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Office of Environmental Management – Grand Junction

MOAB UTAH

UMTRA Project

Moab UMTRA Project Site Water Quality Study Plan

March 2007

U.S. Department of Energy

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Work Performed Under DOE Contract No. DE–AC01–02GJ79491
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Moab UMTRA Project Site

Water Quality Study Plan

March 2007

Work Performed by S.M. Stoller Corporation under DOE Contract No. DE–AC13–02GJ79491
for the U.S. Department of Energy, Grand Junction, Colorado

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1.0 Introduction

The sole driver for ground water remediation at the Moab Uranium Mill Tailings Remedial Action (UMTRA) Project Site (site) is to protect surface water quality in the Colorado River. The areas that are most vulnerable to impacts from site-related contamination are also those most favorable to serve as endangered fish habitat (particularly the Colorado pikeminnow). The U.S. Department of Energy (DOE)'s critical commitments are in meeting the reasonable and prudent measures identified by the U. S. Fish and Wildlife Service (USF&WS) in their Biological Opinion included in the Final Environmental Impact Statement (FEIS) for the site (DOE 2005a) and included in DOE's Record of Decision (ROD) (DOE 2005b) for the site. The reasonable and prudent measures are as follows:

1. Monitor backwater habitats near the site for any indication of fish being affected by surface water contamination.
2. Evaluate the effectiveness of DOE's initial action.
3. Address uncertainties associated with the ground water remediation program.
4. Reduce effects of surface water contamination in habitats along the south bank of the Colorado River, if necessary.
5. Reduce the effects of entrainment at all project pumping sites.

To address these measures the USF&WS identified specific terms and conditions that DOE must comply with (Table 1). A number of these terms and conditions are associated with the preparation of a Water Quality Study Plan (WQSP) for the site that is supposed to address uncertainties associated with the ground water remediation program (reasonable and prudent measure #3), including implementation of the initial action and the need for remediation on the south and east side of the river.

2.0 Purpose and Scope

Specifically, the WQSP is required to address the requirements presented in Table 1.

Table 1. Water Quality Study Plan Requirements

Requirement #	Terms and Conditions
1.	Identify protocols and parameters for implementing the initial action.
2.	Develop data quality objectives for the WQSP.
3.	Evaluate the effectiveness of current and expanded ground water remediation efforts.
4.	Assess the validity of the tenfold ground water to surface water dilution factor.
5.	Verify that the target goal of 3 milligrams per liter (mg/L) in ground water will result in compliance objectives in surface water.
6.	Assess the validity of the assumption that by reducing concentrations of ammonia the other constituents of concern (manganese, sulfate, uranium, copper, and selenium) will also be reduced to protective levels.
7.	Identify the requirements and schedule for DOE's reporting to the USF&WS.
8.	Determine if refinement of the conceptual site model is necessary.
9.	Evaluate the need for expanding ground water remediation efforts to the south side of the river (Matheson Wetlands Preserve).

As a separate effort, DOE was also required by the Biological Opinion to prepare and implement a biota monitoring plan to evaluate the effects, if any, of site-related contamination on fish in backwater habitats. The plan was completed in January 2006 and implemented in the summer of 2006. Though not identified as a component of the WQSP in the Biological Opinion, it is critical that the biota monitoring efforts be integrated and coordinated with WQSP requirements in order to assess the effectiveness of the ground water remediation program. Therefore, the biota monitoring is also discussed in this plan with proposed modifications to the existing plan.

3.0 Ongoing and Completed Monitoring at the Moab Site

DOE has been conducting several types of monitoring efforts since the site was transferred. Early monitoring efforts were geared toward further characterizing the site and refining the conceptual site model (DOE 2003). Since that time, monitoring efforts have been substantially expanded in order to assess performance of the various interim ground water remediation systems that have been installed. Biota monitoring was initiated as required by the Biological Opinion included in the FEIS (DOE 2005a). Monitoring is also conducted in conjunction with operation of the initial action. As part of this WQSP, the intent is to integrate the various monitoring activities to best meet the requirements laid out in the Biological Opinion. This section describes ongoing and completed monitoring efforts for the site that are relevant to the objectives of this WQSP. Modifications to some of those monitoring events are proposed to better satisfy the objectives of this plan. Section 4 discusses how the different monitoring data collected will be used to meet each objective. Subsequent to completion of this WQSP, specific sampling and analysis plans will be prepared to reflect revisions to existing plans.

3.1 Initial Action Monitoring

As noted in the Biological Opinion, DOE has the infrastructure in place to implement an "initial action" as an immediate measure in the event that monitoring of backwater areas adjacent to the site indicates non protective levels of contamination. The system was constructed in areas that were deemed most likely to provide potential fish habitat based on initial surveys of the site (DOE 2002). The location of the initial action system is shown in Figure 1. The initial action is designed to pump clean water into backwater areas to dilute or flush out potentially contaminated water. Implementation and monitoring of the initial action is described in the Work Plan for Implementation of the Initial Action in the Sandbar Area Adjacent to the Moab Site (DOE 2002). Surface water sampling is conducted prior to startup of the initial action to provide baseline water quality. Sampling is conducted throughout operation of the initial action to the extent practicable. The initial action was operated in both 2005 and 2006. Results are documented in calendar year reports (DOE 2006a, 2007a).

As a requirement of the biological opinion (Requirement 1), a set of protocols and parameters for implementation of the initial action were prepared by DOE and submitted to USF&WS in September 2006 (Appendix B). These protocols represent a refinement of the original implementation plan based on 2 years of operational experience. Monitoring conducted during initial action operation indicated that no surface water quality standards were exceeded in the initial action vicinity (see DOE 2006a, 2007a).

