

## EXECUTIVE SUMMARY

This report has been prepared by LSA Associates, Inc. (LSA) for Citation Homes Central (Citation) of Santa Clara, California. This report presents the Year 3 monitoring results for Citation's "Heron Bay" residential development at Roberts Landing in San Leandro, California. This report is based on the *Final Roberts Landing Mitigation and Monitoring Plan* (hereinafter referred to as the MMP) prepared by Resource Management International, Inc. (RMI 1995).

This report documents the monitoring results for the mitigation project. Results for Year 3 are compared to Year 1, Year 2, baseline data collected prior to mitigation activities, and to the performance criteria, as outlined in the MMP. This report is in compliance with the conditions of Permit No. 19548E48 issued by the San Francisco District of the Army Corps of Engineers on July 14, 1995.

Construction for the mitigation at Roberts Landing began on August 31, 1995 with implementation of the contaminant cleanup and well closure activities required under Corps Permit Special Condition 1, and as directed by the Executive Officer of the San Francisco Bay Regional Water Quality Control Board. Major mitigation construction activities (completion of the tide gate and bridge structure on Roberts Landing Slough, removal of dikes and fill in the Bluebird restoration area, and channel excavation) was completed on July 30, 1997 and tidal action was reintroduced into the site on July 31, 1997. After an initial trial period, the tide gates were closed and some remedial grading, disking of compacted soils, and additional channel excavation to increase circulation in some areas was conducted. This work was completed in September through December 1987. The tide gates were re-opened in mid-December 1997. The site is currently operated with all four Roberts Landing Slough tide gates in fully opened positions.

The Year 3 results indicate that the enhanced and restored marsh areas are generally meeting or exceeding the performance criteria and are demonstrating positive trends towards meeting the mitigation goals outlined in the Plan (RMI 1995). The following summarizes the monitoring results relative to the performance criteria:

- **Tidal Elevations** - Target inundation periods have been achieved within all areas of the restored and enhanced marsh.
- **Channel Stability** - Excavated tidal channels are evolving as predicted, developing hybrid cross-sections. Sediment accumulation in the channels is not impeding flow. The outflow gate at Estudillo Canal was closed due to vandalism, and likely caused some significant sediment accumulation in the upper reaches. The sediment levels will reach an equilibrium now that the gate has been opened.
- **Marsh Wetland Vegetative Cover** - Relative cover by wetland plant species in the restored marsh is 100 percent of the reference areas, exceeding the performance criterion. Sixty-three percent of the species present in the restored marsh are native marsh species, which is less than the Year Three 70 percent performance criterion.

- **Community Similarity** - The marsh restoration areas have a community similarity value of 0.91 in relation to the reference area. This exceeds the Year 3 performance criterion.
- **Upland Vegetation Cover** - The upland areas have 99 percent absolute vegetative cover, with less than 5 percent invasive exotic species. These values exceed the Year 3 performance criteria.
- **Total Plant Cover** - The rate of increase in total plant cover within the restored marsh met the Year 3 performance criteria, including those areas where panne ponds have developed. The development of panne ponds is an unexpected but beneficial feature for marsh fauna. Excluding the panne pond areas, the total plant cover increased to 59 percent. Fifty-six percent of the species present are native. Within the enhanced marsh, the transitional grassland areas have increased in cover by wetland species, as expected, with 68 percent native plant cover. Along interior tidal channels, the total cover by plant species initially decreased in response to improved tidal inundation, however this trend is gradually reversing with increased sedimentation along these transects. The total plant cover along the channels is 66 percent.
- **Productivity** - Above-ground phytomass has increased 56 percent in the restored marsh over the past year. If this trend continues, it will exceed the expected rate of increase. After the initial decrease in the above-ground phytomass along the channel margins, the biomass appears to have stabilized, and slowly increased in total cover. This is expected to continue to increase in Years 4 and 5, as the interior channels evolve in response to the tidal regime.
- **Annual Grass Cover** - The annual grass cover in the restored marsh decreased to less than 1 percent. In the enhanced marsh, the annual grass cover declined from 58 percent at pre-restoration conditions, to 6 percent in Year 3. Both results are consistent with performance criteria.
- **Soil Organic Matter** - As expected, there has been a marginal upward trend in soil organic matter in the restored marsh.
- **Bird Populations** - In Year 3, the bird species richness, density and habitat use indexes are becoming more similar to the enhanced marshes, as anticipated under the performance criteria.
- **Salt Marsh Harvest Mouse Population** - Trapping conducted in Year 3 found salt marsh harvest mouse distributed throughout the enhancement marsh areas. This species is expected to occur in the restored marsh once the habitat has matured. Additional trapping will be conducted in Year 5.

