<u>Hart Mine Marsh</u>:

Existing Conditions Report

April 30, 2007

Interim Report:

Work Done to Date Regarding Evaluating the Potential of Restoring the <u>Cibola National Wildlife Refuge</u>'s Hart Mine Marsh Unit

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Hart Mine Marsh Existing Conditions Report: Table of Contents

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1. INTRODUCTION

The United States Fish and Wildlife Service (Service) is evaluating the potential of restoring marsh habitat on the Cibola National Wildlife Refuge's Hart Mine Marsh Unit. This document is an interim product that details the work done thus far to characterize the Hart Mine Marsh unit's existing conditions. As data collection and analyses will continue through the summer of 2007, this report will be updated and modified as more information becomes available. Additionally, the final version of this report will be incorporated into the Service's *Comprehensive Conceptual Restoration Plan for Hart Mine Marsh*, due to be finalized on September 7, 2007.

1.2 Primary Report Objectives:

Goal 1: Determine if the restoration of the Hart Mine Marsh is compatible with both the objectives of the LCR MSCP and objectives, with available resources, to the Cibola NWR.

Goal 2: Describe data gathered to inform the design of the restoration plan and identify opportunities and constraints for restoration.

Goal 3: Describe data gathered that will provide the baseline for the development of success criteria for the restoration project and long-term monitoring of the project.

1.3 Background

The Service is collaborating with the U.S. Bureau of Reclamation (Reclamation) on this project, as both these sister agencies are members of the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The LCR MSCP is a state/federal/private partnership that, when implemented over the next 50-years, hopes to "ensure long-term compliance with applicable federal and state the environmental laws, while permitting the continued utilization of lower Colorado River water and power resources". Reclamation is the implementing agency for the LCR MSCP, and is interested in the potential for this on-refuge project to produce marsh habitat mitigation credit for the program.

The LCR MSCP is committed to restore 512 acres of marsh habitat along the lower Colorado River. Reclamation is approaching landowners, including wildlife refuges, to assess their willingness to dedicate their land and water for restoration or creation of these specific habitats. Reclamation hopes to be able to claim marsh mitigation credit under the LCR MSCP for the Hart Mine Marsh project, when the habitat meets the appropriate performance criteria. The Service is working with Reclamation to determine if the Hart Mine Marsh project will work within this context.

According to the terms of the LCR MSCP, certain biological requirements need to be met for mitigation credits to be produced. For marsh habitat, these requirements are specified in terms of four target species of interest. These species are: the Yuma Clapper Rail, the California Black Rail, the Least Bittern, and the Colorado River Cotton Rat.

Requirements specific to the Yuma Clapper Rail, the Least Bittern, and the Colorado River Cotton Rat are: mosaic of marsh vegetation species and open water in greater-than-acre patches with emergent vegetation at varying water depths (for the Yuma Clapper Rail, water depths not to exceed twelve inches.) Marsh habitats created for California Black Rail will also provide habitat for these species.

In addition, the California Black Rail requires moist soil marshes in greater-than-acre patches with a predominance of three-square bulrush at water depths not to exceed one-inch.

1.4 Hart Mine Marsh

Hart Mine Marsh is a decadent marsh located on Cibola NWR (Figure 1). The entire marsh occupies 646 acres, 123 acres of which are estimated to be upland habitat (and would not apply to marsh restoration activities). Currently, drainage water from the refuge's agricultural fields enters Hart Mine Marsh through gated structures in the Arnett Ditch, and culverts from Farm Unit 2. There is limited outflow from the marsh, therefore drain water typically "dead ends" in the marsh to stagnate and evaporate, resulting in poor water quality, marginal marsh habitat, and saline upland areas, some completely devoid of vegetation.

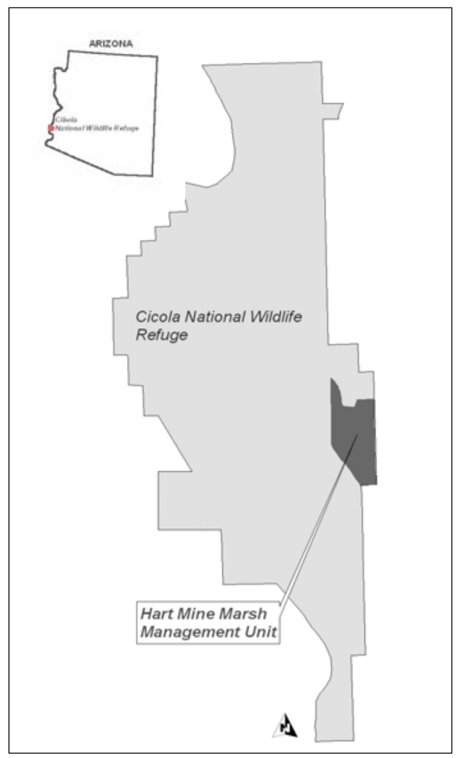

Figure 1. Location of Cibola NWR and the Hart Mine Marsh.

2.0 TOPOGRAPHY

A topographic map of the site was developed based on Reclamation survey data. According to the data received from Reclamation and field observations, much of the proposed area was not accessible for survey due to heavy tamarisk growth. Narrow openings were cleared through the brush using heavy equipment to allow cross section surveys at near random intervals. Those portions of the project area that were accessible were thoroughly surveyed.

A topographic map was generated using Reclamation data and Autodesk LDD software, converting survey points and 3D polylines to form a triangulated irregular network (TIN), and finally elevation contours using a utility software that interpolates the TIN. Typically, generating a topography map would start with an even distribution of survey point data covering the project area, and 3D polylines connecting some of these points to define linear features. The Reclamation survey had neither. 3D polylines were created by digitizing over photo images and estimating the Z values based on nearby survey points, vegetation types, visual observations in the field, and at times, educated guessing. In some areas, no survey points were available, so the Z values are estimated. The overall result is a surface (Appendix 1) that is conceptual, but provides a sufficient starting point for conceptual designs. The field data has insufficient point density to produce a map truthful to the ground (e.g., one that could be used for engineering designs.)

The topographic data shows that the project area falls on average about 2' from north to south, and relatively flat from east to west, sloping slightly toward the river. The southeast corner of the project area is higher in elevation than other areas, rising steeply as a result of alluvial fans created by washes to the east, and mine tailings. The lowest elevations are associated with historical channels created by high river flows prior to the construction of dams and levees, averaging about 1' to 2' below the surrounding grade.

Most of the area (80% +) is relatively flat, and conducive to flood irrigation or ponded water conditions, although the existing infrastructure presents a severe limitation. Some earthwork would be required to create units for greater irrigation efficiency and management. The amount of earthwork required cannot be quantified at this time, requiring first the completion of a conceptual design(s) and additional survey work once the area is cleared of brush.

3.0 EXISTING HYDROLOGY AND WATER QUALITY

3.1 Overall Water Budget for the Cibola Refuge

3.11 Water Use -- General

Water used at the refuge broadly falls into two categories: (1) water that is mechanically diverted from the Colorado River and applied to actively managed lands, and (2) water that is passively used by native and non-native vegetation on refuge lands that are not actively managed. The refuge has annual water entitlements that allow the active diversion of water from the Colorado River of 27,000 acre-feet, plus 7,500 acre-feet for circulation purposes. The refuge's consumptive use entitlements (which are legally defined in the Arizona vs. California Supreme Court Decree as being "diversion minus measured return flow") equal 16,793 acre-feet.

Water is diverted in three locations through the use of pumps to irrigate three primary habitat management areas. These include Farm Unit 1, Farm Unit 2, and the Island Unit. Each primary management area has a pumping station that lifts water from the river to lined ditches for conveyance of water to the individual habitat units. Pumps consist of vertical turbine pumps mounted on platforms located in the river.

There are several factors that influence the amount of the Colorado River water used by the refuge. These include the area of actively managed lands, the type of habitat (i.e., moist soil vs. native riparian), management practices, and refuge water entitlements. Long-term climate change could also have a significant impact on water use, but is speculative and beyond the scope of this report.

3.12 Cibola NWR Water Entitlements and Water Accounting

Congress established the Cibola NWR on August 21, 1964, by Public Land Order 3442. The enabling legislation concisely described the refuge's purpose as being ". . . *reserved for use of the United States Fish and Wildlife Service, as the Cibola National Wildlife Refuge*" and "*subject to their use for reclamation or wildlife refuge purposes*."

In order for the refuge to meet these congressionally defined purposes, the refuge was granted rights to divert and use water from the lower Colorado River. In 1982, the Secretary of the Interior reserved a specified amount of Colorado River water for use on the Cibola NWR based on the date that refuge lands were withdrawn (August 21, 1964).

These "entitlements" to Colorado River water were designed to allow the refuge to meet its land management responsibilities, in support of wildlife habitats, in the form of a "Secretarial Reservation" as published in the Federal Register, Vol. 17, No. 237, December 9, 1982, pp. 55430-31:

Consistent with the February 9, 1944, contract between the United States and the State of Arizona, notice is given that the following amount of Colorado River water is reserved for the United States for use on the Cibola National Wildlife Refuge in Arizona: The diversion of 27,000 acre-feet annually from the mainstream or the consumptive use of 16,793 acre-fee annually from the mainstream, which ever is less, with a priority date of August 21, 1964.

A secretarial reservation of water is allowed through Section 5 of the Boulder Canyon Project Act, authorized by Congress in 1928. The Act allows the Secretary of the Interior to enter into contracts for the storage and delivery of river water for beneficial uses. Since a public agency cannot enter into a contract with itself, the Secretary can "reserve" water for use by a federal agency. A secretarial reservation is considered a "second priority" (sixth being the lowest), meaning that it is only subordinate to first priority rights, also known as present perfected rights, which were established at the time the Act was authorized. In years when water supplies are insufficient, water is first withdrawn from those with a lower priority (as opposed to other federal water project contracts where shortages are shared among contractors). Thus, Cibola NWR's water entitlements are of relatively high priority and would only be subject to reductions during the most extreme shortages. As such, reductions in deliveries due to periods of low precipitation were not assumed.

In addition, the refuge also has 7,500 acre-feet for providing circulation, as published in the Senate Report 408, 90th Congress, First Session: "The annual water requirement for the refuge is (1) *7,500 acre-feet diverted from the main stream for circulation water with minimal consumptive use*, and (2) 27,000 acre-feet diverted from the main stream or the consumptive use of 16,793 acre-feet of main stream water, whichever is less, with a priority date of August 21, 1964."

This additional entitlement of 7,500 acre-feet has typically been tied, in concept, to Cibola Lake, although the Service would maintain that the establishing authority is sufficiently broad to merit the consideration of applying this *circulatory water* to support Hart Mine Marsh as well. At the present time, the refuge does not have a dedicated diversion associated with this circulatory water right.

Reclamation represents the Secretary of Interior on the lower Colorado River and in this capacity is often referred to as the "Water Master". The Water Master has the arduous responsibility of accounting for Colorado River water use. As part of their accounting process, the Water Master tracks diversions from the river by water entitlement holders, and return flows if a portion of the diverted water is unused and returned to the river for the benefit of downstream users. Again, the *consumptive use* represents diversions less measured return flows.

As part of Reclamation's water use accounting system, some water entitlement holders also receive an *unmeasured return flow credit*. This credit represents diverted river water that makes its way back into the river system, primarily in the form of subsurface percolation and seepage. Reclamation applies said credit by applying a multiplier against the measured diversion value, the resultant of which is then used to reduce the entitlement holder's consumptive use. Cibola NWR currently receives a 38% unmeasured return flow credit.

As of 2003, Reclamation has instituted the practice of directly applying the unmeasured return flow credit to a given diverter, thus providing significant relief to entitlement holders like Cibola NWR. Prior to 2003, Reclamation provided the unmeasured return flow credits at the lower basin states (NV, CA and AZ) level, and no direct relief was provided to individual diverters within a given state. The Service has requested that Reclamation provide written confirmation that this new practice is now the official policy of the Water Master, which the analysis within this report assumes is the case.

3.13 Past Water Use

Water diverted from the Colorado River for use at Cibola NWR is used for a combination of wildlife habitat and cooperative farming: both farms units (#1 and #2) have lands that are leased to private farmers who grow crops, of which a portion is dedicated to wildlife. Habitats actively managed that use river water include woody riparian (cottonwood and mesquite), moist soils, and seasonal wetlands.

All water diverted for actively managed lands at Cibola NWR is measured to ensure the refuge is within its legal entitlement. To date, the maximum diversion for the refuge is approximately 14,000 acre-feet. In the recent past, no measured return flow has occurred. Table 1 shows measured diversions for each of the three diversion points since 1998 (as measured by the Service). Table 1 also shows the consumptive use amount charge to the refuge, as published by Reclamation in their water accounting reports.

As there are currently no measured return flows associated with the refuge, prior to 2003 the Service has used a conservative interpretation that consumptive use is equal to diversions. As shown in the table, if “diversion” equates to “consumptive use” for the refuge, then the refuge’s annual consumptive use approaches the consumptive use limit of 16,793 acre-feet. However, when an unmeasured return flow credit is directly applied (assumed from 2003 and beyond), and assuming no measured return flows, it is anticipated that the refuge will not exceed its consumptive use entitlement before it reaches its diversionary cap of 27,000 acre-feet.

Since 1998, the refuge has added several acres of new habitat, primarily in Farm Unit 1 and the Island Unit. New habitat projects have included riparian vegetation and moist soil units. Predictably, the annual use of water at Cibola NWR has generally increased during that period. Figure 2 illustrates a trend of steadily increasing water consumption.

3.14 Future Water Use

An important objective of this analysis is to determine the amount of water available, if any, for new habitat improvements at Hart Mine Marsh. The basis of the analysis is to quantify the amount of water necessary to operate and maintain habitat and farming operations, and project the water that will be used once the refuge completes development of habitat areas already in process or currently planned.

In the past several years, the refuge has made substantial progress improving lands and irrigation systems to develop new habitats, primarily in Farm Unit 1 and the Island Unit. For example, approximately 600 acres of new lands [1] have been cleared, leveled,

[1] Habitat units include Hippy Burn, Long Pond, and Crane Roost.

Table 1. Cibola NWR River Diversions & Consumptive Use Charges (acre-feet per annum)

Year	Farm Unit 1	Farm Unit 2 *	Island Unit	Total Diversion	Reclamation's Consumptive Use
1998	6,609	1,690	2,150	10,449	6,435
1999	4,980	1,228	3,030	9,238	8,161
2000	5,004	1,244	2,831	9,079	14,567
2001	4,276	1,913	4,339	10,528	11,025
2002	8,112	1,591	4,135	13,838	13,339
2003	7,562	1,456	4,425	13,443	8,335
2004	6,824	1,300	3,140	11,264	6,982
2005	6,494	1,188	3,803	11,485	6,812
2006	7,122	2,779	3,903	13,804	n/a

*Farm Unit 2 diversions include Cibola Sportsman Club diversions
Data Source: Consumptive Use values: *USBR--Colorado River Accounting and Water Use Reports (Arizona, California and Nevada) (1998-2005)*, while all other data comes from Service gages at each refuge units (note: all 2006 values are provisional).

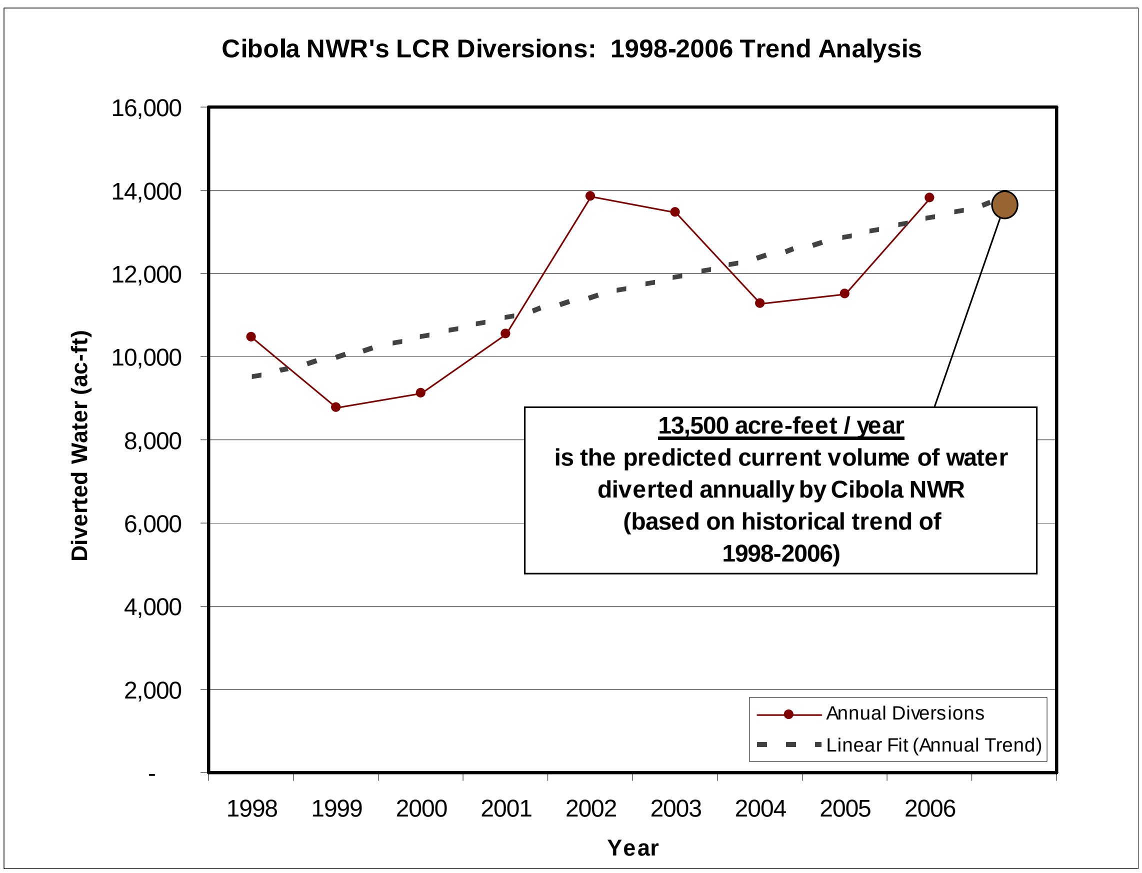

Figure 2. Cibola NWR's lower Colorado River water diversions from 1998 to 2006 showing an overall increase in use due to the addition of new habitat units.

and water systems constructed to develop new habitat areas, but are either not functioning or not fully functioning at this time. Once these areas are planted or seeded, water will be required to develop and manage the units.