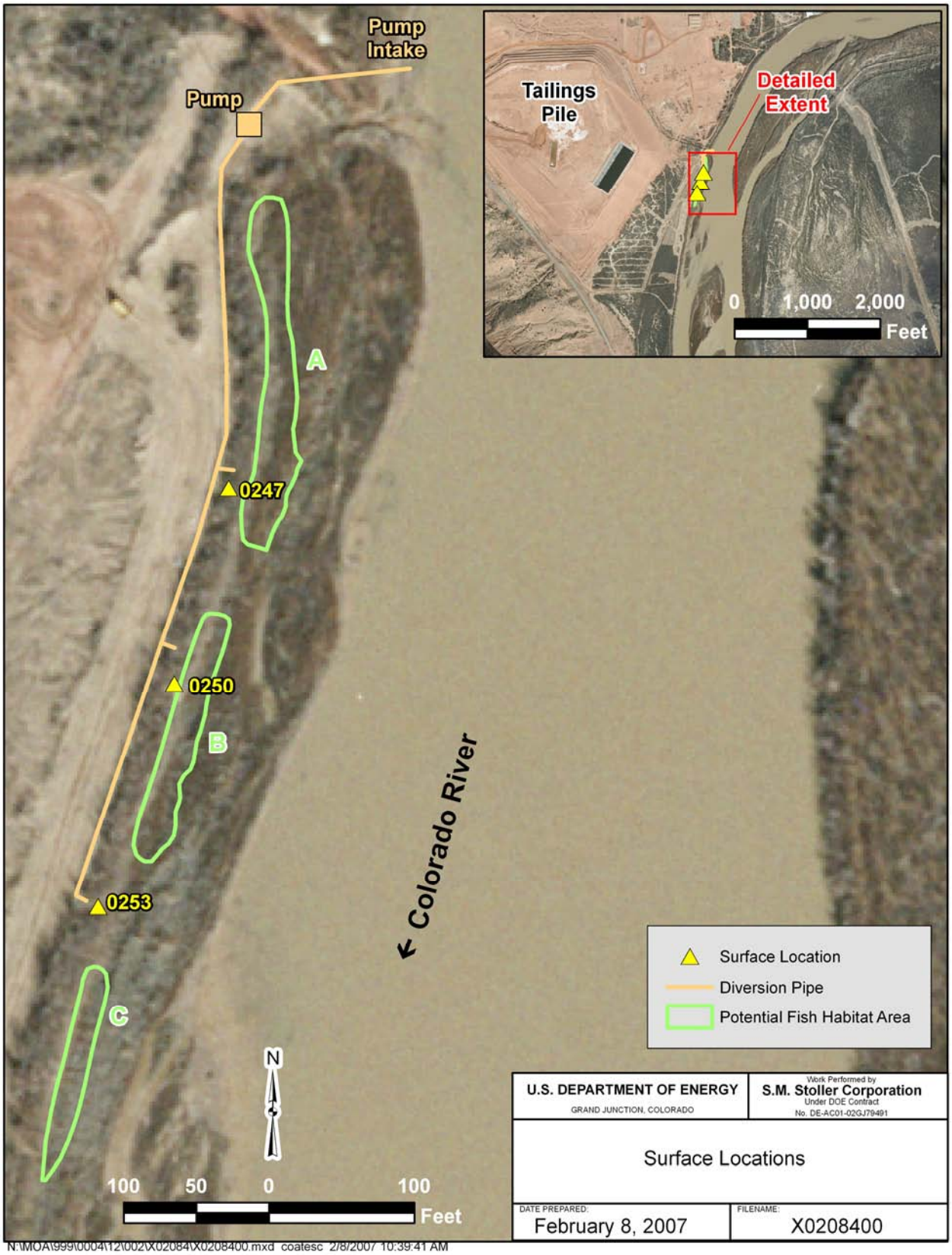

Figure 1. Surface Locations

3.2 Routine Ground Water and Surface Water Monitoring

Routine ground water and surface water sampling has been conducted for the last several years according to procedures outlined in the Surface Water and Ground Water Monitoring Plan for the Moab Site (DOE 2004). Routine sampling was established before the implementation of the interim ground water remediation systems. Routine sampling has been conducted three times a year and involves the collection of collocated ground water and surface water samples as well as "opportunistic" (biased) sampling of potential fish habitat areas. Collocated samples were designed to better understand potential dilution of ground water discharging to the surface. At some locations both near shore and in stream (compliance) surface water samples were collected to determine if proximity to the shoreline affected sample results. During each routine event, opportunistic surface water samples were collected, if applicable, from areas representing the best potential fish habitat. Routine sampling locations for ground water and surface water are shown in Figure 2, and sample types and rationale are described in Table 2.

To better integrate routine sampling efforts with other monitoring that has since been implemented, several changes to the routine ground water and surface monitoring plan are proposed. These are also identified in Table 2. Results of past monitoring has indicated that discharge of site-related ground water only has potential to affect near shore surface locations and that "in stream" locations are unaffected. Therefore, DOE proposes to discontinue in stream sampling adjacent to the site. Sampling upstream and downstream of the tailings pile will be continued to provide a complete monitoring record throughout remediation.

In conjunction with interim action implementation, DOE has been conducting intensive ground water, surface water, and piezometer (now referred to as well points) sampling adjacent to the remediation systems. Sampling in these areas takes place at least quarterly and often more frequently. Routine sampling of the interim action areas has often been redundant. To reduce this redundancy, DOE proposes to eliminate routine sampling locations along the interim action area from well 0406 to the north to well 0407 to the south (Figure 2). The wells and surface locations between these two points will be covered by the interim action sampling (see section 3.3). In addition, to better focus on potential fish habitat, DOE proposes to shift opportunistic surface water sampling to accompany the biota monitoring (see section 3.4). Thus routine sampling will include upstream, downstream, and onsite locations only as shown in Table 2. Routine sampling will still take place three times a year, but with the flexibility to select sampling times to coincide with river or precipitation events that can help maximize site knowledge. Several on-site locations are proposed for addition to the routine event to better monitor ground water responses to surface remedial activities.

3.3 Interim Action Monitoring

Monitoring data on ground water and surface water quality collected during operations of the interim action will be used to evaluate the effectiveness of the system at achieving remediation goals. Other operating parameters for the system are monitored as described in the site operations plan (DOE 2007b), but are not discussed here. Water quality measurements will be performed at the evaporation pond, the well field, the fresh water pond, and at river water locations. Ten extraction wells, 19 observation wells, nine well points, and two river water locations are available for performance monitoring in Configuration 1.

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Figure 2. Ground Water and Surface Water Sampling Location Map

Table 2. Proposed Changes to Routine Ground Water and Surface Water Sampling Program

Well Location	Surface Water Location	Sampling Type/Rationale	Proposed Changes
Routine Monitoring			
TP-02	218—near shore 204—in stream	Collocated SW/GW In-stream compliance	Eliminate 204
401/408		Collocated SW/GW	Eliminate from routine monitoring—include in interim action performance monitoring
402	233—near shore 234—in stream	Collocated SW/GW In-stream compliance	
403	224	Collocated SW/GW	
404	221	Collocated SW/GW	
405	220	Collocated SW/GW	
406	219	Collocated SW/GW	
407	225	Collocated SW/GW	
492	CR-3—near shore 233—in stream	Collocated SW/GW In-stream compliance	Eliminate 233
TP-17	226	Collocated SW/GW	Retain
TP-18	227—near shore 232—in stream	Collocated SW/GW In-stream compliance	Eliminate 232
TP-19	228	Collocated SW/GW	Retain
437		Monitor deep ammonia plume	Retain
439		Monitor shallow ammonia plume	Retain
ATP2S		Monitor historical trends	Retain
ATP2D		Monitor historical trends	Retain
	CR5	In-stream compliance	Retain as downstream "background"
	201	In-stream compliance	Eliminate; if contamination detected at CR-5 may reinstate
	CR1	Background	Retain
	217	Monitor background in habitat-like area	Eliminate
Opportunistic Sampling			
	Areas A, B, C (Figure 1)	Opportunistic habitat sampling	Include opportunistic sampling with biota monitoring (up to approximately 25 surface water samples per season)
	TBD (1 or 2 locations)	Opportunistic habitat sampling during routine sampling events	

Ten extraction/injection wells, 13 observation wells, nine well points, one fresh water injection location, and three river water locations are available for performance monitoring in Configuration 2. Ten extraction/injection wells, 10 observation wells, nine well points, and two river water locations are available for performance monitoring in Configuration 3. Ten extraction/injection wells, eight observation wells, six well points, and one river water location are available for performance in Configuration 4. Four observation wells and three well points are also available for performance monitoring of the infiltration trench. Flow rates, cumulative volumes, and pressures will be recorded for the remediation wells.

Baseline Area monitoring will continue to be used to refine the understanding of the unstressed ground water system. In particular, the water-quality monitoring network is designed to determine vertical and horizontal distributions of ammonia and total dissolved solids (TDS)

concentrations and to determine the significance of the brine surface with respect to ammonia distribution. The alluvial system in the Baseline Area has shown significant natural variability related to changes in river stage. The data collected from the Baseline Area will continue to be used, during evaluation of the well field, to distinguish natural variations in flow processes and water chemistry from the effects of system operation.

