impacts present at most construction sites, such as noises, dust, heavy equipment, etc., and would be required to follow all Occupational Safety and Health Administration (OHSA) construction-related health and safety guidelines. The impacts would be minimized by adhering to City of Pasadena requirements for construction hours, traffic control, noise, and dust control.

Construction activities would last approximately six to nine months due to the need for installation of 5,000 feet of new 24-inch-diameter pipelines to transport water to the Behner site and back to the Windsor Reservoir. The existing surface water treatment plant would need to be demolished before starting the construction of the groundwater plant, increasing the length of construction activities by two to three months. In addition, the current access roads would need to be widened and improved structurally to handle truck traffic. This would also increase the length of construction.

Truck traffic would increase on Windsor Avenue, the Windsor Avenue extension coming to the JPL east parking lot, and also within the JPL parking lot during the construction period and during operations and maintenance (O&M). As part of the system O&M, three to four deliveries per month of LGAC and/or ion exchange resin would be expected. All used media (e.g., used LGAC and resin) would be transported and disposed in accordance with state and federal regulations. The environmental impact to the Arroyo Seco area would likely be negligible other than removal of some vegetation that may be required for granting access to the trucks and equipment. In addition, because the proposed facility would be located along the Arroyo Seco, views from higher elevations (e.g., Altadena and La Cañada-Flintridge) would be difficult to mitigate.

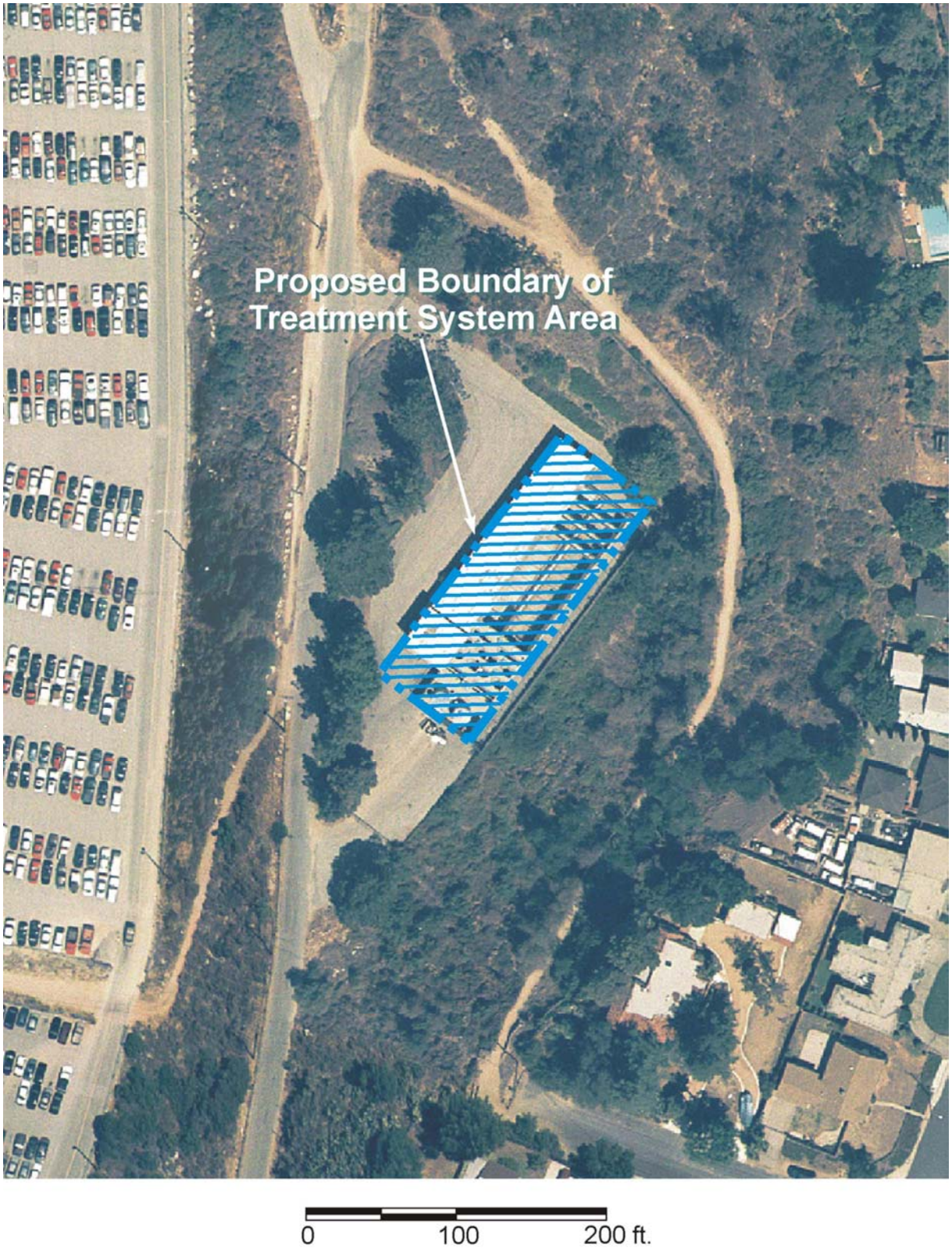

Figure 3. Aerial photograph of Behner Treatment Plant, showing proposed location of new treatment facility

