Merit
Use Attainability Analysis

to Accompany Petition to Change Use Criteria on Cottonwood Creek Near Hamilton Dome, Hot Springs County, Wyoming as Provided Under Wyoming Surface Water Quality Standards, Chapter 1

Prepared under the direction of Merit Energy Company
For consideration by the Wyoming Department of Environmental Quality,
Water Quality Division

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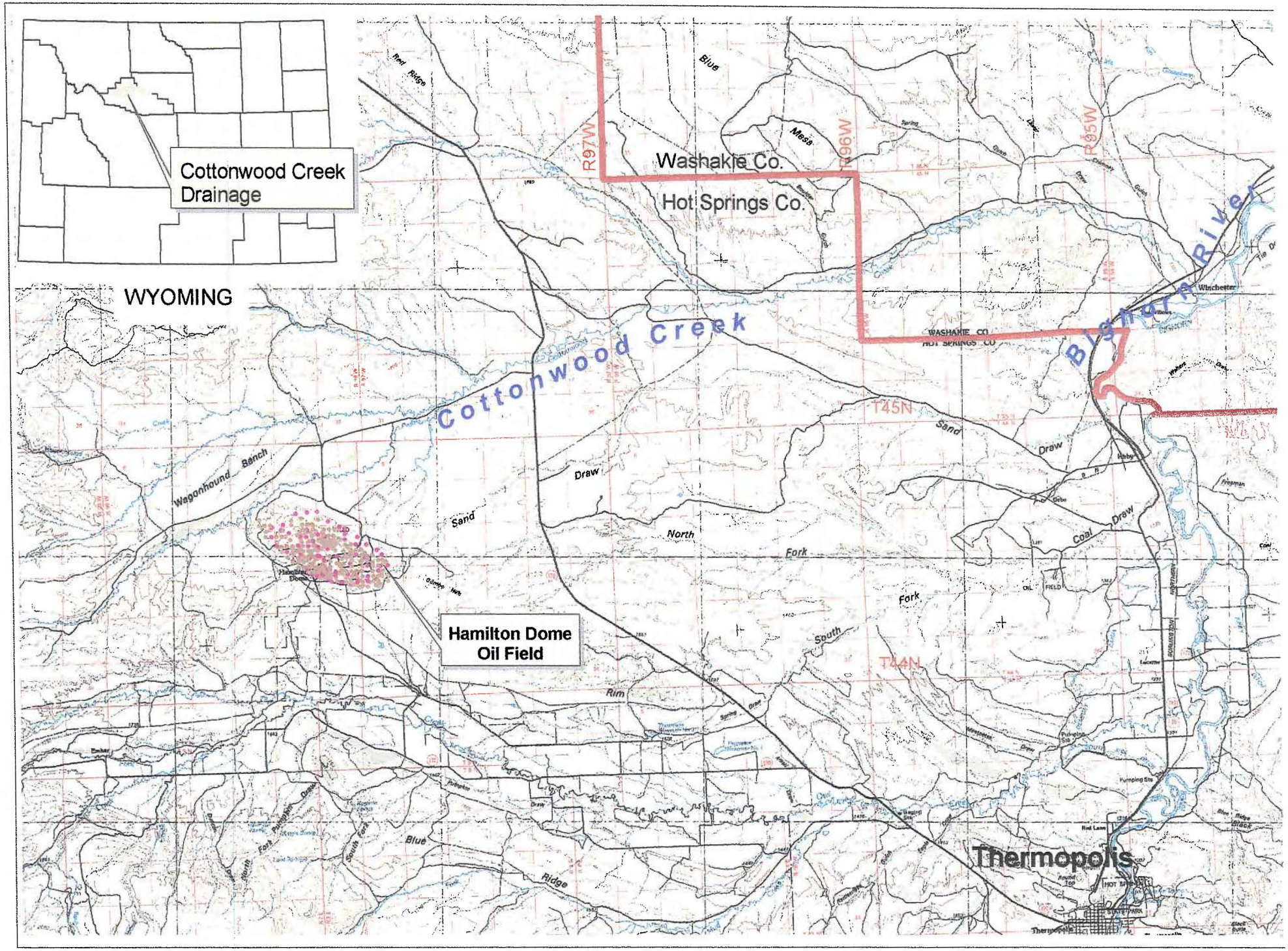
Cottonwood Creek Drainage
WYOMING
Washakie Co.
Hot Springs Co.
R97W
R96W
R95W
T45N
T44N
Cottonwood Creek
Bighorn River
Wagonhound Bench
Sand Draw
North Fork
South Fork
Coal Draw
Blue Ridge
Hamilton Dome Oil Field
Thermopolis
Winchester
Hamilton Dome

Introduction

Merit Energy Company (MEC) produces crude oil at the Hamilton Dome Field located 25 miles northwest of Thermopolis, in Hot Springs County, Wyoming. Merit Energy Company presently retains two NPDES permits (WY0000175 and WY0000680) to discharge produced water from the Hamilton Dome Field into unnamed tributaries that eventually flow into Cottonwood Creek.

The federal Clean Water Act requires that all surface water be swimmable and fishable. The Water Quality Division (WQD) of the Wyoming Department of Environmental Quality (DEQ) made changes to their statewide water classification system, and recently updated Water Quality Rules and Regulations, Chapter 1. Chapter 1 establishes water quality criteria for all classes of water. Until the recent update of Chapter 1, the classification of the tributaries and Cottonwood Creek was Class 4. The tributaries are now class 3B and Cottonwood Creek is now class 2C. The relevant classifications stipulate the following:

> Class 2C waters are those known to support or have the potential to support only nongame fish populations or spawning and nursery areas at least seasonally including their perennial tributaries and adjacent wetlands. Class 2C waters include all permanent and seasonal nongame fisheries and are considered "warm water". Uses designated on Class 2C waters include nongame fisheries, fish consumption, aquatic life other than fish, primary contact recreation, wildlife, industry, agriculture, and scenic value.
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> Class 3B waters are tributary waters including adjacent wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable. Class 3B waters are intermittent and ephemeral streams with sufficient hydrology to normally support and sustain communities of aquatic life including invertebrates, amphibians, or other flora and fauna which inhabit waters of the state at some stage of their life cycles. In general, 3B waters are characterized by frequent linear wetland occurrences or impoundments within or adjacent to the stream channel over its entire length. Such characteristics will be a primary indicator used in identifying Class 3B waters.

Chapter 1 simultaneously requires the protection of the existing uses of a stream. Existing, beneficial uses of the water in Cottonwood Creek include livestock water, wildlife water and forage, aquatic habitat, and irrigation. With the stoppage of MEC discharges to Cottonwood Creek, the extent of these uses would be markedly lost. The Wyoming Game and Fish Department has provided to the Wyoming DEQ a generic statement regarding their position on the beneficial use of historic oil and gas field water discharges (see full letter dated June 10, 2002 in Appendix H):

> *The Wyoming Game and Fish Department recognizes that historic discharges by oil and gas production facilities have demonstrated a beneficial use to fish and/or wildlife. Provided there are no changes to the quantity of discharge, and the water quality continues to meet DEQ standards for discharge, any permit renewal for these discharges will be considered by the Department as having a beneficial use for fish and/or wildlife.*

In order to renew its discharge permits under the current classification, MEC could be required to treat the Hamilton Dome discharge water to meet Class 2C standards. Appendix A demonstrates that the financial impact of treating the discharge to meet Class 2C standards would result in closure of the field.

Through this Use Attainability Analysis, MEC proposes to work with the Wyoming DEQ/WQD to increase water quality criteria allowing discharge of the produced water to continue without additional treatment. To that end, this document will provide an evidential summary to sustain three crucial factors that would warrant consideration by the Wyoming DEQ/WQD to establish site-specific criteria that are more appropriate to both the natural and man-made circumstances of this water course. These three factors are as follows:

1. The physical habitat is historically, and in dominant measure remains, dependent upon MEC discharges, and therefore, stopping the discharge would cause more environmental damage than if the discharges were allowed to remain in place.

2. A scientific evaluation of chemical and biological factors demonstrate that existing uses incur no detrimental effects from MEC discharges, and therefore, a subcategory of use that requires less stringent criteria is appropriate.

3. Closure of the field prior to the full recovery of the available crude oil resources would trigger significant economic distress on the local economy, and would result in substantial and widespread economic and social impact.

Evidence 1: Stopping the discharge would cause more environmental damage than if allowed to remain in place.

Hydrology Report (Appendix B) Summary

The natural runoff on Cottonwood Creek (in the absence of approximately 13 cfs of year-round Hamilton Dome discharges) was estimated using available USGS gage data and records of active irrigation water rights to conduct a simple water balance. Aerial photo interpretation, records analysis, and interviews with local ranchers indicate that there are between 1,600 and 2,000 acres of irrigated cropland along Cottonwood Creek. There are presently on record with the State Engineer just under 2,800 permitted acres along Cottonwood Creek with a water allocation of nearly 36 cubic feet per second (cfs) from the creek.

A water balance analysis (see Appendix B) was conducted to assess the potential hydrology of Cottonwood Creek in the absence of Hamilton Dome water discharges. The analysis indicates that the Cottonwood Creek drainage would have experienced as much as 14 cfs of water shortages in three of the seven years of record (1994-2000). It is important to note that the analysis is calibrated using relatively wet-year data, so this estimate is considered misleadingly optimistic. In fact, the preponderance of testimony from local ranchers indicate that Cottonwood Creek generally runs dry for all but the spring runoff and early irrigation season. This testimony is supported by additional gage data available during the summer months of 1977 and 1978 (see Appendix B).

The addition of approximately 13 cfs of MEC discharge water, delivered on a consistent year-round basis, greatly alleviates potential shortages during the summer irrigation season as well as significantly supplements livestock watering, wetland preservation,

aquatic habitat, and other natural beneficial uses during the off-season. It is also evident that the supplemental water discharges, under the assumption that the quality of this water is not detrimental to the existing uses along Cottonwood Creek, provide considerable relief from the current and ongoing drought conditions.

Wetland Report (Appendix C) Summary

All wetlands that would be lost if Hamilton Dome discharge were to cease were inventoried and mapped according to guidelines in the Wetland Delineation Manual developed by the U.S. Army Corps of Engineers. Wetland identification methods defined in this manual are generally universally accepted by all state and federal regulatory agencies.

Discharge from Hamilton Dome is conveyed to Cottonwood Creek by an irrigation ditch on the west end, and through a natural drainage as well as an irrigation ditch on the east end. Substantial wetlands have formed as a result of canal seepage in these areas. The total size of wetlands created directly by discharge was digitized and found to be 91.3 acres.

According to National Wetland Inventory (NWI) mapping, there are approximately 585 acres of wetlands along Cottonwood Creek. Wetlands along Cottonwood Creek downstream of the discharge are noticeably different than upstream. There was no flowing water in Cottonwood Creek above the discharge when field work was conducted on June 27, 2002. The stream bottom above the discharge is much wider and shallower due to scouring by water during high spring flows. This scouring is not present below the discharge, likely due to the presence of wetland fringes along the stream bank which tend to stabilize the banks and reduce the effects of erosion. With the exception of approximately the first 600 stream meters above the uppermost discharge, there were virtually no wetlands adjacent to the stream. Below the uppermost discharge point, there was a continuous wetland fringe along the creek with a mean width over 6 times the

width of the mean wetland fringe width above the discharge. The large difference in wetland widths along Cottonwood Creek above and below Hamilton Dome discharge indicates that Hamilton Dome discharge supports a substantial amount of riparian wetlands along Cottonwood Creek that would be lost if discharge were to cease.

It is estimated that approximately 600 acres of high-quality wetlands would likely be lost if the discharge from Hamilton Dome and associated irrigation of hay fields were to cease. This total includes nearly 100 acres supported directly by discharge and another approximately 500 acres along Cottonwood Creek that are indirectly supported by Hamilton Dome discharge.

Landowner Testimony (Appendix D) Summary

Landowners are largely in agreement that ranching operations along Cottonwood Creek would cease altogether with closure of the Hamilton Dome field (see Landowner Questionnaire Responses and Affidavit provided as Appendix D). The water discharged provides late season grass and hay irrigation and year-round livestock watering. These beneficial uses would be otherwise limited to scant resources from natural runoff through the early summer season, and consequently would not viably support the ranching operations.

In addition to economic benefits, landowners bear witness to the ecological benefits provided by the discharges, including abundant wildlife habitat and vegetation and moreover testify that the water quality does not induce evident ill effects to natural vegetation, wildlife, livestock, nor their irrigated pastures.

Evidence 2: A scientific evaluation of chemical and biological factors demonstrate that existing uses incur no detrimental effects from MEC discharges.

Terrestrial and Aquatic Wildlife Report (Appendix E) Summary

One of the major environmental benefits of Hamilton Dome discharge is the continuous support of an aquatic environment for fish and aquatic invertebrates, creation of riparian and other wildlife habitat, and provision of a year-round water supply in an otherwise arid environment.

Information on terrestrial wildlife use of the area was obtained through searching the Wildlife Observation System database maintained by the Wyoming Game and Fish Department (WGFD-WOS). Additional information was obtained by interviewing the WGFD biologist in Thermopolis (Kevin Hurley). The Terrestrial and Aquatic Wildlife Report (Appendix E) also includes observations of wildlife and habitat in the project area made while conducting field visits to obtain data for this use attainability analysis. Potential impacts of losing a water source were identified based on availability and distance to alternative sources of water.

Available data on aquatic invertebrates were obtained from the Wyoming Department of Environmental Quality Water Quality Division (WDEQ-WQD). Data on fish in Cottonwood Creek were obtained from the Wyoming Game and Fish Department (WGFD). These data were supplemented with data collected during other portions of the current study to evaluate selenium levels in fish and aquatic invertebrates.

Threatened, Endangered, Proposed, and Petitioned Species

The Cottonwood Creek riparian corridor and surrounding area provides habitat for threatened, endangered, and other sensitive species. With perhaps the exception of sage grouse, continued discharge of produced water in Cottonwood Creek is not likely crucial to the survival of any populations of these species; however, it does provide some habitat for sensitive species at certain times of the year and may be important to the continued survival of some individuals.

Big Game

In a letter to WDEQ dated June 20, 1990, the WGFD stated their opposition to eliminating discharge to Cottonwood Creek (see Appendix H). Their primary concern at that time was with the large number of mule deer that concentrate along Cottonwood Creek in the winter. Several hundred deer can be found along the crucial winter range riparian zone associated with Cottonwood Creek, and Cottonwood Creek supports one of the major concentrations of mule deer in Management Areas 119 and 120. During post-season classifications, 200-300 mule deer are routinely found along a two-mile stretch of the creek. The WGFD believes that these deer concentrations are directly tied to the produced water from Hamilton Dome. The WGFD concluded their letter by stating that the water produced at Hamilton Dome "does provide substantial benefits to the wildlife resource which is using this area." Mr. Kevin Hurley, the WGFD biologist stationed in Thermopolis, stated that he has reviewed the 1990 letter and believes that its contents are still applicable to today's situation. In addition to the 1990 letter specific to Cottonwood Creek, the WGFD also submitted another letter to WDEQ dated June 10, 2002 (see Appendix H). The purpose of this letter was to state that the WGFD believes that historic discharges by oil and gas production facilities provide a beneficial use to fish and/or wildlife. The importance of this area to big game can be found in the Wildlife Observation System (WOS) records for those sections through which Cottonwood Creek flows from Hamilton Dome to the Bighorn River. These records include 649 observations totaling 2,564 mule deer, 702 observations totaling 5,664 pronghorn, 7 observations of single white-tailed deer, and one observation of a moose. If Hamilton Dome discharge were to cease, the lack of water would likely severely impact big game as well as other terrestrial wildlife species dependant on this water source, as there are no other perennial water sources available in the area.

Upland Gamebirds

Large numbers of game birds are present in this area primarily due to the availability of Hamilton Dome produced water. Irrigated crop fields provide foraging habitat as well as some nesting habitat and cover. High water tables associated with a perennial stream, irrigation water return flows, and overflows of irrigation water off of crop fields onto

adjacent areas provide substantial vegetative cover for upland game birds. Loss of produced water would eliminate or greatly reduce habitat for upland game birds through elimination of irrigated crops and dense vegetative cover.

Raptors

Due to the presence of cottonwood trees, which provide nesting substrate, and excellent riparian and cropland habitat for prey, numerous raptors have been documented along Cottonwood Creek. Elimination of the produced water would reduce habitat for raptor prey species and likely result in reduced habitat available for both breeding and wintering raptors in the area.

Waterfowl and Waterbirds

Large flocks of waterfowl have been observed using crop fields adjacent to Cottonwood Creek in the area, including flocks containing 65 Canada geese and 57 sandhill cranes. According to Kevin Hurley, Cottonwood Creek is used by many waterfowl. While conducting activities for this project, Canada geese, several adult American coots and one group of young coots, a female gadwall and four young, up to 15 Wilson's phalaropes, a pair of eared grebes, numerous waterfowl (15-25), primarily mallard and blue-winged teal, spotted sandpipers, and killdeer were observed on discharge-related Lake Charlie, adjacent ponds and along the discharge canal. There is a large open water/wetland complex where discharge from Hamilton Dome enters Cottonwood Creek across from Legend Rock. In late June 2002, there were approximately 20 gadwall using this area. Elimination of the produced water would also result in the elimination of a substantial amount of waterfowl and waterbird habitat, especially in late summer after natural spring runoff flows in Cottonwood Creek have ceased.

Neotropical Migrant Birds

Due to loss of habitat and other mortality factors, many species of neotropical migrant birds are showing dramatic population declines. Riparian habitats support the highest density of nongame birds of any habitat in the arid west, and maintaining this habitat is considered critical to maintaining healthy populations of many nongame birds. During

field activities conducted for this project, several species of neotropical migrant birds were observed in and near wetlands created by the discharge from Hamilton Dome prior to it entering Cottonwood Creek. All of these species were breeding in wetlands created by produced water.

Aquatic Fish and Invertebrates

Cottonwood Creek supports a diverse assemblage of fish. It is managed by the WGFD as a unique species fishery, with emphasis on management of native nongame species and Yellowstone cutthroat trout. The native fish in Cottonwood Creek have their own intrinsic value, but presence of fish in Cottonwood Creek is also important because the fish provide forage for a variety of wildlife. Elimination of produced water would convert Cottonwood Creek from a perennial stream with a unique species fishery to an ephemeral stream incapable of supporting fish for most of the year.

The stream also supports a diverse and abundant macroinvertebrate community. Presence of large numbers of these taxa is important because they are generally considered to be pollution sensitive and good indicators of overall water/habitat quality. Ponds supported by produced water either directly (i.e., Lake Charlie) or indirectly (ponds receiving irrigation return flows) were also found to have a diverse aquatic invertebrate community during sampling to document selenium concentrations (see Appendix F). During extremely dry years, as occurred in 2002, Cottonwood Creek is the only stream with flowing water within several miles, and loss of this resource could impact population levels of wildlife that depend on aquatic invertebrates and fish in the stream.

Wildlife Habitat

Wetlands are very valuable wildlife habitats and the extensive loss of wetlands if Hamilton Dome discharges were to cease (see Appendix C) would result in population declines and displacement of wildlife species associated with wetlands. Conversion of Cottonwood Creek from a perennial to an ephemeral stream would also impact riparian vegetation and further reduce habitat for those species of wildlife within the riparian

corridor. The lack of a water source throughout the entire growing season would result in less diverse riparian plant community. This change would reduce habitat effectiveness for many species of wildlife dependant on riparian communities. The expected impact to wetlands and other riparian plant communities if discharge of produced water were to cease can be seen by examining pictures of Cottonwood Creek in the Wetland Report (see Appendix C) that clearly show reduced habitat effectiveness upstream of the discharge vs. below the discharge.

Water Quality Report (Appendix F) Summary

Cottonwood Creek originates in the Owl Creek Mountains in the Southwestern Big Horn Basin and traverses northeast across the semi-arid high plains until its confluence with the Bighorn River. Flows above Hamilton Dome Field are dependent on springs, snowmelt, precipitation runoff, evaporation, evapotranspiration and infiltration. The conductivity (EC) of the pristine water upstream of the Hamilton Dome Field is in the range of 60 to 790 μmhos/cm. Ambient aluminum concentrations exceed DEQ/WQD Chapter I chronic water quality standards for fish and aquatic life. Chloride concentrations are very minimal. Selenium concentrations are less than the chronic limit of 5 micro grams/L except for samples collected on August 29, 1983.

The water quality of Cottonwood Creek below Hamilton Dome Field is influenced by the soils environment of the watershed, the weather (evaporation and infiltration), the quality of MEC discharges, snowmelt runoff and precipitation runoff events, and irrigation diversions and return flows. The natural runoff from snowmelt consists of pristine quality water. Runoff from other precipitation events is generally of pristine quality; however, these events have a tendency to transport large amounts of sediment that chemically react and dissolve in the water. The high aluminum concentrations that are evident upstream of the discharges, which exceed Wyoming Water Quality standards contained in Chapter I for fish and aquatic life use, result from this natural process.

The produced water discharged by MEC at the Hamilton Dome Field is generally classified for livestock water use and has an EC ranging from 4,100 to 4,500 μmhos/cm. This water has chlorides and selenium that exceed the DEQ/WQD Chapter I water quality standards for fish and aquatic life.

The water quality at sample point B on Cottonwood Creek downstream of the Hamilton Dome discharges is consistent with the water quality of MEC discharges in the absence of natural runoff. Under these circumstances, evaporation and irrigation return flows tend to increase concentrations of EC, chlorides, and selenium from sample point B to the Bighorn River. On the contrary, during periods of rainfall or snowmelt runoff, concurrent dilution of the MEC discharges will tend to bring the selenium and chloride concentrations within the DEQ/WQD Chapter I water quality standards for fish and aquatic life.

The MEC Hamilton Dome Field discharges originate primarily from the Phosphoria and Tensleep formations. (The State Park Hot Springs at Thermopolis also originate from the Phosphoria). A sample taken at the large hot spring in Hot Springs State Park on June 21, 2002 had an EC of 2,850 μmhos/cm. The chloride concentration was 245 mg/L and the selenium concentration was 11 μg/L. These natural hot spring flows, which exceed radium, selenium and chloride criteria, are discharged directly into the Bighorn River.

Chloride Evaluation

Data on aquatic invertebrate and fish abundance, composition, and sensitivity to chloride were used to assess potential effects of the existing chloride concentrations in Cottonwood Creek on the aquatic community (Appendix F).

Aquatic invertebrate data collected by WDEQ are presented in the Terrestrial and Aquatic Wildlife Report (Appendix E). The documented presence of large numbers of certain aquatic invertebrate taxa in Cottonwood Creek is important because they are

generally considered to be pollution sensitive and good indicators of overall water/habitat quality.

Cottonwood Creek is managed by the WGFD as a unique species fishery, supporting a diverse assemblage of fish. Examination of chloride toxicity data for species present in Cottonwood Creek indicate that, of the five species of fish for which chloride toxicity data exist, only one species (bluegill) is more sensitive to chloride than the two species of fish that have been documented in Cottonwood Creek (rainbow trout and fathead minnow).

The aquatic invertebrate and fish abundance and composition data do not indicate that chloride concentrations are having a significant impact in the stream. The fact that several taxa considered the most sensitive to chloride toxicity are present in Cottonwood Creek indicates that chloride levels are below levels of concern, and that the chloride water quality criteria is very conservative.

Selenium Evaluation

The current water criteria for selenium are 20 µg/L for acute (one-hour average) levels and 5 µg/L for chronic (4-day average) levels. Selenium levels ranged from 29-31 µg/L in Cottonwood Creek and 25 to 37 µg/L in Hamilton Dome discharges. The current water-based criteria were developed using data that are now 15 years old (U.S. Environmental Protection Agency [EPA] 1987). After reviewing more extensive and recent data, the EPA is proposing that selenium criteria be based on fish tissue concentrations, rather than concentrations in water. According to the new proposed criteria (EPA 2002):

> *Freshwater aquatic life should be protected if the concentration of selenium in whole-body fish tissue does not exceed 7.9 µg/g dry weight, and if the short-term average concentration of selenium dissolved in the water seldom exceeds 185 µg/L.*

Toward substantiating a petition to establish site-specific criteria for selenium on Cottonwood Creek and its tributaries, a detailed study of selenium was conducted. The

sampling design was developed in conjunction with Mr. Pete Ramirez of the U.S. Fish and Wildlife Service Ecological Field Services Office in Cheyenne, Wyoming.

Selenium concentrations at the stream and pond sampling stations were 16 to 29 µg/L above the current chronic value criteria of 5 µg/L, but well below the new proposed criteria guideline that the short-term average concentration of selenium dissolved in the water seldom exceeds 185 µg/L.

All whole body selenium concentrations in fish were below the new proposed criteria of 7.9 µg/g. Selenium concentrations in aquatic invertebrates within Cottonwood Creek averaged 4.18 µg/g, and in three sampled ponds averaged 3.01 µg/g.

After reviewing selenium toxicity data for birds, the EPA (2002) concluded that the final chronic value of 7.9 µg/g dry weight in fish tissue is expected to be protective of birds dependent on an aquatic food chain. Because all selenium values in fish and aquatic invertebrates measured during this study were below this value, no unacceptable impacts should occur to migratory birds consuming fish or aquatic invertebrates in the study area.

To develop the new selenium criteria, acceptable data on the acute effects of selenium in freshwater were available for 12 invertebrate species and 11 species of fish (EPA 2002). The most sensitive of the 12 invertebrates was a species of *Daphnia*, and the most sensitive of the 11 species of fish was fathead minnow. *Daphnia* were extremely abundant in one of the irrigation return flow ponds (Pond 1) sampled during this study, and fathead minnow was documented within Cottonwood Creek during this study as well as by the Wyoming Game and Fish Department during earlier studies. Presence of these sensitive species provides further evidence that the selenium concentrations in Hamilton Dome discharge are below levels of concern.

Evidence 3: Closure of the field would trigger significant economic distress on the local economy, and would result in substantial and widespread economic and social impact.

Economic Report (Appendix G) Summary

Ongoing production of petroleum crude from Merit Energy Company's Hamilton Dome field is a significant source of economic stimulus for Hot Springs County and the State of Wyoming. In fact, these contributions are proxy measures of the adverse impacts that would result from the premature closure of the Hamilton Dome field. The report provided as Appendix G focuses on the following aspects of the economy:

A. the economic stimulus associated with Hamilton Dome employment, purchases of goods and services, payment of taxes and the associated multiplier effect,

B. the effect of Hamilton Dome tax payments on the Hot Springs County tax base and the taxing entities who rely on these payments to help fund services provided to residents, including students enrolled in local public schools,

C. hay and livestock production along Cottonwood Creek supported by the water discharged from Hamilton Dome; and,

D. the significance of Hamilton Dome crude oil to the Wyoming refining industry and the production of asphalt and road oil.

This economic study concludes that substantial negative economic impacts in Hot Springs County would accrue to residents, businesses and local governmental entities with premature closure of the Hamilton Dome oil field, and should be taken into account in the overall assessment of the benefits and costs associated with compliance with Class 2C water quality standards.

Economic Contributions of Hamilton Dome

Annual crude production from the Hamilton Dome field averaged 1.67 million barrels over the past five years.

- Employment and Labor Income: Based on annual operating expenses averaged over the past five years, Hamilton Dome supports an estimated total of 186 jobs in the State of Wyoming including 136 jobs in Hot Springs County (about 4 percent of total employment in the county in 2000) and 50 jobs elsewhere in Wyoming. The associated Hamilton Dome labor income impact in Hot Springs County totals $4.07 million (about 7 percent of total labor income in the county in 2000) and $2.54 million elsewhere in Wyoming.

- Overall Economic Output: The economic contribution of the Hamilton Dome oilfield is conservatively estimated at nearly $28.7 million annually, most of which occurs in Hot Springs County.

Fiscal Contributions of Hamilton Dome

Merit Energy Company is the largest taxpayer in Hot Springs County and the Hamilton Dome field is the county's largest source of property tax.

Property Tax

Over the past 5 years, Hamilton Dome property tax revenue has averaged 29 percent of total property tax revenue for all countywide taxing entities ($1.9 million out of a total $6.6 million). Property taxes are the largest source of locally-derived funding for local governmental entities and represent a major source of non-earmarked revenue subject to discretionary spending control. Counties are statutorily limited to a 12-mill cap for basic county operating purposes (general fund, hospital, library and fair board), limiting their capacity to increase property taxes to offset reductions in revenues. Hot Springs County's property tax rates are at the 12-mill limit. Consequently, a major reduction in revenues associated with the premature shutdown of the Hamilton Dome field would likely trigger reductions in basic service levels.

Over the past five years, property taxes from Hamilton Dome have accounted for the following revenue contributions to major funds and entities:

- County General Fund: 9 percent of total general fund revenues.

- Library, Fair Board, Hospital: 27 percent of the library system's total revenues, 15 percent of the Fair Board's total revenues and 2 percent of the Hot Springs County Memorial Hospital District's total revenues.

- Hot Springs County Weed and Pest District: Two separate levies fund operations of the Weed and Pest District. Hamilton Dome property tax revenues provide 9 percent of the district's pest eradication budget and 29 percent of its mosquito control budget.

- Hot Springs County Rural Fire Protection District: Hamilton Dome property tax revenues fund 29 percent of the district's budget. Because the district is staffed by volunteers, a loss of that revenue would not reduce services, but would delay the purchase of needed equipment, supplies and training.

- Hot Springs County School District # 1: Over the past five years, Hamilton Dome property taxes for school-related funds averaged $1.4 million annually. Of that amount, $910,000 was for operational purposes and $188,000 for debt service. The Wyoming School Foundation Fund received an average of $325,000. The entitlement provisions of the state foundation program would offset any loss in Hamilton Dome property tax revenue on the operating budget. Based on the five-year average, the Wyoming School Foundation Fund would experience a net cost of $1.235 million from lost revenues and additional entitlement costs, assuming no change in enrollment levels. Reductions in the number of Hamilton Dome-related students would reduce School District #1's entitlement and revenue with little reduction in educational costs. Loss of the Hamilton Dome property tax revenues would increase the school debt service mill levy for other county taxpayers by 2.8 mills, based on the five-year average.

Severance Tax

Over the last two years, severance taxes on Hamilton Dome production have averaged $1.8 million annually.

Federal Mineral Royalties

Over the past two years, federal mineral royalty payments for Hamilton Dome production averaged $4.4 million. Wyoming's share of these royalties averaged an estimated $2.2 million annually.

Sales and Use Tax

In 2001, MEC estimates that it paid over $400,000 in sales and use taxes on purchase of goods and services for the Hamilton Dome field.

The Role of Hamilton Dome Produced Water in the Cottonwood Creek Ranching Economy

Approximately 35 Cottonwood Creek-area landowners benefit directly or indirectly from water discharged from the Hamilton Dome field into the creek. These landowners use the water for irrigation and stock watering purposes. Based on a survey of several of these landowners, the loss of Hamilton Dome discharges into Cottonwood Creek would result in a corresponding loss of:

- 1,600 acres of irrigated cropland,
- 4,000 tons of annual hay production,
- 15 to 20% reduction in herd size (about 3,200 cows) and a $2 million reduction in related sales receipts (based on $650 head) and,
- 20 full time and seasonal jobs in the ranching industry.

Additional losses would be likely for ranches not included in the survey. Several ranchers contacted for the survey expressed concern for the economic viability of their operations without the Hamilton Dome water.

The IMPLAN model was used to estimate the total economic losses in Hot Springs County, including the indirect and induced impacts on other sectors, associated with the direct reduction in annual livestock receipts. Those losses, which include a net reduction of $3.3 million (1.7%) in the county's total annual economic output, a loss of $645,000 in annual labor income, and a net loss of 32 full and part-time jobs, would be in addition to those impacts directly attributable to the cessation of Merit's Hamilton Dome production operations.

The Role of Hamilton Dome in the Wyoming Refining Industry

Hamilton Dome crude production represents about 3.3 percent of the daily feedstock supply needed to sustain Wyoming's five refineries at full production. However, Hamilton Dome supplies more than 20 percent of the crude necessary to sustain asphalt

and road oil production. The loss of this production coupled with the absence of an alternate supply could force the closure of one or more Wyoming refineries.

Alternative: Discreet Recalculation of Site-Specific Criteria

One alternative measure to changing the classification of Cottonwood Creek and its tributaries would be to establish site-specific water quality standards criteria. The recalculation procedure is intended to allow a site-specific criterion to differ from a national aquatic life criterion if justified by demonstrated pertinent toxicological differences between the aquatic species that occur at the site and those that were used in the derivation of the national criterion. However, attempts to calculate a site-specific chloride criterion for Cottonwood Creek using the EPA recalculation procedure (U.S. EPA. 1994. The Recalculation Procedure. Appendix B in "Interim Guidance on Determination and Use of Water-Effect Ratios for Metals." EPA-823-B-94-001) could not be reasonably accomplished at this time (Reference Memo from Greg Johnson dated November 1, 2002 in Appendix H).

The recalculation procedure basically involves deleting species used to develop the national criterion but that do not occur in Cottonwood Creek. Before EPA allows the recalculation procedure, available chloride toxicity data for the procedure must meet the "Eight Family Rule". In accordance with the U.S. EPA 1985 (Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, PB85-227049), the following eight families satisfy the minimal data requirements for the general recalculation procedure:

1. The family Salmonidae in the class Osteichthyes (i.e., a trout or salmon)
2. A second family in the class Osteichthyes, preferably a commercially or recreationally important warm water species (e.g., bluegill, channel catfish, etc.)
3. A third family in the phylum Chordata (may be in the class Osteichthyes [a fish] or may be an amphibian, etc.)
4. A planktonic crustacean (e.g., cladoceran, copepod, etc.)
5. A benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish, etc.)
6. An insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge, etc.)

7. A family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca, etc.)
8. A family in any order of insect or any phylum not already represented (Large to small: Kingdom, Phylum, Class, Order, Family, Genus, Species)

The national chloride criterion are based on published toxicity data for species representing only 11 families (U.S. EPA. 1988. Ambient Water Quality Criteria for Chloride - 1988, EPA 440/5-88-001). Of these 11, five do not occur in Cottonwood Creek (fingernail clam, mosquito, American eel, goldfish, and bluegill) and would therefore be removed during the deletion process. After deleting these five, however, only chloride data for six families are left to calculate the new site-specific criteria for Cottonwood Creek, but this does not meet the "8 family rule." When this occurs, the general recalculation procedure cannot be used, which means that the only possible option left is to use the Special Recalculation Procedures. For the Special Recalculation Procedures, toxicity data are required for at least one species in each of the families that occur at the site. Between the Wyoming Department of Environmental Quality (WDEQ) aquatic invertebrate and Wyoming Game and Fish Department fish data for Cottonwood Creek, however, there are numerous families of fish and aquatic invertebrates present in Cottonwood Creek for which there are no chloride toxicity data. Therefore, neither the general nor special recalculation procedures can be used to recalculate a site-specific chloride criteria for Cottonwood Creek.

The only remedy for this situation would be to develop chloride toxicity data for a host of organisms through laboratory toxicity tests, which is an intensive and costly venture. Another potential remedy for the problem is to raise the chloride criteria, which is currently being requested of the WDEQ by the Petroleum Association of Wyoming (see letter dated August 22, 2002 in Appendix H).

Recommendations

This document provides a basis for establishing site-specific water quality criteria on Cottonwood Creek and its tributaries, under the provisions of the Water Quality Standards Regulation (40 CFR 131.10), by demonstration of the following:

- Prescribed management practices are not cost-effective, implying closure of the oil field.
- A hydrologic analysis in the absence of discharges indicates seasonal water shortages detrimental to existing biological and economic uses.
- Biological analyses indicate relative benefit of Hamilton Dome discharges to wetland maintenance and aquatic and terrestrial wildlife habitat, and indicate more damage to the environment, in the form of drastic reduction of wetland acreage and decreased biodiversity, would result if the discharges were stopped.
- Chemical analyses document that chloride sensitive species indeed thrive in the discharge/Cottonwood Creek effluent waters, and that selenium levels are in compliance with proposed EPA criteria.

Given the scientifically documented impact assessments of hydrology, wetlands, aquatic and terrestrial wildlife, water quality, and economics provided in the Merit Use Attainability Analysis, the following revised water quality criteria are recommended as applicable to the Hamilton Dome discharges:

Chloride: ~~800~~ mg/L 860
Selenium: ~~100~~ µg/L 43

The revised chloride criteria may be justified by the provided evidence that all existing uses of Cottonwood Creek are in fact thriving with the provision of the water provided by the Hamilton Dome discharges. On the contrary, in the absence of these discharges, the stream would change from a perennial to an ephemeral stream, negatively impacting wetlands, diminishing aquatic and terrestrial wildlife habitat, and severely impacting the regional economy. Moreover, it is abundantly clear that the present class 2C and 3B criteria under consideration are exceedingly conservative. The chronic chloride criteria of 230 mg/L is equivalent to human consumption criteria which, in the surrounding states, only applies to designated drinking water supplies—the equivalent of Class 1,

Class 2AB, and Class 2A waters. The only other chloride standard in the surrounding states is for "coldwater permanent fish life propagation waters" in South Dakota—the equivalent of Class 1, Class 2AB, and Class 2B waters.

Finally, with the proposed EPA selenium criteria "to seldom exceed 185 µg/L", and the demonstration that all dry-weight selenium samples collected through the Use Attainability Analysis study are below the criteria of 7.9 µg/g, and the water quality is well below 185 µg/L (25 to 37 µg/L), a reasonable water quality criteria for selenium would be above the existing levels.

APPENDIX A

ECONOMIC ANALYSIS OF FAILURE TO OBTAIN CHLORIDE AND SELENIUM VARIANCES

Economic Analysis of Failure to Obtain Chloride and Selenium Variances

In the event that the Chloride and Selenium variances for Cottonwood Creek are not granted, Merit Energy Company ("Merit") will have two options to bring the Hamilton Dome Oil Field ("Hamilton Dome") into compliance. The first of these options is to reinject the produced water. The second option would be to install and maintain reverse osmosis facilities to reduce chloride and selenium concentrations in discharged water. The economic implications of these options are as follows:

Reinjection

Hamilton Dome currently produces 270,000 barrels of water per day of which 60,000 barrels are reinjected. The remaining 210,000 barrels are discharged into Cottonwood Creek. Assuming the average disposal well could take 3,000 barrels of water per day, 70 wells would have to be converted to injection at an average cost of $200,000 per well. This would result in a capital investment of $14,000,000. In addition, a disposal facility with storage capacity of 250,000 barrels and pump capacity to dispose of a like volume would be required. The cost of this facility along with additional injection lines would be an additional $5,000,000 investment. The total capital cost of reinjection at Hamilton Dome would therefore be $19,000,000. On top of the capital investment, lease operating expense would increase approximately $150,000 per month due to increased electrical demands and increased facility maintenance. Moreover, because many of the wellbores that would have to be converted are currently producing oil wells, there would be a loss in oil production of 600 barrels of oil per day.

Reinjection is not a viable option at Hamilton Dome. Given no alternative, Merit's election would be to shut in and abandon Hamilton Dome.

Treatment by Reverse Osmosis

Installing reverse osmosis to reduce the chlorides to an acceptable level would require a capital investment of approximately $500 per gallon per minute of treatment capacity. At a current discharge rate of 210,000 barrels per day, this would result in a $3,000,000 capital expenditure. Significantly and more importantly, associated operating expenses would be approximately $250,000 per month. An increase in operating expense of this magnitude would be fiscally untenable for Merit's investors, leaving Merit with no alternative but to abandon Hamilton Dome.

In conclusion, neither reinjection nor reverse osmosis treatment of the Hamilton Dome produced water is acceptably cost-effective. Merit would shut in and abandon the field. The economic consequences of the loss of Hamilton Dome to the surrounding area and the state of Wyoming are comprehensively addressed in the economic study performed by Blankenship Consulting LLC, included as Appendix G of this report.

APPENDIX B

HYDROLOGY REPORT

HYDROLOGY REPORT

Hamilton Dome Oil Field Use Attainability Analysis

Prepared by

Chris Jessen
Jack Meena

States West Water Resources Corporation
1904 East 15th Street
Cheyenne, Wyoming 82001

November 13, 2002

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Introduction

Merit Energy Company (MEC) produces crude oil at the Hamilton Dome Field located 25 miles northwest of Thermopolis, in Hot Springs County, Wyoming. Merit Energy Company presently retains two NPDES permits to discharge produced water from the Hamilton Dome Field into unnamed tributaries that eventually flow into Cottonwood Creek.

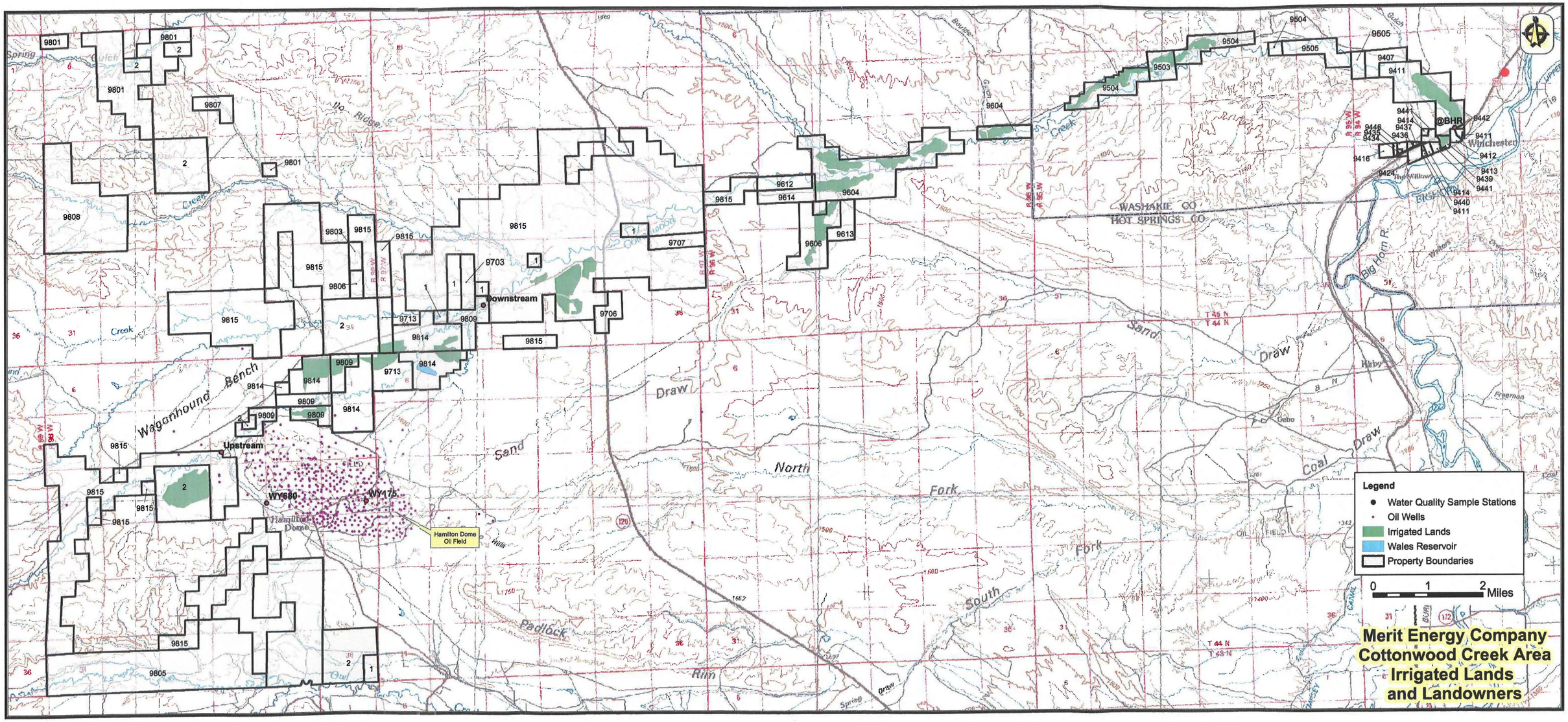
The federal Clean Water Act requires that all surface water be swimmable and fishable. The Water Quality Division (WQD) of the Wyoming Department of Environmental Quality (DEQ) made changes to their statewide water classification system, and recently updated Water Quality Rules and Regulations, Chapter 1. Chapter 1 establishes water quality criteria for all classes of water. Until the recent update of Chapter 1, the classification of the tributaries and Cottonwood Creek was Class 4. The tributaries are now class 3B and Cottonwood Creek is now class 2C.

The field currently produces 4,250 barrels of oil per day from the Tensleep and Phosphoria reservoirs which is transported via pipeline to regional refineries. As an integral part of the recovery process, the field also produces 285,000 barrels of water per day, 85,000 of which are re-injected for waterflood purposes while the remaining 200,000 are discharged to the surface from the two discharge points (NPDES permits WY0000175 and WY0000680). The discharged volume translates to approximately 13 cfs.

Stock/Irrigation Water Rights

The map on the following page details land ownership, irrigated acreage, and water right information. Ownership was determined from Hot Springs and Washakie County Assessor records. The irrigated acreage was derived from aerial photo interpretation at a

Map and Data Listing of Cottonwood Creek Area Landowners, Irrigated Lands, and 2002 Water Quality Sample Locations


Legend
Water Quality Sample Stations
Oil Wells
Irrigated Lands
Wales Reservoir
Property Boundaries
0 1 2 Miles
Merit Energy Company
Cottonwood Creek Area
Irrigated Lands
and Landowners
WASHAKIE CO
HOT SPRINGS CO
Downstream
Upstream
WY680
WY175
Hamilton Dome Oil Field
@BHR
Winchester
Wagonhound Bench
Sand Draw
North Fork
South Fork
Coal Draw
Padlock Rim
Big Horn R.
Hyattville
Kirby
Gebo
Freeman
Ho Ridge
Spring Gulch
Cottonwood Creek

Acreage, Water Rights, and Landowners
(Map Details)

ACREAGE	PERMIT #	PRIORITY DATE	PERMITTED AMOUNT (CFS)	PERM. ACRES	USE	TRACT ID	LANDOWNER NAME
85.0	6320	19041110	4.0	277.0	irr-stk-d	9411	E.R. Ranch LLC
95.1	6320	19041110	4.0	277.0		9411	E.R. Ranch LLC
90.0	6729	19050601	0.8	54.8	irr	9604	Holman, Gerald E. & Barbara J.
14.7	6728	19050601	1.1	74.6	irr	9604	Holman, Gerald E. & Barbara J.
6.5	6728	19050601	1.1	74.6	irr	9604	Holman, Gerald E. & Barbara J.
11.1	8434	19071021	8.8	616.5	irr	9814	Prospect Land & Cattle LLC
122.7	8434	19071021	8.8	616.5	irr	9814	Prospect Land & Cattle LLC
60.7	8346	19080118	1.7	120.0	irr	9809	Legend Rock Res.
93.4	1859	19080401	1.7	117.0	irr	9814	Prospect Land & Cattle LLC
100.3	10447	19101215	6.2	436.5	irr	9606	
27.3	10447	19101215	6.2	436.5	irr	9606	
45.8	10307	19101215	1.1	133.0	irr	9815	Robbins, H. Frank Jr. Et. Al.
188.0	10307	19101215	1.1	133.0	irr	9815	Robbins, H. Frank Jr. Et. Al.
20.1	10307	19101215	1.1	133.0	irr	9815	Robbins, H. Frank Jr. Et. Al.
3.3	9657	19103010	2.6	184.0	irr-stk-d	9503	Cannella, Len
127.5	9657	19103010	2.6	184.0	irr-stk-d	9504	Sundown, Inc.
54.6	11822	19130502	1.2	82.0	irr	9604	Holman, Gerald E. & Barbara J.
62.9	2910 Enl.	19140117	1.1	84.4	irr	9809	Legend Rock Res.
67.2	2961 Enl.	19140502	0.5	35.0	irr	9604	Holman, Gerald E. & Barbara J.
46.2	3540 Enl.	19151012	2.3	162.0	irr	9504	Sundown, Inc.
19.5	3540 Enl.	19151012	2.3	162.0	irr	9504	Sundown, Inc.
37.1	3540 Enl.	19151012	2.3	162.0	irr	9503	Cannella, Len
3.0	3540 Enl.	19151012	2.3	162.0	irr	9503	Cannella, Len
31.5	4750 Enl.	19301128	0.5	38.0	irr	9814	Prospect Land & Cattle LLC
96.6	5206 Enl.	19351204	0.6	39.0	irr	9713	Mink, Dorothy J.
46.7	6387 Enl.	19710401	2.2	153.3	irr	9604	Holman, Gerald E. & Barbara J.
11.4	6387 Enl.	19710401	2.2	153.3	irr	9604	Holman, Gerald E. & Barbara J.
24.6	6745 Enl.	19760706	1.6	115.5	irr	9604	Holman, Gerald E. & Barbara J.
89.0	6745 Enl.	19760706	1.6	115.5	irr	9604	Holman, Gerald E. & Barbara J.
1.4	6826 Enl.	19850419	0.3	18.7		9411	E.R. Ranch LLC
17.7	6826 Enl.	19850419	0.3	18.7		9413	Kubiak, Frank & Elizabeth
1.7	6826 Enl.	19850419	0.3	18.7		9412	Davis, Terry M.
0.8	6826 Enl.	19850419	0.3	18.7		9441	Marathon Pipeline Co.
3.8						9614	Ward, Paul I. & Ginger L.
0.0						9606	
1.1						9613	
3.8						2	State of Wyoming
23.7	1209 Res.					9814	Prospect Land & Cattle LLC
260.5						2	State of Wyoming
5.3						9815	Robbins, H. Frank Jr. Et. Al.

Total Delineated Acreage:	**2,001.60**
Total Permitted Diversion	**35.82**
Total Permitted Acreage:	**2,741.30**

scale of approximately 1:24,000. Wyoming State Engineer Office water right records were investigated by Mr. Frank Carr.

Aerial photo interpretation yielded potentially 2,000 acres of irrigated cropland. For comparison, interviews of a subset of all landowners along Cottonwood Creek conducted by George Blankenship documented some 1,600 acres of cropland (see Appendix G).

There are presently on record with the State Engineer just under 2,800 permitted acres along Cottonwood Creek with a water allocation of nearly 36 cubic feet per second (cfs) from the creek.

Estimated Hydrology—Water Balance

An attempt was made to install two "V" notch weirs on Cottonwood Creek upstream of the Hamilton Dome discharges for the purpose of measuring evaporation and infiltration rates. This would have provided an on-site assessment of the likely stream hydrology in the absence of the discharges. Unfortunately, due to the ongoing drought conditions through the 2002 season, adequate flow above the discharges ceased before any measurements could be taken.

Additionally, the precise hydrogeologic character of the Cottonwood Creek drainage basin has not been thoroughly investigated. Therefore, the potential influence of groundwater on the base flow of the creek remains uncertain. In the absence of a rigorous hydrogeologic study, the natural runoff on Cottonwood Creek (in the absence of Hamilton Dome discharges) was estimated using available USGS gage data and records of active irrigation water rights to conduct a simple water balance.

In order to define the runoff on Cottonwood Creek, gage information was used in conjunction with a simple area comparison technique. Information from USGS gage 6265337 defined the inflow above the Hamilton Dome area prior to any irrigation. This gage contained flow data from 1993 to 2001 for a drainage area of 82 square miles. The

stream flow for the remainder of the drainage (334 square miles) was approximated by the use of a drainage area comparison with a calibration factor. To determine the calibration factor, the mean monthly flow from the inflow gage was compared to the mean monthly flow at USGS gage 6265500 located at the confluence with the Bighorn River. This gage has a record spanning from 1941 to 1946. A calibration factor of 0.5 resulted in similar values. This factor accounts for losses/gains in the system and spatial differences in the runoff basin.

To provide a more accurate balance, the spreadsheet accounted for irrigation diversions. All active water rights were assumed to irrigate at full permitted value from May through July. A total diversion amount of 35.82 cfs was used. During the month of August, the value was cut to 25 percent or 8.95 cfs. The diversions were assumed to have a 50 percent consumption with the remaining water allowed to return to the creek on a delay. The delay permitted 60% of the return flow during the diversion month, 25% during the following month, and the remaining 15% two months after diversion. These assumptions were used in the determination of the calibration factor since the vast majority of the water rights predate the available gauging data.

The assumptions stated above allowed for water balances to be constructed solely based on the inflow gage information, and assuming the likely predominance of irrigation consumptive use only during the months of May through August. Additional flow below the gage was calculated by the method above while irrigation provided the water usage component. Balances were done for the seven full years of irrigation data available for the inflow gage. Results that provide estimated base flow of Cottonwood Creek near the confluence with the Bighorn River (site of gage 6265500) are presented in the following tables.

Cottonwood Creek Water Balancing
Callibration of Additional Area Inflow with Gage 06265500

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gage 6265337*	1.03	1.53	7.66	12.30	38.40	51.50	14.70	4.83	3.95	5.19	2.92	1.27
Additional Area	2.10	3.12	15.60	25.05	78.20	104.88	29.94	9.84	8.04	10.57	5.95	2.59
Sub-Total Inflow	3.13	4.65	23.26	37.35	116.60	156.38	44.64	14.67	11.99	15.76	8.87	3.86
Irrigation	0.00	0.00	0.00	0.00	35.82	35.82	35.82	8.95	0.00	0.00	0.00	0.00
Return Flow	0.00	0.00	0.00	0.00	10.75	15.22	17.91	9.85	3.81	0.67	0.00	0.00
Sub-Total Irrigation	0.00	0.00	0.00	0.00	25.07	20.60	17.91	0.90	3.81	0.67	0.00	0.00
Estimated Flow At Bighorn	3.13	4.65	23.26	37.35	91.53	135.79	26.73	15.57	15.80	16.43	8.87	3.86
Gage 06265500**	2.28	3.88	30.10	38.00	84.10	183.00	42.20	13.10	11.10	6.28	7.52	3.90

* Monthly mean of available records from 1993 to 2001
** Monthly mean of available records from 1941 to 1945
deficit numbers in gray

Cottonwood Creek Water Balancing
Inflow Year - 1994

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gage 6265337	1.30	1.47	6.41	13.10	15.10	5.00	2.55	1.05	0.11	7.07	0.39	0.06
Additional Area	2.65	2.99	13.05	26.68	30.75	10.18	5.19	2.14	0.22	14.40	0.79	0.12
Sub-Total Inflow	3.95	4.46	19.46	39.78	45.85	15.18	7.74	3.19	0.33	21.47	1.18	0.17
Irrigation	0.00	0.00	0.00	0.00	35.82	35.82	35.82	8.95	0.00	0.00	0.00	0.00
Return Flow	0.00	0.00	0.00	0.00	10.75	15.22	17.91	9.85	3.81	0.67	0.00	0.00
Sub-Total Irrigation	0.00	0.00	0.00	0.00	25.07	20.60	17.91	0.90	3.81	0.67	0.00	0.00
Estimated Flow At Bighorn	3.95	4.46	19.46	39.78	20.78	5.41	10.17	4.09	4.14	22.14	1.18	0.17

deficit numbers in gray

Cottonwood Creek Water Balancing
Inflow Year - 1995

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gage 6265337	0.02	0.28	6.13	6.68	52.20	96.10	24.20	4.91	4.27	3.44	3.38	0.39
Additional Area	0.03	0.57	12.48	13.60	106.31	195.72	49.29	10.00	8.70	7.01	6.88	0.79
Sub-Total Inflow	0.05	0.85	18.61	20.28	158.51	291.82	73.49	14.91	12.97	10.45	10.26	1.18
Irrigation	0.00	0.00	0.00	0.00	35.82	35.82	35.82	8.95	0.00	0.00	0.00	0.00
Return Flow	0.00	0.00	0.00	0.00	10.75	15.22	17.91	9.85	3.81	0.67	0.00	0.00
Sub-Total Irrigation	0.00	0.00	0.00	0.00	25.07	20.60	17.91	0.90	3.81	0.67	0.00	0.00
Estimated Flow At Bighorn	0.05	0.85	18.61	20.28	133.44	271.22	55.58	15.81	16.77	11.12	10.26	1.18

deficit numbers in gray

Cottonwood Creek Water Balancing
Inflow Year - 1996

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gage 6265337	0.04	3.30	6.40	7.46	17.20	18.70	1.87	6.41	1.22	1.11	1.79	1.53
Additional Area	0.08	6.72	13.03	15.19	35.03	38.08	3.81	13.05	2.48	2.26	3.65	3.12
Sub-Total Inflow	0.12	10.02	19.43	22.65	52.23	56.78	5.68	19.46	3.70	3.37	5.44	4.65
Irrigation	0.00	0.00	0.00	0.00	35.82	35.82	35.82	8.95	0.00	0.00	0.00	0.00
Return Flow	0.00	0.00	0.00	0.00	10.75	15.22	17.91	9.85	3.81	0.67	0.00	0.00
Sub-Total Irrigation	0.00	0.00	0.00	0.00	25.07	20.60	17.91	0.90	3.81	0.67	0.00	0.00
Estimated Flow At Bighorn	0.12	10.02	19.43	22.65	27.16	36.19	12.23	20.36	7.51	4.04	5.44	4.65

deficit numbers in gray

Cottonwood Creek Water Balancing
Inflow Year - 1997

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gage 6265337	2.83	2.51	4.80	13.80	39.20	142.00	30.60	7.43	5.50	4.25	3.02	2.96
Additional Area	5.76	5.11	9.78	28.10	79.83	289.20	62.32	15.13	11.20	8.66	6.15	6.03
Sub-Total Inflow	8.59	7.62	14.58	41.90	119.03	431.20	92.92	22.56	16.70	12.91	9.17	8.99
Irrigation	0.00	0.00	0.00	0.00	35.82	35.82	35.82	8.95	0.00	0.00	0.00	0.00
Return Flow	0.00	0.00	0.00	0.00	10.75	15.22	17.91	9.85	3.81	0.67	0.00	0.00
Sub-Total Irrigation	0.00	0.00	0.00	0.00	25.07	20.60	17.91	0.90	3.81	0.67	0.00	0.00
Estimated Flow At Bighorn	8.59	7.62	14.58	41.90	93.96	410.60	75.01	23.46	20.51	13.58	9.17	8.99

deficit numbers in gray

Cottonwood Creek Water Balancing
Inflow Year - 1998

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gage 6265337	1.90	1.63	26.90	23.50	43.40	49.70	27.50	8.95	9.11	14.70	4.71	2.33
Additional Area	3.87	3.32	54.78	47.86	88.39	101.22	56.01	18.23	18.55	29.94	9.59	4.75
Sub-Total Inflow	5.77	4.95	81.68	71.36	131.79	150.92	83.51	27.18	27.66	44.64	14.30	7.08
Irrigation	0.00	0.00	0.00	0.00	35.82	35.82	35.82	8.95	0.00	0.00	0.00	0.00
Return Flow	0.00	0.00	0.00	0.00	10.75	15.22	17.91	9.85	3.81	0.67	0.00	0.00
Sub-Total Irrigation	0.00	0.00	0.00	0.00	25.07	20.60	17.91	0.90	3.81	0.67	0.00	0.00
Estimated Flow At Bighorn	5.77	4.95	81.68	71.36	106.71	130.32	65.60	28.08	31.47	45.31	14.30	7.08

deficit numbers in gray

Cottonwood Creek Water Balancing
Inflow Year - 1999

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gage 6265337	1.62	1.54	5.93	30.20	84.10	86.60	14.70	6.62	7.11	4.81	3.06	0.33
Additional Area	3.30	3.14	12.08	61.50	171.28	176.37	29.94	13.48	14.48	9.80	6.23	0.67
Sub-Total Inflow	4.92	4.68	18.01	91.70	255.38	262.97	44.64	20.10	21.59	14.61	9.29	1.00
Irrigation	0.00	0.00	0.00	0.00	35.82	35.82	35.82	8.95	0.00	0.00	0.00	0.00
Return Flow	0.00	0.00	0.00	0.00	10.75	15.22	17.91	9.85	3.81	0.67	0.00	0.00
Sub-Total Irrigation	0.00	0.00	0.00	0.00	25.07	20.60	17.91	0.90	3.81	0.67	0.00	0.00
Estimated Flow At Bighorn	4.92	4.68	18.01	91.70	230.30	242.37	26.73	21.00	25.40	15.28	9.29	1.00

deficit numbers in gray

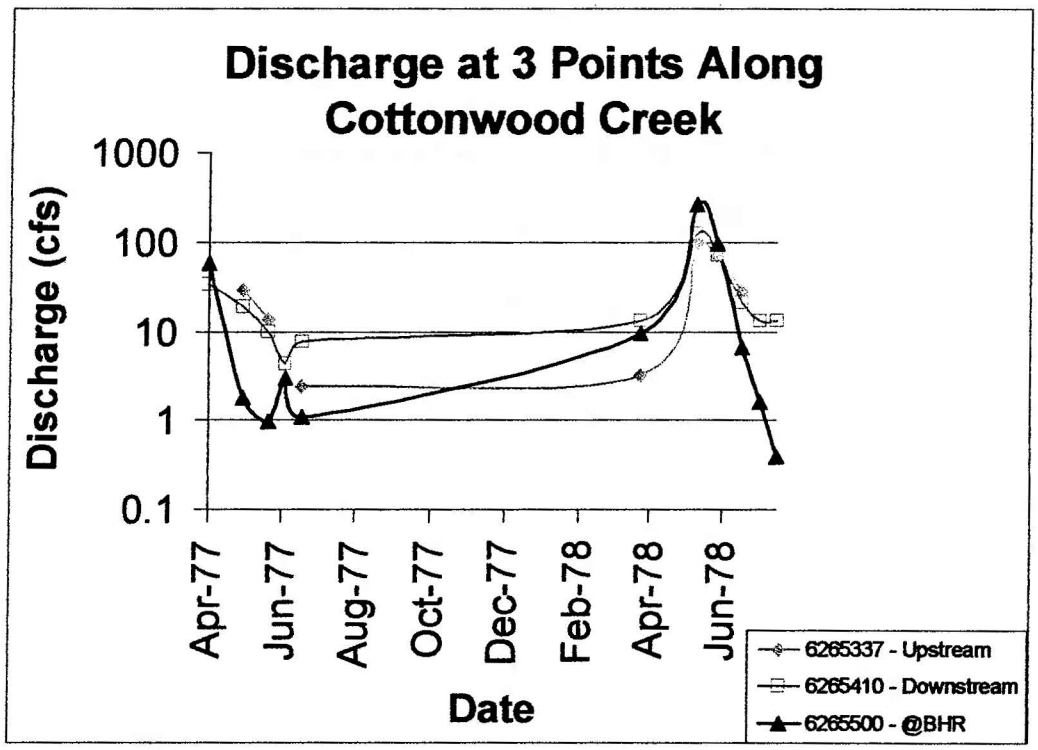
Cottonwood Creek Water Balancing
Inflow Year - 2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Gage 6265337	0.52	4.54	2.64	6.72	17.50	7.44	1.01	0.02	0.00	0.53	0.10	0.00
Additional Area	1.06	9.25	5.38	13.69	35.64	15.15	2.06	0.04	0.00	1.08	0.20	0.00
Sub-Total Inflow	1.58	13.79	8.02	20.41	53.14	22.59	3.07	0.06	0.00	1.61	0.30	0.00
Irrigation	0.00	0.00	0.00	0.00	35.82	35.82	35.82	8.95	0.00	0.00	0.00	0.00
Return Flow	0.00	0.00	0.00	0.00	10.75	15.22	17.91	9.85	3.81	0.67	0.00	0.00
Sub-Total Irrigation	0.00	0.00	0.00	0.00	25.07	20.60	17.91	0.90	3.81	0.67	0.00	0.00
Estimated Flow At Bighorn	1.58	13.79	8.02	20.41	28.07	2.00	14.84	0.96	3.81	2.28	0.30	0.00

deficit numbers in gray

Gaged Hydrology

During the summer of 1977 and 1978, three gages along the creek had concurrent discharge data. The data would have incorporated the Hamilton Dome discharges. The chart below provides this data which demonstrates two important points. First, except during periods of very high runoff, flow generally diminished from the upstream gage to the confluence with the Bighorn River. This is indicative of the water demand as well as the effects of evaporation and infiltration. Second, in the absence of the Hamilton Dome discharge, and given the water demand and evaporation/infiltration effects, the creek would have evidently run dry at the confluence with the Bighorn River during all but the early 1977 and 1978 runoff seasons.