Assumptions used to estimate the amount of surplus water that may be available for new projects are listed as follows:

- **Water Reservations –** Some lands on the refuge have been improved (i.e. cleared, earthwork, irrigation systems, etc.), but have not been placed into operation. In addition, some lands associated with a habitat unit are part of a pre-existing plan for future development. Estimates for water use of said areas were accounted for and "reserved", thereby reducing available entitlements for new projects (i.e. Hart Mine Marsh) accordingly. [2] Since resources were previously dedicated to develop selected areas, and the completion of all planned habitat units (avoiding fragmentation) is important to the habitat value of adjacent units, water for said areas was given first priority.

- **Unmeasured Return Flow Credit –** The current unmeasured return flow credit of 38% was used in determining the amount of water that can be diverted and used for refuge objectives without exceeding the consumptive use entitlement. This value was calculated at 27,292 acre-feet annually.

- **Return Water –** Neither the drain water from irrigation activities conveyed in the Arnett Ditch, nor the 7,500 acre-feet circulation flow water entitlement were included in the estimates of available supplies.

- **Water Use –** A unit water use value (acre-feet per acre) was calculated based on existing uses (recorded diversions) and refuge lands that are actively managed (irrigated). Although ET values are available for various types of vegetation, historical use patterns based on actual management practices may be the best indicator of future demands. Water use can vary depending on the type of habitat/vegetation of a given area. However, since water use on individual units was not measured, and the actual types of all proposed habitats are unknown, an overall *average* unit demand was calculated for water demand projections that include planned developments.

  For purposes of this study, actual demands (recorded diversions[3]) were divided by the area of actively managed lands (1,867 acres), equating to an annual unit demand of 7.23 acre-feet per acre. This value is greater than accepted ET estimates for crops and habitats that exist at the refuge, which generally range from approximately 4.5 to 5.5 acre-feet per acre. However, ET values do not account for other factors that can raise water use, such as irrigation efficiency,

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[2] Includes approximately 800 acres in the north and northwest section of Farm Unit 1, and approximately 270 acres of "fill in" areas within the existing Island Unit.
[3] Based on predicted current diversions from 1998-2006 period of record shown in Table 2.

conveyance losses, salt management, habitat objectives, etc. Thus, an average unit demand of 7.23 acre-feet per acre is within the range of plausible values that could be used for planning exercises. It should be noted that extensive development of new riparian habitat (and associated management for special status species) could result in unit demands substantially greater than the estimated value used in this study.

Table 2. Cibola NWR -- Water Use Projections (ac-ft/yr)

Status	Farm Unit 1	Farm Unit 2	Island Unit	Total	Water Use[4]
Actively Managed	1,120	362	385	1,867	13,500
Proposed	796	-	268	1,064	7,693
Other (private) [5]		92			(665)
			Projected Use		20,526
Maximum allowable DIVERSION that would not exceed Consumptive Use Entitlement (with unmeasured return flow credit applied)					27,292
Diversion Entitlement (maximum diversion allowable per entitlement)[6]					27,000
Available Water for Other Projects (Surplus)					6,474

Based on the surplus water calculated of 6,474 acre-feet and the unit water demand estimate of 7.23 acre-feet/acre, it is estimated that a total of 895 additional acres can be developed at the refuge using diverted lower Colorado River water without exceeding the refuge's entitlements.

In the event that there are changes in the assumptions used to develop these estimates, the amount of surplus water could vary significantly. For example, if the unmeasured return flow credit were to be reduced or eliminated, it is doubtful that any surplus water would remain available. Average unit water demands greater than the 7.23 ac-ft/acre projected would also adversely impact surplus supplies

[4] Water use = acres x 7.23 ac-ft (where 7.23 ac-ft is the water duty associated with the refuge's actively managed lands)(e.g., 1,867 acres * 7.23 acre-ft/acre = 13,500 acre-feet)
[5] Private lands (north of Farm Unit 2) whose water diversions are included in the records of diversions, but are not counted against refuge entitlements.
[6] Since the diversion entitlement is greater than the consumptive use entitlement (with the unmeasured return flow credit applied), the diversion allowance dictates.

3.2. Hydrology and Water Quality at the Hart Mine Marsh

3.21 Surface and Ground Water Hydrology

The greatest controls on the surface water hydrology of the lower Colorado River and its effects on the Cibola NWR and the Hart Mine Marsh are Parker Dam releases, channelization, and the extensive series of levees. Of these, Parker Dam releases arguably play the most significant role in controlling the refuge's hydrology, while the others play a lesser, yet still important role. Parker Dam's most notable changes to the hydrograph in the Cibola reach are the dampening of peak flood levels, removal of the annual spring flood pulse and diurnal hydroelectric pulses. Channelization and levees have removed important overbank flood processes that were historically coincident with these flood events, including sheet flow, sediment deposition and transport, and seasonal fluctuations in ground water elevations.

To characterize the surface water hydrology of the LCR at the Cibola NWR, the Service used water surface elevation data from the Reclamation's gage referred to as *Colorado River at Cibola*. Initial analysis of the groundwater hydrology at the Hart Mine Marsh was based upon data from an array of 12 groundwater wells drilled into the shallow alluvial aquifer (see Figure 3). Each well was instrumented with a pressure transducer datalogger to obtain water surface elevation (WSEL) and temperature data. Additionally, surface water elevations at the Arnett Ditch and Hart Mine Marsh are being recorded using dataloggers (See Figure 4). It is important to note that the equipment at the Arnett Ditch and Hart Mine Marsh have not yet been surveyed for elevation, removing our ability to assess relative water surface elevations. This work will take place early spring, 2007.

At this initial stage of data collection, hourly data from an approximately two week period, from December 13 – 27, 2006, were analyzed. The LCR's role as a control on ground water hydrology was examined using regression analysis. The reader should note that while regression analysis is often used as a statistical model to examine surface and ground water interactions, the approach does suffer from limitations as a statistical model. Hydrologic efficiency, or the "dampening" of surface water fluctuations as reflected by ground water elevations, often creates a scenario where the multiple coefficient of determination (R^2) values may suggest that there is not a link between dependant and independent variables when one actually exists. With that said, regression analysis of WSEL data from the LCR and ground water monitoring wells indicates that for the period of time examined, the river is a dominant control on groundwater levels between the LCR and the Arnett Ditch. Monitoring wells HMM_01 and HMM_09, located between the LCR and the Arnett Ditch, closely track WSEL of the LCR, with R^2 values of 0.94 and 0.98, respectively.

Furthermore, regression analysis indicates that the LCR river levels exert a control on groundwater levels to the east of the Arnett Ditch: monitoring well HMM_10 tracks WSEL of the LCR with an R^2 of 0.90. Statistical models for monitoring well HMM_06

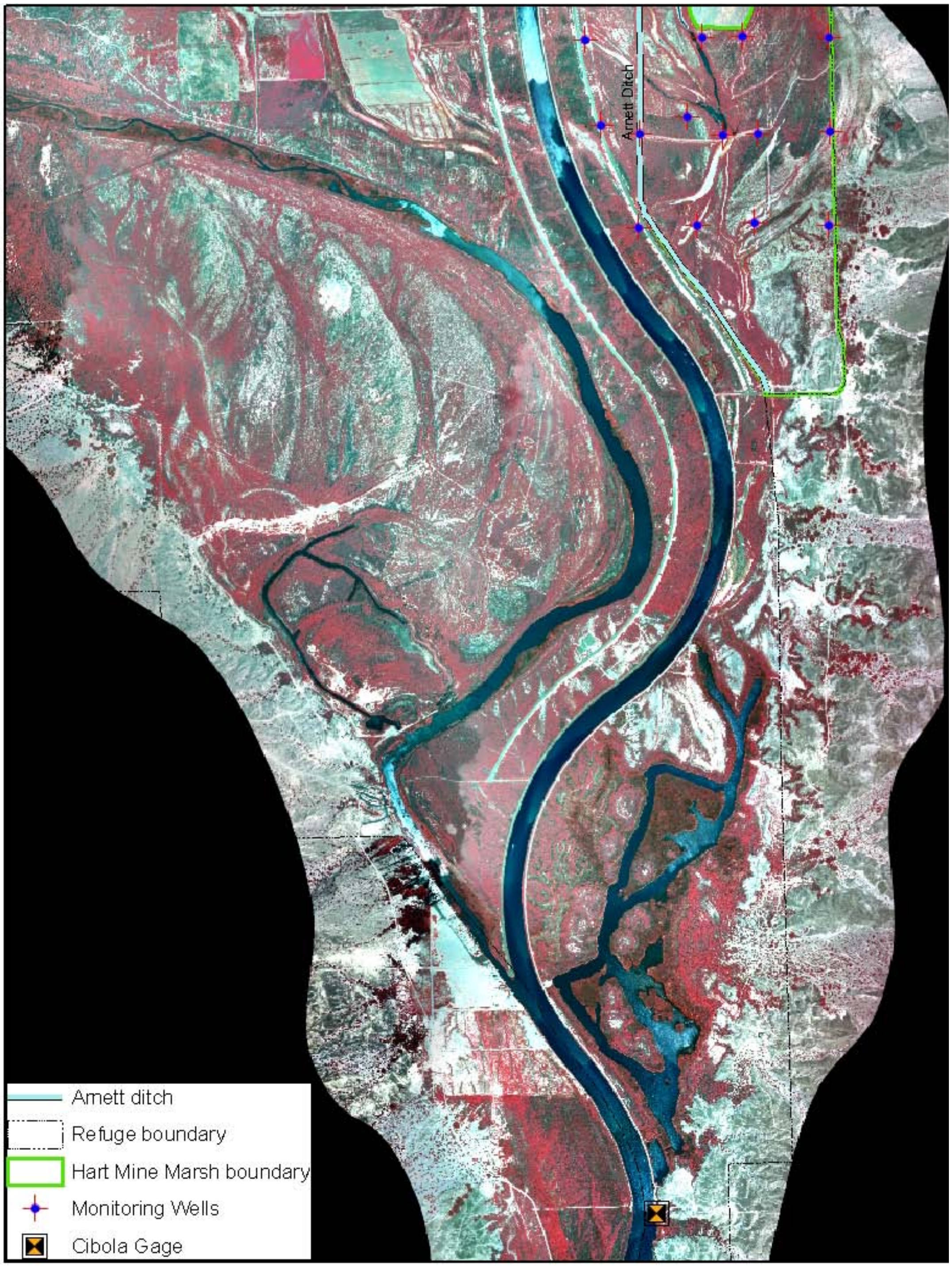

Figure 3. Location of monitoring wells and surface water dataloggers. The USBR's Cibola Gage is located at the lower extent of the image.

visa-vie the LCR did not produce as good a fit (R^2=0.70). The general shape of the WSEL curve for monitoring well HMM_06 suggests that it is also tracking the WSEL of the LCR, but that there is an overall dampening of the curve. This dampening may be the result of some hydrologic property related to the subsurface matrix. Wells HMM_02 and HMM_08 follow the overall WSEL trend, suggesting further dampening of the LCR WSEL curve. The properties of wells HMM_02, HMM_06, and HMM_08 discussed here are mostly speculative and will be subject to further analysis.

The overall trend revealed by this initial analysis is that the Hart Mine Marsh is hydrologically connected to the lower Colorado River, suggesting that Parker Dam operations will figure into future restoration considerations. Additionally, the effects of the Arnett Ditch and Hart Mine Marsh water levels on the hydrology of the study area have not been examined (an effort that awaits the 2007 irrigation season). It is probable that the Arnett Ditch in particular is influencing not only the ground water hydrology of the Hart Mine Marsh, but may be a potential source of elevated levels of salinity, nutrients and contaminants in both the soils and the waters of the Hart Mine Marsh.

3.22 Water Quality

As an aquatic ecosystem, water quality conditions at the Hart Mine Marsh management unit play a significant role in the functioning of existing habitat. To assist with site characterization, water quality conditions were sampled at multiple points in time at the Arnett Ditch, the Farm Unit 2 drain, and the Hart Mine Marsh. The Arnett Ditch is an agricultural drain, and serves as a main source of surface water at the Hart Mine Marsh (precipitation, alluvial fan runoff are other contributors). The ditch originates outside of the Hart Mine Marsh; it forms the western boundary as it flows through the Marsh, and terminates at the southern end of the Hart Mine Marsh. The Farm Unit 2 drain forms the northern boundary of the Hart Mine Marsh.

One water quality sample was taken at the northern extent of the ditch's path through the marsh. A second sample was taken in the Farm Unit 2 drain[7], and a third sample was taken in the marsh itself (see Figure 5). In August and October of 2006, dissolved oxygen (DO), pH, and conductivity were measured using a Hydrolab H2O water quality sonde. Grab samples were taken in August 2006 for laboratory analysis (see Appendix 3 for water quality results). Flow velocities at the time of sampling were negligible, suggesting that the upstream agricultural fields were not being actively irrigated and that flushing was not taking place.

Initial analysis of water quality parameters suggest that conditions in the Arnett Ditch are consistent with water bodies that have agricultural influences. For all parameters discussed in this section, elevated concentrations can also be attributed to evaporation.

[7] At the time of sampling, the Farm Unit 2 drain was not hydrologically connected to the Hart Mine Marsh. However, a culvert connecting the two water bodies suggest that the two may be connected at certain water levels.

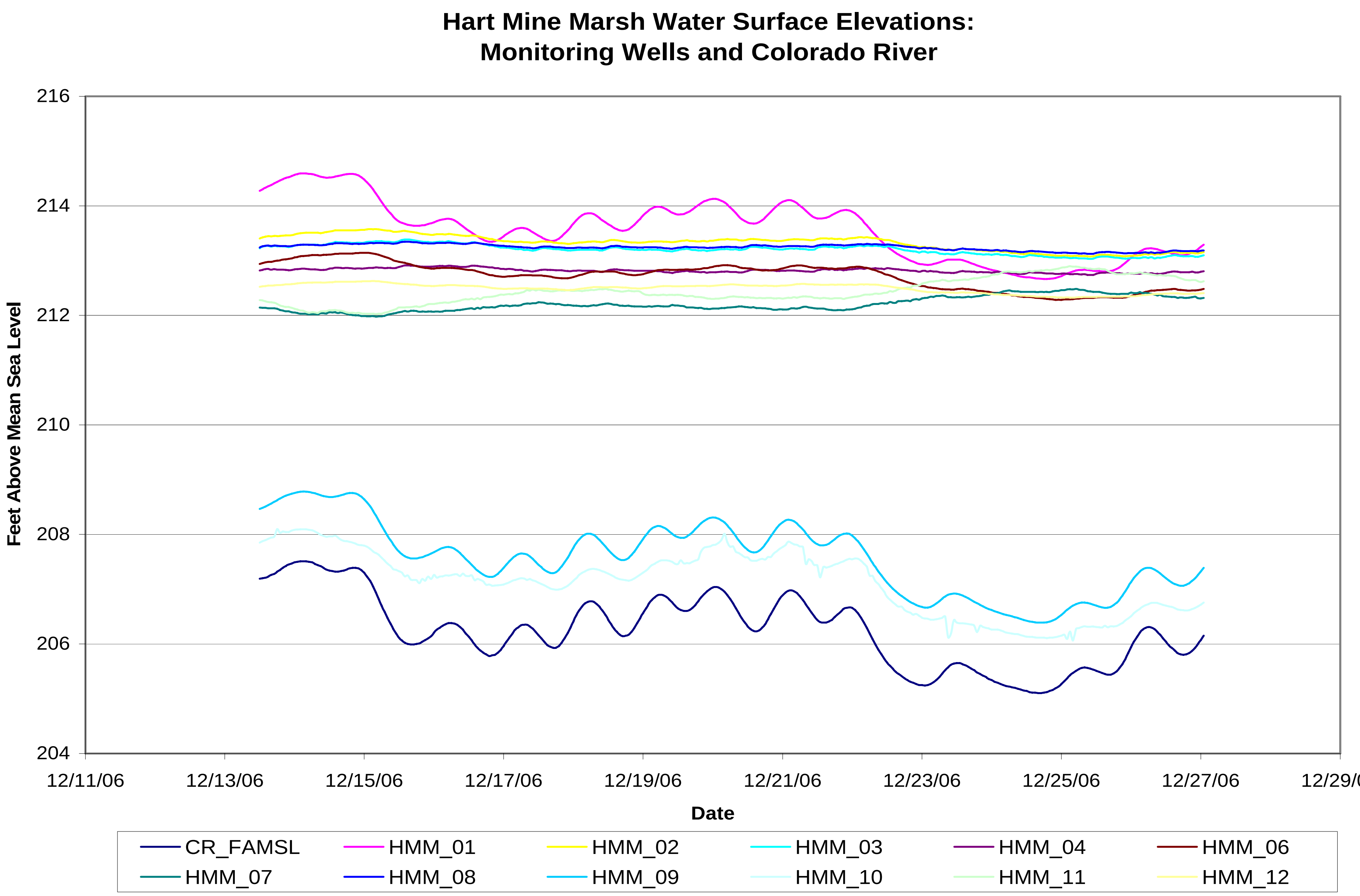

Figure 4. Relative elevations of Hart Mine Marsh ground water monitoring wells and lower Colorado River (at Cibola Gage) demonstrate a clear connection between the LCR and groundwater between the LCR and the Arnett Ditch.

The minimum value of pH was 6.95 and the maximum was 9.45, with a mean value of 8, in the moderately alkaline range. Nutrient levels of nitrogen and phosphorous were elevated, and salt content was high (measured both by conductivity, and levels of sodium and chloride). Nitrogen concentrations as nitrate+nitrite – N were low (0.01 – 0.08 mg/L), while ammonia – N levels were high (0.09 – 0.88 mg/L) (U.S. EPA 2000).

High levels of ammonia – N can be toxic to aquatic life, and toxicity is increased depending upon temperature and pH. Thus, the warmer temperatures and higher pH of the Hart Mine Marsh further increase the toxicity of the ammonia – N concentrations in Hart Mine Marsh. Additionally, ammonia – N can be associated with mine tailings. This complicates tracing the source of ammonia – N in the Hart Mine Marsh. It is possible (and still undetermined) that during precipitation events of sufficient intensity, Hart Mine Marsh's namesake mine may be a source of ammonia via runoff.

Additionally, total phosphorous concentrations (0.114 – 0.541 mg/L) were high relative to other arid land water bodies (Ibid). This data suggests that upstream nutrient inputs are flushed into the Arnett Ditch and when water levels drop, remain in the ditch. While DO levels at the benthic interface were not measured, it is likely that hypoxic or anaerobic conditions exist. This would create reducing conditions where nitrate+nitrite – N could be metabolized by benthic biota and converted to gaseous form and ammonium-N. Phosphorous measured as total P would be released as a byproduct of benthic metabolism (Wetzel 2001).

