Feasibility Study for

POTENTIAL IMPROVEMENTS

to McClellan-Palomar Airport Runway

FINAL REPORT - AUGUST 1, 2013

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The primary objective of the Feasibility Study for Potential Runway Improvements at McClellan-Palomar Airport (CRQ) project was to find a runway extension alternative that would satisfy the following criteria:

- ✈ The runway extension must be technically feasible from an engineering perspective.
- ✈ The runway extension must be fiscally responsible. It must be a good use of the funds that would be required for construction.
- ✈ The runway extension must make good business sense.
- ✈ The runway extension must be eligible for funding by FAA programming criteria.

If an alternative did not achieve all four of these criteria, it was to be considered infeasible.

McClellan-Palomar Airport is currently a primary, non-hub airport with a Runway Design Code (RDC) of B-II-4000 which relates to an airplane approach speed of greater than 91 knots but less than 121 knots with a wingspan of 49’ -< 79’ and a tail height between 20’ and 30’ with visibility minimums of lower than 1 mile but not less than ¾ mile.

An extension to the east of the existing runway would be over Unit 3 of an unlined former municipal solid waste landfill. The 200 foot alternative would require minimal improvements over the landfill in comparison to the longer extensions. Treatment of the existing landfill material to provide a stable base to construct a new pavement system that satisfies FAA design criteria is eligible to receive FAA funding. The priority of funding being made available to support this construction is uncommitted by the FAA as the total needs of the FAA funding is greater than the amount of funding that is actually available. Any potential future settlement of the existing landfill presents development challenges for the Airport, as funding of any repairs to the pavement surface prior to the end of its useful life is doubtful.

Currently, the airport is being used by a variety of aircraft (C-III) which are larger than the facility is designed to handle (B-II) and the forecast indicates that this usage will continue in the future. Although the footprint of the overall airport is able to handle a runway extension to reclassify the airport as a C-III, the change would involve extensive reconfiguration of the entire airfield including tenant improvements, airplane parking loss and/or relocation, impacts to buildings, and the relocation of NAVAIDs, fuel tank/station and the airfield lights and signs systems. Therefore any extension alternative that would reclassify the airport would be considered not feasible.

The forecast generated for McClellan-Palomar indicates that to meet the current and future needs for an Airport Reference Code (ARC) B-II airfield, a runway length of 5,800 feet would meet the departure needs. A landing length of 5,200 feet was determined to be most reasonable for these B-II business jet operators. A length of at least 5,000 feet for departure and landing would permit the operators more flexibility in their operations by reducing delays or flight cancellation. The Falcon 2000 (B-II design aircraft for runway length) the extra 100 feet would allow approximately 600-700 lb additional payload on takeoff. The impact varies depending upon the aircraft. It can also make a difference for landings because aircraft must take a 15 percent penalty when the runway is wet, extending the runway length greater than 5000 feet would remove the imposed dry only restriction to Hawkers and G IV/450 fleets and allow all fleets to operate closer to their design specifications.

After determining and evaluating the forecast for CRQ, preliminarily laying out the airfield geometry, analyzing the structural stabilization alternatives available, drafting rough order of magnitude construction costs, and developing a business case and benefit cost analysis, three alternatives for extensions on the east side of the runway and one safety improvement on the west side were evident.

WEST END

With the realization that 45% of the total business jet operations are by aircraft with recommended design standards greater than the design of the runway, the recommended solution for the west side of the runway, regardless of the east end alternative, was to improve the safety area beyond the B-II standard to account for the volume of more demanding aircraft that visit this airport. To provide the equivalent runway safety area margins at the west end of the existing runway a 315 foot Engineered Material Arresting System (EMAS) is proposed along with the required platform construction to support this new EMAS. This EMAS would be located 35 feet from the existing west end of the runway and extend 315 feet to the west. This EMAS would effectively provide the required runway safety area (RSA) for the existing ARC of B-II as well as satisfy the criteria to the C-III aircraft operating from the airport. With the installation of the EMAS, the existing localizer equipment is required to be relocated approximately 50 feet further west, but no other navigational equipment will need to be adjusted. See **Figure ES-A** for the recommended safety improvements for the west end of the runway. The estimated construction cost for the west end safety improvements are as follows:

Alternative	Description	Probable Construction Costs
West End	West End Safety Improvement including EMAS and grading	$25.4 Million

EAST END

A major factor in determining the recommended extension alternative on the east end was the impact to the Municipal Solid Waste from an old landfill. In order to be considered feasible, the extension needed to be eligible for FAA funding and the FAA will not fund projects built directly on landfill due to continued settlement issues. Therefore part of this study investigated structural stabilization alternatives (landfill mitigation options) that would accompany the different length alternatives. The four structural alternatives and their associated cost per square foot are as follows:

LANDFILL OPTIONS

- Option 1a: Structural Slab Supported on Steel Driven Piles – $121/SF
- Option 1b: Structural Slab Supported on Displaced Driven Concrete Piles – $109/SF
- Option 2: Drilled Displacement Columns – $72/SF
- Option 3: Injection Grouting (Compaction Grouting) – $70/SF
- Option 4: MSW Excavation (clean closure) – $207/SF

Each of the ground improvement alternatives for the airfield stabilization was evaluated according to how well it addressed the current and future settlement of the MSW materials, construction impacts to airport operations, as well as initial and future lifecycle costs. Taking this into consideration, the recommended alternative for the airfield stabilization are drilled displacement columns (DDC) supporting lightweight fill and an asphalt concrete pavement section. DDCs provide a cost effective ground improvement option for increasing the bearing capacity and load transfer capabilities of the underlying materials while reducing the potential for future settlement of the airfield.

With options to provide a stable base to construct on, the east end extension options and needs were explored. Three length options were further evaluated to provide varying levels of operational support for the B-II aircraft forecasted to use this runway into the future; those alternatives are as follows (See **Figures ES-B, ES-C, and ES-D**):

EXTENSION ALTERNATIVES

- Alternative A: a runway extension of 200 feet, for a total length of 5,100 feet maintaining the existing ARC of B-II, minimal impact to the unlined landfill
- Alternative B: a runway extension of 900 feet, for a total length of 5,800 feet maintaining the existing ARC of B-II, best meet the forecasted demand for runway length
- Alternative C: a runway extension of 1,200 feet, for a total length of 6,100 feet; potential change in ARC to C-III with accompanying airfield improvements deeming this alternative not feasible

Each alternative was preliminarily laid out on the east end of the runway to determine grading limits, retaining wall locations and varying taxiway improvements required for the extension option. A rough order of magnitude construction cost was generated for each of the various options associated with the extension alternatives and are as follows:

Alternative	Description	Probable Construction Costs
A	200 ft extension with north and south side end connector taxiways	$22.5 Million
B-1	900 ft extension with north side end connector taxiway	$49.6 Million
B-2	900 ft extension with north and south side end connector taxiways	$69.7 Million
C-1	1200 ft extension with north side end connector taxiway	$61.3 Million
C-2	1200 ft extension with north and south side end connector taxiways – realign Palomar Airport Rd	$183.9 Million
C-3	1200 ft extension with north and south side end connector taxiways – bridge Palomar Airport Rd	$550.4 Million

This study has determined that this project is eligible for grant funding consideration. However, the FAA determines prioritization for distribution of CIP grant funds based on safety, security, maintaining existing facilities and capacity, in that order. Based on this prioritization, the west end safety improvements would be eligible for grant funding before the east end extension portion of this study. The east end extension is considered a capacity project and would therefore be considered for funding after higher priority projects on the FAA list. The east end extension also has the potential for a higher cost sharing by the County associated with funding due to the capacity nature of the project.

The preferred runway extension alternative varies based on the funding availability, whether the project is built in phases or all at once. If the ultimate funding amount is not available at one time, it is recommended that Alternative A be built as it satisfies the immediate needs of the B-II airfield with minimal impact to the unlined landfill. When additional FAA funding becomes available, then Alternative B is the preferred alternative for the longer term needs of the airport serving B-II aircraft operations. The difference in cost based on the phasing is as follows:

Alternative	Description	Probable Construction Costs
A	200 ft extension with north and south side end connector taxiways	$22.5 Million
B-2 as second phase of A	900 ft extension with north and south side end connector taxiways	$51.0 Million
	Total Cost building A & B	$73.5 Million
B-2 w/o A	900 ft extension with north and south side end connector taxiways	$69.7 Million
	Incremental Cost	$4.5 Million

In order to select the best combination of runway length and structural stabilization alternative, a matrix was developed with multiple categories ranging from technically feasible to cost to RSAT issues. These alternatives were ranked on a scale from 1 to 9, 1 being the worst option and 9 being the best. Based on this analysis, the preferred Runway Extension Alternative if total funding is not available for a one phase project is Alternative A: a runway extension of 200 feet for a total length of 5,100 feet, using either the clean closure option or DDC piles to handle the landfill mitigation issue. If the funding is available, the recommended alternative combination based on the analysis is Alternative B: a runway extension of 900 feet for a total length of 5,800 using DDC piles to handle the landfill mitigation. Regardless of what is funded for the east end extension, the west end safety improvements should be built. The cost for the preferred alternative is as follows:

Alternative	Description	Probable Construction Costs
B-2 +West End	900 ft extension with north and south side end connector taxiways	$95.1 Million

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FIGURE ES-A: West Side Safety Improvements

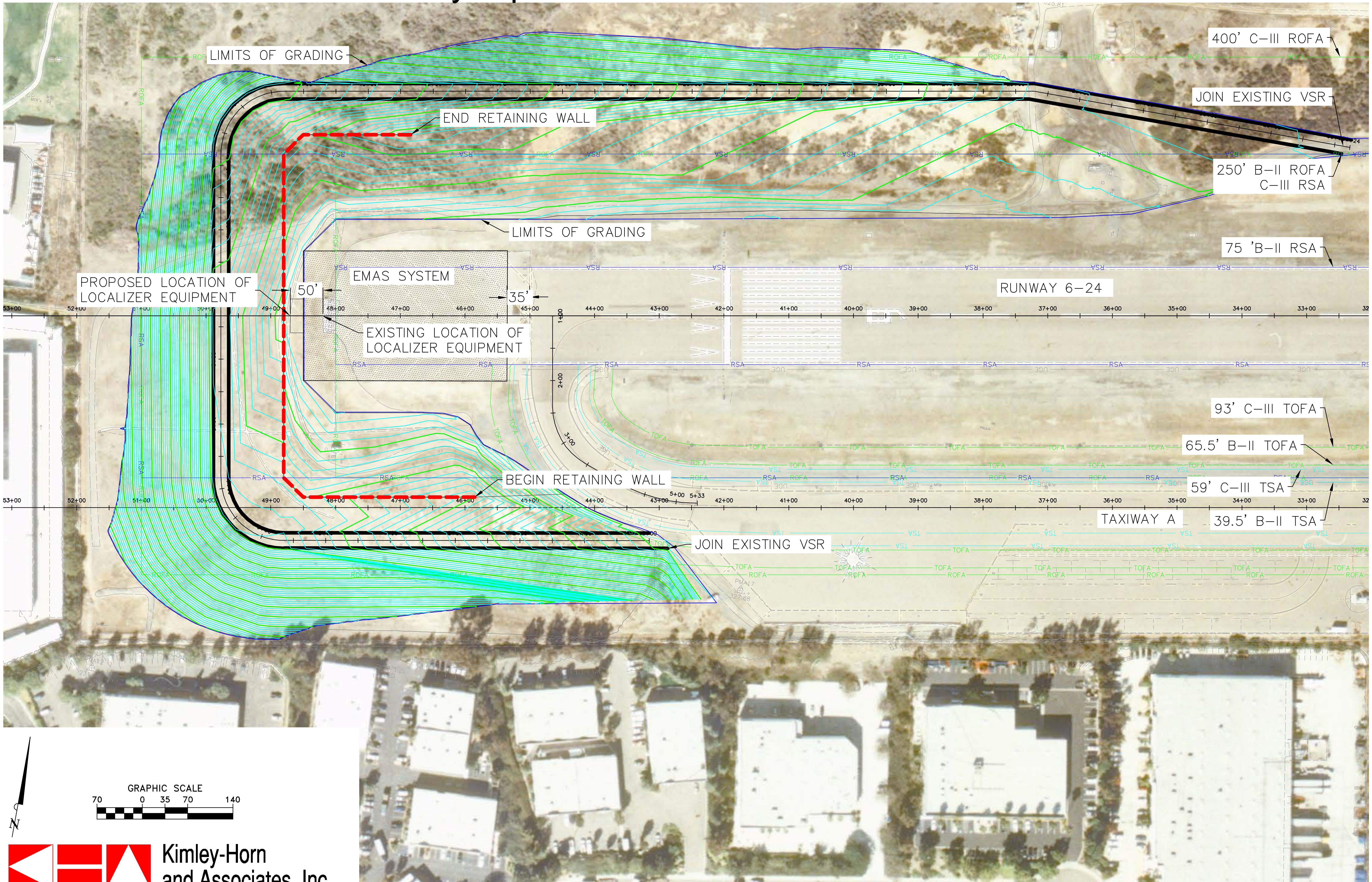

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FIGURE ES-B: Alternative A - 200' Extension of Runway 6-24

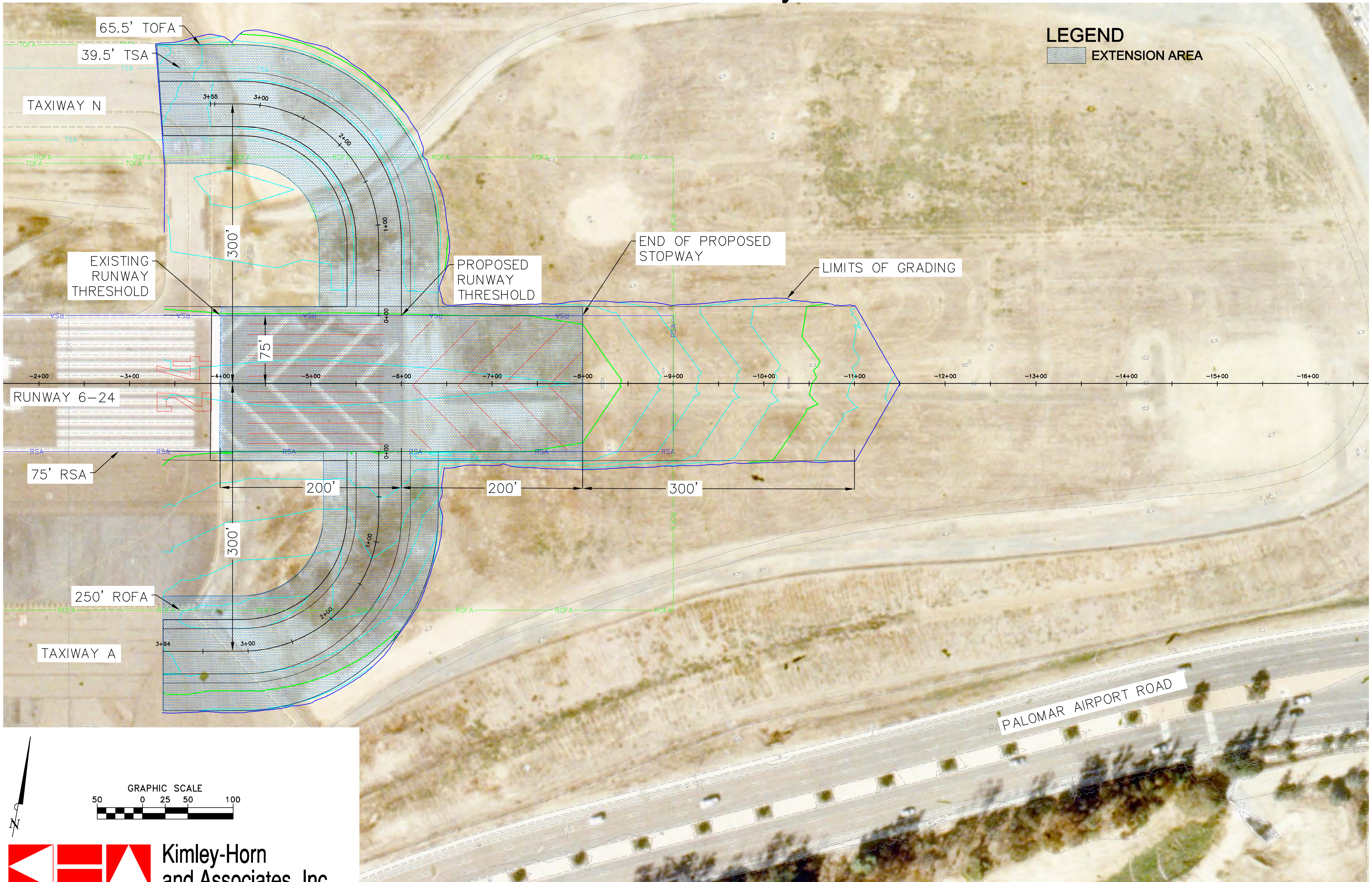

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FIGURE ES-C: Alternative B - 900' Extension of Runway 6-24 and Taxiway N

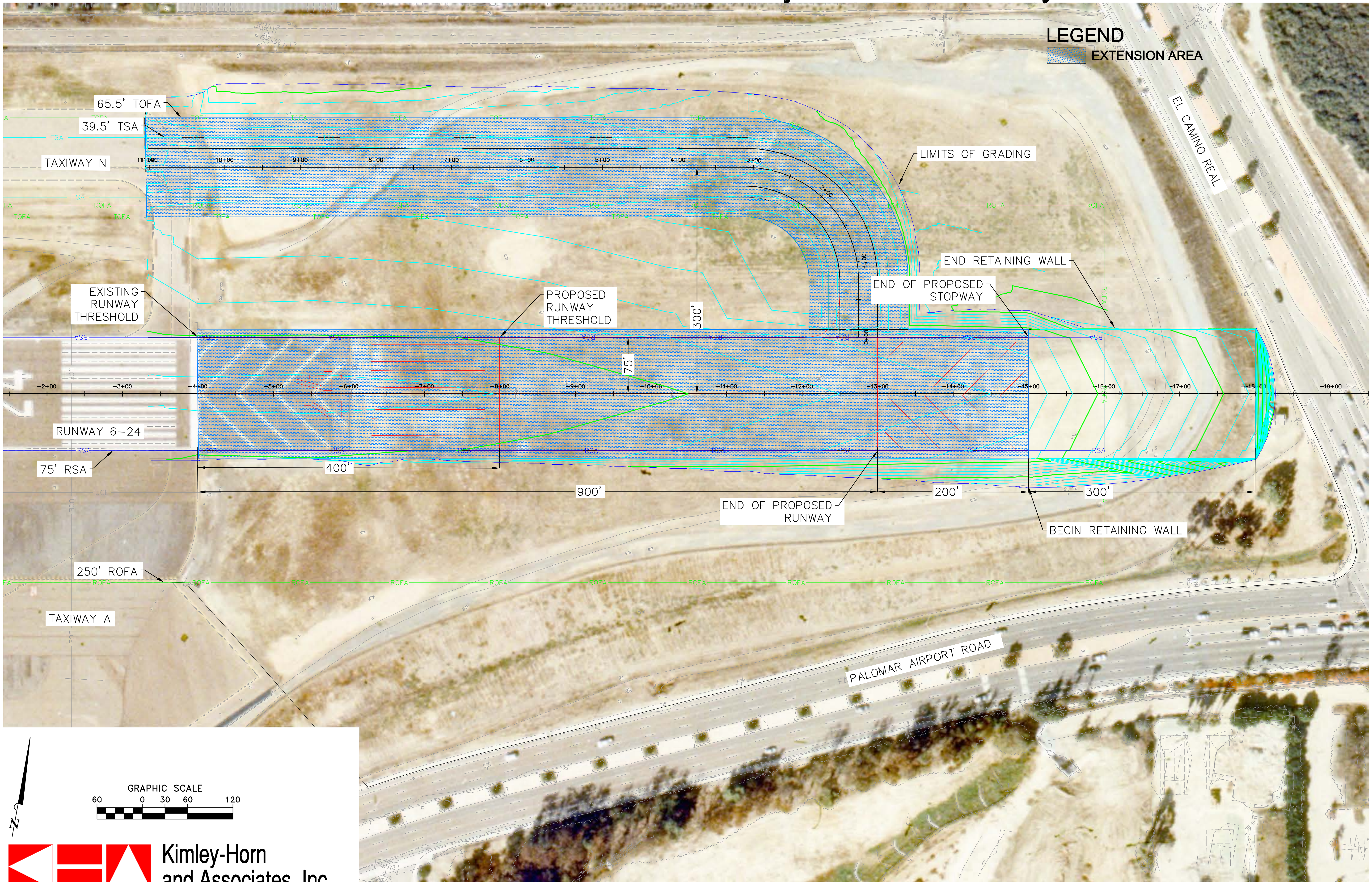

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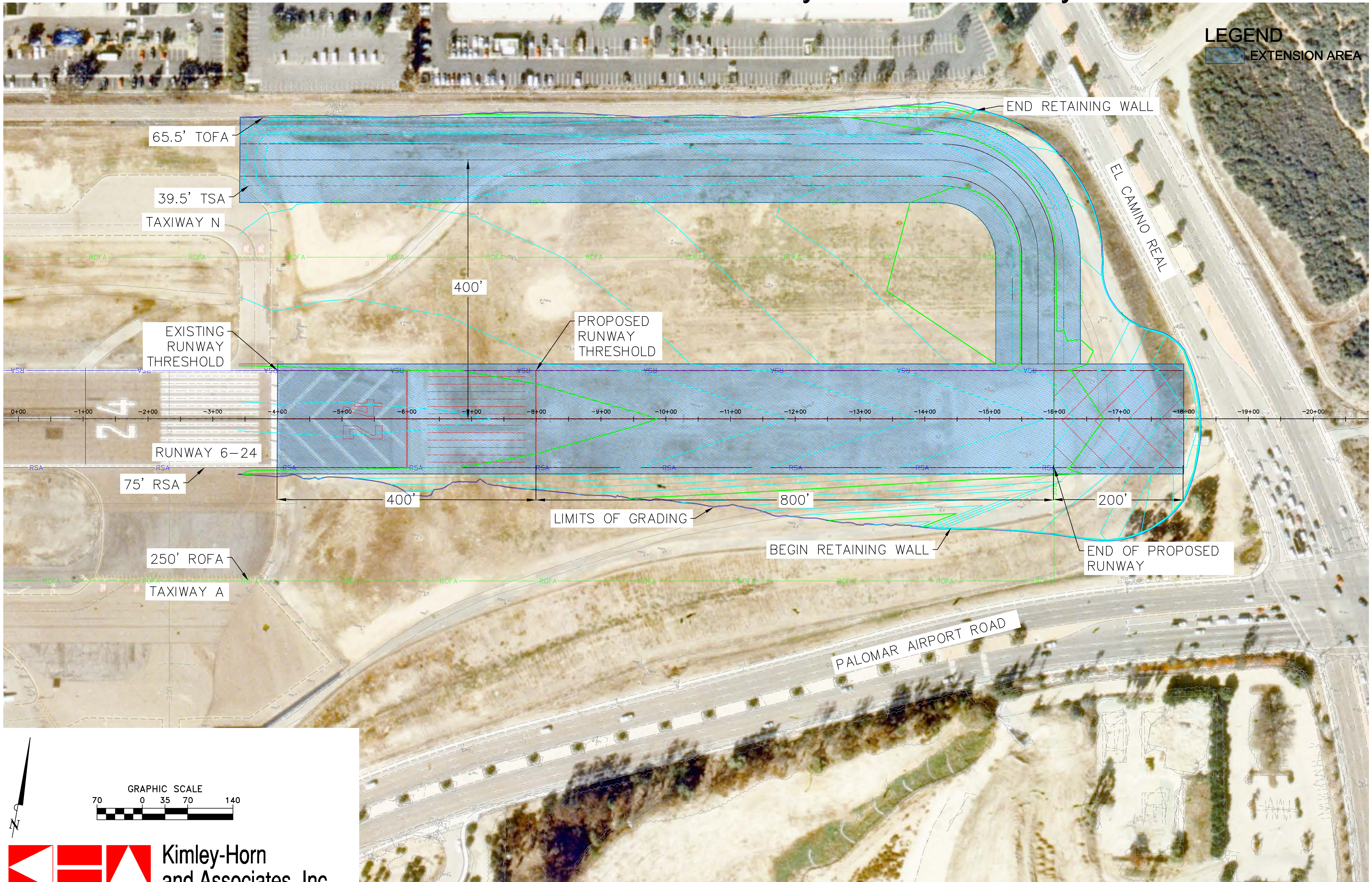
FIGURE ES-D: Alternative C - 1200' Extension of Runway 6-24 and Taxiway N



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Chapter One INTRODUCTION

McClellan-Palomar Airport (CRQ) is located in the City of Carlsbad, California, about 35 miles north of San Diego and 90 miles south of Los Angeles. **Figure 1A** shows the location of the airport in relation to the rest of San Diego County. Daily operations at CRQ are overseen by an airport manager with an administrative staff of eight people. In spite of its relatively small size and limited employment pool, the airport ranks as one of the country's busiest single-runway airports and is known as the premier general aviation service provider in northern San Diego County.

McClellan-Palomar Airport is currently designated with an Airport Reference Code (ARC) of B-II. The airport is being financed by the Federal Aviation Administration (FAA) and the County of San Diego, Department of Public Works, Airports Division. CRQ is classified in the National Plan of Integrated Airport Systems as a Primary Airport, which means that it has more than 10,000 annual passengers.

Since the airport was first constructed, it has undergone significant expansions and improvements. The runway has been extended and widened, several taxiways have been added, lighting and navigation systems have been installed, FAA facilities and safety features have been built, and a new terminal building has recently been opened as well. Each of these changes has played a role in the success of McClellan-Palomar Airport. However, in order to meet the growing demands of the airport, additional improvements are still required.

Projected data has shown that an additional runway extension at McClellan-Palomar Airport would lead to a significant economic benefit for the facility. Details about how these benefits can be achieved are shown in *Chapter 2 – Runway Extension Justification Statement.* Unfortunately, there are constraints on the potential project area that beg the question of whether or not such an extension is actually achievable. *The Feasibility Study for Potential Runway Improvements at McClellan-Palomar Airport* was conducted to address this question and to identify the potential drawbacks or benefits that would result from a runway extension.

The primary objective of this feasibility study was to find a runway extension alternative that would meet the following criteria:

- The runway extension must be technically feasible from an engineering perspective.
- The runway extension must be fiscally responsible. It must be a good use of the funds that would be required for construction.
- The runway extension must make good business sense.
- The runway extension must be eligible for funding by FAA programming criteria.

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FIGURE 1A: Project Location

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Not achieving all four of these criteria would cause an alternative to be considered infeasible. Details about how these objectives were accomplished are shown in *Chapter 6 – Alternative Analysis*.

The first phase of *The Feasibility Study for Potential Runway Improvements at McClellan-Palomar Airport* required a complicated research process. Historical airport usage data was collected and examined, land use and zoning requirements were investigated, and the existing airport infrastructure was thoroughly analyzed. Based on the data that was collected, a series of runway extension alternatives were developed and reviewed to assess their feasibility. The three most viable options were then researched in greater detail to determine what their economic benefits would be and how those benefits weighed against the costs of construction. Information about each of these three options was then used to create the Final Feasibility Report.

HISTORY

Palomar Airport was originally developed in the late 1950s as a replacement for Del Mar Airport which was closed to make way for the construction of Interstate 5. The site for the new airport was situated on 250 acres on top of a mesa with several crossing canyons that were used as landfills until 1986. Once they had been filled, these canyons were graded and capped. Methane extraction facilities and monitoring wells were subsequently installed throughout the site. Portions of the capped landfills have since been used for airfield and aircraft parking, but not as a base for any runway or taxiway pavement.

In 1975, the County of San Diego completed a Master Plan for the airport which called for a runway extension and the acquisition of 160 acres on the north side of the airport. The City of Carlsbad annexed the airport in 1978. In 1980, the County applied for a zoning change and a conditional use permit that allowed some flexibility in the development of the airport. Conditional Use Permit 172 (CUP-172) was issued by the City on September 24, 1980. Details about land use and zoning information are shown in the *Land Use and Zoning* section. McClellan was added to the name of the airport in 1982 to honor a Carlsbad private pilot and civic leader. Since that time, the airport has grown to cover nearly 500 acres and several of the airport's facilities have undergone expansions and improvements.

LAND USE AND ZONING

The 1975 Master Plan for McClellan-Palomar Airport included a runway extension and the acquisition of 160 acres on the north side of the airport to accommodate an additional runway, taxiways, and other airport facilities. After the Master Plan plan was completed, a group of local citizens became concerned that further development of the airport would have a negative impact on their community. This group began a petition that would require a vote of the people to approve any additional airport expansions. This petition led to the creation of City Council ordinance No. 9558 in August of 1980 which prevented a zoning change, General Plan Amendment, or any other legislative action to authorize the expansion of the airport without a City-wide vote.

Conditional Use Permit 172 was issued by the City of Carlsbad on September 24, 1980 with conditions that limited the approved uses of the airport and prohibited changes to CRQ's designation as a General Aviation Basic Transport Airport. CUP-172 prescribed that the installation of any airport administration buildings, passenger facilities, or dining establishments would require approval by the Carlsbad Planning Commission and a City-wide vote prior to construction activities.

The County of San Diego updated the Master Plan for McClellan-Palomar Airport in 1997. The new Master Plan maintained development within the current airport property and included the acquisition of some property, but development was limited to areas within the approaches to maintain and enhance safety for aircraft operations. The County of San Diego applied for amendment CUP-172A to reflect the improvements that were recommended in the Master Plan, but the application was later withdrawn.

In 2004, the Carlsbad Planning Commission approved Conditional Use Permit Amendment 172(B) to allow the development of three existing airport parcels with the condition that they be used only for parking. This amendment also stated that the current permitted uses and the existing airport designation as a General Aviation Basic Transport Airport shall not be changed unless a new amendment to CUP-172 is approved by the Carlsbad Planning Commission.

The conditions of CUP-172 require a vote of the people before any airport expansions may be permitted. For this reason, construction activities outside of airport property are considered to be infeasible. All improvements at McClellan-Palomar Airport must remain within the current airport property limits in order to comply with this permit. Today, the area surrounding McClellan-Palomar Airport is predominantly used for industrial and commercial purposes. The closest residential areas are located about one mile south of the airport and parcels directly to the south of the airport are currently being developed as commercial, retail, and professional areas. According to CUP-172, usage of these areas for airport expansion and improvements will not be allowed without a City-wide vote.

CURRENT AIRPORT FACILITIES

Airport facilities can typically be divided into one of three categories: airside, landside, or airport support. The airside facilities at McClellan-Palomar Airport consist of Runway 6-24, two parallel taxiways, nine connecting taxiways, parking areas and aprons to the north and south of the airfield, navigation aids, communications equipment, and airfield lighting.

When it first opened, Runway 6-24 at Palomar Airport was 3700 feet long and

100 feet wide. In the 1960s, it was extended to 4,700 feet and widened to its current width of 150 feet. Today, the runway is 4,897 feet long with a pavement section composed of a 12 inch cement treated subgrade, 6 inch asphalt treated base, and a 5 inch grooved bituminous surface course. The runway pavement has a strength rating of 60,000 pounds for single-wheel loading (SWL), 80,000 pounds for dual-wheel loading (DWL), and 110,000 pounds for dual-tandem wheel loading (DTWL). This means that the runway is capable of supporting the weight of the aircraft that use the runway, but it is not long enough to allow these aircraft to operate at maximum capacity. More information about how runway length can affect operations is shown in *Chapter 2-Runway Extension Justification Statement*.

Runway 6-24 is equipped with two parallel taxiways. Taxiway A runs for the full-length of the runway on the south side and has a width of 50 feet. Taxiway N is only 35 feet wide and it only runs from the east end of the runway to the west edge of the north airfield parking area. Taxiway A has six connecting taxiways which serve as exits off of the runway. Two of these taxiways serve as high-speed exits near the mid-point of the runway. Taxiway N has three connecting taxiways, but none of them serve as high-speed exits.

To aid with airport identification and navigation, runway lighting, airport marking aids, an Air Traffic Control Tower (ATCT), an Instrument Landing System (ILS), and an approach lighting system were installed during the 1960s and 1970s. High intensity approach lighting was added during the 1990s. Additional navigational systems at CRQ include an airport beacon with an optical system, lighted wind cones, taxiway lighting, visual approach slope indicators, threshold lights, pavement markings, the Non-directional Beacon in the City of Escondido, and many others.

Landside facilities mainly consist of accommodations for pilots, passengers, and aircraft while they are on the ground. Hangars, aircraft parking aprons, fuel storage tanks, vehicle parking areas, and the new 18,000 square foot terminal building that opened in 2009 are all covered under this category. Other landside services include fuel and oil sales, emergency aircraft removals, inspections, and facilities for aircraft cleaning, maintenance, and storage.

Support facilities such as airport access and available utilities are not classified as landside or airside, but they play a vital role in airport operations. Palomar Airport Road provides access to the airport from Interstate 5 to the west and El Camino Real provides access from Highway 78 to the north. Both roads are major arterials with three lanes in each direction. In terms of available utilities, McClellan-Palomar Airport receives water and sewage treatment services from the City of Carlsbad, natural gas and electric power from San Diego Gas and Electric, and telephone service from Pacific Bell.

Airport support facilities at CRQ are well established and are not in need of any renovations at this time. With the addition of the new terminal building, improvements to the airport's landside facilities are nearing completion as well. With the exception of the overall length of Runway 6-24, all of the facilities that are currently in place at McClellan-Palomar Airport are considered to be adequate to meet the growing demands of the airport. More detail about these systems is shown under *Facility Requirements*.

FACILITY REQUIREMENTS

In order to understand the future requirements of the facilities at McClellan-Palomar Airport, it is first important to analyze aviation demand forecasts and the inadequacies of the existing airport facilities. *Chapter 3 – Forecasts* shows a detailed analysis of the aviation demand forecasts for the airport. The conclusions drawn from this chapter were used to determine the scope of facilities that would be necessary to handle the growing demands of the airport.

RUNWAYS AND TAXIWAYS

The requirements for future runway improvements at McClellan-Palomar Airport were based on existing and forecasted aircraft usage and what geometry would best serve the airport and its users. Runway 6-24 currently meets the FAA recommended wind coverage standards, so there is no need for a multiple runway system or crosswind runways. However, additional capacity should be provided in order to meet the projected demands of the airport. This could be achieved with the addition of a parallel runway, but due to the limited space available and the limitations imposed by CUP-172, this is not an option. Instead, other methods of increasing capacity are recommended. Some of these methods include high-speed exit taxiways, displaced runway thresholds, and an increased length of runway.

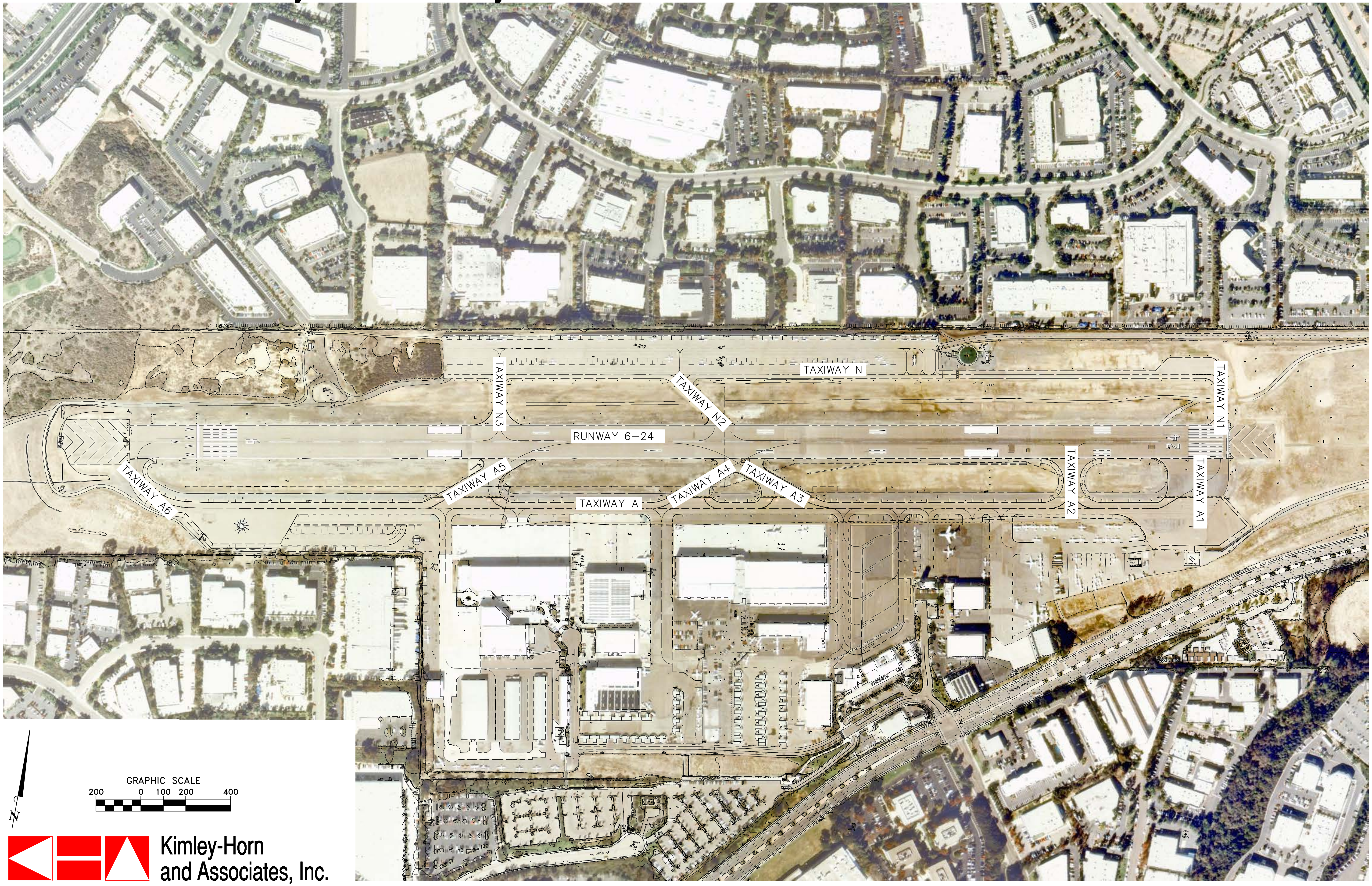
Runway 6-24 is currently supported by two parallel taxiways and nine exit taxiways which were built to facilitate aircraft movements to and from the runway. **Figure 1B** shows the layout of the airport with Runway 6-24 and its supporting taxiways. Building additional taxiways would result in a higher airside capacity, but similar to the limitations on building a parallel runway, such an undertaking would not be permitted. Therefore, an increase in the length of Runway 6-24 is the only feasible solution to increase airside capacity.

MARKING AND LIGHTING

Airports use pavement markings, lighting, and signage to keep pilots aware of their location, especially at night. Runway markings are delineated according to the type of available approach. Markings on other paved areas are designed to ensure that aircraft stay on the pavement. Details about the design of airport markings are shown in *FAA AC 150/5340-1K, Standards for Airport Markings*.

At McClellan-Palomar Airport, a system of pavement markings and signage has been strategically arranged to inform pilots of their location. Most of the airfield signage has been recently installed or upgraded to meet FAA design standards, but an

FIGURE 1B: Runways and Taxiways



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ongoing inventory should be performed to ascertain which of the existing signs are in need of maintenance, repairs, or replacement. The current runway markings show that Runway 24 is equipped with precision approach capability and Runway 6 only has visual capability. Based on their existing instrument approach capabilities these markings are in accordance with AC requirements, but they will need to be updated if additional navigational aids are installed on the airfield.

CRQ is currently equipped with a wide array of lighting systems which provide crucial support to pilots during periods of low visibility and after dark. The majority of these lighting systems is up to date and will continue to be useful for years to come as long as they are properly maintained.

The rotating beacon at McClellan-Palomar Airport projects an alternating green and white light that is visible several miles away from the airport. High intensity runway edge lighting aids pilots in identifying the limits of the runway when visibility is low, and medium intensity taxiway lighting is provided along the edges of all taxiways throughout the airport. Runway end identifier lights (REILs) and medium intensity approach lighting systems with runway alignment indicator lights (MALSRs) have been installed on Runway 24 only, as it is the primary approach runway.

Providing that they are properly maintained, all of the aforementioned lighting systems will be more than enough to adequately meet the future needs of the growing airport.

NAVIGATIONAL AIDS

Navigational aids are designed to provide visual, precision, or non-precision guidance to an airport or runway. McClellan-Palomar Airport currently uses visual guidance as well as precision and non-precision instrument approaches on Runway 6-24.

The precision approach at the airport is supplied by an ILS which provides an approach path for the descent of an aircraft, vertical and horizontal guidance, range, and visual alignment. This ILS is capable of providing precision approach capabilities, even in some of the worst visibility conditions. At this time, there is no reason to remove, replace, or upgrade the ILS system in any way.

Both ends of Runway 6-24 are equipped with visual approach slope indicator (VASI) lights as well as with newer, more accurate, precision approach path indicators (PAPIs). The VASI, PAPI, and REIL systems supply the non-precision guidance at CRQ. As previously indicated in this section, these navigational aids are in need of nothing more than routine maintenance.

In recent years, global positioning systems (GPS) have become widely used for aircraft navigation. GPS uses a network of orbiting satellites to determine an object's location based on triangulation. This technology provides information that is accurate enough to allow precision instrument approaches without using any ground-based navigation equipment. However, GPS technology works best when it is used in conjunction with other systems. Therefore, GPS systems should be used as a supplement to the navigational systems that are currently in use at McClellan-Palomar Airport, but they should not be used as a replacement.

LANDSIDE FACILITIES

Demand for the landside facilities at McClellan-Palomar Airport has been projected to rise over the next several years as the airport continues to grow. As larger aircraft increase their usage of these facilities, they will require increasingly more space for parking, storage, maintenance, and other operations. To meet these demands, landside improvements at CRQ have already been in progress for several years.

The most significant of the recent landside improvements is the new 18,000 square foot terminal building which opened in 2009. The new facility was a welcome change from the trailers that had previously been used as a terminal. Features of the new terminal included a U.S. Customs station, improved security and baggage claim areas, public waiting rooms, and dining facilities. Aircraft parking aprons and vehicle parking lots have been recently added to the airport as well. With the exception of the hangars, which are due for an expansion, but other than that, the landside facilities at CRQ are all currently up to date.

AIRPORT SUPPORT SERVICES

Airport support services at McClellan-Palomar Airport include access to the airport, utilities, Airport Rescue and Fire Fighting (ARFF), fuel storage, and airport maintenance. As stated earlier in this chapter, the current access routes and utilities being used by the airport are more than adequate to meet the growing demands of the airport. Furthermore, since commuter aircraft are currently limited to 30 seats or less, an ARFF facility is not necessary at this time either. Only if this limitation is removed, and commercial aircraft at McClellan-Palomar airport are allowed to carry 30 passengers or more, will an ARFF facility with a rating of Index A be required at the airport.

Projected fuel storage requirements were determined by analyzing historical fuel usage data of the airport. It was concluded that the current fuel storage capacity would not be enough to meet future demands. Therefore, it is recommended either that additional fuel storage tanks be installed or fuel deliveries be made to the airport more frequently.

With a few exceptions, most of the existing facilities at McClellan-Palomar airport have been deemed as adequate to meet the projected demands of the airport. The navigation aids should be updated to incorporate more usage of GPS technology, and the fuel storage facilities need to be expanded, but most of the systems which are currently in place are in need of little more than minor improvements.

As long as routine maintenance is performed on the lighting, signage, and navigation systems at McClellan-Palomar Airport, the current system of runways and taxiways is the only facility which is in serious need of expansion or improvement at this time. Since the conditions of CUP-172 prohibit the acquisition of additional airport property, the only solution to increase airfield capacity is to extend the length of Runway 6-24 and the parallel taxiways that serve it.

SCOPE OF SERVICES

Research has indicated that an increase in airfield capacity is necessary for the long-term good of McClellan-Palomar Airport. The most palpable benefit to the airport would be achieved with an extension of Runway 6-24. However, there are significant constraints on the potential project area that would severely hinder many aspects of the construction process. The *Feasibility Study for Potential Runway Improvements at McClellan-Palomar Airport* was conducted for two primary reasons. The first was to address the question of whether or not the runway at McClellan-Palomar Airport can actually be extended. The second was to identify the potential drawbacks or benefits that would be associated with a runway extension.

The main goal of the feasibility study was to create a potential runway extension that would meet four criteria:

- The runway extension must be technically feasible from an engineering perspective.
- The runway extension must be fiscally responsible. It must be a good use of the funds that would be required for construction.
- The runway extension must make good business sense.
- The runway extension must be eligible for funding by FAA programming criteria.

Alternatives which did not meet these four criteria were considered to be infeasible. Details about how these objectives were accomplished are shown in *Chapter 6 – Alternative Analysis*.

Before an extension alternative could be selected for study, a complicated data collection and research process needed to be performed. Historical airport usage data was collected and examined, land use and zoning requirements were investigated, and the existing airport infrastructure was thoroughly analyzed. Several potential runway extension alternatives were developed and reviewed based on the information that was collected during this phase of the project. The three most viable options were selected and researched in greater detail to determine what their economic impacts would be. The costs were compared against the benefits and information about each of the three options was used to create the Final Feasibility Report.

DATA COLLECTION

The data collection phase of the Runway Extension Feasibility Study required the completion of several individual subtasks. First of all, CUP-172 was reviewed and evaluated to verify that construction on airport property would be permitted. Historical air traffic activity data was obtained and evaluated. Aircraft activity forecasts were prepared and stakeholders were interviewed to discuss potential airport users that would benefit from extending the runway. Based on this information, a Runway Extension Justification Statement was developed to determine the current critical aircraft demand and the length requirements that would justify a runway extension at McClellan-Palomar Airport.

The data collection phase of the project required the development of two aviation forecasts. The first predicted what would happen to the airport if Runway 6-24 was maintained in its current condition. The second forecast was for the airport with a runway extension as proposed in the Runway Extension Justification Statement. The forecasts were prepared with five year and ten year time frames, using 2011 as the base year and only considering existing traffic as part of the base line. Projected traffic was not considered as part of the base line. Based on the forecasts, the next step was to determine the existing and future airport reference codes (ARC), identify weight penalties on existing and potential aircraft that use the runway, and calculate the runway length requirements for those aircraft to determine the critical runway lengths for a runway extension.

Once the critical runway length was determined, a preliminary evaluation of the runway safety area options was performed. Potential threshold locations were devised and issues related to the runway protection zone, departure surfaces, navigational aids, and FAA instruments were identified. Landfill remediation issues and potential impacts to the existing methane extraction system were discussed in this phase as well, but they were not analyzed in explicit detail until the Alternative Analysis process.

All of the information that was compiled during the data collection phase of the project was used as input in the subsequent phases of the project. *Chapter 6* contains specific details about the Alternative Analysis process, *Chapter 5* discusses the runway extension alternatives as well as the landfill remediation issues in greater detail, *Chapter 2* discusses the Runway Extension Justification Statement, and *Chapter 3* contains detailed information about how the aviation forecasts were assembled.

AIRPORT INFRASTRUCTURE ANALYSIS

As the data collection phase was coming to an end, it was time for the Airport Infrastructure Analysis to begin. Based on the information that was obtained from the forecast scenarios, the existing airport infrastructure was evaluated in relation to the size of the aircraft that would be using the facilities in the future. The analysis included aprons, hangars, taxiways, runway pavement, and parking areas. The intention of this research was to ensure that the existing infrastructure was capable of supporting the current and future critical aircraft. The infrastructure was deemed to be adequate, but only under the condition that the size of the aircraft using the facilities would be constrained to the existing fleet mix. No larger or heavier aircraft would be allowed to use the airport.

ALTERNATIVE ANALYSIS

After the existing airport infrastructure had been thoroughly examined, the next step was to define a rational process to analyze the options that would address the development needs of the runway. This ranking analysis used quantitative criteria and qualitative analysis to identify the most viable runway extension options. Quantitative criteria included estimating the cost of each alternative and evaluating it on an engineering basis. Qualitative criteria ranked the options based on environmental issues, safety concerns, and operational constraints. According to these criteria, as well as input from the project stakeholders, the Runway Extension Alternatives Selection Matrix was developed to assist the decision makers by ranking the alternatives based on the defined goals of the project.

The final step in selecting a runway extension alternative was to identify which of the most viable options best met the needs of the airport. The options with the highest scores from the Runway Extension Alternatives Selection Matrix were assessed against a new range of evaluation criteria including operational performance, best planning tenets, environmental factors, and fiscal factors (including FAA funding eligibility). Based on this study, the three most viable runway extension alternatives were selected for further analysis and preliminary engineering.

McClellan-Palomar Airport is designated with an ARC of B-II. However, there are users of the airfield that operate aircraft which are larger than these criteria. The operation of these aircraft has been deemed safe by the flight operations of these users based on the characteristics of their aircraft. As referenced in *Chapter Three,* there are aircraft operating from CRQ with more than 500 annual operations that exceed the B-II ARC design standards.

Based on current capabilities, the County has elected to operate the airport as a B-II ARC airfield. This decision is based on the impediments to improving the existing airfield to meet the criteria for the next higher flight characteristic level, an Airplane Approach Category (AAC) of C. As such, the recommendations for the runway alternatives are based on the consideration of a B-II ARC, the economic benefits it offers to the airport, and whether maintaining this ARC justifies the alternative improvements as feasible as defined by the scope of this project.

PRELIMINARY ENGINEERING

During the preliminary engineering phase, the most viable options that were developed during the early stages of the feasibility study were researched in greater detail. For each of these runway extension alternatives, engineering design criteria was outlined, landfill mitigation options were investigated more thoroughly, and concept designs and preliminary cost estimates were developed.

Finally, conceptual engineering was developed on the preferred alternatives to confirm their feasibility. This process included compiling an opinion of probable costs, examining the costs of completing environmental studies and obtaining permits, preparing plans, specifications, and estimates, and the costs of engineering, construction, construction management, surveys, and inspections. Once the advantages of each alternative had been weighed against the disadvantages, the preliminary concept design had been laid out, and all of the potential costs had been determined, it was time to consider the potential economic benefits of a runway extension in greater detail.

BUSINESS CASE STUDY

Also known as the *Economic Benefit Study*, the main purpose of the *Business Case Study* was to identify the economic benefits that would be achieved by extending the runway at McClellan-Palomar Airport. This study projected the future impacts of construction, expanded operations, variations in aircraft mix, and other expenditures that would be likely to affect the airport over a period of ten years. The study also provided a detailed analysis of the potential financial benefits of a runway extension.

Some of the main economic benefit factors which were measured include employment, earnings, economic activity, increases in government tax revenues and fees, and spending in the area that would be associated with runway construction. As part of this study, estimates of changes in the mix of aircraft were developed and economic activity from airport tenants providing general aviation services and fuel sales were analyzed.

The *Business Case Study* also looked at the impacts that would result from the influx of additional commercial and general aviation air visitors. These impacts would be associated with off-airport spending on lodging, food, ground transportation, recreation, and retail goods and services. The study showed how these additional benefits spread throughout the entire economy over time, creating jobs and further economic growth as a result of the runway extension.

Finally, the *Business Case Study* calculated the extra revenue to state and local governments that would result from an increase in aviation activity, the supply of aviation related goods and services, the use of aviation services and facilities, and greater air visitor spending in the service area. The *Business Case Study* and more details about how it was conducted are shown in *Chapter 7.*

BENEFIT COST ANALYSIS

Once the *Business Case Study* was complete, the final step in the *Runway Extension Feasibility Study* was to perform a *Benefit-Cost Analysis*. The intention of this analysis was to define the Runway 6-

24 extension project, state its primary objectives, and specify the assumptions that described the most likely future of the airport. The analysis also required a meeting with FAA Staff to confirm that the assumptions and forecasts being used were adequate and that the *Benefit-Cost Analysis* was prepared in accordance with FAA Benefit-Cost Analysis Guidance from December 15, 1999.

The primary objective of the *Cost-Benefit Analysis* was to analyze whether or not benefits exceed costs for each of the runway extension alternatives, and determine which option has the greatest net present value. This required the total benefits and costs to be compared in a manner that recognized that the present value of money decreases over time.

The analysis also included a sensitivity study which was intended to examine how the ranking of alternatives would hold up to a change in the projected airport usage and under what conditions the project is or is not worth doing. The sensitivity analysis also considered what a slowdown in the airport activity growth could have on the overall effectiveness of the project.

Another purpose of the *Benefit-Cost Analysis* was to identify the base case to achieve the objectives of the project. This base case was intended to represent the best course of action that could be pursued without the major initiative to obtain the desired objectives. The base case was to be derived from the proposed alternatives that were analyzed in the earlier tasks to outline why the preferred alternative was ultimately recommended.

The *Benefit-Cost Analysis* also estimated the value in dollars of all quantifiable benefits and costs over each of the twenty years in the useful life span for each alternative. The benefits were quantified in terms of dollar savings to aircraft operators and passengers. Construction costs provided by earlier tasks and potential changes to operating costs after project completion were used to complete this estimate. Non-quantifiable costs were identified as well. These costs considered the interaction between the project benefits and the increased airport usage that could impose additional demands on the airport infrastructure.

The *Benefit-Cost Analysis* shown in Chapter 8 includes a recommendation as to whether or not the runway extension should be constructed. It discusses which alternative should be selected in order to achieve the most benefits for the cost. The recommendation is based on the quantifiable and non-quantifiable costs and benefits as well as the sensitivity of the results to changes in assumptions. Essentially, it is the culmination of all of the research, data collection, forecasts, alternative analysis, engineering, cost estimating, and benefit analysis that was used in creating the *Feasibility Study for Potential Runway Improvements at McClellan-Palomar Airport.*

FINAL FEASIBILITY REPORT

The final report for the *Runway Extension Feasibility Study at McClellan-Palomar Airport* is divided into nine separate chapters. *Chapter 1* serves as an introduction to the project. It includes an overview of the history of the airport, a description of the airport's existing facilities and future needs, and a brief summary of the project's scope of services.

Chapter 2 includes the Runway Justification Statement which was devised during the data collection phase of the project and the critical information that was used in the development of that statement. *Chapter 3* is also closely related to the data collection phase of the project, but it is more focused on the two aviation forecasts that were developed to be compared against one another.

Chapter 4 shows the proposed airfield geometry of the potential runway extensions. *Chapter 5* describes the proposed runway extension alternatives in much greater detail, provides preliminary estimates of what each of these alternatives might cost, and gives descriptions of the various landfill mitigation options. *Chapter 6* explains the process that was used in creating the Runway Extension Alternatives Selection Matrix and selecting the preferred alternative.

Chapter 7 describes the business case of the project and provides an analysis of the potential financial benefits that would be created by the project. *Chapter 8* is a detailed benefit cost analysis which weighs the advantages of extending the runway against the disadvantages. *Chapter 9* explains the environmental screening process and the course of action that is required to complete it.

Chapter Two
PRELIMINARY RUNWAY EXTENSION JUSTIFICATION STATEMENT

The Federal Aviation Administration (FAA) has established policy and provides guidance for the planning and justification of improvements to runway length at airports to be eligible for federal funding under the Airport Improvement Program (AIP). Documents that outline this policy and guidance include:

- Order 5090.3C, *Field Formulation of the National Plan of Integrated Airport Systems* (NPIAS)
- Order 5100.38C, *Airport Improvement Program Handbook*
- Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*
- *Planning Information Needed for FAA Headquarters Review of Benefit Cost Analysis (BCA)* 3/31/06

FAA Order 5090.3C establishes the eligibility threshold for airfield dimensional standards improvements including runway length. From Paragraph 3-4, Page 21:

*"**3-4. AIRPORT DIMENSIONAL STANDARDS***

> *Airport dimensional standards (such as runway length and width, separation standards, surface gradients, etc.) should be selected which are appropriate for the critical aircraft that will make substantial use of the airport in the planning period. Substantial use means either 500 or more annual itinerant operations, or scheduled commercial service. The critical aircraft may be a single aircraft or a composite of the most demanding characteristics of several aircraft. The critical aircraft (or composite aircraft) is used to identify the appropriate Airport Reference Code for airport design criteria. Design criteria (such as dimensional standards and appropriate pavement strength) are contained within AC 150-5300-13, Airport Design."*

FAA Order 5100.38C in Paragraph 505, Page 64 discusses airfield project justification:

*"**505. AIRFIELD PROJECT JUSTIFICATION***

a. ***Aviation User Requirements****. The general eligibility of work is not the same as justification based on current airport user needs. ….Except as otherwise noted, the activity levels used for accepting NPIAS airport roles apply to project justification, and Order 5090.3 describes procedures for field formulation of the NPIAS.*

b. ***Documented Aeronautical Need****. The simple endorsement of a project by the airport sponsor or a forecast of activity is not adequate by itself to establish justification for the work…no project should be approved for funding without analysis of the specific requirements for development and documentation of aeronautical demand used to justify the work."*

FAA AC 150/5325-4B, Paragraph 102 reconfirms the critical aircraft and substantial use threshold. It then outlines the procedure and rationale for determining runway lengths:

"102. DETERMINING RECOMMENDED RUNWAY LENGTHS

a. ***Assumptions and Definitions****.*

(2) ***Critical Design Airplanes****. The listing of airplanes (or a single airplane) that results in the longest recommended runway length. The listed airplanes will be evaluated either individually or as a single family grouping to obtain a recommended runway length.*

(8) ***Substantial Use Threshold****. Federally funded projects require that critical design airplanes have at least 500 or more annual itinerant operations at the airport (landings and takeoffs are considered as separate operations) for an individual airplane or family grouping of airplanes.*

b. ***Procedure and Rationale for Determining Recommended Runway Lengths****.*

This AC uses a five-step procedure to determine the recommended runway lengths for a selected list of critical design airplanes. "

The following analysis for the justification of runway length needs at McClellan-Palomar Airport follows the five-step process outlined in the advisory circular.

STEP #1 - Identify the list of critical airplanes that will make regular use of the proposed runway for an established planning period of at least five years.

The FAA's Operations and Performance Data for activity at McClellan-Palomar Airport was researched to determine the critical list of airplanes for current operations. Specifically, the Enhance Traffic Management System Counts (ETMSC), which provides information regarding the mix of aircraft operating at the airport, was queried for 2011 airport activity. Based upon observations at the airport, the data was queried first for turbine-powered fixed-wing aircraft weighing over 12,500 pounds. The results are presented on **Table 2A**. With over 14,000 operations by aircraft over 12,500 pounds, it was confirmed the analysis could begin to be narrowed down to large aircraft.

TABLE 2A
Large Aircraft Mix for Preliminary Runway Length Justification
McClellan-Palomar Airport

Aircraft	MTOW	2011 Operations
Large Aircraft over 60,000 lbs.		
GLEX – Bombardier BD-700 Global Express	98,106	242
GLF5 – Gulfstream V/G500	90,689	474
GL5T – Bombardier BD-700 Global 5000	87,700	24
GLF4 – Gulfstream IV/G400	73,193	976
GLF3 – Gulfstream III/G300	71,100	42
FA7X – Dassault Falcon F7X	69,000	50
Total Operations over 60,000 lbs.		**1,808**
100% Large Aircraft Fleet 60,000 lbs. or Less		
CL60 – Bombardier Challenger 600/601/604	47,600	554
L29B – Lockheed L-1329 Jetstar 731	44,500	4
E135 – Embraer ERJ 135/140/Legacy	44,070	74
HA4T – Hawker 4000	39,500	14
F2TH – Dassault Falcon 2000	35,803	576
C750 – Cessna Citation X	35,699	566
GLF2 – Gulfstream II/G200	35,600	20
GALX – IAI 1126 Galaxy/Gulfstream G200	34,851	276
H25C – Bae/Raytheon HS 125-1000/Hawker 1000	30,997	24
H25B – Bae HS 125/700-800/Hawker 800	27,403	996
G150 – Gulfstream G150	26,150	200
ASTR – IAI Astra 1125	24,648	76
LJ60 – Bombardier Learjet 60	23,104	256
LJ55 – Bombardier Learjet 55	21,010	58
Total Operations 100% Fleet Less than 60,000 lbs.		**3,694**
75% Large Aircraft Fleet 60,000 lbs. of Less (Jet)		
F900 – Dassault Falcon 900	46,738	174
CL30 – Bombardier (Canadair) Challenger 300	38,850	326
FA50 – Dassault Falcon/Mystere 50	38,801	198
J328 – Fairchild Dornier 328 Jet	33,510	10
C650 – Cessna III/VI/VII	30,997	60
C680 – Cessna Citation Sovereign	30,300	44
FA20 – Dassault Falcon/Mystere 20	28,660	30
H25A – Bae HS 125-1/2/3/400/600	25,000	58
HS25 – Bae HS 125; British Aerospace	25,000	6
WW24 – IAI 1124 Westwind	22,928	40
LJ40 – Learjet 40; Gates Learjet	21,000	54
C56X – Cessna Excel/XLS	20,200	988
SBR1 -- North American Rockwell Sabre 40/60	20,000	6
LJ45 – Bombardier Learjet 45	19,511	266
FA10 – Dassault Falcon/Mystere 10	18,739	6
LJ35 – Bombardier Learjet 35/36	18,298	244
LJ36 – Learjet 36	18,298	4

TABLE 2A (Continued)
Large Aircraft Mix for Preliminary Runway Length Justification
McClellan-Palomar Airport

Aircraft	MTOW	2011 Operations
75% Large Aircraft Fleet 60,000 lbs. of Less (Jet) *(Continued)*		
BE40 – Raytheon/Beech Beechjet 400/T-1	16,095	400
C560 – Cessna Citation V/Ultra/Encore	15,895	576
LJ31 – Bombardier Learjet 31/A/B	15,498	16
C550 – Cessna Citation II/Bravo	15,102	352
C551 – Cessna Citation II/SP	15,100	4
LJ25 – Bombardier Learjet 25	14,991	18
LJ24 – Bombardier Learjet 24	13,001	2
Subtotal Operations 75% Fleet Less than 60,000 lbs. (Jet)		**3,882**
75% Large Aircraft Fleet 60,000 lbs. of Less (Turboprop)		
C2 – Grumman C-2 Greyhound	60,000	2
D328 – Dornier 328 Series	30,840	4
E120 – Embraer Brasilia EMB 120	25,353	4,408
SW3 – Fairchild Swearingen SA-226T/TB Merlin 3	13,230	16
B190 – Beech 1900/C-12J	17,120	2
SW4 – Swearingen Merlin 4/4A Metro2	13,230	12
B350 – Beech Super King Air 350	15,000	258
BE30 – Raytheon 300 Super King Air	14,000	178
Subtotal Operations 75% Fleet Less than 60,000 lbs. (Turboprop)		**4,880**
Total Operations 75% Fleet Less than 60,000 lbs.		**8,762**
Total Large Aircraft Operations		**14,264**

STEP #2 – Identify the airplanes that will require the longest runway lengths at the maximum certificated takeoff weight (MTOW).

This step is used to determine the method for establishing the recommended runway length. Except for regional jets, when the MTOW of the listed airplanes is 60,000 pounds or less, the recommended runway length is determined according to a *family grouping of airplanes* having similar performance characteristics and operating weights. When the MTOW of the listed airplanes is over 60,000 pounds, the recommended runway length is determined according to *individual airplanes*.

Thus, the aircraft were grouped into three categories based upon certificated maximum takeoff weight (MTOW).

1) 75 percent of the aircraft fleet weighing less than 60,000 pounds
2) 100 percent of the aircraft fleet weighing less than 60,000 pounds
3) Aircraft weighing more than 60,000 pounds

Table 2A also presents the aircraft make and model and the 2011 operations by each aircraft in each of the three groupings. The 100 percent and 75 percent fleet groupings were determined in accordance with AC 150/5325-4B, Paragraph 303.a.(1) which indicates the distinction between the two is that airplanes in the 100 percent fleet require at least 5,000 feet of runway at maximum takeoff weight, mean sea level, and the standard day temperature of 59 degrees Fahrenheit (F).

It is evident from the table that each grouping currently has more than 500 annual itinerant operations. For aircraft weighing over 60,000 pounds, the Gulfstream IV (G400/450) had at least 976 operations at the airport in 2011. The Gulfstream V (G500/550) had just under the threshold at 474 operations according to ETMSC.

STEP #3 – Using Table 2B, and the airplanes identified in Step #2, determine the method that will be used for establishing the recommended runway length.

For purposes of the preliminary runway extension justification, the runway length requirements for the 75 and 100 percent fleet groupings, plus that of the Gulfstream IV, were determined. Besides the critical aircraft, the runway length requirements are based upon the following factors:

- Airport elevation – 330 feet above mean sea level (AMSL)
- Mean maximum temperature of the hottest month – 75 degrees F
- Aircraft loading – varies with passengers, cargo, and fuel for trip length
- Runway grade change – 13.8 feet

TABLE 2B
Airplane Weight Categorization for Runway Length Requirements

Airplane Weight Category Maximum Certificated Takeoff Weight (MTOW)			Design Approach	Location of Design Guidelines
12,500 pounds (5,670 kg) or less	Approach Speeds less than 30 knots		Family grouping of small airplanes	Chapter 2; Paragraph 203
	Approach Speeds of at least 30 knots but less than 50 knots		Family grouping of small airplanes	Chapter 2; Paragraph 204
	Approach Speeds of 50 knots or more	With Less than 10 Passengers	Family grouping of small airplanes	Chapter 2; Paragraph 205 Figure 2-1
		With 10 or more Passengers	Family grouping of small airplanes	Chapter 2; Paragraph 205 Figure 2-2
Over 12,500 pounds (5,670 kg) but less than 60,000 pounds (27,200 kg)			Family grouping of large airplanes	Chapter 3; Figures 3-1 or 3-2[1] and Tables 3-1 or 3-2
60,000 pounds (27,200 kg) or more or Regional Jets[2]			Individual large airplane	Chapter 4; Airplane Manufacturer Websites (Appendix 1)

Note[1]: When the design airplane's APM shows a longer runway length than what is shown in Figure 3-2, use the airplane manufacturer's APM. However, ,users of an APM are to adhere to the design guidelines found in Chapter 4.

Note[2]: All regional jets regardless of their MTOW are assigned to the 60,000 pounds (27,200 kg) or more weight category.

Source: FAA AC 150/5325-4B

AC 150/5325-4B provides a series of runway length curves to be used for determining the runway length requirements for 75 percent of large airplanes weighing no more than 60,000 pounds. There is a graph for takeoffs at 60 percent useful load, and the other is for takeoffs at 90 percent useful load. Applying the design temperature and the airport elevation, the takeoff length for 75 percent of the fleet was determined to be 4,602 feet at 60 percent useful load. At 90 percent useful load, the takeoff length was determined to be 5,760 feet.

Similar runway length curves are provided in the advisory circular for 100 percent of the large airplanes weighing no more than 60,000 pounds. At 60 percent useful load, the takeoff length was determined to be 4,978 feet. At 90 percent useful load, the design length for 100 percent of the fleet was determined to be 7,283 feet.

The manufacturer's performance tables were referenced to determine the runway length requirements for the Gulfstream IV/450. At 60 percent useful load and using 20 percent flap settings, the Gulfstream 450 was determined to need a runway length of 4,807 feet. At 90 percent useful load, the aircraft was determined to need 5,773 feet at 20 percent flap settings. **Table 2C** summarizes the runway length requirements for each aircraft grouping and the Gulfstream IV/450 and the V/550.

STEP #4 – Select the runway length from among the various runway lengths generated by Step #3 per the process identified in Chapters 2, 3, and 4 as applicable.

The useful load provides an indication of the runway length requirement for a range of trip lengths. The 60 percent useful load is considered as the standard criteria for typical short and medium haul trip lengths. This will normally provide adequate non-stop lengths for trips approximately halfway across the United States.

Longer haul flights can require higher loadings. The 90 percent useful load is a typical consideration for coast-to-coast travel in the U.S. as well as international travel. A check of frequented destinations indicates there is significant east coast and international destinations for aircraft departing from McClellan-Palomar Airport.

Other frequent destinations such as eastern Colorado, western Kansas, and Anchorage, Alaska typically suggest they are really fuel stops that are necessary due to the limits on runway length at McClellan-Palomar Airport. For example, Qualcomm currently operates four aircraft weighing over 60,000 pounds from the airport. These include the Global Express, a Gulfstream V, a Gulfstream 550, and a Gulfstream 450. They indicated they had 42 departures with international destinations, and 40 of them required fuel stops due to the runway length limitations. Other users have indicated that they must make fuel stops for flights to the northeast United States as well as international destinations.

NetJets, a company that provides fractional ownership services, indicated their aircraft made 820 departures from McClellan-Palomar in 2011 to 139 distinct destinations, using 28 different models of aircraft. Three types of aircraft that had long-haul destinations which required fuel stops were the Hawker 400XP, the Citation X, and the Gulfstream 200.

It is evident that many of the large aircraft departing from the airport are often weight-restricted and, as a result, cannot reach their intended destination without stopping to refuel. Thus, the 90 percent useful load is indicative of what is needed on a regular basis for departures from McClellan-Palomar Airport.

Step #5 – Apply any necessary adjustment to the obtained runway length, when instructed by the applicable chapter in this AC, to the runway length generated in step #4 to obtain a final runway length.

Typical adjustments include those for runway grade change or for landing on a wet runway. The runway grade changes 13.8 feet over the length of the runway. This requires an adjustment of 10 feet of takeoff length for each foot of grade differential.

For wet runway landings for large aircraft under 60,000 pounds, the load curves are increased by 15 percent for 60 percent useful load, up to 5,500 feet, whichever is less. For the 90 percent useful load, the results from the useful load curves are increased by 15 percent up to 7,000 feet. Since this percentage is added to the FAA departure curves, the landing distance requirement can tend to be overestimated, so only the 60 percent useful load for landing is considered at this stage in the justification. These are presented in **Table 2C**.

For the Gulfstream aircraft considered critical at the current time, the landing tables from the manufacturer were utilized with a 15 percent increase for wet runway as well.

TABLE 2C
Preliminary Runway Length Requirements
McClellan-Palomar Airport

Airport Elevation	330 feet
Mean Maximum Temperature of the Hottest Month	75 F
Runway Grade change	13.8 feet
RUNWAY LENGTHS RECOMMENDED FOR AIRPORT PLANNING AND DESIGN	
	Runway Length (feet)
Large airplanes weighing no more than 60,000 pounds	
75 percent of the fleet	
Takeoff at 60 percent useful load	4,700
Takeoff at 90 percent useful load	5,900
Landing at 60 percent useful load	5,500
100 percent of fleet	
Takeoff at 60 percent useful load	5,200
Takeoff at 90 percent useful load	7,500
Landing at 60 percent useful load	5,500
Critical aircraft weighing more than 60,000 pounds	
Gulfstream IV/450	
Takeoff at 60 percent useful load (20 degree flaps)	4,900
Takeoff at 90 percent useful load (20 degree flaps)	5,900
Landing at 60 percent useful load	5,600
Gulfstream V/550	
Takeoff at 60 percent useful load (20 degree flaps)	4,700
Takeoff at 90 percent useful load (20 degree flaps)	6,100
Landing at 60 percent useful load	5,700

Sources: FAA AC 150/5325-4B for aircraft groupings
Manufacturer's Quick Reference Handbooks for individual aircraft

CONCLUSIONS

It is evident from this preliminary analysis that the current runway length at McClellan-Palomar Airport is not sufficient for the regular needs of its users. For 75 percent of the large aircraft fleet weighing no more than 60,000 pounds, a runway length of 5,900 feet would be more suitable. For 100 percent of the fleet weighing not more than 60,000 pounds, a runway length up to 7,400 feet would fully meet the needs at 90 percent useful load.

The Gulfstream IV/450 at 90 percent useful load requires 5,900 feet for takeoff, while the Gulfstream V/550 requires 6,100 feet. The Gulfstream IV requires 5,600 feet to land on a wet runway using the same criteria as outlined for the FAA curves. Qualcomm bases and regularly operates these aircraft at the airport, and has indicated that a reasonable runway length to meet their needs would be 6,200 feet.

NetJets is a company that does not base aircraft at the airport, but is a major operator with 820 departures by jet aircraft in 2011. They have indicated that a 6,000-foot runway length would satisfy the majority of their needs at McClellan-Palomar. They also indicated that extending the usable runway length greater than 5,000 feet would remove the company's self-imposed dry runway-only restriction to Hawkers and their G-IV and G450 fleets as well as allow all of their fleet to operate closer to their design specifications.

From this preliminary analysis, a runway length of 6,100 feet can be readily justified for McClellan-Palomar Airport. This will be evaluated in more detail later in this study to determine the optimum runway length that will best meet the needs of the users, while weighing economic and environmental factors.

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Chapter Three FORECASTS

An important factor in airport needs planning is the examination of not only existing demand, but also that which may reasonably be expected to occur over a defined period of time. For the purposes of this Runway Improvement Feasibility Study, this planning involves projecting potential aviation activity over the next ten years, or through 2021. For a non-hub, primary commercial service airport such as McClellan-Palomar Airport (CRQ), forecasts of passengers, based aircraft, operations (takeoffs and landings), and aircraft mix help form the basis for the analysis.

The Federal Aviation Administration (FAA) has a responsibility to review aviation forecasts that are submitted to the agency in conjunction with airport feasibility and planning studies. The FAA reviews such forecasts with the objective of including them in its *Terminal Area Forecasts* (TAF) and the *National Plan of Integrated Airport Systems* (NPIAS). In addition, aviation activity forecasts are an important input to the benefit-cost analyses associated with airport development, and the FAA reviews these analyses when federal funding requests are submitted.

As stated in FAA Order 5090.3C, *Field Formulation of the National Plan of Integrated Airport Systems* (NPIAS), dated December 4, 2004, forecasts should:

- Be realistic
- Be based on the latest available data
- Reflect current conditions at the airport
- Be supported by information in the study
- Provide adequate justification for the airport planning and development

The forecast process consists of a series of basic steps that can vary depending on the issues to be addressed and the level of effort required to develop the forecast. These steps include a review of previous forecasts, determination of data needs, identification of data sources, collection of data, selection of forecast methods, preparation of the forecasts, and evaluation and documentation of the results.

The following forecast analysis for McClellan-Palomar Airport was produced following these basic guidelines. Other recent forecasts were examined and compared against current and historic activity. The historical aviation activity was then examined along with other factors and trends that could affect demand. The intent is to provide an updated set of aviation demand projections for McClellan-Palomar Airport that can be incorporated into the analyses of this feasibility study.

For the record, this forecast effort was completed in the first half of 2012 using 2011 as its base year. This chapter reflects the conditions at that time and uses socioeconomic and aviation industry forecasts that were in effect at that time.

NATIONAL AVIATION FORECASTS

Each year, the FAA updates and publishes a national aviation forecast. Included in this publication are forecasts for the large air carriers, regional/commuter air carriers, general aviation, and FAA workload measures. The forecasts are prepared to meet budget and planning needs of the constituent units of the FAA and to provide information that can be used by state and local authorities, the aviation industry, and the general public.

The current edition when this forecast was prepared was FAA *Aerospace Forecasts - Fiscal Years 2012-2032*, published in March 2012. The FAA forecasts used the economic performance of the United States as an indicator of future aviation industry growth. Similar economic analyses were applied to the outlook for aviation growth in international markets.

ECONOMIC OUTLOOK

The aviation industry in the United States has experienced an event-filled decade. Since the turn of the century, the industry has faced the impacts of the events of September 11, 2001, scares from pandemics such as SARS, the bankruptcy of five network air carriers, all-time high fuel prices, and a serious economic downturn with global ramifications. The Bureau of Economic Research has determined that the worst economic recession in the post-World War II era began in December 2007. Eight of the world's top 10 economies were in recession by January 2009.

As the recession began, unemployment in the United States was at 5.0 percent. While it grew through 2008, unemployment intensified in 2009 until peaking at 10.1 percent in October, although the recession officially ended in June of that year. At of the end of 2011, unemployment stood at 8.6 percent of the labor force.

This recession did not face the high inflationary environment of the recession in the early 1980s or the high-energy costs of the mid-1970s recession. While recessions during the post-war era have an average duration of 10 months, this one lasted 19 months. Continued levels of high debt, a weak housing market, and tight credit, are expected to keep the recovery modest by most standards. The resolution of those factors will determine the future path of the recovery.

The nation's gross domestic product (GDP) is the primary measure of overall economic growth. The GDP growth rate for federal fiscal year (FY) 2011 was 2.1 percent, indicating that the economy was still in a slow recovery phase. An even slower growth rate of 1.6 percent was forecast for FY 2012. The FAA forecasts are based upon a 3.1 percent annual average growth in GDP from FY 2013 through FY 2017. For the long term, the FAA forecasts are based upon real GDP growth slowing to 2.5 percent annually.

Economic growth on the global scale is expected to be higher with Asia/Pacific and Latin America leading the way. The global GDP was projected to grow at an average of 3.3 percent over the 20-year forecast period.

The following subsection examines the FAA's forecasts for the key sectors of aviation activity served at McClellan-Palomar Airport: commercial passenger service and general aviation.

COMMERICAL AIR SERVICE INDUSTRY FORECAST

Although the recession has officially been over for more than two years, air carriers continue to deal with economic uncertainties such as strained business travel budgets and unemployment above eight percent. Capacity reductions in recent years helped to counter fuel costs and reduced demand. Load factors and trip lengths have increased while available seats per aircraft-mile (capacity) decreased. The reduction in capacity allowed the carriers to raise air fares when demand began to return. This has allowed the industry to post net profits for the past two years.

Although capacity improved slightly in 2011, the FAA projects that it will decline slightly in 2012. The domestic available seat-miles (ASM) are projected to increase at an average annual rate of 2.7 percent through the forecast period. Revenue passenger-miles (RPM) are projected to increase at a slightly higher rate (2.8 percent). Domestic system-wide load factors increased to an all-time high of 82.5 percent in 2011, and are projected to grow to 84.8 percent by 2032. Domestic enplanements (boardings) are projected to grow at an annual average rate of 2.4 percent through 2032.

McClellan-Palomar Airport has historically been served by regional (commuter) carriers. This portion of domestic air travel is projected to increase at a faster rate than the whole. ASMs for the regional carrier portion of domestic air travel are projected at 3.5 percent annual growth rate, while RPMs are projected to increase at a 3.6 percent rate. The FAA projects regional airline enplanements to grow at a 2.6 percent average annual rate through 2032.

The cost of air fare to the passenger is related to revenue per passenger mile (yield) for the airlines. The nominal yield on domestic flights is projected by the FAA to increase by an average of 1.2 percent annually. The real (inflation-adjusted) yield will actually continue to decline at 0.8 percent annually. The projected yields for regional carriers alone are similar.

While aircraft size has been increasing for both mainline and regional carriers, the continued decreasing ratio of capacity flown by the mainline carriers relative to the regional carriers has resulted in a relatively flat overall average aircraft size of around 122.6 seats. The overall domestic seats per aircraft are projected by FAA to rise at 0.1 percent annually through 2032.

In response to globalization, international passenger traffic between the U.S. and the rest of the world is projected to grow at a faster rate than domestic passenger traffic. The FAA forecasts an average annual rate of 4.3 percent over the forecast period. **Figure 3A** depicts the history and projected growth in U.S. passenger enplanements.

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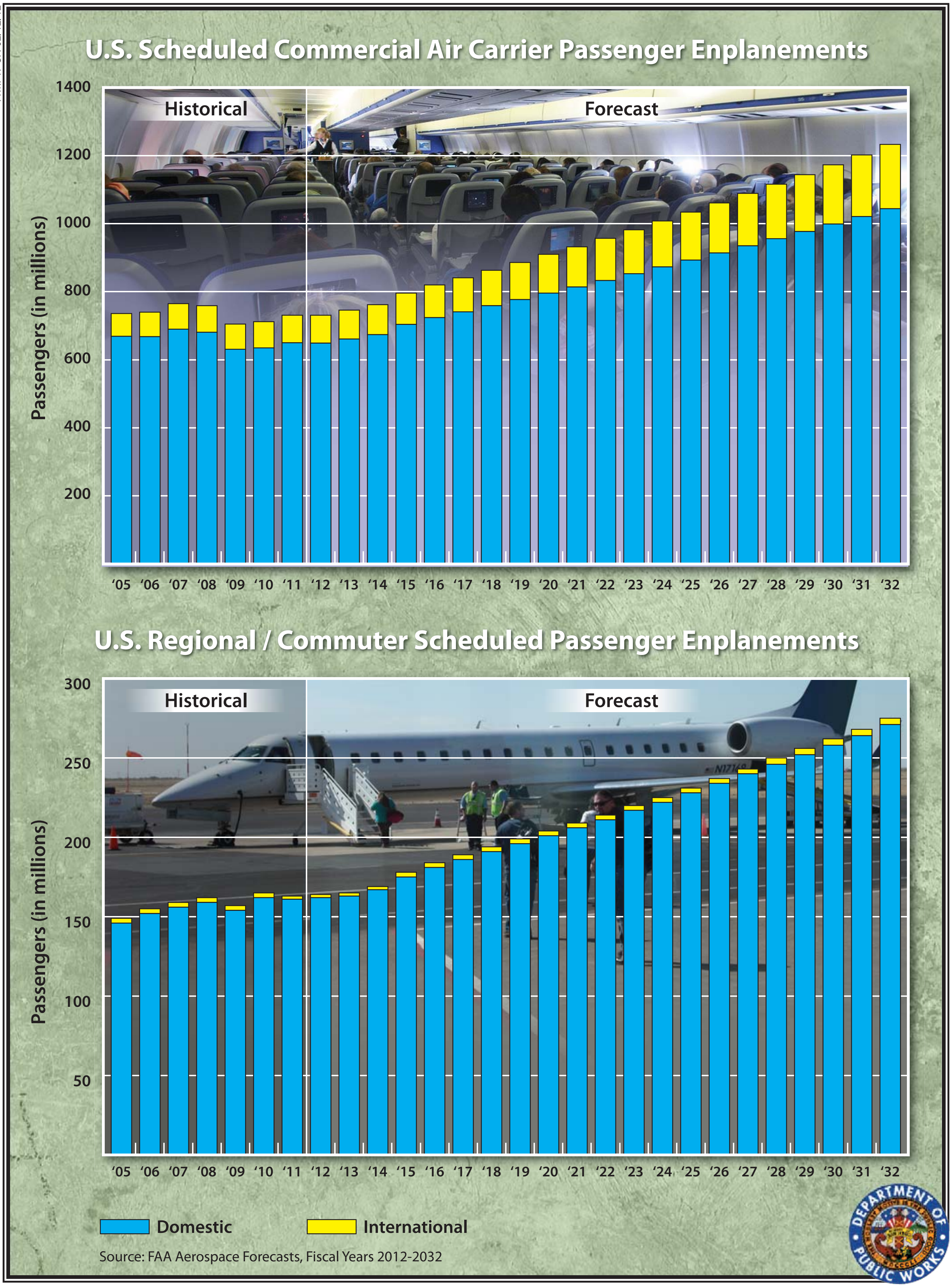

Figure 3A
U.S. COMMERCIAL AIR CARRIER AND
REGIONAL/COMMUTER FORECASTS

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GENERAL AVIATION INDUSTRY FORECAST

Following more than a decade of decline, the general aviation industry was revitalized with the passage of the *General Aviation Revitalization Act* in 1994. This legislation limits the liability on general aviation aircraft to 18 years from the date of manufacture. This sparked an interest to renew the manufacture of general aviation aircraft due to the reduction in product liability as well as renewed optimism for the industry. The high cost of product liability insurance had been a major factor in the decision by many American aircraft manufacturers to slow or discontinue the production of general aviation aircraft.

In the seven years prior to the events of September 11, 2001, the U.S. civil aviation industry experienced unprecedented growth in demand and profits. The negative impacts to the economy and aviation industry from the events of 9/11 were immediate and significant. The economic climate and aviation industry had been recovering until early 2008 when it became clear that an economic downturn was underway. High oil prices and an economic recession caused general aviation activity at FAA air traffic facilities to fall sharply in 2008, declining by 5.6 percent. The extended downturn in the economy dampened the near-term prospects for the general aviation industry. As the U.S. and world economy recovers, general aviation demand is anticipated to rebound and grow.

In 2010, there were an estimated 222,520 active general aviation aircraft in the United States. **Figure 3B** depicts the FAA forecast for active general aviation aircraft. The FAA projects an average annual increase of 0.6 percent through 2032, resulting in 253,205 active aircraft. Active piston-powered aircraft (including rotorcraft) are expected to decline from 159,007 in 2011 to 151,685 by 2032 for a net average annual decrease of 0.1 percent. Single engine fixed-wing piston aircraft are projected to decrease at 0.1 percent annually, and multi-engine fixed-wing piston aircraft are projected to decrease by 0.5 percent per year. This is due, in part, to declining numbers of multi-engine piston aircraft and the expectation that the new, light sport aircraft and the relatively inexpensive very light jets (VLJ) will dilute or weaken the replacement market for piston aircraft.

New models of business jets are also stimulating interest for the high-end market. The FAA expects the business segment to expand at a faster rate than personal/sport flying. Safety and security concerns combined with increased processing time at commercial terminals make business/corporate flying an attractive alternative. Turbine-powered aircraft (turboprop and jet) are expected to grow at an average annual rate of 2.9 percent through 2032. Even more significant, the jet portion of this fleet is expected to grow at an average annual growth rate of 4.0 percent. The total number of jets in the general aviation fleet is projected to grow from 11,760 in 2011, to 26,935 by 2032.

With the advent of the relatively inexpensive twin-engine VLJ, many questions have arisen as to the future impact they may have. The lower acquisition and operating costs of the VLJs were believed to have the potential to revolutionize the business jet market, particularly by being able to sustain a true on-demand air-taxi

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U.S. Active General Aviation Aircraft

	2012	2017	2022	2027	2032
FIXED WING					
Piston					
Single Engine	137,600	133,650	132,010	132,660	135,340
Multi-Engine	15,735	15,425	15,010	14,680	14,350
Turbine					
Turboprop	9,505	9,870	10,300	10,860	11,445
Turbojet	12,050	14,470	17,620	21,760	26,935
ROTORCRAFT					
Piston	3,780	4,250	4,680	5,180	5,705
Turbine	6,940	8,180	9,465	10,965	12,550
EXPERIMENTAL					
	24,480	26,165	27,825	29,480	31,140
SPORT AIRCRAFT					
	6,930	7,845	8,630	9,410	10,195
OTHER					
	5,670	5,635	5,605	5,575	5,545
TOTAL	**222,690**	**225,490**	**231,145**	**240,570**	**253,205**

Source: FAA Aerospace Forecasts, Fiscal Years 2012-2032.

Notes: An active aircraft is one that has a current registration and was flown at least one hour during the calendar year.

Figure 3B
U.S. ACTIVE GENERAL AVIATION AIRCRAFT FORECASTS

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service. While initial forecasts called for over 400 aircraft to be delivered each year, events such as the recession, along with the bankruptcy of VLJ manufacturer, Eclipse, and the Florida air-taxi start-up, DayJet, have led the FAA to temper more recent forecasts. The recent introduction of the Embraer's Phenom 100 to the market has helped boost the turbine market. Despite that, the impacts of the recession have led to dampened expectations.

In 2005, a new category called "light sport" aircraft was created that was not previously included in FAA registry counts. At the end of 2010, a total of 6,528 aircraft were estimated to be in this category. Down from earlier forecasts, the FAA estimates this fleet will increase by approximately 4.0 percent per year until 2013, then slow to about 2.0 per year. By 2032, a total of 10,195 light sport aircraft are projected to be in the fleet.

Aircraft utilization rates are projected to increase through the forecast period. The number of general aviation hours flown is projected to increase at 1.7 percent annually. Similar to active aircraft projections, there is projected disparity between piston and turbine aircraft hours flown. Hours flown in turbine aircraft are expected to increase at 3.6 percent annually, compared to just 0.03 percent for piston-powered aircraft. Jet aircraft hours flown are projected to increase at 5.3 percent annually over the next 20 years. The increasing size of the business jet fleet, resulting in longer flights along with the improved utilization rates account for much of this increase. At the other end of the spectrum, the light sport aircraft fleet is anticipated to experience a 5.4 percent average annual growth rate in hours flown through 2032, primarily reflecting the anticipated growth in the light sport aircraft.

The total general aviation pilot population is projected to increase by 35,000 in the next 20 years reaching 510,295 in 2032. This represents an average annual growth rate of 0.3 percent. The student pilot population is forecast to decline at an annual rate of 0.1 percent, from 118,657 in 2011 to 116,720 in 2032. The growth rate for the private pilot category is forecast at 0.1 percent, while the commercial pilot growth rate is projected at 0.4 percent.

REGIONAL FACTORS AND TRENDS

AIRPORT SERVICE AREAS

McClellan-Palomar Airport is one of 12 public use airports in San Diego County as shown on **Figure 3C**. It is the only airport in the county, other than San Diego International Airport, that has commercial passenger service. San Diego County also comprises the San Diego metropolitan statistical area (MSA).

As mentioned earlier, McClellan-Palomar Airport is classified as a non-hub primary commercial service airport in the *National Plan of Integrated Airport Systems* (NPIAS). This means the airport enplanes at least 10,000 passengers annually, but less than 0.25 percent of the total enplaned passengers in the United States. By comparison, San Diego International Airport (SAN) is classified as a large hub airport because it enplanes at least one (1.0) percent of U.S. enplanements. The airport enplaned 8,441,957 passengers in 2011. The airport is served by 22 airlines

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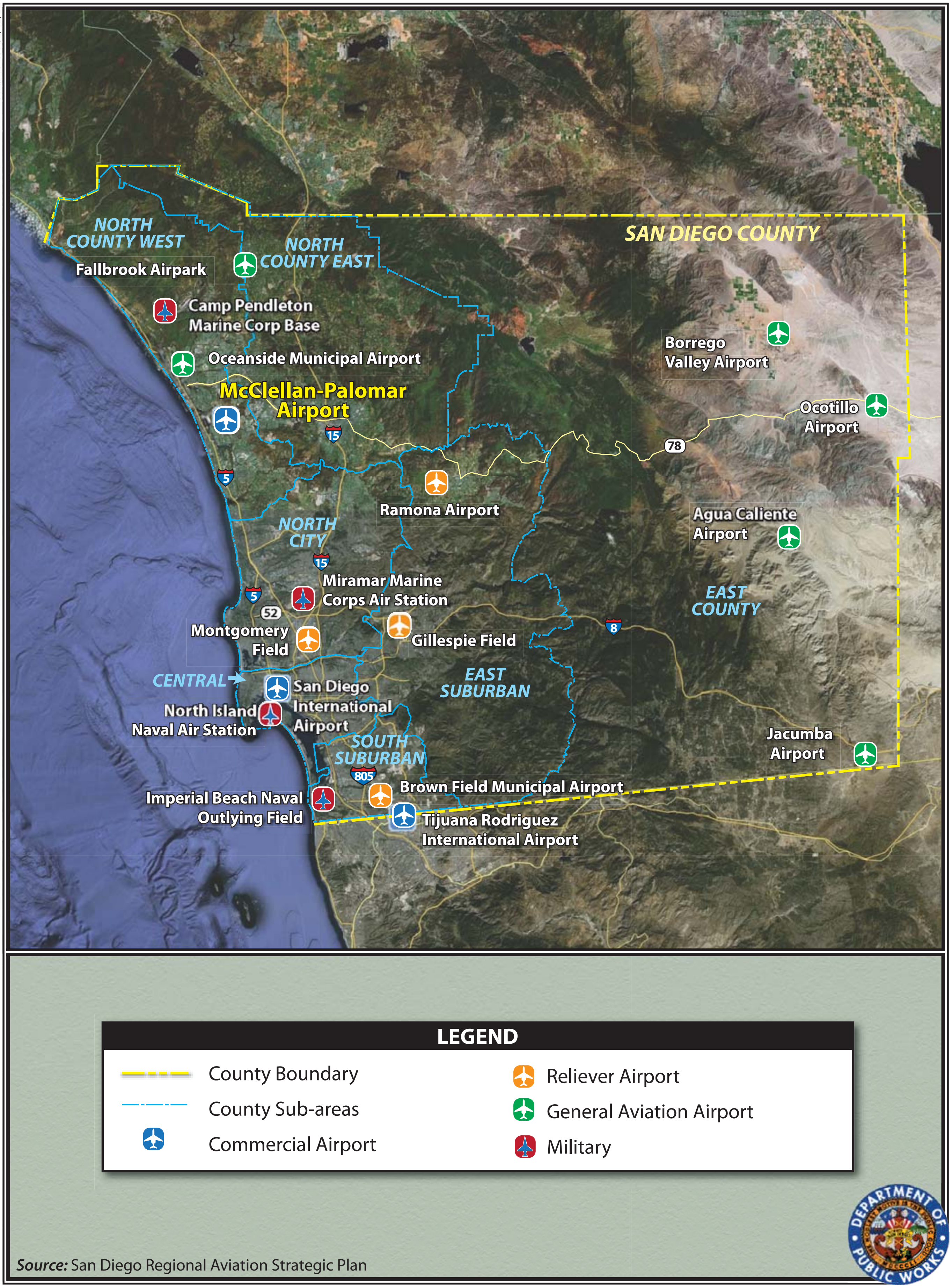

Source: San Diego Regional Aviation Strategic Plan

Figure 3C
SAN DIEGO COUNTY
AIRPORT SYSTEM

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that fly non-stop to 52 different domestic and international destinations.

The commercial service area for McClellan-Palomar Airport is also influenced by other commercial service airports to the north, in the Los Angeles metropolitan area. Located 58 miles to the north, John Wayne Airport in Orange County is the closest. This airport enplanes over 4.3 million annual passengers, which classifies it as a medium hub airport (enplaning between 0.50 and 1.0 percent of U.S. enplanements).

With large and medium hub airports located within 60 miles in each direction, McClellan-Palomar Airport's commercial service area is primarily limited to the northwest portion of San Diego County. Due to their higher level of service, the larger hub airports capture a significant portion of air travelers from this service area. This will be further discussed later in the chapter.

All 12 public use airports in San Diego County serve general aviation. The four closest public use airports to McClellan-Palomar Airport include two that are classified as general aviation airports and two that are classified as general aviation reliever airports. As such, these airports define and share McClellan-Palomar Airport's general aviation service area.

Fallbrook Community Airpark and Oceanside Municipal Airport are the two closest airports. Both are located to the north and both have runways less than 2,200 feet in length. This effectively limits both airports to serving smaller piston-powered aircraft. While both are equipped with instrument approaches, neither has an airport traffic control tower (ATCT).

Ramona Airport, located 19 nautical miles to the west, and Montgomery Field, located 20 nautical miles to the south, are both classified as reliever airports and are equipped with ATCT and instrument approaches. Ramona Airport has a 5,001-foot runway and a 95,000 pound dual wheel pavement strength which makes it capable of accommodating general aviation aircraft similar to that at McClellan-Palomar Airport; however, Ramona Airport does not have any based jet aircraft. Montgomery Field is somewhat more limited by its 4,577-foot runway length and 12,000-pound dual wheel pavement strength, but still has 10 based jets. As the closest reliever airport to San Diego International Airport and the San Diego central business district (CBD), Montgomery Field has more annual operations than McClellan-Palomar Airport. **Table 3A** compares the major characteristics of each airport.

As with commercial service, the general aviation service area for McClellan-Palomar Airport is primarily the northwest portion of San Diego County. The smaller general aviation aircraft have additional options in Fallbrook and Oceanside, but Ramona Airport is the closest airport with similar capabilities to serve business aircraft.

TABLE 3A
Public-Use Airports Closest to McClellan-Palomar Airport

Airport Name	Distance (nm)	NPIAS[1] Role	Longest Runway	Based Aircraft	2011 GA Operations[2]	Instrument Approaches
McClellan-Palomar	-	Non-Hub	4,897'	290	143,670	Y
Fallbrook Community	13.6 N	GA	2,160'	94	25,400	Y
Oceanside Municipal	6. NW	GA	2,172'	53	12,00	Y
Ramona	19.1 E	Reliever	5,001	144	100,042	Y
Montgomery Field	20.0 S	Reliever	4,577	479	199,141	Y

Source: FAA 5010 Reports.
[1]National Plan of Integrated Airport Systems.
[2]FAA Tower Reports, except for Fallbrook and Oceanside, which is estimate included in FAA 5010 Report.

SOCIOECONOMIC TRENDS AND FORECASTS

Local and regional forecasts developed for key socioeconomic variables provide an indication of the potential for supporting growth in aviation activity. Three local variables that are typically useful in evaluating the service area and its potential for air traffic growth are population, employment, and income. The U.S. Bureau of Economic Analysis is a source for these and other socioeconomic variables with annual estimates down to local jurisdictional levels. The California Department of Finance is another source for economic data within the state.

Population forecasts are regularly prepared by a number of sources. At the regional level, the San Diego Association of Governments (SANDAG) has recently prepared population, employment, and income forecasts for the San Diego MSA and subareas in support of its *2050 Regional Transportation Plan* (RTP). These forecasts were prepared with a 2008 base year and were adopted by SANDAG in October 2011. The California Department of Finance will be updating its forecasts in 2012, so its current forecasts were considered outdated for use in this analysis. Thus, the SANDAG forecasts are considered here and presented in **Table 3B**.

TABLE 3B
Socioeconomic Forecasts
San Diego County

	2008	2020	2030	2040	2050	AARG 2008-2020
Population Forecasts						
San Diego MSA	3,131,552	3,535,000	3,870,000	4,163,688	4,384,867	1.01%
North County West	424,311	472,913	500,391	513,545	523,362	0.91%
North County East	428,471	470,887	529,558	584,607	617,182	0.79%
Employment Forecasts						
San Diego MSA	1,501,080	1,619,615	1,752,630	1,877,668	2,003,038	0.64%
North County West	175,792	196,461	212,374	225,234	236,755	0.93%
North County East	170,748	183,955	205,804	226,798	245,772	0.62%
Median Household Income (1999$)						
San Diego MSA	$51,920	$58,746	$66,153	$72,200	$76,857	1.03%
North County West	59,005	67,039	74,624	82,347	88,544	1.07%
North County East	51,898	59,419	67,733	74,267	79,787	1.13%
Per Capita Personal Income(2005$)						
San Diego MSA	$43,121	$47,951	$56,581	$67,653		0.89%

AARG: Average Annual Growth Rate
Source: Final Series 12 – Regional Growth Forecast, SANDAG, Adopted October 2011
PCPI: Complete Economic and Demographic Source (CEDDS), Woods & Poole, 2011

The SANDAG forecasts were developed for the RTP in ten-year increments to the planning horizon of 2050. The forecasts are for the county, as well as the two subareas that comprise the north county, which is the core of the McClellan-Palomar service area. The North County West subarea makes up the core of the service area for general aviation.

Because the forecast period being considered for this project extends to 2021, the average annual growth rate between 2008 and 2020 is presented in the table. Between 2008 and 2020, the annual average growth rate (AAGR) of population in the county is projected at 1.01 percent. This is higher than the rate projected for the North County West subarea (0.91 percent) and the North County East subarea (0.79 percent).

The annual growth rate for employment in the county is projected at 0.64 percent. The North County West subarea is projected to see employment grow at a faster rate of 0.93 percent. This is also a faster growth rate than projected for population in the subarea through 2020. The East subarea is projected to grow more in line with the county at 0.62 percent.

The median household income in the North County West subarea is 13.6 percent higher than the county. The North County West subarea essentially reflects the county average for median household income. Through 2020, the two subareas are projected to see median household income grow at a faster rate than the county. While the county is expected to have an AAGR of 1.03 percent, the West subarea is projected at 1.07 percent and the East subarea at 1.13 percent.

Woods and Poole Economics annually updates forecasts of economic indicators for its *Complete Economic and Demographic Data Source (CEDDS)*. The most recent forecasts were prepared in 2011 based upon the 2010 Census Data. Since SANDAG did not forecast per capita personal income, the Woods and Poole forecast was used for that indicator, and is included in **Table 3B** as well.

Total personal income adjusted for inflation to 2005 dollars was projected to grow at an AAGR of 0.89 percent annually in the MSA through 2020.

COMMERCIAL AIRLINE FORECASTS

McCLELLAN-PALOMAR AIRPORT AIR SERVICE HISTORY

Historical passenger enplanements at McClellan-Palomar Airport from 1990 through 2011 are presented in **Table 3C**. The annual percentage rate changes are also presented in the table. Over the 1990s, passenger enplanements grew from 2,023 to 80,630 in 2000, as service grew from four daily flights to Los Angeles International Airport (LAX) by one airline using small Cessna aircraft to 15 daily flights to LAX and Phoenix by two airlines using 30-seat turboprops.

The events of September 11, 2011 (9/11), combined with the start of an economic recession earlier in the year, appear to be a turning point in passenger growth. While both United Express (operated by SkyWest Airlines) and America West Express (operated by Mesa Airlines) maintained service, flights were cut about half. From 2002 to 2007, both airlines continued to serve the airport, but annual enplanements flattened out around 50,000.

As noted earlier, passenger traffic began to decline when the most recent recession began in December 2007. Mesa Airlines discontinued service in February 2008. By 2009, enplanements had declined to 25,160, the lowest total at the airport since 2004. The new airport terminal opened in October 2009. In 2010, there was a slight increase in passengers, and in 2011, traffic increased over 69 percent to jump back to the mid-decade level. As of the first quarter of 2012, SkyWest Airlines had six daily flights (41 weekly) from McClellan-Palomar Airport.

TABLE 3C
Enplanement History
McClellan-Palomar Airport

Year	CRQ Enplanements	Annual % Change
1990	2,023	NA
1991	8,551	322.7%
1992	11,735	37.2%
1993	14,556	24.0%
1994	21,862	50.2%
1995	28,622	30.9%
1996	44,729	56.3%
1997	50,714	13.4%
1998	58,251	14.9%
1999	78,364	34.5%
2000	80,630	2.9%
2001	73,173	-9.2%
2002	51,844	-29.1%
2003	49,275	-5.0%
2004	49,447	0.3%
2005	48,927	-1.1%
2006	50,157	2.5%
2007	46,924	-6.4%
2008	35,033	-25.3%
2009	25,160	-28.2%
2010	28,355	12.7%
2011	47,983	69.2%

A start-up airline, California Pacific, is currently working to gain certification and approval to provide service from McClellan-Palomar Airport to five domestic and one international destination. These destinations include San Jose, Oakland, and Sacramento in California, Las Vegas, Nevada, and Phoenix, Arizona. Initially, flights are anticipated to two of the California cities plus Las Vegas, with the other two added later, along with weekend flights to Los Cabos in Mexico. The airline plans to use 70-seat Embraer 170 (ERJ170) regional jets in its service. The reasons for the airline's interest in serving McClellan-Palomar were borne out recently in the passenger retention study discussed below.

PASSENGER RETENTION STUDY/TRUE PASSENGER MARKET SIZE ANALYSIS

In 2010, the Sixel Consulting Group prepared a *Passenger Retention Study and True Market Size Analysis* for McClellan-Palomar Airport. The study examined airline trips taken by those living in the immediate McClellan-Palomar Airport service area for a 12-month period ending March 31, 2010. This period was near the recent low point for passengers at McClellan-Palomar Airport.

Through its methodology, the study determined that McClellan-Palomar Airport was capturing just 1.6 percent of air travelers from its immediate market area in the North County. It was found that 76 percent were using San Diego International Airport to the south, while 5.6 percent used John Wayne/Orange County Airport. An estimated 15.8 percent were going even further to use LAX. More local travelers (1.8 percent) were using Ontario International Airport than used McClellan-Palomar Airport during the study period.

It was determined that the local air service area generated an estimated 3.27 million origin-destination passengers in the 12 months that were studied, which equates to approximately 1.14 million annual enplanements. The five top destinations were:

1) San Francisco Bay Area (13.8 percent)
2) New York/Newark (6.8 percent)
3) Seattle/Tacoma (4.2 percent)
4) Las Vegas (4.1 percent)
5) Sacramento (3.8 percent)

In its conclusions, the study indicated that "the breadth of airline service provided by airlines at these other airports surrounding McClellan-Palomar Airport is the biggest impediment to potential local air service in Carlsbad." The study pointed out that it could not accurately determine the percentage of local passengers that would use additional air service, and that considerable time and effort marketing new service through the region would be necessary to change engrained travel habits.

Finally, the study concluded "it appears that the biggest challenge to passenger retention at the McClellan-Palomar Airport is the fact that it offers the fewest non-stop destinations of all airports in Southern California…The key to reduced leakage will be increases in non-stop destinations, daily flights, and available seats."

The proposed service by California Pacific Airlines would provide service to three of the local service area's top five destinations. Phoenix ranked just out of the top five at 3.5 percent. Thus, at least 25 percent of the travelers determined from the study are going to proposed California Pacific Airlines destinations. All four destinations are within 450 nautical miles of McClellan-Palomar Airport.

It should be noted that California Pacific plans call for the aforementioned service from the existing runway length. This feasibility study is intended to examine runway improvements based upon the needs of corporate aircraft serving the airport. Therefore, the forecasts assume that commercial air service will continue with the current level of commuter service.

PASSENGER FORECASTS

As discussed in the chapter's introduction, the first steps involved in updating the airport's forecasts include reviewing previous forecasts in comparison to actual activity to determine what changes, if any, may be necessary. After that comes consideration of the effects of any potential new factors that could affect the forecasts, such as changes in the socioeconomic climate or the potential effects of service changes.

Previous Passenger Forecasts

Two sets of previous forecasts were reviewed and are outlined in **Table 3D**. These include projections from the *Regional Aviation Strategic Plan* (RASP) prepared by the San Diego Regional Airport and published in 2011, and the FAA *Terminal Area Forecasts* (TAF), issued in January 2012.

