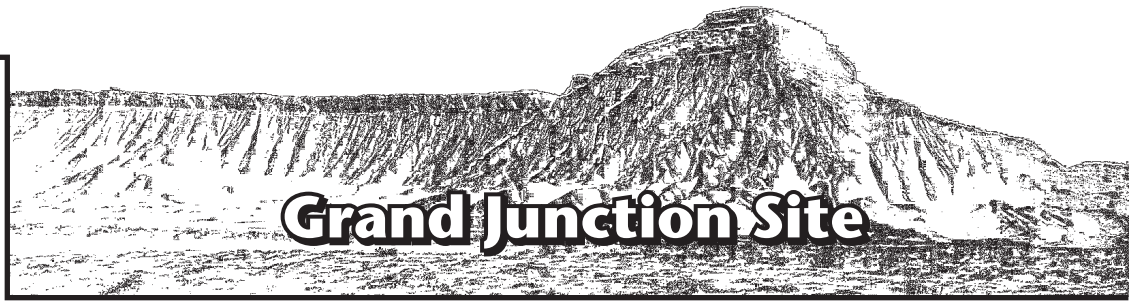
GJO–2004–561–TAC

Moab Project

Surface Water and Ground Water Monitoring Plan for the Moab, Utah, Site

February 2004



U.S. Department of Energy

Work Performed Under DOE Contract No. DE–AC01–02GJ79491 for the U.S. Department of Energy Grand Junction Site.
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Moab Project

Surface Water and Ground Water Monitoring Plan for the Moab, Utah, Site

February 2004

Work Performed by S.M. Stoller Corporation under DOE Contract No. DE AC01–02GJ79491
for the U.S. Department of Energy, Grand Junction, Colorado

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Acronyms

cfs	cubic feet per second
DOE	U.S. Department of Energy
ft	feet/foot
ft^2	square feet
HS	horseshoe vortex
HSP	health and safety plan
ISMP	interagency standardized monitoring program
m	meter
m^2	square meter(s)
MS	migrating sand waves
SC	scour channel
SE	shoreline eddy
SH	shoreline
SOWP	site observational work plan

End of current text

1.0 Introduction

The Moab, Utah, site (Moab site) is a former uranium-ore processing facility located approximately 3 miles northwest of the city of Moab in Grand County, Utah (Figure 1–1). The plant was constructed in 1956 by the Uranium Reduction Company, which operated the mill until 1962 when the assets were sold to the Atlas Minerals Corporation (Atlas). Operations continued under Atlas until 1984. When the processing operations ceased in 1984, the mill had accumulated an estimated 10.5 million tons of uranium mill tailings in an unlined impoundment in the floodplain of the Colorado River. The tailings pile covers approximately 130 acres, is about 0.5 mile in diameter, averages about 94 feet in height above the surface of the Colorado River terrace, and is located about 750 feet west of the Colorado River. Atlas placed an interim cover over the tailings pile as part of decommissioning activities ongoing between 1988 and 1995. In October 2001, the title of the property and responsibility for remediation of the tailings pile and contaminated ground water beneath the site were transferred to the U.S. Department of Energy (DOE).

Results of a number of investigations, including the most recent one completed by DOE (DOE 2003a), indicate that contaminants have leached from the tailings pile into the ground water. Several site-related contaminants have been identified, but the most pervasive and highest concentration constituent is ammonia. DOE's studies have identified two plumes of ammonia associated with the site—a deep plume beneath the tailings pile and a shallower plume emanating from the toe of the tailings pile to the Colorado River. Ground water from the shallow plume has been demonstrated to discharge to the Colorado River and to have a localized impact on surface water quality. Degradation of surface water quality is of concern because of potential effects on aquatic species in the area—particularly endangered fish.

DOE has initiated an interim action to pump contaminated ground water from the shallow plume to an evaporation pond on top of the tailings pile. The goal of the action is to reduce contaminant mass in the aquifer until a full-scale remediation system can be designed and installed. The interim action has been in place since summer 2003. Each of the 10 extraction wells in the system is equipped to withdraw groundwater at rates between 1 and 7 gpm. In its draft environmental impact statement for remediation of the Moab site (DOE 2003b), DOE has proposed to intercept ground water and control discharge of contaminants to the river until concentrations in the alluvial system are reduced to levels that permit unrestricted discharge to the river. This proposed action could involve scaling up of the interim action system or augmenting it in some other way.

