5.4 TASK D – HYDRAULIC CONTROL MEASURES FOR THE COLLAPSED AREA OF ST. LOUIS TUNNEL ADIT

A portion of the St. Louis Tunnel immediately behind the existing masonry block portal structure has collapsed, apparently due to borrowing of the overlying colluvium/talus deposits. The current condition is a tangle of broken timbers and lagging among a heterogeneous mix of sand to boulder size blocks resulting in unstable voids of varying size and shape. The discharge from the tunnel is impeded at the east (upgradient) end of the collapse such that flow is observed at approximately the former tunnel roof level. This flow then falls and works its way through the collapse to exit at the original tunnel floor grade in the still standing portal structure. As a result of this condition, there may be an accumulation of debris or precipitated solids near the adit opening.

The purpose of this task is to provide engineered controls for the release of the mine water and impounded metals precipitate from behind the collapsed St. Louis Tunnel adit. The task will be accomplished by analyzing existing mine maps and other data regarding the mine and geology, investigating the collapsed portion of the adit behind the St. Louis Tunnel portal, developing preliminary conceptual engineering alternatives, developing designs for engineered hydraulic controls, and construction of the hydraulic control features.

Analysis of existing mine geology and mine plans and workings and development of control strategies will be performed by qualified professionals with experience in underground mine investigation and remediation. The evaluation by these individuals will include the following tasks and reporting.

5.4.1 Subtask D1 – Adit Collapse Area Investigations

The primary objectives of the investigation of the collapsed portion of the St. Louis Tunnel adit immediately above the portal structure are to: 1) assess the possible accumulation of settled solids and mine water build-up behind the existing debris blockage in the collapsed area; and 2) provide information to support design of an appropriate hydraulic control system(s) such as a pressure bulkhead with valve-controlled piping for the discharge. Additional borings outside the immediate area of the collapse and other approaches to investigate the adit condition are described below.

Compile, Review and Evaluate Existing Data. Existing information on the grade and alignment of the St. Louis Tunnel (from existing mine plans) and on the geology of the portal area from previous site exploration and additional exploration will be compiled, reviewed, and evaluated to support the investigations under this task and the preliminary design of hydraulic controls.

Detailed Survey and Site Reconnaissance. A detailed topographic survey of the collapsed area will be conducted and a map prepared at a contour interval of 1 foot or less. The survey will be performed using conventional (total station or survey-grade Global Positioning System [GPS]) techniques unless it is determined that direct access onto the collapsed rubble is not safe. In that event, the feasibility of access utilizing a mobile telescopic or articulated man-lift will be evaluated. Given the existing topography at the RTOU, it appears that this approach would be limited to the downgradient end of the collapse without grading an access platform between the toe of the Soil Lead Repository and the collapsed area. If conventional surveying proves infeasible, then ground-based Lidar will be used. Set-up locations for the Lidar equipment appear feasible on the Soil Lead Repository.

In addition to surveying the surface of the rubble, detailed panoramic digital photographs will be taken and video recorded with recognizable temporary benchmarks visible for which coordinates and elevation are known. The presence, location (with coordinates and elevation to the extent feasible), character (color, presence of suspended solids or turbidity), and estimated flow rate of any visible flow or seepage within the collapse area will be recorded to the extent safe and feasible.

Assessment Options. A written plan shall be developed and submitted to EPA detailing the adit investigation approach addressing the full scope of this task as described in this Work Plan. The feasibility of drilling a boring(s) to intersect the St. Louis Tunnel just upgradient of the collapsed portion of the tunnel above the portal will be evaluated. A platform for the drilling rig would be constructed by grading either on the slope just south of the collapsed area or on the adjacent Soil Lead Repository to the north. The objective of the boring(s) is to confirm the extent of the collapse and observe if precipitated solids are encountered within the tunnel, either by discharges from the tunnel in the drill pipe, or by camera survey if no discharges occur. Drill pipe diameter will be selected in coordination with identification of a suitable pipe inspection camera system. Pipe diameter as small as 2 inches is feasible with a push system, but deployment length is typically limited to 200 to 300 feet. A crawler system typically requires at least a 4-inch pipe diameter, but length is not a limiting factor in this application. Coring will be performed where possible to collect samples of competent rock for geotechnical assessment.

If drilling an exploratory boring is determined not feasible, or if conditions in the tunnel remain uncertain even with an exploratory boring, then an approach of staged, protected excavation of the collapsed portion of the adit or development of alternate access to the adit will be developed.

It is anticipated that it will be necessary either to remove the blockage at the portal or to create an alternate access to direct mine water to bypass the existing portal collapse and allow entry into the St. Louis Tunnel adit. A determination will be made during the adit portal investigation of the most effective method to reopen and install structural support to the adit inbound to enable direct physical inspection and sampling for the purpose of placing an effective hydraulic control structure. This evaluation will be performed by qualified individuals with underground, hardrock mining experience. If this option is determined appropriate, then a qualified mining firm will be employed to perform the necessary work to re-establish a safe entry structure into the adit. Precautions to manage surge water and associated solids behind the collapse, such as containment and settling, and other treatment as necessary, will be in place prior to draining or opening the adit.

Adit and Portal Investigation Report. An Adit and Portal Investigation Report summarizing the findings of the investigation will be completed and submitted to EPA. The Adit and Portal Investigation Report will include the topographic map, photographs, and a log of the exploratory boring (if drilled). If a camera survey is performed, a video and extracted photographs will also be provided.

5.4.2 Subtask D2 – Preliminary Design of Hydraulic Controls of the Adit Discharge

The primary objectives for hydraulic controls of the adit discharge are to: 1) to the extent practicable, gather and convey all of the tunnel discharge to the water treatment system in a controlled manner; and 2) mitigate the risk of release of settled solids and debris that may have accumulated in the St. Louis Tunnel behind the blockage in the collapsed adit area.

This task will involve developing and evaluating hydraulic control concepts and then carrying the selected concepts forward to the 30 percent design level. Following approval of the 30 percent design, a final design will be developed and submitted to EPA.

Develop Hydraulic Control Concepts. Based on existing information and preliminary consideration of this issue, the following concepts will be further characterized and evaluated to meet the objectives noted above. Additional control measures will be considered as needed to meet the objectives of this task.

- Local excavation of collapsed debris immediately upgradient of the existing masonry block portal structure; grading and local lining of a collection basin for tunnel discharges to capture and direct flows through the existing portal structure; upgrading of conveyance through the structure if necessary: and integration with the inlet channel downgradient of the portal structure and to the upgraded ponds treatment system.

- Depending on the results of the investigative boring described above, enlarge the pilot bore (likely requiring drilling a new bore) and install a permanent pipe drain sized to prevent build-up of head within the lower St. Louis Tunnel/CHC Hill; construct the pipe with a vertical riser as the pressure control measure, and provide means to convey any flows/solids discharging from the drain pipe to the ponds system for treatment.

- Evaluate the need and practicality of constructing a surge basin within the collapse area as a back-up to detain flows and drop out solids, should a release of materials accumulated behind the collapsed portion of the adit occur; this would involve constructing a lined earthen dike at the upgradient end of the catchment basin noted above, with a lined spillway section to convey flows over the dike and into the basin in a controlled manner.

- An evaluation of the conditions at the portal and the investigation information in relation to the objectives described in the Work Plan will be performed to determine if removing all of the rock and debris within the full 200-foot long collapsed area upgradient of the proposed collection basin is necessary. Consideration will be given to the potential benefit the debris may provide as erosion protection, safety, the engineering feasibility of working with the existing collapse and still collecting the discharge and preventing conditions that may lead to future "blowouts" near the portal area. In addition, the investigation of the workings and areas of influent water will be factored into this decision. EPA will make a determination based on this evaluation as to whether the debris will need to be removed.

Develop Preliminary (30 percent) Design of Adit Hydraulic Controls. The selected adit area hydraulic control concepts will be designed to the 30 percent level based on the results of the investigations. The objective of the 30 percent design is to confirm the technical feasibility of the selected concepts in terms of: 1) constructability given site physical and environmental (weather) conditions; 2) location of major components and their relationship to other project facilities and existing infrastructure at the RTOU; and 3) key materials required for construction. The 30 percen t design will include the evaluations and analyses and work products described in the following paragraphs.

Evaluations and Analyses. Previous evaluations of the anticipated range of discharge flows from the St. Louis Tunnel will be reviewed and revised or updated as necessary. These evaluations will utilize the existing predictive model developed from historic tunnel discharge, ponds system discharge, and Dolores River flow measurements. The predicted range of flows and any new information collected under this Work Plan will be utilized as input in sizing and designing the collection system. Collection basin capacity and conveyance will be analyzed utilizing standard hydraulic equations and/or simplified routing models.