The commercial service projections for the RASP included a baseline scenario and a high scenario. The baseline forecast assumed that the current level of air service would continue through the planning period, which was 2030. This would involve SkyWest or a similar airline continuing to serve the airport exclusively with 30-seat turboprops to LAX. The RASP forecast indicated that SkyWest is removing the Embraer 120 (EMB120) that currently serves McClellan-Palomar Airport from its fleet, and assumed that it would be replaced with a Canadair Regional Jet 200 (CRJ-200) or similar aircraft by 2013. SkyWest's *2010 Annual Report* indicates an attrition of its EMB120 fleet from 48 in 2011 to 9 by 2014.

Table 3D presents the baseline RASP forecast which remains at 50,000 annual enplanements through 2030.

TABLE 3D
Previous Enplaned Passenger Forecasts
McClellan-Palomar Airport

	2011	2016	2021	2030
Actual	47,983			
San Diego RASP Forecast Scenarios				
Baseline – Maintain Current Service	50,000	50,000	50,000	50,000
High – Regional Jet Service	50,000	258,100	402,600	426,200
FAA-TAF 2011	42,462	50,556	60,188	82,390

The High Scenario RASP forecast assumed that regional jet service without restriction would be implemented. The RASP assumed that carriers would use regional jets to serve new destinations around 2015. The High Scenario forecast is also included in the table and indicates a high rate of growth in passengers through 2020, then a significantly slower rate of growth thereafter.

The 2011 TAF is the most recently prepared forecast as it is updated every year by the FAA. This forecast anticipated an increase to over 42,000 enplanements in 2011. Enplanements were then projected to grow at an annual average growth rate of 3.6 percent through 2030. The TAF for McClellan-Palomar Airport is also included in **Table 3D**.

Enplanement Forecast Analysis

Due to the influence of larger commercial service airports on the McClellan-Palomar air service area, many of the typical analytical forecasting techniques are not applicable. Rather, the airport's future passenger traffic levels will depend more upon its ability to retain passengers from its own service area. This will be driven by level of service factors such as frequency of flights, number of non-stop destinations, air fares, and even aircraft. Local airport factors, such as convenience and cost of parking, are already in McClellan-Palomar Airport's favor.

A market share analysis provides a first look at potential growth based on the share of the U.S. passenger enplanement market that McClellan-Palomar Airport captures. **Table 3E** compares the airport's share of the U.S. domestic enplanement market since 1990. As can be seen in the table, the airport's share of the market rose to its high in 2000 at 0.126 percent of U.S. domestic enplanements. With the events of 9/11, the airport's market share declined to a lower level averaging around 0.075 percent between 2003 and 2007. The economic recession combined with the discontinuance of service by Mesa Airlines, saw the market share decline to a low of 0.40 percent in 2009. In 2011, the airport saw a recovery to the levels that were experienced in the post-9/11 period with the market share once again at 0.75 percent.

TABLE 3E
Enplanement Market Share Analysis
McClellan-Palomar Airport

Year	CRQ Enplanements	Millions U.S. Domestic Enplanements	CRQ Market Share %
1990	2,023	456.6	0.0004%
1991	8,551	445.9	0.0019%
1992	11,735	464.7	0.0025%
1993	14,556	470.4	0.0031%
1994	21,862	511.3	0.0043%
1995	28,622	531.1	0.0054%
1996	44,729	558.1	0.0080%
1997	50,714	579.1	0.0088%
1998	58,251	592.1	0.0098%
1999	78,364	613.3	0.0128%
2000	80,630	641.2	0.0126%
2001	73,173	626.8	0.0117%
2002	51,844	574.5	0.0090%
2003	49,275	587.8	0.0084%
2004	49,447	628.5	0.0079%
2005	48,927	669.5	0.0073%
2006	50,157	668.4	0.0075%
2007	46,924	690.1	0.0068%
2008	35,033	608.7	0.0051%
2009	25,160	630.8	0.0040%
2010	28,355	635.3	0.0045%
2011	47,983	641.1	0.0075%
Forecast			
2016	54,000	723.9	0.0075%
2021	62,000	832.6	0.0075%

The *Passenger Retention Study* discussed earlier occurred during the period of lower traffic in 2009-10. The study determined that only 1.6 percent of air travelers from the McClellan-Palomar immediate service area were using the airport. Adjusting the study's potential travelers at the growth rate experienced nationally in 2011, McClellan-Palomar was capturing approximately three (3.0) percent of its service area in 2011.

A constant market share projection is depicted in **Table 3E** based on McClellan-Palomar retaining the 0.75 percent share that appears to be established with the current level of service at the airport. In line with the FAA domestic enplanement forecast, the constant share projection shows an average annual growth rate of 2.6 percent through 2021.

This projection can be considered to make assumptions similar to that of the RASP baseline projection acknowledged earlier. The primary assumption is that air service at the airport would continue to be by 30-seat turboprop aircraft with flights to LAX. As indicated earlier, SkyWest plans to phase out its turboprop aircraft in favor of an all-regional jet fleet. So the service may ultimately require turboprop service from another airline. The 2021 baseline forecast of 62,000 annual enplanements is within approximately three percent of the FAA TAF forecast of 60,188 enplanements for that year, and is the recommended commercial service forecast for this study. **Figure 3D** depicts the recommended forecast in comparison to the TAF as well as the RASP baseline and high range forecasts for McClellan-Palomar Airport.

AIRLINE OPERATIONS

The commercial service fleet mix is needed to project airline operations for the airport. A projection of the fleet mix for McClellan-Palomar Airport has been developed by reviewing the equipment used and projected to be used by the commuter turboprop service at the airport.

The airlines have been undergoing a dramatic adjustment in their fleet mix composition. As older aircraft are retired, some routes have been transferred to regional airlines and adjustments have been made to domestic routes. Higher fuel prices led to a reduction in domestic capacity as airlines attempted to generate a profit. A slowing U.S. economy also impacted their ability to quickly return to profitable operations.

SkyWest, the airline currently serving the airport, utilizes the EMB120 turboprop aircraft. When Mesa Airlines was also providing service earlier in the decade, it was also using a turboprop, the 34-seat Dehavilland Dash 8, newer models of which are known as the Bombardier Q200. Thus, both aircraft are in the same range of seating capacity.

Table 3F examines the annual percentage breakdown of major airline fleet mix by seating capacity at McClellan-Palomar Airport since 2007. The aircraft mentioned above fall within the 30-39 seat range and have comprised 100 percent of airline fleet at the airport during this period. The average seats per departure have been 30 the last four years as the airport has been served exclusively by the 30-seat EMB120. The ratio was slightly higher as the 34-seat Dash 8 was in the mix for the first few months of the year.

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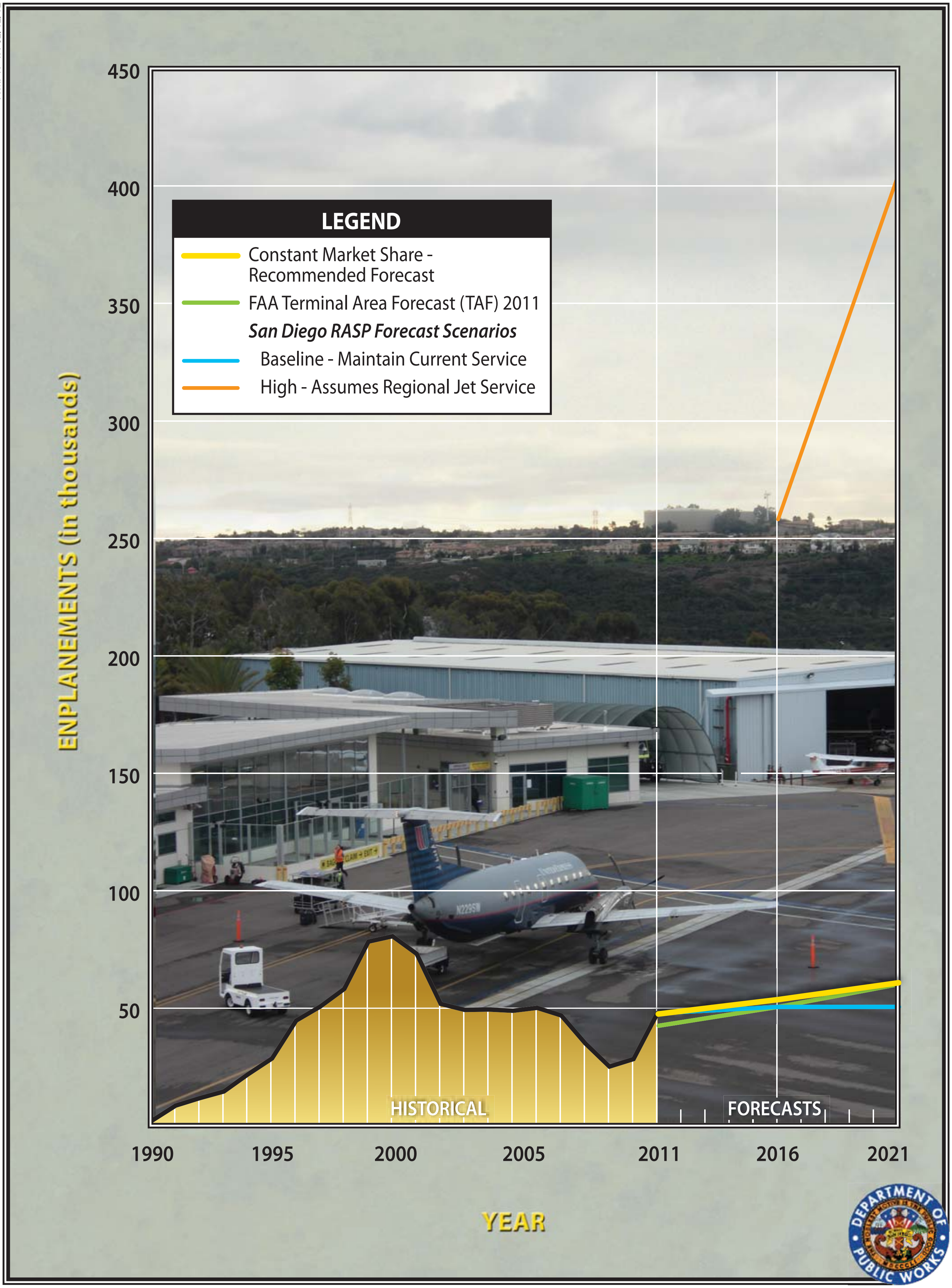

Figure 3D
ENPLANEMENT PROJECTIONS
McCLELLAN-PALOMAR AIRPORT

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TABLE 3F
Existing Airline Fleet Mix by Seat Capacity
McClellan-Palomar Airport

	Actual				
Fleet Mix Seating Capacity	**2007**	**2008**	**2009**	**2010**	**2011**
60-79	0.0%	0.0%	0.0%	0.0%	0.0%
40-59	0.0%	0.0%	0.0%	0.0%	0.0%
20-39	100.0%	100.0%	100.0%	100.0%	100.0%
< 20	0.0%	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%
Average Seats per Departure	30.5	30.0	30.0	30.0	30.0
Boarding Load Factor	57.9%	51.3%	38.8%	55.0%	73.8%
Enplanements per Departure	17.6	15.4	11.6	16.5	22.2
Annual Enplanements	46,924	35,033	25,160	28,355	47,983
Annual Departures	2,659	2,275	2,163	1,717	2,166
Annual Operations	5,318	4,550	4,326	3,434	4,332

Representative Aircraft:
< 20 – Beech 1900
20-39 – Embraer 120, DeHavilland Dash 8
40-59 – Canadair RJ 200, Embraer 145
60-79 – Embraer 170, Canadair 700, Bombardier Q400

The boarding load factor (BLF) is defined as the ratio of passengers boarding aircraft compared to the seating capacity of the aircraft. The BLF percentage at McClellan-Palomar Airport was in the 50s in three of the past five years. It dipped to 38.8 percent during the low point of 2009, but has recovered to a high of 73.8 percent in 2011. This can be expected to stay in a range of 65 to 75 percent in the future depending upon the airline service, but trending toward the higher end over time to follow along with the rise projected for U.S. domestic regional airline load factors.

Table 3G presents the resulting fleet mix and operations forecast based upon the enplanement forecasts at McClellan-Palomar Airport. The forecast maintains the current 30-seat turboprop service over the next ten years. The BLF would be maintained near the recent percentages and would result in an increase to 5,600 annual operations by 2021.

TABLE 3G
Airline Fleet Mix and Operations Forecast
McClellan-Palomar Airport

Fleet Mix Seating Capacity	Forecast 2011	2016	2021
60-79	0.0%	0.0%	0.0%
40-59	0.0%	0.0%	0.0%
20-39	100.0%	100.0%	100.0%
< 20	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%
Average Seats per Departure	30.0	30.0	30.0
Board Load Factor	73.8%	72.0%	74.0%
Enplanements per Departure	22.2	21.6	22.2
Annual Enplanements	47,983	54,000	62,000
Annual Departures	2,166	2,500	2,800
Annual Operations	4,332	5,000	5,600

GENERAL AVIATION FORECASTS

The following forecast analysis examines each of the general aviation demand categories at McClellan-Palomar Airport through 2030. Each segment will be examined individually, and then collectively, to provide an understanding of the overall aviation activity at the airport.

The remainder of this section presents the forecasts for general aviation demand, which includes the following:

- Based Aircraft
- Based Aircraft Fleet Mix
- Local and Itinerant Operations

BASED AIRCRAFT

The number of based aircraft is perhaps the most basic indicator of general aviation demand. By developing a forecast of based aircraft, the growth of aviation activities at the airport can be projected. Aircraft basing at the airport is somewhat dependent upon the nature and degree of aircraft ownership in the local service area. As a result, aircraft registrations in the area were reviewed and forecast first.

Registered Aircraft Forecasts

Table 3H outlines the historic registered aircraft in San Diego County since 1993. This information was obtained from records of the FAA's Aircraft Registry. According to the FAA, there were 2,837 aircraft registered in San Diego County in 1993. Registrations declined to 2,677 in 1996, then began to grow each year through 2007 when registrations reached 3,238. This represented an average annual growth rate of 1.7 percent. With the recession, the county has experienced a decline in aircraft ownership. In 2011, aircraft registrations stood at 3,091. There are no recently prepared forecasts of registered aircraft to examine and compare. As a result, a projection of county aircraft registrations was developed for this study.

TABLE 3H
Registered Aircraft Forecast
San Diego County

Year	County Registered Aircraft	U.S. Active Aircraft	Market Share
1993	2,837	177,120	1.602%
1994	2,816	172,936	1.628%
1995	2,736	188,089	1.455%
1996	2,677	191,129	1.401%
1997	2,698	192,414	1.402%
1998	2,743	204,710	1.340%
1999	2,814	219,464	1.282%
2000	3,025	217,533	1.391%
2001	3,053	211,446	1.444%
2002	3,066	211,244	1.451%
2003	3,083	209,708	1.470%
2004	3,131	219,426	1.427%
2005	3,142	224,352	1.400%
2006	3,142	226,422	1.388%
2007	3,238	221,943	1.459%
2008	3,228	228,668	1.412%
2009	3,201	223,920	1.430%
2010	3,118	224,172	1.391%
2011	3,091	222,520	1.389%
Constant Market Share Forecast			
2016	3,124	224,720	1.390%
2021	3,193	229,695	1.390%

As a starting point, the county's market share of U.S. active general aviation aircraft was examined. This market share analysis compared the county's aircraft ownership trends versus national aircraft ownership trends. As evidenced in **Table 3H**, the county's market share of U.S. active general aviation aircraft has been somewhat consistent since 1996, fluctuating between a low of 1.28 percent and a high of 1.47 percent. The market share in 2011 was near the mid-range at 1.39 percent. Applying this percentage, a constant market share projection was applied to the forecast years and yields 3,193 registered aircraft in San Diego County by 2021.

A time-series analysis was conducted next to evaluate the growth of aircraft ownership over three different time periods. These included periods beginning with 1993, 1996 (post-*General Aviation Revitalization Act of 1994*), and 2002 (post-9/11 era). As is evident from **Table 3J**, the longest period provided the best correlation by far (0.86), although only slightly better than the 1996-2011 period (0.85).

TABLE 3J
Correlation Analysis
San Diego County Aircraft Registrations

	r-value
Time Series Correlation	
Aircraft Registrations, 1993-2011	0.86
Aircraft Registrations, 1996-2011	0.85
Aircraft Registrations, 2002-2011	0.36
Single Variable Correlations	
vs. Population	
San Diego MSA (1993-2011)	0.87
San Diego MSA (1996-2011)	0.89
San Diego MSA (2002-2011)	0.14
vs. Employment	
San Diego MSA (1993-2011)	0.90
San Diego MSA (1996-2011)	0.95
San Diego MSA (2002-2011)	0.78
vs. Per Capita Personal Income (million 2005$)	
San Diego MSA (1993-2011)	0.92
San Diego MSA (1996-2011)	0.97
San Diego MSA (2002-2011)	0.85
vs. U.S. Active General Aviation Aircraft	
(1993-2011)	0.79
(1996-2011)	0.84
(2002-2011)	0.61

The correlation coefficient (Pearson's "r") measures the association between changes in the dependent variable (enplanements) and the independent variable(s) (calendar years). In social sciences, an r-value greater than 0.90 generally indicates reasonably good predictive reliability. A value below 0.90 may still be used with the understanding that the predictive reliability is lower. The statistical fit of the time-series analysis, while not considered a strong correlation, provides a basic trend line projection for enplanements.

The next analysis tested socioeconomic data for population, employment, and inflation-adjusted per capita personal income (PCPI) as independent variables and registered aircraft as the dependent variable. In addition, the industry variable of U.S. active general aviation aircraft was tested. **Table 3J** compares the resulting correlations. The best correlations were for the period beginning in 1996. PCPI provided the best correlation at 0.97 percent, with employment next at 0.95 percent. U.S. active aircraft provided a 0.84 correlation. Projections from these three regressions were considered further.

Table 3K and **Figure 3E** summarize the registered aircraft projections for San Diego County that were considered along with the market share that was discussed earlier. The resulting market share for each projection is also depicted. Maintaining the current market share resulted in the lowest projection (3,191 aircraft in 2021), while the employment regression was the highest (3,605). The U.S. active aircraft regression yielded a 1.40 percent market share through the entire forecast period. In general, the socioeconomic variables yielded a growing market share though the period.

To account for the socioeconomic growth as well as the general aviation industry growth, a forecast that results in a moderately growing market share of U.S. active aircraft was selected. The market share would grow to 1.42 percent in 2016, and 1.45 percent in 2021, resulting in 3,320 registered aircraft by that year, and an annual average growth rate of 0.7 percent.

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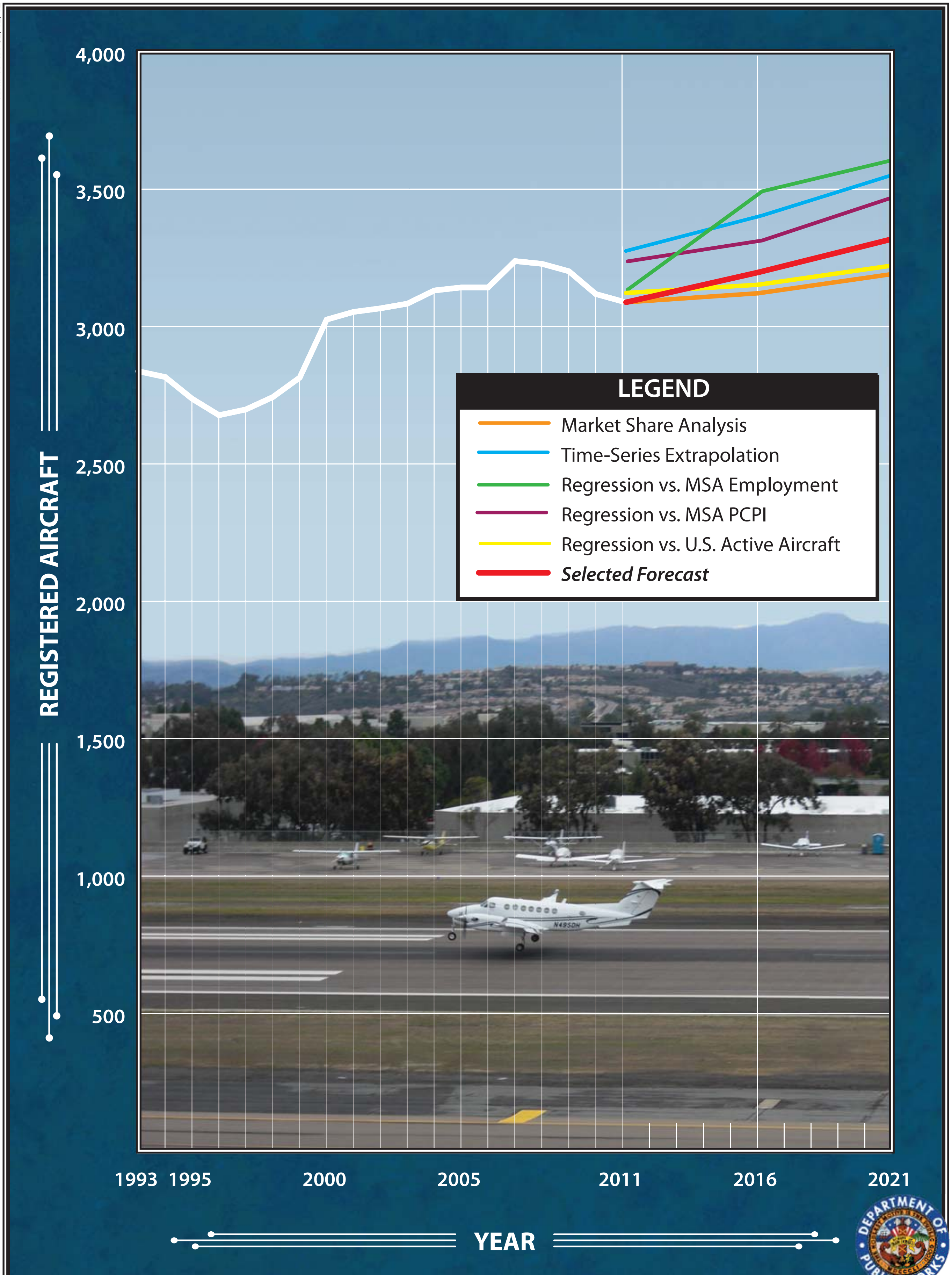

Figure 3E
REGISTERED FORECAST

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TABLE 3K **San Diego County Aircraft Registration Projections**	**2011**	**2016**	**2021**
U.S. Active General Aviation Aircraft Forecasts	222,520	224,720	229,695
San Diego County Registered Aircraft			
Market Share Analysis	3,091	3,122	3,193
Share of U.S. Market (%)	*1.39%*	*1.39%*	*1.39%*
Time-Series Extrapolation	3,264	3,404	3,605
Share of U.S. Market (%)	*1.47%*	*1.51%*	*1.55%*
Regression vs. MSA Employment	3,134	3,492	3,605
Share of U.S. Market (%)	*1.41%*	*1.55%*	*1.57%*
Regression vs. MSA PCPI	3,237	3,313	3,469
Share of U.S. Market (%)	*1.45%*	*1.47%*	*1.51%*
Regression vs. U.S. Active Aircraft	3,125	3,155	3,224
Share of U.S. Market (%)	*1.40%*	*1.40%*	*1.40%*
Selected Forecast	**3,091**	**3,200**	**3,320**
Share of U.S. Market (%)	***1.39%***	***1.42%***	***1.45%***

Based Aircraft Forecasts

As with passenger enplanements, the RASP and the TAF also provide recent forecasts of general aviation aircraft for McClellan-Palomar Airport. These are presented in **Table 3L.** The RASP included both a baseline and high forecast of based aircraft for the public use airports in the county. This essentially represented annual growth rates of 0.8 percent and 1.8 percent county-wide that were then distributed between airports. The 2030 forecast for McClellan-Palomar Airport was the same for both the baseline and high forecast (484).

TABLE 3L **Previous Based Aircraft Forecasts** **McClellan-Palomar Airport**	**2011**	**2016**	**2021**	**2030**
Actual	290			
San Diego RASP Forecast	365	393	423	484
FAA-TAF 2011	349	367	391	440

This resulted in an annual average growth rate of 1.5 percent. This is higher than the county-wide growth rate because the airport has a high number of based business jets. Business jets are projected to grow at a higher rate than other types of general aviation aircraft. The high forecast assumed that the airport would be at its maximum basing capacity at 484 based aircraft. This was projected with 2007 as the base year, when based aircraft totaled 344. In 2011, based aircraft were down to 290.

The TAF projected based aircraft to grow from 341 in its base year of 2010 to 391 in 2021 and 446 in 2030. This is an average annual growth rate of 1.35 percent. As with the RASP, the base year accounted for more than 50 additional based aircraft than the airport's most recent count of 290.

Table 3M presents historical based aircraft totals for McClellan-Palomar Airport. Over the past 20 years, based aircraft has fluctuated between a high of 496 in 1997 and a low of 274 in 2010.

TABLE 3M
Based Aircraft Forecasts
McClellan-Palomar Airport

Year	CRQ Based Aircraft	County Registered Aircraft	CRQ Market Share
1993	351	2,837	12.4%
1994	292	2,816	10.4%
1995	292	2,736	10.7%
1996	465	2,677	17.4%
1997	496	2,698	18.4%
1998	496	2,743	18.1%
1999	480	2,814	17.1%
2000	480	3,025	15.9%
2001	377	3,053	12.3%
2002	377	3,066	12.3%
2003	380	3,083	12.3%
2004	395	3,131	12.6%
2005	376	3,142	12.0%
2006	309	3,142	9.8%
2007	344	3,238	10.6%
2008	341	3,228	10.6%
2009	332	3,201	10.4%
2010	274	3,118	8.8%
2011	290	3,091	9.4%
Based Aircraft Forecast w/o Project			
2016	310	3,200	9.7%
2021	332	3,320	10.0%
Based Aircraft Forecast w/Project			
2016	314	3,200	9.8%
2021	340	3,320	10.2%

The based aircraft forecast is a function of the registered aircraft forecast that was completed previously. **Table 3M** also presents the based aircraft as a market share of registered aircraft in San Diego County. This percentage generally trended downward from the mid-1990s. From 2001 through 2005, the percentage was relatively constant averaging 12.3 percent of the county aircraft ownership. Beginning with 2006, the percentage has averaged 9.9 percent.

The 290 based aircraft at McClellan-Palomar Airport currently equal approximately 9.4 percent of registered aircraft in the county. A projection was developed with based aircraft growing at the TAF projected rate of 1.35 percent. This would begin to gradually recover the share of aircraft ownership to 10.0 percent of the county registered aircraft by 2021. This percentage share is in line with the average share of registered aircraft experienced over the last six years.

This would result in 332 based aircraft by the end of the planning period. This appears to be a reasonable growth rate for the airport taking into account the growth rates projected both for the registered aircraft and by the TAF based aircraft forecast. Thus, it is depicted as the based aircraft forecast without a runway improvement project in **Table 3M** as well as on **Figure 3F.**

According to interviews with the airport's fixed base operators, at least one business jet owner is known to have chosen to base its aircraft elsewhere because of the runway length limitations at McClellan-Palomar Airport. The operators feel that there are others who do not consider the airport due to its runway length. Adequate runway length could potentially affect business jet basing by five to eight percent.

Table 3M also presents a forecast with the runway project which allows for a five to eight percent increase in business jets if the runway were to be improved. The 340 based aircraft in 2021 would represent an average annual increase of 1.6 percent, or just slightly higher than the 1.5 percent rate projected by the RASP, which also considered a runway extension. It would also be equivalent to 10.2 percent of the registered aircraft forecast for San Diego County.

Aircraft Fleet Mix

While the total number of general aviation aircraft based at McClellan-Palomar Airport is projected to increase, it is also important to know the type of aircraft expected to base at the airport. According to airport records, the 2011 mix of aircraft based at the airport consisted of 176 single-engine piston aircraft, 23 multi-engine piston aircraft, 16 turboprops, 63 jets, and 11 helicopters. Compared to 2005, piston aircraft declined by 30 while business jet aircraft increased by 14.

The forecast mix of based aircraft was determined by comparing existing and forecast U.S. general aviation fleet trends to the fleet mix at McClellan-Palomar Airport. The national trend in general aviation is toward a greater percentage of larger, more sophisticated aircraft as part of the national fleet. Even with based aircraft growing through 2021, the based piston aircraft are expected to show a slight decline. Meanwhile, the major growth will be in the business jet fleet, and there will be smaller increases in turboprops and helicopters under both scenarios. The fleet mix projections for McClellan-Palomar Airport are presented in **Table 3N**.

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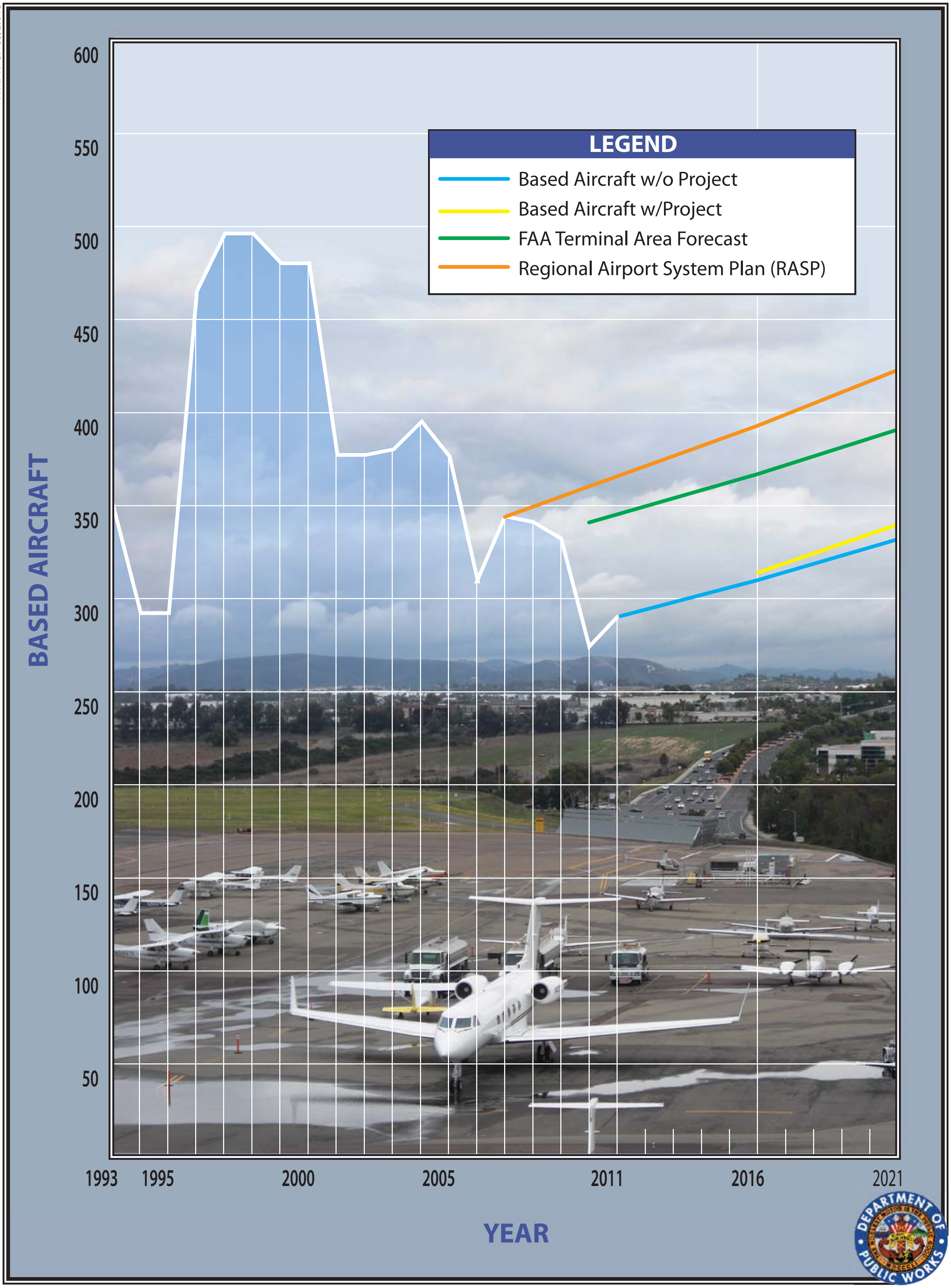

Figure 3F
BASED AIRCRAFT FORECAST

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TABLE 3N
Based Aircraft Mix Forecast
McClellan-Palomar Airport

Year	Total	Single Engine	Multi-Engine	Turboprop	Jet	Helicopter
2006	309	197	32	20	49	11
2011	290	176	23	16	63	12
Forecast w/o Project						
2016	310	175	22	18	80	15
2021	332	173	21	20	101	17
Forecast w/Project						
2016	314	175	22	18	84	15
2011	340	173	21	20	109	17

GENERAL AVIATION OPERATIONS

General aviation operations are classified by the ATCT as either local or itinerant. A local operation is a take-off or landing performed by an aircraft that operates within sight of the airport, or which executes simulated approaches or touch-and-go operations at the airport. Itinerant operations are those performed by aircraft with a specific origin or destination away from the airport. Generally, local operations are characterized by training operations. Typically, itinerant operations increase with business and commercial use.

Table 3P presents the historical general aviation operations at McClellan-Palomar Airport, as reported by the ATCT since 1990. Operations began in the 1990s at 242,585, declined to 186,908 by 1995, but recovered and grew to a peak of 264,293 in 1999. Operations then began to decline each year through 2003. Through 2007, operations appeared to stabilize around 192,000 annually, until the economic recession led to a decline that reached a low point of 122,818 in 2010. In 2011, general operations had grown to 133,591, but were still lower than at any time during the previous two decades. Forecasts of general aviation operations will be examined individually as itinerant and local operations.

TABLE 3P
Historical General Aviation Operations
McClellan-Palomar Airport

Year	Itinerant Operations	Local Operations	Total Operations
1990	154,806	87,779	242,585
1991	139,129	66,893	206,022
1992	135,897	75,061	210,958
1993	134,155	69,338	203,493
1994	135,360	71,473	206,833
1995	131,289	55,619	186,908
1996	144,149	66,512	210,661
1997	159,362	73,683	233,045
1998	180,988	79,726	260,714
1999	180,069	84,224	264,293
2000	152,184	78,405	230,589
2001	131,284	70,671	201,955
2002	126,266	62,918	189,184
2003	121,026	57,182	178,208
2004	124,242	67,663	191,905
2005	120,128	72,396	192,524
2006	125,723	53,073	178,796
2007	132,111	60,720	182,831
2008	113,781	62,684	176,465
2009	99,089	59,918	159,007
2010	82,602	40,216	122,818
2011	89,298	44,293	133,591

Source: Air Traffic Activity System (ATADS), FAA

Itinerant GA Operations

Table 3Q presents an examination of general aviation itinerant operations in relationship to the same type of operations at towered airports in the U.S. since the year after the events of 9/11. Through 2008, general aviation itinerant operations were in the range of 120,000 to 132,000 annually. With the recession, not only did based aircraft decline, but so did the ratio of operations per based aircraft. As such, itinerant operations declined to 82,602 by 2010. The operations level recovered slightly in 2011 to total 89,298.

TABLE 3Q General Aviation Itinerant Operations Forecast McClellan-Palomar Airport					
Year	CRQ Itinerant Operations	US ATCT GA Itinerant (millions)	CRQ Market Share %	CRQ Based AC	Itinerant Ops Per AC
2002	126,266	21.45	0.589%	377	335
2003	121,026	20.23	0.598%	380	318
2004	124,242	20.00	0.621%	395	315
2005	120,128	19.30	0.622%	376	319
2006	125,723	18.71	0.672%	309	407
2007	132,111	18.58	0.711%	344	384
2008	113,781	17.52	0.649%	341	334
2009	99,089	15.57	0.636%	332	298
2010	82,602	14.86	0.556%	274	301
2011	89,298	14.53	0.615%	290	308
Constant Market Share Projection					
2016	88,885	14.46	0.615%	310	287
2021	90,679	14.75	0.615%	332	273
Operations Per Based Aircraft Projection					
2016	95,456	14.46	0.660%	310	308
2021	102,231	14.75	0.693%	332	308
FAA-TAF Projection					
2016	90,766	14.46	0.628%	367	247
2021	92,255	14.75	0.625%	391	236
Forecast without Project					
2016	93,300	14.46	0.645%	310	301
2021	98,400	14.75	0.667%	332	296
Forecast with Project					
2016	94,500	14.46	0.653%	314	301
2021	100,800	14.75	0.683%	340	296

The first forecast method used to project itinerant general aviation operations examined the airport's itinerant operations in relation to the total general aviation itinerant operations at towered airports in the U.S. As shown in **Table 3Q**, the airport's market share, as a percentage of general aviation itinerant operations at towered airports across the country, has fluctuated between a low of 0.556 percent and high of 0.711 percent during the past decade. McClellan-Palomar Airport's current market share (0.615 percent) is slightly below the average for the last ten years (0.627). The former percentage was applied to the forecast years as a constant market share projection and yields 93,776 itinerant general aviation operations at the airport by 2021.

Table 3Q also depicts the itinerant operations as a ratio to based aircraft. As evidenced in the table, this ratio has varied over the past ten years between 298 and 407. The years of 2006 and 2007 had ratios that were significantly higher than the rest of the decade. If these two years are discounted, the average for the decade was 316 operations per based aircraft. The 89,298 itinerant operations in 2011 resulted in 308 operations per based aircraft. Applying this as a constant ratio through the forecast years would yield 102,231 itinerant general aviation operations at McClellan-Palomar Airport by 2021.

Table 3Q presents constant market share and operations per based aircraft projections for itinerant general aviation operations. The constant market share projections result in lower itinerant operations per based aircraft ratio. The operations per based aircraft projection results in a growing market share.

The FAA-TAF forecasts for itinerant operations are also included for comparison. This forecast falls within the range of the two previous projections. The TAF projection results in a slightly higher market share over the forecast period. The operations per based aircraft are lower primarily since the FAA-TAF had a higher based aircraft forecast due to a higher base year count.

A forecast within the range of these projections is most likely. As depicted in **Table 3Q**, the selected forecast without the potential runway improvements allows for a recapture of market share within the range of the last 10 years.

The forecast with the project is also presented in the table. The increase in based aircraft expected with the project was applied to the same operations per based aircraft resulting in an additional 2,400 annual operations by 2021.

Local General Aviation Operations

The airport's local operations have varied over the past two decades depending on the number of small aircraft based at the airport and the pilot training that has been available. **Table 3R** presents operations over the past ten years in relation to local general aviation operations at U.S. towered airport and to based aircraft.

The same methodology that was utilized to forecast itinerant general aviation operations was used to forecast local operations. As presented in **Table 3R**, the airport's market share as a percentage of general aviation local operations at towered airports across the country has fluctuated between a low of 0.343 percent and high of 0.488 percent during the past decade. The most recent market share in 2011 of 0.387 percent falls in the lower third of this range. This was applied to the forecast years as a constant market share projection, yielding 45,128 local general aviation operations at the airport by 2021.

Table 3R also depicts the itinerant operations as a ratio to based aircraft. Similar to the market share, this ratio has varied over the past decade from 147 to 193. The 2011 ratio of 153 was applied as a constant ratio through the forecast years yielding 50,796 local general aviation operations by 2021.

The FAA-TAF forecast that is also included in the table results in a declining market share compared to U.S. towered local operations as well as a declining operations per based aircraft ratio. With the number of piston-powered aircraft declining and the cabin-class aircraft increasing at McClellan-Palomar Airport, it is likely that the operations per based aircraft ratio will decline at least slightly. A mid-range forecast was selected that follows such a trend and is presented in **Table 3R**. The local operations forecast is not expected to change with or without the runway project as the aircraft conducting local operations do not require any additional runway length.

TABLE 3R
General Aviation Local Operations Forecast
McClellan-Palomar Airport

Year	CRQ Local Operations	US ATCT GA Local (millions)	CRQ Market Share %	CRQ Based AC	Local Ops Per AC
2002	62,918	16.17	0.389%	377	167
2003	57,182	15.29	0.374%	380	150
2004	67,663	14.96	0.452%	395	171
2005	72,396	14.84	0.488%	376	193
2006	53,073	14.37	0.369%	309	172
2007	60,720	14.56	0.417%	344	177
2008	62,684	14.15	0.443%	341	184
2009	59,918	12.45	0.481%	332	180
2010	40,216	11.72	0.343%	274	147
2011	44,293	11.44	0.387%	209	153
Constant Market Share Projection					
2016	44,039	11.37	0.387%	310	142
2021	45,128	11.65	0.387%	332	147
Operations Per Based Aircraft Projection					
2016	47,430	11.37	0.417%	310	153
2021	50,796	11.65	0.436%	332	153
FAA-TAF Projection					
2016	42,376	11.37	0.373%	367	115
2021	42,676	11.65	0.366%	391	109
Forecast without Project					
2016	45,700	11.37	0.402%	310	147
2021	48,000	11.65	0.412%	332	142
Forecast with Project					
2016	45,700	11.37	0.402%	314	146
2021	48,000	11.65	0.412%	340	141

AIR TAXI OPERATIONS

The air taxi operations as reported by the ATCT include commuter airline operations as well as for-hire general aviation operations. Some operations by aircraft operated under fractional ownership programs are also counted as air taxi operations. Since the airline operations have been forecast, this section reviews the growth potential for air taxi operations.
Historical air taxi operations for the airport were obtained from tower reports and are presented in **Table 3S**. Since 2007, air taxi operations have declined greatly, similar to general aviation operations, reflecting the effects of the economic recession. Since the other air taxi operations are essentially for-hire general aviation operations, the table analyzes air taxi in ratio to itinerant general aviation activity at McClellan-Palomar Airport. This ratio declined between 2007 and 2010, but increased in 2011.

The air taxi operations were projected to reclaim a portion of this ratio as business activity recovers. The forecast without the runway project as presented in the table would gradually grow to the average of the ratio over the past five years.

TABLE 3S
Other Air Taxi Operations Forecasts
McClellan-Palomar Airport

Year	CRQ Air Taxi Operations	CRQ GA Itinerant Operations	CRQ Market Share %
2007	12,211	132,111	0.0092%
2008	8,062	113,781	0.0071%
2009	5,103	99,089	0.0051%
2010	4,223	82,602	0.0051%
2011	4,958	89,298	0.0056%
Forecast without Project			
2016	5,600	93,300	0.0060%
2021	6,300	98,400	0.0064%
Forecast with Project			
2016	6,200	94,500	0.0066%
2021	6,900	100,800	0.0068%

Air taxi aircraft must operate under FAR Part 135, which requires that the calculated landing distance for the aircraft be 60 percent of the length of the available runway. Fractional ownership aircraft operate under FAR Part 91, in which Subpart k requires the aircraft to be able to land within 80 percent of the available runway. This can affect the ability of some air taxi and fractional aircraft to operate at the airport, particularly during wet runway conditions when the runway length requirement is increased another 15 percent. To account for this, the potential runway improvement project was projected to allow for an increase of up to 10 percent in air taxi operations. Both forecast scenarios are presented in **Table 3S.**

MILITARY OPERATIONS

Military activity accounts for the smallest portion of the operational traffic at McClellan-Palomar Airport. Historical military operations were obtained from tower reports and are presented in **Table 3T**. After 9/11, military operations at the airport declined dramatically, and continued to decline through 2008. For the past three years, operations have been relatively stable, averaging 783 a year. With the Department of Defense facing budget reductions, this level of activity or less could be expected. **Table 3T** projects an average of 800 military operations annually through the forecast period.

TABLE 3T
Military Operations
McClellan-Palomar Airport

Year	Itinerant	Local	Total
2002	1,894	72	1,966
2003	1,838	85	1,923
2004	1,476	59	1,535
2005	1,414	171	1,585
2006	1,268	303	1,571
2007	1,184	479	1,663
2008	900	478	1,378
2009	561	277	838
2010	537	185	722
2011	564	225	789
Forecast			
2017	550	250	800
2022	550	250	800
2030	500	250	800

FORECAST SUMMARY

Figure 3G provides a summary of the aviation activity forecasts developed for McClellan-Palomar Airport for 2016 and 2021. This includes two scenarios, one without any improvement to the runway length, and one with the runway length extended.

Without the project, the airport is forecast to handle 150,400 operations in 2016 and 159,100 in 2021. With the potential project, the forecasts increase to 152,200 in 2016, and 162,100 in 2021.

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FORECAST SUMMARY

	ACTUAL	FORECASTS W/O PROJECT		FORECASTS WITH PROJECT	
	2011	2016	2021	2016	2021
ANNUAL OPERATIONS					
General Aviation					
Itinerant	89,298	93,300	98,400	94,500	100,800
Local	44,293	45,700	48,000	45,700	48,000
Total General Aviation	133,591	139,000	146,400	140,200	148,800
Airline	4,332	5,000	5,600	5,000	5,600
Other Air Taxi	4,958	5,600	6,300	6,200	6,900
Military	789	800	800	800	800
Total Annual Operations	**143,670**	**150,400**	**159,100**	**152,200**	**162,100**
AIRLINE ENPLANEMENTS	**47,983**	**54,000**	**62,000**	**54,000**	**62,000**
BASED AIRCRAFT					
Single-Engine Piston	176	175	173	175	173
Multi-Engine Piston	23	22	21	22	21
Turboprop	16	18	20	18	20
Jet	63	80	101	84	109
Helicopter	12	15	17	15	17
Total Based Aircraft	**290**	**310**	**332**	**314**	**340**

OPERATIONS FORECAST WITH AND WITHOUT PROJECT

Figure 3G
FORECAST SUMMARY

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Chapter Four
RUNWAY FACILITY REQUIREMENTS

The forecasts of aviation activity at McClellan-Palomar Airport provide a basis for examining the runway needs of the airport's users. These forecasts have been used to determine the feasibility of the improvement alternatives that would best serve the current airport users and the community in an economically and environmentally responsible manner.

The types of aircraft to be operated at an airport should be considered in the planning and design of that airport. If the design aircraft meets the FAA criteria as the critical aircraft, the sponsor of the airport may be eligible for funding from the FAA Airport Improvement Program to upgrade the airport's design. However, for an eligible project to be funded, it must be proven to be economically practicable and feasible as well. The project will also be subject to environmental approval under both the National Environmental Protection Act (NEPA) and the California Environmental Quality Act (CEQA).

While it is desirable to plan and design to the standards for the critical aircraft as set forth by the FAA, it may not be practicable to do so. If the plan is an upgrade from the airport's current standards, the FAA funding policy seldom approves non-standard design. In that case, funding for an airport may be limited to the improvement needs of a classification that fulfills the critical aircraft criteria for which the design standards can be met.

An airport that does not meet the FAA design standard guidelines for a particular classification of aircraft is not necessarily unsafe for operations by those aircraft. Under federal law, the FAA has the exclusive authority to regulate in the field of aviation safety. Unless an airfield is determined as inherently unsafe by the FAA in accordance with the current Code of Federal Regulations (CFR), the final decision to land and/or depart from the airfield is up to the aircraft operator, who must also abide by the CFRs regarding the aircraft and its operation. Such is the case at McClellan-Palomar Airport, where aircraft in a classification that exceeds the current airport design commonly operate.

Airport owners may exercise authority in regulation of aviation safety, but that authority does not extend to a ban on classes of aircraft. With the acceptance of federal airport improvement grants for McClellan-Palomar Airport, the County of San Diego is bound under grant assurances to make the airport available as an airport for public use under fair and reasonable terms and without unjust discrimination to all types, kinds and classes, of aeronautical uses.

This chapter first examines the critical aircraft for McClellan-Palomar Airport. It then examines the current airport planning and design standards, the design standard of the critical aircraft, and the reasonable runway lengths to be considered for aircraft in each classification. From this analysis, runway improvement options will be identified, and in later chapters, they will be examined and compared for practicability and feasibility.

CRITICAL AIRCRAFT

The design standards applied to an airport are based on the type of aircraft that regularly use the facility with the most demanding characteristics. Regular use is defined by the Federal Aviation Administration (FAA) as that aircraft or family of aircraft that will perform at least 500 annual operations at the airport.

FAA Advisory Circular (AC) 150/5300-13A, *Airport Design*, establishes a coding system to help classify the most demanding aircraft for an individual airport. The coding system correlates to the operational and physical characteristics of the critical design aircraft. The identified critical design aircraft can influence design criteria such as runway length, runway width, separation distances, building setbacks, and the dimensions of required clearances surrounding the runway and taxiway system.

The coding system has two components. The first component, depicted by a letter, is the aircraft approach category (AAC), which relates to aircraft approach speed (operational characteristic). The second component, depicted by a Roman numeral, is the airplane design group (ADG), which relates to aircraft wingspan and tail height (physical characteristics). Generally, aircraft approach speed applies to runways and runway-related facilities, while airplane wingspan primarily relates to separation criteria involving taxiways, taxilanes, and landside facilities. **Table 4A** presents the coding system.

TABLE 4A
Aircraft Classification Coding System

Aircraft Approach Category		Airplane Design Group		
Category	**Speed**	**Group**	**Tail Height (ft.)**	**Wingspan (ft.)**
A	< 91 Knots	I	< 20	< 49
B	91- < 121 Knots	II	20- < 30	49- < 79
C	121- < 141 Knots	III	30- < 45	70- < 118
D	141- < 166 Knots	IV	45- < 60	118- < 171
E	>= 166 Knots	V	60- < 66	171- < 214
		VI	66- < 80	214- < 262

Source: FAA Advisory Circular (AC) 150/5300-13A, *Airport Design*
Utilize the most demanding category

As an example, a Beech King Air 200 with an approach speed of 103 knots and wingspan of 54.5 feet is categorized in B-II, while a larger corporate jet, such as a Gulfstream V/550, with an approach speed of 140 knots and a wingspan of 93.5 feet, is included in classification C-III. **Figure 4A** presents examples of ARC categories and their corresponding aircraft types.

The FAA recommends designing airport functional elements to meet the requirements for the most demanding aircraft that regularly use it. McClellan-Palomar Airport is used by a wide variety of general aviation aircraft ranging from small piston-engine aircraft to large business jet aircraft such as the Gulfstream 550 and the Global Express.

11MP17-4A-05/11/12

A-I

- Beech Baron 55
- **Beech Bonanza**
- Cessna 150
- Cessna 172
- Cessna Citation Mustang
- Eclipse 500/550
- Piper Archer
- Piper Seneca

C-II, D-II

- Cessna Citation X
- **Gulfstream II, III, IV**
- Challenger 300/600
- ERJ-135, 140, 145
- CRJ-200/700
- Embraer Regional Jet
- Lockheed JetStar
- Hawker 800

B-I

- Beech Baron 58
- Beech King Air 100
- Cessna 402
- **Cessna 421**
- Piper Navajo
- Piper Cheyenne
- Swearingen Metroliner
- Cessna Citation I
- Beechjet 400

C-III, D-III *less than 100,000 lbs.*

- ERJ-170
- CRJ 705, 900
- Falcon 7X
- **Gulfstream 500**, 550, 650
- Global Express, Global 5000

B-II

- Super King Air 200
- Cessna 441
- DHC Twin Otter
- Super King Air 350
- Beech 1900
- Citation Excel, Sovereign
- Falcon 50, 900, 2000
- **Citation II**, III, IV, VII
- Embraer 120

C-III, D-III *over 100,000 lbs.*

- ERJ-90
- **Boeing Business Jet**
- B-727
- B-737-300, 800
- MD-80, DC-9
- A319, A320

A-III, B-III

- DHC Dash 7
- **DHC Dash 8**
- DC-3
- Convair 580
- Fairchild F-27
- ATR 72
- ATP

C-IV, D-IV

- **B-757**
- B-767
- C-130
- DC-8-70
- MD-11

C-I, D-I

- Beech 400
- **Lear 25, 31, 35, 45, 55, 60**
- Israeli Westwind

D-V

- **B-747** Series
- B-777

Note: Aircraft pictured is identified in bold type.

Figure 4A
AIRPORT REFERENCE CODES

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At non-hub commercial service airports, such as McClellan-Palomar Airport, which are located in larger metropolitan areas, business jet operations are typically those that will influence airport facility design as the critical design aircraft. In *Chapter Two – Preliminary Justification Statement*, data regarding the number and type of business jet operations was obtained from FAA's *Enhanced Traffic Management System Counts* (ETMSC).

Table 4B presents the logged business jet aircraft operations for the 2011 calendar year. As detailed in the table, aircraft using the airport include a wide array of jets comprising several different makes and models of Cessna Citations, Falcons, Learjets, Challengers, and Gulfstreams, and others. There was a total of 13,236 business jet operations logged in 2011.

Business jet operations in approach category B accounted for 54.9 percent of the total. The greatest number of jet operations logged in any single family was 4,844 in B-II, or 36.6 percent of the total.

C-III is currently the most demanding aircraft classification with at least 500 annual operations, totaling 790. C-III includes the Falcon 7X, the Bombardier Global 5000 and Global Express aircraft as well as the aforementioned Gulfstream V/550.

Also to be noted is that the Gulfstream IV/450, which also has over 500 annual operations (976), has the highest AAC, but a lesser ADG. Since most standards related to C and D aircraft are similar, the C-III classification remains the most demanding due to the higher ADG.

TABLE 4B
Business Jet Operational Fleet Mix
McClellan-Palomar Airport

Aircraft	2011 Operations
B-I	
BE40-Raytheon/Beech Beechjet 400/T-1	400
C500-Cessna 500/Citation I	66
C501-Cessna I/SP	164
C510-Cessna Citation Mustang	202
C525-Cessna Citation Jet/CJ1	644
E50P-Embraer Phenom 100	588
EA50-Eclipse 500	170
FA10-Dassault Falcon/Mystère 10	6
MU30-Mitsubishi MU300/Diamond I	6
PRM1-Raytheon Premier 1/390/Premier 1	148
Total B-I	**2,394**
Percentage B-I	**18.1%**
B-II	
C25A-Cessna Citation CJ2	540
C25B-Cessna Citation CJ3	806
C25C-Cessna Citation CJ4	38
C550-Cessna Citation II/Bravo	352
C551-Cessna Citation II/SP	4
C560-Cessna Citation V/Ultra/Encore	576
C56X-Cessna Excel/XLS	988
C650-Cessna III/VI/VII	60
C680-Cessna Citation Sovereign	476
E55P-Embraer Phenom 300	26
F2TH-Dassault Falcon 2000	576
F900-Dassault Falcon 900	174
FA20-Dassault Falcon/Mystère 20	30
FA50-Dassault Falcon/Mystère 50	198
Total B-II	**4,844**
Percentage B-II	**36.6%**
C-I	
AJET-Dassault-Bréguet/Dornier Alpha Jet	2
F5-Northrop F-5 Freedom Fighter	4
H25A-BAe HS 125-1/2/3/400/600	58
HS25-BAe HS 125; British Aerospace	6
LJ24-Bombardier Learjet 24	2
LJ25-Bombardier Learjet 25	18
LJ31 Bombardier Learjet 31/A/B	16
LJ35-Bombardier Learjet 35/36	242
LJ36-Learjet36	4
LJ40-Learjet40; Gates Learjet	54
LJ45-Bombardier Learjet 45	266
LJ55-Bombardier Learjet 55	58
C-I (cont'd)	
LR35-Learjet 35	2
SBR1-North American Rockwell Sabre 40/60	6
WW24-IAI 1124 Westwind	40
Total C-I	**778**
Percentage C-I	**5.5%**
C-II	
ASTR-IAI Astra 1125	76
C750-Cessna Citation X	566
CL30-Bombardier (Canadair) Challenger 300	326
CL60-Bombardier Challenger 600/601/604	554
E135-Embraer ERJ 135/140/Legacy	74
H25B-BAe HS 125/700-800/Hawker 800	996
H25C-BAe/Raytheon HS 125-1000/Hawker 10	24
HA4T-Hawker 4000	24
J328-Fairchild Dornier 328 Jet	10
L29B-Lockheed L-1329 Jetstar 731	4
Total C-II	**2,654**
Percentage C-II	**20.1%**
C-III	
FA7X-Dassault Falcon F7X	50
GL5T-Bombardier BD-700 Global 5000	24
GLEX-Bombardier BD-700 Global Express	242
Total C-III	**790**
Percentage C-III	**6.0%**
D-1	
LJ60-Bombardier Learjet 60	256
Total D-I	**256**
Percentage D-I	**1.9%**
D-II	
G150-Gulfstream G150	200
G4-Gulfstream IV	2
GALX-IAI 1126 Galaxy/Gulfstream G200	278
GLF2-Gulfstream II/G200	22
GLF3-Gulfstream III/G300	42
GLF4-Gulfstream IV/G400	976
Total D-II	**1,520**
Percentage D-II	**11.5%**
D-III	
None	
Total D-III	**0**
Percentage D-III	**0.0%**
Total Business Jet Operations	**13,236**

Source: ETMSC Logs, FAA

As indicated earlier in *Chapter Three - Forecasts*, business jets are expected to grow from five percent of the United States' active general aviation fleet in 2011 to over 10 percent of the fleet by 2032. The forecast for McClellan-Palomar Airport indicated most of the growth in based aircraft is expected to be in business jets. These are expected to contribute to an increase in business jets as a percentage of the operational fleet mix at as well.

Table 4C projects the future mix of business jet operations by aircraft classification for McClellan-Palomar Airport, both with and without any runway improvements. Business jet operations are forecast to grow from 13,236 in 2011 to 21,000 by 2021 with the current runway capabilities. Runway improvements could increase the business jet operations to 24,000 by 2021. Aircraft classification B-I is expected to grow the most with the anticipated growth of very light jets. While each reference code group will grow in operations, C-III and D-III are the only other groups anticipated to grow in percentage.

TABLE 4C
Business Jet Operations Mix Forecast
By Aircraft Classification

		W/O PROJECT		W/PROJECT	
AAC-ADG	**2011**	**2016**	**2021**	**2016**	**2021**
Operations					
B-I	2,394	3,549	5,040	3,553	5,040
B-II	4,844	5,831	6,825	5,984	6,840
C-I	778	845	840	935	960
C-II	2,654	3,296	3,990	3,927	5,040
C-III	790	1.268	1,890	1,590	2,880
D-I	256	254	210	374	360
D-II	1,520	1,859	2,205	2,338	2,880
D-III	0	0	0	0	0
Total Business Jet Ops	13,236	16,900	21,000	18,700	24,000
Percentage					
B-I	10.5%	13.5%	16.5%	12.5%	14.5%
B-II	44.2%	42.0%	40.0%	38.5%	35.0%
C-I	5.9%	5.0%	4.0%	5.0%	4.0%
C-II	20.1%	19.5%	19.0%	21.0%	21.0%
C-III	2.4%	3.5%	4.5%	4.0%	6.0%
D-I	1.9%	1.5%	1.0%	2.0%	1.5%
D-II	11.5%	11.0%	10.5%	12.5%	12.0%
D-III	0.0%	0.0%	0.0%	0.0%	0.0%
Total Percentage	100.0%	100.0%	100.0%	100.0%	100.0%

The aircraft currently providing commercial service to the airport is the 19-seat Embraer 132. While this turboprop aircraft is in B-II, it is not a factor in the runway length needs because several business jets currently using the airport, including many within B-II, are more demanding.

RUNWAY LENGTH

Runway length is perhaps the most important consideration for runway capability. As outlined previously in *Chapter Two – Preliminary Runway Extension Justification*, runway length requirements for the critical aircraft, or any aircraft using the airport, are based upon four primary elements:

- Airport Elevation – 330.1 feet above mean sea level (AMSL)
- Mean maximum temperature of the hottest month – 75 degrees F
- Runway gradient – 0.28 percent (13.8 feet between the highest and lowest elevation on the runway)
- Aircraft loading – varies with the payload which is comprised of passengers, cargo, and fuel required for the trip length.

Wind can affect the runway length requirement as well. A headwind can reduce the amount of length required for takeoff or landing, while a tailwind will increase the needed length. This is one reason why the operation of aircraft into the wind is preferred. At the same time, a headwind en-route to a destination will increase the amount of fuel required for the trip, thereby increasing the aircraft loading and the runway length required. Similarly, a tailwind may reduce the amount of fuel required. For airport planning, the zero wind condition is the basic assumption used.

The business jets that used McClellan-Palomar Airport in 2011 are presented by ARC in **Table 4B.** Earlier in Chapter Two, Table 2A presented groupings of large aircraft (weighing over 12,500 pounds) that use the airport. For runway length design, the FAA allows grouping of the large airplane fleet weighing less than 60,000 pounds into two categories: 75 percent of the fleet (8,762 operations in 2011), and 100 percent of the fleet (3,694 operations). The breakdown of each aircraft make/model was included in Table 2A as well. Runway length requirements must be determined for each individual aircraft weighing over 60,000 pounds. These aircraft totaled 1,808 operations in 2011. The following subsections first examine the takeoff length, followed by an evaluation of the landing length needs of most business jet users at McClellan-Palomar Airport.

TAKEOFF LENGTH

In FAA Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*, the FAA provides runway length design curves for the large airplane fleet under 60,000 pounds. The curves determine a design takeoff length for each group operating at 60 percent useful load and 90 percent useful load. Useful load is determined as the difference between the takeoff weight of the aircraft and its operating empty weight (OEW). Curves were not developed for 100 percent useful load which would be maximum takeoff weight (MTOW). This was because many aircraft can become operationally limited in the second segment of climb, meaning the allowable gross takeoff weight may be limited by temperature and elevation prior to consideration of the runway length.

The 60 percent useful load is the baseline used in the Midwest where the trip length of domestic flights is more limited. In the western United States, and particularly on the west coast, cross-country and overseas trips are longer haul flights which require larger fuel loads. According to FAA ETMSC data, there were 335 departures to east coast states and 287 departures to foreign destinations from McClellan-Palomar Airport in 2011. This does not include those flights where a fuel stop was necessary due to the airport's limited runway length.

As an example, Qualcomm bases four aircraft at McClellan-Palomar Airport, all of which weigh over 60,000 pounds. In 2011, they made 42 departures for international destinations including 19 to Europe, 20 to Asia, and three to Central and South America. All but two of the flights (both to South Central/South America) required a fuel stop before reaching the final destination.

The captain of a based Falcon 2000 indicated that the aircraft is limited to approximately 73 percent of its useful load at the design temperature of 75 degrees Fahrenheit. The current runway length has hindered the aircraft's flights to the northeastern United States as well as to Europe and Brazil.

As a final example, NetJets is a fractional operator that conducted 1,792 operations at McClellan-Palomar Airport in 2011 with 28 different makes/models of business jets. Three types of aircraft - the Hawker 800XP, Citation X, and Gulfstream 200 - required fuel stops in traveling to long-haul destinations during the spring and summer months.

Table 4D presents the takeoff length requirements for the critical business jets and groups of business jets using McClellan-Palomar Airport. The runway lengths at maximum takeoff weight (100 percent useful load), as well as other useful load percentages ranging down to 60 percent, are presented for the critical aircraft.

TABLE 4D
Business Jet Takeoff Requirements
McClellan-Palomar Airport

			Takeoff Length Requirements (ft.)			
		2011 CRQ	@	Useful Load		
Aircraft	**MTOW (lbs.)**	**Operations**	**MTOW**	**90%**	**75%**	**60%**
GALX-IAI 1126 Galaxy/Gulfstream G200	34,851	276	***7,000***	***6,500***	***5,800***	4,900
GLF5–Gulfstream V/G500/550	90,689	474	***6,800***	***6,100***	***5,100***	4,800
GLEX–Bombardier BD-700 Global Express	98,106	242	***6,600***	***6,000***	***5,300***	4,200
F2TH–Dassault Falcon 2000	35,800	576	***6,200***	***5,800***	***5,200***	4,600
GLF4-Gulfstream IV/G400/450	73,193	976	***6,400***	***5,900***	**5,100**	4,900
CL60-Bombardier Challenger 600/601/604	47,600	554	***6,200***	***5,400***	4,600	
G150-Gulfstream G150	26,150	200	***6,100***	***5,700***	***5,500***	***5,200***
LJ60-Bombardier Learjet 60	23,104	256	***6,000***	***5,500***	4,800	
C750-Cessna Citation X	35,699	566	***5,500***	***5,200***	4,600	
H25B-BAe HS 125/700-800/Hawker 800	27,403	996	***5,300***	**51000**		
75% Large Business Jets weighing less than 60,000 lbs.	<60,000	3,882		**5,900**		4,800
Small Business Jets Weighing 12,500 lbs. or less		3,804	***4,400***			
Total Operations		12,802				
Percent of Total Jet Operations		96.7%				

Design Temperature 75 deg. F.: Elevation 330 ft. MSL; Runway Gradient 0.28%
Bold indicates takeoff length requirements exceeding current runway capabilities at McClellan-Palomar Airport

The current runway length of 4,897 feet is enough to accommodate all frequently used aircraft at 60 percent useful load except the Gulfstream 150. The runway length begins to become inadequate at higher loadings as demonstrated by the runway length requirements at 75 percent loading. At these higher takeoff weights, the Gulfstream 200 requires the most runway length. But since it conducted only 276 operations at the airport in 2011, it does not qualify as the critical aircraft.

The Gulfstream V/550 had 474 operations in 2011, but records indicate that it has exceeded 500 operations in the past, and forecasts suggest that it will again in the future. Thus, a runway length of 6,100 feet is needed to accommodate the critical aircraft at 90 percent useful load. A runway length of 6,700 feet would accommodate the critical aircraft at maximum takeoff weight.

Interviews with some key users and fixed base operators indicate a runway length in the range of 6,100 to 6,700 feet would fully meet their needs. While all realize the high end of that range is not likely to be feasible, most indicate a takeoff length in the range of 6,000 to 6,200 feet could reasonably meet most of their needs. A length of 6,100 feet would allow the aircraft responsible for approximately 77 percent of the jet operations at the airport the flexibility to operate at maximum takeoff weight during the design conditions. Aircraft accounting for 98 percent of the business jet operations would have the flexibility to takeoff with at least 90 percent of useful load at 6,100 feet.

LANDING LENGTH

Except in arid climates, landing length design is based on landing on a contaminated (wet or icy) runway. This is to be expected as the frictional characteristics of the pavement that assist in braking action during landing are reduced. AC 150/5325-4B suggests increasing the runway length determined from the useful load curves by 15 percent for landing on a wet runway. Maximums are set at 5,500 feet for 60 percent useful load curves and 7,000 feet for 90 percent useful load curves. When examining individual aircraft landing requirements on a dry runway, the same 15 percent factor is used to account for wet runway conditions.

When an aircraft operates "for hire" under Code of Federal Regulation (CFR) Part 135, or as a fractional ownership under CFR Part 91 subpart K, the operator must calculate an additional factor for landing. The CFR 135 requires that the aircraft must be capable of landing within 60 percent of the available runway length. This is applicable not only to air taxi aircraft operating under Part 135, but also includes Part 91(k) fractional ownership aircraft operating under the control of the fractional operator. Fractional aircraft operating under the control of the individual fractional owner using the aircraft must be capable of landing within 80 percent of the available runway length.

The 60 percent rule can be modified to 80 percent if the operator uses a Destination Airport Analysis Program (DAAP). DAAP is recognition that the operator of the flight has the systems and processes in place to assess airports and conditions that are suitable for the increased regulatory landing distance. There are 22 conditions governing the use of DAAP that must be in place prior to departure to the destination airport.

Table 4E lists aircraft that conducted at least 200 annual operations at McClellan-Palomar Airport in 2011. These aircraft account for over 87 percent of the business jet operations at the airport, including over 94 percent of the business jet operations counted as Part 135 or 91(k) operations. They are sorted by their FAA Landing Field Length for maximum landing weight at sea level and standard temperature conditions of 59 degrees F under dry runway conditions. The landing length for each aircraft was then adjusted for the airport elevation (330 feet) and design temperature (75 F) at McClellan-Palomar Airport, plus a 15 percent adjustment for wet runway conditions. As indicated on the table, all the key business jet aircraft have the capability to land with the length of the current runway under wet runway conditions.

TABLE 4E
Business Jet Landing Length Requirements (in feet)
@ Maximum Landing Weight

Aircraft	2011 CRQ Operations	2011 Air Taxi Operations	FAA Landing Field Length	CRQ Adjusted Wet Runway	CRQ Part 91k/ Part 135 w/DAAP	CRQ Part 91k/ Part 135 w/o DAAP
LJ60-Bombardier Learjet 60	256	180	3,420	4,370	**5,462**	**7,283**
C750-Cessna Citation X	566	362	3,400	4,344	**5,430**	**7,240**
GALX-IAI 1126 Galaxy/ Gulfstream G200	278	146	3,280	4,191	**5,239**	**6,985**
GLF4-Gulfstream IV/G400	976	60	3,260	4,165	**5,207**	**6,942**
C550-Cessna Citation II/Bravo	352	8	3,180	4,063	**5,079**	**6,772**
C56X-Cessna Excel/XLS	988	574	3,180	4,063	**5,079**	**6,772**
E50P-Embraer Phenom 100	588	334	3,000	3,833	4,791	**6,389**
G150-Gulfstream G150	200	10	2,880	3,680	4,600	**6,133**
C560-Cessna Citation V/Ultra/Encore	576	164	2,865	3,661	4,576	**6,101**
CL60-Bombardier Challenger 600/601/604	554	54	2,776	3,547	4,434	**5,911**
GLF5-Gulfstream V/G500/550	474	10	2,770	3,539	4,424	**5,899**
BE40-Raytheon/Beech Beechjet/ 400/T-1	400	190	2,730	3,488	4,360	**5,814**
GLEX-Bombardier BD-700 Global Express	242	8	2,670	3,411	4,264	**5,686**
LJ45-Bombardier Learjet 45	266	84	2,660	3,399	4,248	**5,664**
F2TH-Dassault Falcon 2000	576	98	2,660	3,399	4,248	**5,664**
C680-Cessna Citation Sovereign	476	218	2,650	3,386	4,232	**5,643**
C25A-Cessna Citation CJ2	540	2	2,619	3,346	4,183	**5,577**
CL30-Bombardier (Canadair) Challenger 300	326	100	2,600	3,322	4,153	**5,537**
LJ35-Bombardier Learjet 35/36	242	20	2,550	3,258	4,073	**5,430**
C525-Cessna Citation Jet/CJ1	644	8	2,488	3,179	3,974	**5,298**
C25B-Cessna Citation CJ3	806	58	2,411	3,081	3,851	**5,134**
H25B-BAe HS 125/700-800/ Hawker 800	996	122	2,344	2,995	3,744	**4,992**
C510-Cessna Citation Mustang	202	0	2,126	2,716	3,395	4,527
Total Operations	11,524	2,810				
Percent of Total Jet Operations	87.1%	94.5%				

FAA Landing Field Length – Landing length at sea level and standard temperature (59 degrees)
CRQ Adjusted Wet Runway – FAA length adjusted for CRQ elevation 330 ft. MSL, design temperature 75 F, and wet runway
DAAP – Destination Airport Analysis Program
FAR 91k/135 w/DAAP - CRQ Adjusted Wet Length /0.80
FAR 91k/135 w/o DAAP - CRQ Adjusted Wet Length /0.60

Bold indicates landing length requirements exceeding current runway capabilities at McClellan-Palomar Airport

When the Part 135 criteria of landing within 60 percent of the available runway, just two of the aircraft listed could land at maximum landing weight. It can be seen from the table that applying the criteria allowed with a DAAP of landing within 80 percent of the available runway, the aircraft comprising 53 percent of the operations could still land at McClellan-Palomar Airport under the design conditions.

When examining the critical aircraft for landing under Part 135 and 91(k), the Cessna Citation X becomes the most demanding aircraft which comprises at least 500 air taxi operations. A DAAP would allow the vast majority of these users to operate. Therefore, 5,400 feet is a reasonable design length available for landing.

RUNWAY LENGTH SUMMARY

The analysis above determined that a runway length of 6,100 feet would meet 98 percent of the departure needs at 90 percent useful load. A landing length of 5,400 feet was determined to be most reasonable for business jet operators. A length of at least 5,000 feet for departure and landing would permit the operators more flexibility in their operations by reducing delays or flight cancellation.

RUNWAY DESIGN STANDARDS

Runway design standards define the widths and clearances to optimize safe operations in the landing and takeoff area. These dimensional standards vary depending upon the Airport Reference Code (ARC) of each runway. The airport layout plan (ALP) for McClellan-Palomar Airport, dated June 2010, indicates the ARC as B-II.

FAA Advisory Circular (AC) 150/ 5300-13A, *Airport Design,* published on September 28, 2012, defines the ARC in Paragraph 102.i. and reads, *"An airport designation that signifies the airport's highest Runway Design Code (RDC), minus the third (visibility) component of the RDC. The ARC is used for planning and design only and does not limit the aircraft that may be able to operate safely on the airport."*

The RDC is defined in Paragraph 102.mmm. as, *"A code signifying the design standards to which the runway is to be built."* Paragraph 105.c. indicates that the AAC, the ADG, and the approach visibility minimums combine to form the RDC of a particular runway. These provide the information needed to determine the applicable design standards.

As determined earlier in this chapter, the critical approach category for the airport is AAC C, and the critical airplane design group is ADG III. The forecasts of future aircraft mix also indicate that the critical aircraft in the future will be C-III. While the airport's ARC designation is B-II, the activity meets the criteria for considering C-III. As indicated earlier, however, upgrading to a new design standard requires improvements to be both practicable and feasible.

Table 4F outlines the key runway safety dimensional standards established by the FAA based upon ARCs B-II and C-III. From the landing surface out, these include the runway width, obstacle free zone (OFZ), runway safety area (RSA), runway object free area (ROFA), and runway protection zone (RPZ). The following discusses each of the standards as they relate to McClellan-Palomar Airport.

TABLE 4F
Runway Safety Design Standards

	Current Dimensions (ft.)	B-II Standard (ft.) ¾ mile Visibility	C-III Standard (ft.) ¾ mile Visibility
Runway Width	150	75	100
Obstacle Free Zone*			
Width	400	400	400
Length Beyond Runway End	200	200	200
Runway Safety Area			
Width	150	150	500
Behind Landing Threshold	300	300	600
Beyond Departure End	300	300	1,000
Runway Object Free Area			
Width	500	500	800
Beyond Runway End	300	300	1,000
Runway Centerline to:			
Holding Position	250	200	250
Parallel Taxiway Centerline	300	240	400
Aircraft Parking Area	337	250	500
Runway Protection Zones			
¾-mi. Visibility (Runway 24)			
Inner Width	1,000	1,000	1,000
Length	1,700	1,700	1,700
Outer Width	1,500	1,500	1,500
One mi. or greater Visibility (Runway 6)			
Inner Width	500	500	500
Length	1,000	1,000	1,200
Outer Width	700	700	1,010
Departure			
Inner Width	500	500	500
Length	1,000	1,000	1,700
Outer Width	700	700	1,010
Tail Height		20'-<30'	30'-<45'
Wingspan		49'-<79'	79'-<118'
Shoulder Width	10	10	25
Blast Pad Width	150	95	200
Blast Pad Length	200	150	200

* Runway 24 OFZ subject to 50:1 approach surface at 200 feet beyond runway to 200 feet past last approach light and 6:1 transitional surface beyond width.

RUNWAY WIDTH

The runway width is the width of the surface available and intended for the landing and/or departure of an aircraft. Runway 6-24 is a paved surface currently 150 feet wide. This exceeds the FAA design standards of 75 feet for ARC B-II and 100 feet for ARC C-III.

RUNWAY OBSTACLE FREE ZONE

The runway OFZ is an imaginary surface which precludes object penetrations, including taxiing and parked aircraft. The only allowance for OFZ obstructions is navigational aids mounted on a frangible base which are fixed in their location by function, such as airfield signs or runway and taxiway lights. The OFZ is established to ensure the safety of aircraft operations.

For runways serving large aircraft (those weighing more than 12,500 pounds), the OFZ is 400 feet wide (200 feet on either side of the runway centerline), and extends 200 feet beyond each end of the runway. Runway 6-24 at McClellan-Palomar Airport currently meets this standard. The runway OFZ is depicted on **Figure 4B** and is the same for both B-II and C-III, as each include aircraft weighing over 12,500 pounds.

A precision OFZ (POFZ) is defined as volume of airspace beginning at the landing threshold at the threshold elevation and extended on the runway centerline 200 feet long by 800 feet wide. The POFZ is only in effect for instrument approaches with 1) cloud ceiling minimums below 250 feet or visibility minimums below ¾-mile; 2) those minimums are in effect; and 3) there is an aircraft on final approach within two miles of the threshold. Because Runway 24 has cloud ceiling minimums down to 200 feet, the POFZ standard applies to that runway end at McClellan-Palomar Airport. The POFZ is depicted on **Figure 4C** and is the same for both B-II and C-III.

An inner-approach OFZ is applicable for runways with an approach lighting system. It protects airspace centered on the approach area, beginning at the end of the runway OFZ (200 feet from the threshold) at the elevation of the threshold and extending 200 feet beyond the last light unit in the approach lighting system. The width is the same as the runway OFZ, but it rises at a slope of 50:1 (horizontal to vertical). The inner approach OFZ applies to the Runway 24 approach since it is equipped with an approach light system, and the standard is currently met.

An inner-transitional surface OFZ is designed to protect airspace to the sides of the runway OFZ when there is an approach with visibility minimums lower than ¾-mile. The inner-transitional OFZ begins at the edges of the runway OFZ, and then rises vertically based on an equation that considers the wingspan of the most demanding aircraft and the runway threshold elevation. From that point, it then slopes 6:1 outward to a height of 150 feet. Calculated for the maximum wingspan of 99.6 feet (Gulfstream 650) and 330 feet elevation, the elevation at the point where the slope begins would be 51 feet above the runway. This surface currently does not apply at McClellan-Palomar Airport because the lowest minimums available are ¾-mile. Should the minimums ever be improved to a Category I instrument approach with ½-mile visibility, the inner-transitional OFZ would apply.

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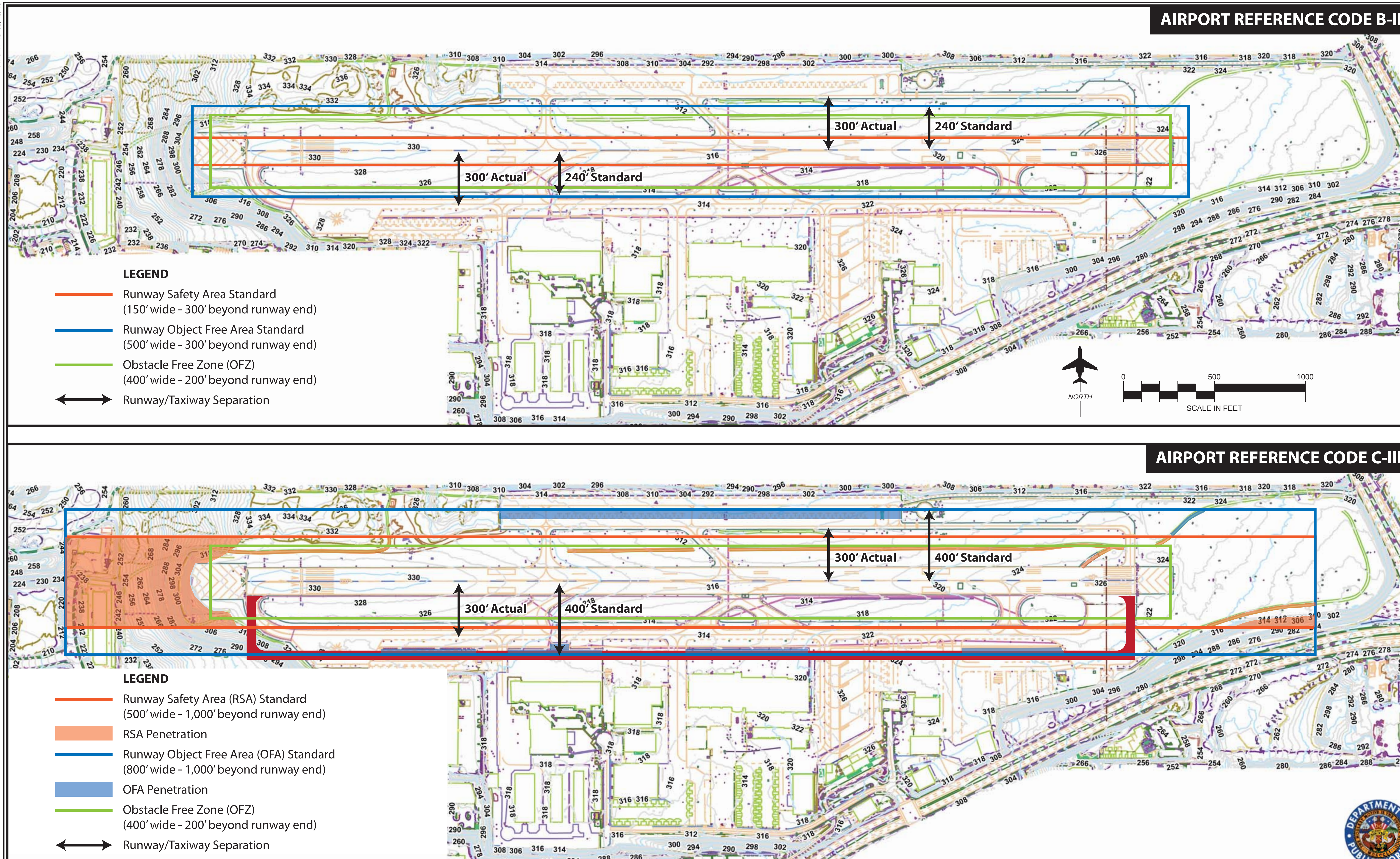

Figure 4B
AIRPORT DESIGN STANDARDS

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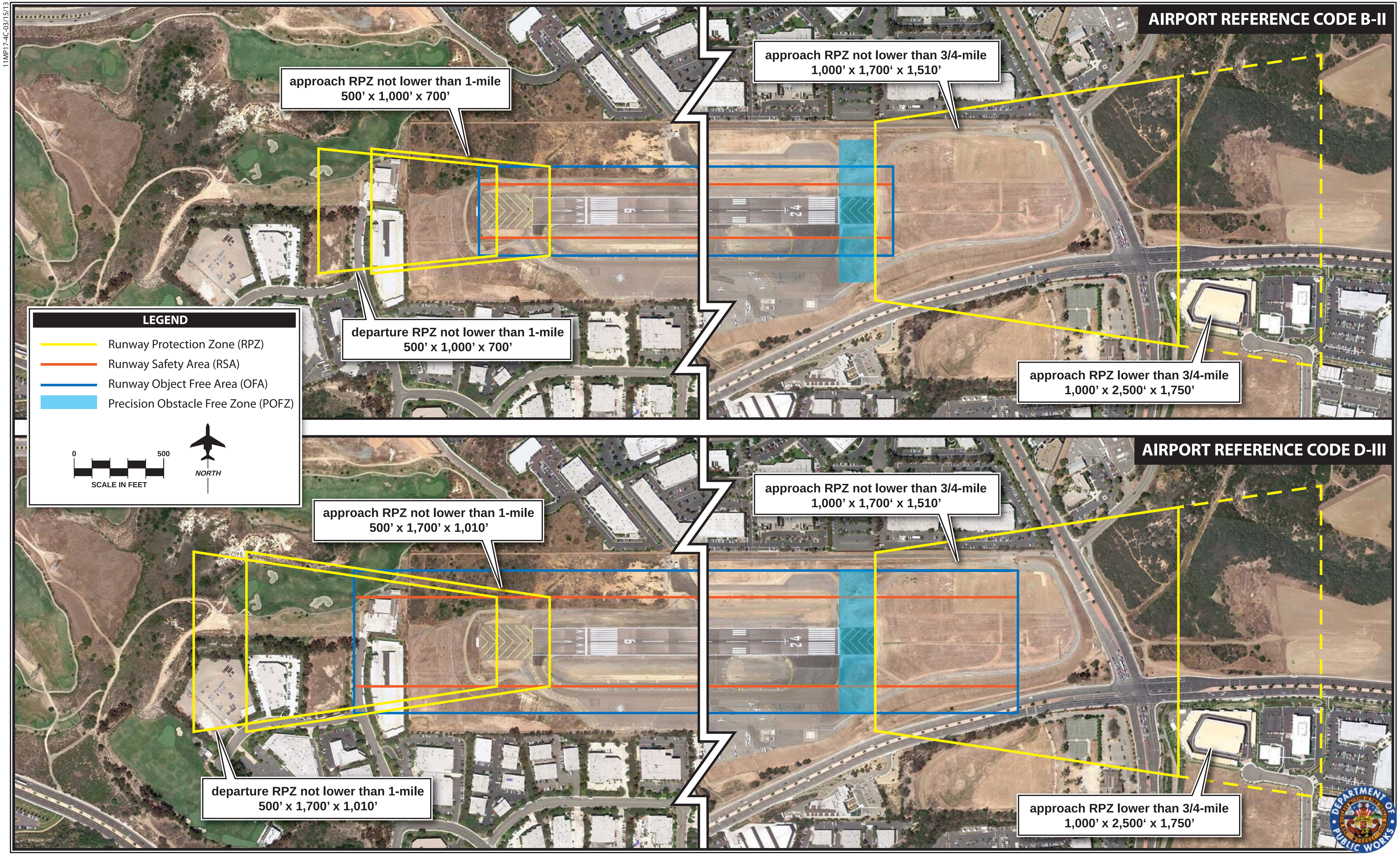

Figure 4C
RUNWAY PROTECTION ZONE DESIGN STANDARDS

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RUNWAY SAFETY AREA (RSA)

The RSA is defined in FAA AC 150/5300-13, *Airport Design*, as a "surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway." The RSA is centered on the runway and dimensioned in accordance with the approach speed of the critical aircraft using the runway. The FAA requires the RSA to be cleared and graded, drained by grading or storm sewers, capable of accommodating the design aircraft as well as fire and rescue vehicles, and free of obstacles not fixed by navigational purpose.

The FAA has placed a higher significance on maintaining adequate RSAs at all airports due to previous aircraft accidents. Under Order 5200.8, effective October 1, 1999, the FAA established a *Runway Safety Area Program*. The Order states, "The objective of the Runway Safety Area Program is that all RSAs at federally-obligated airports … shall conform to the standards contained in AC 150/5300-13, *Airport Design*, to the extent practicable." Each Regional Airports Division of the FAA is obligated to collect and maintain data on the RSA for each runway at the airport and perform inspections.

For ARC B-II, the FAA design standards for RSAs are 150 feet wide centered on the runway and extending 300 feet beyond the runway ends. With the RSA the same width as the runway, there are no encroachments within the B-II standard. Portions of the current RSA extending beyond the east end and within the existing blast pad on the west end, however, currently exceed the grade limitations for B-II.

For approach categories C and D, regardless of the airplane design group, the design standard is 500 feet wide and extends 1,000 feet beyond the takeoff end of the runway. For landing, the RSA must extend at least 600 feet behind the landing threshold. These RSA dimensions are overlaid on the existing runway in **Figure 4B.** There is an unpaved airfield service road along the north side of the runway that encroaches upon the RSA standard and the extended RSA beyond the ends of the runway does not meet the grading standards. Beyond the west end, the RSA would extend beyond the airport's property, encompassing two buildings in the adjacent business park.

RUNWAY OBJECT FREE AREA (ROFA)

The FAA defines the ROFA as an area centered on the runway extending laterally and beyond each runway end, in accordance with the critical aircraft design category utilizing the runway. The ROFA must provide clearance of all ground-based objects protruding above the RSA edge elevation, unless the object is fixed by function (i.e., airfield lighting) serving air or ground navigation.

For ARC B-II, the ROFA is 500 feet wide and extends 240 feet beyond the runway end. For approach categories C and D, regardless of the design group, the ROFA is 800 feet wide and extends 1,000 feet beyond each runway end.

The ROFA dimensions are overlaid on the existing runway on **Figure 4B**. There are no encroachments in the B-II RSA; however, several aircraft parking positions both north and south of the runway would be within the C-III OFA standard.

RUNWAY PROTECTION ZONE (RPZ)

The RPZ is a trapezoidal area centered on the runway, typically beginning 200 feet beyond the runway end. The RPZ has been established by the FAA to provide an area clear of obstructions and incompatible land uses in order to enhance the protection of approaching aircraft, as well as people and property on the ground. The dimensions of the RPZ vary according to the visibility requirements serving the runway and the type of aircraft operating on the runway.

The RPZ is comprised of the central portion of the RPZ and the controlled activity area. The central portion extends from the beginning to the end of the RPZ, is centered on the runway, and is the width of the ROFA. The controlled activity area is any remaining portion of the RPZ.

While the RPZ is intended to be clear of incompatible objects or land uses, some uses are permitted with conditions and other land uses are prohibited. According to AC 159/5300-13A, the following land uses are permissible within the RPZ:

- Farming that meets the minimum buffer requirements,
- Irrigation channels as long as they do not attract birds,
- Airport service roads, as long as they are not public roads and are directly controlled by the airport operator,
- Underground facilities, as long as they meet other design criteria, such as RSA requirements, as applicable, and
- Unstaffed navigational aids (NAVAIDs) and facilities, such as required for airport facilities that are fixed by function in regard to the RPZ.

Any other land uses considered within RPZ land owned by the airport sponsor must be evaluated and approved by the FAA Office of Airports. The FAA has published *Interim Guidance on Land Uses within a Runway Protection Zone* (9.27.2012), which identifies several potential land uses that must be evaluated and approved prior to implementation. The specific land uses requiring FAA evaluation and approval include:

- Buildings and structures (Examples include, but are not limited to: residences, schools, churches, hospitals or other medical care facilities, commercial/industrial buildings, etc.)
- Recreational land use (Examples include, but are not limited to: golf courses, sports fields, amusement parks, other places of public assembly, etc.)
- Transportation facilities. Examples include, but are not limited to:
  - Rail facilities - light or heavy, passenger or freight
  - Public roads/highways
  - Vehicular parking facilities
- Fuel storage facilities (above and below ground)
- Hazardous material storage (above and below ground)
- Wastewater treatment facilities
- Above-ground utility infrastructure (i.e., electrical substations), including any type of solar panel installations.

The *Interim Guidance on Land within a Runway Protection Zone* states, "RPZ land use compatibility also is often complicated by ownership considerations. Airport owner control over the RPZ land is emphasized to achieve the desired protection of people and property on the ground. Although the FAA recognizes that in certain situations the airport sponsor may not fully control land within the RPZ, the FAA expects airport sponsors to take all possible measures to protect against and remove or mitigate incompatible land uses."

Currently, the RPZ review standards are applicable to any new or modified RPZ. The following actions or events could alter the size of an RPZ, potentially introducing an incompatibility:

- An airfield project (e.g., runway extension, runway shift),
- A change in the critical design aircraft that increases the RPZ dimensions,
- A new or revised instrument approach procedure that increases the size of the RPZ, and/or
- A local development proposal in the RPZ (either new or reconfigured).

Since the Interim guidance only addresses new or modified RPZs, existing incompatibilities are essentially grandfathered under certain circumstances. While it is still necessary for the airport sponsor to take all reasonable actions to meet the RPZ design standard, FAA funding priority for certain actions, such as relocating existing roads in the RPZ, will be determined on a case by case basis.

The lowest existing visibility minimums for McClellan-Palomar Airport are ¾-mile with 200-foot cloud ceilings on Runway 24. According to FAA standards, the corresponding RPZ dimensions call for a 1,000-foot inner width, extending outward 1,700 feet to a 1,510-foot outer width. This RPZ applies to both ARC B-II and C-III.

Runway 6 does not have a straight-in approach; the lowest minimums are for the not-lower-than-one-mile visibility minimums. At ARC B-II, the RPZ is currently has an inner width of 500 feet, a length of 1,000 feet, and an outer width of 700 feet. For approach categories C and D, the existing RPZs for these minimums have an inner width of 500 feet, overall length of 1,700 feet, and an outer width of 1,010 feet.

There is also a standard departure RPZ to be applied to the departure end of each runway. These dimensions are the same as the approach RPZ for one mile minimums. The departure RPZ is typically contained within the approach RPZ, except when the landing threshold is displaced. This is true on the west end of Runway 6-24.

On the currently-approved airport layout plan (ALP) for McClellan-Palomar Airport the Runway 24 RPZ is depicted at the lower than ¾-mile standard of 1,000-foot inner width, overall length of 2,500 feet, and an outer width of 1,750 feet, even though the current approach is only ¾-mile. On Runway 6, the RPZ has a 500-foot inner width, 1,000-foot length, and an outer width of 700 feet. The RPZs corresponding to each runway end at McClellan-Palomar Airport are compared on **Figure 4C**.

Under the airport's current B-II standards, the only buildings in an RPZ are off the west end of the runway, and they are at an elevation significantly below the runway. The west RPZs do extend off-property over those buildings, and the departure RPZ extends further over a roadway and an empty lot. If Approach Categories C and D were applied, the RPZs off the west end would extend over an office building and associated parking lot.

Off the east end, the RPZ for the current approach of not lower than 3/4-mile does extend off property, but does not extend over any buildings. There are parking lots and tennis courts to the sides, but these are outside of the central portion of the RPZ for both ARC B-II and C-III. El Camino Real crosses the RPZ, but is at a lower elevation, and Palomar Airport Road is also within the RPZ. It is outside the central portion for Category B, but is within the central portion for Categories C and D.

If the lower than ¾-mile standards were to be applied, the longer RPZ would extend over some buildings on the southeast side. Those office buildings would be just outside the central portion of the RPZ for the C and D approach standard, thus would be well outside the B-II approach standard.

HORIZONTAL GEOMETRY

This study looked at three different alternatives (A-C) using the classifications of B-II and C-III. Depending on the classification, each alternative was evaluated based on how meeting the AC requirements would affect the airport overall. The airport currently meets the criteria for a B-II facility and alternatives A and B were designed to B-II standards. Alternative C was planned as a C-III option. With Alternative C, significant modifications to the entire airport would be required. Both parallel taxiways would need to be shifted 100 feet further away from the runway to meet centerline to centerline separation criteria.

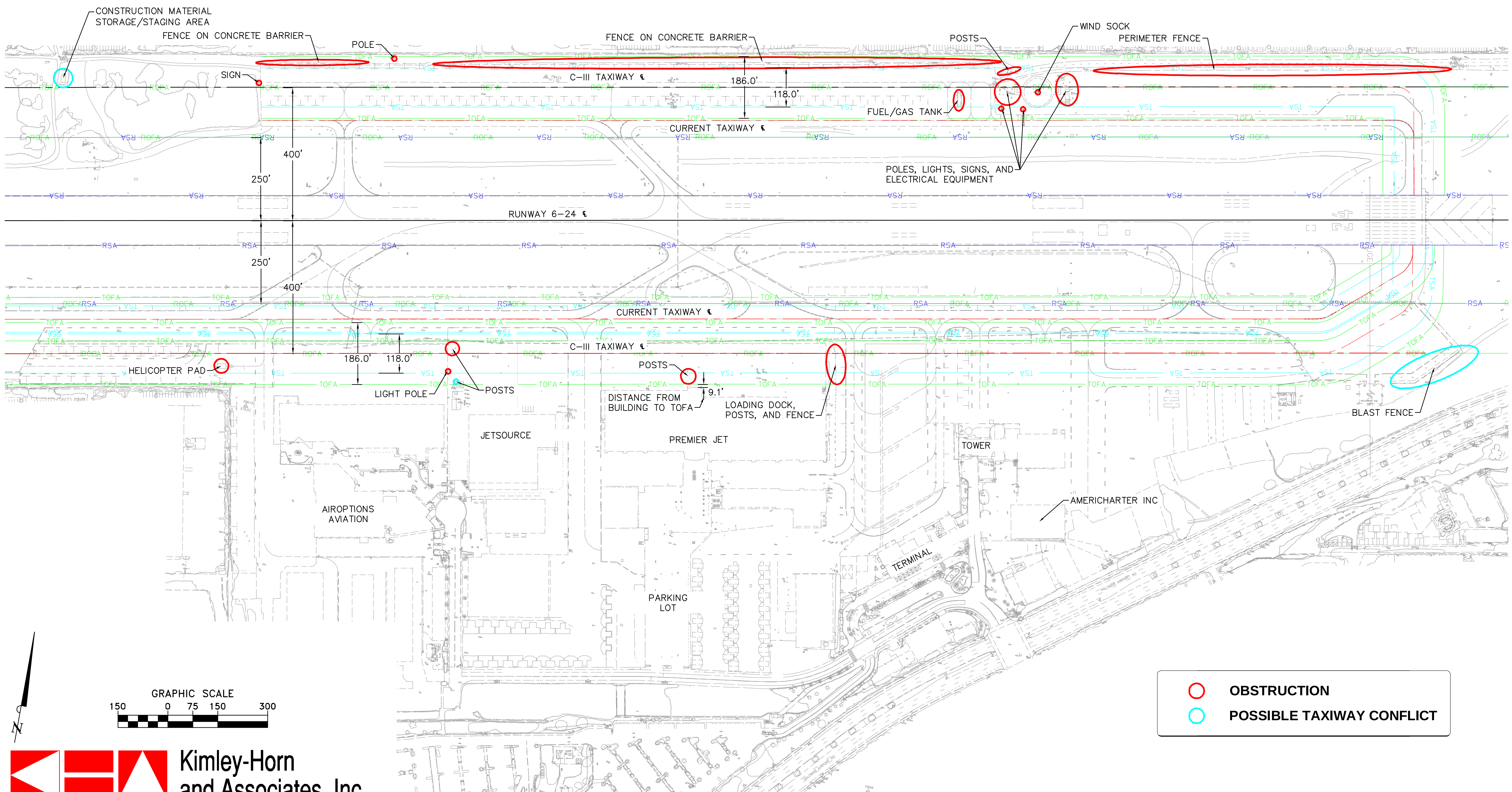
Shifting Taxiway A 100 feet to the south would put the existing buildings (hangars, terminal, fixed base operators) within 9.2 feet of the resulting Taxiway Object Free Area. This action would eliminate any potential/existing apron parking or tie downs. Likewise, the 100 foot shift of Taxiway N to the north would completely eliminate the existing parking apron on the north side of the airport; in addition the electrical vault, fuel storage, and navaids on the north side would require relocation. The horizontal constraints required for a C-III designation would be a major undertaking and costly alternative. See **Figure 4D** for a graphical depiction of the horizontal restrictions that result in the C-III alternative.

VERTICAL GEOMETRY

The vertical geometry (profile) of the existing runway at McClellan-Palomar is designed to meet Aircraft Approach Category B criteria as follows:

- The maximum longitudinal grade is +/- 2.0 percent.
- The maximum allowable grade change is +/- 2.0 percent.
- Vertical curves for longitudinal grade changes are parabolic. The length of the vertical curve is a minimum of 300 feet for each 1.0 percent of change. A vertical curve is not necessary when the grade change is less than 0.40 percent.

FIGURE 4D: Airport Reference Code C-III Obstructions



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This criterion was followed when the B-II runway extension alternatives were evaluated. The existing profile was picked up where it ends today and extended the full length of each alternative. See **Figure 4E** for preliminary profile for B-II alternatives (Alternative A and B), with the 200 foot extension the profile would be terminated at the end of the stopway and the grading would be completed in accordance with the criteria set forth in the FAA advisory circulars and referenced in the grading section of this chapter.

The vertical geometry (profile) for an Aircraft Approach Category C is as follows:

- The maximum longitudinal grade is +/- 1.50 percent, however, longitudinal grades may not exceed +/- 0.80 percent in the first and last quarter of the runway length.
- The maximum allowable grade change is +/- 1.50 percent, however, no grade changes are allowed in the first and last quarter of the runway length.
- Vertical curves for longitudinal grade changes are parabolic. The length of the vertical curve is a minimum of 1,000 feet for each 1.0 percent change.

Due to Alternative C being designed as an Aircraft Approach Category C, a large section of the existing runway would need to be reconstructed for the profile to be within criteria. Approximately 720' of the existing runway would require reconstruction in order to meet the parabolic vertical curve requirement while keeping a grade change out of the first/last quarter of the runway. This alternative, with the added reconstruction of the existing runway, would add approximately $800,000 to the overall cost of the project. See **Figure 4F** for preliminary profile for C-III alternative (Alternative C).

GRADING

All extension alternatives analyzed were graded to adhere to the grading criteria within AC 150/5300-13A. The typical section used in the design analysis will generate a constant cross slope grade for the entire runway length.

The areas outside of the structural pavement have been graded to meet the advisory circular criteria. Within the Runway Safety Area, the grading was held at 1.5% to 5% and no more than 3% in the area between the runway and taxiway. Once outside of the safety area the alternatives were evaluated using the logic of minimizing the grading by maximizing the slope necessary to tie back into existing ground. In several of the alternatives, retaining walls were implemented to reduce the project footprint by decreasing the amount of construction activity and disturbance off of Airport property.

The west end of the runway as it currently exists does not meet the criteria for RSA grades at the end of the runway. The criteria for the RSA are as follows:

- 200 feet of the RSA beyond the runway ends, the longitudinal grade is between 0 and 3.0 percent, with any slope being downward from the ends.

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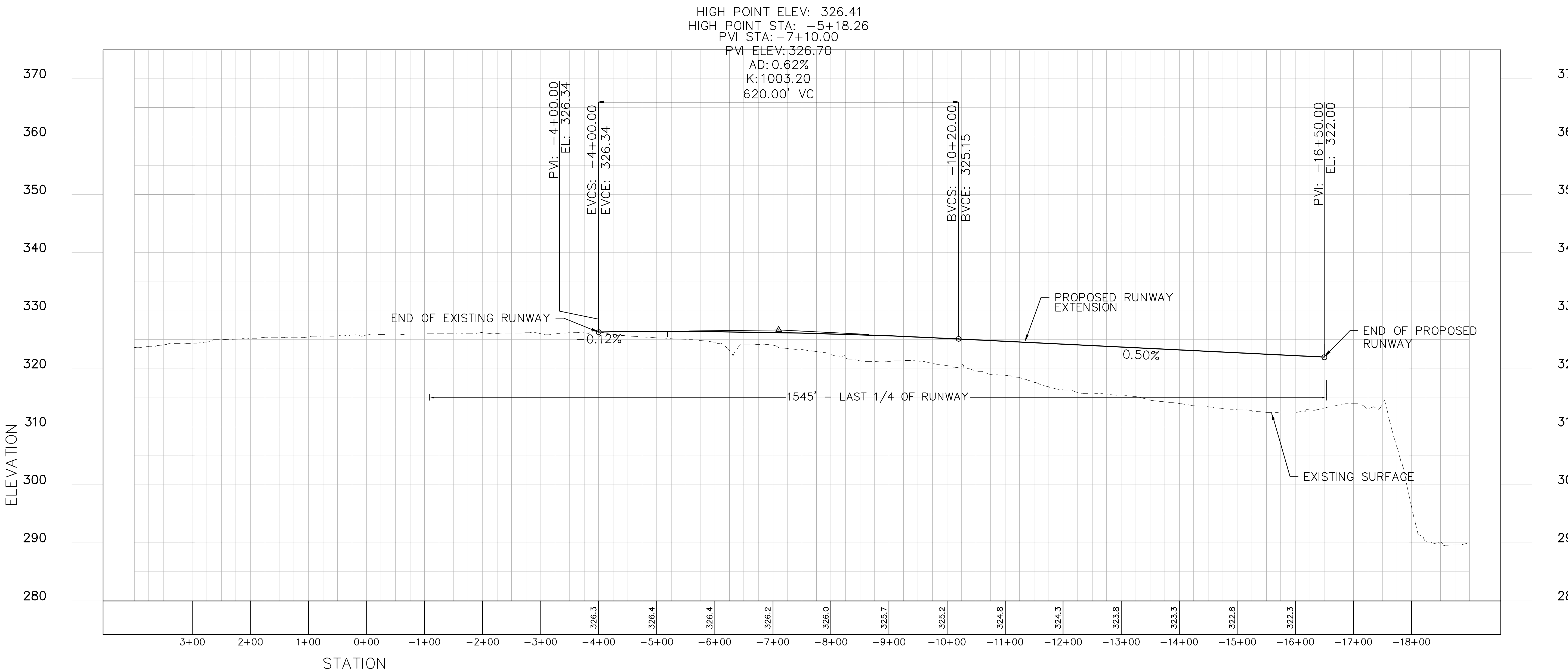
FIGURE 4E: Runway 6-24 Extension - Option 1



MCCLELLAN-PALOMAR AIRPORT

RUNWAY CENTERLINE PROFILE
1240' EXTENSION - B-II CRITERIA

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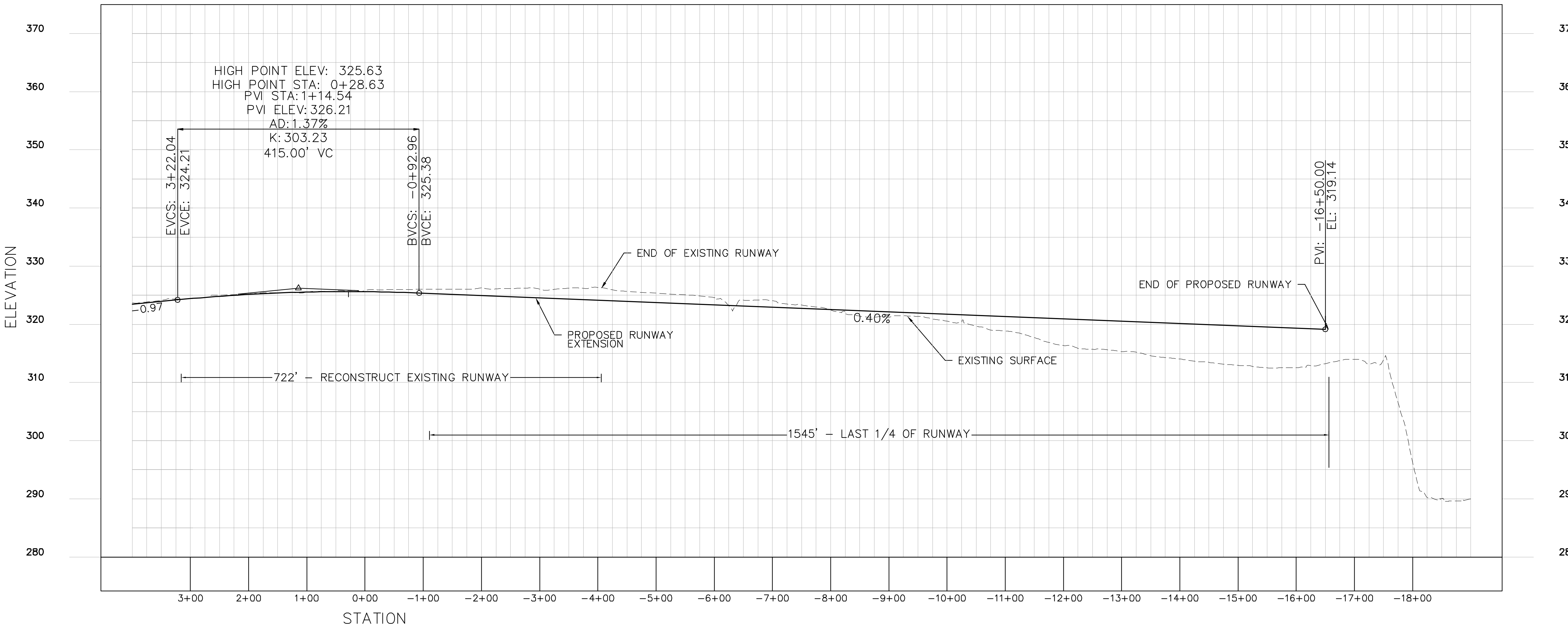
FIGURE 4F: Runway 6-24 Extension - Option 2



MCCLELLAN-PALOMAR AIRPORT

RUNWAY CENTERLINE PROFILE
1240' EXTENSION - C-III CRITERIA

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- Beyond the first 200 feet the maximum allowable positive longitudinal grade is such that no part of the RSA penetrates any applicable approach surface or clearway plane.
- The maximum allowable negative grade is 5.0 percent.
- Limitations on longitudinal grade changes are plus or minus 2.0 percent per 100 feet

The existing RSA has a very large slope within 300 feet of the runway end, to the magnitude of +28%, as indicated on **Figure 4G**. The existing blast pad has areas of slopes greater than 7%, well over the required maximum of 5%. In order to increase safety on the west end of the runway, the existing blast pad will be replaced with an Engineered Material Arrest System (EMAS). The introduction of the EMAS greatly reduces the length of the RSA allowing for the grading to remain steep outside the RSA and accommodate a relocated VSR. Also, included with the EMAS construction will be the re-grading of the RSA areas north of the runway to bring the slopes within the advisory circular criteria suggested range.