Figure 4. Photograph showing fenced area where Behner Treatment Plant would be located; the existing surface water treatment plant (shown in the picture) would need to be demolished

Long-Term Effectiveness (◑): Because the site has served in the past as the location for a surface water treatment plant, there would be no additional risk to the areas in the vicinity of this location. The used LGAC and ion exchange resin would be removed and replaced using specialized equipment and trucks. The proposed LGAC and ion exchange systems do not require storage of any chemicals on site as part of routine operations. In addition, due to the long pipeline distance between the treatment facility and Windsor Reservoir, increased flushing of the pipelines would be required after periods of shutdown address bacterial growth.

As in each location, the treated water would need to be disinfected before the City of Pasadena could serve the water. Disinfection of water requires the use of certain chemicals, including sodium hypochlorite (i.e., bleach) and ammonium hydroxide (i.e., ammonia). To disinfect 10 million gallons of water per day requires a significant amount of these chemicals, which would be stored at the site in 2,000 and 5,000 gallon (approximately) tanks. The supply for these chemicals would be trucked to the site on a regular basis. All federal and state requirements would be followed in handling and storage of these chemicals to prevent spills, including separate, fully-enclosed, fully-contained tanks equipped with leak detection devices. This will minimize potential risk of exposure to any fumes. The treatment system parameters would be monitored to prevent a potential risk to the nearby community.

Implementability (●): This site does have the appropriate Public Space (PS) zoning for construction of a treatment facility and could accommodate the proposed facility, assuming a concrete pad with dimensions of 200 feet by 75 feet and some additional grading at the site. Although zoning would

allow for the proposed use of this site, a Conditional Use Permit would be required by the City of Pasadena. The required electrical power could be diverted to the area by means of overhead poles. Approximately 1,000 feet of piping (24-inch-diameter) would need to be installed to transfer the extracted groundwater to the site. The treated water would also require approximately 4,000 feet of separate pipeline to transfer the water to the Windsor Reservoir prior to distribution. Due to this site's location along a narrow forest service access road on a small bench partway up the side of the Arroyo, traffic access would be especially challenging. The access road to the site (North Arroyo Seco Road) would require major improvements to become usable for construction and operation purposes. After starting the system operation, truck deliveries of LGAC, ion exchange media, and the disinfection chemicals would occur three to four times per month. Due to limited space, large trucks would need to enter the site by driving the narrow forest service road and then exit by going the length of the JPL east parking lot and then up the narrow, winding Winsor Avenue extension. The extension of the Windsor Avenue is the only way to access east parking lot for the JPL employees.

The increased traffic due to deliveries would raise the risk level for traffic accidents on Windsor Avenue Extension and the JPL East Parking Lot. The construction activities would be more difficult due to the narrow access to the site and relatively far distance from the freeway (i.e., two miles). These same factors would also affect the ease of treatment plant operation for this site. The available flat land at this site would not accommodate any additions to the treatment train, if required in the future due to new chemicals or new regulations. No natural, historical or archeological resources would be impacted by placing a groundwater treatment plant at this site. It would be likely that the site can get approval from the EPA and RWQCB. Some concerns may be raised by DHS because of the lack of space for any potential addition to the treatment train. The Hahamongna Watershed Park Master Plan adopted by the City of Pasadena would not have to be amended for this site.

Moreover, the City of Pasadena intends to restore and use the existing surface water treatment plant. This would further complicate the administrative approval of placing a groundwater treatment plant at this site because several departments in the City of Pasadena would need to get involved in the approval process. Also, because this option would remove the existing surface water treatment plant, the City would need to construct a new treatment plant elsewhere in the area to directly use surface water as part of the drinking water supply if this site was selected.

Cost (●): The estimated construction cost for this location is $7.0M and includes design, demolition of the existing treatment facility, major improvements to the access road to the plant, 5,000 feet of new pipeline installation, site preparation, plant construction, mechanical systems installation, associated electrical work, and landscaping. The O&M cost is estimated to be $3.2M per year, and includes energy costs for transfer of water to the plant and back to Windsor Reservoir.

Community Acceptance (◑): The residential areas located approximately 200 feet to the east of the site (at a higher elevation) would be exposed to the traffic and noise from the facility during the construction activities. The increase in traffic during the long-term operation would affect traffic to the extension of Windsor Avenue and traffic through the JPL parking lot where recreational users access bicycle and jogging trails. The bicycle and jogging trails would not be available during the construction and delivery times. Therefore, it would be expected that concerns from the nearby residents, recreational users, and JPL employees could be raised in this regard.

Location 2: JPL East Parking Lot

This area is located to the east of JPL and to the northeast of Arroyo Seco, and is approximately 9 acres in size. The land is owned by the City of Pasadena and is currently leased by JPL and being used as a parking lot. The zoning category for this land is Open Space (OS). The southeast corner of the lot was considered for locating the groundwater treatment plant, as it is in the near vicinity of the Arroyo Well (less than 100 feet). Figure 5 shows the area considered for locating the treatment plant. A view of the parking lot looking east is shown in Figure 6.