If necessary based on the results of the investigations described above and review of relevant literature (to the extent available), an assessment will be made of the potential rate and volume of a release of settled solids from the tunnel at the upgradient end of the collapsed area above the portal structure. The estimate of release rate and volume would be used to size and design the catchment dike.

Work Products. The Preliminary (30 percent) Design Report will be submitted as a Technical Memorandum to EPA for review and approval and include the following information and work products.

- Narrative discussion of site investigations, concept development, 30 percent design level evaluations and analyses, and intended operations (both normal and emergency conditions);

- Description of key work items and components to construct the hydraulic controls, including component sizes (key dimensions), capacities, and materials; and

- Layout drawings of hydraulic controls, including plan, sections, and preliminary details.

5.4.3 Subtask D3 – Final Design and Construction of Adit Hydraulic Controls

Upon EPA approval of the Preliminary (30 percent) Design Report, the detailed design for hydraulic controls will be completed and submitted to EPA for approval. The final design will include the following information and work products:

- Narrative discussion of site investigations, concept development, final design level evaluations and analyses, and intended operations (both normal and emergency conditions);

- Description of key work items and components to construct the hydraulic controls, including component sizes (key dimensions), capacities, and materials;

- Scaled layout drawings of hydraulic controls, including plan, sections, and final details; and

- Engineering Specifications and QA/QC Requirements provided as an attachment or addendum to the Final Design.

The hydraulic controls will be constructed in accordance with the final design.

5.5 TASK E – SOURCE WATER INVESTIGATIONS AND CONTROLS

Flows from the St. Louis Tunnel are high and vary significantly by season, requiring a large design capacity for a water treatment system, high neutralization materials requirements, and handling and disposal of a large quantity of waste solids. Depending on the nature of the adit and mine workings, it may be possible to reduce outflows from the St. Louis Tunnel, and thus reduce the loading of contaminants to the Dolores River. It also may be possible to manage water within the mine to attenuate seasonal or storm surge flows through the water treatment system, thus reducing water treatment design capacity. In the long term, reducing flow from the St. Louis Tunnel could be cost-effective as it could result in reduction in the overall water treatment design capacity, peak water treatment capacity, and solids handling and disposal requirements.

The purpose of this task is to identify sources of water entering the mine workings that have the potential for being reduced or eliminated from contributing to the discharge at the St. Louis Tunnel and associated mine openings, and implement actions that are expected to significantly reduce flows and/or contamination of water flowing through the mine. The task includes review of existing data and evaluation of the data including geology, hydrogeology, mine workings, geologic structures, and other relevant features. Findings and recommendations for additional investigations will be submitted to EPA in a Technical Memorandum. Investigations will be conducted to confirm the findings of the data review, determine locations where significant flows of influent waters may be eliminated or reduced such that flows contributing to the metals load in the adit are reduced, and determine if it is feasible to install flow control structures. If it is determined that flow into the mine can be effectively reduced, then preliminary design concepts for source water control structures will be prepared and submitted to EPA for approval. If it is determined that cost-effective options are available, then final designs will be completed and the control structures will be constructed in accordance with the approved designs.

Analysis of existing mine geology and mine plans and workings and development of control strategies will be performed by qualified professionals with experience in underground mine investigation and remediation. The evaluation by these individuals will include the following tasks and reporting.

5.5.1 Subtask E1 – Review Existing Data

Existing mine maps, mine water pool information, hydrogeology information, and other information related to the mine workings and flow of water into and through the mine will be reviewed to assist in identifying potential means for reducing the flow and/or contamination of water in the mine. Potential access points to underground workings will be identified. Appropriate areas to target for further investigation will be identified, and additional subsurface investigations will be proposed.

5.5.2 Subtask E2 – Additional Investigations

Priority will be placed on identifying possible sources of water entering the mine from the surface or near surface. A plan will be developed and submitted to EPA before this task begins defining the approach and scope of this investigation following review of the existing data.

Identifying and confirming the sources of water entering the mine workings may require entry into the workings or other subsurface investigations. Other methods of subsurface investigation and hydrologic evaluation of mine waters will also be employed to assess the mine water sources and flows.

A determination of the appropriate areas to target inspection and the appropriate subsurface investigation methods will be based on the analysis described above.

5.5.3 Subtask E3 – Evaluation of Hydraulic Controls Alternatives

Means of reducing influent water to the mine or isolating water entering the workings may include controls to limit surface water from entering into underground mine features, grouting of faults/fracture systems, or an engineered bulkhead. Following the findings of the above investigations, an analysis of feasible options to reduce flow from the St. Louis Tunnel will be performed and the findings presented to EPA in a Technical Memorandum.

5.5.4 Subtask E4 – Mine Water Source Controls – Design and Construction

If cost-effective alternatives for mine water source controls are identified, then preliminary designs for proposed hydraulic controls will be provided to EPA, and final designs will be prepared upon approval of the preliminary designs. The final design will include the following information and work products:

- Narrative discussion of site investigations, concept development, and final design level evaluations and analyses;
- Description of key work items and components to construct the hydraulic controls, including component sizes (key dimensions), locations, and materials;
- Scaled layout drawings of hydraulic controls, including plan, sections, and final details; and

- Engineering Specifications and QA/QC Requirements provided as an attachment or addendum to the Final Design.

The hydraulic controls will be implemented by qualified personnel in accordance with the final design.

5.6 TASK F – WATER TREATMENT SYSTEM ANALYSIS AND DESIGN

The objective of this task in conjunction with the above tasks is to provide a water management system that provides a sustainable approach to managing the St. Louis Tunnel discharge that is protective of the Dolores River and complies with the associated ARARs. This Work Plan is written with the understanding that Atlantic Richfield has proposed to construct and operate a lime addition treatment system and is seeking a state-issued discharge permit.

This task includes the following subtasks:

- Perform a water treatment technology screening and compare alternatives against the previous method of lime treatment with settling ponds. Submit a Water Treatment Technology Screening Report to EPA.

- Evaluate and present historical data and current data related to the St. Louis Tunnel discharge water chemistry and flow necessary for water treatment technology system screening, design, and operations.

- Submit conceptual design(s) for water treatment and a plan for design investigations. Upon approval of the conceptual designs, perform investigations required for effective system design and operation.

- Conduct design analysis and submit a 30 percent design to EPA for approval.

- Upon EPA approval of the 30 percent design, the final water treatment system design will be completed and the water treatment system will be constructed. An Operation and Maintenance Plan (O&M Plan) will be submitted to EPA for approval, and the water treatment system will be operated and maintained in accordance with the O&M Plan.

The purpose of screening water treatment alternatives is to determine if there is a method to achieve the goals of the Removal Action more reliably, effectively, and/or cost-efficiently than the proposed lime treatment system. Any available information about the previous system should be considered in order to modify the system accordingly to improve performance. The area available for on-site solids disposal is limited, so identification of a method that reduces solids generation may provide long-term cost savings and environmental benefits.

Water treatment system analysis and design for the site may be influenced by modifications to the mine water source controls and the limited area available for long-term solids disposal. The volume and quality of water that requires treatment may be impacted by hydraulic controls that may be constructed as part of Task D. If a substantial reduction in the St. Louis Tunnel discharge flow is achievable, then EPA may allow time to monitor the impacts of any hydraulic modifications before requiring the final water treatment system design and construction. Because water treatment is likely needed even after implementation of hydraulic controls, the investigations to determine a treatment method and conceptual design, and design studies to support ultimate system design will continue as scheduled.

5.6.1 Subtask F1 – Preliminary Water Treatment Alternatives Screening Report

Water treatment technologies applicable to treating mine discharge water will be evaluated and compared to the proposed lime treatment system based on the efficiency of metals removal, metals recovery potential, construction and operating cost, solids disposal requirements, long-term performance, and other factors necessary for comparing and selecting the technology most likely to facilitate treatment of the discharge to the satisfaction of all parties and meet regulatory obligations. At a minimum, the currently proposed lime treatment system, an enhanced lime treatment system such as rotary lime delivery system or high density sludge, and a chemical/biological reactor system will be evaluated in light of conditions at the St. Louis Tunnel.

Alternatives for treating specific source waters such as a small passive chemical/bioreactor to treat leachate from the drying facility or repository should also be considered.

A Water Treatment Technology Screening Report will be submitted to EPA.

5.6.2 Subtask F2 – Treatment System Conceptual Designs and Additional Investigations

A conceptual design(s) for the proposed treatment system(s) will be developed and submitted to EPA. Design studies will be performed as needed to compare alternatives and support water treatment system designs. Investigations may include bench-scale or pilot-scale treatability studies, geologic/geotechnical and groundwater investigations, hydrologic analysis, pond stability analysis, and solids handling, dewatering, and disposal studies. Additional design studies may be required and will be conducted as needed. A plan for the proposed design studies will be submitted to EPA prior to initiation of work.