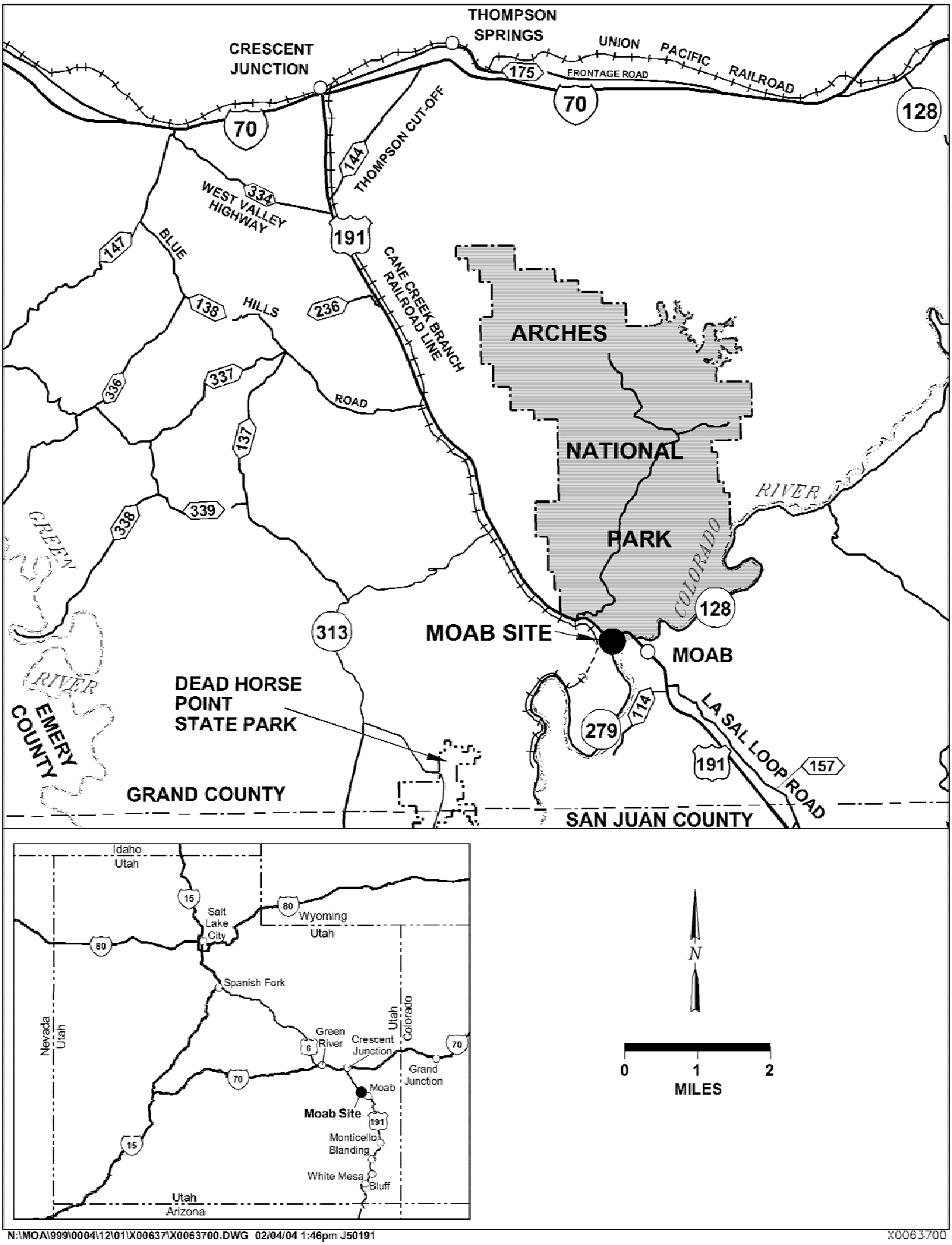

Figure 1–1. Moab, Utah, Site

2.0 Purpose and Scope

The purpose of this document is to provide a plan for monitoring surface water and ground water during remediation of the Moab site. Results of this monitoring will help fulfill several objectives and reduce some uncertainties associated with the conceptual model that has been developed for the site (DOE 2003a). Those objectives include

- Continued in stream monitoring to assess overall water quality of the Colorado River as remediation proceeds.
- Refine the understanding of ground water and surface water interactions (e.g., dilution factors) to better define long-term ground water cleanup goals.
- Better understand impacts of ground water discharge on surface water quality in areas that realistically represent key habitat for endangered fish, depending on life stage of the species.
- Determine if apparent trends identified through the evaluation of historic data are real.
- Obtain improved understanding of ammonia degradation rates and the behavior of the deep ammonia plume.
- Improve the understanding of background water quality in areas with characteristics similar to endangered fish habitat (e.g., depth, velocity).

Two types of sampling events have been identified to fulfill these objectives. “Routine monitoring” involves regular monitoring that will occur 3 times per year at fixed locations along the river. This monitoring includes instream compliance monitoring and monitoring to better define the changing relationship of ground water and surface water interactions during different river flow conditions. “Opportunistic sampling” targets areas in the Colorado River with conditions that render it habitat for endangered fish depending upon the river stage. Because of the dynamic nature of the river system, these conditions will be unpredictable in location and timing and therefore sampling will therefore be “opportunistic” in nature, with locations changing according to river flow conditions and shoreline configuration. Regular surveillance of the river conditions will be conducted and sampling will take place if and when suitable habitat conditions develop. Characterization and monitoring to address design and performance assessment of the interim and final ground water remediation system are being addressed separately in the operations plan for the interim ground water action (DOE 2004).

2.1 Habitat Description

Because a major purpose of future monitoring is to evaluate potential impacts from the site on habitat important to the endangered fish, it is necessary to understand important habitat characteristics so that appropriate sample locations may be selected and samples collected. The endangered species that has been of greatest concern is the Colorado Pikeminnow, though the river is designated critical habitat for three other listed species (razorback sucker, humpback chub, and bonytail chub). While past characterization efforts have clearly demonstrated that ammonia-contaminated ground water does affect surface water quality in some areas, it is not clear whether the affected areas represent locations that are likely to be inhabited by endangered fish. Based on descriptions of sampling locations during previous sampling events, it appears that surface water samples were collected from areas similar to that shown in Figure 2–1 (the puddle on the mud flat). This would be an inappropriate habitat sample location. Guidelines provided in this plan should help prevent future sampling of such inappropriate locations and provide a more valuable indicator of site effects on viable habitat.

Figure 2–1. Northernmost Mud Flat

Habitats used by Colorado pikeminnow have been the subject of numerous studies to assist in implementation of fish recovery efforts. This has resulted in the classification of habitat and backwater areas into different categories, largely based on their mode of formation. A "backwater," as used by fish biologists, is a zero-velocity habitat with a connection to the river, usually located adjacent to sand bars, cobble bars, the downstream end of abandoned side channels, or flooded tributary mouths (Trammel, personal communication).

The categories listed and described in Table 2–1 were used to classify habitats in the Colorado River along a segment of the river including the Moab site (Trammel and Chart 1998). Though other types of habitats have been recognized (e.g., Day and others 1999), the categories in this table appear to encompass the most important habitat types that would likely occur in the vicinity of the Moab site, which has a lower diversity of habitats than along other portions of the river. Several studies have focused on identifying "preferred" habitats, which are more often used by the pikeminnow and on determining which characteristics of these important habitats are most critical (Trammel and Chart 1998; Day and others 1999). The deep, persistent scour channel (SC) habitat has been identified as one of the most important pikeminnow habitats. This habitat type has not to date been identified adjacent to the Moab site; the migrating sand wave (MS) and shoreline (SH) habitats are likely more common. One study in the Green River showed that while MS habitat was quite common, it was not used by pikeminnow in proportion to its presence. The potentially suitable habitat that was the focus of the previously proposed initial action (areas A, B, and C in Figure 2–2; DOE 2002a) would be classified as floodplain (FP) habitat. This habitat type was not identified as being of much importance in previous surveys of the Colorado or Green Rivers (Trammel and Chart 1998; Day and others 1999; Trammel and Chart 1999a), perhaps because of its ephemeral nature.

Table 2–1. Backwater Habitat Classification Categories and Descriptions (from Trammel and Chart 1998)

Habitat Type	Description
Scour channel (SC)	Habitats formed by the erosion/deposition cycle of small channels behind large alternating sandbars. Scoured out during floods and revealed by receding water levels. Usually relatively deep and permanent.
Migrating Sand Waves (MS)	Habitats formed by the relative movement of adjacent migrating sand waves. Relatively shallow and ephemeral; embayments.
Horseshoe Vortex (HS)	Habitats formed by scour holes generated at high flows at the upstream ends of islands due to development of horseshoe vortex patterns. Moderately deep and semi-permanent.
Flooded Tributary Mouth (FT)	Habitats formed by rising river levels flooding into tributary mouths. Related to seasonal high flows or rainfall events.
Shoreline Eddy (SE)	Habitats formed by recirculating areas due to irregularities of the bank.
Shoreline (SH)	Shallow sloping shoreline areas.
Floodplain (FP)	Habitats formed by the inundation of abandoned channels or floodplains. Related to seasonal high flows or rainfall events.