Short-Term Effectiveness (◑): The construction activities would have limited effect on the adjacent community, as the site is over 300 feet from the nearest residence. The construction workers would be subjected to the same impacts as the other construction sites, including noises, dust, heavy equipment, etc., and would be required to follow all OHSA construction-related health and safety guidelines. The impacts would be minimized by adhering to City of Pasadena requirements for construction hours, traffic control, noise, and dust control.

Highlights of the JPL East Parking Lot site:

- *The Hahamongna Water Park Master Plan would need to be amended.*
- *Health and safety issues related to increased truck traffic on Windsor Avenue, the Windsor Avenue Extension, and the JPL East Parking Lot.*
- *Requires approximately 2,500 feet of additional piping to transfer water to Windsor Reservoir.*
- *There is no power currently available.*
- *Construction Cost: $5.1M; Annual O&M Cost: $3.1M.*

The construction duration would be expected to take five to seven months, including installation of approximately 2,500 feet of 24-inch-diameter pipeline for the treated water to be transferred to the Windsor Reservoir.

During the construction and O&M, the truck traffic would increase on the Windsor Avenue, the Windsor Avenue extension coming to and within the JPL East Parking Lot. Also, based on the proposed location of the treatment facility, the entrance to the JPL East Parking Lot would need to be modified. As part of the system O&M, three to four deliveries per month of LGAC and/or ion exchange resin would be expected. All used media (e.g., used LGAC and resin) would be transported and disposed in accordance with state and federal regulations. The environmental impact to the Arroyo Seco area would be limited; however, because the proposed facility would be located in the Arroyo Seco, views from higher elevations (e.g., Altadena and La Cañada-Flintridge) would be difficult to mitigate.

Long-Term Effectiveness (◑): Similar to other locations, the used LGAC and ion exchange resin would be removed and replaced using specialized equipment and trucks. The proposed LGAC and ion exchange systems do not require storage of any chemicals on site as part of routine operations.

As in each location, the treated water would need to be disinfected before the City of Pasadena could serve the water. Disinfection of water requires the use of certain chemicals, including sodium hypochlorite (i.e., bleach) and ammonium hydroxide (i.e., ammonia). To disinfect 10 million gallons of water per day requires a significant amount of these chemicals, which would be stored at the facility in 2,000 and 5,000 gallon (approximately) tanks. The supply for these chemicals would be

Figure 5. Aerial photograph of JPL East Parking Lot, showing proposed area needed for treatment plant

Figure 6. View of JPL East Parking Lot

trucked to the site on a regular basis. All federal and state requirements would be followed in handling and storage of these chemicals to prevent spills, including separate, fully-enclosed, fully-contained tanks equipped with leak detection devices. This will minimize potential risk of exposure to any fumes. The treatment system parameters would be monitored to prevent a potential risk to the nearby community.

Implementability (●): The zoning category for this site Open Space (OS) would allow construction of a treatment facility; however, a Conditional Use Permit would be required. The considered portion of land in the southeast corner could accommodate the proposed treatment system, assuming concrete pad dimensions of 250 by 60 feet. To create an adequate staging area during construction, additional space within the parking lot would have to be blocked for several months. The required electrical power would need to be routed to the area by means of overhead and additional transformer banks would need to be installed. Approximately 100 feet of piping (24-inch-diameter) would need to be installed from the Arroyo Well to the site for transfer of the extracted groundwater. The treated water would also require a separate pipeline (approximately 2,400 feet) to be transferred to the Windsor Reservoir site for distribution. As with all of the locations, after starting the system operation, a regular schedule for trailer trucks, delivering the LGAC and ion exchange media and the disinfection chemicals would be required throughout the duration of the treatment system operation. This traffic would impact the extension of the Windsor Avenue to the JPL east parking lot, a steep, narrow winding road used by bikers and hikers to access the Arroyo Seco and spreading basins, and the only way for the JPL employees to access that lot.

Due to the relatively steep and narrow existing road, safety issues would be of concern. Required deliveries during construction and operation could raise the risk level for traffic accidents on this road. The construction activities would be more difficult due to the narrow access to the site. The same factors also affect the ease of operation for this site.

The available flat land at this site could accommodate additions to the treatment train, if required in the future, by further converting parking spaces. No natural, historical or archeological resources would be impacted by placing a groundwater treatment plant at this site. It would be likely that the site could get approval from the EPA, DHS, and RWQCB. The Hahamongna Watershed Park Master Plan adopted by the City of Pasadena would have to be amended for construction of a treatment plant at this site.

Cost (◑): The estimated construction cost for this location is $5.1M and includes design, 2,500 feet of new pipeline installation, site preparation, plant construction, mechanical systems installation, associated electrical work, and landscaping. The O&M cost is estimated to be $3.1M per year.

Community Acceptance (◑): The residential areas located within 300 feet to the east of the site (at a higher elevation) would be exposed to the additional dust and noise from the facility during the construction activities. The increase in traffic on Windsor Avenue extension during the long-term operation would increase health and safety risks to recreational users and JPL employees. These considerations may raise concerns from the nearby residents, recreational users, and JPL employees.

