DRAFT REPORT

FEASIBILITY STUDY

RED MESA RESERVOIR

LA PLATA COUNTY, COLORADO

WATER DIVISION 7
WATER DISTRICT 33

DAM ID 330105

Prepared for
Red Mesa Reservoir and Ditch Company
7882 County Road 100
Hesperus, CO 81326

July 25, 2016

Prepared By:

AECOM

8181 East Tufts Avenue
Denver, Colorado 80237

Project No. 22244294

Tables **Page**

Figures

Appendices

AF	acre-feet
ALP	Animas - La Plata Project
cfs	cubic feet per second
CWCB	Colorado Water Conservation Board
ESA	Endangered Species Act
EPAT	Extreme Precipitation Analysis Tool
ft	feet/foot
gpm	gallons per minute
LPWCD	La Plata Water Conservancy District
NEPA	National Environmental Policy Act
RMR&DC	Red Mesa Reservoir & Ditch Company
SCS	Soil Conservation Service
SDF	Spillway Design Flood
SEO	Colorado State Engineer's Office
SEO Rules	Rules and Regulations for Dam Safety and Dam Construction
SW Basin	Southwest Basin Roundtable
SWSI	Statewide Water Supply Initiative
TABOR	Taxpayer's Bill of Rights
USBR	United States Bureau of Reclamation
USDA	Unites States Department of Agriculture
USFWS	United States Fish & Wildlife Service
WD	Water District
WSRA	Water Supply Reserve Account

The primary purpose of the proposed project is to construct a spillway at the sponsor's Red Mesa Dam which complies with SEO Rules. Currently, the dam is considerably out of compliance with this standard, and the Red Mesa Reservoir and Ditch Company (RMR&DC), the dam owner and project sponsor, is facing the imminent prospect of restriction that would reduce the storage to zero or even a full breach order if an acceptable spillway is not constructed in the near future. As the required size and cost of a compliant spillway is significant, the owner would like to acquire additional storage space in the reservoir as a benefit to help offset the cost of the spillway construction. This additional storage would utilize some of the owner's existing adjudicated conditional storage rights for the reservoir. Therefore, a limited increase in dam height, reservoir storage depth and reservoir storage is also proposed as a part of the project. Additionally, modifications to the dam's outlet system are required to accommodate the enlarged dam, to meet with dam safety requirements, and to overcome noted structural deficiencies.

Construction of a compliant spillway will require a large amount of excavation of natural materials from the left abutment area of the dam, the proposed location of the enlarged spillway. This volume of material would need to be hauled offsite and wasted unless used to raise the crest of the dam to provide additional flood storage in the reservoir and spillway outflow capacity. Because of the extent of the required excavation, a large cost component is associated with this activity. To most efficiently utilize the material to be excavated, URS, in a previous study funded by a WSRA SW Basin grant, performed an optimization study which balanced required excavation for the spillway with dam fill placement for an enlarged dam and reservoir configuration that would provide for a complaint spillway. This study, entitled Spillway Alternatives Analysis, Red Mesa Reservoir, was completed in September of 2013.

Several scenarios were developed for consideration as a part of that study, including a no-action scenario which was assumed to require a breach of the dam, constructed in accordance with SEO Rules. Other scenarios included spillway construction with no enlargement of the dam; overtopping protection for the dam to allow the design flood to safely pass over the dam; and two reservoir enlargement scenarios coupled with new spillway construction, one to incorporate an additional 250 AF of reservoir capacity, and the other to incorporate an additional 550 AF of capacity.

Ultimately, the option of spillway construction with a reservoir enlargement to provide an additional 550 AF of storage capacity was selected as the most desirable. This requires a spillway having a width of approximately 275 ft, and raising the dam crest (in a downstream raise configuration), by adding material to the existing crest and downstream slope of the embankment, by 14 ft. The normal water line elevation in the reservoir would be increased by approximately 8 ft. This work also requires modification of the existing outlet works to accommodate the raised and widened dam section and the increased storage depth in the reservoir.