5.6.3 Subtask F3 – 30 Percent Design

The objectives of the 30 percent design of the water treatment system are to: 1) provide design criteria that allow the system to meet the overall objective stated in Section 1.0 for this Removal Action; and 2) describe the water treatment system and its components to a 30 percent level, as further described in this section.

Development of a 30 percent design for the water treatment system will involve: a) comprehensive review and evaluation of relevant prior studies and data; b) establishing the design criteria for the system; c) identifying and describing the system components and operations; and d) preparing 30 percent design documents.

Existing information, studies, and conceptual designs relevant to development of a water treatment system to the 30 percent design level will be compiled, reviewed, and evaluated. This will include applicable information from the studies described in Section 4.0, from design and long-term operation of other open pond, lime addition mine water treatment systems including the Warm Springs Ponds and Lower Area One systems designed and operated by Atlantic Richfield in Montana and the Leviathan system operated by Atlantic Richfield in California; and from the additional investigations performed for Subtask F2.

5.6.3.1 Preliminary Design Criteria

The design criteria for the water treatment system include but are not limited to the following.

Influent and Discharge Water Quality. The 30 percent design of the water treatment system will be based on the preliminary effluent limits derived from the CDPHE, 2008 Water Quality Assessment

(WQA) for the St. Louis Tunnel discharge and any updates provided by the state. The WQA is expected to form the basis for development of a CDPS permit for ponds system discharges to the river, and a state-issued permit is anticipated at the completion of this Work Plan.

If mine modifications are proposed as part of Tasks D and E, the influent water quality may change. Water quality changes that may affect system design will be identified and considered in the final designs.

System Hydraulic Capacity. The water treatment system will be designed to treat water discharged from the St. Louis Tunnel at the range of flows and conditions anticipated based on existing data over the design life of the system (50 to 100 years). If source control measures are implemented as part of Tasks D and E, system capacity may be modified based on post-construction conditions and predicted flow analysis. Otherwise, the following approach may be taken.

The normal operating flows adopted for 30 percent design will be based on the monthly design discharge capacities established in the WQA, plus 0.6 cubic foot per second (cfs) to account for currently estimated evaporation and seepage losses from the ponds system. These flows will be reviewed and appropriate adjustments made based on refinement of the tunnel discharge predictive model, new flow data gathered as part of Task A, and refined evaporation and seepage estimates. The maximum instantaneous flow to be accommodated in the 30 percent design will be based on the estimated maximum discharge appropriate to the project design life as derived from the predictive model; at a minimum, the design will accommodate the historic maximum recorded tunnel discharge of 2,200 gallons per minute (gpm).

The monthly tunnel discharges to be used for design as described above reflect the fact that water discharged from the St. Louis Tunnel is a result of precipitation (primarily snowmelt) followed by infiltration to the connected mine workings. The rate of discharge from the tunnel generally parallels the flow rate in the Dolores River; that is, as a rule, when the tunnel discharge is high, so is the Dolores River flow, and when the tunnel discharge is low, the river flow is also low, with the tunnel flow extremes dampened and slightly lagging when compared to the river.

Ponds Integrity. The existing embankments will be rehabilitated as necessary to meet operational needs and dam safety requirements. The key design criteria will include industry standard and/or state dam safety mandated FS against slope failure under applicable loadings (long-term static/steady seepage, short-term/construction phase, and earthquake), and protection against internal erosion (piping) of embankment material due to seepage flows. As part of demonstrating pond embankments meet appropriate integrity standards, the hydraulic structures will also be evaluated. The key evaluation and design criteria for the hydraulic structures will be industry standard and/or state dam safety mandated storm water (i.e., "flood") flows, and protection (to the degree practical) of normal flow outlet piping against blockage by beavers.

Operability. Because of the remote nature of the RTOU, the treatment system should be designed to be simple, reliable, and easy to operate with minimal on-site operations personnel. Other consistent operability goals include low maintenance, infrequent solids handling, and remote monitoring, operation, and control. The system will be designed to prevent solids fouling that could impact effective water treatment operations.

These operational criteria are required to accommodate the following conditions: 1) the RTOU is located in a remote region of the San Juan Mountains near the Town of Rico, which has a population estimated to range from 200 during the winter to 500 in the summer; 2) the nearest urban center with significant population is Cortez, which has a population of approximately 8,300 and is 45 miles (over 1 hour travel time during good weather) from Rico; and 3) the RTOU is at an elevation of approximately 8,800 feet and during the winter is frequently accessible only by snowmobile or by foot (unless a more permanent and consistent snow plowing effort is undertaken).

5.6.3.2 Treatment System Components and Operations

This section presents information developed by Atlantic Richfield for a lime addition-based water treatment system and is presented in this Work Plan assuming that system is implemented. The following components would be included in a lime addition system design.

Flow-Based Lime Addition Control. The range of pH required for optimal operation based on studies to date is between 8.5 and 9.5, with an initial treatment target pH of 9.0. A dosage control concept will be evaluated and characterized to determine if it will facilitate a stable treatment target pH. The flow rate of the collected tunnel discharge would be measured ahead of pH adjustment at the new lime addition facility to enable automatic pacing of lime feed based on incoming flow. The flow and quality of water that flows into the system in downstream ponds, such as leachate from drying operations or the repository, will be considered in the lime dosing calculations.

Lime Storage System. Lime storage capacity will be evaluated during 30 percent design to establish practical sizing. Factors to be considered will include frequency of shipments and reasonable storage life. If practical (with consideration of storage life), lime storage will be based on providing sufficient capacity to continue treatment without additional lime shipments using the maximum expected dosage and during a 30 to 60 day period of peak discharge (late spring/early summer) and/or throughout the winter (when typically lower dosage rates are anticipated). The existing lime silo will be evaluated in terms of its ability to meet the needs of the newly designed system; the silo would be upgraded or replaced to meet the new design requirements. The feasibility of equipping and reusing the existing lime feed building will also be evaluated relative to its condition, size, and suitability. Improvements to the existing access road into the RTOU will also be designed to enable delivery of lime with a suitable turn-around loop near the lime silo.

New Lime Addition Facility. A new hydrated lime facility (as opposed to the original slaked lime system) will be designed to add lime to the tunnel discharge upstream of the first (primary) settling pond. The current concept to be reviewed and refined is for lime to be added continuously and at a rate proportional to incoming flow at a capacity capable of attaining a pH of 9 to 9.5 ahead of the first treatment pond.

Lime Addition Capacity. Lime requirements will primarily be based on bench-scale testing completed to date (and possibly additional verification testing) on tunnel effluent. If water from the drying operations and/or repository will flow into the ponds, the lime requirement for these waters will also be considered. Maximum feed rates will be based on providing lime dosage required to obtain a pH of 9.5 on tunnel discharge and other source waters unless an alternate target is identified during the course of the 30 percent design effort. Use of commercial (versus laboratory) grade lime will be evaluated in terms of materials properties and utilization efficiency versus cost. Maximum lime feed capacity will be based on the design maximum peak discharge from the tunnel determined and assuming dosage rates based on adjusting influent from the tunnel to the target pH range.

Solids Precipitation in Ponds. Due to site constraints, including steep topography and limited open area, the efficient use of available space is desirable. This includes optimizing use of available in-pond solids settling area and volume. Based on studies to date, it appears that only a few ponds will be required to provide reliable solids settling for treatment purposes. Two pond configuration alternatives will be considered for the primary solids precipitation: 1) existing configuration with Pond 18, then Pond 15 as primary settling ponds; and 2) Pond 18 and a new pond to be constructed in the currently off-line, largely filled Ponds 16 and 17 as the primary settling pond (as discussed further below). The design will provide for settling of at least 90 to 95 percent of the solids in the primary settling pond(s), with the remainder of the ponds providing backup settling or "polishing" of the effluent. The potential for immediate settling of solids after lime addition will be considered in the evaluation and design of the location of lime addition relative to the first (primary) settling pond. Means to ensure settling in the ponds to prevent overflow and dissolution of contaminants from the precipitate in lower ponds will be addressed in the design analysis.

Flow Sequence. Alternatives for the primary settling pond and the sequence of flow through the remaining ponds to the point of discharge to the Dolores River will be evaluated in terms of: 1) constructability; 2) detention time; 3) maintaining gravity flow throughout the system; and 4) compatibility and coordination with other project facilities and operations (especially on-site enhanced drying and disposal of settled solids).