Compared against the 1941 to 1945 discharge records for USGS gage 6265500, these were much wetter years than 1977 and 1978, indicating that the water balance model discussed previously provides a misleadingly over-optimistic scenario. In fact, one

eyewitness account (Appendix D) of pre-1950 Cottonwood Creek hydrology points toward the predominance of a dry creek by between late June and early August.

Conclusions

The water balance analysis presented in the preceding tables indicates that, with the given assumptions, water shortages would have occurred in three of the seven years of record—40% of the time. However, additional analysis of gage data which incorporate the MEC discharges as well as eyewitness testimony plainly expose this as a misleadingly optimistic estimate. In fact, even with the MEC discharges, Cottonwood Creek frequently runs dry prior to its confluence with the Bighorn River.

It may be clearly seen that the addition of approximately 13 cfs of water delivered on a consistent year-round basis greatly alleviates potential shortages during the summer irrigation season as well as significantly supplements livestock watering, wetland preservation, aquatic habitat, and other natural beneficial uses during the off-season. It is also evident that the supplemental water discharges, under the assumption that the quality of this water is not detrimental to the existing uses along Cottonwood Creek, provide considerable relief from the current and ongoing drought conditions.

APPENDIX C

WETLAND REPORT

WETLAND REPORT

Hamilton Dome Oil Field Use Attainability Analysis Project

Prepared for

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INTRODUCTION

Merit Energy Company (MEC) produces crude oil at the Hamilton Dome Field located in Hot Springs County, Wyoming. Merit Energy Company applied for and received two NPDES permits to discharge produced water from the Hamilton Dome Field into unnamed tributaries that eventually flow into Cottonwood Creek. The Water Quality Division (WQD) of the Wyoming Department of Environmental Quality (DEQ) recently updated Water Quality Rules and Regulations, Chapter 1, to comply with the federal Clean Water Act that requires all surface water be swimmable and fishable. Wyoming WQD was required to make changes to their statewide water classification system. Until the recent update of Chapter 1, the classification of the tributaries and Cottonwood Creek was Class 4. The tributaries are now class 3B and Cottonwood Creek is now class 2C.

The new classifications require a chloride limit in Cottonwood Creek of 230 mg/L where a limit had not previously existed. This chloride limit of 230 mg/L is more than 200 mg/L less than the current levels of chlorides being discharged at MEC permitted discharge points. Values for selenium are also above existing WQD criteria.

Section 33 of Chapter 1 sets up a process where the WQD Administrator may allow site specific criteria. Therefore, MEC has decided to petition the WQD Administrator to establish site-specific criteria for chlorides and selenium because correcting the existing human-caused conditions (oil field discharge) would cause more environmental damage to correct (i.e., remove) than to leave in place. One of the major environmental benefits of Hamilton Dome discharge is the creation of wetlands. Wetlands occurring along Cottonwood Creek and tributaries used to carry the discharge to Cottonwood Creek have numerous functions and values. Wetlands immediately adjacent to Cottonwood Creek and tributaries used to transport discharge stabilize soils, reduce bank erosion and improve water quality and fish habitat by reducing sediment loads in Cottonwood Creek through reduced erosion and by trapping sediment during high flows. These wetlands also provide food and cover for many wildlife species. During years of extremely high flows, they also have the potential to store large amounts of flood water and reduce potential for flooding further downstream along the creek. Vegetation is dense and structurally diverse; therefore, these

wetlands provide ideal cover and nesting sites for many species of wildlife. Biomass production is great and provides extensive forage for wildlife as well as livestock. Seeds produced by wetland plants also provide a significant food source for many wildlife species, especially waterfowl and other birds. Small ponds created directly or indirectly by the discharge provide a source of water where this resource is generally scarce. The wetland fringe along these stockponds improves water quality by reducing erosion along the shoreline. The objective of this study task was to quantify the acreage of wetlands that would be lost if Hamilton Dome were to cease discharging water.

METHODS

Wetlands Created by Discharge

All wetlands that would be lost if Hamilton Dome discharge were to cease were inventoried and mapped. Because wetlands are often difficult to identify, the U.S. Army Corps of Engineers (1987) developed the Wetland Delineation Manual to help identify those wetlands subject to regulation under Section 404 of the Clean Water Act. Methods in this manual are generally universally accepted by all state and federal regulatory agencies to identify wetlands and these methods were therefore used to delineate wetlands for this project. The manual provides guidelines and sampling procedures to be used to determine if an area is a wetland. The manual directs the user through a series of steps that involve data gathering and decision making and lead ultimately to a wetland/nonwetland decision.

The manual defines wetlands as "...those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." This definition identifies three wetland parameters: hydrophytic vegetation, hydric soils and hydrology. A number of sampling approaches are identified to determine the presence or absence of indicators of these parameters. The most basic approach, and the one used on this project, is known as the routine sampling procedure. The routine procedure requires that a prospective site first be surveyed for disturbance and a map of the vegetative communities prepared. A sample plot is then

located in a representative location within each suspected wetland community. At each plot the vegetation is examined for hydrophytic species as identified in the List of Plant Species That Occur in Wetlands (U.S. Fish and Wildlife Service 1988). This list identifies wetland plant species and assigns each one a rating based on its ability to grow in saturated soil. Species that require saturated soils are rated obligate (OBL), while those better suited to slightly drier conditions are rated facultative wet (FACW). Species that can be found in both wet and dry soils are identified as facultative (FAC). Obligate, Facultative Wet, and Facultative species are all considered to be wetland plants. Facultative upland (FACU) and upland (UPL) species are not considered to be wetland species. Additionally, species not contained in the list are usually considered upland species. A positive (+) or negative (-) sign, when used with the indicators, attempts to more specifically define the frequency of occurrence in wetlands. The positive sign indicates "slightly more frequently found in wetlands" and the negative sign indicates "slightly less frequently found in wetlands". Vegetation is considered to be hydrophytic when more than 50% of the dominant species are rated as OBL, FACW, or FAC. This definition of hydrophytic vegetation was used for the current delineation effort.

The soils at each plot are examined for hydric soil indicators by digging a soil pit to approximately 16 inches. Hydric soils are those that have developed under reducing conditions such as are caused by prolonged and repeated saturation or inundation. Common hydric soil indicators include low chroma colors, mottling, iron and manganese concretions, and gleying. These indicators should be present just below the A horizon or at 10 inches, whichever is shallower.

Hydrology is the driving force behind wetland development. It is the prolonged saturation in the root zone that gives rise to hydrophytic vegetation and hydric soils. The manual requires that there be evidence of saturation usually within 10 inches of the surface. Drainage patterns, drift lines, sediment deposits and visual observation of saturation or inundation are identified as acceptable indicators of wetland hydrology.

Based on the presence or absence of hydrophytic vegetation, hydric soils and wetland hydrology, each plant community is classified as wetland or upland and the wetland/nonwetland boundary is

established. Normally, positive indicators of all three parameters must be present for a community to be considered wetland. However, exceptions to this rule may occur when one indicator, (e.g. hydrology) is absent due to annual or seasonal fluctuations in precipitation or groundwater levels.

Deviations from the sampling approaches are not only permitted by the manual but are sometimes necessary. The manual frequently uses the term "dominant vegetation" but provides no definition. The term is defined by the 1989 Federal Manual for Identifying and Delineating Wetlands, which is no longer in use, as those species the dominance measures of which, when added together, immediately exceed 50% of the total dominance measure, plus those individual species which contribute 20% or more of the total dominance measure. This definition was used in the current delineation effort. Estimated areal coverage was the measure by which dominance was determined. Field work for this project was conducted on June 25-27, 2002. Data forms used for the delineation are attached in Appendix A. Photographs of wetlands created by Hamilton Dome discharge are provided in Appendix B. - End of C

Wetland polygons created either directly or indirectly by Hamilton Dome discharge were mapped on an aerial photo (1" = 400') and the size of each polygon was determined using a calibrated digitizer. (Figure 1). For linear wetlands occurring in drainages, the total length of the drainage and mean width were calculated and used to estimate wetland acreage associated with the drainage.

Wetlands Along Cottonwood Creek

It is more difficult to assess wetland impacts within Cottonwood Creek itself, as fringe wetlands along the creek may be supported by natural flows as well as by discharge. Potential wetland impacts along Cottonwood Creek were assessed by examining wetland types and wetland fringe widths immediately upstream and downstream of the discharge. Photographs of wetlands along Cottonwood Creek above and below the discharge are provided in Appendix C. The wetland fringe width along the creek was determined by delineating wetland boundaries and measuring the width of the fringe. Data points were located using a systematic random sampling design approximately every 100 m of stream length above and below the discharge. Ten data points were measured above the discharge

and 20 were measured below the discharge. Only 10 were measured above the discharge because no wetlands were present beyond this distance. The difference in mean wetland width below and above the discharge was used as an indicator of the amount of wetland which would be lost if discharge ceased. The sampling was limited to areas in close proximity to the points of discharge to avoid influences of irrigation diversions and other factors that influence wetland widths along Cottonwood Creek. The primary purpose of this investigation was to evaluate whether Hamilton Dome discharge supports wetlands along Cottonwood Creek that would not otherwise occur there.

To quantify the amount of wetlands along the entire length of Cottonwood Creek from the point of discharge to where Cottonwood Creek enters the Bighorn River, electronic versions of the National Wetlands Inventory (NWI) maps were obtained and GIS was used to measure the number of and acreage of wetlands by wetland type.

RESULTS

Discharge Wetlands

There are two main points of discharge from Hamilton Dome, one on the east and one on the west side of the oil field. On the west side, discharge occurs along a natural drainage as well as along an irrigation ditch (Figure 1). Three data points (1-3) were used to characterize wetlands in the upper portion of this drainage. The drainage contains shallow marsh wetlands dominated by three-square bulrush (*Scirpus pungens* [OBL]), saltmarsh bulrush (*Scirpus maritimus* [OBL]), and baltic rush (*Juncus balticus* [FACW+]). At the extreme upper end, the wetland extends across the entire drainage bottom, but lower within the drainage the wetland is confined to a fringe along open water within the drainage. This drainage enters an excavated pond (Lake Charlie). There was no wetland fringe associated with this pond. The drainage continues beyond the pond to Cottonwood Creek. Four data points (7-10) were used to characterize wetlands along this portion of the drainage. There is a patchwork of emergent vegetation and open water within the drainage between the pond and Cottonwood Creek. Wetlands in this area are dominated by three-square bulrush, broadleaf cattail (*Typha latifolia* [OBL]), and rabbitfoot polypogon (*Polypogon monspeliensis* [FACW+]). At the point where this drainage enters Cottonwood Creek (data point

10), there is a very large, unique wetland. This wetland is dominated by rabbitfoot polypogon, three-square bulrush, and watercress (*Rorippa nasturtium* [OBL]).

Discharge water from the west end of Hamilton Dome is also conveyed by an irrigation ditch. Water in the irrigation ditch is eventually discharged into Cottonwood Creek west of the natural drainage discharge. Irrigation return flows from this water have collected along an access road adjacent to the natural drainage used for discharge (Figure 1). Three substantial wetlands have formed in these areas. These wetlands were characterized with data points 4, 5, 6 and 11. Dominant species include hardstem bulrush (*Scirpus acutus* [OBL]), three-square bulrush, and broadleaf cattail. There are also several wetlands along the irrigation canal itself. Data points used to characterize these wetlands were points 25-31. Wetlands were formed both as a result of seepage from the canal as well as intentional excavations along the canal where ponds with wetland fringes occur. Dominant plants in these wetlands are baltic rush, hardstem bulrush, and three-square bulrush.

Along the east side, discharge is also through a natural drainage as well as an irrigation ditch. Seepage from the discharge (data point 12) has created a mosaic of wetlands dominated by cattail within a natural drainage. Data point 13 represents a pit within a natural drainage also dominated by cattail. Further down the slope, seepage from the drainage and/or irrigation canal has resulted in several large wetland complexes (data points 14-19, 21-23) that are dominated by broadleaf cattail, three-square bulrush, saltmarsh bulrush, hardstem bulrush, common reed (*Phragmites australis* [FACW+]), and foxtail barley (*Hordeum jubatum* [FAC]). Along the natural drainage that carries discharge water (data points 20 and 24) there are extensive wetland fringes across the entire drainage bottom that are dominated by three-square bulrush, saltmarsh bulrush, and broadleaf cattail. The total size of wetlands created by discharge was digitized and found to be 91.3 acres (Figure 1).

Wetlands along Cottonwood Creek

Cottonwood Creek is noticeably different upstream than downstream of the discharge. There was no flowing water in Cottonwood Creek above the discharge when the field work was conducted on June 27, 2002, whereas flows below the discharge were continuous. The stream bottom above the discharge is much wider and shallower due to scouring by water during high spring flows. This scouring is not present below the discharge, likely due to the presence of wetland fringes along the stream bank which tend to stabilize the banks and reduce the effects of erosion. Wetland fringe widths at 10 cross sections spaced every 100 stream meters along Cottonwood Creek immediately above the discharge ranged from 0 to 6 feet and averaged 2.4 feet (Table 1). With the exception of approximately the first 600 stream meters above the uppermost discharge, there were virtually no wetlands adjacent to the stream. Beyond this point, wetlands were either nonexistent or occurred sporadically as very narrow fringes of approximately 1 foot or less. Therefore, additional cross sections to measure wetland widths were not placed any further upstream. Wetlands above the discharge were dominated by creeping spikerush (*Eleocharis palustris* [OBL]), three-square bulrush, sandbar willow (*Salix exigua* [FACW+]), and American licorice (*Glycyrrhiza lepidota* [FAC+]). Signs of hydrology included inundated areas and saturated soils where standing water was present in some places, sediment deposits, and drift lines. Soils were sandy and generally lacked hydric soil characteristics except near areas of standing water where iron concretions and some gleying were evident.

Below the uppermost discharge point, where irrigation return flows enter Cottonwood Creek, there was a continuous wetland fringe along the creek. Wetland fringe widths at 20 stream cross sections spaced approximately every 100 stream meters along the stream below the discharge ranged from 4.5 to 36 feet, and averaged 15 feet, which is over 6 times the mean wetland fringe width above the discharge. The most common plants occurring in wetlands below the discharge were creeping spikerush, three-square bulrush, foxtail barley, watercress, and Chinese tamarisk (*Tamarix chinensis* [FACW]) saplings. Hydrological indicators included inundation, saturated soils, drift lines, and sediment deposits. The sandy soils had low chromas with extensive gleying and iron concretions.

The large difference in wetland widths along Cottonwood Creek above and below Hamilton Dome discharge indicates that Hamilton Dome discharge supports a substantial amount of riparian wetlands along Cottonwood Creek that would be lost if discharge were to cease. Based on National Wetland Inventory (NWI) mapping, there are approximately 585 acres of wetlands along Cottonwood Creek below the discharge (Table 2). This acreage includes 208 acres of palustrine emergent and 300 acres of scrub-shrub wetlands, both of which have high functions and values.

CONCLUSION

Based on results of this study, if the discharge from Hamilton Dome and associated irrigation of hay fields were to cease, we estimate that approximately 600 acres of high-quality wetlands would likely be lost. This total includes nearly 100 acres supported directly by discharge and another approximately 500 acres along Cottonwood Creek that are indirectly supported by Hamilton Dome discharge.

LITERATURE CITED

U.S. Fish and Wildlife Service. 1988. National list of plant species that occur in wetlands: North Plains (Region 4). U.S. Fish and Wildl. Serv. Biol. Rep. 88(26.4). 64pp.

U.S. Army Corp of Engineers. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Waterways Experiment Station, Vicksburg, Mississippi.

Table 1. Wetland types and widths upstream and downstream of discharge (as measured at systematic intervals of approximately 100 yards).

UPSTREAM OF DISCHARGE					
Plot	Wetland Width (feet)	Species	% cover	Stratum	Indicator
1	6	Eleocharis palustris (creeping spikerush)	80	Herb	OBL
		Hordeum jubatum (foxtail barley)	10	Herb	FAC
		Scirpus pungens (three-square bulrush)	5	Herb	OBL
		Salix exigua (sandbar willow)	5	Shrub	OBL
2	3	Eleocharis palustris (creeping spikerush)	80	Herb	OBL
		Salix exigua (sandbar willow)	15	Shrub	OBL
		Scirpus pungens (three-square bulrush)	2	Herb	OBL
3	4.5	Eleocharis palustris (creeping spikerush)	40	Herb	OBL
		Scirpus pungens (three-square bulrush)	40	Herb	OBL
		Salix exigua (sandbar willow)	20	Shrub	OBL
4	4.5	Eleocharis palustris (creeping spikerush)	60	Herb	OBL
		Salix exigua (sandbar willow)	30	Shrub	OBL
		Carex rostrata (beaked sedge)	10	Herb	OBL
5	1.5	Salix exigua (sandbar willow)	50	Shrub	OBL
		Scirpus pungens (three-square bulrush)	25	Herb	OBL
		Glycyrrhiza lepidota (American licorice)	20	Herb	FAC+
		Juncus bufonius (toadrush)	5	Herb	FACW+
6	3	Glycyrrhiza lepidota (American licorice)	40	Herb	FAC+
		Scirpus pungens (three-square bulrush)	40	Herb	OBL
		Salix exigua (sandbar willow)	20	Shrub	OBL
7	0	no wetland			
8	0	no wetland			
9	1	Scirpus pungens (three-square bulrush)	70	Herb	OBL
		Glycyrrhiza lepidota (American licorice)	20	Herb	FAC+
		Populus angustifolia (narrowleaf cottonwood)	10	Shrub	FACW
10	0				
Mean	2.4				

Table 1. Wetland types and widths upstream and downstream of discharge (as measured at systematic intervals of approximately 100 yards).

DOWNSTREAM OF DISCHARGE					
Plot	Wetland Width (feet)	Species	% cover	Stratum	Indicator
1	9	Eleocharis palustris (creeping spikerush)	85	Herb	OBL
		Scirpus acutus (hardstem bulrush)	5	Herb	OBL
		Populus angustifolia (narrowleaf cottonwood)	5	Shrub	FACW
		Salix exigua (sandbar willow)	5	Shrub	OBL
2	4.5	Eleocharis palustris (creeping spikerush)	90	Herb	OBL
		Salix exigua (sandbar willow)	10	Shrub	OBL
3	9	Eleocharis palustris (creeping spikerush)	45	Herb	OBL
		Salix exigua (sandbar willow)	30	Shrub	OBL
		Hordeum jubatum (foxtail barley)	15	Herb	FAC
		Scirpus pungens (three-square bulrush)	10	Herb	OBL
4	9	Scirpus pungens (three-square bulrush)	60	Herb	OBL
		Salix exigua (sandbar willow)	40	Shrub	OBL
5	12	Scirpus pungens (three-square bulrush)	70	Herb	OBL
		Salix exigua (sandbar willow)	20	Shrub	OBL
		Hordeum jubatum (foxtail barley)	10	Herb	FAC
6	27	Scirpus pungens (three-square bulrush)	70	Herb	OBL
		Eleocharis palustris (creeping spikerush)	10	Herb	OBL
		Glycyrrhiza lepidota (American licorice)	10	Herb	FAC+
		Salix exigua (sandbar willow)	10	Shrub	OBL
7	10.5	Eleocharis palustris (creeping spikerush)	75	Herb	OBL
		Scirpus pungens (three-square bulrush)	15	Herb	OBL
		Hordeum jubatum (foxtail barley)	5	Herb	FAC
		Scirpus acutus (hardstem bulrush)	5	Herb	OBL
8	15	Scirpus pungens (three-square bulrush)	40	Herb	OBL
		Hordeum jubatum (foxtail barley)	20	Herb	FAC
		Eleocharis palustris (creeping spikerush)	20	Herb	OBL
		Tamarix chinensis (Chinese tamarisk)	20	Shrub	FACW

Table 1. Wetland types and widths upstream and downstream of discharge (as measured at systematic intervals of approximately 100 yards).

DOWNSTREAM OF DISCHARGE					
Plot	Wetland Width (feet)	Species	% cover	Stratum	Indicator
9	9	Eleocharis palustris (creeping spikerush)	85	Herb	OBL
		Hordeum jubatum (foxtail barley)	10	Herb	FAC
		Scirpus pungens (three-square bulrush)	5	Herb	OBL
10	9	Scirpus pungens (three-square bulrush)	90	Herb	OBL
		Salix exigua (sandbar willow)	10	Shrub	OBL
11	18	Scirpus pungens (three-square bulrush)	75	Herb	OBL
		Eleocharis palustris (creeping spikerush)	15	Shrub	OBL
		Hordeum jubatum (foxtail barley)	5	Herb	FAC
		Deschampsia cespitosa (tufted hairgrass)	5	Herb	FACW
12	16.5	Scirpus pungens (three-square bulrush)	70	Herb	OBL
		Hordeum jubatum (foxtail barley)	20	Herb	FAC
		Puccinellia nuttalliana (Nuttall's alkaligrass)	5	Herb	FACW+
		Eleocharis palustris (creeping spikerush)	5	Herb	OBL
13	24	Scirpus pungens (three-square bulrush)	80	Herb	OBL
		Eleocharis palustris (creeping spikerush)	10	Herb	OBL
		Deschampsia cespitosa (tufted hairgrass)	5	Herb	FACW
		Hordeum jubatum (foxtail barley)	5	Herb	FAC
14	7.5	Scirpus pungens (three-square bulrush)	80	Herb	OBL
		Hordeum jubatum (foxtail barley)	10	Herb	FAC
		Spartina gracilis (alkali cordgrass)	10	Herb	FACW
		Deschampsia cespitosa (tufted hairgrass)	5	Herb	FACW
15	9	Scirpus pungens (three-square bulrush)	55	Herb	OBL
		Eleocharis palustris (creeping spikerush)	30	Herb	OBL
		Tamarix chinensis (Chinese tamarisk)	10	Shrub	FACW
		Hordeum jubatum (foxtail barley)	5	Herb	FAC

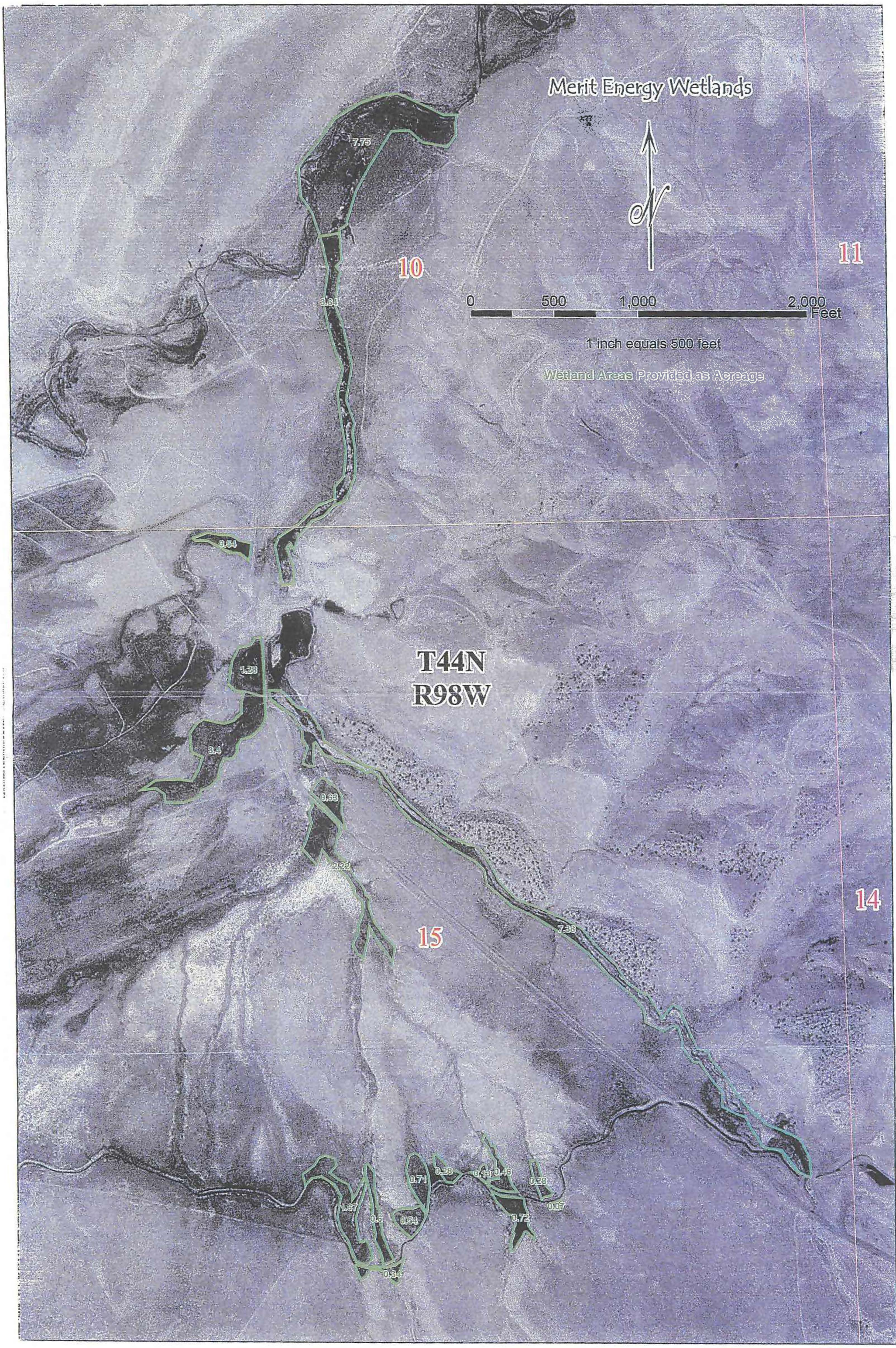
Table 1. Wetland types and widths upstream and downstream of discharge (as measured at systematic intervals of approximately 100 yards).

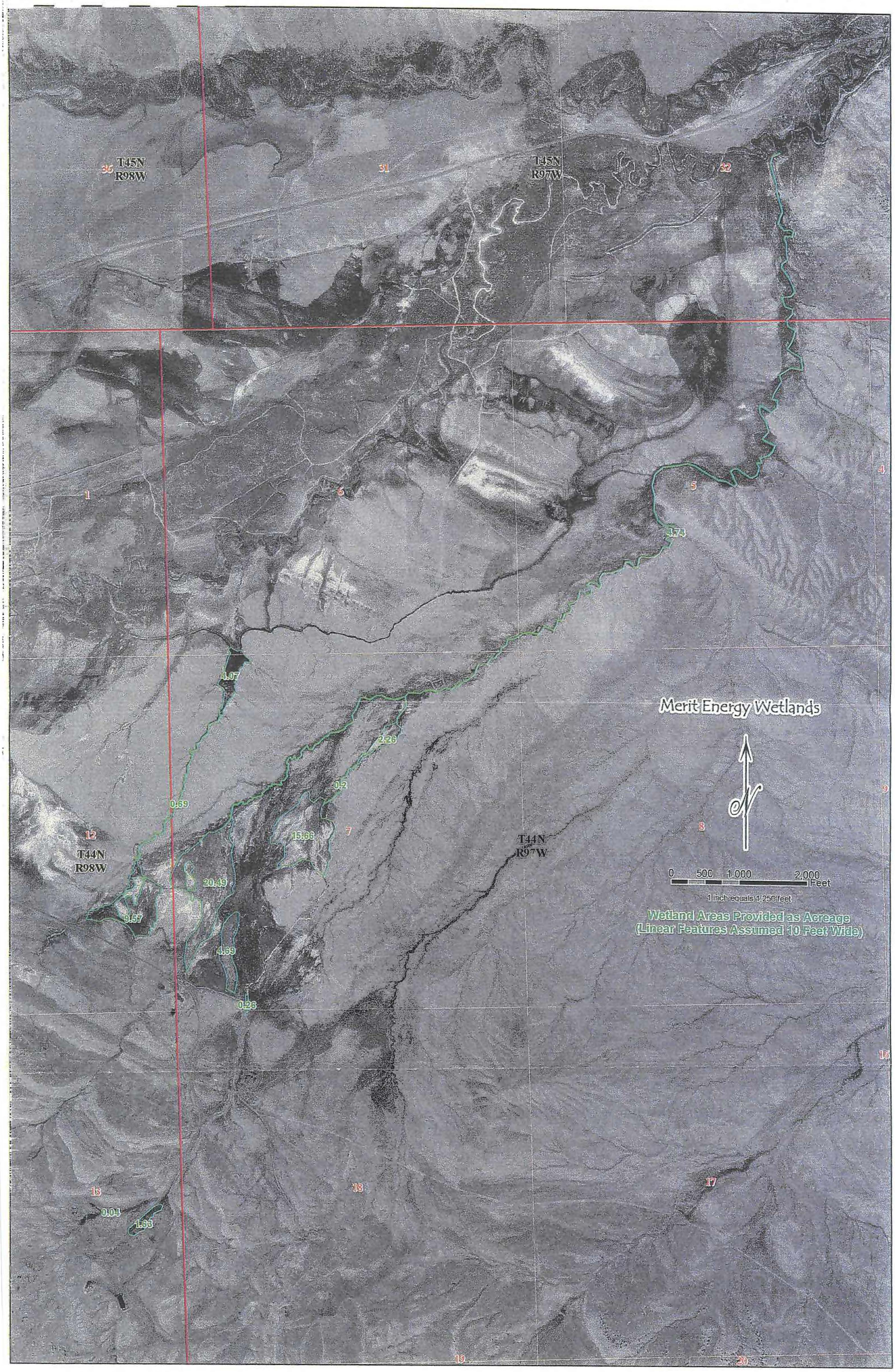
DOWNSTREAM OF DISCHARGE					
Plot	Wetland Width (feet)	Species	% cover	Stratum	Indicator
16	15	Rorippa nasturtium (watercress)	70	Herb	OBL
		Eleocharis palustris (creeping spikerush)	15	Herb	OBL
		Scirpus pungens (three-square bulrush)	10	Herb	OBL
		Hordeum jubatum (foxtail barley)	5	Herb	FAC
17	18	Scirpus pungens (three-square bulrush)	75	Herb	OBL
		Rorippa nasturtium (watercress)	10	Herb	OBL
		Eleocharis palustris (creeping spikerush)	10	Herb	OBL
		Hordeum jubatum (foxtail barley)	5	Herb	FAC
18	6	Rorippa nasturtium (watercress)	70	Herb	OBL
		Scirpus pungens (three-square bulrush)	20	Herb	OBL
		Eleocharis palustris (creeping spikerush)	10	Herb	OBL
19	36	Tamarix chinensis (Chinese tamarisk)	65	Shrub	FACW
		Rorippa nasturtium (watercress)	15	Herb	OBL
		Hordeum jubatum (foxtail barley)	10	Herb	FAC
		Polypogon monspeliensis (rabbitfoot polypogon)	10	Herb	FACW+
20	36	Scirpus pungens (three-square bulrush)	50	Herb	OBL
		Rorippa nasturtium (watercress)	25	Herb	OBL
		Glycyrrhiza lepidota (American licorice)	5	Herb	FAC+
		Hordeum jubatum (foxtail barley)	5	Herb	FAC
		Salix exigua (sandbar willow)	5	Shrub	OBL
		Deschampsia cespitosa (tufted hairgrass)	5	Herb	FACW
		Tamarix chinensis (Chinese tamarisk)	5	Shrub	FACW
Mean	15				

Table 2. Wetland acreage along Cottonwood Creek downstream of Hamilton Dome as based on National Wetland Inventory mapping.

Wetland Type	Number	Acreage
Palustrine Aquatic Bed	9	10.8
Palustrine Emergent	89	208.4
Riverine Intermittant Streambed	63	56.3
Palustrine Scrub-shrub	147	300.5
Palustrine Unconsolidated Bottom	10	5.6
Palustrine Unconsolidated Shore	6	3.5
TOTAL	324	585.1

Figure 1. Location and size of wetlands created by Hamilton Dome discharge


Merit Energy Wetlands
N
0
500
1,000
2,000
Feet
1 inch equals 500 feet
Wetland Areas Provided as Acreage
10
11
14
15
T44N
R98W
7.73
3.64
0.54
1.28
3.4
0.63
2.22
7.38
0.71
0.28
0.43
0.46
0.28
0.07
1.97
0.6
0.54
0.72
0.34


Merit Energy Wetlands
0 500 1,000 2,000 Feet
1 inch equals 1,250 feet
Wetland Areas Provided as Acreage
(Linear Features Assumed 10 Feet Wide)
T45N R98W
T45N R97W
T44N R98W
T44N R97W
36
31
32
1
6
5
4
12
7
8
9
16
17
18
19
20
1.74
1.07
2.26
0.2
0.69
15.66
20.49
9.57
4.69
0.26
0.04
1.63

Appendix A. Routine Wetland Determination Data Forms Used for Project

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 1

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	80	Herb	OBL
2. Scirpus acutus (hardstem bulrush)	15	Herb	OBL
3. Scirpus maritimus (saltmarsh bulrush)	5	Herb	OBL
4. Potentilla fructicosa (shrubby cinquefoil)	5	Shrub	FAC-
5. Hordeum jubatum (foxtail barley)	trace	Herb	FAC
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water 2 (in.)

Depth to Free Water in Pit 8 (in.)

Depth to Saturated Soil 2 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- X Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-1		10 YR 2/1			Loam
1+		10 YR 5/1	7.5 YR 4/6	10%	Clay
			Gley 2.5/N	25%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
X Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is within natural channel that receives discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 2

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus maritimus (saltmarsh bulrush)	70	Herb	OBL
2. Scirpus pungens (three-square bulrush)	15	Herb	OBL
3. Hordeum jubatum (foxtail barley)	10	Herb	FAC
4. Tamarisk chinensis (Chinese tamarisk)	5	Shrub	FACW
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 6 (in.)

Depth to Free Water in Pit _____ (in.)

Depth to Saturated Soil _____ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- X Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-1		10 YR 2/1			Loam
1+		10 YR 5/1	7.5 YR 4/6	10%	Clay
			Gley 2.5/N	50%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
X Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is within natural channel that receives discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 3

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Juncus balticus (baltic rush)	40	Herb	FACW+
2. Scirpus pungens (three-square bulrush)	30	Herb	OBL
3. Polypogon monspeliensis (rabbitfoot polypogon)	30	Herb	FACW+
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water _____ (in.)

Depth to Free Water in Pit 4 (in.)

Depth to Saturated Soil 2 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
__ Inundated
X Saturated in Upper 12 Inches
X Water Marks
__ Drift Lines
__ Sediment Deposits
X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
__ Oxidized Root Channels in upper 12 in.
__ Water-Stained Leaves
__ Local Soil Survey Data
__ FAC-Neutral Test
__ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 4/2			Sandy clay
4+		10 YR 4/1	7.5 YR 4/6	10%	Sandy clay
			Gley 2.5/N	20%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
X Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is within natural channel that receives discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 4

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus acutus (hardstem bulrush)	85	Herb	OBL
2. Scirpus maritimus (saltmarsh bulrush)	10	Herb	OBL
3. Typha latifolia (broadleaf cattail)	5	Herb	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
_____ Stream, Lake or Tide Gauge
_____ Aerial Photographs (infrared)
_____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 5 (in.)

Depth to Free Water in Pit 2 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
X Inundated
X Saturated in Upper 12 Inches
X Water Marks
___ Drift Lines
___ Sediment Deposits
X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
___ Oxidized Root Channels in upper 12 in.
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 5/2			Clay
3+		10 YR 5/1	7.5 YR 4/6	10%	Clay
			Gley 2.5/N	30%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
X Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is a pond that receives irrigation return flows.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 5

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	60	Herb	OBL
2. Typha latifolia (broadleaf cattail)	30	Herb	OBL
3. Alopecurus arundinaceus (creeping foxtail)	5	Herb	FAC
4. Scirpus maritimus (saltmarsh bulrush)	5	Herb	OBL
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water _____ (in.)

Depth to Free Water in Pit 3 (in.)

Depth to Saturated Soil 1 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2		10 YR 5/4			Silty Clay
2+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks: top layer is oxidized

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is a depression that receives irrigation return flows.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 6

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	80	Herb	OBL
2. Typha latifolia (broadleaf cattail)	20	Herb	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 3 (in.)

Depth to Free Water in Pit 2 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- X Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 4/2			Silty Clay
4+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is a depression that receives irrigation return flows.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 7

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	90	Herb	OBL
2. Hordeum jubatum (foxtail barley)	10	Herb	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water 2 (in.)

Depth to Free Water in Pit 2 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- X Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 4/1			Silty Clay
4+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is within a drainage that receives discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 8

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Typha latifolia (broadleaf cattail)	70	Herb	OBL
2. Scirpus pungens (three-square bulrush)	30	Herb	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
_____ Stream, Lake or Tide Gauge
_____ Aerial Photographs (infrared)
_____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 6 (in.)

Depth to Free Water in Pit 2 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- X Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2		10 YR 2/1			Clay loam
4+		10 YR 5/1	Gley 2.5/N	30%	Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is within a drainage that receives discharge water. The drainage has a patchwork of emergent vegetation and open water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 9

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Polypogon monspeliensis (rabbitfoot polypogon)	90	Herb	FACW+
2. Scirpus pungens (three-square bulrush)	10	Herb	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover. Total vegetative cover is around 10-15%

HYDROLOGY

____ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 2 (in.)

Depth to Free Water in Pit 0 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- X Drift Lines
- X Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2		10 YR 5/4			Sandy clay
2+		Gley 2.5/N			Clay sand

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is within a drainage that receives discharge water. The drainage has a patchwork of emergent vegetation and open water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 10

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Polypogon monspeliensis (rabbitfoot polypogon)	75	Herb	FACW+
2. Scirpus pungens (three-square bulrush)	15	Herb	OBL
3. Rorippa nasturtium (watercress)	10	Herb	OBL
4. Eleocharis palustris (creeping spikerush)	5	Herb	OBL
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover. Very unique wetland based on plants.

HYDROLOGY

___ Recorded Data (Describe in Remarks)	Wetland Hydrology Indicators:
___ Stream, Lake or Tide Gauge	Primary Indicators:
___ Aerial Photographs (infrared)	X Inundated
___ Other	X Saturated in Upper 12 Inches
X No Recorded Data Available	___ Water Marks
Field Observations	X Drift Lines
	___ Sediment Deposits
	X Drainage Patterns in Wetlands
Depth of Surface Water 3 (in.)	Secondary Indicators (2 or more required)
	___ Oxidized Root Channels in upper 12 in.
Depth to Free Water in Pit 0 (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 0 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 2/1			Sandy clay
3+		Gley 2.5/N			Clay sand

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is at the point where upper discharge enters Cottonwood Creek. This wetland is very unique based on the large amount of Polypogon.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-25-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 11

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus acutus (hardstem bulrush)	80	Herb	OBL
2. Scirpus pungens (three-square bulrush)	10	Herb	OBL
3. Typha latifolia (broadleaf typha)	10	Herb	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)	Wetland Hydrology Indicators:
____ Stream, Lake or Tide Gauge	Primary Indicators:
____ Aerial Photographs (infrared)	X Inundated
____ Other	X Saturated in Upper 12 Inches
X No Recorded Data Available	___ Water Marks
Field Observations	___ Drift Lines
	___ Sediment Deposits
	___ Drainage Patterns in Wetlands
Depth of Surface Water 4 (in.)	Secondary Indicators (2 or more required)
	___ Oxidized Root Channels in upper 12 in.
Depth to Free Water in Pit 0 (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 0 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2		10 YR 5/3			Sandy clay
2+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland formed due to irrigation return flows.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 12

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Typha latifolia (broadleaf typha)	95	Herb	OBL
2. Scirpus pungens (three-square bulrush)	5	Herb	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
_____ Stream, Lake or Tide Gauge
_____ Aerial Photographs (infrared)
_____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 3 (in.)

Depth to Free Water in Pit 0 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 4/2	Gley 2.5/N	20%	Clay
4+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland formed in drainage receiving seepage from discharge.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 13

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Typha latifolia (broadleaf typha)	100	Herb	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water 3 (in.)

Depth to Free Water in Pit 0 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 4/2	Gley 2.5/N	20%	Clay
4+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland formed in pit used to trap runoff.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 14

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	70	Herb	OBL
2. Hordeum jubatum (foxtail barley)	30	Herb	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water _____ (in.)

Depth to Free Water in Pit 0 (in.)

Depth to Saturated Soil 8 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-6		10 YR 4/2	Gley 2.5/N	10%	Clay
6+		10 YR 4/1	Gley 2.5/N	20%	Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ____
Wetland Hydrology Present? Yes X No ____
Hydric Soils Present? Yes X No ____

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland created due to seepage from discharge.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 15

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Typha latifolia (broadleaf cattail)	60	Herb	OBL
2. Scirpus pungens (three-square bulrush)	30	Herb	OBL
3. Hordeum jubatum (foxtail barley)	5	Herb	FAC
4. Puccinellia nuttalliana (Nuttall's alkaligrass)	5	Herb	FACW+
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water Up to 3 (in.)

Depth to Free Water in Pit 0 (in.)

Depth to Saturated Soil 8 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-5		10 YR 4/2	Gley 2.5/N	10%	Clay
5+		10 YR 4/1	Gley 2.5/N	20%	Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland created due to seepage from irrigation ditch supplied by discharge.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 16

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	60	Herb	OBL
2. Hordeum jubatum (foxtail barley)	30	Herb	FAC
3. Puccinellia nuttalliana (Nuttall's alkaligrass)	5	Herb	FACW+
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water _____ (in.)

Depth to Free Water in Pit _____ (in.)

Depth to Saturated Soil 8 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-5		10 YR 4/2	Gley 2.5/N	10%	Clay
5+		10 YR 4/1	Gley 2.5/N	20%	Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland created due to seepage from irrigation ditch supplied by discharge.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 17

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	70	Herb	OBL
2. Scirpus maritimus (saltmarsh bulrush)	10	Herb	OBL
3. Puccinellia nuttalliana (Nuttall's alkaligrass)	5	Herb	FACW+
4. Scirpus acutus (hardstem bulrush)	5	Herb	OBL
5. Hordeum jubatum (foxtail barley)	5	Herb	FAC
6. Polypogon monspeliensis (rabbitfoot polypogon)	5	Herb	FACW+
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water _____ (in.)

Depth to Free Water in Pit 14 (in.)

Depth to Saturated Soil 7 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Confirm Mapped Type? Yes___ No___

Taxonomy (Subgroup): _____

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 4/2			Clay
3+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland created due to seepage from discharge channel.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 18

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus maritimus (saltmarsh bulrush)	80	Herb	OBL
2. Scirpus pungens (three-square bulrush)	20	Herb	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)	Wetland Hydrology Indicators:
___ Stream, Lake or Tide Gauge	Primary Indicators:
___ Aerial Photographs (infrared)	___ Inundated
___ Other	___ Saturated in Upper 12 Inches
X No Recorded Data Available	X Water Marks
	X Drift Lines
Field Observations	X Sediment Deposits
	___ Drainage Patterns in Wetlands
Depth of Surface Water 3 (in.)	Secondary Indicators (2 or more required)
	___ Oxidized Root Channels in upper 12 in.
Depth to Free Water in Pit 3 (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 0 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 5/1			Sandy clay
3-6		10 YR 2/1			Sandy clay
6+		10 YR 4/1	Gley 2.5/N	20%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland occurs in bottom of discharge channel.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 19

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	60	Herb	OBL
2. Scirpus maritimus (saltmarsh bulrush)	15	Herb	OBL
3. Hordeum jubatum (foxtail barley)	10	Herb	FAC
4. Typha latifolia (broadleaf cattail)	10	Herb	OBL
5. Polypogon monspeliensis (rabbitfoot polypogon)	5	Herb	FACW+
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water _____ (in.)

Depth to Free Water in Pit 12 (in.)

Depth to Saturated Soil 4 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12 Inches
- X Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 5/2			Clay
4+		10 YR 2/1	Gley 2.5/N	10%	Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland occurs adjacent to discharge channel.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 20

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	60	Herb	OBL
2. Typha latifolia (broadleaf cattail)	20	Herb	OBL
3. Hordeum jubatum (foxtail barley)	10	Herb	FAC
4. Scirpus maritimus (saltmarsh bulrush)	10	Herb	OBL
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 2 (in.)

Depth to Free Water in Pit 1 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- __ Water Marks
- X Drift Lines
- X Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 4/1			Sandy Clay
3+		10 YR 2/1	Gley 2.5/N	40%	Sandy Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland occurs within discharge channel that is entirely covered with wetland vegetation.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 21

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	40	Herb	OBL
2. Scirpus maritimus (saltmarsh bulrush)	35	Herb	OBL
3. Scirpus acutus (hardstem bulrush)	20	Herb	OBL
4. Juncus balticus (baltic rush)	trace	Herb	FACW+
5. Typha latifolia (broadleaf cattail)	trace	Herb	OBL
6. Distichlis spicata (inland saltgrass)	trace	Herb	FAC+
7. Hordeum jubatum (foxtail barley)	trace	Herb	FAC
8. Puccinellia nuttalliana (Nuttall's alkaligrass)	trace	Herb	FACW+
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water _____ (in.)

Depth to Free Water in Pit _____ (in.)

Depth to Saturated Soil 6 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
___ Inundated
X Saturated in Upper 12 Inches
X Water Marks
___ Drift Lines
X Sediment Deposits
X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
___ Oxidized Root Channels in upper 12 in.
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 4/2			Clay loam
4+		10 YR 2/1	Gley 2.5/N	20%	Clay
			7.5 YR 4/6	15%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
X Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Large wetland formed due to seepage from irrigation ditch with discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 22a

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	40	Herb	OBL
2. Phragmites australis (common reed)	30	Herb	FACW+
3. Scirpus acutus (hardstem bulrush)	30	Herb	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)	Wetland Hydrology Indicators:
___ Stream, Lake or Tide Gauge	Primary Indicators:
___ Aerial Photographs (infrared)	X Inundated
___ Other	X Saturated in Upper 12 Inches
X No Recorded Data Available	X Water Marks
	___ Drift Lines
Field Observations	___ Sediment Deposits
	X Drainage Patterns in Wetlands
Depth of Surface Water 3 (in.)	Secondary Indicators (2 or more required)
	___ Oxidized Root Channels in upper 12 in.
Depth to Free Water in Pit 2 (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 0 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 4/2			Clay loam
3+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Large wetland formed due to seepage from irrigation ditch with discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 22b

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	65	Herb	OBL
2. Typha latifolia (broadleaf cattail)	20	Herb	OBL
3. Scirpus acutus (hardstem bulrush)	5	Herb	OBL
4. Distichlis spicata (inland saltgrass)	5	Herb	FAC+
5. Salicornia rubra (red saltwort)	5	Herb	OBL
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 3 (in.)

Depth to Free Water in Pit 2 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- X Water Marks
- __ Drift Lines
- __ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- __ Oxidized Root Channels in upper 12 in.
- __ Water-Stained Leaves
- __ Local Soil Survey Data
- __ FAC-Neutral Test
- __ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 4/2			Clay loam
3+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Large wetland formed due to seepage from irrigation ditch with discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 23

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	50	Herb	OBL
2. Typha latifolia (broadleaf cattail)	30	Herb	OBL
3. Scirpus maritimus (saltmarsh bulrush)	20	Herb	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)	Wetland Hydrology Indicators:
___ Stream, Lake or Tide Gauge	Primary Indicators:
___ Aerial Photographs (infrared)	X Inundated
___ Other	X Saturated in Upper 12 Inches
X No Recorded Data Available	___ Water Marks
	___ Drift Lines
Field Observations	___ Sediment Deposits
	X Drainage Patterns in Wetlands
Depth of Surface Water 3 (in.)	Secondary Indicators (2 or more required)
	___ Oxidized Root Channels in upper 12 in.
Depth to Free Water in Pit 2 (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 0 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 4/1			Clay
4+		10 YR 4/1	7.5 YR 4/6	20%	Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
X Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Large wetland formed within channel that receives seepage from irrigation ditch with discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-26-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 24

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	50	Herb	OBL
2. Scirpus maritimus (saltmarsh bulrush)	50	Herb	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 4 (in.)

Depth to Free Water in Pit 0 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- X Drift Lines
- X Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0+		Gley 2.5/N			Sandy Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: wetland is within bottom of drainage that carries discharge.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-27-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 25

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Juncus balticus (baltic rush)	85	Herb	FACW+
2. Typha latifolia (broadleaf cattail)	10	Herb	OBL
3. Hordeum jubatum (foxtail barley)	5	Herb	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water _____ (in.)

Depth to Free Water in Pit 4 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
___ Inundated
X Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
___ Oxidized Root Channels in upper 12 in.
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2		10 YR 5/2			Clay
2+		10 YR 4/1	Gley 2.5/N	30%	Clay
			7.5 YR 4/6	10%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
X Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: wetland is adjacent to irrigation ditch that carries discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-27-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 26

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus acutus (hardstem bulrush)	80	Herb	OBL
2. Scirpus pungens (three-square bulrush)	10	Herb	OBL
3. Juncus balticus (baltic rush)	5	Herb	FACW+
4. Hordeum jubatum (foxtail barley)	5	Herb	FAC
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
____ Stream, Lake or Tide Gauge
____ Aerial Photographs (infrared)
____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water Up to 3 (in.)

Depth to Free Water in Pit 3 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2		10 YR 5/2			Clay loam
2+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is fringe around excavation on irrigation ditch that carries discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-27-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 27

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Juncus balticus (baltic rush)	80	Herb	FACW+
2. Typha latifolia (broadleaf cattail)	15	Herb	OBL
3. Scirpus acutus (hardstem bulrush)	5	Herb	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)	Wetland Hydrology Indicators:
____ Stream, Lake or Tide Gauge	Primary Indicators:
____ Aerial Photographs (infrared)	X Inundated
____ Other	X Saturated in Upper 12 Inches
X No Recorded Data Available	___ Water Marks
	___ Drift Lines
Field Observations	___ Sediment Deposits
	X Drainage Patterns in Wetlands
Depth of Surface Water 1 (in.)	Secondary Indicators (2 or more required)
	___ Oxidized Root Channels in upper 12 in.
Depth to Free Water in Pit 3 (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 0 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2		10 YR 5/2			Clay loam
2+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is adjacent to irrigation ditch that carries discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-27-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 28

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Juncus balticus (baltic rush)	85	Herb	FACW+
2. Tamarix chinensis (Chinese tamarisk)	10	Shrub	FACW
3. Alopecurus arundinaceus (creeping foxtail)	5	Herb	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		
Remarks: Dominance determined using ocular estimate of percent cover.			

HYDROLOGY

___ Recorded Data (Describe in Remarks)	Wetland Hydrology Indicators:
___ Stream, Lake or Tide Gauge	Primary Indicators:
___ Aerial Photographs (infrared)	___ Inundated
___ Other	X Saturated in Upper 12 Inches
X No Recorded Data Available	___ Water Marks
	___ Drift Lines
Field Observations	___ Sediment Deposits
	X Drainage Patterns in Wetlands
Depth of Surface Water ___ (in.)	Secondary Indicators (2 or more required)
	___ Oxidized Root Channels in upper 12 in.
Depth to Free Water in Pit ___ (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 5 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)
Remarks:	

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2		10 YR 5/2			Clay loam
2+		Gley 2.5/N			Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is adjacent to irrigation ditch that carries discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-27-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 29

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	85	Herb	OBL
2. Juncus balticus (baltic rush)	10	Herb	FACW+
3. Typha latifolia (broadleaf cattail)	5	Herb	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

___ Recorded Data (Describe in Remarks)	Wetland Hydrology Indicators:
___ Stream, Lake or Tide Gauge	Primary Indicators:
___ Aerial Photographs (infrared)	X Inundated
___ Other	X Saturated in Upper 12 Inches
X No Recorded Data Available	___ Water Marks
	___ Drift Lines
Field Observations	___ Sediment Deposits
	X Drainage Patterns in Wetlands
Depth of Surface Water 1 (in.)	Secondary Indicators (2 or more required)
	___ Oxidized Root Channels in upper 12 in.
Depth to Free Water in Pit 2 (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 0 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____
Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 5/2			Clay loam
3+		10 YR 4/2	Gley 2.5/N	15%	Clay
			7.5 YR 4/4	20%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
X Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is adjacent to irrigation ditch that carries discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-27-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 30

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Scirpus pungens (three-square bulrush)	100	Herb	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
_____ Stream, Lake or Tide Gauge
_____ Aerial Photographs (infrared)
_____ Other
X No Recorded Data Available

Field Observations

Depth of Surface Water 4 (in.)

Depth to Free Water in Pit 0 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 4/1			Clay loam
3+		10 YR 4/1	Gley 2.5/N	25%	Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

Remarks: Wetland is fringe around excavation on irrigation ditch that carries discharge water.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Hamilton Dome			Date: 6-27-02
Applicant/Owner: Merit Energy			County: Hot Springs
Investigator: Greg Johnson, WEST			State: Wyoming
Do Normal Circumstances exist on the site?	Yes X	No __	Community ID: shallow marsh
Is the site significantly disturbed (Atypical situat.?)	Yes __	No X	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes __	No X	Plot ID: 31

VEGETATION

Dominant Plant Species	% Cover	Stratum	Indicator
1. Juncus balticus (baltic rush)	85	Herb	FACW+
2. Typha latifolia (broadleaf cattail)	10	Herb	OBL
3. Carex nebraskensis (Nebraska sedge)	5	Herb	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).	100		

Remarks: Dominance determined using ocular estimate of percent cover.

HYDROLOGY

____ Recorded Data (Describe in Remarks)
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs (infrared)
- ____ Other

X No Recorded Data Available

Field Observations

Depth of Surface Water 6 (in.)

Depth to Free Water in Pit 0 (in.)