It was noted that pikeminnow are not the only endangered fish that have potential to inhabit the Colorado River in the vicinity. The other important species of most concern in the area is the razorback sucker. While fewer studies have been conducted expressly on the sucker than the pikeminnow, it appears that important habitat for the two species are similar. According to the recovery plan for the razorback sucker (USFWS 2002), young suckers require "nursery environments with quiet, warm, shallow water such as tributary mouths, backwaters, or inundated floodplain habitats in rivers…" Therefore, habitats identified for pikeminnow are inclusive of those required for the sucker. The habitat preferred by humpback and bonytail chub are deeper canyons, which do not exist in the vicinity of the Moab site and which would be unlikely to be affected by site-related contamination.

Several important characteristics that appear to influence habitat use by pikeminnow have been identified. These include water depth, habitat surface area, water velocity, turbidity, and temperature. The two most important factors used in the interagency standardized monitoring program (ISMP) (USFWS 1987) for monitoring pikeminnow populations are water depth and surface area. The protocol also specifies that sampling be conducted using certain equipment and techniques. Other habitat characteristics are noted during pikeminnow sampling (e.g., temperature, turbidity) but are not limiting in selection of sampling locations. However, if monitoring is conducted in true backwater areas, water velocities would necessarily be slow. In addition, temperatures are measured in the backwater and the main channel for comparison. Turbidity of the backwater is noted on a relative scale of 1 to 3 (see Section 3.0). The relationship of the backwater to the main river channel is also noted (also see Section 3.0). A methodology similar to the ISMP is outlined here for use in future sampling events for the Moab site.

Currently the ISMP specifies that sampling be confined to locations with a minimum depth of 0.3 meter (m) (about 1 foot) and a minimum surface area of 30 square meters (m^2) (322 square feet [ft^2]). A recent study has suggested that a reduction of sampling depths to 0.2 to 0.25 m (approximately 8 to 10 inches) may be warranted (Day and others 1999). This same study noted that pikeminnnow have also been found in backwaters with areas as small as 19 m^2 (204 ft^2). Another study to evaluate sampling protocols (Trammel and Chart 1999b) recommended no changes to the current ISMP methodology.

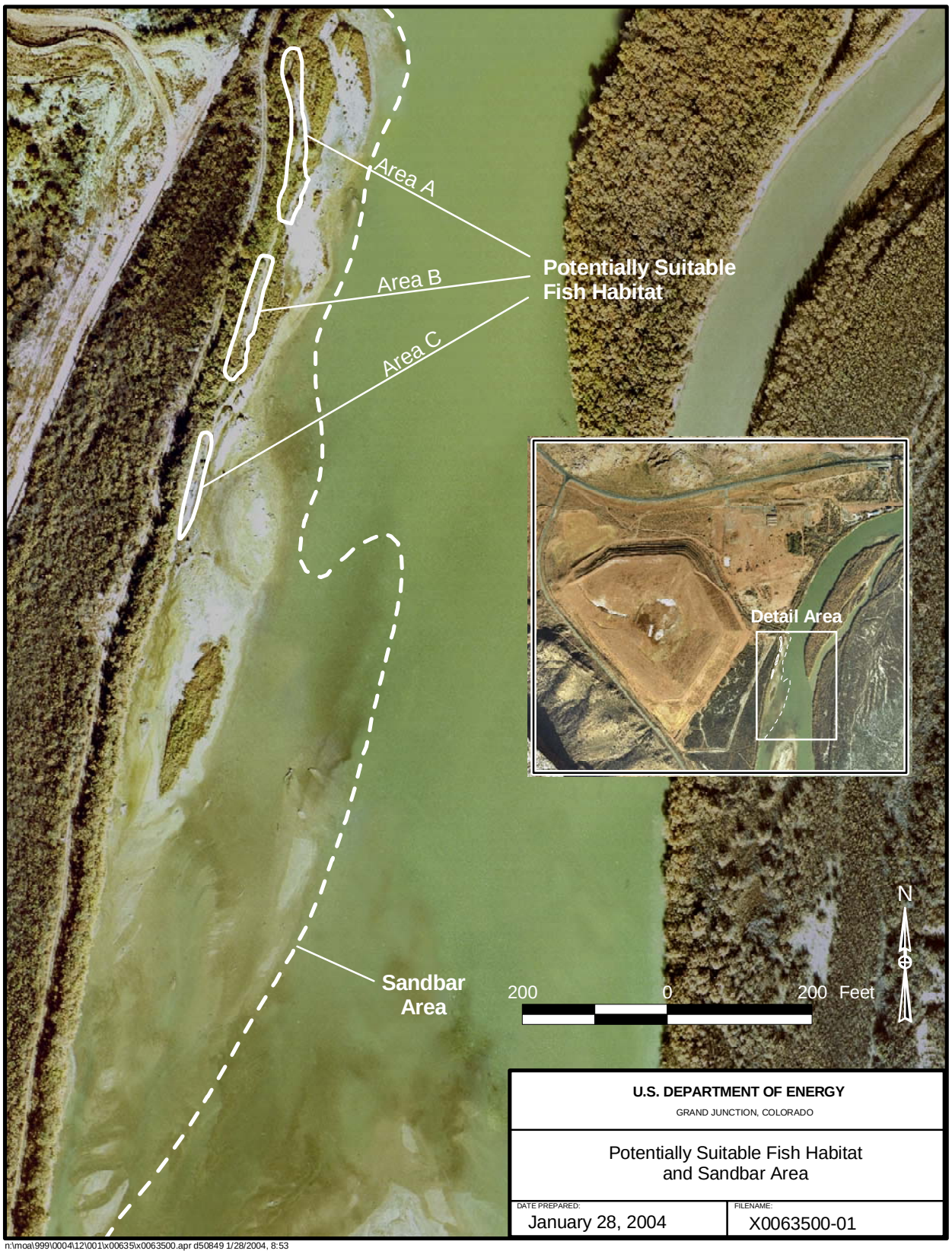

Figure 2–2. Potentially Suitable Habitat Areas

3.0 Routine Sampling and Monitoring

It is anticipated that routine sampling and monitoring will initially take place three times a year. Most ISMP sampling is conducted at this frequency, with a spring, summer, and fall sampling event (Day and others 1999; Trammel and Chart 1998), and a similar approach is proposed for routine monitoring at Moab. A look at the hydrograph for the Colorado River (Figure 3–1) shows that these events would generally correspond to one event on the increasing side of the hydrograph (spring; March/April), one on the decreasing side (summer; August), and one during low flow conditions (fall; October/November). These are probably the times of year when suitable habitat is most likely to occur. Spring sampling should occur before reaching bankfull conditions and summer sampling after bankfull conditions have receded. At peak flows with bankfull conditions, habitat will normally be absent and any contaminated ground water discharging from the site would be rapidly diluted by the high river flows. Exact timing of sampling events for any given year would probably need to be determined based on hydrograph observations for that year, though historical patterns could be used for planning purposes.