Location 3: Windsor Reservoir

This area is located at 2696 Windsor Avenue and covers approximately four acres. The land is owned by the City of Pasadena and has been used as a drinking water reservoir for over a century, with a total capacity of approximately 4.75 million gallons. The zoning category for this land is Public Space. The west portion of the site was considered for locating the groundwater treatment plant. Figure 7 shows the area considered for locating the treatment plant. Figure 8 shows a view of the site looking east from Windsor Avenue.

Highlights of the Windsor Reservoir site:

- *Shortest construction duration of the alternatives.*
- *Necessary power already exists at the site.*
- *Piping from the drinking water wells is already in place because these wells discharge to the Windsor Reservoir.*
- *Increased truck traffic on Windsor Avenue.*
- *The available space at the site will facilitate access and construction staging.*
- *Construction Cost: $3.2M; Annual O&M Cost: $3.1M.*

Short-Term Effectiveness (◑): Because the site would be located in the middle of a residential area, the construction activities could have some effect on neighbors living in the vicinity of the site, including truck traffic, noise, and dust. The impacts would be minimized by adhering to City of Pasadena requirements for construction hours, traffic control, noise, and dust control. The workers would be subjected to the same health impacts as the other evaluated sites, such as noises, dust generation, heavy equipment, etc., and would be required to follow all OHSA construction-related health and safety guidelines.

Construction activities would last approximately 3 to 4 months, assuming no interruptions. Because this location is adjacent to the Windsor Reservoir (the distribution point for the treated water), a very limited amount of pipeline installation is required, only about 300 feet, and all would be placed within the Windsor Reservoir property.

Figure 7. Aerial photograph of Windsor Reservoir site, showing proposed location of treatment plant

Figure 8. View of Windsor Reservoir site, looking west from Windsor Avenue

Truck traffic would increase on Windsor Avenue during the construction period and during O&M. As part of the system O&M, three to four deliveries per month of LGAC and/or ion exchange resin would be expected. All used media (e.g., used LGAC and resin) would be transported and disposed in accordance with state and federal regulations. Because there would be no construction activities in the Arroyo Seco area, no environmental impact to that area would be expected.

Long-Term Effectiveness (◑): The treatment system itself would not result in any longer term impacts from its operation. The used LGAC and ion exchange resin would be removed and replaced using specialized equipment and trucks. The proposed LGAC and ion exchange systems do not require storage of any chemicals on site as part of routine operations.

As in each location, the treated water would need to be disinfected before the City of Pasadena could serve the water. Disinfection of water requires the use of certain chemicals, including sodium hypochlorite (i.e., bleach) and ammonium hydroxide (i.e., ammonia). To disinfect 10 million gallons of water per day requires a significant amount of these chemicals, which would be stored at the site in 2,000 and 5,000 gallon (approximately) tanks. The supply for these chemicals would be trucked to the site on a regular basis. All federal and state requirements would be followed in handling and storage of these chemicals to prevent spills, including separate, fully-enclosed, fully-contained tanks equipped with leak detection devices. This will minimize potential risk of exposure to any fumes. The treatment system parameters would be monitored to prevent a potential risk to the nearby community. When the Windsor Reservoir was in operation previously, gaseous chlorine was stored at this location and used for disinfection.

Implementability (○): This site does have the appropriate zoning (PS) for construction of a treatment facility; however, a Conditional Use Permit would be required by the City of Pasadena. The portion of the site proposed for the treatment facility could easily accommodate a 150 feet by 100 feet concrete

pad. In addition, there would be space available to be used as the staging area that will be used temporarily (three to four months) for construction activities. A number of structural features at the site would facilitate implementation of this location. For example, required electrical power already exists in the area thus none would need to be constructed. Adequate piping for delivery of the extracted water from Arroyo Well, Well 52, Windsor, and Ventura well to the site already exists. Only limited construction of a 24-inch-diameter pipeline (approximately 300 feet) within the open area of the site (to the west of the reservoir) would be required to connect the new treatment system to the existing pipelines and the Windsor Reservoir. After starting system operation, trailer trucks would deliver the LGAC and ion exchange filter media and the disinfection chemicals to the site on a regular basis during O&M. This traffic would impact the Windsor Avenue area south of Windsor Reservoir. The road leading to this location from the south is about 80 feet wide. This provides sufficient space to accommodate trucks access to the site safely outside the flow of traffic.

Construction-related activities would be facilitated due to good accessibility of the site. The site is located less than one mile from the 210 Freeway and on a main street (Windsor Avenue) with two gates for accessing on the north and south ends. The operation of the plant at this site would be facilitated due to frequent daily presence of the City of Pasadena personnel at the site for other ongoing activities at the existing Reservoir. The available flat land at this site could easily accommodate additions to the treatment train, if required in the future. No natural, historical or archeological resources would be impacted because of placing a groundwater treatment plant at this site. EPA, DHS, and RWQCB consider this site technically acceptable for this purpose. The Hahamongna Watershed Park Master Plan adopted by the City of Pasadena would not have to be amended for construction of a treatment plant at this site.