The monitoring network for Configurations 1, 3, and 4 (when used in extraction mode) will be used to monitor changes, if any, in the distribution of ammonia and TDS concentrations during continued ground water extraction. It will also be used to monitor: (1) changes in ground water flow paths above and below the brine surface during pumping, and (2) the extent of the cone of depression maintained by the extraction wells.

The monitoring network for Configurations 2, 3, and 4 (when used in injection mode) will be used to determine if these wells are effective in reducing contaminant concentrations in Colorado River backwater areas. An apparent reduction was observed in 2005 during operation of Configuration 2. Another ongoing objective will be to evaluate how injection affects the position of the brine surface beneath the river and discharge of ammonia to surface water.

A schedule for sampling and analysis of water samples collected from wells, at the surface water locations, and from the evaporation pond is summarized in Table 3. The schedule will be reevaluated after data history is established. Descriptions of the data collection requirements for each parameter are provided in the sections below.

Table 3. Interim Action Data Collection Schedule for Water Sampling and Analysis

Location	Pre-Startup		Startup		Normal Operations	
	Field Parameters	Laboratory Analysis	Field Parameters	Laboratory Analysis	Field Parameters	Laboratory Analysis
Extraction wells	One-time event	One-time event	One-time event	One-time event	NA	Monthly or Quarterly
Injection wells	One-time event	One-time event	NA	NA	NA	NA
Observation wells	One-time event	One-time event	One-time event	One-time event	NA	Monthly or Quarterly
Well point	One-time event	One-time event	One-time event	One-time event	NA	Monthly or Quarterly
River	One-time event	One-time event	One-time event	One-time event	NA	Monthly or Quarterly
Evaporation pond	One-time event	One-time event	One-time event	One-time event	NA	Monthly
Fresh Water pond	NA	NA	NA	NA	NA	Monthly
Infiltration trench	NA	NA	NA	NA	[a]	[a]

NA=not applicable
[a]field parameters and laboratory analyses may be performed for observation wells after trench system flow rate and volume assessment is conducted

3.4 Field Parameters

Field measurements of temperature, specific conductance, and pH are performed on water samples collected from the extraction wells, injection wells, river water locations, the evaporation pond, and from the fresh water storage pond according to the schedule presented in Table 3.

3.5 Laboratory Sampling and Analysis

Data collected through this sampling will improve the understanding of ground water and surface water interactions and help locate the intersection of the brine surface with the riverbed under background flow conditions for the Baseline Area wells and under active remediation conditions for wells at Configurations 1 through 4. Sample collection will continue from the monitor well and well point locations for chemical parameters and hydraulic and chemical performance data. Measurements will include water levels, field parameters, and laboratory analysis. Sampling of the well points will be conducted as river conditions permit. Except during near-bank, full-flow conditions, the shoreline well points are accessible year-round. A surface water sample will be collected (when present) near the base of each well point cluster location to compare local surface water chemistry with underlying ground water chemistry and to monitor the integrity of the well point completion. Sampling frequency requirements are summarized in Table 4 through Table 9. These frequencies have been integrated into the performance sampling events beginning in FY 2007.

Table 4. Monitoring Requirements for the Baseline Area

Location	ID	Purpose	Frequency
Near-shore monitoring well	0405, 0488, 0493	Monitor changes in plume concentrations.	Monthly for laboratory analysis.
Inland monitoring well	SMI-PZ1M, SMI-PZ1D, SMI-PZ1S, SMI-PW01	Monitor changes in plume concentrations.	Quarterly for laboratory analysis.
Well point[a]	(0494 / 0495 / 0597) **(0496 / 0497 / 0598)** (0498 / 0499 / 0599)	Monitor water chemistry in the hyporheic zone and saline water beneath the river.	Monthly / quarterly for laboratory analysis.
River[b]	0241, 0242, 0243	Monitor changes in surface water quality downgradient of well field at river.	Monthly / quarterly for laboratory analysis.

[a]Well points **0496, 0497**, and **0598** are scheduled to be sampled monthly for laboratory analysis.
[b]Surface water sample locations in the river may vary as conditions change; one surface water sample adjacent to one well point cluster will be sampled monthly for laboratory analysis.

Table 5. Sampling Frequency Requirements for Configuration 1

Location	ID	Purpose	Frequency
Extraction well	0470–0479, SMI-PW02	Monitor changes in ground water surface elevation.	Monthly (as a check on telemetry system).
	0470, 0472, 0474, 0476, 0478	Monitor changes in plume concentrations.	Monthly for laboratory analysis.
	0471, 0473, 0475, 0477, 0479		Quarterly for laboratory analysis.
Observation well[a]	0480, 0481, 0483, 0484, 0557–0560	Monitor changes in plume concentrations.	Monthly for laboratory analysis.
	0403, 0407, 0482, 0485, 0552, 0555, 0561, 0596		Quarterly for laboratory analysis.
	0403, 0407, 0480–0485, 0551, 0552, 0554–0559, 0560, 0561, 0596	Monitor changes in ground water surface elevations.	Weekly April through July, Monthly August through March.
Well point[b]	**(0562 / 0563 / 0606)** (0608 / 0611 / 0612) (0564 / 0565 / 0607)	Monitor the hyporheic zone and saline water beneath river.	Monthly / quarterly for laboratory analysis.
River[c]	0216, 0245	Monitor changes in surface water quality downgradient of well field at river.	Monthly / quarterly for laboratory analysis.
Evaporation pond	0547, 0548	Monitor changes in concentrations at inlet and discharge pipe.	Monthly for laboratory analysis.

[a]Actual locations sampled monthly may vary based on field conditions.
[b]Well points **0562, 0563,** and **0606** are scheduled to be sampled monthly for laboratory analysis.
[c]Surface water sample locations in the river may vary as conditions change.

Table 6. Sampling Frequency Requirements for Configuration 2

Location	ID	Purpose	Frequency
Remediation well	0570−0579	Monitor changes in ground water surface elevation.	Weekly April through July, Monthly August through March.
	0570, 0572, 0574, 0576, 0578	Monitor changes in plume concentrations (during extraction mode only).	Monthly for laboratory analysis.
	0571, 0573, 0575, 0577, 0579		Quarterly for laboratory analysis.
Observation well[a]	0408, 0583, 0584, 0587, 0588, 0589	Monitor changes in plume concentrations.	Monthly for laboratory analysis.
	0401, 0581, 0582, 0585, 0586, 0600		Quarterly for laboratory analysis.
	0401, 0402, 0408, 0580–0589	Monitor changes in ground water surface elevation.	Weekly April through July, Monthly August through March.
Well point[b]	**(0590 / 0591 / 0603)** (0604 / 0613 / 0614) (0605 / 0615 / 0616)	Monitor the hyporheic zone and saline water beneath river.	Monthly / quarterly for laboratory analysis.
River[c]	0236, 0239, 0240	Monitor changes in surface water quality downgradient of well field at river.	Monthly / quarterly for laboratory analysis.
Fresh water hydrant	0550 or 0549	Monitor water quality changes in background injection water.	Monthly (when injecting fresh water) for laboratory analysis.

[a]Actual locations sampled monthly may vary based on field conditions.
[b]Well points **0590, 0591,** and **0603** are scheduled to be sampled monthly for laboratory analysis.
[c]Surface water sample locations in the river may vary as conditions change.