OTHER KEY STANDARDS

Other key design standards include the runway centerline distance from the runway holding position and from parallel taxiways. The holding positions at McClellan-Palomar Airport are currently at 250 feet from the runway centerline due to the ¾-mile approach to Runway 24. This meets the design standard for both B-II and C-III.

The runway-taxiway centerline separation is currently 300 feet. This exceeds the B-II standard of 240 feet for the current approaches, and would still meet the B-II standard if the approach were improved to ½-mile. For C-III, the separation standard is 400 feet.

DESIGN STANDARDS SUMMARY

It is evident from this evaluation of design standards that the airfield at McClellan-Palomar Airport can effectively meet B-II standards for planning and design. The airport reference code (ARC) is currently depicted on its approved airport layout plan as B-II. The evaluation of the critical aircraft for the airport indicates that it is C-III. While 55 percent of the business jet operations are classified in approach category B, the fact remains that there are nearly 6,000 operations annually by business jets in approach categories C and D.

This evaluation also indicates that the airport does not currently meet ARC C-III standards. Several improvements would be necessary to meet ARC C-III.

The current level of C-III operations would make the airport eligible for federal funding to upgrade the airfield to ARC C-III standards if practicable. FAA guidance also indicates, however, that “the ARC is used for planning and design only and does not limit the aircraft that may be able to safely operate from the airport.”

In examining the feasibility to meet the runway length needs of the current users, the analysis should also consider the practicability of planning the airport to ARC C-III.

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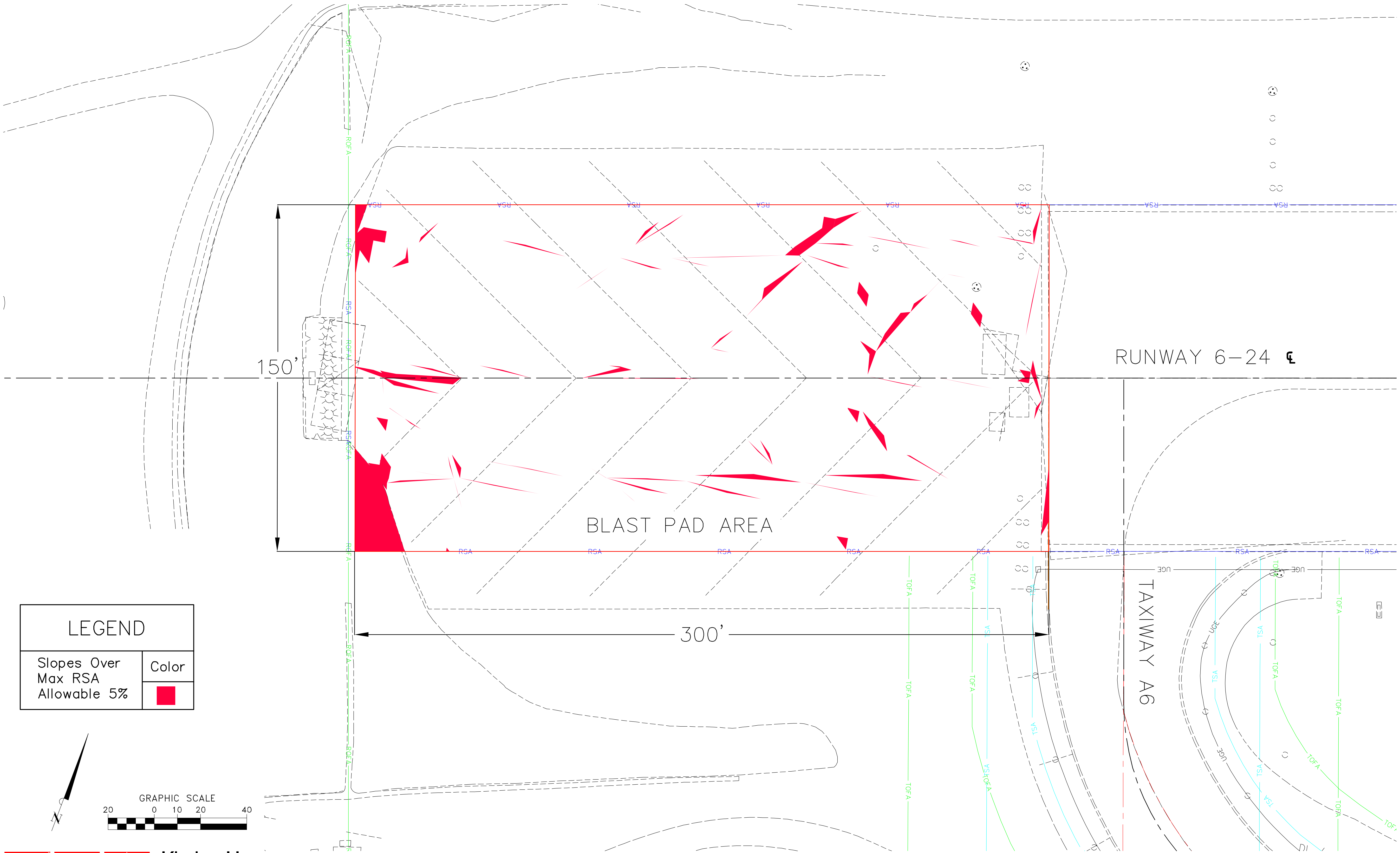
FIGURE 4G: Existing West End RSA Slopes



LEGEND	
Slopes Over Max RSA Allowable 5%	Color

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RUNWAY EXTENSION CONSIDERATIONS

Taking into account the critical aircraft, runway length needs, and the design standards outlined in the previous sections, a preliminary runway extension evaluation was performed. This considered the runway safety area options based upon FAA Orders 5200.8 (*Runway Safety Area Program*) and 5200.9 (*Financial Feasibility and Equivalency of Runway Safety Area Improvements and Engineered Materials Arresting Systems*).

The runway safety area does require some improvement to meet the grading standards for ARC B-II off the west end. However, as indicated on **Figure 4B**, the standard runway safety area for approach categories C and D aircraft beyond the west end of the runway would extend over 300 feet beyond the airport property and require significant fill to meet RSA grading standards.

There is adequate property beyond the east end of the runway to accommodate the standard C-III RSA for the current runway length, but it would still require some grading and some fill along the south edge to meet the standard. The east side of the airfield is the probable end for any runway extension, but a runway extension of over 200 feet would result in the standard C-III RSA extending off current airport property. The standard B-II RSA could be accommodated with a runway extension at least up to 900 feet.

A key consideration with each option is ensuring that the runway safety standard is met. FAA Order 5300.1F, *Modification of Agency Airport Design, Construction, and Equipment Standards,* indicates in Paragraph 6.d. the following:

"... Runway safety areas at both certificated and non-certificated airports that do not meet dimensional standards are subject to FAA Order 5200.8, *Runway Safety Area Program.* Modifications of Standards are **not** issued for nonstandard runway safety areas."

FAA Order 5200.8 establishes the procedures that the FAA will follow in implementing the Runway Safety Area Program. Paragraph 5 of this Order states:

"The objective of the Runway Safety Area Program is that all RSAs at federally obligated airports ... shall conform to the standards contained in AC 150/5300-13, *Airport Design*, to the extent practicable."

The Order goes on to indicate in Paragraph 8.b.:

"The Regional Airports Division Manager shall review all data collected for each RSA in Paragraph 7, along with the supporting documentation prepared by the region/ADO for that RSA, and make one of the following determinations:

(1) The existing RSA meets the current standards contained in AC 150/5300-13.

(2) The existing RSA does not meet the current standards, but it is practicable to improve the RSA so that it will meet current standards.

(3) The existing RSA can be improved to enhance safety, but the RSA will still not meet current standards.

(4) The existing RSA does not meet current standards, and it is not practicable to improve the RSA."

Appendix 2 of FAA Order 5200.8 provides the direction for an RSA determination. This includes the alternatives that must be evaluated. Paragraph 3 of Appendix 2 states:

"The first alternative that must be considered in every case is constructing the traditional graded runway safety area surrounding the runway. Where it is not practicable to obtain the entire safety area in this manner, as much as possible should be obtained. Then, the following alternatives shall be addressed in the supporting documentation . . . :

a. Relocation, shifting, or realignment of the runway.

b. Reduction in runway length where the existing runway length exceeds that which is required for the existing or projected design aircraft.

c. A combination of runway relocation, shifting, grading realignment, or reduction.

d. Declared distances.

e. Engineered Materials Arresting Systems (EMAS)."

Out of the list above, there are certain basic options that can be considered at McClellan-Palomar Airport. The first, and most straightforward alternative, is to fully meet the design standards by providing for the clearing and proper fill and grading of the safety area and object free area off the runway ends. This is certainly the most desirable option as long as physical, environmental, and economic considerations can be accommodated. This is not considered practicable because of severe grade changes to the west and major arterial roadways immediately to the east, which are 30 to 50 feet below the airport grade.

The next option is to relocate, shift, or realign the runway. At McClellan-Palomar Airport, the airport property provides minimal space for shifting or realignment, and is very constrained by development to the north and the south. Thus, this alternative is not considered practicable.

A third option would be to shift the threshold of the runway to effectively relocate the RSA and the object free area (OFA) within the available graded and cleared area. This is accomplished by either relocating or displacing the threshold. Unless combined with an addition of pavement and/or safety area, relocated and displaced thresholds generally reduce the effective length of the runway. The portion of pavement behind a relocated threshold is not available for takeoff or landing. The portion of pavement behind a displaced threshold is not available for landing; however, it may be available for takeoff roll. This option must be weighed not only against the costs of physically implementing the relocation or displacement, the effects on the operational capabilities of the airfield, and the constraints it places on the users of the airport.

Declared distances are used by the FAA to define the effective runway length for landing and takeoff when either a displaced or relocated threshold is involved. Declared distances are defined as the amount of runway declared available for certain takeoff and landing operations. The four types of declared distances, as defined in FAA Advisory Circular 150/530-13, *Airport Design*, are as follows:

Takeoff Run Available (TORA) - The runway length declared available and suitable for the ground run of an airplane taking off.

Takeoff Distance Available (TODA) - The TORA plus the length of any remaining runway and/or clearway beyond the far end of the TORA.

Accelerate-Stop Distance Available (ASDA) - The runway plus stopway length declared available for the acceleration and deceleration of an aircraft aborting a takeoff.

Landing Distance Available (LDA) - The runway length declared available and suitable for landing.

Because they rely on safety area, the most critical of the declared distances are typically ASDA and LDA. Evaluations of the effectiveness of the options will focus on these two declared distances.

A last option would be to determine how much safety area can be provided without significantly affecting the operations of the users of the airport. This is obviously the least desirable option to the FAA, and would be an acceptable determination only if the previous options are proven infeasible and it is proven that the alternative will not unnecessarily endanger lives or property. Paragraph 4 of the Appendix states:

". . . Any portion of land that will increase the RSA, even if it is but an incremental increase, and will not result in meeting the standard fully, is preferable and will serve as a starting point for the consideration of additional alternatives . . . Incremental gains must be obtained whenever possible. The gain may be relatively little, but any gain is valuable."

Paragraph 4.f. of the Appendix further states:

"At any time, when it is not practicable to obtain a safety area that meets the current standards, consideration should be given to enhancing the safety of the area beyond the runway end with the installation of EMAS. The AC 150/5220-22A, *Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns*, pertaining to the installation and use of EMAS, provides details on design to be considered in determining feasibility of this alternative."

Recognizing the difficulties associated with achieving a standard safety area at all airports, the FAA undertook research programs on the use of various materials for arresting systems. Engineered Materials Arresting Systems (EMAS) are comprised of high energy absorbing materials of selected strength which will reliably and predictably crush under the weight of an aircraft. According to the AC, EMAS is not to be considered a substitute for, or equivalent to, any length or width of safety area, and does not affect declared distance calculations. It is also not intended to meet the FAA definition of a stopway.

The following preliminary runway improvement options have been formulated that would meet the runway length requirements and safety area standards. The options focus on each runway end. The west end (Runway 6) includes an option for ARC B-II as well as for C-III, while the east end (Runway 24) includes three options, two for ARC B-II and one for ARC C-III.

WEST END OPTIONS

As indicated earlier, developing a standard Category C/D RSA off the west end of the runway would require acquisition of two commercial buildings, as well as extensive fill of 80 feet or more to raise the RSA to grade. It is evident that a standard RSA would be extremely expensive and have other negative impacts as well.

Even with an ARC of B-II, an airport is not considered inherently unsafe for operation by aircraft in a higher ARC, and an airport sponsor cannot prohibit the aircraft from operating there if the pilot determines it is safe to operate. Subsequently, the McClellan-Palomar Airport accommodates nearly 6,000 Category C and D aircraft annually. Given that and the fact that 97 percent of the airport's operations occur on Runway 24, an EMAS bed would be a valuable safety precaution off the west end, regardless of any other runway improvements.

An EMAS bed is considered equivalent to the standard RSA when it is designed to stop an aircraft leaving the runway at 70 knots. An EMAS bed of 350 feet (315 feet of EMAS with a 35-foot paved lead-in) is needed for the business jets using McClellan-Palomar Airport to be stopped at when exiting the runway at 70 knots.

As shown on **Figure 4H**, most of the EMAS would be placed on the existing 300-foot blast pad, but 50 feet would extend beyond the current paved area. This would require relocating the localizer and raising up the grade to support the additional length of EMAS. This action would maintain the current runway end and displaced threshold. Maintaining ARC B-II, the runway protection zones on the west end of the runway would remain unchanged.

The C-III Alternative is depicted on **Figure 4I** and would be essentially the same, except that the runway safety area would extend 165 feet to either side of the EMAS for the length of the EMAS bed. A 600-foot safety area is the ARC C-III standard behind the landing threshold. This would be met with the combination of the 350-foot EMAS bed and the existing threshold displacement of 300 feet. The approach and departure RPZs of the C-III alternative would extend 700 feet farther and encompass an additional building and parking lot.

RUNWAY 24 OPTIONS

The east end of the runway has room to develop a runway safety area with some fill required on the south side of the RSA. To get more than approximately 240 feet additional runway length, however, the RSA would need to extend over two existing arterial roadways. A means to get additional runway length is through the use of declared distances. This would allow the pavement to be extended to the east as far as the runway safety area. The additional pavement would be available for takeoff to the west from Runway 24. The additional length for takeoff to the east on Runway 6 would be more limited because the full RSA would be needed beyond the useable runway length. This could be

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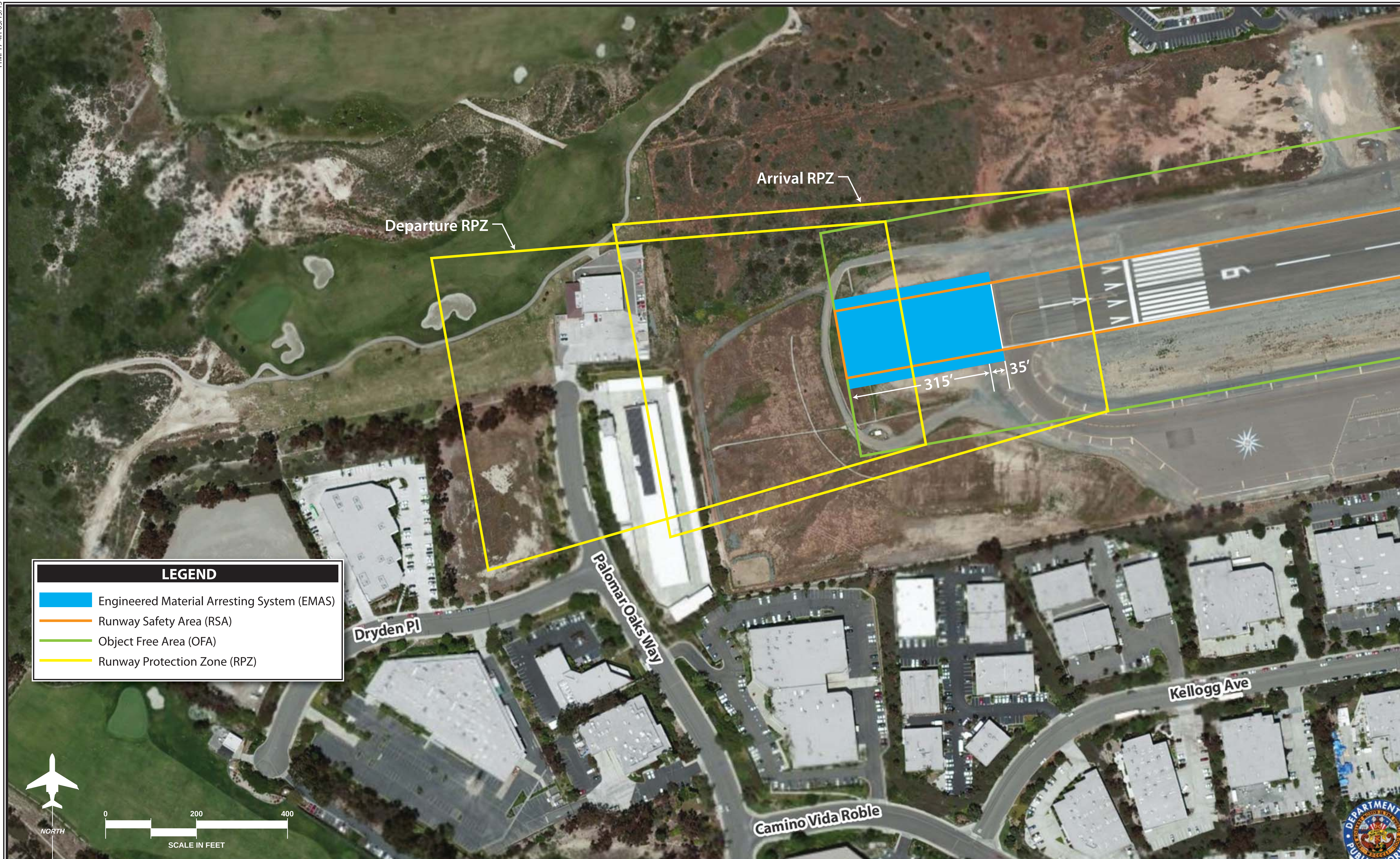

Figure 4H
B-II ALTERNATIVE - WEST END

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Figure 4I
C-III ALTERNATIVE - WEST END

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corrected to some extent by providing EMAS off the east end of the extended runway. A portion of the takeoff length on Runway 24, however, may be sacrificed.

Given that 97 percent of the airport's operations use Runway 24, the expense of EMAS and potential loss of runway length off the east end of the runway would be too great for the limited use it would get. Therefore, the three options look at extending the runway to the east along with the RSA for use in the direction of the primary operational flow (westbound) of the airport.

Alternative A – 5,100' Runway (200' extension, B-II)

Figure 4J depicts a limited extension designed to minimize placing runway pavement over the existing landfill located off the east end of the runway. Mapping of the landfill indicates that a 200-foot extension could be attained to minimize placement over the landfill. The runway safety area would extend over the landfill. Maintaining an ARC B-II design, Taxiways A and N would be extended to the new end of the runway as well.

Under this Alternative, the full length of Runway 24 would be available, providing 5,097 feet for both landing and takeoff and meeting the minimum desired criteria of at least 5,000 feet. Runway 6 would also have the full 5,097 feet for takeoff, but would be 4,797 feet for landing due to the existing displace threshold. That length would still be 200 feet more than currently available.

The approach lighting system on Runway 24 has lighting stations at 200-foot increments. Thus, a minimum 200-foot extension allows for the stations to simply be repositioned on the existing light foundations. Not only does this save relocation costs, but also avoids creating a conflict with El Camino Real, which currently traverses between two existing light stations. Refer to Chapter 5 for further discussion on Alternative A.

Moving the landing threshold 200 feet to the east would shift the approach RPZ over an office building at the southeast corner of Palomar Airport Road and El Camino Real. The building would remain outside the central portion of the RPZ, but would require FAA approval to remain.

Another consideration when relocating a threshold are the approach clearances for Runway 24. The threshold siting surface (TSS), as well as the glide path qualification surface (GQS), were examined for the 200 foot shift in the runway threshold. No obstructions were found to the TSS, and one tree was found to penetrate the GQS by five feet. The tree is located on the very edge of the GQS along Palomar Airport Road, and would need to be lowered or removed to maintain the current approach minimums for Runway 24.

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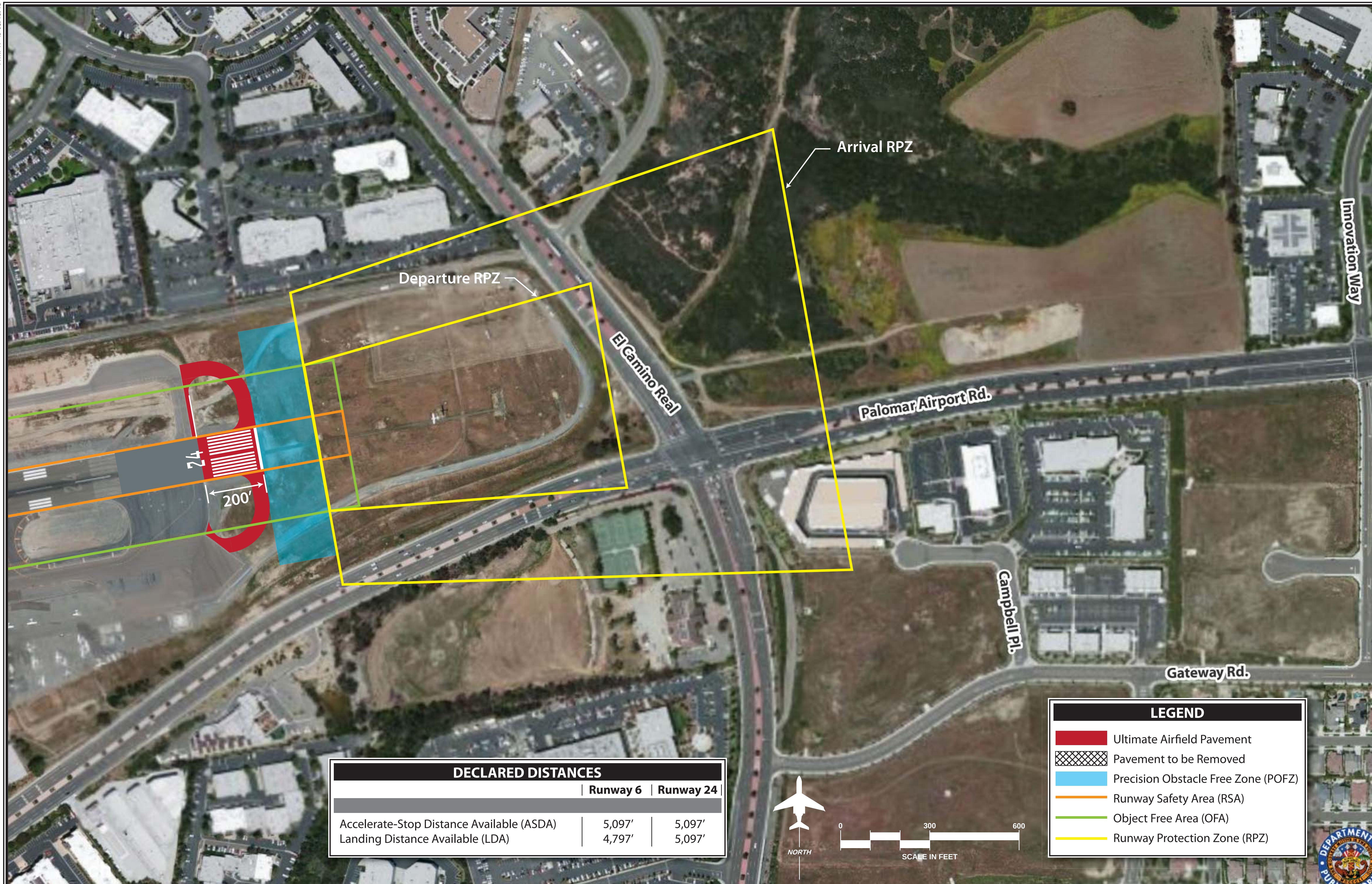

DECLARED DISTANCES

	Runway 6	Runway 24
Accelerate-Stop Distance Available (ASDA)	5,097'	5,097'
Landing Distance Available (LDA)	4,797'	5,097'

Figure 4J
ALTERNATIVE A - EAST SIDE

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Alternative B – 5,800' Runway (900' Extension, B-II)

Alternative B considers improvements to the runway that would also address the runway length needs of B-II aircraft. The most demanding B-II aircraft with regards to takeoff length is the Falcon 2000 which had 576 operations at McClellan-Palomar Airport in 2011. As presented previously on **Table 4D**, the Falcon 2000 design takeoff length at 90 percent useful load is 5,800 feet.

According to the pilot of a Falcon 2000 based at the airport, the aircraft range from the current runway is always limited. Most affected are flights to the northeastern United States and internationally to destinations such as Europe and Brazil. The aircraft has made short flights to San Diego International to use the longer runway after taking on adequate fuel for the long haul flights.

Figure 4K depicts a 900-foot extension which would provide for 5,797 feet of takeoff length on Runway 24.

The full length is also depicted for departure on Runway 6, although with only 3 percent of departures occurring on Runway 6, the full length would not be critical in that direction.

The most demanding B-II aircraft for landing are the Cessna Citation Bravo and the Cessna Citation Excel, which require 5,100 feet under design conditions.

The landing threshold with this alternative is shifted back 200 feet from the current threshold, placing it in the same location as with Alternative A. Similarly, the office building on the corner of Palomar Airport Road and El Camino Real would partially be within the RPZ, but outside the central portion of the RPZ. Thus, the landing distance available would be 5,097 feet. The landing distance available on Runway 6 would actually be greater at 5,497 feet. Refer to Chapter 5 for further discussion on Alternative B.

Alternative C – 6,100' Runway (1,200' extension, B-II)

Alternative C considers runway improvements designed to meet ARC C-III. As indicated in the runway length analysis earlier in the chapter, a runway length of up to 6,100 feet would be most effective. **Figure 4L** depicts a runway extension of 1,204 feet to the east. This is limited by maintaining the southeast corner of the RSA from encroaching on Palomar Airport Road. This would provide 6,101 feet for takeoff on Runway 24.

To meet the design landing length for Category C and D aircraft, the landing threshold would be shifted to the east 400 feet. As with the other alternatives, this would allow the approach light system to be relocated and use the existing foundations for all but the last two stations. This would provide 5,297 feet of landing distance available while providing more than the standard 600 feet of RSA before the landing threshold.

On Runway 6, the full 1,000 feet for RSA must be provided beyond the end of the Runway. As a result, declared distances would be applied to both departure and landing. The accelerate-stop distance available would be 5,297 feet, while the landing distance available would be 4,704 feet.

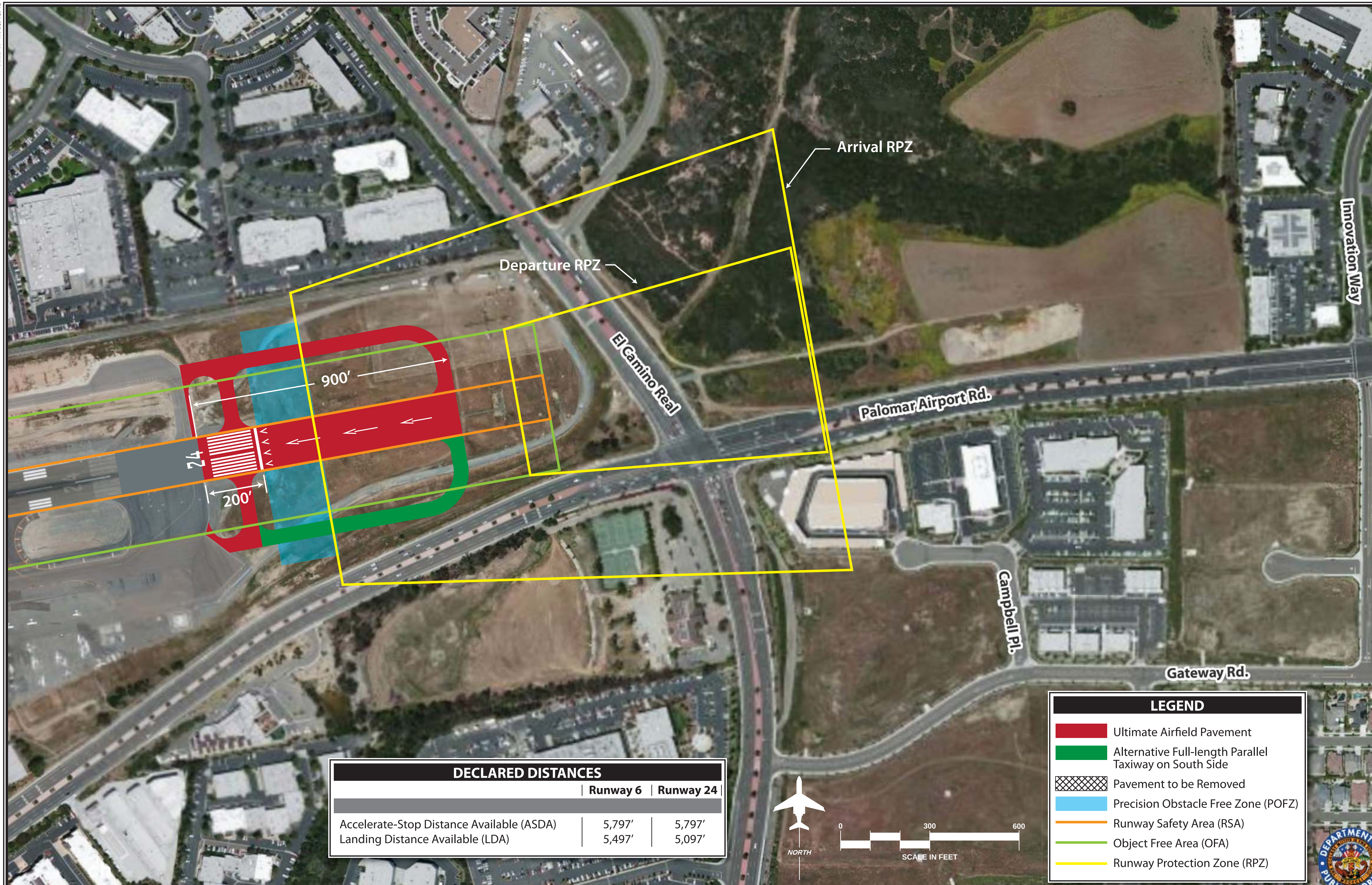
As with the previous two alternatives, the approach surfaces for the relocated threshold were examined. The obstruction along the edge of the GQS in the previous two alternatives is outside the GQS under this alternative. No obstructions were found to the TSS as well.

To fully meet the ARC C-III standard, the parallel taxiways would need to be relocated to 400 feet from the runway. Potential impacts along the existing runway were discussed earlier. On the south side of the extended runway, Taxiway A would extend over Palomar Road. A taxiway on the north side would be a tight fit within the current airport property. Refer to Chapter 5 for further discussion on Alternative C.

SUMMARY

The three alternatives outlined above provide a broad spectrum from which to examine the feasibility of runway improvements at McClellan-Palomar Airport. Alternative A considers a short extension to provide for at least 5,000 feet on landing and takeoff for the current ARC B-II runway. Alternative B examines additional runway length within the current ARC B-II standards that would also meet the design runway length for the most demanding B-II aircraft currently using the airport. Alternative C considers improving the airport to ARC C-III standards and the subsequent design runway length of 6,100 feet.

These alternatives along with structural stabilization alternatives will be examined further in the following chapters. This will include the development costs associated with each extension and structural alternatives. Finally, a business case for the runway will be examined as well as a benefit-cost analysis comparing each alternative to the existing runway.



DECLARED DISTANCES

	Runway 6	Runway 24
Accelerate-Stop Distance Available (ASDA)	5,797'	5,797'
Landing Distance Available (LDA)	5,497'	5,097'

Figure 4K
ALTERNATIVE B - EAST END

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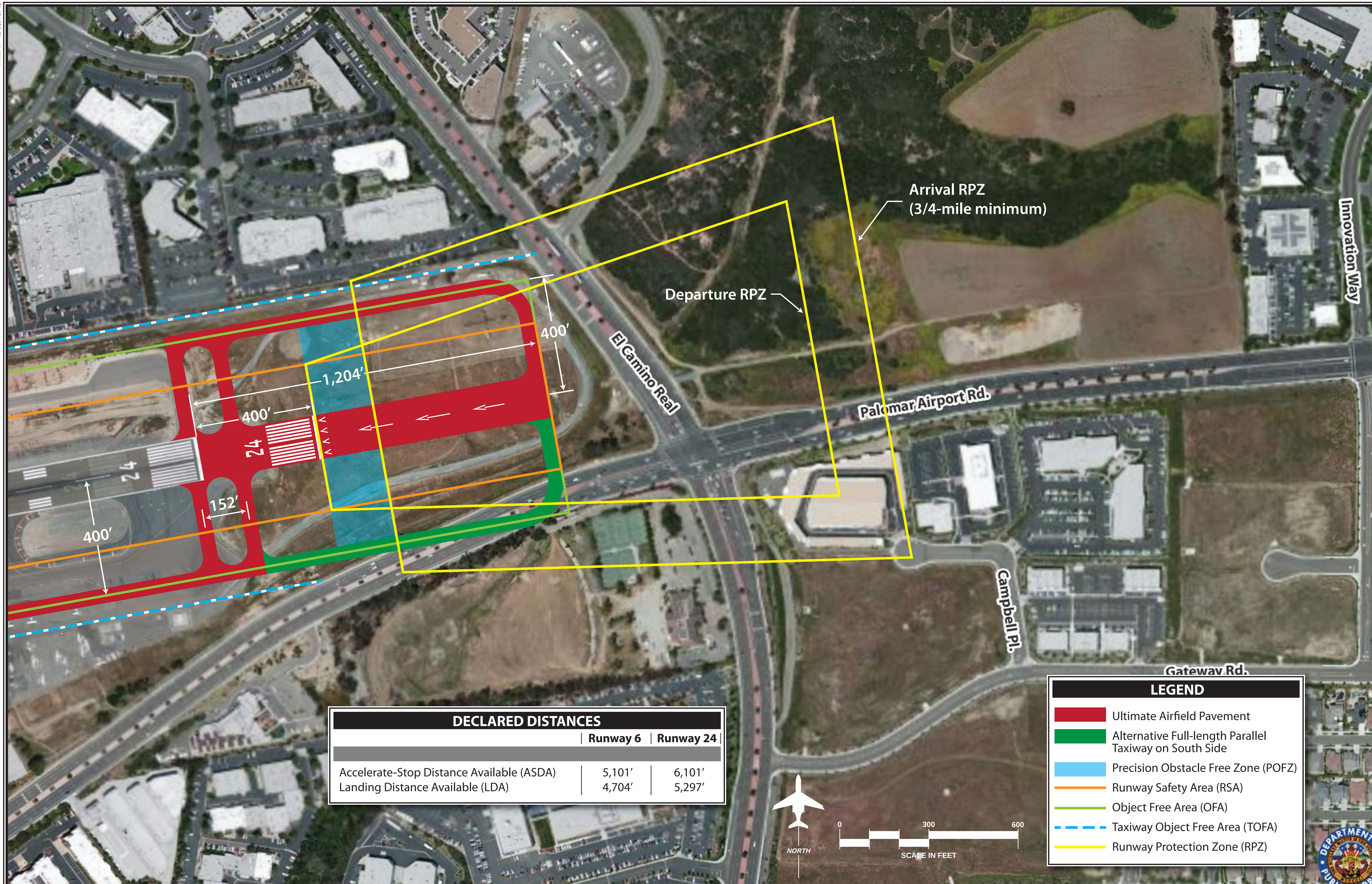

DECLARED DISTANCES

	Runway 6	Runway 24
Accelerate-Stop Distance Available (ASDA)	5,101′	6,101′
Landing Distance Available (LDA)	4,704′	5,297′

Figure 4L
ALTERNATIVE C - EAST END

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Chapter Five
EXTENSION ALTERNATIVES, LANDFILL MITIGATION OPTIONS AND SAFETY UPGRADES

By increasing the length of Runway 6-24, McClellan-Palomar Airport will be able to maximize the operational capacity of the aircraft that currently use the facility. Since the airport property is situated on top of a mesa, there are steep vertical drops surrounding the airfield on almost all sides. These drops are much too steep and sudden for an extension to be considered feasible on the west side of the runway, but the area to the east of the runway is sloped much more gradually; the vertical drop does not occur until about 50 feet from the property line.

A significant portion of the airfield on the east side of the runway has been built on top of MSW landfill material which is unsuitable to use as a stabilized base due to settlement issues. The unique topography of the site makes the east side of the runway the only logical location for a potential runway extension, but since this area is on top of a landfill, special considerations must be made to mitigate settlement issues before a runway extension may be considered feasible. Furthermore, changes being made on the west side of the runway must be limited to upgrades to navigation aids and other safety improvements.

Today, Runway 6-24 serves a published Runway Design Code (RDC) of B-II-4000. However some of the airfield's users do operate aircraft that are larger than the RDC design criteria. The operation of these aircraft has been deemed safe by the flight operations of these users based on the characteristics of their aircraft. As referenced in *Chapter Three,* there are aircraft operating from CRQ with more than 500 annual operations that exceed the B-II-4000 RDC design standards.

Based on current capabilities, the County has elected to operate the airport as a B-II-4000 RDC airfield. This decision is based on the impediments to improving the existing airfield to meet the criteria for the next higher flight characteristic level, an Airplane Approach Category (AAC) of C. As such, the recommendations for the runway alternatives are based on the consideration of a B-II-4000 RDC, the economic benefits it offers to the airport, and whether maintaining this RDC justifies the alternative improvements as feasible as defined by the scope of this project.

In the base year for this study (2011) there were a total of 13,326 corporate jet operations, of which 5,998 were associated with aircraft greater than a B-II-4000 RDC. In 2031 this number is anticipated to grow to a total of 9,135 operations with the percentage of aircraft larger than the RDC choosing to operate at CRQ to be equal to the existing proportion, or 43.5%. With this information in hand, improvements to the west end of Runway 24 may be warranted to accommodate the largest aircraft envisioned during the planning horizon.

These "west end" improvements would be considered safety enhancements to address the known aircraft which are known to operate at the airfield. These improvements will also enable a Runway Safety Area to be provided to assist these aircraft if an issue occurred on takeoff or during landings and a runway overshoot is required.

Based on the focus of this study, the improvements for the runway are divided into two separate categories: Safety enhancements for the existing operations at the airport (west end improvements) and capacity issues (runway extension alternatives).

WEST SIDE SAFETY ALTERNATIVE UPGRADE

The safety improvements recommended for the west end of Runway 6-24 are common to every one of the proposed improvements on the east end, which are centered on achieving a desired runway length designation. On the west end, these upgrades are primarily focused on improving the safety area so that it meets the guidelines set forth in FAA Advisory Circular 150/5300-13A for the fleet of aircraft which currently use the airport.

The main feature of the proposed safety improvements on the west end of the runway is an Engineered Material Arrest System (EMAS). With the installation of the 350 foot EMAS bed (315 feet of EMAS material plus 35 feet of structural pavement), the existing localizer equipment will need to be relocated approximately 50 feet further west, but no other navigational equipment will require adjustment.

The start of the proposed EMAS is 35 feet beyond the runway edge to provide clearance for aircraft operations under standard operating procedures without wing overhang of the EMAS. This provides a total length of 350 feet for the EMAS bed beyond the end of the runway. The west end RSA was graded to meet B-II criteria. Outside of the RSA footprint, the plateau was designed such that it could be upgraded to C-III standards in the future without major structural changes to any retaining wall locations if the airport decided to reclassify the Airport Reference Code (ARC). The proposed retaining walls and vehicle service road have been planned outside of the RSA limits for an ARC C-III to accommodate a future change.

A retaining wall has been proposed 10 feet to the west of the relocated localizer. This wall would wrap around both the north and the south edges of the existing runway to allow for the relocation of the Vehicle Service Road (VSR) while remaining out of the safety areas. The retaining wall is proposed to be approximately 1020 feet long and 12 feet tall at its highest point.

In addition to the installation of the EMAS and retaining wall, the existing ground to the north of the runway is proposed to be re-graded to achieve the slope requirements of AC 150/5300-13A inside the runway safety area. West side upgrades will also include the installation of new drainage facilities and re-vegetation of the entire project area.

Figure 5A shows the location of the proposed safety improvements on the west side of Runway 6-24 and an itemized cost estimate for these improvements is shown in **Table 5A**. This estimate was developed using cost information from past project bid tabs, construction estimates, and through discussions and estimates provided by southern California contractors. These safety upgrades are suggested regardless of the proposed capacity improvements on the east end of Runway 6-24.

TABLE 5A
West Side Safety Improvements
McClellan-Palomar Airport

McClellan - Palomar Airport Runway Extension Alternatives West Side Safety Improvements				
Item	**Unit**	**Unit Cost**	**Quantity**	**TOTAL**
Embankment	CY	$ 50	110212	$ 5,510,615
VSR Pavement	SF	$ 3.75	44000	$ 165,000
Retaining Wall	SF	$ 71	13163	$ 934,600
Electrical	LS	$ 800,000	1	$ 800,000
EMAS	LS	$ 6,300,000	1	$ 6,300,000
Drainage	LS	$ 998,800	1	$ 998,800
Revegetation	AC	$ 1,500	16	$ 24,000
Subtotal				$ 14,733100
25% Contingency				$ 3,683,275
TOTAL CONSTRUCTION				**$ 18,416,400**
Engineering		$ 18,416,400	8%	$ 1,473,400
Administrative Mgmt		$ 18,416,400	22%	$ 4,051,700
Construction Mgmt		$ 18,416,400	8%	$ 1,473,400
TOTAL SOFT COSTS				**$ 6,998,500**
TOTAL ESTIMATE				**$ 25,414,900**

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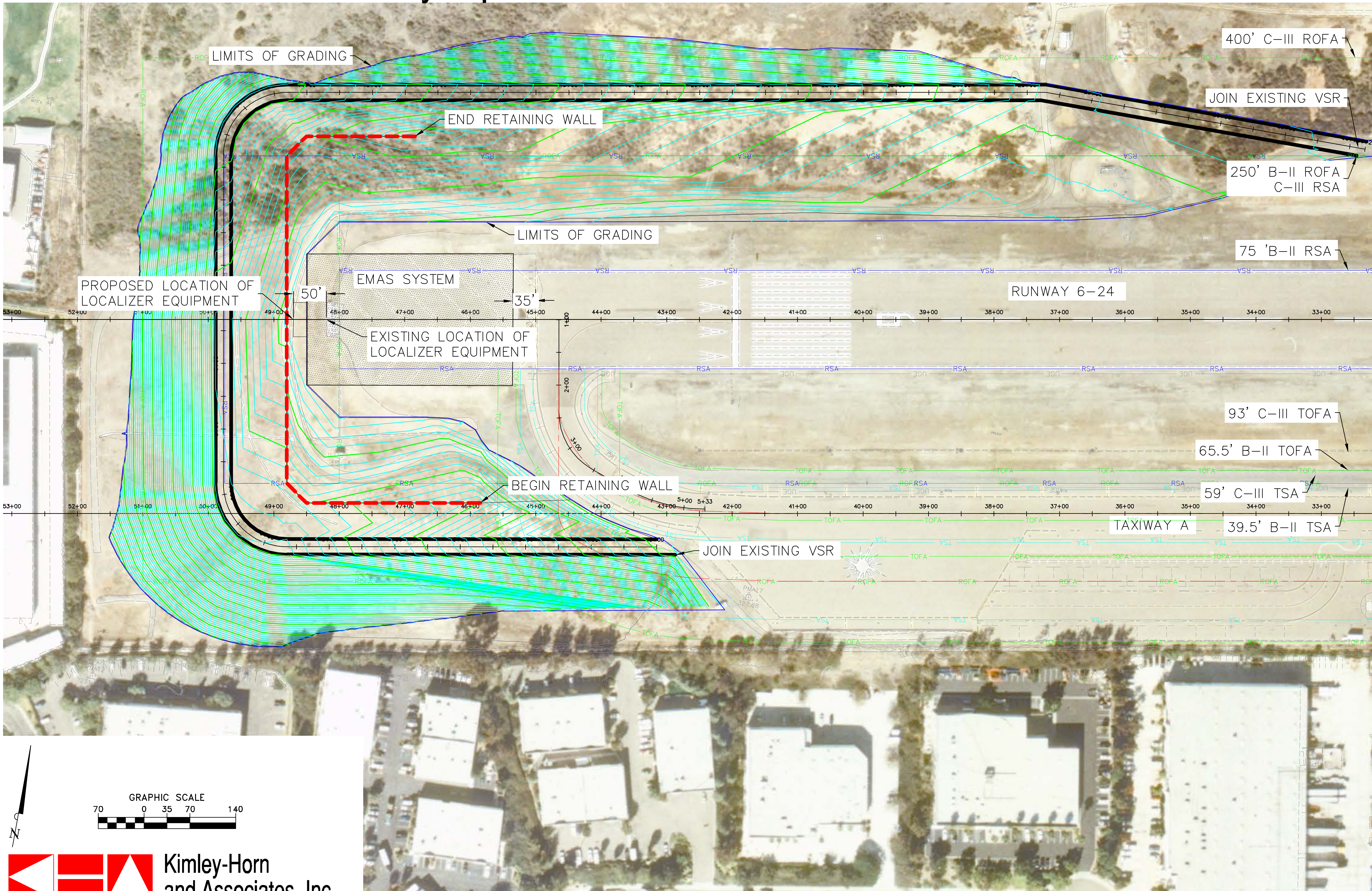
FIGURE 5A: West Side Safety Improvements



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EAST SIDE IMPROVEMENTS

As an accompaniment to the proposed safety upgrades on the west side of Runway 6-24, three alternatives have been developed for expansions and improvements on the east side of the runway. For the design critical aircraft, (B-II-4000 RDC), the three alternatives provide operating capacity for B-II aircraft through enhanced stage length. These alternatives are:

- Alternative A: a runway extension of 200 feet, for a total length of 5,100 feet.
- Alternative B: a runway extension of 900 feet, for a total length of 5,800 feet.
- Alternative C: a runway extension of 1200 feet, for a total length of 6,100 feet, almost all the way to the limits of airport property.

Each of these options has been designed to achieve a specific ARC: B-II for Alternatives A and B and C-III for Alternative C. These alternatives and the cost estimates associated with them are as follows.

ALTERNATIVE A – 5,100' Runway (200' extension, B-II)

Alternative A would classify the runway the same as it is currently, as a B-II runway. This alternative consists of a 200 foot extension of Runway 6-24 along with the lengthening of Taxiway N (north) and Taxiway A (south) to the proposed new end of the runway. This option would not have any effect on the widths of safety areas, object free areas, or runway / taxiway centerline separations; only the length of the runway would be changed. The result would be an overall runway length of approximately 5100 feet, which would allow the entire fleet of aircraft that currently use the airport to take off at up to 60 percent useful load. With the existing runway length of 4897 feet, only about 75% of the fleet is able to operate with such a load. More details about how additional runway length affects aircraft usage are shown in *Chapter 2 – Runway Extension Justification Statement*.

With a runway extension of 200 feet, the extensions to Taxiways A and N could be easily built without significant impact to either Palomar Airport Road to the south or to the apron area to the north. Grades could be achieved through minimal surface grading, the VSR could remain where it is today, and there would be no need to build retaining walls to the east or south of the runway. Alternative A would remain clear of most of the landfill as well, minimizing the need for structural stabilization improvements of the material underneath the runway. The extension would require little more than installing structural pavement in place of the existing stopway pavement and re-grading the new stopway.

The addition of 200 feet of runway pavement would make the relocation of existing runway approach lighting relatively straightforward as well. The approach lighting system on Runway 24 has stations at 200-foot increments.

Thus, a minimum 200-foot extension allows for the stations to simply be repositioned on the existing light foundations. Not only does this save relocation costs, but also avoids creating a conflict with El Camino Real, which currently traverses between two existing light stations.

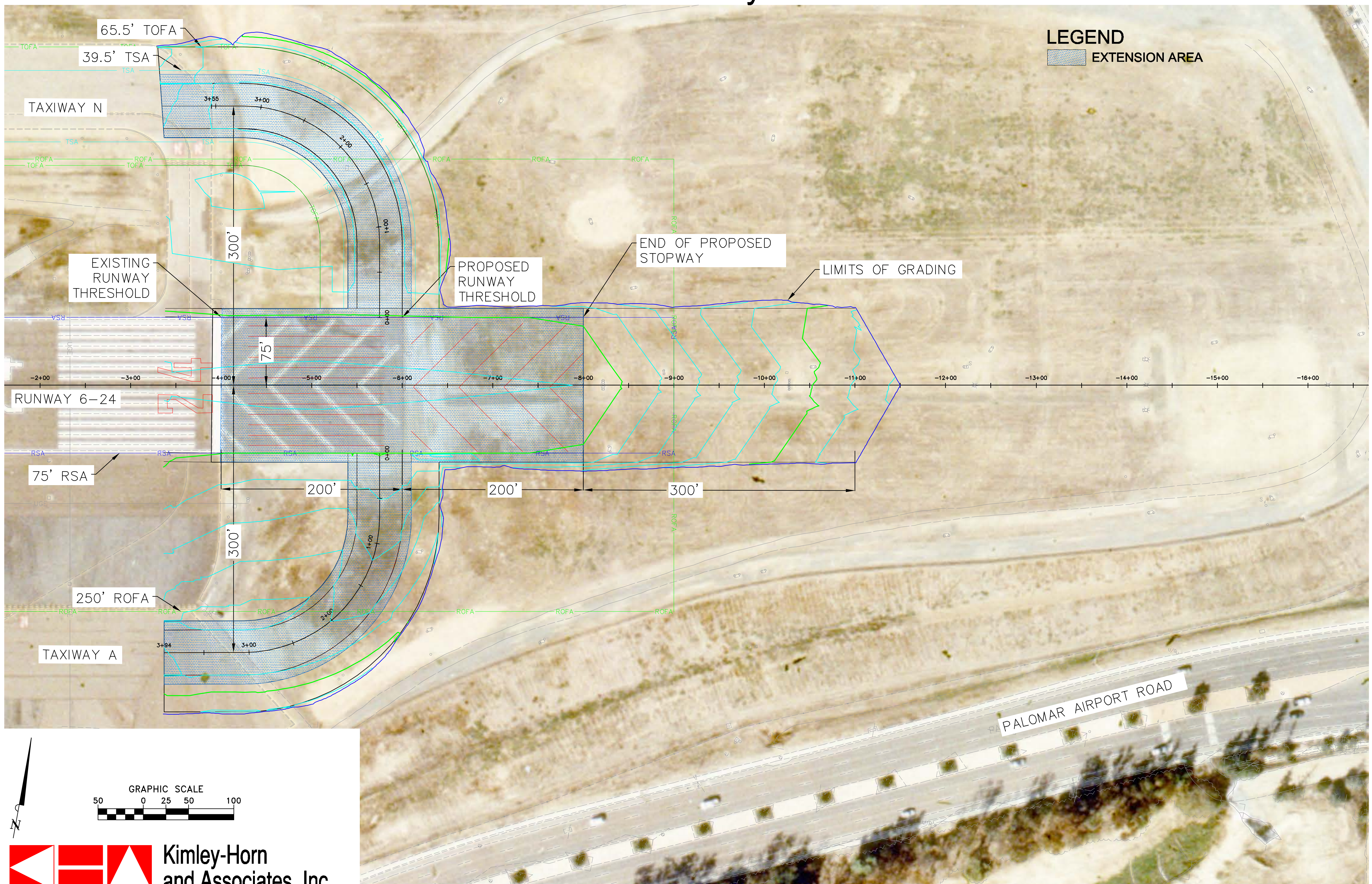
Alternative A would also include the installation of new drainage facilities. However, no re-vegetation would be required with this alternative and mitigation of the methane extraction system would be minimal. Furthermore, this option does not require the import of new fill material. Instead, there would be approximately 10,000 cubic yards of extra material to either be exported or used as fill on the west side improvements of Runway 6-24.

Figure 5B shows the proposed layout of Runway Extension Alternative A and an itemized cost estimate for this option is shown in **Table 5B**. This estimate was developed using cost information from past project bid tabs, construction estimates, and through discussions and estimates provided by southern California contractors. These upgrades are recommended in addition to the proposed safety improvements on the west side of the runway.

TABLE 5B
East Side Runway Improvements
Alternative A – 200' Extension

McClellan - Palomar Airport Runway Extension Alternatives B-II Runway, 200' Extension				
Item	**Unit**	**Unit Cost**	**Quantity**	**TOTAL**
Pavement	LS	$ 1,539,389	1	$ 1,539,400
Export	CY	$ 50	10,441	$ 522,100
Pavement Markings	LS	$ 13,600	1	$ 13,600
Electrical	EA	$ 2,100,000	1	$ 2,100,000
Structural Improvements	LS	$ 8,470,000	1	$ 8,470,000
Drainage	LS	$ 80,900	1	$ 80,900
Methane Extraction	LS	$ 289,800	1	$ 289,800
Subtotal				$ 13,015,800
25% Contingency				$ 3,253,950
TOTAL CONSTRUCTION				**$ 16,269,800**
Engineering		$ 16,269,800	8%	$ 1,301,600
Administrative Mgmt		$ 16,269,800	22%	$ 3,579,400
Construction Mgmt		$ 16,269,800	8%	$ 1,301,600
TOTAL SOFT COSTS				**$ 6,182,600**
TOTAL ESTIMATE				**$ 22,452,400**

FIGURE 5B: Alternative A - 200' Extension of Runway 6-24



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ALTERNATIVE B – 5,800' Runway (900' Extension, B-II)

Alternative B consists of a 900 foot extension of Runway 6-24, with a displaced threshold of 700 feet (locating it in the same location as Alternative A), for a total runway length of 5,797 feet. In order to minimize the impact to the surrounding community by the approach surface, while still maintaining the required landing length determined in Chapter 4 (5,000ft), a displaced threshold was introduced. With the introduction of a displaced threshold, a longer departure runway length (5,797ft) can be provided while maintaining the runway safety areas using a declared total landing distance available.

The location of the displaced threshold in Alternative B is 200 feet east of the existing threshold. The resulting shift in the approach surface would reduce the obstructions as the office building on the corner of Palomar Airport Road and El Camino Real would now only be partially within the RPZ, but remain outside the central portion of the RPZ.

Along with the added runway length, this alternative proposes an extension of Taxiway N to the proposed end of the runway as well as a connecting taxiway to the location of the displaced threshold. Taxiway A is proposed to either connect as it did in Alternative A, at the displaced runway threshold, or extend for the entire added runway length to mirror the extension of Taxiway N.

With Alternative B, the overall length of the runway would be approximately 5,800 feet with 5,100 feet of available landing distance. These lengths would allow the majority of the aircraft using the airport to take off at 90 percent useful load. Like Alternative A, this alternative would classify the runway as a B-II runway, maintaining the classification as it is today.

A significant portion of Runway Extension Alternative B would have to be built on top of existing landfill material which requires stabilization. Several options for structural improvements have been explored to mediate the effects of the landfill on the runway extension. Each of these options would provide a stabilized base for the 900 foot extension to be built on top of. The Landfill Mitigation Options described later in this chapter show additional details about the structural improvement alternatives required for landfill stabilization.

In order to accommodate the full length runway and taxiway extensions proposed in Alternative B, while providing grades within AC requirements, a retaining wall would need to be built to the south and east of the end of Runway 6-24. This wall would be approximately 1450 feet long and 45 feet tall at its highest point. It would eliminate potential impact to both Palomar Airport Road on the south and El Camino Real on the east as it would not require any roadway realignment or intersection relocation. If Taxiway A was only extended to connect with the displaced runway threshold, the length of the retaining wall would be reduced to approximately 1,150 feet as it would only be required to accommodate the additional length of runway.

As with Alternative A, the addition of an even 900 feet of runway pavement with the 700 foot displaced threshold would make relocation of the existing runway lighting relatively straightforward. The approach lighting system on Runway 24 has lighting stations at 200-foot increments. By locating the displaced threshold in the same location as Alternative A, this will allow for the stations to simply be repositioned on the existing light foundations. Not only does this save relocation costs, but also avoids creating a conflict with El Camino Real, which currently traverses between two existing light stations.

Similar to the west side safety upgrades, the installation of new drainage facilities and re-vegetation of the project area would be included with Alternative B. However, this option would also require extensive mitigation and reconstruction of the existing methane extraction system depending on which of the landfill mitigation options is selected.

Figures 5C and **5D** show the proposed layout of Runway Extension Alternative B and cost estimates for these options are shown in **Tables 5C** and **5D**. **Table 5C** approximates the costs of extending Runway 6-24 and Taxiway N for 900 feet each. **Table 5D** includes the same information as 5C, but with the full-length extension of Taxiway A. These estimates were developed using cost information from past project bid tabs, construction estimates, and through discussions and estimates provided by southern California contractors. As with Alternative A, these improvements are recommended in addition to the proposed safety upgrades on the west side of the runway.

FIGURE 5C: Alternative B - 900' Extension of Runway 6-24 and Taxiway N

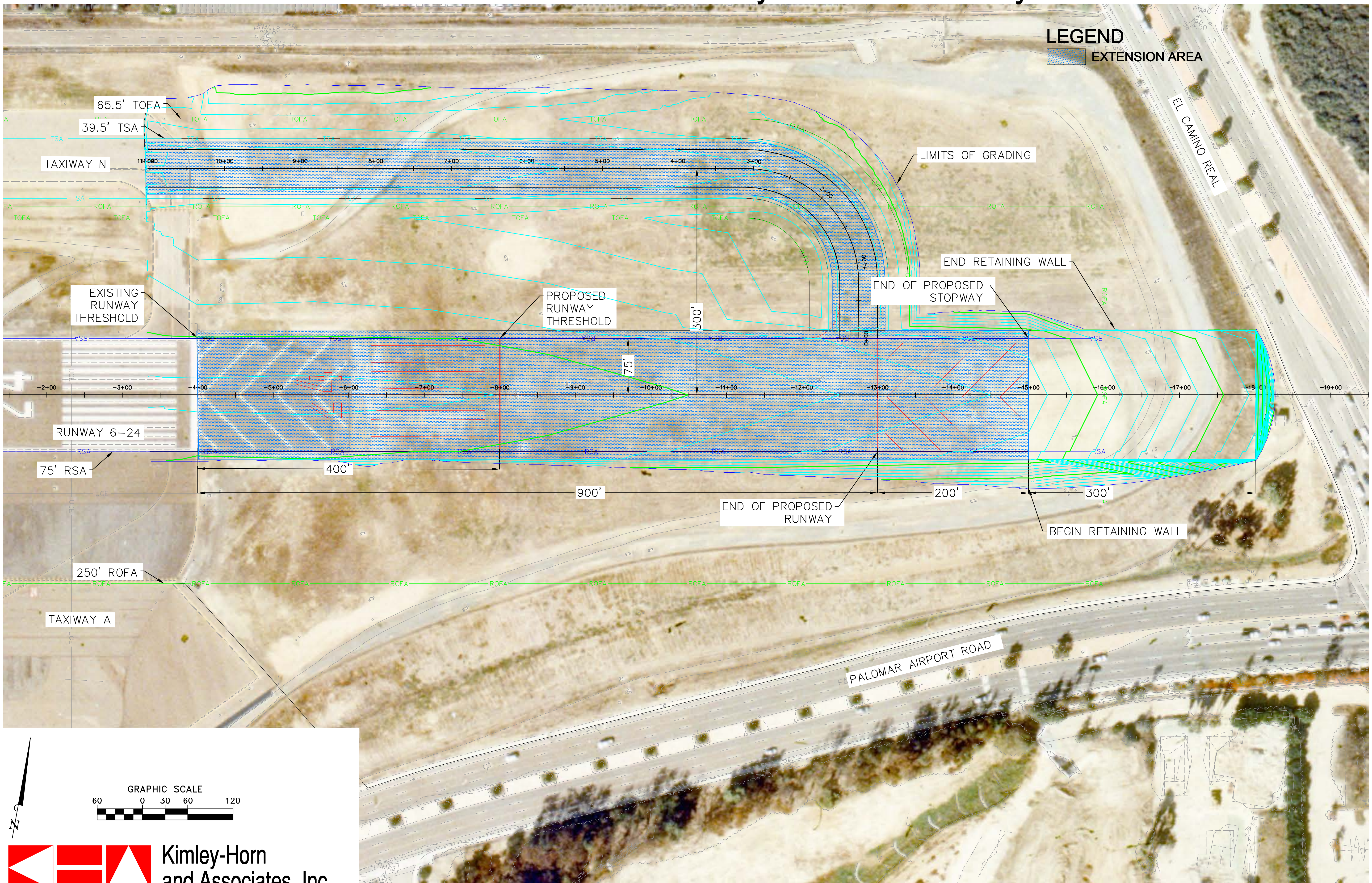

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FIGURE 5D: Alternative B - 900' Extension of Runway 6-24, Taxiway N, and Taxiway A

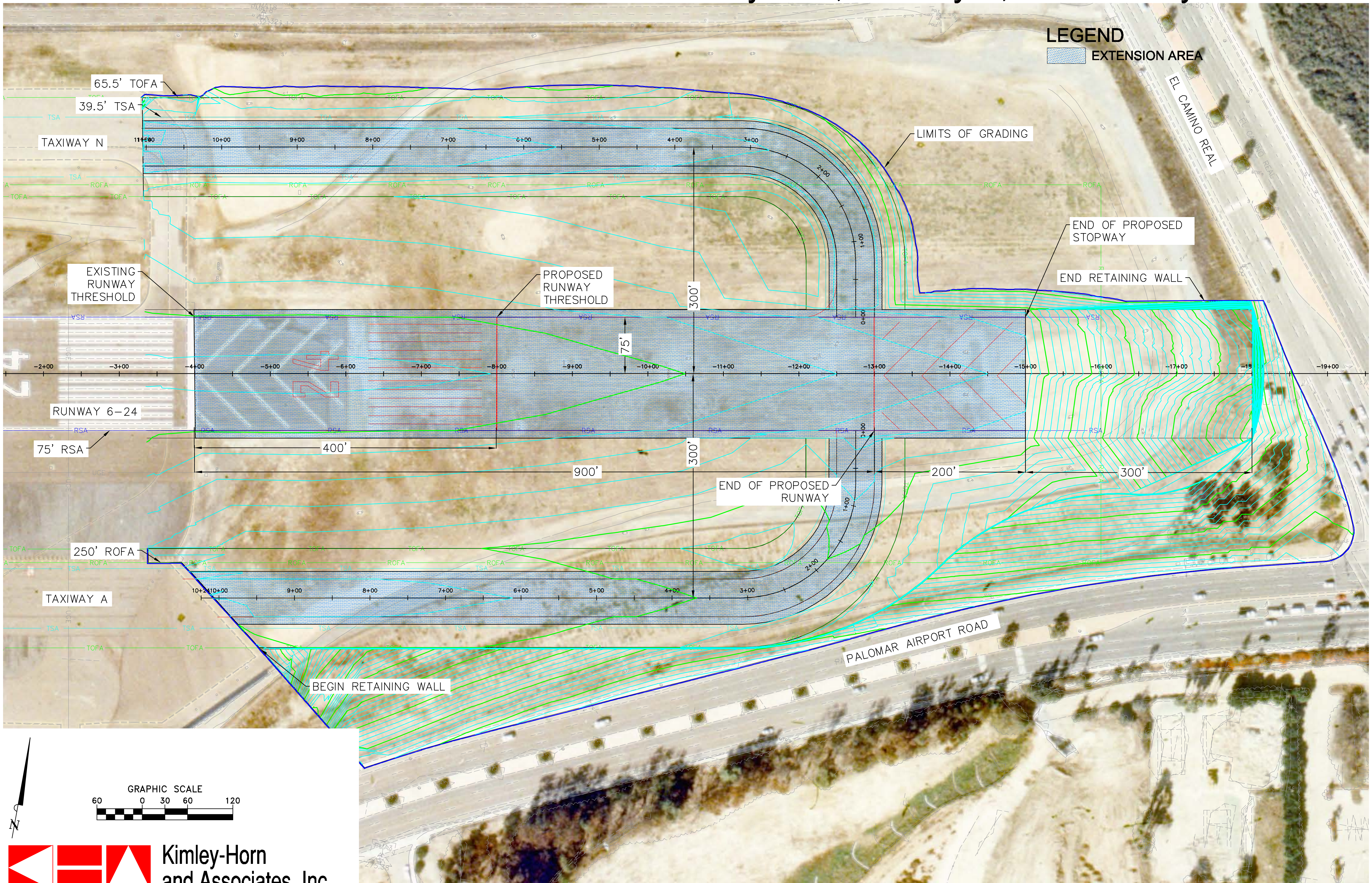

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TABLE 5C
East Side Runway Improvements
Alternative B – 900’ Extension of Runway 6-24 and Taxiway N

McClellan - Palomar Airport Runway Extension Alternatives B-II Runway, 900' Extension, North Taxiway Only				
Item	**Unit**	**Unit Cost**	**Quantity**	**TOTAL**
Pavement	LS	$ 3,320,100	1	$ 3,320,100
Embankment	CY	$ 50	46,323	$ 2,316,200
Pavement Markings	LS	$ 20,700	1	$ 20,700
Retaining Wall	SF	$ 71	25,358	$ 1,800,418
Electrical	LS	$ 2,300,000	1	$ 2,300,000
Structural Improvements	LS	$ 17,669,200	1	$ 17,669,200
Drainage	LS	$ 598,600	1	$ 598,600
Methane Extraction	LS	$ 711,300	1	$ 711,300
Revegetation	AC	$ 1,500	10	$ 15,000
Subtotal				$ 28,751,600
25% Contingency				$ 7,187,900
TOTAL CONSTRUCTION				**$ 35,939,500**
Engineering		$ 35,939,500	8%	$ 2,875,200
Administrative Mgmt		$ 35,939,500	22%	$ 7,906,700
Construction Mgmt		$ 35,939,500	8%	$ 2,875,200
TOTAL SOFT COSTS				**$ 13,657,100**
TOTAL ESTIMATE				**$ 49,596,600**

TABLE 5D
East Side Runway Improvements
Alternative B – 900' Extension of Runway 6-24, Taxiway N, and Taxiway A

McClellan - Palomar Airport Runway Extension Alternatives B-II Runway, 900' Extension, North & South Taxiways				
Item	**Unit**	**Unit Cost**	**Quantity**	**TOTAL**
Pavement	LS	$ 4,062,900	1	$ 4,062,900
Embankment	CY	$ 50	151,746	$ 7,587,400
Pavement Markings	LS	$ 26,600	1	$ 26,600
Retaining Wall	SF	$ 71	42,050	$ 2,985,600
Electrical	LS	$ 2,800,000	1	$ 2,800,000
Structural Improvements	LS	$ 21,458,100	1	$ 21,458,100
Drainage	LS	$ 746,000	1	$ 746,000
Methane Extraction	LS	$ 711,300	1	$ 711,300
Revegetation	AC	$ 1,500	17	$ 25,500
Subtotal				$ 40,403,400
25% Contingency				$ 10,100,850
TOTAL CONSTRUCTION				**$ 50,504,300**
Engineering		$ 50,504,300	8%	$ 4,040,400
Administrative Mgmt		$ 50,504,300	22%	$ 11,111,000
Construction Mgmt		$ 50,504,300	8%	$ 4,040,400
TOTAL SOFT COSTS				**$ 19,191,800**
TOTAL ESTIMATE				**$ 69,696,100**

ALTERNATIVE C – 6,100' Runway (1,200' extension, B-II)

Alternative C consists of a 1200 foot extension of Runway 6-24 with a displaced threshold of 800 feet for a total runway length of 6,101 feet. In order to minimize the impact to the surrounding community by the approach surface, while still maintaining the required landing length determined in Chapter 4 (5,000ft), a displaced threshold was introduced. With the introduction of a displaced threshold a longer departure runway length (6,101ft) can be provided while maintaining the runway safety areas using a declared total landing distance available.

The location of the displaced threshold in Alternative B is located 400 feet east of the existing threshold, the resulting shift in the approach surface will reduce the obstructions as the office building on the corner of Palomar Airport Road and El Camino Real would now only be partially within the RPZ, but remain outside the central portion of the RPZ. The added length in this alternative would designate the runway as a C-III runway, but for the airport to be classified as C-III additional improvements would need to be made to the taxiway systems.

As with the other alternatives, this option would allow the approach light system to be relocated and use the existing foundations for all but the last two stations.

Runway Extension Alternative C proposes an extension of Taxiway N to the proposed end of Runway 6-24 with two connecting taxiways, one at the existing threshold and one that lies 152 feet to the east. However, in order to achieve the C-III 400 foot centerline to centerline separation requirement, this option would require Taxiway N to be shifted 100 feet to the north and Taxiway A to be relocated 100 feet to the south.

Shifting Taxiway A 100 feet to the south would put the existing buildings (hangars, terminal, fixed base operators) within 9.2 feet of the resulting Taxiway Object Free Area. This action would eliminate any potential/existing apron parking or tie downs. Likewise, the 100 foot shift of Taxiway N to the north would completely eliminate the existing parking apron on the north side of the airport. In addition, the electrical vault, fuel storage, and navigation aids on the north side would require relocation. In summary, the horizontal constraints required for a C-III designation would be a major undertaking and costly alternative.

Alternative C also proposes an additional set of new taxiways on the south side of the runway. These taxiways would mirror the lengthening of Taxiway N to the proposed end of Runway 6-24 and the two new connecting taxiways as well.

In light of the added improvements associated with the C-III ARC, it has been determined that the airport will remain a B-II facility regardless of the length of the runway extension.

Alternative C would bring the overall runway length to just over 6,100 feet, which would allow nearly all of the aircraft that use the facility to take off at 90 percent useful load. However, the full extension of Taxiway A would require additional infrastructure improvements as it would have a severe impact on Palomar Airport Road. Either roadway realignment with property acquisition and intersection relocation or a bridge spanning over the road would be required with this option.

A significant portion of Runway Extension Alternative C would have to be built on top of existing landfill material. Several structural improvement options have been explored to mediate the effects of the landfill on the runway extension. Any of these options would provide a stabilized base for the runway extension to be built on top of. The Landfill Mitigation Options described later in this chapter show additional details about the structural improvement alternatives.

In order to accommodate the proposed runway extension and provide grades within AC requirements, a retaining wall would need to be built to the south and east of the proposed Runway 6-24. This wall would be approximately 1,150 feet long and 35 feet tall at its highest point. If it is constructed, the wall will minimize the impact to El Camino Real, requiring no roadway realignment or intersection relocation unless Taxiway A was to be fully extended as well.

If Taxiway A is to be fully extended as well, a massive retaining wall would be need to be built all the way from the southwest side of Taxiway A to the northeast side of Taxiway N, basically around the entire half of the airfield. This wall would need to be more than 3,000 feet long and 45 feet tall its highest point. Building a bridge over Palomar Airport Road would necessitate a much smaller wall (similar to the one that would be built without the extension of Taxiway A), significantly less land acquisition, and no realignment of the existing roadway, but construction of such a bridge would severely impact the community around the airport and be extremely expensive as well.

If Taxiway A is only to be relocated south for the sake of meeting the centerline separation requirements, no roadway realignment or intersection relocation would be required. Unfortunately, a retaining wall would still be needed to accommodate the additional length of Runway 6-24 and the north extension of Taxiway N and minimize the impacts to El Camino Real. A much smaller wall may also be required to alleviate some of the effects of the project to Palomar Airport Road.

As with the west side improvements, Alternative C would also include the installation of new drainage facilities and re-vegetation of the project area. This alternative would also require extensive mitigation and possibly reconstruction of the existing methane extraction system.

The proposed layouts of Runway Extension Alternative C are shown in **Figures 5E** and **5F**. Cost estimates for these options are shown in **Tables 5E**, **5F**,

FIGURE 5E: Alternative C - 1200' Extension of Runway 6-24 and Taxiway N

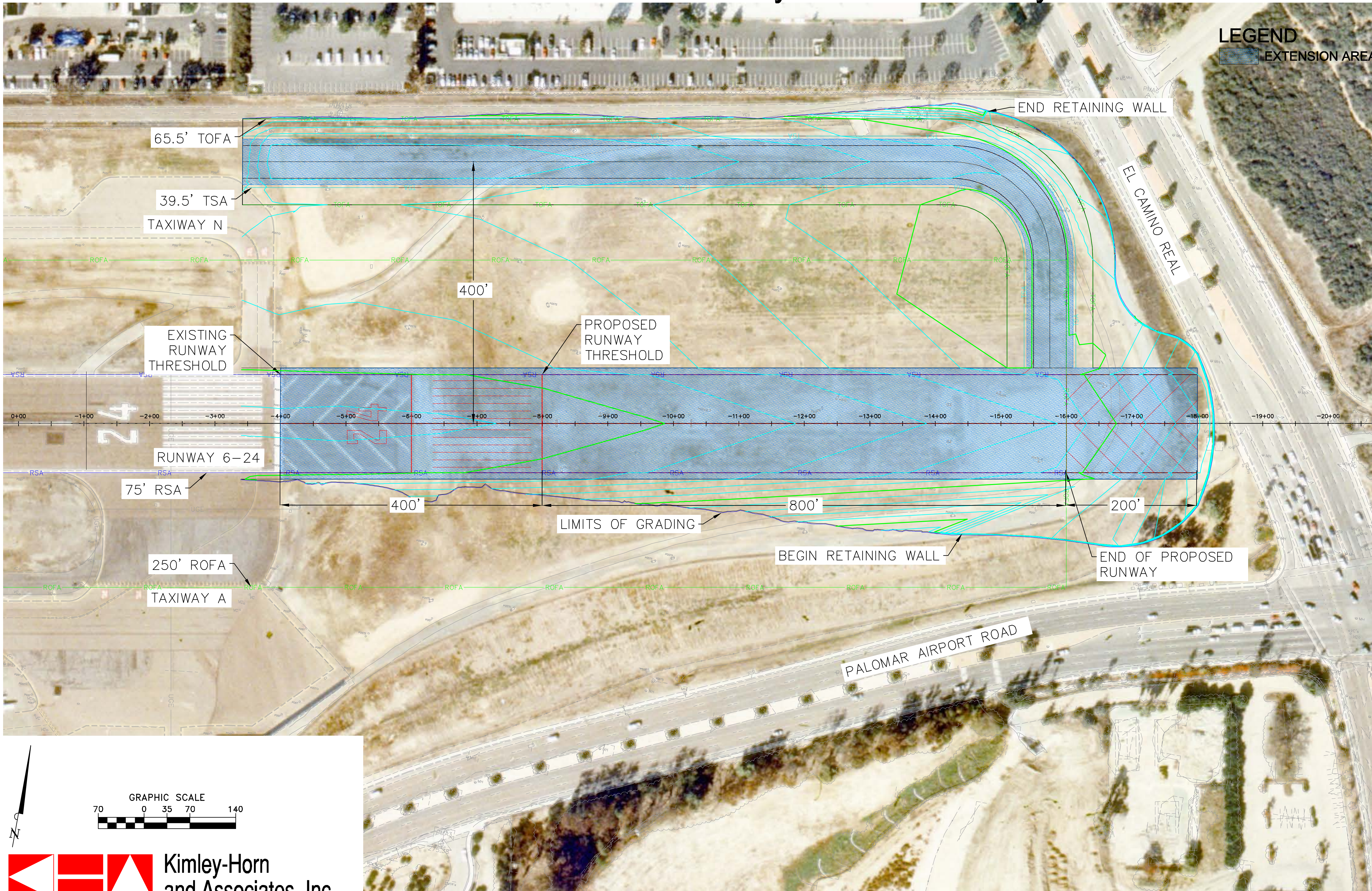

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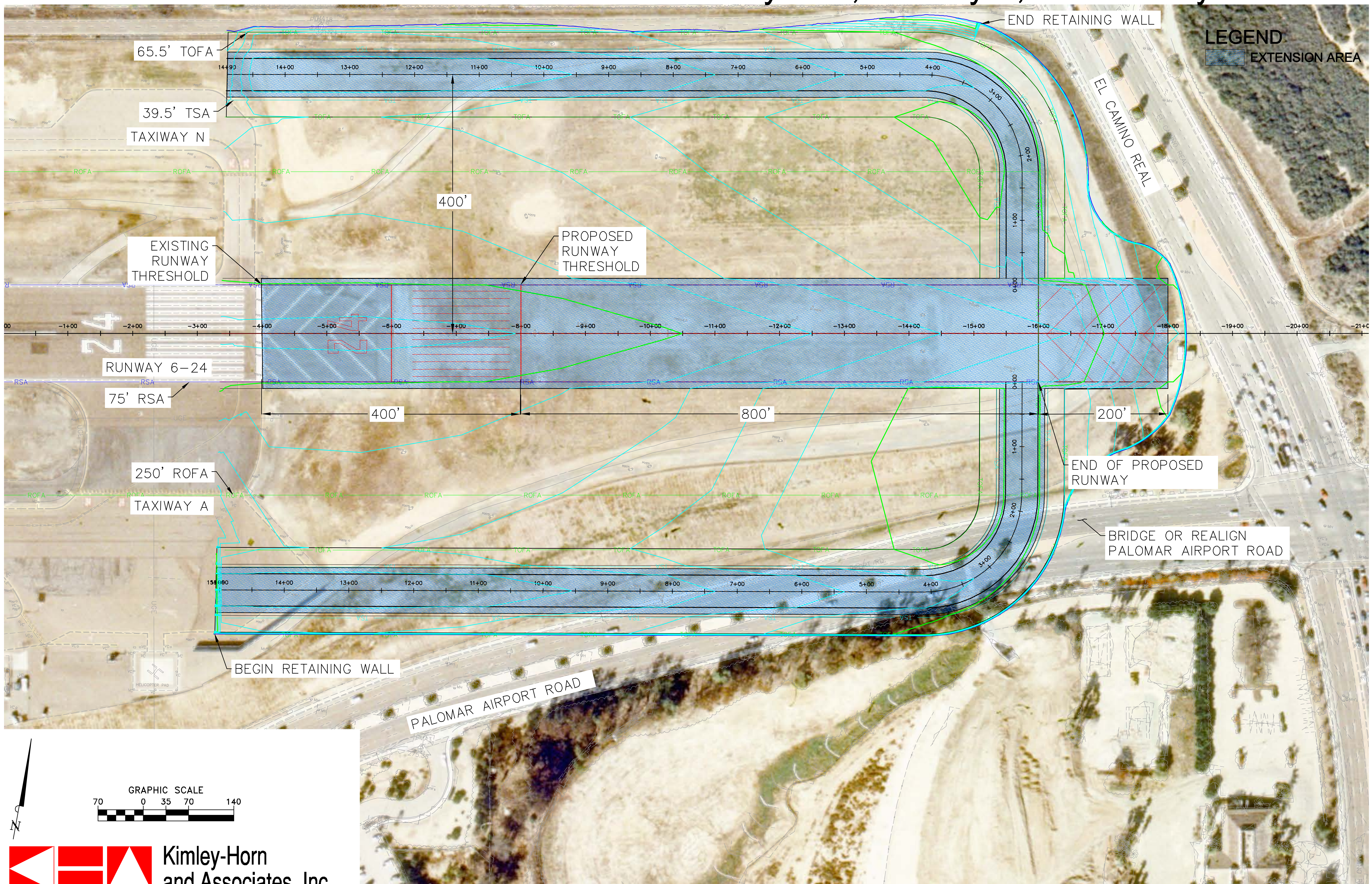
FIGURE 5F: Alternative C - 1200' Extension of Runway 6-24, Taxiway N, and Taxiway A



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and **5G**. **Table 5E** estimates the cost of extending Runway 6-24 and Taxiway N only. **Table 5F** also accounts for the full-length extension of Taxiway A and the realignment of Palomar Airport Road. **Table 5G** takes into consideration the full length extension of Taxiway A and the construction of a bridge over Palomar Airport Road. These estimates were developed using cost information from past project bid tabs, construction estimates, and through discussions and estimates provided by southern California contractors. As with Alternatives A and B, improvements to the east side of the runway are recommended in addition to the proposed safety upgrades on the west side.

TABLE 5E
East Side Runway Improvements
Alternative C – 1200' Extension of Runway 6-24 and Taxiway N

McClellan - Palomar Airport Runway Extension Alternatives				
C-III Runway, 1200' Extension, North Taxiway Only				
Item	**Unit**	**Unit Cost**	**Quantity**	**TOTAL**
Pavement	LS	$ 4,257,200	1	$ 4,257,200
Embankment	CY	$ 50	55,648	$ 2,782,500
Pavement Markings	LS	$ 25,200	1	$ 25,200
Retaining Wall	SF	$ 71	25,358	$ 1,800,500
Electrical	LS	$ 2,300,000	1	$ 2,300,000
Structural Improvements	LS	$ 22,617,400	1	$ 22,617,400
Drainage	LS	$ 910,800	1	$ 910,800
Methane Extraction	LS	$ 824,100	1	$ 824,100
Revegetation	AC	$ 1,500	11	$ 16,500
Subtotal				$ 35,534,200
25% Contingency				$ 8,883,550
TOTAL CONSTRUCTION				**$ 44,417,800**
Engineering		$ 44,417,800	8%	$ 3,553,500
Administrative Mgmt		$ 44,417,800	22%	$ 9,772,000
Construction Mgmt		$ 44,417,800	8%	$ 3,553,500
TOTAL SOFT COSTS				**$ 16,879,000**
TOTAL ESTIMATE				**$ 61,296,800**

TABLE 5F
East Side Runway Improvements
Alternative C – 1200' Extension of Runway 6-24, Taxiway N, and Taxiway A Realignment of Palomar Airport Road

McClellan - Palomar Airport Runway Extension Alternatives C-III Runway, 1200' Extension, Realign Palomar Airport Road				
Item	**Unit**	**Unit Cost**	**Quantity**	**TOTAL**
Pavement	LS	$ 5,344,100	1	$ 5,344,100
Embankment	CY	$ 50	438,490	$ 21,924,600
Pavement Markings	LS	$ 36,900	1	$ 36,900
Retaining Wall	SF	$ 71	112,833	$ 8,011,200
Electrical	LS	$ 3,100,000	1	$ 3,100,000
New Property	LS	$ 280,598,500	1	$ 280,598,500
Structural Improvements	LS	$ 28,418,100	1	$ 28,418,100
Drainage	LS	$ 3,988,100	1	$ 3,988,100
Methane Extraction	LS	$ 824,100	1	$ 824,100
Revegetation	AC	$ 1,500	19	$ 28,500
Subtotal				$ 352,274,100
25% Contingency				$ 88,068,525
TOTAL CONSTRUCTION				**$ 440,342,700**
Engineering		$ 440,342,700	5%	$ 22,017,200
Administrative Mgmt		$ 440,342,700	15%	$ 66,051,500
Construction Mgmt		$ 440,342,700	5%	$ 22,017,200
TOTAL SOFT COSTS				**$ 109,340,800**
TOTAL ESTIMATE				**$ 546,703,100**

TABLE 5G
East Side Runway Improvements
Alternative C – 1200’ Extension of Runway 6-24, Taxiway N, and Taxiway A
Bridge Over Palomar Airport Road

McClellan - Palomar Airport Runway Extension Alternatives C-III Runway, 1200' Extension, Bridge Over Palomar Airport Road				
Item	**Unit**	**Unit Cost**	**Quantity**	**TOTAL**
Pavement	LS	$ 5,311,400	1	$ 5,311,400
Embankment	CY	$ 50	49,473	$ 2,473,700
Pavement Markings	LS	$ 36,900	1	$ 36,900
Retaining Wall	SF	$ 71	25,358	$ 1,800,500
Electrical	LS	$ 3,100,000	1	$ 3,100,000
New Property/Bridge	SF	$ 500	133,958	$ 66,979,000
Structural Improvements	LS	$ 28,418,100	1	$ 28,418,100
Drainage	LS	$ 2,492,400	1	$ 2,492,400
Methane Extraction	LS	$ 824,100	1	$ 824,100
Revegetation	AC	$ 1,500	19	$ 28,500
Subtotal				$ 111,464,600
25% Contingency				$ 27,866,150
TOTAL CONSTRUCTION				**$ 139,330,800**
Engineering		$ 139,330,800	6%	$ 8,359,900
Administrative Mgmt		$ 139,330,800	20%	$ 27,866,200
Construction Mgmt		$ 139,330,800	6%	$ 8,359,900
TOTAL SOFT COSTS				**$ 44,586,000**
TOTAL ESTIMATE				**$ 183,916,800**

LANDFILL MITIGATION OPTIONS

SITE IMPROVEMENT DESCRIPTION

McClellan-Palomar Airport (Airport) is partially constructed over a former municipal solid waste (MSW) landfill containing three distinctive fill areas identified as Unit 1, Unit 2, and Unit 3 from west to east respectively. Units 1 and 2 are located south of Runway 6-24 and Unit 3 is located at the east end of Runway 6-24. A typical cross section of the finished runway surface over the existing landfill material is shown in **Figure 5G**. **Figure 5H** shows the approximate limits of Unit 3 of the landfill in relation to the runway extension alternatives. The layout and approximate cost of reconstruction for the methane extraction system are shown in **Appendix D**.

The project area, Unit 3 of the former MSW landfill, is currently a dirt surfaced portion of the Airport property. It is bounded by El Camino Real on the east, Palomar Airport Road to the south, commercial properties to the north, and Runway 6-24 to the west. Fill slopes from past landfill operations along the eastern and southern property boundaries outline the limits of Unit 3. Within this area, current improvements include the Unit 3 methane gas extraction system. This system consists of gas extraction wells, header piping, and condensate pumps. Other existing improvements in the project area include airport lighting systems and the associated underground utility conduits.

Three alternatives (A, B, and C) for the proposed airfield improvements are presented in this document. All three include an extension of Runway 24 to the east over Unit 3 of the former landfill and the extension of Taxiway N to the north of the runway over Unit 3. Alternatives A and B also include the extension of Taxiway A to the south of the runway. Alternatives B and C include retaining walls along the southern and eastern limits of the airfield. The following is a brief description of the proposed airfield improvement alternatives:

Alternative A: 200-ft extension of Runway 6-24, Taxiway N, and Taxiway A.

Alternative B: 900-ft extension of Runway 6-24, Taxiway N, and Taxiway A.

Alternative C: 1,200-ft extension of Runway 6-24 Taxiway N.

Figures 5B-F depict the alternatives that have been evaluated.

The continued settlement of the existing landfill presents development challenges for the Airport. Runway surfaces require smooth pavements for safe operations. FAA Advisory Circular No. 150/5370-10F sets pavement smoothness tolerances for finished surfaces at 1.56%, ¼” over 16-ft. When this tolerance is exceeded pavement rehabilitation and/or replacement becomes necessary. Therefore, any of the airfield improvement alternatives will need to account for differential settlement over

FIGURE 5G: Typical Runway Cross Section

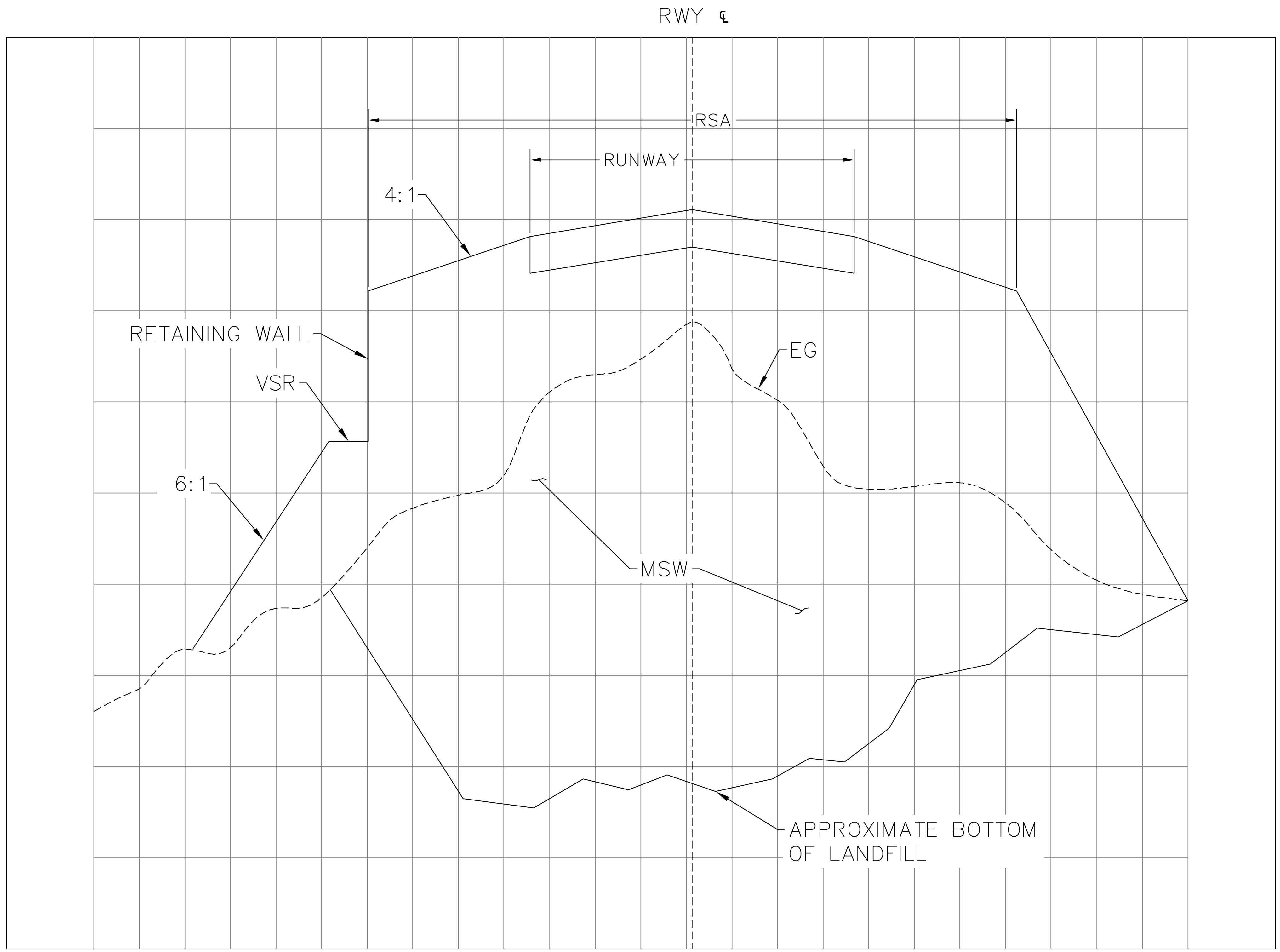

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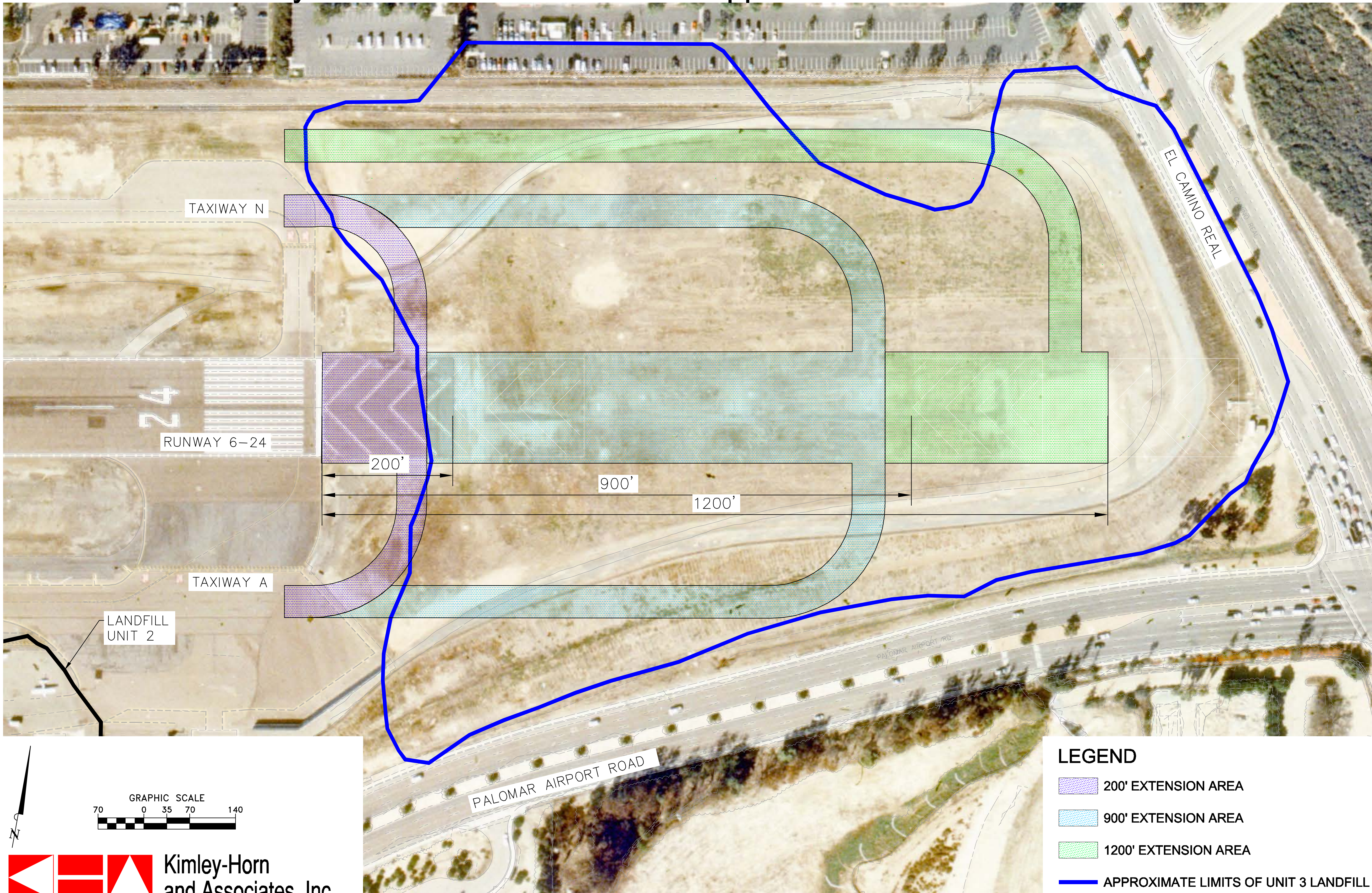
FIGURE 5H: Runway Extension Alternatives and Approximate Location of Landfill



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any improvements that are constructed over the existing landfill.

Site/Landfill Background

The Palomar Airport Sanitary Landfill operated from 1962 to 1975. The County of San Diego has estimated that Unit 1 operated from 1962 to 1968; Unit 2 operated from 1968 to 1972 and Unit 3 operated from 1972 to 1975. The area, volume of fill and depth of fill have been calculated for each landfill unit based on comparison of topographic maps. Topographic changes corresponding to the filling of each Unit were documented between 1949-1963, 1963-1975 and 1975-1990. The estimated area and volume of fill for each landfill Unit are summarized below:

Landfill Unit	Area (acres)	Volume (cubic yards)
1	9	214,000
2	5	195,000
3	19	697,000

Based on records from the California Water quality Control Board (CWQCB) (CWQCB, 1996), the amount of municipal solid waste that was accepted at the landfill ranged from 30 to 50 tons per day up to a maximum of 200 tons per day. The majority of this waste consisted of residential waste. The site is also known to have accepted commercial, industrial, agricultural and pathological waste as well as treated sewage sludge.

The landfill is currently classified as an inactive (closed) Class III MSW landfill. CWQCB estimated that the Unit 3 landfill occupies approximately 19 acres and includes approximately 697,000 cubic yards of MSW. A previous report related to the landfill states that "The landfill was constructed without a liner, and does not have a leachate collection or removal system", (Geosyntec, 2005).

A comparison of topographic mapping from 1963, pre-landfill, with mapping from 2011 indicates that the depth of MSW fill below the limits of the proposed airfield improvements ranges from 6-ft to 45-ft to the bottom of the MSW material.

Airfield Stabilization Analysis

Due to the existing and future settlement of the landfill materials within Unit 3, ground stabilization is required for any airfield improvements constructed over the landfill area. Various ground stabilization methods exist that have been implemented on similar highway, runway, and site development projects. The airfield stabilization analysis included these methods as well as historical documentation of the landfill operations, a review of technical literature and articles, specific case studies, published design manuals, previous soil investigation reports, correspondences with local contractors, and the findings and conclusions presented in the recent *Geotechnical Feasibility Study, Runway 6-24 Extension McClellan-Palomar Airport Carlsbad, California* dated November 14, 2012 prepared by Ninyo & Moore.

Settlement Estimations & Landfill Consistency

Based on the findings presented in the Ninyo & Moore report, the estimated future settlement due to biodegradation that will occur within Unit 3 of the landfill ranges from 2.7-ft to 3.8-ft over approximately 40 years depending on the depth of landfill material. There will also be settlement of approximately 0.7-ft to 0.9-ft due to residual creep/void filling over the design life of the runway extension (20 years). These values are consistent with previous estimates prepared by others (SCS, 2010).

Borings performed by Ninyo & Moore show blow counts ranging from 12 to over 50 blows per foot at depths within the MSW material. The majority of these values were above 30. The analysis of the earlier boring data by others is consistent with these recent findings and supports the previous conclusion that the landfill properties are relatively consistent; appear to be moderately to well compacted, and moderately to well-decomposed (SCS, 2010).

A number of settlement mitigation options were analyzed for the proposed airfield improvements over Unit 3 of the landfill. This analysis uses the proposed airfield improvement geometric parameters for the various alternatives being considered. Ground improvement stabilization will occur below the limits of the runway, taxiway and where required for retaining walls.

The following list includes the conceptual settlement mitigation options considered:

Structural Options:
- Conventional Bridging of Landfill (elevated structure)
- Structural slab supported by driven piles

Soil Improvement Options:
- Fill supported on Stone Columns (vibro-compaction)
- Fill Supported on Drilled displacement columns
- Accelerated settlement by surcharging
- Deep Dynamic Compaction
- Injection grouting (compaction or slurry grouting)
- MSW excavation & backfilling

Maintenance Options:
- Placing lightweight fill to grade with periodic AC overlays
- Placing standard fill to grade with periodic AC overlays

The maintenance options were excluded from consideration as they do not provide a viable, long-term solution to the settlement problem. Any of the structural and/or soil improvement options would require a detailed geotechnical investigation strategy during final design. The options for supporting the airfield improvements include those that were determined to be the most viable to meet the needs of the projects. For comparison purposes the 900-ft long runway extension, Alternative B, has been used for the following options:

Option 1: Structural Slab Supported on Driven Piles (Figure 5I)

This option includes bridging the landfill material by constructing a structural concrete slab supported on steel pipe or precast/prestressed concrete driven piles. The piles would extend through the landfill materials to bear on competent formational materials. Preliminary pile layouts have the piles spaced at 10-ft on center transversely to the runway/taxiway centerlines with 20-ft spans along the lengths of the runway/taxiway. The piles would extend above existing grade to the elevation of the structural slab. The area around the exposed piles would be filled with lightweight cellular concrete to the bottom of structural slab elevation. This would provide support (ie, falsework) for the construction of the reinforced structural slab while creating a lateral restraint between the piles. Based on existing survey and mapping of the site, the thickness of the space to be filled with cellular concrete is estimated to vary from approximately 3-ft to 15-ft.

The use of a driven pile foundation system which penetrates the MSW essentially circumvents the concerns with the various components of landfill settlement beneath the runway extension since the piles bear in material below the limits of the landfill. The structural slab is designed to span between the piles such that even if there is settlement between the piles, the slab will remain in-place and support the runway and taxiway loads.

The placement of the piles could be facilitated by pre-drilling the piles by means of a displacement auger. This approach would increase pile production while also adding an additional benefit of laterally compacting the soil around the displacement drill.

For the areas between the runway and taxiways, suitable fill materials would be placed to raise the grade to the desired elevation. Periodic fill and grading would be required to re-establish grade outside the limits of the runway and taxiways over time as settlement continues in this area.

Although this option for construction is feasible and viable, there are various design and construction considerations. Design considerations include the amount of additional force that will be imposed on the piles from down-drag created by the settling landfill materials. Construction may be hindered by difficult drilling conditions due to debris within the landfill. It would require full runway closures or night work and would require the existing methane gas collection system be re-constructed.

Production rates for the driven piles without pre-drilling would vary from 8 to 12 piles per 8 hour shift per pile driving rig. Therefore, the estimated timeframe required to place the driven piles for a 900-ft long by 150-ft wide runway section (135,000 ft2) is 65 days based on one 8 hour shift with one pile driving rig per day. Pre-drilling would increase product rates to between 12 to 14 piles per 8 hour shift per drilling/pile driving rig. A relatively flat 25-ft by 30-ft pad would be required for pile driving.

1) Advantages:
    a. Eliminates settlement issues.
    b. Use of lightweight concrete below the slab eliminates the need for temporary falsework for slab construction.
    c. Controlled placement of piles.
    d. No landfill excavation.
2) Disadvantages:
    a. High initial costs.
    b. Pile placement will have windows of night work only and therefore a longer construction schedule.
    c. Re-construction of methane gas collection system required.

Option 2: Drilled Displacement Columns (Figure 5J)

Drilled displacement columns (DDC) are a form of ground improvement used to increase the bearing capacity and stability of soils and to reduce settlement in compressible materials. DDC's, also referred to as controlled modulus columns (CMC) and/or controlled low-strength material (CLSM) columns are constructed using a drilling tool (partial flight auger or drilling bit mounted on the end of a displacement barrel or casing) that is advanced through the landfill material to the formational materials below. Drilling is advanced into the soil as a result of both the rotation of the drilling tool and the crowd (axial) force applied by hydraulic rams. During advancement, the tool pushes the soil out in a radial pattern creating a soil form as the soil around the tool is densified. Once the drilling tool reaches the desired depth, the sacrificial tip or end plate is released from the casing or displacement body. Use of an end plate and the bottom discharge concreting method precludes the need to pull the stem up prior to pumping and results in higher end bearing than other cast-in-place pile types. Concrete or grout that is placed through the casing as the drilling tool is extracted from the ground leaves an 18 to 24 inch diameter column. This method ensures no decompression of the soils. If required, reinforcement can be placed in the wet concrete/grout for added capacity. The lack of spoils removes risk of high costs and delays dealing with and disposing of contaminated soil.

The zones of improvement for the DDC's would include the area beneath the runway extension and the taxiways. The DDC's are installed in an equilateral triangular grid pattern with center to center spacing's of approximately 7.5-ft on center. Subsequent to DDC installation, fill soils reinforced with geogrid or lightweight fill material such as cellular concrete would be placed to raise the grade from original ground to required finished grade. The runway and taxiway surfaces would be composed of an asphalt concrete pavement section. Although the settlement due to biodegradation will still occur, the system of the DDC's overlain by a geogrid reinforced fill or lightweight fill would be designed to "bridge" any settlement between the columns. Furthermore, the installation process is anticipated to aid in the filling of subsurface voids, lessening the amount of settlement attributable to residual creep/consolidation.

The use of drilled displacement columns installed through the landfill material is considered a viable option for the airfield improvements. The DDC's eliminates the need to address the mechanisms of landfill settlement by penetrating the landfill material and bearing on formational materials.