Salt concentrations were also consistent with the effects of agricultural activity. Conductivities were high for a fresh water system (2,520 µS/cm – 23,900 µS/cm) indicating significant salt loading. Laboratory analysis of surface water grab samples bore this out (see Appendix 3). In the Arnett Ditch and Farm Unit 2 drain, chloride levels were at a minimum of 707 mg/L, a maximum of 2,150 mg/L, and sodium levels were at a minimum of 414 mg/L and a maximum of 1,140 mg/L. The values of chloride and sodium were significantly higher in the Hart Mine Marsh, 10,700 mg/L and 4,860 mg/L respectively. These concentrations meet or exceed toxicity thresholds for a variety of plants and invertebrates (U.S. Department of Interior 1998).

4.0 SOILS BASELINE CONDITIONS

Soils result from the weathering of geologic material. Rainfall and surface runoff can chemically breakdown rock, as well as transport and deposit rock particles elsewhere. Once in place, water continues to break down and chemically alter minerals and organic matter into different soil types. The type of soil is dependent on the type of parent material, the climate, the topography, the vegetation, time, and management.

Soils vary continuously over the surface of the earth; to map soils a range of characteristics to be included in a mapped unit and a scale must be determined. The scale of the NRCS Soil Survey maps is 1:24,000. At this scale the minimum size of a

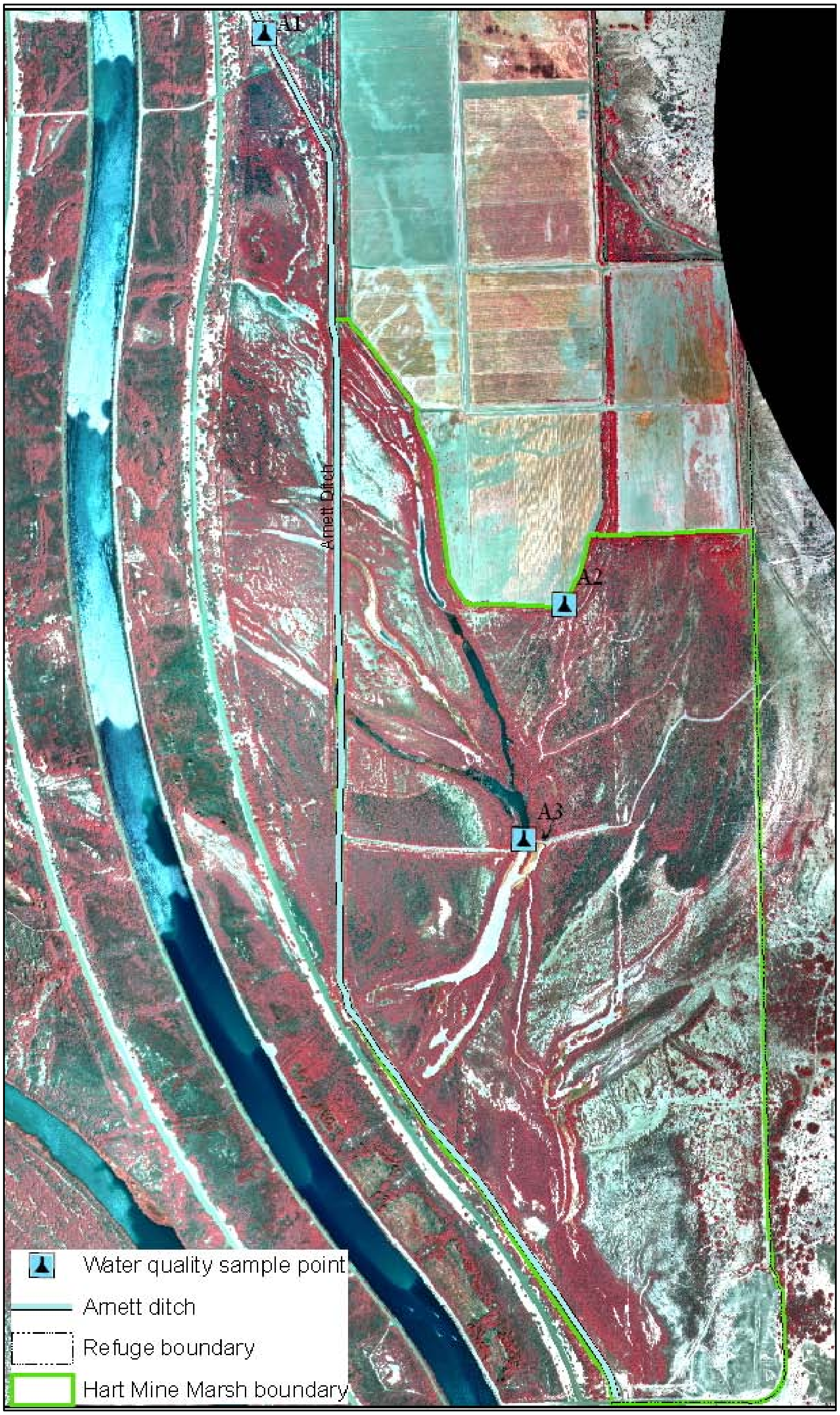

Figure 5. Location of water quality sample sites.

delineated soil unit is 5.7 acres; soil units smaller than 5.7 acres will not be shown on this type of map. A more detailed soil map will show features that are too small to appear on the soil survey (Singer & Munns, 1996).

This section includes a discussion a of sections of the Natural Resource Conservation Service (USDA-NRCS) Soil Survey, a geomorphic map of the site prepared in October 2006, and the results of soil sampling and analysis at 22 locations at 3 depths in the Hart Mine Marsh conducted in October and December 2006.

4.1 The NRCS Soil Map

The soils mapped at the Hart Mine Marsh are typical for soils forming on alluvial fans and flood plains in the Sonoran Desert. The NRCS has mapped three main soil types at the Hart Mine Marsh. The locations of the map units are shown on Figure 6.

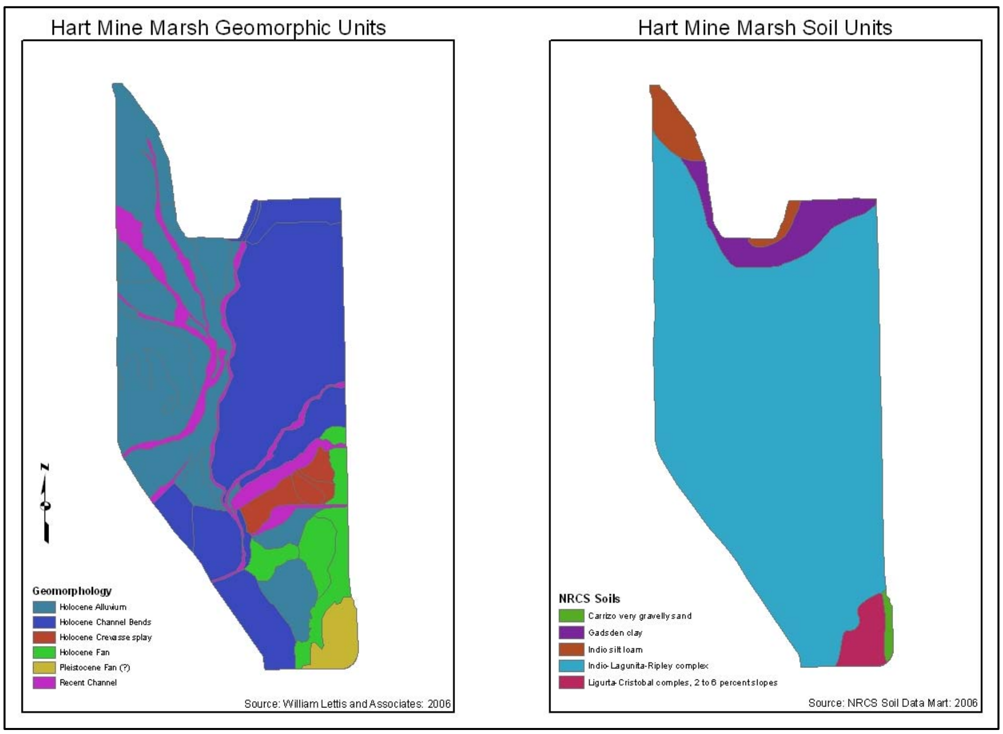

Figure 6. Comparison of surficial geology map (left) and NRCS soil map units (right) at the Hart Mine Marsh unit.

Gadsen Clay-(Map Unit 8)- this soil is found on found on flood plains (slopes are 0 to 1 percent). It is a deep soil; typical profile has a clay texture to 60 inches and the depth to a restrictive laver is greater than 60 inches. Gadsen is rated as having no limitations for use in creating ponds. The high content of shrink swell clays in this soil leads to severe limitations for use creating levees or embankments (See Attached Ponds and Embankments (CA).

Indio-Lagunita-Ripley Complex (Map Unit 16)

*Indio (35% of the complex)—*this soil is found on found on flood plains and alluvial fans (slopes are 0 to 1 percent). It is a deep soil; typical profile has a surface silt loam horizon from 0 to 6 inches and a stratified very fine sandy loam horizon from 6 to 63 inches. This soil has a strongly sodic horizon within 30 inches of the soil surface. Indio is rated as having relatively severe limitations for use creating ponds; the permeability is 0.6-2"/hour. This soil has a very high piping potential.

Lagunita (25% of the complex)-- this soil is found on found on terraces (slopes are 0 to 2 percent). It is a deep soil; typical profile has a surface loamy sand horizon from 0 to 8 inches and a loamy sand horizon from 8 to 60 inches. This soil has a moderately sodic horizon within 30 inches of the soil surface. Lagunita is rated as having severe limitations for use creating ponds; the permeability is > 2"/hour. This soil has a very high piping.

Ripley (25% of the complex)-- this soil is found on found on drainageways (slopes are 0 to 1 percent). It is a deep soil; typical profile has a surface silt loam horizon from 0 to 6 inches, a fine sandy loam horizon from 6 to 25 inches, and a sand horizon from 25 to 60 inches. This soil has a slightly sodic horizon within 30 inches of the soil surface. Ripley is rated as having severe limitations for use creating ponds; the permeability is > 2"/hour. This soil has a very high piping potential.

Ligurta-Cristobal Complex, 2 to 6 percent slopes (Map Unit 21)

*Ligurta (65% of the complex)--*this soil is found on found on alluvial fans (slopes are 2 to 6 percent). It is a deep soil; typical profile has a surface very gravelly loam horizon from 0 to 2 inches and a very gravelly clay loam horizon from 2 to 60 inches. This soil is moderately to strongly saline (16.0 to 32.0 mmhos/cm).

*Cristobal (25% of the complex)--*this soil is found on found on alluvial fans (slopes are 2 to 6 percent). It is a deep soil; typical profile has a surface very gravelly loam horizon from 0 to 2 inches, a very gravelly clay loam horizon from 2 to 25 inches, and a very gravelly clay loam horizon from 25 to 60 inches. This soil is moderately to strongly saline (16.0 to 32.0 mmhos/cm).

4.2 Surficial Geologic Map of the Hart Mine Marsh

William Lettis & Associates prepared a short text and GIS database that summarizes their surficial geologic mapping of floodplain deposits within the project site (October, 20 2006; letter and Map are attached in Appendix 2). They mapped seven different geomorphic units at the site most of which are fluvial deposits directly associated with historic and paleo-channels of the Colorado River (floodplain). The locations of the mapped units are shown on Figure 6. Past wetland restoration activities (Fredrickson 2003) have shown that incorporating knowledge of geomorphic landforms can significantly increase the likelihood of achieving the restoration objectives.

4.3 Site Soil Analysis

Soil samples were collected at 22 locations at three different depths: 0 to 2 inches, 24 to 26 inches and 34 to 36 inches. The locations of the sample sites are shown on Figure 7. The samples were analyzed at a commercial laboratory. The analysis package included pH, electrical conductivity, Ca Mg, Na, exchangeable Na percent, B, NO_3-N, PO_4-P, K, and Zn.

4.31 Soils Results

A summary of the data is shown in Table 2 (See Appendix 3's Report of Soil Analysis for complete data set).

Table 3. Summary of Saturation Percentage, pH, EC and ESP for 22 samples at depths of: 0-2", 24-26", and 34-36".

Sample Depth		**SP %**	**pH**	**EC x10^3** (decSiemen/m)	**ESP %**
0-2 "	Average	56.36	7.67	159.60	44.27
0-2"	St Dev	20.40	0.62	142.73	19.26
0-2"	Range			0.69-307	
24-26"	Average	50.23	8.01	45.19	31.45
24-26"	St Dev	18.74	0.37	30.46	13.26
24-26"	Range			0.98-118	
34-36"	Average	49.05	8.03	45.87	31.79
34-36"	St Dev	20.69	0.29	30.11	11.96
34-36"	Range			5.32-119	

The SATURATION PERCENTAGE is the number of grams of water required to saturate 100 grams of soil. The water-holding capacity of a soil when irrigated and allowed to drain is approximately half the SP. About half the water-holding capacity is available for crop use. Approximate relationship of SP to soil texture follows:
Below 20 Sandy or Loamy Sand
20 – 35 Sandy Loam
35 – 50 Loam or Silt Loam
50 – 65 Clay Loam
65 – 150 Clay

EC_e ELECTRICAL CONDUCTIVITY of the saturation extract is an index of salt content expressed as millimhos per centimeter or decisiemens per meter at 25° C.
Below 0.5--Water penetration may be impaired.
Under 2--No salinity problem for most crops.
2 - 4--Restricts growth of very salt-sensitive crops.
4 - 8 Restricts growth of all but moderately salt-tolerant crops.
8 - 16--Restricts growth of all but very salt-tolerant crops.
Above 16Only a few salt-tolerant crops grow satisfactorily.

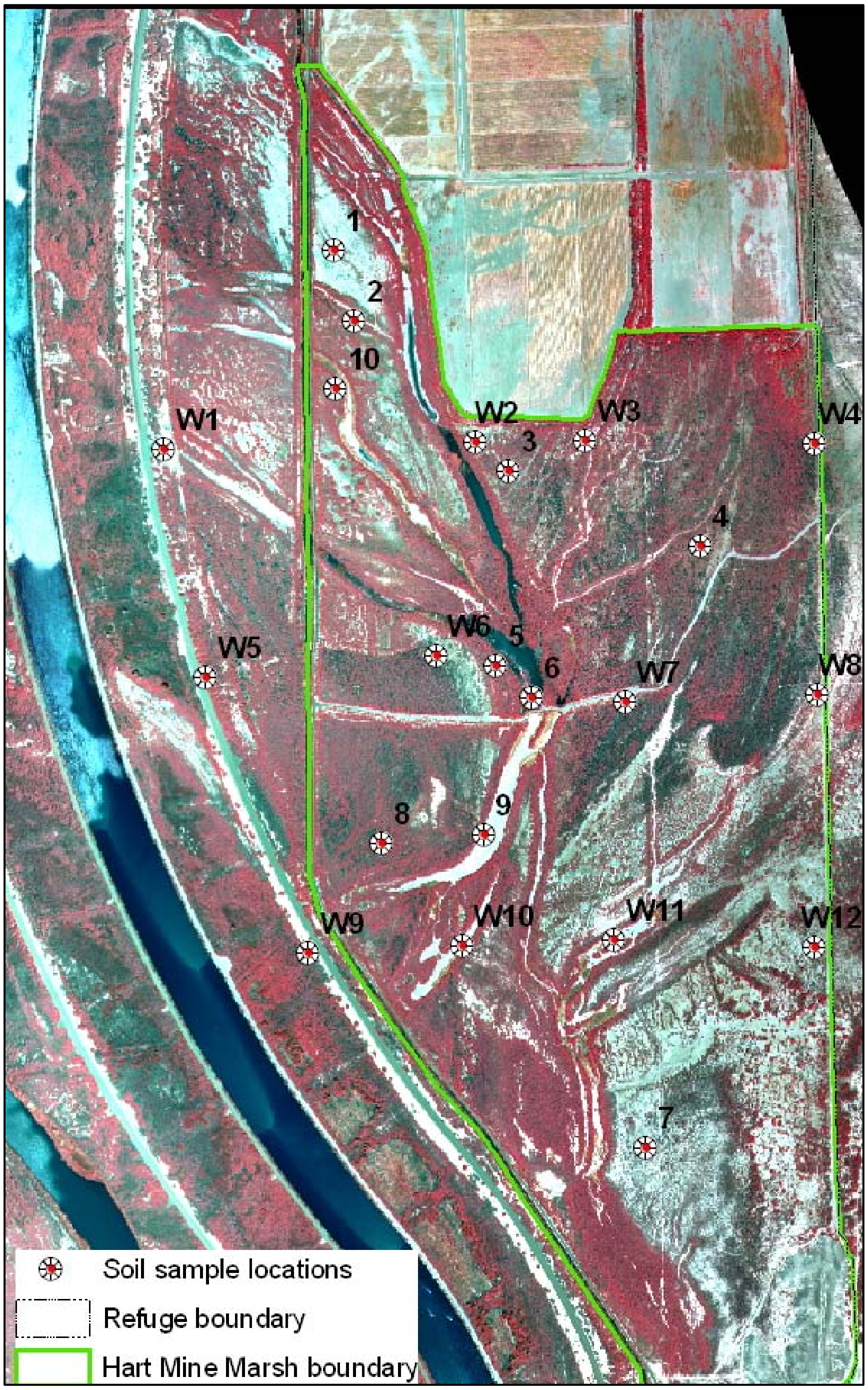

Figure 7. Soil sample locations, includes samples taken from soil pits and monitoring well drill holes.

ESP EXCHANGEABLE SODIUM PERCENTAGE is the degree to which the soil exchange complex is saturated with sodium. It is used to determine soil permeability and potential phytotoxicity. Organic soils have no minerals, so are not affected by sodium.
Below 10--No permeability problem; however, sodium sensitive plants may show phytotoxicity such as chlorosis or slight yield reduction.
10 - 15--Soils with SP above 50 may have problems with permeability and/or phytotoxicity.
Above 15--Permeability problems are likely on all mineral soils except those with an SP below 20. Most crops show phytotoxicity

4.4 Soils Discussion

Salinity is a soil property referring to the amount of soluble salt in the soil. It is generally a problem of arid and semiarid regions. Electrical conductivity (EC) is the most common measure of soil salinity and is indicative of the ability of an aqueous solution to carry an electric current. Plants are detrimentally affected, both physically and chemically, by excess salts in some soils and by high levels of exchangeable sodium in others. Soils with an accumulation of exchangeable sodium are often characterized by poor structure and low permeability making them unfavorable for plant growth.

By agricultural standards, soils with an EC greater than 4 dS/m are considered saline. In actuality, salt-sensitive plants may be affected by conductivities less than 4 dS/m and salt tolerant species may not be impacted by concentrations of up to twice this maximum agricultural tolerance limit.