Table 7. Sampling Frequency Requirements for Configuration 3

Location	ID	Purpose	Frequency
Remediation well	0670−0679	Monitor changes in ground water surface elevation.	Monthly (as a check on telemetry system).
	0670, 0672, 0674, 0676, 0678	Monitor changes in plume concentrations (during extraction mode only).	Monthly for laboratory analysis.
	0671, 0673, 0675, 0677, 0679		Quarterly for laboratory analysis.
Observation well[a]	0682, 0683, 0687, 0688, 0689	Monitor changes in plume concentrations.	Monthly for laboratory analysis.
	0404, 0680, 0681 0684, 0685, 0686		Quarterly for laboratory analysis.
	0404, 0680−0689	Monitor changes in ground water surface elevation.	Weekly April through July, Monthly August through March.
Well point[b]	(**0690** / **0691** / **0692**) (0693 / 0694 / 0695) (0696 / 0697 / 0698)	Monitor the hyporheic zone and saline water beneath river.	Monthly / quarterly for laboratory analysis.
River[c]	0257, 0258, 0259	Monitor changes in surface water quality downgradient of well field at river.	Monthly / quarterly for laboratory analysis.
Fresh water hydrant	0550 or 0549	Monitor water quality changes in background injection water.	Monthly (when injecting fresh water) for laboratory analysis.

[a]Actual locations sampled monthly may vary based on field conditions.
[b]Well points **0690**, **0691**, and **0692** are scheduled to be sampled monthly for laboratory analysis.
[c]Surface water sample locations in the river may vary as conditions change.

Table 8. Sampling Frequency Requirements for Configuration 4

Location	ID	Purpose	Frequency
Remediation well	0770−0779	Monitor changes in ground water surface elevation.	Monthly (as a check on telemetry system).
	0770, 0772, 0774, 0776, 0778	Monitor changes in plume concentrations (during extraction mode only).	Monthly for laboratory analysis.
	0771, 0773, 0775, 0777, 0779		Quarterly for laboratory analysis.
Observation well[a]	0780, 0781, 0782, 0786, 0787	Monitor changes in plume concentrations.	Monthly for laboratory analysis.
	0783, 0784, 0785		Quarterly for laboratory analysis.
	0780–0787	Monitor changes in ground water surface elevation.	Weekly April through July, Monthly August through March.
Well point[b]	(**0790** / **0791** / **0792**) (0793 / 0794 / 0795)	Monitor the hyporheic zone and saline water beneath river.	Monthly / quarterly for laboratory analysis.
River[c]	0274	Monitor changes in surface water quality downgradient of well field at river.	Monthly / quarterly for laboratory analysis.
Fresh water hydrant	0550 or 0549	Monitor water quality changes in background injection water.	Monthly (when injecting fresh water) for laboratory analysis.

[a]Actual locations sampled monthly may vary based on field conditions.
[b]Well points **0790**, **0791**, and **0792** are scheduled to be sampled monthly for laboratory analysis.
[c]Surface water sample locations in the river may vary as conditions change.

Table 9. Sampling Frequency Requirements for Infiltration Trench

Location	ID	Purpose	Frequency
Observation well[a]	0730–0733	Monitor changes in lateral extent of injected fresh water.	Monthly for laboratory analysis.
	0730–0733	Monitor changes in ground water surface elevation.	Weekly April through July, Monthly August through March.
Well point[b]	(0724 / 0725 / 0726)	Monitor the hyporheic zone and saline water beneath river, determine extent of injected fresh water .	Monthly for laboratory analysis.

[a]Actual locations sampled monthly may vary based on field conditions.
[b]Well points **0724, 0725**, and **0726** are scheduled to be sampled quarterly during the biogeochemical sampling event.

Water samples will be submitted to a commercial laboratory for analyses of the constituents listed in Table 10 and Table 11. More extensive sampling may also be conducted on an as needed basis at selected locations in the system or at new monitoring locations established at a later date to monitor the effectiveness of the interim action. All constituents could be analyzed, but given the low volume of ground water that is available from some well points, not all may be included during each sampling event. The well points selected for analysis may not be the same for each sampling event. Well points will be selected for sampling on the basis of river conditions and analytical results of previous sampling events.

Table 10. Analytes and Methods for Ground Water and Evaporation Pond Samples

Analyte	Sample Container	Preservation	EPA Method	Detection Limit	Line Item Code
Ammonia-N	125 mL poly	H_2SO_4, pH < 2	350.3	0.1 mg/L	WCH-A-005
Chloride	500 mL poly	Cool, 4 °C	9056	0.5 mg/L	MIS-A-039
Bromide			9056	0.5 mg/L	MIS-A-038
Sulfate			9056	0.5 mg/L	MIS-A-044
TDS	125 mL poly	Cool, 4 °C	160.1	10 mg/L	WCH-A-033
Copper	500 mL poly	HNO_3, pH < 2	SW-846 6010	25 µg/L*	MET-A-020
Selenium			SW-846 6020	0.1 µg/L	GJO-14
Manganese			SW-846 6010	5 µg/L	GJO-17
Uranium			SW-846 6020	0.1 µg/L	GJO-1

*µg/L = micrograms per liter

Table 11 also lists the relative priority of each analyte or group for sample collection during each biogeochemical sampling event. The biogeochemical analyses will be conducted quarterly only on ground water samples from river well points beginning in FY 2007.

Table 11. Biogeochemical Analytes and Methods for Ground Water Samples

Analyte	Sample Container	Preservation	EPA Method	Detection Limit	Line Item Code	Relative Priority
Nitrate / Nitrite-N	125 mL poly	HNO_3, pH < 2	MCAWW 353.2	0.1 mg/L	WCH-A-005	High
Chloride	500 mL poly	Cool, 4 °C	MCAWW 300.0A	0.5 mg/L	MIS-A-039	
Bromide			MCAWW 300.0A	0.5 mg/L	MIS-A-038	
Sulfate			MCAWW 300.0A	0.5 mg/L	MIS-A-044	
TDS	125 mL poly	Cool, 4 °C	160.1	10 mg/L	WCH-A-033	
Sulfide	1 L poly	NaOH/ZnOAc	376.1	2 mg/L	WCH-A-038	
Ammonia-N	125 mL poly	HNO_3, pH < 2	MCAWW 350.1	0.1 mg/L	WCH-A-005	
Dissolved Organic Carbon	250 mL glass	Cool 4 °C	MCAWW 415.1	1 mg/L	WCH-A-024	
Total Inorganic Carbon	250 mL glass	Cool 4 °C	MCAWW 415.1	1 mg/L	GJO-49	
Iron (Fe)	500 mL poly	HNO_3, pH < 2	6010B	50 mg/L	GJO-16	
Manganese (Mn)	500 mL poly	HNO_3, pH < 2	6010B	5 mg/L	GJO-17	
Uranium (U)	500 mL poly	HNO_3, pH < 2	6020A	0.1 µg/L	GJO-1	
Total Organic Carbon	250 mL glass	Cool 4 °C	MCAWW 415.1	1 mg/L	WCH-A-025	
Chemical Oxygen Demand	250 mL poly	H_2SO_4, 4 °C	MCAWW 410.4	5 mg/L	WCH-A-010	
Total Kjeldahl Nitrogen	250 mL poly	H_2SO_4, 4 °C	MCAWW 351.2	0.2 mg/L	WCH-A-039	Low

Field parameters include: alkalinity, dissolved oxygen, redox potential, pH, specific conductance, turbidity, and temperature.