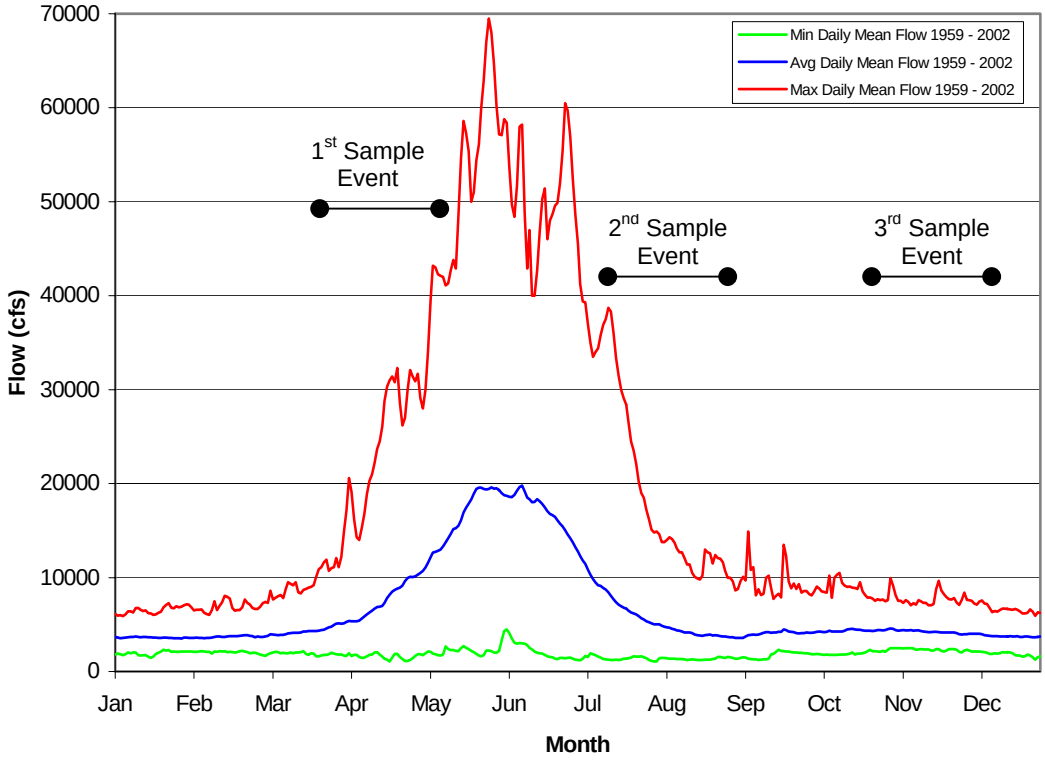

Figure 3–1. Minimum, Maximum, and Average Daily Mean Flows Measured at the Cisco Gaging Station, 1959-2003

Both ground water and surface water samples will be collected during the routine monitoring events. Ground water will be sampled from existing or newly installed wells at targeted locations. Surface water samples will be collected from fixed locations along the shoreline (from upstream to downstream), but because of variation in river flow conditions will necessarily be collected from different distances perpendicular to the bank. Criteria for surface and ground water sampling are further described below.

3.1 Collocated Ground Water and Surface Water Sampling

In order to better understand the impacts of ground water discharge on surface water quality, collocated ground water and surface water sampling will take place. Monitoring at these locations will also help assess the effectiveness of the active remediation system in achieving surface water quality goals. Table 3–1 lists paired ground water and surface water sampling locations. All wells but one are at existing locations. All but one surface location are new and have been established to as closely coincide with its corresponding well location as possible. These locations are shown on Figure 3–2.

Table 3–1. Ground Water and Surface Water Sampling Requirements

Well Location	Surface Water Location	Sampling Type/Rationale	Frequency of Sampling
Routine Monitoring			
TP-02	218— 1 nearshore 1 In stream	Collocated SW/GW In-stream Compliance	3 times/year
401/408	222	Collocated SW/GW	3 times/year
402	223— 1 nearshore 1 In stream	Collocated SW/GW In-stream compliance	3 times/year
403	224	Collocated SW/GW	3 times/year
404	221	Collocated SW/GW	3 times/year
405	220	Collocated SW/GW	3 times/year
406	219	Collocated SW/GW	3 times/year
407	225	Collocated SW/GW	3 times/year
492	CR-3—1 nearshore 1 In stream	Collocated SW/GW In-stream compliance	3 times/year
TP-17	226	Collocated SW/GW	3 times/year
TP-18	227— 1 nearshore 1 In stream	Collocated SW/GW In-stream compliance	3 times/year
TP-19	228	Collocated SW/GW	3 times/year
437		Monitor deep ammonia plume	3 times/year
439		Monitor shallow ammonia plume	3 times/year
ATP2S		Monitor historical trends	3 times/year
ATP2D		Monitor historical trends	3 times/year
	CR5	In-stream compliance	3 times/year
	201	In-stream compliance	3 times/year
	CR1	Background	3 times/year
	217	Monitor background in habitat-like area	3 times/year
Opportunistic Sampling			
	Areas A, B, C (Figure 2–2)	Opportunistic habitat sampling	When flow conditions are right—one short time period after runoff.
	TBD (1 or 2 locations)	Opportunistic habitat sampling during routine sampling events – locations determined at that time	0 to 3 times/year depending on conditions.

Routine ground water monitoring locations are fixed in their location along the shoreline, but the location of each corresponding surface water sample will vary with river stage across the riverbank. Because one objective of the sampling is to understand the potential effects of ground water discharge in areas that have the potential to be inhabited by endangered fish, samples should be collected from waters that can reasonably be expected to host fish, either as they pass through the area or for more prolonged use. As discussed above, previous studies have shown that Colorado pikeminnow, the main species of concern in the Moab area, occupy waters with a minimum depth of about 8 inches and a minimum surface area of approximately 204 ft^2