Information about the conditions required by native species in the arid southwest has been painstakingly collected over the last several decades on numerous restoration projects. The native species requirements data presented in Table 4 was collected at Bosque del Apache NWR and generally supports the conclusion presented in Anderson, Russell, and Ohmart's "Riparian Revegetation" (2004).

Table 4. Salinity, Soil and Water Table Planting Requirements for Selected Riparian Species at Bosque del Apache National Wildlife Refuge, New Mexico.

Species	**Soil EC (dS/m)**	**Soil Type**	**Water Table Depth (ft)**
Cottonwood	<1.0-2.5	Sandy-Loamy	4.9-12.8
Black Willow	<1.0 -2.9	Sandy- Clay Loam	3.9-10.2
New Mexico Olive	<1.0-2.5	Sandy-Loamy	<3.9
Skunkbush Sumac	<1.0-2.5	Sandy-Loamy	<3.9
Sliver Buffaloberry	<1.0-2.5	Loamy- Clay Loam	<3.9
Screwbean Mesquite	3.0 -7.99	Clay Loam – Clay	<3.9
Wolfberry	3.0 -7.99	Sandy-Loamy	<3.9
Four-Wing Saltbush	8.0-13.99	Sandy-Loamy	<3.9-6.4

Nitrate numbers are quite high. This is in contrast to the high ammonium and low nitrate numbers seen in the water quality analysis. These numbers would be consistent with high inputs of ammonium associated with either agricultural runoff or mine drainage carried into the marsh in the Arnett ditch. The ammonium is subsequently oxidized to nitrate by soil microbes in a process known as nitrification.

While the NRCS mapped soil series at the site do have elevated ECs (Indio and Cristobal have saline or sodic subsoils in the range of 16-32 dS/m), the soils sampled at the Hart Mine Marsh have ECs that are substantially higher than predicted by the NRCS. The high Ecs are presumably due to the lack of flushing which has exacerbated the problem. The high EC of the soils at the Hart Mine Marsh present a serious constraint to restoration at the site. Management will have to include a long-term salt salinity reduction program.

5.0 VEGETATION INVENTORY

April of 2006, the USFWS Region 2 Habitat and Population Evaluation Team (HAPET) completed a comprehensive spatial vegetation inventory of the 646 acre Hart Mine Marsh unit on Cibola NWR (see Figure 8). The inventory was conducted over 2 days in which field crews collected data across the Unit. Data were collected utilizing a sample design (plots) derived from an object based classifier generated from a 2001 1–foot GSD color infrared image. Field crews used handheld GPS field computers to navigate to and record plot (polygon) plant community, species, species density and structure. Community, species and structural classifications were derived through ocular estimations while in the field. Over 70 percent of the Unit area was classified during the field data collection portion of the inventory. The remainder of the area was classified through photo interpretation. Photo interpretation was conducted at a level of direct recognition, using the filed data as the training source. Because of the high percentage field data collected and level of recognition used in the photo interpretation process an accuracy assessment was not conducted. The overall accuracy can be assumed to be > 90%.

Plant communities were classified to the Association level of the National Vegetation Classification System (NVCS). The Association level is the most detailed level of NVCS. It classifies plant communities at the floristic level, identifying the dominate species at multiple strata of the plant community.
Hink-Omart structural classification was used to record plant community structure.

A total of 8 different plant communities were identified and associated with 3 distinct landforms occurring in the unit (Figure 8). The majority of the Unit encompasses the historic Colorado River floodplain. Over 80% of this area has been invaded by mixed and monotypic stands of Salt Cedar *(Tamarix ssp.)*. The densest and most robust stands of Salt Cedar were found the areas adjacent to active water channels and in lower elevation areas that appeared to pool surface water. Areas directly adjacent to open water or currently active channels contained areas of tall emergent plant communities

Figure 8. Vegetation Inventory of the Hart Mine Marsh

dominated by Cattail *(Typha ssp.)* and *(Schoenoplectus ssp.)* Bull Rush (See Appendix 5 for a table of vegetation communities and acreage).

The plant communities on the east central portion of the marsh are influenced by alluvial deposition (alluvial fan) resulting from an arroyo entering the historic floodplain from the east. This portion of the site contains the most plant diversity and appears to be closest to functioning within the natural process of the system, although plant community composition may seem to indicate possible influences from adjacent man made perturbations and disruptions in natural hydrological processes. The eastern edge of this area is woodland dominated by Mesquite *(Prosopis (glandulosa var. torreyana, velutina)* and Wolfberry *(Lycium ssp.)*. Further west the area transitions from a course alluvial aggregate to fine. The toe of the alluvial fan is dominated by Iodinebush *(Allenrolfea occidentalis)* and areas of sparse Salt Cedar.

A relatively small portion of the southeast corner of the unit can be classified as upland. This area is mesa top disconnected form the floodplain. It is dominated by sparse Creosote bush *(Larrea tridentate)* and little else.

6.0 HART MINE MARSH RESTORATION POTENTIAL

There is an array of possible Hart Mine Marsh restoration alternatives, and corresponding development and management efforts, ranging from fairly passive to intensely active. Obviously, active alternatives likely entail commitment of greater resources, but are probable to yield greater value. Any alternatives developed must meet both the Cibola NWR's needs and the goals and objectives of the LCR MSPCP program.

Any restoration effort at Hart Mine Marsh must involve a commitment of resources to create and maintain the project in the form of funding, personnel, and water. In essence, personnel is actually a funding issue, so resources can be simplified to equal money and water. Since grant money is not commonly available for operations, the decision to restore all or a portion of Hart Mine Marsh will require a long-term commitment of these resources by the federal government to ensure project success.

Habitat types making up a restoration project at Hart Mine Marsh can be broadly categorized as riparian/woody revegetation, seasonal/moist soil wetlands, permanent water, or crops. The portion of each type of habitat is partially dictated by local conditions, including the variables of soil texture, soil chemistry, and depth to groundwater. Of these characteristics, soil chemistry is easily the most feasible variable to change or modify (yet still far from easy…). Since habitat type and local conditions are not always compatible (e.g. ponded water in coarse sands, riparian vegetation in saline soils), some area/habitat combinations can be "ruled out" early in the decision making process. Afterward, decisions become more preference based.

6.1 Hart Mine Marsh: Restoration Alternatives

It should be re-emphasized that it is highly probable that this project will only move forward if it addresses the needs of the refuge and the LCR MSPCP, and be feasible with available resources. Since water availability is relatively predictable and perhaps the most rigid of the resources, restoration alternatives were developed based on water. Restoration alternatives can be broadly defined as described herein:

1. **Alternative 1 - Arnett Ditch Supply :** This alternative assumes that only passive water (water from Arnett Ditch, seepage water from Farm Unit 2, standing groundwater) would be used to restore the marsh. Water could be lifted from the ditch mechanically, or simply raised with water control structures and diverted via gravity into select units. Re-routing of the Arnett Ditch so it drains directly into the marsh has been discussed. Under this alternative, no direct delivery of diverted river water to the marsh would occur. Depending on the type of habitat developed (e.g. marsh, riparian or mesquite), some conveyance facilities (pumps, pipe, etc.) may be required.

2. **Alternative 2 – Combination Arnett Ditch and River Water Supply:** This alternative would include using a combination of Arnett Ditch water and water from a Colorado River water diversion. Existing Farm Unit 2 gravity conveyance systems could be extended to newly developed areas in the marsh. Ideally, water from the ditch would be combined with river water in the conveyance system to improve the quality of the ditch water, which would likely require mechanical lifting.

3. **Alternative 3 – River Water Supply:** This alternative would use river water solely from expansion of existing diversion and conveyance facilities. Similar to Alternative 2, Farm Unit 2's water conveyance systems would be extended to newly developed areas. This alternative would provide the highest quality of water for the project, but would likely entail the highest costs (e.g., pumping costs, etc.). Fully separating Hart Mine Marsh from all drain waters is likely to provide maximum improvement of marsh conditions, and should be considered if direct river diversions are the exclusive source of water for the project.

6.2 Hart Mine Marsh: Water Budget Discussion

The water demands associated with restoration efforts at Hart Mine Marsh can vary widely with: (1) acres of habitat developed, (2) type of habitat developed, and (3) management/objectives of habitat. However, for initial planning purposes, it is assumed that the average water use for the project will reflect that found elsewhere on the refuge.

River water that can be legally diverted and utilized by the project is a potential constraint to Alternatives 2 and 3. As discussed earlier in this document, there is approximately 6,474 acre-feet of discretionary entitlement water available for new restoration efforts on the refuge, or approximately 895 acres of land with water.[8] While the entire Hart Mine Marsh unit is approximately 646 acres[9], it is estimated that some 123 acres are upland in nature, and not considered part of the proposed marsh restoration area.[10]

Thus, the initial estimate of acres at Hart Mine Marsh that have the potential to support marsh habitat is approximately 523 acres, which equates to roughly 81% of the unit. Further, if the water demand of 7.23 acre-feet per acre is applied to the 523 acres, it is roughly estimated that an annual volume of water required will be 3,781 acre-feet per annum. This volume of water represents 58% of the 6,474 acre-feet that is estimated as the amount of available water that Cibola NWR has to support ALL future projects. Alternatives 1 and 2 include use of Arnett Ditch water.

Due to the high salinity content found in the soil at Hart Mine Marsh, and the relatively high salinity content of the return water (as well as other water quality concerns associated with the ditch), the authors recommend that over the next months a priority be placed upon better characterizing the advantages and disadvantages associated with using Arnett Ditch water to support the restoration of Hart Mine Marsh.

It is suggested that the feasibility of re-routing the drain water such that it is returned to the river be evaluated. The returned water could potentially be measured and deducted from the refuge's diversion entitlement, thereby allowing additional diversions. Since Arnett Ditch's flow is not measured, the potential credit is not quantifiable at this time. Depending on the measured return flow credit from Arnett Ditch water, and the type of habitat developed, it is plausible that full restoration of the Hart Mine Marsh could proceed based on Alternative 3's assumptions.

It is important to emphasize that the provisional water budget analysis put forth in this document is believed to be conservative in nature, especially in that it did not assess the potential use of water from the Arnett Ditch (which has an unknown volume) nor from the 7,500 acre-feet per year circulatory water right the refuge possess (an entitlement that has never been put to explicit use).

It is the Service's understanding that the LCR MSCP is looking at the Hart Mine Marsh project to support approximately 100 acres of marsh habitat that would be have mitigation credit associated with it. Hence, the assessed maximum acreage for marsh habitat of 523 acres is likely to be in excess of what would be directly associated with the LCR MSCP program.

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[8] Assumes 7.23 acre-feet per acre annual demand.
[9] Hart Mine Marsh area does not include areas west of the Arnett Ditch and east of the Colorado River.
[10] Higher ground on the southeast side of the marsh (above 218') would be difficult to irrigate with existing
gravity conveyance systems, and would be difficult to flood irrigate due to steep topography.

6.3 Hart Mine Marsh Restoration: Conclusions

The existing conditions report met Goal 1, which is to determine if the restoration of the Hart Mine Marsh is compatible with both the objectives of the LCR MSCP and objectives and resources available to the Cibola National Wildlife Refuge. It appears that restoration of the marsh is possible and can be designed to meet the objectives of the LCR MSCP and the refuge. While there are constraints (e.g. high salinity) to restoration of the marsh, there are well established methodologies with reclaiming saline/sodic soils.

It also appears that restoration of the marsh is compatible with water quantities available to the refuge. Because the restoration of the marsh will require the flushing of substantial amounts of salts out of the marsh, the design will have to include protection of water quality in Cibola Lake if the project is to be compatible with the overall objectives of the refuge. The refuge does have an entitlement to 7,500 acre feet of water for circulation purposes which may be needed to protect water quality in the lake.

The report met Goal 2, which is to describe data gathered to inform the design of the restoration plan and identify opportunities and constraints for restoration. The data described in the report will be essential to the development of the restoration plan. One section that will require further data gathering and analysis is hydrology. To fully characterize seasonal groundwater profiles and agricultural runoff and returns will require monitoring over a longer period of time (e.g., complete yearly cycle).

The report did identify and quantify several important constraints that will have to be taken into account in the preparation of the restoration plan for the marsh. Water quality in the Arnett Ditch and lack of circulation back to the river are major concerns which have exacerbated soil salinity and may cause ammonium toxicity in both the restored marsh and Cibola Lake.

An additional major constraint is the lack of an effective means to control water elevations and delivery of water to the marsh, and to evacuate water form the marsh. The area’s low slope and minimal differences in relative heads are important site considerations, as is the need to promote a mosaic of habitats and an effective method to flush salts.

It is highly recommended that the selected restoration approach provides the maximum amount of management flexibility. Achievement of this goal is best facilitated by robust infrastructure improvements associated with water delivery and control. The greatest degree of flexibility would be gained by having multiple options for water control, associated with both the inflow and outflow portions of the project’s infrastructure. While detailing these elements is beyond the scope of this report, effective infrastructure improvements that allow for managing for a wide array of conditions is deemed critical if restoration efforts are to be successful.

The report met Goal 3, which is to describe data gathered that will provide the baseline for the development of success criteria for the restoration project and long-term monitoring of the project. In particular, the vegetation mapping and soil data compiled in this report will serve as the baseline to compare pre-project and post-project conditions.

Project Timeline

- A Wetland Review Workshop is scheduled to meet in April 10-12, 2007 to discuss the project's options;
- Data acquisition will continue through summer 2007;
- Final *Comprehensive Conceptual Restoration Plan for Hart Mine Marsh* is due in September 2007;
- The Service and Reclamation will hold a meeting in early FY08 to discuss next steps.

Final Conclusion

After review of the data compiled in this report, our initial assessment indicates that the proposed project is both feasible and likely to meet the goals and objectives of the LCR MSCP and the National Wildlife Refuge Service.

7.0 Existing Conditions Report: List of Figures and Tables

8.0 Existing Conditions Report: BIBLIOGRAPHY

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9.0 Existing Conditions Report: APPENDICES

(available under separate cover)

9.1 Appendix 1. Topography: Contour Maps & USBR Survey

9.2 Appendix 2. Geomorphic Assessment (WL & Associates)

9.3 Appendix 3. Water Quality Lab Results and xls File

9.4 Appendix 4. Soils

9.5 Appendix 5. HMM Vegetation Communities and Acreages

9.1 Appendix 1 -- Topography: Contour Maps & USBR Survey

9.11 Appendix 1 Topographic Contour Map (1 of 2)

9.12 Appendix 1 Topographic Contour Map (2 of 2)

9.13 Appendix 1 USBR Hart Mine Marsh Survey

MATCH LINE SEE SHEET 2

PROJECT NO.	-
DESIGNED BY:	-
DRAWN BY:	PG
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DATE	1/17/07
SHEET	1 OF 2

CIBOLA NWR
HART MINE MARSH
ESTIMATED CONTOURS

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MATCH LINE SEE SHEET 1

PROJECT NO.	-
DESIGNED BY:	-
DRAWN BY:	RS
SURVEYED BY:	USBR
CHECKED BY:	
DATE	1/17/07
SHEET	2 OF 2

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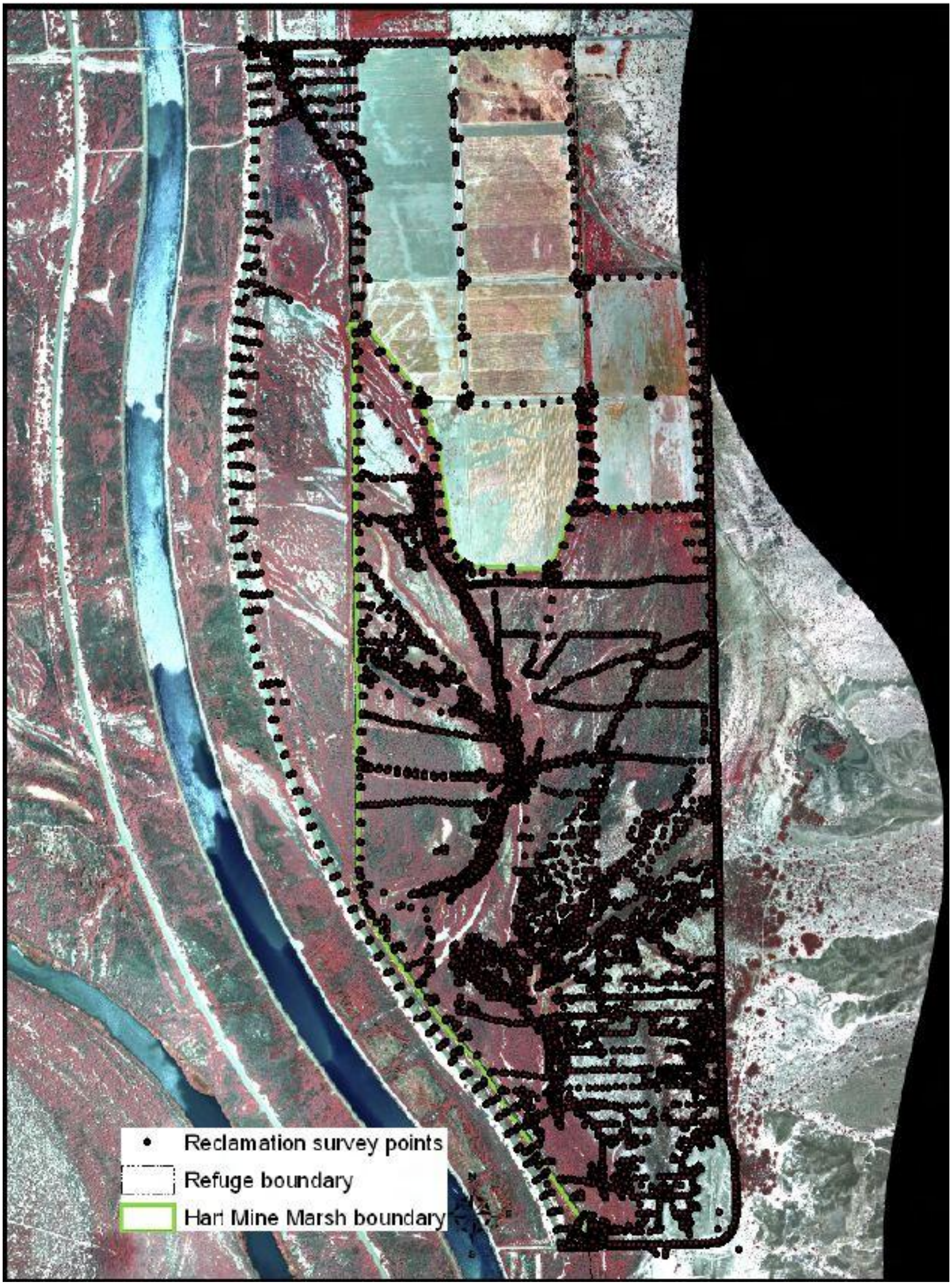
Reclamation survey points
Refuge boundary
Hart Mine Marsh boundary

9.2 Appendix 2 -- Geomorphic Assessment (4 page letter from William Lettis & Associates)

WLA
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October 20, 2006

Mr. Darrell Kundargi
Hydrologist
U.S. Fish and Wildlife Service
Branch of Water Resources
500 Gold Street SW, Ste 9016
Albuquerque, NM 87102

Subject: **Surficial Geologic Map of the Hartmine restoration Area, Cibola National Wildlife Refuge, Arizona**

Dear Mr. Kundargi:

William Lettis & Associates, Inc. is pleased to provide this letter and GIS database that summarizes our surficial geologic mapping of floodplain deposits within the Hartmine Restoration area of the Lower Colorado River in Cibola National Wildlife Refuge, Arizona. This project is designed to help land managers and scientists effectively characterize, monitor and restore this area. We provide the surficial mapping as a GIS database (see attached shape files).