The cost to design and construct the proposed project is currently estimated at approximately $5.1 million. Of this total cost, the RMR&DC feels that they can afford to pay debt service on a CWCB construction fund loan of about $700,000. The funding source for the remaining $4.4 million is as yet unknown, but might include funding from WSRA basin and statewide grants, as well as locally-sourced grant funds and, potentially, sales of the additional water stored in an enlarged reservoir.

The RMR&DC (originally formed as the Red Mesa Ward Reservoir and Ditch Company) was established in 1923 as a not-for-profit corporation under Colorado law, for the purposes of (1) filing on, appropriating or otherwise acquiring approximately 4,000 AF of the "flood water of the La Plata River" and other nearby sources for storage in reservoirs and for distribution and use for domestic and irrigation purposes by shareholders; (2) acquiring rights-of-way for headgates, ditches and flumes and storage facilities, as necessary to convey water from the source of supply to storage reservoirs, to store waters in the reservoirs, and to distribute stored waters from the reservoirs to shareholders; (3) acquiring ownership of the land on which to construct, maintain and operate reservoirs; (4) constructing, operating and maintaining said facilities; and (5) levying and collecting assessments for the repair, operation, maintenance and superintendence of facilities.

The Articles of Incorporation filed with the Secretary of State in 1923 provide for five directors of the RMR&DC, who are empowered to make by-laws which are proper and necessary for the management, conduct and control of company business. However, by-laws were never actually developed or filed by the directors. The Articles of Incorporation are included as Appendix A.

To the end described by the Articles of Incorporation, the RMR&DC owns and operates (a) Red Mesa Dam and Reservoir, located on the lower end of Hay Gulch, a tributary to the La Plata River; (b) a diversion structure on the La Plata River; and (c) the Supply Ditch, which conveys flows diverted from the river to the reservoir. The construction of these facilities was initiated prior to 1905 and completed in its original form in about 1908. The dam which was constructed at that time was of smaller size than exists at the site today, as several rebuilds/enlargements were constructed over the years, as described in Section 3. Original decreed diversion capacity of the RMR&DC's diversion structure on the La Plata River northeast of the reservoir is 120 cfs; the company directors indicate that actual capacity is near that amount and is adequate to fill the reservoir when water is available.

The decreed storage capacity of Red Mesa Reservoir is 1,176 AF. The Articles of Incorporation call for one share for each AF of water stored; currently, the water is divided among 1,138 shares, which, if full delivery of decreed reservoir capacity occurred, would result in slightly more than one AF per share. Actual delivery is, of course, somewhat less than that, as some loss of storage has occurred due to sedimentation, the reservoir is not filled to capacity in all years, and it is not necessarily drained completely every year. The shares are currently held by 48 different shareholders, with the 7 largest shareholders holding over 50 shares each, comprising approximately 56% of the total shares in the RMR&DC.

Operating revenue for the RMR&DC is derived totally from shareholder assessments; the current (2015) annual shareholder assessment is $20/share. This amounts to an annual collection of $22,760, of which approximately $8,000/year is expended on operation and maintenance of facilities and other administrative costs, including one part-time employee. Since the assessments were increased to the current level in about 2010, the surplus above operation and maintenance expenses has largely been expended to pay for RMR&DC's share of corrective action studies undertaken to resolve dam safety issues, and to build up the capital reserves of the RMR&DC in preparation for actual construction work. Prior to 2010, assessments were about $9/share, so the current assessment represents an increase of about 125% since that time.

The service area for the RMR&DC generally surrounds the unincorporated town of Red Mesa in southwest La Plata County, as shown on Figure 2-1. The water is distributed primarily by three ditches fed by diversion structures on the La Plata River downstream of its confluence with Hay Gulch: the Joseph Freed Ditch, the Revival Ditch and the Warren-Vosburgh Ditch. A lesser amount of reservoir water is also delivered via the Old Indian Ditch (not shown on Figure 2-1), which has its point of diversion in Hay Gulch upstream of its confluence with the La Plata. Additionally, nine shares of reservoir water are delivered to the La Plata annually as well augmentation water. Approximately 1,140 acres of land are irrigated by water released from the reservoir, so actual delivery of stored water is something less than 1 AF per acre even in the best years.