Depth to Saturated Soil 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required)
- ___ Oxidized Root Channels in upper 12 in.
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Field Observations
Taxonomy (Subgroup): _____ Confirm Mapped Type? Yes___ No___

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3		10 YR 4/1			Clay loam
3+		10 YR 4/1	Gley 2.5/N	25%	Clay

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

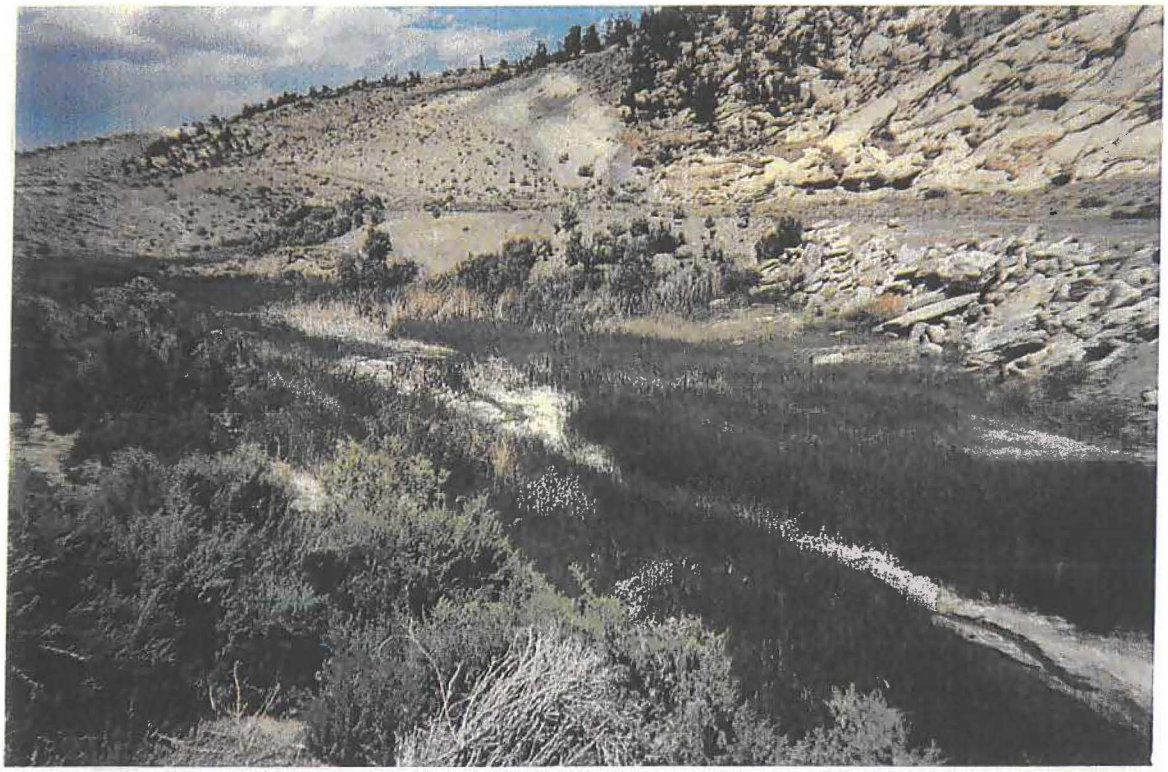
Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is this Sampling Point Within a Wetland? Yes X No ___

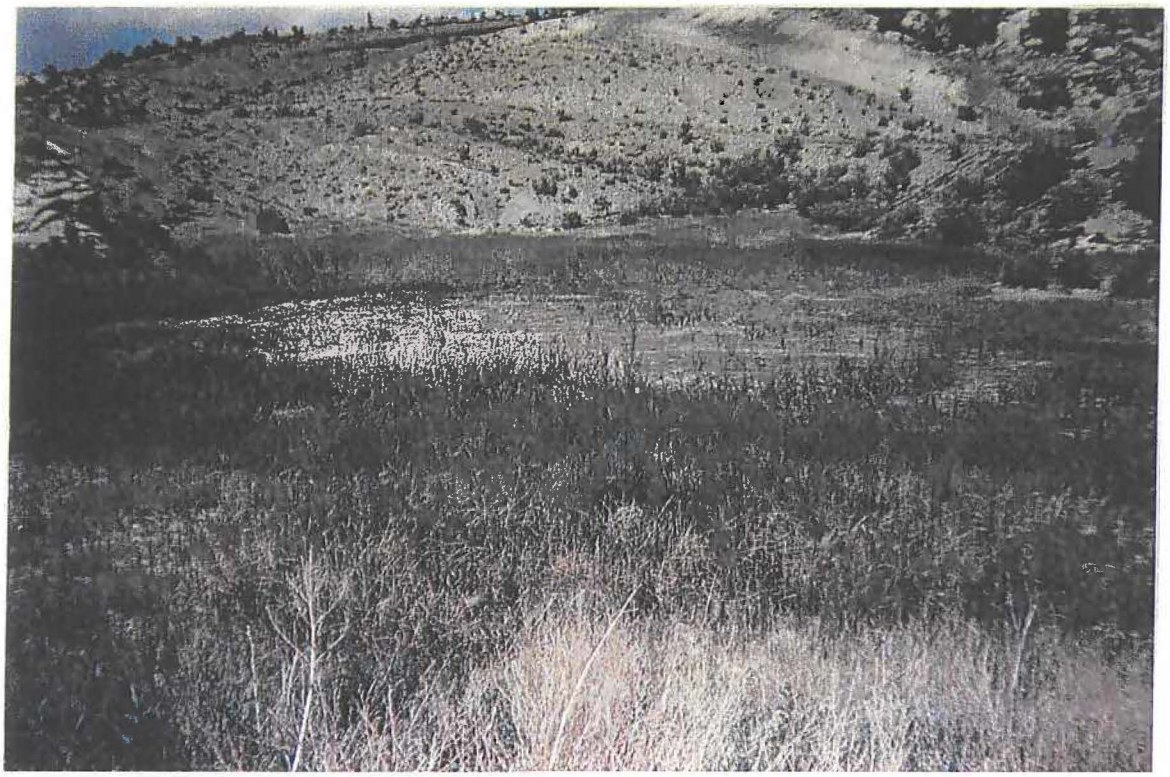
Remarks: Wetland is adjacent to irrigation ditch that carries discharge water.

Appendix B. Photographs of wetlands created by Hamilton Dome discharge

Wetlands along west discharge drainage (data point 1)

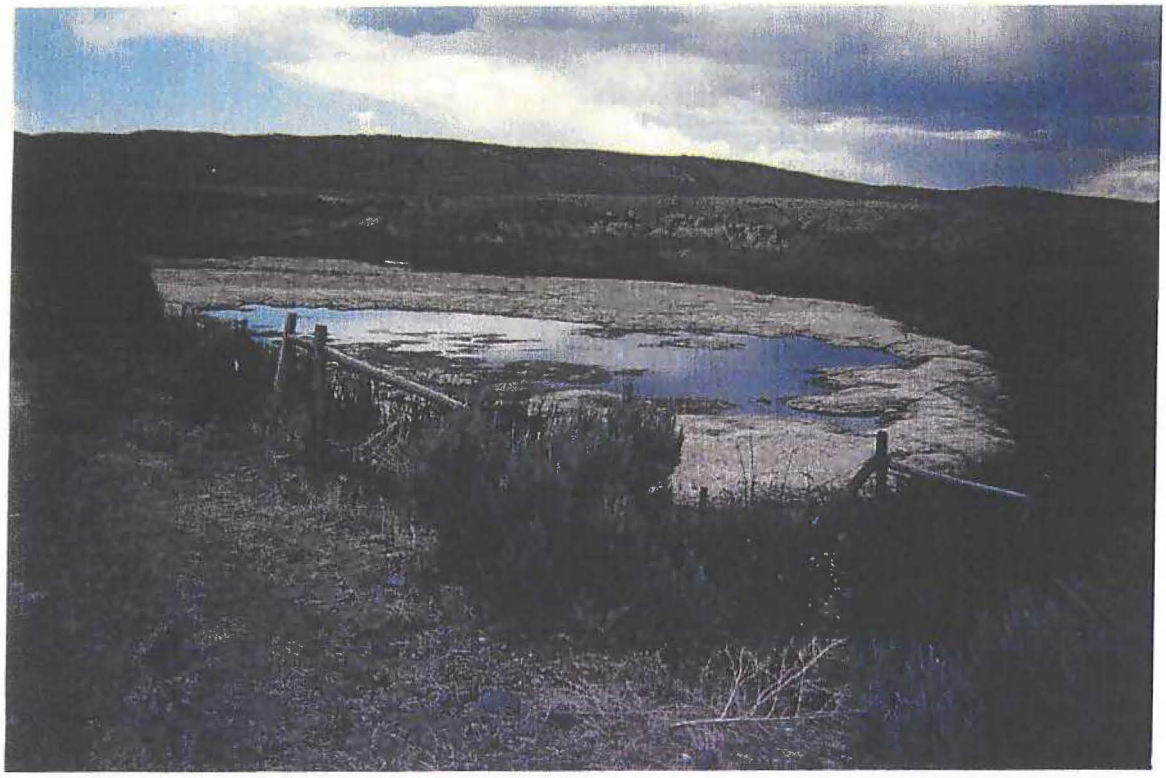


Wetlands along west discharge drainage (data point 2)



Wetlands along west discharge drainage (data point 3)

Wetland receiving irrigation return flows from west discharge (data point 4)

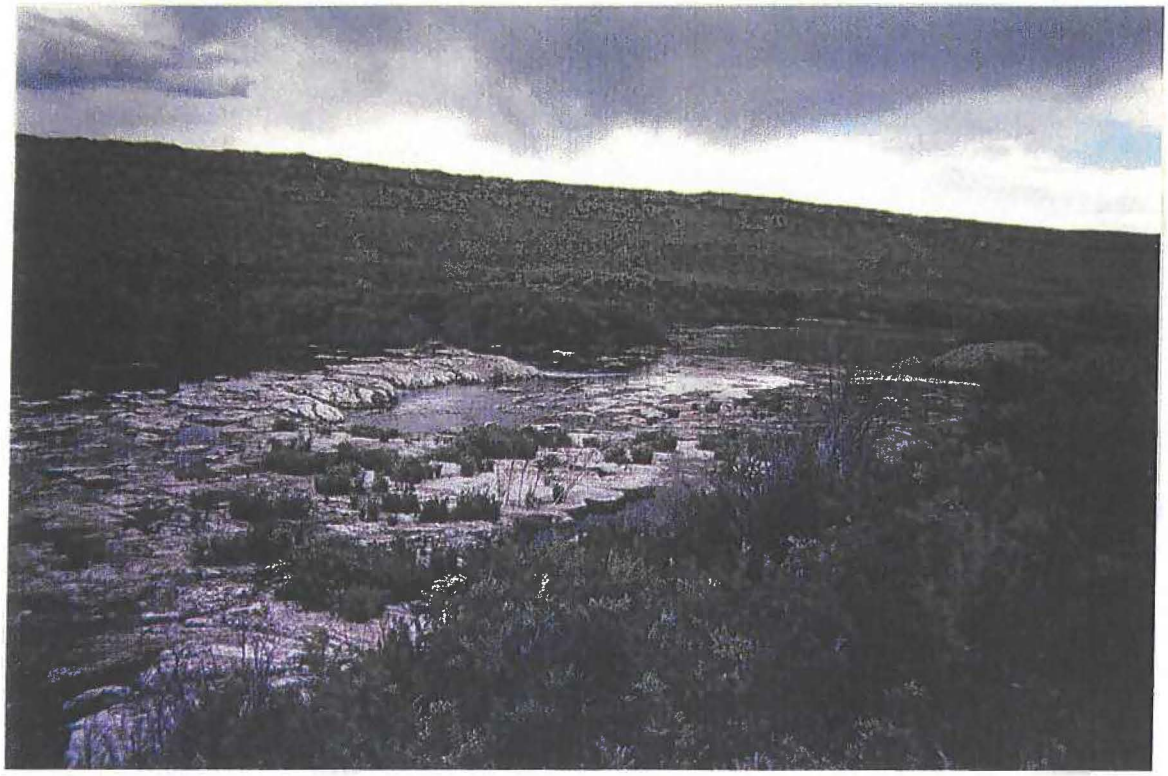


Depressional wetland receiving irrigation return flow from west discharge (data point 5)

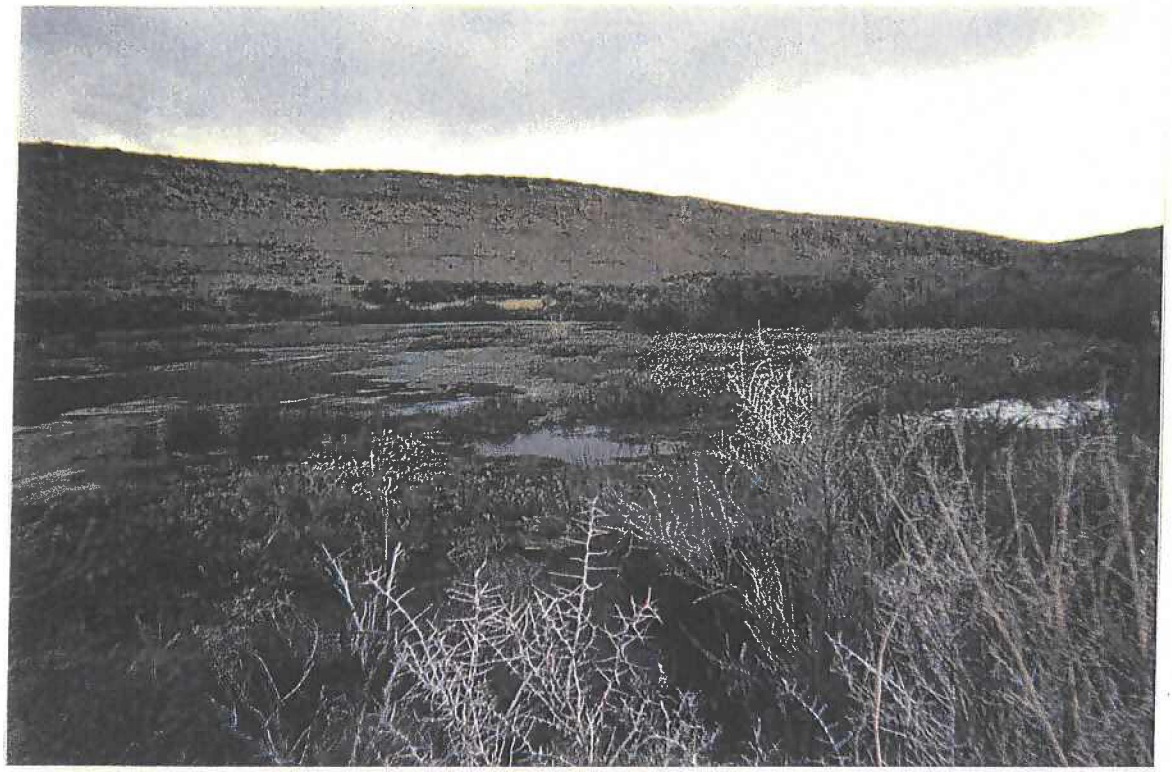
Depressional wetland receiving irrigation return flow from west discharge (data point 6)

Wetland along west discharge drainage (data point 7)

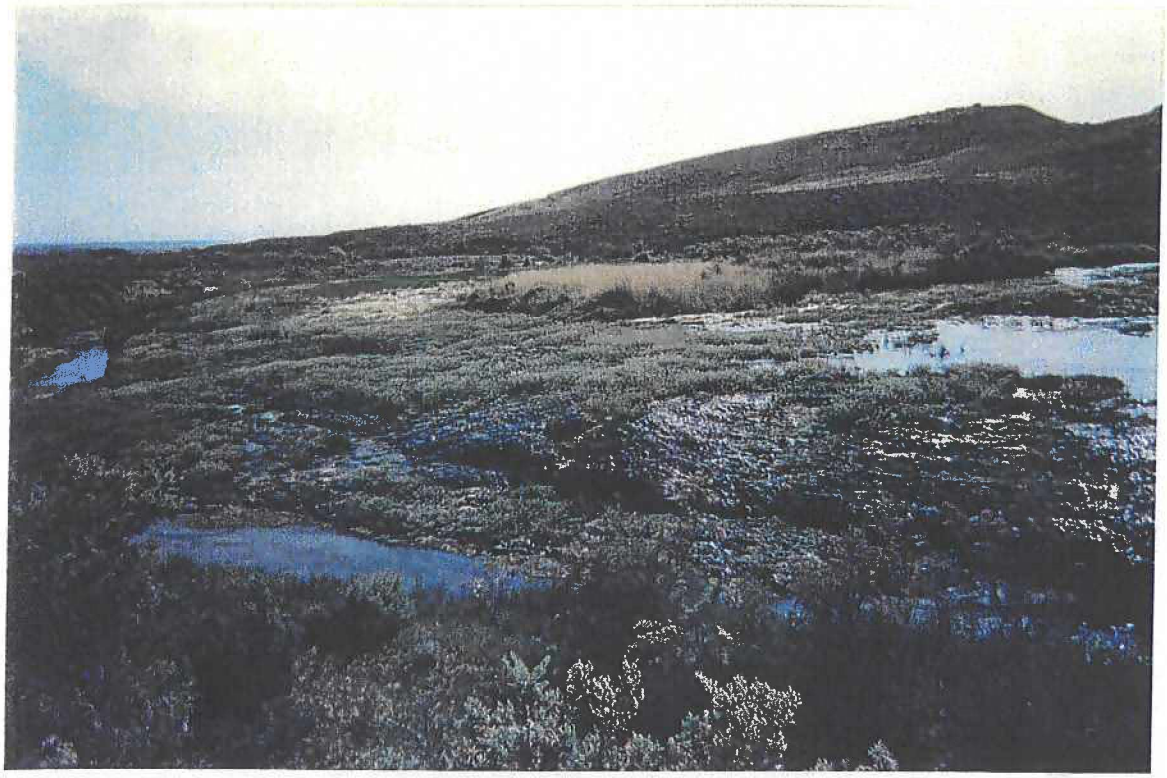
Wetland along west discharge drainage (data point 8)



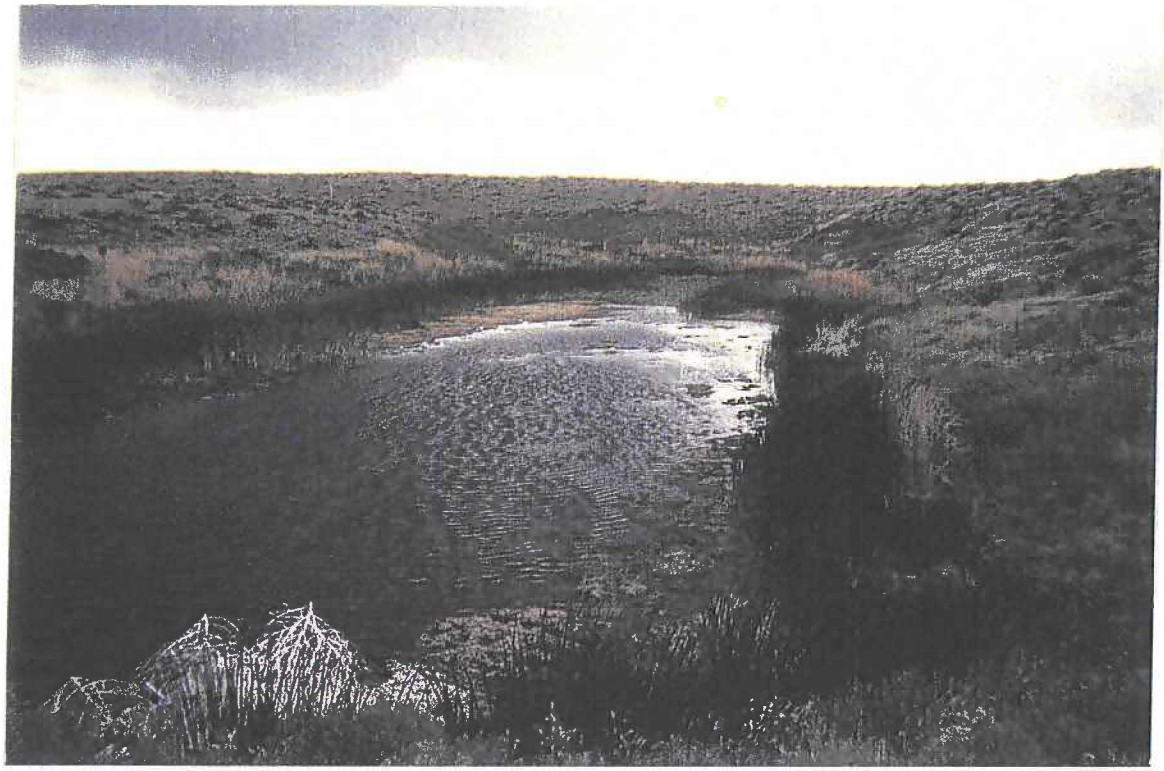
Wetland where west discharge drainage enters Cottonwood Creek (data point 10)



Wetland where west discharge drainage enters Cottonwood Creek (data point 10)



Wetland receiving irrigation return flows from west discharge (data point 11)



Wetland in drainage receiving seepage from east discharge (data point 12)

Wetland in pit receiving seepage from east discharge (data point 13)

Wetland receiving seepage from east discharge (data point 14)

Wetland receiving seepage from east discharge (data point 15)

Wetland receiving seepage from east discharge (data point 16)

Wetland receiving seepage from east discharge (data point 17)

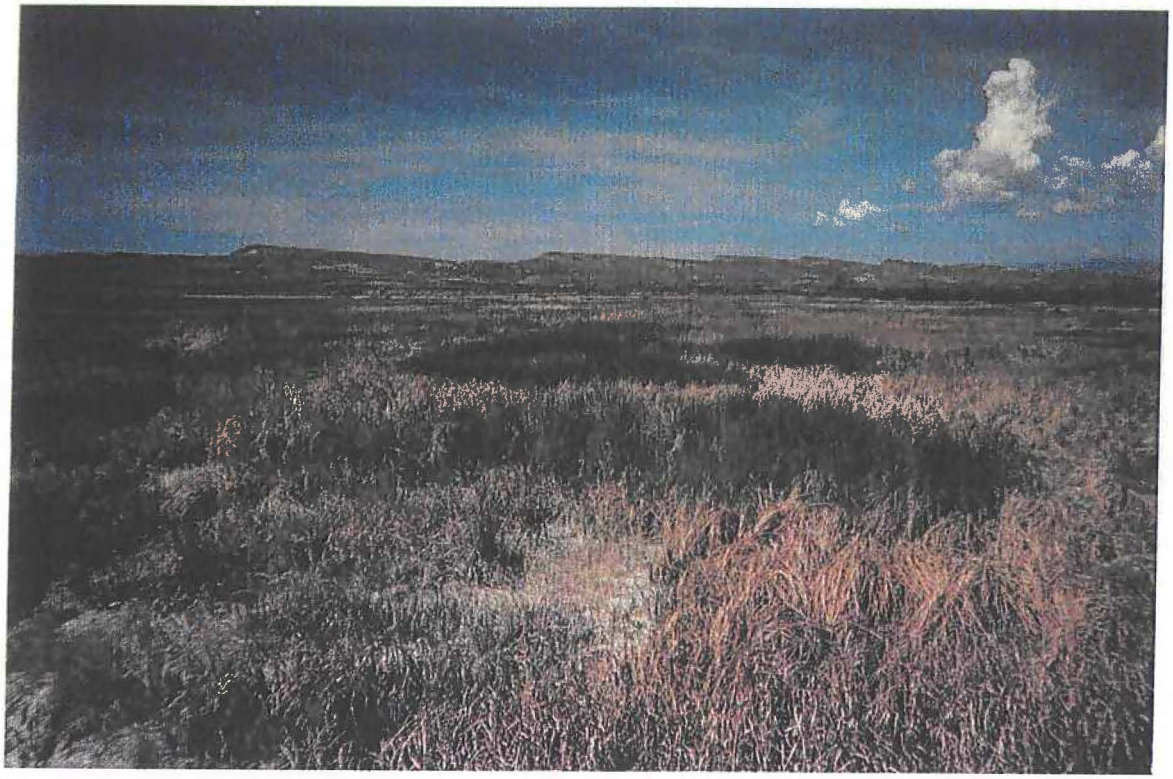
Wetland along east discharge drainage (data point 18)

Wetland adjacent to east discharge drainage (data point 19)

Wetland along east discharge drainage (data point 20)

Wetland formed by seepage from east discharge (data point 21)

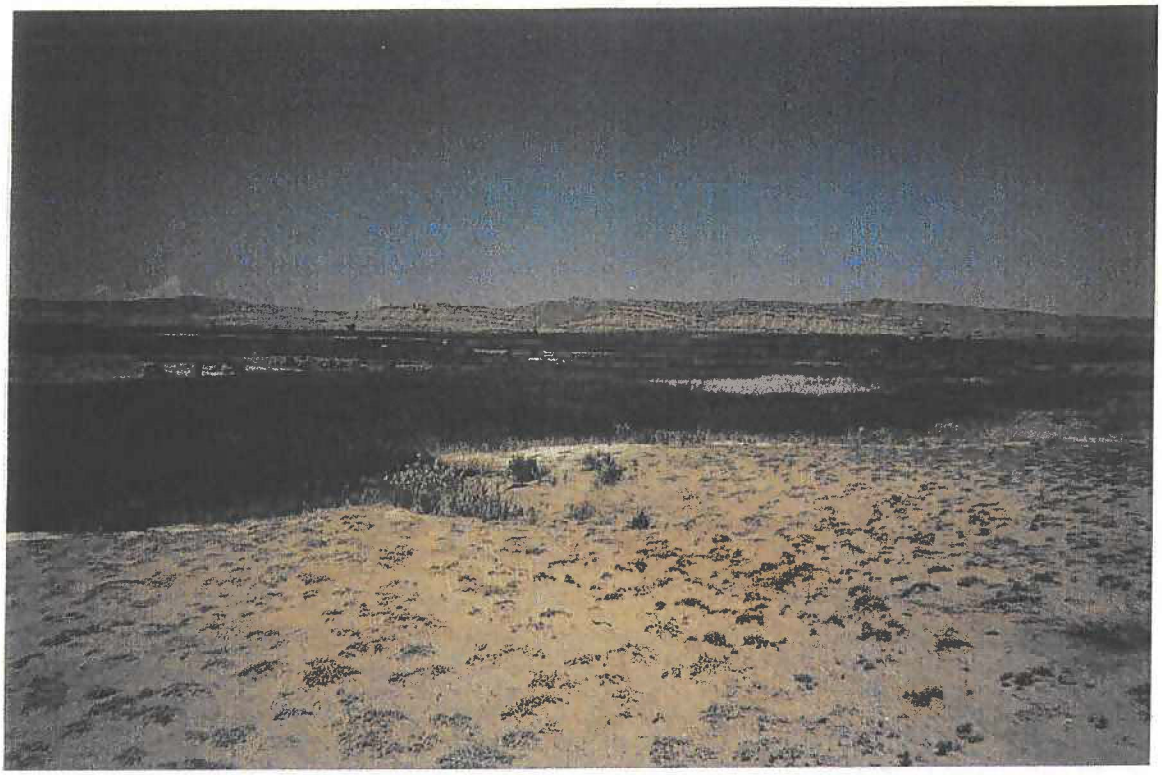
Wetland formed by seepage from east discharge (data point 21)



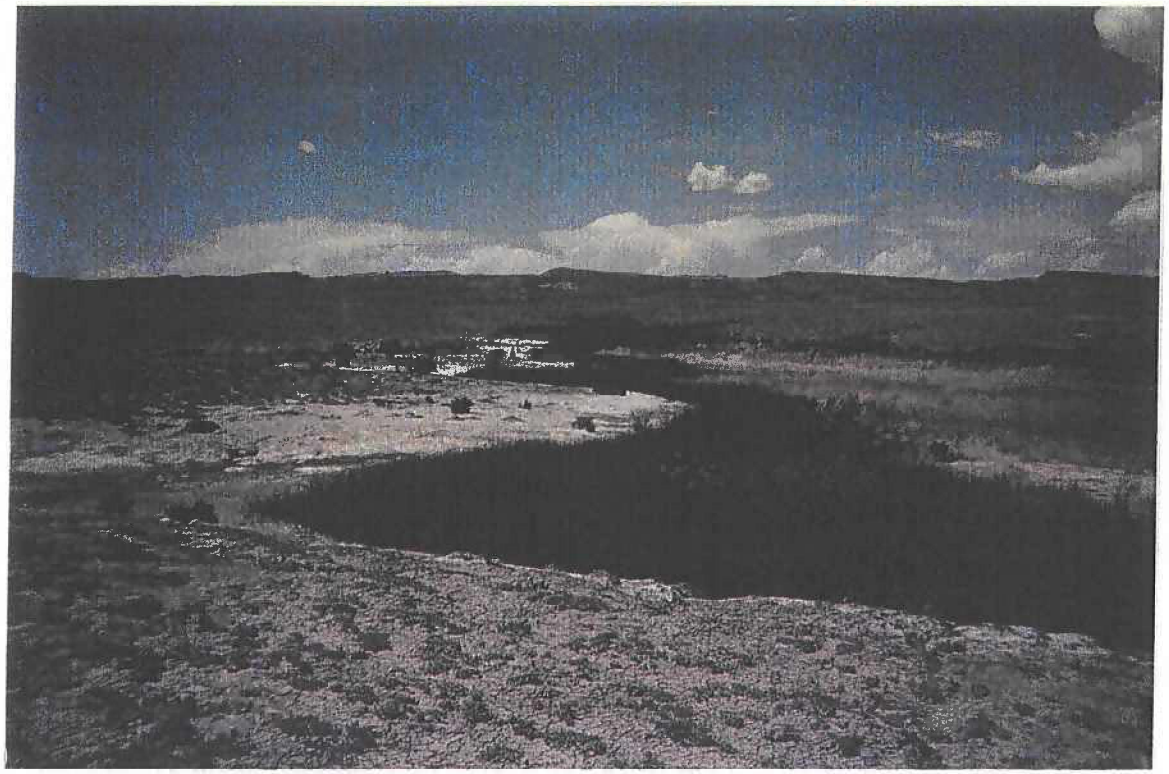
Wetland formed by seepage from east discharge (data point 22)

Wetland formed by seepage from east discharge (data point 22)

Wetland formed by seepage from east discharge (data point 23)



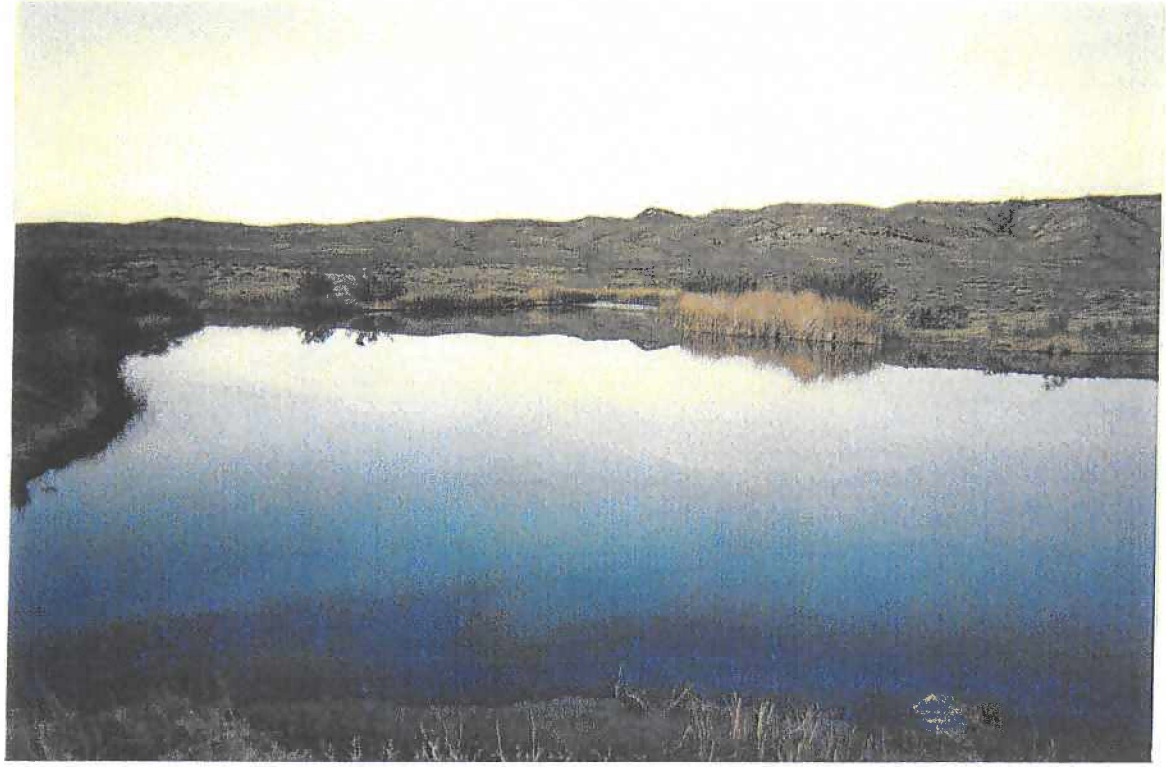
Wetland formed by seepage from east discharge (data point 23)



Wetland along east discharge drainage (data point 24)

Wetland formed by seepage from west discharge irrigation ditch (data point 25)

Wetland fringe around excavated pond on west discharge irrigation ditch (data point 26)

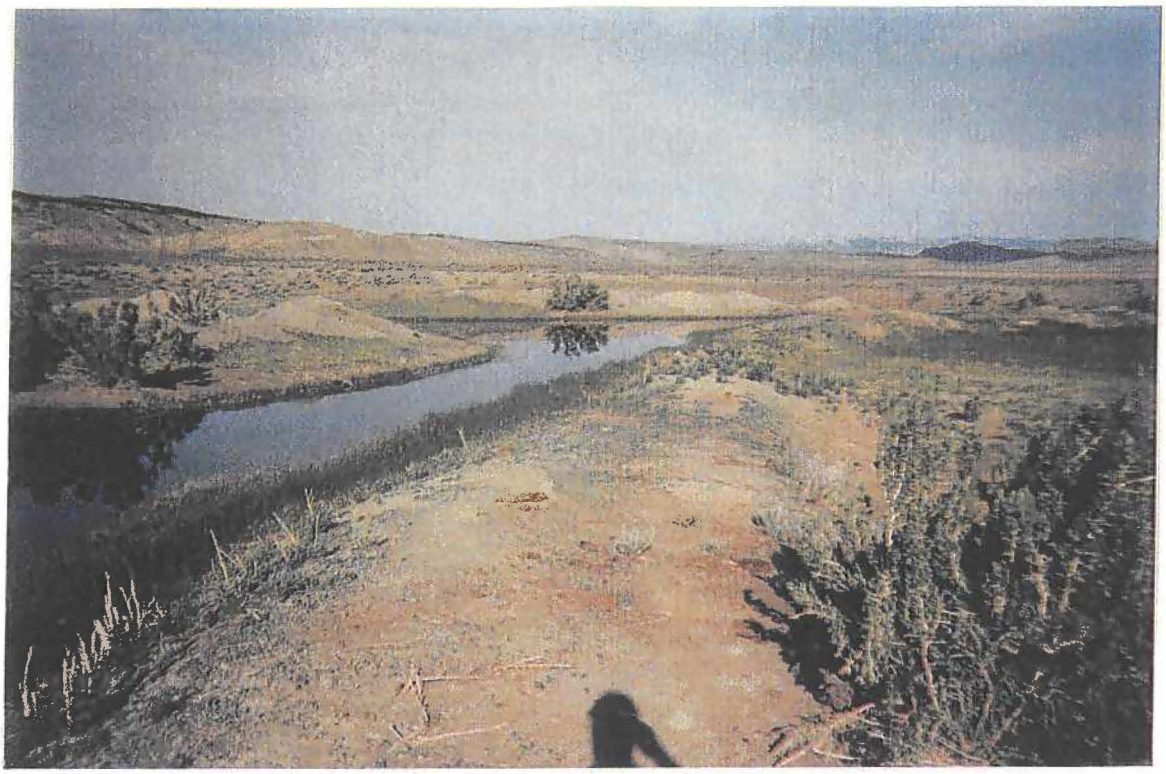


Wetland formed by seepage from west discharge irrigation ditch (data point 27)

Wetland formed by seepage from west discharge irrigation ditch (data point 28)

Wetland formed by seepage from west discharge irrigation ditch (data point 29)

Wetland fringe around excavated pond on west discharge irrigation ditch (data point 30)



Wetland formed by seepage from west discharge irrigation ditch (data point 31)

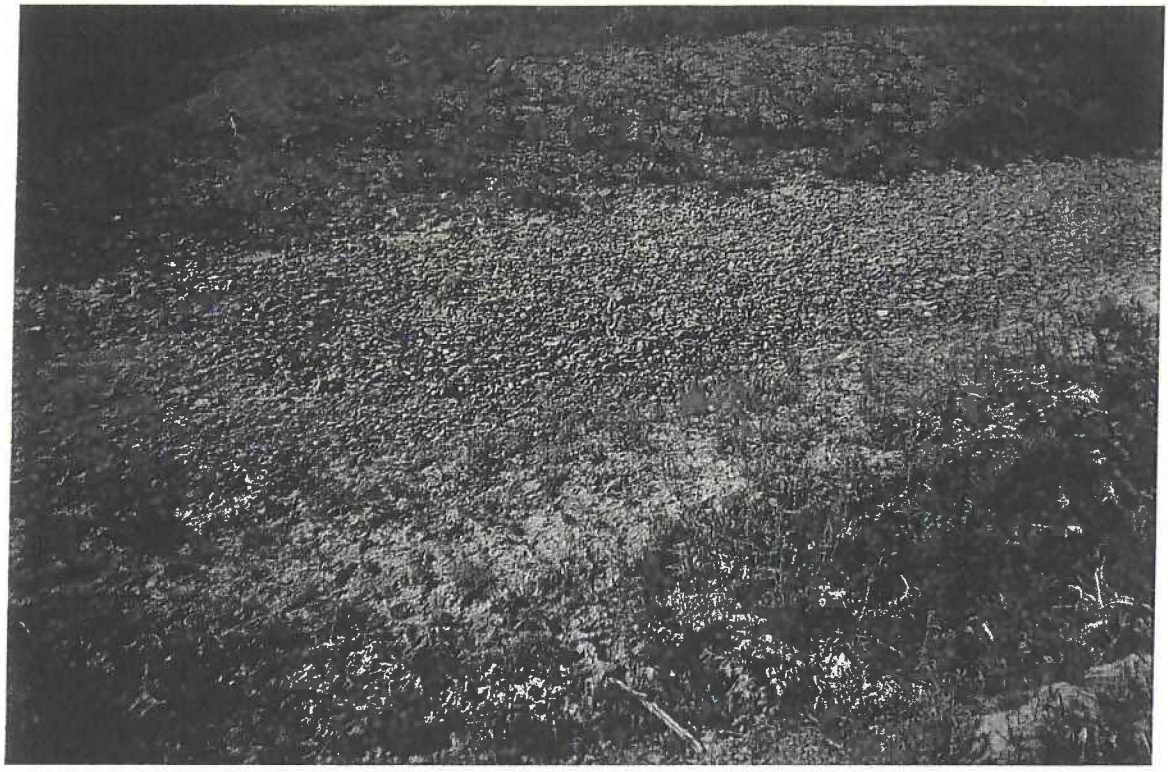
Appendix C. Photographs of wetlands along Cottonwood Creek above and below the discharge

Cottonwood Creek above Hamilton Dome discharge

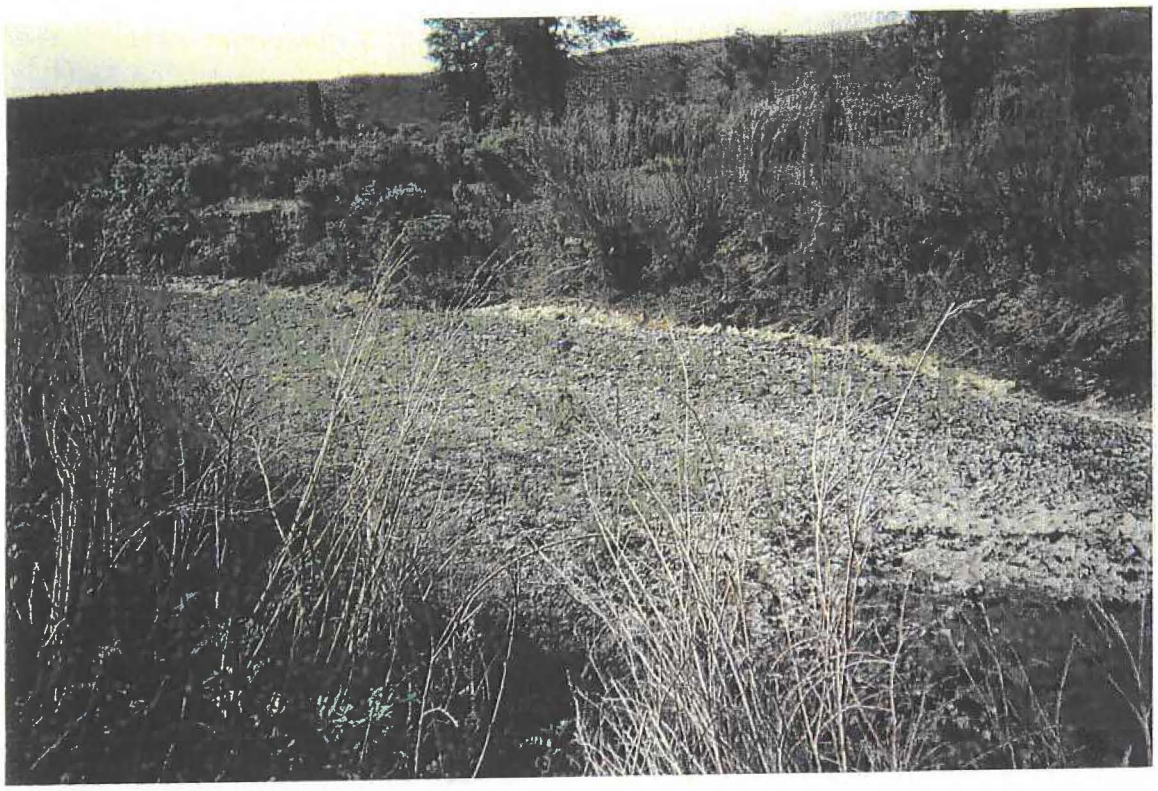
Cottonwood Creek above Hamilton Dome discharge

Cottonwood Creek above Hamilton Dome discharge

Cottonwood Creek above Hamilton Dome discharge



Cottonwood Creek above Hamilton Dome discharge

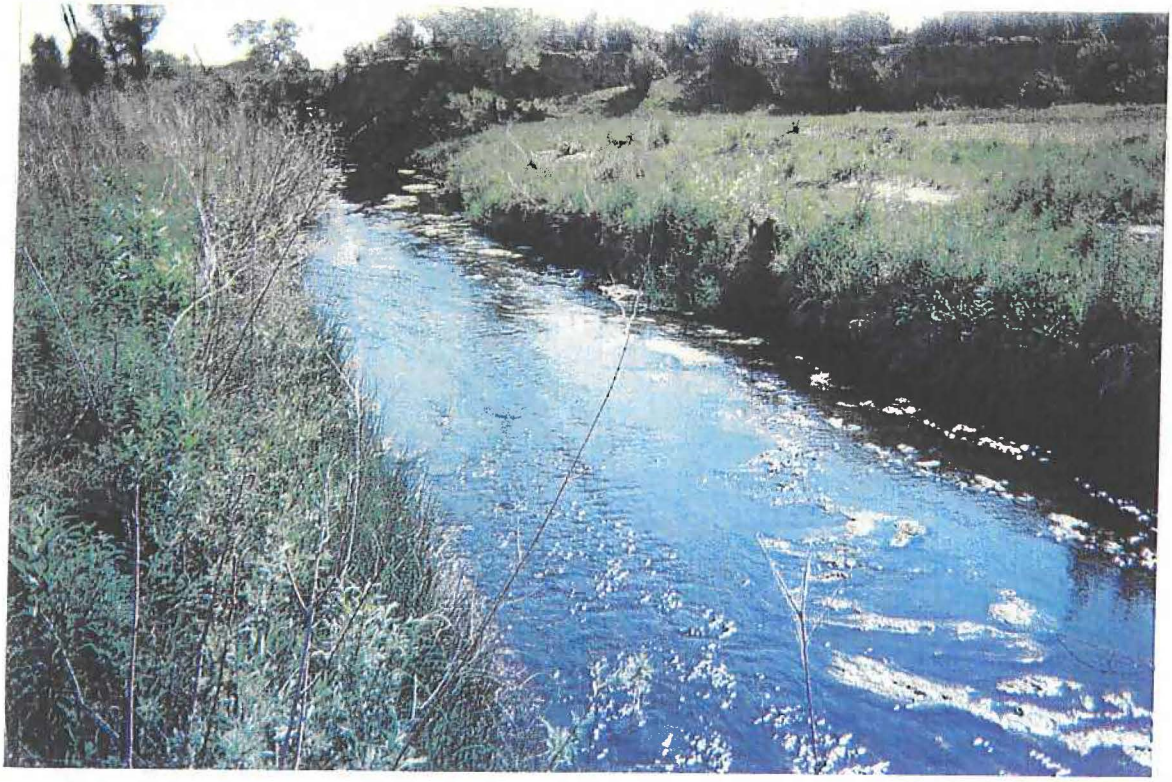


Cottonwood Creek above Hamilton Dome discharge

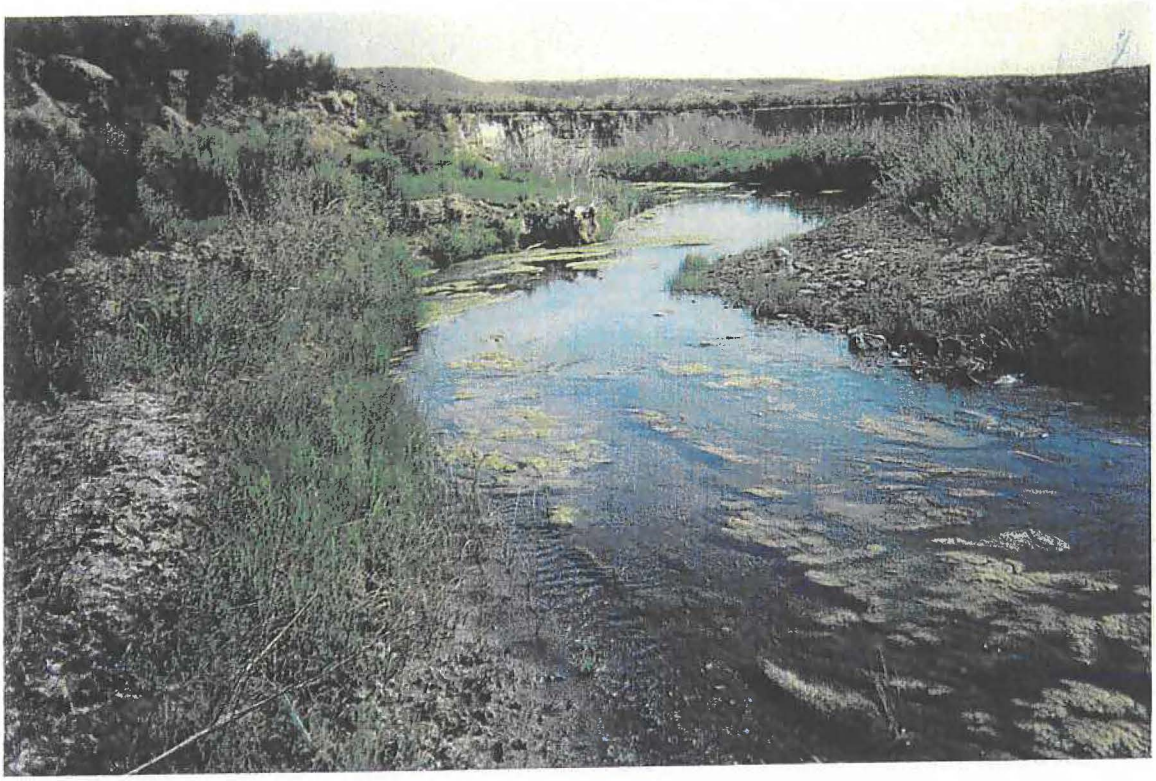
Cottonwood Creek above Hamilton Dome discharge

Cottonwood Creek below Hamilton Dome discharge

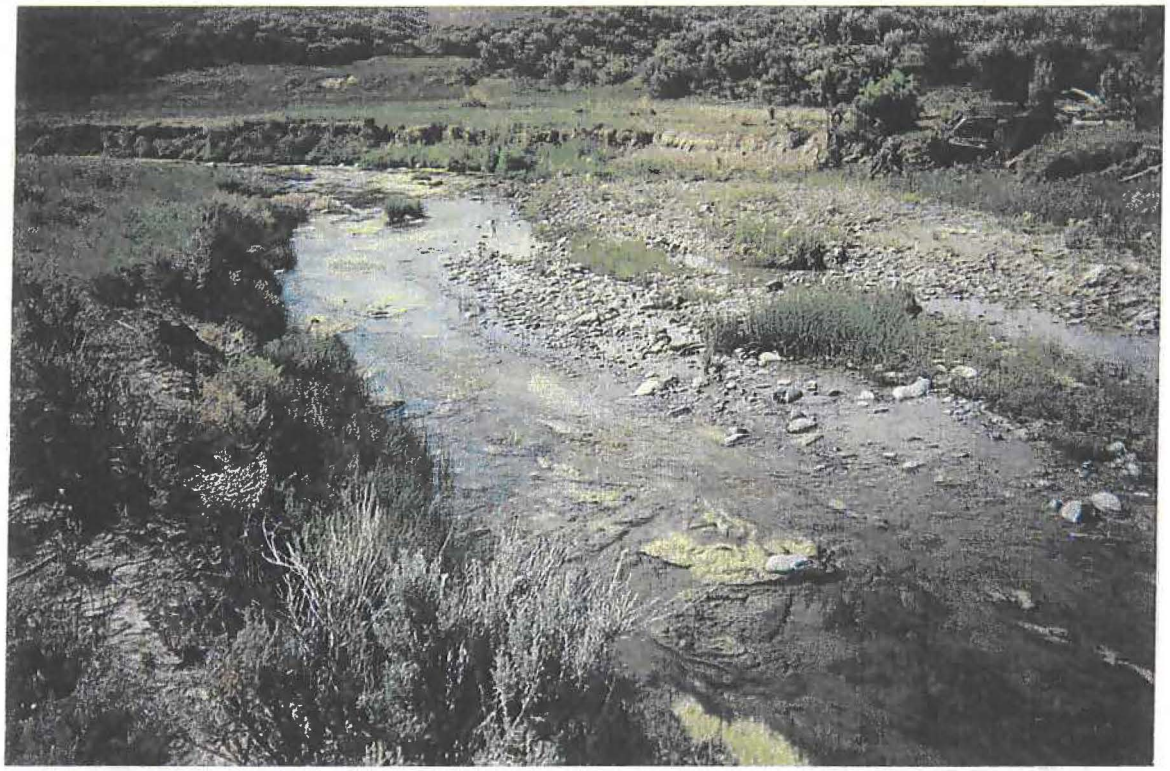
Cottonwood Creek below Hamilton Dome discharge

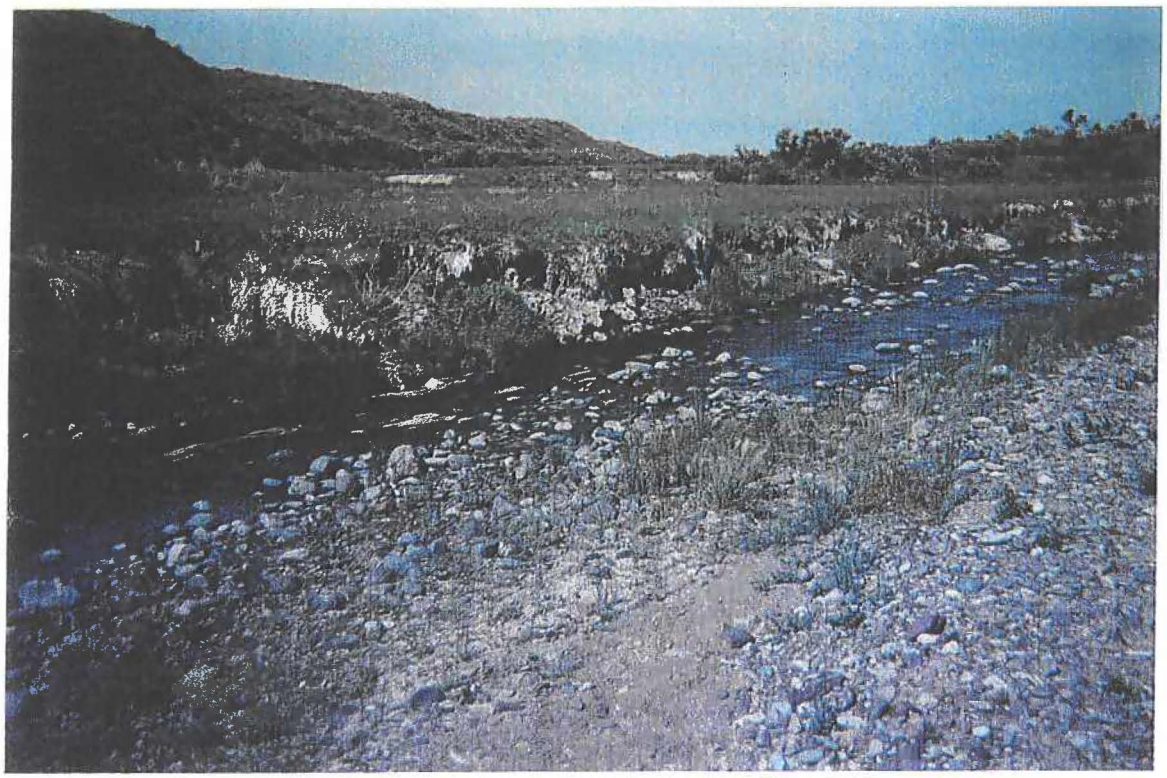


Cottonwood Creek below Hamilton Dome discharge



Cottonwood Creek below Hamilton Dome discharge





Cottonwood Creek below Hamilton Dome discharge

Cottonwood Creek below Hamilton Dome discharge

Cottonwood Creek below Hamilton Dome discharge

Cottonwood Creek below Hamilton Dome discharge

APPENDIX D

LANDOWNER TESTIMONY AND AFFIDAVIT

BEFORE THE WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY, WATER QUALITY DIVISION

RENEWAL OF MERIT ENERGY	)
COMPANY'S PERMITS TO	)
DISCHARGE, PERMIT NUMBERS	)
WY0000175 AND WY0000680	)

AFFIDAVIT OF FRANK RHODES

I, Frank Rhodes, being duly sworn upon his oath, being of lawful age and otherwise competent to testify and having personal knowledge of the matters contained herein do state:

1. I was a rancher on six to eight miles of Cottonwood Creek from 1948 to 1993, just north of Hamilton Dome, Wyoming.

2. During this time, I ranched approximately 13,000 acres of deeded land, and approximately 26,000 acres of land leased from the Bureau of Land Management.

3. I ranched on Cottonwood Creek prior to the time when produced water was discharged from the Hamilton Dome oil field into Cottonwood Creek.

4. Prior to produced water being discharged, Cottonwood Creek would only flow from approximately March to July or August, and would sometimes be dry as early as June. For the rest of the year, Cottonwood Creek was dry with the exception of intermittent flows of rain or snow melt.

5. Prior to the discharge of produced water, I had to use well water to water my livestock.

6. After produced water was discharged into the Cottonwood Creek, the creek would flow year-round.

7. My ranch, which was sold in 1993, has water rights for water out of Cottonwood Creek and one of the unnamed tributaries into which the produced water is discharged.

8. I used the produced water to water my livestock and irrigate hay. The produced water was extremely valuable to my ranching operations.

9. Additionally, after produced water was discharged, I witnessed a large increase in the number of ducks, geese, pheasants, and mule and white-tail deer on or around Cottonwood Creek.

10. The produced water from the Hamilton Dome oil field has been invaluable to my ranching operations as well as the other ranches and farms that are along Cottonwood Creek below the confluence the produced water with Cottonwood Creek, and has created a very beneficial environment for the area's wildlife.

11. Without the produced water, Cottonwood Creek and the surrounding area would return to the dry, arid condition that existed prior to Cottonwood Creek being a year-round stream due to produced water, and ranchers, farmers, and the wildlife would suffer greatly.

FURTHER AFFIANT SAYETH NAUGHT.

Frank Rhodes

Frank Rhodes

STATE OF WYOMING)
)SS:
COUNTY OF HOT SPRINGS)

The foregoing instrument was subscribed and sworn to before me by Frank Rhodes on the 26 day of August, 2002.

James A Michel Jr

Notary Public

My Commission Expires: April 24, 2006

NOTARY PUBLIC
JAMES A MICHEL JR.
COUNTY OF WASHAKIE
STATE OF WYOMING
My Commission Expires Apr. 24, 2006

HAMILTON DOME WATER DISCHARGES
TO COTTONWOOD CREEK:

LANDOWNER ASSESSMENTS

GROUNDWATER HYDROLOGY ISSUES

1. Does the current flow of Cottonwood Creek affect the water table level on your property? If yes, do you see increased vegetation in areas of high groundwater table? (i.e. along stream banks) How much? (5 feet, 5 yards, 20 yards, etc.)

2. How many additional livestock can you operate with due to this increased vegetation from the raised groundwater table? (None, 5%, 10%, 20%, etc.)

3. Have you seen any affect of the water table in any water wells in the area? If yes, "What is the depth of the well(s)?"

SURFACE WATER HYDROLOGY ISSUES

States West will assess the current hydrology of Cottonwood Creek and predict the hydrology if the discharges were to cease.

1. Do you have any knowledge of conditions of Cottonwood Creek before 1950? If Yes: How many years out of 10 would it normally be dry at some time during the year? What month would it normally go dry? In the spring, when would water start running in the stream above Hamilton Dome?

2. Do you irrigate with water solely from Hamilton Dome discharges?

3. Do you irrigate with water that is mixed with runoff? If yes: How do you determine if the water quality is adequate for irrigation?

4. How many times a year do you irrigate?

5. Have you seen any impact to your fields from irrigating with Cottonwood Creek water?

6. Have you ever seen any adverse health effects on livestock or wildlife from Cottonwood Creek?

ECONOMIC ISSUES

1. What is your typical season/period of use of water from Cottonwood Creek?

   Begin: _____
   End: _____

2. For what purpose(s) is the water used? (May indicate more than one answer)

   Livestock watering (immediate use): _____
   Livestock watering (stored/impounded for later use): _____
   Irrigate Pastures: _____
   Irrigate Cropland: _____

3. How long has your operation used this water?

4. If you checked livestock watering in Question #2, what kind and how many head of livestock are supported by the water?

   _____/_____/_____
   Cattle / Sheep / Horses
   (cow-calf pairs)

5. Does the livestock watering occur on your own land, leased private land, or federal/state grazing allotments?

6. If you checked irrigation in Question #2, please describe the type and use of the irrigated acreage.

   Acres: _____/_____
   Pasture / cropland

   If cropland, the type of crop grown:_____

   Average productivity/acre over the past 3 seasons: _____

   If the crop is alfalfa or grass hay, is it used as winter feed for your herd or is it sold? _____

7. How many people, including family members, work or are employed by your operation?

   Year-round: _____
   Seasonal: _____

Please review the analysis of the effects of the loss of Hamilton Dome produced water on Cottonwood Creek (i.e., reduced average flow volumes by month). Then address questions 8-12:

8. How would a reduction/loss of the water affect your operation, (e.g., reduce herd size by _____, reduce crop production by _____%, or _____)?