Our approach in delineating the surficial deposits in the Hartmine Restoration area was to analyze 1938 aerial photography and input the geologic interpretation into a GIS. We utilized black and white aerial photography taken in April, 1938 and geo-rectified in 2006 as part of a USGS open-file report (Norman et al., 2006). Infra-red imagery taken in 2004 also were reviewed for additional detail, although the mapped units were based on deposits visible on the 1938 photographs. In conjunction with the analysis of aerial photography, the USGS 7.5-minute Picacho NW quadrangle topographic map was used to assess deposit boundaries and landform origin. Map units were delineated through interpretation of planform patterns, tonal contrasts and elevation differences. Vegetation type, alignments, and densities also provided information from which to differentiate map units. We developed surficial geology map units on the basis of recent similar mapping projects in the inner Rio Grande valley (Pearce and Kelson, 2003). This mapping effort was entirely an office-based analysis of aerial photographs and did not include field verification of mapped units. The GIS database delivered is a polygon shape file and associated metadata. Each polygon feature is attributed with a name and description of the mapped unit. The digital database was created in ArcMap 9.1 and is provided in State Plane Coordinates, NAD 83.

Results

The geologic units mapped were classified on the basis of both genetic origin and age, as best interpreted from the aerial photography. On the 1938 imagery, we identified deposits and landforms that reflect active fluvial processes, as well as deposits and landforms that are late Pleistocene (tens of thousands of years old), late Holocene (within the past few thousand years) or recent (within the past couple of centuries).

Fluvial deposits directly associated with historic or paleo-channels of the Colorado River are grouped into two map units for each deposit-age group. These two groups include deposits associated with: outside channel bends (Hcb) and crevasse splays (Hcs). Deposits derived from tributary arroyos draining into the inner Colorado River Valley are designated by Hfa (Holocene alluvial fan) or Pfa

(Pleistocene alluvial fan). Modern channels are differentiated as Rch (Recent channels). In some locations, the genetic origin of individual alluvial deposits was not easily distinguished, as a result of indistinct signatures on the imagery or dense vegetation. In the absence of field investigation, specific unit designation is not possible. These undifferentiated Holocene alluvial deposits are therefore designated as "Hal".

In addition to delineating surficial geologic deposits within the inner Colorado River valley, we note the generalized characteristics of vegetation within each map polygon. As noted above, we base this simple characterization on the type and density of vegetation land cover determined from the 1938 vintage imagery. Similar to the classification used by Pearce and Kelson (2003)m the vegetation classes are defined as follows:

Class 0	Water
Class 1	Bare soil
Class 2	Bare soil and grasses
Class 3	Grasses
Class 4	Grasses and shrubs
Class 5	Mixed grass, shrubs and trees
Class 6	Low-density trees and shrubs
Class 7	High-density trees and shrubs
Class 8	Disturbed lands

Our intent with this classification scheme is to (1) differentiate geologic map units associated with distinct vegetation types and densities, and (2) provide a relative numerical scale that reflects a general succession of vegetation development on fluvial deposits in the inner valley. For example, cross-cutting fluvial relationships in the inner valley suggest that relatively younger deposits are associated with Classes 1, 2, or 3, and relatively older deposits are associated with Classes 5, 6, or 7. Our intent in developing this numerical classification is that the database will be used for identifying any possible correlations between vegetation characteristics and geologic map units, and for analyzing progressive changes in vegetation through time. This effort refines a similar classification completed by Hendrickx and Harrison (2000) and Pearce and Kelson (2003) for the Rio Grande Valley and in central New Mexico.

Observations

Although this map was generated based on the land features visible in the 1938 aerial photos, some comparisons with the 2004 satellite imagery were noted. Changes in vegetation within the Hartmine Restoration area are the most significant difference visible between the 1938 photos and the 2004 photos. The changes in vegetation are due in part to the encroachment of the invasive phreatophyte, tamarisk, (salt cedar). Another obvious vegetation change is the area along the northwestern edge of the study area which was cleared for agriculture in the late 1930's but is vegetated in the 2004 imagery. Other changes could be linked to seasonal variations or water table variations.

There are only a few subtle changes in the actual geomorphic landforms during this same time period. Because this area has not been developed, the same processes that were sculpting the land forms in the late 1930's are still active today. For example, the crevasse splays present in the southwest corner of section five were distinguishable mainly from the vegetation patterns on the 2004 maps. It is presumed that these were originally formed by the Colorado River when it was still flowing along this particular channel bend. The crevasse splays were, therefore, present in the 1938 and are mapped as such, even though they are not as easily distinguished in the 1938 photos. Several of the channels visible in the 1938 photos are much more pronounced in the 2004 photo particularly in the area just north of the mapped crevasse splays. Again, this type of change could be a result of water table changes due to seasonal variations between the photos or invasion of tamarisk, as opposed to geomorphic changes in stream positions.

It has been a pleasure to provide this information to the USFWS. If there are any questions or if we can be of further assistance, please do not hesitate to call either of the undersigned,

Respectfully,
WILLIAM LETTIS & ASSOCIATES, INC.

Keith I Kelson, C.E.G.
Principal Geologist

Anne C. Tillery, C.F.M.
Senior Staff Geologist

Enclosure (GIS shapefiles)

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9.3 Appendix 3 -- Water Quality Lab Results (28 pages) and spreadsheet file

AQUATIC CONSULTING & TESTING, INC.

1525 W. University Drive, Suite 106
P.O. Box 1510
Tempe, Arizona 85281
Phone: (480) 921-8044 • FAX: (480) 921-0049

Lic. No. AZ0003

27 September 2006

Mr. Darrell Kundargi
US Fish and Wildlife Service
500 Gold Avenue Southwest
Albuquerque, New Mexico 87102

Attached please find the results for the samples submitted on 16 August 2006. Data packages are also included for subcontracted organic analyses.

Please note that some dissolved metals are slightly higher than total metals. We believe that the difference is the result of slightly different concentrations in the two separate samples (one for total and one for dissolved metals processing) collected. Should you wish us to check the total concentration on the non-preserved sample from which the dissolved values were obtained, please contact us and we would be happy to do so at your request. Please note that in those cases, both dissolved and total concentrations detected were well below any of the surface water maximum levels.

Please also note that the laboratory PQL for mercury is 0.5 ug/L and the chronic A&W maxima are as low as 0.01 ug/L. Measurement at that level requires ultra clean sampling techniques and ultra low level mercury analysis.

For those metal constituents with Arizona surface water standards, a table has been attached showing the results and the maximum level for each designated use.

Respectfully,

Frederick A. Amalfi, Ph.D.
Laboratory Director

Designated Use	As, max ug/L	Hg, max ug/L	Se, max ug/L
DWS	50 T	2 T	50 T
FC	1450 T	0.6 T	9000 T
FBC	50 T	420 T	7000 T
PBC	420 T	420 T	7000 T
AgI	2000 T	NNS	20 T
AgL	200 T	10 T	50 T
Sample AZ	4 T	<0.5 T	<2 T
Sample A1	<2 T	<0.5 T	<2 T
Sample A3	<2 T	<0.5 T	<2 T
A&Wc Acute	360 D	2.4 D	20 T
A&Wc Chronic	100 D	0.01 D	2.0 T
A&Ww Acute	360 D	2. D	20 T
A&Ww Chronic	190 D	0.01 D	2.0 T
A&Wedw Acute	360 D	2.6 D	50 T
A&Wedw Chronic	190 D	0.2 D	2.0 T
A&We Acute	440 D	5.0 D	33 T
Sample AZ	8 D	<0.5 D	<2 T
Sample A1	5 D	<0.5 D	<2 T
Sample A3	2 D	<0.5 D	<2 T

Limits from Title 18, Chapter 11, Section109 Numeric Water Quallity Standards. Arizona Administrative Code 2002. NNS= no numeric standard

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Tempe, Arizona 85281
Phone: (480) 921-8044 • FAX: (480) 921-0049

Lic. No. AZ0003

LABORATORY REPORT

Client: U.S. Fish & Wildlife Service
500 Gold Avenue SW
Albuquerque, NM 87102

Date Submitted: 08/16/06
Date Reported: 09/27/06

Attn: Darrell Kundargi

Project: HMM

RESULTS

Client ID: A2
ACT Lab No.: BN09538

Sample Type: Surface Water
Sample Time: 08/15/06 13:00

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Alkalinity, Total	08/17/06	08/17/06	SM 2320 B	138.	mg/L as CaCO3
Ammonia - N	08/22/06	08/22/06	350.2	0.35	mg/L as N
Chloride	08/17/06	08/17/06	325.3	707.	mg/L
Nitrate + Nitrite - N	08/22/06	08/22/06	SM4500NO3 E	0.08	mg/L as N
Phosphorus, Total	08/18/06	08/18/06	365.3	0.541	mg/L as P
Sulfate	08/28/06	08/28/06	SM4500SO4 D	581.	mg/L
Total Kjeldahl Nitrogen	08/24/06	08/24/06	351.3	2.67	mg/L as N
Arsenic, Dissolved	09/14/06	09/14/06	200.9	0.008	mg/L
Arsenic, Total	09/01/06	09/01/06	200.9	0.004	mg/L
Calcium, Dissolved	08/21/06	08/21/06	200.7	177.	mg/L
Calcium, Total	08/28/06	08/28/06	200.7	202.	mg/L
Magnesium, Dissolved	08/21/06	08/21/06	200.7	66.8	mg/L
Magnesium, Total	08/28/06	08/28/06	200.7	77.6	mg/L
Mercury, Dissolved	08/28/06	08/28/06	245.1	<0.0005	mg/L
Mercury, Total	08/28/06	08/28/06	245.1/7470A	<0.0005	mg/L
Selenium, Dissolved	08/29/06	08/29/06	200.9	<0.002	mg/L
Selenium, Total	08/29/06	08/29/06	200.9	<0.002	mg/L
Sodium, Dissolved	08/21/06	08/21/06	200.7	364.	mg/L
Sodium, Total	08/28/06	08/28/06	200.7	414.	mg/L
Chlorinated Pesticides	08/22/06	08/24/06	EPA 608	See Attached *	ug/L
Organophosphorus Pesticides	08/21/06	08/28/06	8141A	See Attached *	ug/L

RESULTS

Client ID: A1
ACT Lab No.: BN09539

Sample Type: Surface Water
Sample Time: 08/15/06 16:00

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Alkalinity, Total	08/17/06	08/17/06	SM 2320 B	223.	mg/L as CaCO3
Ammonia - N	08/22/06	08/22/06	350.2	0.09	mg/L as N
Chloride	08/17/06	08/17/06	325.3	2150.	mg/L
Nitrate + Nitrite - N	08/22/06	08/22/06	SM4500NO3 E	0.01	mg/L as N
Phosphorus, Total	08/18/06	08/18/06	365.3	0.114	mg/L as P
Sulfate	08/28/06	08/28/06	SM4500SO4 D	1060.	mg/L
Total Kjeldahl Nitrogen	08/24/06	08/24/06	351.3	1.31	mg/L as N
Arsenic, Dissolved	09/14/06	09/14/06	200.9	0.005	mg/L
Arsenic, Total	09/01/06	09/01/06	200.9	<0.002	mg/L
Calcium, Dissolved	08/21/06	08/21/06	200.7	413.	mg/L
Calcium, Total	08/28/06	08/28/06	200.7	466.	mg/L
Magnesium, Dissolved	08/21/06	08/21/06	200.7	126.	mg/L
Magnesium, Total	08/28/06	08/28/06	200.7	147.	mg/L
Mercury, Dissolved	08/29/06	08/29/06	245.1	<0.0005	mg/L
Mercury, Total	08/28/06	08/28/06	245.1/7470A	<0.0005	mg/L
Selenium, Dissolved	08/29/06	08/29/06	200.9	<0.002	mg/L
Selenium, Total	08/29/06	08/29/06	200.9	<0.002	mg/L
Sodium, Dissolved	08/21/06	08/21/06	200.7	1220.	mg/L
Sodium, Total	08/28/06	08/28/06	200.7	1140.	mg/L
Chlorinated Pesticides	08/22/06	08/24/06	EPA 608	See Attached *	ug/L
Organophosphorus Pesticides	08/21/06	08/28/06	8141A	See Attached *	ug/L

RESULTS

Client ID: A3
ACT Lab No.: BN09540

Sample Type: Surface Water
Sample Time: 08/15/06 16:50

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Alkalinity, Total	08/17/06	08/17/06	SM 2320 B	70.	mg/L as CaCO3
Ammonia - N	08/22/06	08/22/06	350.2	0.88	mg/L as N
Chloride	08/17/06	08/17/06	325.3	10700.	mg/L
Nitrate + Nitrite - N	08/22/06	08/22/06	SM4500NO3 E	0.05	mg/L as N
Phosphorus, Total	08/18/06	08/18/06	365.3	0.450	mg/L as P
Sulfate	08/28/06	08/28/06	SM4500SO4 D	3950.	mg/L
Total Kjeldahl Nitrogen	08/24/06	08/24/06	351.3	6.00	mg/L as N
Arsenic, Dissolved	09/14/06	09/14/06	200.9	0.002	mg/L
Arsenic, Total	09/01/06	09/01/06	200.9	<0.002	mg/L
Calcium, Dissolved	08/21/06	08/21/06	200.7	1350.	mg/L
Calcium, Total	08/28/06	08/28/06	200.7	1490.	mg/L
Magnesium, Dissolved	08/21/06	08/21/06	200.7	517.	mg/L
Magnesium, Total	08/28/06	08/28/06	200.7	518.	mg/L
Mercury, Dissolved	08/29/06	08/29/06	245.1	<0.0005	mg/L
Mercury, Total	08/28/06	08/28/06	245.1/7470A	<0.0005	mg/L
Selenium, Dissolved	08/29/06	08/29/06	200.9	<0.002	mg/L
Selenium, Total	08/29/06	08/29/06	200.9	<0.002	mg/L
Sodium, Dissolved	08/21/06	08/21/06	200.7	4220.	mg/L
Sodium, Total	08/28/06	08/28/06	200.7	4860.	mg/L
Chlorinated Pesticides	08/22/06	08/24/06	EPA 608	See Attached *	ug/L
Organophosphorus Pesticides	08/21/06	08/28/06	8141A	See Attached *	ug/L

* Analysis performed by Test America (AZ0426)

Reviewed by: ______________________
Frederick A. Amalfi, Ph.D.
Laboratory Director

TestAmerica
ANALYTICAL TESTING CORPORATION

LABORATORY REPORT

Prepared For: Aquatic Consulting & Testing
1525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project:USFWS-NM / HMM

Sampled: 08/15/06
Received: 08/17/06
Issued: 08/28/06 14:11

NELAP #01109CA California ELAP#2446 Arizona DHS#AZ0426 Nevada #AZ907

The results listed within this Laboratory Report pertain only to the samples tested in the laboratory. The analyses contained in this report were performed in accordance with the applicable certifications as noted. All soil samples are reported on a wet weight basis unless otherwise noted in the report. This Laboratory Report is confidential and is intended for the sole use of TestAmerica and its client. This report shall not be reproduced, except in full, without written permission from TestAmerica. The Chain of Custody, 1 page, is included and is an integral part of this report.
This entire report was reviewed and approved for release.

CASE NARRATIVE

LABORATORY ID	CLIENT ID	MATRIX
PPH0509-01	BN-09538	Water
PPH0509-02	BN-09539	Water
PPH0509-03	BN-09540	Water

SAMPLE RECEIPT: Samples were received intact, at 2°C, on ice and with chain of custody documentation.

HOLDING TIMES: All samples were analyzed within prescribed holding times and/or in accordance with the TestAmerica Sample Acceptance Policy unless otherwise noted in the report.

PRESERVATION: Samples requiring preservation were verified prior to sample analysis.

QA/QC CRITERIA: All analyses met method criteria, except as noted in the report with data qualifiers.

COMMENTS: No significant observations were made.

SUBCONTRACTED: Refer to the last page for specific subcontract laboratory information included in this report.