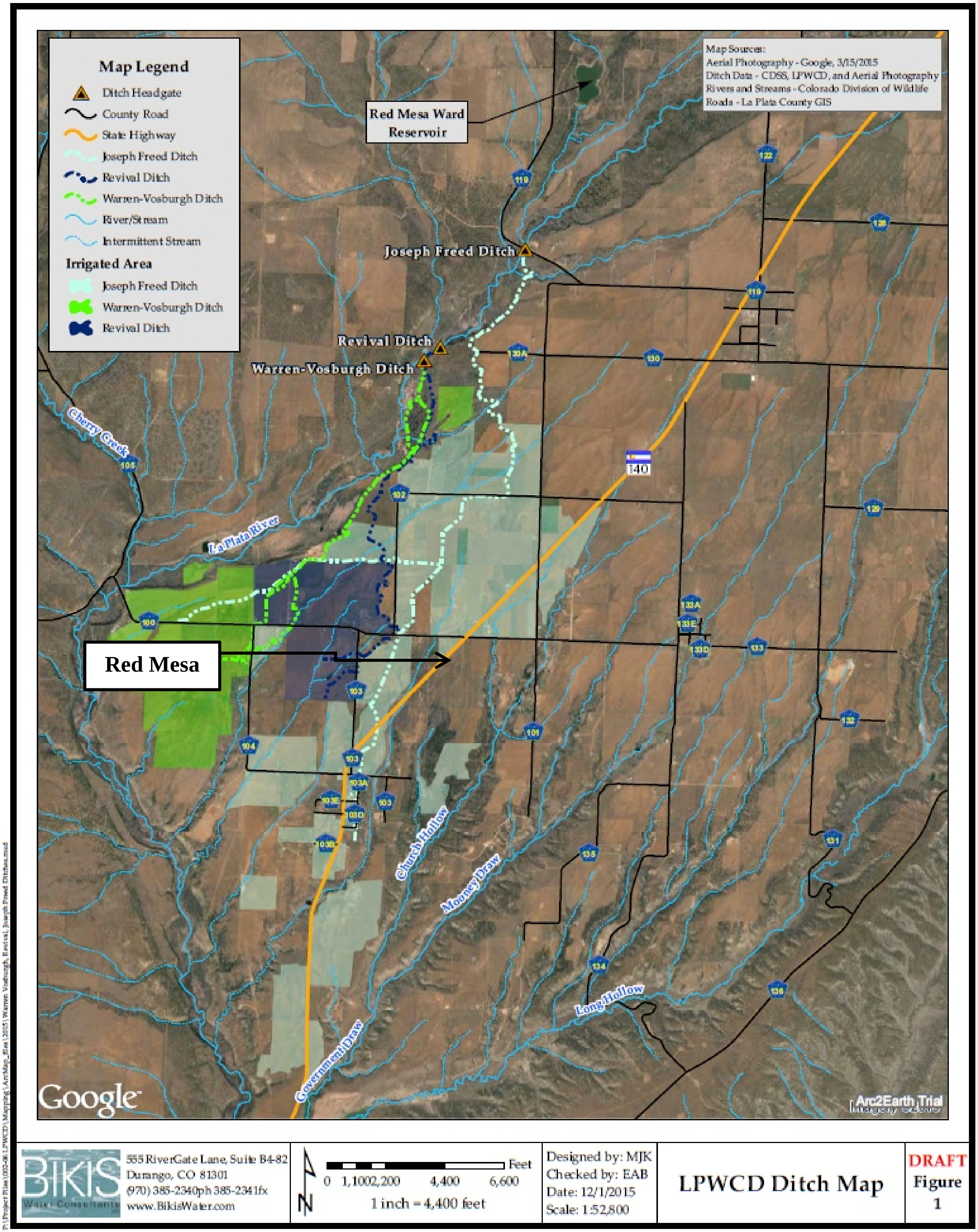


Figure 2-1: Red Mesa Reservoir and Ditch Company Service Area

The Red Mesa Reservoir (aka, Red Mesa Ward Reservoir, Mormon Reservoir) is located in southwest La Plata County, Colorado, approximately 16 miles southwest of Durango, as shown on Figure 3-1. The reservoir has been in existence for over one hundred years, and, until the recent construction of Long Hollow Reservoir, provided the only significant water storage facility on the La Plata River system in Colorado.