Cost (○): The estimated construction cost for this location is $3.2M and includes design, 300 feet of new pipeline installation, site preparation, plant construction, mechanical systems installation, associated electrical work, and landscaping. The O&M cost is estimated to be $3.1M per year.

Community Acceptance (◑): Based on input received during the public meetings, the neighbors adjacent to and near the Windsor Reservoir site would be concerned about the noise, plant aesthetics, and possibility for impacts from construction and operation of the treatment plant. Community acceptance will be determined based on input received during the comment period on the Proposed Plan.

Location 4: Existing Air Stripping Treatment Facility

This area is located in the Arroyo, next to the Arroyo Seco discharge basins, and to the west of Windsor Avenue. This is a narrow area and the available land is less than 0.5 acres. The land is owned by the City of Pasadena and is currently being used as the location of the existing air stripper unit which is no longer operational. Concurrence has been obtained from the DHS to remove the air stripper from the groundwater treatment train. The zoning category for this land is Open Space (OS). The site is right next to the Ventura well location. Figure 9 shows the area considered for locating the treatment plant. Figure 10 shows a view of the site from the adjacent Auzenne Avenue.

Highlights of the Existing Air Stripping Treatment Facility site:

- *Located within recreation area/natural open space.*
- *Would require amending the Hahamongna Water Park Master Plan.*
- *Shortage of space to accommodate the proposed treatment plant.*
- *No room for construction staging or possible addition to the treatment train.*
- *Difficult access for construction and operation purposes.*
- *Construction Cost: $5.2M; Annual O&M Cost: $3.1M.*

Figure 9. Aerial photograph of the Existing Air Stripping Treatment Facility, showing proposed area needed for new facility

Figure 10. View of Existing Air Stripping Treatment Facility, from Auzenne Avenue

Short-Term Effectiveness (●): The construction activities would have limited effect on the adjacent community, as the site is over 200 feet from the nearest residence. The workers would be subjected to the same impacts as the other construction sites, such as noises, dust, heavy equipment, etc. and would be required to follow all OHSA construction-related health and safety guidelines. The impacts would be minimized by adhering to City of Pasadena requirements for construction hours, traffic control, noise, and dust control. The construction duration would be expected to take approximately 12 to 15 months due to the difficult access to the site and associated road improvements.

The truck traffic would increase on Windsor Avenue and the Windsor Avenue extension that leads to the JPL east parking lot during the construction period and during O&M. As part of the system O&M, three to four deliveries per month of LGAC and/or ion exchange resin would be expected during system operation. All used media (e.g., used LGAC and resin) would be transported and disposed in accordance with state and federal regulations. In addition, the road leading to this location is used by recreational users, which would be interrupted.

The environmental impact to the Arroyo Seco area would be significant due to considerable need for construction within the Arroyo Seco, including improvements to Auzenne Avenue located immediately to the east of the infiltration basins. In addition, because the proposed facility would be located along the Arroyo Seco, views from higher elevations (e.g., Altadena and La Cañada-Flintridge) would be difficult to mitigate.

Long-Term Effectiveness (◑): Similar to other locations, the used LGAC and ion exchange resin would be removed and replaced using specialized equipment and trucks. The proposed LGAC and ion exchange systems do not require storage of any chemicals on site as part of routine operations.

As in each location, the treated water would need to be disinfected before the City of Pasadena could serve the water. Disinfection of water requires the use of certain chemicals, including sodium hypochlorite (i.e., bleach) and ammonium hydroxide (i.e., ammonia). To disinfect 10 million gallons of water per day requires a significant amount of these chemicals, which would be stored at the site in 2,000 and 5,000 gallon (approximately) tanks. The supply for these chemicals would be trucked to the site on a regular basis. All federal and state requirements would be followed in handling and storage of these chemicals to prevent spills, including separate, fully-enclosed, fully-contained tanks equipped with leak detection devices. This will minimize potential risk of exposure to any fumes. The treatment system parameters would be monitored to prevent a potential risk to the nearby community.

Implementability (⊗): The zoning category for this site (OS) would allow construction of a treatment facility; however, a Conditional Use Permit would be required. Conceptually, the available land in the area could accommodate the proposed treatment system, assuming concrete pad dimensions of 50 feet by 300 feet. However, there would be no practical space to be used as the staging area for construction. Installation of a retaining wall would be necessary at this site. The Pasadena Fire Department would not allow any long-term parking of large vehicles on the road next to the site. This would complicate any deliveries or staging of heavy equipment such as cranes at the site. In addition there would be only limited space on the access road for larger vehicles to turn around for exiting the area.

The required electrical power could be supplied to the area by means of the existing lines for the air stripper system. Because this site is the location of the existing air stripping plant, much of the needed pipelines are already in place. Installation of approximately 300 feet of 24-inch-diameter pipelines would be required to connect the new treatment system to the existing pipelines. Also the traffic on Windsor Avenue extension would be significantly impacted. Due to the difficulty of construction and a need for grading of the adjacent land, the duration of construction would be prolonged three to four times the estimated duration for the other sites (i.e., 12 to 15 months).