Based on the analysis of Year 3 monitoring results, the following adjustments to the monitoring plan will be implemented:

#### **Operational and Maintenance Changes:**

- The City should conduct increased debris removal frequency (monthly) at the Estudillo Canal and Roberts Landing Slough tide gates by the City of San Leandro.
- Increased inspections and maintenance of the Estudillo Canal tide gate should be conducted due to possible ground subsidence and slumping behind the structure, and blockage of the

flap gates due to vandalism. The City of San Leandro is responsible for maintaining this structure.

- Barnacle accumulations should be annually removed from both tide gate structures to keep these structures functioning as designed. This maintenance action is performed by the City of San Leandro.
- The four tide gates of the bridge gate structure should continue to remain opened all the time.
- Yearly removal (mowing) of invasive exotic species should be conducted in the buffer areas. The City of San Leandro is responsible for the maintenance activities in the buffer areas.
- Public access control measures should continue to be implemented to discourage unauthorized public intrusions into the marsh area. In particular, those measures that restrict access to the sensitive marsh areas by dogs should be employed. The locked gate installed across the main levee should be maintained.
- Control of feral predators (cats, fox) should be initiated.

**Monitoring Changes:**

- The hydrology monitoring was adjusted to include two representative tidal cycles to provide additional verification of the tidal elevation results. This should continue through the duration of the monitoring period.
- Three of the six vegetation transects installed in the restored Bluebird Marsh occur within panne ponds. This improperly skewed vegetation data in these areas. To adjust for this, two additional 50M transects were placed within the non-panne areas of Bluebird during Year 3. These transects should be monitored in Years 4 and 5.

## 4.0 MONITORING RESULTS AND ANALYSIS

### 4.1 YEAR THREE MONITORING RESULTS

This section summarizes monitoring results recorded for Year 3 (2000), and analyzes the results with respect to the corresponding MMP performance criteria (Table B). Baseline data collected in 1996/1997 and previous years data collected in Year 1 (1998) and Year 2 (1999) are also shown where appropriate.

#### 4.1.1 Performance Criterion: Total Plant Cover

The MMP envisions a fair degree of variability in the rate of increase in total plant cover from year to year. However, within the restored and enhanced salt marsh habitats, natural recruitment is expected to gradually increase in cover over the period of monitoring. Total plant cover values are expected to be driven mainly by pickleweed colonization and expansion; however, other component species will also play a role. Within the salt marsh enhancement areas, increases in cover are expected to be more gradual as pickleweed starts to colonize areas of annual grasses and perhaps grow more vigorously within existing stands. The specific performance criteria and monitoring results for total plant cover are described below:

**Salt Marsh Restoration Area:** A minimum 10 percent increase in total cover by native salt marsh species (e.g., pickleweed) should occur for at least three consecutive years.

**Year 3 Monitoring Results** - As shown in Table C, total cover by native marsh species within the restored marsh (i.e., "Bluebird Marsh") increased between Year 1 (1998) and Year 3 (2000).

Table C - Mean Percent Total Cover by Native Salt Marsh Species Salt Marsh Restoration Area			
Baseline - 1996	Year 1 - 1998	Year 2 - 1999	Year 3 - 2000
0%	14.8% $s_x = 2.7$ n = 30	18.7% $s_x = 4.7$ n = 30	30.3% $s_x = 6.2$ n = 30

$s_x$  = Standard Error

Following completion of restoration grading in 1996, the Bluebird Marsh site consisted of bare, moderately dry to moist soils that were rapidly colonized by ruderal upland and facultative species (e.g., *Polypogon*, *Medicago*, *Lolium*). These ruderal species persisted until the completion of the tide gate and re-introduction of tidal flow to the site in August 1997. Following the introduction of tidal flow, a significant shift from ruderal to wetland species occurred. This is reflected in the summarized raw data (Table D and Appendix B) which shows a general decline in cover by facultative species accompanied by a significant increase in salt marsh species cover in Year 3 (2000).