9. Estimate the reduction in your operations annual net income associated with the effects identified in Question #8 above? _____

10. Is there an alternative source of water available to replace this water? If yes, please describe, including the costs associated with obtaining water from the alternative source. _____

11. How would you adjust your operation's labor to deal with the effects associated with the reduction in water? _____

12. Would your operation remain viable with the reduction in volume or the loss of this water?

ECOLOGICAL ISSUES

1. What changes have you noticed with regard to wildlife use of the area since the stream became perennial rather than intermittent?

2. Has the ability to produce alfalfa using discharge water increased use of the area by wildlife, especially big game and game birds?

3. What would become of the irrigated hayfields if you could no longer irrigate?

4. Has there been a change in plants (more willows, cottonwoods, marshes, etc.?)

HAMILTON DOME WATER DISCHARGES
TO COTTONWOOD CREEK:

LANDOWNER ASSESSMENTS

GROUNDWATER HYDROLOGY ISSUES

1. Does the current flow of Cottonwood Creek affect the water table level on your property? If yes, do you see increased vegetation in areas of high groundwater table? (i.e. along stream banks) How much? (5 feet, 5 yards, 20 yards, etc.)

2. How many additional livestock can you operate with due to this increased vegetation from the raised groundwater table? (None, 5%, 10%, 20%, etc.)

3. Have you seen any affect of the water table in any water wells in the area? If yes, "What is the depth of the well(s)?"

I Can't Really Answer These first Three questions Because The Creek has Always Run Since we have owned The Property

SURFACE WATER HYDROLOGY ISSUES

States West will assess the current hydrology of Cottonwood Creek and predict the hydrology if the discharges were to cease.

1. Do you have any knowledge of conditions of Cottonwood Creek before 1950? If Yes: How many years out of 10 would it normally be dry at some time during the year? What month would it normally go dry? In the spring, when would water start running in the stream above Hamilton Dome?

2. Do you irrigate with water solely from Hamilton Dome discharges?

3. Do you irrigate with water that is mixed with runoff? If yes: How do you determine if the water quality is adequate for irrigation?

4. How many times a year do you irrigate?

5. Have you seen any impact to your fields from irrigating with Cottonwood Creek water?

6. Have you ever seen any adverse health effects on livestock or wildlife from Cottonwood Creek? NO

ECONOMIC ISSUES

1. What is your typical season/period of use of water from Cottonwood Creek?

   Begin: June
   End: October

2. For what purpose(s) is the water used? (May indicate more than one answer)

   Livestock watering (immediate use): X
   Livestock watering (stored/impounded for later use): _____
   Irrigate Pastures: _____
   Irrigate Cropland: _____

3. How long has your operation used this water?
   3 years

4. If you checked livestock watering in Question #2, what kind and how many head of livestock are supported by the water?

   _____ / _____ / 25
   Cattle / Sheep / Horses
   (cow-calf pairs)

5. Does the livestock watering occur on your own land, leased private land, or federal/state grazing allotments? Private Land

6. If you checked irrigation in Question #2, please describe the type and use of the irrigated acreage.

   Acres: 320 / _____
   Pasture / cropland

   If cropland, the type of crop grown: _____

   Average productivity/acre over the past 3 seasons: _____

   If the crop is alfalfa or grass hay, is it used as winter feed for your herd or is it sold? _____

7. How many people, including family members, work or are employed by your operation?

   Year-round: _____
   Seasonal: 4

Please review the analysis of the effects of the loss of Hamilton Dome produced water on Cottonwood Creek (i.e., reduced average flow volumes by month). Then address questions 8-12:

8. How would a reduction/loss of the water affect your operation, (e.g., reduce herd size by 100%, reduce crop production by _____%, or _____)?

9. Estimate the reduction in your operations annual net income associated with the effects identified in Question #8 above? 5000 to 12,000

10. Is there an alternative source of water available to replace this water? If yes, please describe, including the costs associated with obtaining water from the alternative source. Possible well, 8,000

11. How would you adjust your operation's labor to deal with the effects associated with the reduction in water? We would Be OUT of Bussiness

12. Would your operation remain viable with the reduction in volume or the loss of this water? NO

ECOLOGICAL ISSUES

1. What changes have you noticed with regard to wildlife use of the area since the stream became perennial rather than intermittent? WE havent owned The Land Long Enough to Answer This Question

2. Has the ability to produce alfalfa using discharge water increased use of the area by wildlife, especially big game and game birds?

3. What would become of the irrigated hayfields if you could no longer irrigate?

4. Has there been a change in plants (more willows, cottonwoods, marshes, etc.?)
No Change. But we have lots of willows and trees on our property.

irby Creek mule Co.

Jeff Van Antwerp
224 S. 9th Street
Theemopolis, WY
82443

Clay Van Antwerp
805 Bushnell
Rock Springs, WY
307-362-4898

HAMILTON DOME WATER DISCHARGES
TO COTTONWOOD CREEK:

LANDOWNER ASSESSMENTS

GROUNDWATER HYDROLOGY ISSUES

1. Does the current flow of Cottonwood Creek affect the water table level on your property? If yes, do you see increased vegetation in areas of high groundwater table? (i.e. along stream banks) How much? (5 feet, 5 yards, 20 yards, etc.) yes, yes

2. How many additional livestock can you operate with due to this increased vegetation from the raised groundwater table? (None, 5%, 10%, 20%, etc.)

3. Have you seen any affect of the water table in any water wells in the area? If yes, "What is the depth of the well(s)?" no

SURFACE WATER HYDROLOGY ISSUES

States West will assess the current hydrology of Cottonwood Creek and predict the hydrology if the discharges were to cease.

1. Do you have any knowledge of conditions of Cottonwood Creek before 1950? If Yes: How many years out of 10 would it normally be dry at some time during the year? What month would it normally go dry? In the spring, when would water start running in the stream above Hamilton Dome? no

2. Do you irrigate with water solely from Hamilton Dome discharges? yes

3. Do you irrigate with water that is mixed with runoff? If yes: How do you determine if the water quality is adequate for irrigation? yes, historic use of this same water proves it is adequat

4. How many times a year do you irrigate? most feilds get 2 per year

5. Have you seen any impact to your fields from irrigating with Cottonwood Creek water? no

6. Have you ever seen any adverse health effects on livestock or wildlife from Cottonwood Creek? no

ECONOMIC ISSUES

1. What is your typical season/period of use of water from Cottonwood Creek?

   Begin: March
   End: Nov

2. For what purpose(s) is the water used? (May indicate more than one answer)

   Livestock watering (immediate use): ✓
   Livestock watering (stored/impounded for later use): ✓
   Irrigate Pastures: ✓
   Irrigate Cropland: ✓

3. How long has your operation used this water? mine for 2 year, but this ranch has used the water since 1905 that I know of and probably longer

4. If you checked livestock watering in Question #2, what kind and how many head of livestock are supported by the water?

   450 / 40 / 25
   Cattle / Sheep / Horses
   (cow-calf pairs)

5. Does the livestock watering occur on your own land, leased private land, or federal/state grazing allotments? My own + state and fedral allotme

6. If you checked irrigation in Question #2, please describe the type and use of the irrigated acreage.

   Acres: 661 acres
   Pasture / cropland

   If cropland, the type of crop grown: _____

   Average productivity/acre over the past 3 seasons: 2 ton per acre hay

   If the crop is alfalfa or grass hay, is it used as winter feed for your herd or is it sold? feed

7. How many people, including family members, work or are employed by your operation?

   Year-round: 7
   Seasonal: 4

Please review the analysis of the effects of the loss of Hamilton Dome produced water on Cottonwood Creek (i.e., reduced average flow volumes by month). Then address questions 8-12:

8. How would a reduction/loss of the water affect your operation, (e.g., reduce herd size by 50, reduce crop production by 50 %, or more)?

9. Estimate the reduction in your operations annual net income associated with the effects identified in Question #8 above? 100,000.00 or more

10. Is there an alternative source of water available to replace this water? If yes, please describe, including the costs associated with obtaining water from the alternative source. no. not that I'm aware of

11. How would you adjust your operation's labor to deal with the effects associated with the reduction in water? I would have to let them all go.

12. Would your operation remain viable with the reduction in volume or the loss of this water? no

ECOLOGICAL ISSUES

1. What changes have you noticed with regard to wildlife use of the area since the stream became perennial rather than intermittent? N/A

2. Has the ability to produce alfalfa using discharge water increased use of the area by wildlife, especially big game and game birds? lot's of wildlife in this area

3. What would become of the irrigated hayfields if you could no longer irrigate? the would become weed frilds

4. Has there been a change in plants (more willows, cottonwoods, marshes, etc.?) N/A

HAMILTON DOME WATER DISCHARGES
TO COTTONWOOD CREEK:

LANDOWNER ASSESSMENTS

GROUNDWATER HYDROLOGY ISSUES

1. Does the current flow of Cottonwood Creek affect the water table level on your property? If yes, do you see increased vegetation in areas of high groundwater table? (i.e. along stream banks) How much? (5 feet, 5 yards, 20 yards, etc.)

   YES – 10 yds

2. How many additional livestock can you operate with due to this increased vegetation from the raised groundwater table? (None, 5%, 10%, 20%, etc.)

3. Have you seen any affect of the water table in any water wells in the area? If yes, "What is the depth of the well(s)?" YES 80'

SURFACE WATER HYDROLOGY ISSUES

States West will assess the current hydrology of Cottonwood Creek and predict the hydrology if the discharges were to cease.

1. Do you have any knowledge of conditions of Cottonwood Creek before 1950? NO If Yes: How many years out of 10 would it normally be dry at some time during the year? What month would it normally go dry? In the spring, when would water start running in the stream above Hamilton Dome?

2. Do you irrigate with water solely from Hamilton Dome discharges? NO – BUT solely from Cottonwood creek.

3. Do you irrigate with water that is mixed with runoff? If yes: How do you determine if the water quality is adequate for irrigation? YES – Clarity & water testing

4. How many times a year do you irrigate? 8-9 months

5. Have you seen any impact to your fields from irrigating with Cottonwood Creek water? Positive impact only

6. Have you ever seen any adverse health effects on livestock or wildlife from Cottonwood Creek? NO

ECONOMIC ISSUES

1. What is your typical season/period of use of water from Cottonwood Creek?

   Begin: MARCH
   End: November

2. For what purpose(s) is the water used? (May indicate more than one answer)

   Livestock watering (immediate use): YES
   Livestock watering (stored/impounded for later use): Well
   Irrigate Pastures: YES
   Irrigate Cropland: YES

3. How long has your operation used this water?

   This property has used Cottonwood Creek water Since 1904

4. If you checked livestock watering in Question #2, what kind and how many head of livestock are supported by the water?

   200 / 0 / 2
   Cattle / Sheep / Horses
   (cow-calf pairs)

5. Does the livestock watering occur on your own land, leased private land, or federal/state grazing allotments? OWN LAND

6. If you checked irrigation in Question #2, please describe the type and use of the irrigated acreage.

   Acres: 340 / 300
   Pasture / cropland

   If cropland, the type of crop grown: HAY

   Average productivity/acre over the past 3 seasons: 4 TON/ACRE

   If the crop is alfalfa or grass hay, is it used as winter feed for your herd or is it sold? BOTH

7. How many people, including family members, work or are employed by your operation?

   Year-round: 5
   Seasonal: 6

Please review the analysis of the effects of the loss of Hamilton Dome produced water on Cottonwood Creek (i.e., reduced average flow volumes by month). Then address questions 8-12:

8. How would a reduction/loss of the water affect your operation, (e.g., reduce herd size by 50 %, reduce crop production by 80 %, or _____)?

9. Estimate the reduction in your operations annual net income associated with the effects identified in Question #8 above? Cause for Liquidation

10. Is there an alternative source of water available to replace this water? If yes, please describe, including the costs associated with obtaining water from the alternative source. None

11. How would you adjust your operation's labor to deal with the effects associated with the reduction in water? Property would be Liquidated ALL Associated Jobs would be Lost.

12. Would your operation remain viable with the reduction in volume or the loss of this water? NO — ALL operations would cease.

ECOLOGICAL ISSUES

1. What changes have you noticed with regard to wildlife use of the area since the stream became perennial rather than intermittent?

   MORE WildLiFe OF every Kind

2. Has the ability to produce alfalfa using discharge water increased use of the area by wildlife, especially big game and game birds? YES TO BOTH

3. What would become of the irrigated hayfields if you could no longer irrigate?

   DRY Land pasture — WASTE Land

4. Has there been a change in plants (more willows, cottonwoods, marshes, etc.?)

   Profoundly Yes

HAMILTON DOME WATER DISCHARGES
TO COTTONWOOD CREEK:

LANDOWNER ASSESSMENTS

GROUNDWATER HYDROLOGY ISSUES

1. Does the current flow of Cottonwood Creek affect the water table level on your property? If yes, do you see increased vegetation in areas of high groundwater table? (i.e. along stream banks) How much? (5 feet, 5 yards, 20 yards, etc.)
   Doesn't Run by my Land.
2. How many additional livestock can you operate with due to this increased vegetation from the raised groundwater table? (None, 5%, 10%, 20%, etc.)
3. Have you seen any affect of the water table in any water wells in the area? If yes, "What is the depth of the well(s)?" I have two wells over 300' deep. Since the drought, they haven't been Good water- full of heavy minerals or metals, Sulphur & ~~[illegible]~~ Sodium

SURFACE WATER HYDROLOGY ISSUES

States West will assess the current hydrology of Cottonwood Creek and predict the hydrology if the discharges were to cease.

1. Do you have any knowledge of conditions of Cottonwood Creek before 1950? If Yes: How many years out of 10 would it normally be dry at some time during the year? What month would it normally go dry? In the spring, when would water start running in the stream above Hamilton Dome? Only been using since about 1974 or 75- We start as soon as there's water in spring & thru fall, if there's water- This is Second Bad Drought We've Had-
2. Do you irrigate with water solely from Hamilton Dome discharges?
   Solely From whats in Cottonwood Creek-
3. Do you irrigate with water that is mixed with runoff? If yes: How do you determine if the water quality is adequate for irrigation?
4. How many times a year do you irrigate? From April thru Oct or Nov- As Long as we can before Freezes up.
5. Have you seen any impact to your fields from irrigating with Cottonwood Creek water? No.
6. Have you ever seen any adverse health effects on livestock or wildlife from Cottonwood Creek? No.

ECONOMIC ISSUES

1. What is your typical season/period of use of water from Cottonwood Creek?

   Begin: early Spring
   End: late Fall

2. For what purpose(s) is the water used? (May indicate more than one answer)

   Livestock watering (immediate use): Not Allowed
   Livestock watering (stored/impounded for later use): Not Allowed
   Irrigate Pastures: _____
   Irrigate Cropland: X

3. How long has your operation used this water?
   Since about 74 or 75, when there was water

4. If you checked livestock watering in Question #2, what kind and how many head of livestock are supported by the water?

   _____ / _____ / _____ N/A
   Cattle / Sheep / Horses
   (cow-calf pairs)

5. Does the livestock watering occur on your own land, leased private land, or federal/state grazing allotments? N/A

6. If you checked irrigation in Question #2, please describe the type and use of the irrigated acreage.

   Acres: _____ / 311 Not Adjudicated for Rest of Property.
   Pasture / cropland

   If cropland, the type of crop grown: Alfalfa Hay - Grain

   Average productivity/acre over the past 3 seasons: Depends on water - 2001 - no crops at all - Had no water at all -

   If the crop is alfalfa or grass hay, is it used as winter feed for your herd or is it sold? Used For Livestock

7. How many people, including family members, work or are employed by your operation?

   Year-round: 1 + wife
   Seasonal: 1

Please review the analysis of the effects of the loss of Hamilton Dome produced water on Cottonwood Creek (i.e., reduced average flow volumes by month). Then address questions 8-12:

8. How would a reduction/loss of the water affect your operation, (e.g., reduce herd size by _____, reduce crop production by _____%, or _____)?
   I have No idea - MY cattle drink well water - But I Need the creek 100% for crop production.
9. Estimate the reduction in your operations annual net income associated with the effects identified in Question #8 above? _____

10. Is there an alternative source of water available to replace this water? If yes, please describe, including the costs associated with obtaining water from the alternative source. None.

11. How would you adjust your operation's labor to deal with the effects associated with the reduction in water? MY partner Would probably have To seek employment AWAY FROM Ranch IN winter time -
12. Would your operation remain viable with the reduction in volume or the loss of this water? No -

ECOLOGICAL ISSUES

1. What changes have you noticed with regard to wildlife use of the area since the stream became perennial rather than intermittent? Before the Drought we have lots of Wildlife + Wild fowl -

2. Has the ability to produce alfalfa using discharge water increased use of the area by wildlife, especially big game and game birds? yes, when available

3. What would become of the irrigated hayfields if you could no longer irrigate?
   Have to lay fallow -

4. Has there been a change in plants (more willows, cottonwoods, marshes, etc.?)
   We don't have a tree on our 520 acres -

HAMILTON DOME WATER DISCHARGES
TO COTTONWOOD CREEK:

LANDOWNER ASSESSMENTS

GROUNDWATER HYDROLOGY ISSUES

1. Does the current flow of Cottonwood Creek affect the water table level on your property? If yes, do you see increased vegetation in areas of high groundwater table? (i.e. along stream banks) How much? (5 feet, 5 yards, 20 yards, etc.) Varies from 15-25 yds.

2. How many additional livestock can you operate with due to this increased vegetation from the raised groundwater table? (None, 5%, 10%, 20%, etc.) 15%

3. Have you seen any affect of the water table in any water wells in the area? If yes, "What is the depth of the well(s)?" Well @ house is 95' and produces in excess of 40 gpm.

SURFACE WATER HYDROLOGY ISSUES

States West will assess the current hydrology of Cottonwood Creek and predict the hydrology if the discharges were to cease.

1. Do you have any knowledge of conditions of Cottonwood Creek before 1950? No If Yes: How many years out of 10 would it normally be dry at some time during the year? What month would it normally go dry? In the spring, when would water start running in the stream above Hamilton Dome?

2. Do you irrigate with water solely from Hamilton Dome discharges? – NO

3. Do you irrigate with water that is mixed with runoff? Yes If yes: How do you determine if the water quality is adequate for irrigation? - When there is enough water you utilize it - have had no problems.

4. How many times a year do you irrigate? 2 - 6 depending on water

5. Have you seen any impact to your fields from irrigating with Cottonwood Creek water? Without it they will die.

6. Have you ever seen any adverse health effects on livestock or wildlife from Cottonwood Creek? Absolutely none

ECONOMIC ISSUES

1. What is your typical season/period of use of water from Cottonwood Creek? - Non-drought yrs.

   Begin: April 1-20 - - - - - - - Sept. 1-30
   End: May 20-June 30 - - - - - - - Oct. 1-30

2. For what purpose(s) is the water used? (May indicate more than one answer)

   Livestock watering (immediate use): Year round
   Livestock watering (stored/impounded for later use): _____
   Irrigate Pastures: Spring & fall
   Irrigate Cropland: Spring & fall

3. How long has your operation used this water? - We have owned and used this property for 5 years.

4. If you checked livestock watering in Question #2, what kind and how many head of livestock are supported by the water?

20-40	0	2-4
Cattle (cow-calf pairs)	Sheep	Horses

5. Does the livestock watering occur on your own land, leased private land, or federal/state grazing allotments? Own land

6. If you checked irrigation in Question #2, please describe the type and use of the irrigated acreage.

   Acres: 25 / 30-35
   Pasture / cropland

   If cropland, the type of crop grown: HAY

   Average productivity/acre over the past 3 seasons: 1-1½ T (drought years)

   If the crop is alfalfa or grass hay, is it used as winter feed for your herd or is it sold? Winter feed

7. How many people, including family members, work or are employed by your operation?

   Year-round: 2 [Wife & myself]
   Seasonal: 0

Please review the analysis of the effects of the loss of Hamilton Dome produced water on Cottonwood Creek (i.e., reduced average flow volumes by month). Then address questions 8-12:

8. How would a reduction/loss of the water affect your operation, (e.g., reduce herd size by 50-100%, reduce crop production by 50 %, or _____)?

9. Estimate the reduction in your operations annual net income associated with the effects identified in Question #8 above? $13,500

10. Is there an alternative source of water available to replace this water? If yes, please describe, including the costs associated with obtaining water from the alternative source. No

11. How would you adjust your operation's labor to deal with the effects associated with the reduction in water? Economically unfeasable to operate

12. Would your operation remain viable with the reduction in volume or the loss of this water? No - cease operations.

ECOLOGICAL ISSUES

1. What changes have you noticed with regard to wildlife use of the area since the stream became perennial rather than intermittent? Much more wildlife using stream as a water source & the riparian areas.

2. Has the ability to produce alfalfa using discharge water increased use of the area by wildlife, especially big game and game birds? Absolutely - lots of deer, chukar and pheasants.

3. What would become of the irrigated hayfields if you could no longer irrigate? They would die

4. Has there been a change in plants (more willows, cottonwoods, marshes, etc.?) Yes, without the water the cottonwood community and surrounding riparian areas would cease to exist.

APPENDIX E

TERRESTRIAL AND AQUATIC WILDLIFE REPORT

TERRESTRIAL AND AQUATIC WILDLIFE REPORT

Hamilton Dome Oil Field Use Attainability Analysis Project

Prepared for

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Cheyenne, Wyoming

Prepared by

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October 30, 2002

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INTRODUCTION

Merit Energy Company (MEC) produces crude oil at the Hamilton Dome Field located in Hot Springs County, Wyoming. Merit Energy Company applied for and received two NPDES permits to discharge produced water from the Hamilton Dome Field into unnamed tributaries that eventually flow into Cottonwood Creek. The Water Quality Division (WQD) of the Wyoming Department of Environmental Quality (DEQ) recently updated Water Quality Rules and Regulations, Chapter 1, to comply with the federal Clean Water Act that requires all surface water be swimmable and fishable. Wyoming WQD was required to make changes to their statewide water classification system. Until the recent update of Chapter 1, the classification of the tributaries and Cottonwood Creek was Class 4. The tributaries are now class 3B and Cottonwood Creek is now class 2C.

The new classifications require a chloride limit in Cottonwood Creek of 230 mg/L where a limit had not previously existed. This chloride limit of 230 mg/L is more than 200 mg/L less than the current levels of chlorides being discharged at MEC permitted discharge points. Values for selenium are also above existing WQD criteria. Section 33 of Chapter 1 sets up a process where the WQD Administrator may allow site specific criteria. Therefore, MEC has decided to petition the WQD Administrator to establish site-specific criteria for chlorides and selenium because correcting the existing human-caused conditions (oil field discharge) would cause more environmental damage to correct (i.e., remove) than to leave in place. One of the major environmental benefits of Hamilton Dome discharge is the continuous support of an aquatic environment for fish and aquatic invertebrates, creation of riparian and other wildlife habitat, and provision of a year-round water supply in an otherwise arid environment. The purpose of this report is to characterize the benefits of Cottonwood Creek to the terrestrial and aquatic wildlife resources in the area.

METHODS

Information on terrestrial wildlife use of the area was obtained through searching the Wildlife Observation System database maintained by the Wyoming Game and Fish Department (WGFD-WOS). The WGFD-WOS computer search included all species and all years for the sections through which Cottonwood Creek flows from Hamilton Dome to the Bighorn River. The WGFD-

WOS is a computer database of wildlife observations made by WGFD personnel since 1975. Additional information was obtained by interviewing the WGFD biologist in Thermopolis (Kevin Hurley). This report also includes observations of wildlife and habitat in the project area made while conducting field visits to obtain data for this use attainability analysis. Potential impacts of losing a water source were identified based on availability and distance to alternative sources of water.

Available data on aquatic invertebrates were obtained from the Wyoming Department of Environmental Quality Water Quality Division (WDEQ-WQD). This agency routinely monitors water quality of Wyoming streams, and sampling usually includes collection of data on aquatic macroinvertebrates. Data on fish in Cottonwood Creek were obtained from the Wyoming Game and Fish Department (WGFD). These data were supplemented with data collected during other portions of the current study to evaluate selenium levels in fish and aquatic invertebrates.

RESULTS

Threatened, Endangered, Proposed, and Petitioned Species

The Cottonwood Creek riparian corridor and surrounding area provides habitat for threatened, endangered, and other sensitive species. The Wildlife Observation System (WOS) contains 6 records of the threatened bald eagle. Bald eagles likely forage for fish along the stream during the winter months. There are also records of three mountain plovers, which have been proposed for listing as threatened. Although not typically associated with riparian areas, they have been known to stage as well as nest in cultivated areas and mountain plovers may use the agricultural fields adjacent to the stream in early spring. Two species documented along the stream have been petitioned for listing as threatened, including the northern sage-grouse and yellow-billed cuckoo. Yellow-billed cuckoos are rare residents of cottonwood riparian zones and there is one observation along Cottonwood Creek in the WOS records. The Cottonwood Creek riparian area and associated agricultural areas are apparently very important for sage grouse in this region. The WOS database contains 88 records totaling 385 sage grouse. The riparian zone along the creek and associated crop fields, especially alfalfa, provide excellent sage grouse brood-rearing and late

summer foraging habitat. Availability of this habitat may be important to maintenance of this sage grouse population. There have also been observations of western small-footed myotis (a bat) along the stream. This species is considered sensitive in the western U.S. due to low populations. With perhaps the exception of sage grouse, continued discharge of produced water in Cottonwood Creek is not likely crucial to the survival of any populations of these species; however, it does provide some habitat for sensitive species at certain times of the year and may be important to the continued survival of some individuals.

Big Game

In a letter to WDEQ dated June 20, 1990, the WGFD stated their opposition to eliminating discharge to Cottonwood Creek (see Appendix H). Their primary concern at that time was with the large number of mule deer that concentrate along Cottonwood Creek in the winter. Several hundred deer can be found along the crucial winter range riparian zone associated with Cottonwood Creek, and Cottonwood Creek supports one of the major concentrations of mule deer in Management Areas 119 and 120. During post-season classifications, 200-300 mule deer are routinely found along a two-mile stretch of the creek. The WGFD believes that these deer concentrations are directly tied to the produced water from Hamilton Dome. The WGFD stated that although they are not as directly tied to the produced water as are the mule deer, 50-75 pronghorn antelope are commonly found in and around the Hamilton Dome complex throughout the year. The WGFD concluded their letter by stating that the water produced at Hamilton Dome "does provide substantial benefits to the wildlife resource which is using this area." Mr. Kevin Hurley, the WGFD biologist stationed in Thermopolis, stated that he has reviewed the 1990 letter and believes that its contents are still applicable to today's situation. In addition to the 1990 letter specific to Cottonwood Creek, the WGFD also submitted another letter to WDEQ dated June 10, 2002 (see Appendix H). The purpose of this letter was to state that the WGFD believes that historic discharges by oil and gas production facilities provide a beneficial use to fish and/or wildlife. The importance of this area to big game can be found in the Wildlife Observation System (WOS) records for those sections through which Cottonwood Creek flows from Hamilton Dome to the Bighorn River. These records include 649 observations totaling 2,564 mule deer,

702 observations totaling 5,664 pronghorn, 7 observations of single white-tailed deer, and one observation of a moose (Table 1). If Hamilton Dome discharge were to cease, the lack of water would likely severely impact big game as well as other terrestrial wildlife species dependant on this water source, as there are no other perennial water sources available in the area. The lack of an alternative water source is illustrated by the National Wetland Inventory map on Figure 1, which shows a nearly complete lack of other water sources within 5 miles of Cottonwood Creek throughout much of its length. Without the produced water, big game populations, especially those of mule deer, would likely be reduced.

Upland Gamebirds

The relationship between sage grouse (also an important game bird) and Cottonwood Creek is discussed above in the sensitive species section. In addition to sage grouse, the Cottonwood Creek riparian area and associated irrigated croplands provide excellent habitat for ring-necked pheasant, gray partridge, and other upland game birds. The WOS records contain 11 observations totaling 73 gray partridge, 59 observations totaling 819 chukar, 24 observations totaling 139 ring-necked pheasants, and 11 observations totaling 22 mourning doves. Large numbers of game birds are present in this area primarily due to the availability of Hamilton Dome produced water. Irrigated crop fields provide foraging habitat as well as some nesting habitat and cover. High water tables associated with a perennial stream, irrigation water return flows, and overflows of irrigation water off of cropfields onto adjacent areas provide substantial vegetative cover for upland game birds. Loss of produced water would eliminate or greatly reduce habitat for upland game birds through elimination of irrigated crops and dense vegetative cover.

Raptors

Due to the presence of cottonwood trees, which provide nesting substrate, and excellent riparian and cropland habitat for prey, numerous raptors have been documented along Cottonwood Creek. Several small mammals used as prey by many raptor species have been documented in this area, including masked shrew, desert cottontail, least chipmunk, Wyoming ground squirrel, montane vole, and long-tailed vole (Table 1). Golden eagle appears to use this area the most. The WOS

contains records of 49 golden eagles. As mentioned above, 6 bald eagles have also been observed in this area. Other species of raptors documented include northern harrier (2 records), red-tailed hawk (4 records), prairie falcon (2 records), merlin (1 record), American kestrel (5 records), great horned owl (5 records), and burrowing owl (1 record) (Table 1). Elimination of the produced water would reduce habitat for raptor prey species and likely result in reduced habitat available for both breeding and wintering raptors in the area.

Waterfowl and Waterbirds

Large flocks of waterfowl have been observed using crop fields adjacent to Cottonwood Creek in the area, including flocks containing 65 Canada geese and 57 sandhill cranes. According to Kevin Hurley, Cottonwood Creek is used by many waterfowl. Duck species documented along Cottonwood Creek on WOS records include observations of 26 mallards and 12 blue-winged teal. Other species of waterbirds documented by the WGFD along the creek include great blue heron, Wilson's phalarope, spotted sandpiper, and killdeer (Table 1).

While conducting activities for this project, Canada geese were observed in Lake Charlie in the spring of 2002. In June 2002, several adult American coots and one group of young coots were observed on ponds adjacent to Lake Charlie that are supported indirectly by Hamilton Dome discharge, and spotted sandpipers and killdeer were observed along the discharge canal. There is a large open water/wetland complex where discharge from Hamilton Dome enters Cottonwood Creek across from Legend Rock. In late June 2002, there were approximately 20 gadwall using this area. Other waterbirds at the site included killdeer, spotted sandpipers, and Wilson's phalaropes. In late August, a female gadwall and four young were observed on Lake Charlie; up to 15 Wilson's phalaropes and a pair of eared grebes were also present on the lake. Numerous waterfowl (15-25), primarily mallard and blue-winged teal, were using the ponds adjacent to Lake Charlie. Several killdeer were observed in and near wetlands created by discharge water before it entered Cottonwood Creek. Elimination of the produced water would also result in the elimination of a substantial amount of waterfowl and waterbird habitat, especially in late summer after natural spring runoff flows in Cottonwood Creek have ceased.

Neotropical Migrant Birds

Thirty species of neotropical migrant birds have been identified along Cottonwood Creek by the Wyoming Game and Fish (Table 1). Neotropical migrants breed in the United States and Canada but spend in the winter in Central and South America. Due to loss of habitat and other mortality factors, many species of neotropical migrants are showing dramatic population declines. Riparian habitats support the highest density of nongame birds of any habitat in the arid west, and maintaining this habitat is considered critical to maintaining healthy populations of many nongame birds.

During field activities conducted for this project, several species of neotropical migrant birds were observed in and near wetlands created by the discharge from Hamilton Dome prior to it entering Cottonwood Creek. These species included Brewer's blackbird, red-winged blackbird, common yellowthroat, savannah sparrow, and song sparrow. All of these species were breeding in wetlands created by produced water.

Other Wildlife

During surveys for this project, several recent beaver dams were located along Hamilton Dome discharge channels prior to the channels entering Cottonwood Creek. The WGFD has records of coyote, red fox, long-tailed weasel, badger, bobcat, and mountain lion along Cottonwood Creek. No amphibians have been documented in the project area. The only reptile documented is bull snake (Table 1).

Aquatic Fish and Invertebrates

Cottonwood Creek supports a diverse assemblage of fish. It is managed by the WGFD as a unique species fishery, with emphasis on management of native nongame species and Yellowstone cutthroat trout (Welker, M. 2000. Basin Management Plan: Middle Big Horn River. Wyoming Game and Fish Department, Cheyenne. 9 pp.). Native fish species documented in Cottonwood Creek by the WGFD include flathead chub, fathead minnow, lake chub, longnose sucker, mountain sucker, stonecat, white sucker, and Yellowstone cutthroat. Introduced species documented in Cottonwood Creek include carp, plains killifish, and rainbow trout.

The Wyoming Game and Fish Department sampled five locations along Cottonwood Creek downstream of Hamilton Dome discharge in May 1990, and documented the presence of plains killifish, flathead chub, and longnose sucker. More recently, the WGFD sampled fish at two locations along Cottonwood Creek downstream of the discharge in the spring of 1999. At one station located approximately 14 miles downstream of the discharge, two species of game fish (rainbow trout and Yellowstone cutthroat trout) were documented along with several species of nongame fish, including white sucker, longnose sucker, mountain sucker, carp, longnose dace, fathead minnow, and plains killifish. At the other station located near the confluence with the Bighorn River, several species of nongame fish including white sucker, longnose sucker, mountain sucker, carp, lake chub, flathead chub, fathead minnow, and plains killifish were documented. During sampling conducted by WEST, Inc. in August 2002 at three locations along Cottonwood Creek, nongame fish were documented at each location sampled. Several species were present including longnose dace, plains killifish, longnose sucker, fathead minnow, flathead chub, and white sucker. The native fish in Cottonwood Creek have their own intrinsic value, but presence of fish in Cottonwood Creek is also important because the fish provide forage for a variety of wildlife. Elimination of produced water would convert Cottonwood Creek from a perennial stream with a unique species fishery to an ephemeral stream incapable of supporting fish for most of the year.

Aquatic invertebrate data are available from three sampling locations along Cottonwood Creek. The stream supports a diverse and abundant macroinvertebrate community. Densities at the three sites ranged from 641 to 1196 individuals per square meter. The number of invertebrate taxa identified at each site ranged from 29 to 35. At each station, the proportion of the invertebrates comprised of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa ranged from 28% to 49% and averaged 42% (Table 2). Presence of large numbers of these taxa is important because they are generally considered to be pollution sensitive and good indicators of overall water/habitat quality. Ponds supported by produced water either directly (i.e., Lake Charlie) or indirectly (ponds receiving irrigation return flows) were also found to have a diverse aquatic invertebrate community during sampling to document selenium concentrations. A list of taxa

documented in these ponds is in Table 2. During extremely dry years, as occurred in 2002, Cottonwood Creek is the only stream with flowing water within several miles, and loss of this resource could impact population levels of wildlife that depend on aquatic invertebrates and fish in the stream.

Wildlife Habitat

Based on results of the wetland impact study conducted for this project, if the discharge from Hamilton Dome and associated irrigation of crop fields were to cease, it was estimated that approximately 600 acres of high-quality wetlands would likely be lost, including 100 acres supported directly by discharge and another approximately 500 acres along Cottonwood Creek that are indirectly supported by Hamilton Dome discharge. Wetlands are very valuable wildlife habitats and this extensive loss would result in population declines and displacement of wildlife species associated with wetlands. Conversion of Cottonwood Creek from a perennial to an ephemeral stream would also impact riparian vegetation and further reduce habitat for those species of wildlife within the riparian corridor. Although some of the more mature trees such as the larger cottonwoods with well-established roots would continue to survive within the watershed, the lack of a water source throughout the entire growing season would result in substantial changes in the riparian plant community. The community would become less diverse with the loss of wetlands and other mesic plant communities. This change would reduce habitat effectiveness for many species of wildlife dependant on riparian communities. The expected impact to wetlands and other riparian plant communities if discharge of produced water were to cease can be seen by examining pictures of Cottonwood Creek in the wetland report that clearly show reduced habitat effectiveness upstream of the discharge vs. below the discharge.

Table 1. Wildlife documented by the Wyoming Game and Fish in sections along Cottonwood Creek from Hamilton Dome downstream to the confluence with the Bighorn River

Species	No. Groups	No. Individuals
Birds		
Mallard	5	26
Blue-winged teal	4	12
Canada goose	1	65
Great blue heron	1	4
Sandhill Crane	1	57
Wilson's phalarope	7	33
Spotted Sandpiper	2	14
Killdeer[a]	3	11
Mountain Plover[a]	2	3
Gray partridge	11	73
Chukar	59	819
Sage Grouse	88	385
Ring-necked Pheasant	24	139
Mourning Dove[a]	11	22
Northern harrier[a]	2	2
Red-tailed hawk[a]	3	4
Golden eagle[a]	40	49
Bald eagle	5	6
Prairie falcon[a]	2	2
Merlin[a]	1	1
American kestrel[a]	5	5
Great horned owl	2	2
Burrowing owl[a]	1	1
Yellow-billed cuckoo[a]	1	1
Belted kingfisher[a]	1	1
Common nighthawk[a]	1	2
Western kingbird[a]	1	2
Cassin's kingbird[a]	1	1
Horned lark[a]	6	8
Black-billed magpie	3	5
Western meadowlark[a]	27	97
Brewer's blackbird[a]	6	11

Table 1. Wildlife documented by the Wyoming Game and Fish in sections along Cottonwood Creek from Hamilton Dome downstream to the confluence with the Bighorn River

Species	No. Groups	No. Individuals
Pine siskin[a]	7	11
Vesper sparrow[a]	6	9
Savannah sparrow[a]	3	4
Grasshopper sparrow[a]	2	2
Lark sparrow[a]	1	1
Song sparrow[a]	1	1
Lark bunting[a]	27	155
Cliff swallow[a]	6	10
Sage thrasher[a]	2	7
Rock wren[a]	2	2
American robin[a]	1	1
Mountain bluebird[a]	1	1
Mammals		
Masked shrew	2	2
Western small-footed myotis	2	2
Desert cottontail	4	4
Least chipmunk	1	1
Wyoming ground squirrel	1	1
Montane vole	2	2
Long-tailed vole	2	2
Coyote	11	13
Red fox	2	2
Long-tailed weasel	1	1
Badger	1	1
Bobcat	59	61
Mountain lion	2	2
Moose	1	1
Mule deer	649	2564
White-tailed deer	7	7
Pronghorn	702	5664
Reptiles		
Bullsnake	1	1

[a] neotropical migratory bird

Table 2. Data on aquatic invertebrates in Cottonwood Creek and ponds associated with Hamilton Dome discharge

Cottonwood Creek - lower, 225-1ME, August 13, 1998

WY: DEQ-Water Quality Division. Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD058

IDENTIFICATION CODE	98WD058
CORRECTION FACTOR	2.24

Taxon	Abundance	%
Enchytraeidae	13	1.12
Mesenchytraeus minutus	4	0.37
Nais bretscheri	2	0.19
Nais communis	4	0.37
Uncinais uncinata	7	0.56
Imma. Tubificid with cap. setae	13	1.12
Rhyacodrilus coccineus	2	0.19
Acari	16	1.31
TOTAL: NON INSECTS	63	5.24
Ophiogomphus	16	1.31
TOTAL: ODONATA	16	1.31
Baetis tricaudatus	4	0.37
Tricorythodes minutus	408	34.08
TOTAL: EPHEMEROPTERA	412	34.46
Hydropsyche	16	1.31
Hydroptila	25	2.06
Ochrotrichia	36	3.00
TOTAL: TRICHOPTERA	76	6.37
Optioservus	2	0.19
TOTAL: COLEOPTERA	2	0.19
Ceratopogoninae	4	0.37
Empididae	4	0.37
Hemerodromia	13	1.12
Simulium	65	5.43
Tabanidae	2	0.19
Dicranota	2	0.19
TOTAL: DIPTERA	92	7.68
Chironomidae-pupae	125	10.49
Cricotopus	164	13.67
Cricotopus Bicinctus Gr.	119	9.93
Eukiefferiella	4	0.37
Orthocladius Complex	9	0.75
Polypedilum	25	2.06
Rheotanytarsus	9	0.75
Saetheria	81	6.74
TOTAL: CHIRONOMIDAE	535	44.76
GRAND TOTAL	1196	100.00

Cottonwood Creek - lower, 225-1ME, August 13, 1998
WY: DEQ-Water Quality Division. Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD058

Total invertebrate abundance	= 1196.1	EPT abundance	= 488.3
Total number of taxa	= 29	Number EPT taxa	= 5
Hilsenhoff Biotic Index	= 5.41	Brillouin H	= 2.27

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	8	62.7	5.23
Odonata	1	15.7	1.31
Ephemeroptera	2	412.2	34.45
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	3	76.2	6.37
Lepidoptera	0	0.0	0.00
Coleoptera	1	2.2	0.19
Misc. Diptera	6	91.8	7.67
Chironomidae	8	535.3	44.76

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	6	42.6	3.55
Parasite	1	15.7	1.31
Collector-gatherer	13	831.0	69.46
Collector-filterer	3	89.6	7.49
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	2	60.5	5.06
Scraper	1	2.2	0.19
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	2	29.1	2.43
Unknown	1	125.4	10.49

DOMINANT TAXON	ABUNDANCE	PERCENT
Tricorythodes minutus	407.7	34.08
Cricotopus	163.5	13.67
Chironomidae-pupae	125.4	10.49
Cricotopus Bicinctus Gr.	118.7	9.93
Saetheria	80.6	6.74
SUBTOTAL 5 DOMINANTS	895.9	74.91
Simulium	65.0	5.43
Ochrotrichia	35.8	3.00
Hydroptila	24.6	2.06
Polypedilum	24.6	2.06
Acari	15.7	1.31
TOTAL 10 DOMINANTS	1061.7	88.77

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	0	0.0	0.00
B Tolerant mayflies	1	407.7	34.08
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	2	60.5	5.06
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	1	2.2	0.19
H Intolerant flies	0	0.0	0.00
I Tolerant flies	2	15.7	1.31
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Cottonwood Creek - lower, 225-1ME, August 13, 1998
WY: DEQ-Water Quality Division. Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD058

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 0.91
Hydropsychidae/Total Trichoptera	= 0.21
Baetidae/Total Ephemeroptera	= 0.01

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.03
Scraper/(Scraper + C.-filterer)	= 0.02
Shredder/Total organisms	= 0.00

Biotic Condition Index

Community Tolerance Quotient (a)	= 102.83
Community Tolerance Quotient (d)	= 105.61

DIVERSITY MEASURES

Shannon H (loge)	= 2.32
Shannon H (log2)	= 3.34
Evenness	= 0.69
Simpson D	= 0.17

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	469.8	39.28
Univoltine	708.4	59.23
Semivoltine	17.9	1.50

Cottonwood Creek @ Baird, 225-2ME, August 13, 1998

WY: DEQ-Water Quality Division. Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD059

IDENTIFICATION CODE	98WD059
CORRECTION FACTOR	1.92

Taxon	Abundance	%
Nematoda	4	0.39
Nais variabilis	4	0.39
Ophidonais serpentina	10	0.97
Imma. Tubificid with cap. setae	4	0.39
Imma. Tubificid w/o cap. setae	6	0.58
TOTAL: NON INSECTS	27	2.72
Ophiogomphus	13	1.36
TOTAL: ODONATA	13	1.36
Baetidae	8	0.78
Acentrella insignificans	2	0.19
Baetis tricaudatus	10	0.97
Tricorythodes minutus	136	13.81
TOTAL: EPHEMEROPTERA	156	15.76
Hydropsyche	23	2.33
Hydroptila	54	5.45
Ochrotrichia	46	4.67
Oecetis	2	0.19
TOTAL: TRICHOPTERA	125	12.65
Microcylloepus	4	0.39
TOTAL: COLEOPTERA	4	0.39
Ceratopogoninae	2	0.19
Empididae	4	0.39
Hemerodromia	6	0.58
Limnophora	2	0.19
Simulium	56	5.64
Dicranota	2	0.19
TOTAL: DIPTERA	71	7.20
Chironomidae-pupae	148	14.98
Cricotopus	169	17.12
Cricotopus Bicinctus Gr.	13	1.36
Cricotopus Trifascia Gr.	27	2.72
Eukiefferiella	13	1.36
Larsia	4	0.39
Orthocladius Complex	36	3.70
Paratanytarsus	4	0.39
Polypedilum	106	10.70
Rheotanytarsus	4	0.39
Saetheria	33	3.31
Stictochironomus	27	2.72
Thienemanniella	4	0.39
Thienemannimyia Gr.	4	0.39
TOTAL: CHIRONOMIDAE	591	59.92
GRAND TOTAL	987	100.00

Cottonwood Creek @ Baird, 225-2ME, August 13, 1998
WY: DEQ-Water Quality Division. Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD059

Total invertebrate abundance	= 986.9	EPT abundance	= 280.3
Total number of taxa	= 35	Number EPT taxa	= 8
Hilsenhoff Biotic Index	= 5.80	Brillouin H	= 2.65

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	5	26.9	2.72
Odonata	1	13.4	1.36
Ephemeroptera	4	155.5	15.75
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	4	124.8	12.64
Lepidoptera	0	0.0	0.00
Coleoptera	1	3.8	0.39
Misc. Diptera	6	71.0	7.18
Chironomidae	14	591.4	59.92

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	8	36.5	3.68
Parasite	1	3.8	0.39
Collector-gatherer	15	487.7	49.40
Collector-filterer	3	82.6	8.36
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	2	99.8	10.12
Scraper	1	3.8	0.39
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	3	121.0	12.25
Unknown	2	151.6	15.37

DOMINANT TAXON	ABUNDANCE	PERCENT
Cricotopus	169.0	17.12
Chironomidae-pupae	147.8	14.98
Tricorythodes minutus	136.3	13.81
Polypedilum	105.6	10.70
Simulium	55.7	5.64
SUBTOTAL 5 DOMINANTS	614.4	62.25
Hydroptila	53.8	5.45
Ochrotrichia	46.1	4.67
Orthocladius Complex	36.5	3.70
Saetheria	32.6	3.31
Cricotopus Trifascia Gr.	26.9	2.72
TOTAL 10 DOMINANTS	810.2	82.10

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	0	0.0	0.00
B Tolerant mayflies	1	136.3	13.81
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	3	101.8	10.31
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	1	3.8	0.39
H Intolerant flies	0	0.0	0.00
I Tolerant flies	2	7.7	0.77
J Intolerant midges	0	0.0	0.00
K Tolerant midges	1	26.9	2.72
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Cottonwood Creek @ Baird, 225-2ME, August 13, 1998
WY: DEQ-Water Quality Division, Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD059

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 0.47
Hydropsychidae/Total Trichoptera	= 0.18
Baetidae/Total Ephemeroptera	= 0.12

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.05
Scraper/(Scraper + C.-filterer)	= 0.04
Shredder/Total organisms	= 0.00

Biotic Condition Index

Community Tolerance Quotient (a)	= 100.11
Community Tolerance Quotient (d)	= 104.21

DIVERSITY MEASURES

Shannon H (loge)	= 2.72
Shannon H (log2)	= 3.92
Evenness	= 0.77
Simpson D	= 0.10

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	542.4	54.96
Univoltine	427.2	43.29
Semivoltine	17.3	1.75

Cottonwood Creek @ Legend Rock, 224-1ME, Aug. 12, 1998

WY: DEQ-Water Quality Division. Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD057

IDENTIFICATION CODE	98WD057
CORRECTION FACTOR	1.35

Taxon	Abundance	%
Nematoda	1	0.21
Enchytraeidae	3	0.42
Enchytraeus albidus	5	0.84
Nais communis	3	0.42
Pristina jenkinae	8	1.26
Uncinais uncinata	19	2.95
Imma. Tubificid with cap. setae	8	1.26
Imma. Tubificid w/o cap. setae	16	2.53
Limnodrilus hoffmeisteri	5	0.84
Rhyacodrilus coccineus	58	9.05
Tubifex	3	0.42
Physella	1	0.21
Acari	28	4.42
TOTAL: NON INSECTS	159	24.84
Ophiogomphus	1	0.21
TOTAL: ODONATA	1	0.21
Baetidae	3	0.42
Acentrella insignificans	84	13.05
Baetis tricaudatus	32	5.05
Rhithrogena	3	0.42
Tricorythodes minutus	142	22.11
TOTAL: EPHEMEROPTERA	263	41.05
Skwala	3	0.42
TOTAL: PLECOPTERA	3	0.42
Hydropsyche	39	6.11
Ochrotrichia	11	1.68
TOTAL: TRICHOPTERA	50	7.79
Chelifera	5	0.84
Hemerodromia	1	0.21
Limnophora	1	0.21
Simulium	18	2.74
TOTAL: DIPTERA	26	4.00
Chironomidae-pupae	22	3.37
Cricotopus	39	6.11
Cricotopus Trifascia Gr.	19	2.95
Eukiefferiella	4	0.63
Orthocladius Complex	26	4.00
Parametriocnemus	1	0.21
Rheotanytarsus	27	4.21
Thienemannimyia Gr.	1	0.21
TOTAL: CHIRONOMIDAE	139	21.68
GRAND TOTAL	641	100.00

Cottonwood Creek @ Legend Rock, 224-1ME, August 12, 1998
WY: DEQ-Water Quality Division. Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD057

Total invertebrate abundance	= 641.3	EPT abundance	= 315.9
Total number of taxa	= 34	Number EPT taxa	= 8
Hilsenhoff Biotic Index	= 5.65	Brillouin H	= 2.69

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	13	159.3	24.83
Odonata	1	1.4	0.21
Ephemeroptera	5	263.3	41.05
Plecoptera	1	2.7	0.42
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	2	50.0	7.79
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	4	25.6	4.00
Chironomidae	8	139.0	21.69

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	6	13.5	2.10
Parasite	2	29.7	4.63
Collector-gatherer	19	475.2	74.10
Collector-filterer	3	83.7	13.06
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	1	10.8	1.68
Scraper	1	2.7	0.42
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	1	4.0	0.63
Unknown	1	21.6	3.37

DOMINANT TAXON	ABUNDANCE	PERCENT
Tricorythodes minutus	141.8	22.11
Acentrella insignificans	83.7	13.05
Rhyacodrilus coccineus	58.0	9.05
Hydropsyche	39.1	6.11
Cricotopus	39.1	6.11
SUBTOTAL 5 DOMINANTS	361.8	56.43
Baetis tricaudatus	32.4	5.05
Acari	28.4	4.42
Rheotanytarsus	27.0	4.21
Orthocladius Complex	25.6	4.00
Chironomidae-pupae	21.6	3.37
TOTAL 10 DOMINANTS	496.8	77.48

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	1	1.4	0.21
B Tolerant mayflies	1	141.8	22.11
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	1	10.8	1.68
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	2	2.7	0.42
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Cottonwood Creek @ Legend Rock, 224-1ME, August 12, 1998
WY: DEQ-Water Quality Division. Deter. by Aquatic Biology Associates, Inc.
Benthic invertebrate biomonitoring. Composite 8 Surbers (500 micron).
Abundance per square meter, 500+ organism subsample. FILE: 98WD057

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 2.27
Hydropsychidae/Total Trichoptera	= 0.78
Baetidae/Total Ephemeroptera	= 0.45

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.03
Scraper/(Scraper + C.-filterer)	= 0.03
Shredder/Total organisms	= 0.00

Biotic Condition Index

Community Tolerance Quotient (a)	= 98.85
Community Tolerance Quotient (d)	= 100.52

DIVERSITY MEASURES

Shannon H (loge)	= 2.78
Shannon H (log2)	= 4.01
Evenness	= 0.79
Simpson D	= 0.09

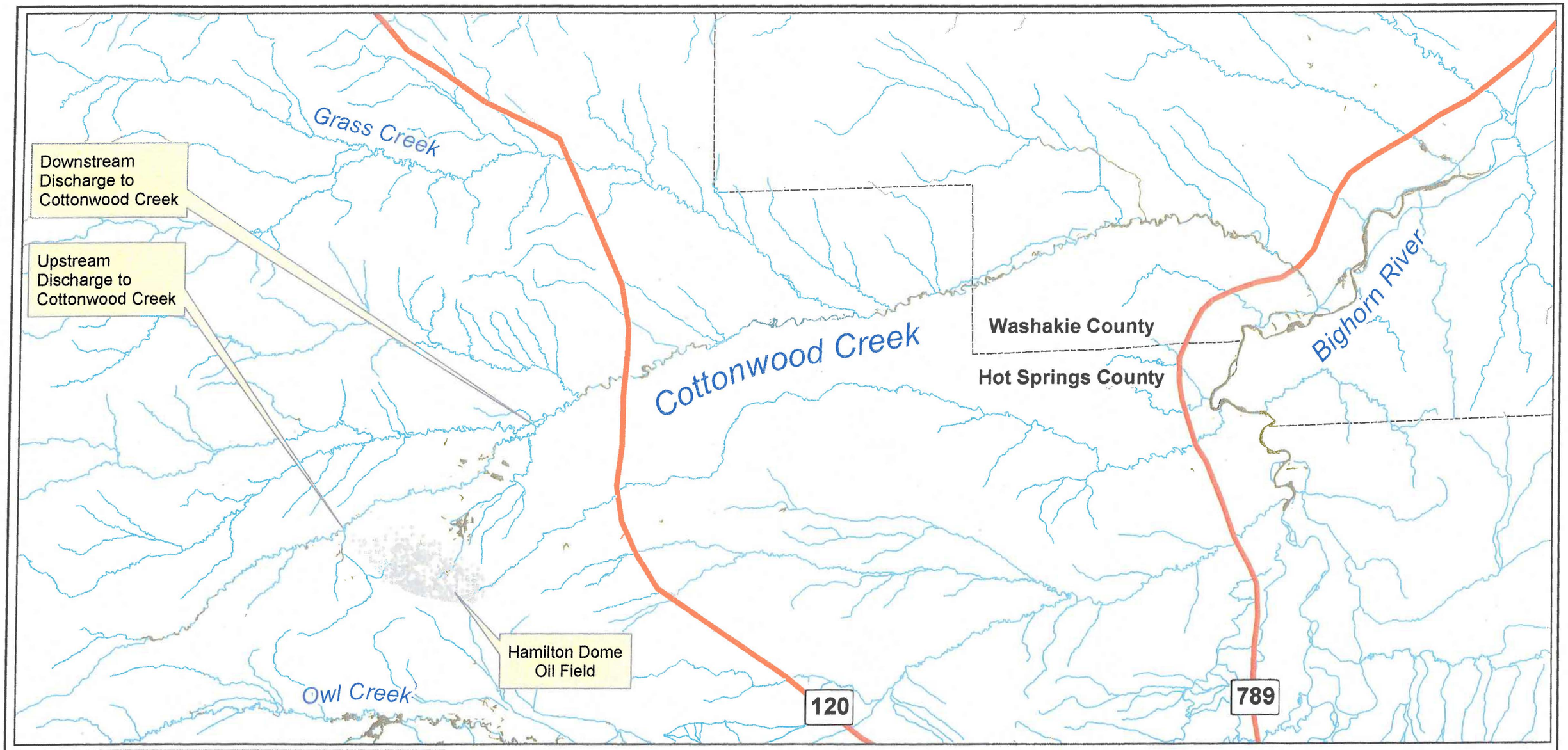
COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	241.0	37.58
Univoltine	399.0	62.21
Semivoltine	1.4	0.21

Aquatic invertebrates documented in three ponds receiving produced water from Hamilton Dome, August 2002

Location	Invertebrate Composition
Pond 1 (NW of Lake Charlie - receives irrigation return flows comprised of produced water)	snails (Gastropoda)
	mayfly larvae (Ephemeroptera)
	stonefly larvae (Plecoptera)
	water boatman (*Corixa* sp.)
	water flea (*Daphnia* sp.)
	fly larvae (Diptera)
	midge larvae (Chironomidae)
Pond 2 (immediately west of Lake Charlie - also receives irrigation return flows comprised of produced water)	snails (Gastropoda)
	mayfly larvae (Ephemeroptera)
	stonefly larvae (Plecoptera)
	diving beetle (Dytiscidae)
	water boatmen (*Corixa* sp.)
	beetles (Coleoptera)
	midge larvae (Chironomidae)
	fly larvae (Diptera)
	copepods (Copepoda)
Pond 3 (Lake Charlie - excavation receiving direct input of produced water)	mayfly larvae (Ephemeroptera)
	stonefly larvae (Plecoptera)
	midge larvae (Chironomidae)
	water boatmen (*Corixa* sp.)
	snails (Gastropoda)
	beetles (Coleoptera)
	scud (*Gammarus* sp.)

Figure 1. National Wetland Inventory Map showing location of other water sources within five miles of Cottonwood Creek



Legend

NWI Wetlands Within 5 Miles of Cottonwood Creek

N
W E
S

5 2.5 0 5 Miles

STATES WEST

WATER RESOURCES CORPORATION

October 25, 2002

Merit Energy Company Wetlands Within 5 Miles of Cottonwood Creek And Hamilton Dome Discharge Related Wetlands

APPENDIX F

WATER QUALITY REPORT

WATER QUALITY REPORTS

MERIT ENERGY COMPANY
HAMILTON DOME FIELD
NPDES DISCHARGES AND COTTONWOOD CREEK

CONTENTS:

Summary Report

Water Quality Criteria Exceedence Report

Map of Sampling Stations and Data

Chloride Report

Selenium Report

WATER QUALITY SUMMARY

Introduction

Cottonwood Creek originates in the Owl Creek Mountains in the Southwestern Big Horn Basin and traverses northeast across the semi-arid high plains until its confluence with the Bighorn River.

The following summarizes the status of the water quality of NPDES discharges, and Cottonwood Creek water quality upstream and downstream of the discharges. There are three subsequent self-contained reports in this appendix:

1. Water Quality Criteria Exceedence Report
2. Chloride Report
3. Selenium Report

Available USGS and BLM water quality data on Cottonwood Creek as well as 2002 sampling conducted by States West Water Resources Corporation have been compiled in spreadsheet and graphic forms. These documents follow the "Water Quality Criteria Exceedence Report," and includes a map of sampling sites (Figure I). Complete data sheets obtained from the Water Resource Data Systems website are available on request.

Water Quality upsteam of MEC Hamilton Dome Field

Flows above Hamilton Dome Field are dependent on springs, snowmelt, precipitation runoff, evaporation, evapotranspiration and infiltration. The conductivity (EC) of the pristine water upstream of the Hamilton Dome Field is in the range of 60 to 790 µmhos/cm. Ambient aluminum concentrations exceed DEQ/WQD Chapter I chronic

water quality standards for fish and aquatic life. Chloride concentrations are very minimal. Selenium concentrations are less than the chronic limit of 5 micro grams/L except for samples collected on August 29, 1983. All sampling locations upstream of Hamilton Dome Field exceeded the limit of 5 micro grams/L on that date. (The first 2002 sampling location labeled as Sample A and dated 3/20/02 was not above the MEC discharges from the hay field).

MEC Hamilton Dome Field NPDES Discharges

The produced water discharged by MEC at the Hamilton Dome Field is generally classified for livestock water use and has an EC ranging from 4,100 to 4,500 µmhos/cm. This water has chlorides and selenium that exceed the DEQ/WQD Chapter I water quality standards for fish and aquatic life. Theoretically, this discharge water would not fall under an agricultural use classification for alfalfa irrigation due to the high EC. However, water in this drainage is at a premium and the ranchers want the water to irrigate alfalfa and pastures. One rancher has invested a large amount of capital into a sprinkler irrigation system. The irrigated soils on the High Island property, which is only irrigated by MEC discharges, show an increase in soil salts to an EC level consistent with the MEC produced water. The surface has an SAR of 4.66 while the EC has a high of 6,130 µmhos/cm at a depth of 18-24 inches below the surface and 4,290 µmhos/cm at the surface. The photos on the following page reveal the sustained health of the alfalfa in this area.

