Cottonwood Wash TMDL

Utah Department of Environmental Quality
Division of Water Quality

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TMDL Section

Cottonwood Wash TMDL

Waterbody ID	Cottonwood Wash
Location	San Juan County, southeastern Utah
Hydrologic Unit Code	14080201
Pollutants of Concern	Gross Alpha Radiation
Impaired Beneficial Uses	Class 1C - Protected for domestic purposes with prior treatment. Class 4 - Protected for agricultural uses including irrigation of crops and stockwatering.
Percent required reduction to meet TMDL target Explicit Margin of Safety Total required reduction to meet TMDL target Maximum expected target site load at maximum baseflow	17 percent 10 percent 27 Percent 35.7 million pCi/day
Defined Targets/Endpoints	15 picocuries per liter (pCi/L)
Implementation Strategy	Comprehensive reclamation of mining-related impacts by multi-agency mined land reclamation initiative

COTTONWOOD WASH TMDL

I. INTRODUCTION

This TMDL is being completed in conjunction with an Interdepartmental Abandoned Mine Lands Watershed Initiative between the U.S. Bureau of Land Management (BLM), the U.S.D.A. Forest Service (FS), the Utah Division of Oil, Gas and Mining (UDOGM), and the Utah Division of Water Quality (DWQ). Reclamation of abandoned mines and mining related disturbances within the Cottonwood Wash watershed is being conducted using Clean Water Act funding obtained by the FS and BLM.

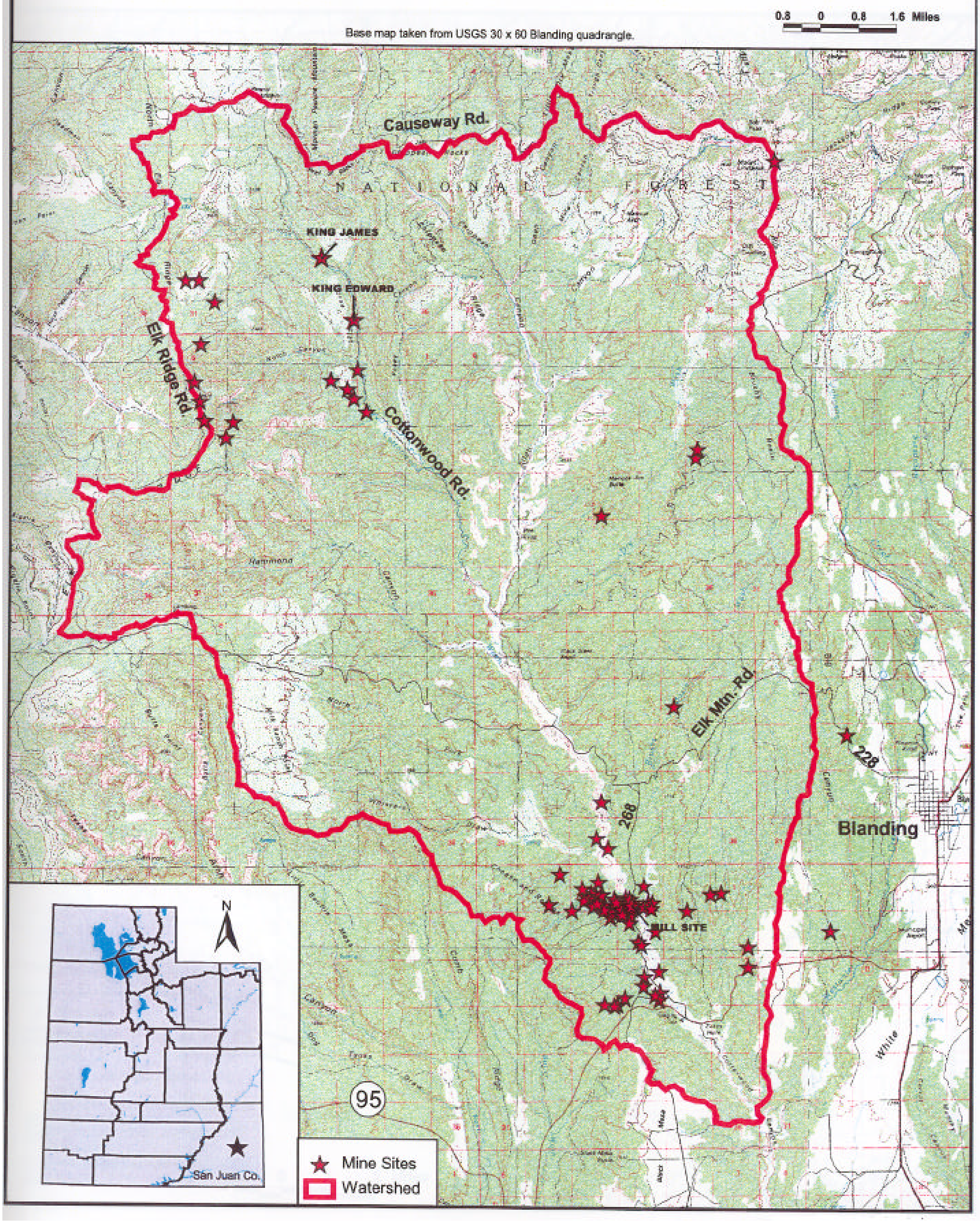
The Division of Water Quality was approached for technical assistance after the Cottonwood Wash Project was selected as the proposed project site by the BLM and Forest Service, and prior to collection and analysis of water quality data. Water quality samples were collected by Division of Water Quality staff in March, May, July and September of 1998 at 13 stations in the Cottonwood Wash drainage near Blanding, Utah. Two additional sampling runs, which included additional sampling locations, were conducted in the spring of 1999. Results of sample analysis indicate that Cottonwood Creek is not supporting its 1C and 4 beneficial uses due to exceedences of the gross alpha radiological standard. As a result, the stream was listed on the state's 2000 303(d) list of non-supporting waters. The 303(d) list designated LCC as having high priority for TMDL completion during the 2000-2002 time period.

A TMDL analysis (Brown and Caldwell, 2000) was then developed concurrently with the Cottonwood Wash Watershed Abandoned Mine Project Environmental Assessment (BLM et. al., 2000). This TMDL is based on the findings of these two studies.

The Cottonwood Wash gross alpha radiation TMDL, as proposed, is based on the best available information at this time. As additional data from monitoring is obtained, this TMDL may be modified in the future. This TMDL addresses baseflow conditions in the watershed from the TMDL target site at the intersection of Cottonwood Creek and State Highway 95 (STORET Station 495332) upstream to STORET Station 495329, Cottonwood Creek upstream of millsite. A phased approach is appropriate in this case for the following reasons:

- A high degree of uncertainty exists regarding pollutant loading sources in the upper watershed (above STORET495336, Cottonwood Wash at US Forest Service Boundary). Additional data is required to establish the relationship between potential mining-related sources and background contributions in this stream segment.
- The majority of the mining-related impacts in the watershed will be addressed by reclamation activities conducted under the Interdepartmental Abandoned Mine Lands Watershed Initiative during the 2001 and 2002 construction seasons.
- Lack of water quality data associated with high flow and storm flow events in the watershed.

Figure 1. Cottonwood Wash Watershed Area



Location

Cottonwood Wash is located about 5 miles west of Blanding, in San Juan County, southeastern Utah (Figure 1). Although fairly close to Blanding, the watershed is in a rural area with a small human population and limited economic development. The area included for analysis in this TMDL is bordered by drainage divides to the north, west, and east, and U.S. Highway 95 (US-95) on the south. The watershed can be reached from either direction on US-95, by turning north on the Cottonwood Wash road, which parallels the main drainage to the upper portion of the watershed. Access to other areas of the watershed may be reached on Forest System roads from Elk Ridge to the west and the area surrounding Canyonlands National Park to the north. National Forest System and San Juan County roads may be used to reach the area from Monticello (northeast of the watershed) and Blanding.

Physiography

The watershed contains approximately 143,000 acres (224 sq. mi.) and ranges in elevation from about 4,000 feet above sea level in the southern-most sections to about 10,000 feet above sea level in the upper portions of Elk Ridge. The topography and physical characteristics of the surrounding area are highly variable. The Cottonwood Wash watershed is contained primarily within the Blanding Basin section of the Colorado Plateau physiographic province. The Colorado Plateau is one of the most distinctive areas in the United States, famous for its scenic attractions and geological diversity. Much of this part of Utah is the result of geological uplift, igneous intrusions, faulting, glaciation, and erosion, which has produced a land characterized by broad mesas, buttes, steep-walled canyons, and high mountains. The land in the vicinity of Cottonwood Wash is dominated by low mesas, buttes, and finger-like points between relatively shallow south-flowing drainages, with higher plateaus and "island" mountain ranges, such as the Abajo Mountains northeast of the watershed, scattered throughout the area. Lower portions of the watershed have bare rock surfaces, and sparse soil and vegetation. Upper portions receive more moisture, and have more highly developed soil and vegetative cover.