The increase in cover by native salt marsh species between Year 0 and Year 3 (1997- 2000) was approximately 30 percent which meets the performance criterion of 10 percent per annum.

This result is somewhat deceptive due to an anomaly caused by the locations of vegetation transects and the type of wetland habitat that is developing. As seen in the photographs (Appendix A) and the infra-red aerial photograph (Figure 18), the Bluebird Marsh is developing into a heterogeneous mosaic of salt marsh vegetation, 1st-3rd order tidal channels, and panne ponds (*i.e.*, "salt pannes") that is evocative of the structure of natural tidal marsh systems in San Francisco Bay (Joselyn 1983). Panne ponds are desirable natural features that provide small zones of open water where invertebrates become concentrated, providing excellent feeding and foraging habitat for water birds. Bird monitoring of the mitigation area documents that the new panne ponds have become major bird attractants.

Based on the past three years of observations and the infra-red aerial photograph, developing panne ponds may ultimately encompass 20-25 percent of the Bluebird Marsh. Vegetation transects were placed randomly in the Bluebird Marsh, prior to the introduction of tidal waters. By pure chance, three of the six 50M transect segments (TB3, TB4, TB5) occur within developing panne ponds, skewing vegetation data toward deceptively low cover values, and causing an inordinate degree of data heterogeneity, as reflected in the standard errors (Table C).

When the three pond segments are excluded, the actual cover data exceeds the 10 percent annual increase as shown in Table E.

Table E - Mean Percent Total Cover by Native Salt Marsh Species Salt Marsh Restoration Area, Excluding Panne Ponds			
Baseline - 1996	Year 1 - 1998	Year 2 - 1999	Year 3 - 2000
0	25.6% $s_x = 7.3$ n = 15	35.3% $s_x = 7.2$ n = 15	55.7% $s_x = 7.2$ n = 15

It is not known if some or all of the existing panne ponds will persist or will gradually become colonized by pickleweed. Therefore, we propose to maintain the existing vegetation transects in their current locations, but we will add two additional 50M transects within the non-panne areas of Bluebird. These new transects will be monitored in 2001 (Year 4).

**Salt Marsh Enhancement Areas:** The performance criterion for the marsh enhancement areas is that an upward trend in total cover by salt marsh natives should occur over a 5-year monitoring period (Table F).

Transitional Grasslands				Channel Edges			
Baseline 1996	Year 1 1998	Year 2 1999	Year 3 2000	Baseline 1996	Year 1 1998	Year 2 1999	Year 3 2000
19.4	53.0	45.8	67.5	91.3	64.0	53.8	66.2
$s_x = 5.6$	$s_x = 5.6$	$s_x = 4.1$	$s_x = 5.8$	$s_x = 1.6$	$s_x = 6.6$	$s_x = 6.8$	$s_x = 6.6$
$n = 30$	$n = 30$	$n = 30$	$n = 30$	$n = 30$	$n = 30$	$n = 30$	$n = 30$

Within the transitional grassland (*i.e.*, seasonal wetland) areas, a significant increase (from approximately 19.4 percent to 67.5 percent) in salt marsh vegetation occurred following the introduction of tidal waters. This strong shift in vegetation cover is likely related to two causes, as follows:

1. Transitional grasslands already contained a small component of salt marsh species (e.g., salt grass, marsh rosemary) that were probably able to rapidly exploit the wetter conditions following tidal introduction.
2. The transitional grasslands are all located near pickleweed stands, which would have provided a ready sources of colonization by seeds and by sloughed-off pickleweed vegetative parts (a common additional source of pickleweed regeneration).

The decrease in marsh species cover in the second year is considered insignificant, in light of the Year 3 increase indicating an overall upward trend in marsh vegetation cover.

Along the channel edges, native salt marsh cover consists entirely of pickleweed. We originally expected a fairly pronounced increase in pickleweed cover along the channel edges because they would receive the greatest immediate benefits from tidal introduction. However, pickleweed cover along the channel edges decreased from approximately 97 percent (under pre-project conditions) to approximately 54 percent by Year 2. This reduction was due to the fact that the vigor of the pickleweed stands growing along the channels was adversely affected by the increased tidal influence. The channel edges tend to be lower in elevation, and remained inundated for longer periods of time following tidal introduction<sup>1</sup>. This resulted in increased die-off of the picklweed.