Two design alternatives will be further considered. As shown on Figure 5-4, Alternative 1 would utilize the existing Pond 18 as the primary settling/initial consolidation basin receiving lime-amended inflows from the St. Louis Tunnel. Ponds 16 and 17 would not be constructed under Alternative 1, and would thus be available for use as the permanent drying facility site. This alternative would have the same flow path as Alternative 1 downgradient of Pond 18.

As shown on Figure 5-5, Alternative 2 will add a newly reconstructed Pond 16 and 17 ahead of the existing Pond 18. From Pond 16/17, flow will be routed through Pond 18, followed by Ponds 15, 14, 12, 11, 9, 10, 8, 7, 6, and 5 before discharge to the river. This area lies directly east of the existing settling Ponds 15 and 18. It has the advantage of being close to the existing ponds and the potential permanent drying facility in Pond 13 (if selected). The bottom of the pond would be located above surrounding high groundwater levels facilitating gravity drainage during periods of in-pond initial dewatering and consolidation.

Polishing Treatment. The lower ponds (below Pond 11) in the existing system are generally free of accumulated solids and have developed wetlands which may help improve treated discharge water quality. Unless a reason arises during the 30 percent design process indicating otherwise, these existing ponds would be maintained on the hydraulic flow path for passive treatment and provide a buffer against upset conditions in the upper ponds.

5.6.3.3 Planned Pond Upgrades

Utilize Existing System to the Maximum Degree Practical. Both pond configuration Alternatives 1 and 2 include retention of the majority of the existing ponds and embankments, and reinforcement and/or upgrading of embankments, if necessary, to ensure stability. Existing hydraulic structures will be evaluated to determine if they need altering or replacing. Finally, providing bypass piping around certain ponds or groups of ponds will be evaluated. Pond configuration Alternative 2 would also include adding a new primary treatment pond upstream of Pond 18 in the vicinity of historic Ponds 16 and 17. Currently off-line Pond 10 could also be brought on-line to add additional detention/polishing for either Alternative 1 or 2.

Pond Embankments. The existing embankments will be retained to the maximum degree technically feasible and rehabilitated as necessary to meet operational needs, dam safety requirements, and current standards of practice. At present, it is envisioned that any necessary upgrades would be constructed on the downstream slopes and at the downstream toes of existing embankments. Typical measures would likely include: stripping and compacting the existing slope and toe area; placing a filter blanket and if necessary an overlying drainage blanket on the prepared stripped surface; and placing fill as necessary to protect the filter/drain zones and to meet required factors of safety against downstream slope failure under appropriate loading conditions. Where appropriate, drainage relief and/or piping protection will be provided in the downstream toe foundations.

Pond 16/17 Embankment. Under pond configuration Alternative 1, the Ponds 16 and 17 area will be used for the permanent solids drying facility. Under pond configuration Alternative 2, a new embankment would be constructed around the current Ponds 16 and 17 to create a new primary settling pond. Foundation improvements would be designed and constructed if/as necessary (e.g., removing locally unsuitable material; providing for pore pressure relief and/or piping protection). The embankment would be constructed using standard design measures and construction methods appropriate to the borrow materials available to provide for slope and foundation stability, seepage control, and protection against internal erosion (piping).

Hydraulic Structures. New outlet structures and overflow spillways will be considered in each of the major ponds (Ponds 11, 15, 16, 17 and 18), and Pond 10 if added to the flow path. Outlet structures will be provided with adjustable overflow weirs to regulate pond level. An emergency overflow spillway (independent of the outlet structure) will also be provided to handle excess flows or in the event that the normal outlet structure should become plugged. Bypass piping will be provided on certain ponds to enable bypassing of the subsequent downstream pond. Structures will be designed if necessary to meet operational needs, and for those ponds under State Engineer's Office (SEO) jurisdiction, in accordance with applicable dam safety rules and regulations.

5.6.3.4 Solids Removal

After initial solids removal from the ponds, solids removal will be performed as needed to allow ongoing effective treatment and maintain an adequate detention time. The following solids consolidation method is proposed by Atlantic Richfield to reduce the frequency of solids removal from each pond. The effectiveness of solids consolidation will be analyzed during the design studies and/or the initial cycling process.

Periodically (on the order of once every 2 to 3 years) solids will be consolidated in-place within the uppermost (primary) settling pond to reduce the solids volume and restore a portion of the settling volume and detention time. During the period when solids are being consolidated (estimated to require approximately 1 to 2 months), the flow from the primary settling pond will be diverted to the second pond in series, which will provide primary settling during the consolidation phase. Surface water will be decanted from the uppermost pond to the second pond in series. Ongoing seepage and evaporation in the absence of tunnel water influent to the off-line settling pond will allow the consolidated solids to dewater. Prior bench scale and field testing to date indicates that consolidation in this manner should reduce the settled solids volume to approximately 50 percent of its initial volume (thereby doubling the density of the settled solids to approximately 20 percent solids by weight). Over time (approximately every two to three in-pond consolidation cycles, or on the order of every 4 to 9 years) the volume available for settling post-consolidation will decrease. When this occurs, the consolidated solids will be removed from the primary settling pond to fully restore its initial settling volume and detention time. The initially dewatered and consolidated solids would then be removed and placed in the permanent drying facility prior to disposal in the on-site repository.

5.6.3.5 Automated Monitoring System

An evaluation of the technical feasibility, advantages, and potential operational or maintenance issues of automated monitoring and recording of key treatment process parameters will be conducted. Based on studies to date, the following parameters would be included in the evaluation:

- Flow and pH of tunnel discharge,
- Flow from the final outfall into the Dolores River,
- pH of effluent from the uppermost primary settling pond and the ponds system effluent to the Dolores River, and
- Lime feed rate.

A control system will be developed for automatic flow proportional lime slurry feed based on the flow discharge from the St. Louis Tunnel, and an operator dosage selection.

Remote access to the monitoring data and lime feed control system will also be evaluated. Specific equipment types, methods, and other details of remote monitoring and lime feed operation will be evaluated in terms of need, technical feasibility, reliability and cost.

5.6.3.6 Prepare and Submit 30 Percent Design Documents

The 30 percent design of the water treatment system will be prepared and submitted to EPA for comment and approval. The design report will be comprised of a summary narrative describing the studies and results from the preceding subtasks, and the following work products: 1) comprehensive process flow diagrams; 2) a piping and instrumentation control diagram; 3) plan layout drawings of key facilities/features including other site facilities (e.g., roads, drying facility, repository), and 4) preliminary equipment specifications. The studies will be provided as attachments if they have not been provided to EPA prior to submission of the 30 percent design report. Each of these work products is described in the following paragraphs.

Process Flow Diagrams. The process flow diagrams will illustrate and characterize the key components in the flow path from the tunnel discharge, through the ponds treatment system, ending at the discharge into the Dolores River. Components to be included will include:

- Portal collection facility,
- Conveyance to primary settling pond,
- Inflow measurement structure,
- Lime feeder and storage silo(s), and
- Primary and supplemental settling ponds.

Flow paths for normal operation and operations during periodic solids removal will be shown on separate diagrams. The design range of flow rates, lime feed rates, and pond volumes, detention times, and solids capacities will be shown on the process flow diagrams and/or provided in accompanying tables.

A preliminary material balance will be included as a part of the process flow diagrams. This balance will identify design and normal flow rates for relevant water and treatment solids streams. The material balance will also list projected treatment efficiencies associated with the water treatment system.

The process flow diagrams will also show conceptual layouts for key piping and major equipment (i.e., pumps, mixers, vessels, etc.), and illustrate local and remote monitoring and control instrumentation and associated operational concepts for the water treatment system.

Plan Layout Drawings. Plan drawings illustrating the location and interrelationship of the treatment system facilities/structures will be prepared on the existing 2-foot contour topographic base map for the KTOU, with and without the latest available aerial photography for reference as appropriate. If necessary, notations will be made to indicate where topography has changed since preparation of the currently available mapping. In addition to the facilities listed above under Process Flow Diagram, the drawings will show the conceptual layout of: 1) access road(s), turnaround, and parking areas for the lime storage and lime feed facilities; 2) process-related buried piping alignments; and 3) existing and/or relocated utility lines (electrical power, telephone). The location and characteristics of structural and hydraulic upgrades to the existing ponds and pond embankments will be shown in plan and section views, and key typical details will be included.

5.6.4 Subtask F4 – Final Design and Construction of the Water Treatment Facility

Final design documents will be prepared and submitted to EPA for approval. The final design will include the following information and work products:

- Narrative discussion of site investigations, concept development, final design level evaluations and analyses, and intended operations (both normal and emergency conditions);
- Description of key work items and components to construct the water treatment system, including component sizes (key dimensions), capacities, and materials;
- Scaled layout drawings, including plan, sections, and final details; and
- Engineering Specifications and QA/QC Requirements provided as an attachment or addendum to the Final Design.