Land Ownership

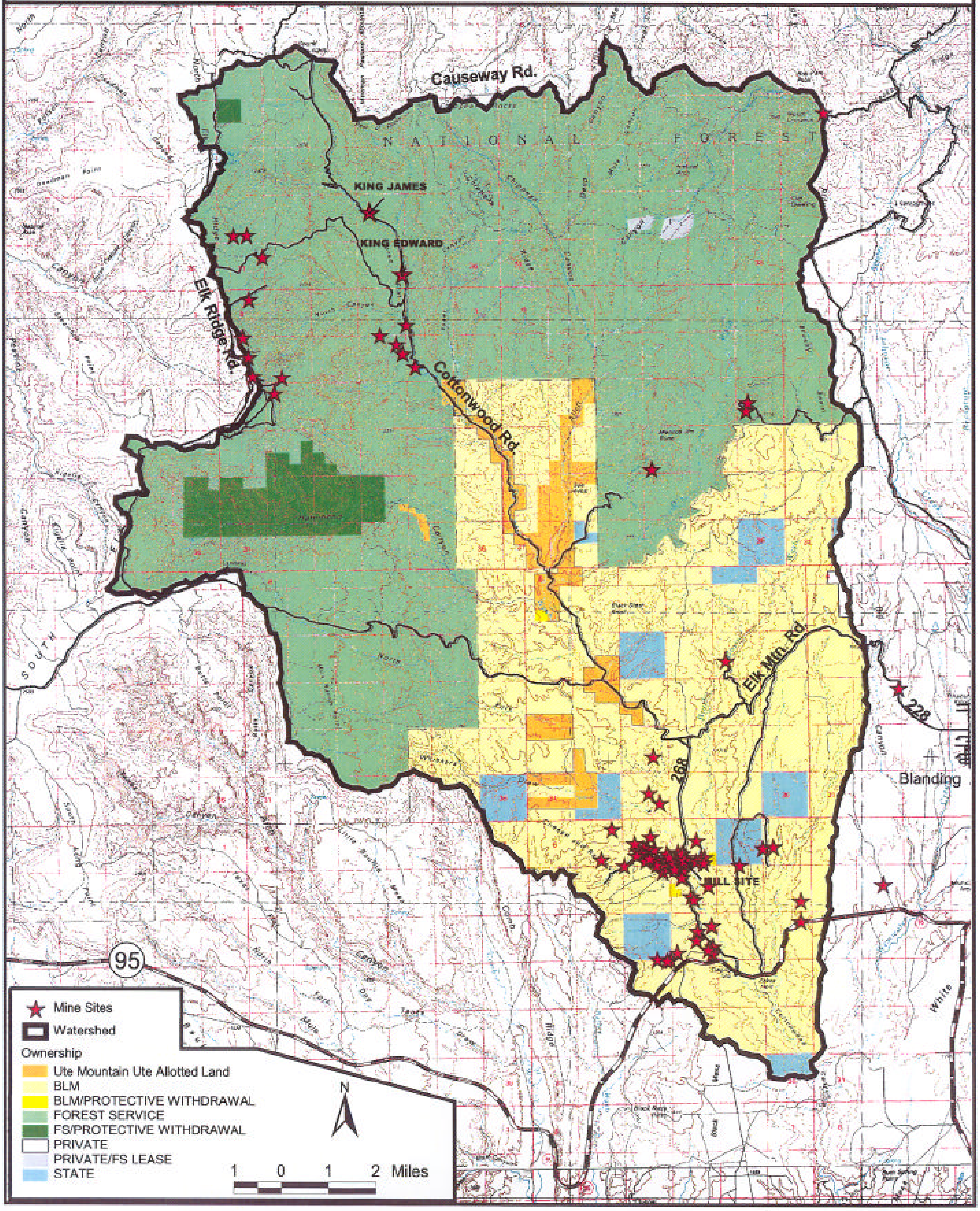
Most of the area within the watershed consists of federal lands, as shown on Figure 2. BLM–managed lands account for approximately 34 percent of the watershed, about 48,100 acres, while the USDA Forest Service has management jurisdiction over about 85,480 acres or approximately 60 percent of the watershed. The remaining lands are held in almost equal proportions by the state of Utah and private owners. About 4,900 acres, representing 3 percent of the watershed, is state-owned property.

The Ute Mountain Ute tribe holds most of the remaining 3 percent of the watershed, about 4,480 acres of private property held in allotment.

Geology

The Colorado Plateau includes an area described as the Four Corners Region: northwest New Mexico, northeast Arizona, eastern Utah, and western Colorado. The geological record for this area indicates that the various layers of rock were deposited primarily in three processes, 1) as water-laid sediments from shallow seas that advanced and retreated over time, 2) as sediments deposited during a period of continental uplift, and 3) as sediments deposited as wind-blown (eolian) sand.

Figure 2. Cottonwood Wash Land Ownership



The oldest, exposed geological formations in the area are members of the Hermosa Group, dating from the Middle Pennsylvanian Age (286 to 320 million years ago), and consist of limestone, shale, salt, and sandstones deposited in a shallow sea environment. These members are exposed only in the deeper canyons of the area, such as Dark Canyon, west of the watershed, and the canyons of the San Juan and Colorado Rivers. Overlying these members are younger deposits of the Permian Age, consisting of limestone, shale, and sandstones. The Permian deposits are represented by the Cutler Group. Triassic age deposits overlay the Permian, with the reddish-brown siltstones of the Moenkopi Formation deposited as near-shore and tidal-lagoon sediments.

The uranium-bearing Shinarump Member of the Chinle Formation, which consists mostly of fresh water sandstones and shales, and the Glen Canyon Group chronologically follow the Moenkopi Formation. The Glen Canyon Group is made up of Wingate Sandstone, the Kayenta Formation, and the Navajo Sandstone. The Wingate and Navajo were wind-deposited sandstones, while the Kayenta was deposited as river-borne sediment. Overlaying the Triassic-age deposits are sediments of Jurassic age, deposited as shallow sea sediments of sandstone and mudstone, and represented by Entrada Sandstone, Bluff Sandstone, the Summerville Formation, and the uranium and vanadium-bearing Morrison Formation. Cretaceous Age sediments are the youngest found in the area, represented by the Dakota Sandstone, Burro Canyon Formation, and the Mancos Shale (Chenoweth 1993).

The mineral-rich beds within the Cottonwood Creek drainage have an orientation dipping towards the southeast as a result of their position on the Monument Upwarp, a large oval dome feature mostly in Utah that formed during the Eocene Period. This structural orientation of the uranium deposits causes the older Chinle Formation to be exposed in the steep cliffs of the higher elevation in the northern (upper) part of the drainage (Chenoweth 1993). Compared to the Chinle, the younger Morrison Formation occurs at a lower elevation near the south-central area of the drainage, displays a much less dramatic relief change or cliff structure, and has much less surface area exposure in the basin. This factor is discussed further in the source assessment section of the TMDL

The significant geological strata for uranium and vanadium mining within the Cottonwood Wash watershed boundary are, in ascending order, the Shinarump Member of the Chinle Formation and the Salt Wash Member of the Morrison Formation. The Shinarump is the host for uranium deposits found on Forest System lands and the Salt Wash is the host for uranium and vanadium deposits found on BLM-managed lands.

Mining

There are two mining district in the Watershed, the Cottonwood Wash mining district, and the Elk Ridge mining District. The Cottonwood Wash mining district is centered at the junction of Cottonwood Wash and Brushy Basin Washes, Approximately 7 miles southwest of the town of Blanding. Although many claims were staked and a small amount of ore was mined in this district in 1931, the claims remained idle until 1936, when production for vanadium commenced. The vanadium mills operated in this area from 1937 until about 1943. Mining in the Cottonwood Wash effectively ceased in the mid-1980's, but there continue to be period increases of mining activity corresponding to higher vanadium market prices. The Elk Ridge mining district is located in the upper portions of the Cottonwood Wash watershed. Uranium deposits in this area were discovered by drilling programs in the early 1950's and production continued through the mid 1970's.

Hydrology

Cottonwood Wash displays variable flow conditions within the watershed boundary. The main stem upstream of the boundary between the Manti-LaSal National Forest and BLM lands usually displays perennial flow. Below the boundary, Cottonwood Wash may flow year-round during wet cycles, but during dry cycles some segments of the wash may lose all flow. Therefore, the lower part of the basin may be intermittently dry. Near US-95 and further downstream in Cottonwood Wash no flow may occur during protracted dry periods. Many of the tributaries within the watershed boundary are ephemeral, flowing only in response to storms.

Average annual rainfall for the area measures 13.4 inches in Blanding, Utah, located 8 miles to the east. Precipitation is spread somewhat evenly through the year, with much of the precipitation in November through February falling as snow. June is the driest month of the year, averaging 0.47 inches, and August and October measure 1.40 and 1.46 inches respectively for the wettest months of the year.

Flow data are also available from U.S. Geological Survey (USGS) gauging station number 09378700 that was active at the US-95 bridge from 1959 through 1987. These data show that the peak average daily flow measured at the bridge was 4,340 cubic feet per second (cfs) on 1 August 1968, whereas streamflow 7 days prior to that time measured 0 cfs. The highest instantaneous flow reading from the station was 20,500 cfs during the same August event. These statistics illustrate the extreme flashy nature of the hydrologic system in Cottonwood Wash.