Year 3 (2000) results indicate that the vigor and total cover by pickleweed is increasing along these transects. With increased sedimentation over time, the vigor of the picklweed is expected to continue to improve. Monitoring over the next few years will determine if this criteria will be met, and if the pickleweed will grow vigorously, as found during pre-restoration monitoring.<sup>2</sup> Photos in Appendix A illustrate the pickleweed community along the channels.

<sup>1</sup> Tidal channels were purposely routed through lower-lying areas for better drainage.

<sup>2</sup> Preliminary results from Year 4 indicate that this is indeed occurring.

## 4.2 SUMMARY OF COMPLIANCE WITH YEAR THREE PERFORMANCE CRITERIA

Table P provides a summary of the compliance with the Year 3 performance criteria. Year 3 results indicate that the enhanced and restored marsh areas generally meet or exceed the performance criteria and are demonstrating positive trends toward meeting the mitigation goals outlined in the MMP. The following summarizes the monitoring results relative to the performance criteria:

- **Tidal Elevations** - Target inundation periods have been achieved within all areas of the restored and enhanced marsh.
- **Channel Stability** - Excavated tidal channels are evolving as predicted, developing hybrid cross-sections.
- **Marsh Wetland Vegetative Cover** - Relative cover by wetland plant species in the restored marsh is 100% of the reference areas, exceeding the performance criterion. The native component of the restored marsh is 63%, which is less than the Year 3 performance criterion of 70%. However, the native component is expected to increase significantly in Years 4-5.
- **Community Similarity** - The marsh restoration areas have a community similarity value of 0.91 in relation to the reference area. This exceeds the Year 3 performance criterion.
- **Upland Vegetation Cover** - The upland areas have 99% absolute vegetative cover, with less than 5% invasive exotic species. These values exceed the Year 3 performance criteria.
- **Total Plant Cover** - The rate of increase in total plant cover within the restored marsh met the Year 3 performance criteria. The total cover by native salt marsh species is 30%. Within the enhanced marsh, the transitional grassland areas have increased in cover by wetland species, as expected. Along interior tidal channels, the total cover by plant species decreased in response to improved tidal inundation. However, this trend is expected to gradually reverse with increased sedimentation.
- **Productivity** - Above-ground phytomass has increased 56% in the restored marsh. This exceeds the expected rate of increase. There was a decrease in the above-ground phytomass along the channel margins, however, this is expected to increase as the interior channels evolve in response to the new tidal regime.
- **Annual Grass Cover** - The annual grass cover in the restored marsh decreased to less than 1%. In the enhanced marsh, the annual grass cover declined from 58% at pre-restoration conditions, to less than 6% in Year 3. Both results are consistent with performance criteria.
- **Soil Organic Matter** - Initially there was an upward increase in soil organic matter in the restored marsh. Since then, the percent organic matter in the restored marsh soil has decreased slightly. It appears that the soil organic matter may have stabilized, or reached an equilibrium. As vegetation continues to colonize this area, the amount of organic matter in the soils may increase over time.
- **Faunal Populations** - The values for bird species richness, density and habitat use indexes in the restored marsh are becoming more similar to the enhanced marsh, as anticipated under the performance criteria.
- **Salt Marsh Harvest Mouse Population** - Salt marsh harvest mouse was found throughout the enhancement marsh areas in Year 3. Seventeen were captured in the enhanced marsh

areas, however this species was absent from the restored marsh (Bluebird). Use of the restored marsh by this species is expected by Year 5.

- ***Benthic Invertebrates*** - Consistent with performance criteria, a macro-invertebrate community characteristic of San Francisco Bay has become established throughout the restored and enhanced marsh.