The water treatment facility will be constructed in accordance with the final designs.

6.0 LAND OWNERSHIP AND SITE ACCESS

Performance of the tasks specified in this Work Plan will not require that Atlantic Richfield obtain additional access rights or agreements. The water treatment system will eventually be constructed and operated on parcels of land that currently include a mix of privately owned patented lode and placer claims, and U.S. Forest Service-managed National Forest System lands located within San Juan National Forest. As design and construction phases proceed, Atlantic Richfield will arrange for acquisition of the necessary private patent claims or portions thereof from their present owners and of certain San Juan National Forest tracts from the Forest Service pursuant to the Small Tracts Act. The lime addition facilities, the ponds, and the repository will be located on lands that will be transferred to the North Rico Trust. Atlantic Richfield will fund, own, and operate the constructed water treatment system and treatment solids facilities.

The water treatment system facilities will be accessed using an existing road that currently is subject to a Forest Service Road Use Permit held by Atlantic Richfield. Upon consolidation and transfer of the subject lands to the trust, Atlantic Richfield will control use of the road to prevent interference with operation of the water treatment system.

7.0 ARARS

The Action Memorandum for this Site has identified federal and state ARARs. The ARARS are attached to the Action Memorandum and will be followed to the extent practicable. These ARARs include substantive provisions of applicable or relevant and appropriate requirements. These do not include administrative requirements that may be associated with the applying for and issuance of permits set for.h in the State of Colorado or in Dolores County.

8.0 SCHEDULE

The schedule for the tasks described in this Work Plan is shown below.

Previous Work/Site Studies Delivered to EPA		April 1, 2011
Task A - Pre-Design And Ongoing Site Monitoring		
A1	Ongoing Water Quality and Flow Monitoring	
	Flow monitor installation	March 31, 2011
	Quarterly downloads	begins June 2011
A2	Seasonal Water Quality and Flow Monitoring	
	SAP/QAPP	April 1, 2011
	First sampling event	April, 2011
Task B – Management of Precipitation Solids in the Upper Settling Ponds		
B1	Develop Initial Solids Removal Plan	May 1, 2011
B2	Drying Bed Construction and Solids Removal, and Solids Management	
	Mobilization and site preparation	June 6, 2011
	Pond 18 solids removal	July 6 – December 1, 2011
	Downstream ponds solids removal	July 2012 – December 2013
	Permanent drying facility design	March 2012
	Permanent drying facility construction	Completed by December 2012
B3	Pond Stability Analysis and Upgrades	
	Pond stability analysis (Geotechnical and Hydrology)	September 2011
	Embankment armoring	December 2011-August 2012
	Stability upgrades – structural	(see Task F schedule)
Task C – Design and Construction of a Solids Repository		
C1	Develop a Repository Design and Operating Plan	
	Submit Repository Design and Operating Plan	October1, 2011
	Permitting (not required; anticipated timing)	Complete by May 2012
C2	Solids Repository Construction and Initial Solids Placement	Completed by October 2012
	Mobilization	June 2012
	Construct repository	June – October 2012
	Placement of dried Pond 18 solids	December 2012
	Placement of downstream ponds solids	June 2013 – December 2014
Task D – Hydraulic Control Measures for the Collapsed area of St. Louis Tunnel Adit		
D1	Adit Collapse Area Investigations Plan	July 15, 2011
	Adit and Portal Investigation Report	December 8, 2011
D2	Preliminary Design of Hydraulic Controls of the Adit Discharge	
	Preliminary Design Report	March 1, 2012
D3	Final Design and Construction of Adit Hydraulic Controls	
	Final design	June 15, 2012
	Construction	August – November 2012
Task E - Source Water Investigations and Controls		
E1	Review Existing Data	April – July 2011
E2	Additional Investigations	July 2011 – September 2012
E3	Evaluation of Hydraulic Controls Alternatives	October 2012

E4	Mine Water Source Controls - Design and Construction (Pending E3 Findings)	
	Preliminary design and Additional Data Collection	March - June 2013
	Final design	July 2013
	Construction	August 2013

Task F – Water Treatment System Analysis and Design

F1	Preliminary Water Treatment Technology Alternatives Screening Report	August 2011
F2	Treatment System Conceptual Designs and Additional Investigations	June – October 2011
F3	30-Percent Design Report	June 2012
F4	Final Design and Construction of the Water Treatment Facility	
	Final Design	December 1, 2012
	Construction	May – November 2013

9.0 REFERENCES

Atlantic Richfield Company. 2008. Technical Memorandum on Mixing Zone Analysis for the St. Louis Ponds Discharge, Rico, Colorado. July 1, 2008.

CDPHE. 2008. Water Quality Assessment, Mainstem of the Dolores River, St. Louis Tunnel Discharge, October 29, 2008.

Paser, K. 1996. Characterization of and Treatment Recommendations for the St. Louis Adit Drainage and Associated Settling Ponds in Rico, Colorado. Colorado School of Mines Master's Thesis.

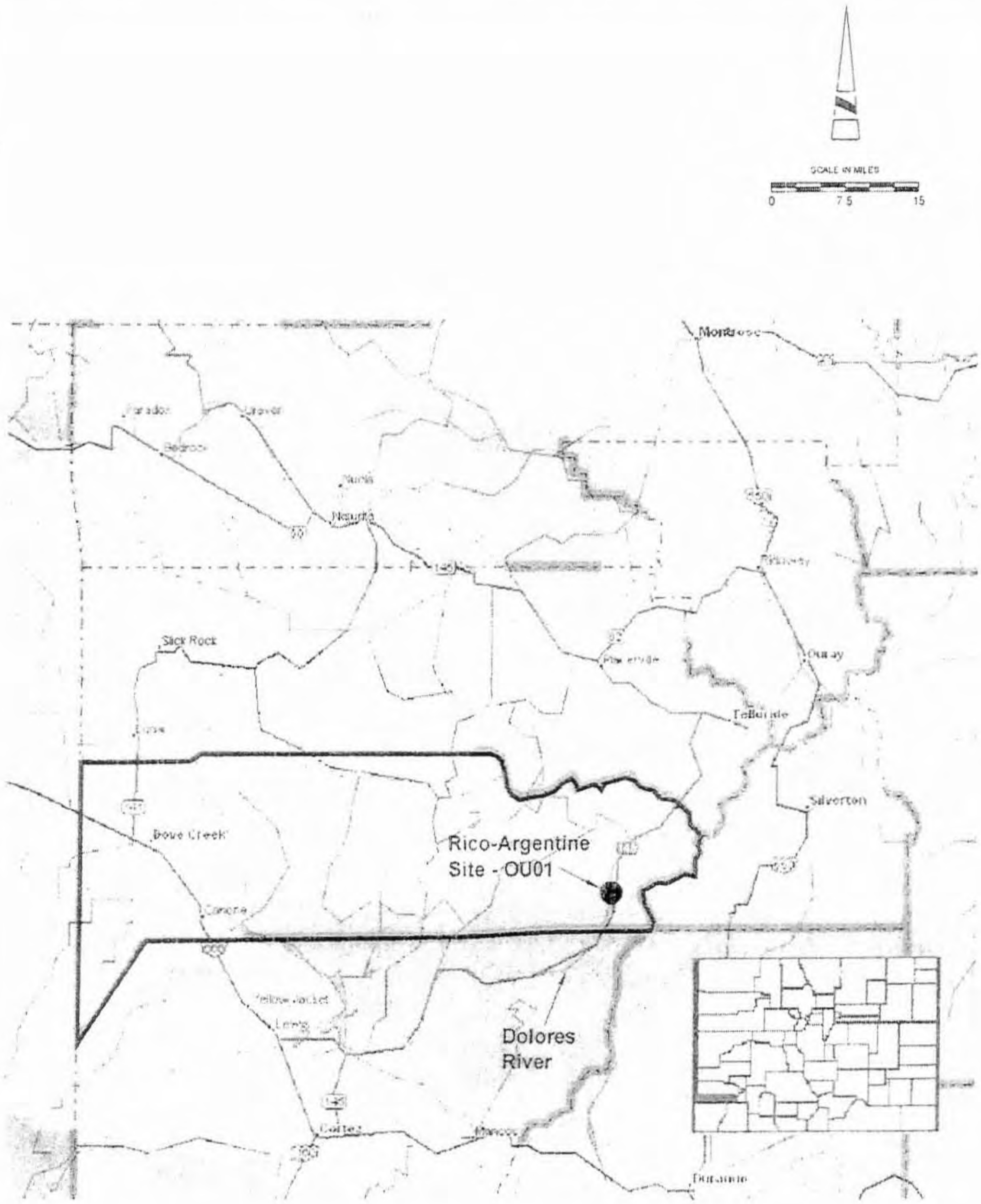
TABLE 5-1
Surface Water Sample Locations