The months of July and August show the largest magnitude flow events in Cottonwood Wash, and they are caused by intense thunderstorms forming during the monsoonal air flow period. Moist air streams in from the southeast from the Gulf of Mexico in late June to early September and creates a consistent pattern of afternoon thunderstorms.

Zero flow readings at the USGS gauging station occur in all months of the year over the period of record, however, June and November showed the most zero flow days. The most continuous and uniform stream flow occurs in Cottonwood Wash from March through April in response to snow melt runoff.

II. WATER QUALITY STANDARDS AND TMDL ENDPOINTS

The Utah Water Quality standards (R317-2, Utah Administrative Code) designate the following beneficial use classifications for Cottonwood Wash:

Class 1C - Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water.

Class 2B - Protected for secondary contact recreation such as boating, wading, or similar uses.

Class 3B - Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.

Class 4 - Protected for agricultural uses including irrigation of crops and stockwatering.

The state gross alpha radiation water quality standard of 15 pCi/L (picocuries per liter) applies to the Class 1C and Class 4 use designations for this waterbody. Cottonwood Wash was listed as an impaired waterbody on the 2000 Utah 303(d) list based on exceedances of gross alpha radiation standard. Therefore, the numeric criterion of 15 pCi/L (picocuries per liter) is an appropriate water quality target for this analysis.

For the purposes of this analysis, the TMDL endpoint is established at 15 pCi/L gross alpha, expressed as an instantaneous measurement at STORET Station 495332, Cottonwood Wash at State Highway 95.

III. SOURCE ASSESSMENT

Available Surface Water Quality Data

Raw water quality data were acquired from the Utah DWQ, EPA STORET database, and other agencies for the evaluation of gross alpha radiation in Cottonwood Creek Watershed surface waters. In addition, the following reports which document sampling events (soil and water) and data collected in the Cottonwood Creek Watershed were reviewed.

- *US EPA memorandum (May 20*, 1999) - documents the radiochemical results for Cottonwood Creek soil samples taken at the Mill Site.
- *US Forest Service July* 22, 1996 *Laboratory Report (Barringer Laboratories, Inc.)* - documents the results from 168 soil/water samples taken at the King Edward, Laura, and Tony mines.
- *US Forest Service September* 9, 1998 *Memorandum* - documents the results from Uranium waste rock samples collected at the King James/Virgene and Laura Bell mines.
- *US Forest Service Engineering Evaluation and Cost Analysis (EE/CA) (August* 1998) - evaluates alternatives to select a preferred alternative for a Removal Action initiated in 1990 by the Forest Service under its cleanup authorities (42 U.S.C. 9604(a); 7CFR 2.60(a)(40) and Federal Executive Order 12580).
- *U.S. Forest Service laboratory report (ACZ Laboratories) (August* 31, 1999)- documents the results from streambed and vegetation sampling in Cottonwood Creek to attempt to determine if contaminants from King Edward Mine are migrating downstream.

Although historic data are available in the Cottonwood Creek Watershed, a number of data limitations occur which control the ability to fully characterize Cottonwood Creek, its tributaries, and potential sources of pollution without making various assumptions. The primary limitations or inconsistencies in the data include:

- Limited continuous flow data throughout the watershed;
- Lack of water quality and flow data for storm/runoff events (high flow);

- Limited data (including paired data) collected on a synoptic level (event-based), six events total in 1998 and 1999;
- Lack of groundwater data; and
- Limited data for primary potential pollutant sources such as waste piles, adits or portals, potential seeps or other.

These issues are not uncommon in water quality analysis because the data are often collected using different methods and analyses, and for different purposes. For the development of a gross alpha radiation TMDL, having paired or synoptic gross alpha radiation and flow data, over a wide range of flows, is essential. Future analyses could be refined with more data.

Based on the assessment of available surface water quality and flow data, and TMDL data needs, data for several constituents (flow, gross alpha, TSS, and TDS) from six synoptic sampling events were utilized to characterize surface water quality conditions in Cottonwood Creek and its tributaries. Although a large amount of data exists for other constituents, those constituents are not relevant to the development of the gross alpha radiation TMDL and were not evaluated or incorporated into the TMDL. Data used in the TMDL analysis, and the basis for their selection, is presented below.

Water quality samples were collected by Utah DWQ in March, May, July and September of 1998, and from two events in February and April of 1999, at 13 sampling stations throughout the Cottonwood Wash Watershed (Table 1). These synoptic data were utilized for the analysis of water quality and will be used to develop the TMDL because they provide a more complete assessment of the watershed than snapshots of conditions in one area or another. Table 2 provides a summary of the gross alpha, flow, total suspended solids (TSS), and total dissolved solids (TDS) data collected and used for the analyses.

Table 1. Water Quality Sample Locations

STORET #	Description
495332	Cottonwood Wash at US-95 TMDL target site crossing
495327	Brushy Basin Wash Instream -tributary to Cottonwood Wash
495329	Cottonwood Wash upstream of Instream Millsite
495329(A)	Cottonwood Wash upstream of Instream mine impacts at Millsite
495331	Hammond Canyon Wash upstream Instream -tributary to Cottonwood Wash
495333	Dry Wash Instream -tributary to Cottonwood Wash
495334	Allen Canyon Wash Instream -tributary to Cottonwood Wash
495336	Cottonwood Wash at USDA-FS Instream Boundary
495337(A)	Cottonwood Wash downstream of Instream King Edward Mine
495337	King Edward Mine Portal South Nonpoint source
495338	King Edward Mine Portal North Nonpoint source
495339	Cottonwood Wash upstream of Instream background King Edward Mine

495339(A)	Cottonwood Wash near headwaters Instream background

Water Quality Assessment

Elevated gross alpha radiation in surface waters within the watershed can be driven by hydrologic conditions (e.g., baseflow or storm flow event conditions) and each should be addressed in the TMDL. These hydrologic conditions of interest are discussed below:

1. Baseflow: Under baseflow conditions, gross alpha radiation contributions can be from several sources: groundwater inflows; baseflow from the upper portion of the basin as it travels through areas of higher potential geologic-induced contamination; and in-stream sources such as impacted stream sediments.

2. Stormflow: Stormflow contributions of gross alpha radiation are likely to occur during runoff events from overland flow and sediment transport within the watershed and into Cottonwood Creek. These contributions ultimately increase the amount of gross alpha radiation present within the system and can affect subsequent releases of gross alpha radiation from the sediment during baseflow conditions.

Ultimately, the TMDL will account for contributions of gross alpha radiation during both baseflow and storm flow conditions. At this point in time, data are only available for baseflow conditions. The "hotspots" (areas of high gross alpha radiation concentration) that have been identified during baseflow conditions would also be expected to contribute gross alpha radiation to surface waters during storm events. It is also expected that gross alpha concentrations will be lower during high flows due to the effects of dilution. If this expectation holds true, then the low flow period would become the critical period for meeting the in-stream water quality standard. Further data collection will be required to confirm this expectation.

The following is a summary of contributing sources to water degradation in Cottonwood Wash. All of these locations were sampled under low flow or base flow conditions. They came from stream reaches in the upper portion of the basin above King Edward Mine to 25 miles downstream at the US-95 bridge. As shown by the historic data, background gross alpha radiation levels are well above the standard in the upper portions of the basin and increase to higher levels below the King Edward Mine. Levels then decrease steadily until another increase occurs below the Millsite.

Figures 3 and 4 show the gross alpha concentrations and flow collected by DWQ for the six 1998 and 1999 sampling events Cottonwood Wash and some of its tributaries. Due to sampling conditions at sampling site 495327 (Brushy Basin) where samples were taken from a pool of standing water, these values are not considered valid and were not included in the analysis. Also, King Edward Mine portal data were not included on Figures 3 and 4 due to their nonpoint source nature (termed “nonpoint” because there is no data indicating a connection between the portal seeps and Cottonwood Creek) and high gross alpha values, which if added to the figures make it difficult to see the trend of lower values. The King Edward Mine data, however, are taken into account in the overall assessment of gross alpha contamination sources to surface waters.

<u>King Edward Mine</u>

The King Edward Mine (495337), a CERCLA site, had north and south portal discharge concentrations of gross alpha ranging from 1,559 pCi/L to 8,860 pCi/L, respectively (Table 2). These values are approximately 100 to 500 times the Cottonwood Wash gross alpha standard.

Although these concentrations are high, there are no definitive data indicating a portal discharge and Cottonwood Wash surface water connection. However, higher concentrations measured downstream of the mine at site 495336 (approximately 2 miles downstream), indicate that the King Edward Mine discharge may contribute to the elevated gross alpha levels. Flow observed at the portal sites are very low, at less than 0.1 cfs and can best be characterized as a seep.

During the April 14, 1999 sampling event, two additional stations were added in an effort to bracket the King Edwards mine complex: Station 495339(A) Cottonwood Creek near headwaters, and station 495337(A) Cottonwood Creek downstream of King Edwards Mine. Sample results did not show a significant increase gross alpha concentration between the upper station (11.7 pCi/L) and the lower station (12.7 pCi/L).