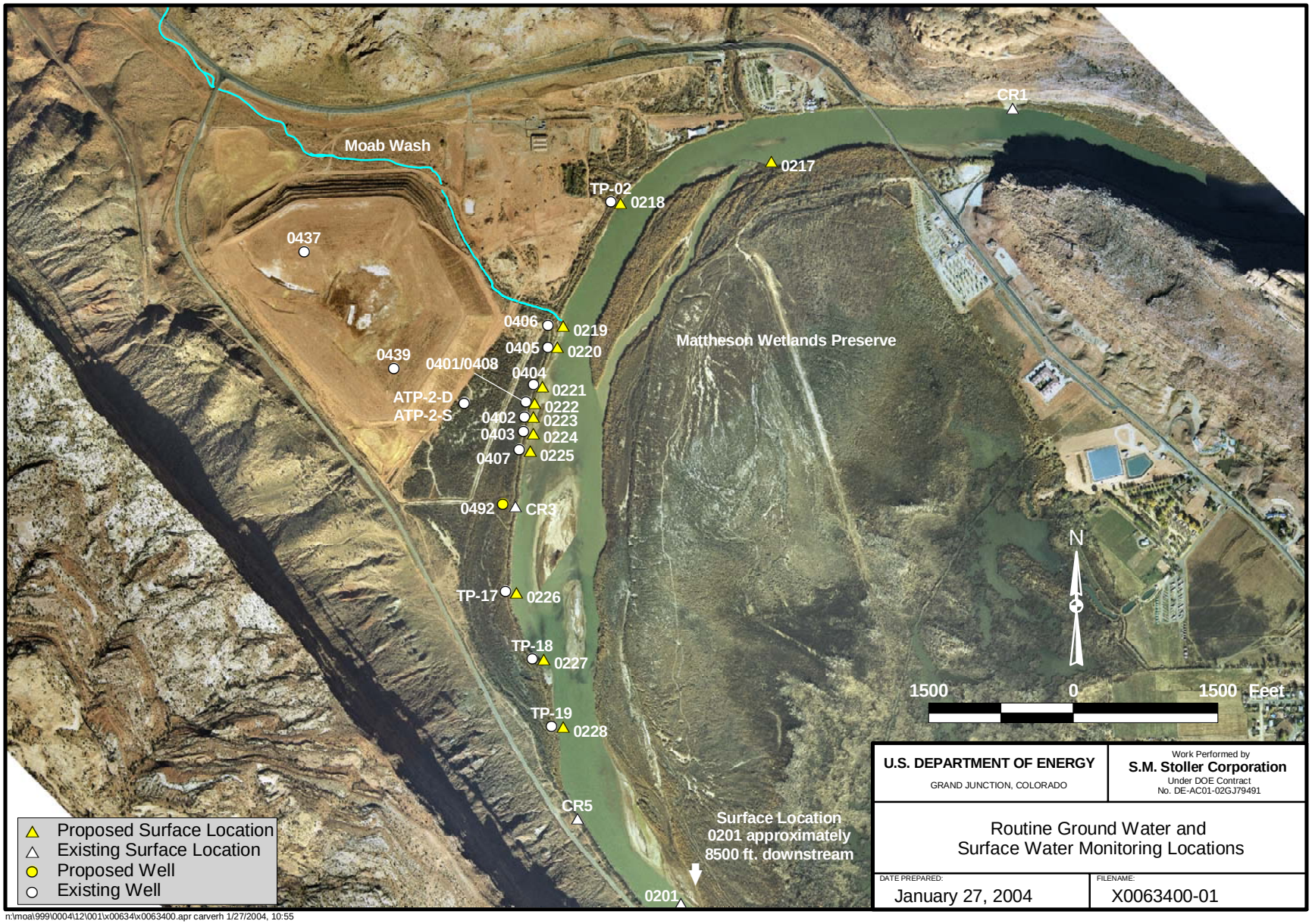

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Figure 3–2. Ground Water and Surface Water Sampling Location Map

(Day and others 1999). Therefore, to be conservative, routine surface water samples should be collected far enough into the river that a minimum 8-inch depth of water is observed. An attempt should be made to locate areas where the surface area of the open water is at least 200 ft^2, though this is less critical than the depth requirement. In addition, the area sampled should have some connection to the main river channel (i.e., no samples should be collected from isolated pools unless they are large and fish are observed in them). When the sample is collected, the location should be photographed and described. If the location has the characteristics of one of the habitat areas listed in Table 2–1, the type should be noted and the aspect of the backwater mouth described as shown in Figure 3–3 (from Day and others 1999). Water flow rates should be qualitatively described as no flow (e.g., if the water is open to the river on the downstream side and water is essentially still), low velocity (moving but smooth surface), moderate velocity (ripples on the surface), or fast moving. Temperature should be measured just above the river bottom. If the location qualifies as a backwater and is not in the main channel, the temperature of the main channel waters should be measured as well. Turbidity of the water should be designated as 1 for clear, 3 for exceptionally cloudy (<2 inch visibility), and designated 2 for somewhere in between (Day and others 1999). The nature of the bottom sediments should be described (mud, sand, cobbles, etc.). If there is any type of cover over the area (vegetation, bank overhang), this should be described and percent cover estimated. The presence or absence of fish (of any kind) should also be noted. A form is provided as Attachment 1 for purposes of describing the sample location. While the intent of the routine sampling is not to target preferred habitat for the endangered fish, it will be useful to know how suitable existing conditions are for that purpose and how much they change in these fixed locations. This can help improve the understanding of how dynamic an environment exists adjacent to the site.