Site ID	Site Description
DR-4SW	Dolores River below Silver Swan
DR-1	Dolores River above St. Louis settling pond system
DR-2	Dolores River immediately above the St. Louis settling pond system outfall
DR-3	St. Louis tunnel discharge at adit
DR-4	Discharge of Pond 15
DR-5	Discharge of Pond 8
DR-6	St. Louis settling pond system outfall to the Dolores River
DR-7	Dolores River below St. Louis settling pond system outfall
DR-G	Dolores River at USGS gauging station #09165000

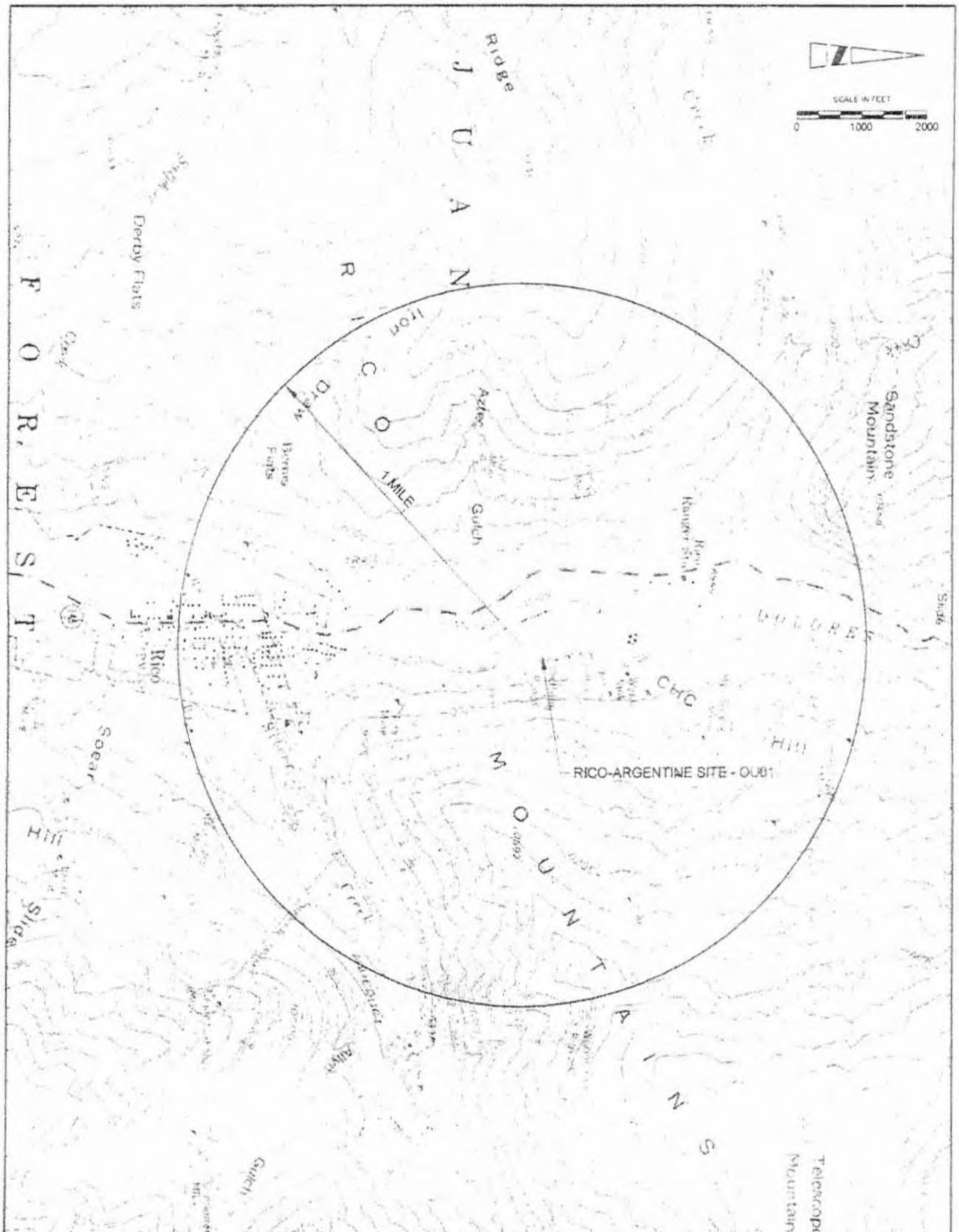
TABLE 5-2
Surface Water Sample Analysis

Field Analyses	Laboratory Analyses	
	Non-Metals	**Total and Dissolved Metals**
pH	Alkalinity	Aluminum
Temperature	Hardness (total, Ca, and Mg)	Antimony
Conductivity	Total Dissolved solids	Arsenic
Dissolved Oxygen	Total suspended solids	Barium
	Salinity	Beryllium
		Cadmium
		Calcium
		Chromium
		Copper
		Cyanide
		Iron, dissolved and total recoverable
		Lead
		Magnesium
		Manganese
		Mercury, total recoverable
		Nickel
		Potassium
		Selenium
		Silver
		Sodium
		Thallium
		Sulfate
		Vanadium
		Zinc

Figures are attached as a separate file due to file size constraints.