In addition to the King Edward Mine portal discharges, the geology in this portion of the basin is different than that of the lower portion of the basin and may also be contributing high gross alpha concentrations to surface waters. Cottonwood Wash waters may increase in gross alpha concentrations as a result of contact with naturally exposed uranium-bearing rock outcrops in the immediate area.

Cottonwood Wash Below King Edward Mine

Only one sample site (495336 -near the National Forest boundary) on Cottonwood Wash is located between the King Edward Mine and the Millsite downstream. This sample site exhibits the highest gross alpha concentrations in Cottonwood Wash compared to all other sample sites. Gross alpha concentrations ranged from 12 to 76 pCi/L with an average of 46 pCi/L. Flow at this site ranged from 0.3 to 3.0 cfs.

Cottonwood Wash From the Millsite to the Highway 95 Bridge

Gross alpha concentrations decrease substantially from sample site 495336 (Cottonwood Wash at US Forest Service Boundary) to the Millsite. The Millsite area is located between Whiskers Draw and Brushy Basin. Gross alpha concentrations then increase again from the Millsite (495339) to the US-95 bridge (495332) for all sampling events. Concentrations measured above the Millsite ranged from 9 pCi/L to 12 pCi/L while concentrations downstream of the Millsite at the US-95 bridge ranged from 2 pCi/L to 18 pCi/L. The water quality standard was exceeded at the US-95 bridge during two of the six sampling events. The flows above the Millsite ranged from 3 cfs to 6.5 cfs while flows at the TMDL target site ranged from 0.2 cfs to 7 cfs.

Tributaries

Nearly all tributaries measured for gross alpha, flow, and other constituents (except for Brushy Basin) are located between the National Forest boundary and the Millsite. Gross Alpha concentrations ranged from 2 pCi/L at Dry Wash Basin to 18 pCi/L to Allen Canyon. Measured tributary flows ranged from 0.1 cfs at Dry Wash Basin to 3.5 cfs at Allen Canyon.

Background

Based on available surface water quality data, two distinct background conditions for gross alpha radiation exist. The two distinct geologic formations (the Chinle and Morrison Formations, as discussed above) may be the primary source for this distinction. The two background conditions above King

Edward Mine and above the Millsite are defined as (1) the condition upstream of the King Edward Mine, as represented by sampling site 459339, and (2) directly upstream of the Millsite area as represented by sampling site 495329.

Figure 3. Gross Alpha concentrations as a function of distance from Cottonwood Wash above King Edward Mine (495339)

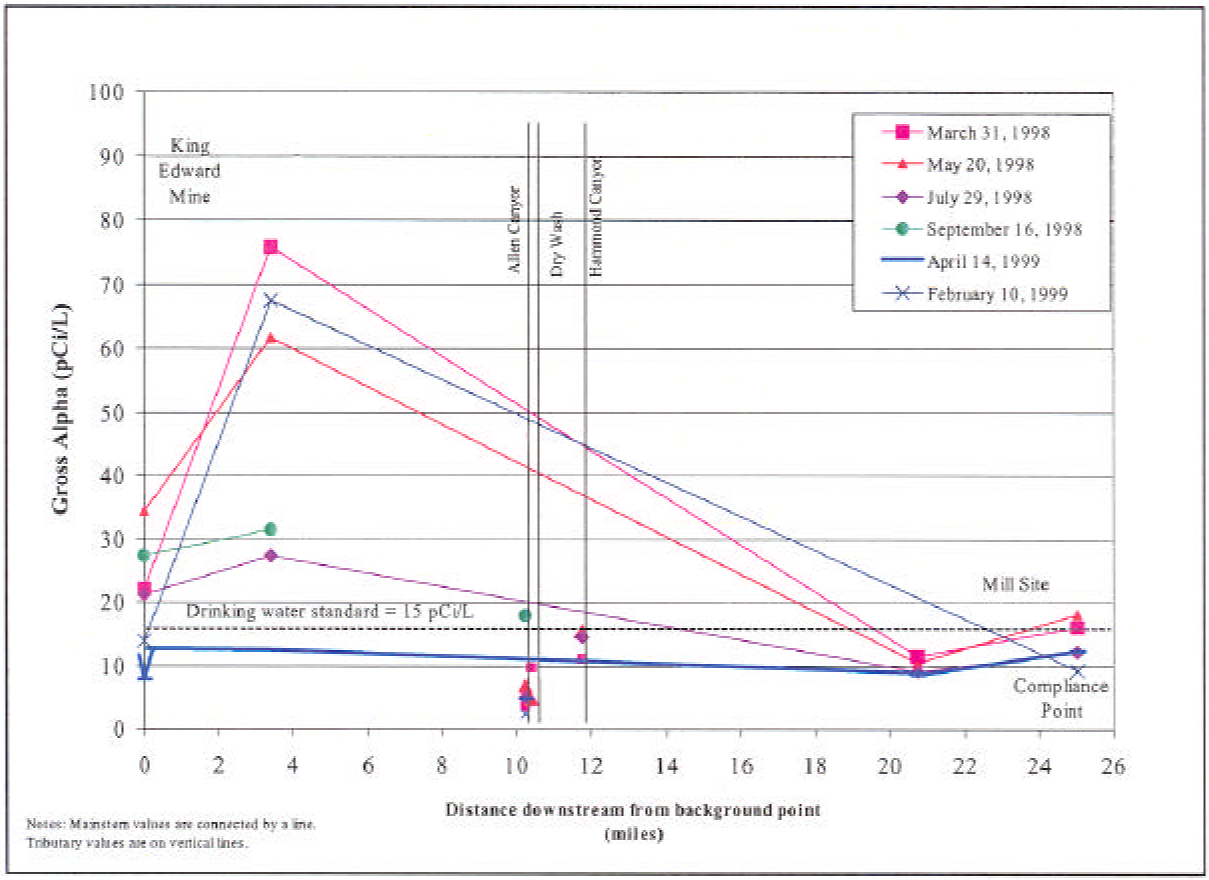


Figure 4. Flow as a function of Distance from Cottonwood Wash above King Edward Mine (495339).

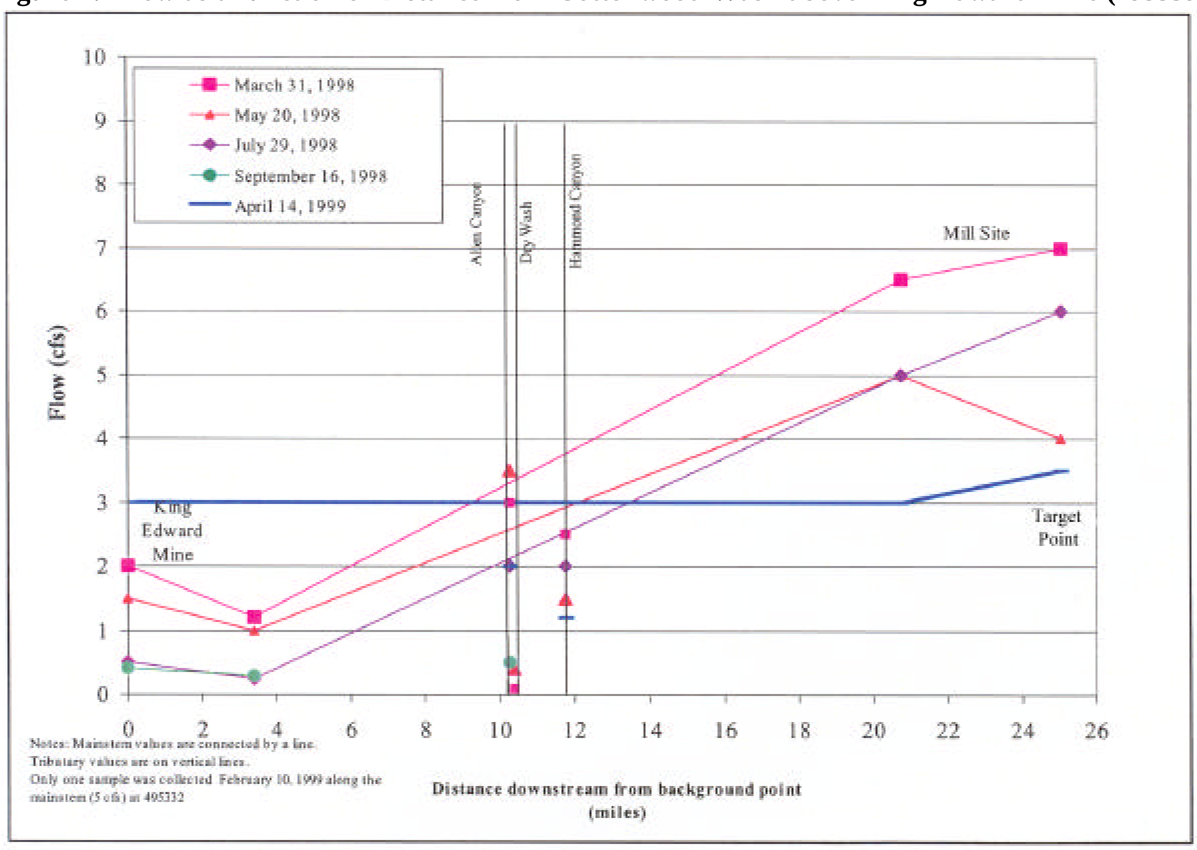


Table 2. Summary of DWQ's 1998 and 1999 Data.