Reviewed By:

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

Aquatic Consulting & Testing
1525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: USFWS-NM / HMM

Report Number: PPH0509

Sampled: 08/15/06
Received: 08/17/06

ORGANOCHLORINE PESTICIDES (EPA 608)

Analyte A2	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PPH0509-01 (BN-09538 - Water)								
Reporting Units: ug/l								
Aldrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
alpha-BHC	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
beta-BHC	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
delta-BHC	EPA 608	6H22055	0.20	ND	1	8/22/2006	8/24/2006	
gamma-BHC (Lindane)	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Chlordane	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/24/2006	
4,4'-DDD	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
4,4'-DDE	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
4,4'-DDT	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Dieldrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan I	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan II	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan sulfate	EPA 608	6H22055	0.20	ND	1	8/22/2006	8/24/2006	
Endrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endrin aldehyde	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endrin ketone	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Heptachlor	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Heptachlor epoxide	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Methoxychlor	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Toxaphene	EPA 608	6H22055	5.0	ND	1	8/22/2006	8/24/2006	
Surrogate: Tetrachloro-m-xylene (35-115%)				*55 %*				
Surrogate: Decachlorobiphenyl (45-120%)				*68 %*				

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

Aquatic Consulting & Testing 1525 W. University, Suite 106 Tempe, AZ 85281 Attention: Chris Christian	Project ID: USFWS-NM / HMM Report Number: PPH0509	Sampled: 08/15/06 Received: 08/17/06

ORGANOCHLORINE PESTICIDES (EPA 608)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PPH0509-02 (BN-09539 - Water) A1								
Reporting Units: ug/l								
Aldrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
alpha-BHC	EPA 608	6H22055	0.10	**0.94**	1	8/22/2006	8/24/2006	
beta-BHC	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
delta-BHC	EPA 608	6H22055	0.20	ND	1	8/22/2006	8/24/2006	
gamma-BHC (Lindane)	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Chlordane	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/24/2006	
4,4'-DDD	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
4,4'-DDE	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
4,4'-DDT	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Dieldrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan I	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan II	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan sulfate	EPA 608	6H22055	0.20	ND	1	8/22/2006	8/24/2006	
Endrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endrin aldehyde	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endrin ketone	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Heptachlor	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Heptachlor epoxide	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Methoxychlor	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Toxaphene	EPA 608	6H22055	5.0	ND	1	8/22/2006	8/24/2006	
Surrogate: Tetrachloro-m-xylene (35-115%)				*61 %*				
Surrogate: Decachlorobiphenyl (45-120%)				*71 %*				

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

Aquatic Consulting & Testing
1525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: USFWS-NM / HMM

Report Number: PPH0509

Sampled: 08/15/06
Received: 08/17/06

ORGANOCHLORINE PESTICIDES (EPA 608)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PPH0509-03 (BN-09540 - Water)								
Reporting Units: ug/l								
Aldrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
alpha-BHC	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
beta-BHC	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
delta-BHC	EPA 608	6H22055	0.20	ND	1	8/22/2006	8/24/2006	
gamma-BHC (Lindane)	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Chlordane	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/24/2006	
4,4'-DDD	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
4,4'-DDE	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
4,4'-DDT	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Dieldrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan I	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan II	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endosulfan sulfate	EPA 608	6H22055	0.20	ND	1	8/22/2006	8/24/2006	
Endrin	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endrin aldehyde	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Endrin ketone	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Heptachlor	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Heptachlor epoxide	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Methoxychlor	EPA 608	6H22055	0.10	ND	1	8/22/2006	8/24/2006	
Toxaphene	EPA 608	6H22055	5.0	ND	1	8/22/2006	8/24/2006	
Surrogate: Tetrachloro-m-xylene (35-115%)				*48 %*				
Surrogate: Decachlorobiphenyl (45-120%)				*64 %*				

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

Aquatic Consulting & Testing
1525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: USFWS-NM / HMM
Report Number: PPH0509

Sampled: 08/15/06
Received: 08/17/06

TOTAL PCBS (EPA 608)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PPH0509-01 (BN-09538 - Water)								
Reporting Units: ug/l								
Aroclor 1016	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1221	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1232	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1242	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1248	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1254	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1260	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Surrogate: Decachlorobiphenyl (45-120%)				*77 %*				
Sample ID: PPH0509-02 (BN-09539 - Water)								
Reporting Units: ug/l								
Aroclor 1016	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1221	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1232	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1242	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1248	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1254	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1260	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Surrogate: Decachlorobiphenyl (45-120%)				*92 %*				
Sample ID: PPH0509-03 (BN-09540 - Water)								
Reporting Units: ug/l								
Aroclor 1016	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1221	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1232	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1242	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1248	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1254	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Aroclor 1260	EPA 608	6H22055	1.0	ND	1	8/22/2006	8/22/2006	
Surrogate: Decachlorobiphenyl (45-120%)				*69 %*				

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

Aquatic Consulting & Testing
1525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: USFWS-NM / HMM

Report Number: PPH0509

Sampled: 08/15/06
Received: 08/17/06

METHOD BLANK/QC DATA

ORGANOCHLORINE PESTICIDES (EPA 608)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 6H22055 Extracted: 08/22/06										
Blank Analyzed: 08/22/2006 (6H22055-BLK1)										
Aldrin	ND	0.10	ug/l							
alpha-BHC	ND	0.10	ug/l							
beta-BHC	ND	0.10	ug/l							
delta-BHC	ND	0.20	ug/l							
gamma-BHC (Lindane)	ND	0.10	ug/l							
Chlordane	ND	1.0	ug/l							
4,4'-DDD	ND	0.10	ug/l							
4,4'-DDE	ND	0.10	ug/l							
4,4'-DDT	ND	0.10	ug/l							
Dieldrin	ND	0.10	ug/l							
Endosulfan I	ND	0.10	ug/l							
Endosulfan II	ND	0.10	ug/l							
Endosulfan sulfate	ND	0.20	ug/l							
Endrin	ND	0.10	ug/l							
Endrin aldehyde	ND	0.10	ug/l							
Endrin ketone	ND	0.10	ug/l							
Heptachlor	ND	0.10	ug/l							
Heptachlor epoxide	ND	0.10	ug/l							
Methoxychlor	ND	0.10	ug/l							
Toxaphene	ND	5.0	ug/l							
Surrogate: Tetrachloro-m-xylene	*0.360*		*ug/l*	*0.500*		*72*	*35-115*			
Surrogate: Decachlorobiphenyl	*0.448*		*ug/l*	*0.500*		*90*	*45-120*			
LCS Analyzed: 08/23/2006 (6H22055-BS1)										**Q8**
Aldrin	0.400	0.10	ug/l	0.500		80	35-120			
alpha-BHC	0.440	0.10	ug/l	0.500		88	45-120			
beta-BHC	0.473	0.10	ug/l	0.500		95	50-120			
delta-BHC	0.503	0.20	ug/l	0.500		101	50-120			
gamma-BHC (Lindane)	0.432	0.10	ug/l	0.500		86	40-120			
4,4'-DDD	0.577	0.10	ug/l	0.500		115	55-120			
4,4'-DDE	0.473	0.10	ug/l	0.500		95	50-120			
4,4'-DDT	0.556	0.10	ug/l	0.500		111	55-120			
Dieldrin	0.473	0.10	ug/l	0.500		95	50-120			
Endosulfan I	0.431	0.10	ug/l	0.500		86	50-120			
Endosulfan II	0.470	0.10	ug/l	0.500		94	55-120			
Endosulfan sulfate	0.591	0.20	ug/l	0.500		118	60-120			

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

Aquatic Consulting & Testing 1525 W. University, Suite 106 Tempe, AZ 85281 Attention: Chris Christian	Project ID: USFWS-NM / HMM Report Number: PPH0509	Sampled: 08/15/06 Received: 08/17/06

METHOD BLANK/QC DATA

ORGANOCHLORINE PESTICIDES (EPA 608)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 6H22055 Extracted: 08/22/06										
LCS Analyzed: 08/23/2006 (6H22055-BS1)										Q8
Endrin	0.521	0.10	ug/l	0.500		104	55-120			
Endrin aldehyde	0.543	0.10	ug/l	0.500		109	55-120			
Endrin ketone	0.539	0.10	ug/l	0.500		108	55-120			
Heptachlor	0.410	0.10	ug/l	0.500		82	40-115			
Heptachlor epoxide	0.411	0.10	ug/l	0.500		82	50-120			
Methoxychlor	0.546	0.10	ug/l	0.500		109	55-120			
Surrogate: Tetrachloro-m-xylene	*0.378*		*ug/l*	*0.500*		*76*	*35-115*			
Surrogate: Decachlorobiphenyl	*0.509*		*ug/l*	*0.500*		*102*	*45-120*			
LCS Dup Analyzed: 08/22/2006 (6H22055-BSD1)										
Aldrin	0.371	0.10	ug/l	0.500		74	35-120	8	30	
alpha-BHC	0.401	0.10	ug/l	0.500		80	45-120	9	30	
beta-BHC	0.437	0.10	ug/l	0.500		87	50-120	8	30	
delta-BHC	0.445	0.20	ug/l	0.500		89	50-120	12	30	
gamma-BHC (Lindane)	0.403	0.10	ug/l	0.500		81	40-120	7	30	
4,4'-DDD	0.501	0.10	ug/l	0.500		100	55-120	14	30	
4,4'-DDE	0.421	0.10	ug/l	0.500		84	50-120	12	30	
4,4'-DDT	0.485	0.10	ug/l	0.500		97	55-120	14	30	
Dieldrin	0.431	0.10	ug/l	0.500		86	50-120	9	30	
Endosulfan I	0.402	0.10	ug/l	0.500		80	50-120	7	30	
Endosulfan II	0.438	0.10	ug/l	0.500		88	55-120	7	30	
Endosulfan sulfate	0.527	0.20	ug/l	0.500		105	60-120	11	30	
Endrin	0.469	0.10	ug/l	0.500		94	55-120	11	30	
Endrin aldehyde	0.495	0.10	ug/l	0.500		99	55-120	9	30	
Endrin ketone	0.494	0.10	ug/l	0.500		99	55-120	9	30	
Heptachlor	0.383	0.10	ug/l	0.500		77	40-115	7	30	
Heptachlor epoxide	0.387	0.10	ug/l	0.500		77	50-120	6	30	
Methoxychlor	0.512	0.10	ug/l	0.500		102	55-120	6	30	
Surrogate: Tetrachloro-m-xylene	*0.351*		*ug/l*	*0.500*		*70*	*35-115*			
Surrogate: Decachlorobiphenyl	*0.479*		*ug/l*	*0.500*		*96*	*45-120*			

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

Aquatic Consulting & Testing 1525 W. University, Suite 106 Tempe, AZ 85281 Attention: Chris Christian	Project ID: USFWS-NM / HMM Report Number: PPH0509	 Sampled: 08/15/06 Received: 08/17/06

METHOD BLANK/QC DATA

TOTAL PCBS (EPA 608)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 6H22055 Extracted: 08/22/06										
Blank Analyzed: 08/22/2006 (6H22055-BLK1)										
Aroclor 1016	ND	1.0	ug/l							
Aroclor 1221	ND	1.0	ug/l							
Aroclor 1232	ND	1.0	ug/l							
Aroclor 1242	ND	1.0	ug/l							
Aroclor 1248	ND	1.0	ug/l							
Aroclor 1254	ND	1.0	ug/l							
Aroclor 1260	ND	1.0	ug/l							
Surrogate: Decachlorobiphenyl	*0.479*		*ug/l*	*0.500*		*96*	*45-120*			
LCS Analyzed: 08/22/2006 (6H22055-BS2)										**Q8**
Aroclor 1016	3.43	1.0	ug/l	4.00		86	45-115			
Aroclor 1260	3.65	1.0	ug/l	4.00		91	55-115			
Surrogate: Decachlorobiphenyl	*0.433*		*ug/l*	*0.500*		*87*	*45-120*			
LCS Dup Analyzed: 08/22/2006 (6H22055-BSD2)										
Aroclor 1016	3.77	1.0	ug/l	4.00		94	45-115	9	30	
Aroclor 1260	4.16	1.0	ug/l	4.00		104	55-115	13	25	
Surrogate: Decachlorobiphenyl	*0.494*		*ug/l*	*0.500*		*99*	*45-120*			

LCS = Cab Control Standard

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

Aquatic Consulting & Testing
1525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: USFWS-NM / HMM

Report Number: PPH0509

Sampled: 08/15/06
Received: 08/17/06

DATA QUALIFIERS AND DEFINITIONS

Q8 Insufficient sample received to meet method QC requirements. Batch QC satisfies ADEQ policies 0154 and 0155.

ND Analyte NOT DETECTED at or above the reporting limit or MDL, if MDL is specified.

RPD Relative Percent Difference

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

Aquatic Consulting & Testing 1525 W. University, Suite 106 Tempe, AZ 85281 Attention: Chris Christian	Project ID: USFWS-NM / HMM Report Number: PPH0509	 Sampled: 08/15/06 Received: 08/17/06

Certification Summary

Subcontracted Laboratories

Aerotech Laboratories, Inc. *Arizona Cert #AZ0610*

1501 W Knudsen Drive - PHX, AZ 85027

Analysis Performed: 8141A-Full

Samples: PPH0509-01, PPH0509-02, PPH0509-03

TestAmerica - Irvine, CA *NELAC Cert #01108CA, California Cert #1197, Arizona Cert #AZ0671, Nevada Cert #CA72-2002-63*

17461 Derian Ave. Suite 100 - Irvine, CA 92614

Method Performed: EPA 608

Samples: PPH0509-01, PPH0509-02, PPH0509-03

TestAmerica - Phoenix, AZ
Linda Eshelman
Project Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

SUBCONTRACT ORDER - PROJECT # PPH0509

SENDING LABORATORY:	RECEIVING LABORATORY:
TestAmerica - Phoenix, AZ	TestAmerica - Irvine, CA
9830 South 51st Street, Suite B-120	17461 Derian Ave. Suite 100
Phoenix, AZ 85044	Irvine, CA 92614
Phone: (480) 785-0043	Phone :(949) 261-1022
Fax: (480) 785-0851	Fax: (949) 261-1228 IPH2110
Project Manager: Linda Eshelman	

Analysis	Expiration	Due	Comments
Sample ID: PPH0509-01 Water	**Sampled: 08/15/06 13:00**		
608 (Pest./PCBs)-I	08/22/06 13:00	08/28/06 12:00	Irvine
Containers Supplied:			
1 L Amber (PPH0509-01A)			
1 L Amber (PPH0509-01B)			
Sample ID: PPH0509-02 Water	**Sampled: 08/15/06 16:00**		
608 (Pest./PCBs)-I	08/22/06 16:00	08/28/06 12:00	Irvine
Containers Supplied:			
1 L Amber (PPH0509-02A)			
1 L Amber (PPH0509-02B)			
Sample ID: PPH0509-03 Water	**Sampled: 08/15/06 16:50**		
608 (Pest./PCBs)-I	08/22/06 16:50	08/28/06 12:00	Irvine
Containers Supplied:			
1 L Amber (PPH0509-03A)			
1 L Amber (PPH0509-03B)			

BT 8/19/06 1040

SAMPLE INTEGRITY:

All containers intact:	☑ Yes ☐ No	Sample labels/COC agree:	☑ Yes ☐ No	Samples Received On Ice::	☑ Yes ☐ No
Custody Seals Present	☐ Yes ☑ No	Samples Preserved Properly:	☑ Yes ☐ No	Samples Received at (temp):	/

Released By	Date	Time	Received By	Date	Time
[signature]	8/15/06	18:00	Fed Ex		
			Eileen N	8/19/06	1040

Aerotech Environmental Laboratories

a division of Aerotech Laboratories, Inc.

Thursday, August 31, 2006

Linda Eshelman
Del Mar
9830 South 51st Street
Suite B-120
Phoenix, AZ 85044

TEL: (480) 785-0043
FAX (480) 785-0851

RE: PPH0509

Order No.: 06080716

Dear Linda Eshelman:

Aerotech Environmental, Inc. received 3 sample(s) on 8/18/2006 for the analyses presented in the following report.

This report includes the following information:
- Case Narrative.
- Analytical Report: includes test results, report limit (Limit), any applicable data qualifier (Qual), units, dilution factor (DF), and date analyzed.
- QC Summary Report.

 If you have any questions regarding these test results, please do not hesitate to call.

Sincerely,

Cindy Bentley
Project Manager

Aerotech Environmental, Inc. **Date:** *31-Aug-06*

CLIENT: Del Mar
Project: PPH0509
Lab Order: 06080716

CASE NARRATIVE

Samples were analyzed using methods outlined in references such as:
- ·Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995.
- ·Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.
- ·Methods for the Determination of Organic Compounds in Drinking Water: Supplement III, EPA/600/R-95/131, August 1995.
- ·Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition.
- ·40 CFR, Part 136, Revised 1998. Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater.
- ·NIOSH Manual of Analytical Methods, Fourth Edition, 1994.
- ·Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, 1999.

Aerotech Environmental Laboratories (AEL) holds Arizona certification no. AZ0610.

Aerotech Environmental Laboratories (Laboratory ID 154268) is accredited by the American Industrial Hygiene Association (AIHA) in the industrial hygiene program for the analytical techniques noted on the scope of accreditation.

Analytical Comments:
All method blanks and laboratory control spikes met EPA method and/or laboratory quality control objectives for the analyses included in this report.

Data Qualifiers:
Listed below are the data qualifiers used in your analytical report to explain any analytical or quality control issues. You will find them noted in your report under the column header "QUAL". Any quality control deficiencies that cannot be adequately described by these qualifiers will be addressed in the analytical comments section of this case narrative.

Q8 Insufficient sample received to meet method QC requirements. Batch QC requirements satisfies ADEQ policies 0154 and 0155.

■ Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
■ Tucson Facility: 4455 S. Park Ave. Ste. 110 Tucson, AZ 85714 Phone: 520.807.3801 Fax: 520.807.3803

Aerotech Environmental Laboratories

a division of Aerotech Laboratories, Inc.

Aerotech Environmental, I **Analytical Report** **Date:** *31-Aug-06*

CLIENT:	Del Mar	**Client Sample ID:**	PPH0509-01 A2
Lab Order:	06080716	~~**Tag Number:**~~	
Project:	PPH0509	**Collection Date:**	8/15/2006 1:00:00 PM
Lab ID:	06080716-01A	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ORGANOPHOSPHORUS PESTICIDES		**SW8141A**				Analyst: **HH**
Chlorpyrifos	< 2.5	2.5		µg/L	1	8/28/2006
Demeton, Total	< 5.0	5.0		µg/L	1	8/28/2006
Diazinon	< 2.5	2.5		µg/L	1	8/28/2006
Disulfoton	< 2.5	2.5		µg/L	1	8/28/2006
Ethion	< 2.5	2.5		µg/L	1	8/28/2006
Fenthion	< 2.5	2.5		µg/L	1	8/28/2006
Malathion	< 2.5	2.5		µg/L	1	8/28/2006
Methyl parathion	< 2.5	2.5		µg/L	1	8/28/2006
Parathion	< 2.5	2.5		µg/L	1	8/28/2006
Surr: TPP (Surrogate)	81.7	49.6-123		%REC	1	8/28/2006
Surr: Tributylphosphate (Surrogat	81.8	51.7-113		%REC	1	8/28/2006

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.

(1) AEL - Tucson Laboratory

(2) AEL - Knudsen Laboratory

(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

■ Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
■ Tucson Facility: 4455 S. Park Ave. Ste. 110 Tucson, AZ 85714 Phone: 520.807.3801 Fax: 520.807.3803
■ Corporate Address: 1501 W. Knudsen Drive, Phoenix, Arizona 85027 Phone: 623.780.4800 Toll Free: 800.651.4802 Fax: 623.780.7695 www.aerotechlabs.com

Aerotech Environmental Laboratories
a division of Aerotech Laboratories, Inc.