Production rates for the DDC's would very between 800 and 1,200 linear feet per 8 hour shift. The estimated timeframe required to place the DDC's for a 900-ft long by 150-ft wide runway section (135,000 ft2) is 68 days based on one 8 hour shift with one rig per day. A relatively flat pad capable of supporting a tracked rig with approximately 15 psi tack pressure would be required. The existing methane gas collection system would need to be re-constructed.

1) Advantages:
   a. Almost entirely eliminates settlement issues.
   b. Low initial cost.
   c. Placement of drilled displacement columns increases the strength and stiffness of the surrounding material increasing bearing capacity.
   d. Controlled placement of columns.
   e. Minimal spoils from placement of columns.
   f. The soil/lightweight fill layers will help bridge potential localized settlement.
   g. No landfill excavation.
2) Disadvantages:
   a. Drill rig would impact airport operations requiring night work or full airport closure.
   b. Re-construction of methane gas collection system required.

Option 3: Injection Grouting (Compaction Grouting) (Figure 5K)

Similar to Option 2, Option 3 is a form of ground improvement used to increase the bearing capacity and stability of soils and to reduce settlement. Injection grouting (compaction grouting) involves the injection of low slump grout under pressure into the landfill materials creating elliptical "bulbs". Installation into the subsurface occurs at various elevations to create the bulb shape grout column within the underlying mass. The columns are placed in a specified horizontal grid pattern composed of a primary, secondary, and tertiary injection locations developed for the specific area being improved. As the grout bulb expands while being injected it compacts the surrounding material. This compaction creates zones of stiffer material between grout bulbs. A further benefit of the grout injections is that while being injected the grout will fill any voids present in the decomposing material that will lessen the amount of settlement associated with residual creep/consolidation.

The zone of improvement for the injections would include the area beneath the runway and taxiway improvements from the formational soils below the MSW material to the existing ground surface. Current estimates include installation of the grout through deep injection points spaced at approximately 8 feet on center.

Subsequent to the grout injections, fill soils reinforced with geogrid would be placed to raise the grades to the required elevations for the runway and taxiway improvements. The runway and taxiway surfaces would be composed of an asphalt concrete pavement section. As with Options 1 and 2, suitable fill materials would then be used to raise the grade along the sides of the extended portion of the runway.

The estimated timeframe required to treat the landfill material with injection grout for a 900-ft long by 150-ft wide runway section (135,000 ft^2) is 62 days based on one 8 hour shift with one drilling rig per day.

1) Advantages:
    a. Reduces settlement issues.
    b. Use of geogrid reinforced soil layers will help bridge potential localized settlement.
    c. No landfill excavation.
    d. No spoils from installation.
2) Disadvantages:
    a. Re-construction of methane gas collection system required.
    b. Potential for localized settlement between locations of injections.
    c. Difficult to determine quantities of injection grout needed based on limited knowledge of potential voids.
    d. Potential global settlement of decomposing materials.

Option 4: MSW Excavation

Option 4 entails the excavation and removal of the landfill materials from below the airfield improvements. The trapezoidal prisms below the runway and taxiways would be excavated to the formational material. Handling and disposal of the MSW material would be strictly regulated. Approximately 255,000 cubic yards of landfill material would need to be excavated and disposed of for Alternative B. Suitable fill material would then be hauled in and placed to re-establish grade. The runway and taxiway surfaces would be composed of an asphalt concrete pavement section.

Excavation of the site would include permitting and coordination with multiple regulatory agencies. Approximately 60 trucks per 8 hr shift are anticipated to be able to enter and exit the site during day-time work. The frequency of trucks entering and exiting the site during night-time work is anticipated to drop to approximately 40 per 8 hr shift. The estimated timeframe required to excavate and haul the existing landfill material for a 900-ft long by 150-ft wide runway section accounting for 2:1 slopes on the excavation pit (175,000 ft^2) is 243 days assuming average depth of landfill being 25-ft deep and using an average of 720 cubic yards a day being excavated with day-time work shifts.

1) Advantages:
    a. Removes landfill material from site.
    b. Eliminates long-term settlement issues.
2) Disadvantages:
    a. High excavation and disposal costs.
    b. Special permitting required.
    c. Longest construction duration.

Airfield Stabilization Cost Comparisons

Cost estimates for the various airfield stabilization alternatives were developed utilizing cost information gathered from past project bid tabs, construction estimates, and through discussions and budgetary estimates provided by local contractors located in southern California. The depth and quantity of ground improvement required for each alternative was estimated by comparing historical topography and contour maps of the site pre-landfill and with current survey and mapping of the airport property provided by the client. Appendix B includes cost data and detailed quantity calculations used. The following table summarizes the approximately cost per square foot of airfield improvements for the runway and taxiways.

Table Z – Airfield Stabilization Costs

Option	Method	Cost
1a	Driven Steel Piles	$121/ft^2$
1b	Displaced Driven Concrete Piles	$109/ft^2$
2	Drilled Displacement Columns	$72/ft^2$
3	Injection Grouting	$70/ft^2$
4	MSW Excavation	$207/ft^2$

The above unit costs include the cost for the ground improvements, fill material to grade, and structural concrete slabs and/or asphalt concrete pavement where applicable. They do not include the cost of the reconstruction of the methane gas recovery system, or the general fill material that would be required between the runway and taxiways where applicable. These costs were developed to compare the various ground improvement techniques available. Full airfield improvement costs are included in the beginning of this chapter report.

Recommended Alternative for Airfield Stabilization

Selection of a ground improvement method for the airfield stabilization should address current and future settlement of the MSW materials, construction impacts to airport operations, as well as initial and future lifecycle costs. Taking this into consideration, the recommended alternative for the airfield stabilization are drilled displacement columns supporting lightweight fill and an asphalt concrete pavement section. DDC's provide a cost effective ground improvement option for increasing the bearing capacity and load transfer capabilities of the underlying materials while reducing the potential for future settlement of the airfield. Comparisons of the options are included in Table **6B**.

Retaining Walls (Alt B & C)

El Camino Real and Palomar Airport Road are located along the eastern and southern limits of the Airport property respectively. For the full build-out of Alternatives B and C, retaining walls are required for supporting the southern taxiway and vehicle service road parallel to Palomar Airport Road. For Alternative 3 retaining walls are required parallel to Palomar Airport Road and El Camino Real. These areas include varying depths of MSW material below and within the retained portion of the walls. Initial proposals include the use of segmental retaining walls for these purposes. Segmental walls possess the ability to tolerate relatively small amounts of differential settlement. However, they are not designed to tolerate the large amounts of settlement that is associated with the landfill materials. Therefore, stabilization of the landfill material below the reinforced zone is required.

The retaining wall along the eastern portion of the airfield is anticipated to have an average height of approximately 15-ft and will be constructed above underlying landfill materials. The retaining wall along the southern limits is anticipated to be up to 50-ft tall with an average wall height of 28-ft. A portion of this wall is situated in front of the southern slope for the landfill. Based on this location, the reinforced zone for the southern segmental retaining wall would be outside the limits of the landfill and would not require stabilization. The remaining portion of the wall is located along the southern slope of the landfill. The depths of landfill material present within these limits varies from 5-ft to 30-ft. Due to the landfill material at this location, stabilization is required below the reinforced zone of the wall.

The stabilization methods for walls located over relatively deep layers of landfill material include drilled displacement columns or driven piles. For the locations with relatively shallow (4-ft to 6-ft) layers of landfill material injection grouting is considered to be an economical solution to provide the necessary bearing capacity for the walls.

Recommended Retaining Wall Stabilization Alternative & Costs

The recommended alternative for the retaining wall stabilization for either of Alternatives B or C is drilled displacement columns. The estimated cost, measured by square foot (ft^2) of face of wall, is $71/$ft^2$. This cost includes ground stabilization using drilled displacement columns below the reinforced zone of the MSE walls.

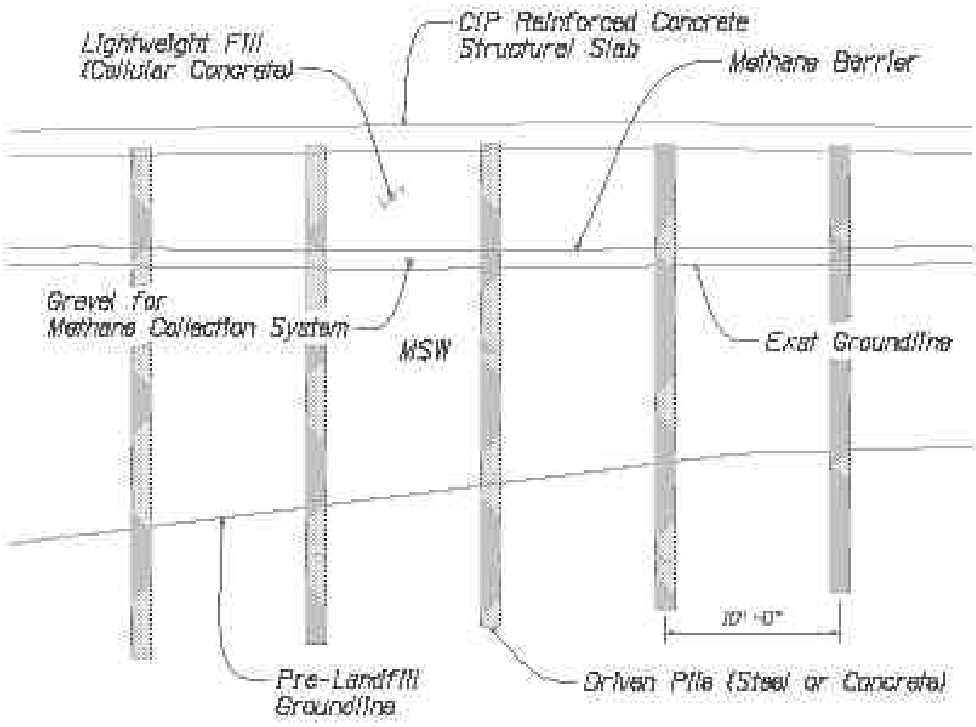


Figure 5I: Extension Option 1 - Elevated Sturcture

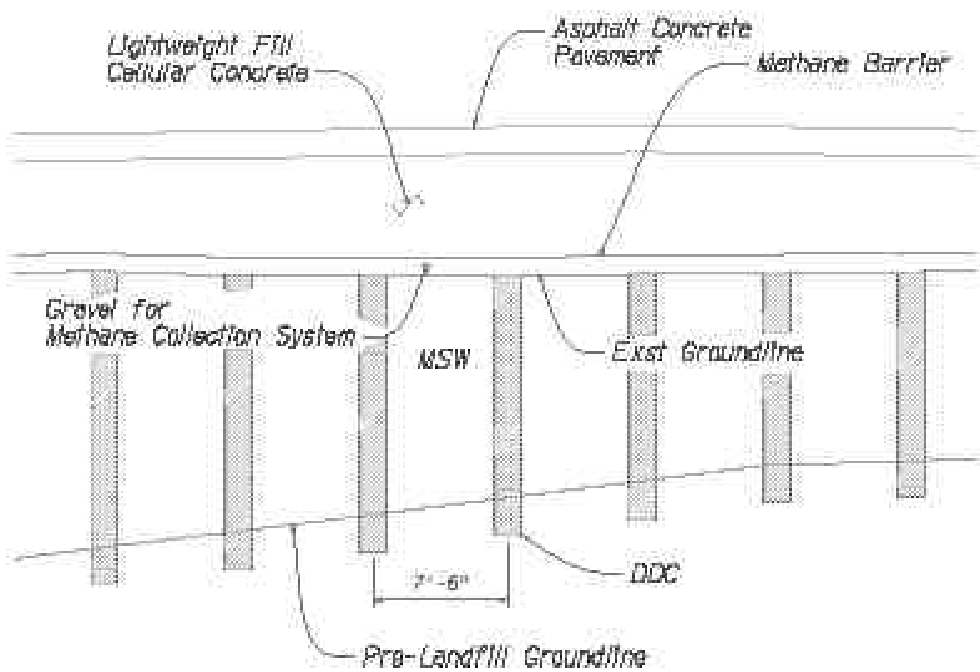


Figure 5J: Extension Option 2 - Drilled Displacement Columns

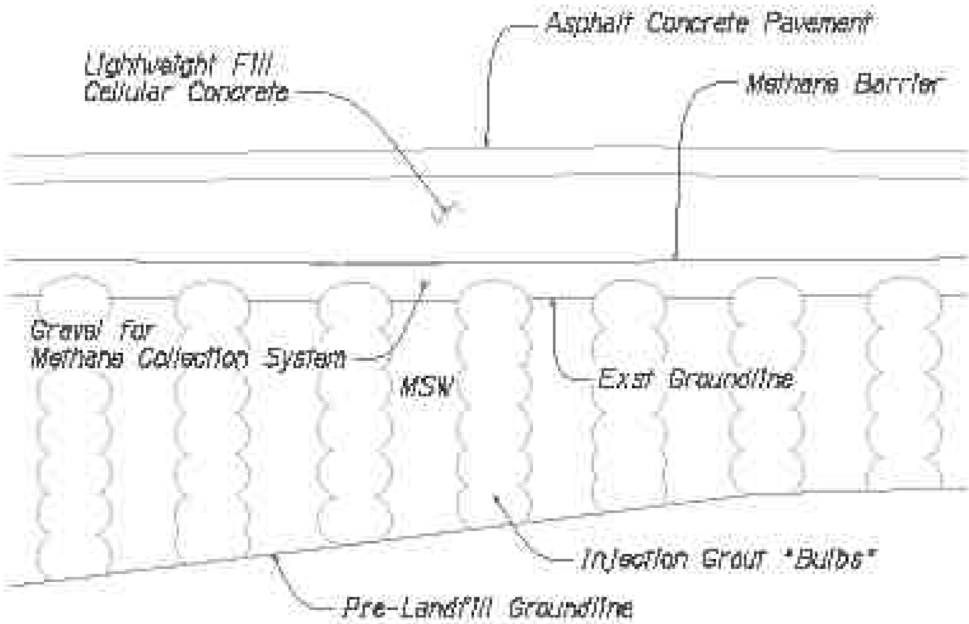
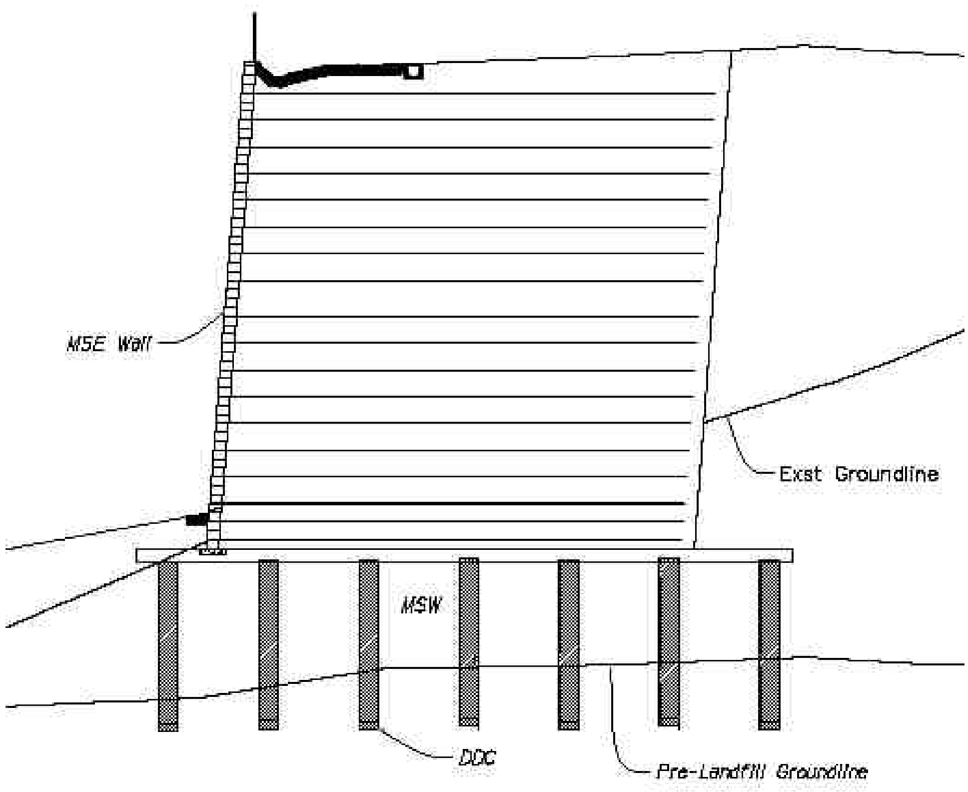


Figure 5K: Extension Option 3 - Deep Injections



Drilled Displacement Column/MSE Wall Typical Section

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Chapter Six
ALTERNATIVE ANALYSIS

In order to decide on a viable set of runway extension alternatives, there were four main criteria that needed to be considered. For the first requirement, the proposed runway extensions had to be technically feasible from an engineering perspective. Secondly, each of the suggested alternatives needed to be fiscally responsible. The third step was to determine whether or not each of the propositions made good business sense. Finally, only after the other criteria had all been satisfied, the last step was to ensure that the proposed runway extensions at McClellan-Palomar Airport would be eligible for funding by FAA programming criteria as defined in the Airport Improvement Handbook.

PRELIMINARY SELECTION

The first step in selecting a runway extension alternative was to devise a preliminary set of options that would be technically feasible. Each of these options had to actually be buildable using current technology, not just theoretically possible. Although the alternatives did not need to be fully designed, their basic layouts needed to be established in order to determine whether or not they would be acceptable for the next phase of the project. With very few exceptions, almost every one of the options that was considered during this exploratory phase of the project was deemed to be achievable. As long as the construction area remained confined to existing airport property on the west side of El Camino Real, there did not appear to be any potential issues with the technical feasibility of the project.

For the next step, the pool of technically feasible alternatives was narrowed down to verify which, if any of the options demonstrated fiscal responsibility. Not only did these alternatives have to be buildable, building them had to make sense financially. To complete this task, preliminary research was performed about the past usage data and projected future needs of the airport. Preparatory estimates were compiled for each of the proposed alternatives and the body of choices was condensed even further.

Based on the data that was uncovered in determining technical feasibility and fiscal responsibility, the next step was to confirm that each of the runway extension proposals made good business sense. After the costs of each alternative were weighed against the benefits, building these options had to make logical sense for the long term good of the airport. By this point, the pool of choices had been narrowed down to the three most viable runway extension options. The first option proposed that 200 feet be added to the runway, the second lengthened the runway by 900 feet, and the last was an extension of 1100 feet. Each of these selections was determined to be technically feasible, fiscally responsible, and made good business sense. Additional information about the suggested runway extension alternatives is shown in *Chapter 5 – Extension Alternatives, Landfill Mitigation Options and Safety Upgrades*.

The final step in the preliminary selection process was to ascertain which of the chosen alternatives would be eligible for funding by the FAA. To accomplish this task, additional research about some of the various landfill remediation options for the site was required. Until this research was complete, there would be no way to accurately assess which one of the alternatives best met the airport's runway needs.

LANDFILL REMEDIATION

As indicated in *Chapter 1 – Introduction*, A substantial portion of McClellan-Palomar Airport is built on top of a former landfill. The area underneath of the proposed runway extension contains close to 700,000 cubic yards of Municipal Solid Waste (MSW). This waste is mostly composed of residential waste, but the landfill is also known to contain commercial, industrial, agricultural, and pathological waste as well as sewage sludge. The area is classified as an inactive (closed) Class III MSW landfill, with no liner or leachate collection / removal system. However, it is equipped with a methane gas extraction system, consisting of wells, header piping, and pumps, which would need to be accounted for and either protected or replaced depending on which alternative was selected.

It was determined that the MSW landfill material underneath of the proposed runway extension would not be capable of supporting the weight of the aircraft that would be landing on it. In order to solve this problem, some kind of ground improvement stabilization would need to be performed underneath of the new runway, taxiways, and retaining walls wherever applicable. These stabilization options included but were not limited to the following: building a cantilever bridge over the landfill area, installing a structural slab supported by driven piles, structural fill supported by either stone or drilled displacement columns, accelerated settlement by surcharging, injection grouting, placing lightweight or standard fill to meet grade requirements with periodic asphalt overlays, and excavation and backfilling of the entire landfill area.

Although all of the aforementioned options were considered to be both technically feasible and fiscally responsible, the following alternatives were determined to best meet the project objectives: structural slab on driven piles, drilled displacement columns, injection grouting, and MSW excavation.

STRUCTURAL SLAB ON DRIVEN PILES

This option involves the construction of a concrete slab on grade supported by either steel or precast reinforced piles that have been driven all the way through the MSW landfill and into the formational material below. Once in place, these piles would be surrounded by lightweight concrete fill from the top of the existing surface to the bottom of the structural slab. The resulting structure would provide support for the runway surface while creating a rigid connection between the individual piles at the same time.

For the areas between the runway and taxiways, suitable fill materials would be brought in to raise the grade to the desired elevation. Although it would be required to a much smaller extent than it is today, periodic fill and grading would still be necessary to re-establish grade outside the limits of the runway and taxiways as the MSW material continues to decompose over time.

Although this approach is considered to be feasible for construction, there are some disadvantageous considerations must be accounted for. In addition to the requirement for periodic fill and grading, the landfill material will create a downward drag force on the bases of the columns as it settles. Construction of a structural slab on driven piles would require either full runway closures or night work as well. Drilling conditions in the MSW material may be complicated due to large portions of unforeseen debris in the landfill and the methane extraction system would either need to be protected, repaired, or completely rebuilt.

DRILLED DISPLACEMENT COLUMNS

Drilled displacement columns (DDCs) are constructed by advancing a drilling tool through the landfill and into the formational materials below. As it is advanced, the tool pushes the soil outwards, which creates a form and compresses the soil. Once the desired depth has been reached, the end plate of the drilling tool is released and abandoned. Concrete or grout is then pumped through the drilling tool as it is extracted from the ground, leaving a column in its place. If necessary, reinforcement can be placed inside of the wet column for added capacity.

After the columns have been installed, fill soils reinforced with layers of geogrid would be placed to raise the original ground to the required finished grade. This system of columns overlain by geogrid is expected to minimize the long term effects of the decomposing MSW. As with the previous option, suitable fill materials would still need to be placed to raise the grade to the desired elevation in the areas between the runway and taxiways, and periodic fill and grading would still be required over time, but not to the same extent that it would be with the structural slab option.

Installing drilled displacement columns through the landfill material is considered to be one of the most viable options for the airfield improvements. This method addresses the settlement of the landfill by penetrating all the way through the MSW material and transferring the bulk of the load to the formational materials below. Placing the DDCs does not require any landfill excavation; the columns increase the strength and stiffness of the material around them and using geogrid material keeps localized settlement at a minimum.

As with the structural slab option, there are some disadvantages associated with the drilled displacement columns method. For example, running the drill rig would have a significant impact on airport operations; either night work or full airport closure would be required. This method would most likely require reconstruction of the methane extraction system as well.

INJECTION GROUTING

The injection grouting process involves the creation of elliptical bulb-shaped columns within the landfill material by injecting grout directly into the soil through slotted tubes. These columns are built in a grid pattern that has been specifically designed for each location. As the grout expands, the material around it is compacted and zones of stiff material are created between the columns. This method will fill in the voids within the decomposing material as well, which will help to mitigate additional settlement in the area.

As with the previous two options, fill soils reinforced with geogrid would need to be placed to raise the original ground to the required finished grade underneath the runway and taxiways. Suitable fill materials would then be used to raise the grade along the sides of the extended runway and behind the retaining walls to the south and east of the runway.

Injection Grouting is considered to be a viable option for construction, but the process may be complicated by difficult drilling conditions and the potential for clogging, damaging, or destroying the existing methane gas extraction system. Furthermore, it may be difficult to determine the actual quantities of injection grout that would be required based on limited knowledge of potential voids beneath the surface.

MSW EXCAVATION

The final structural improvement option that was analyzed involves the excavation and removal of all landfill material from underneath the area of proposed airfield improvements. Handling and disposing of this material would have to be strictly regulated and would require permitting and coordination with several regulatory agencies. After excavation, suitable fill material would be imported and placed to re-establish the required grade.

Although this option is considered to be technically feasible, the process would be very complicated. MSW Excavation would completely eliminate any settlement issues, but it would also be extremely expensive, it would require a number of additional special permits, and it would necessitate the full-scale reconstruction of the entire methane gas extraction system that exists today.

RETAINING WALLS

During construction of the airfield improvements, retaining walls will be built along the eastern and southern portions of the airport property to aide with the proposed grade changes. Initial proposals included the use of terraced, segmental retaining walls to support the fill required for the project. These types of walls are capable of tolerating relatively small amounts of differential settlement. They are not designed to tolerate the large amounts of settlement that would be associated with the landfill materials in this particular case. For this reason, it was concluded that stabilization of the landfill material below the reinforced zone would be required.

With the exception of the 200 foot extension option, the retaining wall is anticipated to have a different height and length for each of the proposed runway extension alternatives. The average wall heights range from about 22 feet to 37 feet and the lengths range from approximately 1150 feet to 3025 feet. Significant portions of these retaining walls will require stabilization, as they will be constructed above underlying landfill materials, especially on the east end of the runway extension. Stabilization will also be required below the reinforced zone of the wall along the southern slope of the landfill, but the reinforced zone for the southern retaining wall would not require stabilization as it lies outside the limits of the landfill. As indicated in *Chapter 5 – Alternative Cost Estimates*, there is no requirement for a retaining wall with the 200 foot extension option.

The stabilization methods for retaining walls located over relatively deep layers of landfill material include drilled displacement columns and driven piles. For the locations with relatively shallow layers of landfill material injection grouting is considered to be a more economical solution. As an alternative to the segmental walls, a cast-in-place wall supported on deep foundations would also be effective. Additional details about the retaining walls and the structural improvement options can be found in *Chapter 5 – Extension Alternatives, Landfill Mitigation Options and Safety Upgrades*.

ALTERNATIVE ANALYSIS

After the preliminary layouts had been established and the landfill remediation options had been thoroughly analyzed and compared, it was time for the final selection process to begin. This proved to be quite a daunting task as there were several different issues that needed to be explored. To aid in this operation, the Runway Extension Alternatives Selection Matrix was created.

The Runway Extension Alternatives Selection Matrix was designed to account for some of the most critical factors that needed to be considered in the construction of an extension to Runway 6-24, Taxiway N, and Taxiway A. This matrix was divided into 17 columns, which represented the different categories of selection criteria. The categories included the following: technical feasibility, fiscal responsibility, good business sense, eligibility for FAA funding, cost, airport operations, flight operations, Runway Safety Action Team (RSAT) issues, weight penalties, stage length benefits, benefit cost analysis, achievement of business case, and all of the structural improvement options. A point value was assigned to every column for each of the alternatives, the points were added up, and the option with the highest score was selected as the preferred alternative.

The Runway Extension Alternatives Selection Matrix is shown in **Table 6A**.

All categories were rated for each criteria on a scale from 1 to 9, 1 being the worst option and 9 being the best. **Table 6B** describes the different ratings categories and how each of the alternatives was scored. The Landfill Mitigation Options Selection Matrix is shown in **Table 6C**. Based on this analysis and the availability of FAA funding at the time of construction, the preferred Runway Extension Alternative based on limited available funds from the FAA is Option A: a runway extension of 200 feet for a total length of 5,097 feet, using either the clean closure option or DDC piles to handle the landfill mitigation issue. If the FAA funding for a long extension is available, the recommended extension is Alternative B. The 900 foot extension, 5,797 foot runway length, would better meet the long term needs of the airport and the users.

TABLE 6A
Runway Extension Alternatives Selection Matrix
McClellan-Palomar Airport

RUNWAY EXTENSION ALTERNATIVES SELECTION MATRIX - DRAFT

Extension	Alternative	Technically Feasible	Fiscally Responsible	Good Business Sense	Eligible for FAA Funding	Cost	Airport Operations	Flight Operations	RSAT Issues	Weight Penalities	Stage Length Benefits	BCA	Achieves Business Case	Sub-Total	Steel Piles	Precast Concrete Piles	Drilled Displacement Columns	Injection Grouting	Clean Closure	TOTAL POINTS
5100'	N + S Twy	9	9	7	9	9	6	6	9	5	5	7	5	86	2					88
																3				89
																	8			94
																		7		93
																			8	94
5800'	N Twy	8	8	4	8	6	4	4	7	6	3	6	3	67	5					72
																6				73
																	8			75
																		5		72
																			2	69
	N + S Twy	7	7	6	7	4	7	7	8	6	6	8	6	79	5					84
																7				86
																	8			87
																		6		85
																			3	82
6100'	N Twy	5	5	5	5	5	5	5	4	7	4	5	4	59	6					65
																8				67
																	8			67
																		4		63
																			2	61
	N + S Twy Realignment	1	1	3	2	1	9	9	5	8	7	1	8	55	6					61
																8				63
																	8			63
																		4		59
																			2	57
	N + S Twy Bridge	1	1	3	2	2	9	9	5	8	7	4	8	59	5					64
																8				67
																	3			62
																		2		61
																			1	60

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TABLE 6B
Runway Extension Alternatives Matrix
Scoring Breakdown

Rating Category	Justification for Points Awarded
Technically Feasible	Options that were considered to be the least challenging to build received the most points in this category.
Fiscally Responsible	Options that were considered to make the sense most financially received the most points in this category.
Good Business Sense	Options that made the most sense in terms of economic impact to the airport received the most points in this category.
Eligible for FAA Funding	Options that were more likely to receive FAA funding received the most points in this category.
Cost	The least expensive options received the most points in this category.
Airport Operations	The options that would benefit airport operations the most received the most points in this category.
Flight Operations	The options with the greatest benefit to flight operations received the most points in this category.
RSAT Issues	The options that would have the least negative impact on issues with the Runway Safety Action Team received the most points in this category.
Weigth Penalties	The options that would require the smallest aircraft weight penalties received the most points in this category.
Stage Length Benefits	Options that would provide the most additional runway length would also receive the greatest benefits, so they scored the most points in this category.
Benfit-Cost Analysis	Options that were determined to have the most benefits for the cost required to build them received the most points in this category.
Achieves Business Case	Options that would best achieve the business objectives of the project scoed the highest in this category.
Steel Piles	This option scored relatively low because of its high cost and the potential for future settlement.
Reinforced Piles	These would cost less than the steel piles to build, but future settlement wold still be an issue.
DDC Piles	This option is less expensive than steel or reinforced piles, and it addresses the issue of settlement, but operating the drill rig would hinder airport operations.
Injection Piles	This option is more expensive than many of the others and is difficult to quantify until it is actually being built.
Clean Closure	This option would mitigate all of the issues with the landfill, but it would be extremely time consuming and expensive.

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TABLE 6C

Structural Improvement Alternatives

Option	Reliability	Constructability	Timeframe	Design	Environmental	Cost	Score
Driven Steel Piles	9.5	5	6.5	4	9	3.5	37.5
Displacement Driven Precast Concrete Piles	9.5	6	8	4	8	4.5	40
Drilled Displacement Columns	7.5	7	6.5	4.5	8	7.5	41
Injection Grouting (Compaction Grouting)	4.5	7	7.5	2	8.5	8	37.5
MSW Excavation	9.5	6	1	9	2.5	1.5	29.5

	Steel Piles	Concrete Piles	DDC's	Grouting	Excavation	
Reliability How well does the Option Address Settlement at the Airfield	9.5	9.5	7.5	4.5	9.5	10 Eliminates Potential for Settlement 5 Mitigates Settlement 1 Future Settlement Expected
Constructability Is the construction method anticipated to be difficult?	5	6	7	7	6	10 Simple 5 Moderate 1 Highly
Timeframe (Construction Duration & Impacts to Airport Operations) Will the time required for construction impact the Airport operations?	6.5	8	6.5	7.5	1	10 < 6 months 5 > 6 mon < 1 yr 1 > 1 yr
Design Complexity Does the design require complex planning, investigations and analyses?	4	4	4.5	2	9	10 Low 5 Med 1 High
Environmental Are there environmental impacts and regulatory obstacles that will need to be addressed?	9	8	8	8.5	2.5	10 Low 5 Med 1 High
Estimated Cost Relative to the Options evaluated, is the cost at, above, or below the average?	3.5	4.5	7.5	8	1.5	10 Low 5 Average 1 High

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Chapter Seven
BUSINESS CASE ANALYSIS

This section presents a business case analysis of potential runway improvements at McClellan-Palomar Airport. The purpose is to provide a foundation for objective decision making by evaluating the range of benefits created by investment to improve the existing runway, in comparison to not making the investment.

Financial and cost considerations often rank highest on the list of factors that decision-makers review when considering investment projects. However, business case analysis also incorporates qualitative and subjective elements into the decision process.

Safety, for example, is especially important for airport managers. Other stakeholders may look at time delays or improved customer service. In addition, compliance with rules and regulations of the FAA or recommendations or guidelines from aircraft manufacturers are important to consider.

Business case analysis is broader than benefit-cost analysis, which is based on quantitative relationships of costs and benefits. Because financial or cost factors ultimately play a key role in public sector investment, the benefit-cost analysis shown in chapter 8 is critical to decision making and should be integral to the overall process. Business case analysis rounds out the discussion of the value of the project by considering a broader matrix of elements.

This chapter reviews the qualitative benefits of runway extension for stakeholders and the public. In addition, an economic benefit analysis is presented to evaluate the incremental revenues, jobs, and income created in the service area due to the runway extension.

SUMMARY OF FINDINGS

McClellan-Palomar airport is home to a wide range of business jet aircraft. The existing runway length of 4,897 feet imposes constraints on the utilization of these aircraft to achieve full potential competitive benefits that are critical in the current business environment.

Runway alternatives under consideration involve extension to 5,097 feet, 5,800 feet and 6,100 feet. The business case analysis does not choose among these three alternatives. Instead, the analysis focuses on the incremental benefits of runway extension versus no extension.

A longer runway will have significant economic development effects, facilitating the use of larger aircraft with extended national or global range. Variation in fleet mix (with upgraded aircraft) and growth in aviation activity such as operations translates into economic benefits, as increased flights or greater numbers of based aircraft generate enhanced revenues for airport business and more employment opportunities along with greater incomes for workers and proprietors.

In addition to revenues and jobs on the airport, the presence of an airport attracts visitors that arrive by air. Air taxi passengers and owners of transient general aviation aircraft tend to make substantial expenditures in the service area for food, lodging and other goods and services when they visit for business or personal reasons.

The baseline economic benefits of McClellan-Palomar Airport in 2012 were direct on-airport revenues of $110.7 million, employment on-site of 344 workers, and incomes to workers and proprietors of $18.6 million. Air visitors using the airport injected $56.5 million into the economy, creating 587 jobs and worker incomes of $21.3 million. After recycling in the regional economy, the direct spending resulted in total economic benefits of $321.4 million revenues, 2,215 jobs and $81.3 million income to workers.

Without runway extension, the growth in aviation activity still would result in cumulative total benefits over the next 20 years of $8.3 billion in revenues within the airport service area due to the presence of the airport. But, with runway extension (to either 5,800 feet or 6,100 feet), projections indicate that cumulative incremental total economic benefits over a 20 year period would be greater by $163.2 million.

Applying standard business case analysis techniques, the present value of the difference in revenue over the 20 year period is $100.3 million at a 4 percent discount rate and $72.2 million with a 7 percent discount rate (both rates are typically used for public sector project evaluation). Both of these present value figures exceed the estimated costs of the 900 and 1,200 feet extensions.

When public funds are involved, it is reasonable to consider cost recovery in the form of tax revenues. At the end of the 20 year study period, local tax collections will have increased by $367.7 million and state taxes will have increased by $128.9 million in 2013 dollars.

In summary, the business case analysis is designed to aid in the decision of extension versus no extension. The runway extension option has favorable support based on business case analysis and the economic benefit measures resulting from investment in the extension project.

ALTERNATIVES

As an initial step, the options under consideration by decision makers must be identified. In the analysis that is presented in this chapter, the options are (a) no runway extension versus (b) extension at three alternative cost levels, associated with three different runway lengths.

The first alternative (A) is an extension of 200 feet. Alternative B is a 903 foot extension, to 5,800 feet, and alternative C is an extension of 1,203 feet that would lengthen the runway to 6,100 feet. Cost estimates are reviewed in Chapter 5. For purposes of the business case analysis, alternative A will be estimated at $22.4 million, B at $48.7 million, and C at $60.4 million. Option C, the most costly, extends the runway to the greatest length, and upgrades the airfield to a higher level of standards for aircraft use.

The business case analysis undertaken here does not choose among the three alternatives. The basic decision analyzed is whether to invest in a runway extension versus no extension. All three alternatives offer benefits compared to the alternative of no runway improvement. However, the 5,800 foot extension and the 6,100 foot extension are more likely to bring the greater benefits discussed below. For purposes of the business case analysis, examples based on extension versus no extension will include either of the two higher cost alternatives (900 feet and 1,200 feet).

Moreover, the extensions of 900 feet and 1,200 feet are consistent with the forecast operations and based aircraft levels developed in detail in chapter 3. These forecasts were used to compute the annual revenue stream for the economic benefit calculations discussed below. While the 200 foot extension would likely also increase economic benefits, at this time there are no separate projections for increased operations or based aircraft with this lower cost alternative.

QUALITATIVE BENEFITS

Airports play a vital role in the economy by enabling travel of passengers and goods and facilitating commerce. But it is important for citizens and policy makers to be aware that there are unmeasured but qualitative benefits from aviation that represent significant social and economic value created by airports for the regions that are served.

For example, airports enhance safety and quality of life by supporting law enforcement and medical flights. Apart from cost and benefit decisions, investments such as runway extension that increase the capability of the airfield to serve the general public are a desirable application of public funds.

Airports are now widely recognized as vital for economic development. Regional economist John Kasarda, originator of the "aerotropolis" concept, has said he believes airports will "shape business location and urban development in the 21st century as much as highways did in the 20th century, railroads in the 19th and seaports in the 18th."

While it is often thought that movement of cargo is most closely linked with economic growth, studies have found that people movement (as seen at active regional airports such as CRQ) is even more important. An often-cited study by Mellander found regional wealth, higher levels of education, and high tech industry are all associated with airport activity.

In addition to exerting a positive influence on economic development in general, aviation often reduces costs and increases efficiency in individual firms. Annual studies by the National Business Aviation Association show that those firms with business aircraft have sales 4 to 5 times larger than those that do not operate aircraft. In 2010, the net income of aircraft operating companies was 6 times larger than non-operators. Two thirds of the *Fortune* 500 firms operate aircraft and 88 percent of the top100 have business aircraft (see National Business Aviation Association, *Fact Book*, 2010).

Because of the competitive advantages offered by the use of business aircraft, it is important to have facilities and infrastructure that support aviation, as an aid to regional economic development. Higher quality infrastructure leads to higher growth.

USER BENEFITS

McClellan-Palomar airport is home to a wide range of business jet aircraft. In 2011, there were 63 jet aircraft, many with global capability. The existing runway length of 4,897 feet imposes constraints on the utilization of these aircraft to achieve full potential benefits and maximize the return on the substantial private investment involved in aircraft acquisition.

Moreover, runway constraints effect operations by itinerant aircraft arriving at CRQ from distant originations. These aircraft are typically bringing executives, suppliers, clients, or materials and equipment to support business activity within the airport service area.
Runway improvement will enhance the capabilities of current business aircraft users to obtain full value from their investment and achieve maximum competitive advantage.

A longer runway length will lead to greater efficiency and, importantly, safety. For example, one critical and costly maintenance item for business jet aircraft is brakes. A longer runway reduces brake wear and therefore costs, while improving safety.

A longer runway allows for greater payloads of passengers and cargo, and also additional fuel load. This increases aircraft range and reduces the need for fuel stops on longer flights, which adds to the human costs of business travelers.

Given the relationship between business aircraft and increased economic returns to firms that use these aircraft, it is likely that improvements to the airport infrastructure at CRQ will result in an overall upgrade of quality and number of business aircraft found at the airport. This in turn will provide a stimulus to economic activity at the airport, including impacts on revenues, jobs and incomes to workers.

Fuel Sale Example

An initial example of how runway extension will impact both qualitative and quantitative measures can be seen by examining potential fuel sales. A longer runway will allow large jets to carry more fuel and avoid fuel stops. This is a benefit for the aviation community and will also add to fuel sale revenues for FBO providers.

Coffman Associates has developed a table of additional useful load with alternative runway lengths by aircraft type (Table 7A).

A gallon of fuel weighs 6.8 pounds and fuel prices at CRQ have been in the range of $6.50 per gallon. Therefore, an addition to useful load of 1,000 lbs. allows for up to 147 additional gallons of fuel. The revenue to FBO fuel suppliers is $956 from the sale.

At 6,100 feet, 778,321 additional gallons could be loaded by the current mix of business jets, increasing fuel sales by $5 million. The 5,800 foot alternative increases sales by $4.1 million. Revenue to the airport is 4 cents per gallon. The 6,100 feet alternative raises airport flowage revenue by $31,133 in the initial year of extension completion. The extension to 5,800 feet increases airport fuel revenue by $25,356 in the first year.

There are many other quantitative and financial impacts of runway extension. Greater fuel sales may have an effect on FBO employment, creating jobs and income. Additional or upgraded based aircraft have similar effects on revenues and jobs. These types of revenue and employment benefits from increased operations and based jet aircraft are incorporated in the economic benefit section of the business case analysis below

ECONOMIC BENEFITS

Runway improvements will have an impact on revenues, incomes, employment, and other measures. Estimates of projected business aircraft activity levels at McClellan-Palomar Airport with and without the runway extension have been developed by Coffman Associates and are set out in Table 7B. Baseline annual operations were 143,670 in 2011. Without the project, operations will increase to 158,900 in 2021 (or 10 years). With the runway extension, operations will be 11,700 greater, at 162,100 by 2021.

TABLE 7A
Additional Gallons of Fuel With Longer Runway Length
McClellan-Palomar Airport

Aircraft	90% Useful Load (lbs)	2011 CRQ Operations	Additional Gallons of Fuel At Given Runway Length		
			6,100	5,800	5,100
Galaxy/Gulfstream G200	33,960	276	28,412	13,800	3,653
Gulfstream V/G500/550	86,730	474	135,229	104,559	31,019
Global Express BD-700	94,525	242	72,244	51,603	4,982
Dassault Falcon 2000	35,800	576	30,600	23,800	8,840
Gulfstream IV	70,810	976	307,440	254,334	133,052
Challenger 600/601/604	45,500	554	72,101	59,881	17,109
Gulfstream G150	24,910	200	34,412	30,588	7,882
Learjet 60	22,560	256	15,812	13,553	3,012
Cessna Citation X	34,970	566	34,959	34,959	11,653
Hawker 800	26,940	996	41,012	41,012	11,718
		5,116	778,321	633,889	238,020
Fuel Sales @ $6.50/gal			**$5,019,436**	**$4,082,575**	**$1,513,978**
Airport Revenue @ $0.04/gal			**$31,133**	**$25,356**	**$9,521**

Source: Calculations by Coffman Associates based on aircraft manufacturers and CRQ data

TABLE 7B
Growth of Business Aircraft Activity Without and With Runway Extension
McClellan-Palomar Airport

	Operations	Without Project		With Project	
	2011	2021	Increase	2021	Increase
GA Itinerant	89,298	98,400	10.2%	100,800	12.9%
Air Taxi	4,958	6,100	23.0	6,900	39.2
Total Operations	143,670	158,900	10.6%	162,100	12.8%

Source: Coffman Associates, Feasibility Study for Potential Runway Improvement, 2012

The business case analysis focuses on the increase in itinerant general aviation traffic and air taxi operations with and without the runway extension. (The runway extension alternatives B and C are treated equally in this comparison.)

The percentage increases for each type of business aircraft operation from the baseline year to the end of the first 10 year period (2021) can be seen in table 7B. Without the project, total operations increase by 10.6 percent over the 10 year period. With the project, the increase in total operations is 12.8 percent from 2011 – 2021. Without the project, itinerant GA operations increase by 10.2 percent and air taxi operations are up by 23 percent. But with the project, air taxi increases by 39.2 percent, and both itinerant and air taxi operations growth exceed the growth in total operations.

Investment in the extension project will have an effect on how business jets influence the economic contribution of the airport. Longer flights, higher payloads, and access to larger aircraft are expected to increase sales and revenues by airport firms, along with employment and incomes to workers. In addition, revenues to the airport administration will increase as well with greater activity.

Meanwhile, off airport revenues and jobs will increase in the regional visitor industry. Itinerant GA operations and air taxi operations create economic benefits when visitors arrive who spend for lodging, food, transportation, auto rental and other goods and services purchased within the airport service area. Moreover, itinerant aircraft require fuel and service, as well as food and lodging for crew members.

Although jet aircraft based at the airport are expected to increase with or without runway extension, the effect of runway extension is to encourage a greater number of jets, with accompanying effects on fuel sales, maintenance, and related revenues, incomes to workers, and employment.

Based aircraft are projected to increase from 290 to 332 in 2021 without the runway extension. Jet aircraft will increase by 60 percent and all other aircraft will increase by less than two percent. With the runway extension, based jet aircraft increase by 73 percent, while the increase for all other aircraft types remains unchanged.

Computing Economic Benefits

To standardize the study of airport economic benefits, the FAA has provided recommendations on the use of quantifiable indicators of economic activity, including (a) the dollar value of output/revenues, (b) jobs created and supported, and (c) incomes to workers and business proprietors. The methodology is detailed in the publication by the Federal Aviation Administration, *Estimating the Regional Economic Significance of Airports*, Washington DC, 1992.

Economic benefits are created when economic activity takes place both on and off the airport. On the airport, revenues, incomes and jobs are created by airport businesses and government agencies. Air visitor spending off the airport is also included as a benefit of an airport. As aviation activity increases, on and off-airport benefits normally increase, resulting in greater revenues, more jobs, and increased incomes to workers.

Direct Benefit Sources

The on-airport and off-airport benefits are known as direct benefits, that flow directly to firms and agencies that serve aviation. Secondary benefits flow to the general economy when the initial direct benefits recycle in the regional economy.

Following the FAA methodology, McClellan-Palomar Airport is viewed as a source of measurable economic activity (the production of aviation services) that creates revenues for firms and employment and income for workers on the airport and in the greater regional economy.

Aviation economic activity on the airport includes spending by based aircraft owners on maintenance, fuel, and storage for their aircraft, ranging from single engine prop planes to large corporate jets. This spending generates revenue for FBOs and supports jobs for aviation workers. When transient general aviation travelers arrive at the airport, they add to revenues on the airport when they purchase fuel and eat at the on-site restaurant. Citizens interested in aviation enroll in training courses and provide revenues to flight schools and income for flight instructors.

A second source of benefits is the spending off the airport by air visitors that produces revenues for firms in the hospitality sector. When a transient aircraft arrives at McClellan-Palomar Airport, passengers may rent an auto and stay a few hours in the area while they attend a business meeting or visit an attraction, or they may remain overnight, spending for food and lodging. These external dollars add to regional revenues and create employment and income for workers.

Secondary Benefits

These direct benefits are distinct from secondary benefits, which are created when spending recycles within the regional economy of the airport service area. Direct spending due to the airport circulates into the regional economy in two ways. Revenues of hospitality industry or airport firms or are used to pay workers, who then spend their paychecks in their home communities for consumer goods and services. Airport businesses inject spending into the local economy when they purchase supplies, goods and services from local firms. Hospitality industry firms serving air visitors also rely on local supplies for goods and services to support their businesses.

Airport benefit studies rely on multiplier factors from input-output models to estimate the impact of secondary spending on output, income and employment to determine total benefits.

Airport Vitality Analysis (2008)

The airport economic benefit methodology described above was followed in the report prepared by Kimley-Horn and Associates (*McClellan-Palomar Airport 2008 Economic Vitality Analysis: Final Technical Report*, June 2009).

The economic benefits reported in the Economic Vitality study are shown in Table 7C. The dollar values in the table have been updated to 2013 by adjustment by the Consumer Price Index (CPI). In 2008 there were 404 direct jobs on the airport and direct revenues to airport businesses and government agencies of $125.7 million (in 2013 dollars).

Direct spending by air visitors was $66.6 million, supporting 692 jobs in the hospitality sector of the regional economy.

There were $8.2 million of on-airport expenditures for capital improvement projects during the study year (2008),

TABLE 7C
Economic Benefits 2008 (*in 2013 dollars*)
McClellan-Palomar Airport

	Revenues	Income	Employment
Source	**2008 Direct Economic Benefits ($2013)**		
On-Airport Activity	125,751,346	23,679,468	404
Air Visitor Spending	66,595,808	25,167,522	692
Capital Projects	8,227,429	2,350,694	52
Direct Benefits	**200,574,583**	**51,197,684**	**1,148**
Source	**2008 Secondary Economic Benefits ($2013)**		
On-Airport Activity	109,512,000	35,994,000	833
Air Visitor Spending	68,192,000	15,204,000	679
Capital Projects	8,594,000	3,051,000	69
Secondary Benefits	**186,297,000**	**54,249,000**	**1,581**
Source	**2008 Total Economic Benefits ($2013)**		
On-Airport Activity	235,263,000	59,673,000	1,237
Air Visitor Spending	134,788,000	40,372,000	1,371
Capital Projects	16,821,000	5,402,000	121
Total Benefits	**386,872,000**	**105,447,000**	**2,729**

Source: Kimley-Horn and Associates, Inc., McClellan-Palomar Airport 2008 Economic Vitality Analysis
Notes: Secondary Economic Benefits include indirect (local purchases) and induced (consumer) multiplier effects; all figures are in 2013 dollars adjusted by Consumer Price Index (CPI)

creating 52 jobs in the construction and maintenance industries. These sources of direct benefits summed to $200.6 million revenues, 1,148 direct jobs, and incomes to workers and proprietors of $51.2 million.

Secondary benefits (due to multiplier effects as estimated through application of the RIMS model) were $186.3 million in revenues and 1,581 additional jobs supported in the overall regional economy.

Total economic benefits are the sum of direct and secondary benefits and represent the most comprehensive measure of the economic contribution of the airport. In 2008, total economic benefits were $386.9 million in revenues, and 2,729 jobs supported, with income to workers and proprietors of $105.4 million.

Economic Benefit Baseline

The business case analysis requires comparison of revenues and other economic benefits with and without the airport extension. Future revenue flows and employment must be based on projections of annual growth of aviation activity. The baseline selected for forecasts of future economic activity was 2012. Therefore, it is necessary to establish baseline values for economic benefits, including on-airport and air visitor revenues, employment and incomes to workers and proprietors. As aviation activity rises from the baseline year, economic benefits will rise in step, depending on assumptions about growth.

To develop a baseline of economic benefits , direct employment, incomes, and revenues on-airport and as generated by air visitors were estimated and combined with secondary benefits derived from using the same multiplier coefficients as those applied in the 2008 Economic Vitality Analysis. These baseline economic figures are in Table 7D. Since the 2008 and 2012 economic benefit results are expressed in 2013 dollars and based on the same multipliers, the two studies may be compared to show how economic benefits have changed since 2008.

The economic and aviation environments were quite different in 2008 as compared to 2012. In 2008, the economy was just entering the recession. Operations at CRQ were 190,455 in 2008. By 2011, a recovery year, operations had decreased to 143,676, a drop of 24.6 percent. During this same period, air taxi operations fell by 38.5 percent. Airline operations fell by 4.8 percent in this time, and itinerant operations were down by 21.5 percent. Not including capital expenditures, total benefits of the airport in 2012 were $321.4 million, down by $48.0 million or 13 percent.

A 2012 survey of airport employers found 344 on-site jobs, down by 60 or 14.8 percent from 2008. Combined with air visitor jobs, there were 931 direct jobs in 2012. Including multiplier effects of secondary benefits, there were 2,215 jobs supported by the airport.

Baseline direct revenue benefits summed to $167.1 million, including $110.6 million revenues on the airport and $56.5 million of air visitor spending.

General aviation activity (itinerant and air taxi) is an important part of CRQ visitor spending. There were an estimated 19,690 general aviation visitors in 2012, with average spending per day of $305 per person.

Benefits of Runway Extension

The baseline economic benefits of the airport as shown in Table 7D will increase as operations and other measures of aviation activity increase over time. With the runway extension, certain key aviation activity levels will increase faster, in particular itinerant GA operations and air taxi operations, as well as based jet aircraft. Airline passenger enplanements will grow also, but for the purposes of the current analysis, it is assumed there is no differential growth in enplanements with or without the runway extension project.

The summary result of the economic benefit analysis of the runway extension project is presented in Table 7E. The table compares baseline revenues, incomes to workers, and employment with projected values with and without the runway extension project.

TABLE 7D
Economic Benefits 2012 (*Baseline)*
McClellan-Palomar Airport

	Revenues	Income	Employment
Source	**2012 Direct Economic Benefits ($2013)**		
On-Airport Activity	110,659,000	18,658,000	344
Air Visitor Spending	56,496,000	21,349,000	587
Direct Benefits	167,155,000	40,007,000	931
Source	**2012 Secondary Economic Benefits ($2013)**		
On-Airport Activity	96,369,000	28,361,000	709
Air Visitor Spending	57,850,000	12,897,000	575
Secondary Benefits	**154,219,000**	**41,258,000**	**1,284**
Source	**2012 Total Economic Benefits ($2013)**		
On-Airport Activity	207,028,000	47,019,000	1,053
Air Visitor Spending	114,346,000	34,246,000	1,162
Total Benefits	**321,374,000**	**81,265,000**	**2,215**

Notes: Secondary Economic Benefits include indirect (local purchases) and induced (consumer) multiplier effects; all figures are in 2013 dollars

The table includes snapshots of economic benefits at points in time (5, 10, 15 and 20 years) as well as cumulative total revenues over the entire 20 year period with the runway extension project.

As explained in previous sections, airports provide a source of direct employment and income for workers and revenues for business and governments. Some of this economic activity is on-site, while additional economic benefits result from visitor spending by travelers who arrive in the region by air. These direct benefits are then subject to multiplier effects to create secondary and total benefits that measure the economic contribution of the airport throughout the regional economy of the service area.

(Detailed annual projections on direct and total revenues, income to workers, and employment, along with a discussion of the projection methodology are provided in the final section of this chapter.)

From the perspective of the general public within the regional economy, these broader total benefits (which include all multiplier effects on the overall economy) are the most relevant measure of economic returns from a publically funded investment project.

Total benefits include the initial direct benefits plus secondary benefits due to multiplier effects as spending circulates in the region, creating revenues, jobs and income in the general economy. The multipliers used to calculate total benefits in Table 7E were taken from the 2008 Economic Vitality analysis by Kimley-Horn and Associates. Those multipliers were derived from the RIMS II model of the U. S. Bureau of Economic Analysis, with specific coefficients for San Diego County.

TABLE 7E
Summary of Economic Benefits Without and With Runway Extension
McClellan-Palomar Airport

	Baseline	Year 5	Year 10	Year 15	Year 20
Total Economic Benefits WITHOUT Runway Extension					
Revenues	321,374,000	340,814,000	364,944,000	444,010,000	540,205,000
Income	81,265,000	86,114,000	92,131,000	112,091,000	136,377,000
Employment	2,216	2,353	2,524	3,071	3,736
Total Economic Benefits WITH Runway Extension					
Revenues	321,374,000	346,082,000	373,796,000	454,779,000	553,308,000
Income	81,265,000	87,560,000	94,526,000	115,005,000	139,922,000
Employment	2,216	2,394	2,590	3,150	3,832
Increment to Total Economic Benefits WITH Runway Extension					
Revenue Increment		5,268,000	8,852,000	10,769,000	13,103,000
Income Increment		1,446,000	2,395,000	2,914,000	3,545,000
Employment Increment		41	66	79	96
Cumulative Payback WITH Runway Extension					
Revenue Increment (Cumulative)		15,678,000	52,677,000	102,538,000	163,204,000
Present Value (@ 4%)		13,589,000	40,459,000	70,358,000	100,258,000
Present Value (@ 7%)		12,270,000	33,618,000	54,293,000	72,229,000
Present Value (@ 10%)		11,124,000	28,219,000	42,685,000	53,614,000

Note: Figures are in 2013 dollars

For decision-makers, the most important rows of the table show the increments to total economic benefits that result from runway extension. By year 10, revenues in the regional economy will be higher by $8.8 million, and employment will be greater by 66 additional workers. By year 20, revenues will be $13.1 million greater than without runway extension.

The lower section of the table shows the cumulative incremental additions to total revenues within the service area over a 20 year period. By year 10, total revenues will exceed $50 million generated over all combined years within the service area as a result of runway extension. By year 20, the cumulative difference is $163.2 million.

For decisions affecting investments with returns over a long period, the revenue stream should be discounted to present value. Discounting is particularly important when long term benefits are examined, since a basic foundation of decision making in business is that future benefits, cash flows, or returns are of lesser value than current or present funds. Future cash flows therefore must be equated or brought to present value through a discount rate.
Although current interest rates are at long-term lows in the one percent range, the higher (and therefore more conservative) 4 and 7 percent rates will be used in the current study to calculate the present value of the revenue stream of benefits related to runway extension. In addition, a 10 percent rate is applied to illustrate a test of sensitivity.

The annual differential increases in total revenues in the airport service area from the runway extension project are set out in Table 7F. These flows are discounted to each time period shown in the lower section of Table 7E.

TABLE 7F
Differential Revenues with Project
McClellan-Palomar Airport

	Annual	Cumulative
Year 1	1,027,000	1,027,000
Year 2	2,070,000	3,097,000
Year 3	3,124,000	6,221,000
Year 4	4,189,000	10,410,000
Year 5	5,268,000	15,678,000
Year 6	5,967,000	21,645,000
Year 7	6,674,000	28,319,000
Year 8	7,390,000	35,709,000
Year 9	8,116,000	43,825,000
Year 10	8,852,000	52,677,000
Year 11	9,205,000	61,882,000
Year 12	9,574,000	71,456,000
Year 13	9,958,000	81,414,000
Year 14	10,355,000	91,769,000
Year 15	10,769,000	102,538,000
Year 16	11,200,000	113,738,000
Year 17	11,648,000	125,386,000
Year 18	12,115,000	137,501,000
Year 19	12,600,000	150,101,000
Year 20	13,103,000	163,204,000

The revenue stream shown in Table 7F is the incremental total revenues to the regional economy with the runway project versus no project, in 2013 dollars; the revenue increment is due to greater GA and business jet activity related to runway extension

At a 4 percent discount rate, the present value of the runway extension project over the 20 year study period is \$100.2 million. In comparison with the estimated cost of the 900 foot extension (\$48.7 million) and the 1,200 foot extension (\$60.4 million), the extension investment is favorable, based on comparison with revenues generated by airport related economic activity. At a 7 percent discount rate, with present value of the 20 year revenue of \$72.2 million, both alternatives are again favorable. However, with a 10 percent discount rate the recovery for the 1,200 foot extension will require more time than 20 years.

Project Payback

The fundamental question for decision-makers is whether the runway extension project will provide benefits (or a return) that justifies the initial investment. Among the methods used for project evaluation by business, one of the most easily comprehended of all approaches is the project payback analysis. While this approach is simple in nature, it is often very useful to those not willing to work through the calculations of the present value method.

As an aid to business decision making, the payback analysis focuses on the time period required for the simple income stream from an investment to equal (or pay back) the cost of that initial investment. A shorter time period is considered more desirable than a longer payback period.

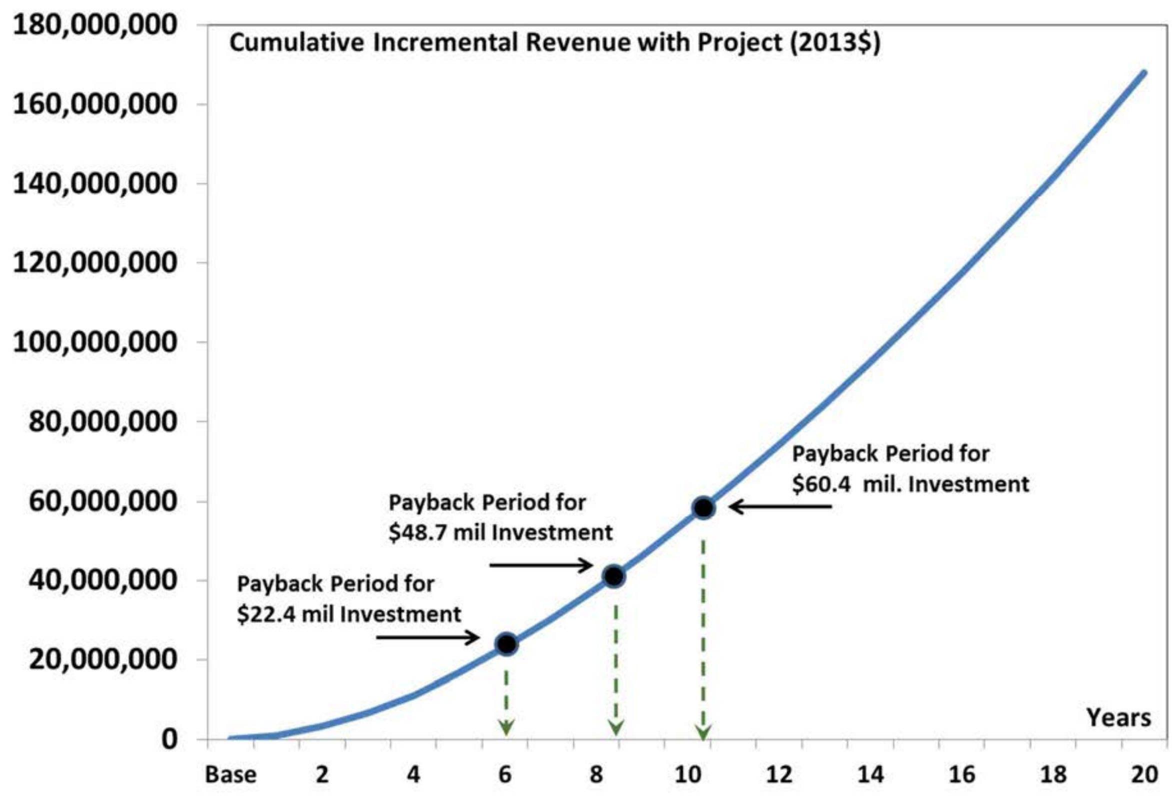
In its most rudimentary formulation, the payback analysis ignores the time value of money. Alternatively, the payback method can be viewed as an evaluation based on the assumption that the relevant rate of interest is zero.

Benefits from the runway extension will accrue each year after the completion of construction, so evaluation of the payback is based on the cumulative stream of returns rather than looking only at isolated benefits five, ten, fifteen and twenty years. The cumulative payback as measured by total revenues (on-airport, to the visitor sector, and in the general economy) is \$52.7 million after ten years and \$163.2 million after 20 years. This elementary payback analysis shows an initial investment of \$50 million would be recovered before ten years.

The simple payback period for three alternative runway extension projects is shown on the accompanying figure. The data for the figure are the cumulative differential revenues with the project in Table 7F. The graph does not incorporate a discount rate for the time value of money. The purpose is only to show when the flow of economic benefits (revenues) will equal the initial investment.

The graph compares the three potential investments. The \$22.4 million investment is the estimated cost for an extension of 200 feet, to 5,097 feet. The runway extension projects most consistent with the forecast activity levels for operations and based aircraft require an outlay of \$48.7 million to extend the runway by 900 feet and the 1,200 foot alternative at \$60.4 million. Payback for the 900 foot option is seen before 10 years. Payback for the 1,200 foot alternative is in year 11.

Payback Period for Runway Extension Project



TAX BENEFITS

The public sector is the source of funds for runway extension, so it is appropriate to examine the returns to the public sector in the form of tax revenues. Tax revenues are already included in the revenue flows to on-airport and air visitor firms described above, since taxes are paid from revenues received by business and incomes received by workers. Although businesses collect sales taxes that are ultimately paid by customers, the revenues used in this business case analysis are before-tax values. Thus, it would be double counting to add tax revenues onto the revenue stream for estimating economic benefits.

Nonetheless, it is reasonable to estimate tax revenues for public sector investments, and these calculations are often a requirement of project evaluation. Tax revenues with and without runway extension are shown in Table 7H. The tax rates in the tables are derived from those reported in the Kimley-Horn and Associates 2008 Vitality Study.

TABLE 7H
Summary of State and Local Taxes Without and With Runway Extension
McClellan-Palomar Airport

Taxes Revenues Without Runway Extension					
	Baseline	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Local Taxes	14,205,000	15,064,000	16,131,000	19,625,000	23,877,000
State Taxes	4,981,000	5,283,000	5,657,000	6,882,000	8,373,000
Total Taxes	19,186,000	20,347,000	21,788,000	26,507,000	32,250,000
Taxes Revenues With Runway Extension					
	Baseline	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Local Taxes	14,205,000	15,297,000	16,522,000	20,101,000	24,456,000
State Taxes	4,981,000	5,364,000	5,794,000	7,049,000	8,576,000
Total Taxes	19,186,000	20,661,000	22,316,000	27,150,000	33,032,000
Increment in Tax Revenues With Runway Extension					
		Year 5	**Year 10**	**Year 15**	**Year 20**
Local Taxes		233,000	391,000	476,000	579,000
State Taxes		81,000	137,000	167,000	203,000
Total Taxes		314,000	528,000	643,000	782,000
Cumulative Increment in Tax Revenues With Runway Extension					
		5 Years	**10 Years**	**15 Years**	**20 Years**
Local Taxes		693,000	2,329,000	4,533,000	7,214,000
State Taxes		243,000	816,000	1,589,000	2,529,000
Total Taxes		936,000	3,145,000	6,122,000	9,743,000

Note: Figures are in 2013 dollars

Baseline 2012 taxes on total revenues (including all multiplier effects of secondary spending) were estimated as $19.2 million to state and local governments. With the runway extension project, cumulative incremental local tax revenues would be $2.3 million greater with the project in 10 years, and $7.2 million greater at the end of the 20 year planning period.

DETAIL ON ECONOMIC BENEFITS OF RUNWAY EXTENSION

The business case economic benefit results indicate that runway extension at McClellan-Palomar Airport to either 5,800 feet or 6,100 feet will create a stream of incremental economic benefits that provides a positive return on the initial project cost.

The following tables provide detail on how the 20 year revenue stream was calculated for this business case analysis. In addition, calculations for employment and incomes to workers and proprietors are also shown.

Aviation Growth Forecasts

Forecasts were developed for growth of aviation activity at McClellan-Palomar Airport by Coffman Associates. Growth rates were projected with and without the runway extension for operations by business jet aircraft, specifically itinerant GA operations and air taxi.

According to the projections (shown in Table 7B) total operations will increase by 10.6 percent by 2021 with no extension of the runway. With extension of the runway, total operations increase by 12.8 percent. However, with runway extension, both itinerant and air taxi operations increase more rapidly than overall operations. Runway extension also results in a greater number of based jet aircraft. Airline enplanements will grow over the study period, but are assumed to not be affected by runway extension. The growth in benefits (revenues, incomes, employment) in driven by business jet activity.

On-Airport Direct Revenues

Airport revenues in the baseline year (2012) are shown above in Table 7D. A survey of airport employers identified 344 jobs on the airport in 2012, with income to workers and proprietors of $21.3 million. Direct revenues to airport businesses and government agencies on the airport were estimated to be $110.6 million (direct revenues represent initial spending flows without multiplier effects).

A growth model was developed for this study to link projected business jet activity growth to increases in revenues, incomes and employment, with and without runway extension. The model accounted for increased general aviation activity including operations and based aircraft with runway extension. Those businesses (such as FBO firms) serving business jet aircraft were assumed to record increases in revenues at the same growth rate as operations and/or based aircraft. Other firms (such as flight training) and government agencies were influenced by total operations.

Table 7I sets out the growth in on-airport direct revenues to airport employers over the 20 year study period, without and with the runway extension project. By year 10, on-airport revenues are $124.2 million without the runway extension and $126.8 million with extension. The cumulative amount of the incremental revenue over the entire 20 years due to runway extension is $48.6 million

Air Visitor Direct Revenues

Air visitor direct revenues in the baseline year 2012 were estimated as $56.5 million, with 587 direct jobs in service area visitor industries (lodging, food service, auto rental, retail, entertainment). Without runway extension, itinerant and air taxi visitor spending is projected to grow to $65.5 million in year 10 (see Table 7J). With runway extension, the additional itinerant and air taxi activity made possible with a longer runway will raise revenues to $67.5 million over that same period. The cumulative amount of the additional direct revenue within the service area visitor industries due to a longer runway is $35.7 million, summed over the entire 20 year project study period.

Combined Direct Revenues

Combined on-airport and air visitor revenues make up the direct revenue benefits of the airport. Table 7K shows the sum of the two benefit measures over the 20 year period. The direct revenues created by the presence of the airport at year 10 are $189.7 million without extension and $194.3 million with extension. The cumulative incremental direct revenue benefits from runway extension sum to $84.3 million over the 20 year planning period.

Total Revenues

Direct revenues are a measure of benefit to providers of aviation services on the airport and firms in the air visitor industry. Total revenues are a broader concept and reflect the economic benefits of the airport that spread to the regional economy of the service through multiplier effects of secondary spending. As can be seen in Table 7D, direct revenue benefits of the airport in the baseline year were $167.2 million and secondary benefits were an additional $154.2 million. Total benefits in the baseline year were the sum of these two sources, $321.4 million.

For a public investment project that is expected to impact the entire service area, the total revenue measure of economic benefits is the best measure for evaluation of the returns from runway extension. Without the runway extension, total revenues are projected to be $364.9 million by year 10 (Table 7L). With extension, total revenues by year 10 will be $373.8 million. The cumulative incremental differential due to the extension project is $52.7 million at year 10 and $163.2 million over 20 years. The column headed “Difference With Project” in Table 7L contains the yearly incremental increase due to the runway extension. These are the same value as in Table 7F, and are used to compute the present value of the future revenues under various discount rates, as shown in Table 7G.

Incomes and Employment

Beginning with Table 7M below, additional tables are provided showing on-airport and air visitor direct and total income to workers and proprietors and direct employment, accompanied by combined on-airport and air visitor direct income and employment, all with and without runway extension.

Tables reporting total income to workers and proprietors incorporate all multiplier effects and show benefits to the service area over the 20 year period.

With runway extension, incomes in the service area are $44.2 million greater over the 20 year period (Table 7P) and employment is higher by an average of 61 jobs per year (Table 7T).

TABLE 7I
Direct Benefits: On-Airport Employer Revenues
McClellan-Palomar Airport

	Direct On-Airport Revenues			
	WITHOUT Project	**WITH Project**	**Difference With Project**	**Cumulative Difference**
Cumulative	2,726,903,000	2,775,475,000	48,572,000	
Annual Average	136,345,150	138,773,750	2,428,600	
Baseline	110,659,000	110,659,000		
Year 1	111,823,000	112,115,000	292,000	292,000
Year 2	113,001,000	113,591,000	590,000	882,000
Year 3	114,192,000	115,088,000	896,000	1,778,000
Year 4	115,398,000	116,606,000	1,208,000	2,986,000
Year 5	116,619,000	118,146,000	1,527,000	4,513,000
Year 6	118,085,000	119,827,000	1,742,000	6,255,000
Year 7	119,572,000	121,534,000	1,962,000	8,217,000
Year 8	121,081,000	123,268,000	2,187,000	10,404,000
Year 9	122,612,000	125,028,000	2,416,000	12,820,000
Year 10	124,164,000	126,815,000	2,651,000	15,471,000
Year 11	129,130,000	131,887,000	2,757,000	18,228,000
Year 12	134,296,000	137,163,000	2,867,000	21,095,000
Year 13	139,668,000	142,650,000	2,982,000	24,077,000
Year 14	145,255,000	148,355,000	3,100,000	27,177,000
Year 15	151,065,000	154,290,000	3,225,000	30,402,000
Year 16	157,107,000	160,462,000	3,355,000	33,757,000
Year 17	163,391,000	166,880,000	3,489,000	37,246,000
Year 18	169,927,000	173,555,000	3,628,000	40,874,000
Year 19	176,724,000	180,498,000	3,774,000	44,648,000
Year 20	183,793,000	187,717,000	3,924,000	48,572,000

Notes: Figures are annual direct revenues to on-airport business and government agencies in 2013 dollars with no multiplier effects; difference and cumulative difference are due to greater GA and business jet activity related to runway extension

TABLE 7J
Direct Benefits: Air Visitor Revenues
McClellan-Palomar Airport

	Direct Air Visitor Revenues			
	WITHOUT Project	**WITH Project**	**Difference With Project**	**Cumulative Difference**
Cumulative	1,430,847,000	1,466,584,000	35,737,000	
Annual Average	71,542,350	73,329,200	1,786,850	
Baseline	56,496,000	56,496,000		
Year 1	57,315,000	57,553,000	238,000	238,000
Year 2	58,133,000	58,610,000	477,000	715,000
Year 3	58,952,000	59,667,000	715,000	1,430,000
Year 4	59,770,000	60,723,000	953,000	2,383,000
Year 5	60,589,000	61,780,000	1,191,000	3,574,000
Year 6	61,578,000	62,916,000	1,338,000	4,912,000
Year 7	62,568,000	64,052,000	1,484,000	6,396,000
Year 8	63,557,000	65,187,000	1,630,000	8,026,000
Year 9	64,546,000	66,323,000	1,777,000	9,803,000
Year 10	65,536,000	67,459,000	1,923,000	11,726,000
Year 11	68,157,000	70,157,000	2,000,000	13,726,000
Year 12	70,883,000	72,963,000	2,080,000	15,806,000
Year 13	73,719,000	75,882,000	2,163,000	17,969,000
Year 14	76,668,000	78,917,000	2,249,000	20,218,000
Year 15	79,734,000	82,074,000	2,340,000	22,558,000
Year 16	82,924,000	85,357,000	2,433,000	24,991,000
Year 17	86,241,000	88,771,000	2,530,000	27,521,000
Year 18	89,690,000	92,322,000	2,632,000	30,153,000
Year 19	93,278,000	96,015,000	2,737,000	32,890,000
Year 20	97,009,000	99,856,000	2,847,000	35,737,000

Notes: Figures are annual direct revenues to firms serving air visitors in 2013 dollars with no multiplier effects; difference and cumulative difference are due to greater GA and business jet activity related to runway extension

TABLE 7K
Direct Benefits: Combined Revenues (On Airport + Air Visitors)
McClellan-Palomar Airport

	Direct On-Airport Plus Air Visitor Revenues			
	WITHOUT Project	**WITH Project**	**Difference With Project**	**Cumulative Difference**
Cumulative	4,157,750,000	4,242,059,000	84,309,000	
Annual Average	207,887,500	212,102,950	4,215,450	
Baseline	167,155,000	167,155,000		
Year 1	169,138,000	169,668,000	530,000	530,000
Year 2	171,134,000	172,201,000	1,067,000	1,597,000
Year 3	173,144,000	174,755,000	1,611,000	3,208,000
Year 4	175,168,000	177,329,000	2,161,000	5,369,000
Year 5	177,208,000	179,926,000	2,718,000	8,087,000
Year 6	179,663,000	182,743,000	3,080,000	11,167,000
Year 7	182,140,000	185,586,000	3,446,000	14,613,000
Year 8	184,638,000	188,455,000	3,817,000	18,430,000
Year 9	187,158,000	191,351,000	4,193,000	22,623,000
Year 10	189,700,000	194,274,000	4,574,000	27,197,000
Year 11	197,287,000	202,044,000	4,757,000	31,954,000
Year 12	205,179,000	210,126,000	4,947,000	36,901,000
Year 13	213,387,000	218,532,000	5,145,000	42,046,000
Year 14	221,923,000	227,272,000	5,349,000	47,395,000
Year 15	230,799,000	236,364,000	5,565,000	52,960,000
Year 16	240,031,000	245,819,000	5,788,000	58,748,000
Year 17	249,632,000	255,651,000	6,019,000	64,767,000
Year 18	259,617,000	265,877,000	6,260,000	71,027,000
Year 19	270,002,000	276,513,000	6,511,000	77,538,000
Year 20	280,802,000	287,573,000	6,771,000	84,309,000

Notes: Figures are annual direct revenues to on-airport and air visitor firms in 2013 dollars with no multiplier effects; difference and cumulative difference are due to greater GA and business jet activity related to runway extension

TABLE 7L
Total Benefits of Combined Revenues (On Airport + Air Visitors)
McClellan-Palomar Airport

	Total Revenues Created in Airport Service Area			
	WITHOUT Project	**WITH Project**	**Difference With Project**	**Cumulative Difference**
Cumulative	8,319,183,000	8,482,387,000	163,204,000	
Average	399,890,200	408,050,400	8,160,200	
Baseline	321,379,000	321,379,000		
Year 1	325,216,000	326,243,000	1,027,000	1,027,000
Year 2	329,074,000	331,144,000	2,070,000	3,097,000
Year 3	332,961,000	336,085,000	3,124,000	6,221,000
Year 4	336,872,000	341,061,000	4,189,000	10,410,000
Year 5	340,814,000	346,082,000	5,268,000	15,678,000
Year 6	345,560,000	351,527,000	5,967,000	21,645,000
Year 7	350,345,000	357,019,000	6,674,000	28,319,000
Year 8	355,170,000	362,560,000	7,390,000	35,709,000
Year 9	360,036,000	368,152,000	8,116,000	43,825,000
Year 10	364,944,000	373,796,000	8,852,000	52,677,000
Year 11	379,541,000	388,746,000	9,205,000	61,882,000
Year 12	394,723,000	404,297,000	9,574,000	71,456,000
Year 13	410,511,000	420,469,000	9,958,000	81,414,000
Year 14	426,933,000	437,288,000	10,355,000	91,769,000
Year 15	444,010,000	454,779,000	10,769,000	102,538,000
Year 16	461,770,000	472,970,000	11,200,000	113,738,000
Year 17	480,241,000	491,889,000	11,648,000	125,386,000
Year 18	499,450,000	511,565,000	12,115,000	137,501,000
Year 19	519,428,000	532,028,000	12,600,000	150,101,000
Year 20	540,205,000	553,308,000	13,103,000	163,204,000

Note: Figures are annual total revenues in airport service area (direct plus indirect plus induced) including all multiplier effects; difference and cumulative difference are due to greater GA and business jet activity related to runway extension

TABLE 7M
Direct Benefits: On-Airport Income
McClellan-Palomar Airport

	Direct Income To On-Airport Workers and Proprietors			
	WITHOUT Project	**WITH Project**	**Difference With Project**	**Cumulative Difference**
Cumulative	197,699,000	200,502,000	2,803,000	
Annual Average	19,769,900	20,050,200	280,300	
Baseline	18,658,000	18,658,000		
Year 1	18,845,000	18,897,000	52,000	52,000
Year 2	19,033,000	19,138,000	105,000	157,000
Year 3	19,223,000	19,383,000	160,000	317,000
Year 4	19,415,000	19,632,000	217,000	534,000
Year 5	19,610,000	19,883,000	273,000	807,000
Year 6	19,841,000	20,155,000	314,000	1,121,000
Year 7	20,075,000	20,430,000	355,000	1,476,000
Year 8	20,312,000	20,710,000	398,000	1,874,000
Year 9	20,551,000	20,993,000	442,000	2,316,000
Year 10	20,794,000	21,281,000	487,000	2,803,000
Year 11	21,626,000	22,132,000	506,000	3,309,000
Year 12	22,491,000	23,017,000	526,000	3,835,000
Year 13	23,391,000	23,938,000	547,000	4,382,000
Year 14	24,327,000	24,896,000	569,000	4,951,000
Year 15	25,300,000	25,892,000	592,000	5,543,000
Year 16	26,312,000	26,928,000	616,000	6,159,000
Year 17	27,364,000	28,005,000	641,000	6,800,000
Year 18	28,459,000	29,125,000	666,000	7,466,000
Year 19	29,597,000	30,290,000	693,000	8,159,000
Year 20	30,781,000	31,502,000	721,000	8,880,000

Note: Figures are annual direct incomes for on-airport workers in 2013 dollars with no multiplier effects; difference and cumulative difference are due to greater GA and business jet activity related to runway extension

TABLE 7N
Direct Benefits: Air Visitor Industry Income
McClellan-Palomar Airport

	Direct Income To Air Visitor Industry Workers & Proprietors			
	WITHOUT Project	WITH Project	Difference With Project	Cumulative Difference
Cumulative	540,597,000	554,200,000	13,603,000	
Annual Average	27,029,850	27,710,000	451,100	
Baseline	21,349,000	21,349,000		
Year 1	21,640,000	21,749,000	109,000	109,000
Year 2	21,967,000	22,149,000	182,000	291,000
Year 3	22,258,000	22,549,000	291,000	582,000
Year 4	22,585,000	22,949,000	364,000	946,000
Year 5	22,876,000	23,349,000	473,000	1,419,000
Year 6	23,240,000	23,749,000	509,000	1,928,000
Year 7	23,640,000	24,186,000	546,000	2,474,000
Year 8	24,004,000	24,622,000	618,000	3,092,000
Year 9	24,367,000	25,058,000	691,000	3,783,000
Year 10	24,767,000	25,495,000	728,000	4,511,000
Year 11	25,758,000	26,515,000	757,000	5,268,000
Year 12	26,788,000	27,576,000	788,000	6,056,000
Year 13	27,860,000	28,679,000	819,000	6,875,000
Year 14	28,974,000	29,826,000	852,000	7,727,000
Year 15	30,133,000	31,019,000	886,000	8,613,000
Year 16	31,338,000	32,260,000	922,000	9,535,000
Year 17	32,592,000	33,550,000	958,000	10,493,000
Year 18	33,896,000	34,892,000	996,000	11,489,000
Year 19	35,252,000	36,288,000	1,036,000	12,525,000
Year 20	36,662,000	37,740,000	1,078,000	13,603,000

Note: Figures are annual direct incomes for visitor industry workers in 2013 dollars with no multiplier effects; difference and cumulative difference are due to greater GA and business jet activity related to runway extension

TABLE 7O
Direct Benefits: Combined Incomes (On Airport + Air Visitor Industry)
McClellan-Palomar Airport

	Direct Income to On-Airport Plus Air Visitor Industry Workers			
	WITHOUT Project	WITH Project	Difference With Project	Cumulative Difference
Cumulative	997,923,000	1,020,421,000	22,498,000	
Annual Average	49,896,150	51,021,050	1,124,900	
Baseline	40,007,000	40,007,000		
Year 1	40,485,000	40,646,000	161,000	161,000
Year 2	41,000,000	41,287,000	287,000	448,000
Year 3	41,481,000	41,932,000	451,000	899,000
Year 4	42,000,000	42,581,000	581,000	1,480,000
Year 5	42,486,000	43,232,000	746,000	2,226,000
Year 6	43,081,000	43,904,000	823,000	3,049,000
Year 7	43,715,000	44,616,000	901,000	3,950,000
Year 8	44,316,000	45,332,000	1,016,000	4,966,000
Year 9	44,918,000	46,051,000	1,133,000	6,099,000
Year 10	45,561,000	46,776,000	1,215,000	7,314,000
Year 11	47,383,000	48,647,000	1,264,000	8,578,000
Year 12	49,278,000	50,593,000	1,315,000	9,893,000
Year 13	51,249,000	52,617,000	1,368,000	11,261,000
Year 14	53,299,000	54,722,000	1,423,000	12,684,000
Year 15	55,431,000	56,911,000	1,480,000	14,164,000
Year 16	57,648,000	59,187,000	1,539,000	15,703,000
Year 17	59,954,000	61,554,000	1,600,000	17,303,000
Year 18	62,352,000	64,016,000	1,664,000	18,967,000
Year 19	64,846,000	66,577,000	1,731,000	20,698,000
Year 20	67,440,000	69,240,000	1,800,000	22,498,000

Note: Figures are annual direct incomes for on-airport and visitor industry workers in 2013 dollars with no multiplier effects; difference and cumulative difference are due to greater GA and business jet activity related to runway extension

TABLE 7P
Total Benefits: Combined Incomes (On Airport + Air Visitor Industry)
McClellan-Palomar Airport

	Total Income Created in Airport Service Area			
	WITHOUT Project	WITH Project	Difference With Project	Cumulative Difference
Cumulative	2,019,693,000	2,063,892,000	44,199,000	
Average	100,984,650	103,194,600	2,209,950	
Baseline	81,265,000	81,265,000		
Year 1	82,203,000	82,509,000	306,000	306,000
Year 2	83,202,000	83,758,000	556,000	862,000
Year 3	84,147,000	85,017,000	870,000	1,732,000
Year 4	85,156,000	86,286,000	1,130,000	2,862,000
Year 5	86,114,000	87,560,000	1,446,000	4,308,000
Year 6	87,280,000	88,887,000	1,607,000	5,915,000
Year 7	88,511,000	90,281,000	1,770,000	7,685,000
Year 8	89,692,000	91,686,000	1,994,000	9,679,000
Year 9	90,876,000	93,099,000	2,223,000	11,902,000
Year 10	92,131,000	94,526,000	2,395,000	14,297,000
Year 11	95,816,000	98,307,000	2,491,000	16,788,000
Year 12	99,649,000	102,239,000	2,590,000	19,378,000
Year 13	103,635,000	106,329,000	2,694,000	22,072,000
Year 14	107,780,000	110,582,000	2,802,000	24,874,000
Year 15	112,091,000	115,005,000	2,914,000	27,788,000
Year 16	116,575,000	119,605,000	3,030,000	30,818,000
Year 17	121,238,000	124,389,000	3,151,000	33,969,000
Year 18	126,088,000	129,365,000	3,277,000	37,246,000
Year 19	131,132,000	134,540,000	3,408,000	40,654,000
Year 20	136,377,000	139,922,000	3,545,000	44,199,000

Note: Figures are annual total incomes in airport service area (direct plus indirect plus induced) including all multiplier effects; difference and cumulative difference are due to greater GA and business jet activity related to runway extension

TABLE 7Q
Direct Benefits: On-Airport Employment
McClellan-Palomar Airport

	WITHOUT Project	WITH Project	Difference With Project
Annual Average	365	430	**5**
Baseline	344	344	
Year 1	347	348	1
Year 2	351	353	2
Year 3	354	357	3
Year 4	358	362	4
Year 5	362	367	5
Year 6	366	372	6
Year 7	370	377	6
Year 8	375	382	7
Year 9	379	387	8
Year 10	384	392	9
Year 11	399	408	9
Year 12	415	424	9
Year 13	432	441	9
Year 14	449	459	10
Year 15	467	477	10
Year 16	486	496	10
Year 17	505	516	11
Year 18	525	537	12
Year 19	546	558	12
Year 20	568	580	12

Note: Figures are direct on-airport workers with no multiplier effects; differences are due to greater GA and business jet activity related to runway extension

TABLE 7R
Direct Benefits: Air Visitor Employment
McClellan-Palomar Airport

	WITHOUT Project	WITH Project	Difference With Project
Annual Average	743	762	19
Baseline	587	587	
Year 1	595	598	3
Year 2	604	609	5
Year 3	612	620	8
Year 4	621	631	10
Year 5	629	642	13
Year 6	639	653	14
Year 7	650	665	15
Year 8	660	677	17
Year 9	670	689	19
Year 10	681	701	20
Year 11	708	729	21
Year 12	736	758	22
Year 13	765	788	23
Year 14	796	820	24
Year 15	828	853	25
Year 16	861	887	26
Year 17	895	922	27
Year 18	931	959	28
Year 19	968	997	29
Year 20	1,007	1,037	30

Note: Figures are direct air visitor industry workers with no multiplier effects; differences are due to greater GA and business jet activity related to runway extension

TABLE 7S
Direct Benefits: On-Airport and Air Visitor Employment
McClellan-Palomar Airport

	WITHOUT Project	WITH Project	Difference With Project
Annual Average	1,165	1,191	17
Baseline	931	931	
Year 1	942	946	4
Year 2	955	962	7
Year 3	966	977	11
Year 4	979	993	14
Year 5	991	1,009	18
Year 6	1,005	1,025	20
Year 7	1,020	1,042	21
Year 8	1,035	1,059	24
Year 9	1,049	1,076	27
Year 10	1,065	1,093	29
Year 11	1,107	1,137	30
Year 12	1,151	1,182	31
Year 13	1,197	1,229	32
Year 14	1,245	1,278	33
Year 15	1,295	1,329	34
Year 16	1,347	1,382	35
Year 17	1,401	1,437	36
Year 18	1,457	1,494	37
Year 19	1,515	1,554	39
Year 20	1,576	1,616	40

Note: Figures are direct air visitor industry workers with no multiplier effects; differences are due to greater GA and business jet activity related to runway extension

TABLE 7T
Total Benefits: On-Airport and Air Visitor Employment
McClellan-Palomar Airport

	WITHOUT Project	WITH Project	Difference With Project
Annual Average	2,764	2,825	61
Baseline	2,216	2,216	
Year 1	2,243	2,252	9
Year 2	2,272	2,287	15
Year 3	2,298	2,322	25
Year 4	2,326	2,358	32
Year 5	2,353	2,394	41
Year 6	2,386	2,432	46
Year 7	2,422	2,471	49
Year 8	2,455	2,510	56
Year 9	2,488	2,550	62
Year 10	2,524	2,590	66
Year 11	2,625	2,693	68
Year 12	2,730	2,801	71
Year 13	2,839	2,913	74
Year 14	2,953	3,029	76
Year 15	3,071	3,150	79
Year 16	3,194	3,276	82
Year 17	3,321	3,407	86
Year 18	3,454	3,543	89
Year 19	3,592	3,685	93
Year 20	3,736	3,832	96

Note: Figures are annual total employment in airport service area (direct plus indirect plus induced) including all multiplier effects; differences are due to greater GA and business jet activity related to runway extension

Chapter Eight
BENEFIT-COST ANALYSIS

Feasibility Study for Potential Runway Improvements McClellan-Palomar Airport

PROJECT DEFINITION

The analyses from the previous chapters in this document have defined a need for additional runway length at McClellan-Palomar Airport. Business jet aircraft that already use the airport on a regular basis are often restricted in their capabilities by the existing runway length of 4,897 feet. The airport currently bases and serves a full range of business jet aircraft, most of which are used to transport employees, suppliers, and/or clients of area businesses.

Some of these aircraft are frequently used to transport personnel on transcontinental and international flights. An aircraft has a fixed weight, known as its operating empty weight (OEW), that is essentially made up of the aircraft and its flight crew. Added to this is a variable weight called useful load that is comprised of the payload (passengers and cargo) plus the fuel on board. The useful loads necessary for these long flights can require more runway length than is currently available at the airport. In these instances, the aircraft may need to delay departure to more favorable conditions, off-load passengers or cargo, and/or depart with less fuel than is required for the flight. In the latter case, the aircraft will require a fuel stop en route that increases trip time, fuel burn, and wear of the aircraft.

The current runway length can also affect landings. An aircraft may have to divert to another airport, delay its departure time to the airport, or off-load passengers or fuel.

The facility requirements indicated that that a runway length of 6,100 feet would meet the design needs of the business jet users. A length of 5,400 feet would be optimal for landing and a length of 5,000 feet would reduce delays or flight cancellations. With these considerations in mind, three runway extension alternatives were identified and evaluated for design feasibility and cost.

PROJECT OBJECTIVE

The project objective is to improve the efficiency and safety of the runway system at McClellan-Palomar Airport. The improved system will better serve the types of corporate jet aircraft that already use the airport by allowing for increased useful loads. This will result in longer non-stop corporate flight segments, reduced trip times, less fuel burn, and more flexibility to carry extra fuel reserves or payload.

UNDERLYING ASSUMPTIONS

To evaluate the benefit-cost of the alternatives, several assumptions must be made with regard to economic conditions and development programming. These assumptions are outlined below.

Airport Activity Forecasts

Airport activity forecasts were updated and presented in Chapter 3. The forecasts were prepared for the airport with the existing runway, as well as for the airport with the runway extension being considered in this feasibility study. The only difference in the two forecasts is due to recognizing a potential increase in business jet operations that could be attributed to additional runway length. **Table 8A** provides a summary of the forecast for business jet aircraft operations by classification mix both with and without a project.

TABLE 8A
Business Jet Operations Mix Forecast
By Aircraft Classification

		W/O PROJECT		W/PROJECT	
AAC-ADG	**2011**	**2016**	**2021**	**2016**	**2021**
Operations					
B-I	2,394	3,549	5,040	3,553	5,040
B-II	4,844	5,831	6,825	5,984	6,840
C-I	778	845	840	935	960
C-II	2,654	3,296	3,990	3,927	5,040
C-III	790	1.268	1,890	1,590	2,880
D-I	256	254	210	374	360
D-II	1,520	1,859	2,205	2,338	2,880
D-III	0	0	0	0	0
Total Business Jet Ops	13,236	16,900	21,000	18,700	24,000
Percentage					
B-I	10.5%	13.5%	16.5%	12.5%	14.5%
B-II	44.2%	42.0%	40.0%	38.5%	35.0%
C-I	5.9%	5.0%	4.0%	5.0%	4.0%
C-II	20.1%	19.5%	19.0%	21.0%	21.0%
C-III	2.4%	3.5%	4.5%	4.0%	6.0%
D-I	1.9%	1.5%	1.0%	2.0%	1.5%
D-II	11.5%	11.0%	10.5%	12.5%	12.0%
D-III	0.0%	0.0%	0.0%	0.0%	0.0%
Total Percentage	100.0%	100.0%	100.0%	100.0%	100.0%

Economic Assumptions

The economic assumptions of this analysis follow the guidelines of the FAA as outlined in *FAA Airport Benefit-Cost Analysis Guidance*, Office of Aviation Policy and Plans, USDOT, December 1999. Benefits and costs are denominated in 2013 constant dollars. A discount rate of seven percent is used to determine the present value of future benefits and costs.

Sunk costs are excluded from the analysis because they are not relevant to future decision making. Relevant costs include any non-sunk investment costs and recurring costs for operations and maintenance (primarily pavement maintenance costs) over the program life cycle of 20 years. Operations and maintenance costs were estimated based on the scope of additional pavement to be maintained for each alternative versus the baseline. Construction cost estimates for each alternative are taken from Chapter 5.

According to the FAA guidance, additional runway length is a potentially important, but difficult-to-quantify capacity benefit, especially regarding general aviation use. Typical benefits include the elimination of ground travel to a more distant airport and a reduced cost in delays, additional fuel burn, and wear on aircraft from fuel stops or flight delays to await cooler temperatures, dry runways, or more favorable winds. Benefits also include improved safety with extra length and the ability to take on additional fuel reserves, especially when the destination is a congested metropolitan area, or when changing weather may unexpectedly become a factor en route.

The FAA further indicates within its guidance that it is receptive to other methodology for measuring potential benefits of additional runway length.

In the case of McClellan-Palomar Airport, the primary quantifiable benefits of additional runway length will come from a reduction in payload penalties. **Table 8B** lists business jets by make and model that can be affected by the existing runway length on takeoff. Each conducted at least 200 operations at McClellan-Palomar in 2011 for a combined total of 5,116 operations.

TABLE 8B
Added Useful Load with Alternative Runway Lengths
McClellan-Palomar Airport

			Additional Useful Load (lbs) at Given Runway Length (ft)			
Aircraft	**MTOW (lbs)**	**2011 CRQ Operations**	**6,100**	**5,800**	**5,100**	**4,897**
GALX - IAI 1126 Galaxy/Gulfstream G200	35,450	276	3,500	1,700	450	-
GLF5 - Gulfstream V/G500/550	91,000	474	9,700	7,500	2,525	-
GLEX - Bombardier BD-700 Global Express	99,500	242	10,150	7,250	700	-
F2TH - Dassault Falcon 2000	35,800	576	4,500	3,500	1,300	-
GLF4 - Gulfstream IV/G400/450	73,900	976	10,710	8,860	4,635	-
CL60 - Bombardier Challenger 600/601/604	47,600	554	4,425	3,675	1,050	-
G150 - Gulfstream G150	26,150	200	5,850	5,200	1,340	-
LJ60 - Bombardier Learjet 60	23,500	256	2,100	1,800	400	-
C750 - Cessna Citation X	36,100	566	2,100	2,100	700	-
H25B - BAe HS 125/700-800/Hawker 800	28,000	996	1,400	1,400	400	-
Total Annual Operations		5,116				

Design Temperature 75 deg F.; Elevation 330 ft. MSL; Runway Gradient 0.28%
Bold indicates takeoff length requirements exceeding current runway capabilities at McClellan-Palomar Airport)

Table 8B also lists the additional useful load that each aircraft could accommodate for the alternative runway lengths versus the existing runway length (baseline) at the design temperature of 75 degrees F (mean maximum temperature of the hottest month). Thus, the impact on payload also provides a more readily discerning benefit-cost comparison between each of the runway length alternatives.

Considerations also needed to be given to the fact that the value or need for additional payload can vary for each flight and weather conditions. It must be considered that not every flight by the most demanding aircraft is to a long haul destination. Even on flights to closer destinations, there is still value to the user in carrying added fuel reserves or payload above the minimum.

At McClellan-Palomar, the lower airport elevation and minimal temperature extremes limit a wide variance. The mean maximum temperature of 75 degrees is exceeded 66 days a year and the average temperature is 61.7 degrees, just 13.3 degrees less than the design temperature. The average minimum temperature of 55 degrees is just 20 degrees less than the design temperature. All of the aircraft on the table would still be facing a weight penalty at 55 degrees F. To take into account the temperature variation and lesser loadings, the average useful load penalty was reduced to 40 percent of the maximum listed in **Table 8B** for each alternative length.

The value of the additional useful load benefit was measured in the cost of Jet A fuel. In March of 2013, the average cost of Jet A at McClellan-Palomar Airport was \$6.50 per gallon. With Jet A weighing 6.8 pounds per gallon, this would be equivalent to a benefit of \$0.96 cents per pound of additional useful load.

IDENTIFY ALTERNATIVES

The FAA recommends that the base case represent the best course of action that would be pursued in the absence of a major initiative to obtain the specified objectives. The base case or baseline alternative will assume optimal use of the existing runway infrastructure, plus the west end EMAS safety area improvements recommended earlier in the report that is assumed to occur regardless of the alternative.

The alternatives to meet the project objective were identified and screened earlier in the report. The three alternatives to be examined in the benefit-cost analysis include:

Alternative A – Extend runway along with taxiway access 200 feet east to a length of 5,100 feet at ARC B-II standards.

Alternative B – Extend runway along with taxiway access 900 feet east to a length of 5,800 feet and maintain ARC B-II design standards.

Alternative C – Extend runway along with taxiway access 1,200 feet east to a length of 6,100 feet and upgrade the airfield to ARC C-III standards.

ESTIMATE OF BENEFITS AND COSTS

COST IDENTIFICATION

The net costs above the baseline alternative for each of the alternatives meeting the project objective consist of non-sunk costs of investment, operations, and maintenance. The costs compared are marginal in that they only include those incremental costs which are incurred because the alternative is undertaken. Those costs which would be incurred in any event (such as the west end EMAS safety area improvements) are not included in this analysis.

Thus, the marginal costs for each alternative consist of the investment, recurring, and total costs associated with the extension of the runway. Construction costs for each alternative were broken down in **Chapter 5**.

Operations and maintenance for each alternative represent the estimated annual costs of additional pavement. The cost of a pavement overlay is included as a construction cost midway through the 20-year period. **Figures 8A, 8B, and 8C** present the costs in both 2013 constant dollars and as net present value discounted to the construction year for Alternatives A, B, and C.

BENEFITS DETERMINATION

Benefits are quantified from the reduced penalties to each business jet's useful load for the runway length corresponding to each alternative. **Table 8C** presents the operational forecasts for each aircraft that would benefit from a runway extension. The upper forecast is with no project, while the lower forecast reflects the potential increase in operations that could be experienced with a runway extension. The baseline forecast represents the activity that is anticipated with the baseline alternative as well as Alternative A. The project forecast is representative of the activity anticipated with Alternatives B and C. The forecast assumes a 4.0 percent annual growth in business jet activity beyond 2021 that is in line with FAA's forecast for growth in active business jets in the United States.

TABLE 8C
Critical Business Jet Operations Forecasts
McClellan-Palomar Airport

	Actual	Forecast w/o Project			
Aircraft	**2011**	**2016**	**2021**	**2028**	**2035**
GALX - IAI 1126 Galaxy/Gulfstream G200	276	337	400	527	693
GLF5 - Gulfstream V/G500/550	474	763	1,133	1,491	1,962
GLEX - Bombardier BD-700 Global Express	242	390	578	761	1,002
F2TH - Dassault Falcon 2000	576	703	835	1,099	1,446
GLF4 - Gulfstream IV/G400/450	976	1,191	1,415	1,862	2,451
CL60 - Bombardier Challenger 600/601/604	554	687	831	1,094	1,439
G150 - Gulfstream G150	200	244	290	382	502
LJ60 - Bombardier Learjet 60	256	254	210	276	364
C750 - Cessna Citation X	566	702	849	1,117	1,470
H25B - BAe HS 125/700-800/Hawker 800	996	1,235	1,494	1,966	2,587
Total Annual Operations	5,116	6,505	8,036	10,575	13,915
	Actual	**Forecast with Project**			
Aircraft	**2011**	**2016**	**2021**	**2028**	**2035**
GALX - IAI 1126 Galaxy/Gulfstream G200	276	422	522	686	903
GLF5 - Gulfstream V/G500/550	474	953	1,725	2,270	2,988
GLEX - Bombardier BD-700 Global Express	242	486	881	1,159	1,525
F2TH - Dassault Falcon 2000	576	852	1,094	1,440	1,895
GLF4 - Gulfstream IV/G400/450	976	1,493	1,854	2,440	3,211
CL60 - Bombardier Challenger 600/601/604	554	820	1,053	1,385	1,823
G150 - Gulfstream G150	200	306	378	497	655
LJ60 - Bombardier Learjet 60	256	374	360	474	623
C750 - Cessna Citation X	566	838	1,075	1,415	1,862
H25B - BAe HS 125/700-800/Hawker 800	996	1,474	1,892	2,490	3,277
Total Annual Operations	5,116	8,019	10,835	14,258	18,763

Figures 8A, 8B, and 8C present the resulting benefits as calculated for each alternative based on the assumptions outlined earlier. As with costs, the benefits are presented both in 2013 constant dollars and as net present value.

ALTERNATIVE COMPARISON

All of the alternatives were compared to the baseline alternative to determine if they have a net present value (NPV) greater than zero and a benefit-cost ratio greater than 1.0. For each alternative that meets the criteria, this ratio indicates that the alternative is economically preferred over the baseline alternative.