Sampling Sites and Descriptions													
STORET #	495327[a]	495329	495331	495332	495333	495334	495336	495337[b]	495338[b]	495339	Above 495329	Above 495339	Below 495337
Site Description	Brushy Basin Above Cottonwood Wash	*Cottonwood Wash above Mill Site*	Hammond Canyon above Cottonwood Wash	*Cottonwood Wash at U.S. 95 crossing (target site)*	Dry Wash above Cottonwood Wash	Allen Canyon Wash above Cottonwood Wash	*Cottonwood Wash at Forest Service Boundary*	King Edward Mine Portal South	King Edward Mine Portal North	*Cottonwood Wash above Mine Site*	*Cottonwood Wash above mine impacts at Millsite*	*Cottonwood Wash near headwaters*	*Cottonwood Wash below King Edward Mine*
Alpha (pCi/l)													
N	2	4	4	8	2	6	6	3	3	6	1	1	1
Min	480	9	11	2	5	2	12	1559	3340	8	9	12	13
Max	489	12	15	18	10	18	76	8860	7330	34			
Mean	485	10	13	11	7	7	46	5843	5483	21	9	12	13
Flow (cfs)													
N	1	4	4	24	2	5	5	2	2	4	1	1	1
Min	0.1	3	1.2	0.2	0.1	.05	0.3	0.1	0.1	0.4	3	2.5	3
Max		6.5	2.5	90	0.4	3.5	3.0	0.1	0.1	2			
Mean	0.1	4.9	1.8	12.6	0.3	2.2	1.2	0.1	0.1	1.1	3	2.5	3
Total Suspended Solids (mg/l)													
N	2	4	4	22	2	6	6	3	3	5	1	1	1
Min	4	<4	<4	2	4	6	4	1046	5	4	<4	2620	703
Max	25	4073	1008	8180	73	524	2316	5076	52	487			
Mean	15	1025	255	632	39	97	556	2623	28	122	4	2620	703
Total Dissolved Solids (mg/l)													
N	2	4	4	24	2	6	6	3	3	5	1	1	1
Min	1430	182	260	180	198	236	190	362	888	136	366	116	162
Max	1694	380	328	530	498	544	410	864	1778	414			
Mean	1562	314	307	335	348	339	324	691	1338	290	366	116	162

N=number of samples
[A]Brushy Basin sampling data were not used for analysis due to sampling conditions (i.e., low to no flow) under which data were acquired.
[B]Portal sites were not used for analysis.
For mean calculations, if a value was reported as"<", the detection level was used to represent the value.
Italic text = Cottonwood Wash mainstem sampling sites.
Source: Brown & Caldwell 2000

Background gross alpha concentrations upstream of the King Edward Mine (sampling site 495339) ranged from 8 to 34 pCi/L, while the flows ranged from 0.4 to 2 cfs in the six 1998 -1999 DWQ sampling events. The 15 pCi/L water quality criterion was exceeded during four of the six events. One additional site located higher up in the basin (495339A) was sampled during one event and measured at 12 pCi/L, which are below the water quality criterion. Given the elevated gross alpha radiation concentrations upstream of the King Edward Mine, which are assumed to be primarily due to natural geologic conditions, but also may reflect impacts from other sources, the 15 pCi/L criterion may not be applicable and an ambient criterion would be considered. The gross alpha concentration at sampling site 495329 directly upstream of the Millsite is considered a "baseline" site. It should be noted that due to the location of the baseline sample site (495329), which is lower in the basin, it integrates all upstream effects, but consistently has gross alpha radiation levels less than the water quality criterion.

Source Identification

Two general source areas were identified by surface water sampling sites that had gross alpha concentrations above the water quality standard were identified in the Cottonwood Wash Watershed under baseflow conditions: 1) The stream segment between sampling station 495339 (Cottonwood Creek upstream of mine site) and sampling site 495336 (Cottonwood Creek at US Forest Service boundary; and 2) Cottonwood Creek in the vicinity of the millsite. Existing data indicate that these areas make significant contributions to the gross alpha concentrations in Cottonwood Wash. Because data were collected under base or low-flow conditions, it was not possible to identify if additional source areas are present which would contribute significant gross alpha radiation under runoff, or high flow conditions, but it is expected that impacts away from Cottonwood Creek could effect Cottonwood Creek water quality under runoff conditions. As described in Monitoring Plan section, in order to identify other potential sources of contaminants, additional monitoring at storm flows are required.

Water Quality Relationships

To evaluate the potential effectiveness of proposed control strategies and to potentially assess water quality conditions that may occur under high flow conditions, different water quality relationships were evaluated between gross alpha, total suspended solids (TSS), total dissolved solids (TDS) and flow. As depicted on Figure 5, no direct relationship between gross alpha and TSS, TDS or flow was apparent when all of the sampling sites were analyzed. Additional data, as well as data representing a full range of flow conditions, may lead to a stronger relationship.

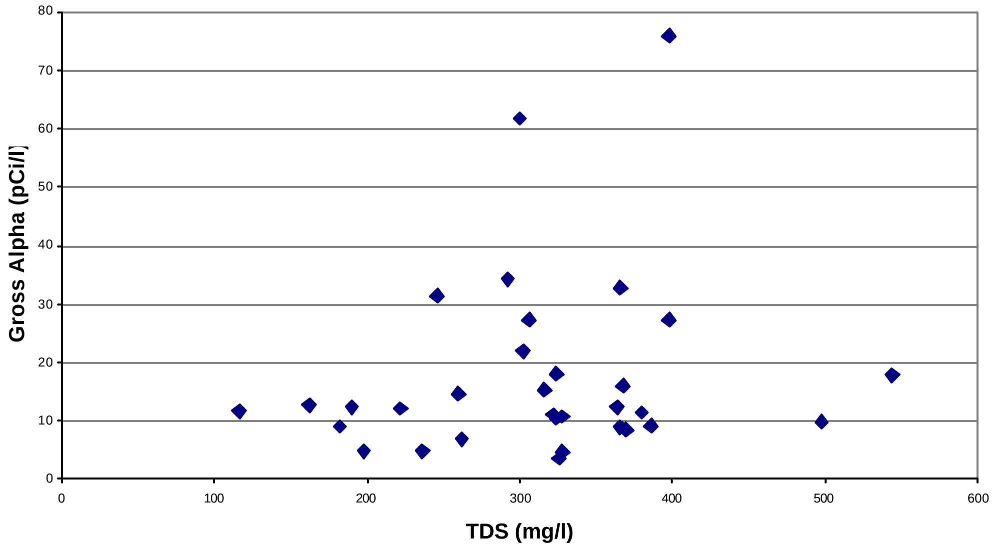
However, as Brown and Caldwell (2000) noted, it is clear that just as gross alpha increases in Cottonwood Creek downstream of the mill site area, TSS is also typically higher downstream of the mill site. This general relationship confirms what is intuitively expected - highly disturbed land surfaces such as the mill site area are generally responsible for elevated downstream levels of TSS compared to non-disturbed areas. Sources of TSS to the watershed are any disturbed areas where soil and sediment is exposed without vegetation cover to prevent erosion. Obvious sources of sedimentation in the watershed would likely include mine waste dumps and the numerous locations where roads cross Cottonwood Creek. In fact, the travel by vehicle within the watershed confirms that each time the creek is crossed on the main Cottonwood Wash road, more sediment is dislodged from the road bed and captured by the surface water. As illustrated earlier, the areas disturbed by past mining activities are most likely responsible for the majority of the elevated gross alpha emissions in Cottonwood Creek.

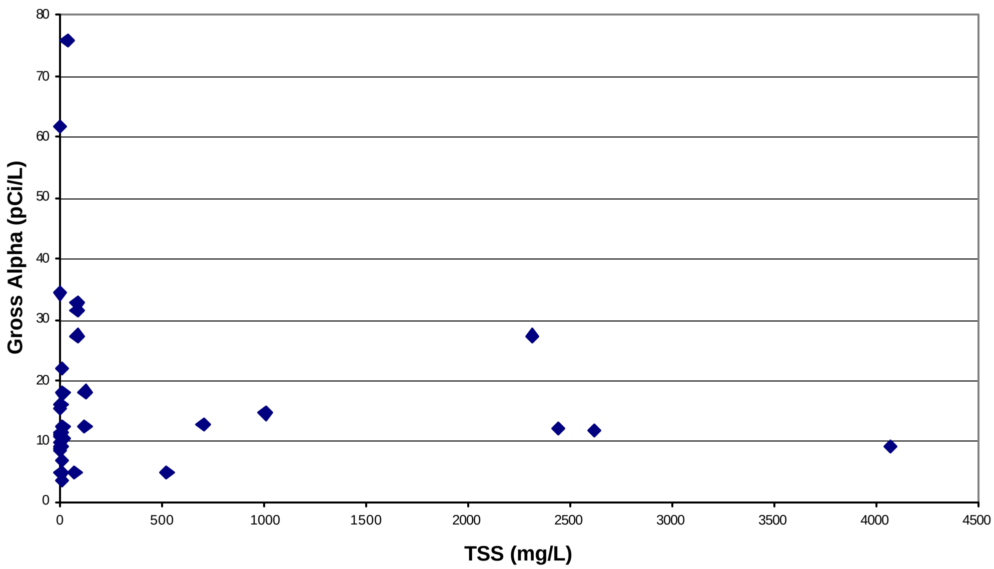
When considering sources of water quality degradation, it is also appropriate to discuss the episodic nature of some forms of degradation. Two contrasting hydrologic conditions in the watershed (periods of base flow or low stream flow and, storm flow or periods of relatively high streamflow) probably influence the levels of gross alpha radiation. Existing data are not extensive enough to show this relationship in Cottonwood Wash, but physical principles explain why some relationship probably exists.