Water downstream of MEC Hamilton Dome discharges

The water quality of Cottonwood Creek below Hamilton Dome Field is influenced by the soils environment of the watershed, the weather (evaporation and infiltration), the quality of MEC discharges, snowmelt runoff and precipitation runoff events, and irrigation diversions and return flows. The natural runoff from snowmelt consists of pristine quality water. Runoff from other precipitation events is generally of pristine quality; however, these events have a tendency to transport large amounts of sediment that

chemically react and dissolve in the water. The high aluminum concentrations that are evident upstream of the discharges, which exceed Wyoming Water Quality standards contained in Chapter I for fish and aquatic life use, result from this natural process.

Alfalfa Fields Along Cottonwood Creek

The water quality at sample point B on Cottonwood Creek downstream of the Hamilton Dome discharges is consistent with the water quality of MEC discharges in the absence of natural runoff. Under these circumstances, evaporation and irrigation return flows tend to increase concentrations of EC, chlorides and selenium from sample point B to the Bighorn River.

On the contrary, during periods of rainfall or snowmelt runoff, concurrent dilution of the MEC discharges will tend to bring the selenium and chloride concentrations within the DEQ/WQD Chapter I water quality standards for fish and aquatic life.

Water Quality of the hot spring at Hot Springs State Park

The MEC Hamilton Dome Field discharges originate primarily from the Phosphoria and Tensleep formations. (The State Park Hot Springs at Thermopolis also originate from the Phosphoria). A sample taken at the large hot spring on June 21, 2002 had an EC of 2,850 μmhos/cm. The chloride concentration was 245 mg/L and the selenium concentration was 11 μg/L. Both of these parameters exceed the DEQ/WQD Chapter I water quality standards for fish and aquatic life. (The sample also indicated a radium 226 concentration of 17.5 pico curries per liter).

Despite DEQ having indicated that they will not consider the case of the hot springs water quality as justification for increasing the selenium and chloride criteria on Cottonwood Creek, it is a peculiar irony that the natural hot spring flows, which exceed radium, selenium and chloride criteria, are discharged directly into the Bighorn River while the MEC discharged flows are put to beneficial uses on Cottonwood Creek before ever reaching the Bighorn River.

WATER QUALITY CRITERIA EXCEEDENCE REPORT

Hamilton Dome Oil Field Use Attainability Analysis Project

Prepared for

States West Water Resources Corporation
Cheyenne, Wyoming

Prepared by

Greg Johnson

Western EcoSystems Technology, Inc.
2003 Central Avenue
Cheyenne, WY 82001

November 14, 2002

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INTRODUCTION

Merit Energy Company (MEC) produces crude oil at the Hamilton Dome Field located in Hot Springs County, Wyoming. Merit Energy Company applied for and received two NPDES permits to discharge produced water from the Hamilton Dome Field into unnamed tributaries that eventually flow into Cottonwood Creek. The Water Quality Division (WQD) of the Wyoming Department of Environmental Quality (DEQ) recently updated Water Quality Rules and Regulations, Chapter 1, to comply with the federal Clean Water Act that requires all surface water be swimmable and fishable. Wyoming WQD was required to make changes to their statewide water classification system. Until the recent update of Chapter 1, the classification of the tributaries and Cottonwood Creek was Class 4. The tributaries are now class 3B and Cottonwood Creek is now class 2C. The new classifications require a chloride limit in Cottonwood Creek of 230 mg/L where a limit had not previously existed.

To obtain detailed information on water quality, States West Water Resources collected water samples on three different occasions in 2002. The first sampling on March 20, 2002 included the two Hamilton Dome discharge points. In addition, samples were collected at the following locations along Cottonwood Creek in March, April, and June 2002: Cottonwood A, upstream of the Hamilton Dome discharges; Cottonwood B, downstream of the Hamilton Dome discharges; and Cottonwood @ BHR, a sampling location on Cottonwood Creek downstream of the Hamilton Dome discharges and just prior to the confluence with the Big Horn River (see Figure 1). The Cottonwood A sample collected in March 2002 was later discovered to have come from a location that was not downstream of the Hamilton Dome discharges. As a result, the Cottonwood A location was moved further upstream for the April and June sampling events. In June 2002, a sample was also collected from the large mineral hot spring in Hot Springs State Park to provide a comparison to produced water in the Hamilton Dome oil field. The purpose of this report is to summarize water quality data for those parameters that exceeded Wyoming Department of Environmental Quality Aquatic Life Criteria.

METHODS

Water samples collected by States West Water Resources personnel were analyzed for the following 36 parameters: Bicarbonate, Boron, Calcium, Chlorides, Dissolved Cadmium, Dissolved Chromium, Dissolved Copper, Dissolved Iron, Dissolved Lead, Dissolved Manganese, Dissolved Mercury, Dissolved Nickel, Dissolved Silver, Dissolved Zinc, Fluoride, Magnesium, Potassium, pH, Phenol, Radium 226, Sodium Adsorption Ratio (SAR), Sodium, Specific Conductance, Sulfates, Total Dissolved Solids (TDS), Total Alkalinity, Total Aluminum, Total Antimony, Total Arsenic, Total Barium, Total Beryllium, Total Cyanide, Total Hardness, Total Selenium, Total Thallium, and Total Petroleum Hydrocarbons (TPH). Prior to sampling, a sampling kit for each sampling location was obtained from the Inter-Mountain Laboratories, Inc. (IML) facility in Gillette, Wyoming. Each kit included 7 bottles necessary to analyze for all 36 parameters. The sampling bottles for Phenols, Radium 226, Total Cyanide, and TPH all contained an acid preservative. Acid preservative was also added to the dissolved metals sampling bottle by IML personnel at the lab prior to filtering and analysis. For those bottles that did not contain preservatives, each bottle was rinsed twice with sampling water prior to obtaining the sample. For those bottles that did contain preservatives, samples were gathered with the raw sample bottle (part of the 7 bottle set with no preservatives), and then poured into the bottles containing preservatives. The raw sample bottle was also rinsed twice with sampling water prior to pouring into the other bottles. Field parameters for temperature, conductivity, and pH were then immediately taken with a Corning CheckMate II pH/conductivity meter. The meter was rinsed with distilled water prior to taking field measurements. Field measurements were recorded onto the raw sample bottle and chain-of-custody forms, and other sampling bottles were labeled with client information (date, time, site, and client name). The sampling kits were then stored in a cooler, and hand-delivered the same day to the IML laboratory in Sheridan, Wyoming.

RESULTS

Values for three of the parameters sampled (chloride, aluminum, selenium) exceeded WYDEQ aquatic life criteria on at least one of the locations sampled (Table 1). At the station in Cottonwood Creek upstream of all discharge, chloride levels were $\leq$ 8.5 mg/L all three sampling occasions (the

chronic criteria is 230 mg/L). Selenium concentrations were <5 μg/L all three occasions (the chronic criteria is 5 μg/L). However, aluminum values in Cottonwood Creek above the discharge were 1700 μg/L in both March and April and 100 μg/L in June. All of these values exceeded the chronic criteria of 87μg/L.

At the two sampling locations on Cottonwood Creek downstream of the discharge, chloride values ranged from 356 to 803 mg/L, with an average of 503 mg/L. All values were above the chronic criteria of 230 mg/L. Selenium values ranged from 25 to 67 μg/L with an average of 36 μg/L. The current chronic criteria for selenium is 5 μg/L. At Cottonwood B, aluminum values were above the chronic criteria in March (590 μg/L) and April (150 μg/L), but were below the criteria in June (80 μg/L). At the BHR Cottonwood Creek station, aluminum values were above the criteria all thee sampling occasions, ranging from 190 to 3,960 μg/L.

Chloride values were 392 mg/L at both Hamilton Dome discharge sample points. Historical data for chloride values at these two discharges indicate levels ranging from 369 to 540 mg/L (Table 2). Selenium values were 25 μg/L at one of the discharge points and 37 μg/L at the other. Aluminum values in the two discharge points were <50 and 70 μg/L, both of which are below the chronic criteria and substantially lower than aluminum levels in Cottonwood Creek.

Produced water from Hamilton Dome likely comes from some of the same formations that water at the Hot Springs in Thermopolis comes from. Chloride (245 mg/L) and selenium (11 μg/L) levels in water from the Hot Springs also exceeds chronic criteria. The value for aluminum (<50 μg/L) does not exceed the criteria.

CONCLUSIONS

Because the values for chloride and selenium are far below chronic criteria in Cottonwood Creek above Hamilton Dome discharge, but are higher than the criteria in Hamilton Dome discharge as well as in Cottonwood Creek below the discharge, the elevated levels of both chloride and selenium in Cottonwood Creek are likely due to discharge into the creek. However, because aluminum values

in Hamilton Dome discharge are very low (ranging from <50 to 70 μg/L), and because aluminum values in Cottonwood Creek above the discharge are greatly elevated, it does not appear that exceedence of the aluminum criteria in Cottonwood Creek is caused by Hamilton Dome discharge.

Table 1. Water quality values for parameters exceeding State of Wyoming Aquatic Life Criteria in Hamilton Dome discharge, Cottonwood Creek, and the Thermopolis Hot Springs (exceedences are in **bold**)

Cottonwood Creek A (upstream of discharge)					
Parameter	Date			Aquatic Life Criteria[a]	
	3-20-02	4-17-02	6-21-02	Acute	Chronic
Chloride (mg/L)	8.5	8.5	<5.0	860	230
Aluminum (μg/L)	**1700**	**1700**	**100**	750	87
Selenium (μg/L)	<5	<5	<5	20	5
Cottonwood B (downstream of discharge)					
Chloride (mg/L)	**430**	**373**	**492**	860	230
Aluminum (μg/L)	**590**	**150**	80	750	87
Selenium (μg/L)	**31**	**26**	**25**	20	5
Cottonwood at BHR (downstream of discharge)					
Chloride (mg/L)	**356**	**563**	**803**	860	230
Aluminum (μg/L)	**3,960**	**190**	**310**	750	87
Selenium (μg/L)	**29**	**36**	**67**	20	5
Discharge 680 (Hamilton Dome discharge)					
Chloride (mg/L)	**392**	--	--	860	230
Aluminum (μg/L)	<50	--	--	750	87
Selenium (μg/L)	**25**	--	--	20	5
Discharge 175 (Hamilton Dome discharge)					
Chloride (mg/L)	**392**	--	--	860	230
Aluminum (μg/L)	70	--	--	750	87
Selenium (μg/L)	**37**	--	--	20	5
Thermopolis Hot Springs					
Parameter	Date			Aquatic Life Criteria[a]	
	3-20-02	4-17-02	6-21-02	Acute	Chronic
Chloride (mg/L)	--	--	**245**	860	230
Aluminum (μg/L)	--	--	<50	750	87
Selenium (μg/L)	--	--	**11**	20	5

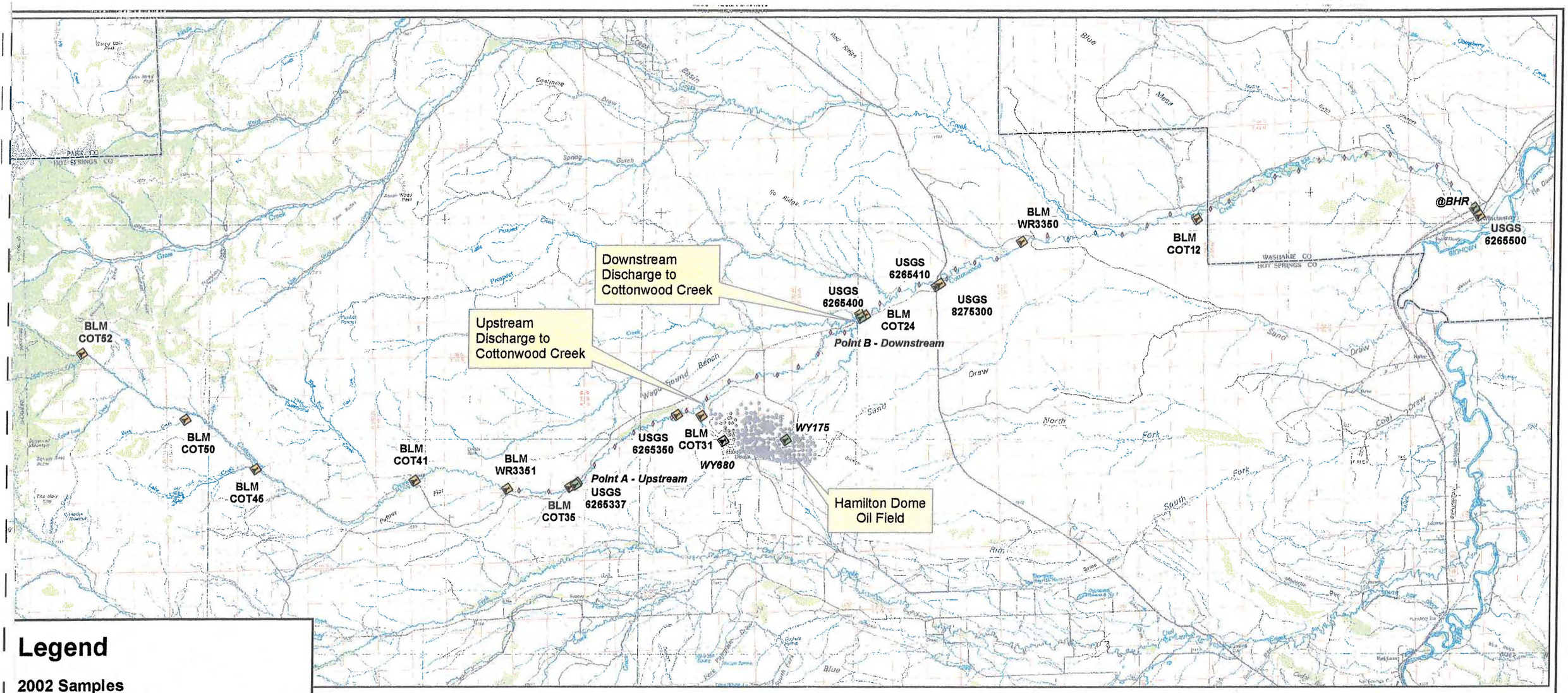
-- = no data

Table 2. Historical data for chloride levels in Hamilton Dome discharge

Discharge Point, Permit # WY0000175 .	
Date	Chlorides Mg/L
1/19/81	460
6/11/81	470
12/16/81	428
3/12/82	460
3/22/82	490
5/28/82	460
12/9/82	484
6/23/83	460
5/2/84	450
11/21/84	446
4/8/86	416
11/18/86	417
4/29/87	463
4/13/88	462
10/25/88	465
4/18/90	438
2/23/01	429
4/30/01	393
6/29/01	410
2/27/02	438
4/29/02	432
6/25/02	446
8/12/02	420
10/17/02	435

Discharge Point, Permit # WY0000680	
Date	Chlorides Mg/L
4/29/69	540
12/24/74	464
1/10/75	460
1/30/75	460
3/30/76	500
5/31/77	530
7/14/83	412
2/23/01	415
4/30/01	369
6/29/01	378
2/27/02	386
4/29/02	386
6/25/02	396
8/12/02	382
10/17/02	396

Figure 1. Locations for collecting Hamilton Dome discharge and Cottonwood Creek water quality samples



Legend

2002 Samples

Samples Taken by States West Water Resources Corporation
Samples Processed by Inter-Mountain Laboratories

Water Quality Grab Samples

Sources:
U.S. Geological Survey
BLM
Water Resources Data Systems (WRDS)

Stream Mile Markers

County Line

N
W E
S

10 5 0 10 Miles

STATES WEST

WATER RESOURCES CORPORATION

October 18, 2002

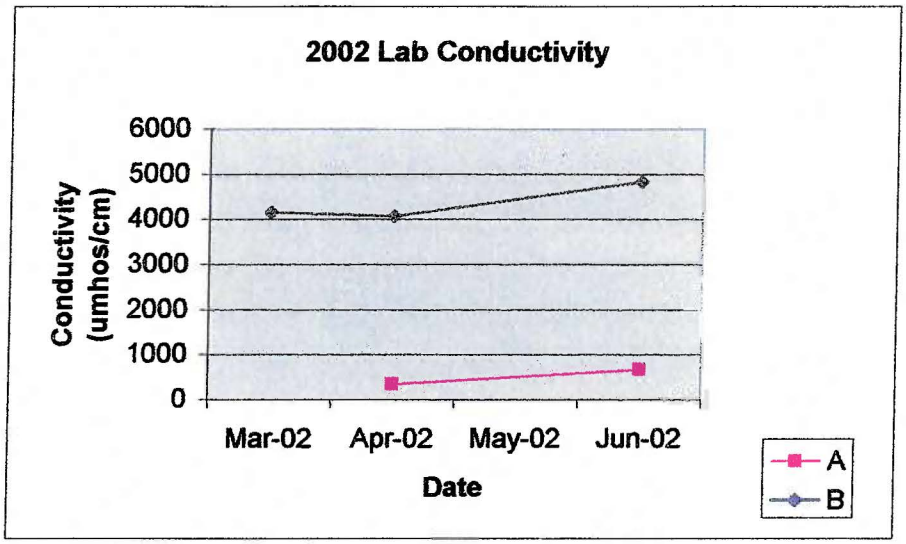
Figure 1
Merit Energy Company
USGS, BLM and 2002
Water Quality Sample Points

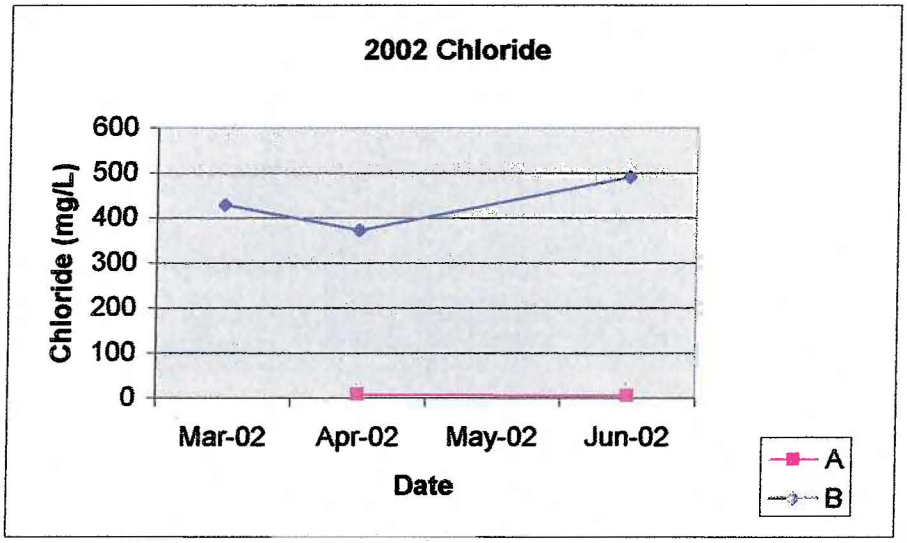
Attachment A. Water quality results for all parameters measured in Hamilton Dome discharge, Cottonwood Creek, and the Thermopolis Hot Springs.

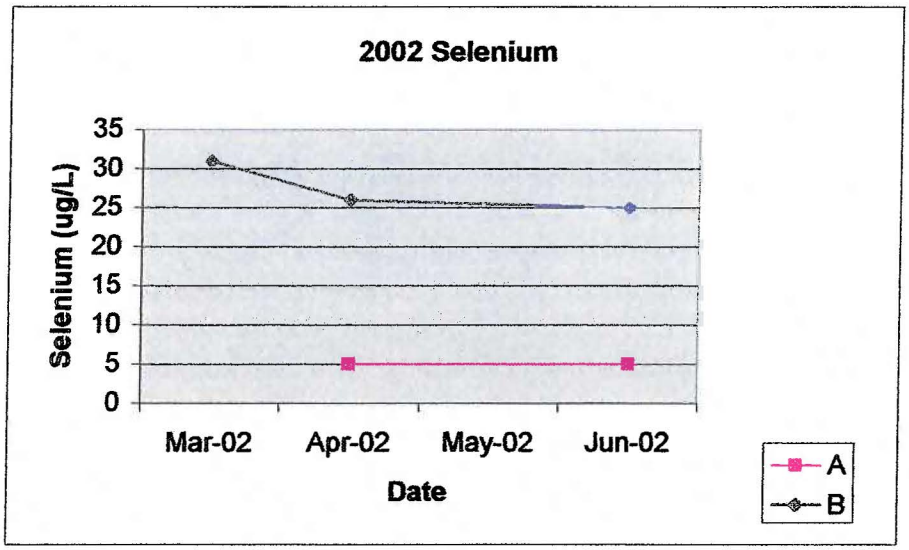
Sample ID: Cottonwood A = upstream of discharge
Sample ID Cottonwood B = downstream of discharge
Sample ID Cottonwood @ BHR = downstream of discharge
Sample ID WY0000680 = discharge
Sample ID WY00175 = discharge
Sample ID Hot Springs = Thermopolis Hot Springs

States West Water
Resources Corporation
2002 MEC Sample Results

A = Sample Point A - Upstream
B = Sample Point B - Downstream







Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome Cottonwood Creek
Sample ID: Cottonwood A
Lab ID: 0102W06214
Matrix: Water
Condition: Cool/Intact

Date Received: 04/17/02
Date Reported: 05/03/02
Date Sampled: 04/17/02
Time Sampled: 0750

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
General Parameters									
Lab pH	8.1	s.u.			0.1	EPA 150.1	04/19/02	2040	DB
Lab Conductivity @ 25°C	354	µmhos/cm			1	SM 2510 B	04/19/02	2040	DB
Total Dissolved Solids @ 180°C	260	mg/L			10	SM 2540 C	04/19/02	1345	RM
Total Alkalinity as CaCO3	130	mg/L			1.0	SM 2320 B	04/19/02	2040	DB
Total Hardness as CaCO3	69.0	mg/L			1.0	SM 309 A	04/23/02	1502	
Boron	<0.1	mg/L			0.1	EPA 200.7	04/23/02	1553	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	05/01/02	1336	KB
Phenols	<10	µg/L			10	EPA 420.2	04/24/02	1206	KB
Radium 226	<0.4±0.2L	pCi/L			0.2	EPA 903	05/02/01	0922	MW
TPH 418.1	<1	mg/L			1	EPA 418.1	04/25/02	1349	LA
Sodium Adsorption Ratio	2.7				N/A	N/A	04/23/02	1502	
Anions									
Bicarbonate as HCO3	159	mg/L	2.60	meq/L	1.0	SM 2320 B	04/19/02	2040	DB
Chloride	8.5	mg/L	0.24	meq/L	5.0	EPA 300.0	04/19/02	0730	DB
Fluoride	0.39	mg/L	0.02	meq/L	0.08	SM 4500-F	04/19/02	2040	DB
Sulfate	218	mg/L	4.54	meq/L	10	EPA 300.0	04/19/02	0730	DB
Cations									
Calcium	19.8	mg/L	0.99	meq/L	1.0	EPA 200.7	04/23/02	1502	BA
Magnesium	4.7	mg/L	0.39	meq/L	1.0	EPA 200.7	04/23/02	1502	BA
Potassium	1.4	mg/L	0.04	meq/L	0.2	EPA 200.7	04/23/02	1502	BA
Sodium	51.0	mg/L	2.22	meq/L	0.2	EPA 200.7	04/23/02	1502	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 8280

Client: Merit Energy
Project: Hamilton Dome Cottonwood Creek
Sample ID: Cottonwood A
Lab ID: 0102W06214
Matrix: Water
Condition: Cool/Intact

Date Received: 04/17/02
Date Reported: 05/03/02
Date Sampled: 04/17/02
Time Sampled: 0750

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	04/25/02	0941	MS
Chromium	<1	µg/L		1	EPA 200.9	04/19/02	0926	MH
Copper	2	µg/L		1	EPA 200.8	04/25/02	0941	MS
Iron	240	µg/L		30	EPA 200.7	04/23/02	1553	BA
Lead	<2	µg/L		2	EPA 200.8	04/25/02	0941	MS
Manganese	<10	µg/L		10	EPA 200.7	04/23/02	1553	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	04/24/02	1039	MS
Nickel	<10	µg/L		10	EPA 200.7	04/23/02	1553	BA
Silver	<3	µg/L		3	EPA 200.8	04/25/02	0941	MS
Zinc	<10	µg/L		10	EPA 200.7	04/23/02	1553	BA
Total Metals								
Aluminum	1,700	µg/L		50	EPA 200.7	04/23/02	1502	BA
Antimony	<5	µg/L		5	EPA 200.8	04/25/02	0933	MS
Arsenic	2	µg/L		1	EPA 200.8	04/25/02	0933	MS
Barium	<100	µg/L		100	EPA 200.8	04/25/02	0933	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	04/23/02	1502	BA
Selenium	<5	µg/L		5	EPA 200.8	04/25/02	0933	MS
Thallium	<10	µg/L		10	EPA 200.8	04/25/02	0933	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood A
Lab ID: 0102W12295
Matrix: Water
Condition: Cool/Intact

Date Received: 06/21/02
Date Reported: 07/15/02
Date Sampled: 06/21/02
Time Sampled: 0926

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
Field Parameters									
Field pH	8.34	s.u.			0.1	EPA 150.1			
Field Conductivity	678	µmhos/cm			0.1	SM 2510 B			
Field Temperature	19.8	°C			0.1	Field			
General Parameters									
Lab pH	8.5	s.u.			0.1	EPA 150.1	06/25/02	0037	DB
Lab Conductivity @ 25°C	717	µmhos/cm			1	SM 2510 B	06/25/02	0037	DB
Total Dissolved Solids @ 180°C	450	mg/L			10	SM 2540 C	06/24/02	1330	DB
Total Alkalinity as CaCO3	244	mg/L			1.0	SM 2320 B	06/25/02	0037	DB
Total Hardness as CaCO3	176	mg/L			1.0	SM 309 A	07/03/02	1125	
Boron	<0.1	mg/L			0.1	EPA 200.7	07/03/02	1237	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	07/01/02	1345	KB
Phenols	10	µg/L			10	EPA 420.2	06/26/02	1519	KB
Radium 226	<0.3±0.1L	pCi/L			0.2	EPA 903	07/02/02	1144	CS
TPH 418.1	<1	mg/L			1	EPA 418.1	07/01/02	1210	LA
Sodium Adsorption Ratio	2.9				N/A	N/A	07/03/02	1125	
Anions									
Bicarbonate as HCO3	276	mg/L	4.52	meq/L	1.0	SM 2320 B	06/25/02	0037	DB
Chloride	<5.0	mg/L	0.08	meq/L	5.0	EPA 300.0	06/25/02	0710	LH
Fluoride	0.73	mg/L	0.04	meq/L	0.08	SM 4500-F-C	06/25/02	0037	DB
Sulfate	109	mg/L	2.26	meq/L	10	EPA 300.0	06/25/02	0710	LH
Cations									
Calcium	45.7	mg/L	2.28	meq/L	1.0	EPA 200.7	07/03/02	1125	BA
Magnesium	15.0	mg/L	1.23	meq/L	1.0	EPA 200.7	07/03/02	1125	BA
Potassium	1.9	mg/L	0.05	meq/L	0.2	EPA 200.7	07/03/02	1125	BA
Sodium	87.9	mg/L	3.82	meq/L	0.2	EPA 200.7	07/03/02	1125	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 8280

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood A
Lab ID: 0102W12295
Matrix: Water
Condition: Cool/Intact

Date Received: 06/21/02
Date Reported: 07/15/02
Date Sampled: 06/21/02
Time Sampled: 0926

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	07/09/02	1029	MS
Chromium	<1	µg/L		1	EPA 200.9	06/25/02	0904	MH
Copper	2	µg/L		1	EPA 200.8	07/09/02	1029	MS
Iron	<30	µg/L		30	EPA 200.7	07/03/02	1237	BA
Lead	<2	µg/L		2	EPA 200.8	07/09/02	1029	MS
Manganese	<10	µg/L		10	EPA 200.7	07/03/02	1237	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	06/28/02	1004	MS
Nickel	<10	µg/L		10	EPA 200.7	07/03/02	1237	BA
Silver	<3	µg/L		3	EPA 200.8	07/09/02	1029	MS
Zinc	<10	µg/L		10	EPA 200.7	07/03/02	1237	BA
Total Metals								
Aluminum	100	µg/L		50	EPA 200.7	07/13/02	1125	BA
Antimony	<5	µg/L		5	EPA 200.8	07/09/02	0921	MS
Arsenic	1	µg/L		1	EPA 200.8	07/09/02	0921	MS
Barium	<100	µg/L		100	EPA 200.8	07/09/02	0921	MS
Beryllium	2.4	µg/L		0.9	EPA 200.7	07/13/02	1125	BA
Selenium	<5	µg/L		5	EPA 200.8	07/09/02	0921	MS
Thallium	<10	µg/L		10	EPA 200.8	07/09/02	0921	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN
Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood B
Lab ID: 0102W04326
Matrix: Water
Condition: Cool/Intact

Date Received: 03/20/02
Date Reported: 04/09/02
Date Sampled: 03/20/02
Time Sampled: 1002

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
Field Parameters									
Field pH	8.26	s.u.			0.1	EPA 150.1			
Field Conductivity	4,160	µmhos/cm			0.1	SM 2510 B			
Field Temperature	4.6	°C			0.1	Field			
General Parameters									
Lab pH	8.1	s.u.			0.1	EPA 150.1	03/21/02	1923	DB
Lab Conductivity @ 25°C	4,380	µmhos/cm			1	SM 2510 B	03/21/02	1923	DB
Total Dissolved Solids @ 180°C	3,210	mg/L			10	SM 2540 C	03/22/02	1300	RM
Total Alkalinity as CaCO3	461	mg/L			1.0	SM 2320 B	03/21/02	2005	DB
Total Hardness as CaCO3	1,200	mg/L			1.0	SM 309 A	03/27/02	1442	
Boron	1.5	mg/L			0.1	EPA 200.7	03/27/02	1719	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	04/01/02	1051	KB
Phenols	30	µg/L			10	EPA 420.2	04/02/02	1136	KB
Radium 226	11.7±0.7L	pCi/L			0.2	EPA 903	04/04/02	1627	TR
TPH 418.1	<1	mg/L			1	EPA 418.1	03/27/02	1315	LA
Sodium Adsorption Ratio	6.5				N/A	N/A	03/27/02	1442	
Anions									
Bicarbonate as HCO3	562	mg/L	9.22	meq/L	1.0	SM 2320 B	03/21/02	2005	DB
Chloride	430	mg/L	12.14	meq/L	5.0	EPA 300.0	03/21/02	0820	LH
Fluoride	2.0	mg/L	0.11	meq/L	0.1	SM 2540 F	03/21/02	2005	DB
Sulfate	1,180	mg/L	24.58	meq/L	10	EPA 300.0	03/21/02	0820	LH
Cations									
Calcium	304	mg/L	15.17	meq/L	1.0	EPA 200.7	03/27/02	1442	BA
Magnesium	108	mg/L	8.89	meq/L	1.0	EPA 200.7	03/27/02	1442	BA
Potassium	77.4	mg/L	1.98	meq/L	0.2	EPA 200.7	03/27/02	1442	BA
Sodium	517	mg/L	22.49	meq/L	0.2	EPA 200.7	03/27/02	1442	BA

L = Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood B
Lab ID: 0102W04326
Matrix: Water
Condition: Cool/Intact

Date Received: 03/20/02
Date Reported: 04/09/02
Date Sampled: 03/20/02
Time Sampled: 1002

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	03/25/02	1108	MS
Chromium	<1	µg/L		1	EPA 200.9	03/25/02	0945	MH
Copper	2	µg/L		1	EPA 200.8	03/25/02	1108	MS
Iron	<30	µg/L		30	EPA 200.7	03/27/02	1719	BA
Lead	<2	µg/L		2	EPA 200.8	03/25/02	1108	MS
Manganese	40	µg/L		10	EPA 200.7	03/27/02	1719	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	03/26/02	0916	MS
Nickel	<10	µg/L		10	EPA 200.7	03/27/02	1719	BA
Silver	<3	µg/L		3	EPA 200.8	03/25/02	1108	MS
Zinc	<10	µg/L		10	EPA 200.7	03/27/02	1719	BA
Total Metals								
Aluminum	590	µg/L		50	EPA 200.7	03/27/02	1607	BA
Antimony	<5	µg/L		5	EPA 200.8	03/25/02	1524	MS
Arsenic	6	µg/L		1	EPA 200.8	03/25/02	1524	MS
Barium	<100	µg/L		100	EPA 200.8	03/25/02	1524	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	03/27/02	1607	BA
Iron	600	µg/L		30	EPA 200.7	03/27/02	1607	BA
Manganese	90	µg/L		10	EPA 200.7	03/27/02	1607	BA
Selenium	31	µg/L		5	EPA 200.8	03/25/02	1524	MS
Thallium	<10	µg/L		10	EPA 200.8	03/25/02	1524	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome Cottonwood Creek
Sample ID: Cottonwood B
Lab ID: 0102W06215
Matrix: Water
Condition: Cool/Intact

Date Received: 04/17/02
Date Reported: 05/03/02
Date Sampled: 04/17/02
Time Sampled: 0822

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
General Parameters									
Lab pH	8.3	s.u.			0.1	EPA 150.1	04/19/02	2108	DB
Lab Conductivity @ 25°C	4,080	µmhos/cm			1	SM 2510 B	04/19/02	2108	DB
Total Dissolved Solids @ 180°C	3,020	mg/L			10	SM 2540 C	04/19/02	1345	RM
Total Alkalinity as CaCO3	384	mg/L			1.0	SM 2320 B	04/19/02	2108	DB
Total Hardness as CaCO3	1,130	mg/L			1.0	SM 309 A	04/23/02	1502	
Boron	1.1	mg/L			0.1	EPA 200.7	04/23/02	1553	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	05/01/02	1336	KB
Phenols	10	µg/L			10	EPA 420.2	04/24/02	1210	KB
Radium 226	3.3±0.4L	pCi/L			0.2	EPA 903	05/02/01	0922	MW.
TPH 418.1	<1	mg/L			1	EPA 418.1	04/25/02	1349	LA
Sodium Adsorption Ratio	6.4				N/A	N/A	04/23/02	1502	
Anions									
Bicarbonate as HCO3	468	mg/L	7.67	meq/L	1.0	SM 2320 B	04/19/02	2108	DB
Chloride	373	mg/L	10.52	meq/L	5.0	EPA 300.0	04/19/02	0730	DB
Fluoride	1.47	mg/L	0.08	meq/L	0.08	SM 4500-F	04/19/02	2108	DB
Sulfate	1,260	mg/L	26.14	meq/L	10	EPA 300.0	04/19/02	0730	DB
Cations									
Calcium	279	mg/L	13.91	meq/L	1.0	EPA 200.7	04/23/02	1502	BA
Magnesium	106	mg/L	8.70	meq/L	1.0	EPA 200.7	04/23/02	1502	BA
Potassium	47.2	mg/L	1.21	meq/L	0.2	EPA 200.7	04/23/02	1502	BA
Sodium	498	mg/L	21.66	meq/L	0.2	EPA 200.7	04/23/02	1502	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 8280

Client: Merit Energy
Project: Hamilton Dome Cottonwood Creek
Sample ID: Cottonwood B
Lab ID: 0102W06215
Matrix: Water
Condition: Cool/Intact

Date Received: 04/17/02
Date Reported: 05/03/02
Date Sampled: 04/17/02
Time Sampled: 0822

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	04/25/02	0943	MS
Chromium	<1	µg/L		1	EPA 200.9	04/19/02	0926	MH
Copper	3	µg/L		1	EPA 200.8	04/25/02	0943	MS
Iron	<30	µg/L		30	EPA 200.7	04/23/02	1555	BA
Lead	<2	µg/L		2	EPA 200.8	04/25/02	0943	MS
Manganese	120	µg/L		10	EPA 200.7	04/23/02	1555	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	04/24/02	1039	MS
Nickel	<10	µg/L		10	EPA 200.7	04/23/02	1555	BA
Silver	<3	µg/L		3	EPA 200.8	04/25/02	0943	MS
Zinc	<10	µg/L		10	EPA 200.7	04/23/02	1555	BA
Total Metals								
Aluminum	150	µg/L		50	EPA 200.7	04/23/02	1502	BA
Antimony	<5	µg/L		5	EPA 200.8	04/25/02	0935	MS
Arsenic	<1	µg/L		1	EPA 200.8	04/25/02	0935	MS
Barium	<100	µg/L		100	EPA 200.8	04/25/02	0935	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	04/23/02	1502	BA
Selenium	26	µg/L		5	EPA 200.8	04/25/02	0935	MS
Thallium	<10	µg/L		10	EPA 200.8	04/25/02	0935	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 8280

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood B
Lab ID: 0102W12296
Matrix: Water
Condition: Cool/Intact

Date Received: 06/21/02
Date Reported: 07/15/02
Date Sampled: 06/21/02
Time Sampled: 1003

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
Field Parameters									
Field pH	8.10	s.u.			0.1	EPA 150.1			
Field Conductivity	4,840	µmhos/cm			0.1	SM 2510 B			
Field Temperature	18.8	°C			0.1	Field			
General Parameters									
Lab pH	8.2	s.u.			0.1	EPA 150.1	06/25/02	0049	DB
Lab Conductivity @ 25°C	4,980	µmhos/cm			1	SM 2510 B	06/25/02	0049	DB
Total Dissolved Solids @ 180°C	3,740	mg/L			10	SM 2540 C	06/24/02	1330	DB
Total Alkalinity as CaCO3	308	mg/L			1.0	SM 2320 B	06/25/02	0049	DB
Total Hardness as CaCO3	1,310	mg/L			1.0	SM 309 A	07/03/02	1125	
Boron	1.6	mg/L			0.1	EPA 200.7	07/03/02	1239	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	07/01/02	1346	KB
Phenols	250	µg/L			10	EPA 420.2	06/26/02	1519	KB
Radium 226	1.8±0.4L	pCi/L			0.2	EPA 903	07/02/02	1144	CS
TPH 418.1	<1	mg/L			1	EPA 418.1	07/01/02	1210	LA
Sodium Adsorption Ratio	7.2				N/A	N/A	07/03/02	1125	
Anions									
Bicarbonate as HCO3	375	mg/L	6.15	meq/L	1.0	SM 2320 B	06/25/02	0049	DB
Chloride	492	mg/L	13.88	meq/L	5.0	EPA 300.0	06/25/02	0710	LH
Fluoride	1.69	mg/L	0.09	meq/L	0.08	SM 4500-F-C	06/25/02	0049	DB
Sulfate	1,700	mg/L	35.35	meq/L	10	EPA 300.0	06/25/02	0710	LH
Cations									
Calcium	301	mg/L	15.02	meq/L	1.0	EPA 200.7	07/03/02	1125	BA
Magnesium	136	mg/L	11.19	meq/L	1.0	EPA 200.7	07/03/02	1125	BA
Potassium	64.5	mg/L	1.65	meq/L	0.2	EPA 200.7	07/03/02	1125	BA
Sodium	597	mg/L	25.97	meq/L	0.2	EPA 200.7	07/03/02	1125	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I". May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 8280

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood B
Lab ID: 0102W12296
Matrix: Water
Condition: Cool/Intact

Date Received: 06/21/02
Date Reported: 07/15/02
Date Sampled: 06/21/02
Time Sampled: 1003

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	07/09/02	1032	MS
Chromium	<1	µg/L		1	EPA 200.9	06/25/02	0904	MH
Copper	4	µg/L		1	EPA 200.8	07/09/02	1032	MS
Iron	<30	µg/L		30	EPA 200.7	07/03/02	1239	BA
Lead	<2	µg/L		2	EPA 200.8	07/09/02	1032	MS
Manganese	<10	µg/L		10	EPA 200.7	07/03/02	1239	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	06/28/02	1004	MS
Nickel	<10	µg/L		10	EPA 200.7	07/03/02	1239	BA
Silver	<3	µg/L		3	EPA 200.8	07/09/02	1032	MS
Zinc	<10	µg/L		10	EPA 200.7	07/03/02	1239	BA
Total Metals								
Aluminum	80	µg/L		50	EPA 200.7	07/13/02	1125	BA
Antimony	<5	µg/L		5	EPA 200.8	07/09/02	0924	MS
Arsenic	3	µg/L		1	EPA 200.8	07/09/02	0924	MS
Barium	<100	µg/L		100	EPA 200.8	07/09/02	0924	MS
Beryllium	2.4	µg/L		0.9	EPA 200.7	07/13/02	1125	BA
Selenium	25	µg/L		5	EPA 200.8	07/09/02	0924	MS
Thallium	<10	µg/L		10	EPA 200.8	07/09/02	0924	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood @ B. H. R.
Lab ID: 0102W04328
Matrix: Water
Condition: Cool/Intact

Date Received: 03/20/02
Date Reported: 04/09/02
Date Sampled: 03/20/02
Time Sampled: 1139

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
Field Parameters									
Field pH	8.16	s.u.			0.1	EPA 150.1			
Field Conductivity	3,840	µmhos/cm			0.1	SM 2510 B			
Field Temperature	1.6	°C			0.1	Field			
General Parameters									
Lab pH	8.1	s.u.			0.1	EPA 150.1	03/21/02	1923	DB
Lab Conductivity @ 25°C	3,920	µmhos/cm			1	SM 2510 B	03/21/02	1923	DB
Total Dissolved Solids @ 180°C	2,860	mg/L			10	SM 2540 C	03/22/02	1300	RM
Total Alkalinity as CaCO3	351	mg/L			1.0	SM 2320 B	03/21/02	2031	DB
Total Hardness as CaCO3	999	mg/L			1.0	SM 309 A	03/27/02	1442	
Boron	1.1	mg/L			0.1	EPA 200.7	03/27/02	1723	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	04/01/02	1053	KB
Phenols	10	µg/L			10	EPA 420.2	04/02/02	1144	KB
Radium 226	2.3±0.3L	pCi/L			0.2	EPA 903	04/04/02	1627	TR
TPH 418.1	<1	mg/L			1	EPA 418.1	03/27/02	1315	LA
Sodium Adsorption Ratio	7.0				N/A	N/A	03/27/02	1442	
Anions									
Bicarbonate as HCO3	428	mg/L	7.02	meq/L	1.0	SM 2320 B	03/21/02	2031	DB
Chloride	356	mg/L	10.05	meq/L	5.0	EPA 300.0	03/21/02	0820	LH
Fluoride	1.3	mg/L	0.07	meq/L	0.1	SM 2540 F	03/21/02	2031	DB
Sulfate	1,170	mg/L	24.41	meq/L	10	EPA 300.0	03/21/02	0820	LH
Cations									
Calcium	239	mg/L	11.95	meq/L	1.0	EPA 200.7	03/27/02	1442	BA
Magnesium	97.4	mg/L	8.02	meq/L	1.0	EPA 200.7	03/27/02	1442	BA
Potassium	44.0	mg/L	1.13	meq/L	0.2	EPA 200.7	03/27/02	1442	BA
Sodium	512	mg/L	22.25	meq/L	0.2	EPA 200.7	03/27/02	1442	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood @ B. H. R.
Lab ID: 0102W04328
Matrix: Water
Condition: Cool/Intact

Date Received: 03/20/02
Date Reported: 04/09/02
Date Sampled: 03/20/02
Time Sampled: 1139

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	03/25/02	1113	MS
Chromium	<1	µg/L		1	EPA 200.9	03/25/02	0945	MH
Copper	2	µg/L		1	EPA 200.8	03/25/02	1113	MS
Iron	<30	µg/L		30	EPA 200.7	03/27/02	1723	BA
Lead	<2	µg/L		2	EPA 200.8	03/25/02	1113	MS
Manganese	30	µg/L		10	EPA 200.7	03/27/02	1723	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	03/26/02	0916	MS
Nickel	<10	µg/L		10	EPA 200.7	03/27/02	1723	BA
Silver	<3	µg/L		3	EPA 200.8	03/25/02	1113	MS
Zinc	<10	µg/L		10	EPA 200.7	03/27/02	1723	BA
Total Metals								
Aluminum	3,960	µg/L		50	EPA 200.7	03/27/02	1611	BA
Antimony	<5	µg/L		5	EPA 200.8	03/25/02	1529	MS
Arsenic	<1	µg/L		1	EPA 200.8	03/25/02	1529	MS
Barium	<100	µg/L		100	EPA 200.8	03/25/02	1529	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	03/27/02	1611	BA
Iron	4,420	µg/L		30	EPA 200.7	03/27/02	1611	BA
Manganese	240	µg/L		10	EPA 200.7	03/27/02	1611	BA
Selenium	29	µg/L		5	EPA 200.8	03/25/02	1529	MS
Thallium	<10	µg/L		10	EPA 200.8	03/25/02	1529	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome Cottonwood Creek
Sample ID: Cottonwood @BHR
Lab ID: 0102W06216
Matrix: Water
Condition: Cool/Intact

Date Received: 04/17/02
Date Reported: 05/03/02
Date Sampled: 04/17/02
Time Sampled: 1319

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
General Parameters									
Lab pH	8.3	s.u.			0.1	EPA 150.1	04/19/02	2119	DB
Lab Conductivity @ 25°C	6,560	µmhos/cm			1	SM 2510 B	04/19/02	2119	DB
Total Dissolved Solids @ 180°C	4,970	mg/L			10	SM 2540 C	04/19/02	1345	RM
Total Alkalinity as CaCO3	413	mg/L			1.0	SM 2320 B	04/19/02	2119	DB
Total Hardness as CaCO3	1,540	mg/L			1.0	SM 309 A	04/23/02	1502	
Boron	1.4	mg/L			0.1	EPA 200.7	04/23/02	1553	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	05/01/02	1336	KB
Phenols	30	µg/L			10	EPA 420.2	04/24/02	1214	KB
Radium 226	0.9±0.2L	pCi/L			0.2	EPA 903	05/02/01	0922	MW
TPH 418.1	<1	mg/L			1	EPA 418.1	04/25/02	1349	LA
Sodium Adsorption Ratio	10.7				N/A	N/A	04/23/02	1502	
Anions									
Bicarbonate as HCO3	503	mg/L	8.25	meq/L	1.0	SM 2320 B	04/19/02	2119	DB
Chloride	563	mg/L	15.87	meq/L	5.0	EPA 300.0	04/19/02	0730	DB
Fluoride	0.99	mg/L	0.05	meq/L	0.08	SM 4500-F	04/19/02	2119	DB
Sulfate	2,410	mg/L	50.12	meq/L	10	EPA 300.0	04/19/02	0730	DB
Cations									
Calcium	286	mg/L	14.27	meq/L	1.0	EPA 200.7	04/23/02	1502	BA
Magnesium	201	mg/L	16.54	meq/L	1.0	EPA 200.7	04/23/02	1502	BA
Potassium	24.7	mg/L	0.63	meq/L	0.2	EPA 200.7	04/23/02	1502	BA
Sodium	964	mg/L	41.93	meq/L	0.2	EPA 200.7	04/23/02	1502	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 828(

Client: Merit Energy
Project: Hamilton Dome Cottonwood Creek
Sample ID: Cottonwood @BHR
Lab ID: 0102W06216
Matrix: Water
Condition: Cool/Intact

Date Received: 04/17/02
Date Reported: 05/03/02
Date Sampled: 04/17/02
Time Sampled: 1319

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	04/25/02	0946	MS
Chromium	<1	µg/L		1	EPA 200.9	04/19/02	0926	MH
Copper	3	µg/L		1	EPA 200.8	04/25/02	0946	MS
Iron	<30	µg/L		30	EPA 200.7	04/23/02	1557	BA
Lead	<2	µg/L		2	EPA 200.8	04/25/02	0946	MS
Manganese	150	µg/L		10	EPA 200.7	04/23/02	1557	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	04/24/02	1039	MS
Nickel	<10	µg/L		10	EPA 200.7	04/23/02	1557	BA
Silver	<3	µg/L		3	EPA 200.8	04/25/02	0946	MS
Zinc	<10	µg/L		10	EPA 200.7	04/23/02	1557	BA
Total Metals								
Aluminum	190	µg/L		50	EPA 200.7	04/23/02	1502	BA
Antimony	<5	µg/L		5	EPA 200.8	04/25/02	0938	MS
Arsenic	<1	µg/L		1	EPA 200.8	04/25/02	0938	MS
Barium	<100	µg/L		100	EPA 200.8	04/25/02	0938	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	04/23/02	1502	BA
Selenium	36	µg/L		5	EPA 200.8	04/25/02	0938	MS
Thallium	<10	µg/L		10	EPA 200.8	04/25/02	0938	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 8280

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood @ BHR
Lab ID: 0102W12298
Matrix: Water
Condition: Cool/Intact

Date Received: 06/21/02
Date Reported: 07/15/02
Date Sampled: 06/21/02
Time Sampled: 1144

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
Field Parameters									
Field pH	8.05	s.u.			0.1	EPA 150.1			
Field Conductivity	8,900	µmhos/cm			0.1	SM 2510 B			
Field Temperature	25.9	°C			0.1	Field			
General Parameters									
Lab pH	8.2	s.u.			0.1	EPA 150.1	06/25/02	0135	DB
Lab Conductivity @ 25°C	9,310	µmhos/cm			1	SM 2510 B	06/25/02	0135	DB
Total Dissolved Solids @ 180°C	7,320	mg/L			10	SM 2540 C	06/24/02	1330	DB
Total Alkalinity as CaCO3	520	mg/L			1.0	SM 2320 B	06/25/02	0135	DB
Total Hardness as CaCO3	1,680	mg/L			1.0	SM 309 A	07/03/02	1125	
Boron	2.1	mg/L			0.1	EPA 200.7	07/03/02	1245	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	07/01/02	1348	KB
Phenols	210	µg/L			10	EPA 420.2	06/26/02	1519	KB
Radium 226	0.3±0.2L	pCi/L			0.2	EPA 903	07/02/02	1144	CS
TPH 418.1	<1	mg/L			1	EPA 418.1	07/01/02	1210	LA
Sodium Adsorption Ratio	17.2				N/A	N/A	07/03/02	1125	
Anions									
Bicarbonate as HCO3	634	mg/L	10.40	meq/L	1.0	SM 2320 B	06/25/02	0135	DB
Chloride	803	mg/L	22.67	meq/L	5.0	EPA 300.0	06/25/02	0710	LH
Fluoride	1.21	mg/L	0.06	meq/L	0.08	SM 4500-F-C	06/25/02	0135	DB
Sulfate	3,270	mg/L	68.02	meq/L	10	EPA 300.0	06/25/02	0710	LH
Cations									
Calcium	340	mg/L	16.96	meq/L	1.0	EPA 200.7	07/03/02	1125	BA
Magnesium	202	mg/L	16.60	meq/L	1.0	EPA 200.7	07/03/02	1125	BA
Potassium	22.8	mg/L	0.58	meq/L	0.2	EPA 200.7	07/03/02	1125	BA
Sodium	1,620	mg/L	70.32	meq/L	0.2	EPA 200.7	07/03/02	1125	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 828(

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Cottonwood @ BHR
Lab ID: 0102W12298
Matrix: Water
Condition: Cool/Intact

Date Received: 06/21/02
Date Reported: 07/15/02
Date Sampled: 06/21/02
Time Sampled: 1144

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	07/09/02	1037	MS
Chromium	<1	µg/L		1	EPA 200.9	06/25/02	0904	MH
Copper	9	µg/L		1	EPA 200.8	07/09/02	1037	MS
Iron	<30	µg/L		30	EPA 200.7	07/03/02	1245	BA
Lead	<2	µg/L		2	EPA 200.8	07/09/02	1037	MS
Manganese	<10	µg/L		10	EPA 200.7	07/03/02	1245	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	06/28/02	1004	MS
Nickel	<10	µg/L		10	EPA 200.7	07/03/02	1245	BA
Silver	<3	µg/L		3	EPA 200.8	07/09/02	1037	MS
Zinc	<10	µg/L		10	EPA 200.7	07/03/02	1245	BA
Total Metals								
Aluminum	310	µg/L		50	EPA 200.7	07/13/02	1125	BA
Antimony	<5	µg/L		5	EPA 200.8	07/09/02	0929	MS
Arsenic	<1	µg/L		1	EPA 200.8	07/09/02	0929	MS
Barium	<100	µg/L		100	EPA 200.8	07/09/02	0929	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	07/13/02	1125	BA
Selenium	67	µg/L		5	EPA 200.8	07/09/02	0929	MS
Thallium	<10	µg/L		10	EPA 200.8	07/09/02	0929	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: _____

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: WY0000680
Lab ID: 0102W04324
Matrix: Water
Condition: Cool/Intact

Date Received: 03/20/02
Date Reported: 04/09/02
Date Sampled: 03/20/02
Time Sampled: 0843

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
Field Parameters									
Field pH	7.80	s.u.			0.1	EPA 150.1			
Field Conductivity	4,180	µmhos/cm			0.1	SM 2510 B			
Field Temperature	42.2	°C			0.1	Field			
General Parameters									
Lab pH	8.0	s.u.			0.1	EPA 150.1	03/21/02	1923	DB
Lab Conductivity @ 25°C	4,430	µmhos/cm			1	SM 2510 B	03/21/02	1923	DB
Total Dissolved Solids @ 180°C	3,310	mg/L			10	SM 2540 C	03/22/02	1300	RM
Total Alkalinity as CaCO3	1,050	mg/L			1.0	SM 2320 B	03/21/02	1923	DB
Total Hardness as CaCO3	1,650	mg/L			1.0	SM 309 A	03/27/02	1442	
Boron	1.4	mg/L			0.1	EPA 200.7	03/27/02	1715	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	04/01/02	1049	KB
Phenols	50	µg/L			10	EPA 420.2	04/02/02	1127	KB
Radium 226	38.6±3.8L	pCi/L			0.2	EPA 903	04/04/02	1627	TR
TPH 418.1	4	mg/L			1	EPA 418.1	03/27/02	1315	LA
Sodium Adsorption Ratio	4.4				N/A	N/A	03/27/02	1442	
Anions									
Bicarbonate as HCO3	1,270	mg/L	20.90	meq/L	1.0	SM 2320 B	03/21/02	1923	DB
Chloride	392	mg/L	11.05	meq/L	5.0	EPA 300.0	03/21/02	0820	LH
Fluoride	3.3	mg/L	0.17	meq/L	0.1	SM 2540 F	03/21/02	1923	DB
Sulfate	878	mg/L	18.29	meq/L	10	EPA 300.0	03/21/02	0820	LH
Cations									
Calcium	514	mg/L	25.65	meq/L	1.0	EPA 200.7	03/27/02	1442	BA
Magnesium	89.7	mg/L	7.38	meq/L	1.0	EPA 200.7	03/27/02	1442	BA
Potassium	88.2	mg/L	2.26	meq/L	0.2	EPA 200.7	03/27/02	1442	BA
Sodium	413	mg/L	17.94	meq/L	0.2	EPA 200.7	03/27/02	1442	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: WY0000680
Lab ID: 0102W04324
Matrix: Water
Condition: Cool/Intact

10 AM.

Date Received: 03/20/02
Date Reported: 04/09/02
Date Sampled: 03/20/02
Time Sampled: 0843

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	03/25/02	1103	MS
Chromium	<1	µg/L		1	EPA 200.9	03/25/02	0945	MH
Copper	4	µg/L		1	EPA 200.8	03/25/02	1103	MS
Iron	<30	µg/L		30	EPA 200.7	03/27/02	1715	BA
Lead	<2	µg/L		2	EPA 200.8	03/25/02	1103	MS
Manganese	30	µg/L		10	EPA 200.7	03/27/02	1715	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	03/26/02	0916	MS
Nickel	<10	µg/L		10	EPA 200.7	03/27/02	1715	BA
Silver	<3	µg/L		3	EPA 200.8	03/25/02	1103	MS
Zinc	<10	µg/L		10	EPA 200.7	03/27/02	1715	BA
Total Metals								
Aluminum	<50	µg/L		50	EPA 200.7	03/27/02	1603	BA
Antimony	<5	µg/L		5	EPA 200.8	03/25/02	1519	MS
Arsenic	6	µg/L		1	EPA 200.8	03/25/02	1519	MS
Barium	<100	µg/L		100	EPA 200.8	03/25/02	1519	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	03/27/02	1603	BA
Iron	<30	µg/L		30	EPA 200.7	03/27/02	1603	BA
Manganese	30	µg/L		10	EPA 200.7	03/27/02	1603	BA
Selenium	25	µg/L		5	EPA 200.8	03/25/02	1519	MS
Thallium	<10	µg/L		10	EPA 200.8	03/25/02	1519	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: WY0000175
Lab ID: 0102W04327
Matrix: Water
Condition: Cool/Intact

Date Received: 03/20/02
Date Reported: 04/09/02
Date Sampled: 03/20/02
Time Sampled: 1020

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
Field Parameters									
Field pH	7.32	s.u.			0.1	EPA 150.1			
Field Conductivity	4,630	µmhos/cm			0.1	SM 2510 B			
Field Temperature	44.0	°C			0.1	Field			
General Parameters									
Lab pH	7.9	s.u.			0.1	EPA 150.1	03/21/02	1923	DB
Lab Conductivity @ 25°C	4,830	µmhos/cm			1	SM 2510 B	03/21/02	1923	DB
Total Dissolved Solids @ 180°C	3,660	mg/L			10	SM 2540 C	03/22/02	1300	RM
Total Alkalinity as CaCO3	1,040	mg/L			1.0	SM 2320 B	03/21/02	2020	DB
Total Hardness as CaCO3	1,650	mg/L			1.0	SM 309 A	03/27/02	1442	
Boron	1.6	mg/L			0.1	EPA 200.7	03/27/02	1721	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	04/01/02	1052	KB
Phenols	30	µg/L			10	EPA 420.2	04/02/02	1140	KB
Radium 226	43.6±4.0L	pCi/L			0.2	EPA 903	04/04/02	1627	TR
TPH 418.1	5	mg/L			1	EPA 418.1	03/27/02	1315	LA
Sodium Adsorption Ratio	5.4				N/A	N/A	03/27/02	1442	
Anions									
Bicarbonate as HCO3	1,270	mg/L	20.87	meq/L	1.0	SM 2320 B	03/21/02	2020	DB
Chloride	392	mg/L	11.06	meq/L	5.0	EPA 300.0	03/22/02	0942	RM
Fluoride	3.3	mg/L	0.17	meq/L	0.1	SM 2540 F	03/21/02	2020	DB
Sulfate	1,250	mg/L	25.98	meq/L	10	EPA 300.0	03/21/02	0820	LH
Cations									
Calcium	513	mg/L	25.60	meq/L	1.0	EPA 200.7	03/27/02	1442	BA
Magnesium	88.9	mg/L	7.32	meq/L	1.0	EPA 200.7	03/27/02	1442	BA
Potassium	95.2	mg/L	2.43	meq/L	0.2	EPA 200.7	03/27/02	1442	BA
Sodium	504	mg/L	21.92	meq/L	0.2	EPA 200.7	03/27/02	1442	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

Client: Merit Energy
Project: Hamilton Dome
Sample ID: WY0000175
Lab ID: 0102W04327
Matrix: Water
Condition: Cool/Intact

Date Received: 03/20/02
Date Reported: 04/09/02
Date Sampled: 03/20/02
Time Sampled: 1020

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	03/25/02	1110	MS
Chromium	<1	µg/L		1	EPA 200.9	03/25/02	0945	MH
Copper	3	µg/L		1	EPA 200.8	03/25/02	1110	MS
Iron	<30	µg/L		30	EPA 200.7	03/27/02	1721	BA
Lead	<2	µg/L		2	EPA 200.8	03/25/02	1110	MS
Manganese	30	µg/L		10	EPA 200.7	03/27/02	1721	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	03/26/02	0916	MS
Nickel	<10	µg/L		10	EPA 200.7	03/27/02	1721	BA
Silver	<3	µg/L		3	EPA 200.8	03/25/02	1110	MS
Zinc	<10	µg/L		10	EPA 200.7	03/27/02	1721	BA
Total Metals								
Aluminum	70	µg/L		50	EPA 200.7	03/27/02	1609	BA
Antimony	<5	µg/L		5	EPA 200.8	03/25/02	1526	MS
Arsenic	<1	µg/L		1	EPA 200.8	03/25/02	1526	MS
Barium	<100	µg/L		100	EPA 200.8	03/25/02	1526	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	03/27/02	1609	BA
Iron	<30	µg/L		30	EPA 200.7	03/27/02	1609	BA
Manganese	30	µg/L		10	EPA 200.7	03/27/02	1609	BA
Selenium	37	µg/L		5	EPA 200.8	03/25/02	1526	MS
Thallium	<10	µg/L		10	EPA 200.8	03/25/02	1526	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 828C

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Hot Springs
Lab ID: 0102W12297
Matrix: Water
Condition: Cool/Intact

Date Received: 06/21/02
Date Reported: 07/15/02
Date Sampled: 06/21/02
Time Sampled: 1106

Parameter	Analytical Result	Units		Units	PQL	Method	Analysis Date	Time	Init.
Field Parameters									
Field pH	6.40	s.u.			0.1	EPA 150.1			
Field Conductivity	2,850	µmhos/cm			0.1	SM 2510 B			
Field Temperature	48.8	°C			0.1	Field			
General Parameters									
Lab pH	7.7	s.u.			0.1	EPA 150.1	06/25/02	0123	DB
Lab Conductivity @ 25°C	2,810	µmhos/cm			1	SM 2510 B	06/25/02	0123	DB
Total Dissolved Solids @ 180°C	1,920	mg/L			10	SM 2540 C	06/24/02	1330	DB
Total Alkalinity as CaCO3	549	mg/L			1.0	SM 2320 B	06/25/02	0123	DB
Total Hardness as CaCO3	1,040	mg/L			1.0	SM 309 A	07/03/02	1125	
Boron	0.6	mg/L			0.1	EPA 200.7	07/03/02	1241	BA
Total Cyanide	<5	µg/L			5	EPA 335.4	07/01/02	1347	KB
Phenols	30	µg/L			10	EPA 420.2	06/26/02	1519	KB
Radium 226	17.5±1.1L	pCi/L			0.2	EPA 903	07/02/02	1144	CS
TPH 418.1	<1	mg/L			1	EPA 418.1	07/01/02	1210	LA
Sodium Adsorption Ratio	2.7				N/A	N/A	07/03/02	1125	
Anions									
Bicarbonate as HCO3	669	mg/L	10.97	meq/L	1.0	SM 2320 B	06/25/02	0123	DB
Chloride	245	mg/L	6.92	meq/L	5.0	EPA 300.0	06/25/02	0710	LH
Fluoride	4.12	mg/L	0.22	meq/L	0.08	SM 4500-F-C	06/25/02	0123	DB
Sulfate	524	mg/L	10.90	meq/L	10	EPA 300.0	06/25/02	0710	LH
Cations									
Calcium	315	mg/L	15.72	meq/L	1.0	EPA 200.7	07/03/02	1125	BA
Magnesium	62.2	mg/L	5.12	meq/L	1.0	EPA 200.7	07/03/02	1125	BA
Potassium	37.4	mg/L	0.96	meq/L	0.2	EPA 200.7	07/03/02	1125	BA
Sodium	199	mg/L	8.66	meq/L	0.2	EPA 200.7	07/03/02	1125	BA

L - Analyzed by a contract laboratory.