After starting the system operation, a regular schedule for trailer trucks, delivering the LGAC and ion exchange media and the disinfection chemicals would be followed for the duration of O&M. This traffic would impact the extension of the Windsor Avenue to the JPL east parking lot. The trailer trucks would have to make a U-turn at the intersection of Windsor Extension and Auzenne Avenue which would be difficult to make, and would likely require traffic control during each delivery. This traffic also would impact recreational use of the extension of the Windsor Avenue and Auzenne Avenue, as these roads are used to access the Arroyo Seco and spreading basis using these roads.

The same difficulties (such as accessibility) would also affect the operation at this site. The available flat land at this site could not accommodate additions to the treatment train, if required in the future. Natural resources may be impacted because of placing a groundwater treatment plant at this site due to additional grading of the land that would be required. The site likely could get approval from the EPA and RWQCB, but DHS may not approve of the location due to shortage of space for possible addition to the treatment train. The Hahamongna Watershed Park Master Plan adopted by the City of Pasadena would have to be amended for construction of a treatment plant at this site and it would

likely face opposition from the City of Pasadena and environmental groups due to sensitive species[11] and recreational use.

Cost (◑): The estimated construction cost for this location is $5.2M and includes design, 300 feet of new pipeline installation, 1,000 feet of retaining wall, site preparation, plant construction, mechanical systems installation, associated electrical work, and landscaping. The O&M cost is estimated to be $3.1M per year.

Community Acceptance (●): The residential areas located within 200 feet to the east of the site (at a higher elevation) would be exposed to the additional traffic and noise from the facility during the construction activities. The increase in traffic on Windsor Avenue, the Windsor Avenue extension, and Auzenne Avenue during construction and long-term operation would adversely affect residents, recreational users, and JPL employees. Due to the amount of construction that would be required in the Arroyo Seco, concern from environmental groups would likely be raised. Therefore, it would be expected that concerns from all these parties would be raised.

Location 5: JPL South Parking Lot

This area is located to the south of JPL and to the west of Arroyo Seco and it is approximately 1.1 acres. The land is owned by the City of Pasadena and is currently leased by JPL and used as a parking lot. The zoning category for this land is Planned Development (PD-16). The northern portion of the lot was considered for locating the groundwater treatment plant. Figure 11 shows the area considered for locating the treatment plant. Figure 12 shows a view of the site looking toward southeast.

Highlights of the JPL South Parking Lot site:

- *Installation of over one mile of new piping through the Arroyo Seco area would require amending the Hahamongna Master Plan and may have adverse effect on the natural resources and environment*
- *Construction Cost: $7.1M; Annual O&M Cost: $3.1M.*

Short-Term Effectiveness (●): The construction activities would not have any effect on the health of the JPL employees and adjacent communities. The workers would be subjected to the same impacts as the other construction sites, such as noises, dust, heavy equipment, etc. and would be required to follow all OHSA construction-related health and safety guidelines. The impacts would be minimized by adhering to City of Pasadena requirements for construction hours, traffic control, noise, and dust control. The construction duration would be expected to take approximately nine to 12 months due to the need for installation of approximately 6,000 feet of 24-inch-diameter pipelines across the Arroyo Seco. A separate pipeline has to be constructed to transfer the treated water from the site, across the Arroyo Seco, and down the Windsor Avenue Extension back to the Windsor Reservoir site.

The truck traffic would increase on Surveyor Road coming to JPL's south gate and also within the JPL parking lot during the construction period and during O&M. As part of the system O&M, three to four deliveries per month of LGAC and/or ion exchange resin would be expected during system operation. All used media (e.g., used LGAC and resin) would be disposed in accordance with state and federal regulations. The environmental impact to the Arroyo Seco area would be significant due to the need to construct a pipeline across the basin. In addition, because the proposed facility would be located in the Arroyo Seco, views from higher elevations (e.g., Altadena and La Cañada-Flintridge) would be difficult to mitigate.

[11] City of Pasadena, Arroyo Seco Master Plans, Hahamongna Watershed Park Master Plan, Section 2.3 The Natural Environment, pp. 2-5 et seq. September 29, 2003

Figure 11. Aerial photograph of JPL South Parking Lot, showing proposed area needed for a treatment facility

Figure 12. View of JPL South Parking Lot, looking south

Long-Term Effectiveness (◑): Similar to other locations, the used LGAC and ion exchange resin would be removed and replaced using specialized equipment and trucks. The proposed LGAC and ion exchange systems do not require storage of any chemicals on site as part of routine operations. In addition, due to the long pipeline distance between the treatment facility and Windsor Reservoir, increased flushing of the pipelines would be required after periods of shutdown address bacterial growth.