AECOM	RICO-ARGENTINE SITE - OU01 REMOVAL ACTION WORK PLAN	AECOM PROJECT NO.	FIGURE
	REGIONAL MAP	60157757	3-1

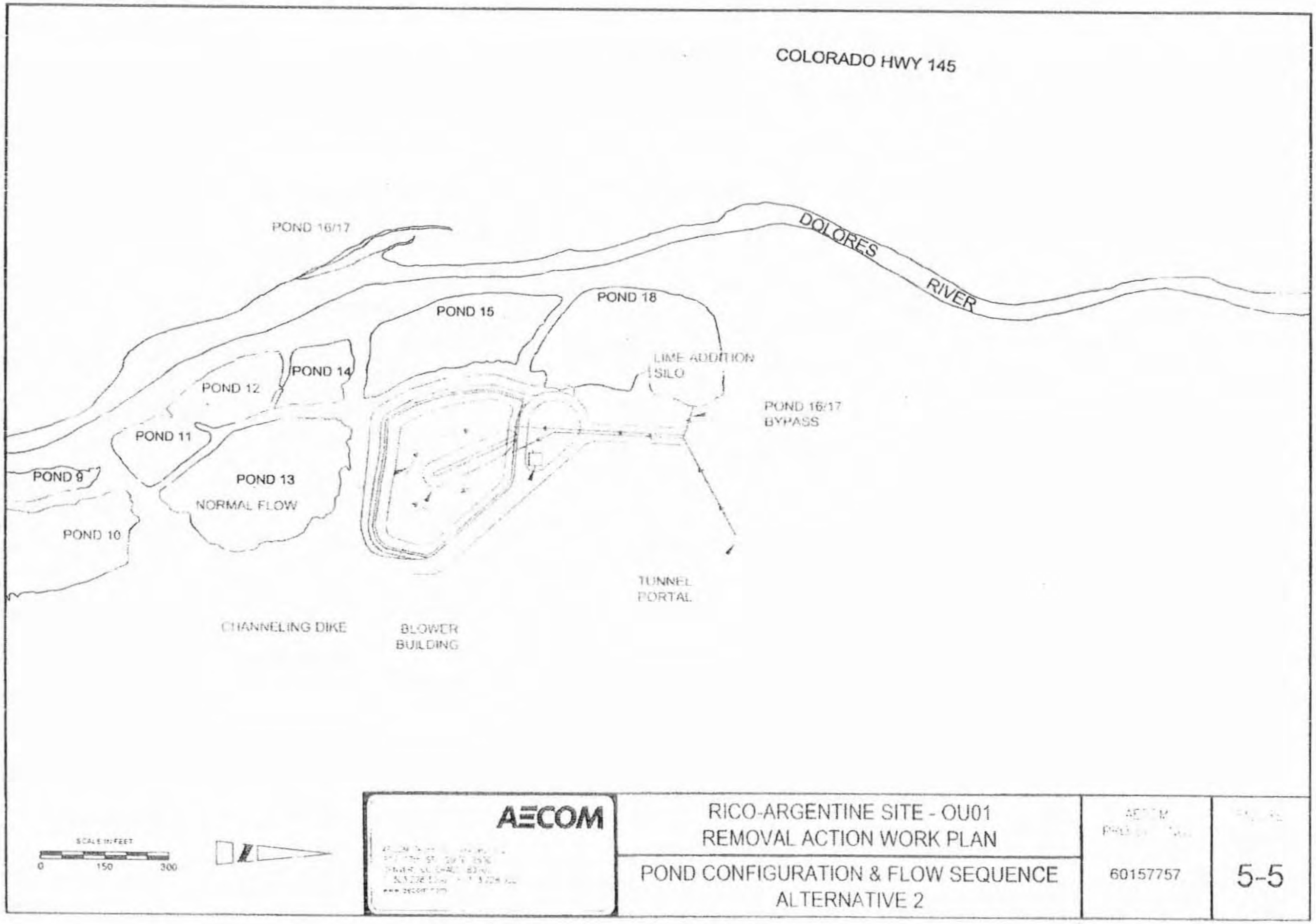


AECOM

RICO-ARGENTINE SITE - OU01
REMOVAL ACTION WORK PLAN

LOCATION MAP

AECOM PROJECT NO.	FIG.
60157757	3-2



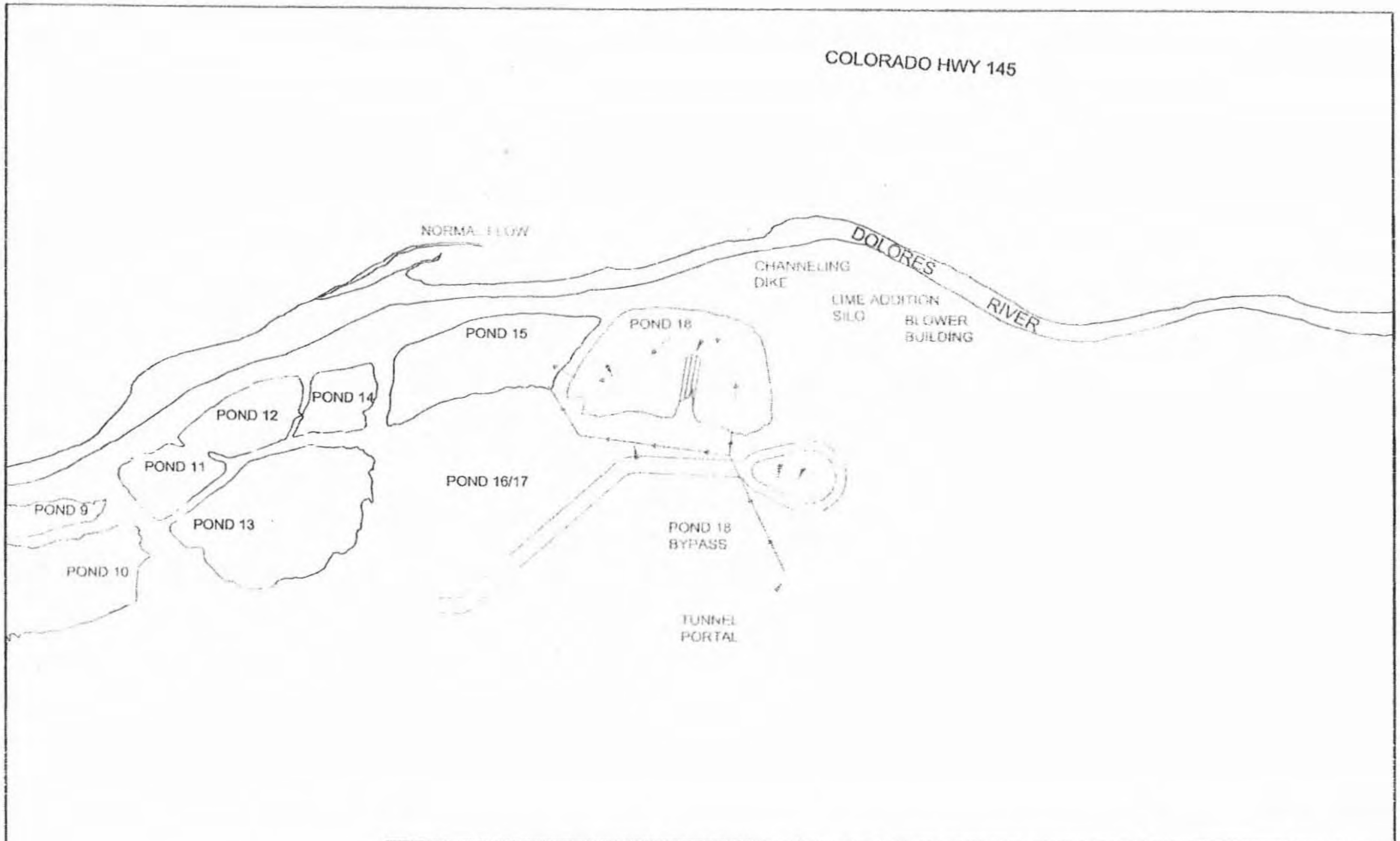
AECOM

RICO-ARGENTINE SITE - OU01
REMOVAL ACTION WORK PLAN

POND CONFIGURATION & FLOW SEQUENCE
ALTERNATIVE 2

60157757

5-5



SCALE IN FEET
0 150 300

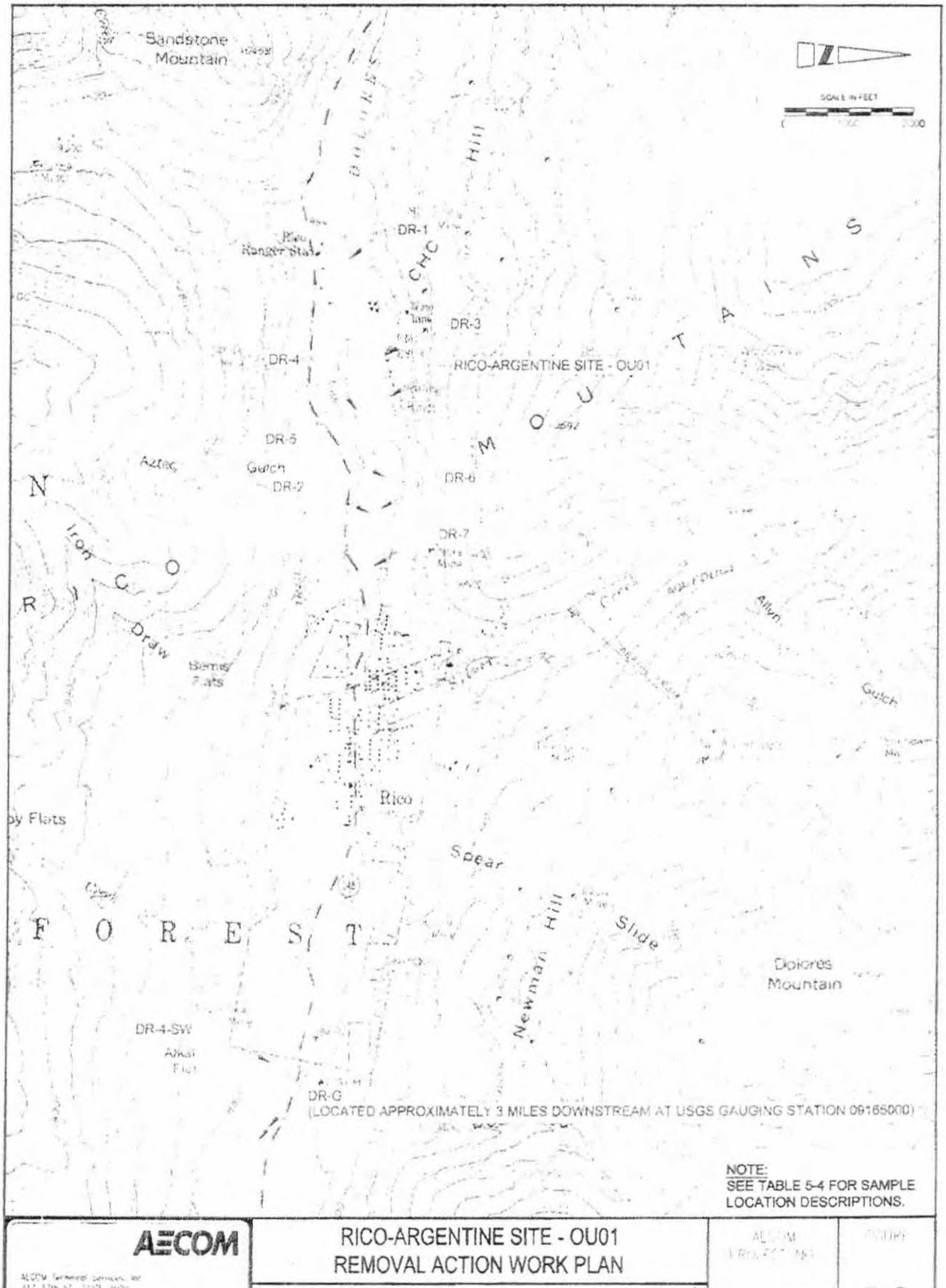
AECOM

RICO-ARGENTINE SITE - OU01
REMOVAL ACTION WORK PLAN

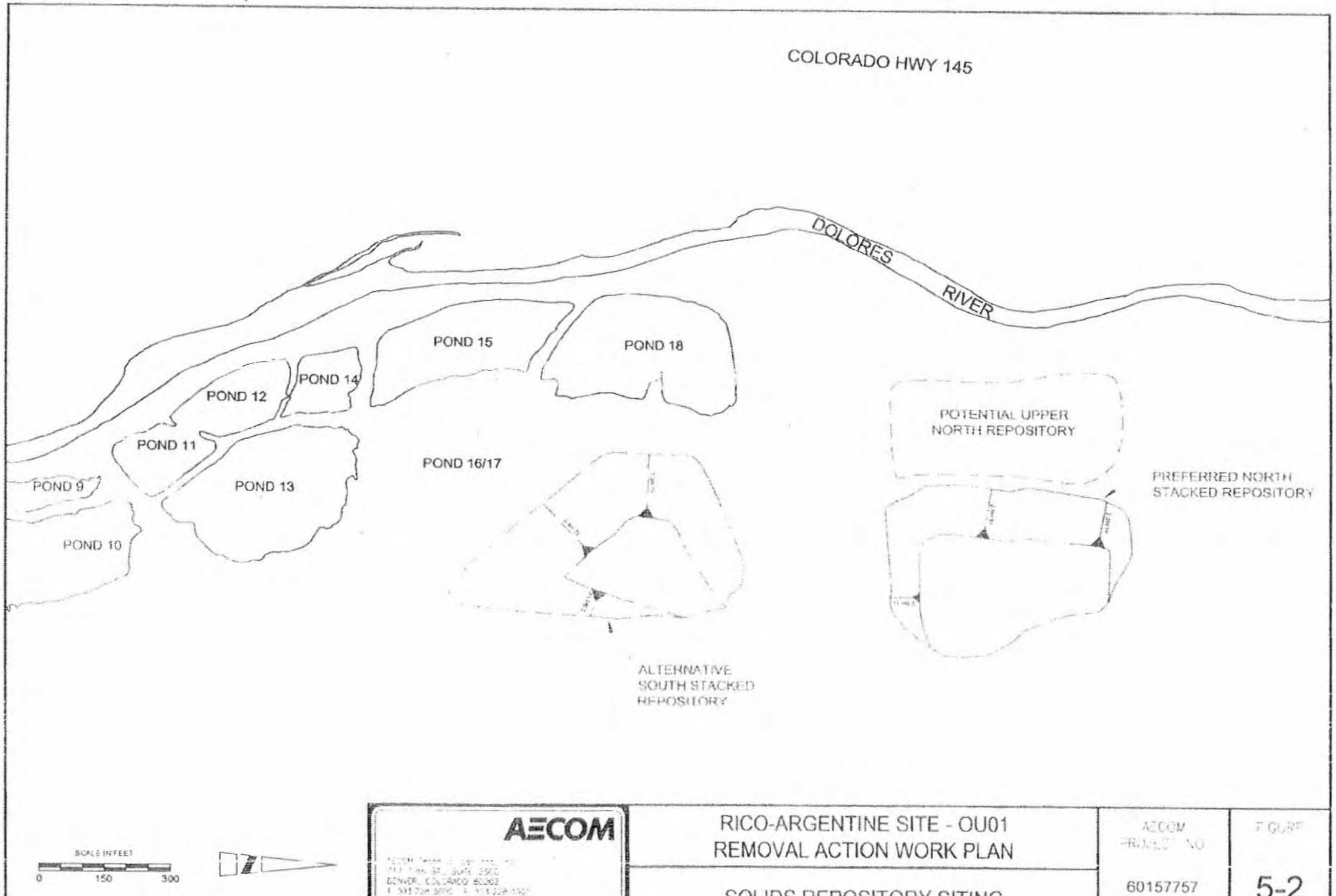