Reference: U.S.E.P.A 600/4-79-020, "Methods for Chemical Analysis of Water and Wastes", 1983.
"Standard Methods For The Examination of Water and Wastewater", 19th ed., 1995.
EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994
EPA 600/R93/100, "Methods for the Determination of Inorganic Substances in Environmental Samples", Aug. 1993.

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 8280

Client: Merit Energy
Project: Hamilton Dome
Sample ID: Hot Springs
Lab ID: 0102W12297
Matrix: Water
Condition: Cool/Intact

Date Received: 06/21/02
Date Reported: 07/15/02
Date Sampled: 06/21/02
Time Sampled: 1106

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis Date	Time	Init.
Dissolved Metals								
Cadmium	<0.1	µg/L		0.1	EPA 200.8	07/09/02	1035	MS
Chromium	<1	µg/L		1	EPA 200.9	06/25/02	0904	MH
Copper	3	µg/L		1	EPA 200.8	07/09/02	1035	MS
Iron	<30	µg/L		30	EPA 200.7	07/03/02	1241	BA
Lead	<2	µg/L		2	EPA 200.8	07/09/02	1035	MS
Manganese	30	µg/L		10	EPA 200.7	07/03/02	1241	BA
Mercury	<0.06	µg/L		0.06	EPA 245.1	06/28/02	1004	MS
Nickel	10	µg/L		10	EPA 200.7	07/03/02	1241	BA
Silver	<3	µg/L		3	EPA 200.8	07/09/02	1035	MS
Zinc	<10	µg/L		10	EPA 200.7	07/03/02	1241	BA
Total Metals								
Aluminum	<50	µg/L		50	EPA 200.7	07/13/02	1125	BA
Antimony	<5	µg/L		5	EPA 200.8	07/09/02	0926	MS
Arsenic	5	µg/L		1	EPA 200.8	07/09/02	0926	MS
Barium	<100	µg/L		100	EPA 200.8	07/09/02	0926	MS
Beryllium	<0.9	µg/L		0.9	EPA 200.7	07/13/02	1125	BA
Selenium	11	µg/L		5	EPA 200.8	07/09/02	0926	MS
Thallium	<10	µg/L		10	EPA 200.8	07/09/02	0926	MS

Reference: EPA 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994

Reviewed By: WN

Wade Nieuwsma, Water Lab Supervisor

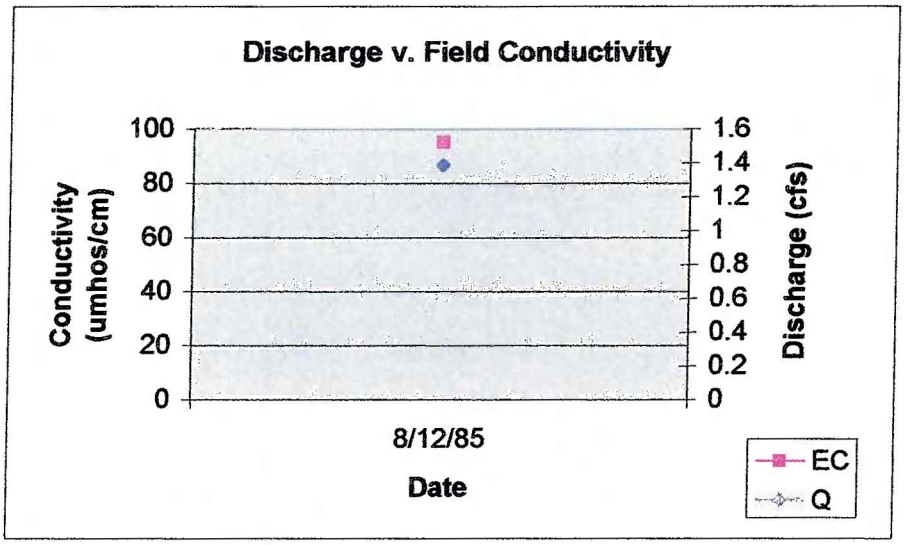
Y-M-D				CFS		S.U.		S.U.		µmhos/cm		µmhos/cm		mg/L		mg/L		ratio		mg/L		µg/L	
BEG_REC	END_REC	SOURCE	STATION	DISCH_L	DISCH_H	FPH_L	FPH_H	LPH_L	LPH_H	FCOND_L	FCOND_H	LCOND_L	LCOND_H	ALK_L	ALK_H	TDS_L	TDS_H	SAR_L	SAR_H	CHLOR_L	CHLOR_H	SELE_L	SELE_H
19850812		BLM	COT52	1.39		6.50		6.97		95		147		73		95				4.0		5	
19820812	19850812	BLM	COT50	1.83	7.20	6.50	6.50	7.56	8.26	110	145	145	200	64	91	87	154			1.8	6.0	1	9
19820812	19850812	BLM	COT45	1.52	8.80	6.50	6.50	7.92	8.60	90	220	120	250	60	115	81	182			2.9	8.0	1	13
19790613	19790710	BLM	COT41	6.90	40.40			7.90	8.04	100						142	249			3.2	11.0		
19760402		BLM	WR3351													293		3.53		101.0			
19770510	19860911	BLM	COT35	0.50	29.00	6.50	6.50	8.10	9.28	65	450	274	790	115	246	121	541			0.3	10.0	1	15
19770510	20000714	USGS	6265337	2.40	97.00	9.72						200	700	73	160	121	254	2.30	3.90	1.7	3.5		
19700930		USGS	6265350	8.50		8.00						4140		283		3110		7.80		420.0			
19790613	19790710	BLM	COT31	2.00	14.10			7.77	8.30	430						454	1616			45.0	176.0		
19790613	19860911	BLM	COT24	6.00	20.00	6.50	6.50	7.80	8.60	1020	3750	2590	4600	299	367	937	4023			151.0	515.0	2	72
19700930		USGS	6265400	2.20		8.80						972		176		600		5.40		33.0			
19770411	19780726	USGS	6265410	4.30	124.00							1450	5000	110	350	902	3400	4.30	8.10	65.0	450.0		
19760520	19760914	USGS	8275300									1400	4420										
19760402		BLM	WR3350													1994		6.56		236.0			
19830830	19850814	BLM	COT12	2.40	3.54	6.50	6.50	8.05	8.10	3000	4100	4700	4790	317	368	4030	4205			480.0	493.0	2	182
19650626	19780726	USGS	6265500	0.40	259.00							1400	7500	160	440	833		4.80	17.00	55.0	630.0		

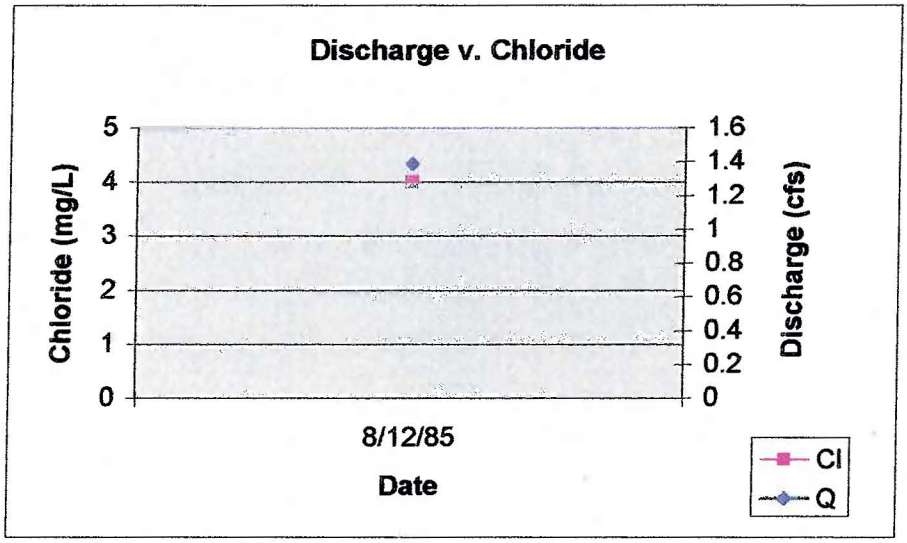
BEG_REC = Beginning of Record
END_REC = End of Record
_L = Minimum
_H = Maximum
DISCH = Discharge
FPH = Field pH
LPH = Laboratory pH
FCOND = Field Conductivity
LCOND = Laboratory Conductivity
ALK = Total Alkalinity
TDS = Total Dissolved Solids (Residue @ 105 or 180 degrees C.)
SAR = Sodium Adsorption Ratio
CHLOR = Chloride
SELE = Selenium

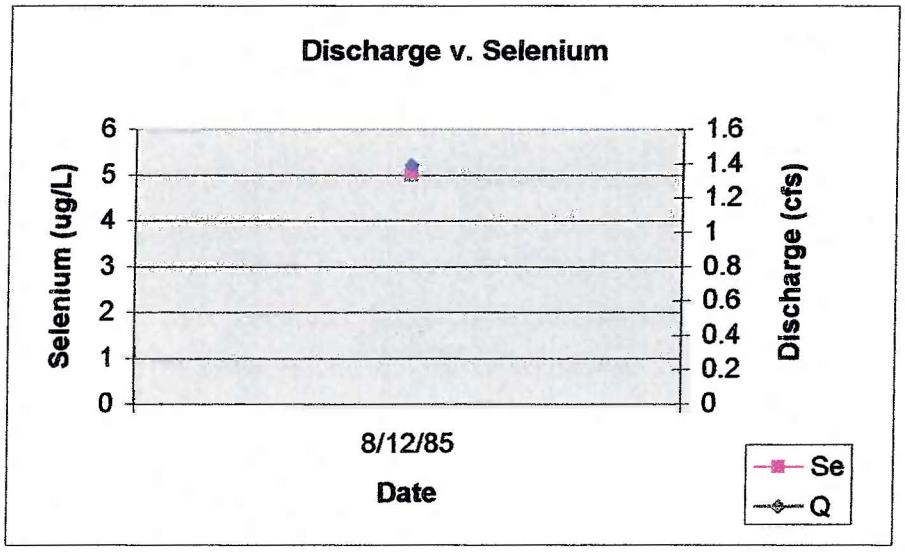
(Stations ordered from West to East along Cottonwood Creek).
Single samples restricted to the "Minimum" column.

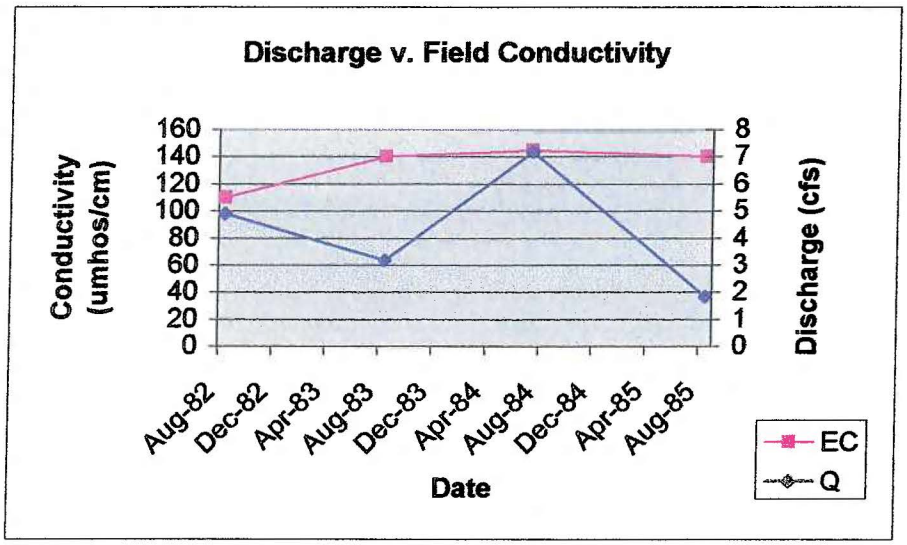
Charts of Conductivity, Chloride, and Selenium follow.
(Full data printouts are available on request).

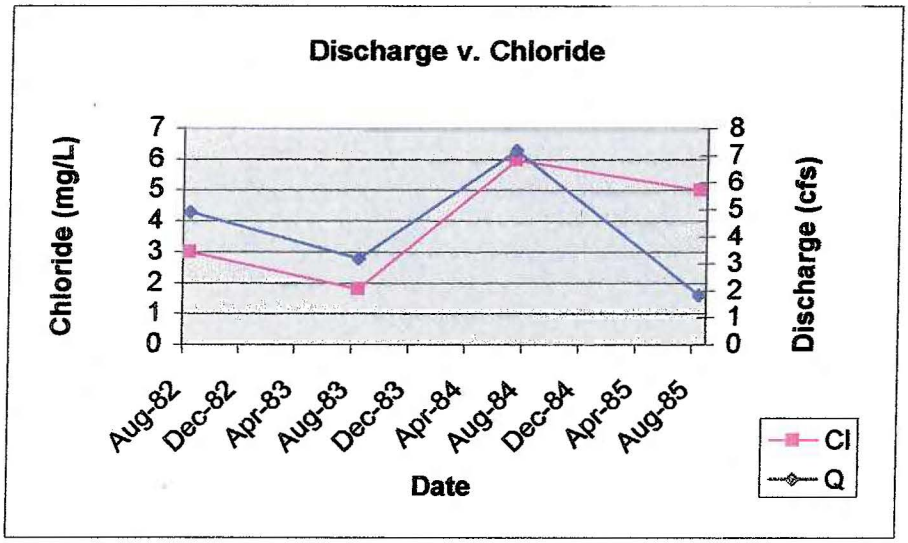
Merit Energy Company
Water Quality Grab Samples

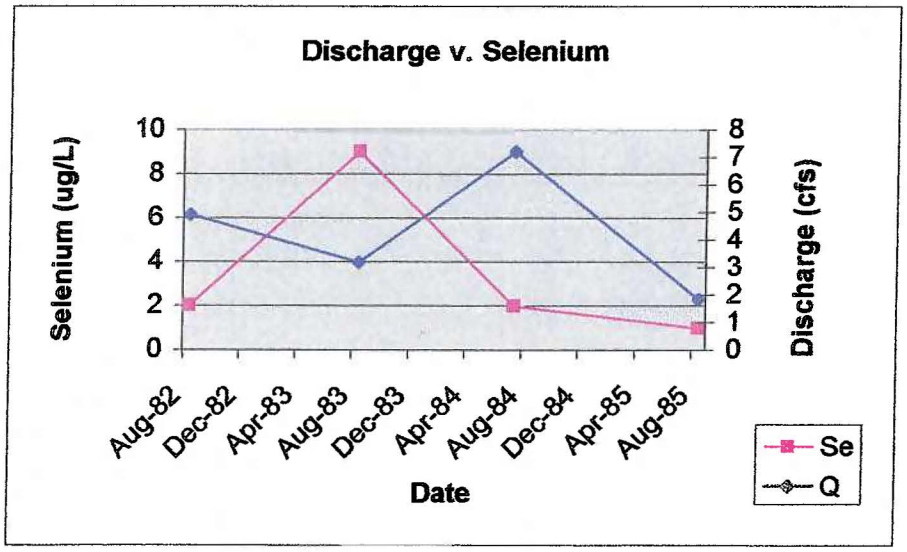

Discharge v. Field Conductivity
Conductivity (umhos/cm)
100
80
60
40
20
0
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Discharge (cfs)
8/12/85
Date
EC
Q

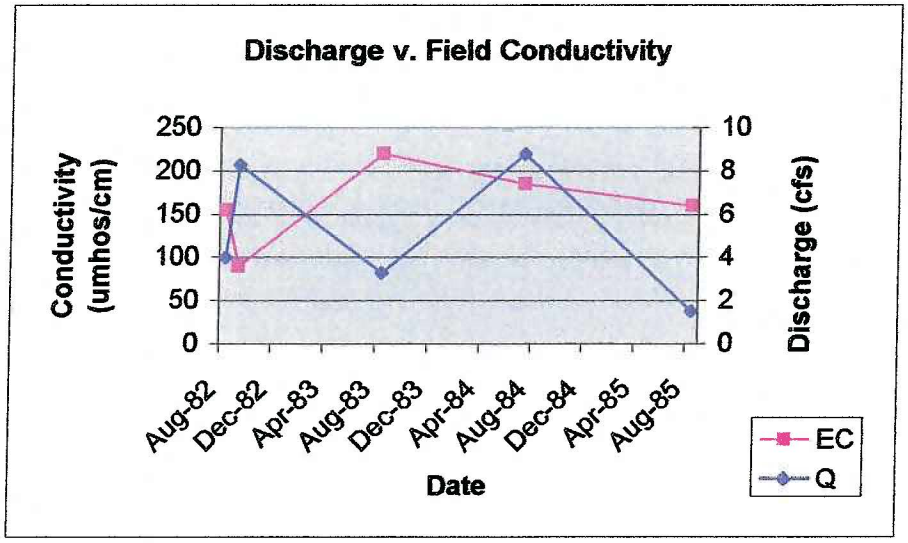

Discharge v. Chloride
Chloride (mg/L)
5
4
3
2
1
0
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Discharge (cfs)
8/12/85
Date
Cl
Q

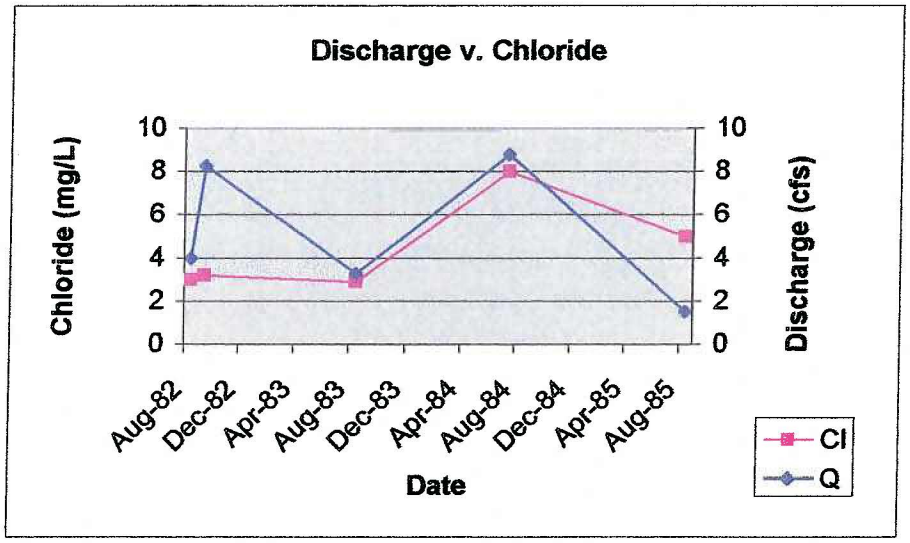

Discharge v. Selenium
Selenium (ug/L)
6
5
4
3
2
1
0
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Discharge (cfs)
8/12/85
Date
Se
Q

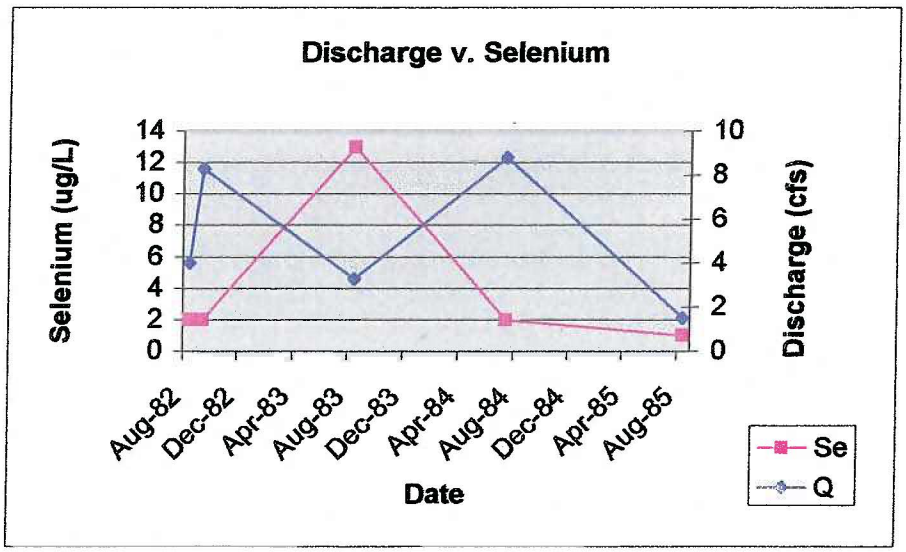

Discharge v. Field Conductivity
Conductivity (umhos/cm)
160
140
120
100
80
60
40
20
0
8
7
6
5
4
3
2
1
0
Discharge (cfs)
Aug-82
Dec-82
Apr-83
Aug-83
Dec-83
Apr-84
Aug-84
Dec-84
Apr-85
Aug-85
Date
EC
Q

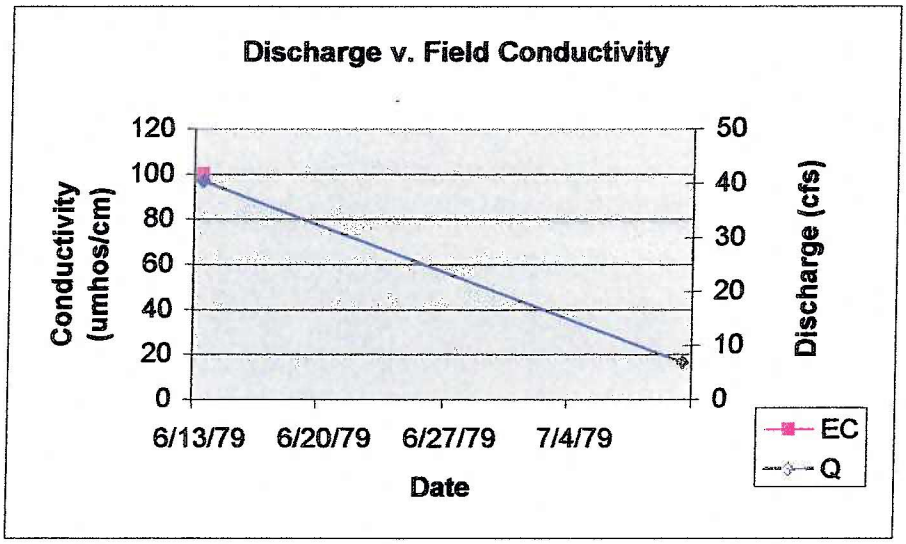

Discharge v. Chloride
Chloride (mg/L)
7
6
5
4
3
2
1
0
8
7
6
5
4
3
2
1
0
Discharge (cfs)
Aug-82
Dec-82
Apr-83
Aug-83
Dec-83
Apr-84
Aug-84
Dec-84
Apr-85
Aug-85
Date
Cl
Q

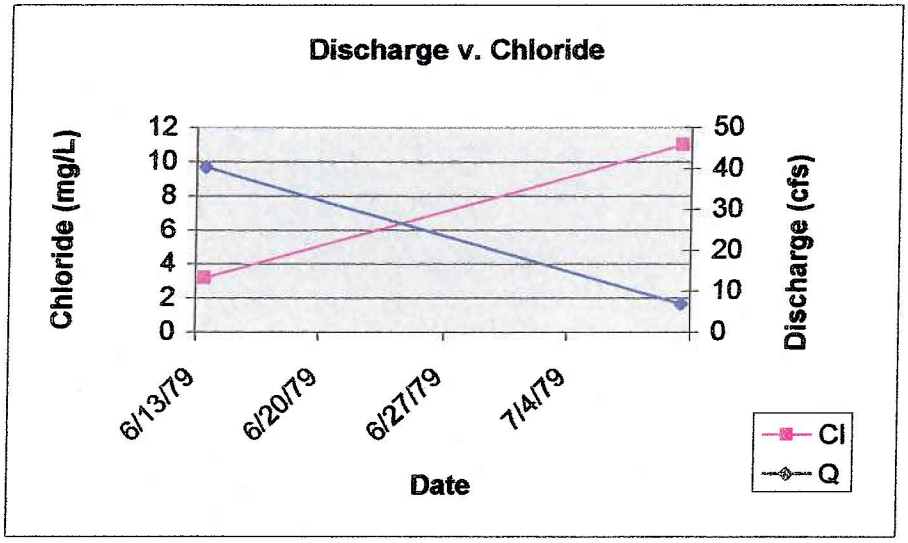

Discharge v. Selenium
Selenium (ug/L)
10
8
6
4
2
0
8
7
6
5
4
3
2
1
0
Discharge (cfs)
Aug-82
Dec-82
Apr-83
Aug-83
Dec-83
Apr-84
Aug-84
Dec-84
Apr-85
Aug-85
Date
Se
Q

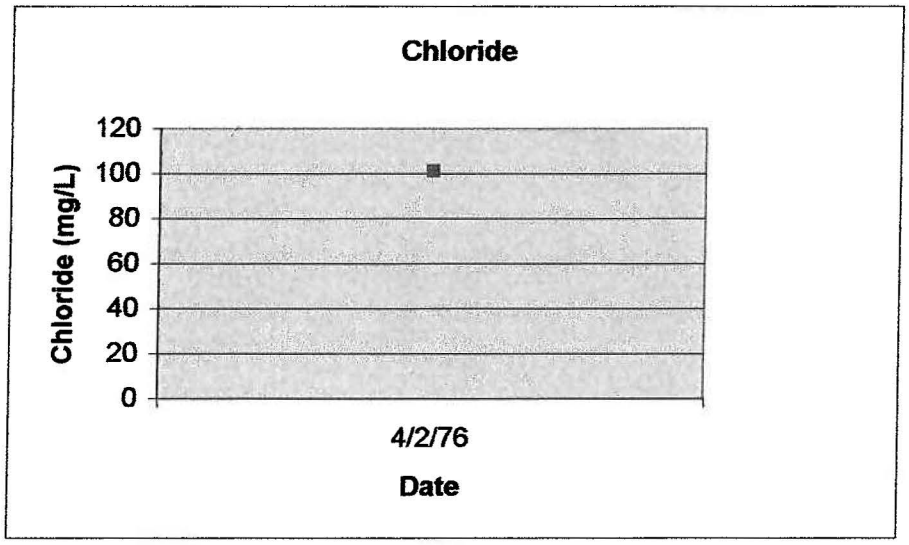

Discharge v. Field Conductivity
Conductivity (umhos/cm)
250
200
150
100
50
0
10
8
6
4
2
0
Discharge (cfs)
Aug-82
Dec-82
Apr-83
Aug-83
Dec-83
Apr-84
Aug-84
Dec-84
Apr-85
Aug-85
Date
EC
Q

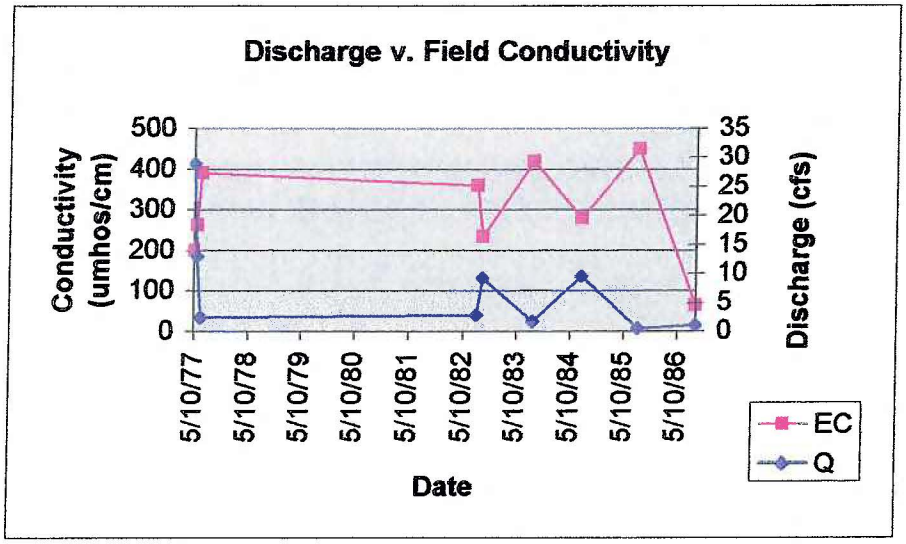

Discharge v. Chloride
Chloride (mg/L)
10
8
6
4
2
0
10
8
6
4
2
0
Discharge (cfs)
Aug-82
Dec-82
Apr-83
Aug-83
Dec-83
Apr-84
Aug-84
Dec-84
Apr-85
Aug-85
Date
Cl
Q

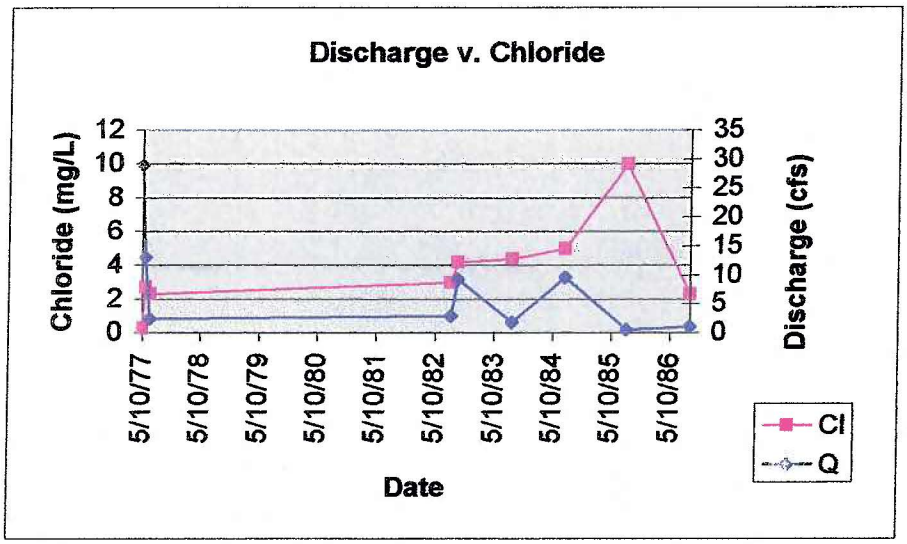

Discharge v. Selenium
Selenium (ug/L)
14
12
10
8
6
4
2
0
10
8
6
4
2
0
Discharge (cfs)
Aug-82
Dec-82
Apr-83
Aug-83
Dec-83
Apr-84
Aug-84
Dec-84
Apr-85
Aug-85
Date
Se
Q

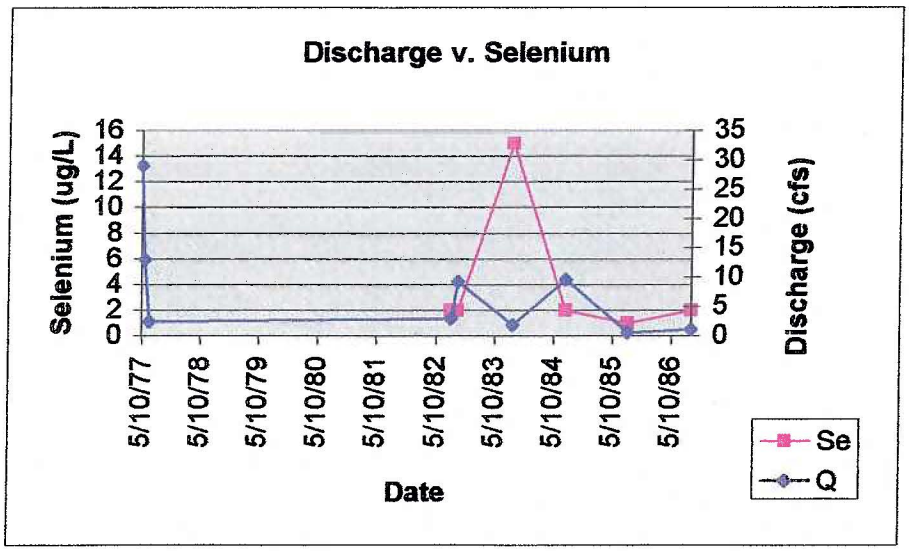

Discharge v. Field Conductivity
Conductivity (umhos/cm)
120
100
80
60
40
20
0
50
40
30
20
10
0
Discharge (cfs)
6/13/79
6/20/79
6/27/79
7/4/79
Date
EC
Q

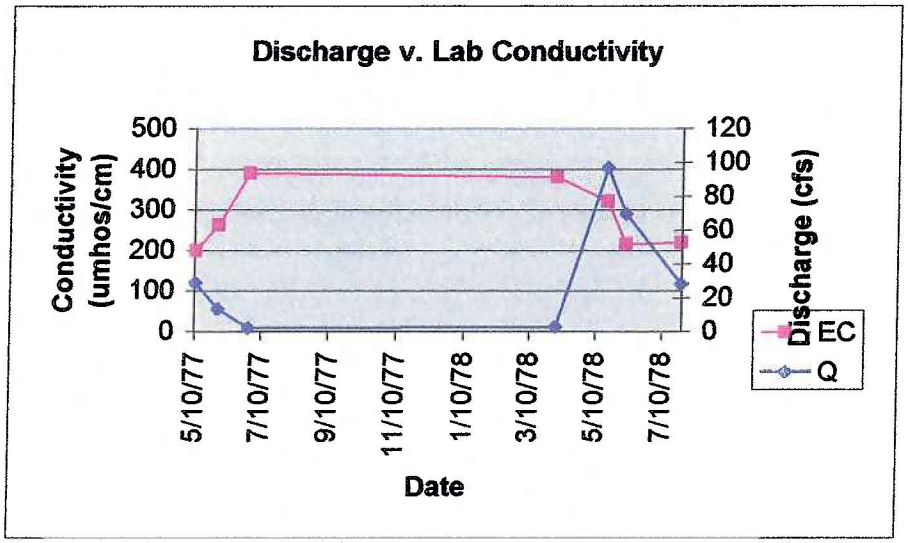

Discharge v. Chloride
Chloride (mg/L)
12
10
8
6
4
2
0
50
40
30
20
10
0
Discharge (cfs)
6/13/79
6/20/79
6/27/79
7/4/79
Date
Cl
Q

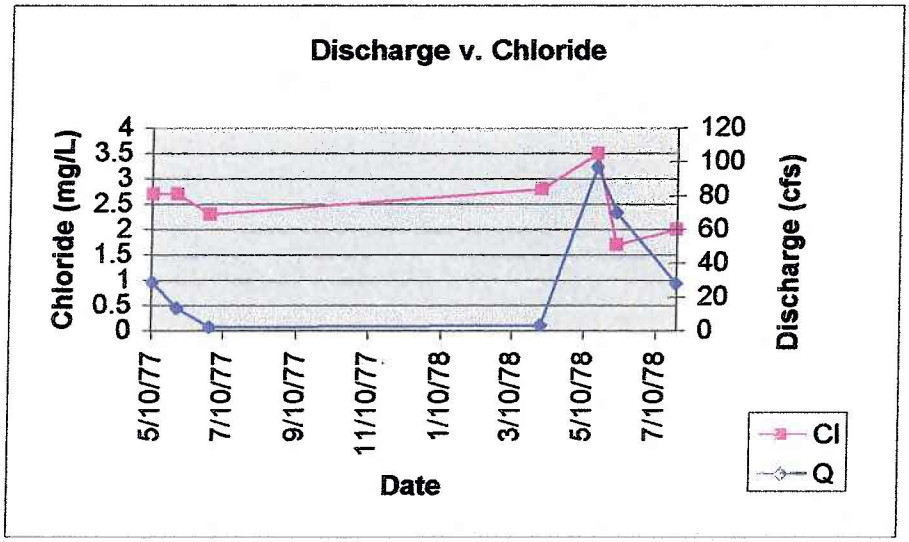

Chloride
Chloride (mg/L)
120
100
80
60
40
20
0
4/2/76
Date

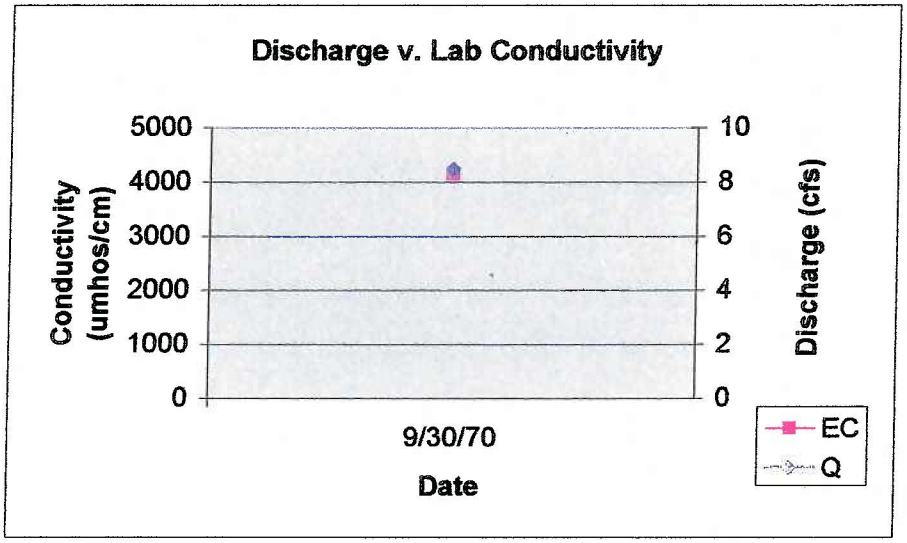

Discharge v. Field Conductivity
Conductivity (umhos/cm)
500
400
300
200
100
0
35
30
25
20
15
10
5
0
Discharge (cfs)
5/10/77
5/10/78
5/10/79
5/10/80
5/10/81
5/10/82
5/10/83
5/10/84
5/10/85
5/10/86
Date
EC
Q

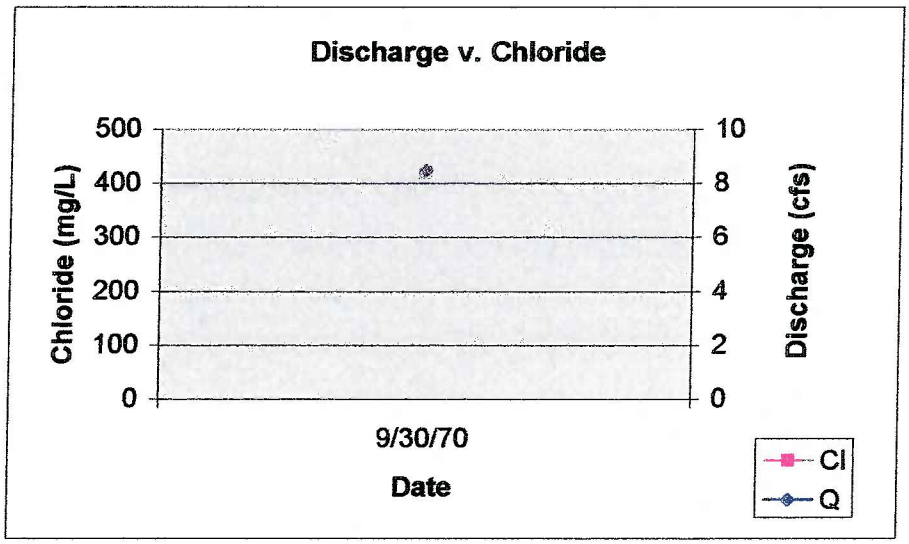

Discharge v. Chloride
Chloride (mg/L)
12
10
8
6
4
2
0
35
30
25
20
15
10
5
0
Discharge (cfs)
5/10/77
5/10/78
5/10/79
5/10/80
5/10/81
5/10/82
5/10/83
5/10/84
5/10/85
5/10/86
Date
Cl
Q

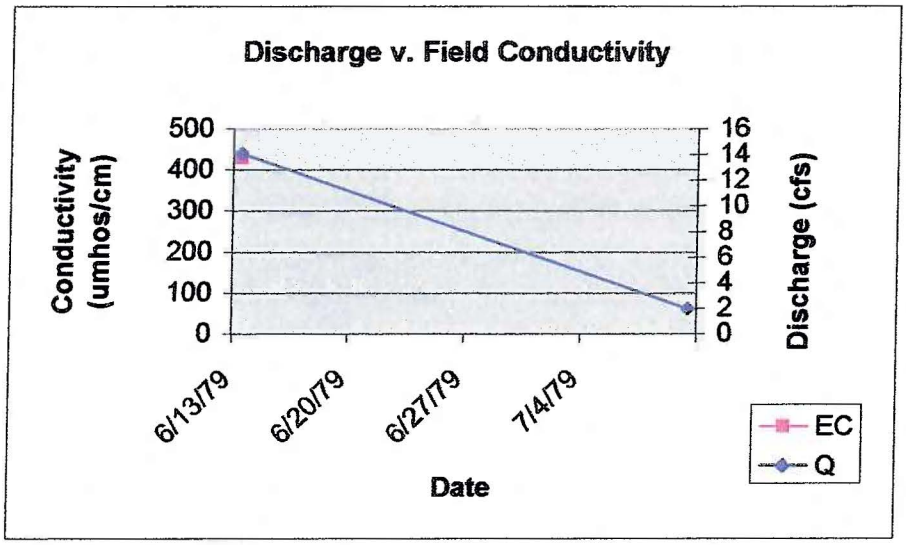

Discharge v. Selenium
Selenium (ug/L)
16
14
12
10
8
6
4
2
0
35
30
25
20
15
10
5
0
Discharge (cfs)
5/10/77
5/10/78
5/10/79
5/10/80
5/10/81
5/10/82
5/10/83
5/10/84
5/10/85
5/10/86
Date
Se
Q

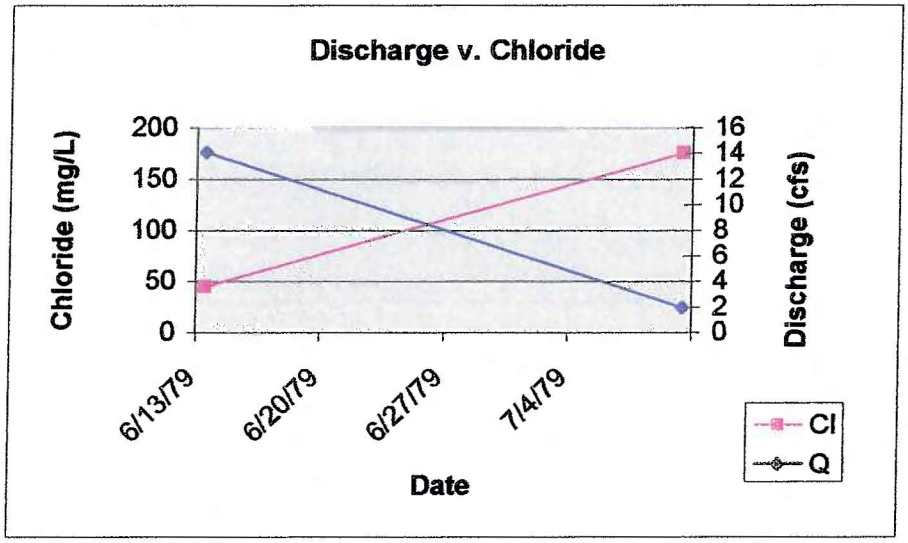

Discharge v. Lab Conductivity
Conductivity (umhos/cm)
500
400
300
200
100
0
120
100
80
60
40
20
0
Discharge (cfs)
5/10/77
7/10/77
9/10/77
11/10/77
1/10/78
3/10/78
5/10/78
7/10/78
Date
EC
Q

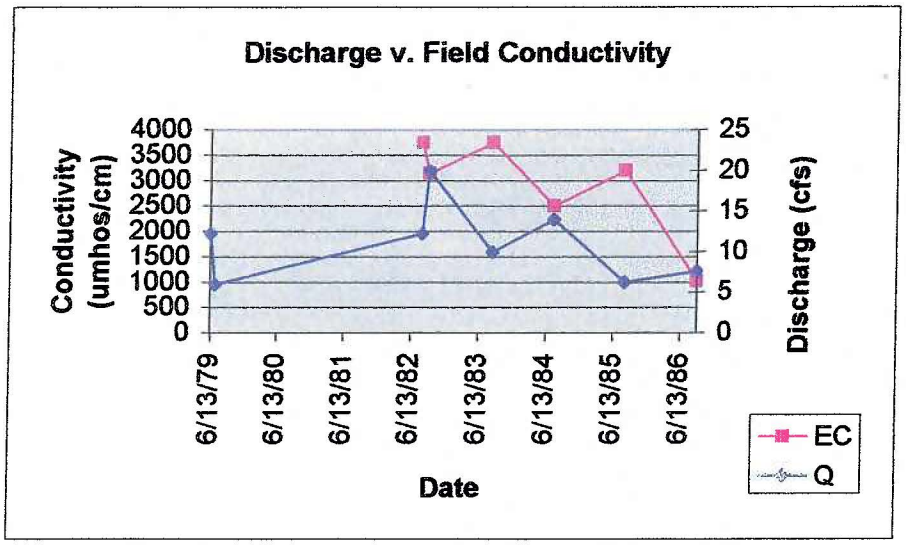

Discharge v. Chloride
Chloride (mg/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
120
100
80
60
40
20
0
Discharge (cfs)
5/10/77
7/10/77
9/10/77
11/10/77
1/10/78
3/10/78
5/10/78
7/10/78
Date
Cl
Q

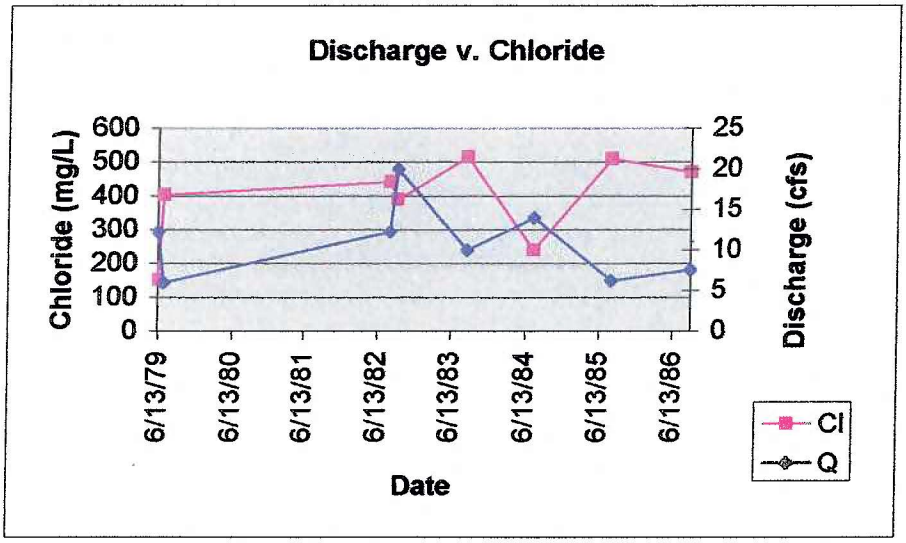

Discharge v. Lab Conductivity
Conductivity (umhos/cm)
5000
4000
3000
2000
1000
0
10
8
6
4
2
0
Discharge (cfs)
9/30/70
Date
EC
Q

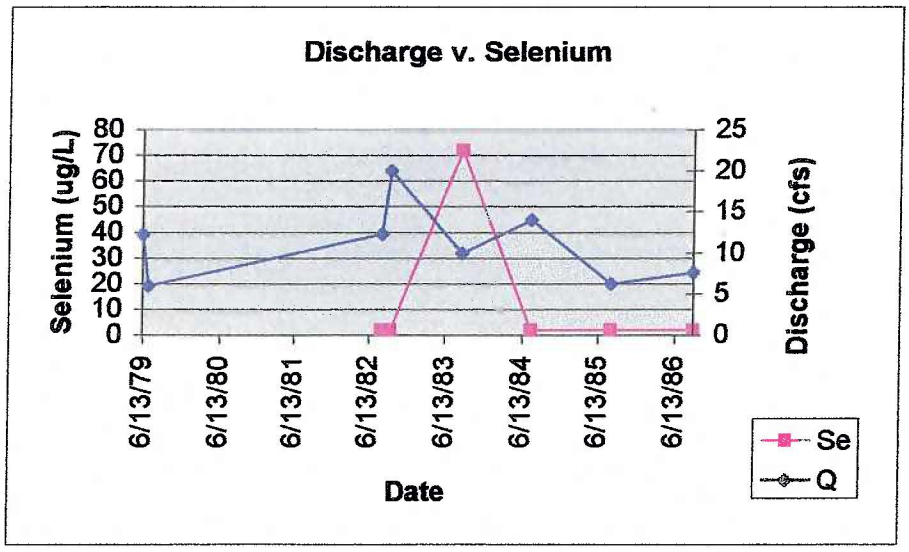

Discharge v. Chloride
Chloride (mg/L)
500
400
300
200
100
0
10
8
6
4
2
0
Discharge (cfs)
9/30/70
Date
Cl
Q

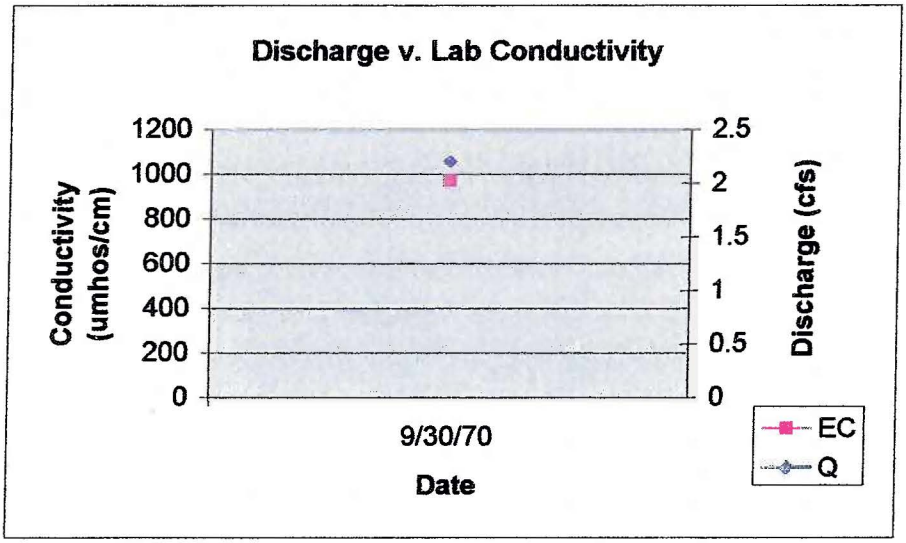

Discharge v. Field Conductivity
Conductivity (umhos/cm)
500
400
300
200
100
0
16
14
12
10
8
6
4
2
0
Discharge (cfs)
6/13/79
6/20/79
6/27/79
7/4/79
Date
EC
Q

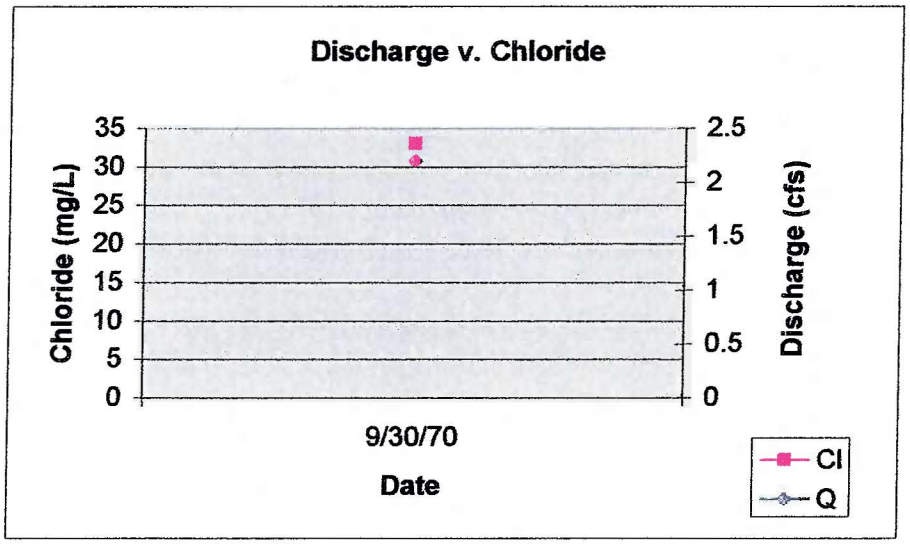

Discharge v. Chloride
Chloride (mg/L)
200
150
100
50
0
16
14
12
10
8
6
4
2
0
Discharge (cfs)
6/13/79
6/20/79
6/27/79
7/4/79
Date
Cl
Q

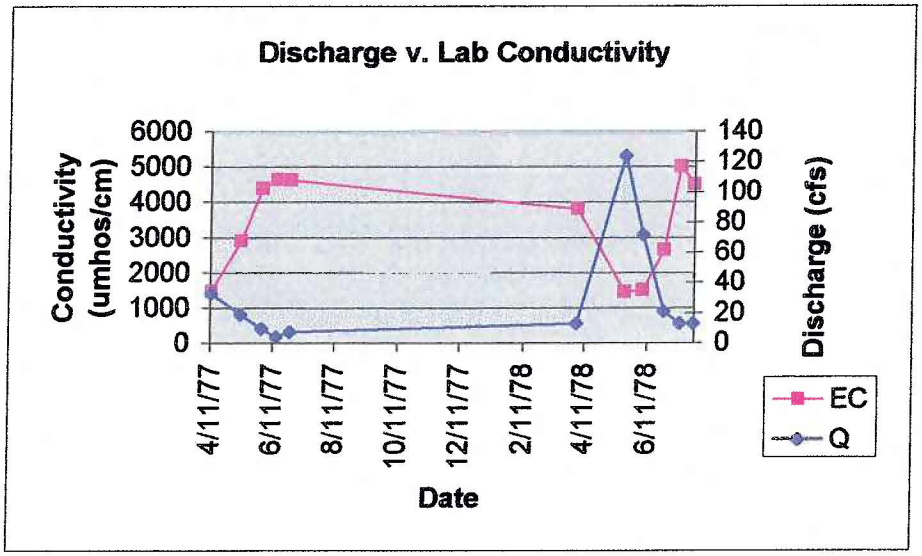

Discharge v. Field Conductivity
Conductivity (umhos/cm)
4000
3500
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
Discharge (cfs)
6/13/79
6/13/80
6/13/81
6/13/82
6/13/83
6/13/84
6/13/85
6/13/86
Date
EC
Q

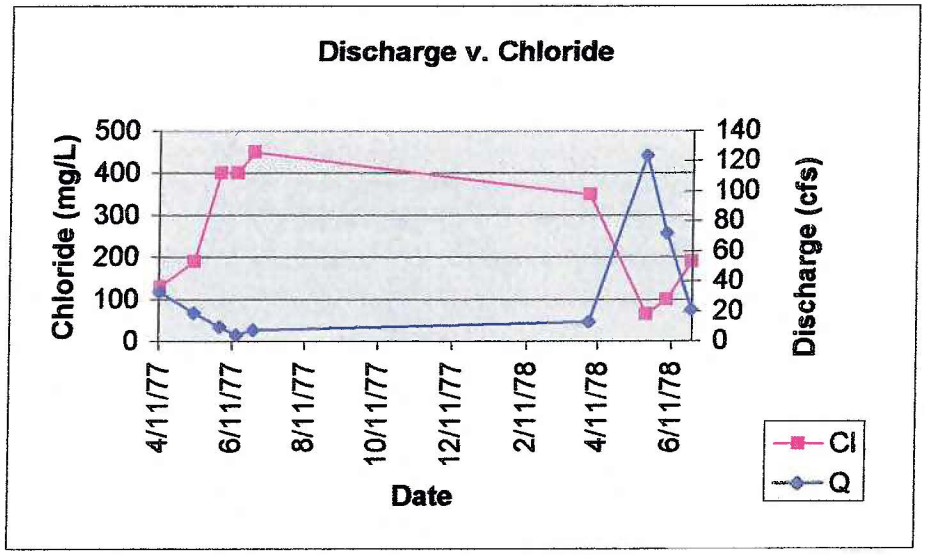

Discharge v. Chloride
Chloride (mg/L)
600
500
400
300
200
100
0
25
20
15
10
5
0
Discharge (cfs)
6/13/79
6/13/80
6/13/81
6/13/82
6/13/83
6/13/84
6/13/85
6/13/86
Date
Cl
Q