3.6 Biota Monitoring

A biota monitoring plan is specified as a requirement of the Biological Opinion. A plan was developed by DOE in consultation with the USF&WS and issued in January 2006 (DOE 2006b). Biota monitoring was initiated in the spring of 2006. A summary of the biota monitoring plan and approach is summarized in this section.

The Biota Monitoring Plan (DOE 2006b) for the site was designed to evaluate potential effects of site-related contamination on endangered fish in the Colorado River, in particular, the Colorado pikeminnow. The preferred habitat for the pikeminnow includes backwaters that are connected to the river downstream. However, based on communication with USFW&S, any areas with low velocity waters are potential habitat. Ammonia is the main contaminant of concern because of its potential effects (higher toxicity) on aquatic species.

Results from the 2006 biota monitoring program indicate that the backwater areas along the site consist of favorable habitat areas only during specific Colorado River discharge values. The discharge values may vary from year to year depending on the geometry of the backwater channels. Monitoring will be conducted according to methods and timing described in the Biota Monitoring Plan (DOE 2006b).

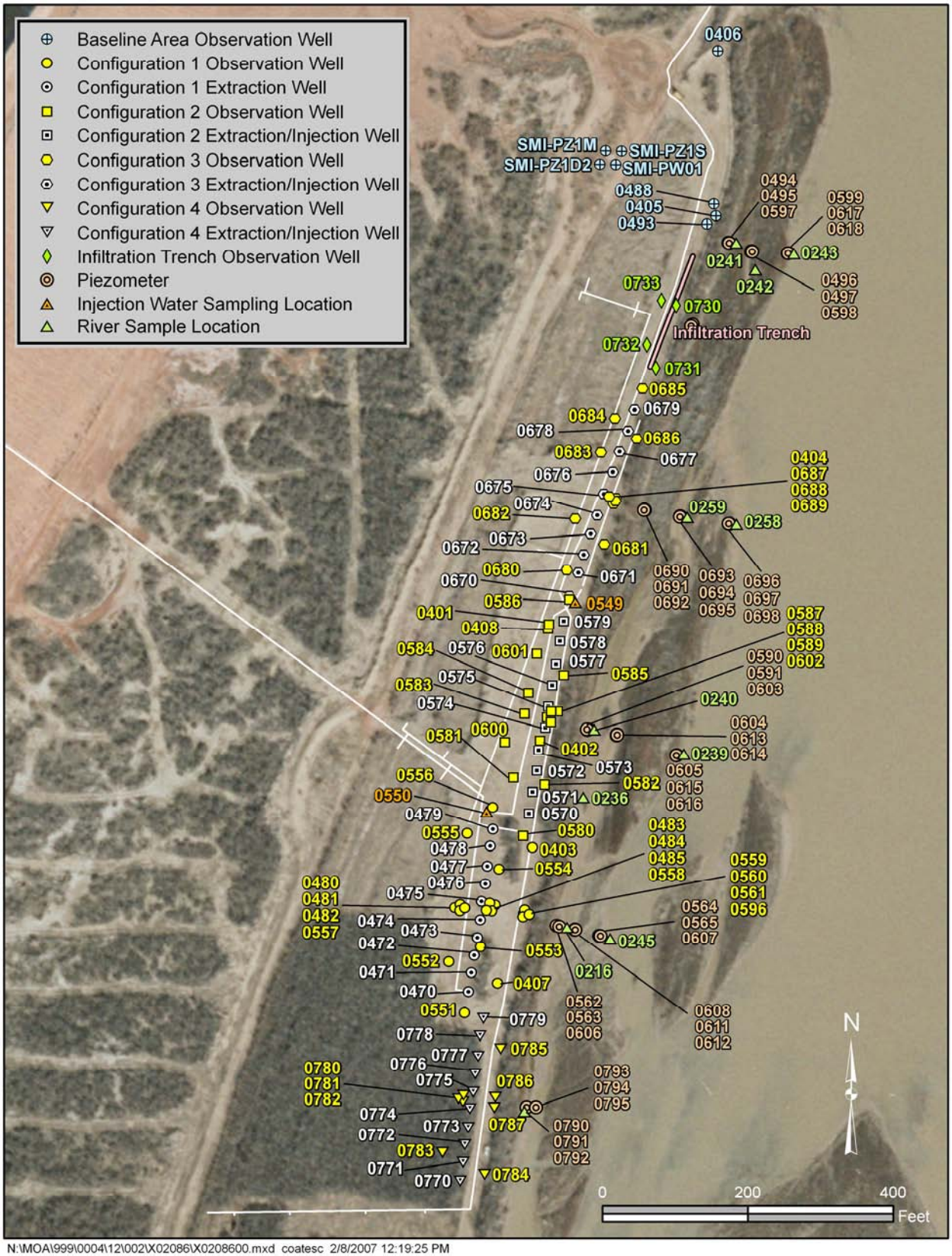

Figure 3. Sample Locations at the Interim Action Well field and Baseline Area (may include locations not sampled)

3.6.1 Purpose and Objectives

The main purpose of biota monitoring is to monitor the backwater habitat areas along the western bank of the Colorado River, adjacent to the site to evaluate effects of ground water discharge on any fish present. This information can be used in conjunction with water quality data to help assess the effectiveness of active ground water remediation.

Another purpose of the monitoring is to identify, collect, and preserve for subsequent identification of any injured, stressed, or dead fish along the banks of the Colorado River adjacent to the site. These data can be used for the purposes of estimating or quantifying "take," if any, of endangered fish as a result of exposure to site-related contamination.

3.6.2 Monitoring Approach

Young of year endangered fish are most likely to be present in the river adjacent to the site on the descending limb (after spring runoff peaks) of the hydrograph for the Colorado River. Biota monitoring will commence after the hydrograph has peaked and descended to approximately 7,000 cubic feet per second (cfs) (as measured at the Cisco gaging station). If the river flow does not reach 7,000 cfs, monitoring will start on approximately July 10. Monitoring will continue through September 30.

By the end of September, young of year endangered fish should have reached a size of approximately 40 millimeter (mm) and have the ability to avoid harmful conditions. The frequency of the monitoring will be dependent on the river discharge. An initial monitoring period will take place in early summer to determine the upper and lower brackets of river flow through the backwater area.

3.6.3 Sampling/Reporting Methods

Potential habitat areas extending from the Moab Wash to the backwater along Configuration 4 will be visually monitored for fish (alive, dead, or distressed), and channel configuration, characteristics, and surface water parameters will be collected. A Moab Biota Monitoring field data sheet (Appendix A) will be completed each day of monitoring and photographs will be taken of the backwater areas.

When the backwater is shut off (or nearly shut off) from the river on the upstream but open to the river downstream, parameters (temperature, oxidation-reduction potential [ORP], pH, conductivity) and surface water samples will be collected from potential habitat areas to monitor the water quality. The sample locations will include backwater locations that have been sampled during the monthly and routine sampling event (Figure 4 and Table 12). Additional surface water samples may be collected if further suitable habitat areas are observed.

The surface water sample analytes will include ammonia, bromide, chloride, sulfate, TDS, copper, manganese, selenium, and uranium. Any dead or dying fish that are encountered will be collected and preserved according to the Biota Monitoring Plan (DOE 2006b). Immediately upon collection, the USF&WS Ecological Services Office will be notified.