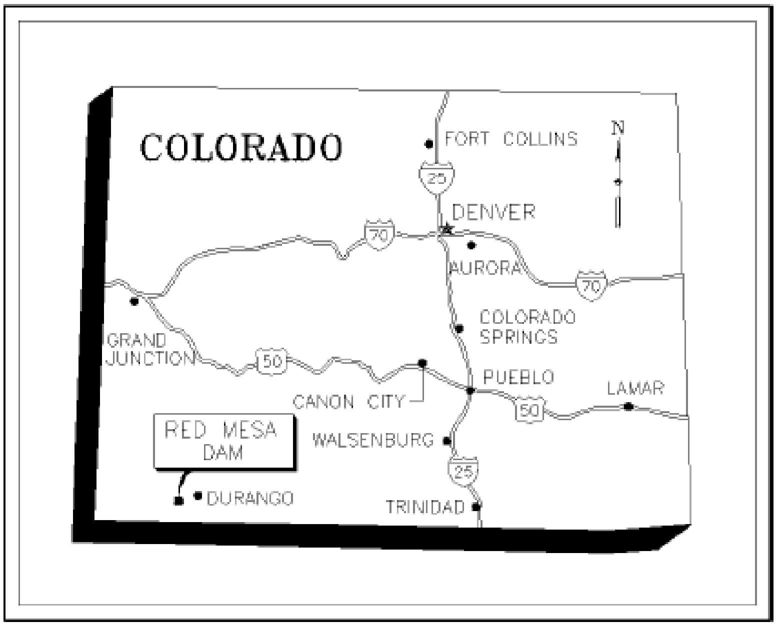


Figure 3-1: Red Mesa Reservoir Vicinity Map

According to the water court storage decree for the reservoir, construction of the original storage facility at this site appears to have been initiated prior to 1905, with that iteration of the dam eventually completed several years later and reaching a maximum embankment height of about 40 ft at a crest elevation of about 6,880. The dam utilized an open channel spillway of nominal width cut through the left (east) abutment. A concrete-lined tunnel bored through the sandstone/shale bedrock of the lower left abutment served as the outlet works. Filling of the reservoir was accomplished by diversion from the La Plata River via the RMR&DC's Supply Ditch and by natural flows in Hay Gulch, the watercourse across which the dam was constructed.

The original dam which was completed around 1910 was subsequently overtopped and breached in the 1920's by a flood which exceeded the existing spillway capacity. Previous studies for the dam cite sources indicating that the original dam was destroyed by a large flood in 1929. However, it appears from the records of the State Engineer's Office that the breach occurred sometime prior to 1925. A set of plans detailing reconstruction of the dam, and showing the breach section existing within the dam at that time, was approved for construction in February of 1925, not post-1929. Therefore, failure of the original dam must have occurred sometime prior to 1925.

The 1925 repair design included an enlargement of the previous structure to a maximum embankment height of about 48 ft at a crest elevation of 6,888, and established a new, somewhat wider, open-cut spillway on the steeper right abutment of the dam. Enlargement of the dam was accomplished by a downstream embankment raise. The outlet tunnel from the original dam was utilized in the enlarged dam, modified by the construction of a new concrete gate tower at the upstream end of the tunnel and the construction of a reinforced concrete cover over the existing masonry inlet channel upstream of the tunnel, with a reinforced concrete conduit extension upstream of the old masonry section. These modifications to the outlet works were approved by the State Engineer in September 1927, as replacement drawings for the original plan set, possibly indicating that construction was either imminent or underway in 1927. It appears from subsequent plan sets in later years, however, that the actual height of the dam constructed at this time was somewhat less than the design height.