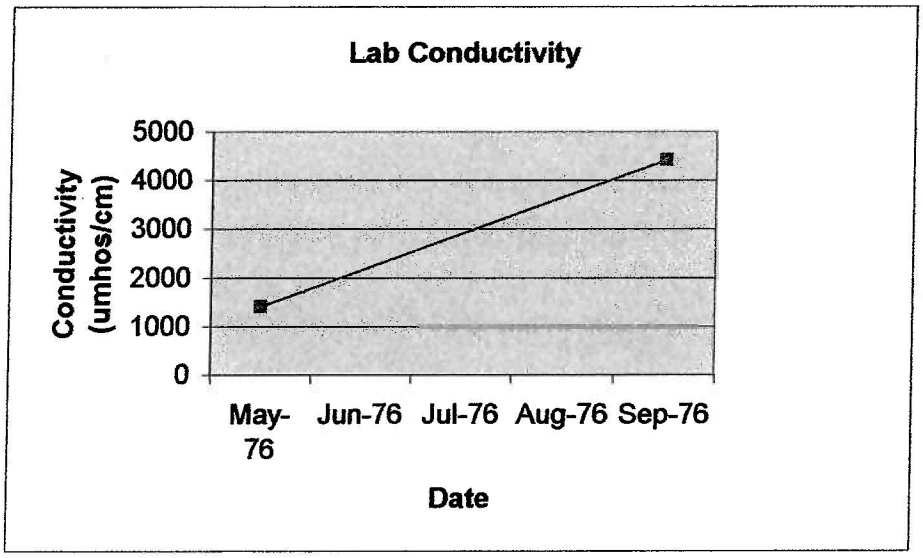

Discharge v. Selenium
Selenium (ug/L)
80
70
60
50
40
30
20
10
0
25
20
15
10
5
0
Discharge (cfs)
6/13/79
6/13/80
6/13/81
6/13/82
6/13/83
6/13/84
6/13/85
6/13/86
Date
Se
Q

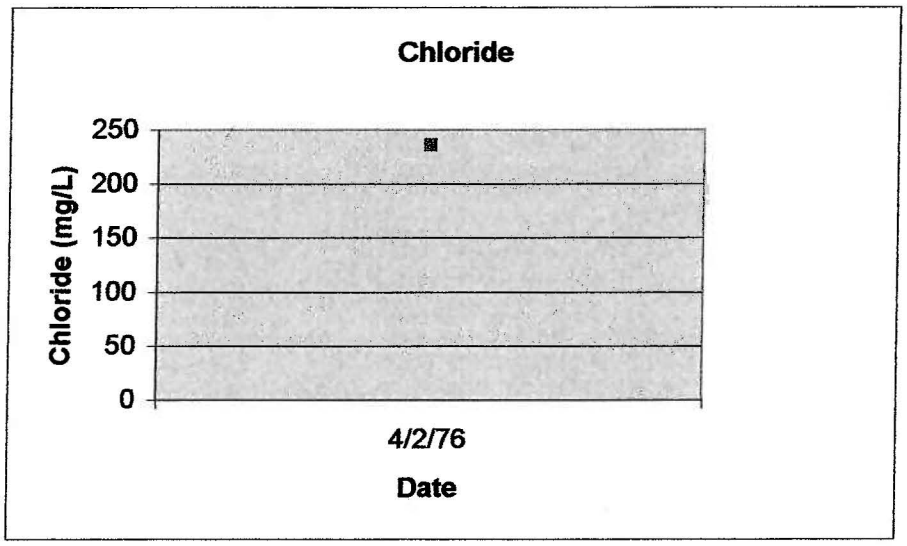

Discharge v. Lab Conductivity
Conductivity (umhos/cm)
1200
1000
800
600
400
200
0
2.5
2
1.5
1
0.5
0
Discharge (cfs)
9/30/70
Date
EC
Q

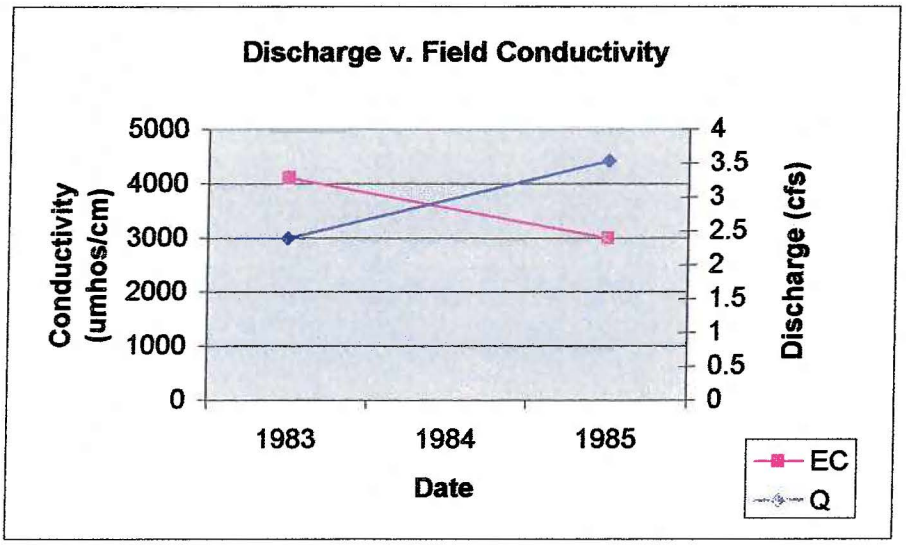

Discharge v. Chloride
Chloride (mg/L)
35
30
25
20
15
10
5
0
2.5
2
1.5
1
0.5
0
Discharge (cfs)
9/30/70
Date
Cl
Q

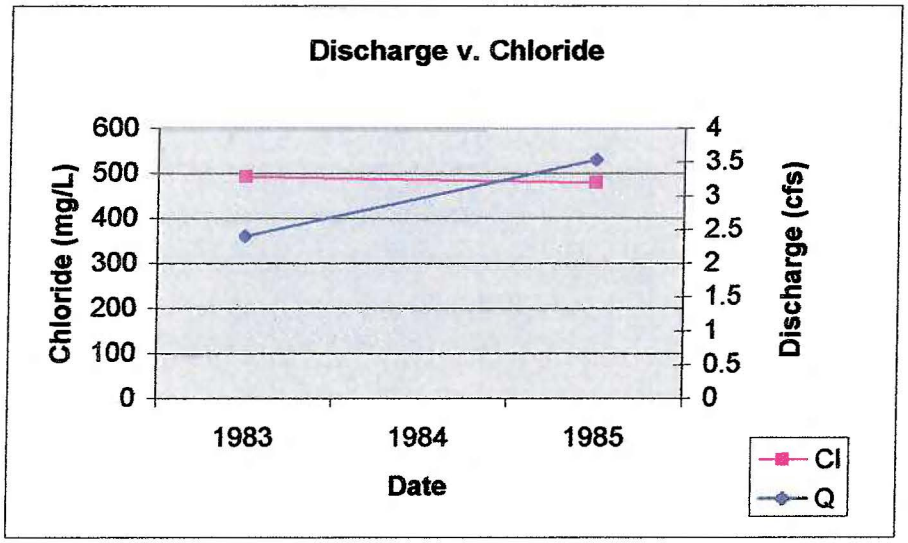

Discharge v. Lab Conductivity
Conductivity (umhos/cm)
6000
5000
4000
3000
2000
1000
0
140
120
100
80
60
40
20
0
Discharge (cfs)
4/11/77
6/11/77
8/11/77
10/11/77
12/11/77
2/11/78
4/11/78
6/11/78
Date
EC
Q

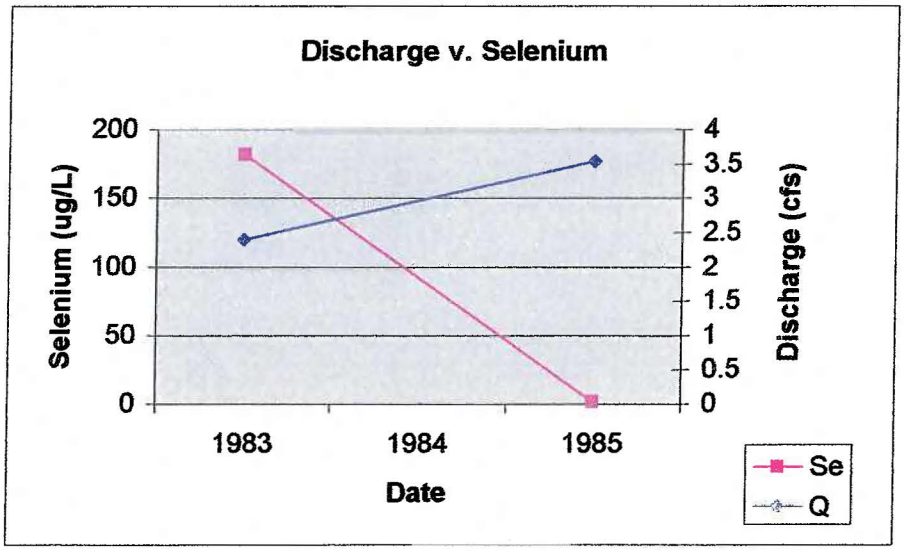

Discharge v. Chloride
Chloride (mg/L)
500
400
300
200
100
0
140
120
100
80
60
40
20
0
Discharge (cfs)
4/11/77
6/11/77
8/11/77
10/11/77
12/11/77
2/11/78
4/11/78
6/11/78
Date
Cl
Q

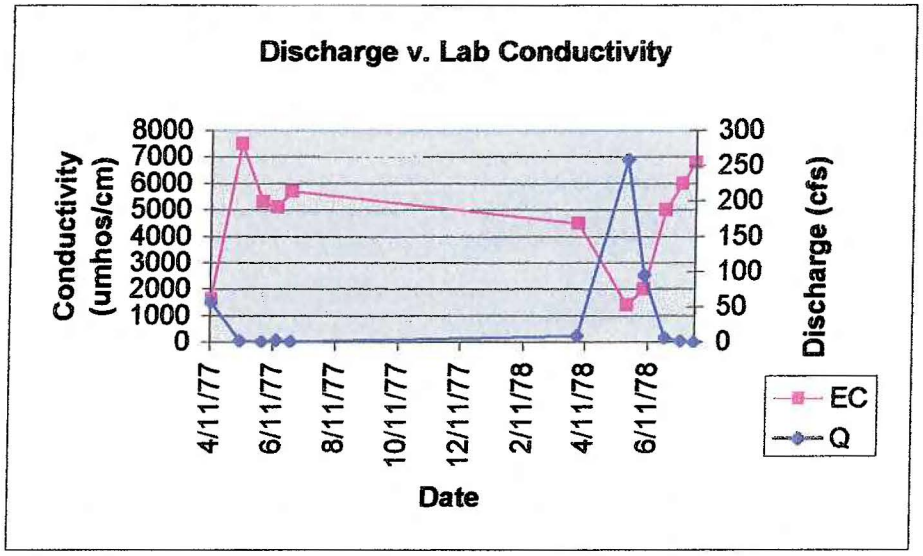

Lab Conductivity
Conductivity (umhos/cm)
5000
4000
3000
2000
1000
0
May-76
Jun-76
Jul-76
Aug-76
Sep-76
Date

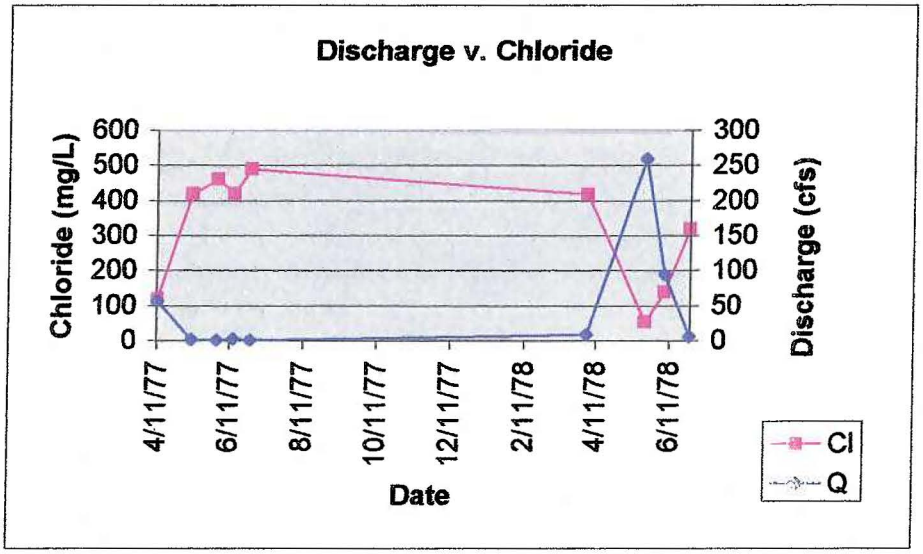

Chloride
250
200
150
100
50
0
Chloride (mg/L)
4/2/76
Date


Discharge v. Field Conductivity
Conductivity (umhos/cm)
5000
4000
3000
2000
1000
0
4
3.5
3
2.5
2
1.5
1
0.5
0
Discharge (cfs)
1983
1984
1985
Date
EC
Q


Discharge v. Chloride
Chloride (mg/L)
600
500
400
300
200
100
0
4
3.5
3
2.5
2
1.5
1
0.5
0
Discharge (cfs)
1983
1984
1985
Date
Cl
Q


Discharge v. Selenium
Selenium (ug/L)
200
150
100
50
0
4
3.5
3
2.5
2
1.5
1
0.5
0
Discharge (cfs)
1983
1984
1985
Date
Se
Q


Discharge v. Lab Conductivity
Conductivity (umhos/cm)
8000
7000
6000
5000
4000
3000
2000
1000
0
300
250
200
150
100
50
0
Discharge (cfs)
4/11/77
6/11/77
8/11/77
10/11/77
12/11/77
2/11/78
4/11/78
6/11/78
Date
EC
Q


Discharge v. Chloride
Chloride (mg/L)
600
500
400
300
200
100
0
300
250
200
150
100
50
0
Discharge (cfs)
4/11/77
6/11/77
8/11/77
10/11/77
12/11/77
2/11/78
4/11/78
6/11/78
Date
Cl
Q

CHLORIDE REPORT

Hamilton Dome Oil Field Use Attainability Analysis Project

Prepared for

States West Water Resources Corporation
Cheyenne, Wyoming

Prepared by

Greg Johnson

Western EcoSystems Technology, Inc.
2003 Central Avenue
Cheyenne, WY 82001

November 11, 2002

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Table 1. Chloride toxicity in aquatic organisms ranked from least to most sensitive 4

INTRODUCTION

Merit Energy Company (MEC) produces crude oil at the Hamilton Dome Field located in Hot Springs County, Wyoming. Merit Energy Company applied for and received two NPDES permits to discharge produced water from the Hamilton Dome Field into unnamed tributaries that eventually flow into Cottonwood Creek. The Water Quality Division (WQD) of the Wyoming Department of Environmental Quality (DEQ) recently updated Water Quality Rules and Regulations, Chapter 1, to comply with the federal Clean Water Act that requires all surface water be swimmable and fishable. Wyoming WQD was required to make changes to their statewide water classification system. Until the recent update of Chapter 1, the classification of the tributaries and Cottonwood Creek was Class 4. The tributaries are now class 3B and Cottonwood Creek is now class 2C.

The new classifications require a chloride limit in Cottonwood Creek of 230 mg/L where a limit had not previously existed. This chloride limit of 230 mg/L is more than 200 mg/L less than the current levels of chlorides being discharged at MEC permitted discharge points. Section 33 of Chapter 1 sets up a process where the WQD Administrator may allow site specific criteria. Therefore, MEC has decided to petition the WQD Administrator to establish site-specific criteria for chlorides because correcting the existing human-caused conditions (oil field discharge) would cause more environmental damage to correct (i.e., remove) than to leave in place. The purpose of this report is to assess the potential effects of existing chloride concentrations on the Cottonwood Creek aquatic system.

METHODS

Available data on aquatic invertebrates were obtained from the Wyoming Department of Environmental Quality Water Quality Division (WDEQ-WQD) for three stations along Cottonwood Creek. Data on fish in Cottonwood Creek were obtained from the Wyoming Game and Fish Department (WGFD). These data were supplemented with data collected during other portions of the 2002 WEST study to evaluate selenium levels in fish and aquatic invertebrates. Data on aquatic invertebrate and fish abundance, composition, and sensitivity to chloride were used to assess potential effects of the existing chloride concentrations in Cottonwood Creek on the aquatic community.

RESULTS

Aquatic invertebrate data collected by WDEQ are presented in the Terrestrial and Aquatic Wildlife Report (Appendix E). These data indicate that Cottonwood Creek supports a diverse and abundant macroinvertebrate community. Densities at the three sites ranged from 641 to 1196 individuals per square meter. The number of invertebrate taxa identified at each site ranged from 29 to 35. At each station, the proportion of the invertebrates comprised of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa ranged from 28% to 49% and averaged 42%. Presence of large numbers of these taxa is important because they are generally considered to be pollution sensitive and good indicators of overall water/habitat quality. Ponds supported by produced water either directly (i.e., Lake Charlie) or indirectly (ponds receiving irrigation return flows) were also found to have a diverse aquatic invertebrate community during sampling to document selenium concentrations (see Selenium Report in this appendix, and Aquatic and Terrestrial Wildlife report in Appendix E).

Cottonwood Creek supports a diverse assemblage of fish. It is managed by the WGFD as a unique species fishery, with emphasis on management of native nongame species and Yellowstone cutthroat trout (Welker, M. 2000. Basin Management Plan: Middle Big Horn River. Wyoming Game and Fish Department, Cheyenne. 9 pp.). Native fish species documented in Cottonwood Creek by the WGFD include flathead chub, fathead minnow, lake chub, longnose sucker, mountain sucker, stonecat, white sucker, and Yellowstone cutthroat. Introduced species documented in Cottonwood Creek include carp, plains killifish, and rainbow trout. The Wyoming Game and Fish Department sampled five locations along Cottonwood Creek downstream of Hamilton Dome discharge in May 1990, and documented the presence of plains killifish, flathead chub, and longnose sucker. More recently (spring 1999), the WGFD sampled fish at two locations along Cottonwood Creek downstream of the discharge. At one station located approximately 14 miles downstream of the discharge, two species of game fish (rainbow trout and Yellowstone cutthroat trout) were documented along with several species of nongame fish, including white sucker, longnose sucker, mountain sucker, carp, longnose dace, fathead minnow, and plains killifish. At the other station located near the confluence with the Bighorn River, several species of nongame fish including white sucker, longnose sucker, mountain

sucker, carp, lake chub, flathead chub, fathead minnow, and plains killifish were documented. During sampling conducted by WEST, Inc. in August 2002 at three locations along Cottonwood Creek, nongame fish were documented at each location. Several species were present including longnose dace, plains killifish, longnose sucker, fathead minnow, flathead chub, and white sucker.

Further evaluations of the effect of existing chloride concentrations in Cottonwood Creek can be made by examining chloride toxicity data for species present in Cottonwood Creek. The national chloride criterion are based on published toxicity data for 13 taxa representing 11 families (U.S. EPA. 1988. Ambient Water Quality Criteria for Chloride - 1988, EPA 440/5-88-001). Of these 13 taxa, two species of fish and six species of aquatic invertebrates occur in Cottonwood Creek or a related taxa occurs in Cottonwood Creek (Table 1). Of the five species of fish for which chloride toxicity data exist, only one species (bluegill) is more sensitive to chloride than the two species of fish that have been documented in Cottonwood Creek (rainbow trout and fathead minnow). All five invertebrate taxa considered the most sensitive to chloride (caddisfly, midge, isopod, water flea, and snail) also either occur in Cottonwood Creek or have a related taxa present in Cottonwood Creek.

CONCLUSIONS

The aquatic invertebrate and fish abundance and composition data do not indicate that chloride concentrations are having a significant impact in the stream. The fact that several taxa considered the most sensitive to chloride toxicity are present in Cottonwood Creek appears to indicate that chloride levels are below levels of concern, indicating that the chloride water quality criteria is very conservative.

Table 1. Chloride toxicity in aquatic organisms ranked from least to most sensitive

Species	Species Mean Acute Value (mg/L)	Chronic Value (mg/L)
Fish		
American eel (*Anguilla rostrata)*	11,940	--
Goldfish (*Carassius auratus*)	8,906	--
Rainbow trout (*Salmo gairdneri*)[a]	6,743	922.7
Fathead minnow (*Pimephales promelas*)[a]	6,570	433.1
Bluegill (*Lepomis macrochirus*)	5,870	--
Aquatic Invertebrates		
Mosquito (*Culex* sp.)	6,222	--
Midge (*Chironomus attenuatus*)	4,900	--
Caddisfly (*Hydroptila angusta*)[a]	4,039	--
Midge (*Cricotopus trifascia*)[a]	3,795	--
Isopod (*Lireus fontinalis*)[a]	2,950	--
Water flea (*Daphnia magna*)[a]	2,650	--
Snail (*Physa gyrina*)[a]	2,540	--
Water flea (*Daphnia pulex*)[a]	1,470	372.1

[a] species that exists in Cottonwood Creek or has a related taxa in Cottonwood Creek

SELENIUM REPORT

Hamilton Dome Oil Field Use Attainability Analysis Project

Prepared for

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Cheyenne, Wyoming

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INTRODUCTION

Merit Energy Company (MEC) produces crude oil at the Hamilton Dome Field located in Hot Springs County, Wyoming. Merit Energy Company applied for and received two NPDES permits to discharge produced water from the Hamilton Dome Field into unnamed tributaries that eventually flow into Cottonwood Creek. The Water Quality Division (WQD) of the Wyoming Department of Environmental Quality (DEQ) recently updated Water Quality Rules and Regulations, Chapter 1, to comply with the federal Clean Water Act that requires all surface water be swimmable and fishable. Wyoming WQD was required to make changes to their statewide water classification system. Until the recent update of Chapter 1, the classification of the tributaries and Cottonwood Creek was Class 4. The tributaries are now class 3B and Cottonwood Creek is now class 2C.

The new classifications require a chloride limit in Cottonwood Creek of 230 mg/L where a limit had not previously existed. To obtain detailed information on water quality, water in tributaries used to discharge water and water in Cottonwood Creek both above and below Hamilton Dome discharge points were sampled by States West Water Resources personnel in the spring and summer of 2002. Although the primary purpose of this sampling was to obtain detailed data on chloride levels, several water quality parameters were measured, including selenium.

Selenium levels were also found to be above existing WQD criteria. The current water criteria for selenium are 20 μg/L for acute (one-hour average) levels and 5 μg/L for chronic (4-day average) levels. On March 20, 2002, selenium levels were 29 to 31 μg/L in Cottonwood Creek and 25 to 37 μg/L in Hamilton Dome discharge. Selenium levels in Cottonwood Creek were 26 to 36 μg/L on April 17, 2002 and 25 to 67 μg/L on June 21, 2002. The current water-based criteria were developed using data that are now 15 years old (U.S. Environmental Protection Agency [EPA] 1987). After reviewing more extensive and recent data, the EPA is proposing that selenium criteria be based on fish tissue concentrations, rather than concentrations in water. According to the new proposed criteria (EPA 2002), "freshwater aquatic life should be protected if the concentration of selenium in whole-body fish tissue does not exceed 7.9 μg/g dry weight, and if the short-term average concentration of selenium dissolved in the water seldom exceeds 185 μg/L".

Selenium is a naturally occurring metalloid and occurs in many soil types. It enters the ground and surface waters through natural weathering processes such as erosion, leaching and runoff. It is considered an essential trace element and aquatic and terrestrial organisms require 0.5 μg/g dry weight of selenium in their diet (EPA 2002). However, at higher levels, selenium is toxic. Among the most sensitive aquatic organisms, death can occur at water concentrations of 60 to 600 μg/L, and sublethal effects including anemia and reduced hatch of rainbow trout have been shown to occur at selenium water concentrations of 47 to 53 μg/L. In areas where selenium concentrates through evaporation, it can also pose a threat to migratory birds. For example, severe reproductive effects were reported in aquatic birds nesting in irrigation drainwater ponds in California, where selenium concentrations in water were 300 μg/L (Eisler 1985). The most important aspect of selenium accumulation in aquatic food chains is not direct toxicity to the organisms themselves, but the dietary source of selenium that the organisms provide to fish and wildlife. Most selenium in fish tissues results from uptake through the diet rather than through water (Lemly 1996). For this reason, a water-based criterion is not appropriate for selenium (EPA 2002).

Section 33 of Chapter 1 sets up a process where the WQD Administrator may allow site specific criteria. Therefore, MEC has decided to petition the WQD Administrator to establish site-specific criteria for chlorides and selenium because correcting the existing human-caused conditions (oil field discharge) would cause more environmental damage to correct (i.e., remove) than to leave in place. As part of this petition, a detailed study of selenium was conducted to (1) obtain additional data on selenium levels in Cottonwood Creek; (2) obtain data on selenium levels in areas where selenium may be concentrated through evaporation; (3) measure selenium levels in fish tissue for comparison to the new proposed chronic criteria; and (4) measure selenium levels in fish and aquatic invertebrates to assess the potential for selenium to impact migratory birds in the project area.

METHODS

Sampling Design

The sampling design was developed in conjunction with Mr. Pete Ramirez of the U.S. Fish and Wildlife Service Ecological Field Services Office in Cheyenne, WY. The protocol required collection of fish, aquatic invertebrate, and water samples at three locations along Cottonwood Creek (upper 1/3, mid 1/3 and lower 1/3) (see Figure 1). If available, the protocol dictated collection of fish from two size classes (<3 and $\geq$ 3 inches in length). The protocol also included collection of as many different invertebrate sample types as possible based on abundance and composition of the invertebrate population at each site.

Collection of aquatic invertebrates and water was also required at three areas of standing Hamilton Dome discharge water that might concentrate selenium through evaporation. Fish were not present at any of these areas and therefore could not be sampled. No areas of standing water were located along Cottonwood Creek. Several old oxbows were examined, but none contained standing water. There are two main points of discharge from Hamilton Dome, one on the east and one on the west side of the oil field; both discharges contain water from the same formation. There were no areas of standing water associated with the east discharge. The only areas of standing water available for sampling were associated with the discharge on the west side of the oil field, where water is discharged through a natural drainage as well as through an irrigation ditch. Discharge through the natural drainage enters an excavated settling pond, known as Lake Charlie. The discharge water conveyed by an irrigation ditch is used to irrigate an adjacent pasture. Irrigation return flows from this pasture have collected in two ponds backed up by a Hamilton Dome access road (see Figure 2). Lake Charlie and these two ponds were selected as the standing water sites for sampling.

Field Methods

Sampling was conducted on August 21-23, 2002. During this time, Hamilton Dome discharge was the only source of water in Cottonwood Creek; there was no water in the stream above the discharge and there were no other inputs from tributaries below the discharge. At each

Cottonwood Creek station, one grab sample of stream water was collected. A seine was then pulled through the stream to collect fish. Both fish size classes (<3 and ≥ 3") were collected at the middle and lower stream reaches; only the smaller size class of fish were collected at the uppermost station. A minium of 100 m of stream was sampled with the seine at each location. No trout or other game fish were captured in Cottonwood Creek. The nongame fish captured included plains killifish, longnose dace, fathead minnow, white sucker, longnose sucker, and flathead chub (Table 1). A surber sampler was used to collect aquatic macroinvertebrates in riffle habitats. The sampler was seated firmly on the substrate and cobbles were overturned to dislodge any invertebrates present. Three invertebrates samples were obtained at each stream site. Invertebrates present in the samples were dragonfly nymphs, mayfly nymphs, fly larvae, beetles, rotifers, midge larvae, and snails. Because the minimum sample mass required for selenium analysis was 1 g, some insect groups were compiled to obtain the necessary sample mass.

At the three ponds, one grab sample of water from the approximate center of each pond was collected. Aquatic invertebrates were collected using several methods. At the two ponds collecting irrigation return flows, abundant snail populations were present. One sample of snails was collected from each of those ponds by picking up individual snails until a sufficient sample mass was obtained. Additional invertebrates were collected in each of the three ponds using a sweep net. Transects through each pond were walked while slowly sweeping the net through the water column. Finally, light traps were used to passively collect insects on two nights in each pond. The light traps consist of a small battery-powered light which is positioned to attract invertebrates through a funnel and into a plastic container. Nine invertebrate samples were collected from the three ponds. In addition to snails, other invertebrates present in samples included mayfly larvae, stonefy larvae, water boatmen, daphnia, fly larvae, midge larvae, aquatic beetles, and copepods. In some cases several insect groups were compiled to obtain the minium sample mass required for analysis.

Water grab samples were preserved with nitric acid and submitted for analysis. Fish were maintained on ice while in the field and frozen within 24 hours. All invertebrate samples were

maintained on ice, sorted into groups, frozen and submitted for analysis within 48 hours of collection.

Laboratory Methods

Water analyses were conducted by Intermountain Labs (IML), Sheridan, Wyoming. This lab was chosen to ensure consistency with earlier analyses IML conducted on water samples collected by States West in the spring of 2002. Total selenium levels were determined using EPA method 600/R94/111, "Methods for the Determination of Metals in Environmental Samples-Supplement I", May 1994. Selenium concentrations in fish and aquatic invertebrates were determined by the Wyoming State Veterinary Laboratory in Laramie, Wyoming. Each sample was weighed, oven dried, and re-weighed, then ground and mixed prior to digestion with a mixture of HNO3 and H2O2. Fish samples were homogenized with a blender prior to drying. Digests were analyzed for selenium on an Elan ICP-MS by the method of standard additions. Quality control consisted of standard reference materials (e.g., NRCC DOLT) and selenium-fortified samples.

RESULTS

Selenium concentrations in water within Cottonwood Creek measured during this study were 22 μg/L at the upper reach, 21 μg/L at the middle reach, and 29 μg/L at the lower reach (Table 1). Selenium concentrations previously determined at two Cottonwood Creek locations downstream of Hamilton Dome averaged 30 μg/L in March 2002, 31 μg/L in April 2002 and 46 μg/L in June 2002; the average in August 2002 was 24 μg/L. These data indicate relatively stable selenium concentrations in Cottonwood Creek over time. Selenium concentration in the three ponds was lowest in Lake Charlie (21μg/L); concentrations in the other two ponds receiving irrigation return flows were 32 μg/L and 34μg/L. Selenium concentrations at all stream and pond sampling stations were above the current chronic value criteria of 5 μg/L in water (Wyoming Department of Environmental Quality 1990).

Whole body selenium concentrations in fish <3" in length ranged from 4.69 to 5.49 μg/g dry weight (dw), and averaged 5.15 μg/g dw (Table 2). Concentrations in fish $\geq$ 3" in length were

4.76 μg/g at the middle reach and 7.77 μg/g at the lower reach, for an average of 6.27 μg/g. All whole body selenium concentrations in fish were below the new proposed criteria of 7.9 μg/g.

Within Cottonwood Creek, selenium concentrations in aquatic invertebrates ranged from 2.31 μg/g dw in fly larvae collected in the middle reach to 5.57 μg/g in mayfly larvae collected in the upper reach (Table 3). Invertebrate selenium concentrations were similar along the entire steam reach, ranging from 3.34 μg/g in the middle reach to 4.86 μg/g in the lower reach. The mean value for all sampling locations and invertebrate types included in the samples was 4.18 μg/g.

In the three ponds, aquatic invertebrate selenium concentrations ranged from 1.27 μg/g dw in a sample from Pond 3 (Lake Charlie) containing mayfly and stonefly larvae to 4.76 μg/g in a diving beetle sample collected at Pond 2 (Table 3). The mean invertebrate selenium concentration in all three ponds combined was 3.01 μg/g dw.

CONCLUSIONS

After reviewing selenium toxicity data for birds, the EPA (2002) concluded that the final chronic value of 7.9 μg/g dw in fish tissue is expected to be protective of birds dependent on an aquatic food chain. Because all selenium values in fish and aquatic invertebrates measured during this study were below this value, no unacceptable impacts should occur to migratory birds consuming fish or aquatic invertebrates in the study area.

To develop the new selenium criteria, acceptable data on the acute effects of selenium in freshwater were available for 12 invertebrate species and 11 species of fish (EPA 2002). The most sensitive of the 12 invertebrates was a species of *Daphnia*, and the most sensitive of the 11 species of fish was fathead minnow. *Daphnia* were extremely abundant in one of the irrigation return flow ponds (Pond 1) sampled during this study, and fathead minnow was documented within Cottonwood Creek during this study as well as by the Wyoming Game and Fish Department during earlier studies. Presence of these sensitive species provides further evidence that the selenium concentrations in Hamilton Dome discharge are below levels of concern.

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Table 1. Selenium concentrations in water samples collected at invertebrate and fish sample sites

Sample Site	Selenium concentration (μg/L)
Pond 1	32
Pond 2	34
Pond 3	21
Pond Mean	**29**
Cottonwood Creek - upper reach	22
Cottonwood Creek - middle reach	21
Cottonwood Creek - lower reach	29
Cottonwood Creek Mean	**24**

Table 2. Selenium concentrations in fish samples collected from Cottonwood Creek

Stream reach	Size Class	Species	No. in sample	Selenium Concentration (μg/g dry weight)
Upper	<3"	longnose dace (*Rhinichthys cataractae*)	12	5.26
		plains killifish (*Fundulus zebrinus*)	3	
		longnose sucker (*Catostomus catostomus*)	2	
		fathead minnow (*Pimephales promelas*)	1	
	≥ 3"	none	0	--
Middle	<3"	plains killifish (*Fundulus zebrinus*)	15	4.69
		longnose dace (*Rhinichthys cataractae*)	2	
		flathead chub (*Hybopsis gracilis*)	1	
		longnose sucker (*Catostomus catostomus*)	1	
	≥3"	flathead chub (*Hybopsis gracilis*)	3	4.76
Lower	<3"	plains killifish (*Fundulus zebrinus*)	29	5.49
		white sucker (*Catostomus commersoni*)	24	
		flathead chub (*Hybopsis gracilis*)	17	
		longnose dace (*Rhinichthys cataractae*)	4	
	≥ 3"	flathead chub (*Hybopsis gracilis*)	3	7.77
		white sucker (*Catostomus commersoni*)	1	
			FISH MEAN (<3")	5.15
			FISH MEAN (≥ 3")	6.27

Table 3. Selenium concentrations in aquatic invertebrate samples collected in Cottonwood Creek and at three ponds receiving Hamilton Dome discharge.

Location	Sample	Composition	Selenium Concentration (μg/g dry weight)
Pond 1	1	snails (Gastropoda)	1.71
	2	mayfly larvae (Ephemeroptera)	4.62
		stonefly larvae (Plecoptera)	
	3	water boatman (*Corixa* sp.)	3.66
		water flea (*Daphnia* sp.)	
		fly larvae (Diptera)	
		midge larvae (Chironomidae)	
		Pond 1 Mean	3.33
Pond 2	1	snails (Gastropoda)	1.75
	2	mayfly larvae (Ephemeroptera)	4.19
		stonefly larvae (Plecoptera)	
	3	diving beetle (Dytiscidae)	4.76
	4	water boatmen (*Corixa* sp.)	3.02
		beetles (Coleoptera)	
		midge larvae (Chironomidae)	
		fly larvae (Diptera)	
		copepods (Copepoda)	
		Pond 2 Mean	3.43
Pond 3	1	mayfly larvae (Ephemeroptera)	1.27
		stonefly larvae (Plecoptera)	
	2	midge larvae (Chironomidae)	2.12
		water boatmen (*Corixa* sp.)	
		snails (Gastropoda)	
		beetles (Coleoptera)	
		scud (*Gammarus* sp.)	
		Pond 3 Mean	1.70
		POND MEAN	3.01

Table 3 (Continued). Selenium concentrations in aquatic invertebrate samples collected in Cottonwood Creek and at three ponds receiving Hamilton Dome discharge.

Location	Sample	Composition	Selenium Concentration (μg/g dry weight)
Cottonwood Creek - Upper	1	dragonfly larvae (Odonata)	4.63
	2	mayfly larvae (Ephemeroptera)	5.57
	3	beetles (Coleoptera)	2.78
		snails (Gastropoda)	
		Upper Reach Mean	4.33
Cottonwood Creek - Middle	1	dragonfly larvae (Odonata)	5.23
	2	fly larvae (Diptera)	2.31
	3	beetles (Coleoptera)	2.48
		rotifers (Rotifera)	
		fly larvae (Diptera)	
		mayfly larvae (Ephemeroptera)	
		Middle Reach Mean	3.34
Cottonwood Creek - Lower	1	dragonfly larvae (Odonata)	4.90
	2	water boatmen (*Corixa* sp.)	5.31
	3	water strider (*Gerris* sp.)	4.38
		mayfly larvae (Ephemeroptera)	
		beetles (Coleoptera)	
		Lower Reach Mean	4.86
		COTTONWOOD CREEK MEAN	4.18

Figure 1. Location of sampling stations along Cottonwood Creek

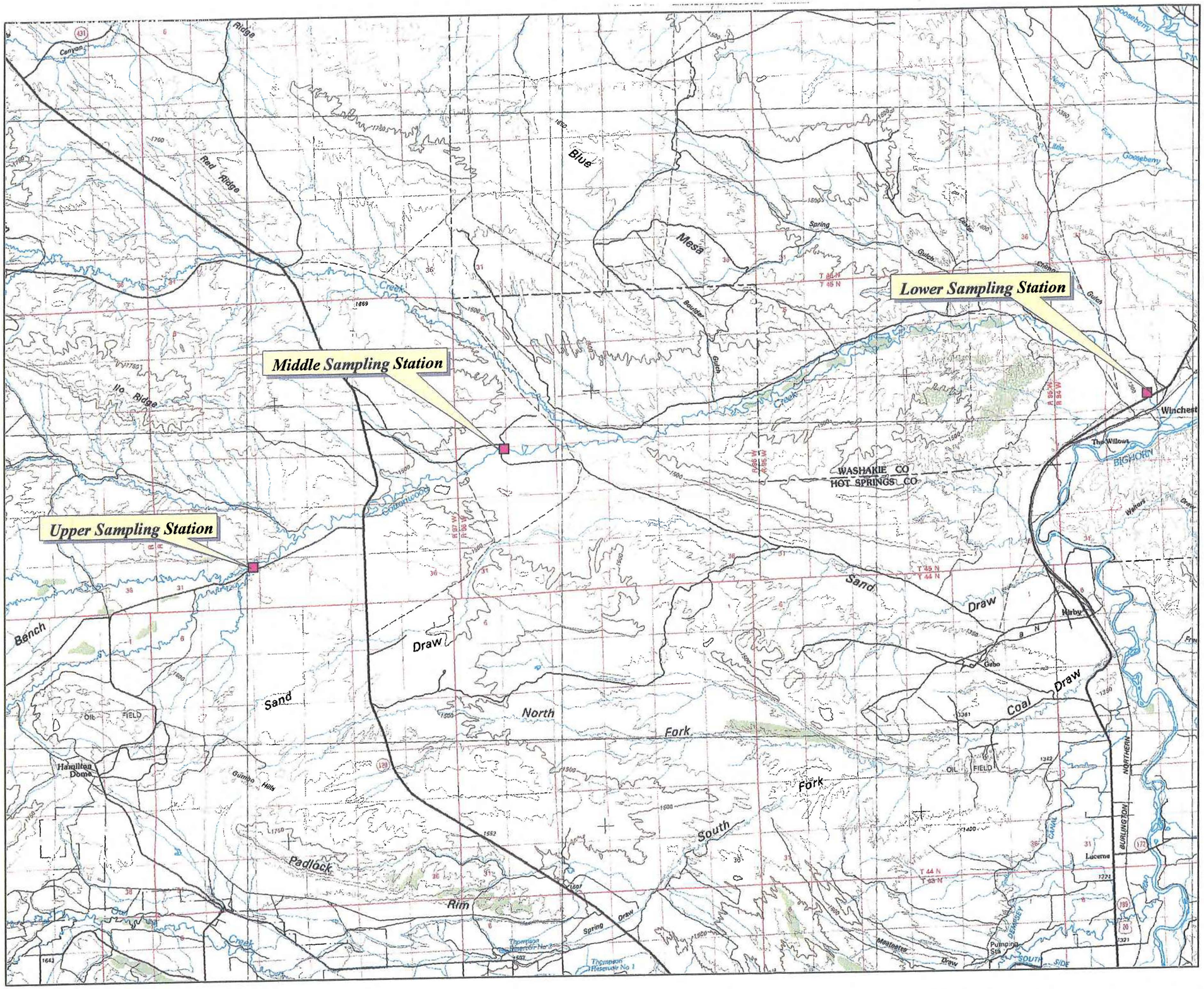

Figure 1. Locations of sampling stations along Cottonwood Creek.

WEST, Inc.

Specializing in Ecological Field Studies

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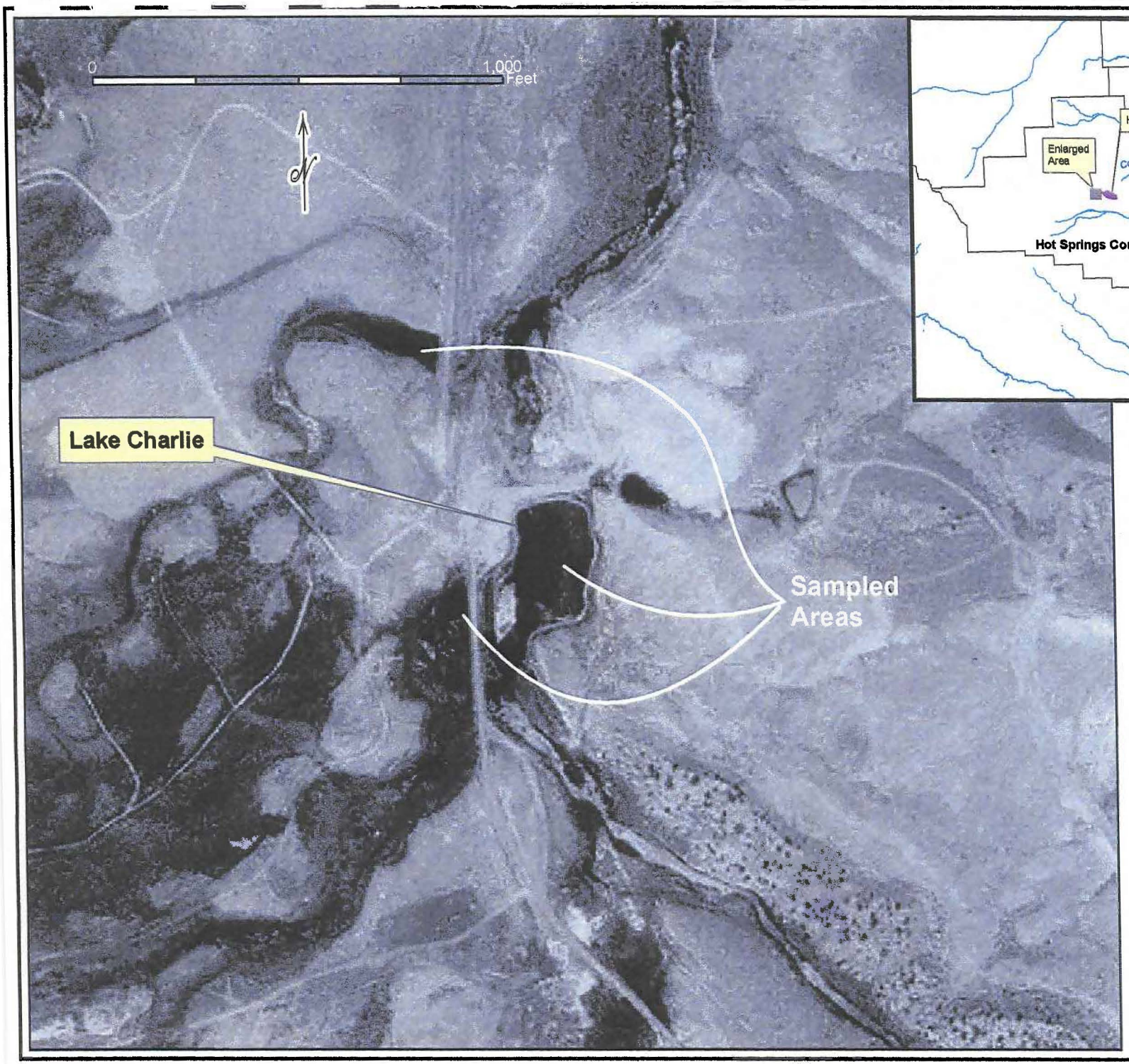
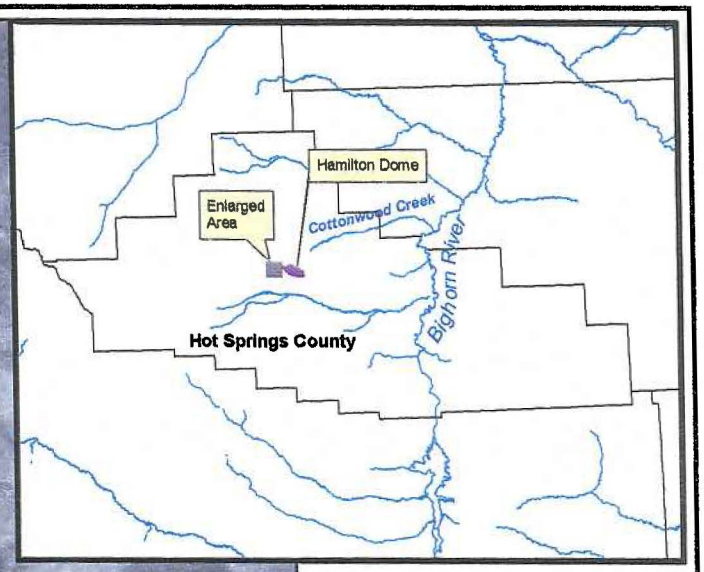
Figure 2. Location of three ponds selected for selenium samples
Pond 1 is furthest north, Pond 2 is west of Lake Charlie, and Pond 3 is Lake Charlie





Aerial View Northwest of Hamilton Dome Oil Field Showing Water Areas Sampled for Selenium (Section 15 T44N R98W)

APPENDIX G

ECONOMIC REPORT

The Economic Significance
of the
Hamilton Dome Oilfield

November 6, 2002

Prepared for
Merit Energy Company

Blankenship Consulting LLC **Hammer Siler George Associates**

in association with
States West Water Resources Corporation

EXECUTIVE SUMMARY

Ongoing production of petroleum crude from Merit Energy Company's Hamilton Dome field is a significant source of economic stimulus for Hot Springs County and the State of Wyoming. This report provides an assessment of the contributions of Merit's Hamilton Dome oilfield to the economy of Hot Springs County and the State of Wyoming. In fact, these contributions are proxy measures of the adverse impacts that would result from the premature closure of the Hamilton Dome field. The report focuses on the following aspects of the economy:

- the economic stimulus associated with Hamilton Dome employment, purchases of goods and services, payment of taxes and the associated multiplier effect,
- the effect of Hamilton Dome tax payments on the Hot Springs County tax base and the taxing entities who rely on these payments to help fund services provided to residents, including students enrolled in local public schools,
- hay and livestock production along Cottonwood Creek supported by the discharge of produced water from the Hamilton Dome; and,
- the significance of Hamilton Dome crude oil to the Wyoming refining industry and the production of asphalt and road oil.

The substantial negative economic impacts in Hot Springs County that would accrue to residents, businesses and local governmental entities with premature closure should be taken into account in the overall assessment of the benefits and costs associated with compliance with Class 2C water quality standards.

Economic Contributions of Hamilton Dome

Annual crude production from the Hamilton Dome field averaged 1.67 million barrels over the past five years.

- Employment and Labor Income: Based on annual operating expenses averaged over the past five years, Hamilton Dome supports an estimated 186 jobs in the State of Wyoming including 136 jobs in Hot Springs County (about 4 percent of total employment in the county in 2000) and 50 jobs elsewhere in Wyoming. The associated Hamilton Dome labor income impact in Hot Springs County totals $4.07 million (about 7 percent of total labor income in the county in 2000) and $2.54 million elsewhere in Wyoming.

- Overall Economic Output: The economic contribution of the Hamilton Dome oilfield is conservatively estimated at nearly $28.7 million annually, most of which occurs in Hot Springs County.

Fiscal Contributions of Hamilton Dome

Merit Energy Company is the largest taxpayer in Hot Springs County and the Hamilton Dome field is the county's largest source of property tax.

Property Tax

Over the past 5 years, Hamilton Dome property tax revenue has averaged 29 percent of total property tax revenue for all countywide taxing entities ($1.9 million out of a total $6.6 million). Property taxes are the largest source of locally-derived funding for local governmental entities and represent a major source of non-earmarked revenue subject to discretionary spending control. Counties are statutorily limited to a 12-mill cap for basic county operating purposes (general fund, hospital, library and fair board), limiting their capacity to increase property taxes to offset reductions in revenues. Hot Springs County's property tax rates are at the 12-mill limit. Consequently, a major reduction in revenues associated with the premature shutdown of the Hamilton Dome field would likely trigger reductions in basic service levels.

Over the past five years, property taxes from Hamilton Dome have accounted for the following revenue contributions to major funds and entities:

- County General Fund: 9 percent of total general fund revenues.

- Library, Fair Board, Hospital: 27 percent of the library system's total revenues, 15 percent of the Fair Board's total revenues and 2 percent of Hot Springs County Memorial Hospital's total revenues.

- Hot Springs County Weed and Pest District: Two separate levies fund operations of the Weed and Pest District. Hamilton Dome property tax revenues provide 9 percent of the district's pest eradication budget and 29 percent of its mosquito control budget.

- Hot Springs County Rural Fire Protection District: Hamilton Dome property tax revenues fund 29 percent of the district's budget. Because the district is staffed by volunteers, a loss of that revenue would not reduce services, but would delay the purchase of needed equipment, supplies and training.

- Hot Springs County School District # 1: Over the past five years, Hamilton Dome property taxes for school-related funds averaged $1.4 million annually. Of that amount, $910,000 was for operational purposes and $188,000 for debt service. The Wyoming School Foundation Fund received an average of $325,000. The entitlement provisions of the state foundation program would offset any loss in Hamilton Dome property tax revenue on the operating budget. Based on the five-year average, the Wyoming School Foundation Fund would experience a net cost of $1.235 million from lost revenues and additional entitlement costs, assuming no change in enrollment levels. Reductions in the number of Hamilton Dome-related students would reduce School District #1's entitlement and revenue with little reduction in educational costs. Loss of the Hamilton Dome property tax revenues would increase the school debt service mill levy for other county taxpayers by 2.8 mills, based on the five-year average.

Severance Tax

Over the last two years, severance taxes on Hamilton Dome production have averaged $1.8 million annually,

Federal Mineral Royalties

Over the past two years, federal mineral royalty payments for Hamilton Dome production averaged $4.4 million. Wyoming's share of these royalties averaged an estimated $2.2.million annually.

Sales and Use Tax

In 2001, MEC estimates that it paid over $400,000 in sales and use taxes on purchase of goods and services for the Hamilton Dome field.

The Role of Hamilton Dome Produced Water in the Cottonwood Creek Ranching Economy

Approximately 35 Cottonwood Creek-area landowners benefit directly or indirectly from water discharged from the Hamilton Dome field into the creek. These landowners use the water for irrigation and stock watering purposes. Based on a survey of several of these landowners, the loss of Hamilton Dome discharges into Cottonwood Creek would result in a corresponding loss of:

- 1,600 acres of irrigated cropland,
- 4,000 tons of annual hay production,
- 15 to 20% reduction in herd size (about 3,200 cows) and a $2 million reduction in related sales receipts (based on $650 head) and,
- 20 full time and seasonal jobs in the ranching industry.

Additional losses would be likely for ranches not included in the survey. Several ranchers contacted for the survey expressed concern for the economic viability of their operations without the Hamilton Dome water.

The IMPLAN model was used to estimate the total economic losses in Hot Springs County, including the indirect and induced impacts on other sectors, associated with the direct reduction in annual livestock receipts. Those losses, which include a net reduction of $3.3 million (1.7%) in the county's total annual economic output, a loss of $645,000 in annual labor income, and a net loss of 32 full and part-time jobs, would be in addition to those impacts directly attributable to the cessation of Merit's Hamilton Dome production operations.

The Role of Hamilton Dome in the Wyoming Refining Industry

Hamilton Dome crude production represents about 3.3 percent of the of the daily feedstock supply needed to sustain Wyoming's five refineries at full production. However, Hamilton Dome supplies more than 20 percent of the crude necessary to sustain asphalt and road

oil production. The loss of this production coupled with the absence of an alternate supply could threaten the economic viability of one or more Wyoming refineries.

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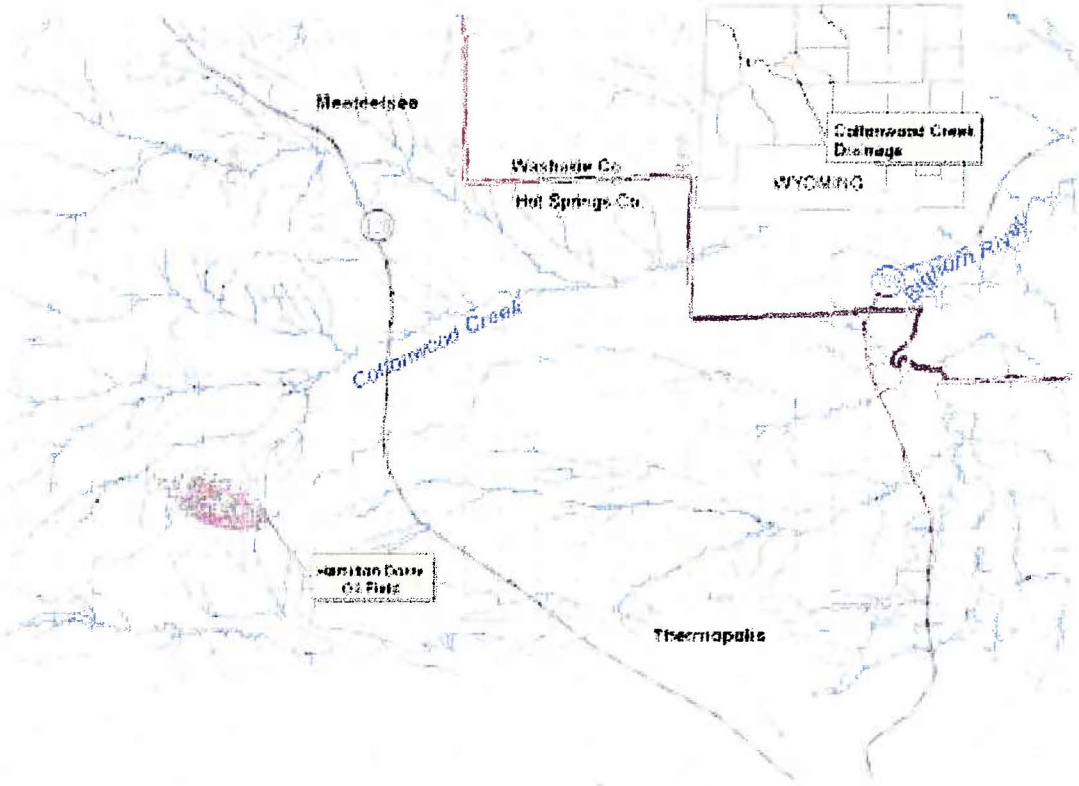
INTRODUCTION

The Hamilton Dome oil field, discovered in 1918, is located 25 miles northwest of the Town of Thermopolis in Hot Springs County, Wyoming. Through 2001, Hamilton Dome had produced 256 million barrels of oil and 1.59 billion cubic feet of natural gas (WOGCC 2001). Merit Energy Company (MEC), the operator of the field, anticipates 2002 production to total 4,250 barrels of oil per day (BOPD), primarily from the Tensleep and Phosphoria reservoirs; the field no longer produces marketable quantities of natural gas. Over the last five years, the Hamilton Dome Field has been on average the eighth most productive oil field in the State of Wyoming, averaging 42 percent of total Hot Springs County oil production and 2.7 percent of total statewide oil production. Oil produced from the field is sold and transported by pipeline to refineries in Wyoming and adjacent states.

Vicinity Map: Hamilton Dome Oilfield and Cottonwood Creek



Source: States West Water Resources Corporation

Also during 2002, Hamilton Dome is anticipated to produce 285,000 barrels of water per day (BWPD). An average of 85,000 BWPD is re-injected to enhance oil recovery. The remaining 200,000 BWPD is discharged from two separate points into unnamed tributaries that eventually flow into Cottonwood Creek (MEC 2002). Discharges of water produced from

Hamilton Dome into the Cottonwood Creek drainage have occurred since the early 1970's. Two NPDES permits, WY0000175 and WY0000680, authorize these discharges.

Cottonwood Creek flows generally eastward from its source in the Owl Creek Mountains at Cottonwood Peak in Township 45 North, Range102 West. It flows eastward 47 river miles into the Bighorn Basin to its confluence with the Bighorn River in Township 45 North, Range 94 West. Hamilton Dome discharges enter Cottonwood Creek at approximately river miles 12 and 19, measured from the upstream end (Jessen 2002).

Until recently, Cottonwood Creek and the tributaries receiving the Hamilton Dome discharge were classified by the Wyoming Department of Environmental Quality, Water Quality Division (WQD) as Class 4 streams. The water discharged from Hamilton Dome meets standards for Class 4 waters. The WQD recently updated Chapter 1 of the *Wyoming Water Quality Rules and Regulations* to comply with the federal Clean Water Act. As a result of this reclassification, Cottonwood Creek is now classified as 2C and the tributaries that receive Hamilton Dome discharges are classified as 3B. The Hamilton Dome discharges exceed Class 2C standards for several constituents including chloride and selenium.

In order to renew its discharge permits, MEC could be required to treat the Hamilton Dome discharge water to meet Class 2C standards. The company believes the financial impact of treating the discharge to meet Class 2C standards would result in closure of the field (Diem 2002). MEC is working with the Wyoming DEQ/WQD to either reclassify the stream or establish site-specific criteria allowing discharge of the produced water to continue without additional treatment. The company also believes that closure of the field prior to the full recovery of the available crude oil resources would trigger significant economic distress on the local economy. The following regional economic analysis has been prepared to examine those economic implications.