Aerotech Environmental, I **Analytical Report** **Date:** *31-Aug-06*

CLIENT:	Del Mar	**Client Sample ID:**	PPH0509-02 A1
Lab Order:	06080716	**Tag Number:**	
Project:	PPH0509	**Collection Date:**	8/15/2006 4:00:00 PM
Lab ID:	06080716-02A	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ORGANOPHOSPHORUS PESTICIDES		**SW8141A**				Analyst: **HH**
Chlorpyrifos	< 2.5	2.5		µg/L	1	8/28/2006
Demeton, Total	< 5.0	5.0		µg/L	1	8/28/2006
Diazinon	< 2.5	2.5		µg/L	1	8/28/2006
Disulfoton	< 2.5	2.5		µg/L	1	8/28/2006
Ethion	< 2.5	2.5		µg/L	1	8/28/2006
Fenthion	< 2.5	2.5		µg/L	1	8/28/2006
Malathion	< 2.5	2.5		µg/L	1	8/28/2006
Methyl parathion	< 2.5	2.5		µg/L	1	8/28/2006
Parathion	< 2.5	2.5		µg/L	1	8/28/2006
Surr: TPP (Surrogate)	90.6	49.6-123		%REC	1	8/28/2006
Surr: Tributylphosphate (Surrogat	90.5	51.7-113		%REC	1	8/28/2006

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory
(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

■ Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
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■ Corporate Address: 1501 W. Knudsen Drive, Phoenix, Arizona 85027 Phone: 623.780.4800 Toll Free: 800.651.4802 Fax: 623.780.7695 www.aerotechlabs.com

Aerotech Environmental Laboratories
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Aerotech Environmental, I **Analytical Report** **Date:** *31-Aug-06*

CLIENT:	Del Mar	**Client Sample ID:**	PPH0509-03
Lab Order:	06080716	**Tag Number:**	43
Project:	PPH0509	**Collection Date:**	8/15/2006 4:50:00 PM
Lab ID:	06080716-03A	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ORGANOPHOSPHORUS PESTICIDES		**SW8141A**				Analyst: **HH**
Chlorpyrifos	< 2.5	2.5		µg/L	1	8/28/2006
Demeton, Total	< 5.0	5.0		µg/L	1	8/28/2006
Diazinon	< 2.5	2.5		µg/L	1	8/28/2006
Disulfoton	< 2.5	2.5		µg/L	1	8/28/2006
Ethion	< 2.5	2.5		µg/L	1	8/28/2006
Fenthion	< 2.5	2.5		µg/L	1	8/28/2006
Malathion	< 2.5	2.5		µg/L	1	8/28/2006
Methyl parathion	< 2.5	2.5		µg/L	1	8/28/2006
Parathion	< 2.5	2.5		µg/L	1	8/28/2006
Surr: TPP (Surrogate)	63.8	49.6-123		%REC	1	8/28/2006
Surr: Tributylphosphate (Surrogat	63.7	51.7-113		%REC	1	8/28/2006

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory
(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

■ Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
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Aerotech Environmental Laboratories

a division of Aerotech Laboratories, Inc.

Aerotech Environmental, Inc.

Date: *31-Aug-06*

CLIENT: Del Mar
Work Order: 06080716
Project: PPH0509

ANALYTICAL QC SUMMARY REPORT

TestCode: 8141AZ_w

Sample ID: **MB-26713** SampType: **MBLK** TestCode: **8141AZ_w** Units: **µg/L** Prep Date: **8/21/2006** RunNo: **78215**
Client ID: Batch ID: **26713** TestNo: **SW8141A** Analysis Date: **8/28/2006** SeqNo: **929673**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Chlorpyrifos	<2.5	2.5									
Demeton, Total	<5.0	5.0									
Diazinon	<2.5	2.5									
Disulfoton	<2.5	2.5									
Ethion	<2.5	2.5									
Fenthion	<2.5	2.5									
Malathion	<2.5	2.5									
Methyl parathion	<2.5	2.5									
Parathion	<2.5	2.5									
Surr: TPP (Surrogate)	40.15	5.0	50	0	80.3	51.1	116				
Surr: Tributylphosphate (Surrogate)	38.52	5.0	50	0	77.0	46.8	117				

Sample ID: **LCS-26713** SampType: **LCS** TestCode: **8141AZ_w** Units: **µg/L** Prep Date: **8/21/2006** RunNo: **78215**
Client ID: Batch ID: **26713** TestNo: **SW8141A** Analysis Date: **8/28/2006** SeqNo: **929674**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Chlorpyrifos	8.042	2.5	10	0	80.4	72.8	103				Q8
Demeton, Total	14.94	5.0	20	0	74.7	64.5	104				Q8
Diazinon	8.574	2.5	10	0	85.7	70.9	107				Q8
Disulfoton	9.406	2.5	10	0	94.1	66.5	106				Q8
Ethion	7.388	2.5	10	0	73.9	72.7	104				Q8
Fenthion	8.891	2.5	10	0	88.9	73.6	102				Q8
Malathion	10.06	2.5	10	0	101	70	109				Q8
Methyl parathion	8.692	2.5	10	0	86.9	64.1	110				Q8
Parathion	7.995	2.5	10	0	79.9	73.7	103				Q8
Surr: TPP (Surrogate)	46.64	5.0	50	0	93.3	51.1	116				
Surr: Tributylphosphate (Surrogate)	44.19	5.0	50	0	88.4	46.8	117				

Qualifiers:
E Value above quantitation range
ND Not Detected at the Reporting Limit
H Holding times for preparation or analysis exceeded
R RPD outside accepted recovery limits
J Analyte detected below quantitation limits
S Spike Recovery outside accepted recovery limits

■ Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
■ Tucson Facility: 4455 S. Park Ave. Ste. 110 Tucson, AZ 85714 Phone: 520.807.3801 Fax: 520.807.3803

Aerotech Environmental Laboratories

a division of Aerotech Laboratories, Inc.

CLIENT: Del Mar
Work Order: 06080716
Project: PPH0509

ANALYTICAL QC SUMMARY REPORT

TestCode: 8141AZ_w

Sample ID: **LCSD-26713** SampType: **LCSD** TestCode: **8141AZ_w** Units: **µg/L** Prep Date: **8/21/2006** RunNo: **78215**
Client ID: Batch ID: **26713** TestNo: **SW8141A** Analysis Date: **8/28/2006** SeqNo: **929675**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Chlorpyrifos	9.020	2.5	10	0	90.2	72.8	103	8.042	11.5	35	Q8
Demeton, Total	14.51	5.0	20	0	72.5	64.5	104	14.94	2.95	35	Q8
Diazinon	8.348	2.5	10	0	83.5	70.9	107	8.574	2.67	35	Q8
Disulfoton	8.744	2.5	10	0	87.4	66.5	106	9.406	7.30	35	Q8
Ethion	8.640	2.5	10	0	86.4	72.7	104	7.388	15.6	35	Q8
Fenthion	9.625	2.5	10	0	96.2	73.6	102	8.891	7.93	35	Q8
Malathion	9.501	2.5	10	0	95.0	70	109	10.06	5.70	35	Q8
Methyl parathion	8.741	2.5	10	0	87.4	64.1	110	8.692	0.564	35	Q8
Parathion	8.494	2.5	10	0	84.9	73.7	103	7.995	6.06	35	Q8
Surr: TPP (Surrogate)	47.98	5.0	50	0	96.0	51.1	116	46.64	0	0	
Surr: Tributylphosphate (Surrogate)	46.43	5.0	50	0	92.9	46.8	117	44.19	0	0	

Qualifiers:
E Value above quantitation range
ND Not Detected at the Reporting Limit
H Holding times for preparation or analysis exceeded
R RPD outside accepted recovery limits
J Analyte detected below quantitation limits
S Spike Recovery outside accepted recovery limits

■ Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
■ Tucson Facility: 4455 S. Park Ave. Ste. 110 Tucson, AZ 85714 Phone: 520.807.3801 Fax: 520.807.3803

Aerotech Environmental Laboratories Sample Receipt Checklist

Project Checked By:

Laboratory Number: 06-08-0716	Checklist completed by: [signature]
Client Name: Del Mar / Test America	Signature/Date 8-18-06
Matrix: Water / Carrier Name: Client	Date/Time Rec'd: 8-18-06 1921 By: RF

Temperature of Samples? 3.9 °C   Circle one: Blue Ice (Wet Ice) Not Present

	Yes	No*	Not Present
Shipping container/cooler in good condition?	X		
Custody seals intact on shipping container/cooler?			X
Custody seals intact on sample containers?			X
Chain of Custody present and relinquished/received properly?	X		
Chain of Custody agrees with sample labels?	X		
Samples in proper containers/bottles?	X		
Sample containers intact?	X		
All samples received within holding time?	X		**See Comment about Chlorine and pH
Is there sufficient sample volume to perform the tests?	X		
40mL vials for volatiles & SOCs received with zero headspace?			X

Soil Containers:
- Brass Sleeve____
- Glass Jar____
- Methanol____
- Plastic Bag____
- Encore Samplers____

Total number of bottles received: 7   IH sample media:

If applicable, how many sample bottles were shipped from AEL-Tucson?   N/A X

Number of containers received by preservative and by sample number: (If more than 15 samples are rec'd, please continue on separate sheet(s))

Preservative	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A-General	2	2	2	1											
B-HNO3															
C-H2SO4															
D-HCl															
E-Na2S2O3															
F-NaOH															
G-Sulfide															
H-Na Sulfite															
I-MCAA															
J-Methanol															
K-HAA															
L-Other															

Water-pH acceptable upon receipt? Yes No N/A X

Preservative & pH		pH of samples upon receipt	If pH requires adjustment, list sample number, and reagent ID. number
Metals	<2		
Nutrients	<2		
Total Phenols	<2		
413 (O&G)	<2		
418 (TPH)	<2		
Cyanide	>12		
Sulfide	>9		

**Any No response must be detailed in the comments section below. Contact the PM immediately to determine how to proceed. Refer to SOP 11-001.04, Section 1.8.6. Continue on back if additional space is needed.*

***The holding time for pH and Total Residual Chlorine analysis is immediate. For the most accurate result, the pH and Total Residual Chlorine should be taken in the field within 15 minutes of sampling.*

Comments:

Corrective Action:

TestAmerica
ANALYTICAL TESTING CORPORATION

06-08-0716

SUBCONTRACT ORDER - PROJECT # PPH0509

SENDING LABORATORY:	RECEIVING LABORATORY:
TestAmerica - Phoenix, AZ	Aerotech Labs
9830 South 51st Street, Suite B-120	1501 W Knudsen Drive
Phoenix, AZ 85044	PHX, AZ 85027
Phone: (480) 785-0043	Phone :623-780-4800
Fax: (480) 785-0851	Fax: (623) 445-6250
Project Manager: Linda Eshelman	

Standard TAT is requested unless specific due date is requested => Due Date:__________ Initials:______

Analysis	Expiration	Comments
Sample ID: PPH0509-01 Water	**Sampled: 08/15/06 13:00**	
8141A-Full-O	08/22/06 13:00	Aerotech

Containers Supplied: 1
1 L Amber (PPH0509-01C)
1 L Amber (PPH0509-01D)

Analysis	Expiration	Comments
Sample ID: PPH0509-02 Water	**Sampled: 08/15/06 16:00**	
8141A-Full-O	08/22/06 16:00	Aerotech

Containers Supplied: 2
1 L Amber (PPH0509-02C)
1 L Amber (PPH0509-02D)

Analysis	Expiration	Comments
Sample ID: PPH0509-03 Water	**Sampled: 08/15/06 16:50**	
8141A-Full-O	08/22/06 16:50	Aerotech

Containers Supplied: 3
1 L Amber (PPH0509-03C)
1 L Amber (PPH0509-03D)

SAMPLE INTEGRITY:

All containers intact:	☐ Yes ☐ No	Sample labels/COC agree:	☐ Yes ☐ No	Samples Received On Ice::	☐ Yes ☐ No
Custody Seals Present:	☐ Yes ☐ No	Samples Preserved Properly:	☐ Yes ☐ No	Samples Received at (temp):	3 [illegible]

Released By	Date	Time	Received By	Date	Time
Tori Shaw	8/18/06	0900	[signature]	8/18/6	0900
[signature]	8/18/6	0921	[signature]	8/18/06	0921

[redacted]

University Dr.
Suite 105
Tempe, AZ 85281
(480) 921-8044
(480) 921-0049 FAX
E-Mail Address: cchristian@aquaticconsulting.com
Attention: Chris Christian

Subcontract Chain of Custody

DATE August 16, 2006 PAGE 1 OF 1

Subcontract Laboratory:

Test America - Phx
P.M.:Linda Eshelman
9830 South 51st Street Suite 120 B
Phoenix, AZ 85044
Telephone 480-785-0043
Attn: Sample Receiving

AC&T Sample ID	Date	Time	Matrix	Lab ID	EPA 608	EPA 8141	Number of Containers
BN-08889	08/02/06	5:00 PM	AQ	PPH0509-01	X	X	2

Sampler Name: d. Kundargin

Project Name	Sample Receipt	
USFWS-NM	No. Containers:	2
Project Number	Custody Seals:	
HMM	Received Intact:	Yes No
Notes:	Received Cold:	Yes No
	Temperature:	2-2-2
	PRIORITY	Standard

RELINQUISHED BY:
Signature: T. Johnsen Time: 09:37
Printed Name: T. Johnsen Date: 8/17/2006
Aquatic Consulting & Testing

RELINQUISHED BY:
Signature: Bob Eldredge Time: 10:20
Printed Name: Date: 8/17/2006

SAMPLED RECEIVED BY:
Signature: Bob Eldredge Time: 8/17/06
Printed Name: Date: 8/17/2006
09:37

SAMPLED RECEIVED BY:
Signature: [signature] Time: 10:20
Printed Name: [illegible] S Date: 8/17/2006
Test America - Phx

AQUATIC CONSULTING & TESTING, INC.
1525 W. University Drive, Suite 106 • Tempe, AZ 85281
Phone: (480) 921-8044 • Fax: (480) 921-0049

CHAIN OF CUSTODY

PWS ID #

PAGE ___ OF ___

Client Name: US Fish & Wildlife Service
Address: 500 Gold Avenue SW
Street
Albuquerque, NM 87102
City, State, Zip
Phone: 505 248-6430
Fax: 505 248 7950
Contact: Darrell Kundargi
Sampler Signature: [signature]

PO#
Project HMM
Remarks: 795⁰⁰ per sample quote

SAMPLE ID	SAMPLE Date	SAMPLE Time	AM/PM	SAMPLE TYPE	Metals (See Below)	❑ TDS ❑ TSS ❑ TS ❑ SETT ❑ TVS ❑ VSS	❑ O+G ❑ TPHC ❑ MBAS ❑ CN ❑ Sulfide	❑ ~~BOD ❑ COD ❑ New Source~~ Cl, SO4, Alk	❑ Tot.P ❑ O-PO4	❑ Nitrate + Nitrite ❑ Nitrite	❑ TKN ❑ Ammonia	❑ ~~THMs ❑ HAAs~~ EPA 608, 8141	❑ Phenol ❑ 420.1 ❑ 625 ❑ 8270	❑ 8260 ❑ 624 ❑ BTEX	❑ Perchlorate ❑ Radio ❑ Asbestos	Total Coliform ❑ P/A ❑ Colilert ❑ MPN	❑ E. Coli ❑ Fecal Strep	Fecal Coliform ❑ MPN ❑ MF	❑ MICRO SCOPE ID	❑ Plate Count ❑ BIOLOG		❑ Acute ❑ Chronic	❑ AWET (SWRO)			$Na_2S_2O_3$	H_2SO_4	HNO_3	NONE	NaOH	NaOH/ZnAc	Laboratory Number
A2	8/15	1300	AM PM	SW	X			X	X	X	X	X															1	1	5			BN-09538
			AM PM																													
A1	8/15/06	1600	AM PM		X			X	X	X	X	X															1	1	5			9539
			AM PM																													
A3	8/15	1650	AM PM		X			X	X	X	X	X															1	1	5			9540
			AM PM																													
			AM PM																													
			AM PM																													
			AM PM																													
			AM PM																													
			AM PM																													
			AM PM																													
			AM PM																													

Metals: ❑ Al ❑ Sb ☒ As ❑ Ba ❑ Be ❑ B ☒ Cd ☒ Ca ❑ Cr ❑ Co ❑ Cu ❑ Au ❑ Fe ❑ Pb ☒ Mg ❑ Mn ☒ Hg ❑ Mo ❑ Ni ☒ Se ❑ Ag ☒ Na
❑ Sr ❑ Tl ❑ Sn ❑ Ti ❑ V ❑ Zn

[X] TOTAL [X] DISSOLVED [ ] SDWA [ ] TCLP [ ] RCRA

Sample Types: DW, GW, SW, WW, AQ, Soil, Sludge or Solid

Sample Receiving:
Intact: X Yes ___ No
Temp: 9°C Auth Init: ___
Pres: 6 Yes (V) 9/15 No/Lab
+3 LAB FILT/Pres
Sterile: ___ Yes X No
Total # containers: 21

1. Relinquished By: [signature]		2. Relinquished By:		3. Relinquished By:	
Date: 8/16/06	Time: 16:35 AM PM	Date:	Time: AM PM	Date:	Time: AM PM
1. Received By: T. Johnsen		2. Received By:		3. Received By:	
Date: 8-16-06	Time: 16:35 AM PM	Date:	Time: AM PM	Date:	Time: AM PM

Attn: Your signature on this document authorizes analysis regardless of sample condition at time of submittal

By signing this chain of custody, the designated client and agent agree to pay Aquatic Consulting & Testing, Inc. for all services rendered in conjunction with the submitted samples within 30 days of invoice. It is the client's responsibility to note purchase order numbers or other responsible parties on the form and failure to do so does not constitute justification for non-payment.