In October of 1945, yet another enlargement of the dam and reservoir was approved by the State Engineer, this time to the current decreed reservoir capacity of 1,176 AF. This enlargement of the dam, also constructed as a downstream embankment raise, increased the dam height by approximately 17 ft and the normal water line elevation by about 14 ft. To accommodate the enlargement, a concrete cut-and-cover conduit extension was added to the downstream end of the outlet conduit, the gate tower was extended upward and equipped with a new access bridge from the left abutment, and a new open-channel spillway having a bottom width of about 25 ft was constructed on the left abutment.

The dam and reservoir exist today in essentially the configuration shown on the 1945 plans. Repairs to the outlet gate tower were constructed in 1973 to address concrete cracking and structural deflection issues at the location where the tower was added to during the 1945 construction. Lateral bracing of the upper part of the tower was added in the 1990's to help control tower deflections under reservoir ice loading conditions.

Copies of the prior approved construction plans for the dam are included in Appendix B.

Although the version of the dam in place since the 1945 enlargement has generally performed well from a dam safety perspective, one glaring deficiency exists: the spillway has been identified as being inadequate, form a flood capacity standpoint, since at least the time that the SEO issued a revision to the Rules and Regulations for Dam Safety and Dam Construction in 1986, which contained updated standards for spillway sizing. The version of the dam constructed in 1945 incorporated a spillway with a bottom width of about 25 ft, providing about 6 ft of freeboard to the dam crest. This spillway has been evaluated numerous times since 1986, and has been found to be inadequate, using every standard applied since that time, to route the design flood from the approximately 30-square-mile drainage basin of Hay Gulch upstream of the dam.

The State Engineer currently considers Red Mesa Dam to be a Small, High Hazard structure, according to SEO Rules. The hazard classification was revised from "Significant" to "High" by the SEO in 2008, reflecting the probability of loss of human life if the dam were to fail with the reservoir full to the spillway crest. This size and hazard class dictates the most conservative requirements for spillway sizing within the SEO Rules, with the Inflow Design Flood (IDF) developed according to one of several possible extreme storm evaluation methodologies.

In order to identify potential options for moving forward with spillway improvements, RMR&DC, utilizing WSRA SW Basin grant funds, retained URS Corporation in 2010 to perform an analysis of the IDF. This study, entitled Incremental Damage Assessment and Inflow Hydrology for Red Mesa Dam, was completed in May of 2011. The Incremental Damage Assessment (IDA) did not support the reduction of the IDF and recommended that the SDF be equal to the IDF. The IDF was developed using EPAT software and hasa peak reservoir inflow of 26,133 cfs (URS 2011). By comparison, the existing spillway is estimated to have a capacity of less than 1,000 cfs.

This lack of spillway capacity has caused a significant amount of concern to the State's Dam Safety office, to the point where a significant storage restriction, likely to zero storage, and potentially a breach order, are understood to be enforced in the near future unless corrective actions are proactively undertaken.

One additional problem of note which has developed over the years is the condition of the outlet works. Although the original concrete-lined tunnel section has continued to function without apparent issues, other components have not performed as well. The outlet gate tower constructed in about 1927 and raised in 1945 was noted to be cracked and displaced along the cold joint where the enlargement was constructed in 1945, resulting in a visible downstream lean of the tower; this was corrected by casting a reinforced concrete "collar" around the square-shaped tower at the location of the crack in 1973. The cracking was felt to be due to reservoir ice loading on the tower during winter storage in the reservoir. Further measures to protect the tower were taken during the 1990's by the placement of steel struts against the tower and anchored to concrete blocks placed in the dam upstream slope / left abutment area to provide resistance to ice loading forces. Still, concerns for the integrity of the tower have led to a reluctance on the part of the owner to fill the reservoir into the upper part of the storage pool in the fall and winter months to prevent ice loading problems. This has resulted in the inability to fill above about the 700 to 750 AF storage level in the early portions of the filling season, even though water may be both physically and legally available.

The existing outlet gate and operating system, contained within the tower, have also essentially reached the end of their service life and need to be considered for replacement.