The objectives of this economic analysis are to describe the contributions of the Hamilton Dome oil field to the economies of Hot Springs County and the State of Wyoming, to the tax base of Hot Springs County and its relevant taxing entities, to the ranching economy along Cottonwood Creek, and to the Wyoming petroleum refining industry. The contributions described below are proxy measures of the adverse economic impacts that would result from the premature closure of the Hamilton Dome field. In other words, although the narrative typically discusses the economic contributions in positive or beneficial terms, these contributions are measures of what is "at-risk" from requiring compliance with the more stringent water quality standards, the anticipated result of which would be to halt production.

ECONOMIC CONTRIBUTIONS OF MERIT ENERGY COMPANY'S HAMILTON DOME OPERATIONS

On-going production of petroleum crude from the Hamilton Dome field is a source of significant economic stimulus for the Thermopolis and Hot Springs County economies. Moreover, the economic repercussions of that production extend to the broader statewide economy.

With respect to the local economy, the primary economic stimulus encompasses the company's direct payroll and its purchases of goods and services from oil field service companies, utilities and other suppliers and the consumer purchases of its employees. These direct economic infusions indirectly support yet other local businesses and jobs through what is known as the "economic multiplier effect." Finally, production and ad valorem taxes paid by the company, as well as taxes paid by its employees and the businesses and employees whose jobs are supported indirectly by the company's operation help support public education and governmental functions.

A second dimension of the field's economic stimulus derives from its linkages to local farming and ranching located along Cottonwood Creek. Oil production from the Hamilton Dome field yields a substantial quantity of water as a byproduct. Further production is supported by reinjecting a portion of that water into the oil-bearing formations. However, much of that water, about 6,700 acre-feet of water in 2001, discharges into the Cottonwood Creek drainage from where local ranchers subsequently use it for irrigation, stock watering and other agricultural purposes. That water is vital to helping sustain the local agricultural industry because of the region's semi-arid climate. The water also supports wildlife and wildlife habitat in the area.

Yet a third dimension of the field's economic significance is its role in supplying crucial feedstock for the Wyoming refining industry. More specifically, crude from the Hamilton Dome field is transported via pipelines to refineries in Casper and Sinclair, supplying a portion of the total feedstock for those facilities. That supply not only helps sustain the operating viability of those refineries and the economies of the respective communities, but the refined products supply fuel and asphalt to help support the state's economy and highway infrastructure.

Finally, the economic benefits associated with the Hamilton Dome field extend beyond the local communities. Economic linkages between local service firms and suppliers and wholesale and service firms located elsewhere in the state and the flows of consumer purchases to larger regional economies, result in a portion of the indirect and induced "multiplier" effects being captured elsewhere, such as in Cody, Riverton or Casper.

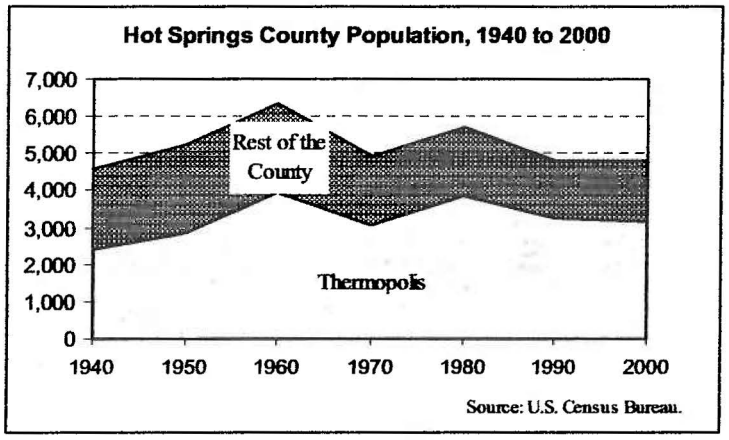
This section of the report examines each of those key economic linkages, quantifying their significance in terms of the numbers of jobs, labor income and annual economic output supported.

Local Setting

The Hamilton Dome field is located in Hot Springs County, Wyoming and is part of a broader region known as the Big Horn Basin. The field is 25 miles northwest of Thermopolis, the county seat and its largest community.

Hot Springs County covers an area of more than 2,000 square miles (1,294,080 acres). Approximately 30 percent of the land in the county is in private ownership. Various federal or state agencies manage the remaining lands or hold them in trust for the Eastern Shoshone and Northern Arapaho tribes as part of the Wind River Indian Reservation.

Hot Springs County is rural. Its population has fluctuated over time, primarily in response to energy and mineral exploration and development. Population peaked at 6,365 residents in 1960. By 1990, the county's population had declined to 4,809 with little population growth in the ensuing decade as the county registered a population of 4,882 residents in the 2000 census. Consequently, Hot Springs County ranked 22nd among Wyoming's 23 counties in terms of population in 2000.



Throughout its contemporary history, most of the county's residents have lived in Thermopolis. In 2000, Thermopolis had 3,172 residents compared to 1,710 residents in the outlying areas of the county.

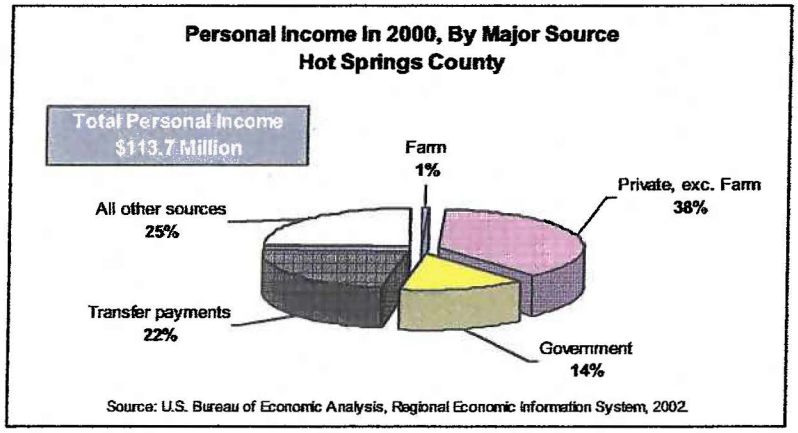
The economic mainstays of the county's economy include agriculture, energy and mineral production, and tourism/outdoor recreation. These "basic" industries generate much of the inflow of wealth into the economy through their sales of goods and services. In turn, the respending of business and employee incomes and local taxes support local retail trade, services and the local public sector. There is little manufacturing or regional wholesale trade activity based in Hot Springs County. Unlike the stagnation characterizing the county's recent population growth, total employment in Hot Springs County increased 334 jobs, nearly 12 percent, between 1990 and 2000 – see Table 1 below. Most of the increase was in the retail trade and services sectors.

TABLE 1
HOT SPRINGS COUNTY EMPLOYMENT, BY MAJOR CATEGORY

Category	1990	1995	2000
Farm	206	198	205
Oil, Gas & Mining	230	150	200
Other Private Sector	1,763	2,075	2,155
Government	614	557	587
Total	**2,813**	**2,980**	**3,147**

Source: U.S. Bureau of Economic Analysis, 2002.

Local retail trade and service businesses, as well as local government, gain additional support from consumer expenditures by the relatively large number of retirees living in the county. According to the 2000 census, more than one of every four local households depend on retirement, social security or some other form of government payments for their income. Income from such transfer payments accounted for 22 percent of the total personal income of $113.7 million in 2000. While such income serves an important function in supporting the local economy, it tends to be relatively fixed over time. When combined with the limited number of higher-paying jobs in the basic industries, this fact translates into comparatively low per capita income in Hot Springs County. In 2000, Hot Springs County ranked 15th among Wyoming counties with a per capita personal income of $23,393, nearly 15 percent below the statewide average of $27,372 per person.



Other major sources of income in Hot Springs County include labor earnings, income derived from dividends, interest and rent, and miscellaneous other income. Private sector earnings, excluding local farming and ranching operations but, including education, is the largest contributor to total income, paying more than $43.4 million to employees and owners in 2000 (38% of the total). That amount was nearly triple the aggregate government payroll of $15.7 million. Local farmers and ranchers had a combined income of $874,000 in 2000, less than 0.8 percent of the total. Dividends, rent and other non-earnings sources of revenue accounted for the remaining $28.2 million in personal income of local residents.

Merit Energy's Hamilton Dome Operations

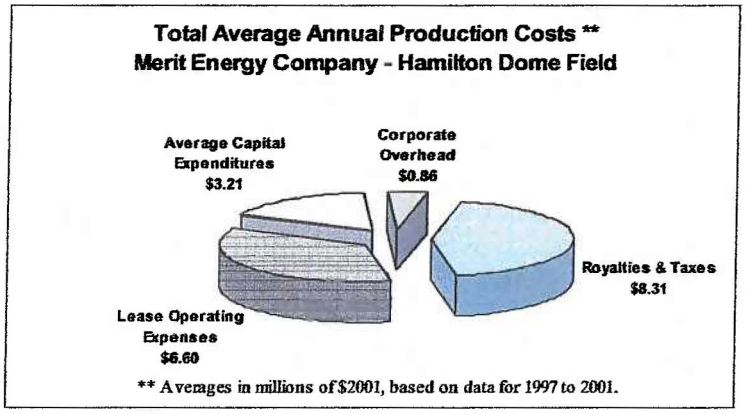
As described above, Merit Energy's primary economic stimulus arises from its production-related expenditures, including the consumer-related purchases of its employees, and its support of public education and government through the taxes it pays. Merit Energy's Hamilton Dome office is the operational base for eight oil fields in Wyoming's Big Horn Basin.

Presently, fifteen (15) of the employees in that office are directly associated with the Hamilton Dome field. Suspending production from the field prior to full recovery of the crude reserves would result in a premature loss of these jobs, their associated incomes and the business volume, jobs, incomes and state and local taxes supported indirectly by the company's operations. Those impacts would be significant.

An analysis of the company's operations, completed using a regional economic model, demonstrates the economic significance of Merit Energy's Hamilton Dome operation. The model uses actual production and operating data for the company for the five-year period, 1997 through 2001. The use of a multi-year data set to summarize the company's economic contributions compensates for much of the market induced year-to-year variability in operating and capital expenditures frequently associated with oil and gas production.

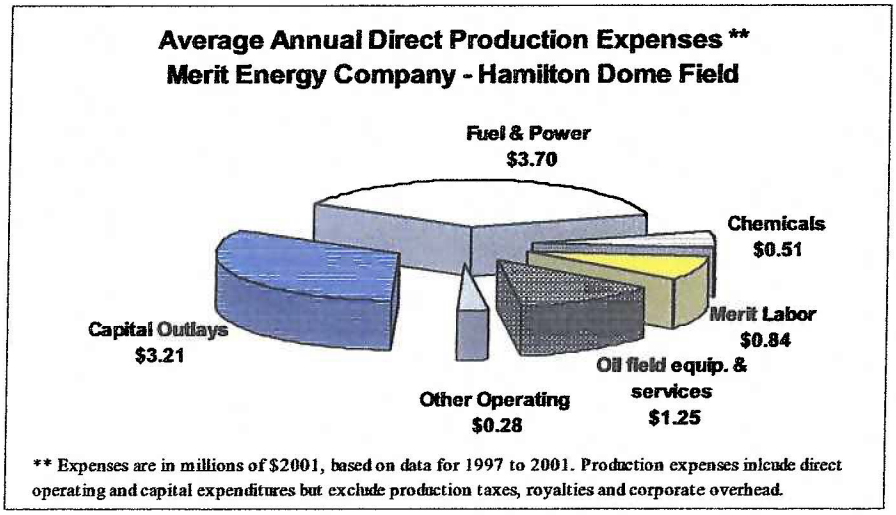
The economic analysis completed for this study, used cost of production data supplied by Merit Energy and the IMPLAN economic modeling software. IMPLAN (**IM**pact Analysis for **PLAN**ning) is an input-output based model originally developed to assist the U.S. Forest Service in land resource management planning. Subsequently, the model and related software were transferred into the private sector, where it is the subject of ongoing refinement and enhancements to provide the analytical capacity to address a broader range of economic and impact planning issues. IMPLAN is widely recognized and accepted in regional economic and economic impact assessment circles. Results of the analysis include direct and total jobs, income and output associated with the operation.

Merit's annual crude production from the Hamilton Dome field averaged 1.67 million barrels of over the past five years. Average annual total costs of production over that same period were $18.98 million ($2001). Royalties and taxes account for the single largest category of production costs, $8.31 million or 44 percent of the total. By comparison, the actual lease operating expenses, which include labor, chemical, equipment, etc., averaged $6.60 million annually – the distribution of costs, by major category, are shown in the accompanying figure.



Of primary relevance to this analysis are the $9.81 million in lease operating and capital expenses made by Merit Energy in a typical year. These expenditures represent the day-to-day purchases of goods and services and payroll outlays to staff that cycle into and through the local and statewide economies, supporting other businesses, jobs for Wyoming residents, and taxes to support government. Fuel and power are the company's single largest production expense category, about $3.70 million annually. Other major categories include labor, replacement

equipment, chemicals, and capital outlays – see the figure below for the direct production expenses by major category.



In addition to the annual volume of purchases, another key determinant of Merit's economic contribution is the extent to which local suppliers provide goods and services. In that regard, Merit Energy actively strives to support local business. It estimates that almost 99 percent of all its annual purchases are from Wyoming businesses and the bulk of those, totaling more than $5.54 million annually, are from contractors and suppliers with an operational presence in Hot Springs County. Table 2 below presents the estimated distribution of Merit's annual operating and capital outlay expenses, by major industrial sector.

TABLE 2
AVERAGE ANNUAL DIRECT PRODUCTION EXPENSES
MERIT ENERGY COMPANY'S HAMILTON DOME FIELD ($2001)

Major Industrial Sector	Hot Springs County	Elsewhere In Wyoming	Total in Wyoming
Oil-field Services, incl. capital outlays	$ 3,365,100	$ 558,300	$ 3,923,400
Electrical Power	$ 167,100	$ 3,342,600	$ 3,509,700
Wholesale Trade	$ 1,125,700	$ 47,300	$ 1,173,000
Retail Trade	$ 6,900	$ 59,200	$ 66,100
Other Services	$ 117,200	$ 55,000	$ 172,200
Merit Energy Payroll	$ 760,100	$ 84,500	$ 844,600
TOTAL	**$ 5,542,100**	**$ 4,146,900**	**$ 9,689,000**

Source: Merit Energy Company, 2002.

Oil field services is the largest category of expenditures, and most of the company's annual outlays for such services are to local contractors. With no major electrical generating facilities in Hot Springs County, electrical power is the single largest production expense from outside the local economy.

Merit Energy currently has 15 employees assigned to the Hamilton Dome operations. However, the significant volume of oil field services and repairs the company contracts to others and its other purchases combine with the jobs supported by employee spending to generate a much higher overall employment impact. Based on the average annual operating expenses, the IMPLAN model estimates a total employment impact from Merit's Hamilton Dome field of 186 jobs statewide; 136 jobs in Hot Springs County and an additional 50 jobs elsewhere in Wyoming – see Table 3. The statewide estimate is exclusive of jobs supported by the expenditures of royalty payments and severance and sales taxes budgeted through the state. The total local jobs supported represents about 4% of total employment in Hot Springs County in 2000.

TABLE 3
PRIVATE SECTOR JOBS SUPPORTED IN WYOMING BY MERIT ENERGY COMPANY'S HAMILTON DOME FIELD

	In Hot Springs County	Elsewhere In Wyoming	Total Wyoming Jobs
Merit Energy	15	0	15
Oil-field services & suppliers	36	25	61
Other private sector	24	23	47
Government and Education	61	2	63
TOTAL	**136**	**50**	**186**

Note: The numbers of jobs supported were derived using IMPLAN, based on Merit Energy Company's average annual expenditures for 1997 through 2001.

The largest number of jobs supported is in local government and education (63 jobs). The strong support for these jobs stems from the company's substantial annual tax payments (these payments are discussed further in a later section.) [1]Another 61 jobs in the oil field service and supply industries followed by 47 jobs in wholesale and retail trade, services, construction and other private sector industries.

A corollary dimension of Merit's positive employment impacts is the beneficial impact on personal income. Over the past five years, Merit Energy Company's direct payroll has averaged about $844,000 annually, though it presently is at about $740,000 on an annual basis. The incomes supported by Merit's operations in government, education, oil field services and other industries magnify that direct impact. When summed across all industries, the estimated labor income impact in Hot Springs County totals $4.07 million annually, with another $2.54 million elsewhere in the state –see Table 4 on the following page. The total local labor income represents nearly 7% of the corresponding total labor income in Hot Springs County in 2000.

[1] The IMPLAN estimates of the number of jobs in education reflect the proportion of the district's total locally derived property taxes paid by Merit. In reality, increases in state school foundation funds would offset much of the loss of Merit's taxes, resulting in a more limited reduction in staffing. Consequently, though the IMPLAN estimates likely overstate Merit's actual employment impacts, they are representative of the company's fiscal support for education.

TABLE 4
ANNUAL LABOR INCOME SUPPORTED BY MERIT ENERGY COMPANY'S HAMILTON DOME FIELD (MILLIONS OF $2002)

	In Hot Springs County	Elsewhere In Wyoming	Total
Merit Energy Direct	$ 0.84	$ 0.00	$ 0.84
Oil-field services & suppliers	$ 1.13	$ 1.02	$ 2.15
Other private sector	$ 0.56	$ 1.46	$ 2.02
Government and education	$ 1.54	$ 0.06	$ 1.60
TOTAL	**$ 4.07**	**$ 2.54**	**$ 6.61**

Note: Estimated annual labor incomes were derived using the IMPLAN model and Merit Energy average annual expenditures for 1997 through 2001.

Another measure of the economic contributions of Merit Energy's Hamilton Dome operation is its impact on overall economic output. A conservative estimate of the total statewide impact is nearly $28.7 million annually, most of which occurs in Hot Springs County. The largest portion of the total is represented by Merit's operations, including contracted services – see Table 5 below. By way of comparison, the total estimated 1999 economic output of Hot Springs County was about $195 million. The estimate is conservative as it does not account for the output associated with subsequent rounds of government spending and investments supported by the royalty and production tax payments or that associated with the subsequent refining and consumption of refined petroleum products across Wyoming supported by Merit's Hamilton Dome production.

TABLE 5
ANNUAL STATEWIDE OUTPUT SUPPORTED BY MERIT ENERGY'S HAMILTON DOME FIELD (MILLIONS OF $2002)

Category	Annual Amount
Direct Production Expenses	$ 9.81
Corporate Overhead	$ 0.86
Royalties, Taxes and Gross Net Revenue	$ 13.59
Indirect and Induced Private Sector Output	$ 4.40
Total Annual Statewide Output	**$ 28.66**

Note: The output estimates were derived using IMPLAN and Merit Energy expenditure data for 1997 through 2001

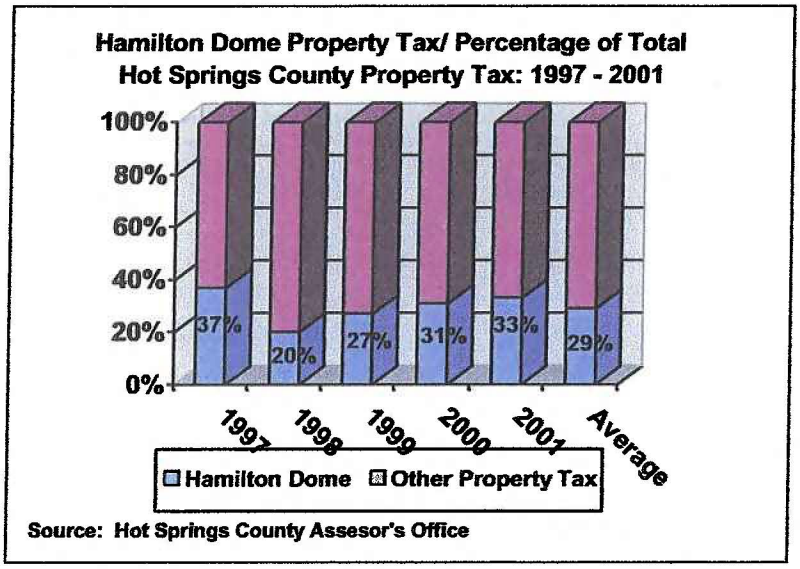
FISCAL CONTRIBUTIONS OF THE HAMILTON DOME OILFIELD

Wyoming oil producers pay ad valorem property taxes on production and on oilfield facilities, severance taxes on production, and sales and use taxes on some purchases of goods and services. Revenues from these taxes accrue to counties, school districts, and certain special districts, to the state general fund, and to a variety of other state funds and accounts. Additionally, the State of Wyoming receives half of the mineral royalties oil producers pay to the federal government and a portion of these revenues is distributed to local governments.

Ad Valorem Property Taxes

Oil producers pay property taxes on the assessed (taxable) value of production and oilfield facilities. Oil production is assessed at 100 percent of the fair market value (wellhead sales price) and facilities are assessed at 11.5 percent of fair market value (depreciated replacement value).

Property tax revenue from production and oil field facilities has accounted for two-thirds to three-quarters of the total property tax revenues received by county-wide taxing entities in Hot Springs County in recent years, (WTA 1997 – 2001). Crude oil production alone accounted for 73 percent of Hot Springs County assessed valuation in 2001 and has averaged 65 percent of total valuation between 1997 and 2001.



MEC is the largest taxpayer in Hot Springs County, and Merit's Hamilton Dome oil field is the county's largest single source of property tax. In 2001, Hamilton Dome accounted for 33 percent of total countywide property taxes paid in Hot Springs County ($2.7 million out of a total $8.3 million). Property tax revenue from Hamilton Dome production averaged 29 percent of total property tax revenue over the last five years ($1.9 million out of an average $6.6 million) (Deromedi 2002).

Property Tax Distribution

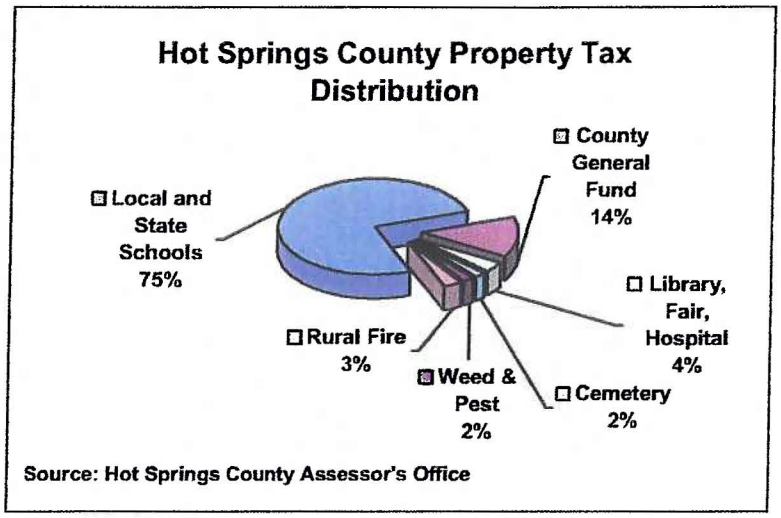
Schools receive the lion's share of property tax revenue in Wyoming. In Hot Springs County, an average of 75 percent of total countywide property tax revenue (including the state school

foundation program and the local school bond issue) has been distributed to schools over the last five years.

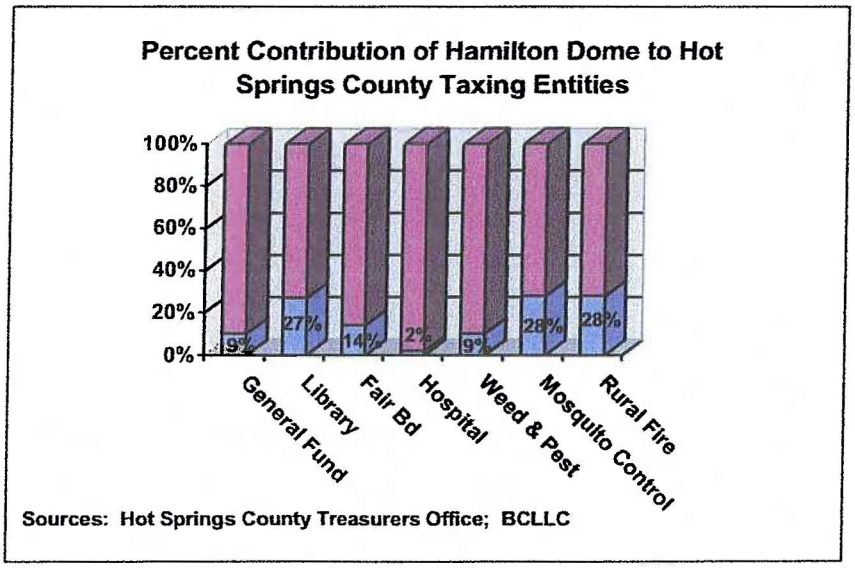
Hot Springs County General Fund

On a countywide basis, property tax revenues accrue to the Hot Springs County General Fund, and to the Library, County Fair and County Hospital funds. These entities are limited to a combined total levy of 12 mills, by state statute.

The county general fund provides revenues for all major county functions. Property tax revenues accounted for 40 percent of Hot Springs County general fund revenues during 2001[2], and averaged 37 percent of general fund revenues over the past four years[3] (Hot Springs County Treasurer's Office).



The relative importance of property tax revenue to the county general fund is greater than its percentage of total revenue however. Much of the county's non-property tax revenue is received from federal or state sources and is earmarked for specific programs or items. In Hot Springs County, property tax is the major source of revenue over which the commissioners exercise discretionary control. Consequently, any substantial reduction in property tax revenue will trigger reductions in basic county services because the commissioners cannot raise the mill levy above the 12-mill limit (Ford 2002).



Hamilton Dome property tax revenue accounted for 12 percent

[2] Total general fund revenues for 2001 were adjusted to account for an early federal PLT payment.
[3] County revenue data for 1997 were not readily available.

of total Hot Springs County General Fund revenue in 2001[4] ($356,000 out of a total $2.986 million), and averaged 9 percent of total revenues over the past four years ($241,000 out of average total $2.576 million).

Hot Springs County Library

The Hot Springs County Library receives property tax revenues from an average one-mill levy. Property tax revenues make up an estimated 95 percent of the library's budget (Bendlin 2002). Based on that estimate, Hamilton Dome property taxes have accounted for an average of 27 percent of the library's budget over the past five years ($27,000 out of an average total of $100,000). Because the library is included within the county 12-mill limit, a 27 percent reduction in revenues would result in a corresponding reduction in library services.

Hot Springs County Fair Board

The Hot Springs County Fair Board receives property tax revenues from a mill levy that has averaged six-tenths of one mill over the last five years. In 2002, property taxes received from a 0.79 mill levy will account for an estimated 52 percent of the fair board's total revenues (Smith 2002). Based on the 1997 through 2001 average property tax contributions, Hamilton Dome Property taxes would account for about 15 percent of the fair board's revenues ($16,000 out of an average total of $108,000).

Hot Springs County Memorial Hospital

The Hot Springs County memorial Hospital receives property tax revenues from a mill levy that has averaged nine-tenths of one mill over the last five years. Property tax accounts for an average of about 6 percent of the hospital's total revenues (Nading 2002) and Hamilton Dome property tax revenue accounts for an average of about 2 percent of the hospital's total revenues.

In addition to the entities identified above, whose property tax levies must fit under the 12-mill cap, other local government entities (districts) also collect property tax revenues. These entities include the Hot Springs County Weed and Pest District, the Hot Springs County Rural Fire Protection District, and Hot Springs County School District # 1.

Hot Springs County Weed and Pest District

The Hot Springs County Weed and Pest District receives property tax revenues from two separate one-mill levies. A statutory one-mill levy funds 30 percent of the district's weed and pest eradication program, the remainder is funded through payment for services. A one-mill special levy funds 100 percent of the district's mosquito control program (Smith 2002). Over the past five years, Hamilton Dome property tax revenues account for about 9 percent of the district's weed and pest eradication budget ($27,000 out of an average total of $312,000) and about 29 percent of the district's mosquito control budget[5] ($27,000 out of an average total of $94,000).

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[4] Adjusted revenues as discussed in footnote #3.
[5] Based on 2002 budget

Hot Springs County Rural Fire Protection District

The Hot Springs County Rural Fire District receives property taxes from a mill levy that has averaged 2.2 mills over the past five years. The rural portion of the district relies totally on property taxes for funding its operations[6]. The department is staffed by volunteers. Property tax revenues are used to purchase equipment and supplies and to defray training costs. Hamilton Dome property taxes have funded an average of 29 percent of the rural fire district's budget over the past five years ($60,000 out of an average total $207,000). A reduction of 29 percent in total revenues would not result in a reduction of services, but it would mean that some needed equipment would not be purchased or replaced in a timely manner (Taylor, 2002).

Hot Springs County School District # 1

Hot Springs County School District # 1 receives property tax revenues from three different mill levies: a 26.5 mill special school levy, a 6 mill mandatory school levy, and a school levy to fund debt service on a bond issue. The latter has averaged 7.4 mills over the past five years. Property tax revenues from the special school and mandatory levies fund school district operations, and have comprised between 44 to 55 percent of the district's total operating budget in recent years (Cady 2002). The district also receives entitlement payments from the Wyoming school foundation fund. Revenues from the debt service levy go toward retiring a school bond issued for facilities construction. The bonds are scheduled to be retired in 2010.

Revenues from a 12-mill levy are distributed to the Wyoming School Foundation Fund. The foundation program guarantees a minimum level of funding, known as entitlement, for all public school students in Wyoming. School districts that cannot raise the specified amount from local resources receive payments from the school foundation fund to make up the difference. School districts whose local property tax base yields revenues substantially above the specified amount are subject to recapture, and the excess funds are paid to the state foundation account by the district. In general, reductions in Hot Springs County School District #1 property tax revenues from the special district and mandatory school levies would be made up by payments to the district from the school foundation fund.

If the Hamilton Dome field were to cease production, the Wyoming School Foundation fund would lose the revenue associated with the Hamilton Dome field, which have averaged $325,000 annually over the past five years. Additionally, the state foundation fund would have to increase entitlement payments to makeup for the loss of Hamilton Dome-related revenues from the 26.5 mill special school levy and the 6-mill mandatory school levy. Combined revenue from these levies has averaged $910,000 over the past five years. Therefore, the annual net cost to the Wyoming School foundation fund would total $1.235 million, based on the five-year average.

Because the school district's entitlement is based in large part on attendance, the district would lose revenue if Hamilton Dome employees moved out of Hot Springs County. The reduction in enrollment would likely be spread across a number of grades and schools; therefore,

[6] The district also provides coverage within the municipal areas, which is funded by contract, and on occasion receives grants to purchase equipment.

the loss in revenues would not be accompanied by a corresponding reduction in costs. If District # 1 were to lose enrollment, the net cost to the state foundation program would decrease.

The Hot Springs School Bond levy is funded 100 percent by property tax. Over the past five years, the school bond levy would have been an average of 2.8 mills higher without Hamilton Dome property tax revenues.

Wyoming Severance Tax

Wyoming oil producers pay a 6 percent severance tax[7] on oil produced in the state. In 2000, the Hamilton Dome field generated about $2.1 million in severance tax revenues. In 2001, severance tax revenues from the field totaled about $1.6 million[8]. These payments represent about 4 and 2 percent of total oil severance taxes for those years, respectively, and 0.08 and 0.04 percent of total severance tax payments.

Severance tax proceeds are distributed to the Mineral Trust Fund, Leaking Underground Storage Tank (LUST) account, the State General Fund, Water Development funds (I and II), Highway Fund, counties, county roads, cities and towns, capital construction, Budget Reserve Account.

Royalty Payments

Oil produced from the Hamilton Dome field generated about $5.1 million in federal mineral royalties in 2000, and about $3.7 million in 2001. The federal government distributes 50 percent of federal mineral royalties to the state where the minerals were produced. Hamilton Dome federal mineral royalty revenues to the State of Wyoming totaled $2.55 million in 2000 and $1.85 million in 2001.

In Wyoming, Federal Mineral Royalties are distributed to many different entities and funds. These include the University of Wyoming, the Wyoming School Foundation Fund, the Highway Fund, the Highway Fund for County Roads, and local municipal entities. Funds are also provided to special district and school districts for capital construction, state aid to county roads, Legislative Impact Royalty Account, community colleges, transportation enterprise account, general fund administrative account and others.

In 2000, federal mineral royalties generated by Hamilton Dome accounted for an estimated 1.7 percent of all federal mineral royalties to the state[9], in 2001, Hamilton Dome's contribution was about 0.8 percent of total.

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[7] Between 1/99 and 11/99 the severance tax rate was 4 percent. Severance tax rates are less for stripper oil, oil recovered from tertiary methods, new wells, incremental oil from workovers and completions and renewed production.

[8] Prior to 2000, Hamilton Dome was partially owned by another company, therefore total severance tax payments are not available for prior years.

[9] Including coal lease bonuses.

Sales and Use Tax

In Wyoming, sales and use taxes are levied on gross receipts from sales of tangible personal property and selected services including receipts from public utilities. The state levies a 4 percent sales and use tax; 28 percent of the revenues from this tax (less administrative costs) is distributed to the county and incorporated municipalities in the county of origin, according to a population-based formula. Hot Springs County also levies a 1- percent general revenue sales and use tax; proceeds from this tax are distributed to the county and its incorporated municipalities in the same manner as the local portion of the state tax.

It is conservatively estimated that MEC paid $400,000 in sales and use taxes on purchases of goods used in the Hamilton Dome field during 2001 (Kobielusz 2002). This is about 12 percent of all sales and use taxes collected in Hot Springs County during fiscal year 2001. However, because some vendors may have reported sales and use tax collections in their home counties, it is likely that not all of the local share of these revenues were distributed to Hot Springs county and its incorporated municipalities.

ECONOMIC LINKAGES BETWEEN THE HAMILTON DOME OILFIELD AND HOT SPRINGS COUNTY AGRICULTURE

As across most of Wyoming, farming and ranching in Hot Springs County is a way of life and a mainstay of the local economy. Though constrained by the limited amount of land in private ownership, an arid climate, and the difficult economic market conditions affecting livestock and commodity producers, the county's agriculture sector supports the economic livelihood of many Hot Springs county households.

Every five years the U.S. Census Bureau conducts a census of the nation's agriculture industry. Conducted at the end of those years ending with the number "2" and "7", the census compiles and reports data on production, size and other operating parameters for all farms and ranchers. According to the 1997 census, results of which were published in 1999, a total of 147 farms and ranches operated in Hot Springs County.

The census provides additional insights into these operations and the individuals and families who operate them. In terms of size, 64 of the 147 local farming and ranching operations are small, less than 180 acres. Another 42 are between 180 and 999 acres in size, with 41 operating on 1,000 or more acres. Farming and ranching is the principal occupation of the operator in 85 of 147 cases, while 62 operators are part-time or hobby operators with a principal occupation other than farming.

In terms of tenure or ownership, most of the farms and ranches are family owned and operated; 99 of the farms and ranches are operated by full owners, with another 44 operated by part owners. Among the operators, 38 reported operating the present farm for less than 5 years, compared t 62 operators who had been on the present farm 10 years or longer.

Most of the local agricultural operations engage in cattle ranching, with 17 raising sheep. In 1997, Hot Springs county farmers and ranchers reported a total inventory of 33,279 head of cattle, with sales of another 15,849 head during the previous year. Nearly a third of the total operations are farms engaged primarily in growing alfalfa, barley and other crops.

Local farmers and ranchers reported an aggregate total of 944,205 acres of land in use as part of their operations. The total includes land nearly 899,000 acres of private land and state and federal lands covered by grazing allotments used as pastureland or grazing range. Only about 38,000 acres of the total is irrigated, half of which is pastureland and the other half is cropland. Hay used for winter feed is the predominant crop raised in Hot Spring County. In 1997, more than 30,000 tons of hay was grown on just over 17,300 acres. Because these irrigated lands provide vital winter and spring range and winter-feed for the cattle and sheep herds, they are vitally important to the economic viability of the local agriculture industry.

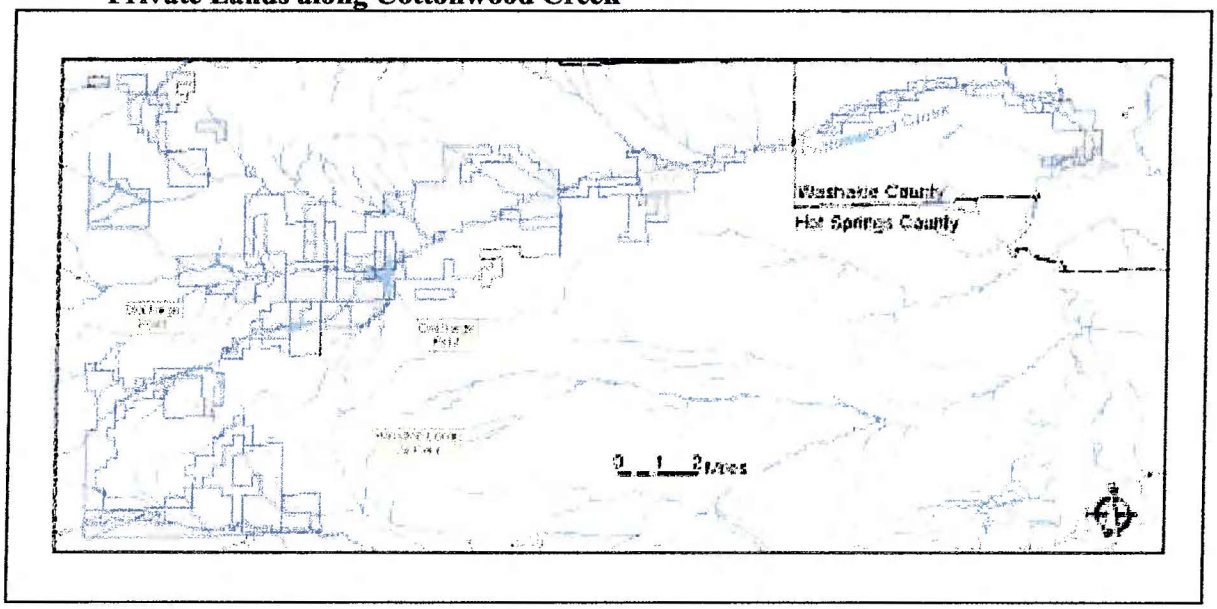
The combined marketing receipts from livestock and commodity sales totaled $9.6 million in 1997, an average of about $65,000 per operation. Of the total, $8.6 million was derived from livestock sales compared to $1.0 million from crop sales. However, operators incurred $7.6 million in production expenses to produce those sales. The major expenses included livestock, feed, fuel, hired labor, interest on loans, rent and property taxes. When these

expenses were combined with other costs, they left a residual net cash return of about $1.5 million, or an average of only about $10,200 per operation.

Cottonwood Creek

Approximately 35 landowners have property on or near Cottonwood creek. Virtually all of these landowners benefit directly or indirectly from the water discharged from the Hamilton Dome field. Three ranches immediately adjacent Hamilton Dome have rights to the discharged water, which is used for irrigation and stock watering. Water unused by these ranches flows down Cottonwood Creek and is used by landowners who have rights to Cottonwood Creek water, again for irrigation and stock watering.

Private Lands along Cottonwood Creek



Source: States West Water Resources Corporation

The indirect benefits of the Hamilton Dome water are substantial. Cottonwood Creek is known to have an intermittent flow above the Hamilton Dome discharge points. Natural flow along the creek is strongest in spring and early summer, diminishing to a trickle in mid-summer and in some years, disappearing altogether during late summer and fall.

Because the Hamilton Dome discharge provides a year-round flow, the water table along Cottonwood Creek is continually saturated and the resultant riparian growth stabilizes the streambed. This means that runoff into Cottonwood Creek from snowmelt and rainfall does not have to recharge the water table; virtually the full flow from these events is available for water users along the creek. Likewise, the stabilized streambed reduces siltation of the stream, resulting in more usable water during spring snowmelt and rainstorms.

Another important benefit of the Hamilton Dome discharge is that the temperature and constant volume minimizes icing of Cottonwood Creek in winter, particularly in the upper reaches. This allows year-round stock watering from the creek, enhancing its value for ranchers.

Although it varies from parcel to parcel, it is likely that more than two thirds of the crop production on irrigated land along Cottonwood Creek is made possible by the availability of water discharged from Hamilton Dome. Most of the irrigated land along the creek is used to irrigate pastures and produce an alfalfa/hay/grass crop, which is used as winter feed for cattle that are grazed on BLM grazing allotments during summer. This ability to graze livestock on leased rangeland during summer, pasture livestock on deeded land along Cottonwood Creek during winter, feed them on hay grown using Hamilton Dome discharge and water them from creek water kept running and open because of Hamilton Dome is key to the continued economic viability of many of the ranches along the creek.

Owners of several of the larger ranching operators along Cottonwood Creek were contacted to discuss the potential impact of curtailed water discharges on their operations. Collectively, these ranchers produce hay on approximately 2,250 acres of irrigated cropland, which in turn supports about 4,650 cows. These estimates reflect "normal" conditions, not the drought conditions that currently exist. In addition, they also create 29 full-time and seasonal jobs for ranch hands. On average, these ranchers estimated that 70% of their annual hay production was dependent on Hamilton Dome water. Prematurely cutting off the water flows would force the ranchers to cut back their herds and reduce the amount of hired labor they use.

For the purposes of this analysis, the loss of Hamilton Dome water is assumed to have a direct, proportional impact on the annual hay and beef production and use of hired labor for these operations. The estimated direct impacts under such a scenario are as follows:

- 1,600 acres converted from irrigated cropland to pasture or non-irrigated cropland
- 4,000 tons less of hay per year (@ net reduction of 2.5 tons per acre)
- A combined herd reduction of 3,200 cows
- An annual reduction of $2,000,000 in livestock sales receipts (@ $650 per head)
- A loss of 20 full-time and seasonal jobs in the ranching industry

Additional losses would be likely for ranches not included in the survey

The IMPLAN model was used to estimate the total economic losses in Hot Springs County, including the indirect and induced impacts on other sectors, associated with the direct reduction in annual livestock receipts. Those losses, which include a net reduction of $3.3 million (1.7%) in the county's total annual economic output, a loss of $645,000 in annual labor income, and a net loss of 32 full and part-time jobs, would be in addition to those impacts directly attributable to the cessation of Merit's Hamilton Dome production operations.

A further economic effect of the loss of produced water from the Hamilton Dome field would be a reduction in value of the agricultural property along Cottonwood Creek; the value of non-irrigated land is substantially less than the value of irrigated land.

THE SIGNIFICANCE OF HAMILTON DOME PRODUCTION TO WYOMING'S REFINING INDUSTRY

Wyoming is home to five operating petroleum refineries. With a combined daily average refining capacity of 140,386 barrels per day, Wyoming's refineries represent approximately 5% of the nation's domestic petroleum refining capacity. The refineries, their respective operators, location and daily distillation capacity are listed in the following table.

TABLE 6
WYOMING PETROLEUM REFINERIES, JANUARY 2001

Refiner	Location	Daily Capacity (barrels per day)
Frontier Refining Inc.	Cheyenne	38,670
Little America Refining Co.	Evansville	24,500
Silver Eagle Refining	Evanston	3,000
Sinclair Oil Corporation	Sinclair	62,000
Wyoming Refining Co.	Newcastle	12,216
STATEWIDE TOTAL		140,386

Source: U.S. Dept. of Energy, Energy Information Administration, 2001.

In 1997, the refining industry produced more than $1.2 billion in output, accounting for about 40 percent of the total statewide manufacturing output. Direct employment at the refineries totaled more than 700 jobs in 1997, those jobs averaging about $50,000 in wages and salaries to yield a combined annual payroll of over $35 million. Many more jobs and additional payrolls were indirectly supported in the pipeline, trucking and other related industries, as well as through consumer expenditures by the households directly and indirectly employed by the industry.

Crude oil from the Hamilton Dome field plays an important role in supporting the state's refining industry. Hamilton Dome crude is transported via pipeline to one of the in-state refineries via pipeline. Production presently averages about 4,600 barrels per day from the Hamilton Dome field. That production represents about 3.3% of the daily feedstock supply needed to sustain the in-state refineries at full production. In reality, Hamilton Dome's production is especially critical because the oil produced from Hamilton Dome is asphaltic crude, the primary source of asphalt and road oil.

Asphalt is a crucial component of highway construction and maintenance, airport runways and aprons and parking lots. As such, it is vital to sustaining Wyoming's economic health and that of surrounding states through its ties to the construction industry and by providing safe, efficient and reliable transportation capacity for residents, commercial traffic and tourists visiting the state. Furthermore, though accounting for only about 2% of the nation's asphalt and road oil refining capacity, asphalt and road oil production in the state has accounted for almost 10% of the nation's production in recent years.

Having a "local" supply of asphaltic crude is, therefore, important to the economic viability of the in-state refining industry. It helps minimize transportation costs and is vital to maintaining the overall operating efficiency and, hence, the cost competitiveness of the existing

refineries. Without the supply from Hamilton Dome crude, the economic viability of one or more of the refineries could be threatened.

Such a situation arises because petroleum refineries are not standardized industrial facilities, each able to process the same types of feedstock or produce the same outputs. Rather, refineries are built to different specifications with respect to inputs and outputs. The differences are manifest in the production capacity of different production streams.

Across the nation, the asphalt and road oil production capacity accounts for approximately 5.2% of the total refining capacity. In Wyoming, such capacity represents more than 13% of the total statewide refining capacity and 15% when adjusted to reflect the capacity of the three refineries that produce asphalt. Hamilton Dome supplies more than 20% of the crude needed to sustain those operations. While the prospect of eliminating the Hamilton Dome production might appear of limited consequence, the loss of that supply, coupled with uncertainty regarding the availability and costs of alternative supplies, could adversely affect the operating economics and profitability sufficiently to curtail asphalt production or even undermine the long-term economic viability of one of more Wyoming refineries. Such an event would trigger substantial job and income losses in the affected community and significant negative fiscal impacts for the affected local governments and school districts. Increased reliance on out-of-state supplies risks higher costs and increased potential for delays or disruption of deliveries, both of which have broad economic implications for the state.

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APPENDIX H

CORRESPONDENCE

COPY

Brown
Yogo
Hurley

June 20, 1990

EIS 6138
EPA/DEQ
ARCO Graham Resources
Santa Fe Energy
Hamilton Dom Oil Field Complex

John Wagner
Department of Environmental Quality
Water Quality Division
Herschler Building
Cheyenne, WY 82002

Dear Mr. Wagner:

The staff of the Wyoming Game and Fish Department offers the following comments for your consideration.

Our personnel took samples along Cottonwood Creek on 5/21/90, from the mouth of the creek at the Bighorn River to approximately 8 miles above the discharge points at Hamilton Dome. Electro-shocking, water samples, water temperatures, and visual observations of fish and wildlife were taken.

Five sections of Cottonwood Creek were electrofished on May 21, 1990. All sites were located downstream from the discharge point(s) associated with the oil field in question. No game fish were captured at any of the sites and no fish species of any kind were captured at the site nearest the point of discharge (Table 1).

Table 1. Summary of electrofishing results at five sites on Cottonwood Creek on May 21, 1990.

Location	Species Present
1/4 Mile Upstream From Bighorn River Confluence	Plains Killifish Flathead Chub Longnose Sucker
Putz Ranch (Four Miles Upstream From Highway 20)	Plains Killifish Flathead Chub
Confluence with Grass Creek	Plains Killifish
Lower Sand Draw Road	Plains Killifish
Dvarishkis Ranch	No Fish Captured

Several species of waterfowl, shorebirds, wading birds, and a variety of nongame birds were also observed during the inspection. A fox den and an active beaver den were also observed in the immediate vicinity of the discharge points/cooling ponds.

We understand EPA and/or DEQ is considering forcing the oil companies involved (ARCO, Graham Resources, Santa Fe Energy) to reinject their produced waters instead of discharging them into Cottonwood Creek. The ARCO discharge goes through a series of cooling/settling ponds before discharging into the creek itself. EPA monitoring is apparently done at the middle cooling pond, approximately 1/2 mile above the point where the discharge water enters Cottonwood Creek.

It is our further understanding that radium levels are slightly above the EPA standard at their monitoring station at the cooling pond, but well below standard at the point where the discharge water enters the stream.

Our primary concern is with the large number of mule deer which concentrate along Cottonwood Creek. Several hundred deer can be found along the crucial winter range riparian zone. In fact, Cottonwood Creek is one of the major concentrations of mule deer in Areas 119 and 120, and post-season classifications routinely find 200-300 or more deer along a couple-mile stretch of the creek.

Although not as directly tied to the produced water as mule deer, 50-75 antelope are commonly found in and around the Hamilton Dome oil field complex throughout the year.

Due to the diversity and number of terrestrial species which rely on the Cottonwood Creek drainage, including the produced waters at various times during the year, we recommend a thorough analysis be made prior to forcing these companies to reinject this produced water. Obviously, if additional sampling/monitoring by DEQ/EPA indicates serious water quality problems, or strong fishery concerns are discovered, injection should be a future alternative. Without further evidence that points to harming the wildlife or people in the area, the water produced does provide substantial benefits to the wildlife resource which is using this area.

Thank you for the opportunity to comment.

Sincerely,

FRANCIS PETERA
DIRECTOR

FP:SCP:as
cc: Game Div.
Fish Div.
USF&WS-Cheyenne.

WYOMING
GAME AND FISH DEPARTMENT

Jim Geringer, Governor Dr. Tom Thorne, Acting Director

"Conserving Wildlife - Serving People"

June 10, 2002

WER 10322

Dennis Hemmer, Director
Wyoming Department of Environmental Quality
Herschler Building, 4 West
Cheyenne, WY 82001

Dear Mr. Hemmer:

In recent weeks, the Wyoming Game and Fish Department has received a number of requests for beneficial use statements from oil and gas operators. Most of these have been for permit renewals of historic, produced-water discharges. We understand that all oil and gas facility discharges now require a statement of beneficial use for either wildlife or agriculture.

Approximately three years ago, Department personnel in the Powder River Basin were becoming inundated by requests from coal bed methane operators for beneficial use statements. We even received a request from the Wyoming Business Council to provide a statewide or regional statement of beneficial use for all discharges meeting water quality standards. The decision was made by the Department at that time to not issue such statements. We felt it would not be possible to easily determine if any given discharge would provide benefits or cause adverse impacts to fish and wildlife, or their habitats, without site-specific reviews and considerable analysis. Such reviews would create a huge burden on our personnel. Our position was stated in Department letters to your Water Quality Division as early as 1999 and was discussed with you by our former Director, John Baughman.

Our position today is unchanged. We will not issue such statements unless the discharge is part of a project on which we partner with industry and on which there is a Department-approved habitat enhancement plan. Given the many thousands of potential beneficial use statement requests, particularly for new discharges by the coal bed methane industry, it is not remotely possible for this Department to be involved.

The Department would like to make one exception to our position on this matter. As I indicated, the recent requests have been for historic discharges that are being considered for permit renewals, with no changes in water quantity or quality. In these instances, we feel a beneficial use for fish and/or wildlife has been demonstrated over time. On a few of these requests, our personnel have conducted site-specific reviews and we have provided two statements of beneficial use. However, this cannot continue as we are receiving more and more of these requests. Therefore, we wish to provide the following generic statement that will apply to all historic discharges for which there are no water quantity or quality changes:

The Wyoming Game and Fish Department recognizes that historic discharges by oil and gas production facilities have demonstrated a beneficial use to fish and/or wildlife. Provided there are no changes to the quantity of discharge, and the water quality continues to meet DEQ standards for discharge, any permit renewal for these discharges will be considered by the Department as having a beneficial use for fish and/or wildlife.

The Department will not issue additional beneficial use statements for these historic discharges. We will assume that the Department of Environmental Quality, Water Quality Division, will accept the above statement as applicable for all historic discharges as described. We will advise all operators requesting statements under these conditions that DEQ has received our blanket statement. For new discharges or discharges that do not meet the conditions described above, we will not issue beneficial use statements except as noted for partnered projects. In these instances, we would appreciate DEQ personnel advising operators to either secure a beneficial use statement through a consultant or from the affected landowner, and not direct them to the Department as has happened on a number of occasions in the past.

Please advise us if you have questions regarding this letter. We would be glad to meet with you and your staff if you so desire. If we have not heard from you by July 12, we will assume our approach is acceptable. Thank you for your assistance in this matter.

Sincerely,

Bill Wichers

BILL WICHERS
DEPUTY DIRECTOR

BW:TC:as

cc: Gary Beach
Leah Krafft
Roland Peterson

WEST, Inc. Western EcoSystems Technology, Inc. 2003 Central Ave., Cheyenne, WY 82001
Phone (307) 634-1756 Fax (307) 637-6981

November 1, 2002

Chris Jessen
States West Water Resources Corporation
1904 E. 15th Street
Cheyenne, WY 82001

RE: CALCULATION OF SITE SPECIFIC CHLORIDE CRITERION FOR COTTONWOOD CREEK

Dear Chris:

The purpose of this letter is to outline my attempt to calculate a site-specific chloride criterion for Cottonwood Creek using the EPA recalculation procedure (U.S. EPA. 1994. The Recalculation Procedure. Appendix B in "Interim Guidance on Determination and Use of Water-Effect Ratios for Metals." EPA-823-B-94-001). The recalculation procedure is intended to allow a site-specific criterion to differ from a national aquatic life criterion if justified by demonstrated pertinent toxicological differences between the aquatic species that occur at the site and those that were used in the derivation of the national criterion.

The recalculation procedure basically involves deleting species used to develop the national criterion but that do not occur in Cottonwood Creek. Before EPA allows the recalculation procedure, available chloride toxicity data for the procedure must meet the "Eight Family Rule". In accordance with the U.S. EPA 1985 (Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, PB85-227049), the following eight families satisfy the minimal data requirements for the general recalculation procedure:

1) The family Salmonidae in the class Osteichthyes (i.e., a trout or salmon)
2) A second family in the class Osteichthyes, preferably a commercially or recreationally important warm water species (e.g., bluegill, channel catfish, etc.)
3) A third family in the phylum Chordata (may be in the class Osteichthyes [a fish] or may be an amphibian, etc.)
4) A planktonic crustacean (e.g., cladoceran, copepod, etc.)
5) A benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish, etc.)
6) An insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge, etc.)
7) A family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca, etc.)
8) A family in any order of insect or any phylum not already represented (Large to small: Kingdom, Phylum, Class, Order, Family, Genus, Species)

The national chloride criterion are based on published toxicity data for 13 taxa representing only 11 families (U.S. EPA. 1988. Ambient Water Quality Criteria for Chloride - 1988, EPA 440/5-88-001). Of these 11, five do not occur in Cottonwood Creek (fingernail clam, mosquito, American eel, goldfish, and bluegill) and would therefore be removed during the deletion process. After deleting these five, however, only chloride data for six families are left to calculate the new site-specific criteria for Cottonwood Creek, but this does not meet the "8 family rule." When this occurs, the general recalculation procedure cannot be used, which means that the only possible option left is to use the Special Recalculation Procedures. For the Special Recalculation Procedures, toxicity data are required for at least one species in each of the families that occur at the site. Between the Wyoming Department of Environmental Quality (WDEQ) aquatic invertebrate and Wyoming Game and Fish Department fish data for Cottonwood Creek, however, there are numerous families of fish and aquatic invertebrates present in Cottonwood Creek for which there are no chloride toxicity data. Therefore, neither the general nor special recalculation procedures can be used to recalculate a site-specific chloride criteria for Cottonwood Creek. The only remedy for this situation would be to develop chloride toxicity data for a host of organisms through laboratory toxicity tests, which I am assuming is beyond the scope of this project.

After reviewing the available chloride toxicity data, I believe that even if one could recalculate a site-specific chloride criteria for Cottonwood Creek, it would not result in a higher site-specific criteria. This is because some of the most chloride-sensitive organisms are present in Cottonwood Creek. If the 13 taxa for which chloride toxicity data exist are ranked from least sensitive to most sensitive, the 5 taxa that could be deleted from the data set because they are not present in Cottonwood Creek are among the 7 taxa considered the least sensitive to chloride. None of the 5 taxa considered the most sensitive to chloride can be deleted from the data set because either the same species or a closely-related species does occur in Cottonwood Creek. The fact that several taxa considered the most sensitive to chloride toxicity are present in Cottonwood Creek appears to indicate that chloride levels are below levels of concern, indicating that the chloride water quality criteria is very conservative.

In the absence of recalculating a site-specific chloride criteria, another potential remedy for the problem is to raise the chloride criteria from 230 mg/L to 860 mg/L, which is currently being requested of the WDEQ by the Petroleum Association of Wyoming (see attached letter dated August 20, 2002). I am unaware of any response to this request by WDEQ.

Please feel free to contact me if you have any questions or requests for additional information regarding the above.

Sincerely,

Greg Johnson
Ecologist/Project Manager

PETROLEUM ASSOCIATION OF WYOMING

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August 22, 2002

Mr. Gary Beach
Administrator, Water Quality Division
Department of Environmental Quality
122 West 25th Street
Cheyenne, Wyoming 82002

Dear Mr. Beach:

The Petroleum Association of Wyoming (PAW) welcomes this opportunity to present to the Division information regarding the proposed revisions to the Water Quality Division Rules and Regulations, Chapter 1.

PAW is Wyoming's largest oil and gas trade association, members of which account for over 90% of the natural gas and 80% of the crude oil produced in the state.

PAW is in support of all the proposed revisions. PAW is particularly supportive of revision #10 in the Outreach Document dealing with aquatic life values of aluminum. The current aquatic life value for aluminum does not take into account soil and water conditions found in Wyoming. PAW believes the proposed rule change would be more representative of that fraction of aluminum that is biologically available.

In addition to the current proposed revisions, PAW is asking for an increase in the chloride standards for Class 2C and all Class 3 water designations.

PAW recommends DEQ revise the aquatic life standard for Class 2C and Class 3 waters for chloride from the chronic value (230 mg/l) to the acute value (860 mg/l). Continued application of the chronic aquatic life value to Class 2C and Class 3 waters will likely result in a loss of discharge water to many Class 2C and Class 3 drainages. This loss of discharge could result in a net loss of wetlands and aquatic life as well as agricultural and wildlife beneficial uses that are currently sustained by the effluent discharged to many of these often dry drainages.

In addition, most EPA Region 8 states do not have chloride standards in their water quality rules for lower water classifications such as Wyoming Class 2C and Class 3 waters. These states include Montana, Utah, and Colorado. South Dakota has a chloride standard, but it only applies to cold-water fisheries, which are the equivalent of Class 1, Class 2AB and Class 2B waters in Wyoming. North Dakota's chloride standard only applies to waters designated as drinking water supplies, which are equivalent to Class 1, Class 2AB, and Class 2A waters in Wyoming. These other western states

[illegible]
[illegible] Quality [illegible]
Department of Environmental [illegible]
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have many of the same geographic, hydrologic, weather and water quality characteristics as Wyoming.

Many Class 3 waters are not perennial water bodies and have very marginal associated wetlands. Supplemental discharge water from oil and gas operations enhances and creates additional wetlands on many Class 3 waters. The aquatic life and other beneficial uses (agriculture and wildlife) created by this water could be lost on a significant portion of water bodies, particularly in northwest Wyoming.

PAW appreciates this opportunity to comment on the proposed Water Quality Division Rules and Regulations, Chapter 1 revisions. Thank you in your consideration of these comments and suggestions.

Sincerely,

John Robitaille
Vice President
Petroleum Association of Wyoming