White-Laboratory Yellow-Report Pink-Client

Sample delivery group # : -027

AQUATIC CONSULTING & TESTING, INC.
1525 W. University Drive, Suite 106 • Tempe, AZ 85281
Phone: (480) 921-8044 • Fax: (480) 921-0049

Pd 9/27

CHAIN OF CUSTODY

PWS ID # $2460.75

PAGE ___ OF ___

Client Name: US Fish & Wildlife Service
Address: 500 Gold Avenue SW
Street
Albuquerque, NM 87102
City, State, Zip
Phone: 505 248-6430
Fax: 505 248 7950
Contact: Darrell Kundargi
Sampler Signature: [signature]

PO#
Project: HMM
Remarks: 795°° per sample quote

Chemistry columns: Metals (See Below); ❑ TDS ❑ TSS ❑ TS ❑ SETT ❑ TVS ❑ VSS; ❑ O+G ❑ TPHC ❑ MBAS ❑ CN ❑ Sulfide; ~~❑ BOD ❑ COD ❑ New Source~~ Cl, SO4, Alk; X Tot.P ❑ O-PO4; X Nitrate + Nitrite ❑ Nitrite; X TKN X Ammonia; ~~❑ THMs ❑ HAAs~~ EPA 608, 8141; ❑ Phenol ❑ 420.1 ❑ 625 ❑ 8270; ❑ 8260 ❑ 624 ❑ BTEX; ❑ Perchlorate ❑ Radio ❑ Asbestos
Biology columns: Total Coliform ❑ P/A ❑ Colilert ❑ MPN; ❑ E. Coli ❑ Fecal Strep; Fecal Coliform ❑ MPN ❑ MF; ❑ MICRO SCOPE ID; ❑ Plate Count ❑ BIOLOG
Biomon columns: ❑ Acute ❑ Chronic; ❑ AWET (SWRO)

SAMPLE ID	SAMPLE Date	SAMPLE Time	AM/PM	SAMPLE TYPE	Metals	Cl, SO4, Alk	Tot.P	Nitrate + Nitrite	TKN/Ammonia	EPA 608, 8141	$Na_2S_2O_3$	H_2SO_4	HNO_3	NONE	NaOH	NaOH/ZnAc	Laboratory Number
A2	8/15	1300		SW	X	X	X	X	X	X		1	1	5			
A1	8/15/06	1600		↓	X	X	X	X	X	X		1	1	5			
A3	8/15/06	1650		↓	X	X	X	X	X	X		1	1	5			

Metals: ❑ Al ❑ Sb X As ❑ Ba ❑ Be ❑ B X Cd X Ca ❑ Cr ❑ Co ❑ Cu ❑ Au ❑ Fe ❑ Pb X Mg ❑ Mn X Hg ❑ Mo ❑ Ni X Se ❑ Ag X Na ❑ Sr ❑ Tl ❑ Sn ❑ Ti ❑ V ❑ Zn

X TOTAL X DISSOLVED [ ] SDWA [ ] TCLP [ ] RCRA

Sample Types: DW, GW, SW, WW, AQ, Soil, Sludge or Solid

Sample Receiving:
Intact: X Yes ___ No
Temp: 9 C Auth Init: ___
Pres: 6 Yes/V 15 No/Lab
Sterile: ___ Yes X No
Total # containers: 21

1. Relinquished By: [signature]	2. Relinquished By:	3. Relinquished By:
Date: 8/16/06 Time: 16:35 AM/PM	Date: Time: AM/PM	Date: Time: AM/PM
1. Received By: [signature]	2. Received By:	3. Received By:
Date: 8-16-06 Time: 16:35 AM/PM	Date: Time: AM/PM	Date: Time: AM/PM

Attn: Your signature on this document authorizes analysis regardless of sample condition at time of submittal

By signing this chain of custody, the designated client and agent agree to pay Aquatic Consulting & Testing, Inc. for all services rendered in conjunction with the submitted samples within 30 days of invoice. It is the client's responsibility to note purchase order numbers or other responsible parties on the form and failure to do so does not constitute justification for non-payment.

White-Laboratory Yellow-Report Pink-Client

Sample delivery group # :

Water Quality Results:

Sonde Data

Site ID	Date	Time	Temp (ºC)	Conductivity (mS/cm^2)	DO (mg/L)	DO (%Sat)	pH
A1	8/15/2006	16:00	31.71	6.51	12.79		7.27
A2	8/15/2006	13:00	36.3	3.14	7.68	127.1	6.95
A3	8/15/2006	16:50	36.86	23.9	11.77		8.73
A1	10/4/2006	10:30	25.64	2.52	6.3	83.1	7.91
A2	10/4/2006	11:40	28.49	9.66	8.45	116	8.22
A3	10/4/2006	13:00	31.49	22.4	10.06	156	9.45

A1=Arnett Ditch A2=Farm Unit 2 Drain A3=Hart Mine Marsh

9.4 Appendix 4 -- Soils (four pages of laboratory analyses)

1910 McKinley, Suite 110 93728

DELLAVALLE Laboratory, Inc.
Chemists and Consultants

1910 W. McKinley, Suite 110, Fresno, CA 93728
FAX (559) 268-8174 - (800) 228-9896 - (559) 233-6129

Report of Soil Analysis

Hugh Rafmon

Life Sciences! Inc
1209 Esplanade Ste 1
Chico CA 95926
15301
50

Lab No. 99324
Sampled
Submitted 10/31/2006
Submitted by Lisa Stallings
Reported 11/8/2006
Job/Ranch/Site Gbola NWR
Copy To Life Science! Inc - Woodland
FAX 530 668-5675
E-Mail

Identification NA

			%			-----	meq/l	-----		%	T/ac-6"	---	Lime	---	mg/l	-----	-----	mg/kg	-----	-----
			SP	pHs	EC x10[3]	Ca	Mg	Na	Cl	ESP	GR	Req lbs/ac-6"	+/-	B	NO_3-N	PO_4-P	K (AA)	K H_2SO_4	Zn
No.	Description	Methods	S1.00	S1.10	S1.20	S1.60	S1.60	S1.60	S1.40		S15.10	S2.50	Handbk 60-23a	S1.50	S3.10	S4.10	S1.60	SSSA	S6.10
1	1-A		61	7.8	205	60.5	410	1327		55.8	0.0		++++	1.3	63	24	497		3.2
2	1-B		55	8.0	70.57	53.9	113	443		41.3	0.0		++++	0.8	6	7	287		1.0
3	1-C		60	8.0	80.92	53.0	120	402		38.4	0.0		++++	0.6	2	5	262		1.2
4	2-A		60	7.8	226	67.1	377	1503		59.1	0.0		++++	1.7	26	28	915		5.4
5	2-B		44	7.8	80.40	60.1	182	508		40.0	0.0		++++	1.6	2	6	321		1.3
6	2-C		32	7.8	34.80	40.8	62.1	253		33.6	0.0		++++	1.2	2	2	140		0.7
7	3-A		58	7.4	224	169.0	280	1502		69.4	0.0		++++	0.9	52	45	832		4.9
8	3-B		34	7.9	56.95	49.0	83.8	373		39.9	0.0		++++	1.3	3	5	127		0.5
9	3-C		28	8.0	103	87.8	139	665		49.5	0.0		++++	1.2	7	8	119		0.7
10	4-A		61	7.0	405	204.0	674	2566		64.2	0.0		++++	6.2	123	18	1012		4.3
11	4-B		31	7.7	71.17	86.8	133	447		38.1	0.0		++++	1.2	3	2	160		0.3
12	4-C		29	7.7	51.61	75.1	89.1	289		31.4	0.0		++++	1.1	2	<2	85		0.2
13	5-A		66	7.3	88.20	188.0	144	477		34.8	0.0		++++	0.9	4	21	505		9.6
14	5-B		37	7.8	19.61	37.7	36.1	145		25.5	0.2		++++	0.8	2	2	169		0.6
15	5-C		26	8.0	11.27	28.0	13.1	58.0		15.3	0.8		++++	0.4	2	<2	42		0.2
16	6-A		100	6.8	44.83	66.7	89.8	289		32.0	0.0		++++	1.4	2	18	471		5.5
17	6-B		79	7.9	7.63	20.7	10.1	39.2		11.9	0.8		+++	<0.1	3	21	624		3.4
18	6-C		82	7.9	6.31	14.5	10.4	35.6		12.0	0.4		+++	0.2	2	16	497		4.4
19	7-A		31	6.6	501	411.0	1277	2602		58.7	0.0		+++	18.1	16	11	540		1.9
20	7-B		41	7.6	118	108.0	169	726		47.3	0.0		++++	4.0	2	4	356		1.8
21	7-C		38	7.5	119	122.0	210	760		46.2	0.0		++++	3.5	2	2	565		0.7
22	8-A		71	7.7	85.80	55.9	126	580		46.9	0.0		+++	0.8	28	21	359		7.3
23	8-B		66	7.8	19.81	36.5	31.8	114		21.5	0.0		++++	0.2	2	10	324		2.6
24	8-C		60	7.8	53.09	60.5	114	314		32.5	0.0		++++	0.4	2	2	193		1.2
25	9-A		88	7.1	33.60	56.8	48.2	238		32.0	0.0		++++	0.6	4	14	481		6.8
26	9-B		74	7.8	18.55	36.8	29.0	98.7		19.4	1.7		++++	<0.1	2	12	434		4.3

DELLAVALLE Laboratory, Inc.
Chemists and Consultants

1910 W McKinley, Suite 110, Fresno, CA 93728
FAX (559) 268-8174 - (800) 228-9896 - (559) 233-6129

Report of Soil Analysis

Life Sciencel Inc
1208 Esplanade Ste 1
Chico CA 95926
15301
50

Identification NA

Lab No. 99324
Sampled
Submitted 10/31/2006
Submitted by Lisa Stallings
Reported 11/8/2006
Job/Ranch/Site Gbola NWR
Copy To Life Sciencel Inc - Woodland
FAX 530 668-5675
E-Mail

No.	Description	Methods	% SP	pHs	EC x10³	meq/l Ca	meq/l Mg	meq/l Na	meq/l Cl	% ESP	T/ac-6" GR	Lime Req lbs/ac-6'	Lime +/- Hndbk	mg/l B	mg/kg NO$_3$-N	mg/kg PO$_4$-P	mg/kg K (AA)	mg/kg K H_2SO_4	mg/kg Zn
			S1.00	S1.10	S1 20	S1.65	S1.60	S1.60	S1.40		S*5.10	S2.50	60-23a	S1.50	S3.10	S4.10	S1 60	SSSA	S6.10
27	9-C		82	7.7	35.44	60.3	56.4	231		30.3	0.0		++++	0.3	2	4	328		1.9
28	10-A		66	7.2	196	157.0	375	1192		51.6	0.0		+++	2.2	3	22	857		4.9
29	10-B		73	7.6	36.38	39.1	63.2	256		34.0	0.0		+++	0.7	2	3	366		1.5
30	10-C		76	8.0	51.04	41.7	99.3	306		34.4	0.0		+++	0.9	1	3	381		1.8

NO_3-N NITRATE-NITROGEN is extracted with 1.0 Normal potassium chloride and expressed as ppm. Nitrogen levels are guides to use with tissue analyses, soil profile nitrogen levels and other information.

PO_4-P PHOSPHATE-PHOSPHORUS is extracted with 0.5 Molar sodium bicarbonate solution at pH 8.5 and expressed as ppm. Critical levels are listed below.

K (AA) POTASSIUM is extracted with 1.0 Normal ammonium acetate solution at pH 7 and expressed as ppm. Critical levels are listed below and should be used with tissue analyses and plant conditions.

K (H_2SO_4) POTASSIUM is extracted with an H_2SO_4 solution and expressed as ppm. When K is low, this method predicts responses more accurately. Soils with less than 2000 ppm K-H_2SO_4 are deficient.

Zn, Mn, Fe, Cu ZINC, MANGANESE, IRON, COPPER are extracted with DTPA-TEA solution and expressed as ppm. Specific critical levels are listed below by crop.

	ppm			
	Zn	Mn	Fe	Cu
Response Likely Below	0.5		2.0	
Response Not Likely Above	1.0	1.0	4.5	0.2

SO_4-S SULFATE SULFUR is extracted with 1 Molar lithium chloride and expressed as ppm. Critical levels are listed below.

CROP GUIDE

The following guide for soil nutrients should be considered along with other factors. Only critical levels listed are supported by correlative information. For critical levels of specific crops not listed, call Dellavalle Laboratory, Inc.

	ppm			
	PO_4-P	K	SO_4-S	Zn
Alfalfa:				
Response likely below	10	50	5	-
Response not likely above	20	80	10	-
Barley and Wheat:				
Response likely below	6	40	5	0.2
Response not likely above	12	60	10	0.8
Cantaloupe:				
Response likely below	8	80	-	0.4
Response not likely above	12	100	-	0.6
Corn:				
Response likely below	6	50	-	0.3
Response not likely above	12	80	-	1.0
Cotton (loamy soils):				
Response likely below	5	80	-	0.4
Response not likely above	9	100	-	1.0
Cotton (clay soils):				
Response likely below	5	100	-	0.4
Response not likely above	9	140	-	1.0
Lettuce (cool season):				
Response likely below	15*	50	-	0.5
Response not like above	25	80	-	1.0
Lettuce (warm season):				
Response likely below	5	50	-	0.5
Response not likely above	9	80	-	1.0

	ppm			
	PO_4-P	K	SO_4-S	Zn
Pasture and Range:				
Response likely below	5	40	5	
Response not likely above	20	60	10	
Potatoes (mineral soils):				
Response likely below	12*	100	-	0.3
Response not likely above	25	150	-	0.7
Rice:				
Response likely below	6	60	-	0.5
Sorghum:				
Response likely below	4*	40	-	0.2
Response not likely above	9	60	-	0.5
Sugar Beets:				
Response likely below	5*	40	-	0.1
Response not likely above	12	70	-	0.2
Tomatoes:				
Response likely below	6*	100	-	0.3
Response not likely above	20	140	-	0.7
Other Field and Warm Season Vegetables:				
Response likely below	5	50	-	0.2
Response not likely above	9	70	-	0.5
Other Cold Season Vegetables:				
Response likely below	10*	50	-	0.5
Response not likely above	20	80	-	1.0

*Plants may be especially responsive to PO_4-P fertilization when planted in cool early spring soils. Suggested PO_4-P levels do not apply if crop follows rice.

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SOIL INTERPRETATION GUIDE

Soil analyses provide information on a soil's nutrient-supplying ability, salinity, acidity or alkalinity. Fertilizer and amendment recommendations can be made using soil analyses coupled with the field's crop history, water supply and the general level of management. This interpretation was developed based upon correlation studies conducted under California conditions by university and government researchers.

SP SATURATION PERCENTAGE is the number of grams of water required to saturate 100 grams of soil. The water-holding capacity of a soil when irrigated and allowed to drain is approximately half the SP. About half the water-holding capacity is available for crop use. Approximate relationship of SP to soil texture follows:

Below 20	Sandy or Loamy Sand
20 - 35	Sandy Loam
35 - 50	Loam or Silt Loam
50 - 65	Clay Loam
65 - 150	Clay
Above 150	Usually Peat or Muck

pH_s DEGREE OF ACIDITY OR ALKALINITY of a saturated soil.

Below 4.2	Too acid for most crops.
4.2 - 5.5	Acceptable for acid-tolerant crops.
5.5 - 8.4	Acceptable for most crops.
Above 8.4	Possible sodium problem; however, sodium problems can occur below 8.4.

EC_e ELECTRICAL CONDUCTIVITY of the saturation extract is an index of salt content expressed as millimhos per centimeter or decisiemens per meter at 25° C. Salt will restrict crop growth as follows:

Below 0.5	Water penetration may be impaired.
Under 2	No salinity problem for most crops.
2 - 4	Restricts growth of very salt-sensitive crops.
4 - 8	Restricts growth of all but moderately salt-tolerant crops.
8 - 16	Restricts growth of all but very salt-tolerant crops.
Above 16	Only a few salt-tolerant crops grow satisfactorily.

Cl CHLORIDE in the saturation extract is expressed in milliequivalents per liter. For most crops, chloride is not a factor when the electrical conductivity is in a safe range.

Ca, Mg, Na CALCIUM, MAGNESIUM, SODIUM ions in the saturation extract are expressed in milliequivalents per liter and are used to calculate ESP.

ESP EXCHANGEABLE SODIUM PERCENTAGE is the degree to which the soil exchange complex is saturated with sodium. It is used to determine soil permeability and potential phytotoxicity. Organic soils have no minerals, so are not effected by sodium.

Below 10	No permeability problem; however, sodium sensitive plants may show phytotoxicity such as chlorosis or slight yield reduction.
10 - 15	Soils with SP above 50 may have problems with permeability and/or phytotoxicity.
Above 15	Permeability problems are likely on all mineral soils except those with an SP below 20. Most crops show phytotoxicity.

GR GYPSUM REQUIREMENT is the amount of gypsum, or its equivalent, required to furnish sufficient calcium to correct a sodium-caused permeability problem and/or phytotoxicity. It is determined when the ESP is above 10; Ca+Mg is less than three times the EC_e or pH_s is above 8.4. GR is expressed in tons of 100% gypsum per acre-six inches of soil.

Lime LIME when reported by one to four pluses (+) indicates that acid-forming amendments (such as sulfur or sulfuric acid) may be used in place of gypsum. The number of pluses estimates the amount of lime present; a minus (-) indicates no lime present. The use of acidifying amendments may cause excessive pH reductions if used in the absence of lime.

A numeric lime value is reported when pH_s is below 6.0. This number indicates the amount of 100% lime ($CaCO_3$) in pounds per acre-six inches required to adjust pH_s to 6.0.

B BORON in saturation extract is expressed as ppm and is required for crop growth but may be toxic. This test evaluates the soil's potential for boron toxicity. Use a different test to detect deficiencies.

Below 0.5	Not toxic for most crops but may be insufficient for some.
Above 1	Sensitive crops may show visible injury.
5	Semi-tolerant crops may show visible injury.
10	Tolerant crops may show visible injury.

9.5 Appendix 5 -- Hart Mine Marsh Vegetation Communities and Acreages

Vegetation Community (NVCS Association)	*Acres*
Allenrolfea occidentalis Shrubland, Type 6 - Very young and low growth	25.4
Larrea tridentata / Sparse Understory Shrubland Association, Type 6 - Very young and low growth	10.9
Pluchea sericea Seasonally Flooded Shrubland [Placeholder], Type 5 - Stands with dense shruby growth	0.1
Prosopis (glandulosa var. torreyana, velutina) Woodland [Placeholder], Type 3 - Intermediate size trees with dense understory	20
Suaeda moquinii Shrubland Association, Type 6 - Very young and low growth	7.8
Tamarix ssp / Sparse Alien Shrubland Association, Type 5 - Stands with dense shruby growth	39
Tamarix ssp / Sparse Alien Shrubland Association, Type 6 - Very young and low growth	2
Tamarix ssp. mixed, Type 5 - Stands with dense shruby growth	8.3
Tamarix ssp. monotypic, Type 3 - Intermediate size trees with dense understory	242.6
Tamarix ssp. monotypic, Type 5 - Stands with dense shruby growth	155.6
Tamarix ssp. monotypic, Type 6 - Very young and low growth	1.1
Tamarix ssp. standing dead, Type 4 - Intermediate size trees with little or no understory	0.1
Tamarix ssp. standing dead, Type 5 - Stands with dense shruby growth	20.8
Typha latifolia - Schoenoplectus acutus Herbaceous Association, Type 5 - Stands with dense shruby growth	9.8
Unconsolodated material sparse vegetation (soil, sand and ash), Type 6 - Very young and low growth	82.2
water, Type 6 - Very young and low growth	10.9