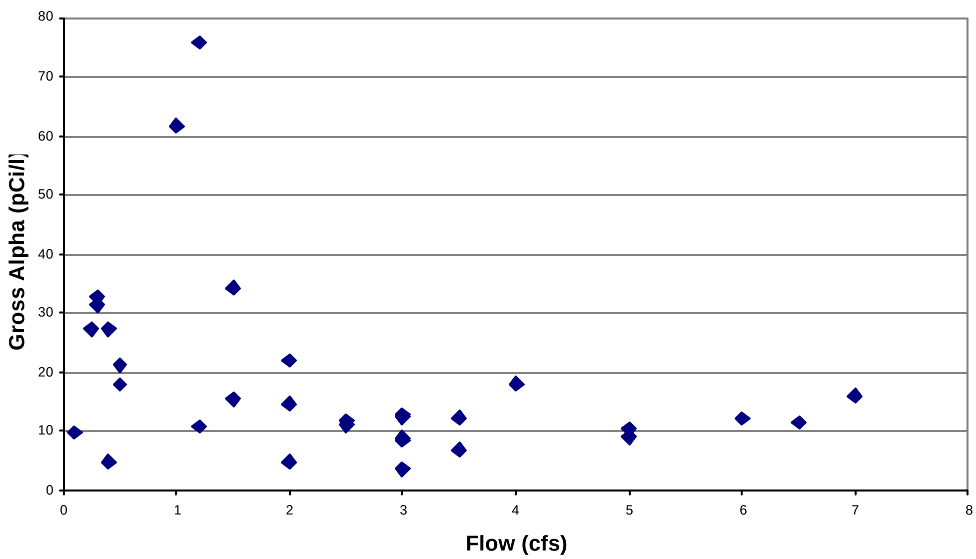
Baseflow conditions consist of relatively low energy stream flow. During these periods the potential for entraining sediment, hence radionuclides existing in sediment, is relative low. Disturbance of sediment is generally related to small-scale events, such as wildlife or cattle crossing streams or vehicles crossing streams at low water road crossings. Sources of gross alpha during these hydrologic conditions would generally consist of groundwater inflow on gaining stream segments, or direct dissolution of radionuclides into water at points where the stream crosses uranium-bearing bedrock. In such instances, since entrained sediment is generally low during low energy conditions, TDS concentrations would be expected to correlate better with gross alpha than would TSS.

Under stormflow conditions, streamflow discharge is elevated, as is stream energy. The volume of water entering the system would tend to dilute or overshadow the water chemistry that exists in low flow conditions. Storm flow has higher potential to move sediment due to the erosive energy of high water, and the fact the water is flowing over surfaces that are normally dry and not continuously exposed to erosive water. Sources for sediment are bare soil surfaces, such as unvegetated mine waste dumps, sediment bars along the wash, dirt roads, or other disturbed areas. Sediment derived from mine waste dumps would be expected to have higher gross alpha concentrations. If considerable sediment is entrained from these or other related locations, then gross alpha concentration would rise along with entrained sediment concentrations. Under stormflow conditions gross alpha concentrations are more likely to correlate better with TSS concentrations that with TDS.

Figure 5 . Relationships between Gross Alpha Radiation and TDS, TSS and Flow.







Additional Data Sources

Mine Inventory

Mine sites in the Cottonwood Wash watershed have been identified using a mine inventory conducted by the USDA-FS, BLM and DOGM. The mine inventory consists of detailed identification of mining-related disturbances along with mapping using georeferenced coordinates. Radiation levels were also measured at the mine sites and at the abandoned vanadium mill. A summary of mining-related features identified by the inventory is presented in Table 3.

Table 3. Summary of Mining-related Features

Mine Feature	Number within Watershed
Mine openings, including: Adits Inclines Shafts	Total 199 179 13 7
Mine pits	12
Mine prospects	75
Mine trenches	31
Subsidence holes	10
Exploration drill holes	282
Mine waste dumps	265
Mine Waste Dump Volume	~143,000 yd^3
Acres of Mine Site Disturbance	~144 acres
Access roads	15.2 miles
Exploration roads and trails	44 miles

Supplemental Data

Although Cottonwood Creek water quality data have not been collected to specifically identify sources of gross alpha radiation contributions to Cottonwood Creek surface waters directly related to specific physical features within the Mill Site such as waste dumps, drill holes, adits, pits and prospects, the Forest Service and BLM have collected substantial soils data from these features. In addition, the Forest Service has collected stream bottom sediment data, the U.S. EPA provided an assessment of radiological data from the Mill Site as documented in their April 26, 2000 correspondence with the Bureau of Land Management (EPA, 2000), and the Oak Ridge National Laboratory (ORNL, 2000) reconnaissance.

All of these data and findings were evaluated and used to complete a qualitative assessment of potential local impacts from mining activities on surface waters within a 250-foot source zone along Cottonwood Creek. The pollutant sources within this zone would be expected to have a greater impact on gross alpha loading to Cottonwood Creek related to baseflow and low flow conditions, as well as storm runoff and transport into Cottonwood Creek. However, it is reasonable to assume that other sites outside of this zone also contribute significantly to the dissolved and suspended gross alpha load to Cottonwood Creek.

Forest Service and BLM soils gross alpha radiation data within a 250-foot zone along Cottonwood Creek indicate that adits have the highest potential to degrade Cottonwood Creek surface waters based on having the most consistent and highest gross alpha radiation readings. Based on BLM provided electronic photographs there are approximately 40 adits located within the 250-foot zone, 36 of which had detected gross alpha radiation. The 36 adits are located within BLM Site Identification Numbers 3, 24, 49, 50 and 51. The highest reading occurred in site 49 with a reading of 2.68 mg/kg gross alpha. No gross alpha readings were detected from the drill hole, waste pile and prospect data based on Forest Service and BLM data.

Based on EPA (EPA, 2000) and Oak Ridge National Laboratory (ORNL, 2000) data, waste dumps have a high potential for seepage and runoff based on the material's uranium and radium content. Although gross alpha radiation levels in waste dumps within the 250-foot zone were zero based on Forest Service and BLM data, measured uranium concentrations indicate the potential for seepage to natural soils below the waste dumps to occur, and eventually leaching further or migrating down gradient to Cottonwood Creek. This would be most likely in waste dump soils with pH greater than 8, which is typical in the local Mill Site soils (ORNL, 2000), and exposure to precipitation. An impact to surface waters would most likely occur during episodic storm events or snow melt periods.

Stream Sediments

In addition to soils data, Cottonwood Creek stream bottom sediment data were collected at 6 sample locations by the Forest Service during one sample event on July 21, 1999. Measured sediment gross alpha levels are listed in Table 4.

Table 4. Gross Alpha Levels in Stream Sediments

Gross Alpha Concentration	Location
2.2 pCi/g	0.3 miles above King Edward Mine
5.4 pCi/g	0.4 miles below King Edward Mine
3.8 pCi/g	1.5 miles below King Edward Mine at turnoff to Laura Mine
0.2 pCi/g	2.6 miles below King Edward Mine at FS boundary
2.5 pCi/g	7.1 miles below King Edward Mine

3.3 pCi/g	Cottonwood Creek at South Elk Ridge Road

As shown by the 2.2 pCi/g level above the King Edward Mine, background sediment gross alpha is elevated and likely due to factors such as historic mining impacts as well and natural geologic conditions. There is an evident increase in sediment gross alpha directly below the King Edward Mine. This increase may be a function of waste materials generated during development of the King Edward Mine portals being transported to Cottonwood Creek during runoff periods or historic waste materials being dumped in Cottonwood Creek directly. Gross alpha sediment concentrations decrease steadily downstream to a low concentration of 0.2 pCi/g 2.6 miles below the King Edward Mine at the Forest Service boundary. Concentrations then increase downstream which is likely due to sediment transport from tributaries including Posey Canyon, Allen Canyon, Dry Wash and Hammond Canyon where historic mining activities have occurred.

An assessment was completed to determine if Cottonwood Creek gross alpha water column concentrations typically follow the same pattern as sediment samples to determine if stream bottom sediments are impacting water quality. This assessment is quantitative in nature and limited since only one sediment data set is available. Typically, the pattern does match when comparing concentrations directly above the King Edward Mine and directly below, as well as the pattern of gross alpha concentrations decreasing downstream of the King Edward mine then rebounding towards the Highway 95 at the bottom of the basin. One location that does not compare well is at the Forest Service boundary. As discussed above, gross alpha water column concentrations were consistently highest at the Forest Service boundary site (495336) but the lowest sediment concentration was measured near this location. This could be a function of sample site location and sample collection timing. Sediment and water column sites were not collected at the same locations and sediment and water column samples were not collected at the same time.