The benefit-cost ratio can also be used to weigh the three alternatives to determine which is the most economically advantageous. Each development alternative provides a different runway length and each runway length presents a separate set of costs which increase with the longer lengths. Subsequently, the longer

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ALTERNATIVE A - EXTEND RUNWAY 200 FEET

		Constant 2013 Dollars				Net Present Value				
Period	Year	Construction Costs	Operations/ Maintenance	Net Cost	Airport and User Benefits	Discount Rate 7%	Construction Costs	Operations/ Maintenance	Net Costs	Airport and User Benefits
0	2015	$ 22,452,400	$ -	$ 22,452,400	$ -	1.0000	$ 22,452,400	$ -	$ 22,452,400	$ -
1	2016	$ -	$ 20,000	$ 20,000	$ 2,087,433	0.9346	$ -	$ 18,692	$ 18,692	$ 1,950,915
2	2017	$ -	$ 20,000	$ 20,000	$ 2,191,005	0.8734	$ -	$ 17,468	$ 17,468	$ 1,913,624
3	2018	$ -	$ 20,000	$ 20,000	$ 2,294,577	0.8163	$ -	$ 16,326	$ 16,326	$ 1,873,064
4	2019	$ -	$ 20,000	$ 20,000	$ 2,398,149	0.7629	$ -	$ 15,258	$ 15,258	$ 1,829,548
5	2020	$ -	$ 20,000	$ 20,000	$ 2,501,722	0.7130	$ -	$ 14,260	$ 14,260	$ 1,783,727
6	2021	$ -	$ 20,000	$ 20,000	$ 2,605,294	0.6663	$ -	$ 13,326	$ 13,326	$ 1,735,907
7	2022	$ -	$ 20,000	$ 20,000	$ 2,709,505	0.6227	$ -	$ 12,454	$ 12,454	$ 1,687,209
8	2023	$ -	$ 20,000	$ 20,000	$ 2,817,886	0.5820	$ -	$ 11,640	$ 11,640	$ 1,640,009
9	2024	$ -	$ 20,000	$ 20,000	$ 2,930,601	0.5439	$ -	$ 10,878	$ 10,878	$ 1,593,954
10	2025	$ 75,000	$ 20,000	$ 95,000	$ 3,047,825	0.5083	$ 38,123	$ 10,166	$ 48,289	$ 1,549,209
11	2026	$ -	$ 20,000	$ 20,000	$ 3,169,738	0.4751	$ -	$ 9,502	$ 9,502	$ 1,505,943
12	2027	$ -	$ 20,000	$ 20,000	$ 3,296,528	0.4440	$ -	$ 8,880	$ 8,880	$ 1,463,658
13	2028	$ -	$ 20,000	$ 20,000	$ 3,428,389	0.4150	$ -	$ 8,300	$ 8,300	$ 1,422,781
14	2029	$ -	$ 20,000	$ 20,000	$ 3,565,524	0.3878	$ -	$ 7,756	$ 7,756	$ 1,382,710
15	2030	$ -	$ 20,000	$ 20,000	$ 3,708,145	0.3624	$ -	$ 7,248	$ 7,248	$ 1,343,832
16	2031	$ -	$ 20,000	$ 20,000	$ 3,856,471	0.3387	$ -	$ 6,774	$ 6,774	$ 1,306,187
17	2032	$ -	$ 20,000	$ 20,000	$ 4,010,730	0.3166	$ -	$ 6,332	$ 6,332	$ 1,269,797
18	2033	$ -	$ 20,000	$ 20,000	$ 4,171,159	0.2959	$ -	$ 5,918	$ 5,918	$ 1,234,246
19	2034	$ -	$ 20,000	$ 20,000	$ 4,338,005	0.2765	$ -	$ 5,530	$ 5,530	$ 1,199,458
20	2035	$ (7,858,340)	$ 20,000	$ (7,838,340)	$ 4,511,526	0.2584	$ (2,030,595)	$ 5,168	$ (2,025,427)	$ 1,165,778
		$ 14,669,060	$ 400,000	$ (7,383,340)	$ 63,640,211		$ 20,459,927	$ 211,876	$ 20,671,803	$ 30,851,558

Benefit Cost Ratio: $\frac{\$\ 30,851,558}{\$\ 20,671,803}$ **B/C= 1.49**

Figure 8A
BENEFIT COST
ALTERNATIVE A

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ALTERNATIVE B - EXTEND RUNWAY 900 FEET

Constant 2013 Dollars						Net Present Value				
Period	Year	Construction Costs	Operations/ Maintenance	Net Cost	Airport and User Benefits	Discount Rate 7%	Construction Costs	Operations/ Maintenance	Net Costs	Airport and User Benefits
0	2015	$ 49,596,600	$ -	$ 49,596,600	$ -	1.0000	$ 49,596,600	$ -	$ 49,596,600	$ -
1	2016	$ -	$ 90,000	$ 90,000	$ 7,017,048	0.9346	$ -	$ 84,114	$ 84,114	$ 6,558,133
2	2017	$ -	$ 90,000	$ 90,000	$ 7,596,649	0.8734	$ -	$ 78,606	$ 78,606	$ 6,634,913
3	2018	$ -	$ 90,000	$ 90,000	$ 8,176,250	0.8163	$ -	$ 73,467	$ 73,467	$ 6,674,273
4	2019	$ -	$ 90,000	$ 90,000	$ 8,755,851	0.7629	$ -	$ 68,661	$ 68,661	$ 6,679,839
5	2020	$ -	$ 90,000	$ 90,000	$ 9,335,452	0.7130	$ -	$ 64,170	$ 64,170	$ 6,656,178
6	2021	$ -	$ 90,000	$ 90,000	$ 9,915,054	0.6663	$ -	$ 59,967	$ 59,967	$ 6,606,400
7	2022	$ -	$ 90,000	$ 90,000	$ 10,311,656	0.6227	$ -	$ 56,043	$ 56,043	$ 6,421,068
8	2023	$ -	$ 90,000	$ 90,000	$ 10,724,122	0.5820	$ -	$ 52,380	$ 52,380	$ 6,241,439
9	2024	$ -	$ 90,000	$ 90,000	$ 11,153,087	0.5439	$ -	$ 48,951	$ 48,951	$ 6,066,164
10	2025	$ 335,000	$ 90,000	$ 425,000	$ 11,599,210	0.5083	$ 170,281	$ 45,747	$ 216,028	$ 5,895,879
11	2026	$ -	$ 90,000	$ 90,000	$ 12,063,179	0.4751	$ -	$ 42,759	$ 42,759	$ 5,731,216
12	2027	$ -	$ 90,000	$ 90,000	$ 12,545,706	0.4440	$ -	$ 39,960	$ 39,960	$ 5,570,293
13	2028	$ -	$ 90,000	$ 90,000	$ 13,047,534	0.4150	$ -	$ 37,350	$ 37,350	$ 5,414,727
14	2029	$ -	$ 90,000	$ 90,000	$ 13,569,435	0.3878	$ -	$ 34,902	$ 34,902	$ 5,262,227
15	2030	$ -	$ 90,000	$ 90,000	$ 14,112,213	0.3624	$ -	$ 32,616	$ 32,616	$ 5,114,266
16	2031	$ -	$ 90,000	$ 90,000	$ 14,676,701	0.3387	$ -	$ 30,483	$ 30,483	$ 4,970,999
17	2032	$ -	$ 90,000	$ 90,000	$ 15,263,769	0.3166	$ -	$ 28,494	$ 28,494	$ 4,832,509
18	2033	$ -	$ 90,000	$ 90,000	$ 15,874,320	0.2959	$ -	$ 26,631	$ 26,631	$ 4,697,211
19	2034	$ -	$ 90,000	$ 90,000	$ 16,509,293	0.2765	$ -	$ 24,885	$ 24,885	$ 4,564,820
20	2035	$ (17,358,810)	$ 90,000	$ (16,945,305)	$ 17,169,665	0.2584	$ (4,485,517)	$ 23,256	$ (4,462,261)	$ 4,436,641
		$ 32,572,790	$ 1,800,000	$ (15,223,810)	$ 239,416,194		$ 45,281,364	$ 953,442	$ 46,234,806	$ 115,029,195

Benefit Cost Ratio: $ 115,029,195 / $ 46,234,806 **B/C= 2.49**

Figure 8B
BENEFIT COST
ALTERNATIVE B

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ALTERNATIVE C - EXTEND RUNWAY 1,200 FEET

		Constant 2013 Dollars				Net Present Value				
Period	Year	Construction Costs	Operations/ Maintenance	Net Cost	Airport and User Benefits	Discount Rate 7%	Construction Costs	Operations/ Maintenance	Net Costs	Airport and User Benefits
0	2015	$ 61,296,800	$ -	$ 61,296,800	$ -	1.0000	$ 61,296,800	$ -	$ 61,296,800	$ -
1	2016	$ -	$ 120,000	$ 120,000	$ 8,700,899	0.9346	$ -	$ 112,152	$ 112,152	$ 8,131,860
2	2017	$ -	$ 120,000	$ 120,000	$ 9,439,163	0.8734	$ -	$ 104,808	$ 104,808	$ 8,244,165
3	2018	$ -	$ 120,000	$ 120,000	$ 10,177,428	0.8163	$ -	$ 97,956	$ 97,956	$ 8,307,834
4	2019	$ -	$ 120,000	$ 120,000	$ 10,915,692	0.7629	$ -	$ 91,548	$ 91,548	$ 8,327,581
5	2020	$ -	$ 120,000	$ 120,000	$ 11,653,956	0.7130	$ -	$ 85,560	$ 85,560	$ 8,309,271
6	2021	$ -	$ 120,000	$ 120,000	$ 12,392,220	0.6663	$ -	$ 79,956	$ 79,956	$ 8,256,936
7	2022	$ -	$ 120,000	$ 120,000	$ 12,887,909	0.6227	$ -	$ 74,724	$ 74,724	$ 8,025,301
8	2023	$ -	$ 120,000	$ 120,000	$ 13,403,425	0.5820	$ -	$ 69,840	$ 69,840	$ 7,800,793
9	2024	$ -	$ 120,000	$ 120,000	$ 13,939,562	0.5439	$ -	$ 65,268	$ 65,268	$ 7,581,728
10	2025	$ 450,000	$ 120,000	$ 570,000	$ 14,497,145	0.5083	$ 228,735	$ 60,996	$ 289,731	$ 7,368,899
11	2026	$ -	$ 120,000	$ 120,000	$ 15,077,030	0.4751	$ -	$ 57,012	$ 57,012	$ 7,163,097
12	2027	$ -	$ 120,000	$ 120,000	$ 15,680,112	0.4440	$ -	$ 53,280	$ 53,280	$ 6,961,970
13	2028	$ -	$ 120,000	$ 120,000	$ 16,307,316	0.4150	$ -	$ 49,800	$ 49,800	$ 6,767,536
14	2029	$ -	$ 120,000	$ 120,000	$ 16,959,609	0.3878	$ -	$ 46,536	$ 46,536	$ 6,576,936
15	2030	$ -	$ 120,000	$ 120,000	$ 17,637,993	0.3624	$ -	$ 43,488	$ 43,488	$ 6,392,009
16	2031	$ -	$ 120,000	$ 120,000	$ 18,343,513	0.3387	$ -	$ 40,644	$ 40,644	$ 6,212,948
17	2032	$ -	$ 120,000	$ 120,000	$ 19,077,253	0.3166	$ -	$ 37,992	$ 37,992	$ 6,039,858
18	2033	$ -	$ 120,000	$ 120,000	$ 19,840,343	0.2959	$ -	$ 35,508	$ 35,508	$ 5,870,758
19	2034	$ -	$ 120,000	$ 120,000	$ 20,633,957	0.2765	$ -	$ 33,180	$ 33,180	$ 5,705,289
20	2035	$ (21,453,880)	$ 120,000	$ (21,333,880)	$ 21,459,315	0.2584	$ (5,543,683)	$ 31,008	$ (5,512,675)	$ 5,545,087
		$ 40,292,920	$ 2,400,000	$ (18,603,880)	$ 299,023,840		$ 55,981,852	$ 1,271,256	$ 57,253,108	$ 143,589,856

Benefit Cost Ratio: $\frac{\$\ 143,589,856}{\$\ 57,253,108}$ **B/C= 2.51**

Figure 8C
BENEFIT COST
ALTERNATIVE C

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lengths have the potential to provide increased benefits in the ability for the aircraft to carry more fuel and/or payload. **Table 8D** summarizes the benefits and costs from the three Figures. Alternative A has a discounted cost of $20.7 million and quantifiable benefits of $30.9 million. Thus, the net present value is $10.2 million with a benefit-cost ratio of 1.49.

Table 8D
Benefit-Cost Analysis
McClellan-Palomar Airport Runway Improvements

	Constant Dollars	Net Present Value
ALTERNATIVE A - 200 Foot Extension, ARC B-II		
Non-Sunk Costs		
Net Investment	$22,527,400	$22,490,523
Recurring	$400,000	$211,876
Total Before Disposal	$22,927,400	$22,702,399
Less Disposal Value	$ (7,858,340)	$ (2,030,595)
Net Life Cycle Costs	$15,069,060	$20,671,803
Benefits		
Increased Useful Load Benefits	$63,640,211	$30,851,558
Benefit Cost Ratio		1.49
ALTERNATIVE B - 900 Foot Extension, ARC B-II		
Non-Sunk Costs		
Net Investment	$50,291,600	$50,126,881
Recurring	$1,800,000	$953,442
Total Before Disposal	$52,091,600	$51,080,323
Less Disposal Value	$ (17,484,810)	$ (4,518,075)
Net Life Cycle Costs	$34,606,790	$46,562,248
Benefits		
Increased Useful Loads	$239,416,194	$115,029,195
Benefit Cost Ratio		**2.47**
ALTERNATIVE C - 1200 Foot Extension, ARC C-III		
Non-Sunk Costs		
Net Investment	$61,746,800	$61,525,535
Recurring	$2,400,000	$1,271,256
Total Before Disposal	$64,146,800	$62,796,791
Less Disposal Value	$ (21,453,880)	$ (5,543,683)
Net Life Cycle Costs	$42,692,920	$57,253,108
Benefits		
Increased Useful Loads	$299,023,840	$143,589,856
Benefit Cost Ratio		**2.51**

Alternative B has a discounted cost of $46.6 million and quantifiable benefits of $115.0 million. This results in a net present value of $68.4 million and a benefit-cost ratio of 2.47.

Finally, Alternative C has a discounted cost of $57.3 million and quantifiable benefits of $143.6 million, resulting in the highest net present value of $86.3 million. While Alternative C has the highest net present value, its benefit-cost ratio is essentially the same as Alternative B at 2.51.

SENSITIVITY ANALYSIS

Several scenarios were considered in the sensitivity analysis for the project which included variations in the discount rate and slower growth in operational activity. These scenarios are discussed below and their benefit-costs are summarized in **Table 8E**.

Table 8E
Sensitivity Analysis
McClellan-Palomar Airport Runway Improvements

	Present Value Costs (million$)	Present Value Benefits (million$)	Benefit/Cost Ratio
Discount Rate Sensitivity			
Four Percent			
Alternative A	$19,188,332	$41,064,176	2.14
Alternative B	$43,123,501	$153,738,063	3.57
Alternative C	$53,440,117	$191,957,928	3.59
Ten Percent			
Alternative A	$21,483,831	$23,960,620	1.12
Alternative B	$47,912,429	$88,945,495	1.86
Alternative C	$59,303,836	$110,999,996	1.89
Lower Activity Growth Sensitivity			
No-Project Growth Rate			
Alternative A	$20,671,803	$30,851,558	1.49
Alternative B	$46,234,806	$84,942,136	1.84
Alternative C	$57,253,108	$105,655,759	1.85
No Traffic Growth			
Alternative A	$20,671,803	$17,234,591	0.83
Alternative B	$46,234,806	$45,694,102	0.99
Alternative C	$57,253,108	$56,317,331	0.98

DISCOUNT RATES

The Office of Aviation Policy and Plans suggests conducting sensitivity estimates at four and ten percent to show the range in impact of varying the discount rate. If the discount rate is lowered to four percent, the benefit-cost ratio increases. Alternative A increases to 2.14, Alternative B increases to 3.57, and Alternative C to 3.59.

If the discount rate increases, the benefit-cost ratios would decrease, but in each alternative, they would remain above 1.0. Alternative A would decrease to 1.12, Alternative B to 1.86, and Alternative C to 1.87.

ACTIVITY PROJECTIONS

The forecasted growth in activity by the business jets that would benefit most from the project included an increase in operations associated with the availability of a longer runway. This increase was applied to Alternatives B and C, but the shorter extension of Alternative A, while benefitting existing users, was not assumed to attract additional traffic.

Because the primary objective of the project is to improve efficiency for the existing users of the airport, a sensitivity analysis was conducted assuming the no project forecast for each alternative. The benefit-cost ratio would remain unchanged at 1.49 for Alternative A because it was based on this growth rate. The lower traffic growth results in a benefit-cost ratio of 1.84 for Alternative B and 1.85 for Alternative C.

To understand the full range of the sensitivity analysis, the benefit-cost was also run based on a no traffic growth scenario. Under this scenario, it is assumed that the operations produced by the critical business jets would remain at their 2011 levels. In this case, the benefit-cost ratio for Alternative A drops below 1.0 to 0.83. Alternative B actually becomes slightly higher than Alternative C at 0.99. Both of the latter Alternatives would become marginally viable with the no growth in traffic scenario.

CONCLUSIONS

Based on the data evaluated, all three alternatives are considered reasonable from a benefit-cost standpoint with ratios above 1.0. The benefit-cost ratios associated with Alternatives B and C are similar, but substantially higher than Alternative A. The higher investment associated with Alternative C results in a marginally higher benefit-cost ratio compared to Alternative B (2.51 versus 2.49). Although the ratio for both options remains near or above 1.0, the difference becomes even less when subject to the sensitivity analysis. As a result, the lesser investment required for Alternative B would seem more prudent and feasible compared to Alternative C.

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Chapter Nine ENVIRONMENTAL ISSUES OVERVIEW

The primary purpose of this overview is to identify potential environmental sensitivities on or near the McClellan-Palomar Airport and to evaluate potential runway improvements to determine whether the proposed actions could individually or collectively affect the quality of the environment.

McClellan-Palomar Airport is located in northern San Diego County within the jurisdictional limits of the City of Carlsbad. Access to the airport is provided via El Camino Real, which forms the airport's eastern boundary, and Palomar Airport Road, which is located directly to the south. These two roads provide the airport with regional access via Interstate 5, located approximately three miles to the west, and via Highway 78, located five to six miles to the north and east (**Figure 9A**).

Construction of the runway improvements would require compliance with the *National Environmental Policy Act* (NEPA) *of 1969*, as amended, as well as evaluation under the *California Environmental Quality Act* (CEQA). For projects not "categorically excluded" under Federal Aviation Administration (FAA) Order 1050.1E, *Environmental Impacts: Policies and Procedures*, compliance with NEPA is generally satisfied through the preparation of an Environmental Assessment (EA). In instances where significant environmental impacts are expected, an Environmental Impact Statement (EIS) may be required. While this environmental overview is not designed to satisfy the NEPA requirements for a categorical exclusion, EA, or EIS, it is intended to provide a preliminary review of environmental issues that would need to be analyzed in more detail within the NEPA process. This evaluation considers all environmental categories required for the NEPA process as outlined in FAA Order 1050.1E and Order 5050.4B, *National Environmental Policy Act* (NEPA) *Implementation Instructions for Airport Actions.* Additional impact analysis may be required under CEQA.

GENERAL ENVIRONMENTAL AND LAND USE CONSTRAINTS

The McClellan-Palomar Airport site is situated on a mesa that was originally crossed by several canyons. These canyons were utilized as landfills by San Diego County up until 1986. The filled canyons were then graded and capped and methane extraction facilities were installed along with monitoring wells. The landfills are unlined. Portions of the airport, which are used for airfield and aircraft parking, were then constructed on a previously closed municipal landfill. Additional detail on the landfill and its location is provided in Chapter Five of this Feasibility Study.

The airport is surrounded primarily by light industrial and commercial development as well as a municipal golf course (The Crossings) directly to the west (**Fig-**

ure 9B). Northeast of the airport across El Camino Real is a natural canyon associated with Agua Hedionda Creek. The area has moderate topography and is wooded with natural trees and other vegetation. The closest residential areas are more than 0.4 mile from the airfield.

Although owned and operated by the County of San Diego, the airport is subject to a Conditional Use Permit (CUP 172) from the City of Carlsbad. This permit was originally issued in September 1980 and specifies the types of uses that are allowed at the airport without the need for additional discretionary review, as well as those uses that require additional Planning Commission or Planning Director approval. The most recent CUP amendment (CUP 172[B]) was approved in 2004 to allow an additional auto parking area at the airport.

In addition to the conditions of the airport's CUP, Ordinance No. 9558 was adopted by the Carlsbad City Council in August 1980. The ordinance was passed in response to the circulation of a citizens' initiative petition and requires any expansion of the airport to be voted on by the electorate of the City of Carlsbad. According to the ordinance, to require a vote, a proposal must involve both an expansion of the airport and necessitate corresponding legislative enactment.

The approved ordinance became part of the Carlsbad Municipal Code of Ordinances (Chapter 21.53.01), which reads:

21.53.015 - Voter authorization required for airport expansion.

> (a) The city council shall not approve any zone change, general plan amendment or any other legislative enactment necessary to authorize expansion of any airport in the city nor shall the city commence any action or spend any funds preparatory to or in anticipation of such approvals without having been first authorized to do so by a majority vote of the qualified electors of the city voting at an election for such purposes.
>
> (b) This section was proposed by initiative petition and adopted by the vote of the city council without submission to the voters and it shall not be repealed or amended except by a vote of the people.

The following impact categories listed in FAA Orders 1050.1E and 5050.4B are addressed in more detail below:

AIR QUALITY

Federal *Clean Air Act* and NEPA Compliance

The United States (U.S.) Environmental Protection Agency (EPA) has adopted air quality standards that specify the maximum permissible short-term and long-term concentrations of various air contaminants based on potential health effects. The National Ambient Air Quality Standards (NAAQS) consist of primary and secondary standards for six criteria pollutants, which include: ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxide (NO), particulate matter (PM_{10} and $PM_{2.5}$), and lead (Pb).

Figure 9A
REGIONAL PROJECT LOCATION

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Figure 9B
EXISTING LAND USE

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Potentially significant air quality impacts associated with an FAA project or action is demonstrated by the project or action exceeding one or more of the NAAQS for any of the time periods analyzed.

To ensure that a federal action complies with the NAAQS, the *Clean Air Act* (CAA) establishes a General Conformity Rule for all general federal actions, including airport improvement projects, if the action is located within a nonattainment area. In 2012, all of San Diego County, California was a nonattainment area for the 2008 federal 8-hour ozone standard and was classified as Marginal.[1] Therefore, a General Conformity analysis would be required for the proposed runway improvements.

Under NEPA, the FAA requires that an air quality emissions inventory be prepared for federal actions at airports where forecast general aviation operations exceed 180,000. As discussed in Chapter Three of the Feasibility Study (**Figure 3G**), the airport is forecast to have future total operations of 172,900 by the year 2021 if the runway improvements are constructed. Therefore, an operational air quality emissions inventory would not be required under NEPA at this time. Construction-related air quality impacts are discussed in the section on Construction Impacts.

California Ambient Air Quality Standards

In California, the California Air Resources Board (CARB) manages air quality, regulates mobile emissions sources, and oversees the activities of county and regional air districts. CARB also regulates local air quality indirectly by establishing California Ambient Air Quality Standards (CAAQS) and vehicle emissions standards, and by conducting research, planning, and coordination activities. California has adopted ambient standards that are more stringent than the federal standards for the criteria air pollutants. Both the NAAQS and CAAQS are shown in **Table 1**. The San Diego County Air Pollution Control District (APCD) is comprised of all of San Diego County and is in nonattainment for ozone and particulate matter (CARB 2012).

[1] For the 2008 8-hour ozone standards, Marginal means an "area has a design value of 0.076 up to but not including 0.086 ppm." Source: http://www.epa.gov/oar/oaqps/greenbk/anay_ca.html, accessed February 2013.

TABLE 1
National and California Ambient Air Quality Standards
County of San Diego

Pollutant	Averaging Time	Federal Standards (NAAQS) Primary Concentration	Federal Standards (NAAQS) Attainment Status[1]	California Standards (CAAQS) Concentration	California Standards (CAAQS) Attainment Status[2]
Carbon Monoxide (CO)	8-hour	9 ppm	Attainment	9 ppm	Attainment
	1-hour	35 ppm	Attainment	20 ppm	Attainment
Lead (Pb)	Rolling 3-month Average	0.15 μg/m³	Attainment	—	—
	30 Day Average	—	—	1.5 μg/m³	Attainment
Nitrogen Dioxide (NO_2)	Annual (arithmetic average)	0.053 ppm	Attainment	0.030 ppm	Attainment
	1-hour	100 ppb	Data not yet available.	0.18 ppm	Attainment
Ozone (O_3)	8-hour	0.075 ppm (2008)	Marginal Nonattainment	0.070 ppm	Nonattainment
	1-hour	—	—	0.09 ppm	Serious Nonattainment
Particulate Matter (PM_{10})	24-hour	150 μg/m³	Unclassified	50 μg/m³	Nonattainment
	Annual (arithmetic average)	—	—	20 μg/m³	Nonattainment
Particulate Matter ($PM_{2.5}$)	Annual (arithmetic average)	15 μg/m³	Attainment	12 μg/m³	Nonattainment
	24-hour	35 μg/m³	Attainment	—	—
Sulfur Dioxide (SO_2)	Annual (arithmetic average)	0.03 ppm	Attainment	—	—
	24-hour	0.14 ppm	Attainment	0.04 ppm	Attainment
	1-hour	75 ppb	Attainment	0.25 ppm	Attainment

NAAQS – National Ambient Air Quality Standards; CAAQS = California Ambient Air Quality Standards
μg/m³ – micrograms per cubic meter; ppm – parts per million; ppb – parts per billion

Sources:
[1] U.S.EPA 2012. http://www.epa.gov/oar/oaqps/greenbk/anay_ca.html, accessed February 2013.
[2] CARB 2012. http://www.arb.ca.gov/desig/adm/adm.htm, accessed February 2013.

Greenhouse Gases

The impact of proposed projects on climate change is another issue of growing concern. Greenhouse gases (GHGs) are those that trap heat in the earth's atmosphere. Greenhouse gases can be either naturally occurring or anthropogenic (man-made) and include water vapor (H_2O) and carbon dioxide (CO_2). Several classes of halogenated substances that contain fluorine, chlorine, or bromine are also GHGs, but they are, for the most part, solely a product of industrial activities. All GHG inventories measure CO_2 emissions, but beyond CO_2, different inventories include different greenhouse gases (such as methane [CH_4], nitrous oxide [N_2O], and O_3).

No federal significance thresholds for the creation of GHGs have been promulgated to date. However, research has shown that there is a direct link between fuel combustion and GHG emissions. Therefore, sources that require fuel or power at an airport are the primary sources that would generate GHGs. Aircraft jet engines, like many other vehicle engines, produce CO_2, H_2O, nitrogen oxides (NO_x), CO, oxides of sulfur (SO_x), unburned or partially combusted hydrocarbons (known as volatile organic compounds, VOCs), particulates, and other trace compounds.

The scientific community is developing areas of further study in order to more precisely estimate aviation's effects on the global atmosphere. The FAA is currently leading or participating in several efforts intended to clarify the role that commercial aviation plays in greenhouse gases and climate changes. The most comprehensive and multi-year program geared towards quantifying climate change effects of aviation is the Aviation Climate Change Research Initiative (ACCRI) funded by the FAA and the National Aeronautics and Space Administration (NASA). ACCRI hopes to reduce key scientific uncertainties in quantifying aviation-related climate impacts and provide timely scientific input to inform policy-making decisions. The FAA also funds Project 12 of the Partnership for Air Transportation Noise & Emissions Reduction (PARTNER) Center of Excellence research initiative to quantify the effects of aircraft exhaust and contrails on global and U.S. climate and atmospheric composition.

Although federal regulations under the *Clean Air Act* regarding the reduction of GHG emissions have yet to be approved, the State of California has adopted the following regulations related to GHG emissions:

- The *California Global Warming Act of 2006* (Assembly Bill [AB] 32) -- establishes a state goal of reducing GHG emissions to 1990 levels by 2020.

- AB 32 Climate Scoping Plan -- this plan, adopted by CARB in December 2008, provides a range of GHG-reducing actions.

- State Bill (SB) 97 -- amended CEQA to require an analysis of GHG emissions and their effects (effective July 1, 2009). The 2009 amendments to the CEQA guidelines (California Public Resources Code [PRC], Division 13, §15064.4) revised the guidelines to include a determination of the significance of GHG emissions.

- SB 375 -- identified regional councils as the agencies responsible for the establishment of goals for emissions-reduction at the local level.

As part of a tiered significance framework, the County of San Diego adopted an operational screening threshold level of 2,500 metric tons (MT) of carbon dioxide equivalent (CO_2E)[2] per year. This threshold is not applied to construction emissions (County of San Diego 2012).

The runway improvements at McClellan-Palomar Airport would improve the efficiency of business jets operating in San Diego County. Currently, due to the run-

[2] GHG emissions are typically measured in terms of pounds or tons of "CO_2 equivalent" (CO_2E). The CO_2E for a gas is derived by multiplying the mass of the gas by the associated global warming potential (GWP) (i.e., potential of a gas or aerosol to trap heat in the atmosphere), such that MT CO_2E = (metric tons of a GHG) x (GWP of the GHG). For example, the GWP for CH_4 is 21.

way limitations, certain cross-country and international business jet flights must make fuel stops enroute. This requires an additional landing-takeoff cycle which increases the amount of fuel burned in reaching the destination. While the fuel stop could be at one of numerous locations enroute, in some cases, a business jet will depart McClellan-Palomar Airport and make the fuel stop at nearby San Diego International Airport which has sufficient runway length. In these cases, the additional landing-takeoff cycle occurs locally in San Diego County. With the runway improvements, the efficiency or "green benefits" of the project would help to offset overall fuel usage and, hence, greenhouse gas and other air quality emissions.

COASTAL RESOURCES

Federal activities involving or affecting coastal resources are governed by the *Coastal Barriers Resource Act* (CBRA), the *Coastal Zone Management Act of 1972* (CZMA), and Executive Order (E.O.) 13089, *Coral Reef Protection*. In California, CZMA (Title 16 United States Code [USC] §1451 et seq.) is implemented through the *California Coastal Act of 1976* (PRC §30000 et seq.). Protected habitats within Coastal Zones include intertidal and near shore waters, wetlands, bays and estuaries, riparian habitat, certain woods and grasslands, streams, lakes, and habitat for rare or endangered plants or animals.

The City of Carlsbad has a Local Coastal Program (LCP) that has been certified by the California Coastal Commission (1996, amended 2010). The airport is located outside of the Coastal Zone and the City's LCP boundary. However, there is one area, located within the City LCP's Mello II segment which is located immediately adjacent to airport property to the north (**Figure 9C**). This parcel is part of the city-owned golf course and contains sensitive biological resources that are protected in the City's *Habitat Management Plan* (HMP) (2004).

COMPATIBLE LAND USE/NOISE

The compatibility of existing and planned land uses in the vicinity of an airport is usually associated with the extent of the airport's noise impacts. Federal land use compatibility guidelines established under Title 14 Code of Federal Regulations (CFR) Part 150, *Airport Noise Compatibility Planning*, indicate that residential land uses and schools are considered incompatible within a 65 decibel (dB) or higher noise contour. Other noise-sensitive land uses include hospitals and places of worship. FAA Orders 1050.1E and 5050.4B define a significant noise impact as one which would occur if the proposed action would cause noise-sensitive areas to experience an increase in noise of 1.5 dB or more at or above the 65 Day-Night Equivalency Level (DNL) noise contour when compared to a No Action alternative for the same timeframe. In California, the FAA allows the use of Community Noise Equivalency Levels (CNEL) rather than DNL to define a significant noise impact.

Existing and projected noise contours associated with the proposed runway improvements are depicted in **Figure 9D.** As can be seen in this figure, existing and future 65 dB noise contours would extend off the airport to the north, south, and west; none of these contours, however,

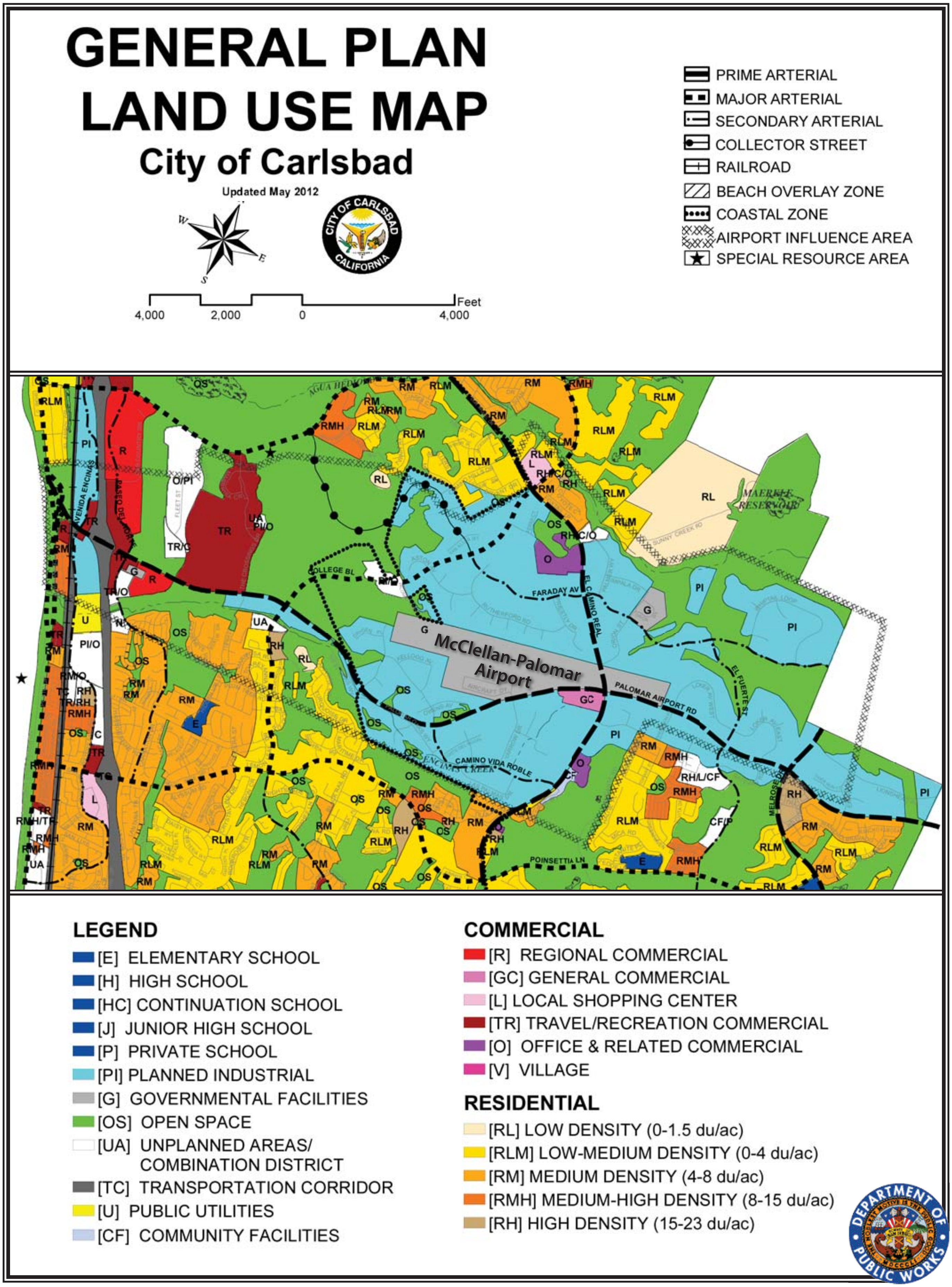

Figure 9C
GENERAL PLAN LAND USE

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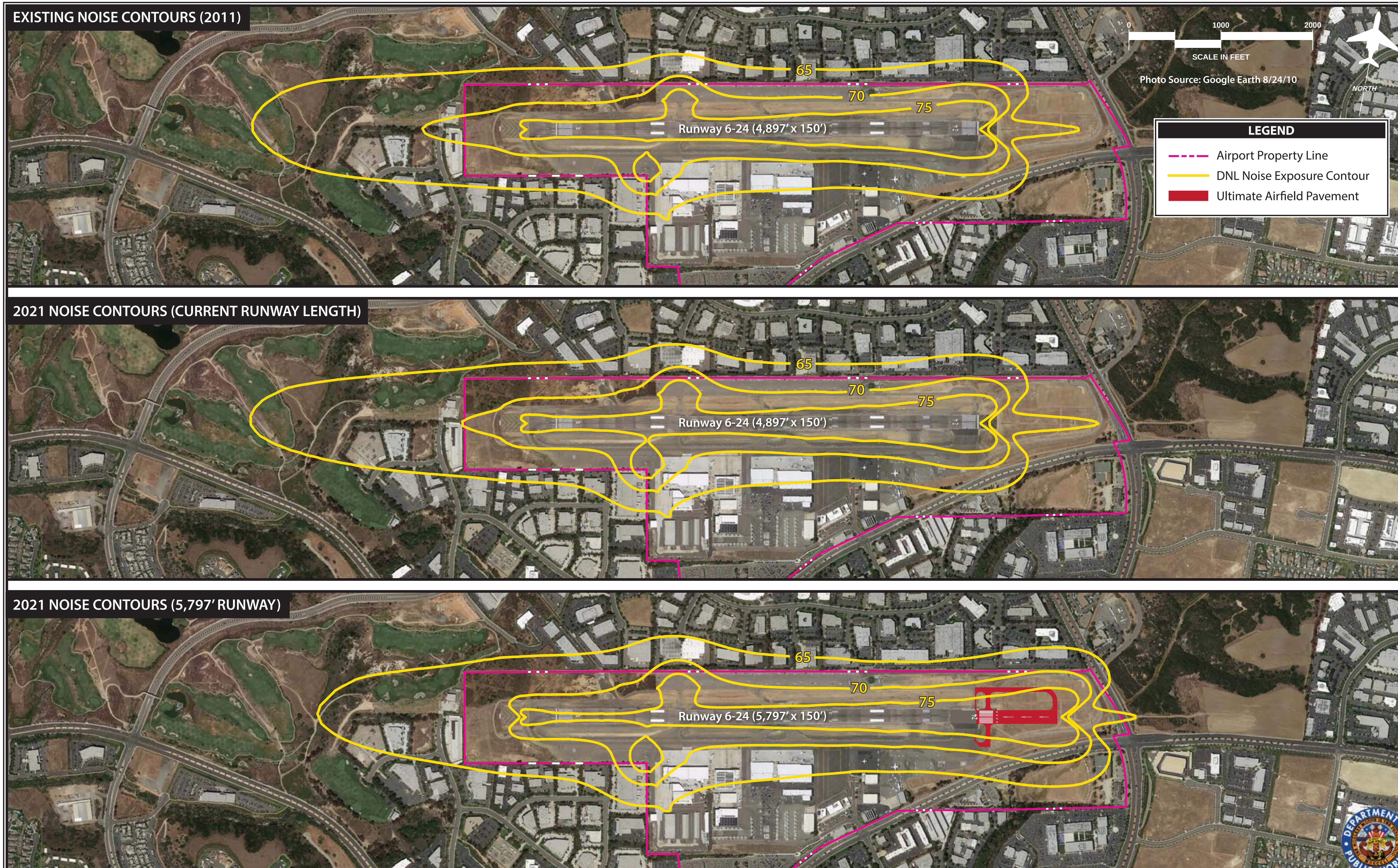

Figure 9D
NOISE CONTOURS COMPARISON

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are located over noise-sensitive land uses. The closest noise-sensitive land uses to the east end of the airport are a church (Holy Cross Episcopal Church) and a residential neighborhood, located approximately 0.3 to 0.4 mile southeast of the airport off Gateway Road, respectively. The closest noise-sensitive land uses to the west side of the airport are more than 0.5 mile away.

If the runway is extended to the east, the noise contours would also shift to the east as shown in the 2021 noise contours in **Figure 9D**. In this scenario, the 65 dB noise contour would extend past the eastern airport boundary very slightly. On the west side, the 65 dB would cover a smaller portion of the golf course than presently occurs. In all of the future scenarios considered, however, the airport, both now and with the proposed runway extension, would remain a compatible land use within the area. No noise-sensitive land uses would be adversely affected.

Compatible land use also addresses nearby features that could pose a threat to safe aircraft operations. These features include land uses that attract wildlife (for example, landfills and water features) or structures within approach and departure zones. Existing land use near the airport includes a golf course and commercial and light industrial development. **Figure 9B** shows generalized land uses surrounding the airport.

There are no land uses that would pose a safety hazard to the airport. The closest water features to the airport are a pond, located approximately 0.5 mile north of the airfield within a light industrial area and two ponds located within the golf course approximately 0.65 mile to the west. The previous landfills in the area have been closed and capped and do not attract wildlife that could be hazardous to airport operations.

In addition, the City of Carlsbad has addressed development surrounding the airport in its General Plan. **Figure 9C** shows the *City of Carlsbad General Plan* Land Use Map designations within the Airport Influence Area. To limit noise impacts on noise-sensitive land uses, the area surrounding the airport is designated primarily as Planned Industrial with an Open Space designation over the golf course and a small area of General Commercial on the southwestern corner of El Camino Real and Palomar Airport Road. The airport itself is designated as Government Facilities. The *City of Carlsbad Land Use Plan* includes the following Implementing Policies and Action Programs related to the airport:

> Industrial Policy
>
> Policy C.4 Concentrate more intense industrial uses in those areas least desirable for residential development -- in the general area of the flight path corridor of McClellan-Palomar Airport.
>
> Special Planning Considerations –- Airport
>
> Policy C.1 Require all parcels of land located in the Airport Influence Area to receive discretionary approval as follows: all parcels must process either a site development plan, planned industrial permit, or other discretionary permit. Unless otherwise approved by City Council, development proposals must be in compliance with the noise standards of the Comprehensive Land Use Plan (CLUP) and meet FAA requirements with respect

to building height as well as the provision of obstruction lighting when appurtenances are permitted to penetrate the transitional surface (a 7:1 slope from the runway primary surface). Consider County Airport Land Use Commission recommendations in the review of development proposals.

Policy C.2 Coordinate with the San Diego Association of Governments and the Federal Aviation Administration to protect public health, safety and welfare by ensuring the orderly operation of the Airport and the adoption of land use measures that minimize the public's exposure to excessive noise and safety hazards within areas around the airport.

The City's Noise Element references San Diego Association of Government's (SANDAG) 1994 Noise Contour map contained in the Comprehensive Land Use Plan (CLUP) for McClellan-Palomar Airport and identifies policies that provide for the following two overall objectives:

Objective B.1 To minimize noise impacts on City residents, the City has planned for nonresidential land uses within the 65 dBA CNEL Noise Contour of McClellan-Palomar Airport, as show on Map 3: Airport Noise Contour Map.

Objective B.2 To develop and enforce programs dealing with airport noise disclosure, avigation.

In addition, the City's Public Safety Element contains Airport Hazards objectives and policies that also reference the airport's CLUP and the City's Noise Element as well as the following policy regarding development within the Airport Influence Area:

C.3 Review development proposals in the Airport Influence Area to ensure that design features are incorporated into proposed site plans which specifically address aircraft crash and noise hazards.

CONSTRUCTION IMPACTS

Airport construction impacts can include dust, air emissions, traffic, storm water runoff, and noise. Construction-related dust impacts are typically mitigated below a level of significance through the use of best management practices (BMPs), such as those identified in FAA Advisory Circular (AC) 150/5370-10F, *Standards for Specifying Construction of Airports, Item P-156, Temporary Air and Water Pollution, Soil Erosion and Siltation Control* (FAA 2011).

A generalized list of BMPs is as follows:

<u>Site Preparation and Construction</u>

- Minimize land disturbance
- Suppress dust on traveled paths which are not paved through wetting, use of watering trucks, chemical dust suppressants, or other reasonable precautions to prevent dust from entering ambient air
- Cover trucks when hauling soil
- Minimize soil track-out by washing or cleaning truck wheels before leaving construction site
- Stabilize the surface of soil piles
- Create windbreaks

<u>Site Restoration</u>

- Revegetate or stabilize any disturbed land not used
- Remove unused material
- Remove soil piles via covered trucks or stockpile dirt in a protected area

In addition to the creation of dust, construction projects planned at the airport could have temporary air quality impacts due to emissions from the operation of construction vehicles and equipment. Thus, air emissions inventories related to construction activities may be required for NEPA or CEQA documentation efforts.

Construction traffic impacts could occur when trucks or heavy equipment need to access a site through a residential neighborhood or other sensitive area or on already congested streets or intersections. In the case of McClellan-Palomar Airport, no construction traffic impacts would occur since access to the airport does not involve residential neighborhoods or congested streets, but would occur directly from Palomar Airport Road or El Camino Real. According to the City's 2012 Traffic Monitoring Program, all roadway segment and intersections along El Camino Real and Palomar Airport Road near the airport operate at acceptable levels of service (i.e., LOS A, B or C), even in the A.M. and P.M. peak hours.

Water quality concerns could occur if there are storm events during the construction period. The *Clean Water Act* (CWA) requires that each state regulate point and nonpoint sources of water pollution, including storm water discharges. State water resources are also protected under California's *Porter-Cologne Water Quality Control Act of 1967*. This Act establishes regional water quality control boards (RWQCBs) to oversee water quality on a day-to-day basis at the regional/local level. There are nine RWQCBs in California. San Diego County is under the administration of the San Diego RWQCB.

The applicable water quality control plan for San Diego County is the updated *Water Quality Control Plan for the San Diego Basin* (Basin Plan), with amendments effective on, or before April 4, 2011. The State of California and its RWQCBs work with the EPA to administer the National Pollutant Discharge Elimination System (NPDES) permit program, including the regulation of storm water. The use of BMPs is a requirement of construction-related permits such as the NPDES Construction General Permit and is incorporated into approved storm water pollution prevention plans (SWPPPs). The airport has a current SWPPP.

Construction projects at the airport would result in temporary noise. The closest noise-sensitive receptors to the airport that could be affected by construction noise are within a residential neighborhood located approximately 2,000 feet southeast of the east end of the airport. Proposed development at the east end of the airport includes the extension of the runway approximately 900 feet and the potential construction of a full-length parallel taxiway on the south side. On the west end, the construction of the proposed runway safety area improvements is at least 2,500 feet from the closest noise-sensitive land uses. According to the City of Carlsbad Noise Ordinance, Section 8.48.020, since there are no inhabited dwellings within 1,000 feet of proposed construction areas, there are no limitations on hours of construction, and construction noise is not expected to have adverse effects.

DEPARTMENT OF TRANSPORTATION (DOT) ACT: SECTION 4(f)

Section 4(f) of the *Department of Transportation Act of 1966* (49 USC 303) protects against the loss of significant publicly-owned parks and recreation areas, publicly-owned wildlife and waterfowl refuges, and historic sites as a result of federally funded transportation projects. The Act states that a project which requires the "use" of such lands shall not be approved unless there is no "feasible and prudent" alternative and the project includes all possible planning to minimize harm from such use. In addition, the term "use" includes not only the physical taking of such lands, but "constructive use" of such lands. "Constructive use" of lands occurs when "a project's proximity impacts are so severe that the protected activities, features, or attributes that qualify a resource for protection under Section 4(f) are substantially impaired" (23 CFR Part 771.135).

There are several publicly-owned recreational areas within proximity to the airport. The closest of these public recreational areas is the city-owned golf course, The Crossings, located adjacent to the airport on its western and northwestern ends. In addition, Aviara Community Park is just over 0.5 mile south of the airport. There are also several neighborhood parks located from 0.5 to 1.0 mile southeast of the airport within the Bressi Ranch residential development.

Currently, the 65 dB CNEL for the airport, extends over a portion of The Crossings golf course. As a result of the proposed improvements, this CNEL would cover a slightly different area in 2021. With the runway extension, the CNEL would cover less of the golf course than if the runway is not extended. Refer to **Figure 9D**. Since the improvements would not increase the amount of Section 4(f) lands affected by noise levels between 65 and 70 CNEL, and may actually reduce the amount of Section 4(f) land affected by airport noise, no loss of Section 4(f) land or its uses would occur. There are no publicly owned wildlife or waterfowl refuges within one mile of the airport.

According to the National Register of Historic Places (NRHP), the closest listed resource on the NRHP, Ranchos de los Kiotes, is more than two miles from the airport.[3] It is not likely that there are significant historic sites located on the airport since the airport was constructed partially over a closed municipal landfill. However, any runway improvements that would occur in previously undisturbed and unsurveyed areas should be subject to a cultural resources literature search and field survey to confirm this conclusion. No historic aboveground structures are present as the airport was constructed in the late 1950s as a replacement for Del Mar Airport.

FARMLAND

Based on U.S. Department of Agriculture (USDA), Natural Resources Conservation Service's Web Soil Survey map, most of the airport is comprised of the following soils: HrD2, Huerhuero loam, 9 to 15 percent slopes; HuC, Huerhuero-Urban land complex, 2 to 9 percent slopes; and LvF3, Loamy alluvial land-Huerhuero complex,

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3 http://nrhp.focus.nps.gov/natreg/docs/Download.html, accessed February 2013.

9 to 50 percent slopes.[4] These soils are not considered to be prime farmland or other farmland categories protected under the *Farmland Protection Policy Act* (FPPA) (7 USC 4201 et seq.).

Other soils located along the northern airport property, however, are considered to be farmland of statewide importance, (i.e., DaC, Diablo clay, 2 to 9 percent slopes, and HrC and HrC2, Huerhuero loams 2 to 9 percent slopes). Therefore, the USDA's Farmland Conversion Impact Rating (Form AD-1006) may need to be completed if potential airport development projects disturb soils located north of the airfield. At this time, proposed grading plans show some minimal disturbance of these soils (**Figures 9E** and **9F**).

FISH, WILDLIFE, AND PLANTS

Section 7 of the *Endangered Species Act* (ESA), as amended (16 USC 1531 et seq.), applies to federal agency actions and sets forth requirements for consultation to determine if a proposed action "may affect" a federally endangered or threatened species. If an agency determines that an action "may affect" a federally protected species, then Section 7(a)(2) requires the agency to consult with U.S. Fish and Wildlife Service (USFWS) to ensure that any action the agency authorizes, funds, or carries out is not likely to jeopardize the continued existence of any federally listed endangered or threatened species, or result in the destruction or adverse modification of critical habitat. If a species has been listed as a candidate species, Section 7(a)(4) states that each agency must confer with USFWS.

The *Fish and Wildlife Coordination Act* requires that agencies consult with the state wildlife agencies and the Department of the Interior concerning the conservation of wildlife resources where the water of any stream or other water body is proposed to be controlled or modified by a federal agency or any public or private agency operating under a federal permit.

The *Migratory Bird Treaty Act* (MBTA) prohibits private parties and federal agencies in certain judicial circuits from intentionally taking a migratory bird, their eggs, or nests. The MBTA prohibits activities which would harm migratory birds, their eggs, or nests unless the Secretary of the Interior authorizes such activities under a special permit.

E.O. 13112, *Invasive Species*, directs federal agencies to use relevant programs and authorities, to the extent practicable and subject to available resources, to prevent the introduction of invasive species and provide for restoration of native species and habitat conditions in ecosystems that have been invaded. The FAA is to identify proposed actions that may involve risks of introducing invasive species on native habitat and populations. "Introduction" is the intentional or unintentional escape, release, dissemination, or placement of a species into an ecosystem as a result of human activity. "Invasive species" are alien species whose introduction does, or is likely to, cause economic or environmental harm or harm to human health.

[4] http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx, accessed February 2013.

FAA Order 1050.1E, Appendix A, Paragraph 8.3, states that a significant impact to federally listed threatened or endangered species occurs when USFWS or National Marine Fisheries Service (NMFS) determines that the proposed action would likely jeopardize the continued existence of the species in question, or would result in the destruction or adverse modification of federally designated critical habitat in the affected area. Paragraph 8.3 also states that an action need not involve a threat of extinction to federally listed species to result in a significant impact; lesser impacts, including impacts on non-listed species, could also constitute a significant impact. Therefore, agencies or organizations having jurisdiction or special expertise concerning the protection and/or management of non-listed species can provide additional significance thresholds.

The airport is located within the San Luis Rey quadrangle of San Diego County. Therefore, the California Natural Diversity Data Base (CNDDB) for this quadrangle was consulted to develop a list of federally listed and regionally protected species within the area.[5] There are six bird, one fish, one mammal, and five plant species listed as endangered or threatened in the federal ESA that are known to occur within the San Luis Rey quadrangle; there are six bird, one mammal, and three plant species listed as endangered or threatened in the state ESA that are known to occur within the San Luis Rey quadrangle. These species and their listed status are shown in **Table 2**.

It is not anticipated that impacts to federal or state listed species would occur as a result of the proposed airport improvements since the areas around the runway have been previously disturbed and graded and suitable habitat is not present. However, additional species are known to occur within the San Luis Rey quadrangle that are considered Fully Protected or Species of Special Concern by the California Department of Fish and Wildlife (CDFW) or are considered locally or regionally rare, threatened, or endangered on the California Native Plant Society's (CNPS) California Rare Plant Ranks. CDFW designated species include numerous birds, several species of bats, San Diego black-tailed jackrabbit, northwestern San Diego pocket mouse, San Diego desert woodrat, coast horned lizard, orange throat whiptail, and several species of snakes.

Since there are numerous species known to occur in the area that are designated by CDFW as Fully Protected or Special Species of Concern or listed as rare plants by the CNPS, biological resource surveys may be required prior to implementation of the proposed runway improvements. In addition, nesting surveys for migratory birds protected by the MBTA may be necessary depending on the time of year and the areas to be disturbed by grading.

The proposed airport projects would not control or modify any water resources; therefore, the *Fish and Wildlife Coordination Act* is not applicable. In addition, per E.O. 13112, no invasive species are likely to be introduced into native habitats as a result of airport development projects; any revegetation plans should utilize native plants to the extent feasible.

[5] http://imaps.dfg.ca.gov/viewers/cnddb_quickviewer/app.asp, accessed February 2013.

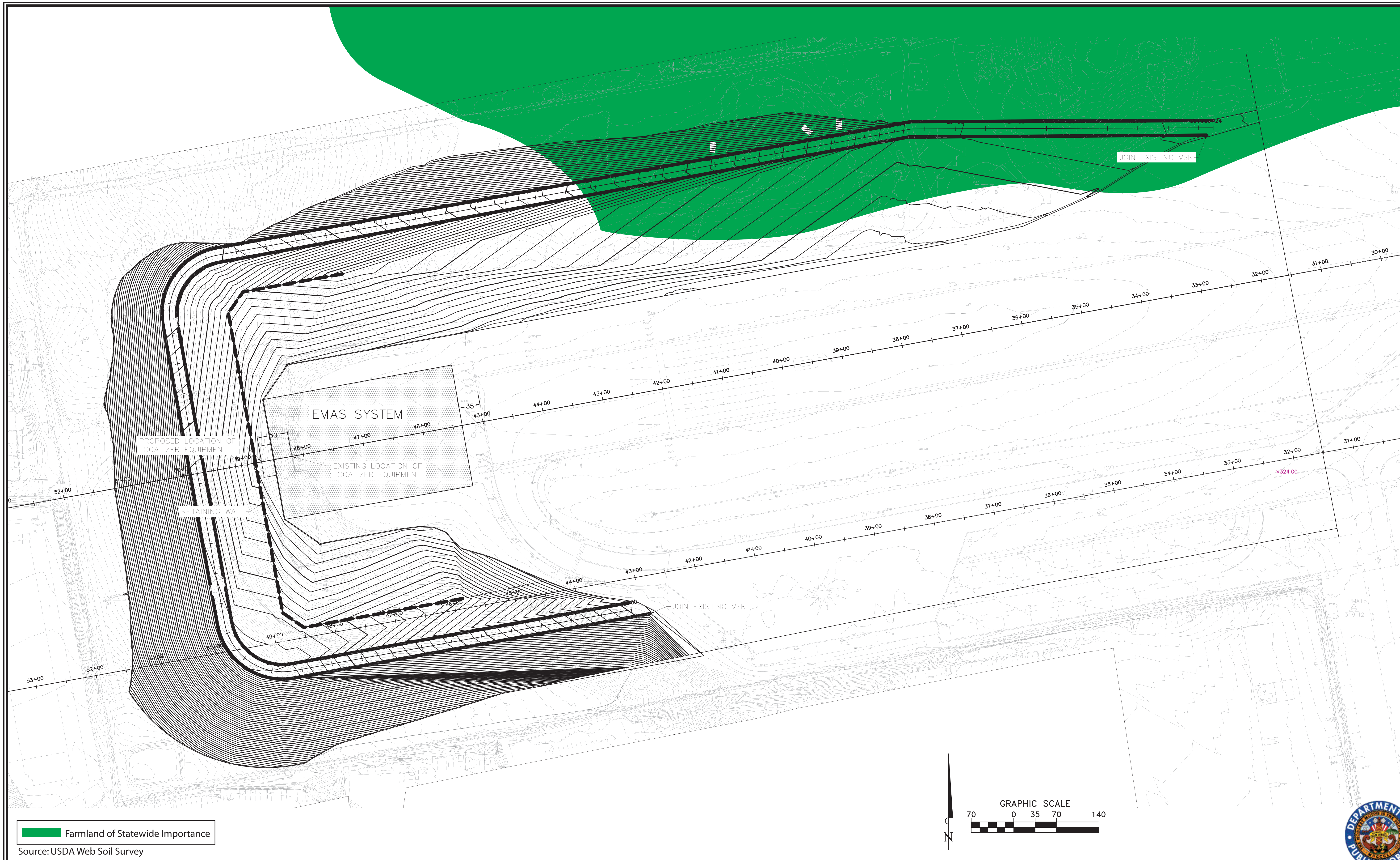

Figure 9E
PROPOSED GRADING PLAN - WEST SIDE IMPROVEMENTS

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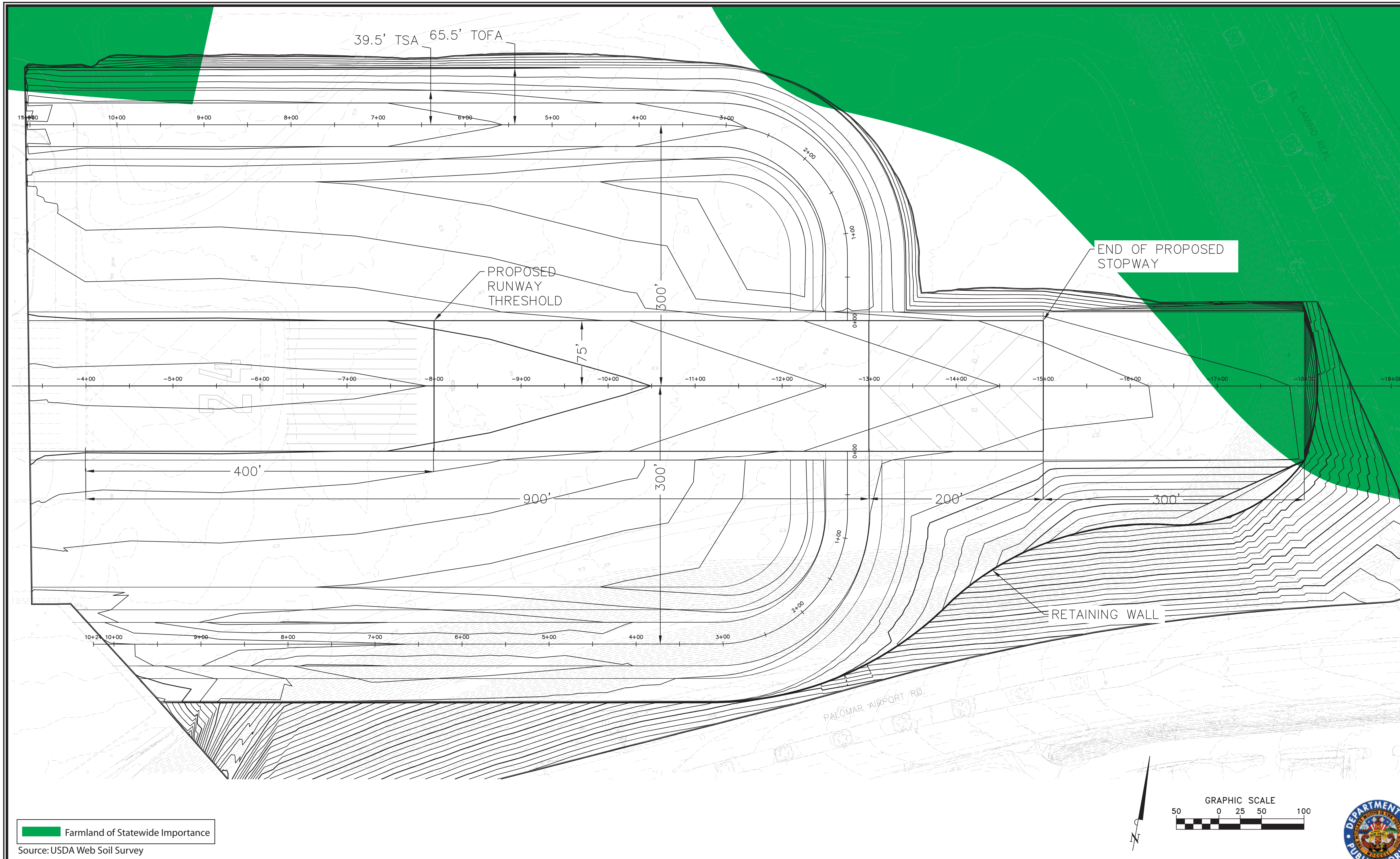

Exhibit 9F

PROPOSED GRADING PLAN - EAST SIDE IMPROVEMENTS

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TABLE 2
Federal and State Listed Wildlife and Plant Species
San Luis Rey Quadrangle, County of San Diego, CA

Scientific Name WILDLIFE SPECIES:	Common Name	Federal ESA Status	California ESA Status
Rallus longirostris levipes	light-footed clapper rail	Endangered	Endangered
Charadrius alexandrinus nivosus	western snowy plover	Threatened	None
Sternula antillarum browni	California least tern	Endangered	Endangered
Empidonax traillii extimus	southwestern willow flycatcher	Endangered	Endangered
Riparia riparia	bank swallow	None	Threatened
Polioptila californica californica	coastal California gnatcatcher	Threatened	None
Vireo bellii pusillus	least Bell's vireo	Endangered	Endangered
Passerculus sandwichensis beldingi	Belding's savannah sparrow	None	Endangered
Eucyclogobius newberryi	tidewater goby	Endangered	None
Dipodomys stephensi	Stephens' kangaroo rat	Endangered	Threatened
PLANT SPECIES:			
Eryngium aristulatum var. parishii	San Diego button-celery	Endangered	Endangered
Ambrosia pumila	San Diego ambrosia	Endangered	None
Arctostaphylos glandulosa ssp. Crassifolia	Del Mar manzanita	Endangered	None
Acanthomintha ilicifolia	San Diego thorn-mint	Threatened	Endangered
Brodiaea filifolia	thread-leaved brodiaea	Threatened	Endangered

Source: CNDDB, http://imaps.dfg.ca.gov/viewers/cnddb_quickviewer/app.asp.

FLOODPLAINS

As defined in FAA Order 1050.1E, agencies are required to "make a finding that there is no practicable alternative before taking action that would encroach on a base floodplain based on a 100-year flood." E.O. 11988, *Floodplain Management,* directs federal agencies to reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values served by the floodplains. Natural and beneficial values of floodplains include providing ground water recharge, water quality and maintenance, fish, wildlife and plants, open space, natural beauty, outdoor recreation, agriculture, and forestry. FAA Order 1050.1E (9.2b) indicates that "if the proposed action and reasonable alternatives are not within the limits of, or if applicable, the buffers of a base floodplain, a statement to that effect should be made" and no further analysis is necessary. The limits of base floodplains are determined by Flood Insurance Rate Maps (FIRMs) prepared by the Federal Emergency Management Agency (FEMA).

The airport is mapped on FIRM map panels 06073C0768G and 06073C0769G, and is designated as Zone X, which includes areas of 0.2 percent annual chance of flood, areas of one percent annual chance flood with average depths of less than one foot or with drainage areas less than one square mile, and areas protected by levees from one percent annual chance flood. The closest 100-year floodway is associated with Agua Hedionda Creek, located north and east of the airport (FEMA 2012).

HAZARDOUS MATERIALS, POLLUTION PREVENTION, AND SOLID WASTE

There are four primary federal laws that govern the handling and disposal of hazardous materials, chemicals, substances, and wastes, all of which fall under the jurisdiction of the U.S. EPA. The two statutes of most importance to the FAA in proposing actions to construct and operate facilities and navigational aids are the *Resource Conservation Recovery Act* (RCRA) (as amended by the *Federal Facilities Compliance Act of 1992*) and the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), as amended (also known as Superfund). RCRA governs the generation, treatment, storage, and disposal of hazardous wastes; CERCLA provides for cleanup of any release of a hazardous substance (excluding petroleum) into the environment. Other laws include the *Hazardous Materials Transportation Act*, which regulates the handling and transport of hazardous materials and wastes, and the *Toxic Substances Control Act* (TSCA), which regulates and controls the use of polychlorinated biphenyls (PCBs) as well as other chemicals or toxic substances in commercial use.

Per FAA Order 1050.1E, Appendix A, thresholds of significance are typically only reached when a resource agency has indicated that it would be difficult to issue a permit for the proposed development. A significant impact may also be realized if the proposed action would affect a property listed on the National Priorities List (NPL).

According to the EPA's Enviromapper EJView Tool, there are no Superfund or NPL sites located at the airport.[6] There are also no hazardous waste and substances sites listed for the City of Carlsbad on the State's Site Cleanup (Cortese) List.[7] Construction of airport development projects would result in earthwork disturbances. These projects would primarily involve the reuse of paved or graded areas. Previous construction at the airport has not resulted in the uncovering of hazardous materials; therefore, it is unlikely that future airport development projects would do so.

Pollution prevention at the airport is regulated through several laws, including the hazardous materials regulations cited above and the CWA. As discussed previously in the Construction Impacts section, the use of BMPs is a requirement of construction-related permits such as the State's NPDES Construction General Permit and should be incorporated into the airport's current SWPPP.

Solid waste in the City of Carlsbad is collected by Waste Management and is taken to the Palomar Transfer Station, located at 5960 El Camino Real, before being transported to one of the County's five subregional landfills: Miramar, Sycamore, Otay/OtayAnnex, Ramona, or Borrego Springs for solid waste disposal. However, a new North County landfill, Gregory

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[6] http://epamap14.epa.gov/ejmap/ejmap.aspx?where-str=2192%20Palomar%20Airport%20Road%2C%20Carlsbad%2C%20CA, accessed February 2013.

[7] http://www.dtsc.ca.gov/SiteCleanup/Cortese_List.cfm, accessed February 2013.

Canyon landfill, is planned to be constructed off Highway 76, approximately three miles east of Interstate 15 and two miles southwest of the community of Pala.

The Gregory Canyon Landfill would be a Class III landfill, with a capacity of 57 million cubic yards. Based on waste generation projections, the project is designed to provide for the disposal of up to one million tons of waste per year, with an estimated closure date of December 2040 (Cal.gov 2011). A Final EIS is currently under preparation; U.S. Army Corps of Engineers (USACE) is the lead agency for this undertaking under NEPA.[8]

HISTORICAL, ARCHITECTURAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

Historical, architectural, and archaeological resources as well as Native American cultural resources are protected by several different federal laws including, but not limited to, the *Archaeological Resources Protection Act* (ARPA) *of 1979*, the *National Historic Preservation Act of 1966*, and the *Native American Graves Protection & Repatriation Act*. In particular, Section 106 of the *National Historic Preservation Act* requires the FAA to consider the effects of proposed actions on sites listed on, eligible for listing on, or potentially eligible for listing on, the NRHP. To assist with this determination, an area of potential effect (APE) is defined in consultation with the State Historic Preservation Officer (SHPO). The APE includes the areas that would be directly or indirectly impacted by proposed actions. Once the APE is defined, an inventory is taken of NRHP-eligible properties within the APE and an assessment of impacts is undertaken. The determination regarding significant impacts on protected resources occurs in consultation with the SHPO as well.

It is not likely that there are significant historic or prehistoric sites located on the airport since the airport was constructed partially over a closed municipal landfill. However, any runway improvements that would occur in previously undisturbed and unsurveyed areas should be subject to a cultural resources literature search and field survey. Cultural resources impacts could occur if the proposed runway improvements disturb any cultural resource sites that have historical, architectural, archaeological, or cultural significance.

LIGHT EMISSIONS AND VISUAL EFFECTS

Airport lighting is characterized as either airfield lighting (i.e., runway, taxiway, approach and landing lights) or landside lighting (i.e., security lights, building interior lighting, parking lights, and signage).

The following airfield lighting is in place at the airport:

- A rotating beacon located atop the airport terminal;
- High intensity runway lighting (HIRL);
- Runway end identifier lights (REILs) (i.e., strobe lights set to the side of the runway landing threshold on the approach to Runway 24);
- Precision approach path indicator lights (PAPI-P4L) serving both ends of the runway;

[8] http://www.gregorycanyon.com/, accessed February 2013.

- Medium-intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) at the end of Runway 24;
- One lighted windsock located northwest of the Runway 24 threshold;
- Lighted airfield signs located throughout the airfield system.

Security and building lights are also present landside.

The airfield lighting runs consistently when the tower is open. There is also a pilot-controlled lighting system (PCL), which allows the pilot to turn on or increase the intensity of these lights from the aircraft using the aircraft's transmitter when the tower is closed.

FAA significance thresholds for light emissions are generally when an action's light emissions create an annoyance that would interfere with normal activities. For example, if a high intensity strobe light, such as a REIL system, would produce glare on any adjoining site, particularly residential uses, this could constitute a significant adverse impact. The visual sight of aircraft, aircraft contrails, or aircraft or airport lighting, especially from a distance that is not normally intrusive, is not assumed to be an adverse impact.

For visual effects, an action is considered significant when consultation with federal, state, or local agencies, tribes, or the public shows that visual effects contrast with the existing environments and the agencies state that the effect is objectionable. Visual and lighting impacts relate primarily to the presence of sensitive visual receptors in proximity to an airport. These would normally be residents or users of a designated scenic resource such as a scenic corridor.

The airport is located on a mesa that is bordered by Palomar Airport Road, El Camino Real, commercial and light industrial development, and a golf course. There are no sensitive visual receptors nor are there any scenic corridors near the airport. Both El Camino Real and Palomar Airport Road are categorized as Community Theme Corridors within the City of Carlsbad's General Plan Circulation Element (1994). The purpose of such corridors is to connect Carlsbad with adjacent municipalities and present the City of Carlsbad to persons entering and passing through the community (p. 9). El Camino Real also has development standards (City of Carlsbad, 1984).

The primary visual and lighting changes proposed as a result of the runway improvements involve extending runway and taxiway lighting approximately 900 feet east from their current location on the east end. In addition, the existing MALSR for runway approaches from the east would need to be extended another 200 feet east to accommodate the proposed shift in the runway approach threshold. All but the last station would either be in-pavement or utilize an existing light station foundation as they are currently set 200 feet apart. Thus, there would be one additional foundation 200 feet farther east. This area is currently open space owned by the airport that is surrounded by industrial development.

A retaining wall would be used to support the runway and taxiway extensions with fill slopes extending from the wall to Palomar Airport Road on the south and El Camino Real on the east (**Figure 9E**). On the west end of the runway, improvements involve the placement of an engineered material arresting system (EMAS) and the relocation of an existing localizer and vehicle service road on the west end. Again, a retaining wall and fill slopes would be necessary to support both the EMAS and the relocated vehicle service roadway (**Figure 9F**).

Neither runway end is expected to have significant visual nor lighting effects since the changes are not likely to be visible from off the airport due to differences in elevation between the airfield and surrounding roads and development. The fill slopes and the retaining walls would be visible from the surrounding areas. However, the airport would continue to maintain its appearances as a general aviation airport overall. Since both El Camino Real and Palomar Airport Road are City-designated Community Theme Corridors, it is expected that landscaping plans and other design or architectural treatments would need to be approved by the City.

NATURAL RESOURCES AND ENERGY

The FAA considers an action to have a significant impact on natural resources and energy when an action's construction, operation, or maintenance would cause demands that exceed available or future (project year) natural resource or energy supplies. Therefore, in instances when proposed actions necessitate the expansion of utilities, power companies or other suppliers of natural resources and energy would need to be contacted to determine if the proposed project demands can be met by existing or planned facilities.

San Diego Gas and Electric (SDGE) Company provides natural gas and electricity to the Carlsbad area, including the airport. The use of energy and natural resources at the airport would occur both during construction of planned facilities and during operation of the airport as it grows. However, none of the planned runway improvement projects are major or are anticipated to result in significant increases in the demand for natural resources or energy consumption beyond what is readily available by SDG&E.

SECONDARY (INDUCED) IMPACTS

FAA Order 1050.1E, Appendix A, states that secondary impacts should be addressed when the proposed project is a major development proposal that could involve shifts in patterns of population movement and growth, public service demands, and changes in business and economic activity due to airport development.

The City of Carlsbad's General Plan Land Use Plan (page 3) discusses in detail the impact that the airport has on business development in the northern part of San Diego:

> "Factor 3: Regional Employment Center
>
> As a result of the nonresidential nature required of the lands surrounding the airport, Carlsbad has designated and zoned most of these lands for industrial and, to a lesser degree, office development. The size of the affected acreage is very substantial, with the result that Carlsbad has created one of the largest inventories of aggregated industrial land and, correspondingly, one of the largest potential employment generators in

> North San Diego County. When fully developed, this generator will provide jobs not only in Carlsbad, but in the entire region as well. This role as regional employment generator will increasingly have major implications for the City's identity, its role in the region, and its future development patterns."

However, the proposed runway improvements at the airport would not be considered major development nor would they involve shifts of population movement or growth. Rather, they would involve the extension of the east end of the runway and parallel taxiway by approximately 900 feet to allow the runway to fully meet B-II standards. EMAS would be installed on the west end of the runway to improve safety at the airport.

Based on the forecast analysis summarized in Chapter Three of the Feasibility Study, the airport is expected to have an average annual growth rate in total operations of approximately two percent through the year 2021 with the proposed runway improvements (**Figure 3G**). Annual growth in based aircraft is expected to be an average annual increase of 1.6 percent through 2021 (**Table 3M**). This amount of annual growth at the airport over the next 10 years would not be expected to result in secondary impacts on the County or the City of Carlsbad.

The proposed improvements would not significantly affect ground traffic or change traffic patterns. The potential increase in aircraft traffic due to the improvements is projected to total 3,000 operations and eight additional based aircraft over 10 years. Using Institute of Transportation Engineers (ITE) trip generation rates, the project would generate approximately 40 additional daily vehicle trips, and just three during the peak hour.

Construction-related work generated by planned airport improvements would provide economic benefits to the County and City in the form of increased employment and income.

SOCIOECONOMIC IMPACTS, ENVIRONMENTAL JUSTICE, AND CHILDREN'S ENVIRONMENTAL HEALTH AND SAFETY RISKS

Socioeconomic impacts known to result from airport improvements are often associated with relocation activities or other community disruptions. These impacts can include alterations to surface transportation patterns, division or disruption of existing communities, interferences with orderly planned development, or an appreciable change in employment related to the project. Social impacts are generally evaluated based on areas of acquisition and/or areas of significant project impact, such as areas encompassed by noise levels in excess of 65 DNL.

Per FAA Order 1050.1E, Appendix A, the thresholds of significance for this impact category are reached if the project negatively affects a disproportionately high number of minority or low-income populations or if children would be exposed to a disproportionate number of health and safety risks. E.O. 12898, *Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations* and the accompanying Presidential Memorandum, and DOT Order 5610.2, *Environmental Justice* require FAA to provide for meaningful public involvement by minority and low-income populations as well as analysis that identifies and addresses potential impacts on these populations that may be disproportionately high and adverse.

Pursuant to E.O. 13045, *Protection of Children from Environmental Health Risks and Safety Risks,* federal agencies are directed to identify and assess environmental health and safety risks that may disproportionately affect children. These risks include those that are attributable to products or substances that a child is likely to come in contact with or ingest, such as air, food, drinking water, recreational waters, soil, or products to which they may be exposed.

The acquisition of residences and farmland is required to conform with the *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970* (Uniform Act). These regulations mandate that certain relocation assistance services be made available to homeowners and tenants of affected properties. This assistance includes help finding comparable and decent substitute housing for the same cost, moving expenses, and in some cases, loss of income.

The U.S. Census, most recently taken in 2010, provides information regarding socioeconomic conditions in San Diego County. General population and employment data and future forecasts are discussed in Chapter Three of the Feasibility Study (see **Table 3B**). The percentage of households living below the poverty level and the percentage of minority populations near the airport are shown on **Figure 9G**.

Approximately 10.5 percent of the households in the same census tract as the airport are living below the poverty rate. (The 2010 Census does not provide poverty rate data by block group.) This includes residential neighborhoods to the southwest and northwest of the airport. The closest residential neighborhood to the airport is actually located to the southeast in a different census tract than the airport. This census tract has only 6.5 percent of its population living below the poverty rate.

Approximately 20 percent of the population in the block group that contains the airport is from minority groups. Population in the block group directly south of the airport is approximately 33 percent from minority groups. The nearest such neighborhood to the airport is located almost 0.5 mile to the south and west.

Since the proposed runway improvements do not involve expanding airport operations beyond the existing airport boundaries, the relocation of housing or businesses would not be necessary to implement the proposed project. Existing communities, transportation patterns, and planned development would not be disrupted. The airport's projected two percent annual growth for the next 10 years would not significantly change future growth in the Carlsbad area or have disproportionate adverse impacts on minority, low-income, or children populations.

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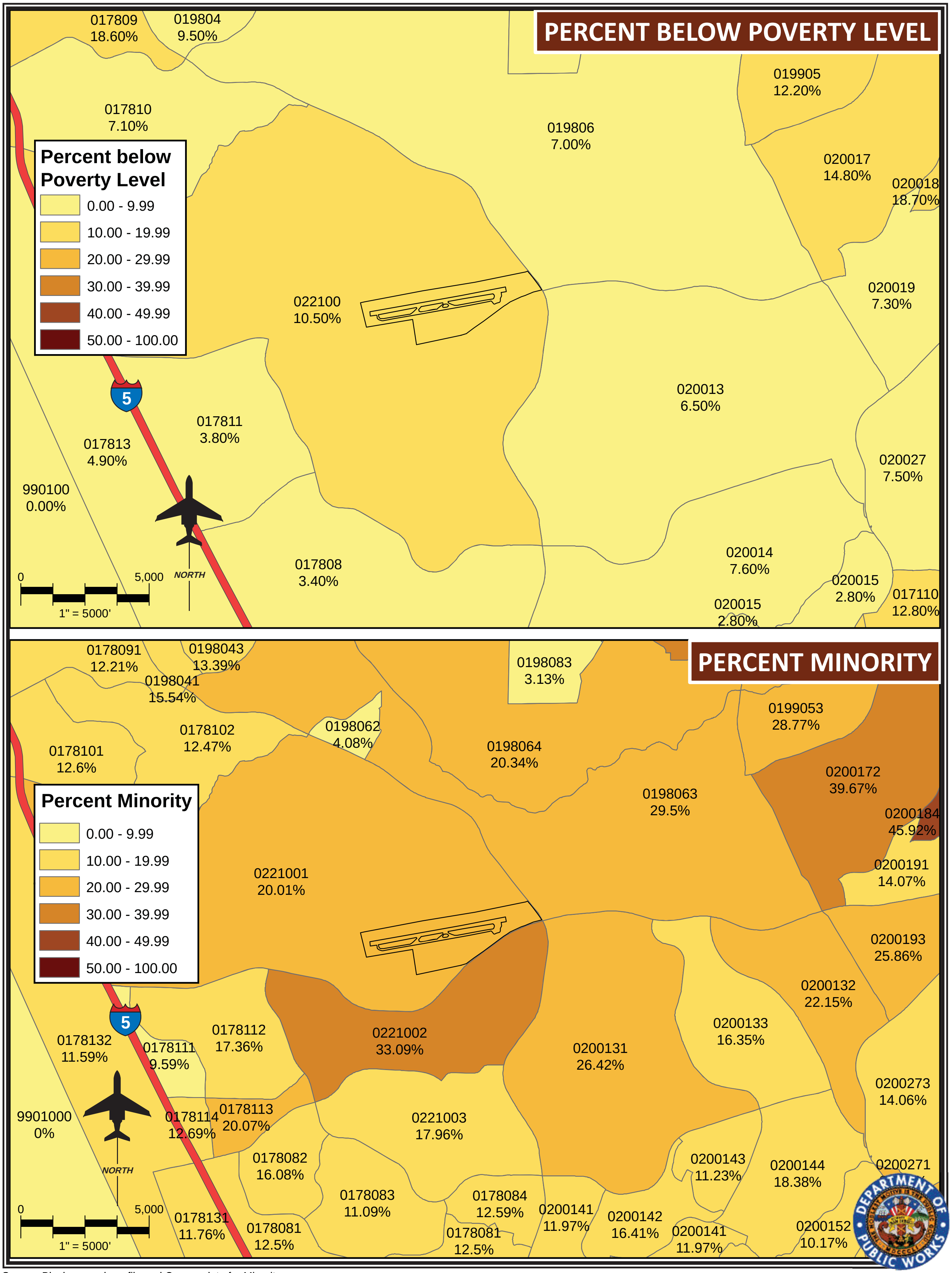

Source: Blockgroup shapefile and Census data for Minority Map are from 2010 Census.
Census Tract shapefile and Census data for Poverty Map are from 2010 Census. (Poverty map is by census tract only because block group data is not available)

Figure 9G
LOW INCOME AND MINORITY POPULATIONS

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WATER QUALITY

The airport is located within the San Luis Rey-Escondido watershed, partially within the Loma Alta Creek-Frontal Gulf of Santa Catalina sub-watershed and partially within the Agua Hedionda Creek sub-watershed. Agua Hedionda Creek is a CWA Section 303(d) Impaired Water for several types of metals, sulfates, and total dissolved solids (TDS).[9]

As discussed previously, the site of the McClellan-Palomar Airport is located on top of a closed municipal landfill. As the landfill is not lined, there is currently no barrier to prevent leaching. The proposed project would not change this existing condition, but is also not expected to exacerbate it. Design methods for stabilizing the proposed improvements over the landfill are discussed in detail in Chapter Five of this Feasibility Study.

All future improvements to the airport would need to be coordinated with both the California Integrated Waste Management Board (CIWMB) and the San Diego RWQCB. This is to ensure that the design concept for the runway improvements is not detrimental to the integrity of the landfill, and thus would also protect water quality (see California Code of Regulations, Title 27, Subchapter 5, §§21190 and 21890).

Water quality in California is monitored and protected under the authority of the California RWCQB's NPDES permitting process. The airport would be subject to the permit conditions of the Countywide permit (NPDES NO. CAS0108758) for discharges of urban runoff from the municipal separate storm sewer systems (MS4s). Future runway improvements should be evaluated to address their interface with the airport's storm water drainage system and should be incorporated into the airport's SWPPP. All new development at the airport would be subject to the conditions of the Countywide MS4 NPDES permit.

Short-term water quality issues related to construction of airport development projects have also been discussed under Construction Impacts.

WETLANDS AND WATERS OF THE U.S.

Certain drainages (both natural and human-made) come under the purview of USACE under Section 404 of the CWA; wetlands are also protected. According to USDA's Web Soil Survey, there are partially hydric soils along the north and east sides of the airfield.[10] However, there are no aquatic features present at the airport that would indicate the potential for wetland habitat based on the National Wetlands Inventory.[11] The airport is located on a flat plateau and is partially constructed over a closed municipal landfill. No wetlands or waters of the U.S. would be affected by the proposed runway improvements.

[9] http://watersgeo.epa.gov/mwm/, accessed February 2013.

[10] http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx, accessed February 2013.

[11] http://watersgeo.epa.gov/mwm/, accessed February 2013.

WILD AND SCENIC RIVERS

There are no designated Wild and Scenic Rivers segments within the County of San Diego.[12] Therefore, no impacts to designated Wild and Scenic Rivers would occur as a result of proposed airport development.

CONCLUSION

There are no known environmental sensitivities present at the airport. However, since the County of San Diego is in nonattainment for ozone and particulate matter, additional air quality assessment of the project may be necessary. The improved efficiency or "green benefits" of the project in reducing the need for fuel stops by business jets on long haul flights would reduce fuel burn, helping offset overall fuel usage, greenhouse gases, and other air quality emissions.

In addition, since the McClellan-Palomar Airport is located on top of a closed municipal landfill, it will be necessary to ensure that the design concept for the runway improvements is not detrimental to the integrity of the landfill. Future improvements to the airport would need to be coordinated with both CIWMB and San Diego RWQCB.

There are sensitive biological resources in the general proximity of the airport, including a parcel of land directly to the north of the airport that is part of the Mello II segment of the Carlsbad's LCP and a City-owned golf course directly to the west. Both of these areas are part of the City's Habitat Management Plan. The airport itself is not located within the Coastal Zone, and a Coastal Zone permit is not required for the proposed runway improvements.

The USDA's Farmland Conversion Impact Rating (Form AD-1006) may need to be completed if potential airport development projects disturb soils designated as farmland of statewide importance located north of the airfield. At this time, proposed grading plans show some minimal disturbance of these soils.

It is not anticipated that impacts to federal or state listed species would occur as a result of the proposed airport improvements since the areas around the runway have been previously disturbed and graded and suitable habitat is not present. However, since there are numerous species known to occur in the area that are designated by CDFW as Fully Protected or Special Species of Concern or listed as rare plants by the CNPS, biological resource surveys may still be required. Nesting surveys for migratory birds protected by the MBTA may also be necessary depending on the time of year and the areas to be disturbed by grading.

Cultural and/or potential Section 4(f) resource impacts could occur if the proposed runway improvements disturb cultural resource sites that have historical, architectural, archaeological, or cultural significance. Therefore, runway improvements that would occur in previously undisturbed and unsurveyed areas should be subject to a cultural resources literature search and field survey.

The proposed project would provide for approximately two percent annual

[12] http://www.rivers.gov/rivers/california.php, accessed February 2013.

growth in total operations and a 1.6 percent annual growth in based aircraft at the airport through the year 2021. This amount of growth would not cause any secondary or socioeconomic impacts on the City of Carlsbad or the County of San Diego.

The proposed improvements would not significantly affect ground traffic or change traffic patterns. The potential increase in air traffic due to the improvements is projected to total 3,000 operations over 10 years. This is equivalent to less than 10 additional takeoffs and landings a day. Traffic implications due to changes in traffic patterns based on improved operations at the airport or due to the proposed redistribution of cross country and international air traffic capacity within the region would be approximately 40 additional daily vehicle trips, and just three during the peak hour.

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APPENDIX A – RUNWAY EXTENSION ALTERNATIVE ESTIMATES

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McClellan - Palomar Airport Runway Extension Alternatives West Side Safety Improvements				
Item	Unit	Unit Cost	Quantity	TOTAL
Embankment	cy	$ 50	110212	$ 5,510,615
VSR Pavement	sf	$ 3.75	44000	$ 165,000
Retaining Wall	sf	$ 71	13163	$ 934,600
Electrical	ls	$ 800,000	1	$ 800,000
EMAS	ls	$ 6,300,000	1	$ 6,300,000
Drainage	ls	$ 998,800	1	$ 998,800
Revegitation	ac	$ 1,500	16	$ 24,000
Subtotal				$ 14,733,100
25% Contingency				$ 3,683,275
TOTAL CONSTRUCTION				$ 18,416,400
Engineering		$ 18,416,400	8%	$ 1,473,400
Administrative Mgmt		$ 18,416,400	22%	$ 4,051,700
Construction Mgmt		$ 18,416,400	8%	$ 1,473,400
TOTAL SOFT COSTS				$ 6,998,500
TOTAL ESTIMATE				$ 25,414,900

McClellan - Palomar Airport Runway Extension Alternatives Alternative A: B-II Runway, 200' Extension				
Item	Unit	Unit Cost	Quantity	TOTAL
Pavement	ls	$ 1,539,389	1	$ 1,539,400
Export	cy	$ 50	10441	$ 522,100
Pavement Markings	ls	$ 13,600	1	$ 13,600
Electrical	ea	$ 2,100,000	1	$ 2,100,000
Structural Improvements	ls	$ 8,470,000	1	$ 8,470,000
Drainage	ls	$ 80,900	1	$ 80,900
Methane Extraction	ls	$ 289,800	1	$ 289,800
Subtotal				$ 13,015,800
25% Contingency				$ 3,253,950
TOTAL CONSTRUCTION				$ 16,269,800
Engineering		$ 16,269,800	8%	$ 1,301,600
Administrative Mgmt		$ 16,269,800	22%	$ 3,579,400
Construction Mgmt		$ 16,269,800	8%	$ 1,301,600
TOTAL SOFT COSTS				$ 6,182,600
TOTAL ESTIMATE				$ 22,452,400

McClellan - Palomar Airport Runway Extension Alternatives Alternative B: B-II Runway, 900' Extension North Taxiway Only				
Item	Unit	Unit Cost	Quantity	TOTAL
Pavement	ls	$ 3,320,100	1	$ 3,320,100
Embankment	cy	$ 50	46323	$ 2,316,200
Pavement Markings	ls	$ 20,700	1	$ 20,700
Retaining Wall	sf	$ 71	25358	$ 1,800,418
Electrical	ls	$ 2,300,000	1	$ 2,300,000
Structural Improvements	ls	$ 17,669,200	1	$ 17,669,200
Drainage	ls	$ 598,600	1	$ 598,600
Methane Extraction	ls	$ 711,300	1	$ 711,300
Revegetation	ac	$ 1,500	10	$ 15,000
Subtotal				$ 28,751,600
25% Contingency				$ 7,187,900
TOTAL CONSTRUCTION				$ 35,939,500
Engineering		$ 35,939,500	8%	$ 2,875,200
Administrative Mgmt		$ 35,939,500	22%	$ 7,906,700
Construction Mgmt		$ 35,939,500	8%	$ 2,875,200
TOTAL SOFT COSTS				$ 13,657,100
TOTAL ESTIMATE				$ 49,596,600

McClellan - Palomar Airport Runway Extension Alternatives Alternative B: B-II Runway, 900' Extension North & South Taxiways				
Item	Unit	Unit Cost	Quantity	TOTAL
Pavement	ls	$ 4,062,900	1	$ 4,062,900
Embankment	cy	$ 50	151746	$ 7,587,400
Pavement Markings	ls	$ 26,600	1	$ 26,600
Retaining Wall	sf	$ 71	42050	$ 2,985,550
Electrical	ls	$ 2,800,000	1	$ 2,800,000
Structural Improvements	ls	$ 21,458,100	1	$ 21,458,100
Drainage	ls	$ 746,000	1	$ 746,000
Methane Extraction	ls	$ 711,300	1	$ 711,300
Revegetation	ac	$ 1,500	17	$ 25,500
Subtotal				$ 40,403,400
25% Contingency				$ 10,100,850
TOTAL CONSTRUCTION				$ 50,504,300
Engineering		$ 50,504,300	8%	4040400
Administrative Mgmt		$ 50,504,300	22%	11111000
Construction Mgmt		$ 50,504,300	8%	4040400
TOTAL SOFT COSTS				$ 19,191,800
TOTAL ESTIMATE				$ 69,696,100

McClellan - Palomar Airport Runway Extension Alternatives Alternative C: C-III Runway, 1200' Extension North Taxiway Only				
Item	Unit	Unit Cost	Quantity	TOTAL
Pavement	ls	$ 4,257,200	1	$ 4,257,200
Embankment	cy	$ 50	55648	$ 2,782,500
Pavement Markings	ls	$ 25,200	1	$ 25,200
Retaining Wall	sf	$ 71	25358	$ 1,800,418
Electrical	ls	$ 2,300,000	1	$ 2,300,000
Structural Improvements	ls	$ 22,617,400	1	$ 22,617,400
Drainage	ls	$ 910,800	1	$ 910,800
Methane Extraction	ls	$ 824,100	1	$ 824,100
Revegetation	ac	$ 1,500	11	$ 16,500
Subtotal				$ 35,534,200
25% Contingency				$ 8,883,550
TOTAL CONSTRUCTION				$ 44,417,800
Engineering		$ 44,417,800	8%	$ 3,553,500
Administrative Mgmt		$ 44,417,800	22%	$ 9,772,000
Construction Mgmt		$ 44,417,800	8%	$ 3,553,500
TOTAL SOFT COSTS				$ 16,879,000
TOTAL ESTIMATE				$ 61,296,800

McClellan - Palomar Airport Runway Extension Alternatives Alternative C: C-III Runway, 1200' Extension Realignment of Palomar Airport Road				
Item	Unit	Unit Cost	Quantity	TOTAL
Pavement	ls	$ 5,344,100	1	$ 5,344,100
Embankment	cy	$ 50	438490	$ 21,924,600
Pavement Markings	ls	$ 36,900	1	$ 36,900
Retaining Wall	sf	$ 71	112833	$ 8,011,143
Electrical	ls	$ 3,100,000	1	$ 3,100,000
New Property	ls	$ 280,598,500	1	$ 280,598,500
Structural Improvements	ls	$ 28,418,100	1	$ 28,418,100
Drainage	ls	$ 3,988,100	1	$ 3,988,100
Methane Extraction	ls	$ 824,100	1	$ 824,100
Revegetation	ac	$ 1,500	19	$ 28,500
Subtotal				$ 352,274,100
25% Contingency				$ 88,068,525
TOTAL CONSTRUCTION				$ 440,342,700
Engineering		$ 440,342,700	5%	$ 22,017,200
Administrative Mgmt		$ 440,342,700	15%	$ 66,051,500
Construction Mgmt		$ 440,342,700	5%	$ 22,017,200
TOTAL SOFT COSTS				$ 110,085,900
TOTAL ESTIMATE				$ 550,428,600

McClellan - Palomar Airport Runway Extension Alternatives Alternative C: C-III Runway, 1200' Extension Bridge Over Palomar Airport Road				
Item	Unit	Unit Cost	Quantity	TOTAL
Pavement	ls	$ 5,311,400	1	$ 5,311,400
Embankment	cy	$ 50	49473	$ 2,473,700
Pavement Markings	ls	$ 36,900	1	$ 36,900
Retaining Wall	sf	$ 71	25358	$ 1,800,418
Electrical	ls	$ 3,100,000	1	$ 3,100,000
New Property/Bridge	sf	$ 500	133958	$ 66,979,000
Structural Improvements	ls	$ 28,418,100	1	$ 28,418,100
Drainage	ls	$ 2,492,400	1	$ 2,492,400
Methane Extraction	ls	$ 824,100	1	$ 824,100
Revegetation	ac	$ 1,500	19	$ 28,500
Subtotal				$ 111,464,600
25% Contingency				$ 27,866,150
TOTAL CONSTRUCTION				$ 139,330,800
Engineering		$ 139,330,800	6%	$ 8,359,900
Administrative Mgmt		$ 139,330,800	20%	$ 27,866,200
Construction Mgmt		$ 139,330,800	6%	$ 8,359,900
TOTAL SOFT COSTS				$ 44,586,000
TOTAL ESTIMATE				$ 183,916,800

McClellan - Palomar Airport Runway Extension Alternatives																		
B-II Runway, 200' Extension																		
Item	Unit	Quantity	Length	lf	Area	sf	Area	sy	Depth	ft	Volume	cf	Volume	cy	Ton	Unit Cost	Cost	TOTAL
Pavement																		$ 1,539,400
P-152	sy				121000		13444		0.667		80667		2988			$ 2	$ 26,889	
P-154	cy				121000		13444		1.042		126042		4668			$ 60	$ 280,093	
P-209	cy				121000		13444		1.333		161333		5975			$ 75	$ 448,148	
P-401	ton				121000		13444		0.417		50417		1867		3921	$ 200	$ 784,259	
VSR	sf				0		0		0.500		0		0			$ 3.75	$ -	
Export	cy												10441			$ 50		$ 522,100
Pavement Markings																		$ 13,600
Rwy CL	lf		200													$ 3	$ 500	
Rwy Edge	lf		925													$ 3	$ 2,313	
Twy CL	lf		800													$ 2	$ 1,200	
Twy Edge	lf		1590													$ 2	$ 3,578	
BlastPad/Stopway	lf		3000													$ 2	$ 6,000	
Electrical																		$ 2,100,000
Airfield Electrical	ea	1														$ 800,000	$ 800,000	
FAA Electrical	ea	1														$ 1,300,000	$ 1,300,000	
Structural Improvements																		$ 8,470,000
Steel Piles	sf				121000											$ 121	$ 14,641,000	
DDP Piles	sf				121000											$ 109	$ 13,189,000	
DDC Piles	sf				121000											$ 72	$ 8,712,000	
Injection Piles	sf				121000											$ 70	$ 8,470,000	
Clean Closure	sf				121000											$ 207	$ 25,047,000	
Drainage																		$ 80,900
Drainage System	lf	0																
Drainage BMPs	ls	0.50%														$ 16,168,700	$ 80,844	
Methane Extraction	ls	1														$ 289,800		$ 289,800
Revegetation	ac	0														$ 1,500		
Subtotal																		$ 13,015,800
25% Contingency																		$ 3,253,950
TOTAL																		$ 16,269,800

McClellan - Palomar Airport Runway Extension Alternatives																		
B-II Runway, 900' Extension, North Taxiway Only																		
Item	Unit	Quantity	Length	lf	Area	sf	Area	sy	Depth	ft	Volume	cf	Volume	cy	Ton	Unit Cost	Cost	TOTAL
Pavement																		$ 3,320,100
P-152	sy				252417		28046		0.667		168278		6233			$ 2	$ 56,093	
P-154	cy				252417		28046		1.042		262934		9738			$ 60	$ 584,299	
P-209	cy				252417		28046		1.333		336556		12465			$ 75	$ 934,878	
P-401	ton				252417		28046		0.417		105174		3895		8180	$ 200	$ 1,636,036	
VSR	sf				28987		3221		0.500		14494		537			$ 3.75	$ 108,702	
Embankment	cy												46323			$ 50		$ 2,316,200
Retaining Wall	sf				25358											$ 71		$ 1,800,418
Pavement Markings																		$ 20,700
Rwy CL	lf		900													$ 3	$ 2,250	
Rwy Edge	lf		2335													$ 3	$ 5,838	
Twy CL	lf		1100													$ 2	$ 1,650	
Twy Edge	lf		2190													$ 2	$ 4,928	
BlastPad/Stopway	lf		3000													$ 2	$ 6,000	
Electrical																		$ 2,300,000
Airfield Electrical	ea	1														$ 800,000	$ 800,000	
FAA Electrical	ea	1														$ 1,500,000	$ 1,500,000	
Structural Improvements																		$ 17,669,200
Steel Piles	sf				252417											$ 121	$ 30,542,457	
DDP Piles	sf				252417											$ 109	$ 27,513,453	
DDC Piles	sf				252417											$ 72	$ 18,174,024	
Injection Piles	sf				252417											$ 70	$ 17,669,190	
Clean Closure	sf				252417											$ 207	$ 52,250,319	
Drainage																		$ 598,600
Drainage System	lf		1400													$ 300	$ 420,000	
Drainage BMPs	ls	0.50%														$ 35,716,300	$ 178,582	
Methane Extraction	ls	1														$ 711,300		$ 711,300
Revegetation	ac	10														$ 1,500		$ 15,000
Subtotal																		$ 28,751,600
25% Contingency																		$ 7,187,900
TOTAL																		$ 35,939,500

McClellan - Palomar Airport Runway Extension Alternatives																		
B-II Runway, 900' Extension, North and South Taxiways																		
Item	Unit	Quantity	Length	lf	Area	sf	Area	sy	Depth	ft	Volume	cf	Volume	cy	Ton	Cost		TOTAL
Pavement																		$ 4,062,900
P-152	sy				306544		34060		0.667		204362		7569			$ 2	$ 68,121	
P-154	cy				306544		34060		1.042		319316		11827			$ 60	$ 709,592	
P-209	cy				306544		34060		1.333		408725		15138			$ 75	$ 1,135,347	
P-401	ton				306544		34060		0.417		127727		4731		9934	$ 200	$ 1,986,857	
VSR	sf				43440		4827		0.500		21720		804			$ 3.75	$ 162,900	
Embankment	cy												151746			$ 50		$ 7,587,400
Retaining Wall	sf				42050											$ 71		$ 2,985,550
Pavement Markings																		$ 26,600
Rwy CL	lf		900													$ 3	$ 2,250	
Rwy Edge	lf		2335													$ 3	$ 5,838	
Twy CL	lf		2095													$ 2	$ 3,143	
Twy Edge	lf		4160													$ 2	$ 9,360	
BlastPad/Stopway	lf		3000													$ 2	$ 6,000	
Electrical																		$ 2,800,000
Airfield Electrical	ea		1													$ 1,300,000	$ 1,300,000	
FAA Electrical	ea		1													$ 1,500,000	$ 1,500,000	
Structural Improvements																		$ 21,458,100
Steel Piles	sf				306544											$ 121	$ 37,091,776	
DDP Piles	sf				306544											$ 109	$ 33,413,252	
DDC Piles	sf				306544											$ 72	$ 22,071,139	
Injection Piles	sf				306544											$ 70	$ 21,458,052	
Clean Closure	sf				306544											$ 207	$ 63,454,525	
Drainage																		$ 746,000
Drainage System	lf		1650													$ 300	$ 495,000	
Drainage BMPs	ls	0.50%														$ 50,190,500	$ 250,953	
Methane Extraction	ls	1														$ 711,300		$ 711,300
Revegetation	ac	17														$ 1,500		$ 25,500
Subtotal																		$ 40,403,400
25% Contingency																		$ 10,100,850
TOTAL																		$ 50,504,300

McClellan - Palomar Airport Runway Extension Alternatives

C-III Runway, 1200' Extension, North Taxiway Only

Item	Unit	Quantity	Length	lf	Area	sf	Area	sy	Depth	ft	Volume	cf	Volume	cy	Ton	Unit Cost	Cost	TOTAL
Pavement																		$ 4,257,200
P-152	sy				323105		35901		0.667		215403		7978			$ 2	$ 71,801	
P-154	cy				323105		35901		1.042		336568		12465			$ 60	$ 747,929	
P-209	cy				323105		35901		1.333		430807		15956			$ 75	$ 1,196,686	
P-401	ton				323105		35901		0.417		134627		4986		10471	$ 200	$ 2,094,200	
VSR	sf				39072		4341		0.500		19536		724			$ 4	$ 146,520	
Embankment	cy												55648			$ 50		$ 2,782,500
Retaining Wall	sf				25358											$ 71		$ 1,800,418
Pavement Markings																		$ 25,200
Rwy CL	lf		1200													$ 3	$ 3,000	
Rwy Edge	lf		2920													$ 3	$ 7,300	
Twy CL	lf		1480													$ 2	$ 2,220	
Twy Edge	lf		2960													$ 2	$ 6,660	
BlastPad/Stopway	lf		3000													$ 2	$ 6,000	
Electrical																		$ 2,300,000
Airfield Electrical	ea	1														$ 800,000	$ 800,000	
FAA Electrical	ea	1														$ 1,500,000	$ 1,500,000	
Structural Improvements																		$ 22,617,400
Steel Piles	sf				323105											$ 121	$ 39,095,729	
DDP Piles	sf				323105											$ 109	$ 35,218,467	
DDC Piles	sf				323105											$ 72	$ 23,263,574	
Injection Piles	sf				323105											$ 70	$ 22,617,364	
Clean Closure	sf				323105											$ 207	$ 66,882,776	
Drainage																		$ 910,800
Drainage System	lf		2300													$ 300	$ 690,000	
Drainage BMPs	ls	0.50%														$ 44,141,800	$ 220,800	
Methane Extraction	ls	1														$ 824,100		$ 824,100
Revegetation	ac	11														$ 1,500		$ 16,500
Subtotal																		$ 35,534,200
25% Contingency																		$ 8,883,550
TOTAL																		$ 44,417,800

McClellan - Palomar Airport Runway Extension Alternatives

C-III Runway, 1200' Extension, North and South Taxiways, Realign Palomar Airport Road

Item	Unit	Quantity	Length	lf	Area	sf	Area	sy	Depth	ft	Volume	cf	Volume	cy	Ton	Unit Cost	Cost	TOTAL
Pavement																		$ 5,344,100
P-152	sy				405972		45108		0.667		270648		10024			$ 2	$ 90,216	
P-154	cy				405972		45108		1.042		422887		15662			$ 60	$ 939,749	
P-209	cy				405972		45108		1.333		541295		20048			$ 75	$ 1,503,598	
P-401	ton				405972		45108		0.417		169155		6265		13156	$ 200	$ 2,631,297	
VSR	sf				47784		5309		0.500		23892		885			$ 4	$ 179,190	
Embankment	cy												438490			$ 50		$ 21,924,600
Retaining Wall	sf				112833											$ 71		$ 8,011,200
Pavement Markings																		$ 36,900
Rwy CL	lf		1200													$ 3	$ 3,000	
Rwy Edge	lf		2920													$ 3	$ 7,300	
Twy CL	lf		2980													$ 2	$ 4,470	
Twy Edge	lf		7155													$ 2	$ 16,099	
BlastPad/Stopway	lf		3000													$ 2	$ 6,000	
Electrical																		$ 3,100,000
Airfield Electrical	ea	1														$ 1,400,000	$ 1,400,000	
FAA Electrical	ea	1														$ 1,700,000	$ 1,700,000	
New Property																		$ 280,598,500
Existing Road Area	sf				333174											$ 300	$ 99,952,050	
Existing Lowes Area	sf				361293											$ 500	$ 180,646,400	
Structural Improvements																		$ 28,418,100
Steel Piles	sf				405972											$ 121	$ 49,122,552	
DDP Piles	sf				405972											$ 109	$ 44,250,894	
DDC Piles	sf				405972											$ 72	$ 29,229,948	
Injection Piles	sf				405972											$ 70	$ 28,418,005	
Clean Closure	sf				405972											$ 207	$ 84,036,101	
Drainage																		$ 3,988,100
Drainge System	lf		6000													$ 300	$ 1,800,000	
Drainage BMPs	ls	0.50%														$ 437,607,500	$ 2,188,100	
Methane Extraction	ls	1														$ 824,100		$ 824,100
Revegetation	ac	19														$ 1,500		$ 28,500
Subtotal																		$ 352,274,100
25% Contingency																		$ 88,068,525
TOTAL																		$ 440,342,700

McClellan - Palomar Airport Runway Extension Alternatives

C-III Runway, 1200' Extension, North and South Taxiways, Bridge Over Palomar Airport Road

Item	Unit	Quantity	Length	lf	Area	sf	Area	sy	Depth	ft	Volume	cf	Volume	cy	Ton	Unit Cost	Cost	TOTAL
Pavement																		$ 5,311,400
P-152	sy				405972		45108		0.667		270648		10024			$ 2	$ 90,216	
P-154	cy				405972		45108		1.042		422887		15662			$ 60	$ 939,749	
P-209	cy				405972		45108		1.333		541295		20048			$ 75	$ 1,503,598	
P-401	ton				405972		45108		0.417		169155		6265		13156	$ 200	$ 2,631,297	
VSR	sf				39072		4341		0.500		19536		724			$ 4	$ 146,520	
Embankment	cy												49473			$ 50		$ 2,473,700
Retaining Wall	sf				25358											$ 71		$ 1,800,418
Pavement Markings																		$ 36,900
Rwy CL	lf		1200													$ 3	$ 3,000	
Rwy Edge	lf		2920													$ 3	$ 7,300	
Twy CL	lf		2980													$ 2	$ 4,470	
Twy Edge	lf		7155													$ 2	$ 16,099	
BlastPad/Stopway	lf		3000													$ 2	$ 6,000	
Electrical																		$ 3,100,000
Airfield Electrical	ea	1														$ 1,400,000	$ 1,400,000	
FAA Electrical	ea	1														$ 1,700,000	$ 1,700,000	
New Property																		$ 66,979,000
New Bridge Area	sf				128458											$ 500	$ 64,229,000	
Existing Lowes Area	sf				5500											$ 500	$ 2,750,000	
Structural Improvements																		$ 28,418,100
Steel Piles	sf				405972											$ 121	$ 49,122,552	
DDP Piles	sf				405972											$ 109	$ 44,250,894	
DDC Piles	sf				405972											$ 72	$ 29,229,948	
Injection Piles	sf				405972											$ 70	$ 28,418,005	
Clean Closure	sf				405972											$ 207	$ 84,036,101	
Drainage																		$ 2,492,400
Drainage System	lf		6000													$ 300	$ 1,800,000	
Drainage BMPs	ls	0.50%														$ 138,465,300	$ 692,400	
Methane Extraction	ls	1														$ 824,100		$ 824,100
Revegetation	ac	19														$ 1,500		$ 28,500
Subtotal																		$ 111,464,600
25% Contingency																		$ 27,866,150
TOTAL																		$ 139,330,800

APPENDIX B – STABILIZATION OPTIONS

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Project: McClellan-Palomar Airport
Subject: Airfield Stabilization - Estimated Volumes of MSW and Fill