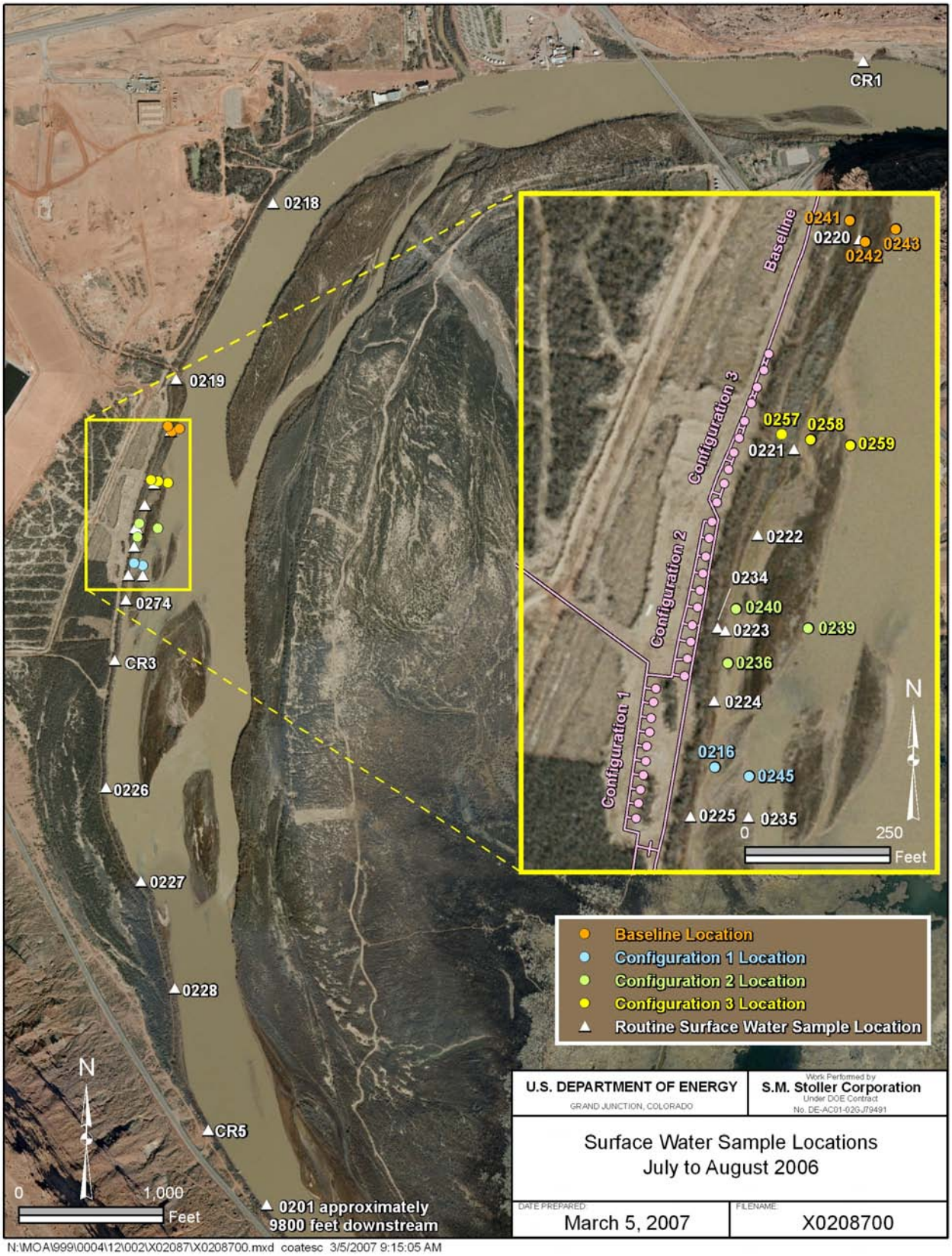

Figure 4. Surface Water Sampling Locations (not all locations sampled)

An annual biota monitoring report will be completed by the end of the calendar year for the duration that biota monitoring is required, and will include field observations, surface water sample results, and data evaluation.

Table 12. Surface Water Sample Locations

Surface Water Sample Locations*	
0274	0242
0216	0243
0245	0225
0236	0235
0240	0224
0239	0234
0259	0223
0258	0222
0241	0221
	0220

*Additional surface water locations may be added if further suitable habitat areas are observed.

3.7 Matheson Wetlands Preserve Monitoring

Several studies conducted in the past focused on the Matheson Wetlands Preserve area located on the opposite side of the Colorado River from the site. Conclusions of studies conducted by the University of Utah (Gardner and Solomon 2003) conflicted with those reached by DOE with respect to contaminant migration from the Moab site to the Matheson Wetlands Preserve. As a result, the Biological Opinion required additional monitoring and analysis of data on the south side of the river.

DOE collected data in 2005 and 2006 to support additional evaluation of potential effects of the site on the Matheson Wetlands Preserve. Sample locations are shown in Figure 5. Results are described in (DOE 2007c) and summarized in Section 4.9 of this plan.