Table P - Summary of Monitoring Results with Reference to Performance Criteria

Parameter	Year 3 Performance Criteria	Year 3 Results
Tidal Elevations (marsh restoration and enhancement areas)	Tidal prisms at least 85% of values predicted by modeled hydrological analysis height duration curves (average monthly inundation period of 5-18%).	Based on observed tidal ranges, target inundation periods achieved within all areas of the restored and enhanced marsh, as follows: <ul style="list-style-type: none"> <li>• lower and middle marshes - monthly inundation = 6-12 percent (1998), 7-13 percent (1999), and 6-13 percent (2000);</li> <li>• upper marsh - monthly inundation = 6-12 percent (1998), 6-14 percent (1999), and 5-15 percent (2000).</li> </ul>
Channel Stability/ Siltation (marsh restoration and enhancement areas)	No evidence of severe erosion or side slope instability. Evidence of gradual evolution of hybrid cross sections in which downstream channel sections maintain relatively steep side slopes that transition into shallow parabolic bottoms in the upstream sections.	Based on channel cross section, all tidal channels are evolving in the expected manner and are meeting the performance criteria. All orders of channels exhibit evidence of hybrid cross section evolution.
Percent Wetland Vegetation Cover (marsh restoration area)	Relative cover within 30% of reference site values; at least 70% of the species native to San Francisco Bay tidal marshes.	Wetland species relative cover in restored marsh = 100% of reference area values. 63% of the species are native to Bay Area tidal marshes. Percent native criterion is expected to increase by year 4.
Community Similarity (marsh restoration area)	IS <sub>R</sub> value of 0.20 or greater in relation to reference area.	IS <sub>E</sub> = 0.91 in relation to reference area. This exceeds the performance criterion.

Table P - Summary of Monitoring Results with Reference to Performance Criteria

Parameter	Year 3 Performance Criteria	Year 3 Results
Upland Vegetation Cover (enhanced upland areas)	60% absolute vegetative cover; problematic invasives no more than 10% of total cover.	99% absolute vegetative cover by grassland species. Less than 5% are invasive exotic species.
Total Plant Cover (marsh restoration area)	A minimum 10% increase in total cover by native San Francisco Bay salt marsh species for at least 3 consecutive years.	15% increase between Year 0 and Year 1; a 4% increase between Year 1 and Year 2; and an 11% increase between Year 2 and Year 3. The total cover by native salt marsh species in year 3 was 30%, which meets this criteria.
Total Plant Cover (marsh enhancement area)	An upward trend in total cover by native San Francisco Bay salt marsh species should be evident following 5 years of monitoring.	An upward trend between Years 0-3 observed in the transitional grassland areas of the enhanced marsh. A downward trend was observed along enhanced channel edges due to decreased pickleweed vigor as a result of greatly increase tidal influence. This is expected to reverse with increased sedimentation over the next few years.
Productivity (marsh restoration area)	A minimum 10% increase in above ground phytomass should be observed for at least 3 consecutive years.	35% increase observed between years 1-2. 56% increase observed between years 2-3.
Productivity (marsh enhancement area)	A stable or upward trend in above ground phytomass along channel margins after year 2.	By year 3, phytomass had not yet increase along channel margins. An increase in biomass is expected in the next few years.
Annual Grass Cover (marsh restoration area)	Relative cover by annual grasses should not increase beyond year 3, and should not exceed 10% total relative cover by year 5.	Relative annual grass cover decreased between years 2-3. The relative annual grass cover was 0.4% in year 3.

**Table P - Summary of Monitoring Results with Reference to Performance Criteria**

Parameter	Year 3 Performance Criteria	Year 3 Results
Annual Grass Cover (marsh enhancement area)	A downward trend in total relative cover of annual grass after 5 years.	Relative annual grass cover declined from 58% (at pre-restoration conditions) in the transitional grassland areas to 6% by year 3.
Soil Organic Matter (marsh restoration area)	An increasing trend in organic matter should be observed over the 5 year monitoring period.	Baseline (1996) mean percent organic matter was 4.6%. By year 1, this had increased to 7.95; in year 2 this decreased slightly to 6.7%; and by year 3 it decreased to 5.8%. The percent organic matter is expected to increase over the next few years.
Faunal Populations (marsh restoration and enhancement areas)	There should be evidence of an upward trend in species richness and species numbers, suggesting similarity between the marsh restoration and enhancement areas (i.e., reference site).	Year 3 results indicate that species richness and diversity is increasing similarity between the restored and enhanced marshes.
Benthic Macroinvertebrates (marsh restoration and enhancement areas)	There should be evidence of colonization by a macroinvertebrate community characteristic of Bay Area tidal marshes.	Based on Year 2 data, a macroinvertebrate community characteristic of Bay Area tidal marshes is developing.
Salt Marsh Harvest Mouse Population (marsh restoration and enhancement areas)	Usage by salt marsh harvest mouse species should be demonstrated in the marsh restoration and enhancement areas.	Based on year 3 trapping, salt marsh harvest mice were found throughout the enhancement marsh areas. Salt marsh harvest mice are expected to use the marsh restoration area once this marsh provides adequate cover and habitat requirements for this species.