Since any proposed solution to the spillway inadequacy problem involved raising the dam crest and downstream slope to provide additional freeboard by using materials from the required spillway excavation, the structural adequacy of the existing outlet system to support the additional fill height was also brought into question. Any enlargement of reservoir storage capacity would also require altering the existing tower arrangement to accommodate the increased water depth. Therefore, all dam modification scenarios considered by the 2013 Alternatives Analysis included rehabilitation of the outlet works as a component of the overall design for remedial work.

Considering the condition of the outlet and its gate system, demolition and removal of the gate tower and the aging conduit section upstream of the tower are proposed. These would be replaced by a new upstream intake structure, trashrack, and hydraulically-operated gate, and a new reinforced concrete conduit section from the new intake structure to the existing concrete-lined tunnel section. To resist additional structural loading on the downstream conduit section, the existing tunnel sections would be lined with 21-inch steel pipe, with the annular space grouted. The steel conduit would be extended downstream an additional 115 ft and encased in concrete to reach the downstream toe of the raised embankment.

The RMR&DC facilities, and the lands served by those facilities, are located in southern La Plata County in southwestern Colorado, approximately 15 to 25 miles southwest of Durango. Red Mesa Reservoir is located near the lower end of Hay Gulch, a tributary of the La Plata River. The lands served by the reservoir are principally located several miles to the south and southwest of the reservoir, as shown on Figure 2-1, generally surrounding the small, unincorporated town of Red Mesa located about 8 miles north of the Colorado - New Mexico state line.

Land irrigated by the reservoir consists largely of flat-to-rolling mesa toplands ranging in elevation from 6,300 ft to 6,700 ft above sea level. Native vegetation on rangelands and woodlands in the area consists of pinion-juniper and sagebrush, with understory grasses of western wheatgrass, Indian ricegrass, galleta, blue gramma, squirreltail, and needle-and-thread.

The climate is typical high desert southwest Colorado, semi-arid, with an average annual precipitation of 18.0 inches. Most of the available moisture comes in the form of winter and spring snowmelt and late summer rains of the southwest monsoon. The annual mean temperature is 46 degrees Fahrenheit. The length of the growing season averages 133 days.

Southwestern La Plata County is very rural in nature, with no large centers of population closer than Durango, Colorado or Farmington, New Mexico. The economy in the Red Mesa Reservoir service area is therefore largely agricultural, with farming the predominant activity and land use. Although most persons who live in the area are in some manner associated with agriculture and derive at least a portion of their income from it, many also have jobs outside of agriculture in the surrounding area and often obtain the majority of their income from those sources.

In this semi-arid climate, irrigation water is a considerable enhancement to crop production, whether derived from storage projects or from direct flows diverted from surface water sources such as the La Plata River. Red Mesa Reservoir is the only significant irrigation water storage feature in the area, and thus serves a very important role in sustaining the agricultural viability of the area. The proposed enlargement of Red Mesa Reservoir could provide additional irrigation water to its service area, enhancing the local economy. Enlargement could also potentially provide a source of domestic water, or well augmentation water, to an area that has been historically water critical for many years due to the constraints on water usage imposed by the La Plata River Compact with New Mexico.

As shown on Figure 2-1, storage water released from Red Mesa Reservoir re-enters the lower end of Hay Gulch, which then flows into the La Plata River approximately 1 mile downstream of the dam. Just below the confluence of Hay Gulch and the La Plata River, the first of the three major ditches which distribute releases from Red Mesa Reservoir toward project lands, the Joseph Freed Ditch, diverts flows from the La PlataRiver. Approximately another mile down the river, first the Revival Ditch and then the Warren-Vosburgh Ditch divert the remainder of stored waters released from Red Mesa Reservoir from the La Plata River. Not shown on Figure 2-1 but also drawing on the stored waters in Red Mesa Reservoir, is the Old Indian Ditch, which diverts from the Lower end of Hay Gulch below Red Mesa Reservoir and serves a relatively minor acreage of land along the west side of the La Plata River above its confluence with Hay Gulch.