IV. TMDL AND LOAD ALLOCATIONS

Reductions in Cottonwood Creek gross alpha radiation concentrations are required to meet the TMDL target at the State Highway 95 target site. Gross alpha concentration reductions are also required to meet the 15 pCi/L water quality criterion downstream of the King Edward Mine at sampling site 495336, which is not defined as a target site for this phase of the TMDL. The percent reductions required to meet the TMDL target at State Highway 95 have been calculated based on measured and mass balance calculations.

Gross alpha radiation concentrations are expressed as an instantaneous. For this purposes of this TMDL, due to limited data, seasonality can not be adequately addressed. Based on available data (1998-1999 Utah DWQ) and for this phase of the TMDL, baseflow is defined as any flow equal to or less than the highest measured flow with corresponding gross alpha measurements, which is approximately 6.5 cfs. Although gross alpha water quality data were only collected at a maximum flow of 6.5 cfs, it is evident that higher flows occur. It is the intent of the Monitoring Plan section of this TMDL to address this issue with the goal of expanding the range of base flow data (higher baseflows) as well as address runoff conditions. For comparative purposes, the base-flow value of approximately 6.5 cfs falls in the 78th percentile of daily average flows measured Cottonwood Creek at Highway 95, based on historic USGS collected data from 1964 through 1987. Flows in the range of 6.5 cfs are shown to occur in Cottonwood Creek during any month of the year but can be exceed during snowmelt or rainfall events.

Estimation of Concentrations (Mass Balance)

Development of the gross alpha TMDL was based on data collected by Utah DWQ during four synoptic sampling events at 13 sampling stations throughout the Cottonwood Creek Watershed. A total of six synoptic events were completed but only four events provided sufficient data to make a technically sound assessment. A simple mass balance was completed for these sampling events, calculating potential gross alpha radiation concentrations and loadings, at four additional locations within Cottonwood Creek where insufficient data were available. These four sites included Cottonwood Creek downstream of King Edward Mine, Allen Canyon, Dry Wash, and Hammond Canyon. The mass balance incorporated existing tributary data and King Edward Mine portal discharge data collected during the same four sampling events. Gross alpha loading calculations in Cottonwood Creek and tributaries were also completed based on measured concentrations and flow rate. Loading calculations were completed at multiple sites along Cottonwood Creek and three tributaries based on four synoptic data events collected by the Utah DWQ from March 1998 through April 1999. As indicated in Table 5, this mass balance analysis shows potential concentration, flow, and loading effects of the three tributaries on Cottonwood Creek in conjunction with measured values in Cottonwood Creek from the same sampling period.

<u>Loading Calculations</u>

Based on the units of measurement for gross alpha radiation (pCi/L) a true mass loading per unit time can not be developed. For purposes of this gross alpha TMDL, "loadings" are presented as pCi/day, which incorporates gross alpha concentration and flow rate. These loadings are presented in Table 5.

Allocation of Pollutant Loads

This phase of the Cottonwood Creek gross alpha radiation TMDL expresses allocations as the required percent reduction at the Mill Site area to meet the TMDL target. The allocation of pollutant loads traditionally consists of 3 components: (1) allocating wasteloads to point sources; (2) allocating loads to nonpoint and background sources; and (3) allocating a margin of safety. The focus of this section is on allocating nonpoint source loads and background loads at the Mill Site plus consideration of an implicit margin of safety. Additional consideration has been given to potential CERCLA driven clean-up actions at the King Edward Mine, which could benefit surface water quality.

As shown on Figure 3, gross alpha radiation concentrations increase sharply downstream of the King Edward Mine at sampling site 495336, compared to background concentrations upstream of the mine. Gross alpha radiation exceeded the 15 pCi/L water quality criterion on five of the six total sampling events, with an average concentration of 46 pCi/L, and a maximum concentration of 75.9 pCi/L. Further, background gross alpha concentrations upstream of the mine exceeded the gross alpha criterion of 15 pCi/L

<u>Ambient Criteria</u>

As indicated by available data in the upper portion of the basin (upstream of the Kind Edward Mine), background gross alpha radiation concentrations exceeded the water quality criterion over 80 percent of the time, averaging 21 pCi/L. In order to account for these elevated ambient conditions, an ambient criterion was evaluated for the river segment upstream of the King Edward Mine to approximately the NFS land boundary at sampling site 495336. The approach used in developing an ambient criterion for a regulated constituent is to apply the 85th percentile of all measured values (mean concentration plus one standard deviation). This equates to an ambient criterion of approximately 28 pCi/L. Alternatively, since the gross alpha radiation criterion is applied as an instantaneous value, the maximum measured background value could be considered. This equates to an ambient criterion of 34 pCi/L.

In order to attain an ambient gross alpha radiation criterion of 28 pCi/L at sampling site 495336, the average concentration of 46 pCi/L needs to be reduced by approximately 39 percent. Additional data are required to define the Cottonwood Creek TMDL in this upstream reach.

King Edward Mine

Although a direct linkage between the King Edward Mine portal discharges and water quality effects on Cottonwood Creek can not be quantitatively defined, it is assumed that based on the proximity of the mine, there is some potential for surface water impacts. The King Edward Mine is a CERCLA site and is not included in the TMDL with respect to recommending control strategies or BMPs. However, the proposed recommended CERCLA actions for monitoring and clean-up could assist in meeting the TMDL gross alpha radiation water quality goals by including a 28 pCi/L ambient criteria at sampling site 495336.

Above Mill Site

Based on gross alpha data collected directly above the Mill Site (sample site 495329), which indicated values are consistently below the 15 pCi/L criteria, and ambient criteria would not be applicable. Baseline concentrations as measured at sample site 495329 are taken into account in the TMDL and utilize part of the assimilative capacity available in Cottonwood Creek.

Load Allocation -Required Reductions to Meet TMDL Target

Load allocations can be expressed as: (1) required numeric maximum allowable load for various sources; (2) narrative statements of desired conditions; or (3) required numeric reduction in pollutant load to meet the TMDL target. For this TMDL, the allocation of gross alpha radiation is expressed as the required reduction at the Mill Site area to meet the TMDL target. Load allocations for discrete or non-point sources may be based on "gross allotments" depending on the availability of data and technique for predicting impacts. This approach is applicable to the Mill Site area where insufficient data are available to define specific individual sources within the Mill Site area contributing to gross alpha radiation increases in Cottonwood Creek.

The allocation or required reduction for this phase of the TMDL focuses on the Mill Site area to achieve the TMDL target for gross alpha radiation at the State Highway 95 target site under baseflow conditions (6.5 cfs or less). The reduction or allocation is expressed in terms of absolute loading or as a percent reduction needed to achieve the TMDL target at State Highway 95. Required reductions and allocations for the Mill Site area are estimated below in Table 6.

Margin of Safety

The margin of safety (MOS) can be explicit or implicit but must be applied in a manner reasonable to assure attainment of the water quality target. Both an explicit and implicit MOS had been applied for the Cottonwood Creek gross alpha radiation TMDL. The implicit MOS for gross alpha radiation in this phase of the TMDL is addressed through: (1) the selection of the most conservative gross alpha radiation reduction required to meet the TMDL target at the State Highway 95 target site based on measured data; (2) use of the largest background concentration variation measured directly upstream of the Mill Site at sampling site 495329; and (3) the currently planned reclamation of mine sites outside of

Table 5 Summary of Loading Calculations at Every Sampling Location

STORET #	495339	495338	495337	495337(A)	NA	495336	495334	NA	495333	NA	495331	NA	495329(A)	495332
Sampling Event	Cottonwood Creek upstream of King Edward Mine Site	King Edward Mine North Portal Discharge	King Edward Mine South Portal Discharge	Cottonwood Creek Directly Downstream of King Edward Mine	Calculated Value – Cottonwood Creek directly Downstream of King Edward Mine	Cottonwood Creek at Forest Service Boundary	Allen Canyon Tributary	Calculated Value – Cottonwood Creek including Allen Canyon	Dry Wash Tributary	Calculated Value – Cottonwood Creek including Dry Wash	Hammond Canyon Tributary	Calculated Value – Cottonwood Creek including Hammond Canyon	Cottonwood Creek upstream of mine impacts at Mill Site	Cottonwood Wash at U.S. 95 crossing (target site)
March 31, 1998														
Gross Alpha – Measured or Calculated, pCi/L	22	3340	1559	Not Collected	243	75.9	3.6	24	9.8	24	11.1	19	11.5	16
Flow – Measured or Calculated, cfs	2	0.1	0.1	Not Collected	2.2	1.2	3	4.2	0.1	4.3	2.5	6.8	6.6	7
Daily Load, million pCi/day	107.6	817.2	381.4	NA	1308	222	26	248	2.4	250	68	316	183	274
May 20, 1998														
Gross Alpha – Measured or Calculated, pCi/L	34.3	5780	7110	Not Collected	1340	61.7	6.8	19	4.8	18	15.4	17	10.4	18.1
Flow – Measured or Calculated, cfs	1.5	0.1	0.1	Not Collected	1.7	1	3.5	4.5	0.4	4.9	1.5	6.4	5	4
Daily Load, million pCi/day	126	1414	1740	NA	5573	151	58	209	4.7	216	56	266	127	177
July 29, 1998														
Gross Alpha – Measured or Calculated, pCi/L	21.2	Not Collected	Not Collected	Not Collected	NA	27.3	4.88	7	Dry – Not Collected	7	14.6	11	9.06	12.1
Flow – Measured or Calculated, cfs	0.5	Not Collected	Not Collected	Not Collected	NA	0.25	2	2.25	Dry – Not Collected	2.25	2	4	5	6
Daily Load, million pCi/day	26	NA	NA	NA	NA	1.7	24	38	NA	38	71	108	111	178
April 14, 1998														
Gross Alpha – Measured or Calculated, pCi/L	7.9	Not Collected	Not Collected	12.7	NA	12.4	4.72	9	Dry – Not Collected	9	10.8	10	8.91	8.55
Flow – Measured or Calculated, cfs	1.75	Not Collected	Not Collected	3	NA	3	2	5	Not Collected	5	1.2	6.2	3	3
Daily Load, million pCi/day	34	NA	NA	93	NA	91	23	110	NA	110	32	152	65	63