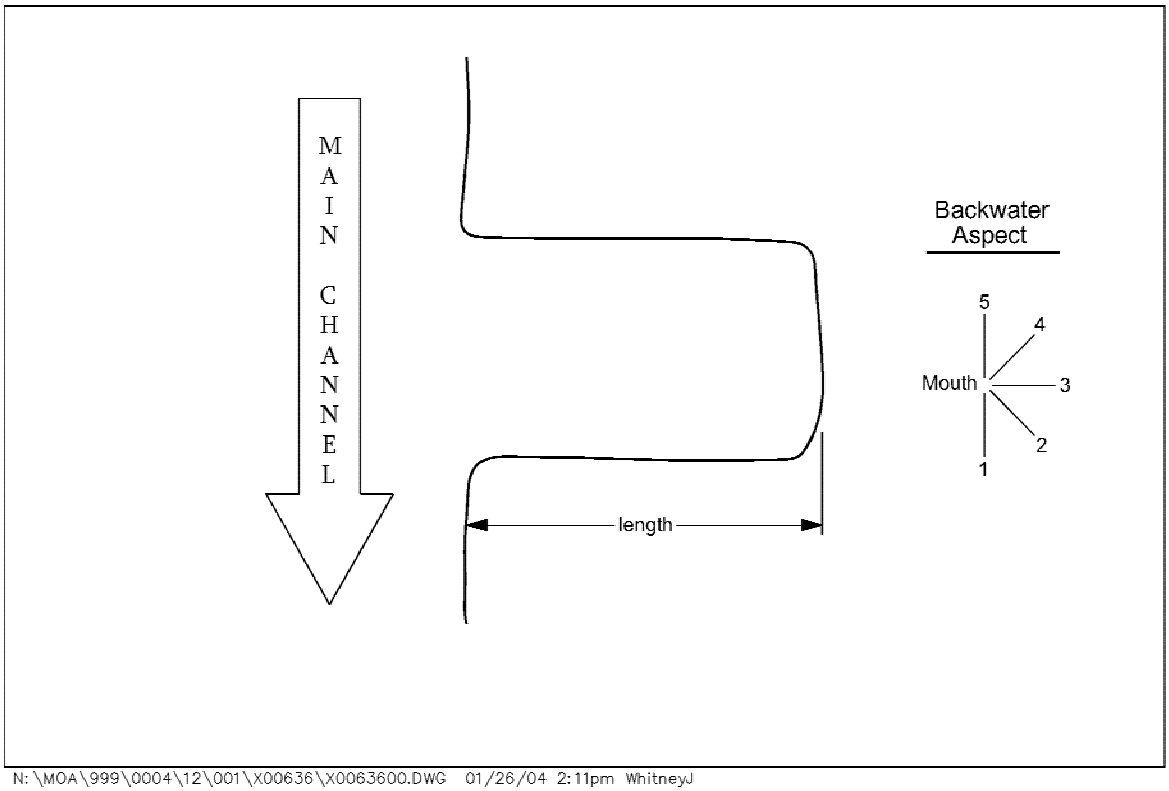

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Figure 3–3. Guidelines for Describing Aspect of Backwater Mouth

Mouth Open Downstream = 1; Mouth Open Upstream = 5

3.2 Instream Monitoring

Six surface water locations are identified for instream monitoring; four of these locations correspond to collocated sampling locations. Compliance monitoring locations are identified in Table 3–1. These surface water samples should be collected from the main channel of the river in flowing water. They should be representative of overall surface water quality as opposed to more restricted backwater areas. Collecting samples at the same locations as collocated samples will also provide information regarding variability in surface water quality with distance from shore. If possible, monitoring samples should be collected at a distance farther into the river than the collocated surface water sample.

3.3 Other Ground Water Monitoring Locations

Several monitoring wells have been selected for monitoring other than the collocated wells (Table 3–1). Data from these locations will help in monitoring plume movement and behavior, and in evaluating the validity of parameters used in the ground water modeling, such as attenuation rates. Wells 437 and 439 will be sampled to monitor the deep and shallow ammonia plumes, respectively. Locations ATP2S (shallow) and ATP2D (deep) are paired wells that have the best historic monitoring records and will be sampled to extend this history and evaluate the apparent trends in the existing data. Though ammonia was not historically an analyte during sampling of these wells, it will be included for the future for use in tracking changes in concentration with depth.

3.4 Background Water Quality Monitoring

Background water quality monitoring will be done for surface water only. Background conditions for ground water are not expected to change and have little bearing on the establishment of remediation goals for ground water. On the other hand, surface water can vary based on river flow conditions and background data are necessary for evaluating the extent to which the site impacts river water quality. CR-1 has been used as the background location in the past and monitoring of this location will continue for historical purposes. However, it was noted in the Site Observational Work Plan (SOWP) (DOE 2003a) that CR-1 may not be representative of background conditions that would be expected in fish habitat areas because CR-1 is on the outer bend of the river and does not represent backwater conditions. Additionally, CR-1 is in a location outside the influence of the Paradox formation, which has a prominent influence on ground water quality at the site and in the Matheson Preserve area across the river. Therefore, a new background location (217) will be selected that meets the minimum criteria for habitat—low velocity water, 8 in minimum depth, 200 ft^2 minimum surface area, connected to the river—and is located within the zone of expected Paradox influence. An attempt should be made to collect a sample from the best potential habitat that exists at the time of sampling, using the same guidelines as the opportunistic sampling (section 4.0). It is recommended that this location be identified on the opposite bank of the river from CR-1, vicinity of the surface location designated as 217 in Figure 3–2. This area appears to have low velocity waters and sand deposits similar to potential habitat areas adjacent to the Moab site. This is also an area where the Paradox formation subcrops. As with the opportunistic sampling of habitat (Section 4.0), the exact sampling location will probably vary with river flow conditions. The area should meet minimum depth and surface area requirements and be described and measurements taken as specified above.

End of current text

4.0 Opportunistic Sampling

4.1 Proposed approach

During routine sampling events, the shoreline of the river adjacent to the site, from about surface location 219 to surface location 228 will be observed visually for the purposes of identifying preferred fish habitat, depending on river stage. During the summer sampling event when young fish would be expected to be present, an attempt should be made to identify and sample habitats along the river where small fish (regardless of species) are actually observed. If no such habitats are found, then the area should meet minimum habitat criteria of depth, velocity, surface area, and connectedness, as described in Section 3.1. It is anticipated that some type of suitable habitat (as described in
Table 2–1) should exist somewhere along the shore except during periods of bankfull river flow. The sampling location should have a water depth of at least 8 in and surface area of at least 200 ft^2. It should have low velocity water and be connected to the main body of the river. Locations meeting the low end of depth and surface area requirements are preferred, because these lower water volume areas should more conservatively provide an indication of potential impacts from ground water discharge to the surface. The habitat should be classified according to the categories listed in Table 2–1 and described in the same manner as the routine sampling locations (using the form in Attachment 1).

In addition to opportunistic sampling associated with routine monitoring events, river flow in the spring will be monitored and potential habitat areas A, B, and C (Figure 2–2) observed on a regular basis. If and when water in those locations meets minimum habitat requirements, those areas will be sampled and described. Based on the analysis provided in the SOWP (DOE 2003a) it is anticipated that those areas will be submerged and continuous with the river at river discharge rates greater than about 12,500 cubic feet per second (cfs). Once river discharge rates decrease to below this threshold, suitable habitat should be present until those areas become completely cut off from the river when the discharge decreases below approximately 8,750 cfs. Therefore visual observations in the vicinity of areas A, B, and C should commence after river flows peak and approach the 12,500 cfs threshold. Sampling will occur at least once when the backwater areas are still connected to the river, but when water depths are approaching the lower end of what is considered suitable (8 to 12 inches).

End of current text

5.0 Monitoring Requirements

5.1 Personnel and Equipment

Sampling will be conducted according to standard sampling protocols and procedures (see section 6.0). Standard equipment and methods will be employed.

5.2 Training

Because much of the focus of surface water monitoring involves recognizing established types of river habitat, personnel performing sampling will be required to undergo in-field training with a qualified fish habitat specialist. It is anticipated that this specialist will have conducted fish surveys in accordance with the ISMP and been involved in habitat classification. Training is likely to consist of accompanying the specialist to the field (probably adjacent to the Colorado River, either at the Moab site or in or around Grand Junction) while different habitats are identified and classified. The specialist may accompany sampling personnel to the field for the initial sampling events described in this plan.