As in each location, the treated water would need to be disinfected before the City of Pasadena could serve the water. Disinfection of water requires the use of certain chemicals, including sodium hypochlorite (i.e., bleach) and ammonium hydroxide (i.e., ammonia). To disinfect 10 million gallons of water per day requires a significant amount of these chemicals, which would be stored at the site in 2,000 and 5,000 gallon (approximately) tanks. The supply for these chemicals would be trucked to the site on a regular basis. All federal and state requirements would be followed in handling and storage of these chemicals to prevent spills, including separate, fully-enclosed, fully-contained tanks equipped with leak detection devices. This will minimize potential risk of exposure to any fumes. The treatment system parameters would be monitored to prevent a potential risk to the nearby community.

Implementability (⊗): The zoning category for this site (PD-16) would allow construction of a treatment facility; however, a Conditional Use Permit would be required. The considered portion of the parking lot could accommodate the proposed treatment facility, assuming concrete pad dimensions of 250 by 60 feet. Also, additional space within the parking lot would need to be secured for several months for safety and staging construction equipment and materials. The required

electrical power can be diverted to the area by means of overhead poles; however, additional transformer banks would need to be installed. Approximately 4,000 feet of piping (24-inch) would need to be installed across the Arroyo Seco basin for transfer of the extracted and treated water. After starting the system operation, a regular schedule for trailer trucks, delivering the LGAC and ion exchange media and the disinfection chemicals would be kept for the entire duration of the treatment system's operation. This traffic would impact the Oak Grove Drive and Surveyor Road to the JPL south parking lot.

The construction activities raise safety concerns due to pedestrian traffic on Oak Grove Drive and within the JPL Facility. The operation of the treatment system at this site will be impacted by same factors as the construction. The available flat land at this site can accommodate additions to the treatment train, if required in the future, by further limiting the parking space. No natural, historical, or archeological resources would be impacted due to placing a groundwater treatment plant at this site.

The site likely could get approval from the EPA and RWQCB. Even though this plan would be visible from the Arroyo Seco, the Hahamongna Watershed Park Master Plan adopted by the City of Pasadena would not have to be amended for construction of a treatment plant at this site; however, the construction of the pipelines across Arroyo Seco would require that modification and it would be likely to face opposition from the City of Pasadena and environmental groups due to sensitive species[12] and recreational use. Because the proposed facility would be located along the Arroyo Seco, views from higher elevations (e.g., Altadena and La Cañada-Flintridge) would be difficult to mitigate. In addition, the accessibility of the site by the Pasadena water treatment personnel (because of JPL security measures) for daily monitoring of the system would have adverse effect on its implementability and would be a concern to DHS for system operation.

Cost (●): The estimated construction cost for this location is $7.1M and includes design, 6,000 feet of new pipeline installation, site preparation, plant construction, mechanical systems installation, associated electrical work, and landscaping. The O&M cost is estimated to be $3.1M per year.

Community Acceptance (◑): Because this site requires construction through the Arroyo Seco, concern by environmental groups would likely be raised.

Location 6: Sheldon Reservoir

This area is located on the Arroyo Boulevard, which is the continuation of Windsor Avenue to the south of Freeway 210. The site is approximately 1.0 mile to the south of Windsor reservoir and it is approximately 6.5 acres. The land is owned by the City of Pasadena and is being used as an active drinking water reservoir with a total capacity of approximately 11.8 million gallons. The zoning category for this land is Single-Family Residential (RS-6). The northern portion of the site was considered for locating the groundwater treatment plant. Figure 13 shows the area considered for locating the treatment plant. Figure 14 shows a view of the access road and the open area just to the north of the Reservoir that is proposed for location of the treatment pad.

Highlights of the Sheldon Reservoir site:

- *Easy access, close to a major freeway.*
- *Would require major piping (two miles) to the site and back to Windsor Reservoir, including crossing the 210 Freeway.*
- *Significant increase in energy consumption for transfer of water from the site.*
- *Lack of space for construction staging and possible addition to the treatment train.*
- *Close vicinity to residential housing (less than 50 feet).*
- *Construction Cost: $9.1M; Annual O&M Cost: $3.2M.*

[12] City of Pasadena, Arroyo Seco Master Plans, Hahamongna Watershed Park Master Plan, Section 2.3 The Natural Environment, pp. 2-5 et seq. September 29, 2003

Figure 13. Aerial photograph of Sheldon Reservoir showing proposed location of new treatment facility

Figure 14. View of access road and open area immediately to the north of Sheldon Reservoir

Short-Term Effectiveness (●): Because the site would be located in the middle of a residential area and due to the limited space available at the site, the construction activities would have some effect on neighbors living in the vicinity, including truck traffic, noise, and dust. The impacts would be minimized by adhering to City of Pasadena requirements for construction hours and dust control. The workers would be subjected to the same impacts as the other construction sites, such as noises, dust, heavy equipment, etc., and would be required to follow all OHSA construction-related health and safety guidelines. The impacts would be minimized by adhering to City of Pasadena requirements for construction hours, traffic control, noise, and dust control. The construction duration would be expected to take longer than for the Windsor Reservoir site due to the need for installation of 24-inch-diameter pipelines across the 210 Freeway, from the Windsor Reservoir to the site and back.