the 250-foot baseflow source zone as well as improvements to the existing haul road and construction of hardened creek crossings. The portion of the MOS applicable to the most conservative gross alpha radiation reduction requirement is inherent in the required reduction calculation (maximum measured value minus target value).

Mill Site Area Reductions

As shown in Table 2, and Figure 3, the gross alpha radiation criterion of 15 pCi/L was exceeded at the State Highway 95 target site on two of six synoptic sampling events. A review of the data upstream of the Mill Site indicates that the exceedances were a result of contributions made from the Mill Site area, which could include historic mining activities and natural geologic conditions. A summary is as follows.

- During the March 31, 1998 sampling event, gross alpha concentrations increased from a background concentration (directly upstream of the Mill Site -sampling site 495329) of 11.5 pCi/L to 16 pCi/L at the target site, an increase of 28 percent, at a flow of approximately 6.5 cfs. Reductions required to achieve the 15 pCi/L criteria at the target site for this event is 6 percent.
- During the May 20, 1998 sampling event, gross alpha concentrations increased from a background concentration (directly upstream of the Mill Site -sampling site 495329) of 10.4 pCi/L to 18.1 pCi/L at the target site, an increase of 74 percent, at a flow of approximately 5 cfs. Reductions required to achieve the 15 pCi/L criteria at the target site for this event is 17 percent.

Since limited data are available, a conservative approach was taken which utilizes the greatest required reduction to achieve 15 pCi/L at the Mill Site (17 percent), which reflects an implicit margin of safety. This corresponds to the May 20, 1998 sampling event where the 18.1 pCi/L measured value at the TMDL target site is 17 percent above the gross alpha target of 15 pCi/L.

An explicit MOS was added based on the highest background concentration measured, 11.5pCi/L. Based on a 74 percent increase as shown on May 20,1998 sampling event, a 74 percent increase above the maximum background value at 11.5 pCi/L would produce a 20 pCi/L concentration at the TMDL target site. The 20 pCi/L value is 10 percent greater than the highest measured value at the TMDL target site, and is defined as the explicit MOS. The total MOS is equal to 17 percent plus 10 percent, or 27 percent, to meet the TMDL target under baseflow conditions (6.5 cfs).

Table 6. Required Mill Site Area Gross Alpha Percent Reduction/Allocation to Meet TMDL Target

Maximum measured concentration at target site, pCi/L	Percent required reduction to meet TMDL target of 15 pCi/L	Explicit margin of safety, percent	Total required reduction to meet TMDL target, percent	Maximum expected target site concentration, pCi/L	Maximum expected target site load at maximum baseflow (6.5 cfs), million pCi/day
18.1	17	10	27	14.6	35.7

Since gross alpha radiation contributions to Cottonwood Creek surface waters in the Mill Site area cannot be specifically attributed to historic mining activities, natural geologic conditions may contribute gross alpha radiation as well. It is felt that the conservative nature of the MOS applied to this TMDL addresses gross alpha variability potential from both historic mining activities and natural conditions. The potential maximum concentration and load at the TMDL target site is shown in Table 6 as well as the gross alpha allocation for the Mill Site area. The estimated 27 percent required reduction/allocation is the goal of the recommended Implementation Plan and is discussed further in that section of this TMDL.

V. IMPLEMENTATION

Abandoned mine sites can be reclaimed using appropriate BMPs to meet TMDL load allocations. These BMPs have been found to effectively reduce nonpoint source contributions of radiation and sedimentation. Based on the available water quality data, which were collected under baseflow conditions, the more significant sources or "hotspots" of gross alpha radiation affecting Cottonwood Creek are located near Cottonwood Creek. It is expected that impacted sediments have been and are currently, transported into, or close to, Cottonwood Creek causing water quality impacts that persist, even under baseflow conditions.

It is clear from the inventory work done that there are a number of highly disturbed sites in the Cottonwood Wash Watershed These sites include exploration adits, waste rock piles, drill hole locations, shallow mine shafts, trenches, excavated slopes, old building locations, and similar disturbances typically found at inactive mining sites. Through the evaluation of soil data and EPA and ORNL reports concerning uranium and gross alpha content in the various disturbed materials at the Cottonwood Mill Site within the 250-foot zone, an assessment was completed to identify the mining features most likely to contribute to water quality degradation. Although this data and information is available, the lack of surface water quality data during rainfall or snow melt periods does not allow an accurate quantitative assessment of the actual reduction that will be achieved when various BMPs are implemented.

Interdepartmental Abandoned Mine Lands Watershed Initiative

The proposed project will stabilize and/or reclaim mining-related disturbances within the Cottonwood Wash watershed as identified above in the Source Assessment section and summarized in Table 3. The project involves reclamation of 81 abandoned mine sites resulting in approximately 144 acres of surface disturbances, reclamation of about 14.4 miles of mine access roads, reclamation of about 44 miles of mining exploration roads, and stabilization of approximately 14 miles of the Cottonwood Wash road. The road stabilization would involve graveling the road and constructing 17 hardened stream crossings.

The Cottonwood Wash Watershed Abandoned Mine Reclamation Project Environmental Assessment (BLM et. al., 2000) details specific practices that will be employed during reclamation. Reclamation would generally involve closing mine openings, reshaping, recontouring or removal of mine waste dumps, seeding of disturbed areas, plugging of drill holes, and rehabilitation of access roads and exploration roads/trails. Mine waste dumps will be regarded to approximate the surrounding slope, after cultural resources are evaluated and protected as appropriate. Mine waste dumps will be placed against cut slopes and portal faces where necessary. All mine waste dumps and backfilled mine features (where mine waste dump material will be used) will be covered with a minimum of 2 feet of native soil and rock materials. Where possible, a pit would be excavated within, or adjacent to, existing disturbed areas on mine sites. The pit would serve as a source of cover material for the mine waste dump area, a source of additional backfill material, or as a place of disposal for excess mine waste dump material. A total of 12 mine waste dumps are located along the banks, or within, Cottonwood Wash. These mine waste dumps will be removed from the drainage and will be used for backfill at nearby mine sites or would be disposed of in pits (as described above) excavated at these mine sites.

The proposed action identified in the Environmental Assessment has been approved by the USDA-FS and the BLM. Construction contracts have been awarded and the project was initiated on the ground in the fall of 2001.

Water Quality Monitoring

Additional monitoring will be conducted in Cottonwood Wash to provide water quality data to meet the following objectives:

- Better define water quality during periods of higher flow
- Identify potential source areas in the stream segment between Station 495336 (Cottonwood Wash at U.S. Forest Service boundary) and Station 495339 (Cottonwood Wash above King Edward Mine).
- Evaluate the effectiveness of reclamation work being conducted under the Abandoned Mine Reclamation Program.

A monitoring program will be developed by DWQ, in cooperation with the participating agencies, to address these objectives. The monitoring program will consist of 1) long-term stations on Cottonwood Wash to address implementation effectiveness and flow variation; and 2) short-term stations specifically tailored to further identify pollutant loading sources and characterize water quality during higher flow events.

VI. PUBLIC PARTICIPATION

The BLM, U.S. Forest Service, Division of Oil, Gas and Mining and the Division of Water Quality have taken steps to inform the public and other stakeholders about the water quality issues and reclamation plans for Cottonwood Wash through a series of public notices, scoping notifications and public hearings.

The Brown and Caldwell (2000) TMDL study was reviewed by representatives of DWQ, DOGM, USDA-FS, and BLM. The findings of the TMDL were referenced and incorporated into the Cottonwood Wash Abandoned Mine Reclamation Project Environmental Assessment (EA). The EA was distributed to a wide group of interested and affected parties for public comment.

Notice of a 30-day public comment period for this draft TMDL was listed on the Division of Water Quality's internet web site and in two newspapers with statewide distribution - the Salt Lake Tribune and the Deseret News.

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