5.3 Environmental Compliance

Additional information (from that given in this section) on environmental compliance, waste management, and emergency response is in the Moab Health and Safety Plan (HSP) (DOE 2003c). Low volumes of waste water will be generated from sampling activities. Purge water from sampling will be managed by spreading the ground water evenly on the ground surface around the well. If 30 gallons or less of purge water are generated, the water will be dispersed in a circle with a radius of at least 2 feet. If greater than 30 gallons of purge water are generated, the water will be dispersed in a circle with a radius of at least 15 feet. This will prevent ground water contaminants from accumulating to unacceptable levels in soils that are not contaminated. Water will not be dispersed onto surface areas that will enable the water to flow into Moab Wash or the Colorado River.

5.4 Health and Safety

Additional information (from that given in this plan) on health and safety, and emergency response is in the Moab HSP (DOE 2003c). The site-specific HSP has been prepared for the Moab site in accordance with the requirements of 29 CFR 1910.120. All activities performed in association with sampling and monitoring of groundwater and surface water will be performed according to the site-specific health and safety requirements developed for this task (DOE 2003c).

5.5 Quality Assurance

All personnel that will conduct sampling and monitoring surface water and ground water at the Moab site are required to read and understand this plan and sign a copy of the “Statement of Understanding” (Attachment 2), of this plan.

End of current text

6.0 Sampling and Analysis

Routine filtered water samples will be collected from the monitor wells and the Colorado River 3 times per year as described in section 3.0. Specific locations to be sampled are listed in Table 3–1 and shown in Figure 3–2. Water samples will be submitted to a commercial laboratory for analyses of the constituents listed in Table 6–1. In addition to the chemical constituents listed in Table 6–1, standard field parameters (alkalinity, dissolved oxygen, redox potential, pH, specific conductance, turbidity, temperature) will also be measured. The shoreline will be visually examined during routine events and potential habitat identified, if possible, for opportunistic sampling during these events. The location of the opportunistic sampling will be surveyed in by GPS. River flow rates in the spring will be monitored and potential habitat areas A, B, and C observed to determine if and when those areas contain water. If and when these areas meet the minimum habitat characteristics of depth and surface area, these areas will be sampled and described in the same manner as routine surface water locations.

Table 6–1. Analytes and Methods for Ground Water and Surface Water Sample

Analyte	Sample Container	Preservation	EPA Method	Detection Limit	Line Item Code (LIC)
Ammonia- N	125 mL poly	HNO_3, pH < 2	350.3	0.1 mg/L	WCH-A-006
Chloride	500 mL poly	Cool, 4° C	300	0.5 mg/L	WCH-A-011
Sulfate			300	5 mg/L	WCH-A-036
TDS	125 mL poly	Cool, 4° C	160.1	10 mg/L	WCH-A-033
Uranium	500 mL poly	HNO_3, pH < 2	GJO-1	0.1 μg/L	GJO-1
Field parameters include: alkalinity, dissolved oxygen, redox potential, pH, specific conductance, turbidity, temperature					

TDS = total dissolved solids; mL = milliliters; mg/L = milligrams per liter; μg/L = micrograms per liter.

6.1 Sampling Procedures

Water sampling will be performed in accordance with the *Ground Water and Surface Water Sampling and Analysis Plan for GJO Projects* (DOE 2002b) and the *Grand Junction Office Environmental Procedures Catalog* (GJO 6). Deviations from these procedures will be noted in a field variance log with an explanation and a description of its possible impacts on data quality. The following specific procedures from the Environmental Procedures Catalog will be used for water sampling:

- GT-1(P), “Standard Practice for Field Documentation Processes.”
- GT-2(P), “Standard Practice for Sample Labeling.”
- GT-3(P), “Standard Practice for Chain-of-Sample-Custody and Physical Security of Samples.”
- LQ-2(T), “Standard Test Method for the Measurement of Water Levels in Ground Water Monitoring Wells.”
- LQ-3(P), “Standard Practice for Purging Monitoring Wells.”
- LQ-4(T), “Standard Test Method for the Field Measurement of pH.”
- LQ-5(T), “Standard Test Method for the Field Measurement of Specific Conductance.”

- LQ-6(T), "Standard Test Method for the Field Measurement of the Oxidation-Reduction Potential (Eh)."
- LQ-7(T), "Standard Test Method for the Field Measurement of Alkalinity."
- LQ-8(T), "Standard Test Method for the Field Measurement of Temperature."
- LQ-9(T), "Standard Test Method for the Field Measurement of Dissolved Oxygen."
- LQ-10(P), "Standard Practice for the Use of a Flow Cell for Field Measurements."
- LQ-24(T), "Standard Test Method for Turbidity in Water."
- LQ-11(P), "Standard Practice for the Sampling of Liquids."
- LQ-12(P), "Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples."
- LQ-19(P), "Standard Practice for the Inspection and Maintenance of Ground water Monitoring Wells."

6.2 Sample Quality Assurance and Control

The objective of sample quality assurance and control measures is to provide systematic control of the tasks so as to maximize accuracy, precision, comparability, and completeness. All procedures will be checked for accuracy through internal laboratory quality control checks such as the analysis of blind duplicates, splits, and known standards. Analytical methods to be used for the water samples are summarized in Table 6–1. Sample preservation will consist of storing the samples in a cooler with ice during field sampling, sample packaging, and shipping.

To maintain evidence of authenticity, the samples collected must be properly identified and easily discernible from other like samples. A label will be attached to the sample container specifying the sample identification number, location, date collected, time collected, and the sampler's name.

Water samples will be kept under custody from the time of collection to the time of analysis. Chain-of-custody records will be used to list all transfers in the possession of the samples. The chain-of-custody form will show that the sample was in constant custody between collection and analysis. While the samples are in shipment to the analytical laboratory, custody seals will be placed over the cooler opening to ensure that the integrity of the samples have not been compromised. The receiving laboratory must examine the seals on arrival and document that the seals are intact. Upon opening the container, the receiving laboratory will note the condition of the sample container (e.g. broken bottles, leaking bottles, etc.).

All sample shipments will be made in compliance with Department of Transportation regulations (49 CFR 171-179) governing shipment of hazardous materials and substances. These regulations govern the packaging, documentation, and shipping of hazardous material, substances, and waste. Special care will be taken to ensure the integrity of the sample through proper packaging and shipping. To determine the proper identification of a hazardous sample, field personnel will review field measurements data and field notes for relevant information concerning the sample material in a container. This information will include field radiological scans and any other information that might be useful in classifying the sample for shipment. If a sample is known or suspected to contain a specific hazardous material, the sampler will note its presence on the sample label. This information is important to the receiving laboratory to determine the proper handling of the sample prior to its analysis.