The truck traffic would increase on the Arroyo Boulevard during the construction period and during O&M. As part of the system O&M, three to four deliveries per month of LGAC and/or ion exchange resin would be expected during system operation. All used media (e.g., used LGAC and resin) would be transported and disposed in accordance with State and Federal regulations. The impact to the area in the vicinity of the 210 Freeway would be significant due to the need to construct the pipeline across the freeway, requiring specialized equipment to install the piping.

Long-Term Effectiveness (◑): Similar to other locations, The used LGAC and ion exchange resin would be removed and replaced using specialized equipment and trucks. The proposed LGAC and ion exchange systems do not require storage of any chemicals on site as part of routine operations. In addition, due to the long pipeline distance between the treatment facility and Windsor Reservoir,

increased flushing of the pipelines would be required after periods of shutdown address bacterial growth.

As in each location, the treated water would need to be disinfected before the City of Pasadena could serve the water. Disinfection of water requires the use of certain chemicals, including sodium hypochlorite (i.e., bleach) and ammonium hydroxide (i.e., ammonia). To disinfect 10 million gallons of water per day requires a significant amount of these chemicals, which would be stored at the site in 2,000 and 5,000 gallon (approximately) tanks. The supply for these chemicals would be trucked to the site on a regular basis. All federal and state requirements would be followed in handling and storage of these chemicals to prevent spills, including separate, fully-enclosed, fully-contained tanks equipped with leak detection devices. This will minimize potential risk of exposure to any fumes. The treatment system parameters would be monitored to prevent a potential risk to the nearby community.

Implementability (⊗): The zoning category for this location would allow for construction of the treatment facility; however, based on the current zoning as a residential area, obtaining City's approval could be difficult. In addition, a Conditional Use Permit would be required. The considered portion of the site could accommodate the proposed treatment system, assuming concrete pad dimensions of 60 feet by 250 feet. The proposed location would impact existing infrastructure, including the chlorine house, the Sheldon well, influent pipelines to the Sheldon Reservoir, sewer lines, power lines, and the service driveway.

The required electrical power would need to be diverted to the area by means of overhead poles and additional transformer banks would need to be installed. Over two miles of 24-inch-diameter pipeline would need to be installed to transfer the extracted for the wells and the treated water back to Windsor Reservoir, including crossing the 210 freeway. After starting the system operation, a regular schedule for trailer trucks, delivering the LGAC and ion exchange media and the disinfection chemicals would be kept for the whole duration of operation. This traffic would impact the Arroyo Boulevard area.

The construction activities would be more difficult due to the shortage of space for the staging area. The available flat land at this site would not likely to accommodate additions to the treatment train, if required in the future. No natural, historical or archeological resources would be impacted because of placing a groundwater treatment plant at this site. The site likely could get approval from EPA and RWQCB. However, due to the lack of space for a potential expansion of the treatment train, DHS likely would discourage the selection of the site. The Hahamongna Watershed Park Master Plan adopted by the City of Pasadena would not have to be amended for construction of a treatment plant at this site.

Cost (●): The estimated construction cost for this location is $9.1M and includes design, 10,000 feet of new pipeline installation, site preparation, plant construction, mechanical systems installation, associated electrical work, and landscaping. The O&M cost is estimated to be $3.2M per year, and includes energy costs for transfer of water back to Windsor Reservoir.

Community Acceptance (●): It would be expected that the neighbors who share the borders of the site with their backyards at the north and east of the reservoir site would be concerned about the noise and associated risk with constructing and operation of the treatment plant. The neighbors who live on the north side of the site would be less than 50 feet from the treatment plant. Therefore, it would be expected that concerns from the community would be raised in this regard.

EVALUATION SUMMARY

Based on the six evaluated alternative locations for the proposed Monk Hill water treatment plant, the Windsor Reservoir site is considered the preferred location (see summary in Table 1 below). The overall rating is based on relatively high ratings for short-term effectiveness, implementability and cost for this location.

The Windsor Reservoir site is followed in ranking by the Behner Water Treatment Plant location and the JPL East Parking Lot. The reduced ranking of these two sites is due to the difficulty and safety concerns of implementing construction and operation activities (in case of the JPL East Parking Lot) and higher overall costs for construction of the plant (in case of the Behner Water Treatment Plant location).

These three locations are followed in rank by the JPL South Parking Lot site, Sheldon Reservoir site, and the Existing Air Stripper Facility location. The relatively low rankings for these sites are generally due to lack of implementability and significant short-term impacts on the adjacent areas.

Table 1. A Comparison of the Practicality of Different Locations for Installation of the Monk Hill Treatment Plant

Location	Short-Term Effectiveness	Long-Term Effectiveness	Implementability	Cost	Community Acceptance	Rank
Behner Water Treatment Plant	◑	◑	●	●	◑	*3*
JPL East Parking Lot	◑	◑	●	◑	◑	*2*
Windsor Reservoir Site	◑	◑	○	○	◑	*1*
Existing Air Stripping Treatment Facility	●	◑	⊗	◑	●	*4*
JPL South Parking Lot	●	◑	⊗	●	◑	*5*
Sheldon Reservoir Site	●	◑	⊗	●	●	*6*

○ = Good; ◑ = Fair; ● = Poor; ⊗ = Impractical