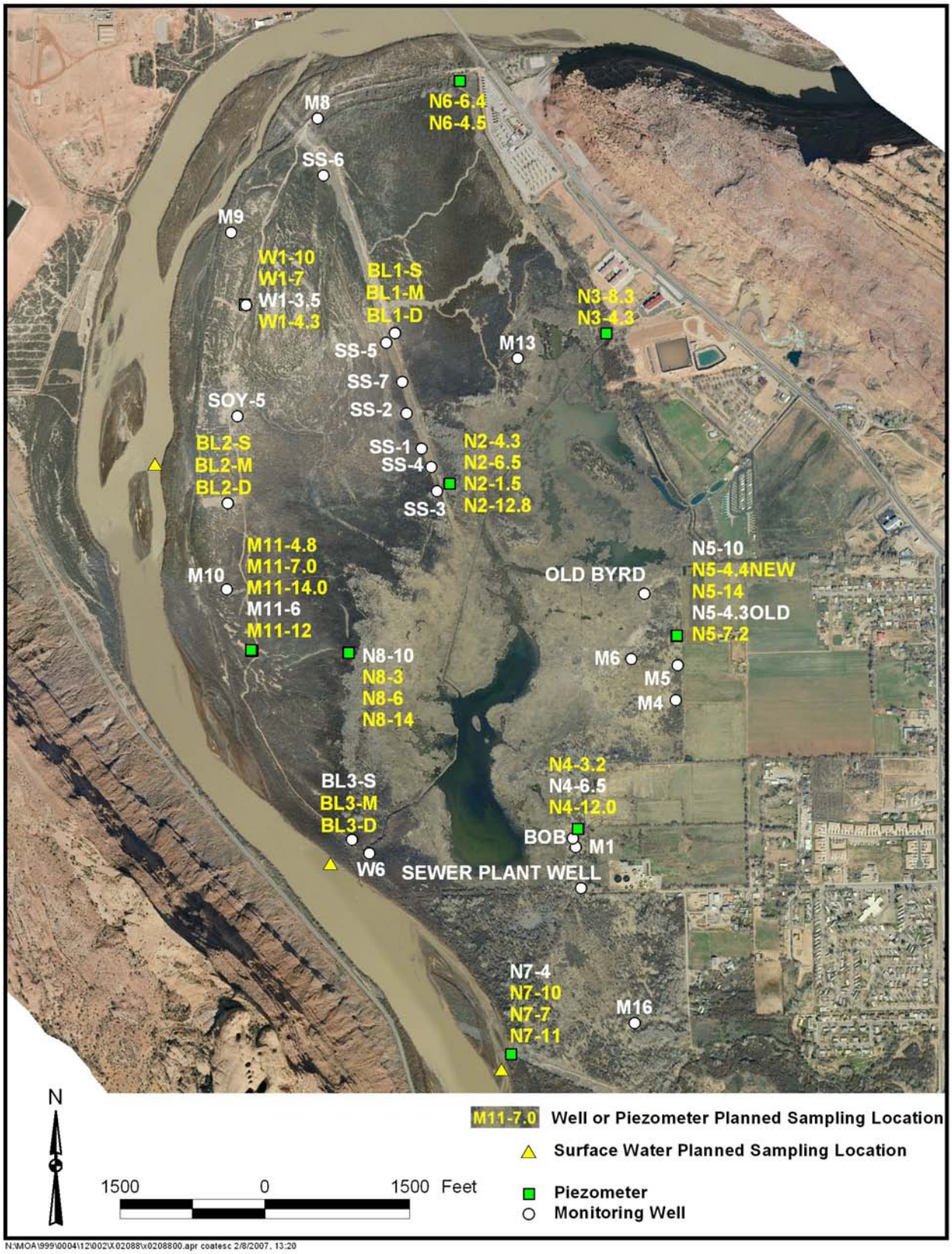

Figure 5. Wells and Piezometers at the Matheson Wetlands Used for Ground Water Sampling in 2005 and 2006

4.0 WQSP Terms and Conditions—Approach and Status

As described in Section 2.0 and listed in Table 1, the Biological Opinion for the site listed a number of terms and conditions that DOE must meet with regard to ground water remediation. The approach to be used in meeting each of those terms and conditions are discussed in this section along with the status of each.

4.1 Initial Action Protocols and Parameters (Requirement 1)

Development of initial action protocols and parameters was required to be developed within 12 months of approval of the ROD. Protocols and parameters are presented in Appendix B and were submitted to USF&WS in September 2006.

4.2 Data Quality Objectives for the WQSP (Requirement 2)

Data quality objectives for the WQSP were developed according to the Biological Opinion. These objectives are presented in Table 13 and were submitted to the USF&WS in March 2006.

Table 13. Moab Water Quality Study Plan Data Quality Objectives

Objective	Purpose	Approach	Document	Comments
Quantify "take" of endangered fish	Better understand potential effects site is having on fish	Walk river on regular basis and conduct visual inspection for dead/stressed fish	Biota Monitoring Plan	Will take place during time that young of the year fish most likely
Refine/confirm tenfold dilution factor from ground water to river	Confirm that target level(s) for ground water will be adequate and protective in the river	Continue to sample collocated surface water and ground water samples	Routine Ground Water and Surface Water Sampling Plan	May deviate from fixed locations based on river flow conditions
Ensure interim action is effective in meeting surface water quality standards	Adjustments in system operation/design may be required to meet water quality standards	Collection of ground water and surface water samples during interim action operation; includes extraction, injection, and observation wells	Interim Action Operations Plan	Will be updated as interim action is expanded; Baseline Area sampled for comparison
Confirm effectiveness of initial action, if required	Adjustments in system operation/design may be required to meet water quality standards	Sampling conducted before and during initial action operation, conditions permitting	Initial Action Implementation Plan	
Demonstrate that if 3 mg/L ammonia target goal is met, river water quality will be protective for all constituents	Better establish ground water compliance goals for all constituents	Use existing data for additional constituents and see if it correlates with changes/trends in ammonia	Not Applicable	May be reported in a calculation set as part of WQSP deliverable

Table 13 (Continued). Moab Water Quality Study Plan Data Quality Objectives

Objective	Purpose	Approach	Document	Comments
Determine spatial and temporal variability in likely habitat areas and the role that ground water discharge plays (versus other factors)	Increase understanding on how/if control of ground water system may improve habitat quality; better understand the magnitude of the "problem"	Intensive sampling approach for habitat area discussed with USF&WS; review of existing data indicates sampling will provide little benefit	Include analysis of existing data in Ground Water / Surface Water Interaction Calculation Set update	Shepard Miller, Inc did extensive, detailed sampling from April to November 2000; an additional effort is unlikely to provide more insight; current routine sampling is biased toward most likely habitat areas
Determine water quality in habitat areas on Matheson Wetlands side of the river	Better understand likelihood that the site has any influence on water quality in critical areas across the river	Identify and sample areas with habitat characteristics on Matheson side of river	Have been sampling Matheson side as part of routine monitoring; will show locations on map in WQSP	Evaluation of potential effects on habitat will be addressed in evaluation report

4.3 Effectiveness of Ground Water Remediation Efforts (Requirement 3)

The effectiveness of ground water remediation efforts will be evaluated using the interim action performance monitoring data. This includes an assessment of ground water in wells and piezometers (well points) associated with the remediation system as well as samples from adjacent surface water locations. Because of the focus on endangered fish habitat, it is expected that results of biota monitoring and opportunistic surface water sampling will augment the interim action performance data. To date, the performance of the interim action system has been described in annual performance assessment reports. Those data have not been integrated with biota monitoring data. All of these data will be used to assess system effectiveness.

The Biological Opinion indicates that the effectiveness of the system must be demonstrated within 10 years of the ROD—the period for which incidental take is granted. It is anticipated that report will be prepared within this time frame to demonstrate that the system is fully operating successfully. This demonstration is expected to take into account Requirements 4 through 6 described below.

4.4 The Tenfold Dilution Factor (Requirement 4)

Routine ground water and surface water monitoring data were collected in the past to further refine the dilution factor. These data were reported in ground water/surface water interaction calculation sets that seemed to support the previously determined dilution factor of 10. However, those data from fixed surface water locations may not have been as relevant to an assessment of habitat areas as more biased sampling might be. More recent sampling efforts have involved conducting more biased surface water sampling in conjunction with biota monitoring to better determine effects of dilution in backwater areas. These data combined with interim action monitoring data should provide a better overall estimate of dilution processes. To date, no detailed analysis of these data has been conducted with respect to the tenfold dilution factor.

A final dilution factor calculation set will be prepared to incorporate all data collected to date.

4.5 Target Goal of 3 mg/L (Requirement 5)

Surface water sampling to date provides an assessment of compliance with surface water standards. These data have been reported in a variety of forms (data validation reports, interim action assessment reports, calculation sets). These data will be integrated to provide a more complete assessment of how the ground water target goal ensures compliance with surface water quality standards (this is dependent on a consideration of the dilution factor and results of biota monitoring and habitat sampling, collectively).

A final calculation set will be prepared to demonstrate that the 3 mg/L ammonia target level will be protective in potential habitat areas.

4.6 Other Constituents of Concern (Requirement 6)

It is expected that data from ongoing monitoring will provide the information to evaluate constituents other than ammonia. To date, however, there has been no detailed analysis of other constituents of concern and the implications of meeting the ammonia target level. This analysis will probably involve a combination of the dilution argument and a correlation of ammonia with other COCs (spatially and concentrations).

A calculation set will be prepared to detail the results of this evaluation. An examination of sulfate and uranium data collected to date seem to indicate that remediation of ammonia will also be protective for other constituents. However, additional data collection for other analytes (copper, manganese, selenium) is required before the analysis can be completed.

4.7 Reporting Requirements and Schedule (Requirement 7)

To date, schedule and reporting requirements have been driven mainly by individual monitoring events or purposes. Currently data are reported in annual initial action monitoring reports, interim and final annual biota monitoring reports, annual interim action performance reports, and data validation reports prepared after each sampling "event." It is expected that these reporting mechanisms will continue for the foreseeable future.