7.0 Reporting

After laboratory analysis is complete, results of each sampling event will be reported in a data validation package. This package will include trip reports with all habitat description forms attached. Data collected during these sampling events will subsequently be analyzed to help refine dilution estimates, make habitat availability estimates and potential impacts, assess effectiveness of ground water remediation, and refine long-term remediation objectives, among other uses. Evaluation and interpretation of the data can be reported in calculation sets, annual reports, as supplements to data validation packages, or some other reporting mechanism(s).

It is anticipated that all data will be loaded into the SEEPRO database for data management. Data not normally included in the SEEPRO system (e.g., habitat designation, water velocity) can be input as comments for each record. However, it may be more useful to develop some other system for managing and analyzing those data (e.g., electronic forms).

End of current text

8.0 References

Day, K.S., Christopherson, K.D., and Crosby, C., 1999, An Assessment of Young-of-the-year Colorado Pikeminnow (*ptychocheilus lucius*) use of backwater habitats in the Green River, Utah *in* Flaming Gorge Studies: assessment of Colorado Pikeminnow Nursery Habitat in the Green River, Publication Number 99-30, Utah Division of Wildlife Resources.

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End of current text

Attachment 1

Form for Recording Habitat Information

Location ID: _____ **Sampler:** _____ **Date:** _____ **Time:** _____

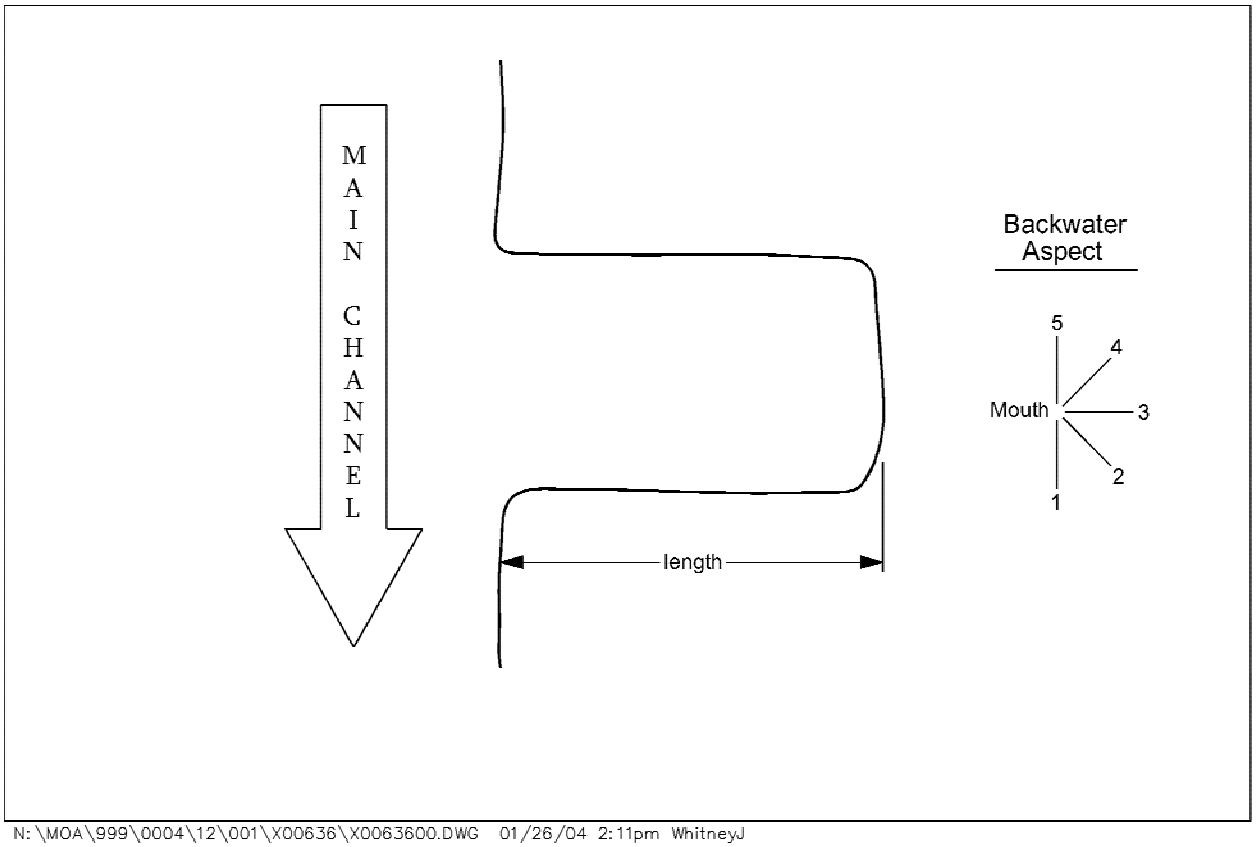
Water Depth	Surface Area (estimate length, width)	Flow Velocity	Turbidity			Temperature at Bottom (plus main channel if this is a backwater)	Habitat Type (see Table 1 on back of page)	Bottom Sediment Type	River Flow (cfs) (at Cisco Gaging Station)
			Clear	Very Cloudy	In Between				

NOTES	SKETCH
Relationship to Main River Channel (i.e., if backwater, orientation of mouth; Figure 1)	
Any Fish Noted? If yes, dead or alive? Size?	
Any Cover? If yes, describe, estimate percent.	
Any Other Notable Characteristics? (e.g., algal growth, discoloration or sheen)	

Table 1

Habitat Type	Description
Scour channel (SC)	Habitats formed by the erosion/deposition cycle of small channels behind large alternating sandbars. Scoured out during floods and revealed by receding water levels. Usually relatively deep and permanent.
Migrating Sand Waves (MS)	Habitats formed by the relative movement of adjacent migrating sand waves. Relatively shallow and ephemeral.
Horseshoe Vortex (HS)	Habitats formed by scour holes generated at high flows at the upstream ends of islands due to development of horseshoe vortex patterns. Moderately deep and semi-permanent.
Flooded Tributary Mouth (FT)	Habitats formed by rising river levels flooding into tributary mouths. Related to seasonal high flows or rainfall events.
Shoreline Eddy (SE)	Habitats formed by recirculating areas due to irregularities of the bank.
Shoreline (SH)	Shallow sloping shoreline areas.
Floodplain (FP)	Habitats formed by the inundation of abandoned channels or floodplains. Related to seasonal high flows or rainfall events.

Figure 1



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Attachment 2

Statement of Understanding

I, the undersigned have received, read, and understand the Ground Water and Surface Water Monitoring Plan for the Moab Project Site.

	Name (Please Print)	Signature	Date	Position
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