POND CONFIGURATION & FLOW SEQUENCE
ALTERNATIVE 1

AECOM PROJECT NO.
60157757

FIGURE
5-4



AECOM	RICO-ARGENTINE SITE - OU01 REMOVAL ACTION WORK PLAN	AECOM PROJECT NO.	FIGURE
	SURFACE WATER SAMPLING STATIONS	60157757	5-3

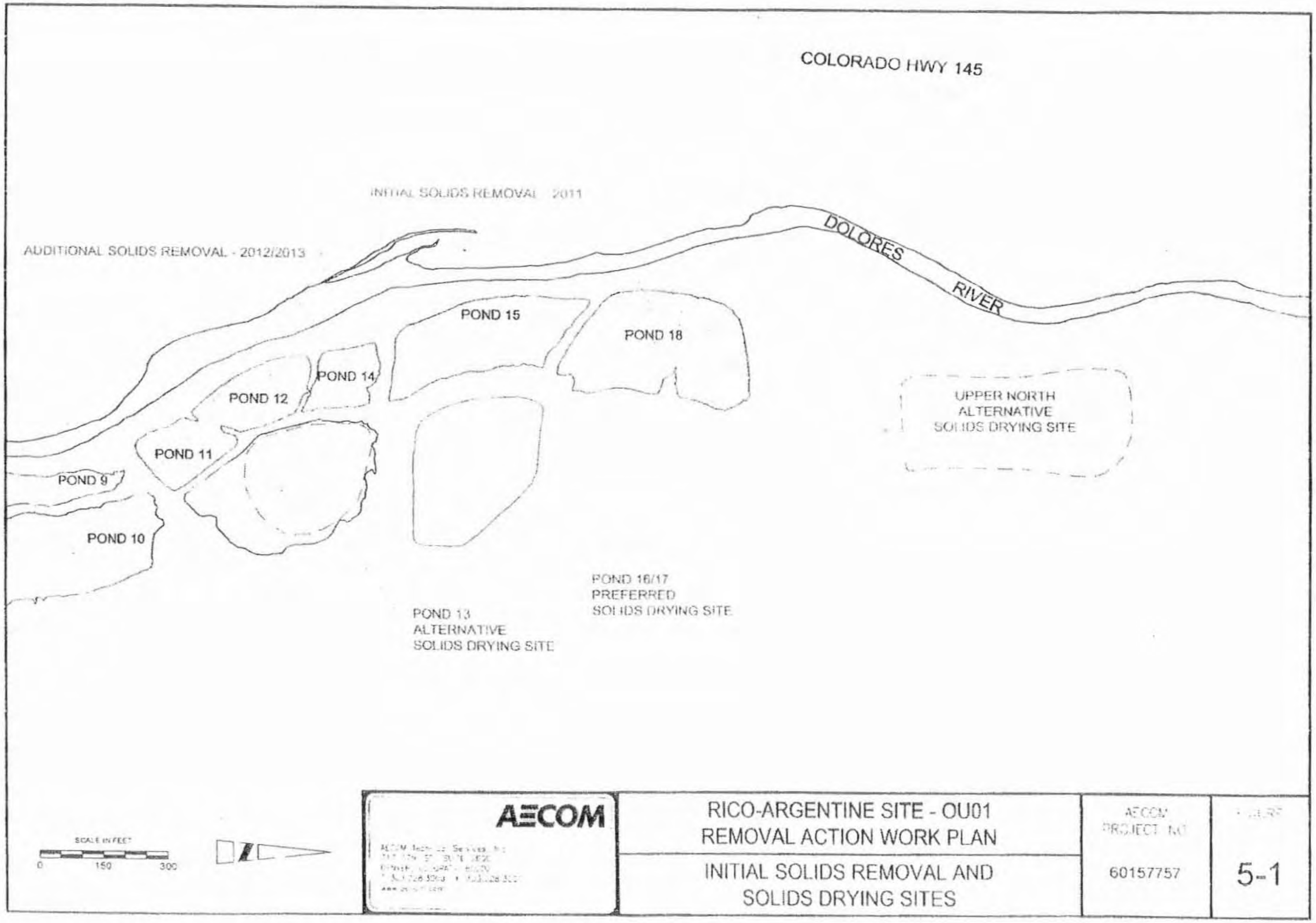


AECOM

RICO-ARGENTINE SITE - OU01
REMOVAL ACTION WORK PLAN

SOLIDS REPOSITORY SITING

AECOM PROJECT NO	FIGURE
60157757	5-2



AECOM

RICO-ARGENTINE SITE - OU01
REMOVAL ACTION WORK PLAN

INITIAL SOLIDS REMOVAL AND
SOLIDS DRYING SITES

AECOM PROJECT NO. 60157757

FIGURE 5-1

AECOM

RICO-ARGENTINE SITE - OU01
REMOVAL ACTION WORK PLAN

SITE MAP

60157757

3-3