Palomar Runway Extension

Depth/Area/Volume of MSW below Runway Extension

Section	Sta	Depth MSW	Length	Area A	Vol
		(ft)	(ft)	(ft^2)	(ft^3)
1	-03+00	7	0	1,050	0
2	-03+50	7	00+50	1,070	53,000
3	-04+00	7	00+50	1,050	53,000
4	-04+50	7	00+50	950	50,000
5	-05+00	8	00+50	820	44,250
6	-05+50	9	00+50	1,430	56,250
7	-06+00	15	00+50	2,490	98,000
8	-06+50	20	00+50	3,220	142,750
9	-07+00	30	00+50	4,030	181,250
10	-07+50	30	00+50	4,750	219,500
11	-08+00	40	00+50	5,560	257,750
12	-08+50	42	00+50	6,770	308,250
13	-09+00	50	00+50	7,060	345,750
14	-09+50	45	00+50	6,610	341,750
15	-10+00	40	00+50	6,420	325,750
16	-10+50	42	00+50	5,350	294,250
17	-11+00	40	00+50	4,540	247,250
18	-11+50	30	00+50	3,770	207,750
19	-12+00	20	00+50	2,890	166,500
20	-12+50	15	00+50	9,130	300,500
21	-13+00	15	00+50	7,990	428,000
22	-13+50	15	00+50	2,080	251,750
23	-14+00	15	00+50	2,120	105,000
24	-14+50	15	00+50	2,100	105,500
25	-15+00	18	00+50	2,330	110,750
26	-15+50	20	00+50	0	58,250
27	-16+00	23	00+50	0	0
28	-16+50	25	00+50	0	0
29	-17+00	25	00+50	0	0
30	-17+50	25	00+50	0	0
0	00+00		0	0	0
	1,450	23 ft (avg)			4,752,750 ft^3

Total CY = 176,100

Palomar Runway Extension

Depth/Area/Volume of MSW below South Taxiway

Section	Sta	Depth MSW	Length	Area A	Vol
		(ft)	(ft)	(ft^2)	(ft^3)
1	-03+00	2	0	75	0
2	-03+50	2	00+50	75	3,750
3	-04+00	2	00+50	75	3,750
4	-04+50	5	00+50	200	6,875
5	-05+00	8	00+50	460	16,500
6	-05+50	15	00+50	630	27,250
7	-06+00	20	00+50	1,250	47,000
8	-06+50	25	00+50	1,590	71,000
9	-07+00	32	00+50	1,850	86,000
10	-07+50	37	00+50	1,870	93,000
11	-08+00	40	00+50	1,700	89,250
12	-08+50	40	00+50	1,740	86,000
13	-09+00	38	00+50	1,820	89,000
14	-09+50	35	00+50	1,880	92,500
15	-10+00	30	00+50	1,480	84,000
16	-10+50	24	00+50	1,110	64,750
17	-11+00	19	00+50	820	48,250
18	-11+50	15	00+50	610	35,750
19	-12+00	18	00+50	750	34,000
20	-12+50	0	00+50	0	18,750
21	-13+00	0	00+50	0	0
22	-13+50	16	00+50	290	7,250
23	-14+00	13	00+50	420	17,750
24	-14+50	21	00+50	580	25,000
25	-15+00	28	00+50	620	30,000
26	-15+50	30	00+50	550	29,250
27	-16+00	29	00+50	570	28,000
28	-16+50	22	00+50	430	25,000
29	-17+00	12	00+50	230	16,500
30	-17+50	5	00+50	100	8,250
0	00+00	0	0	0	0
	1,450	19 ft (avg)			1,004,625 ft^3
					179,750 ft^3

Total CY Taxiway = 37,208
Total CY Retaining Wall = 6,657

Palomar Runway Extension

Depth/Area/Volume of MSW below North Taxiway

Section	Sta	Depth MSW	Length	Area A	Vol
		(ft)	(ft)	(ft^2)	(ft^3)
1	-03+00	9	0	470	0
2	-03+50	9	00+50	485	23,875
3	-04+00	10	00+50	700	29,625
4	-04+50	15	00+50	890	39,750
5	-05+00	15	00+50	980	46,750
6	-05+50	18	00+50	1,185	54,125
7	-06+00	20	00+50	1,160	58,625
8	-06+50	13	00+50	780	48,500
9	-07+00	19	00+50	1,100	47,000
10	-07+50	22	00+50	1,360	61,500
11	-08+00	27	00+50	1,690	76,250
12	-08+50	34	00+50	1,950	91,000
13	-09+00	38	00+50	2,330	107,000
14	-09+50	34	00+50	1,900	105,750
15	-10+00	28	00+50	1,600	87,500
16	-10+50	24	00+50	1,280	72,000
17	-11+00	18	00+50	810	52,250
18	-11+50	13	00+50	420	30,750
19	-12+00	10	00+50	420	21,000
20	-12+50	5	00+50	0	10,500
21	-13+00	5	00+50	0	0
22	-13+50	5	00+50	0	0
23	-14+00	0	00+50	0	0
24	-14+50	0	00+50	0	0
25	-15+00	0	00+50	0	0
26	-15+50	0	00+50	0	0
27	-16+00	0	00+50	0	0
28	-16+50	0	00+50	0	0
29	-17+00	0	00+50	0	0
30	-17+50	0	00+50	0	0
0	00+00	0	0	0	0
	1,450	18 ft (avg)			1,063,750 ft^3

Total CY = 39,398

Palomar Runway Extension

Depth/Area/Volume of MSW below South Retaining Wall

Section	Sta	Wall H	Length	Area A	Vol	Wall Area	Depth MSW	GI Area
		(ft)	(ft)	(ft^2)	(ft^3)	(ft^2)	(ft)	(ft^2)
1	-03+00	0	0	0	0			
2	-03+50	0	00+50	0	0	0		0
3	-04+00	0	00+50	0	0	0		0
4	-04+50	0	00+50	0	0	0		0
5	-05+00	0	00+50	0	0	0		0
6	-05+50	0	00+50	420	10,500	0		0
7	-06+00	0	00+50	820	31,000	0	0	0
8	-06+50	15	00+50	960	44,500	375	25	375
9	-07+00	21	00+50	830	44,750	900	20	900
10	-07+50	28	00+50	890	43,000	1,225	15	1,225
11	-08+00	29	00+50	610	37,500	1,425	16	1,425
12	-08+50	37	00+50	640	31,250	1,650	20	1,650
13	-09+00	40	00+50	675	32,875	1,925	15	1,925
14	-09+50	42	00+50	615	32,250	2,050	15	2,050
15	-10+00	45	00+50	420	25,875	2,175	10	2,175
16	-10+50	47	00+50	0	10,500	2,300	5	2,300
17	-11+00	48	00+50	0	0	2,375	0	2,375
18	-11+50	50	00+50	0	0	2,450	0	2,450
19	-12+00	49	00+50	0	0	2,475	0	2,475
20	-12+50	47	00+50	0	0	2,400	0	2,400
21	-13+00	44	00+50	0	0	2,275	0	2,275
22	-13+50	39	00+50	285	7,125	2,075	10	2,075
23	-14+00	31	00+50	415	17,500	1,750	10	1,750
24	-14+50	19	00+50	580	24,875	1,250	21	1,250
25	-15+00	10	00+50	622	30,050	725	28	725
26	-15+50	5	00+50	545	29,175	375	30	375
27	-16+00	9	00+50	575	28,000	350	29	350
28	-16+50	16	00+50	430	25,125	625	22	625
29	-17+00	15	00+50	230	16,500	775	12	775
30	-17+50	17	00+50	100	8,250	800	5	800
0	00+00	0	0	0	0	0	0	0
	1,450	28 ft (avg)			530,600 ft^3		14	34,725 ft^2

Total CY = 19,652
Total Wall Area = 34,725 ft^2
Average Wall H = 28 ft
Wall Length = 1,250 ft

Palomar Runway Extension

Fill to Grade Below Runway Extension

Section	Sta	Depth MSW	Length	Area A	Vol
		(ft)	(ft)	(ft^2)	(ft^3)
1	-03+00	0.0	0	0	0
2	-03+50	0.0	00+50	0	0
3	-04+00	0.0	00+50	0	0
4	-04+50	0.5	00+50	88	2,200
5	-05+00	1	00+50	147	5,875
6	-05+50	2	00+50	173	8,000
7	-06+00	2	00+50	240	10,325
8	-06+50	2	00+50	275	12,875
9	-07+00	3	00+50	250	13,125
10	-07+50	3	00+50	360	15,250
11	-08+00	4	00+50	440	20,000
12	-08+50	4	00+50	530	24,250
13	-09+00	4	00+50	560	27,250
14	-09+50	4	00+50	560	28,000
15	-10+00	5	00+50	530	27,250
16	-10+50	5	00+50	650	29,500
17	-11+00	6	00+50	850	37,500
18	-11+50	6	00+50	900	43,750
19	-12+00	8	00+50	1,040	48,500
20	-12+50	8	00+50	4,620	141,500
21	-13+00	8	00+50	4,530	228,750
22	-13+50	9	00+50	1,180	142,750
23	-14+00	9	00+50	1,200	59,500
24	-14+50	10	00+50	1,350	63,750
25	-15+00	10	00+50	1,370	68,000
26	-15+50		00+50	0	34,250
27	-16+00		00+50	0	0
28	-16+50		00+50	0	0
29	-17+00		00+50	0	0
30	-17+50		00+50	0	0
0	00+00		0	0	0
	1,450	5 ft (avg)			1,092,150 ft^3

Total CY = 40,500

Palomar Runway Extension

Fill to Grade below South Taxiway

Section	Sta	Depth MSW	Length	Area A	Vol
		(ft)	(ft)	(ft^2)	(ft^3)
1	-03+00	0	0	0	0
2	-03+50	0	00+50	0	0
3	-04+00	0	00+50	0	0
4	-04+50	0	00+50	32	800
5	-05+00	0	00+50	50	2,050
6	-05+50	0	00+50	100	3,750
7	-06+00	0	00+50	195	7,375
8	-06+50	0	00+50	188	9,575
9	-07+00	0	00+50	115	7,575
10	-07+50	0	00+50	280	9,875
11	-08+00	0	00+50	510	19,750
12	-08+50	0	00+50	960	36,750
13	-09+00	0	00+50	1,190	53,750
14	-09+50	0	00+50	1,470	66,500
15	-10+00	0	00+50	1,760	80,750
16	-10+50	0	00+50	1,890	91,250
17	-11+00	0	00+50	2,000	97,250
18	-11+50	0	00+50	2,140	103,500
19	-12+00	0	00+50	1,880	100,500
20	-12+50	0	00+50	0	47,000
21	-13+00	0	00+50	0	0
22	-13+50	0	00+50	0	0
23	-14+00	0	00+50	0	0
24	-14+50	0	00+50	0	0
25	-15+00	0	00+50	0	0
26	-15+50	0	00+50	0	0
27	-16+00	0	00+50	0	0
28	-16+50	0	00+50	0	0
29	-17+00	0	00+50	0	0
30	-17+50	0	00+50	0	0
0	00+00	0	0	0	0
	1,450	0 ft (avg)			738,000 ft^3

Total CY = 27,333

Palomar Runway Extension

Fill to Grage below North Taxiway

Section	Sta	Depth MSW	Length	Area A	Vol
		(ft)	(ft)	(ft^2)	(ft^3)
1	-03+00	0	0	0	0
2	-03+50	0	00+50	0	0
3	-04+00	0	00+50	0	0
4	-04+50	0	00+50	25	625
5	-05+00	0	00+50	25	1,250
6	-05+50	0	00+50	25	1,250
7	-06+00	0	00+50	25	1,250
8	-06+50	0	00+50	25	1,250
9	-07+00	0	00+50	25	1,250
10	-07+50	0	00+50	25	1,250
11	-08+00	0	00+50	25	1,250
12	-08+50	0	00+50	25	1,250
13	-09+00	0	00+50	25	1,250
14	-09+50	0	00+50	100	3,125
15	-10+00	0	00+50	50	3,750
16	-10+50	0	00+50	50	2,500
17	-11+00	0	00+50	100	3,750
18	-11+50	0	00+50	130	5,750
19	-12+00	0	00+50	130	6,500
20	-12+50	0	00+50	0	3,250
21	-13+00	0	00+50	0	0
22	-13+50	0	00+50	0	0
23	-14+00	0	00+50	0	0
24	-14+50	0	00+50	0	0
25	-15+00	0	00+50	0	0
26	-15+50	0	00+50	0	0
27	-16+00	0	00+50	0	0
28	-16+50	0	00+50	0	0
29	-17+00	0	00+50	0	0
30	-17+50	0	00+50	0	0
0	00+00	0	0	0	0
	1,450	0 ft (avg)			40,500 ft^3

Total CY = 1,500

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Project:	McClellan-Palomar Airport	Design:	DJL
Subject:	Airfield Stabilization	Date:	3/15/2013
Description:	Option 1a - Driven Steel Piles	Check:	

Runway Geometry & Subsurface Conditions

Runway Length:	900	ft	AVG Depth of MSW:	25	ft
Runway Width:	160	ft	AVG Depth OG to FG:	5	ft
South T/W Length:	900	ft			
South T/W Width:	60	ft			
North T/W Length:	900	ft			
North T/W Width:	60	ft			

Ground Improvement Method - Driven Pile w/ Reinforced Concrete Slab

Pile Type:	16	in dia steel pipe piling			
Depth into OG:	15	ft			
AVG Pile Length:	45	ft			
Slab Span:	20	ft			
Trans Spacing:	10	ft			
No. pile Trans:	17	(R/W)			
No. pile Long:	46	(R/W)			
No. pile Trans:	7	(S T/W)			
No. pile Long:	46	(S T/W)			
No. pile Trans:	7	(N T/W)			
No. pile Long:	46	(N T/W)			
Total No. pile:	1,426		Cost Furnish pile:	$80.00	LF
Total Length:	64,170	LF	Cost Drive pile:	$700	each
Total pile cost:	$6,131,800				
Slab thickness:	18	in			
Slab area:	252,000	ft^2	lbs of steel / CY concrete:	200	lbs/CY
Concrete Volume:	14,000	CY	Cost structural concrete:	$600.00	CY
Reinforcing Steel:	2,800,000	lbs	Cost reinforcing steel:	$2.50	lbs
Total slab cost:	$15,400,000				

Volume Fill OG to FG:		69,333	CY
Cost of Fill (Cellular Concrete):		$40	CY
Cost Establish Grade:		$2,773,333	
Cost piles, slab & fill:		$24,305,133	
Contingency:	25%	$6,076,283	
Total Cost:		$30,381,417	
		$121	$/ft^2$
		$5,251,645	/acre

Project:	McClellan-Palomar Airport	Design:	DJL
Subject:	Airfield Stabilization	Date:	3/15/2013
Description:	Option 1b - Driven Displacement Precast Piles	Check:	

Runway Geometry & Subsurface Conditions

Runway Length:	900	ft	AVG Depth of MSW:	25	ft
Runway Width:	160	ft	AVG Depth OG to FG:	5	ft
South T/W Length:	900	ft			
South T/W Width:	60	ft			
North T/W Length:	900	ft			
North T/W Width:	60	ft			

Ground Improvement Method - Driven Pile w/ Reinforced Concrete Slab

Pile Type:	14	in square PC/PS concrete pile
Depth into OG:	15	ft
AVG Pile Length:	45	ft
Slab Span:	20	ft
Trans Spacing:	10	ft
No. pile Trans:	17	(R/W)
No. pile Long:	46	(R/W)
No. pile Trans:	7	(S T/W)
No. pile Long:	46	(S T/W)
No. pile Trans:	7	(N T/W)
No. pile Long:	46	(N T/W)

Total No. pile:	1,426		Cost Furnish pile:	$47.00	LF
Total Length:	64,170	LF	Cost Drive pile:	$500	each
Total pile cost:	$3,728,990				
Slab thickness:	18	in			
Slab area:	252,000	ft^2	lbs of steel / CY concrete:	200	lbs/CY
Concrete Volume:	14,000	CY	Cost structural concrete:	$600.00	CY
Reinforcing Steel:	2,800,000	lbs	Cost reinforcing steel:	$2.50	lbs
Total slab cost:	$15,400,000				

Volume Fill OG to FG:		69,333	CY
Cost of Fill (Cellular Concrete):		$40	CY
Cost Establish Grade:		$2,773,333	
Cost piles, slab & fill:		$21,902,323	
Contingency:	25%	$5,475,581	
Total Cost:		$27,377,904	
		$109	$/ft^2$
		$4,732,466	/acre

Project:	McClellan-Palomar Airport	Design:	DJL
Subject:	Airfield Stabilization	Date:	3/15/2013
Description:	Option 2 - Drilled Displacement Columns	Check:	

Runway Geometry & Subsurface Conditions

Runway Length:	900 ft	AVG Depth of MSW:	25 ft
Runway Width:	160 ft	AVG Depth OG to FG:	5 ft
South T/W Length:	900 ft		
South T/W Width:	60 ft		
North T/W Length:	900 ft		
North T/W Width:	60 ft		

Ground Improvement Method - DDC Pile w/ Reinforced Fill to Grade

Pile Type:	24 in dia CLSM
AVG Pile Length:	25 ft
Grid Spacing:	7.5 ft (equilateral triangular distribution)

No. pile Trans:	22 (R/W)
No. pile Long:	121 (R/W)
No. pile Trans:	9 (S T/W)
No. pile Long:	121 (S T/W)
No. pile Trans:	9 (N T/W)
No. pile Long:	121 (N T/W)

Total No. pile:	4,889		
Total Length:	122,233 LF	Cost DDC pile:	$45.00 LF

Total pile cost: $5,500,500

Volume Fill OG to FG::		69,333 CY
Cost of Fill:		$40 CY
Cost Establish Grade:		$2,773,333
Area of Asphalt Concrete Pavement:		252,000 ft^2
Cost of ACP:		$25 SF
Total cost of AC runway pavement:		$6,300,000
Cost Place DDC's, fill & pavement:		$14,573,833
Contingency:	25%	$3,643,458
Total Cost:		$18,217,292

$72 /$ft^2$
$3,148,989 /acre

Project:	McClellan-Palomar Airport	Design:	DJL
Subject:	Airfield Stabilization	Date:	3/15/2013
Description:	Option 3 - Injection Grout MSW	Check:	

Runway Geometry & Subsurface Conditions

Runway Length:	900 ft	AVG Depth of MSW:	25 ft
Runway Width:	160 ft	AVG Depth OG to FG:	5 ft
South T/W Length:	900 ft		
South T/W Width:	60 ft		
North T/W Length:	900 ft		
North T/W Width:	60 ft		

Ground Improvement - Deep Injections w/ Lightweight Fill to Grade

Total Volume of MSW:		252,800	CY
% Volume of Typical Grout Take:		25%	
Amount of Grout - CY:		63,200	CY
Cost of Grouting - $/CY:		$80	/CY
Cost Slurry Grout:		$5,056,000	
Volume Fill OG to FG::		69,333	CY
Cost of Fill:		$40	CY
Cost Establish Grade:		$2,773,333	/CY
Area of Asphalt Concrete Pavement:		252,000	ft^2
Cost of ACP:		$25	SF
Total cost of AC runway pavement:		$6,300,000	
Cost Injection Grout, fill & pavement:		$14,129,333	
Contingency:	25%	$3,532,333	
Total Cost:		$17,661,667	
		$70	$/ft^2$
		$3,052,945	/acre

Project:	McClellan-Palomar Airport	Design:	DJL
Subject:	Airfield Stabilization	Date:	3/15/2013
Description:	Option - 4 MSW Excavation & Fill	Check:	

Runway Geometry & Subsurface Conditions

Runway Length:	900 ft		AVG Depth of MSW:	25 ft
Runway Width:	160 ft		AVG Depth OG to FG:	5 ft
South T/W Length:	900 ft			
South T/W Width:	60 ft			
North T/W Length:	900 ft			
North T/W Width:	60 ft			

Ground Improvement Method - Excavation of MSW w/ Fill to Grade

Total Volume of MSW:		252,800	CY
Cost of MSW Excavation:		$100	/CY
Cost of MSW Disposal:		$15	/CY
Total Excavate & Disposal:		$115	/CY
Cost MSW Removal:		$29,072,000	
Volume Fill to Replace MSW:		252,800	CY
Volume Fill OG to FG::		69,333	CY
Total Fill to Re-establish Grade:		322,133	CY
Cost of Fill:		$20	/CY
Cost Re-establish Grade:		$6,442,667	
Area of Asphalt Concrete Pavement:		252,000	ft^2
Cost of ACP:		$25	SF
Total cost of AC runway pavement:		$6,300,000	
Cost excavate, fill & pavement:		$41,814,667	
Contingency:	25%	$10,453,667	
Total Cost:		$52,268,333	
		$207	$/ft^2$
		$9,034,954.76	/acre

Project:	McClellan-Palomar Airport	Design:	DJL
Subject:	Airfield Stabilization	Date:	3/15/2013
Description:	Retaining Walls (MSE)	Check:	

Retaining Wall Geometry & Subsurface Conditions

Wall Length:	1,250	ft	AVG Depth of MSW:	14 ft
Average Height:	28	ft		
Wall Area:	35,150	ft^2		
Width GI Zone:	33	ft (width of ground improvement zone below wall)		
Length GI Zone:	1,260	ft (length of ground improvement zone below wall)		

Ground Improvement Method - DDC Pile for MSE Support

Pile Type:	24	in dia CLSM		
AVG Pile Length:	14	ft		
Grid Spacing:	7.5	ft (equilateral triangular distribution)		
No. pile Trans:	5			
No. pile Long:	169			
Total No. DDC's:	918			
Total Length:	12,856	LF	Cost DDC pile:	$45.00 LF
Total DDC cost:	$578,532			

Area of MSE Wall:		35,150	CY
Unit Cost of MSE Wall:		$40	CY
Cost of MSE Wall:		$1,406,000	
Cost Place DDC's & MSE Walls:		$1,984,532	
Contingency:	25%	$496,133	
Total Cost:		$2,480,664	
		$71	$/ft^2$

APPENDIX C – ELECTICAL COST ESTIMATES

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AIRFIELD FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 9,000.00	$ 9,000.00
	L-100	TESTING & DEMOLITION	LS	-		$ -
	L-108	CABLE SYSTEMS	LS	1		$ 4,500.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	-		$ -
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 85,500.00
	L-800	LIGHITNG AND SIGNAGE	LS	-		$ -
	L-890	ALCMS MODIFICATIONS	LS	-		$ -
	L-VIS	AIRPORT VISAID FACILITIES	EA	-		$ -
		Subtotal				$ 90,000.00
		Contingency	LS	1	0.25	$ 22,500.00
		CRQ Rwy 6 EMAS	**Airfield Facilities Electrical Total**			**$ 200,000.00**

FAA FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 85,400.00	$ 85,400.00
	L-140	FAA CABLE SYSTEMS	LS	1		$ 15,000.00
	ALS	FAA VISAIDs	LS	-		$ -
	ILS	FAA ILS FACILITIES	LS	1		$ 262,000.00
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ 150,000.00
		Subtotal				$ 427,000.00
		Contingency	LS	1	0.25	$ 106,750.00
		CRQ Rwy 6 EMAS	**FAA Facilities Total**			**$ 600,000.00**

AIRFIELD FACILITIES ELECTRICAL						
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	L-100	TESTING & DEMOLITION	LS	-		$ -
		NO WORK	LS	-	$ -	$ -
	L-108	CABLE SYSTEMS	LS	1		$ 4,500.00
	L-108-1	#1/0 BC FAA Guardwire	LF	1,000	$ 4.50	$ 4,500.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	-		$ -
		NO WORK	EA	-	$ -	$ -
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 85,500.00
	L-110-7	Single-way Duct, (1) 4-inch Conduit, Concrete Encased (Utility Co)	LF	500	$ 35.00	$ 17,500.00
	L-110-7	Multiple-way Duct, (4) 4-inch Conduit, Concrete Encased (FAA)	LF	200	$ 125.00	$ 25,000.00
	L-115-1	Handhole, Furnished and Installed	EA	4	$ 7,000.00	$ 28,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	-		$ -
		NO WORK	EA	-	$ 4,000.00	$ -
	L-890	ALCMS MODIFICATIONS	LS	-		$ -
		NO WORK	LS	-	$ -	$ -
	L-VIS	AIRPORT VISAID FACILITIES	LS	-		$ -
		NO WORK				
		Subtotal				$ 90,000.00
		Contingency	LS	1	25%	$ 22,500.00
		CRQ Rwy 6 EMAS			**Airfield Facilities Electrical Total**	**$ 200,000.00**

FAA FACILITIES ELECTRICAL						
BID ITEM	**SECTION NUMBER**	**ITEM DESCRIPTION**	**UNIT**	**QTY**	**UNIT PRICE**	**EXTENSION**
	L-140	FAA CABLE SYSTEMS	LS	1		$ 15,000.00
	L-140-1	12-Pair, 19-Gauge Communications Cable	L.F.	250	$ 4.00	$ 1,000.00
	L-140-2	USE/XLP, 600V Feeder	L.F.	500	$ 8.00	$ 4,000.00
	L-140-3	Electrical Service (per ILS or ALS facility site)	EA	1	$ 10,000.00	$ 10,000.00
	ALS	FAA VISAIDs	LS	-		$ -
		NO WORK				
	ILS	FAA ILS FACILITIES	LS	1		$ 262,000.00
	L-ILS-6.1	Relocate Rwy 24 LOC Facility, Complete	L.S.	1	$ 250,000.00	$ 250,000.00
	L-ILS-6.2	Rwy 24 LOC Site Demolition	L.S.	1	$ 12,000.00	$ 12,000.00
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ 150,000.00
		Subtotal				$ 427,000.00
		Contingency	LS	1	25%	$ 106,750.00
		CRQ Rwy 6 EMAS			**FAA Facilities Total**	**$ 600,000.00**

AIRFIELD FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 56,320.00	$ 56,320.00
	L-100	TESTING & DEMOLITION	LS	1		$ 28,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 79,200.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 17,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 211,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 203,000.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	EA	1		$ -
		Subtotal				$ 563,200.00
		Contingency	LS	1	0.25	$ 140,800.00
		CRQ Rwy 24 & Twy N 200-Ft Extension	**Airfield Facilities Electrical Total**			**$ 800,000.00**

FAA FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 196,800.00	$ 196,800.00
	L-140	FAA CABLE SYSTEMS	LS	1		$ 9,000.00
	ALS	FAA VISAIDs	LS	1		$ 475,000.00
	ILS	FAA ILS FACILITIES	LS	1		$ 200,000.00
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ 300,000.00
		Subtotal				$ 984,000.00
		Contingency	LS	1	0.25	$ 246,000.00
		CRQ Rwy 24 & Twy N 200-Ft Extension	**FAA Facilities Total**			**$ 1,300,000.00**

AIRFIELD FACILITIES ELECTRICAL						
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	L-100	TESTING & DEMOLITION	LS	1		$ 28,000.00
	L-100-1	Photometric Testing	LS	1	$ 5,000.00	$ 5,000.00
	L-100-2	Regulator Testing	LS	1	$ 3,000.00	$ 3,000.00
	L-100-3	Electrical Demolition	LS	1	$ 20,000.00	$ 20,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 79,200.00
	L-108-1	L-824, Type C, #8, 5 kV Cable	LF	30,000	$ 2.00	$ 60,000.00
	L-108-2	#6 BC Counterpoise	LF	7,000	$ 2.10	$ 14,700.00
	L-108-3	#1/0 BC FAA Guardwire	LF	1,000	$ 4.50	$ 4,500.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 17,000.00
	L-109-2	New 20 kW Regulator, Installed	EA	1	$ 17,000.00	$ 17,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 211,000.00
	L-110-1	Single-way Duct, (1) 2" Conduit, D.B.	LF	5,000	$ 15.00	$ 75,000.00
	L-110-2	Single-way Duct, (1) 2" Conduit, Concrete Encased	LF	400	$ 25.00	$ 10,000.00
	L-110-3	Multiple-way Duct, (4) 2-inch Conduit, Concrete Encased	LF	400	$ 75.00	$ 30,000.00
	L-110-7	Multiple-way Duct, (4) 4-inch Conduit, Concrete Encased	LF	200	$ 125.00	$ 25,000.00
	L-115-1	Handhole, Furnished and Installed	EA	8	$ 7,000.00	$ 56,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 203,000.00
	L-807-1	Wind Cones	EA	1	$ 4,000.00	$ 4,000.00
	L-850C-2	In-pavement Runway Edge Light	EA	2	$ 3,000.00	$ 6,000.00
	L-858-1	New Size 2 1 Module Airside Guidance Sign, Complete with new base	EA	2	$ 6,000.00	$ 12,000.00
	L-858-3	New Size 2, 3 Module Airside Guidance Sign, Complete with new base	EA	4	$ 9,000.00	$ 36,000.00
	L-858-6	Relocate Size 2, 1 Module Airside RDR Sign, Complete with new base	EA	4	$ 11,000.00	$ 44,000.00
	L-861T-1	Elevated Medium Intensity Taxiway Edge Light on L-867 Base	EA	50	$ 1,500.00	$ 75,000.00
	L-862E-1	Elevated High Intensity Runway End Light	EA	8	$ 1,500.00	$ 12,000.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-890-1	ALCMS Modifications	LS	1	$ 25,000.00	$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	LS	1		$ -
		Subtotal				$ 563,200.00
		Contingency	LS	1	25%	$ 140,800.00
		CRQ Rwy 24 & Twy N 200-Ft Extension		**Airfield Facilities Electrical Total**		**$ 800,000.00**

CRQ Rwy 24 & Twy N 200-Ft Extension **PRELIMINARY Electrical Cost Estimate**

FAA FACILITIES ELECTRICAL						
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	L-140	FAA CABLE SYSTEMS	LS	1		$ 9,000.00
	L-140-1	12-Pair, 19-Gauge Communications Cable	L.F.	400	$ 4.00	$ 1,600.00
	L-140-2	USE/XLP, 5 kV Feeder	L.F.	700	$ 6.00	$ 4,200.00
	L-140-3	USE/XLP, 600V Feeder	L.F.	400	$ 8.00	$ 3,200.00
	L-140-4	Electrical Service (per ILS or ALS facility site)	EA	1	$ 10,000.00	$ 10,000.00
	ALS	FAA VISAIDs	LS	1		$ 475,000.00
	L-MALS-2	Approach Lighting System (MALSR), Modify	L.S.	1	$ 350,000.00	$ 350,000.00
	L-880F-1	PAPI (Type FA-10620), Relocate	EA	1	$ 125,000.00	$ 125,000.00
	ILS	FAA ILS FACILITIES	LS	1		$ 200,000.00
	L-ILS-6.1	Relocate Rwy 24 GS Facility, Complete	L.S.	1	$ 140,000.00	$ 140,000.00
	L-ILS-6.2	Rwy 24 GS Site Demolition	L.S.	1	$ 12,000.00	$ 12,000.00
	L-ILS-6.3	Relocate RVR System (Rwy 24 TD), Complete	L.S.	1	$ 48,000.00	$ 48,000.00
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ 300,000.00
		Subtotal				$ 984,000.00
		Contingency	LS	1	25%	$ 246,000.00
		CRQ Rwy 24 & Twy N 200-Ft Extension			**FAA Facilities Total**	**$ 1,300,000.00**

AIRFIELD FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 59,880.00	$ 59,880.00
	L-100	TESTING & DEMOLITION	LS	1		$ 28,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 83,300.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 29,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 249,500.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 184,000.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	EA	1		$ -
		Subtotal				$ 598,800.00
		Contingency	LS	1	0.25	$ 149,700.00
		CRQ Rwy 24 & Twy N 800-Ft Extension	**Airfield Facilities Electrical Total**			**$ 800,000.00**

FAA FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 226,800.00	$ 226,800.00
	L-140	FAA CABLE SYSTEMS	LS	1		$ 9,000.00
	ALS	FAA VISAIDs	LS	1		$ 625,000.00
	ILS	FAA ILS FACILITIES	LS	1		$ 200,000.00
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ 300,000.00
		Subtotal				$ 1,134,000.00
		Contingency	LS	1	0.25	$ 283,500.00
		CRQ Rwy 24 & Twy N 800-Ft Extension	**FAA Facilities Total**			**$ 1,500,000.00**

AIRFIELD FACILITIES ELECTRICAL						
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	L-100	TESTING & DEMOLITION	LS	1		$ 28,000.00
	L-100-1	Photometric Testing	LS	1	$ 5,000.00	$ 5,000.00
	L-100-2	Regulator Testing	LS	1	$ 3,000.00	$ 3,000.00
	L-100-3	Electrical Demolition	LS	1	$ 20,000.00	$ 20,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 83,300.00
	L-108-1	L-824, Type C, #8, 5 kV Cable	LF	31,000	$ 2.00	$ 62,000.00
	L-108-2	#6 BC Counterpoise	LF	8,000	$ 2.10	$ 16,800.00
	L-108-3	#1/0 BC FAA Guardwire	LF	1,000	$ 4.50	$ 4,500.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 29,000.00
	L-109-2	New 20 kW Regulator, Installed	EA	1	$ 17,000.00	$ 17,000.00
	L-109-4	New 10 kW Regulator, Installed	EA	1	$ 12,000.00	$ 12,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 249,500.00
	L-110-1	Single-way Duct, (1) 2" Conduit, D.B.	LF	5,900	$ 15.00	$ 88,500.00
	L-110-2	Single-way Duct, (1) 2" Conduit, Concrete Encased	LF	200	$ 25.00	$ 5,000.00
	L-110-3	Multiple-way Duct, (4) 2-inch Conduit, Concrete Encased	LF	800	$ 75.00	$ 60,000.00
	L-110-7	Multiple-way Duct, (4) 4-inch Conduit, Concrete Encased	LF	200	$ 125.00	$ 25,000.00
	L-115-1	Handhole, Furnished and Installed	EA	8	$ 7,000.00	$ 56,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 184,000.00
	L-807-1	Wind Cones	EA	1	$ 4,000.00	$ 4,000.00
	L-850C-2	In-pavement Runway Edge Light	EA	1	$ 3,000.00	$ 3,000.00
	L-858-1	New Size 2 1 Module Airside Guidance Sign, Complete with new base	EA	2	$ 6,000.00	$ 12,000.00
	L-858-3	New Size 2, 3 Module Airside Guidance Sign, Complete with new base	EA	4	$ 9,000.00	$ 36,000.00
	L-858-6	Relocate Size 2, 1 Module Airside RDR Sign, Complete with new base	EA	4	$ 11,000.00	$ 44,000.00
	L-861T-1	Elevated Medium Intensity Taxiway Edge Light on L-867 Base	EA	29	$ 1,500.00	$ 43,500.00
	L-862-1	Elevated High Intensity Runway Edge Light	EA	7	$ 1,500.00	$ 10,500.00
	L-862E-1	Elevated High Intensity Runway End Light	EA	16	$ 1,500.00	$ 24,000.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-890-1	ALCMS Modifications	LS	1	$ 25,000.00	$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	LS	1		$ -
		Subtotal				$ 598,800.00
		Contingency	LS	1	25%	$ 149,700.00
		CRQ Rwy 24 & Twy N 800-Ft Extension	**Airfield Facilities Electrical Total**			**$ 800,000.00**

FAA FACILITIES ELECTRICAL						
BID ITEM	**SECTION NUMBER**	**ITEM DESCRIPTION**	**UNIT**	**QTY**	**UNIT PRICE**	**EXTENSION**
	L-140	FAA CABLE SYSTEMS	LS	1		$ 9,000.00
	L-140-1	12-Pair, 19-Gauge Communications Cable	L.F.	400	$ 4.00	$ 1,600.00
	L-140-2	USE/XLP, 5 kV Feeder	L.F.	700	$ 6.00	$ 4,200.00
	L-140-3	USE/XLP, 600V Feeder	L.F.	400	$ 8.00	$ 3,200.00
	L-140-4	Electrical Service (per ILS or ALS facility site)	EA	1	$ 10,000.00	$ 10,000.00
	ALS	FAA VISAIDs	LS	1		$ 625,000.00
	L-MALS-2	Approach Lighting System (MALSR), Modify	L.S.	1	$ 500,000.00	$ 500,000.00
	L-880F-1	PAPI (Type FA-10620), Relocate	EA	1	$ 125,000.00	$ 125,000.00
	ILS	FAA ILS FACILITIES	LS	1		$ 200,000.00
	L-ILS-6.1	Relocate Rwy 24 GS Facility, Complete	L.S.	1	$ 140,000.00	$ 140,000.00
	L-ILS-6.2	Rwy 24 GS Site Demolition	L.S.	1	$ 12,000.00	$ 12,000.00
	L-ILS-6.3	Relocate RVR System (Rwy 24 TD), Complete	L.S.	1	$ 48,000.00	$ 48,000.00
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ 300,000.00
		Subtotal				$ 1,134,000.00
		Contingency	LS	1	25%	$ 283,500.00
		CRQ Rwy 24 & Twy N 800-Ft Extension			**FAA Facilities Total**	**$ 1,500,000.00**

AIRFIELD FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 69,110.00	$ 69,110.00
	L-100	TESTING & DEMOLITION	LS	1		$ 28,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 93,600.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 29,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 310,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 205,500.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	EA	1		$ -
		Subtotal				$ 691,100.00
		Contingency	LS	1	0.25	$ 172,775.00
		CRQ Rwy 24 & Twy N 1100-Ft Extension	**Airfield Facilities Electrical Total**			**$ 900,000.00**

FAA FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 256,800.00	$ 256,800.00
	L-140	FAA CABLE SYSTEMS	LS	1		$ 9,000.00
	ALS	FAA VISAIDs	LS	1		$ 775,000.00
	ILS	FAA ILS FACILITIES	LS	1		$ 200,000.00
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ 300,000.00
		Subtotal				$ 1,284,000.00
		Contingency	LS	1	0.25	$ 321,000.00
		CRQ Rwy 24 & Twy N 1100-Ft Extension	**FAA Facilities Total**			**$ 1,700,000.00**

AIRFIELD FACILITIES ELECTRICAL						
BID ITEM	**SECTION NUMBER**	**ITEM DESCRIPTION**	**UNIT**	**QTY**	**UNIT PRICE**	**EXTENSION**
	L-100	TESTING & DEMOLITION	LS	1		$ 28,000.00
	L-100-1	Photometric Testing	LS	1	$ 5,000.00	$ 5,000.00
	L-100-2	Regulator Testing	LS	1	$ 3,000.00	$ 3,000.00
	L-100-3	Electrical Demolition	LS	1	$ 20,000.00	$ 20,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 93,600.00
	L-108-1	L-824, Type C, #8, 5 kV Cable	LF	33,000	$ 2.00	$ 66,000.00
	L-108-2	#6 BC Counterpoise	LF	11,000	$ 2.10	$ 23,100.00
	L-108-3	#1/0 BC FAA Guardwire	LF	1,000	$ 4.50	$ 4,500.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 29,000.00
	L-109-2	New 20 kW Regulator, Installed	EA	1	$ 17,000.00	$ 17,000.00
	L-109-4	New 10 kW Regulator, Installed	EA	1	$ 12,000.00	$ 12,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 310,000.00
	L-110-1	Single-way Duct, (1) 2" Conduit, D.B.	LF	7,500	$ 15.00	$ 112,500.00
	L-110-2	Single-way Duct, (1) 2" Conduit, Concrete Encased	LF	200	$ 25.00	$ 5,000.00
	L-110-3	Multiple-way Duct, (4) 2-inch Conduit, Concrete Encased	LF	1,100	$ 75.00	$ 82,500.00
	L-110-7	Multiple-way Duct, (4) 4-inch Conduit, Concrete Encased	LF	200	$ 125.00	$ 25,000.00
	L-115-1	Handhole, Furnished and Installed	EA	10	$ 7,000.00	$ 70,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 205,500.00
	L-807-1	Wind Cones	EA	1	$ 4,000.00	$ 4,000.00
	L-850C-2	In-pavement Runway Edge Light	EA	1	$ 3,000.00	$ 3,000.00
	L-858-1	New Size 2 1 Module Airside Guidance Sign, Complete with new base	EA	2	$ 6,000.00	$ 12,000.00
	L-858-3	New Size 2, 3 Module Airside Guidance Sign, Complete with new base	EA	4	$ 9,000.00	$ 36,000.00
	L-858-6	Relocate Size 2, 1 Module Airside RDR Sign, Complete with new base	EA	5	$ 11,000.00	$ 55,000.00
	L-861T-1	Elevated Medium Intensity Taxiway Edge Light on L-867 Base	EA	32	$ 1,500.00	$ 48,000.00
	L-862-1	Elevated High Intensity Runway Edge Light	EA	11	$ 1,500.00	$ 16,500.00
	L-862E-1	Elevated High Intensity Runway End Light	EA	16	$ 1,500.00	$ 24,000.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-890-1	ALCMS Modifications	LS	1	$ 25,000.00	$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	LS	1		$ -
		Subtotal				$ 691,100.00
		Contingency	LS	1	25%	$ 172,775.00
		CRQ Rwy 24 & Twy N 1100-Ft Extension	**Airfield Facilities Electrical Total**			**$ 900,000.00**

FAA FACILITIES ELECTRICAL						
BID ITEM	**SECTION NUMBER**	**ITEM DESCRIPTION**	**UNIT**	**QTY**	**UNIT PRICE**	**EXTENSION**
	L-140	FAA CABLE SYSTEMS	LS	1		$ 9,000.00
	L-140-1	12-Pair, 19-Gauge Communications Cable	L.F.	400	$ 4.00	$ 1,600.00
	L-140-2	USE/XLP, 5 kV Feeder	L.F.	700	$ 6.00	$ 4,200.00
	L-140-3	USE/XLP, 600V Feeder	L.F.	400	$ 8.00	$ 3,200.00
	L-140-4	Electrical Service (per ILS or ALS facility site)	EA	1	$ 10,000.00	$ 10,000.00
	ALS	FAA VISAIDs	LS	1		$ 775,000.00
	L-MALS-2	Approach Lighting System (MALSR), Modify	L.S.	1	$ 650,000.00	$ 650,000.00
	L-880F-1	PAPI (Type FA-10620), Relocate	EA	1	$ 125,000.00	$ 125,000.00
	ILS	FAA ILS FACILITIES	LS	1		$ 200,000.00
	L-ILS-6.1	Relocate Rwy 24 GS Facility, Complete	L.S.	1	$ 140,000.00	$ 140,000.00
	L-ILS-6.2	Rwy 24 GS Site Demolition	L.S.	1	$ 12,000.00	$ 12,000.00
	L-ILS-6.3	Relocate RVR System (Rwy 24 TD), Complete	L.S.	1	$ 48,000.00	$ 48,000.00
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ 300,000.00
		Subtotal				$ 1,284,000.00
		Contingency	LS	1	25%	$ 321,000.00
		CRQ Rwy 24 & Twy N 1100-Ft Extension			**FAA Facilities Total**	**$ 1,700,000.00**

CRQ Twy A 800-Ft Extension PRELIMINARY Electrical Cost Estimate

AIRFIELD FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 32,650.00	$ 32,650.00
	L-100	TESTING & DEMOLITION	LS	1		$ 23,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 58,500.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 17,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 134,500.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 68,500.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	EA	1		$ -
		Subtotal				$ 326,500.00
		Contingency	LS	1	0.25	$ 81,625.00
		CRQ Twy A 800-Ft Extension	**Airfield Facilities Electrical Total**			**$ 500,000.00**

FAA FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ -	$ -
	L-140	FAA CABLE SYSTEMS	LS	1		$ -
	ALS	FAA VISAIDs	LS	1		$ -
	ILS	FAA ILS FACILITIES	LS	1		$ -
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ -
		Subtotal				$ -
		Contingency	LS	1	0.25	$ -
		CRQ Twy A 800-Ft Extension	**FAA Facilities Total**			**$ -**

AIRFIELD FACILITIES ELECTRICAL						
BID ITEM	**SECTION NUMBER**	**ITEM DESCRIPTION**	**UNIT**	**QTY**	**UNIT PRICE**	**EXTENSION**
	L-100	TESTING & DEMOLITION	LS	1		$ 23,000.00
	L-100-2	Regulator Testing	LS	1	$ 3,000.00	$ 3,000.00
	L-100-3	Electrical Demolition	LS	1	$ 20,000.00	$ 20,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 58,500.00
	L-108-1	L-824, Type C, #8, 5 kV Cable	LF	24,000	$ 2.00	$ 48,000.00
	L-108-2	#6 BC Counterpoise	LF	5,000	$ 2.10	$ 10,500.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 17,000.00
	L-109-2	New 20 kW Regulator, Installed	EA	1	$ 17,000.00	$ 17,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 134,500.00
	L-110-1	Single-way Duct, (1) 2" Conduit, D.B.	LF	3,100	$ 15.00	$ 46,500.00
	L-110-3	Multiple-way Duct, (4) 2-inch Conduit, Concrete Encased	LF	800	$ 75.00	$ 60,000.00
	L-115-1	Handhole, Furnished and Installed	EA	4	$ 7,000.00	$ 28,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 68,500.00
	L-858-3	New Size 2, 3 Module Airside Guidance Sign, Complete with new base	EA	2	$ 9,000.00	$ 18,000.00
	L-861T-1	Elevated Medium Intensity Taxiway Edge Light on L-867 Base	EA	29	$ 1,500.00	$ 43,500.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-890-1	ALCMS Modifications	LS	1	$ 25,000.00	$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	LS	1		$ -
		Subtotal				$ 326,500.00
		Contingency	LS	1	25%	$ 81,625.00
		CRQ Twy A 800-Ft Extension		**Airfield Facilities Electrical Total**		**$ 500,000.00**

AIRFIELD FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ 37,160.00	$ 37,160.00
	L-100	TESTING & DEMOLITION	LS	1		$ 23,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 60,600.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 17,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 173,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 73,000.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	EA	1		$ -
		Subtotal				$ 371,600.00
		Contingency	LS	1	0.25	$ 92,900.00
		CRQ Twy A 1,100-Ft Extension	**Airfield Facilities Electrical Total**			**$ 500,000.00**

FAA FACILITIES ELECTRICAL			SUMMARY			
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	P-101	Mobilization/Demobilization (10% Max)	LS	1	$ -	$ -
	L-140	FAA CABLE SYSTEMS	LS	1		$ -
	ALS	FAA VISAIDs	LS	1		$ -
	ILS	FAA ILS FACILITIES	LS	1		$ -
	RA	FAA REIMBURSIBLE AGREEMENT	LS	1		$ -
		Subtotal				$ -
		Contingency	LS	1	0.25	$ -
		CRQ Twy A 1,100-Ft Extension	**FAA Facilities Total**			**$ -**

AIRFIELD FACILITIES ELECTRICAL						
BID ITEM	SECTION NUMBER	ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENSION
	L-100	TESTING & DEMOLITION	LS	1		$ 23,000.00
	L-100-2	Regulator Testing	LS	1	$ 3,000.00	$ 3,000.00
	L-100-3	Electrical Demolition	LS	1	$ 20,000.00	$ 20,000.00
	L-108	CABLE SYSTEMS	LS	1		$ 60,600.00
	L-108-1	L-824, Type C, #8, 5 kV Cable	LF	24,000	$ 2.00	$ 48,000.00
	L-108-2	#6 BC Counterpoise	LF	6,000	$ 2.10	$ 12,600.00
	L-109	REGULATOR BUILDING MODIFICATIONS	LS	1		$ 17,000.00
	L-109-2	New 20 kW Regulator, Installed	EA	1	$ 17,000.00	$ 17,000.00
	L-110	DUCT AND HANDHOLE SYSTEM	LS	1		$ 173,000.00
	L-110-1	Single-way Duct, (1) 2" Conduit, D.B.	LF	3,700	$ 15.00	$ 55,500.00
	L-110-3	Multiple-way Duct, (4) 2-inch Conduit, Concrete Encased	LF	1,100	$ 75.00	$ 82,500.00
	L-115-1	Handhole, Furnished and Installed	EA	5	$ 7,000.00	$ 35,000.00
	L-800	LIGHITNG AND SIGNAGE	LS	1		$ 73,000.00
	L-858-3	New Size 2, 3 Module Airside Guidance Sign, Complete with new base	EA	2	$ 9,000.00	$ 18,000.00
	L-861T-1	Elevated Medium Intensity Taxiway Edge Light on L-867 Base	EA	32	$ 1,500.00	$ 48,000.00
	L-890	ALCMS MODIFICATIONS	LS	1		$ 25,000.00
	L-890-1	ALCMS Modifications	LS	1	$ 25,000.00	$ 25,000.00
	L-VIS	AIRPORT VISAID FACILITIES	LS	1		$ -
		Subtotal				$ 371,600.00
		Contingency	LS	1	25%	$ 92,900.00
		CRQ Twy A 1,100-Ft Extension	**Airfield Facilities Electrical Total**			**$ 500,000.00**

APPENDIX D – METHANE EXTRACTION SYSTEM

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McClellan-Palomar Airport Methane Extraction Wells								
Item	Cost	Unit	Alternative A		Alternative B		Alternative C	
			Quantity	Total	Quantity	Total	Quantity	Total
Mobilize	$ 3,500	ea	15	$ 52,500	30	$ 105,000	33	$ 115,500
Drill Well	$ 131	lf	321	$ 42,051	684	$ 89,604	733	$ 96,023
Disposal	$ 400	cy	107	$ 42,800	228	$ 91,200	244	$ 97,600
Pipes	$ 67	lf	1600	$ 107,200	5000	$ 335,000	6200	$ 415,400
Vaults	$ 2,130	ea	15	$ 31,950	30	$ 63,900	33	$ 70,290
Wellhead	$ 886	ea	15	$ 13,290	30	$ 26,580	33	$ 29,238
TOTAL				$ 289,800		$ 711,300		$ 824,100

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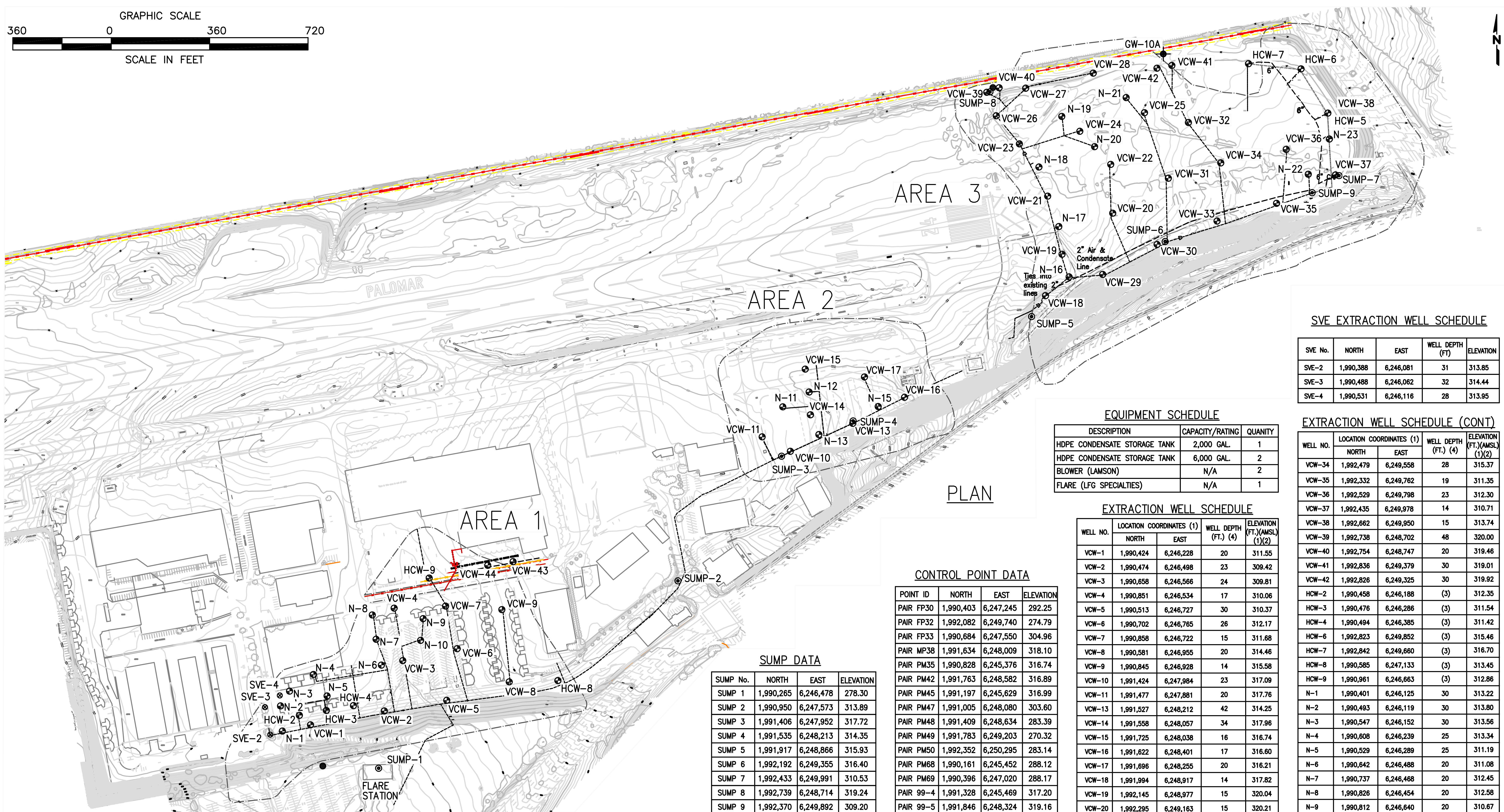

LEGEND

- VCW-1, N-1 LFG EXTRACTION WELL
- HCW-6 HORIZONTAL COLLECTOR
- SVE-2 SOIL VAPOR EXTRACTION WELL
- SUMP CONDENSATE SUMP
- GW-10A GAS MIGRATION MONITORING WELL
- BELOW GRADE HEADERS/LATERALS
- PROPERTY BOUNDRY
- APPROXIMATE LIMITS OF REFUSE

NOTES:

1. COORDINATES AND ELEVATIONS ARE BASED ON CALIFORNIA COORDINATE SYSTEM ZONE 6, NAD 83 DATUM, USFT. SURVEY COMPLETED DECEMBER 20, 2006 BY PROJECT DESIGN CONSULTANTS. NORTH AND EAST COORDINATES ARE PER THE STATE PLANE COORDINATE SYSTEM.
2. AMSL = ABOVE MEAN SEA LEVEL; SURVEY POINT AT GROUND SURFACE.
3. HCW'S ARE HORIZONTAL COLLECTORS, COORDINATES ARE AT LOCATION.
4. WELL DEPTH DATA OBTAINED FROM ORIGINAL BORING LOGS. NUMBER INDICATES PROBE DEPTH IN CASE OF MULTIPLE DEPTH PROBES.
5. EXISTING TOPOGRAPHIC PLAN IS FURNISHED BY PROJECT DESIGN CONSULTANTS. THE TOPOGRAPHY DATA IS BASED ON A COMBINATION OF AERIAL PHOTOGRAPHS DATED 1/31/05, 8/22/01 – REVISED 3/10/06.

SUMP DATA

SUMP No.	NORTH	EAST	ELEVATION
SUMP 1	1,990,265	6,246,478	278.30
SUMP 2	1,990,950	6,247,573	313.89
SUMP 3	1,991,406	6,247,952	317.72
SUMP 4	1,991,535	6,248,213	314.35
SUMP 5	1,991,917	6,248,866	315.93
SUMP 6	1,992,192	6,249,355	316.40
SUMP 7	1,992,433	6,249,991	310.53
SUMP 8	1,992,739	6,248,714	319.24
SUMP 9	1,992,370	6,249,892	309.20

CONTROL POINT DATA

POINT ID	NORTH	EAST	ELEVATION
PAIR FP30	1,990,403	6,247,245	292.25
PAIR FP32	1,992,082	6,249,740	274.79
PAIR FP33	1,990,684	6,247,550	304.96
PAIR MP38	1,991,634	6,248,009	318.10
PAIR PM35	1,990,828	6,245,376	316.74
PAIR PM42	1,991,763	6,248,582	316.89
PAIR PM45	1,991,197	6,245,629	316.99
PAIR PM47	1,991,005	6,248,080	303.60
PAIR PM48	1,991,409	6,248,634	283.39
PAIR PM49	1,991,783	6,249,203	270.32
PAIR PM50	1,992,352	6,250,295	283.14
PAIR PM68	1,990,161	6,245,452	288.12
PAIR PM69	1,990,396	6,247,020	288.17
PAIR 99-4	1,991,328	6,245,469	317.20
PAIR 99-5	1,991,846	6,248,324	319.16

EQUIPMENT SCHEDULE

DESCRIPTION	CAPACITY/RATING	QUANITY
HDPE CONDENSATE STORAGE TANK	2,000 GAL.	1
HDPE CONDENSATE STORAGE TANK	6,000 GAL.	2
BLOWER (LAMSON)	N/A	2
FLARE (LFG SPECIALTIES)	N/A	1

EXTRACTION WELL SCHEDULE

WELL NO.	LOCATION COORDINATES (1)		WELL DEPTH (FT.) (4)	ELEVATION (FT.)(AMSL) (1)(2)
	NORTH	EAST		
VCW-1	1,990,424	6,246,228	20	311.55
VCW-2	1,990,474	6,246,498	23	309.42
VCW-3	1,990,658	6,246,566	24	309.81
VCW-4	1,990,851	6,246,534	17	310.06
VCW-5	1,990,513	6,246,727	30	310.37
VCW-6	1,990,702	6,246,765	26	312.17
VCW-7	1,990,858	6,246,722	15	311.68
VCW-8	1,990,581	6,246,955	20	314.46
VCW-9	1,990,845	6,246,928	14	315.58
VCW-10	1,991,424	6,247,984	23	317.09
VCW-11	1,991,477	6,247,881	20	317.76
VCW-13	1,991,527	6,248,212	42	314.25
VCW-14	1,991,558	6,248,057	34	317.96
VCW-15	1,991,725	6,248,038	16	316.74
VCW-16	1,991,622	6,248,401	17	316.60
VCW-17	1,991,696	6,248,255	20	316.21
VCW-18	1,991,994	6,248,917	14	317.82
VCW-19	1,992,145	6,248,977	15	320.04
VCW-20	1,992,295	6,249,163	15	320.21
VCW-21	1,992,358	6,248,925	15	322.40
VCW-22	1,992,474	6,249,156	18	321.42
VCW-23	1,992,549	6,248,821	13	321.33
VCW-24	1,992,595	6,249,042	23	323.68
VCW-25	1,992,663	6,249,279	23	321.06
VCW-26	1,992,652	6,248,737	13	321.24
VCW-27	1,992,752	6,248,844	13	320.29
VCW-28	1,992,808	6,249,092	19	320.15
VCW-29	1,992,071	6,249,126	17	319.44
VCW-30	1,992,181	6,249,325	46	317.16
VCW-31	1,992,423	6,249,366	40	318.53
VCW-32	1,992,627	6,249,440	27	318.35
VCW-33	1,992,267	6,249,545	34	314.11

SVE EXTRACTION WELL SCHEDULE

SVE No.	NORTH	EAST	WELL DEPTH (FT)	ELEVATION
SVE-2	1,990,388	6,246,081	31	313.85
SVE-3	1,990,488	6,246,062	32	314.44
SVE-4	1,990,531	6,246,116	28	313.95

EXTRACTION WELL SCHEDULE (CONT)

WELL NO.	LOCATION COORDINATES (1)		WELL DEPTH (FT.) (4)	ELEVATION (FT.)(AMSL) (1)(2)
	NORTH	EAST		
VCW-34	1,992,479	6,249,558	28	315.37
VCW-35	1,992,332	6,249,762	19	311.35
VCW-36	1,992,529	6,249,798	23	312.30
VCW-37	1,992,435	6,249,978	14	310.71
VCW-38	1,992,662	6,249,950	15	313.74
VCW-39	1,992,738	6,248,702	48	320.00
VCW-40	1,992,754	6,248,747	20	319.46
VCW-41	1,992,836	6,249,379	30	319.01
VCW-42	1,992,826	6,249,325	30	319.92
HCW-2	1,990,458	6,246,188	(3)	312.35
HCW-3	1,990,476	6,246,286	(3)	311.54
HCW-4	1,990,494	6,246,385	(3)	311.42
HCW-6	1,992,823	6,249,852	(3)	315.46
HCW-7	1,992,842	6,249,660	(3)	316.70
HCW-8	1,990,585	6,247,133	(3)	313.45
HCW-9	1,990,961	6,246,663	(3)	312.86
N-1	1,990,401	6,246,125	30	313.22
N-2	1,990,493	6,246,119	30	313.80
N-3	1,990,547	6,246,152	30	313.56
N-4	1,990,608	6,246,239	25	313.34
N-5	1,990,529	6,246,289	25	311.19
N-6	1,990,642	6,246,488	20	311.08
N-7	1,990,737	6,246,468	20	312.45
N-8	1,990,826	6,246,454	20	312.58
N-9	1,990,812	6,246,640	20	310.67
N-10	1,990,733	6,246,631	20	310.03
N-11	1,991,587	6,247,956	20	318.00
N-12	1,991,641	6,248,052	30	315.90
N-13	1,991,485	6,248,088	30	316.26
N-15	1,991,588	6,248,305	30	314.19
N-16	1,992,062	6,249,003	25	318.71
N-17	1,992,247	6,248,966	20	320.18
N-18	1,992,464	6,248,893	20	322.52
N-19	1,992,649	6,248,977	30	323.05
N-20	1,992,539	6,249,097	35	322.56
N-21	1,992,718	6,249,212	20	322.89
N-22	1,992,438	6,249,878	20	310.29
N-23	1,992,567	6,249,956	20	312.66

NO.	REVISION	DATE

SITE PLAN

PROJECT TITLE: LFG COLLECTION SYSTEM
PALOMAR AIRPORT LANDFILL
2198 PALOMAR AIRPORT ROAD
CARLSBAD, CA 92008

COUNTY OF SAN DIEGO
LANDFILL MANAGEMENT
5201 RUFFIN ROAD
SAN DIEGO, CALIFORNIA 92123

SCS ENGINEERS
ENVIRONMENTAL CONSULTANTS
10300 FOURTH STREET, SUITE 200
RANCHO CUCAMONGA, CA 91730
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PROJ. NO. 07212096.00 | DWN. BY: S.VISWANATHAN | ACAD FILE: | DSN. BY: – | CHK. BY: | APP. BY:

DATE: 12-07-2012

SCALE: 1" = 180'-0"

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APPENDIX F – PALOMAR SETTLEMENT MITIGATION FEASIBILITY STUDY

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SCS ENGINEERS

      

DRAFT Report

Palomar Settlement Mitigation Feasibility Study

Palomar Airport Landfill Carlsbad, CA

Presented to:

County of San Diego Department of Public Works

Landfill Management
5201 Ruffin Road, Suite D, MS 0383
San Diego, CA 92123

Presented by:

SCS ENGINEERS
3900 Kilroy Airport Way
Suite 100
Long Beach, CA 90806-6816
(562) 426-9544

July 6, 2010
File No. 07206406.01

DRAFT Report

Palomar Settlement Mitigation Feasibility Study
Palomar Airport Landfill
Carlsbad, CA

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3900 Kilroy Airport Way
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(562) 426-9544

July 6, 2010
File No. 07206406.01

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Appendices

1.0 EXECUTIVE SUMMARY

SCS was retained by the San Diego County Department of Public Works (DPW) to investigation potential approaches to mitigate on-going surface settlement at the Palomar Airport Landfill. SCS performed a field investigation consisting of drilling numerous holes into Areas 2 and 3, density testing, and lab testing samples for moisture content.

Based on results of the field investigation, SCS's modeling of rates of settlement due to on-going waste decomposition and the preliminary analysis of the on-going settlement monitoring program, the site appears to be settling very slowly -- about one inch over the next 10 years is predicted at the deepest points of refuse of roughly 30 ft.

A review of actual settlement monitoring data taken by the DPW over the past 6 months does not reveal any consistent quantity of settlement -- the rate is probably too low to detect in such a short time frame.

County staff has also indicated that visually observed rates of settlement and related damage seem to have lessened considerably over the past two years.

Therefore, evidence of extensive settlement requiring regular, expensive re-grading and re-paving, as has been experienced over the past ten years, is not consistent with our field findings or actual settlement measurements (although the latter are available only for this short-term period).

It is speculated that some portion of the settlement experienced in the past may have been triggered by the periodic mitigation efforts that involved placing additional weight in the form of pavement or fill soil.

1.1 POTENTIAL MITIGATION APPROACHES

A summary of mitigation approaches identified and evaluated by SCS is listed below, in order of increasing initial expense (costs shown include necessary backfill, and re-paving in Area 2):

- Routine (periodic) grading and maintenance (basically, similar to current approach but enhanced with geogrids and employing light weight aggregate, etc.).

  This is considered applicable only to Area 2. There would be no initial capital expense, but the periodic need to re-grade (and then re-pave) due to localized settlement would continue. However, SCS recommends that replacement fill and paving be reinforced with geogrids and utilize light weight aggregates to reduce the short-term surcharging effect of the additional fill.

  In light of the evidence that settlement rates have declined, and are further declining overt time, this may be the least expensive long-term approach. We would expect that the recent pattern of spending $250,000 per year on such patchwork fixes may be reduced substantially, but this cannot be precisely quantified.

- In-place compaction using Deep Dynamic Compaction (DDC) or similar in-place waste stabilization/densification methods.

  This is potentially applicable to both Area 2 (estimated initial cost of $2.9 million) and Area 3 (limited to the runway extension area - estimated $900,000). The short-term effectiveness is considered very good. The need for further repairs (re-grading, re-paving) is considered minimal over the next five to 10 years, but in frequent repair is likely to be required after that period.

- Surcharging (pre-loading with imported fill, followed by its partial removal).

  This is potentially applicable to both Area 2 (estimated initial cost of $2.6 million) and Area 3 (limited to the runway extension area - estimated $1.1 million). However:

  - Area 2 -- it would likely require up to one year to obtain full benefit, and during that time Area 2 would not be usable.

  - Area 3 -- we would need to confirm that temporarily raising the Area 3 runway approach by 5 feet would be acceptable to Airport operations.

  The short-term effectiveness is considered very good. The need for further repairs (re-grading, re-paving) is considered minimal over the next five to 10 years, but infrequent repair is likely to be required after that period.

- Deep foundation system such as piers, piles or aggregate columns.

  This is considered a near-permanent fix for the Area 3 runway approach, at an estimated cost of $4.2 million. Future settlement of the runway pavement would be completely eliminated for the runway itself, although relatively minor maintenance would be required as the adjacent Area 3 surface continues to settlement and creates a potential separation; also, potential gas buildup directly under the runway would need to be vented.

  However, this is considered cost prohibitive for Area 2, at perhaps $10 million, since it is believed that Area 2 can tolerate more settlement than the proposed extended runway of Area 3, and therefore would not justify such an expensive remedy.

- Injection grouting.

  This is considered potentially applicable only to Area 2, but at substantial expense, estimated at $6.4 million for the total area, and it would be appropriate to conduct a pilot study before using it for its use for any large area. This would also be considered a substantially permanent fix. It is not recommended for the Area 3 runway extension because of potential for creating unintended voids which could result in continued settlement.

- Waste removal and replacement with clean fill.

This would be a permanent fix at a very high expense, particularly due to the need pay tipping fees to dispose of excavated waste at an active (and possibly distant) landfill. We estimate the cost at $19.2 million for Area 2. It would yet more expensive for Area 3, because of the need to excavate waste not only directly under the runway extension, but also at a substantial lateral distance to provide for a stable excavated slope and side (buttress) support for the compacted replacement fill.

For the reader's convenience, Table 7, which summarizes the alternatives, is reproduced below.

Settlement Mitigation Measure Comparison

Alternative Type	Cost		Comments
	Area 2	Area 3	
Routine grading and maintenance	significantly less than the historical $0.25 M/year	N/A	Data, observations suggest settlement slowing
DDC	$2.3-$2.9 M	$1.1-$1.4 M	Effective in near term
Soil Surcharging	$2.2-$2.5 M	$0.9-$1.1 M	Effective in near term; airport restrictions for duration
Pile Foundation	N/A	$4.2 M	Permanent fix for runway extension
Injection Grouting	$5.4-$6.4 M	N/A	May be more applicable to localized settlement
Waste removal and clean fill	$17.2-$19.2 M	$23 M	Permanent fix but very expensive, temporary air impacts.

1.2 RECOMMENDATIONS

SCS is not providing a formal recommendation with submittal of this draft report. Since the potential mitigation approaches vary so dramatically, we instead suggest that we have a discussion of these findings with County DPW and Airports staff to better evaluate and prioritize the alternatives in light of County goals.

2.0 INTRODUCTION

SCS Engineers was retained by the San Diego County DPW to investigate settlement issues at the Palomar Airport Landfill ("the site") related to the underlying municipal solid waste (MSW) landfill and to present alternatives to mitigate (eliminate, minimize or accommodate) future settlement. The site is located at 2198 Palomar Airport Rd. Carlsbad, California. A location map showing site is presented in **Figure 1**.

To obtain information about the site, SCS visited on several occasions, discussed on-going settlement, maintenance, and pavement repair issues with airport staff, and researched landfill records at the San Diego County Department of Environmental Health (DEH) office. Based on this information, SCS designed and performed a field investigation consisting of auger borings extending through surface materials (existing soil and asphalt) and into the waste, and collected representative waste samples for moisture content testing.

This draft report presents the results of our investigation, our findings and provides recommendations for consideration by the DPW.

2.1 PROJECT BACKGROUND

The Site is owned by DPW and is currently operated by Airports division of the DPW. A few portions of the airport are built on an old closed landfill that operated in the 60's and 70's. These areas are designated Areas 1, 2, and 3 as shown in **Figure 2**.

Differential settlement of the asphalt paved surfaces, which we believe is predominantly due to the on-going degradation of the underlying waste plus the impacts of physical loadings (weight) above the waste, has exceeded several feet in some areas and has created nuisances for airport operations and drainage. The settlement has been observed for the past several years and has required various maintenance and surface repair activities, at substantial expense to Airports/DPW.

Area 2 is currently being used to park airplanes. Area 3 is under the runway approach. Both areas have experienced settlement. DPW and airport operations are looking for long term solutions to the settlement problems -- in Area 2 to help airport operations and reduce costs; in Area 3 to support runway extension.

As noted above, SCS designed and performed a subsurface investigation program consisting of auger borings in Areas 2 and 3 assess the current subsurface conditions. Results were incorporated in an "Interim Field Investigation Report" dated June 14, 2010 and presented to DPW and airport operations. Boring logs from this investigation are included in **Appendix B**.

2.2 LANDFILL HISTORY

The Palomar Airport landfill units are situated adjacent to canyons on the east end of the runway, and southeast and southwest end of taxiway. The County began waste filling operations within these canyons in 1968 and continued filling until 1972.

Waste fill consisted primarily of MSW and reached the level of the current runway. A pre-landfill photograph and a pre-landfill topographic map of this area are presented in **Figure 3** and **Figure 4** respectively. As shown in **Figure 5**, after landfilling operations, the southwest and southeast portions of the landfill were used for parking airplanes; these portions were designated as Area 1 and Area 2, respectively. The fill east of the runway was designated as Area 3 and has served as the runway approach.

SCS researched the DEH records to gather basic information about the waste type and density. A map showing typical North-South and East-West cross section through Area 2 and Area 3 was found in the DEH records; however no reference drawings to these cross sections was available -- this information is presented in **Figure 6**. According to this information the maximum waste thickness in Areas 2 and 3 is approximately 30 feet.

SCS has been performing routine maintenance and monitoring of the landfill gas (LFG) well field at this site since 2006. SCS has also been retained by DPW on various projects at the site. Most recently, SCS investigated subsurface fires in Area 2 (2005) and Area 3 (2008). As apart of these investigations, SCS drilled boreholes into the landfill. Boring logs from these locations, along with the location maps, are presented in **Appendix B**. In addition to this field work, Geosyntec Consultants performed a geotechnical investigation in 2007 for the airport improvement at Unit 1. Boring logs from this investigation are also included in **Appendix B**.

3.0 ENGINEERING ANALYSIS

3.1 WASTE DESCRIPTION

Based on our inspection of waste samples obtained during the recent borings, as well as descriptions from previous borings by Geosyntec (2007), the waste mass consists predominantly of municipal trash (or garbage) containing identifiable pieces of wire, metal, tire shreds, plastic, wood chips, cardboard, paper, debris and with varying amounts of soil or soil-like material. The waste ranges in appearance from light colored, dry and slightly decomposed waste to darker (sometimes black), moist to wet, and well decomposed. There is a not a definitive pattern of the apparent degree of decomposition, but our impressions are that the waste becomes more heavily decomposed with depth and with areas of high moisture content, as is common for waste masses of this age and type.

During the drilling program SCS monitored gas emission from the open boreholes. Although some borings exhibited noticeable LFG emissions (detected as methane via field instrumentation) at some depths, overall there was little methane detected which we believe is an indication that significant decomposition of the organic matter has already occurred. This finding is consistent with the age of the waste, as it is well established that gas generation declines with time.

The relative compactness of the waste was measured using standard penetration testing methods, using a 2-inch diameter split-barrel sampler to record “N-values.” By recording the number of blows of a free-falling hammer to drive the sampler into the waste, a numerical value (N-value) is generated which can be correlated to relative compactness of the material sampled.

These values are shown on the boring logs in increments of 6-inches (e.g, 10/20/25). Typically, the first value is discounted due to disturbance caused by the drill bit, and the next two values are added together to arrive a number of blows per foot. Obviously, high or low values are typically discounted since municipal solid waste contains fragments larger than the diameter of the split-spoon sampler resulting in artificially high values, or soft materials resulting in artificially low values.

SCS reviewed the N-values in relation to the material descriptions and depths, and observed that they range from a low of 6 blows per foot (B-2 at 15 feet) to more than 50 blows per 2-inches at several locations and depths. However, the blow count values are generally above 15 to 20 blows per foot at many locations, or higher, which is indicative of a relatively compact waste. Additionally, SCS’s borings and earlier borings by others did not encounter large zones of low blow counts, obvious voids, or large areas of wet material, or soft waste, where the sampler would be advanced just by the weight of the hammer. These results support a conclusion that the waste mass properties are relatively consistent (even though it contains a variety of materials), appear to be moderately to well compacted, and moderately to well-decomposed. Based on these findings, the geotechnical properties for compression and void ratio were assigned to the waste mass which is reflected in the settlement computations.

Based on borings that extended through the waste, current topography, soil cover and asphalt thickness measurement, and original site grades (pre-landfill), we estimate that the waste varies in thickness from approximately 10 to 30 feet, averaging approximately 20 feet.

Representative samples of the waste indicate it is a relatively dry to moist overall, but with localized wet areas. Moisture contents were also measured in 12 samples using laboratory methods, which are summarized in Table 1.

Table 1.   Moisture Content Summary

Sample ID	Moisture Content
#14-10’	14.5
#31-19.2’	19.7
#32-15’	23.2
#10-15’	42.2
#2-5’	15.3
#3-15’	9.2
#11-10’	9.6
#10-5’	33.5
#11-15	37.7
#9-25’	13.4
#2-15’	52.3
#2-10’	25.2

The laboratory moisture contents ranged from as low as 9.2% to over 52%, with an average moisture content of these samples is 24.7%. These values are in the expected range for MSW materials and consistent with our observations.

Overall, the test boring results, moisture content tests, and resulting settlement computations are within the normal range of waste materials found at sites of similar age and type. It can be concluded that the waste was reasonably well spread and compacted when it was originally placed (consistent with the filling practices utilized in the 60’s), contains predominantly MSW and has undergone significant organic decomposition over the past 40 years. However, even though relatively old and decomposed, the Palomar waste will continue to compress over time, and under new physical loads, which will result in settlement at the surface. Large scale field compression tests could be performed to supplement the analytical computations and provide more accurate predictions, but given the relatively low magnitudes of current settlement and anticipated future light loadings from new pavement and transient vehicle loads, such testing may not be timely or justifiable.

3.2 SUMMARY OF SETTLEMENT MEASUREMENTS

County staff has been monitoring surface settlement at over 90 locations since October 2009. These data were provided to SCS. We plotted raw data against time to evaluate the magnitude and rate of settlement. The settlement graphs for points 1001 through 1095 are presented in **Appendix A**, where elevation is presented on Y axis and time is presented on X axis.

Our review of the data indicates that settlement rates are essentially zero and in fact show a very small rise (0.02 to 0.06 inch) over the 5 months (see Section 3.3.2).

3.3 SETTLEMENT OF WASTE MATERIALS

In addition to reviewing the field survey data, SCS also performed theoretical calculations using accepted landfill settlement models for comparison to field data. In this case, we followed the method developed by Sowers (1970), who described the specific processes responsible for waste settlement as follows:

- on-going decomposition of organic matter by aerobic and anaerobic bacteria
- chemical and physical degradation
- raveling (internal shifting and migration) of particles over time
- compression due to self-weight,
- impact of new loadings from structural fill and from the road and fill loadings

For purposes of estimating magnitudes and rates, Sowers divided the settlement modes into two basic categories:

- (1) load-related compression that results from stresses imposed on the waste by new loads (e.g., grading fill, pavement, stockpiles, structures and vehicles, etc.), and

- (2) on-going decomposition of organic components contained within the waste. The former occurs since waste is a relatively compressible material with high void ratios, while the later results from decomposition processes.

For purposes of the calculations, settlement occurring within the waste mass is conservatively assumed to be mimicked at the surface in terms of extent and magnitude, though not exactly the same. In other words, flexible surfaces such as asphalt pavements, soil cover and small buildings or other structures resting on the surface will settle to the same amount as the underlying waste mass compresses. The condition known as "bridging," in which a rigid material or structure is able to span across an area of settlement, is unlikely to occur in a waste mass unless the structure is relatively large and has a reinforced foundation. This means that the occurrence of large open voids beneath the asphalt paved surface is remote, although cannot be completely discounted.

Though Sowers provides a simple and logical model for settlement estimates, accurate predictions of settlement rate and the overall magnitude of settlement of waste are difficult to make under any circumstances due to various unknowns such as exact composition and placement of refuse, rate of decomposition of woody and paper refuse, distribution, age, and moisture content of existing refuse materials. However, based on generally accepted empirical models and the results of the recent borings, we have considered potential short term and long term estimates of settlement.

3.3.1 Initial (Primary) Settlement

The load-related mode of waste of settlement occurs over a short period of time (say, several weeks to months) during the filling process, or after new loads is applied, and is directly related to waste compression properties and total waste thickness. These initial settlements will occur relatively rapidly, often with a few weeks or months of final loading, and may not be detectable if new fill is being added concurrently. In this case, filling ceased approximately 40 years ago, but additional physical loads in the form of final cover soils, roadway pavements patches and overlays, as well as transient traffic loadings and wheel loadings from parked aircraft, have been transmitted into the waste.

To quantity waste settlement that results from post-closure loading, we utilized a one-dimensional compression model (Hough, 1957) and incorporate into that model the waste compression factors developed by Sowers. Although more complex mathematical models exist to estimate waste settlement, such models are only as good as the input data with regard to waste compressibility, density, void ratio, organic content. Given the variability of these properties within any waste mass, and difficultly in testing for these properties, we considered historical information, experience with other landfill projects and published information to provide guidance for estimating the critical properties that can be used in estimating settlement.

In Hough’s one -dimensional settlement model, settlement of a compressible layer, such as the waste, is estimated as follows:

$$\text{Settlement, } S = H^* \frac{Cc}{1+e} {}^*\log(1 + \Delta P/P) \ldots\ldots\ldots\ldots\ldots\ldots \text{Eqn. 1}$$

where, S = Total settlement of the compressible layer under study (waste)

H = original thickness of the compressible layer (waste)

Cc = coefficient of compression of the compressible layer (waste)

e = initial void ratio of the compressible layer (waste)

P = initial stress at center of compressible layer (waste)

ΔP = stress increase due to new loading (soil fill, asphalt, traffic, etc.)

Based on estimates by Sowers’ and Yen & Scanlon (1975) the compressibility factor, Cc, for MSW ranges from a low of 0.0.15*e to a high of 0.55*e. The lower value equates to waste with low organic content or well compacted (in other words, less compressible) while the higher value equates to waste with high organic content or poorly compacted. For a newly closed landfill the Cc value would be in the high range, and for old closed facility such as Palomar, the Cc would be much lower. The Cc reduces over time due to decomposition and on-going compression (which lowers the void ratio). The age of the Palomar waste, and descriptions on the boring logs, suggests that the waste has indeed undergone a significant amount of decomposition over that time period.

Though the amount of compactive effort applied to the waste at the time of placement is not known, it does appear from the borings and Standard Penetration Testing discussed above that the waste is relatively consistent in compactness (for a waste mass), does not exhibit large voids or large soft zones, and therefore must have received some nominal compaction effort during initial placement.

On the basis of SCS's borings, the known age of waste and our experience with waste settlement analysis at other sites, we assumed that compression factor values in the lower end are justified. For this case, we conservatively estimate that Cc would be in the lower half of Sower's range at about 0.05*e. This means that the waste will not compress as much as freshly placed waste, but due to the unknown nature of compaction and other unknown factors, will still compress under new loadings.

The initial void ratio, e, of the waste (current condition) is also variable in any waste mass due to the wide variety of materials, different particle shapes and sizes and degrees of compaction. Based on published literature and estimates of in-place waste density, we estimate the void ratio to be between about 2.5 to 3.0. This is typical for most solid waste materials and corresponds to porosity (n) of approximately 71% to 75%. The equivalent porosity (n) of the waste would be computed as:

$$n = e/(1+e)$$

For void ratios between 2.5 and 3.0, and assuming an average specific gravity (G)of the waste materials between 1.5 and 1.75, and moisture content of 25%, the resulting in-place waste density (wet density) will be somewhere between 800 and 1050 pounds per cubic yard, which is also typical for this type and age. Modern sanitary landfills often achieve densities of over 1200 pcy, but employ large compactors and compact waste in thin lifts.

The significance of calculating settlement due to new loading on the waste is apparent when considering adding even relatively small loads such as necessary to level the pavement, fill-in closed depressions and maintain the maximum 1 percent slope for aircraft.

To put this in prospective, based on current site conditions SCS calculated the amount of settlement that could theoretically be triggered by repaving/grading operations over a large, wide area, such as have occurred in the past several years. Table 2 summarizes the settlement range for waste thicknesses of 10, 20 and 30 feet for a new surface load of 250 psf (equivalent to 2 feet of new soil or 1.7 feet of asphalt equivalent) for a waste void ratio of 3.0 and compression coefficient of 0.15 (=3.0*0.05); Table 3 provides the results assuming the new surface load is 500 psf. Settlements for paving or filling within more localized or smaller areas would be slightly less than calculated.

Table 2. Palomar Airport --settlement estimates from new loadings (e=3.0, Cc = 0.45, Load 250 psf)

Waste Depth	Stress @ Center	New Soil Cover Thickness	Induced Stress @ Center	Waste Void Ratio	Coeff. Of Compression	Estimated Settlement
(H in feet)	(Po in psf)	(feet)	(dP in psf)	(e)	(Cc)	(S, in inches)
10.0	146.3	2	250	3.00	0.45	5.8
20.0	292.5	2	250	3.00	0.45	7.2
30.0	438.8	2	250	3.00	0.45	7.9

Table 3. Palomar Airport --settlement estimates from new loadings (e=3.0, Cc = 0.45, Load 500 psf)

Waste Depth	Stress @ Center	New Soil Cover Thickness	Induced Stress @ Center	Waste Void Ratio	Coeff. Of Compression	Estimated Settlement
(H in feet)	(Po in psf)	(feet)	(dP in psf)	(e)	(Cc)	(S, in inches)
10.0	146.3	4	500	3.00	0.45	8.7
20.0	292.5	4	500	3.00	0.45	11.7
30.0	438.8	4	500	3.00	0.45	13.4

These calculations indicate that adding surface loads of 250 to 500 psf at the present time could induce settlements of about 6 inches to over one foot. Had these same loads been applied in the past, when the waste was somewhat less decomposed, and had a higher compression coefficient and higher void ratio, the settlements would have been somewhat higher.

These calculations confirm that adding new fill or asphalt pavement to re-level the pavement surface could result in noticeable settlement of several inches to a foot or more.

Importantly, this load related settlement would be over and above the settlement that occurs due to long-term decomposition, or other factors that might accelerate decomposition, which is discussed below.

3.3.2 Long Term (Secondary) Settlement

Long term settlement refers to the settlement that occurs over a lengthy period of time (years or decades) after completion of filling or construction activities and not due to any new loadings or stresses. Such settlement would occur relatively slowly, primarily due to decomposition of the organic waste components and other on-going waste degradation processes, but continually, after waste placement is complete. Since the organic component diminishes with time, the rate of settlement would also diminish in time. It is theorized that the rate of long term settlement is proportional to the rate of gas generation, which is known to diminish with time.

For Palomar, we assumed that the refuse exhibits long-term secondary settlement resulting from decomposition of the organic components, similar to municipal solid refuse, as described by Sowers (1973) and Yen & Scanlon (1975).

Recognizing that the underlying refuse has been in place for 38 to 42 years, we can estimate the settlement between any two time periods using the following equation from Sowers:

$\Delta H = H (\acute{\alpha})/(1+ e0) * \text{Log} (T2/T1)$..Eqn. 2

Where

ΔH = settlement of a refuse layer of thickness H

ά = coefficient of secondary compression which ranges between the following

Conditions "favorable to decomposition," ά = 0.09 * e0 = 0.27 (greater potential for settlement)

Conditions "unfavorable to decomposition," ά = 0.03 * e0 = 0.09 (less potential for settlement)

e0 = initial waste void ratio (assumed equal to 2.0 to 3.0)

T1 = average age of refuse placement to current time = 38 to 42 years

T2 = average age of refuse to some future date.

For 2015, T2 = 53 to 57

For 2021, T2 = 58 to 62

For 2025, T2 = 63 to 67

For Palomar, we assumed relatively low long term compression factors given the age and physical appearance of the waste and computed long term settlement for 5, 10 and 20 years from the present time (2010). For these calculations we assumed ά = 0.05 * e0 = 0.15 :

Table 4. Palomar Airport --settlement estimates for 2010 to 2015 (e=3.0, ά = 0.15)

Waste Depth	T2	T1	Void Ratio	Coeff. of Compression	Estimated Settlement
(H in feet)	(Years)	(Years)	(e)	(ά)	(S, in inches)
10.0	45	40	3.00	0.15	0.2
20.0	45	40	3.00	0.15	0.5
30.0	45	40	3.00	0.15	0.7

Table 5. Palomar Airport --settlement estimates for 2010 to 2020 (e=3.0, □ = 0.15)

Waste Depth	T2	T1	Void Ratio	Coeff. of Compression	Estimated Settlement
(H in feet)	(Years)	(Years)	(e)	(ά)	(S, in inches)
10.0	50	40	3.00	0.15	0.4
20.0	50	40	3.00	0.15	0.9
30.0	50	40	3.00	0.15	1.3

Table 6. Palomar Airport --settlement estimates for 2010 to 2030 (e=3.0, ά = 0.15)

Waste Depth	T2	T1	Void Ratio	Coeff. Of Compression	Estimated Settlement
(H in feet)	(Years)	(Years)	(e)	(ά)	(S, in inches)
10.0	60	40	3.00	0.15	0.8
20.0	60	40	3.00	0.15	1.6
30.0	60	40	3.00	0.15	2.4

These calculations indicate that in 2015, or 5 years from the present time, long term decomposition –related settlement would have small magnitudes, less than 1 inch for waste depths of 10, 20 and 30 feet. In 2020, or 10 years from the present time, the long term decomposition settlement would exceed 1 –inch only for the 30 foot waste depth and for 20 years from the present time would exceed 2 inches for the 30 foot depth. These are relatively small magnitudes.

Considering the surface settlement monitoring program that is on-going, the survey readings over a 6 month period of time, according to this approach, would be between 0.024 and 0.060 inches which is relative small and may not be measureable with conventional survey equipment. SCS verified these results with the actual field settlement survey observations and found these results satisfactory.

In reviewing the actual field survey data, there was no obvious downward trend in the surface readings, or reduction over time, which suggests that the settlement rates calculated above are reasonable. The monitoring program should continue so that a true measure of settlement rate can be measured over a longer period of time. However, the frequency of monitoring can be reduced from monthly to quarterly, given the apparent very slow rate of overall settlement.

3.3.3 Differential Settlement

We understand the airplane parking and taxiway areas should have a maximum slope of 1%. This means that across level 100 foot horizontal distance, the allowable settlement would be 12 inches. Unless otherwise calculated, it is typically assumed that differential settlement will be ½ of total settlement. Thus, an area that experiences a 12-inch average settlement, would likely exhibit a maximum differential settlement of 6 inches between two points. With regard to a runway, we assume that even small undulations and depressions in the pavement from differential settlements could be problematic regardless of the slope and depth.

3.4 SUMMARY OF SETTLEMENT OBSERVATION AND MEASUREMENTS

For the Palomar site, we recognize that settlement has been significant in Area 2, requiring multiple grading and re-paving projects over time to level the surface to maintain a maximum 1% slope, eliminate ponding, and to promote positive surface water drainage. There is ample visible evidence of previous settlement and repair, including numerous pavement patches, ponded water in some areas, closed depressions, undulating paved surfaces, as well as the variable asphalt thicknesses measurements in the borings of up to 5 and 6 feet in places. Clearly, the site has experienced settlement of the waste and challenges with operating the airport parking and taxi areas.

However, our field observations and modeling, as well as recent input from DPW staff, suggests settlement, and associated problems, may be decreasing:

- Modeling of settlement rates based on results of the field investigation suggest that the site is settling slowly -- our model predicts about one inch over the next 10-year period at the deepest points of refuse of (roughly 30 ft in Area 2).
- A review of actual settlement monitoring data taken by DPW over the past 6 months does not reveal any consistent quantity of settlement -- the rate is probably too low to detect in such a short time frame.
- County staff has also indicated that visually observed rates of settlement and related damage seem to have lessened considerably over the past two years.
- A condition of extensive settlement requiring regular, expensive re-grading and re-paving, as has been experienced over the past ten years, is not consistent with our field findings or actual, recent settlement measurements (although the latter are available only for this short-term period).

The expense of the repetitive re-grading and surfacing work has been estimated by Airports staff as averaging about $250,000 per year, although specific records of individual re-grading projects were not available.

Based on our review of the data and experience with landfill materials, we believe that the basic causes of the settlement are those described in Section 3.0, but in this case are specifically related to:

1. Normal waste decomposition processes that are still on-going and that result in cyclical process of settlement of the surface pavements, leading to pavement cracking and/or ponding of liquid, followed by increased infiltration of liquid into the waste. The infiltration of liquids into the waste mass in localized areas increases

the moisture content of the waste which, in most cases, will cause an acceleration of waste decomposition, leading to additional settlement.

2. Addition of stresses (loads) from newly placed fill and/or asphalt overlays for re-grading and re-leveling the pavement surface results in temporary acceleration of settlement and eventually additional ponding.

3. Areas where groundwater (or water from buried utilities) may be seeping into the waste from localized decomposition in these areas. Physical loads from parked airplanes and maintenance vehicles may also be contributing to settlement, but their relative influence is limited and localized.

The field data and anecdotal evidence indicates that the Palomar waste has lower compressibility compared to fresh, highly organic waste or waste that it was reasonably well compacted. This is based on borings that indicate the waste is relatively dark in color, which indicates that the organic components have undergone significant decomposition since placement. Although it was reported that on occasion the facility accepted paints, oil and thinners, treated sewage sludge and medical waste[1], we did not observe such materials nor large voids, excessively wet or saturated waste. As discussed above, standard penetration blow counts (N-values) obtained within the waste mass further support the conclusion that the waste is relatively compact.

1 Source: GeoSyntec Geotechnical Recommendations dated 23 May, 2007.

4.0 SETTLEMENT MITIGATION ALTERNATIVES

Considering the depth of waste, previous settlement history and overall goals, the following mitigation alternatives are worth consideration, in approximate order of increasing initial cost:

- Routine grading and maintenance (basically, similar to current approach but enhanced with reinforcement geogrids, light weight aggregate, etc.)
- In-place compaction using DDC or similar methods
- Surcharging (pre-loading), which will require one year or more to complete
- Deep foundation system such as piers, piles or aggregate columns
- Injection grouting
- Waste removal and replacement with clean fill (either full or partial)

Note: There are other solutions currently being practiced, such as in place “stabilization” using anaerobic or aerobic bioreactor technology, but such solutions are more time consuming, expensive and not yet well- tested, therefore, we are not recommending these in this report.

The sections which follow discuss these potential mitigation strategies and apparent/relative costs. A rough estimation of cost for each alternative has been provided in each section and is for comparison purposes only. These estimates were derived based on our experience with different technologies on past projects, or verbal estimates from vendors.

Several of these strategies necessitate the destruction and replacement of pavement in Area 2, as well as replacement of the gas collection and control system (GCCS) in Areas 2 and 3. Our cost estimates below include those costs. A pavement section of 4-inch asphalt over 6-inch aggregate base is assumed for these calculations.

The costs listed below for Area 3 represent the premium (incremental) costs for adequately preparing the area for runway construction, and **do not incorporate the actual cost of that construction** as we presume this is budgeted separately.

4.1 PERIODIC GRADING WITH MAINTENANCE

This option involves periodic, as-needed, re-grading to maintain positive drainage, filling in low or depressed areas prone to ponding, sealing cracks or holes in the asphalt and re-paving areas to address pavement distress. This is <u>similar to the current maintenance program</u>, except that:

- Areas exhibiting more than a few inches of settlement would be dug out to remove excess asphalt, and possibly a limited depth of existing wet or soft underlying waste (if present);

- Refilling to original grades would utilize lightweight aggregate material such as foam, bottom ash, or similar products that have the strength to support aircraft traffic loads; and

- Refilling would be reinforced with reinforcement geogrids to minimize local, differential settlement the future.

As the site would continue settling from decomposition, it is important that the on-going settlement monitoring program be continued and refined, as appropriate, to cover critical areas of pavement and that an operations & maintenance plan be developed to control when and how areas of settlement are treated. The frequency of settlement monitoring can be relaxed to a quarterly basis (or ultimately less) since monthly settlement magnitudes are relatively small. However, settlement readings should be made prior to and after maintenance activities to provide baseline information for making future site improvements. Bench marks should be located on stable ground, off of the waste and surveying be performed using consistent equipment and methods.

The costs for the routine grading and maintenance option will be a function of the future settlement rates, the volume of material required to re-level areas and need for re-pavement. Based on the information provided by airport operations, they have been spending an average of $250,000 per year.

Since the recent field monitoring data, our calculations, and comments provided by site personnel indicate that surface settlement (from waste decomposition) is relatively slow at the present time, the volume of fill required will be relatively small and the need to repave distressed areas will be less frequent than in the past. Hence we believe that this approach could turn out to result in significantly lower annual costs that have recently been incurred.

Area 2

This approach would apply to Area 2 where it has been practiced to date (without the recommended modifications). Although Airports/DPW has indicated it is restricted to a maximum grade of one percent, it is likely that small settlements are tolerable between the periodic mitigation (re-grading) events.

Area 3

Area 3 does not currently require routine grading and maintenance as it is unpaved and only used as a runway approach. However, preparation of the are for the runway extension will necessitate a more aggressive settlement mitigation strategy, from among those listed below.

4.2 IN PLACE DENSIFICATION USING DEEP DYNAMIC COMPACTION

DDC is a proven method to stabilize soft or weak soil materials and has been used for several decades in the US and internationally. The method is simple and involves repeatedly raising and dropping a large heavy (concrete) mass on top of compressible or weak soils a sufficient number of times to compact and strengthen the material. The number of drops, height of each drop, and weight of the rammer is a function of the depth and type of material to be impacted. For pure refuse materials, containing mostly organic matter, the maximum depth of influence only approaches 25 to 30 feet, which approximates the waste depths at Palomar.

The DDC process is performed over the entire area of improvement, and to some nominal distance beyond. (This would encompass the majority of Area 2, and the portion of Area 3 that would lie under and near the runway extension). Surface pavement and other structures in vicinity (if any) would need to be fully removed beforehand. Nearby structures may also be subjected to vibrations and require pre-inspection and pre-treatment such as temporary bracing, removal of sensitive or precarious objects, temporary relocation of smaller structures and temporary disconnection of utilities to minimize potential damage After the DDC process is completed, depressions would remain in the uppermost portion of the material that may be several feet deep. These depressions would need to be backfilled with controlled compacted soil re-level the surface and to provide a cushion to the compacted waste, along with replacement base and paving. Geogrids may be included in the compacted fill to provide further resistance to local, differential settlement.

As this method will disturb (compress) material below and to the sides of the heavy concrete mass, it should not be performed where sensitive underground structures or utilities are present and, or such structures should be protected (or be removed and/or replaced later, such as the LFG system). The allowable safe distance between the DDC impact areas and underground structures will vary from site to site, depending on the material encountered and utility design, and should be discussed with the contractor. It may be prudent to conduct a field test that includes vibration monitors to detect ground motions at various distances.

DDC does not completely eliminate settlement since the waste remains in place, but it will significantly limit future settlement to relatively low and more tolerable levels.

Cost to perform DDC is site-specific, but a rule of thumb is to allow for $50,000 to $60,000 for mobilization and $1 to $2 per square foot of treated area. Provided that the mobilization cost is spread over 10 acres, the total estimate cost for DDC would in roughly $50,000 to $75,000 per acre. Additional cost incurred would include replacement fill to bring site back to original grade and maintain slopes. Assuming an average 4 foot average drop, the cost of replacement fill is estimated at $50,000 to $100,000 per acre and the cost of pavement replacement would add another $150,000. Application of DDC will damage the GCCS and would require replacement; it would add another $30,000 per acre for a grand total cost of between $280,000 and $355,000 per acre.

Area 2

Total cost of DDC in Area 2 (about 8 acres) is estimated at $2.3 million to $2.9 million. Airport parking and taxiway operations will likely need to be closed in that area during the construction. It may not be practical to do Area 2 in pieces, as the noise and vibrations would be a nuisance and possibly safety hazard to aircraft users, but this could be analyzed further with Airports/DPW staff. Further, proximity to the outer slopes would have to be considered to as to avoid potential for slope instability during DDC operations.

Area 3

For Area 3 (approximately 4 acres under and immediately adjacent to the proposed runway) total cost of DDC is estimated to be $1.1 to $1.4 million. Area 3 would not require much surface preparation beyond removal of the upper layer of organic matter and existing vegetation.

As noted, DDC will not completely eliminate future settlement, as the waste remains in place, although in a more compact state. As a result it may be advisable for the runway pavement section to be thickened and/or stiffened to allow for some bridging (spanning small depressions) in the future. Further, the DDC operation involves relatively tall equipment and would probably necessitate restriction of the runway (or closure) during construction.

4.3 SOIL SURCHARGING (PRELOADING)

Surcharging is another widely used and reliable method of improving soft ground conditions, including landfilled waste. The surcharge process involves placing several feet or more of soil across a surface or area to surcharge (or pre-load) the waste.

The surcharge remains in place for a period of time -- such as one year, more or less -- which depends on the compressibility properties of the waste and the depth. The weight of the soil surcharge is selected to be high enough to compresses the underlying soft soil or waste such that when the surcharge is removed, the potential for future settlement is within tolerable limits.

The height of the surcharge, and lateral extent, are functions of the proposed loads and tolerable rate and magnitude of future settlement. Typical guidance is for a surcharge loading (pressure) to be equal to 1.5 to 2 times the planned pressure of the new structure (load) and that the surcharge remains in place until the rate of settlement is reduced to an acceptable level. In cases such as this where the future loadings are low, and settlement from waste decomposition is the key issue, the surcharge thickness can be estimated by applying Sowers' model. Such calculations have not been performed at this time, but it is estimated that a suitable surcharge thickness would be in the range of at least 5 feet and up to 10 feet in areas exhibiting larger movements.

An important advantage of surcharging over the other methods is that monitoring of settlement rates is performed as part of the method. This allows the engineer to track the progress of settlement and make quantitatively based predictions as to when the surcharge may be removed and how much settlement remains. Typically, the initial rate and magnitude of surcharge-induced settlement will be relatively large; however, as time passes, the rate and magnitude will be reduced and eventually begin to level off. Based on the settlement trend, which often follows a logarithmic relationship (refer Equation 2, after Sowers.), a large portion of the surcharge-induced settlement will occur in the initial several months. The disadvantage of surcharging is the time to complete the surcharge is not known until several sets of readings are available, and cost of bringing in and removing fill may be high in areas where fill is costly, or not readily available near the site. Similar to the DDC and grouting methods, soil surcharging the well field will have to modified to keep it operating during surcharging period.

To surcharge areas at Palomar we conservatively assumed clean soil will be used (imported). Assuming a one acre area is surcharged with 5 feet of clean soil, the volume required for this operation will be 8,000 cubic yards. Importing soil is estimated to cost between $15/CY to $20/CY including compaction and filling, the cost of re-pavement at $150,000 per acre, so the cost for surcharging would be with in the range of $270,000 to $310,000 per acre. The cost of surcharging could be significantly reduced if soil from nearby construction projects could be obtained; except for the lowermost 2 feet, the surcharge material may be composted of mixed fills, even rubble.

Area 2

The total cost for soil surcharging for Area 2 is estimated at $2.2 to $2.5 million. In Area 2 some or all of the existing surface features, including the asphalt pavement, gas well features, underground tanks, will need to be abandoned and replaced. Timing is an important factor to consider as surcharging may take up to a year or more to complete. The uppermost part of the surcharge that remains above the design grade, will need to be removed. The LFG well field will need to be modified (raised) so that regular O&M can be performed while surcharging, or a temporary system installed.

Area 3

Surcharging Area 3 (four acres under the proposed runway extension) is estimated to cost $0.9 to $1.1 million (not including the cost of runway construction). The height of the surcharge mound over then runway approach might be a limiting factor for this application. Airport operations or FAA would be consulted. The LFG system will require a modification to allow its continued operation during the surcharging.

4.4 GEOGRID REINFORCEMENT

Geogrids are manufactured thermo-plastic products that are placed within layers or lifts of compacted fill, or over soft ground, to add tensile strength to the subsoils. They are typically made of polyethylene, polyester or similar plastic materials, and are deployed in rolls that are overlapped and buried under soil cover. Geogrids are most frequently used in road projects over soft subgrades to distribute wheel loadings over a larger area.

In the case of pavements and other surface structures, geogrids are capable of improving soil bearing capacity and reducing the potential for abrupt differential settlement between adjacent areas. However, geogrids will not reduce total settlement for sites with significant thickness of underlying compressible materials. In other words, if there is a compressible soil layer below the geogrid, that layer will still compress over time and under load of the new runway/improvements.

It is unlikely that geogrids alone will provide sufficient ground improvement as a stand alone method. However, geogrids may be used in localized areas of settlement or areas where differential settlement is critical along with the other techniques discussed herein. The cost of geogrids is directly dependant on the design basis, the specific product selected and area of treatment Geogrids can range in cost considerably depending on the product selected, but for estimation purposes we assume the cost of material and installation is $0.60 per square foot.

Area 2

As discussed above geo grids can be applied to areas once they have been treated with DDC or soil surcharging. Overall settlement will be minimized with either DDC or soil surcharging, and goegrids will minimize differential settlement. If applied in conjunction with other treatment technologies geogrids can provide a reliable solution to minimize localized, differential settlement.

Area 3

Geo grids can be applied to Area 3 as well, but the area would require pretreatment (DDC or soil surcharging).

4.5 DEEP FOUNDATION SUPPORT SYSTEM (PILES OR PIERS)

Deep foundation systems consist of driven piles, drilled piers, rammed aggregate piers or other vertical structural members that extend from ground surface, through the waste column, and bear upon native materials below the waste.

Deep foundations have been used for numerous landfill redevelopment projects where buildings or other superstructures are involved. They have also been used for roadways over landfills.

Using deep foundations as an overall method for eliminating settlement of the pavement at Palomar would be appropriate provided that several critical issues are considered. First and foremost, the costs of driving piles or drilling piers would be significant, involving complete removal of existing asphalt pavement, refilling these areas with new soil, and then driving or drilling of piers with lengths varying from approximately 20 to 50 feet. The depths of the deep foundation would determined with a supplemental field drilling program focused on locating a suitable bearing layer or bedrock. Reinforced structural concrete grade beams would be necessary to span across the distance between piles or piers.

Future settlement would be completely eliminated for the runway itself, although relatively minor maintenance would be required as the adjacent Area 3 surface continues to settlement and creates a potential separation. Also, potential gas buildup directly under the runway would need to be vented.

The cost of piles including grade beams and slab stiffening is estimated at $25 per square foot.

Area 2

The cost to reconstruct Area 2 (8 acres) on piles would be in the area of $10 million or more -- and the asphalt paving would have to be replaced by a structural slab on the pile/grade beam foundation. This is probably cost prohibitive, since it is believed that Area 2 can tolerate more settlement than the proposed extended runway of Area 3, and therefore would not justify such an expensive remedy.

Area 3

A deep pile foundation may be applicable to Area 3 to support the runway extension. This is due to the need for a solution that essentially eliminates future settlement. Portions of the GCCS may need to be relocated.

For the 1100-foot extension of a 150-ft wide runway, pile foundations are estimated to **add** $4.2 million to cost of runway construction.

4.6 INJECTION GROUTING

In 2005, SCS helped extinguish a landfill fire in the waste mass by injecting a cement based grout into the waste. As time has gone by, it has been observed by site personnel that the grouted area has remained higher than the surrounding areas that are continuing to settle.

Grouting would involve the injection, under pressure, of a cementatious-grout to fill voids to the full depth of refuse deposition. Grouting, as a global, site-wide solution, is likely to prove very costly -- injection into old municipal waste with variable properties presents a number of technical challenges, particularly achieving an even distribution of grout and attendant strength. It may have more applicability for treating localized areas that continue to exhibit significant settlement.

The variables and unknown to be considered in developing the guidelines for such a process include, but are not limited to distribution of grout vertically and horizontally, maximum and minimum injection pressures, potential for creating preferential pathways, and grout mix design. However, pressure grouting, particularly into refuse, could result in the creation of some unintentional small voids, which could result in some local, continued differential settlement (less than have been experienced, but possibly problematic for the runway extension foundation).