To address some of the specific terms and conditions of the Biological Opinion, several other calculation sets or reports are anticipated. These are as follows:

- Tenfold dilution final calculation set (Requirement 4) – September 2007.
- 3 mg/L ammonia ground water target goal final calculation set (Requirement 5) – September 2008.
- Other contaminants of concern (COCs) calculation set (Requirement 6) – September 2009.
- Comprehensive performance evaluation of long-term ground water remediation system (Requirement 3) – report anticipated during fiscal year (FY) 2015.

4.8 Conceptual Site Model (Requirement 8)

It is expected that all data being collected at the site can be used in refining the conceptual model, should that be necessary. To date, it appears that the conceptual model presented in the Site Observational Work Plan (DOE 2003) and FEIS (DOE 2005a) remains valid. This was confirmed by the recent study of the Matheson Wetlands Preserve (see Section 4.9). However, once removal of the tailings pile is initiated, changes in the system could occur. At other UMTRA sites, it has been documented that surface remediation activities often result in effects on the ground water system. The current monitoring system should be able to detect any such changes in the future as surface remediation proceeds. Adjustments in the conceptual site model can be made in the future, as necessary.

4.9 Matheson Wetland Area (Requirement 9)

In 2006, DOE completed an updated assessment of the flow processes and chemistry in ground water in the vicinity of the Matheson Wetlands Preserve (DOE 2007c). The assessment made use of data collected at wells and piezometers (well points) southeast of the river during three sampling events between December 2005 and June 2006. Analysis of shallow ground water level data collected during this period suggests that flow patterns in the area previously identified by Gardner and Solomon (2003) continue to be present in recent years, which in turn have significant influence on the distribution of chemical constituents dissolved in the ground water.

As with multiple previous studies addressing the Matheson Wetlands, chemical data reported in DOE's study indicated that local ground water contains notably high concentrations of TDS, ammonia, and uranium, as well as several other constituents that appear to be largely the result of the high salinity observed in much of the ground water southeast of the river. Using a combination of findings from previous investigations and relatively detailed evaluation of the chemical data collected in 2005 and 2006, DOE's report provided logical explanations for observed spatial and temporal distributions of high concentrations for TDS, ammonia, and uranium. These explanations center mostly on natural flow and transport processes that appear to have been occurring in the northwest end of the Moab Valley for thousands of years.

A major finding stemming from the analysis of transport processes occurring in the Matheson Wetlands is that ground water on the southeast side of the river is unrelated to contaminated ground water beneath the site, located on the opposite (west) side of the river. More detailed evaluation and conclusions are provided in (DOE 2007c). This study fulfills Requirement 9; no further consideration of the Matheson Wetlands is determined to be necessary.

5.0 References

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DOE (U.S. Department of Energy), 2004. *Surface Water and Ground Water Monitoring Plan for the Moab, Utah, Site*, GJO-2004-561-TAC, February.

DOE (U.S. Department of Energy), 2005a. *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement*, DOE/EIS-0355.

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DOE (U.S. Department of Energy), 2006a. *Moab Initial Action Report, 2005 Calendar Year*, DOE-EM/GJ1080-2006, January.

DOE (U.S. Department of Energy), 2006b. *Biota Monitoring Plan, Moab Site, Utah*, DOE-EM/GJ1079-2006, January.

DOE (U.S. Department of Energy), 2007a. *Moab Initial Action Report, 2006 Calendar Year*, DOE-EM/GJ1402-2007, January.

DOE (U.S. Department of Energy), 2007b. *Operations, Maintenance, and Performance Monitoring Plan for the Interim Action Ground Water Treatment System* (Current Version Not Yet Published – Anticipated in April 2007).

DOE (U.S. Department of Energy), 2007c. *Fall 2006 Assessment of Matheson Wetlands Hydrogeology and Ground Water Chemistry*, DOE-EM/GJ1441-2007, March.

Gardner, P., and D.K. Solomon, 2003. *Investigation of the Hydrologic Connection Between the Moab Mill Tailings and the Matheson Wetlands Preserve*, Department of Geology and Geophysics, University of Utah.

Appendix A

Moab Biota Monitoring Field Data Form

Moab Biota Monitoring Field Data

Date_____ Time:_____ Configuration Area_____

Current River Flow:_____ Channel Width_____ Water depth_____

Flow: Low Med. High Turbidity: Low Med High

Channel Characteristics

_____

_____

_____

Open upstream? Yes No Open downstream? Yes No

Fish Observed? Yes No
Comments:_____

_____

_____

Dead or Distressed Fish?_____

Suitable Habitat? Yes No
Comments:_____

_____

_____

Parameters:
Calibration Time:_____

Time	Water Depth	Temp. °C	Conductivity µmhos/cm	DO mg/L	pH	ORP (mV)	Turbidity

Other Notable Characteristics (algal growth, salt precipitation, desiccation cracks, etc.)?

_____

_____

_____

Was this location sampled? Yes No
Reason?_____

_____

_____

_____

Sample Time:_____ Sample Location:_____

Signature:_____

End of current text

Appendix B

Protocols for Initial Action Implementation at the Moab UMTRA Project Site

Protocols for Initial Action Implementation at the Moab UMTRA Project Site

The protocols for implementation of the initial action at the Moab UMTRA Project Site, Moab, Utah, are largely contained in the *Work Plan for Implementation of the Initial Action in the Sandbar Area Adjacent to the Moab Project Site* (DOE 2002, http://gj.em.doe.gov/moab/documents/work_plan_implementation.pdf). Protocols are identified for three elements of the implementation: timing and duration, operation, and monitoring and reporting. Each is listed below. These protocols are to be included in the *Water Quality Study Plan* that is being prepared for the Moab UMTRA Project Site.

Timing and Duration

- Potential habitat areas are visually monitored in the spring as the river stage rises to determine minimum and maximum river flows during which the area is considered to be suitable habitat.
- As river levels decline, the initial action is operated during the period of maximum and minimum flows identified above.

Operation

- Operation of the initial action system will consist of either a diesel-or electric-powered pump connected to an upstream river inlet hose. Will use ¼-inch screen on intake to reduce fish entrainment. [Typical pumping rates for FY 2006 were between 400 and 900 gallons per minute (gpm). Similar pumping rates are expected for future test periods.]
- Diverted river water will be transferred by 6-inch diameter PVC piping parallel to the river, along the top of the bank, and by flexible hoses to individual areas (Areas A, B, or C) previously identified as potential habitat.
- In-line valves will be used to control water flow to these areas. Visual observations will be made to coordinate flow rates to individual areas in order to minimize erosion and turbidity in the backwater channels. Diffusers will be used on the flexible hoses to assist in minimizing erosion and turbidity.

Monitoring and Reporting

- A baseline surface water-sampling event will be conducted before startup of the initial action.
- Sampling during the initial action will take place several times during operation of the initial action, to the extent that this is possible.
- Visual observations (accompanied by photographs, as deemed appropriate) of the initial action area will take place during operation; observations will be recorded in a field logbook and on field worksheets provided in the initial action work plan (DOE 2002). The presence or absence of fish should be noted.
- Results of the initial action will be reported annually to U.S. Fish and Wildlife Service by January 31 for the preceding calendar year.

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Appendix C

Interim Action Well Field Photographs

Interim Action Well Field Configuration 1 Wells

Interim Action Well Field Configuration 2 Wells

Interim Action Well Field Configuration 4 Wells

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