Records of the previous grout injection were not available at the time of this report, but we have estimated quantity of “grout” per acre based on basis geometry factors. The following calculation provides a rough estimate of the quantity of grout to fill a large percent of pores within the waste. however, a field pilot study would be highly recommended due to the variable nature of waste:

Area = 43,560 sq. feet (vertical sides)

Depth of Waste = 20 feet (average depth)

Void ratio, e = 3.0

Total Porosity, n = ¾ = 0.75

Effective (usable) Porosity, n’= 0.50 (n) = 0.375 (assumes 50% of pores are actually fillable with grout)

Volume to fill 1 acre of waste, 20 feet deep (average depth) =

43560 x 20 x 0.375 x 7.48 = 2,443,716 gallons or 12,100 cubic yards

The cost to inject grout to full depth for Palomar is estimated to be in the $700,000 to $800,000 per acre range.

Area 2

Grouting is applicable to Area 2 and particularly can be applied on localized areas which are seeing significant settlement. A pilot test study is recommended before opting for grouting over the entire area to full depth. The total cost for grout injection for Area 2 is estimated approximately $5.4 to 6.4 million.

Area 3

Unintentional voids left during pressure grouting operations could cause the surface to settle unevenly which in-turn can cause differential settlement of the runway. Therefore, grouting is not recommended under the Runway.

4.7 WASTE REMOVAL AND CLEAN FILL

This is widely assumed to be a relatively expensive option that involves the complete (or partial) removal of waste materials from the area of treatment and extending down to stable, native soil.

The excavated waste would be replaced with controlled, compacted engineered fill (soil, not waste). Based on our investigations, the deepest excavation would need to extend to a depth of 44 feet (38 feet of waste, plus the 6 feet of soil cover). Average waste excavation depth would be approximately 24 feet.

With full excavation, there may be some contamination of underlying native soils, which could mean that some degree of overexcavation would be necessary (our estimates do not assume this).

For the runway extension, the horizontal limit of such an excavation would need to be sufficient so that compacted fill is present beneath the new runway pavement surface within an envelope measured from a 1:1 (45-degree) slope from the edge of the runway/structure to the bottom of the excavation. Allowing for a 2:1 excavation sideslope (see Figure 7), the excavation would start a maximum distance of 132 feet on each side from the pavement edge (in the area where the waste is deepest; a lesser-width excavation would suffice for shallower areas).

Partial removal of the waste (say half or two-thirds of the waste depth) followed by replacement with controlled compacted fill may also be considered in cases where waste excavation depths are significant. However, a settlement analysis of this option leads to the conclusion that partial removal could actually result in potentially greater settlement. This is because a partial waste excavation would involve removing a portion of the lighter weight waste mass and replacing it with heavier soil, thereby triggering additional settlement in the left-in-place waste. Partial waste removal is not a recommended option unless lightweight aggregate or similar low density fills are used, but these materials can be more expensive than soil as replacement fill.

We estimate waste excavation alone would cost between $8 per cubic yard (CY) to $15/CY. The presence and need to control localized leachate seepage, gas and other unsuitable materials could increase this range depending on environmental concerns Costs would include fees for disposal at another facility, plus and the cost of importing and compacting soil fill to bring the site back to desired (current) grade.

Assuming a one acre area is excavated to 20 feet deep, the volume of waste removal would be over 32,000 cubic yards and cost between $250,000 to $500,000. Importing and placing/compacting fill to reach existing grades would add another $15 to $20/CY ($480,000 to $640,000 for the acre), depending on soil availability. Adding a tip fee (including transportation) of $80/ton, assuming a density of 900 lbs per CY(14,400 tons per acre) of excavated waste, the disposal and replacement cost (with asphalt paving) is estimated at $2.3 million per acre.

Note also that a major excavation into the landfill would also require a significant environmental evaluation, due to the potential of odor and other air quality impacts associated with large surfaces of partially decomposed, exposed waste.

A variation on the complete waste removal option, that had been discussed for Area 3, would be to remove waste directly under the runway extension footprint, and construct retaining walls (supported on native material) to hold back the remaining waste. The space between the retaining walls would be backfilled with imported engineered fill. It is thought that this could reduce the total amount of waste that would require off-site disposal.

However, the cost of an excavation to allow the construction of the retaining walls, at a stable set-back (also 2:1), plus the cost of the two retaining walls, each up to 40 ft high, is believed to be higher than the cost of disposal and replacement of the waste, and therefore was not considered further.

Area 2

The waste excavation option can be applied to Area 2 but is extremely expensive. The removal of waste from Area 2 (about 8 acres) is estimated at $18.4 million. Construction for clean closure is also time consuming -- excavation typically cannot be accomplished by scrapers, and utilize slower clamshells and excavators -- therefore use of Area 2 for airplane parking would almost certainly have to be halted for a considerable period.

Area 3

The cost of waste removal and clean fill for Area 3 (based on 20 feet average depth) is also estimated at $2.3 million per acre. Area 3 would require excavation over 10 acres to accommodate the (maximum) 132-ft offset from the edges of the proposed runway (as described above) -- at an estimated cost of $23 million.

The waste excavation option would also require that the runway be shut down (or severely restricted/shortened) for a long enough period of time to complete the work. We estimate the waste excavation/fill replacement option would take several months to complete, depending on the number of excavators that could operate simultaeneously, truck access, etc..

5.0 RECOMMENDATIONS

SCS suggests that before making formal recommendations to the County, that the cost and effectiveness information provided in this draft report be discussed in detail. The approach that the County DPW (Airports and Landfill Management) ultimately select will be a function of short term vs. long term costs, the relative effectiveness of the alternative strategies, the tolerance of disruption of Airport operations. The relative priorities of the County (Airport operations and inactive landfill management) will have to be weighed.

The relevant landfill regulatory agencies may also have influence, and of course would have to be appraised of these activities.

Each option has benefits and drawbacks that need to be considered in context with time and budget constraints, and design goals.

The grading and maintenance option is advantageous as it has the potential to be the least costly option if settlement rates, as current field data suggests, are measureably lower than in the past and if coupled with localized treatments such as geogrids or grouting for problem areas.

However, the key difference between this option and the previous maintenance approach is that settlement monitoring will be continued and expanded for the entire area and used to determine where grading is needed as well as the monitor performance.

Additionally, with the benefit of data from the existing settlement program and depth of waste information, we will be able be better predict where settlement will be higher and lower and provide grading plans that anticipate settlement.

The grouting option is also advantageous in that the work can be done relatively quickly and with only limited disruption of activities. However, the cost of grouting may be very high and there are various unknowns related to the spacing of grout holes, pressures and mix design. It may be more applicable to addressing localized settlement, rather than an area-wide fix. To help answer questions regarding these items, we recommend asking several local contractors that perform such services to visit site and provide their expertise in developing a suitable program.

The deep foundation option is also workable, and would all but eliminate future settlement, but may be very costly in comparison to the other methods. However, the County's potential investment in the runway extension, and the revenue that could be generated through increased flights and size of aircraft, may justify the relatively permanent solution of construction on piles.

DDC is also an appropriate option, but like the deep foundation option, requires abandonment and replacement of existing site features. Furthermore, DDC will not entirely eliminate settlement as waste mass remains, but in a more compressed state.

A brief comparison of mitigation measures are presented in the table 7.

Table 7. Settlement Mitigation Measure Comparison

Alternative Type	Cost		Comments
	Area 2	Area 3	
Routine grading and maintenance	significantly less than the historical $0.25 M/year	N/A	Data, observations suggest settlement slowing
DDC	$2.3-$2.9 M	$1.1-$1.4 M	Effective in near term
Soil Surcharging	$2.2-$2.5 M	$0.9-$1.1 M	Effective in near term; airport restrictions for duration
Pile Foundation	N/A	$4.2 M	Permanent fix for runway extension
Injection Grouting	$5.4-$6.4 M	N/A	May be more applicable to localized settlement
Waste removal and clean fill	$17.2-$19.2 M	$23 M	Permanent fix but very expensive, temporary air impacts.

Figures

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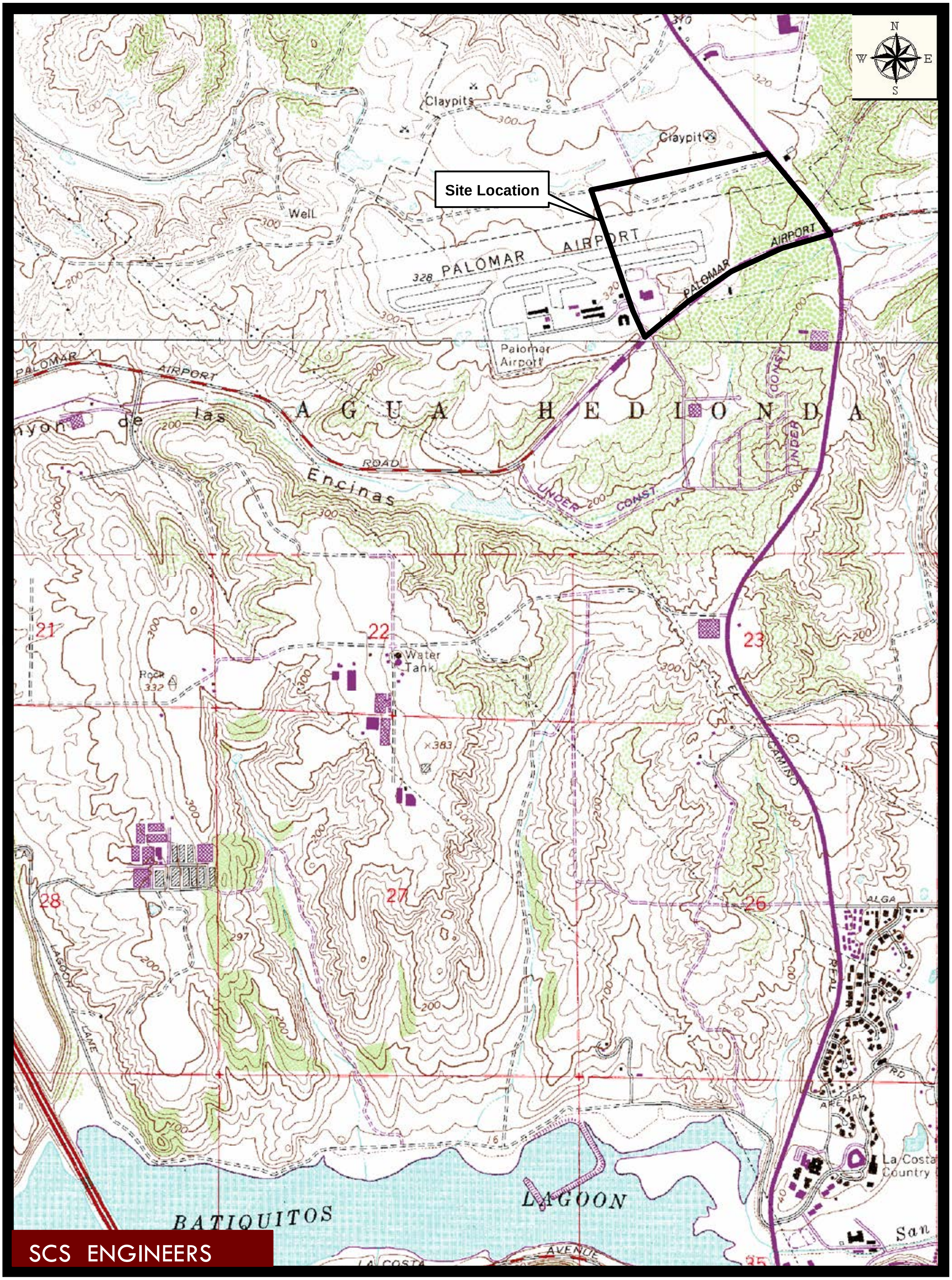

USGS 7.5 Series Quadrangle Maps
San Luis Rey, CA., 1997, UTM Zone 11, NAD83
and Encinitas, CA., 1975, UTM Zone 11, NAD27

Figure 1
Site Location Map

0 1,000 2,000
Feet
1 inch = 2,000 feet

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LEGEND

BORING SAMPLE LOCATION

VCW-1, HCW-6,N-1 EXISTING LFG EXTRACTION WELL

SUMP EXISTING CONDENSATE SUMP

EXISTING BELOW GRADE HEADERS/LATERALS

APPROXIMATE LIMITS OF REFUSE

SITE PLAN

SCALE: 1"=400'-0"

EXISTING TOPOGRAPHIC PLAN IS FURNISHED BY PROJECT DESIGN CONSULTANTS. THE TOPOGRAPHY DATA IS BASED ON A COMBINATION OF AERIAL PHOTOGRAPHS DATED 1/31/05, 8/22/01 - REVISED 3/10/06.

Q:\2009\07206046.01 – Palomar Airport Feasibility Study\Support\Figures\Figure 2.dwg Jun 25, 2010 – 11:6am By: 2747r_r

NO.	REVISION	DATE
	-	2-20-07

SHEET TITLE: SITE PLAN

PROJECT TITLE: LFG COLLECTION SYSTEM PALOMAR AIRPORT 2198 PALOMAR AIRPORT ROAD CARLSBAD, CA 92008

CLIENT: COUNTY OF SAN DIEGO LANDFILL MANAGEMENT 5201 RUFFIN ROAD SAN DIEGO, CALIFORNIA 92123

SCS ENGINEERS
ENVIRONMENTAL CONSULTANTS
3900 KILROY AIRPORT WAY, SUITE 100
LONG BEACH, CA 90806
PH. (562) 426-9544 FAX. (562) 427-0805

PROJ. NO. 07206146.01 | DWN. BY: R. RAMIREZ | ACAD FILE: Q:/2009

DSN. BY: G. ARORA | CHK. BY: B. ISENBERG | APP. BY: M. BEIZER

DATE: 6-25-2010

SCALE: 1" = 400'-0"

DRAWING NO. FIGURE 2

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PRE-LANDFILL PHOTO

N.T.S.

FIGURE 3

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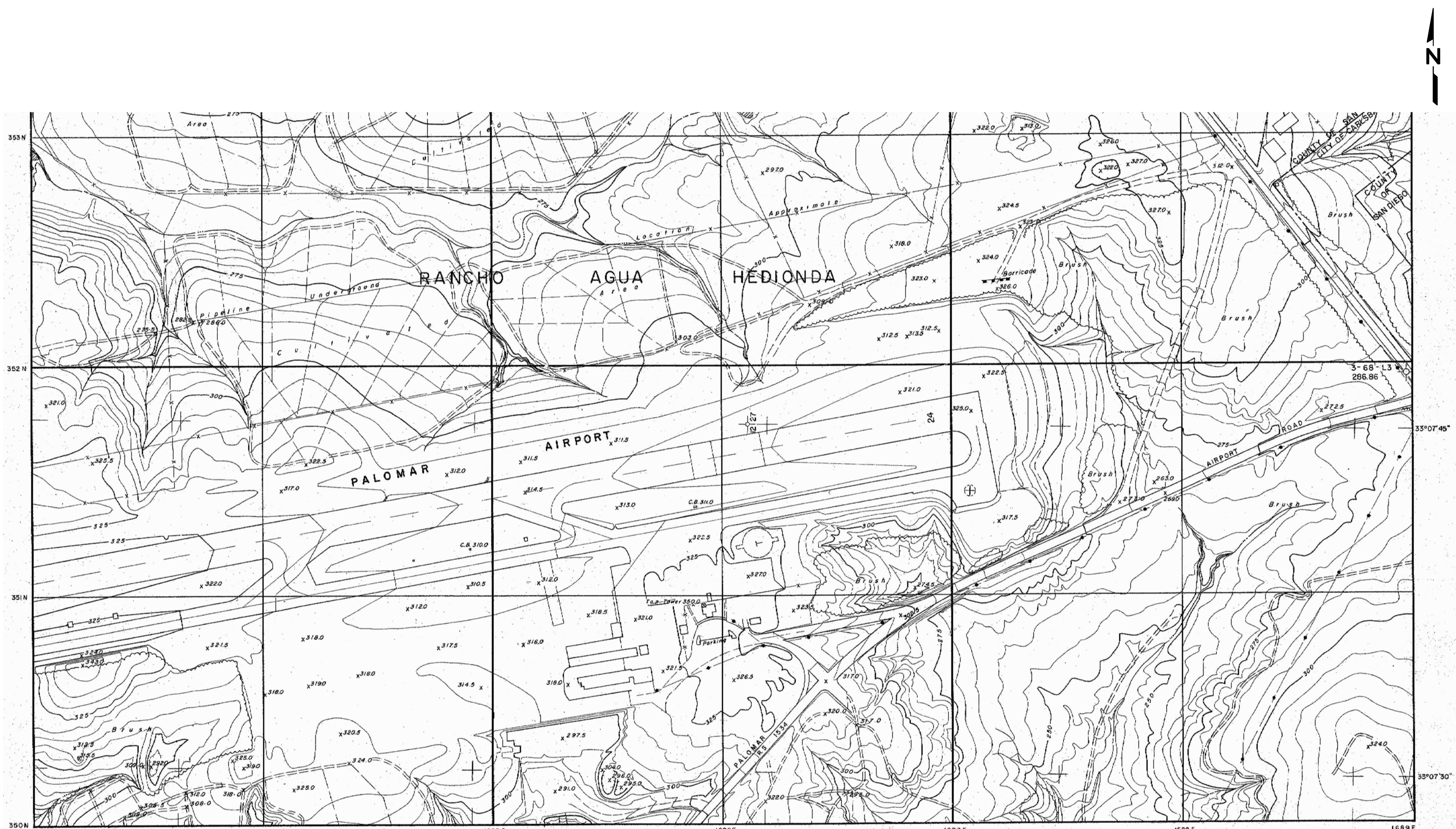

PREPARED UNDER THE DIRECTION OF THE COUNTY SURVEYOR
OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
CONTROL BY U.S.C. & G.S., U.S.G.S. AND THE COUNTY OF SAN DIEGO.
NORTH AMERICAN DATUM 1927.

COMPILED BY PHOTOGRAMMETRIC METHODS
FROM PHOTOGRAPHY DATED MAY 1963 BY

WESTERN AERIAL SURVEYS
A DIVISION OF H.M. GALLAHER, CIVIL ENGINEER
RIVERSIDE CALIFORNIA

SAN DIEGO COUNTY
CALIFORNIA
EDITION OF 1963

PRE-LANDFILL TOPOGRAPHIC MAP
N.T.S.

FIGURE 4

G:\2009\07206046.01 – Palomar Airport Feasibility Study\Report Figures (6-29-10)\Figure 4 (Prelandfill Topographic Map).dwg Jul 06, 2010 – 11:17am By: 2948p_a

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POST-LANDFILL PHOTO

N.T.S.

FIGURE 5

G:\2009\0720604601 -- Palomar Airport Feasibility Study\Report Figures (6-29-10)\Figure 5 (Post-landfill photo).dwg Jul 06, 2010 -- 11:7am By: 2948g_a

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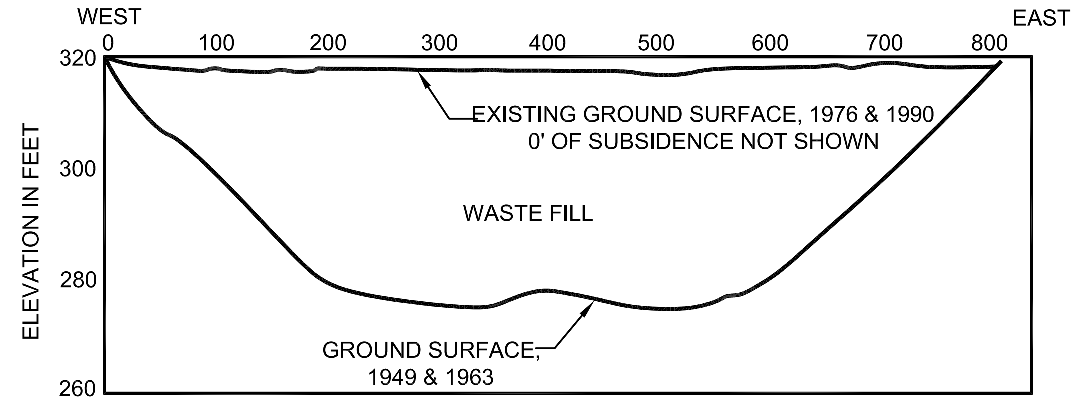
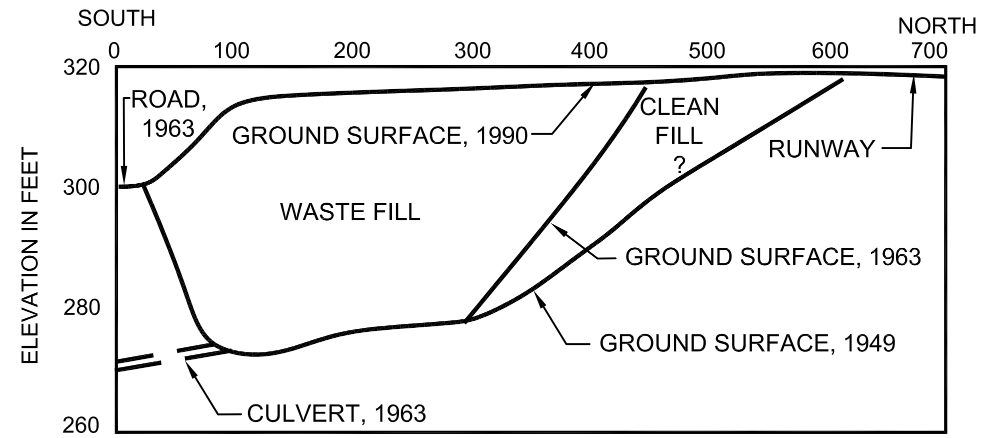
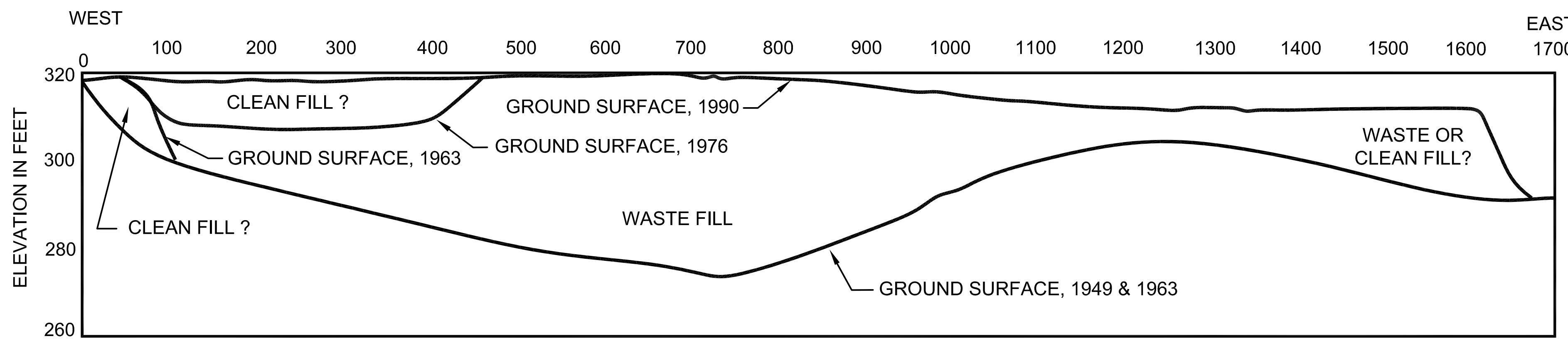


SECTION 2A

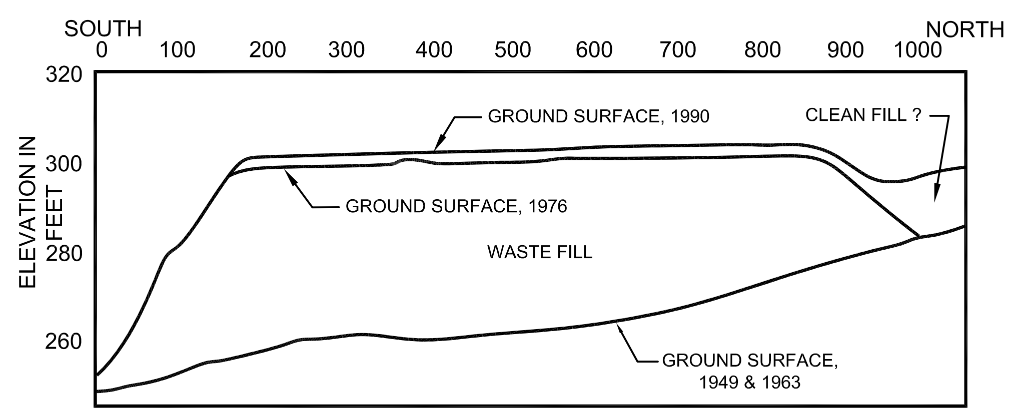
AREA 2 - CROSS SECTION



SECTION 2B



SECTION 3A



SECTION 3B

AREA 3 - CROSS SECTION

AREA 2 AND 3 CROSS SECTION

N.T.S.

FIGURE 6

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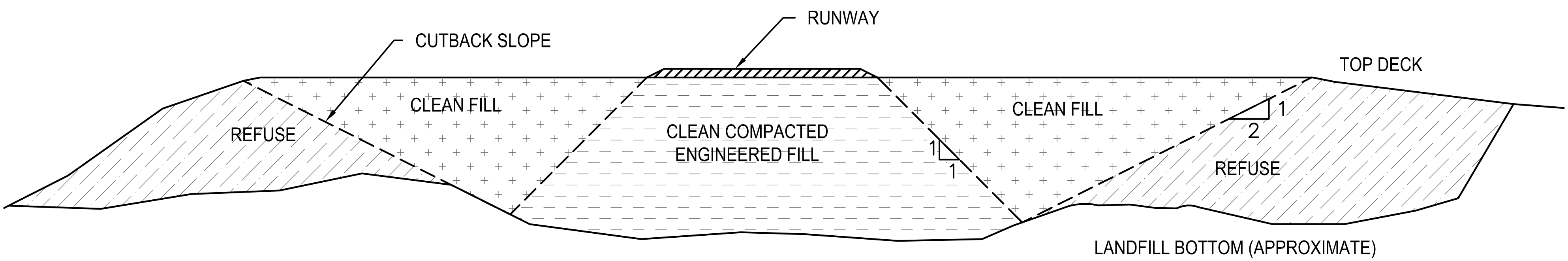
N

N.T.S.



CLEAN FILL APPLICATION SKETCH

N.T.S.

FIGURE 7

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Appendix A
Settlement Graphs

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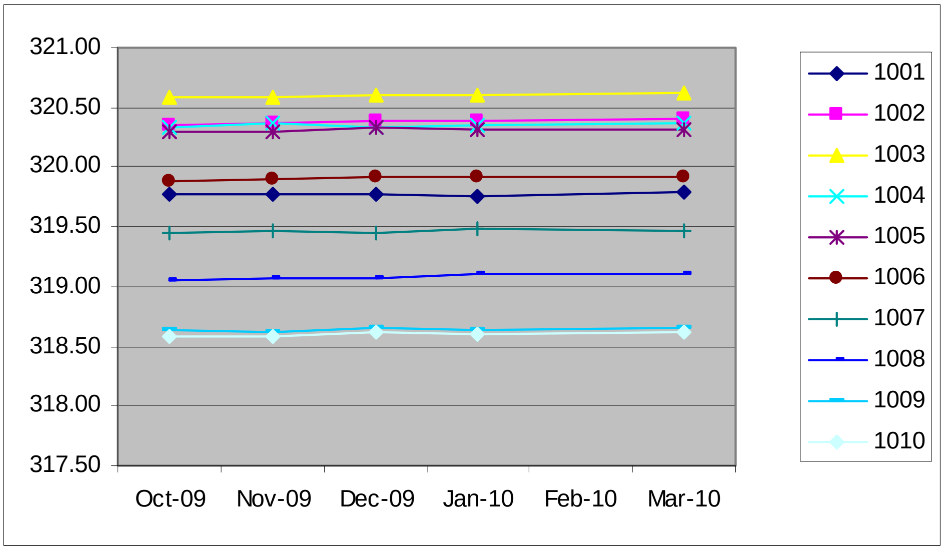
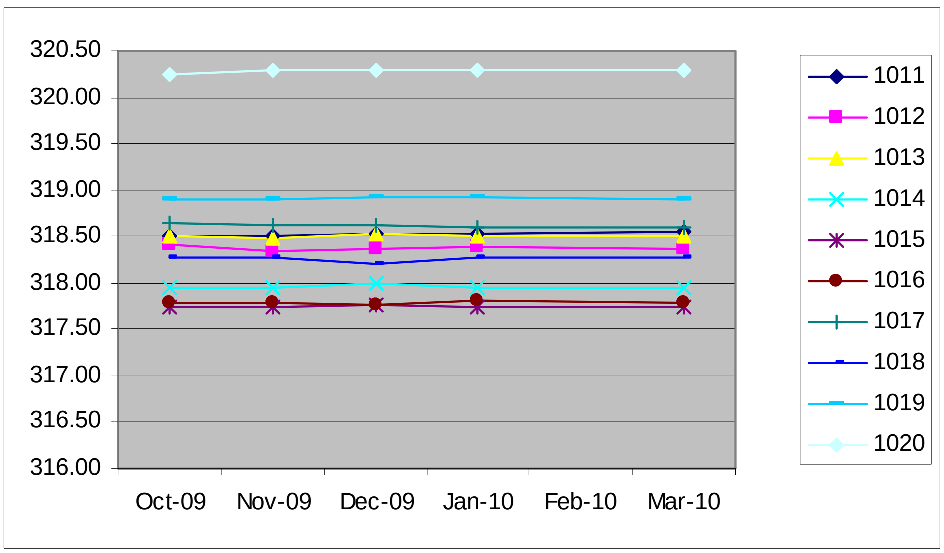
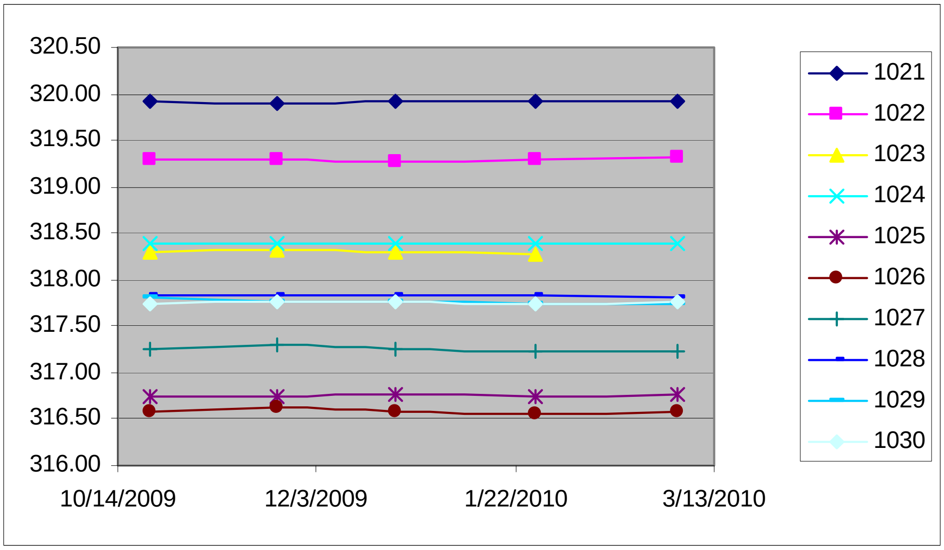
Palomar Settlement Survey (Point # 1011 through 1020)



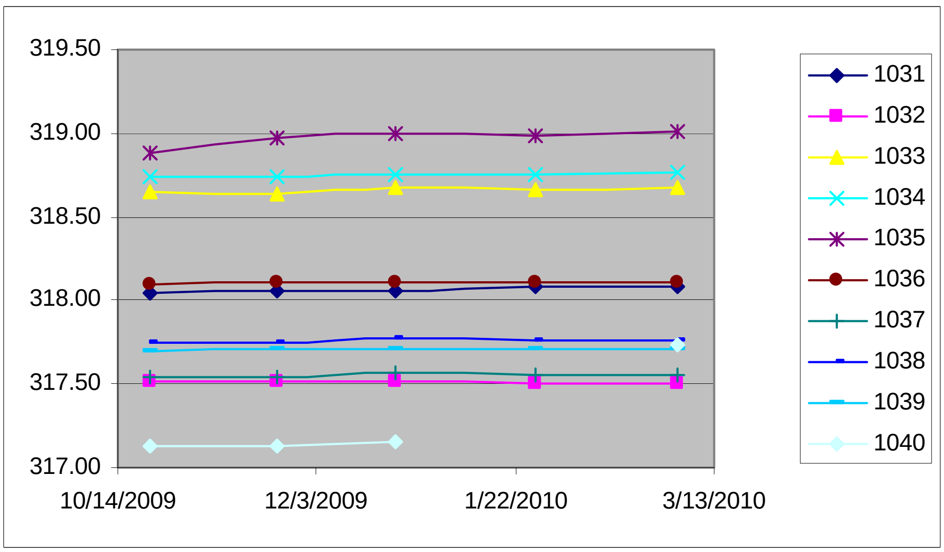
Palomar Settlement Survey (Point # 1011 through 1020)



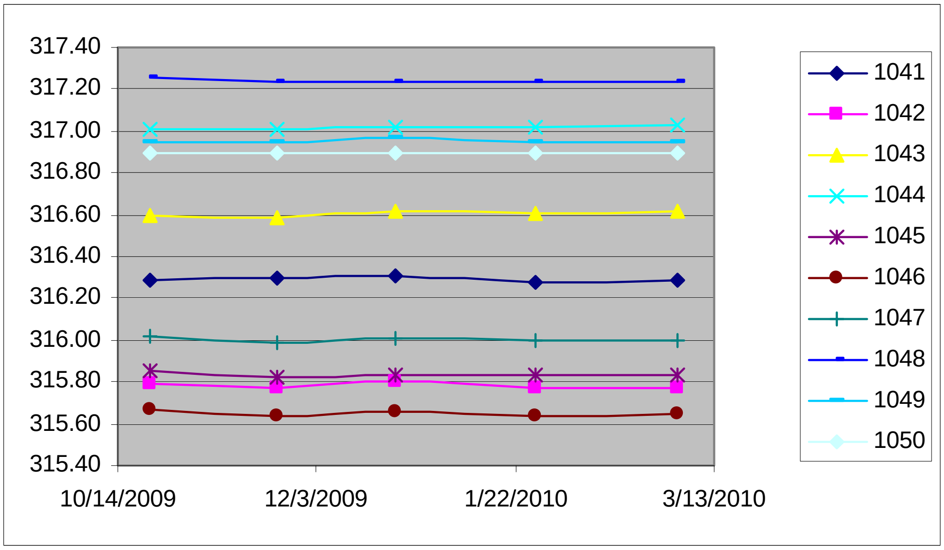
Palomar Settlement Survey (Point # 1021 through 1030)



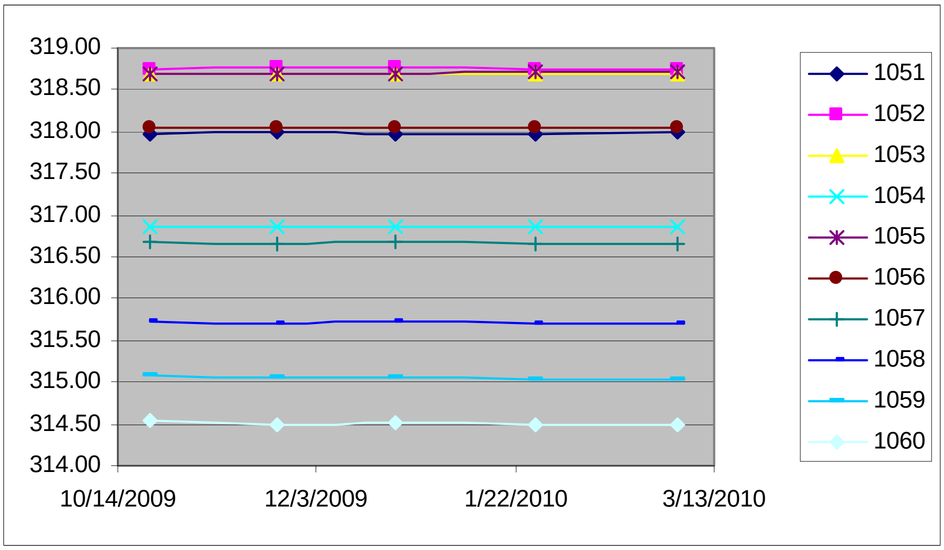
Palomar Settlement Survey (Point # 1031 through 1040)



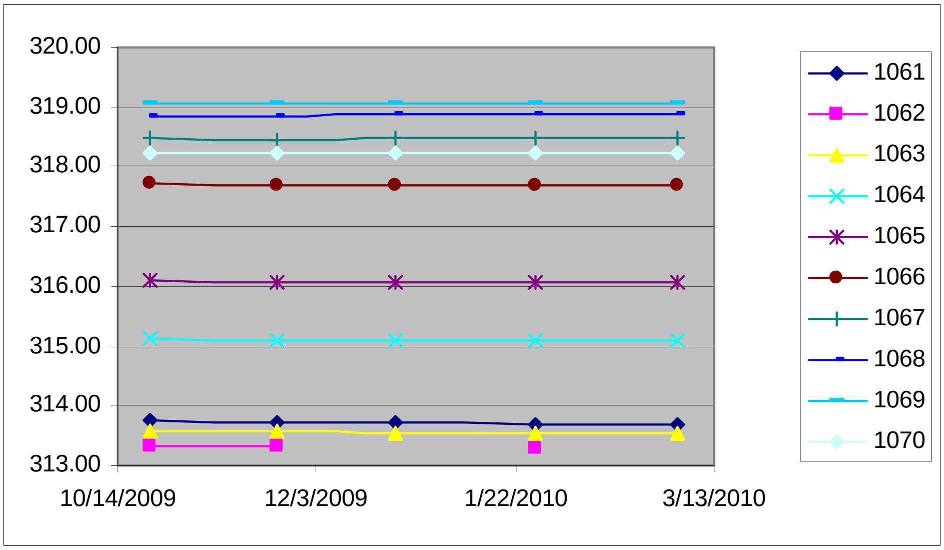
Palomar Settlement Survey (Point # 1041 through 1050)



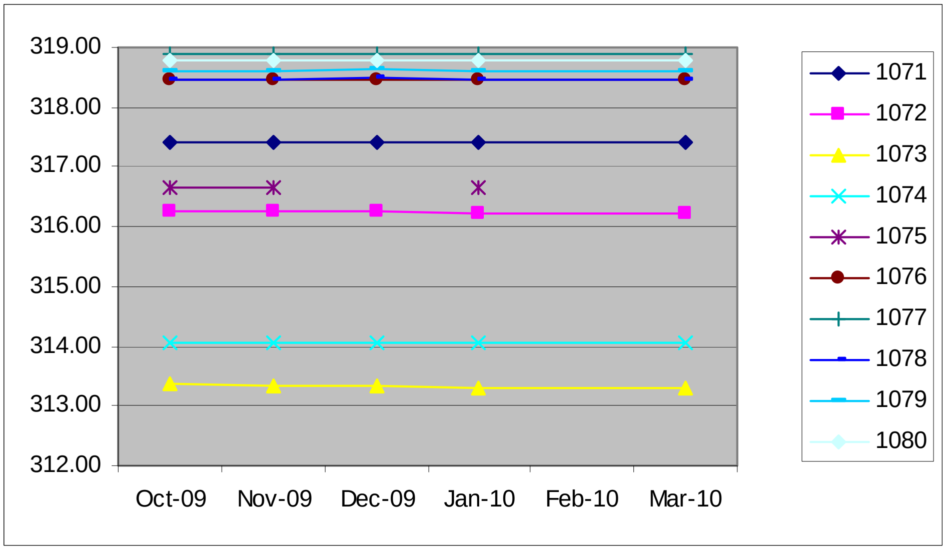
Palomar Settlement Survey (Point # 1051 through 1060)



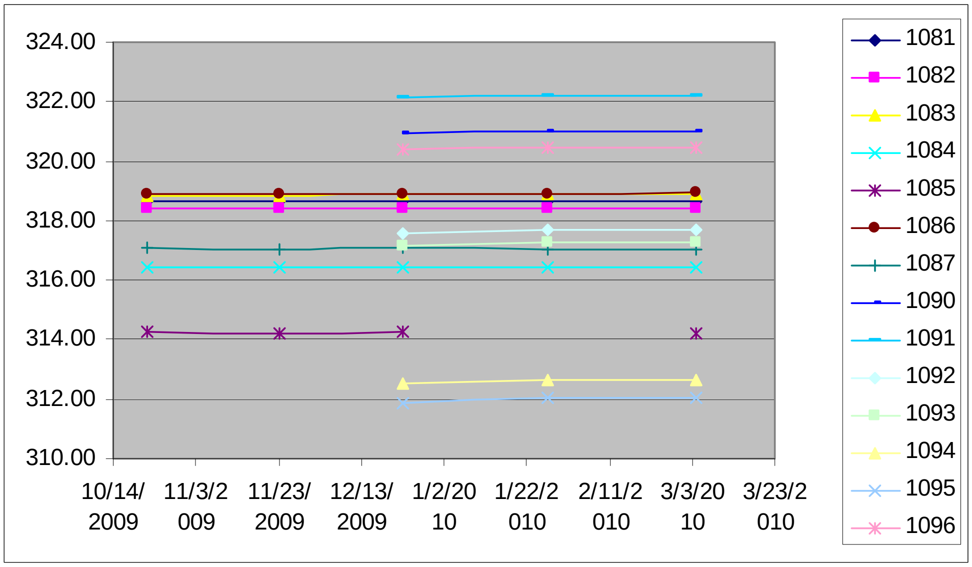
Palomar Settlement Survey (Point # 1061 through 1070)



Palomar Settlement Survey (Point # 1071 through 1080)



Palomar Settlement Survey (Point # 1081 through 1095)



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Appendix B
Boring Logs

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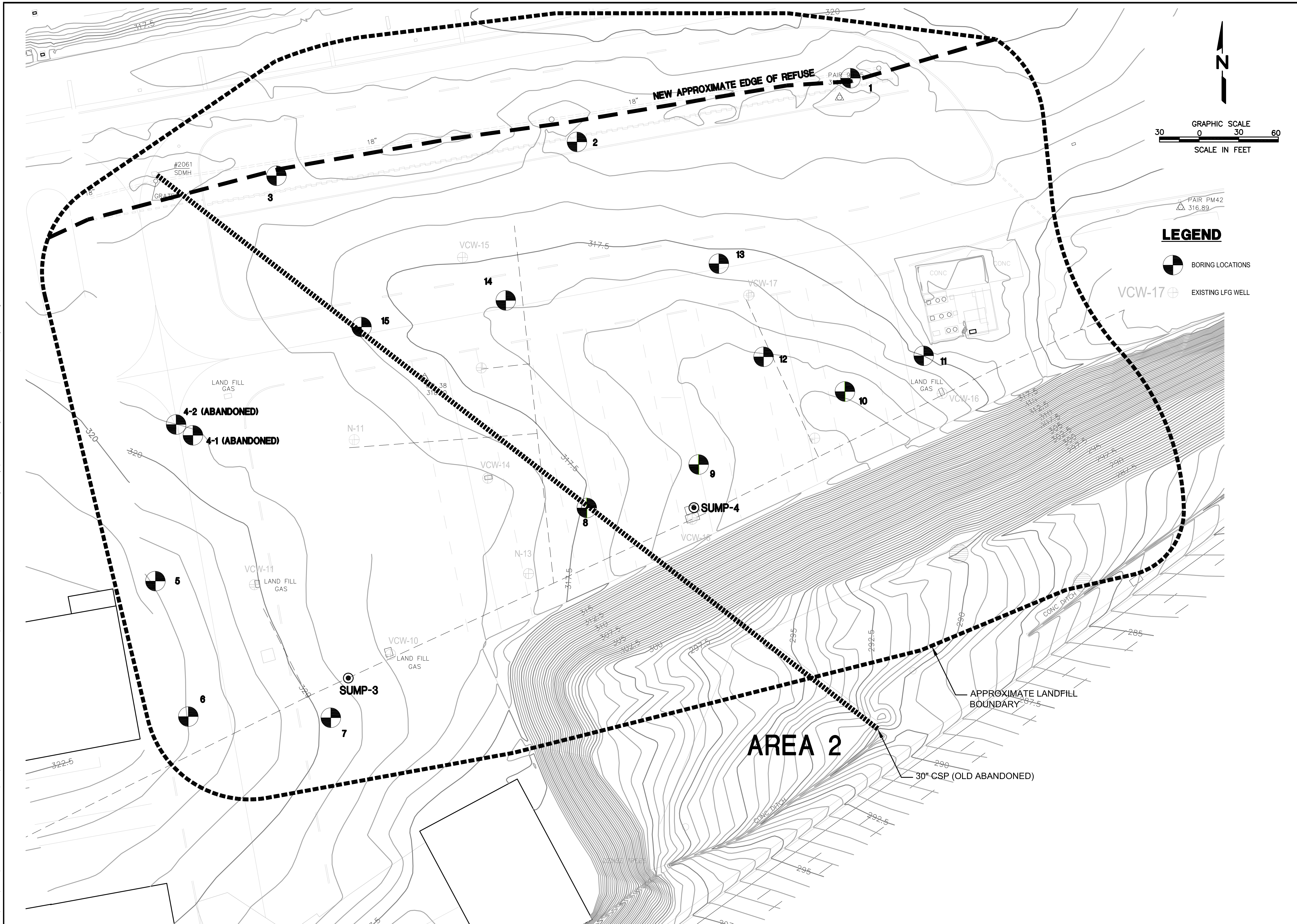

DATE	
REVISION	
NO.	

SHEET TITLE: AREA 2 - BORING LOCATIONS

PROJECT TITLE: PALOMAR SATTLEMENT STUDY CARLSBAD, CALIFORNIA

CLIENT: COUNTY OF SAN DIEGO LANDFILL MANAGEMENT 5201 RUFFIN ROAD SAN DIEGO, CALIFORNIA

SCS ENGINEERS
ENVIRONMENTAL CONSULTANTS
3900 KILROY AIRPORT WAY, SUITE 100
LONG BEACH, CA 90806
PH. (562) 426-9544 FAX. (562) 427-0805

PROJ. NO. -	DWN. BY: R. RAMIREZ	ACAD FILE: Q/2009
DSN. BY: G. ARORA	CHK. BY: M. BEIZER	APP. BY: B. ISENBERG

DATE: 7-6-2010

SCALE: AS SHOWN

1 of 2

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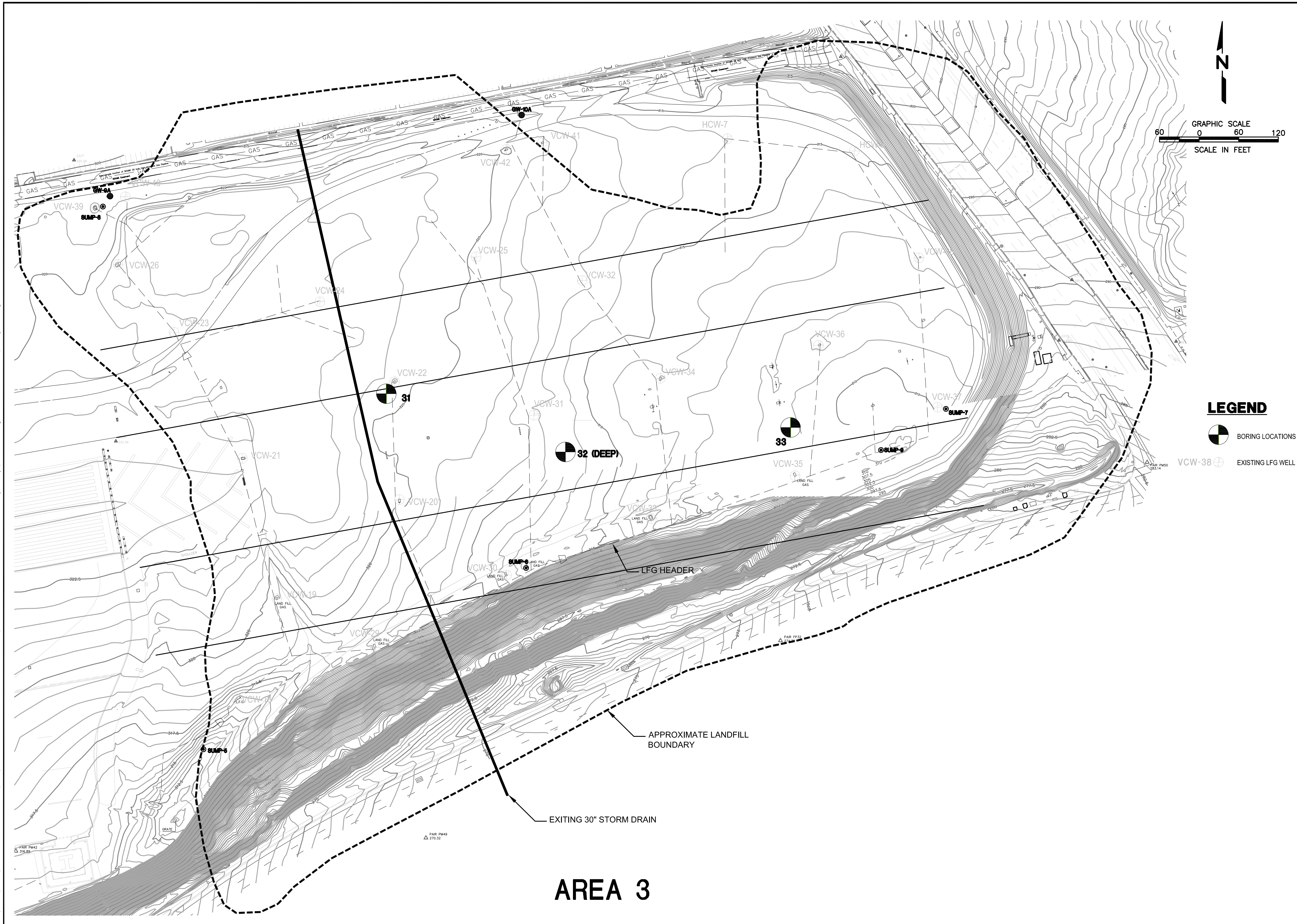

SHEET TITLE:	AREA 3 - BORING LOCATIONS
PROJECT TITLE:	PALOMAR SATTLEMENT STUDY CARLSBAD, CALIFORNIA
CLIENT:	COUNTY OF SAN DIEGO LANDFILL MANAGEMENT 5201 RUFFIN ROAD SAN DIEGO, CALIFORNIA

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ENVIRONMENTAL CONSULTANTS
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PH. (562) 426-9544 FAX. (562) 427-0805

PROJ. NO. -	DWN. BY: R. RAMIREZ	ACAD FILE: Q/2009
DSN. BY: G. ARORA	CHK. BY: M. BEIZER	APP. BY: B. ISENBERG

DATE: 7-6-2010

SCALE: AS SHOWN

2 of 2

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SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 1

Palomar Airport

JOB NUMBER: 07206046.00

REMARKS:
Area # 2

Depth (meters)	Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description	Completion Detail
0	0							Asphalt at Surface	Capped with concrete
									Bentonite chips
1		☒						Brown, Clayey Soil Lumps, Landfill Cover Material	
	5	☒		10 8 6				Brown, Clay Cover Material	Bentonite grout
3	10	☒		10 20 25				No Trash, Clay Cover, Soil Sample, Gray. Hole Sealed at 10.5"	

Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/12/10**
Date Ended: **5/12/10**
Boring Diameter:
Total Depth: **10.5 ft.**

SCS ENGINEERS — BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 2

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description
0						Asphalt at Surface
5	X		4 6 8			Light Brown, Clayey Soil, Lumps of Clay, No Trash
7						Trash, Metal Wires, Debris, Gray Soil, Decomposed, Trash with Slightly Moist Soil
10	X		50-2"			Paper, Cardboard, Wires, Gray Decomposed Trash with Soil, Soft, with Moisture
15	X		2 4 6			Wet Trash with Some Soil. Hole Plugged Up at 16'

Completion Detail:
- Capped with concrete
- Bentonite chips
- Bentonite grout

Drilling Company:	**Test America**	Date Started:	**5/12/10**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**5/12/10**
Logged By:	**G. Arora**	Boring Diameter:	
Sampling Method:	**Split Spoon**	Total Depth:	**16.0 ft.**

STANDARD_LOG 07206046.00.GPJ STD_LOG.GDT 6/7/10

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 3

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
*Used extra grout. Initially pored two drums which vanished and did not fill the hole up, then used chips and water to form a base and pored the grout again.
g

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description	Completion Detail
0						Asphalt at Surface	Capped with concrete
						Dark Brown/Gray, Clean Soil	
						Light Brown Soil, Landfill Cover Material	
5	☒		22 10 15			Trash in Sample	Bentonite grout*
10	☒		25 50-6"			Paper, Debris, Slightly Moist, Soft Gray Soil, Soft Decomposed Black Trash with Some Soil	
15	☒		50-2"			Dry Wood Chips, Black Soil with Paper with Glass, etc.	

Depth scale: meters 0–7; feet 0, 5, 10, 15, 20, 25

Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/12/10**
Date Ended: **5/12/10**
Boring Diameter:
Total Depth: **15.0 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 5

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description
0	X					Asphalt at Surface
						Base and Soil
	X					Light Brown, Soil, Clay Lumps, Soft, No Trash
5	X		35 50-4"			Asphalt
	X		10 10 12			Asphalt
10	X					Dark Gray, Clayey, Soil, Sample with Clayey Soil

Completion Detail:
- Capped with concrete
- Bentonite chips
- Volclay /ground bentonite

Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/13/10**
Date Ended: **5/13/10**
Boring Diameter:
Total Depth: **10.5 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 6

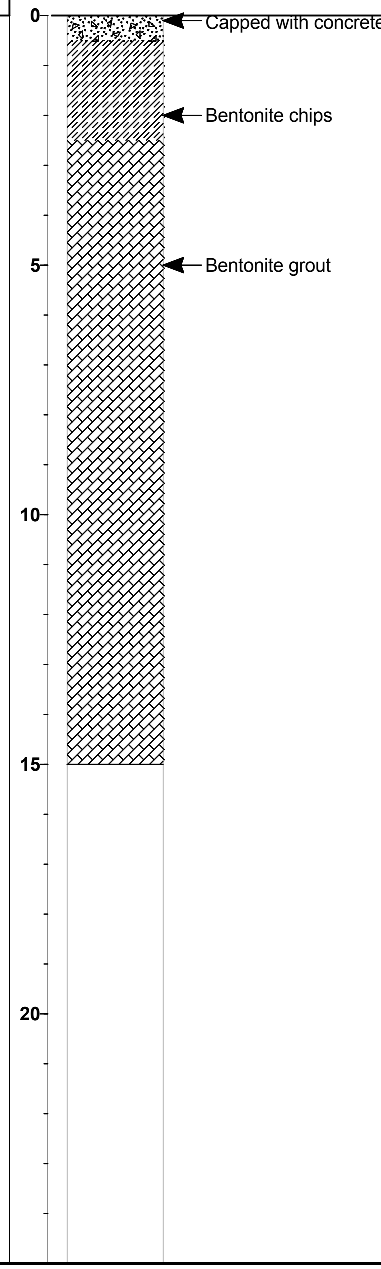
JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description
0	X					Asphalt at Surface
						Asphalt Base with Some Soil
	X					Soil with Brown Clay Lumps
	X					Brown, Moisture, Soil Lumps
	X					
5	X		50-6"			Grounded, Black Asphalt
	X					Gray-Brown, Powdered Asphalt, Ground Asphalt
	X		16 18.20			
10						Light Brown, Brown Cover Soil, (Clay Loams), Slightly Moist
	X					Soil Lumps
	X					Dark Gray Soil and Some Trash.
15						Hole Sealed

Completion Detail



Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/12/10**
Date Ended: **5/12/10**
Boring Diameter:
Total Depth: **15.0 ft.**

SCS ENGINEERS — BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 7

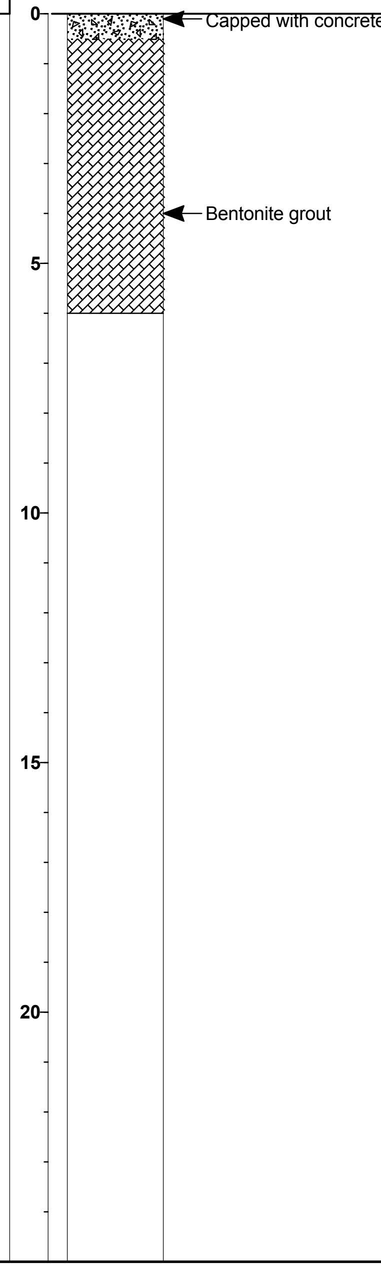
JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description
0	X					Asphalt at Surface
	X					Light Brown, Soft Clay, Sand, Slightly Moist
						Asphalt
5	X		20 10 12			Sandy Soil
	X					Clay in Sample Hole Sealed

Completion Detail



Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/13/10**
Date Ended: **5/13/10**
Boring Diameter:
Total Depth: **6.0 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 8

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description	Completion Detail
0						Asphalt at Surface	Capped with concrete
	☒					Landfill, Light Brown to Dark Brown, Clean, Sandy Clay Loamy, Cover Material	Bentonite chips
						Soft, Clean, Light Gray Clay Loams	Bentonite grout
5	☒		9 10 15				
	☒					Grayish Black, Soft, Decomposed Trash with Soil Lumps with Plastic and Wood	
10	☒		25 12 20			Light Brown, Soil with Little Trash	
15			6 8			Grayish Black, Decomposed Trash with Soil, Soft, Slightly Moist	
	☒		10 10 13			Gray, Decomposed Trash with Soil, Moist, Soft with Metal, Paper, Cardboard. (Collapsed 17'7")	
20							
25							

Depth scale: meters 0–7; feet 0–25.

Drilling Company:	**Test America**	Date Started:	**5/13/10**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**5/13/10**
Logged By:	**G. Arora**	Boring Diameter:	
Sampling Method:	**Split Spoon**	Total Depth:	**17.7 ft.**

SCS ENGINEERS — BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 9

JOB NUMBER: 07206046.00

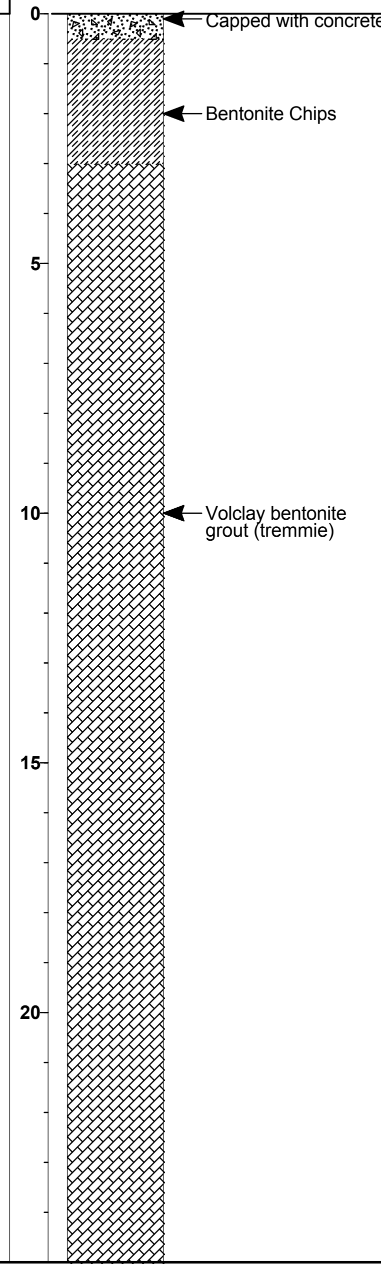
Palomar Airport

REMARKS:
Area # 2

Depth (meters)	Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description
0	0							Asphalt at Surface
	5	X		8 12 13				Light Brown, Clay Lumps, Landfill Cover Material, Soft, Slightly Moist
3	10	X		5 6 10				Grayish, Clay Lumps Little Trash with Soil (Clay-Type Material) and Plastic
	15	X		25 50-3"				Soft, Black, Decomposed Lumps of Trash with Some Soil, and Plastic
								Gray-Black, Decomposed, Soft, Garbage Lumps with Soil, Plastic and Wood
6	20	X		15 20 13				No Sample Recovered
	25			10				Wire, Metals, Shredded Tires, Black, Soft, Decomposed Lumps of Trash

Depth scale (meters): 0, 1, 2, 3, 4, 5, 6, 7; (feet): 0, 5, 10, 15, 20, 25

Completion Detail



Drilling Company:	**Test America**
Drilling Method:	**Hollow Stem Auger**
Logged By:	**G. Arora**
Sampling Method:	**Split Spoon**
Date Started:	**5/13/10**
Date Ended:	**5/13/10**
Boring Diameter:	
Total Depth:	**37.5 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 9

Palomar Airport

JOB NUMBER: 07206046.00

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description	Completion Detail
25			35 50-5"					Volclay bentonite grout (tremmie)
~27							Black Soft Clayey, Material, Decomposed Trash Lumps with Soil	
30			50-1"				No Sample Recovered	
35	☒		10 40 50-6"				Sample Recovered for Bottom with Light Brown-Yellow Soil, Borehole Close/Bottom of Landfill	

Depth scale: meters 8–16; feet 25–55.

SCS ENGINEERS — **BORING LOG**

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 10

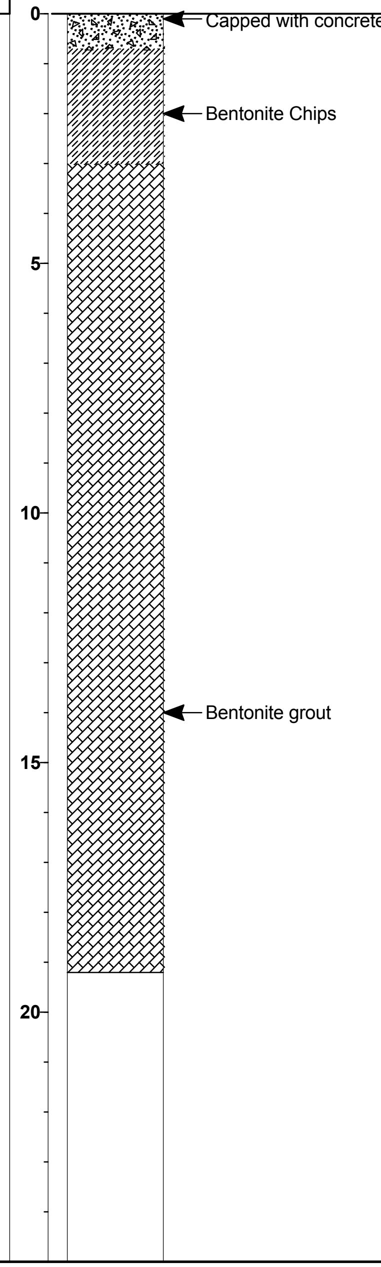
JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description
0						Asphalt at Surface
						Light Brown, Cover Material
~3	☒					Trash, Jute, Plastic, Dry Material
~4.5	☒		50-5"			Trash, Not Decomposed, Dry
10	☒					Gray, Slightly Decomposed Material, Soft with Plastic. No Sample Recovery, Newspaper 1961
15	☒	10-15'	10 30 30			Blackish-Gray, Clay-Type Material, Decomposed Trash with Metals, Dry
						Less Decomposed, Comparatively Dry, Trash with Papers
19.2						Borehole Closed After Sampling, No Signs of Moisture

Completion Detail



Drilling Company:	**Test America**	Date Started:	**5/13/10**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**5/13/10**
Logged By:	**G. Arora**	Boring Diameter:	
Sampling Method:	**Split Spoon**	Total Depth:	**19.2 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 11

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description
0						Asphalt at Surface
						Light Brown, Clay Mixed with Sand
	☒					
	☒					Clay Lumps, Landfill Cover Material
5	☒		4 2 2			Clay Lumps, Landfill Cover Soil
						Trash, Dry, Slightly Decomposed
10	☒		4 4 5			Light Brown, Not Decomposed, Dry, Trash, Plastic, Papers, Brown Ground Cardboard
						Light Brown, Very Dry, Wood Chips, and Plastic Chunks
	☒		10 20 25			Sample with Little Moisture

Depth scale: meters 0–7; feet 0–25.

Completion Detail:
- Capped with concrete
- Bentonite Chips
- Bentonite grout/volclay

Drilling Company:	**Test America**	Date Started:	**5/13/10**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**5/13/10**
Logged By:	**G. Arora**	Boring Diameter:	
Sampling Method:	**Split Spoon**	Total Depth:	**13.2 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

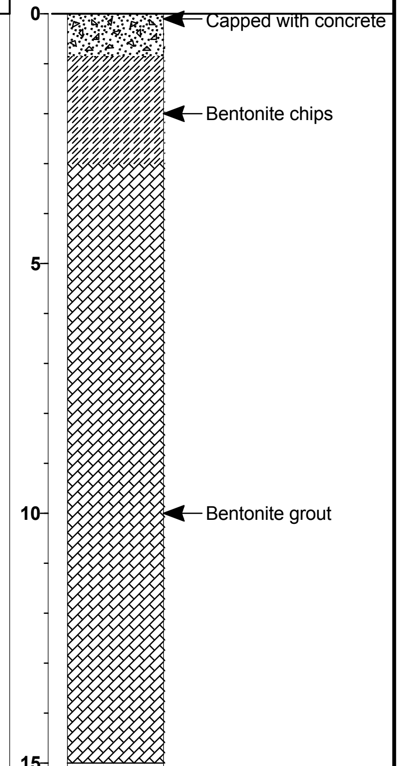
BORING NUMBER: 12

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description	Completion Detail
0						Asphalt at Surface	Capped with concrete
~2						Light Brown, Clay Loams, Landfill Cover Material, Moist, Soft	Bentonite chips
~6	X		6 6 9			Trash with Little Soil	
~9						Black, Soft, Decomposed Trash with Soil, Slightly Moist	
10	X		8 12 15				Bentonite grout
~12						Big Soil Lumps and Decomposed Trash, Moist	
~14	X					Black, Soft, Small Lumps of Soil and Trash, Slightly Moist	
15							



Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/13/10**
Date Ended: **5/13/10**
Boring Diameter:
Total Depth: **15.0 ft.**

SCS ENGINEERS — BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 13

Palomar Airport

JOB NUMBER: 07206046.00

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description	Completion Detail
0							Asphalt at Surface	Capped with concrete
							Light Brown, Clayey Soil with Small Gravel Chips	Bentonite chips
5	☒		5 7 10				Sample- Light Brown, Soil, Clay Loams, Landfill Cover Material	
							Dark Gray Soil with Little Trash, Shredded Tire, Wood, Clay Loams	
10	☒		23 17 15				Shredded Table Cover, Plastic, Moist Soil, Soft, Trash	Bentonite grout

Depth scale: meters 0–7; feet 0, 5, 10, 15, 20, 25.

Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/11/10**
Date Ended: **5/11/10**
Boring Diameter:
Total Depth: **10.0 ft.**

SCS ENGINEERS — BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 14

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description	Completion Detail
0						Asphalt at Surface	Capped with concrete
						Light Brown, Clay, Sandy Soil with Small Gravel	
~3	X		9 8 8			Light Brown Soil, Landfill Cover Material	
5	X		11 50 35			Light Brown Soil with Paper and Debris, Dry	
10	X		50-4"			Paper, Cardboard Debris, Dry with Little Soil	Bentonite grout
15	X		50-4"			Shredded Paper, Glass with Some Soil, Slightly Moist	

Depth scale: meters 0–7; feet 0–25.

Drilling Company:	**Test America**
Drilling Method:	**Hollow Stem Auger**
Logged By:	**G. Arora**
Sampling Method:	**Split Spoon**

Date Started:	**5/11/10**
Date Ended:	**5/11/10**
Boring Diameter:	
Total Depth:	**15.0 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 15

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 2

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description	Completion Detail
0						Asphalt at Surface	Capped with concrete
2	☒	15-2'		14 50 18		Light Brown, Sandy Clay Loams with Small Gravel, Landfill Cover Material	
4							Bentonite grout
6	☒	15-6'		50-4"		Smell of Methane Gas, Strong Odor, Black Soil with Some Trash	
8	☒			50-4"		Trash with Odor	

Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/11/10**
Date Ended: **5/11/10**
Boring Diameter:
Total Depth: **8.5 ft.**

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING LOG

BORING NUMBER: 31

Palomar Airport

JOB NUMBER: 07206046.00

REMARKS:
Area # 3

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description	Completion Detail
0							Vegetative Cover 4-6"	Bentonite grout (0–19.5 ft)
~4							Light Brown, Sandy Silt Loam, Cover Material	
5	☒		15 25 13					
~6							Gray, Sandy Loam with Trash	
10	☒		50-6"				Dark Grayish Soil with Debris, Trash, Plastic with Methane Odor	
15			50-3"				Dark Gray Soil, Decomposed, Trash, Dry No Sample Recovered	
~19			50-4"					

Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/11/10**
Date Ended: **5/11/10**
Boring Diameter:
Total Depth: **19.5 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 32

JOB NUMBER: 07206046.00

Palomar Airport

REMARKS:
Area # 3

Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Description
0						Vegetative Cover 4-6"
5	☒		6 6 10			Sandy Loam with Clay, No Trash, Landfill Cover Material
9	☒		50-6"			Gray Slightly Moist Soil with Trash and Paper
15	☒		15 12 5			Gray-Black Soil and Trash, Soft, Decomposed
20	☒		10 15 20			Soft Black Soil and Decomposed Trash with Strong Odor
24			25 30			Soft Black-Green Soil and Decomposed Trash Lumps

Completion Detail: Volclay bentonite grout (tremmie)

Drilling Company:	**Test America**	Date Started:	**5/11/10**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**5/11/10**
Logged By:	**G. Arora**	Total Depth:	**36.0 ft.**
Sampling Method:	**Split Spoon**	Boring Diameter:	

Palomar Airport

JOB NUMBER: 07206046.00

Depth (meters)	Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description	Completion Detail
	25	☒		35					Volclay bentonite grout (tremmie)
8								Black Decomposed Trash with Clay Loams, Dry	
9	30	☒		25 27 34				Black Decomposed Trash with Clayey Loams	
								Sample with Stiff Clay	
10	35							Bottom of Refuse	
11		☒		25 50-4"					
12	40								
13	45								
14									
15	50								
16	55								

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: 33

Palomar Airport

JOB NUMBER: 07206046.00

REMARKS:
Area # 3

Depth (meters)	Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description	Completion Detail
0	0							Vegetative Cover 4-6"	0
								Light Brown Soil, Landfill Cover Material	
1								Brown Soil with Some Trash, Paper, Plastic	
	5	⊠	33-5'	10 16 21					5
2								Dry Plastic Bags with Soil and Odor	
3	10	⊠	33-10'	50-6"				Dry Grayish, Partially Decomposed Trash with Odor and Paper, Plastic, Newspaper, etc.	10
									Bentonite grout
4									
	15	⊠	33-15'	35 50				Black-Gray, Decomposed Trash	15
5									
								Gray-Black Material, Trash	
				50-2"					
6	20								20
7									
	25								

Drilling Company: **Test America**
Drilling Method: **Hollow Stem Auger**
Logged By: **G. Arora**
Sampling Method: **Split Spoon**

Date Started: **5/11/10**
Date Ended: **5/11/10**
Boring Diameter:
Total Depth: **19.0 ft.**

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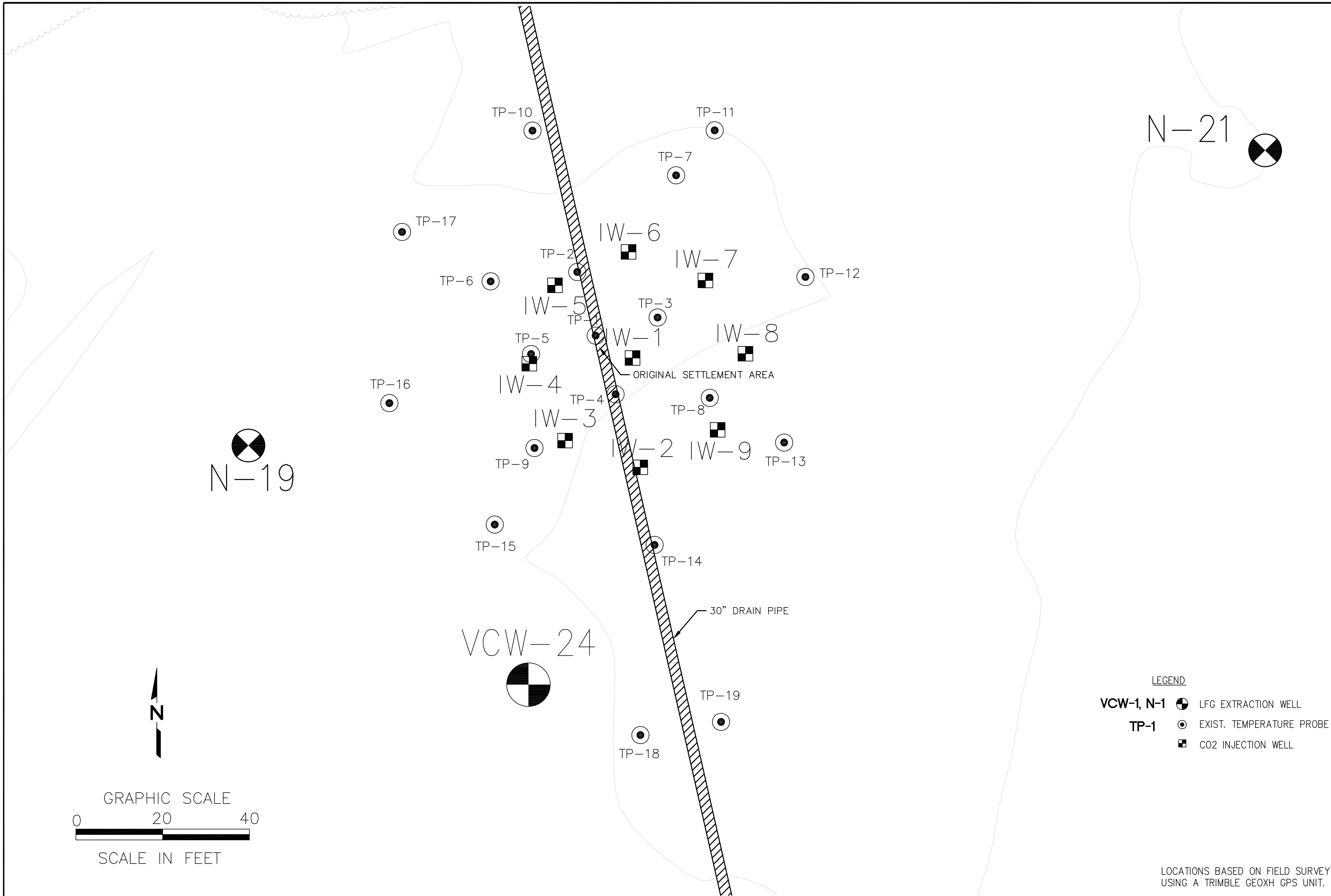

J:\SW\JOBS\2006\07206046.01 - Palomar LF see also 07201333.01\Task 30 - Palomar Fire\figures\INJECTION site GPS.dwg Oct 08, 2008 - 11:10am By: 1103rhh

NO.	REVISION	DATE

SHEET TITLE
SUBSURFACE ELEVATED TEMPERATURE AREA

PROJECT TITLE
PALOMAR AIRPORT LANDFILL
2198 PALOMAR AIRPORT ROAD
CARLSBAD, CA 92008

CLIENT
COUNTY OF SAN DIEGO
LANDFILL MANAGEMENT
5201 RUFFIN ROAD
SAN DIEGO, CALIFORNIA 92123

SCS ENGINEERS
ENVIRONMENTAL CONSULTANTS
3900 KILROY AIRPORT WAY, SUITE 100
LONG BEACH, CA 90806
PH. (562) 426-9544 FAX. (562) 427-0805

PROJ. NO. 01203323.01
DWN. BY: V. CHEW
ACAD FILE:
DSN. BY: W. NAKAGAWA
CHK. BY: W. NAKAGAWA
APP. BY:

DATE: 10-08-08

SCALE: SEE SHEET

DRAWING NO.

FIGURE X

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SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: IW1

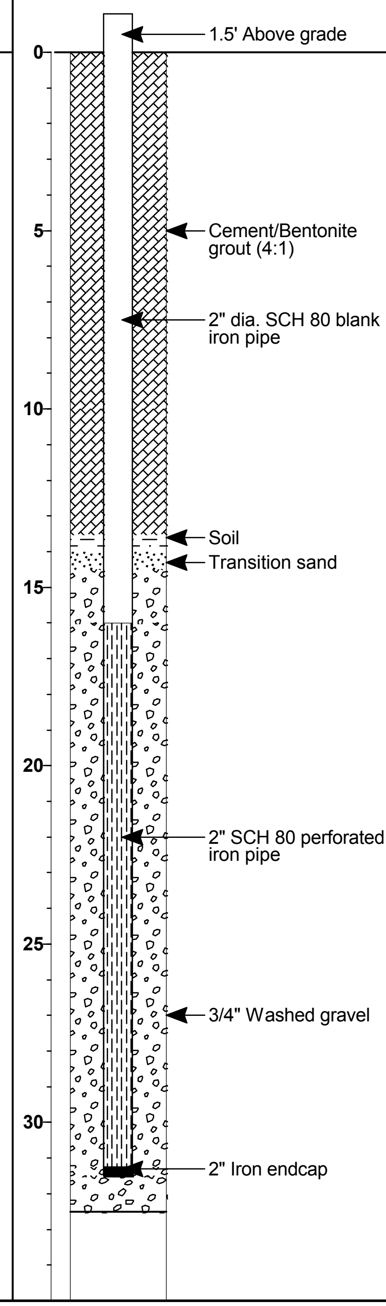
Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

JOB NUMBER: 07206046.01 Task 30

REMARKS:

Depth (meters)	Depth (feet)	Description	Comments
~1		Brown Silty Sand	Soil Cover
	~10	Brown Silty Sand	Soil Cover
	~15	Mixed Soil and Black, Highly Decomposed Refuse	Refuse
	~20	Black, Highly Decomposed Refuse-Wood, Ash	Refuse
	~25	Black, Ash	Refuse
	~30	Black, Ash	Refuse
	32.5	Bottom of Boring 32.5'	

Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/10/08**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/10/08**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**

Time Started:	**09:05**
Time Ended:	**11:35**
Total Depth:	**32.5 ft.**

SCS ENGINEERS

BORING LOG

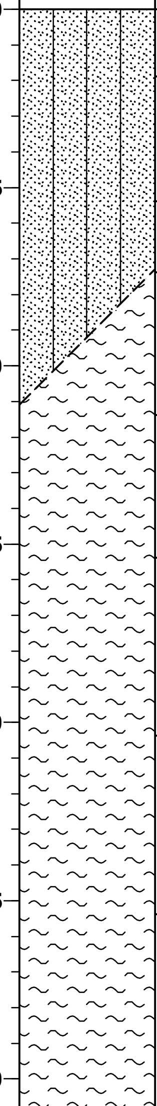
3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: IW2

Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

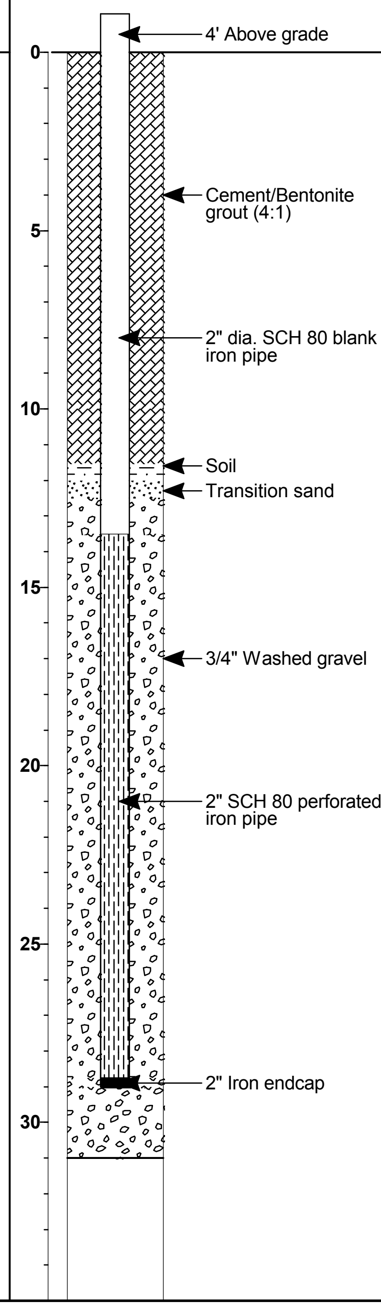
JOB NUMBER: 07206046.01 Task 30

REMARKS:

Depth (feet)	Graphical Log	Description	Comments
0			
~2		Brown Silty Sand	Soil Cover
~5.5		Greenish Gray, Silty Sand	Soil Cover
~7.5		Brown, Silty Sand	Soil Cover
~11.5		Plastic, Dark Black, Soil/Decomposed Trash/Ash	Refuse
~15.5		Highly Decomposed Refuse-Paper/Cardboard	Refuse
~20.5		Black - Cloth, Paper, Metal, Newspaper	Refuse, Newspaper dated 1973
~25.5		Wood, Plastic	Refuse
31		Bottom of Boring 31'	

Depth scale: meters 0–10; feet 0, 5, 10, 15, 20, 25, 30, 35

Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/8/08**	Time Started:	**10:25**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/8/08**	Time Ended:	**14:00**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**	Total Depth:	**31.0 ft.**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**		

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

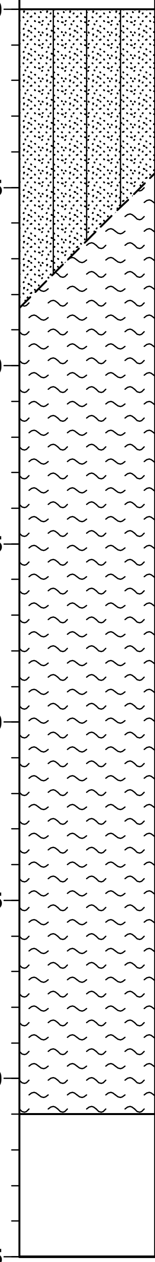
BORING NUMBER: IW3

Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

JOB NUMBER: 07206046.01 Task 30

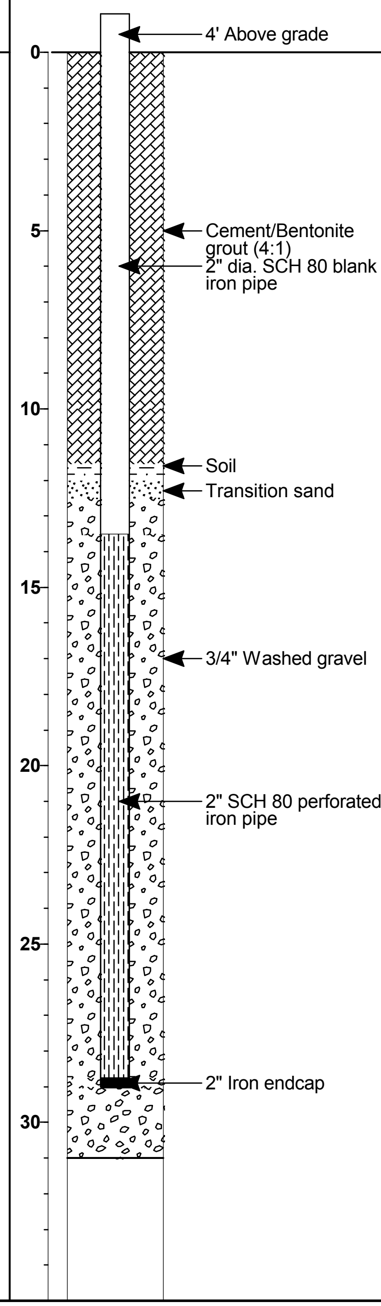
REMARKS:

Graphical Log



Depth (feet)	Description	Comments
0–8 (approx.)	Brown Silty Sand	Soil Cover
	Dark Soil/Decomposed Refuse	Refuse
	Soil, Glass, Plastic, Paper	Refuse
	Greenish Gray Sand, Plastic, Wood, Debris, Glass	Refuse
	Fork, Wood, Plastic, Rubber, Newspaper, Glass	Refuse
31	Bottom of Boring 31'	

Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/8/08**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/8/08**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**

Time Started:	**14:20**
Time Ended:	**16:40**
Total Depth:	**31.0 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: IW4

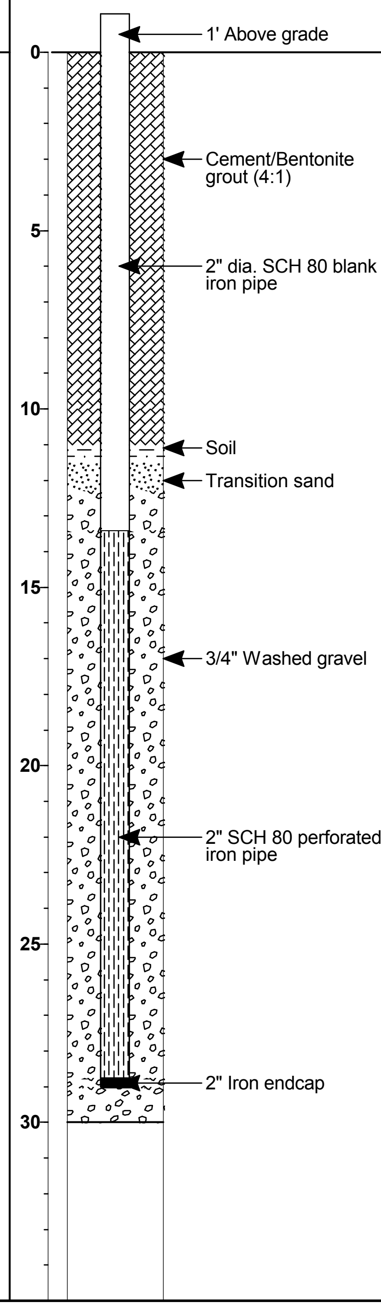
Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

JOB NUMBER: 07206046.01 Task 30

REMARKS:

Depth (feet)	Depth (meters)	Description	Comments
~4.5		Brown Silty Sand	Soil Cover
~10.5		Brown Silty Sand	Soil Cover
~12.5		Refuse	Refuse
~15.5		Highly Decomposed Refuse - Paper, Plastic, Glass	Refuse
~20.5		Highly Decomposed Refuse - Metal, Paper, Plastic	Refuse
~25.5		Newspaper, Glass, Paper	Refuse
~28.5		Paper, Plastic	Refuse
30		Bottom of Boring 30'	

Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/9/08**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/9/08**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**

Time Started:	**07:45**
Time Ended:	**10:25**
Total Depth:	**30.0 ft.**

LB_LFG_WELL_LOG 07206046.01 T30.GPJ SCS_LFG.GDT 10/14/08

SCS ENGINEERS — BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: IW5

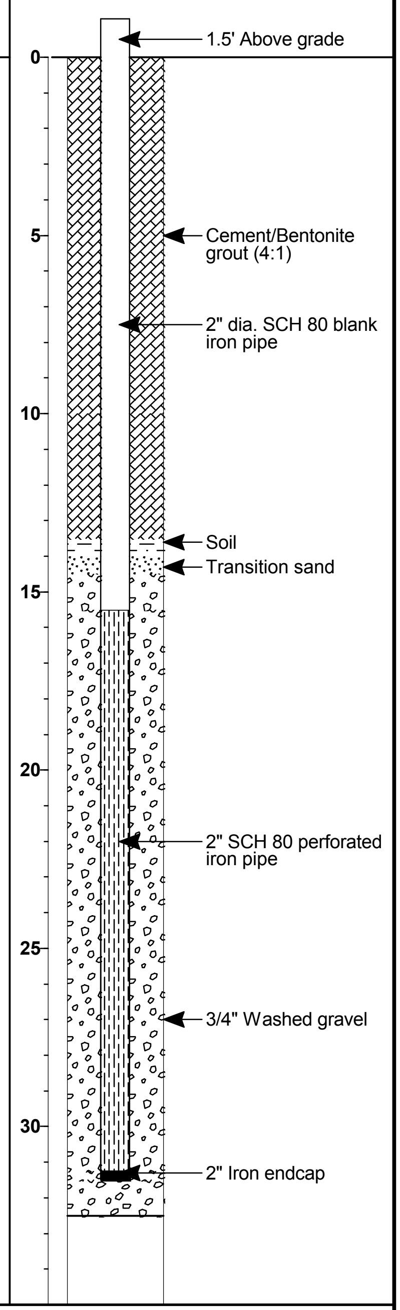
Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

JOB NUMBER: 07206046.01 Task 30

REMARKS:

Depth (meters / feet)	Graphical Log	Description	Comments
0 / 0			
		Brown Silty Sand	Soil Cover
		Highly Decomposed Refuse, Wood, Metal, Black	Refuse
		Highly Decomposed, Metal, Wood, Black	Refuse
		Paper, Tin	Refuse
		Cardboard, Glass, Plastic	Refuse
		Bottom of Hole 32.5'	
35 ft			

Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/11/08**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/11/08**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**

Time Started:	**08:05**
Time Ended:	**11:00**
Total Depth:	**32.5 ft.**

LB_LFG_WELL_LOG 07206046.01 T30.GPJ SCS_LFG.GDT 10/14/08

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

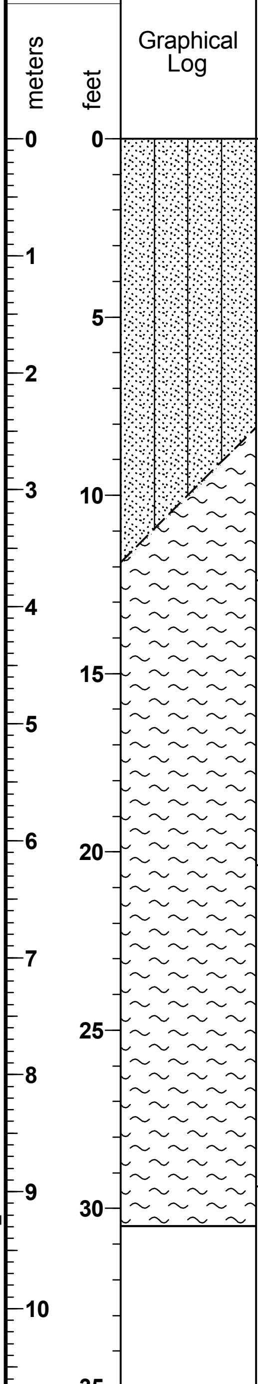
BORING NUMBER: IW6

Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

JOB NUMBER: 07206046.01 Task 30

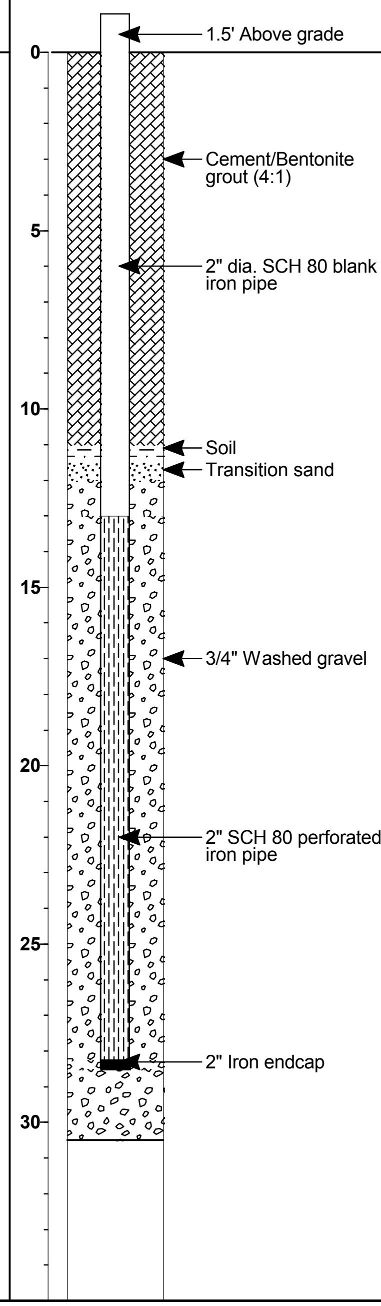
REMARKS:

Depth (meters / feet) — Graphical Log



Description	Comments
Brown, Silty Sand	Soil Cover
Black, Highly Decomposed	Refuse
Wood, Plastic, Metal	Refuse
Paper, Cardboard	Refuse

Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/11/08**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/11/08**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**

Time Started:	**12:00**
Time Ended:	**15:30**
Total Depth:	**30.5 ft.**

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: IW7

Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

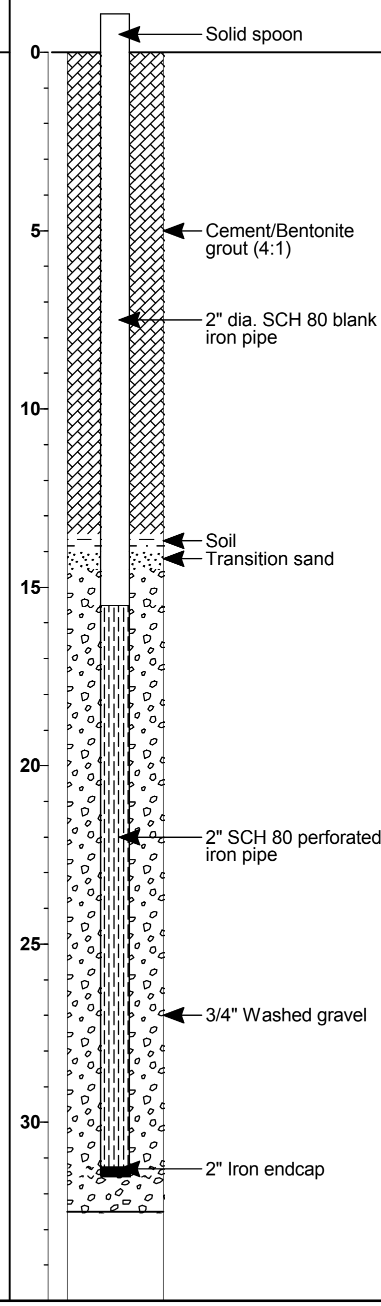
JOB NUMBER: 07206046.01 Task 30

REMARKS:

Depth (feet)	Description	Comments
5	Brown Silty Sand	Soil Cover
10	Brown Silty Sand	Soil Cover
15	Black, Highly Decomposed Refuse, Newspaper, Duct-Tape, Plastic, Wood	Refuse
20	Tin, Shoe, Glass, Wood, Plastic	Refuse
25	Wood, Nail, Cardboard	Refuse
29.5	Dry, Metal, Wood, Glass, Cardboard, Newspaper	Refuse, Newspaper dated April 1972
32.5	Bottom of Boring 32.5'	

Depth scale: meters 0–10; feet 0–35. Graphical Log column.

Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/10/08**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/10/08**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**

Time Started:	**11:50**
Time Ended:	**15:15**
Total Depth:	**32.5 ft.**

S C S   E N G I N E E R S

BORING LOG

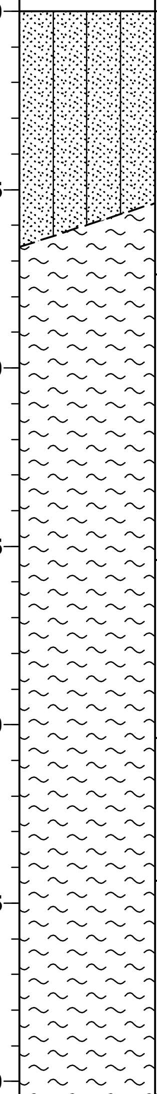
3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: IW8

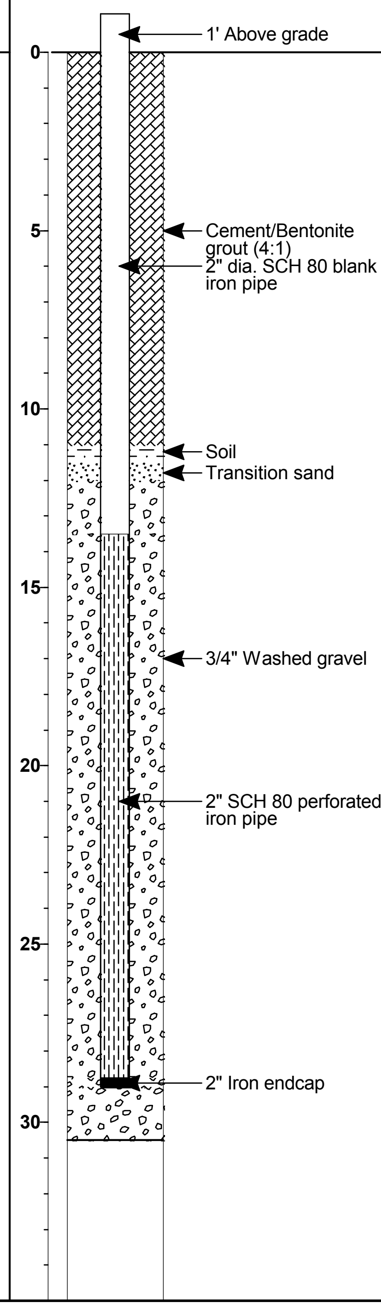
Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

JOB NUMBER: 07206046.01 Task 30

REMARKS:

Depth (meters)	Depth (feet)	Graphical Log	Description	Comments
0	0			
1			Brown, Silty Sand	Soil Cover
2	5		Highly Decomposed, Black	Refuse
3	10			
4				
5	15		Highly Decomposed, Wood, Plastic	Refuse
6	20		Wood, Plastic, Metal	Refuse
7			Dry, Grayish Brown Soil, Metal, Wood	Refuse
8	25			
9	30		Bottom of Boring 30.5'	
10	35			

Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/9/08**	Time Started:	**10:55**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/9/08**	Time Ended:	**14:00**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**	Total Depth:	**30.5 ft.**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**		

LB_LFG_WELL_LOG 07206046.01 T30.GPJ SCS_LFG.GDT 10/14/08

SCS ENGINEERS

BORING LOG

3900 Kilroy Airport Way, Suite 100
Long Beach, California 90806-6816

BORING NUMBER: IW9

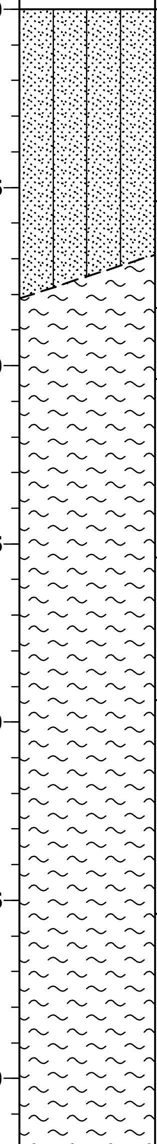
Area 3 CO_2 Injection Project
Palomar Airport Landfill
Carlsbad, CA

JOB NUMBER: 07206046.01 Task 30

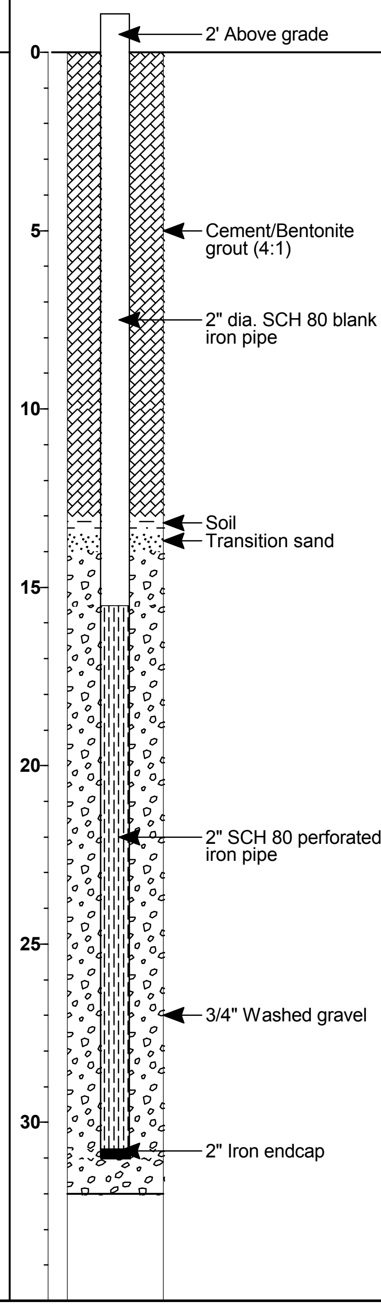
REMARKS:

Depth (feet)	Description	Comments
~5.5	Brown Silty Sand	Soil Cover
~8.5	Highly Decomposed, Wood, Plastic	Refuse
~10.5	Highly Decomposed, Black	Refuse
~15.5	Shoe, Metal, Plastic	Refuse
~19.5	Wood, Glass, Plastic, Metal	Refuse
~25.5	Greenish Gray, Clayey Sand, Metal, Paper	Refuse
32	Bottom of Boring 32'	

Graphical Log



Completion Detail



Drilling Company:	**Tri-County Drilling**	Date Started:	**9/9/08**	Time Started:	**14:10**
Drilling Method:	**Hollow Stem Auger**	Date Ended:	**9/10/08**	Time Ended:	**08:50**
Logged By:	**A. Hutchens**	Boring Diameter:	**10"**	Total Depth:	**32.0 ft.**
Sampling Method:	**Cuttings/Grab Samples**	Well Diameter:	**2"**		

LB_LFG_WELL_LOG 07206046.01 T30.GPJ SCS_LFG.GDT 10/14/08

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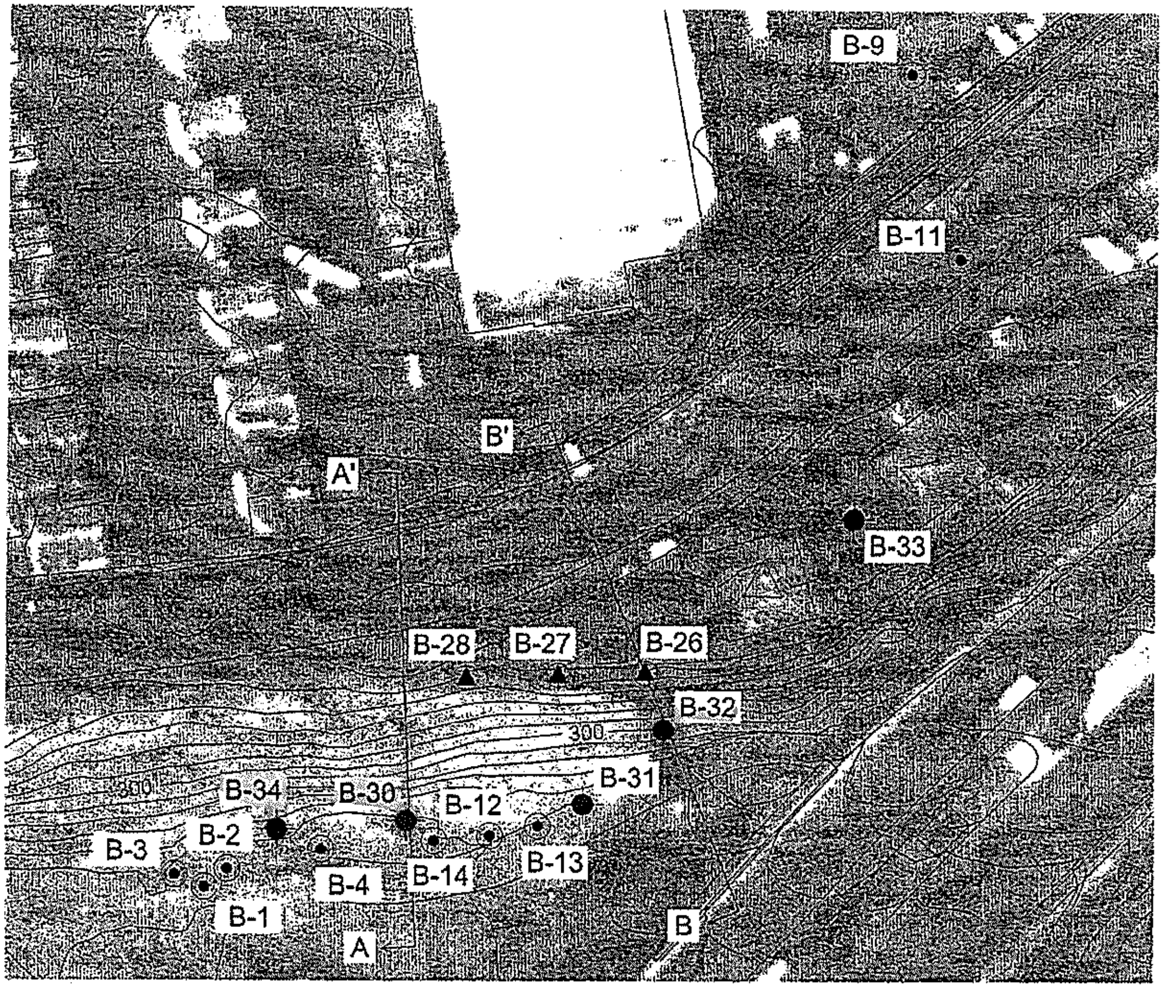

LEGEND

- APPROXIMATE LOCATION OF BORING (OCTOBER-NOVEMBER 2006)
- APPROXIMATE LOCATION OF BORING WHERE LANDFILL WASTE WAS ENCOUNTERED (NOVEMBER 2006)
- APPROXIMATE LOCATION OF BORING (MAY 2006)
- APPROXIMATE PROPERTY BOUNDARY
- A A' APPROXIMATE LOCATION OF CROSS - SECTION

N

50 25 0 50

SCALE IN FEET

LOCATIONS OF EXPLORATORY BORINGS
PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

Geosyntec consultants	DATE: MAY 2007	FIGURE
	PROJECT NO. SC0230	1

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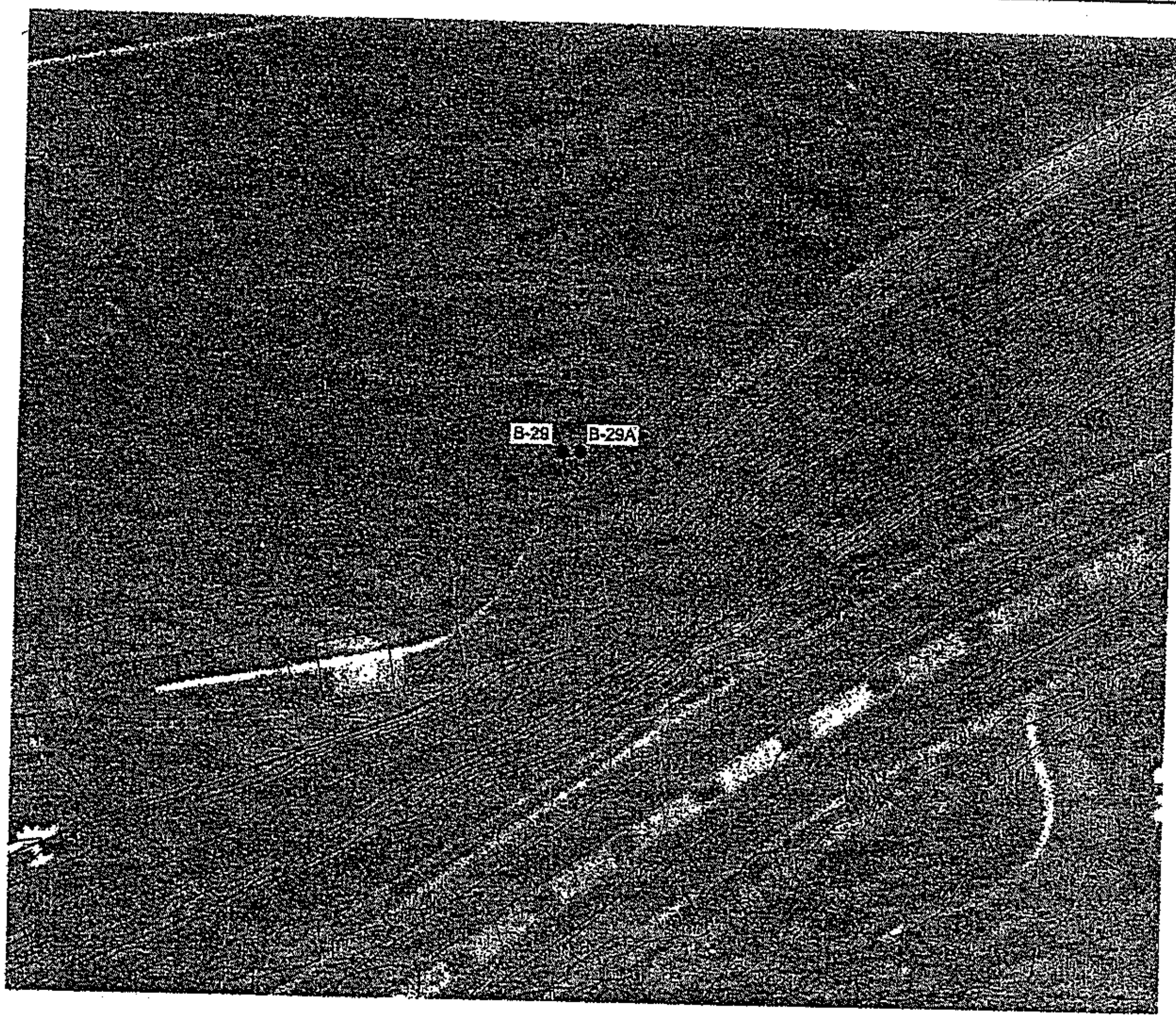

LEGEND

- APPROXIMATE LOCATION OF BORING (MAY 2006)
- APPROXIMATE PROPERTY BOUNDARY

N

50 25 0 50

SCALE IN FEET

LOCATION OF EXPLORATORY BORING
PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

Geosyntec consultants	DATE:	MAY 2007	FIGURE
	PROJECT NO.	SC0230	2

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ATTACHMENT A

Field Explorations

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PROJECT Palomar Airport
PROJECT LOCATION See Site Plan
PROJECT NUMBER SC0230

KEY SHEET - CLASSIFICATIONS AND SYMBOLS

GS FORM: KEY 09/99

EMPIRICAL CORRELATIONS WITH STANDARD PENETRATION RESISTANCE N VALUES *

FINE GRAINED SOILS

N VALUE * (BLOWS/FT)	CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS/SQ FT)
0 - 2	VERY SOFT	<0.25
3 - 4	SOFT	0.25 - 0.50
5 - 8	FIRM	0.50 - 1.00
9 - 15	STIFF	1.00 - 2.00
16 - 30	VERY STIFF	2.00 - 4.00
31 - 50	HARD	>4.00
>50	VERY HARD	

COARSE GRAINED SOILS

N VALUE * (BLOWS/FT)	RELATIVE DENSITY
0 - 4	VERY LOOSE
5 - 10	LOOSE
11 - 30	MEDIUM DENSE
31 - 50	DENSE
>50	VERY DENSE

* ASTM D 1586; NUMBER OF BLOWS OF 140 POUND HAMMER FALLING 30 INCHES TO DRIVE A 2 IN. O.D., 1.4 IN. I.D. SAMPLER ONE FOOT.

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

MAJOR DIVISIONS			SYMBOLS	DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO.4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL -SAND-CLAY MIXTURES
MORE THAN 50% OF MATERIAL COARSER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO.4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL FINER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

NOTE: DUAL SYMBOLS USED FOR BORDERLINE CLASSIFICATIONS

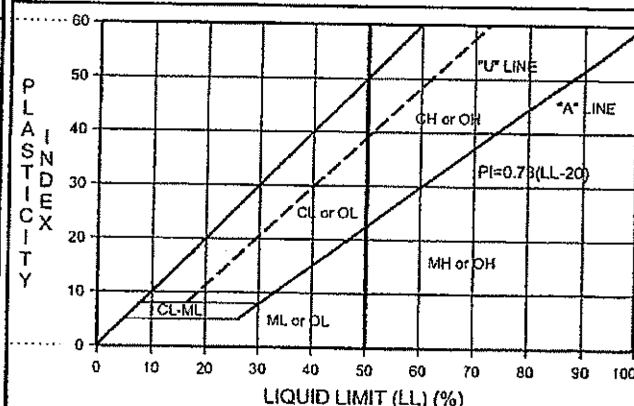
PARTICLE SIZE IDENTIFICATION

BOULDERS	>300 mm
COBBLES	75 - 300 mm
GRAVEL: COARSE	19.0 - 75 mm
GRAVEL: FINE	4.75 - 19 mm
SAND: COARSE	2.00 - 4.75 mm
SAND: MEDIUM	0.425 - 2.00 mm
SAND: FINE	0.075 - 0.425 mm
SILT	0.075 - 0.002 mm
CLAY	<0.002 mm

WELL GRADED - HAVING WIDE RANGE OF GRAIN SIZES AND APPRECIABLE AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES

POORLY GRADED - PREDOMINANTLY ONE GRAIN SIZE, OR HAVING A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING

PLASTICITY CHART



OTHER MATERIAL SYMBOLS

- Siltstone
- Sandstone
- Siltstone/Claystone
- Claystone
- Shale
- Siltstone/Sandstone
- Conglomerate
- Granitic
- Sand
- Silt
- Silty Sand
- Evaporite
- Artificial Fill
- Debris Fill
- Asphalt
- Concrete

WELL SYMBOLS

- HYDRATED GRANULAR BENTONITE
- BENTONITE CEMENT GROUT
- FILTER PACK
- CONCRETE
- NATIVE/ SLOUGH
- CENTRAL-IZER

SAMPLER AND OTHER SYMBOLS

- BULK SAMPLE
- SPLIT SPOON
- STANDARD PENETRATION TEST
- SHELBY TUBE
- CALIFORNIA SAMPLE
- CORE

- ▽ Water Level at Time Drilling, or as Shown
- ▼ Static Water Level
- MSL: Mean Sea Level
- ALS: Above Land Surface
- BLS: Below Land Surface
- BTOC: Below Top of Casing
- HSA: Hollow Stem Auger

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GS FORM: BORE 1/99

BOREHOLE RECORD

BORING B29 SHEET 1 OF 1
START DATE 1 May 07 ELEVATION 318 FT MSL
FINISH DATE 1 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOW COUNTS	SAMPLES % RECOVERY	SAMPLES PID READING	TIME	COMMENTS
	ASPHALT 4 in									
	FILL moist, dark yellowish brown (10YR 4/6), sandy lean clay (CL) with trace gravel									
1			317							
2			316							
3			315							
4			314							
5			313							
6			312							
7	Santiago Formation very dense, dry to moist, light olive brown (2.5Y 5/3), poorly graded fine sand (SP) with gravel (angular up to 1")		311							
8			310			30/35/50/2				
9	Becomes very dark gray (7.5YR 3/1) at 9'		309						11:00	Encountered refusal with augers switched drill lead to try to break through gravel moved 10' east

Refusal at 9 ft. bgs.
Backfilled with 1.5 cu. ft. cement grout and hydrated bentonite capped with portland cement concrete
Groundwater not encountered

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING ----
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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BOREHOLE RECORD

BORING B29A
SHEET 1 OF 1
START DATE 1 May 07
ELEVATION 318 FT MSL
FINISH DATE 1 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOW COUNTS	SAMPLES % RECOVERY	SAMPLES PID READING	TIME	COMMENTS
	ASPHALT 4"									
	FILL moist, dark yellowish brown (10YR 4/2), sandy lean clay (CL) with trace gravel									
1			317							
2			316							
3			315							
4			314							
5	With some gravel		313							
	Santiago Formation very dense, dry to moist, light olive brown (2.5Y 5/3), poorly graded fine sand with gravel (SP)									
6			312							
7			311							
8			310							

Refusal at 8 ft. bgs.
Backfilled with 0.7 cu. ft. cement grout and hydrated bentonite capped with portland cement concrete
Groundwater not encountered

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 4"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING ——
PRINTED 23 May 07

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BOREHOLE RECORD

BORING B-30 SHEET 1 OF 2
START DATE 1 May 07 ELEVATION 294 FT MSL
FINISH DATE 1 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	TYPE	BLOW COUNTS	% RECOVERY	PID READING	TIME	COMMENTS
	FILL, dry to moist, olive brown (2.5Y 4/2), poorly graded medium sand with angular gravel (SP)								13:10	
1			293							
2			292							
3			291							
4	dry to moist, light olive brown (2.5Y 6/3), poorly graded fine sand with trace clay (SC)		290							
5			289							
6			288							
7			287							
8			286							
9			285							
10	moist, light yellowish brown (2.5Y 6/3) sandy lean clay (CL)		284							
11			283							
12			282							
13			281							
14	moist, very dark gray (10YR 3/1), lean clay (CL)		280							
15			279							
16			278							

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING ------
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BORING LOG NO WELL (STEVE) NO SIG SC0230.GPJ GEOSNTEC.GDT 23/5/07

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BOREHOLE RECORD

BORING B-30 SHEET 2 OF 2
START DATE 1 May 07 ELEVATION 294 FT MSL
FINISH DATE 1 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	TYPE	BLOW COUNTS	% RECOVERY	PID READING	TIME	COMMENTS
17	**DEBRIS FILL** wet, black		277							
18	**Santiago Formation** very dense, wet, pale olive (5Y 6/2), with little yellow mottling and iron oxide staining clayey sand (SC)		276							Drilling becomes more difficult
19			275							
20			274						15:30	

Boring Terminated at 20 ft. bgs.
Backfilled with 4 cu. ft. cement grout and hydrated bentonite

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING ----
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BORING LOG NO WELL (STEVE) NO SIG SC0230.GPJ GEOSNTEC.GDT 23/5/07

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GS FORM: BORE 1/99

BOREHOLE RECORD

BORING B-31
SHEET 1 OF 2
START DATE 1 May 07
ELEVATION 296 FT MSL
FINISH DATE 1 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	TYPE	BLOW COUNTS	% RECOVERY	PID READING	TIME	COMMENTS
	FILL dry to moist, olive brown (2.5Y 4/3), poorly graded medium sand (SP) with angular gravel								14:10	
1			295							
2			294							
3	Dry to moist, light yellowish brown (2.5Y 6/3), poorly graded fine sand (SP) with trace clay and angular gravel		293							
4			292							
5			291							
6			290							
7			289							
8			288							
9			287							
10	Becomes moist with some clay		286							
11			285							
12			284							
13	Moist, dark olive gray (5Y 3/2), lean clay (CL)		283							
14	Becomes very dark gray (10YR 3/1)		282							
15			281							
16			280							

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING -----
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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GS FORM: BORE 1/99

BOREHOLE RECORD

BORING B-31 | SHEET 2 OF 2
START DATE 1 May 07 | ELEVATION 296 FT MSL
FINISH DATE 1 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	TYPE	BLOW COUNTS	% RECOVERY	PID READING	TIME	COMMENTS
17			279							
18			278							
19	Santiago Formation very dense, moist, pale olive (5Y 6/3), clayey fine sand (SC) with trace yellow mottling and some iron oxide coloring		277							
20			276							Drilling becomes harder
	Boring Terminated at 20 ft. bgs. Backfilled with 4 cu. ft. cement grout and hydrated bentonite									

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF
NORTHING
EASTING
ANGLE Vertical
BEARING -------
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GS FORM: BORE 1/99

BOREHOLE RECORD

BORING B-32 SHEET 1 OF 2
START DATE 2 May 07 ELEVATION 310 FT MSL
FINISH DATE 2 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOW COUNTS	SAMPLES % RECOVERY	SAMPLES PID READING	TIME	COMMENTS
0	FILL dry to moist, olive brown (2.5Y 4/3), poorly graded medium sand (SP) with angular gravel (up to 1")								8:34	
1			309							
2			308							
3			307							
4			306							
5	Dry to moist, dark yellowish brown (10YR 4/4), poorly graded fine to medium sand (SP)		305							
6			304							
7			303							
8			302							
9			301							
10	Dry to moist, dark yellowish brown (10YR 4/6), fine sandy lean clay (CL)		300							
11			299							
12			298							
13	Moist, very dark gray (10YR 3/1), lean clay (CL)		297							
14	Moist, dark yellowish brown (10YR 4/6), fine sandy lean clay (CL)		296							
14.5	DEBRIS FILL very dark gray (10YR 3/1), sandy lean clay (CL) with some plastic debris									
15			295							
16			294							

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING -----
PRINTED 23 May 07

REMARKS:

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SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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BOREHOLE RECORD

BORING B-32 SHEET 2 OF 2
START DATE 2 May 07 ELEVATION 310 FT MSL
FINISH DATE 2 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	TYPE	BLOW COUNTS	% RECOVERY	PID READING	TIME	COMMENTS
17	Santiago Formation hard, moist, dark yellowish brown (10YR 4/6), fine sandy lean clay (CL)		293							
18			292							
19			291							
20	Hard, moist, dark gray (2.5Y 4/1), lean clay (CL)		290							
21			289							
22			288							
23			287							
24	Hard, wet, greenish gray (GLEY1 6/1), sandy lean clay (CL)		286							
25	Boring Terminated at 25 ft. bgs. Backfilled with 4.9 cu. ft. cement grout and hydrated bentonite		285						9:00	

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING ------
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
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GS FORM: BORE 1/99

BOREHOLE RECORD

BORING B-34 SHEET 1 OF 2
START DATE 1 May 07 ELEVATION 295 FT MSL
FINISH DATE 1 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOW COUNTS	SAMPLES % RECOVERY	SAMPLES PID READING	TIME	COMMENTS
0	FILL dry to moist, olive brown (2.5Y 4/3), poorly graded medium sand (SP) with angular gravel (up to 1")								9:40	
1			294							
2			293							
3			292							
4			291							
5	Dry to moist, light yellowish brown (2.5Y 6/3), poorly graded fine sand (SP) with trace clay		290			5/5/8				
6			289							
7			288							
8			287							
9			286							
10			285							
11			284							
12	Becomes moist		283							
13			282							
13.5	Moist, very dark gray (10YR 3/1), lean clay (CL)									
14			281							
15			280							
16			279							

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING ----
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BORING LOG NO WELL (STEVE) NO SIG SC0230.GPJ GEOSNTEC.GDT 23/5/07

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GS FORM: BORE 1/99

BOREHOLE RECORD

BORING B-34

START DATE 1 May 07
ELEVATION 295 FT MSL
FINISH DATE 1 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	TYPE	BLOW COUNTS	% RECOVERY	PID READING	TIME	COMMENTS
17			278							
18	DEBRIS FILL wet, black		277							
19			276							
20			275							
21	did not hit bottom of waste?		274							Drilling becomes more difficult
22			273							Hole caved to ~ 6.5 ft bgs after removing augers
	Boring Terminated at 22 ft. bgs. Backfilled with 1.3 cu. ft. cement grout and hydrated bentonite									

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale
REVIEWER SF
NORTHING
EASTING
ANGLE Vertical
BEARING -----
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
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GS FORM: BORE 1/99

BOREHOLE RECORD

BORING B-33 SHEET 1 OF 2
START DATE 2 May 07 ELEVATION 312 FT MSL
FINISH DATE 2 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	ELEVATION (ft)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOW COUNTS	SAMPLES: % RECOVERY	SAMPLES: PID READING	TIME	COMMENTS
0	ASPHALT4"							6:25	
	FILL dry to moist, dark yellowish brown (10YR 3/6), silty fine sand with clay (SM) with trace angular gravel								
1		311							
2		310							
3		309							
4	dry to moist, yellowish brown (10YR 4/6) silty fine sand with clay (SM)	308							
5		307							
6	becomes yellowish brown (10YR 5/6)	306							
7		305							
8	dry to moist, very dark yellowish brown (10YR 3/2), poorly graded medium sand (SP) with trace gravel and silt	304							
9		303						6:40	
10		302			10/9/9				
10.5	moist, light brownish gray (2.5Y 4/2), silty fine sand (SM)								
11		301							
12		300							
13	moist, olive brown (2.5Y 4/3), silty fine sand (SM) with trace angular gravel	299							
14		298							
14.5	Santiago Formation hard, moist, olive gray (5Y 4/2), lean clay (CL) with some silt								
15		297							
16		296							

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF
NORTHING
EASTING
ANGLE Vertical
BEARING -----
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

BORING LOG NO WELL (STEVE) NO SIG SC0230.GPJ GEOSNTEC.GDT 23/5/07

Geosyntec consultants
10875 Rancho Bernardo Rd, Suite 200
San Diego, CA 92127
Tel: (858) 674-6559
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GS FORM: BORE 1/99

BOREHOLE RECORD

BORING B-33 SHEET 2 OF 2
START DATE 2 May 07 ELEVATION 312 FT MSL
FINISH DATE 2 May 07
PROJECT Palomar Airport
LOCATION See Site Plan
PROJECT NUMBER SC0230

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	ELEVATION (ft)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOW COUNTS	SAMPLES % RECOVERY	SAMPLES PID READING	TIME	COMMENTS
17			295							
18			294							
19	Becomes light olive gray (5Y 6/2)		293							
20			292						6:55	
21	Becomes olive gray (5Y 4/2)		291							
22			290							Drilling slows
23			289							
24			288			17/23/20				
25	medium dense, dry to moist, light olive gray (5Y 6/2), silty sand (SM), with some clay, mottled with iron oxide coloring		287						7:10	

Boring Terminated at 25 ft. bgs.
Backfilled with 4.9 cu. ft. cement grout and hydrated bentonite

CONTRACTOR Pacific Drilling
EQUIPMENT Limited Access Rig
DRILL MTHD Solid Stem Auger
DIAMETER 6"
LOGGER C. Gale REVIEWER SF

NORTHING
EASTING
ANGLE Vertical
BEARING ——
PRINTED 23 May 07

REMARKS:

COORDINATE SYSTEM: Mean Sea Level
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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APPENDIX G – GEOTECHNICAL FEASIBILITY STUDY RUNWAY 6-24 EXTENSION MCCLELLAN-PALOMAR AIRPORT CARLSBAD, CALIFORNIA

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Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

GEOTECHNICAL FEASIBILITY STUDY
RUNWAY 6-24 EXTENSION
McCLELLAN-PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PREPARED FOR:
Kimley-Horn and Associates, Inc.
401 B Street, Suite 600
San Diego, California 92101

PREPARED BY:
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
5710 Ruffin Road
San Diego, California 92123

April 10, 2013
Project No. 106541009

April 10, 2013
Project No. 106541009

Mr. Vince Hourigan
Kimley-Horn and Associates, Inc.
401 B Street, Suite 600
San Diego, California 92101

Subject: Geotechnical Feasibility Study
Runway 6-24 Extension
McClellan-Palomar Airport
Carlsbad, California

Dear Mr. Hourigan:

In accordance with your request and authorization, we have performed a geotechnical feasibility study for the proposed Runway 6-24 Extension project at the McClellan-Palomar Airport in Carlsbad, California. The purpose of this study was to address the feasibility of six potential construction methods for the runway extension across the existing landfill. Accordingly, this report presents our geotechnical findings and conclusions relating to the project. Ninyo & Moore appreciates the opportunity to be of service on this project.

Respectfully submitted,
NINYO & MOORE

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Distribution: (1) Addressee

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1. INTRODUCTION

In accordance with your request and authorization, we have performed a geotechnical feasibility study for the proposed Runway 6-24 Extension project at the McClellan-Palomar Airport in Carlsbad, California (Figure 1). The purpose of this study was to evaluate the depth of the existing landfill and the potential settlement of the landfill. We also address the geotechnical feasibility of six proposed methods of constructing the runway extension. This report presents our findings and conclusions based on our background review, site reconnaissance, subsurface exploration, geotechnical laboratory testing, and geotechnical analyses.

2. SCOPE OF SERVICES

The scope of our geotechnical services for this feasibility study included the following:

- Reviewing readily available background materials pertaining to the project including previous geotechnical and environmental reports, geologic maps, topographic maps, aerial photographs, project schematic plans prepared by the client, landfill inspection reports, and in-house information.
- Performing a geotechnical reconnaissance of the site to observe the existing conditions and to mark the locations of our exploratory borings.
- Coordinating with Underground Service Alert (USA) to mark potential utility conflicts.
- Acquiring boring permit #LMON108715 from the County of San Diego Department of Environmental Health (DEH).
- Coordinating with and notifying the County of San Diego Solid Waste Local Enforcement Agency (LEA), Air Pollution Control District (APCD), the Regional Water Quality Control Board (RWQCB) and the McClellan-Palomar Airport personnel prior to performing our field work.
- Preparing a site Health and Safety Plan (HASP) for our subsurface exploration. This plan was consistent with the County of San Diego Department of Environmental Health (DEH) Site Assessment and Mitigation Manual (SAM) Guidelines.
- Performing a subsurface exploration consisting of drilling, sampling and logging of three, small-diameter soil borings using a truck-mounted drill rig. Collected soil samples were transported to our in-house geotechnical laboratory for analysis.
- Performing air monitoring within the work area during our subsurface exploration.

- Coordinating with a waste/environmental management company for the disposal of the cuttings generated during the subsurface exploration.
- Performing geotechnical laboratory testing of representative soil samples to evaluate design parameters appropriate for the project.
- Compiling and performing an engineering analysis of the data obtained.
- Preparing this report presenting our findings and conclusions regarding landfill settlement and the feasibility of the six proposed runway extensions options.

3. SITE DESCRIPTION

The project area is located at the east end of the existing Runway 6-24 at McClellan-Palomar Airport in Carlsbad, California. The existing runway is 4,900 feet long by 150 feet wide, and is paved with asphalt concrete (AC). Runway elevations range from approximately 312.5 feet above mean sea level (MSL) to 328.5 feet above MSL. Specifically, the area of the current project is an existing dirt surfaced portion of the McClellan-Palomar Airport property. It is bounded by El Camino Real on the east, Palomar Airport Road to the south, commercial properties to the north, and Runway 6-24 to the west.

The McClellan-Palomar Airport property is partially constructed over a former municipal solid waste (MSW) landfill. The landfill was in use from the early 1960s to 1975. The landfill has an active methane gas extraction system in operation. The project area is also known as Unit 3 of the landfill system within the airport property. Descending fill slopes that outline the limits of Unit 3 are present along the eastern and southern property boundaries. Within this area, current improvements include the Unit 3 gas extraction system. This system consists of gas extraction wells, header piping, and condensate pumps. Other existing improvements in the project area include airport lighting systems and the associated underground utility conduits.

4. SITE BACKGROUND

Based on information compiled for previous projects at McClellan-Palomar Airport, we understand that Runway 6-24 was constructed in the late 1950s. The landfill is separated into three fill areas;

Units 1 and 2 are located south of Runway 6-24 and Unit 3 is located at the east end of Runway 6-24. Based on information presented by the California Water Quality Control Board (CWQCB) (CWQCB, 1996), the landfill primarily received on the order of 30 to 50 tons of residential waste per day (up to 200 tons per day). The landfill is currently classified as an inactive (closed) Class III MSW landfill. Specifically, the CWQCB (1996) estimated that the Unit 3 landfill occupies approximately 19 acres and includes approximately 697,000 cubic yards of MSW. Furthermore, the landfill facility is reported to have accepted residential, commercial, and agricultural waste; however, some industrial waste such as paint, oils and thinners, treated sewage sludge, and medical wastes were reportedly accepted (CWQCB, 1996). A consultant report states that "The landfill was constructed without a liner, and does not have a leachate collection or removal system. (Geosyntec, 2005)."

Figure 2 displays the 1963 topography at the location of the Unit 3 landfill, prior to grading activities. A 1971 aerial photograph (Figure 3) depicts the occurrence of grading operations, presumably preparing the Unit 3 landfill for the receiving of MSW. The 1975 orthotopographic imagery (Figure 4) indicates surface elevations that are close to the existing present day surface grades, thus suggesting the landfill was near closure. However, the imagery presented on Figure 4 indicates that the surface elevation between Station Nos. -3+50 and -6+50 was approximately 308.5 feet above MSL in 1975. This elevation is lower than the elevations from 1963, as shown on Figure 2 for the same area between Station Nos. -3+50 and -6+50. Accordingly, the lower elevations indicate some earthwork removals occurred in this between 1963 and 1975. Accordingly, these elevation changes may be an indicator that the limits of the Unit 3 landfill may extend beyond the estimated westerly limits presented near Station No. -5+00.

5. PROJECT DESCRIPTION

Based on our correspondence with the client, the project includes extension of Runway 6-24 to the east approximately 1,200 feet beyond the existing threshold. The extended portion will span the limits of the Unit 3 landfill. The project is currently is in the feasibility stage of evaluating six options for constructing the runway extension over the landfill. These options include:

- The construction of an elevated "bridge" structure supported on deep foundations that penetrate through the landfill;

- Initial placement of a surcharge fill over the landfill and then the removal of the surcharge and the use of geofoam fill materials to restore the grades;
- Installation of stone columns through the landfill that will then be overlain with a geogrid reinforced fill;
- Installing deep injections of expanding polyurethane resin into the landfill that will be overlain with geogrid reinforced fill;
- Installation of drilled displacement piles through the landfill that will then be overlain with a geogrid reinforced fill;
- Installing deep injections of low-slump, mortar-like grout into the landfill that will be overlain with geogrid reinforced fill.

As part of the project, retaining walls would be constructed along the eastern and southern property limits to facilitate the grade changes. The retaining wall along the eastern portion of the project is anticipated to be approximately 16 feet tall. The retaining wall along the southern side is anticipated to be up to approximately 35 feet tall. Initial proposals include the usage of terraced, segmental retaining walls for these purposes. Presented below are additional details regarding the six proposed options for the construction of the runway extension.

5.1. Project Description - Option 1

Option 1 includes the construction of an elevated concrete slab structure that would span the existing landfill. The concrete slab would be supported on deep foundations consisting of cast-in-steel-shell (CISS) piles that extend through the landfill materials to bear on competent formational materials. For this construction option, the void space between the bottom of the elevated concrete slab and the top of the existing grade would be filled with cellular concrete. Based on preliminary concepts, the thickness of the void to be filled with cellular concrete is estimated to vary from approximately 1 to 9 feet. General fill soils would then be used to raise the grade along the sides of the extended portion of the runway and as backfill behind the retaining walls along the southern and eastern portions of the project area.

5.2. Project Description - Option 2

Option 2 includes the placement of a surcharge fill on the landfill for a specified amount of time. Per initial planning of the surcharge, it is anticipated that up to 10 feet of material will be used for the surcharge of the landfill. Subsequent to the pre-determined surcharge period, the materials used for the surcharge will be removed. After removal, geofoam materials would be placed within the limits of the runway extension to raise the grades. As with Option 1, general fill soils would then be used to raise the grade along the sides of the extended portion of the runway and as backfill behind the retaining walls along the southern and eastern portions of the project area.

5.3. Project Description - Option 3

Option 3 includes the installation of stone columns extending through the landfill into the formational materials. The zone of improvement for the stone columns would include the area beneath the runway extension and the horizontal limits extending approximately 75 feet north and south of the runway extension. Current estimates include installation of the stone columns at spacings of approximately 9 feet on center. Subsequent to the stone column installation, fill soils reinforced with geosynthetic materials would be placed to raise the grades beneath the runway extension and the adjacent areas extending 75 feet to the north and south of the runway extension. As with Option 1, general fill soils would then be used to raise the grade along the sides of the extended portion of the runway and as backfill behind the retaining walls along the southern and eastern portions of the project area.

5.4. Project Description - Option 4

Option 4 includes the deep injection of expanding polyurethane thermoset resin into the landfill materials. The zone of improvement for the deep injections would include the area beneath the runway extension and the horizontal limits extending approximately 75 feet north and south of the runway extension. Current estimates include installation of the polyurethane through deep injection points at spacings of approximately 12 feet on center. Subsequent to the polyurethane deep injections, fill soils reinforced with geosynthetic materials would be placed to raise the grades beneath the runway extension and the adjacent areas extending 75 feet to the north and south of the runway extension. As with Option 1, general fill soils would then be used to raise the grade along the sides of the extended portion of the runway and as backfill behind the retaining walls along the southern and eastern portions of the project area.

5.5. Project Description - Option 5

Option 5 includes the installation of drilled displacement piles extending through the landfill into the formational materials. The zone of improvement for the drilled displacement piles would include the area beneath the runway extension and the horizontal limits extending approximately 75 feet north and south of the runway extension. Current estimates include installation of the drilled displacement piles at spacings of approximately 8 to 10 feet on center. Subsequent to the drilled displacement pile installation, fill soils reinforced with geosynthetic materials would be placed to raise the grades beneath the runway extension and the adjacent areas extending 75 feet to the north and south of the runway extension. As with Option 1, general fill soils would then be used to raise the grades along the sides of the extended portion of the runway and as backfill behind the retaining walls along the southern and eastern portions of the project area.

5.6. Project Description - Option 6

Option 6 includes the deep injection of low-slump, mortar-like grout into the landfill materials. The grout is injected at incremental depth intervals and under high pressure through small-diameter, steel grout pipes to compact and displace the adjacent landfill materials (compaction grouting). The zone of improvement for the compaction grouting would include the area beneath the runway extension and the horizontal limits extending approximately 75 feet north and south of the runway extension. Current estimates include installation of the grout through deep injection points at spacings of approximately 4 to 5 feet on center. Subsequent to the compaction grouting, fill soils reinforced with geosynthetic materials would be placed to raise the grades beneath the runway extension and the adjacent areas extending 75 feet to the north and south of the runway extension. As with Option 1, general fill soils would then be used to raise the grades along the sides of the extended portion of the runway and as backfill behind the retaining walls along the southern and eastern portions of the project area.

6. SUBSURFACE EXPLORATION AND LABORATORY TESTING

Our subsurface exploration was conducted on October 3 through October 5, 2012, and consisted of the drilling of three exploratory borings (B-1 through B-3). A truck-mounted drill rig equipped with 8-inch-diameter continuous-flight hollow-stem augers was used to drill the borings to depths of up to approximately 71 feet. The purpose of the borings was to observe the constituents of the landfill materials encountered, to evaluate the thickness of the landfill materials, and to observe and sample the underlying earth materials. Relatively undisturbed and bulk samples were obtained from within the borings at selected intervals. The approximate locations of the borings are shown on Figure 5, and the boring logs are presented in Appendix A. In accordance with the HASP, during drilling operations, air monitoring (specifically for methane) was performed in the work area.

Geotechnical laboratory testing of samples obtained during our subsurface exploration included an evaluation of the in-situ moisture content and dry density, sieve analysis, and direct shear strength. The tests were performed at our in-house geotechnical laboratory. The results of the in-situ moisture content and dry density tests are shown at the corresponding sample depths on the boring logs in Appendix A. The results of the other laboratory tests performed are presented in Appendix B.

7. GEOLOGY AND SUBSURFACE CONDITIONS

Our findings regarding regional and site geology, including faulting and seismicity, and groundwater conditions at the site are provided in the following sections.

7.1. Regional Geologic Setting

The project area is situated in the western margin section of the Peninsular Ranges Geomorphic Province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California (Norris and Webb, 1990; Harden, 1998). The province varies in width from approximately 30 to 100 miles. In general, the province consists of rugged mountains underlain by Jurassic metavolcanic and metasedimentary rocks, and Cretaceous igneous rocks of the southern California batholith.

The Peninsular Ranges Province is traversed by a group of sub-parallel faults and fault zones trending roughly northwest. Several of these faults, which are shown on Figure 6, are considered active faults. The San Jacinto, Elsinore, and San Andreas are active fault systems located east-northeast of the project area and the Rose Canyon, Coronado Bank, San Diego Trough, and San Clemente, Newport-Inglewood, and Rose Canyon are active fault systems located west to southwest of the project area. Major tectonic activity associated with these and other faults within this regional tectonic framework consists primarily of right-lateral, strike-slip movement.

7.2. Site Geology

Based on our review of background documents and our subsurface evaluation, the site is underlain by fill, MSW, and formational materials of the Eocene-age Santiago Formation. Generalized descriptions of the earth units encountered during our subsurface exploration are provided in the subsequent sections. Additional descriptions of the subsurface units are provided on the boring logs in Appendix A. Figure 7 is a cross section along the longitudinal axis of the proposed runway extension showing the geology as encountered in our borings.

7.2.1. Fill

Fill was encountered within the borings at depths up to approximately 6½ feet. The fill materials were observed to be in two distinct layers. The upper layer of fill soils generally consisted of brown to yellowish brown, damp to moist, loose to medium dense, silty to clayey sand with some gravel and cobbles. This layer of sandy fill was encountered at the ground surface and extended to depths of up to approximately 4½ feet.

The second distinct layer of fill soil generally consisted of various shades of brown and gray, moist, stiff to very stiff, silty clay. This clayey layer was encountered underlying the upper sandy layer and extended to depths of up to approximately 6½ feet. These clayey materials are anticipated to be part of the landfill cap materials.

7.2.2. Municipal Solid Waste (MSW)

MSW materials were encountered within our borings underlying the fill soil. These materials varied in composition and included various types of plastic, wood, metal, paper, and other debris. This debris was intermixed with clay and sand soil. The thickness of the encountered MSW was approximately 52½ feet in Boring B-2 and approximately 37½ feet in Boring B-3. The thickness of the MSW could not be assessed within Boring B-1 due to safety concerns regarding the elevated gas conditions encountered during drilling. Boring B-1 was terminated at a depth of approximately 20 feet.

7.2.3. Santiago Formation

Materials mapped as Santiago Formation (Kennedy and Tan, 2008) were encountered underlying the MSW materials in Borings B-2 and B-3. This material generally consisted of various shades of brown and gray, moist, moderately to strongly cemented, sandstone and moderately to strongly indurated, silty claystone or clayey siltstone.

7.3. Groundwater

Groundwater was not encountered during the drilling operations for this study. Based on information provided by others (Geosyntec, 2012), there is a perched groundwater table and a deeper groundwater table at the location of Unit 3 of the landfill. The perched groundwater table (Geosyntec, 2012) was generally found at elevations ranging between 250 feet and 300 feet above MSL. The shallower portions of the perched groundwater table were situated near the northwest portion of the Unit # landfill. The deeper portions of the perched groundwater were generally near the southern portion of the Unit 3 landfill. The deeper groundwater table was encountered at elevations near 230 feet above MSL. It should be noted that groundwater levels are influenced by seasonal variations in precipitation, irrigation, groundwater pumping, and other factors, and are, therefore, subject to variation.

8. FAULTING AND SEISMICITY

Based on our review of referenced geologic maps and stereoscopic aerial photographs, the ground surface in the vicinity of the subject site is not mapped as being transected by known active or potentially active faults (i.e., faults that exhibit evidence of ground displacement in the last 11,000 years and 2,000,000 years, respectively). Major known active faults in the region consist generally of en-echelon, northwest-striking, right-lateral, strike-slip faults. The San Jacinto, Elsinore, and San Andreas faults are active fault systems located northeast of the project area and the Rose Canyon, Coronado Bank, San Diego Trough, and San Clemente faults are active faults located west to southwest of the project area.

The closest known active fault is the Rose Canyon Fault, which is capable of generating an earthquake with a moment magnitude of 7.2 (Cao, et al, 2003). The Rose Canyon Fault is mapped approximately 6 miles west of the project site.

The principal seismic hazard considerations at the site are surface ground rupture, ground shaking, and seismically induced landsliding. A brief description of the hazards and the potential for their occurrence on site are presented below.

8.1. Ground Rupture

The probability of damage due to surface ground rupture is considered to be low at the site due to the lack of known active faults transecting the project area and its near vicinity. Surface ground cracking related to shaking from distant events is not considered a significant hazard, although it is considered to be a possibility.

8.2. Ground Shaking

The 2010 California Building Code (CBC) recommends that the design of structures be based on the peak horizontal ground acceleration (PGA) having a 2 percent probability of exceedance in 50 years which is defined as the Maximum Considered Earthquake (MCE). The statistical return period for PGA_{MCE} is approximately 2,475 years. Using a Site Class D, The PGA_{MCE} for the site was calculated as 0.48g using the United States Geological Survey (USGS) (2012) ground motion calculator (web-based). The design PGA was estimated to be 0.32g using the USGS ground motion calculator. These estimates of ground motion do not include near-source factors that may be applicable to the design of structures on site.

8.3. Landsliding

Based on our review of referenced geologic maps, literature, topographic maps, and stereoscopic aerial photographs, no landslides or indications of deep-seated landsliding were noted underlying the project site. As such, the potential for significant large-scale slope instability at the site is not a design consideration.

9. FINDINGS AND CONCLUSIONS

The following sections provide our findings and conclusions with regards to the estimated settlement associated with the landfill. The following sections also provide our opinions regarding the feasibility of the six proposed construction methods presented for the runway extension project.

9.1. Landfill Settlement Estimates

According to Leonard et al. (2000), the mechanisms for landfill settlement can be broadly divided into two categories. These include settlement mechanisms that cause relatively small amounts of settlements and those that cause relatively large amounts of settlements. The processes that are considered to cause small amounts of landfill settlement include: physical/chemical/corrosion degradation of steel and combustible organics; interaction through combustion from methane (an underground rapid oxidizing event) and corrosion by organic acids; and, consolidation. Mechanisms that are anticipated to cause relatively large amounts of settlements within a landfill include: mechanical/primary compression; biodegradation; and, physical creep/compression (such as void filling).

According to Liu et al. (2006), landfill settlement can also be divided into five separate stages. Stage I includes the mechanical compression of the MSW. This stage of settlement occurs during the placement and compaction of the MSW and the average daily cover (ADC). Stage II includes the primary mechanical settlement of the landfill due to the weight of the overburden of the materials placed above. This process is generally considered to occur in the first few months after placement of the MSW and ADC materials. Stage III is secondary settlement due to creep within the landfill materials resulting from secondary compression of the MSW and the ADC along with the initial decomposition of the organic matter. Stage III is considered to occur during the first few years after landfill completion. Stage IV settlement results from the biodegradation or primary decomposition of the organic materials. Stage V residual settlement results from mechanical settlement or organic decomposition. This is also, referred to as creep or void filling (Leonard, et al., 2000).

Due to the age of the landfill (last active in 1975), Stage 1 through Stage III mechanisms for landfill settlement were not incorporated into our estimate for the total remaining settlement of the landfill. Specifically, the rationales for not incorporating these mechanisms are as follows:

- Mechanical/primary compression of the MSW and ADC. As noted, this Stage I mechanism involves the compaction process during placement of the MSW and ADC while the landfill is active. Therefore, this process and the resulting settlements are considered to have already occurred.

- Physical/chemical/corrosion degradation of steel and combustible organics along with the interaction process is generally considered to induce relatively small settlements. Due to the small settlements and difficulty in evaluating the settlements that would be estimated from these processes, these settlements are considered minimal and are not included in our total settlement estimation. However, underground rapid oxidizing events can result in larger settlements that may occur at potential oxygen sources such as gas extraction wells. Provided that the gas extraction system is well maintained and operated, settlements associated with underground rapid oxidizing events are not anticipated to occur.

- Consolidation of the landfill mass. Consolidation is the process of expelling water present in the void spaces between soil particles due to increasing pressures. This process then results in settlement. Since the landfill mass is not saturated as defined in typical consolidation theory and the consolidation process generally occurs within a few years, further settlement from this Stage II type mechanism is considered to be minimal.

Therefore, Stage IV biodegradation and Stage V residual settlements such as creep/void filling were used to calculate the remaining, anticipated landfill settlement. The biodegradation process will be the primary cause of the landfill settlement. This settlement can be estimated using the following equation (Leonard, et al., 2000):

$$\mathbf{S_T = O \times T_R \times S_F}$$

where

S_T = Estimated future settlement due to biodegradation,

O = Percentage of decomposable organics as a decimal (estimated as 0.26)

T_R = thickness of MSW layer (52½ feet in Boring B-2 and 37½ feet in Boring B-3),

S_F = settlement factor a_1/a_T (evaluated as 0.28 from Figure 8 based on an initial MSW placement date in 1972, approximately 40 years ago)

Accordingly, we estimate approximately 3.8 to 2.7 feet of future settlement due to biodegradation at Borings B-2 and B-3, respectively.

In addition to the settlement from the biodegradation, residual creep/void filling from mechanical settlement or organic decomposition will add to the future estimated total settlement of the landfill. Based on information presented by Leonard, et al., 2000 (after Watts and Charles, 1990), the settlement related to residual creep/void filling may be estimated as 2 percent of the MSW thickness per log cycle of time in terms of days. Since it is approximately 37 years (~13,500 days) since Unit 3 has received MSW, the landfill has already experienced 4 log cycles of time based on number of days (i.e. 1 to 10 days, 10 to 100 days, 100 to 1,000 days, etc.). The landfill is approximately 3,500 days into the 5th log cycle (10,000 to 100,000 days). Therefore, we estimate that the landfill will likely only experience the remainder of the current log cycle of time (the remainder of this log cycle is another 76,500 days or approximately 210 years).

$$\mathbf{S_R = 0.02 \times [LOG_{10}(t_2) - LOG_{10}(t_1)] \text{ x } T_R}$$

where

S_R = Estimated future settlement due to residual creep/void filling, in feet

t_1 = Initial time (approximate age of the Unit 3 landfill, 13,500 days)

t_2 = End time (using end of 5th log cycle, 100,000 days)
T_R = thickness of MSW layer (52½ feet in Boring B-2 and 37½ feet in Boring B-3),

Accordingly, we estimate approximately 0.9 feet and 0.7 feet of settlement due to residual creep/void filling over the design life of the runway extension based on information from Borings B-2 and B-3, respectively.

For the total estimated future settlement of the landfill we combine the estimated settlements from biodegradation and residual creep/void filling. Based on the calculations presented above, we estimate total future settlements of approximately 4.7 and 3.4 feet based on information collected from Borings B-2 and B-3, respectively.

9.2. Assessment of Proposed Construction Options

Presented below are discussions of the engineering and construction aspects of the six proposed project options.

9.2.1. Elevated Structure

As previously discussed, this option includes the construction of a concrete slab supported on deep foundations consisting of cast-in-steel-shell (CISS) piles. From a geotechnical standpoint, this option is considered a viable method for the runway extension. Due to the deep foundations penetrating the MSW and bearing on formational materials, this option essentially circumvents the concerns with the various components of landfill settlement beneath the runway extension.

Although this option for construction is feasible and viable, there are various design, construction, and maintenance considerations. Design considerations include the amount of additional force that will be imposed on the deep foundations from down-drag created by the settling landfill materials and the effect of the potentially corrosive nature of the adjacent MSW on the steel and concrete materials for the deep foundations. Construction considerations include possible caving of drilled excavations, difficult drilling conditions due to debris, landfill gas generation during drilling, the generation of MSW that will need to be disposed of, and the potential for damaging the existing gas extraction system. Furthermore, the ground adjacent to the runway extension would not be supported on deep foundations. Therefore, the adjacent ground surface will continue to settle and periodic grading will be needed.

9.2.2. Surcharge Fill and Geofoam Backfill

This method of installing a surcharge fill to expedite the settlement process is not considered a viable option for the runway extension. The placement of a surcharge is intended to address the geotechnically-related settlement such as consolidation. As noted earlier, due to the age of the landfill, settlement from consolidation is considered to have already occurred. Increasing the load over the landfill, such as placing a surcharge fill, will increase the amount of consolidation based settlement. We anticipate that the additional consolidation settlement due to the placement of the surcharge fill would take approximately 2 years to occur after installation. However, this method does not address the settlement mechanisms associated with biodegradation or residual creep/void filling.

Furthermore, when a surcharge fill is placed, settlement monitoring is typical performed to evaluate the rate and percentage of consolidation settlement that has occurred. However, due to the other mechanisms of settlement that would occur during the same timeframe, it will be difficult or impossible to accurately measure settlement due to consolidation alone. Therefore, it would be difficult to establish when the surcharge could be removed.

9.2.3. Stone Columns and Geogrid Reinforced Fill

The use of stone columns installed through the MSW of the landfill is considered a viable option for the runway extension. The stone columns obviate the need to address the mechanisms of landfill settlement by penetrating the MSW and bearing on formational materials. Although the settlement due to biodegradation will still occur, the system of the stone columns overlain by a geogrid reinforced fill is anticipated to "bridge" over the settlements. Furthermore, the installation process is anticipated to aid in the filling of subsurface voids, lessening the amount of settlement attributable to residual creep/void filling.

Construction considerations also include difficult drilling/installation conditions due to debris, landfill gas generation during drilling/installation, the generation of MSW that will need to be disposed of, and the potential for damaging the existing gas extraction system. Also, after installation, the stone columns provide an additional pathway for oxygen to infiltrate into the MSW materials. However, as proposed with the reinforced fill extending to horizontal limits of 75 feet beyond the edge of the runway, differential settlement of the adjacent ground surface and the need for periodic grading will be lessened.

If this method is selected, grouted aggregates should be used for the stone column installation. If clean aggregates are used, the aggregate may ravel or migrate into voids created by the biodegradation process, resulting in further settlement. The use of grouted aggregates will limit the potential for the raveling of the stone column aggregates over time.

Another issue with stone column installation is the verification testing procedure. Stone column installation is typically combined with a Cone Penetration Test (CPT) program to monitor the zone of improvement obtained by stone column installation. Due to the presence of various debris within the MSW, advancement of CPTs would be difficult to perform and would likely encounter refusal. Therefore, verification testing would not be feasible.

9.2.4. Polyurethane Resin Deep Injections and Geogrid Reinforced Fill

In general concept, the idea of installing columns of expanding polyurethane thermoset resin is similar to the stone column installation. The construction materials (i.e., gravel or polyurethane resin) are injected into the subsurface at various intervals creating a column of stiffer materials within the underlying mass. The columns are created in a specified grid pattern developed for the individual project. In addition to the creation of a stiffer zone of material, the injection process also densifies the adjacent materials. A further benefit of the polyurethane resin, is that it will expand and fill in voids that will lessen the amount of settlement associated with residual creep/void filling.

The method using the expanding polyurethane thermoset resin is generally considered to be a shallow subsurface application (generally to depths of approximately 30 feet). As the depth of planned improvement for this project reaches beyond 30 feet, the installation process may not be effective. Based on Boring B-2, the depth of polyurethane resin injection would need to be approximately 60 feet. The typical material warranty for the polyurethane resin is 10 years; however, the potential for rapid oxidizing events may result in faster degradation. Further construction considerations include difficult drilling/installation conditions due to debris and the potential for damaging or clogging the existing gas extraction system. Based on the depths of the potential improvement and the typical material warranty for the polyurethane resin being 10 years, the use of this option is not considered viable.

9.2.5. Drilled Displacement Piles and Geogrid Reinforced Fill

The use of drilled displacement piles installed through the MSW of the landfill is considered a viable option for the runway extension. The displacement piles obviate the need to address the mechanisms of landfill settlement by penetrating the MSW and bearing on formational materials. Although the settlement due to biodegradation will still occur, the system of the displacement piles overlain by a geogrid reinforced fill is anticipated to “bridge” over the settlements. Furthermore, the installation process is anticipated to aid in the filling of subsurface voids, lessening the amount of settlement attributable to residual creep/void filling.

Design considerations include the effect of the potentially corrosive nature of the adjacent MSW on the grout materials for the drilled displacement piles. Construction considerations also include possible caving of drilled excavations, difficult drilling/installation conditions due to debris, landfill gas generation during drilling/installation, and the potential for damaging the existing gas extraction system. However, as proposed with the reinforced fill extending to horizontal limits of 75 feet beyond the edge of the runway, differential settlement of the adjacent ground surface and the need for periodic grading will be lessened. Although the installation process is anticipated to aid in the filling of subsurface voids, the potential for the loss of grout material into unfilled voids should be anticipated.

9.2.6. Compaction Grouting and Geogrid Reinforced Fill

In general concept, the idea of compaction grouting is similar to the installation of columns of expanding polyurethane thermoset resin. The construction materials (i.e., grout or polyurethane resin) are injected into the subsurface at various intervals creating a column of stiffer materials within the underlying mass. The columns are created in a specified grid pattern developed for the individual project. In addition to the creation of a stiffer zone of material, the injection process also densifies the adjacent materials. A further benefit of the compaction grouting, is that it will potentially fill in voids that will lessen the amount of settlement associated with residual creep/void filling.

Construction considerations for the compaction grouting include difficult drilling/installation conditions or potential to encounter refusal due to debris and the potential for damaging or clogging the existing gas extraction system. Design considerations include the effect of the potentially corrosive nature of the adjacent MSW on the grout materials.

Another issue with compaction grouting is the verification testing procedure. Compaction grouting is typically combined with a Cone Penetration Test (CPT) program to monitor the zone of improvement obtained by the compaction grouting. Due to the presence of various debris within the MSW, advancement of CPTs would be difficult to perform and would likely encounter refusal. Therefore, verification testing would not be feasible.

9.3. Retaining Walls

As previously mentioned, during extension of the runway, retaining walls will be constructed along the easterly and southern portions of the airport property to aide with proposed grade changes. Specifically, consideration is being given to the use of segmental retaining walls. Although segmental walls do possess the ability to tolerate relatively small amounts of settlements, they are not designed to tolerate the large amounts of settlement that is associated with the landfill materials.

Based on preliminary design drawings prepared by the client, we understand that the proposed eastern retaining wall may be constructed at the top of a slope underlain by landfill materials. Beyond the large amounts of settlements associated with the landfill, additional concerns include the global stability of the eastern slope and walls along with the potential for bearing failure of the wall. Therefore, stabilization of the subsurface materials beneath the reinforced zone of the segmental retaining wall would be needed to make this option viable. Due to the anticipated shallower depths of MSW at this wall location, the use of the expanding polyurethane thermoset resin is more feasible. Due to the proximity of the wall location to the slope face, the installation of stone columns may not be feasible due to the potential slope stability concerns from vibrations created during construction. As an alternative, a cast-in-place wall supported on deep foundations would be feasible.

From the preliminary drawings prepared by the client, the proposed southern retaining wall is situated in front of the southern slope for the Unit 3 landfill. Based on this location, the reinforced zone for the southern segmental retaining wall would be outside the limits of the landfill. Therefore, the usage of the segmental retaining wall for this location is considered a viable method for raising the site grades.

10. LIMITATIONS

The geotechnical study presented in this report has been conducted in general accordance with current practice and the standard of care exercised by reputable geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

11. REFERENCES

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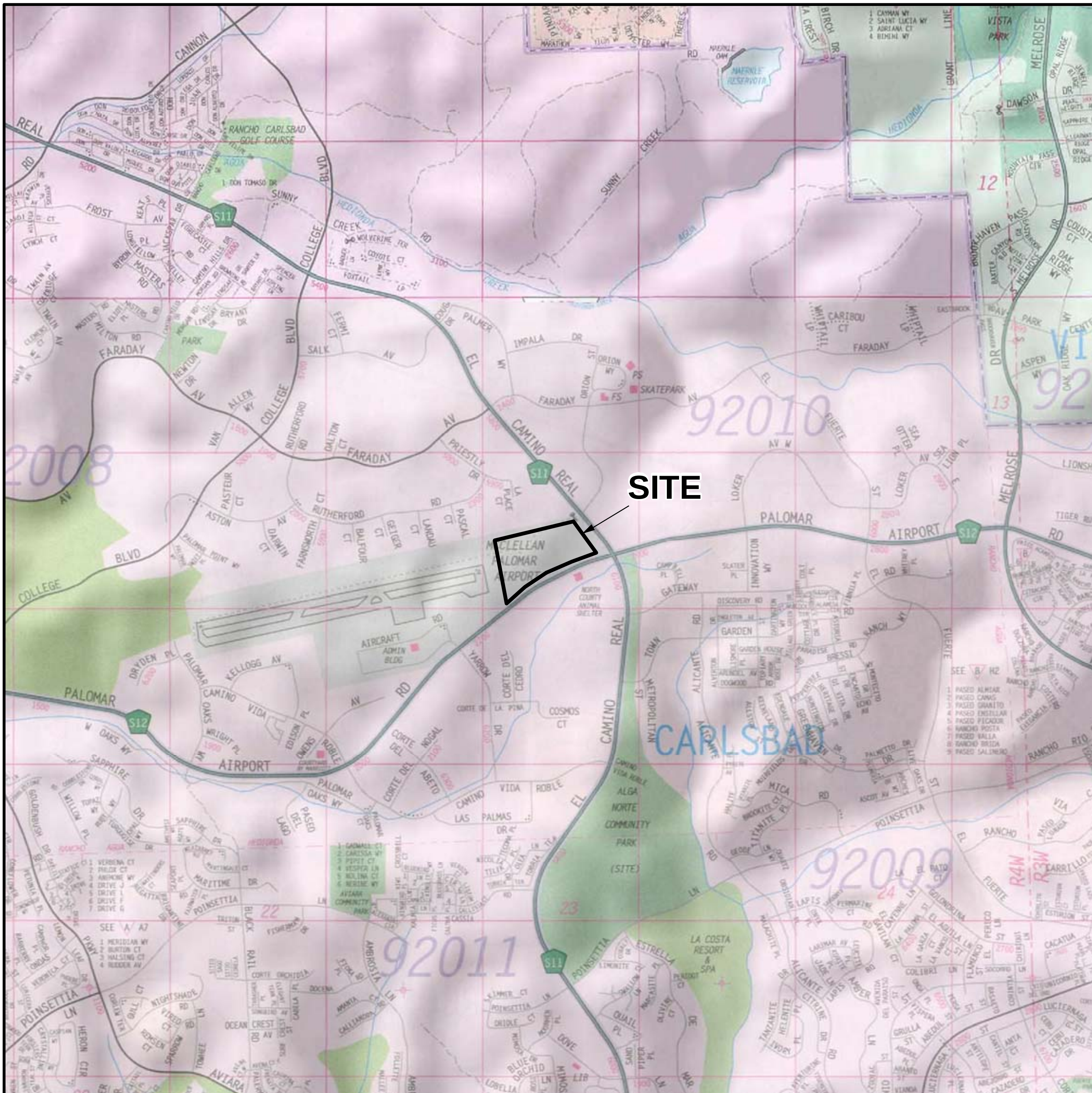
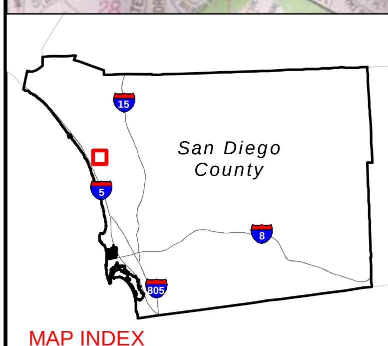
AERIAL PHOTOGRAPHS

Source	Date	Flight	Numbers	Scale
USDA	4-11-53	AXN-8M	19 & 20	1:20,000



SOURCE: 2008 THOMAS GUIDE FOR SAN DIEGO COUNTY, STREET GUIDE AND DIRECTORY; MAP © RAND MCNALLY, R.L.07-S-129



N

SCALE IN FEET

0 2,400 4,800

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

Ninyo & Moore		SITE LOCATION	FIGURE
PROJECT NO.	DATE	RUNWAY 6-24 EXTENSION McCLELLAN-PALOMAR AIRPORT CARLSBAD, CALIFORNIA	1
106541009	4/13		

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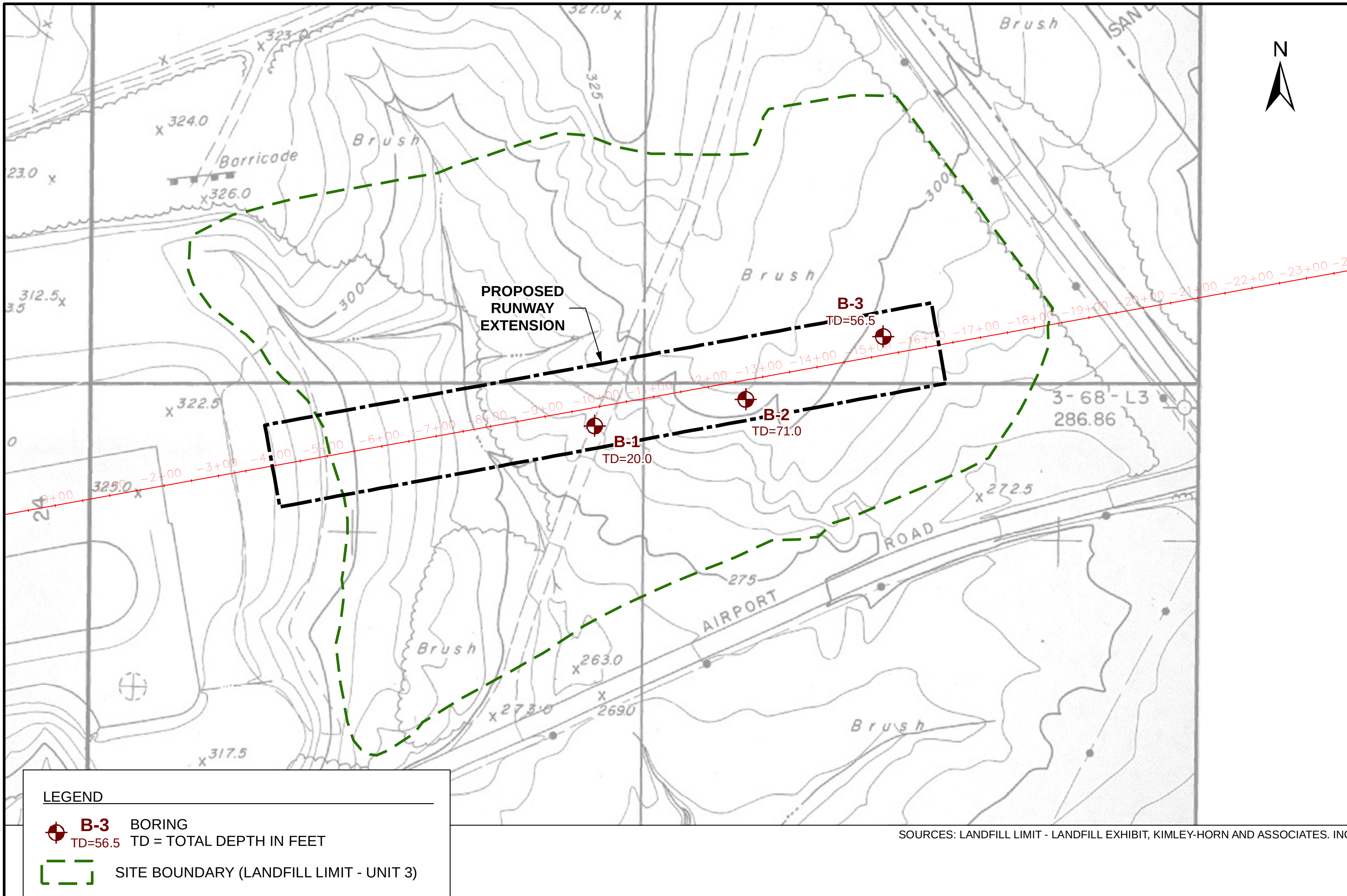

SOURCES: LANDFILL LIMIT - LANDFILL EXHIBIT, KIMLEY-HORN AND ASSOCIATES. INC.

SCALE IN FEET

0 120 240 480

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore

1963 TOPOGRAPHIC MAP

PROJECT NO.	DATE
106541009	4/13

RUNWAY 6-24 EXTENSION
McCLELLAN-PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

FIGURE
2

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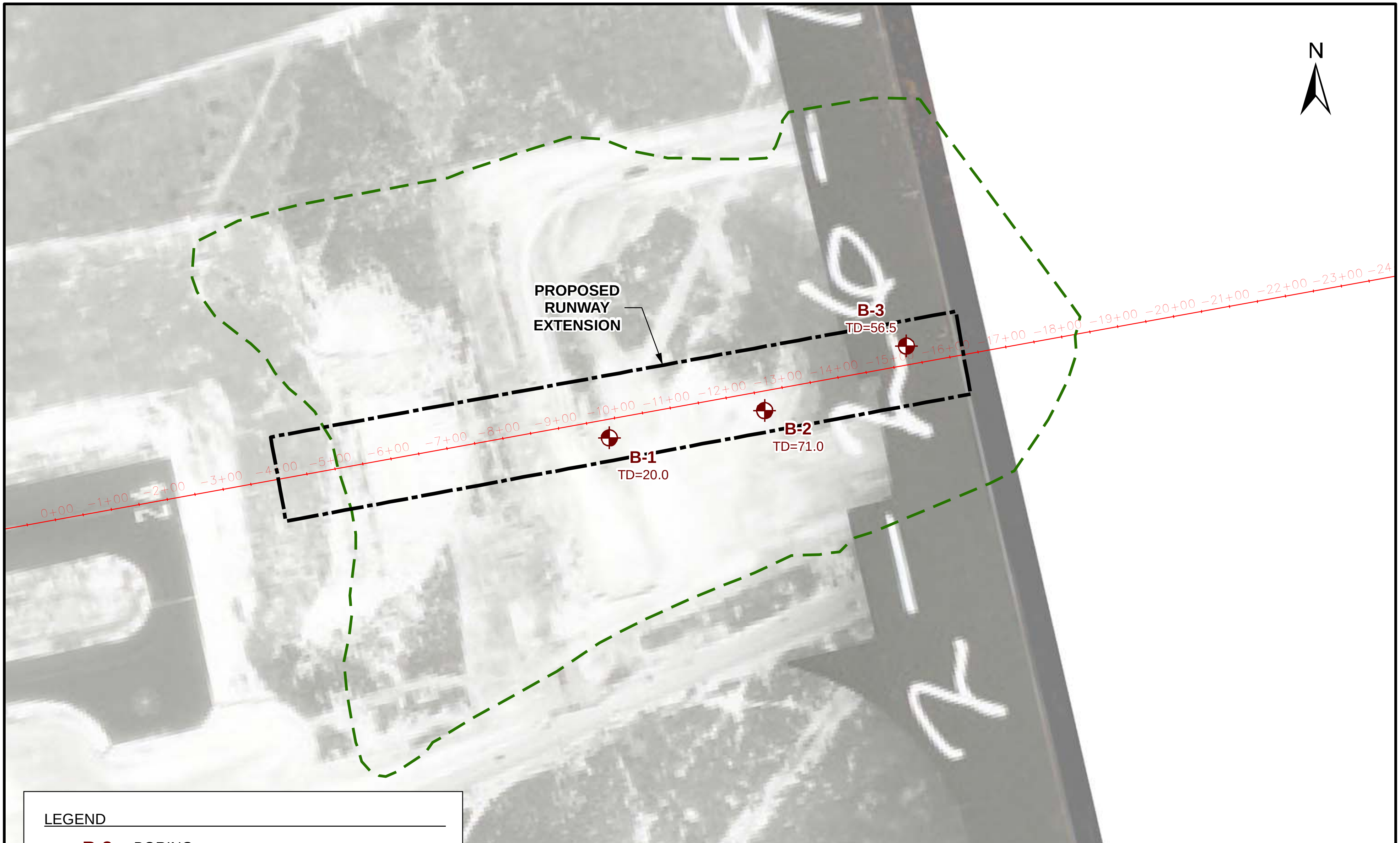

SOURCES: LANDFILL LIMIT - LANDFILL EXHIBIT, KIMLEY-HORN AND ASSOCIATES. INC.

LEGEND

B-3 TD=56.5 BORING
TD = TOTAL DEPTH IN FEET

SITE BOUNDARY (LANDFILL LIMIT - UNIT 3)

SCALE IN FEET

0 120 240 480

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore		1971 AERIAL PHOTOGRAPH	FIGURE
PROJECT NO.	DATE	RUNWAY 6-24 EXTENSION McCLELLAN-PALOMAR AIRPORT CARLSBAD, CALIFORNIA	3
106541009	4/13		

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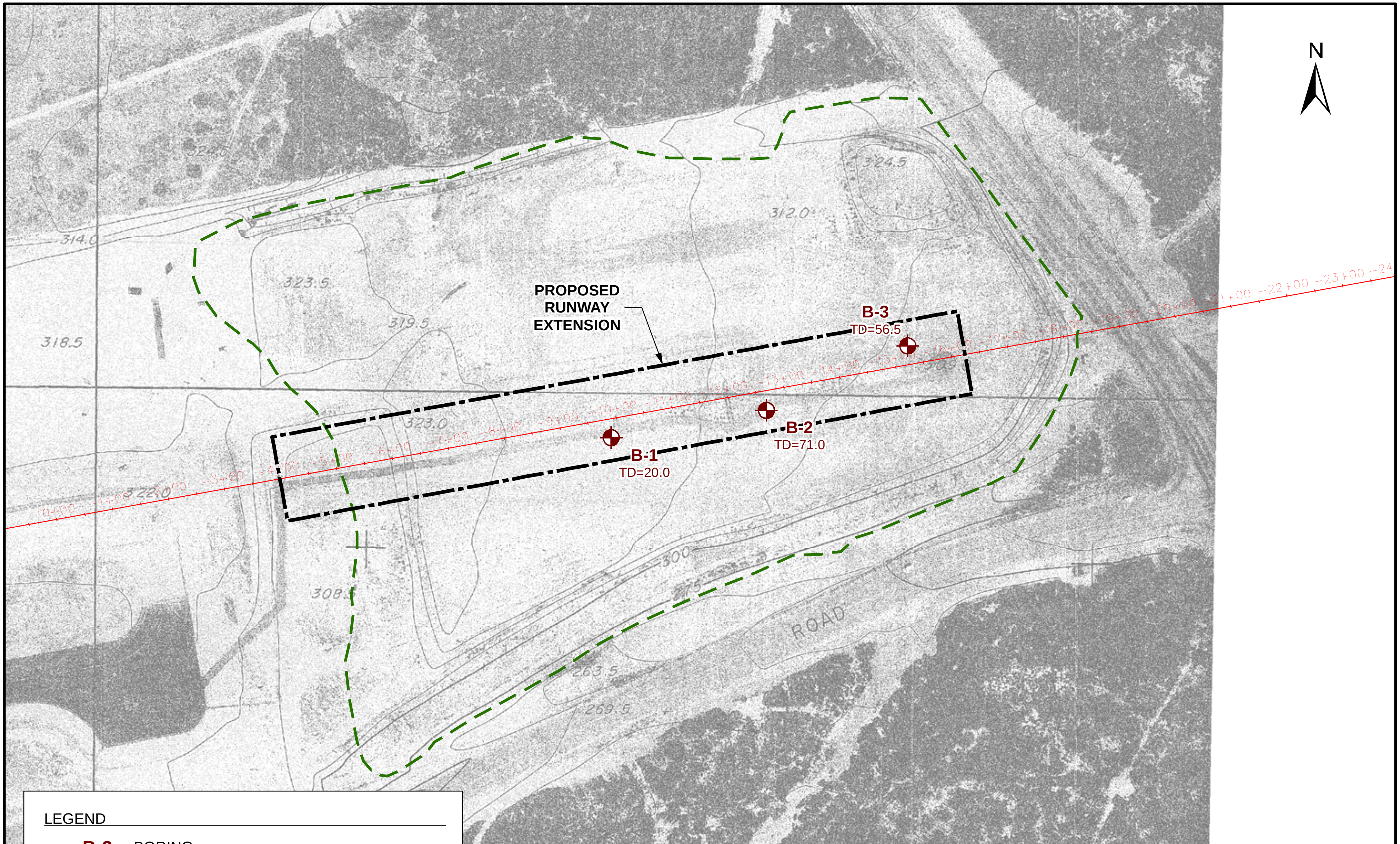

SOURCES: LANDFILL LIMIT - LANDFILL EXHIBIT, KIMLEY-HORN AND ASSOCIATES. INC.

LEGEND

B-3 TD=56.5 BORING
TD = TOTAL DEPTH IN FEET

SITE BOUNDARY (LANDFILL LIMIT - UNIT 3)

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

SCALE IN FEET

0 120 240 480

Ninyo & Moore	1975 ORTHOTOPOGRAPHIC MAP	FIGURE
PROJECT NO. / DATE	RUNWAY 6-24 EXTENSION McCLELLAN-PALOMAR AIRPORT CARLSBAD, CALIFORNIA	4
106541009 / 4/13		

4_106541009_OP_1975.mxd 11/6/2012 1:24:28 PM JDL

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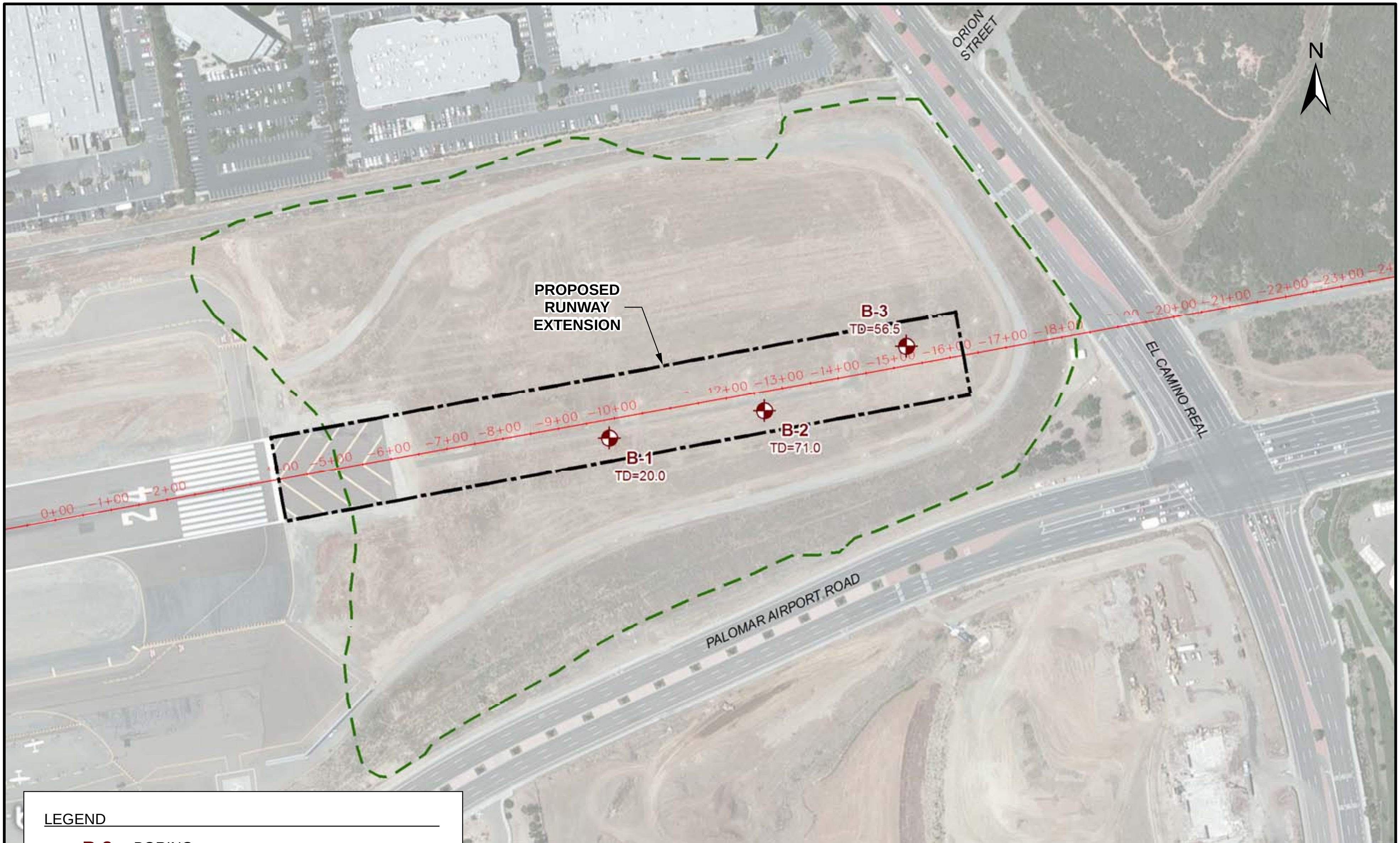

LEGEND

B-3 TD=56.5 BORING
TD = TOTAL DEPTH IN FEET

SITE BOUNDARY (LANDFILL LIMIT - UNIT 3)

SOURCES: LANDFILL LIMIT - LANDFILL EXHIBIT, KIMLEY-HORN AND ASSOCIATES. INC.;
AERIAL IMAGERY - IMAGE COURTESY OF USGS ' 2013 MICROSOFT CORPORATION

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

SCALE IN FEET

0 120 240 480

Ninyo & Moore		BORING LOCATIONS	FIGURE
PROJECT NO.	DATE	RUNWAY 6-24 EXTENSION McCLELLAN-PALOMAR AIRPORT CARLSBAD, CALIFORNIA	5
106541009	4/13		

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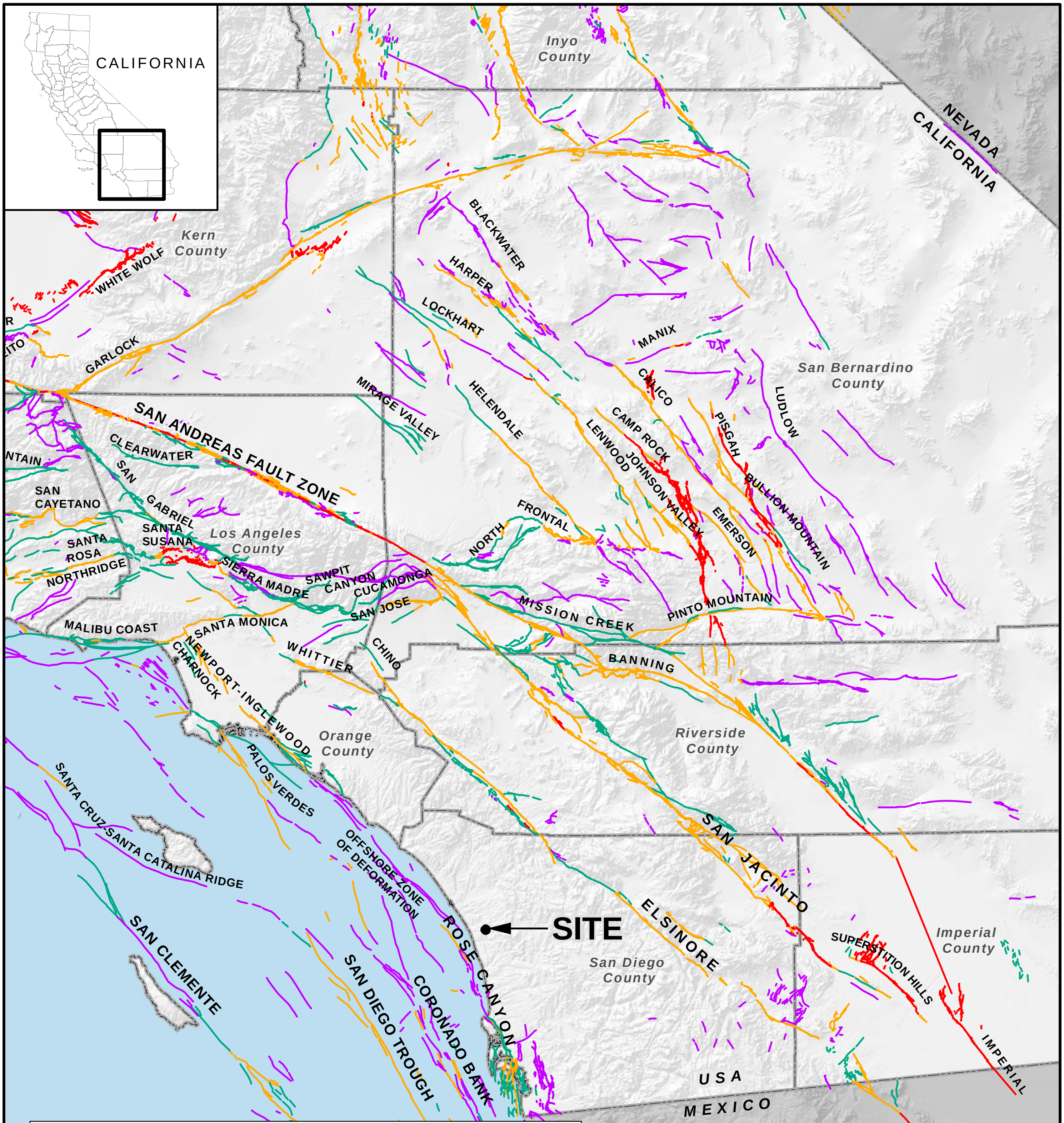

LEGEND

CALIFORNIA FAULT ACTIVITY

- HISTORICALLY ACTIVE
- HOLOCENE ACTIVE
- LATE QUATERNARY (POTENTIALLY ACTIVE)
- QUATERNARY (POTENTIALLY ACTIVE)
- STATE/COUNTY BOUNDARY

SOURCE: U.S. GEOLOGICAL SURVEY AND CALIFORNIA GEOLOGICAL SURVEY, 2006, QUATERNARY FAULT AND FOLD DATABASE FOR THE UNITED STATES.

SCALE IN MILES

0 30 60

N

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

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Ninyo & Moore		FAULT LOCATIONS	FIGURE
PROJECT NO.	DATE	RUNWAY 6-24 EXTENSION McCLELLAN-PALOMAR AIRPORT CARLSBAD, CALIFORNIA	6
106541009	4/13		

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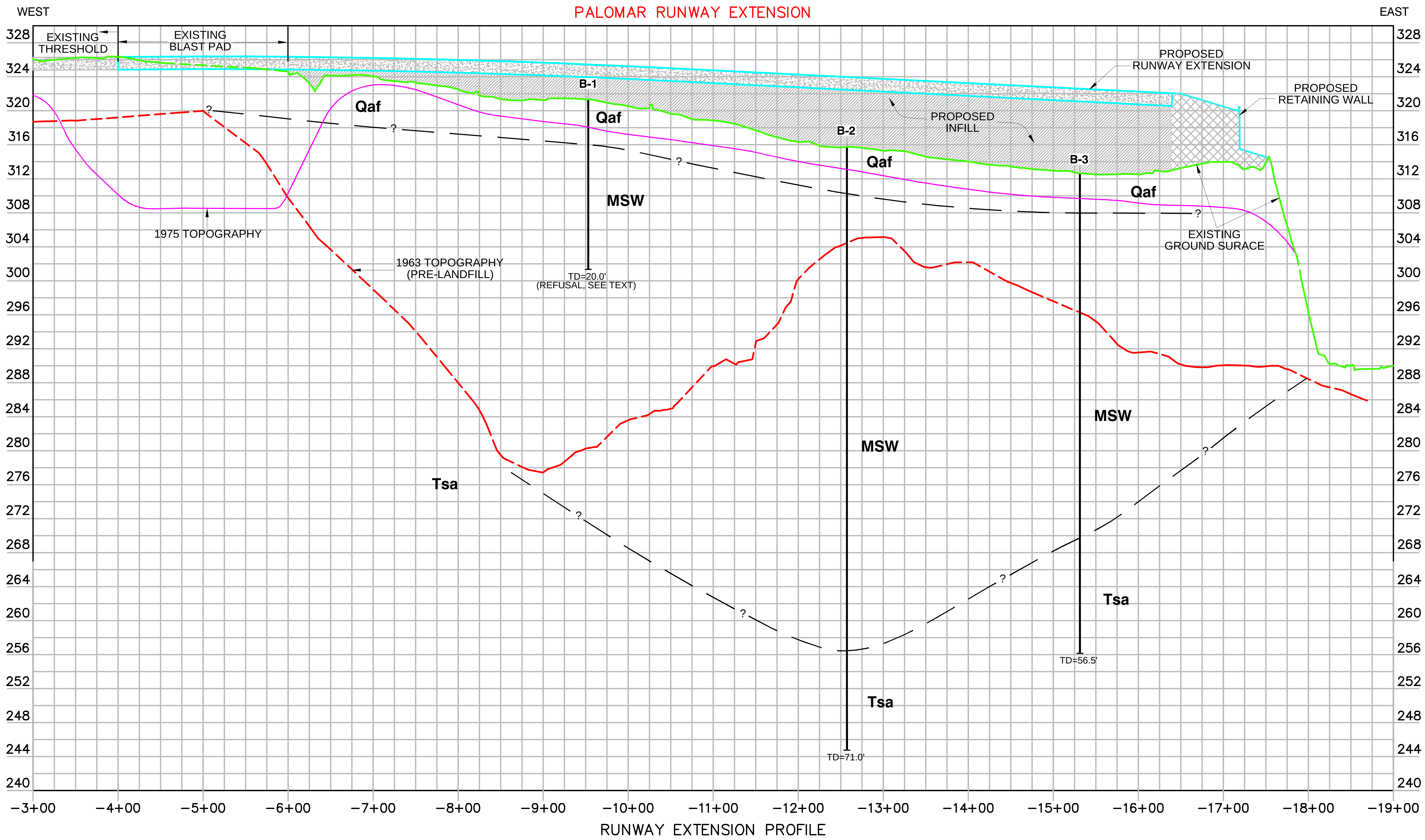

LEGEND

B-3 BORING, TD=TOTAL DEPTH IN FEET (TD=56.5')

Qaf FILL

MSW MUNICIPAL SOLID WASTE

Tsa SANTIAGO FORMATION

— ? — GEOLOGIC CONTACT, QUERIED WHERE UNCERTAIN

SCALE IN FEET: 0, 100, 200

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE

REFERENCE: KIMLEY-HORN, 2012.
COUNTY OF SAN DIEGO, 1975.
COUNTY OF SAN DIEGO, 1963.

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GEOLOGIC CROSS SECTION

RUNWAY 6-24 EXTENSION
McCELLAN-PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE
106541009	4/13

FIGURE 7

7 106541009 cs.dwg

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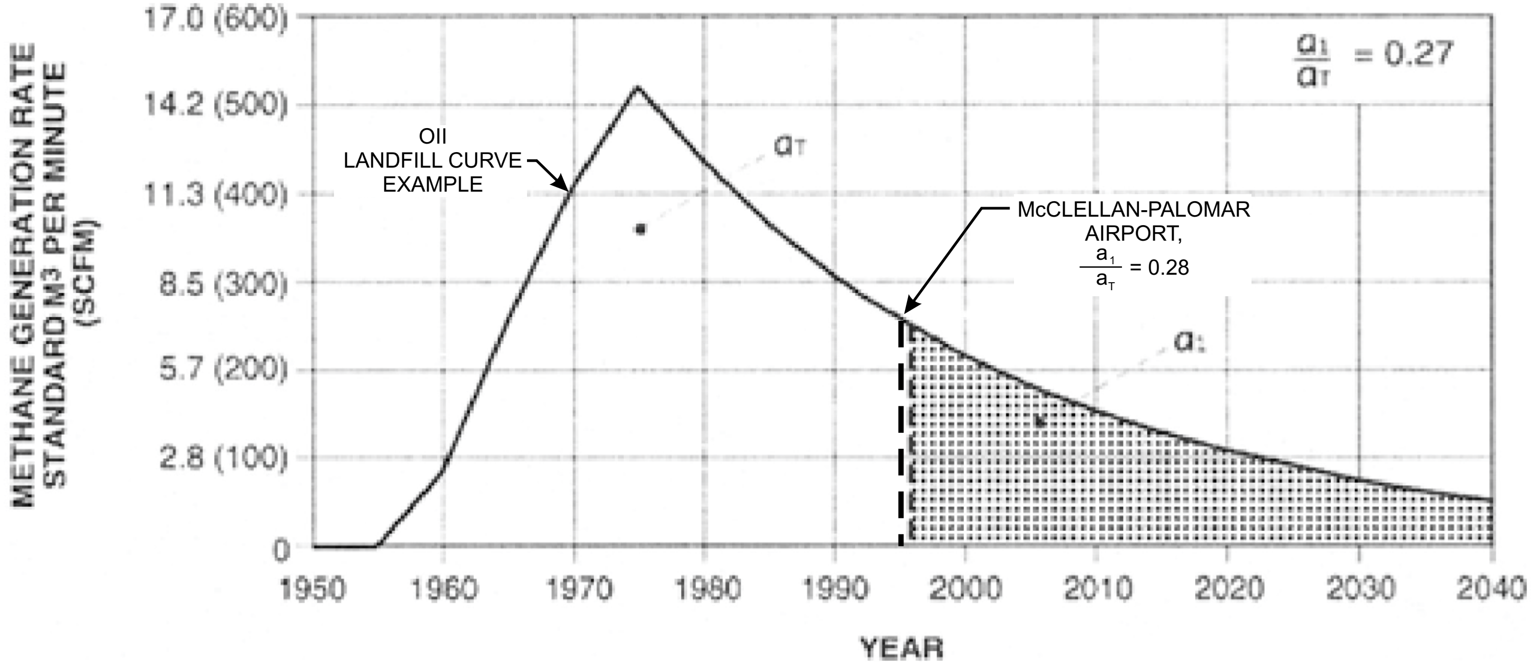

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

REFERENCE: LEONARD ET AL., 2000.

NOT TO SCALE

Ninyo & Moore

PROJECT NO.	DATE
106541009	4/13

TYPICAL LANDFILL GAS GENERATION CURVE

RUNWAY 6-24 EXTENSION
McCLELLAN-PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

FIGURE **8**

7 106541009 GGC.cdr AOB

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APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the Standard Penetration Test (SPT) Sampler. Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the Modified Split-Barrel Drive Sampler. The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a hammer of the drill rig in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel, bagged, sealed, and transported to the laboratory for testing.

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0								Bulk sample.
								Modified split-barrel drive sampler.
								No recovery with modified split-barrel drive sampler.
								Sample retained by others.
								Standard Penetration Test (SPT).
5								No recovery with a SPT.
			XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
								No recovery with Shelby tube sampler.
								Continuous Push Sample.
								Seepage.
10								Groundwater encountered during drilling.
								Groundwater measured after drilling.
							SM	ALLUVIUM: Solid line denotes unit change.
								Dashed line denotes material change.
								Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Sheared Bedding Surface
15								
20								The total depth line is a solid line that is drawn at the bottom of the boring.

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BORING LOG

EXPLANATION OF BORING LOG SYMBOLS

PROJECT NO.	DATE	FIGURE
	Rev. 01/03	

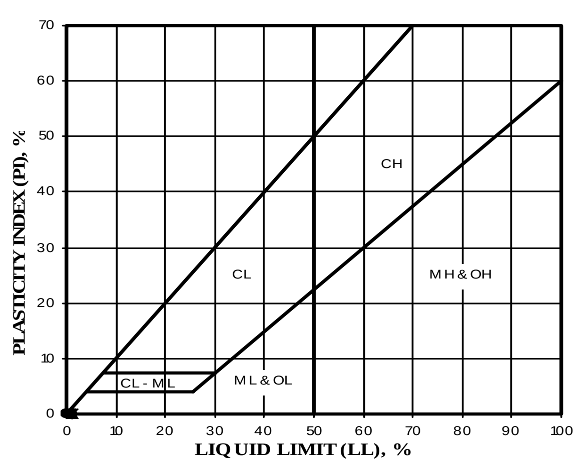
U.S.C.S. METHOD OF SOIL CLASSIFICATION

MAJOR DIVISIONS		SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (More than 1/2 of soil >No. 200 sieve size)	GRAVELS (More than 1/2 of coarse fraction > No. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction <No. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (More than 1/2 of soil <No. 200 sieve size)	SILTS & CLAYS Liquid Limit <50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean
		OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS Liquid Limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

GRAIN SIZE CHART

CLASSIFICATION	RANGE OF GRAIN SIZE	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL **Coarse** **Fine**	3" to No. 4 3" to 3/4" 3/4" to No. 4	76.2 to 4.76 76.2 to 19.1 19.1 to 4.76
SAND **Coarse** **Medium** **Fine**	No. 4 to No. 200 No. 4 to No. 10 No. 10 to No. 40 No. 40 to No. 200	4.76 to 0.075 4.76 to 2.00 2.00 to 0.420 0.420 to 0.075
SILT & CLAY	Below No. 200	Below 0.075

PLASTICITY CHART



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U.S.C.S. METHOD OF SOIL CLASSIFICATION

DATE DRILLED	10/5/12	BORING NO.	B-1	
GROUND ELEVATION	321' ± (MSL)	SHEET	1	OF 2
METHOD OF DRILLING	8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling)			
DRIVE WEIGHT	140 lbs. (Spooling Cable)	DROP	30"	
SAMPLED BY	NMM	LOGGED BY	NMM	REVIEWED BY RDH

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown, damp to moist, loose to medium dense, silty SAND; few gravel and cobbles.
							CL	Yellowish brown and gray, moist, stiff, silty CLAY.
5			12					MUNICIPAL SOLID WASTE AND FILL: Dark gray and black, moist, CLAY with municipal solid waste consisting primarily of scattered wood, paper, and plastic debris.
10			45					
15								Metal debris.
20								

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BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-1

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20								Total Depth = 20 feet. Groundwater not encountered during drilling. Backfilled with approximately 7 cubic feet of bentonite grout shortly after drilling on 10/05/12. Stop work at 20 feet due to elevated gas conditions. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
25								
30								
35								
40								

DATE DRILLED 10/5/12 BORING NO. B-1

GROUND ELEVATION 321' ± (MSL) SHEET 2 OF 2

METHOD OF DRILLING 8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling)

DRIVE WEIGHT 140 lbs. (Spooling Cable) DROP 30"

SAMPLED BY NMM LOGGED BY NMM REVIEWED BY RDH

Ninyo & Moore

BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-2

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 10/4/12 BORING NO. B-2 / GROUND ELEVATION 316' ± (MSL) SHEET 1 OF 4 / METHOD OF DRILLING 8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling) / DRIVE WEIGHT 140 lbs. (Spooling Cable) DROP 30" / SAMPLED BY NMM LOGGED BY NMM REVIEWED BY RDH / DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown to yellowish brown, damp, medium dense, silty SAND; scattered gravel and cobbles.
								Moist; scattered vegetative debris (grass).
							CL	Yellowish brown to grayish brown, moist, very stiff, silty CLAY; scattered plastic debris.
5		■	30					
								MUNICIPAL SOLID WASTE AND FILL: Black, moist, clay with municipal solid waste consisting primarily of wood, plastic, and rubber debris.
10		■	44					
15		■	50/6"					
20								

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BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-3

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.

DATE DRILLED 10/4/12 BORING NO. B-2

GROUND ELEVATION 316' ± (MSL) SHEET 2 OF 4

METHOD OF DRILLING 8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling)

DRIVE WEIGHT 140 lbs. (Spooling Cable) DROP 30"

SAMPLED BY NMM LOGGED BY NMM REVIEWED BY RDH

DESCRIPTION/INTERPRETATION

Depth (feet)	Blows/Foot	Description/Interpretation
20	40	MUNICIPAL SOLID WASTE AND FILL: (Continued) Gray, moist, brown and black, sand and silt with municipal solid waste consisting primarily of wood, plastic, and wire debris.
25	33	Dark gray; yellowish brown; light gray; silty clay with plastic debris.
30	50/6"	Dark gray sand with paper and twine.
35	50/6"	
40		

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BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-4

DATE DRILLED	10/4/12	BORING NO.	B-2	
GROUND ELEVATION	316' ± (MSL)	SHEET	3	OF 4
METHOD OF DRILLING	8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling)			
DRIVE WEIGHT	140 lbs. (Spooling Cable)	DROP	30"	
SAMPLED BY	NMM	LOGGED BY NMM	REVIEWED BY	RDH

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		X	50/6"					MUNICIPAL SOLID WASTE AND FILL: (Continued) Dark gray and brown, moist, clay and sand with municipal solid waste consisting primarily of scattered vegetative debris (wood, grass).
45		■	50/2"					
								Metal debris.
								Child's shoe.
50		■	50/3"					
								Wood, metal, and plastic debris.
55		■	50/6"					Wet.
								SANTIAGO FORMATION: Gray to dark gray, moist, moderately indurated silty CLAYSTONE.
60								

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BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-5

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
60		■	50/6"				SC	SANTIAGO FORMATION: (Continued) Gray to dark gray, moist, moderately to strongly indurated silty CLAYSTONE.
65		■	50/6"	14.9	91.9			Gray, moist, moderately to strongly cemented, fine to medium grained SANDSTONE.
								Bluish gray, moist, moderately to strongly indurated, clayey SILTSTONE; trace sand.
70		■	50/6"					
								Total Depth = 71 feet. Groundwater not encountered during drilling. Backfilled with approximately 25 cubic feet of bentonite grout shortly after drilling on 10/04/12. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
75								
80								

DATE DRILLED 10/4/12 BORING NO. B-2

GROUND ELEVATION 316' ± (MSL) SHEET 4 OF 4

METHOD OF DRILLING 8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling)

DRIVE WEIGHT 140 lbs. (Spooling Cable) DROP 30"

SAMPLED BY NMM LOGGED BY NMM REVIEWED BY RDH

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BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-6

DATE DRILLED	10/5/12	BORING NO.	B-3
GROUND ELEVATION	313' ± (MSL)	SHEET	1 OF 3
METHOD OF DRILLING	8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling)		
DRIVE WEIGHT	140 lbs. (Spooling Cable)	DROP	30"
SAMPLED BY	NMM	LOGGED BY	NMM
REVIEWED BY	RDH		

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SC	FILL: Yellowish brown, damp to moist, very loose to loose, clayey SAND.
							CL	Yellowish brown to brown, moist, stiff, silty CLAY.
5		■	18					MUNICIPAL SOLID WASTE AND FILL: Brown, moist, sand and clay with municipal solid waste consisting primarily of scattered wood, paper, metal, and styrofoam debris.
10		■	30					Dark gray sand and clay with scattered glass and rubber.
15								
20								

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BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-7

DATE DRILLED 10/5/12 BORING NO. B-3

GROUND ELEVATION 313' ± (MSL) SHEET 2 OF 3

METHOD OF DRILLING 8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling)

DRIVE WEIGHT 140 lbs. (Spooling Cable) DROP 30"

SAMPLED BY NMM LOGGED BY NMM REVIEWED BY RDH

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		■	50					MUNICIPAL SOLID WASTE AND FILL: (Continued) Brown and black, moist, clay with municipal solid waste consisting of primarily scattered wood, plastic, paper, and glass debris.
25		■	50/3"					Roots.
30								
35		■	55					Newspaper and glass debris.
40								

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BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-8

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40								MUNICIPAL SOLID WASTE AND FILL: (Continued) Gray to black, moist, clay with municipal solid waste consisting primarily of scattered wood, paper, and metal debris.
								SANTIAGO FORMATION: Grayish brown and yellowish brown, moist, moderately to strongly indurated, silty and sandy CLAYSTONE; few carbonates; iron staining.
45			50/6"					
50								
55			50/2"					Strongly indurated; few concretions.
			50/6"	14.4				
								Total Depth = 56.5 feet. Groundwater not encountered during drilling. Backfilled with approximately 20 cubic feet of bentonite grout shortly after drilling on 10/05/12.
								Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
60								

DATE DRILLED 10/5/12 BORING NO. B-3

GROUND ELEVATION 313' ± (MSL) SHEET 3 OF 3

METHOD OF DRILLING 8" Diameter Hollow-Stem Auger (CME-75) (Cascade Drilling)

DRIVE WEIGHT 140 lbs. (Spooling Cable) DROP 30"

SAMPLED BY NMM LOGGED BY NMM REVIEWED BY RDH

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BORING LOG

RUNWAY 6-24 EXTENSION, MCCLELLAN PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

PROJECT NO.	DATE	FIGURE
106541009	4/13	A-9

APPENDIX B

GEOTECHNICAL LABORATORY TESTING

Classification

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Density Tests

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D 2937. The test results are presented on the logs of the exploratory borings in Appendix A.

Gradation Analysis

A gradation analysis test was performed on a selected representative sample in general accordance with ASTM D 422. The grain-size distribution curve is shown on Figure B-1. The test results were utilized in evaluating the equivalent soil classification in accordance with USCS.

Direct Shear Tests

A direct shear test was performed on a relatively undisturbed sample in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of the selected material. The sample was inundated during shearing to represent adverse field conditions. The results are shown on Figure B-2.

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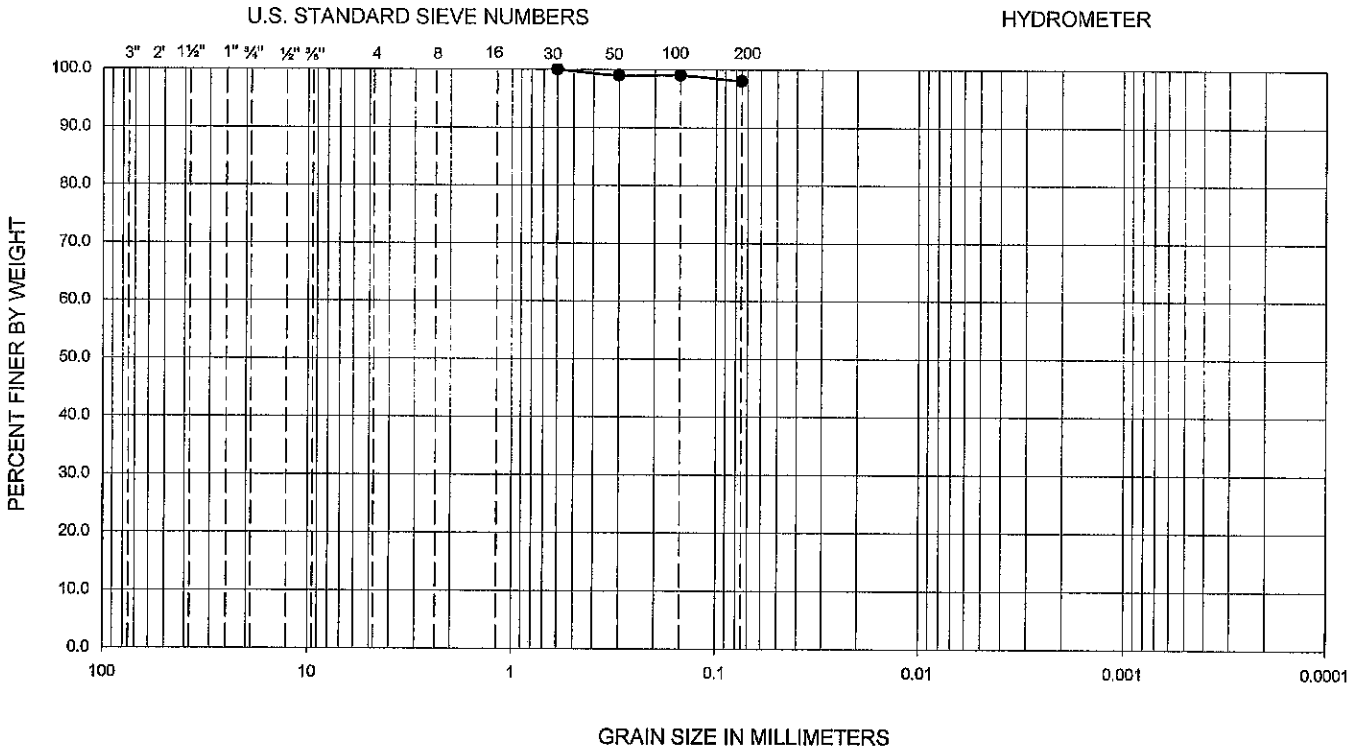
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

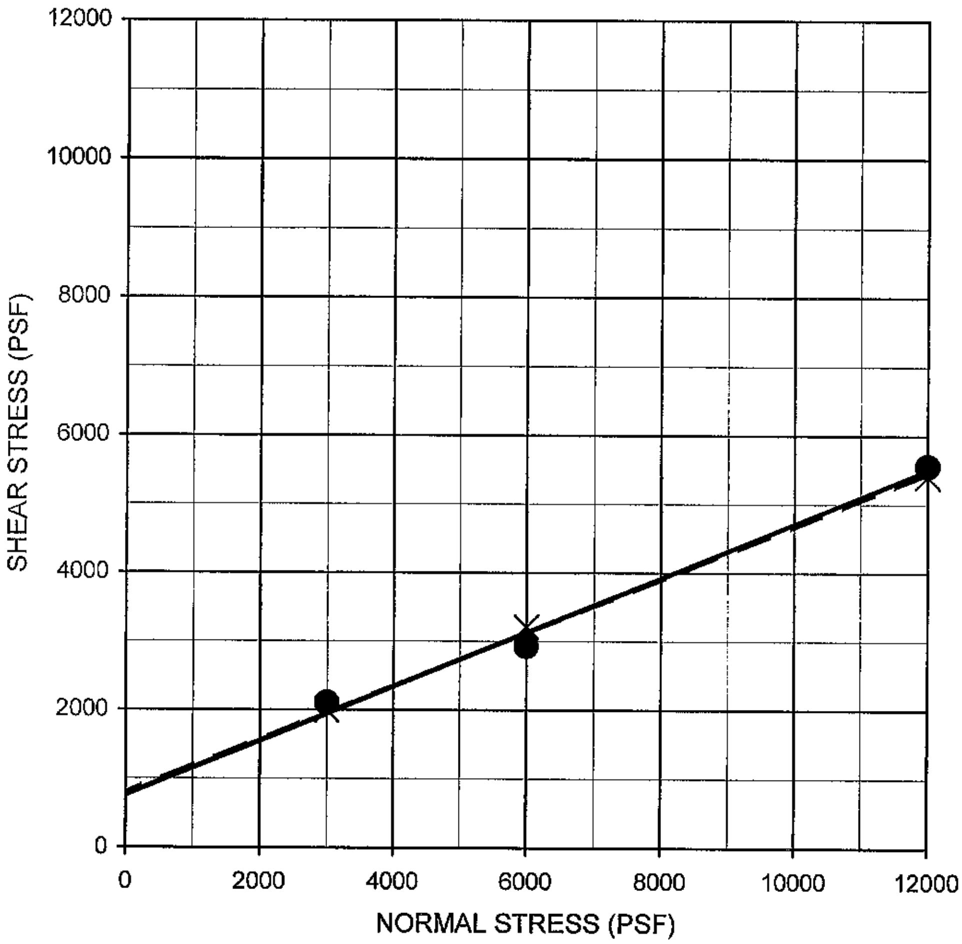


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	Equivalent USCS
●	B-2	60.0-60.5	--	--	--	--	--	--	--	--	98	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore		GRADATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	RUNWAY 6-24 EXTENSION MCCLELLAN-PALOMAR AIRPORT CARLSBAD, CALIFORNIA	B-1
106541009	4/13		

106541009_SIEVE B-2 @ 60.0-60.5.xls



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Sandy SILTSTONE	——●——	B-2	70.0-71.0	Peak	790	21	Formation
Sandy SILTSTONE	- - X - -	B-2	70.0-71.0	Ultimate	790	21	Formation

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

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DIRECT SHEAR TEST RESULTS

PROJECT NO.	DATE
106541009	4/13

RUNWAY 6-24 EXTENSION
MCCLELLAN-PALOMAR AIRPORT
CARLSBAD, CALIFORNIA

FIGURE
B-2

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