Currently, the total land area being irrigated by water released from Red Mesa Reservoir is equal to about 1,140 acres. This is somewhat less than the total land area irrigated by the three ditches shown on Figure 2-1, as not all water users on the ditches own reservoir shares. The Freed Ditch serves the greatest number of acres irrigated from the system, followed by the Warren-Vosburgh and then the Revival. All three ditches have direct flow rights to divert water from the La Plata

River when it is available, in addition to their shares of reservoir water, and, in fact, all three ditches obtain the majority of their irrigation waters from direct flow rights. Releases from storage in Red Mesa Reservoir serve primarily to prolong the effective irrigation season, providing summertime water when direct flows from the river are diminished or unavailable.

According to studies performed in the past by the USBR to support the ALP, at the time when irrigation water for the La Plata basin was still within the scope of that project, approximately 2,900 acres of arable land have the potential for using irrigation water distributed by the three ditches. However, since the La Plata basin irrigation component was eliminated from ALP, the acreage irrigated is considerably less than that due to the unavailability of sufficient water supplies. Depending on water availability, up to 1,600 acres may be irrigated in the early season by direct flows diverted from the river by the ditches. Supplemental water distributed from reservoir storage is only sufficient, however, to support about 1,140 acres in any given year, and this water supports a sustained harvest from the lands to which it is applied.

The primary crop in production from lands irrigated by reservoir water is hay, both alfalfa and alfalfa/grass mix, for use for livestock feed. Approximately 80% of the land irrigated by reservoir water is used to produce alfalfa and alfalfa/grass hay. The hay is of high quality, recently worth about $200 per ton, with a current production ranging from 1 - 2.5 tons per acre per cutting, depending upon which cutting. First cutting annually is the most productive, averaging about 2.5 tons per acre. A full second cutting would average about 1.5 tons per acre, and a full third cutting, if it was available, would average about 1 ton per acre. Maximum annual production available from a full water supply would therefore be expected to yield approximately 5 tons per acre. Since only 1.5 cuttings per year are available on average for the current water supply, approximately 3 tons per acre is currently produced annually, with a value of about $600/acre. Most of the remaining 20% of the acreage not planted in alfalfa is planted in small grains, both wheat and oats. Rate of production for small grains is about 80 bushels per acre, bringing a unit price of $3 to $4 per bushel. At an average price of $3.50 per bushel, this returns about $280 per acre. Minor amounts of corn are also sometimes planted, and can bring 60 bushels per acre at a value of about $3/ bushel, for a return of $180 per acre.

Of the 1,140 acres irrigated by reservoir water, approximately 750 acres are under sprinklers at the current time, with the remainder using ditch irrigation. The number of acres under sprinklers has been increasing gradually, up from about 640 acres in 1995, as the need for improved water application efficiency has increased. Using ditch irrigation, only about 40% of the water released from the reservoir is available for consumptive use by crops, due to losses in the ditch conveyance system. Where conversion to sprinklers has occurred, the use of buried pipelines and side-roll sprinklers to replace open ditch systems has decreased conveyance and application losses, increasing overall efficiency to about 70%, effectively increasing the irrigation water supply.

Numerous studies have been completed over the years since the last enlargement of the reservoir in 1945, generally aimed in some manner at further enlargement to capture and store all or most of the conditional storage rights adjudicated for Red Mesa Reservoir. A summary of the major conclusions of each of those studies is described in the following subsections.

6.1 SCS STUDIES OF THE 1960'S AND 1970'S

The USDA SCS, between 1967 and 1975, conducted geology and geotechnical evaluations for a proposed enlargement of the dam and presented their findings in a series of reports and technical memoranda; available copies of these evaluations are included in Appendix C. The enlargement envisioned at that time consisted of raising the dam crest by about 24 ft, with the emergency spillway crest elevation also raised by about 21 ft, to reach a total storage capacity of about 3,300 AF. Eight borings were advanced with a rotary drill rig to investigate the abutments of the dam and possible emergency spillway areas. Additionally, forty-one test pits were excavated with a backhoe in the dam foundation area, in potential borrow areas, along the proposed outlet conduit downstream extension, in potential spillway locations, and in the existing dam. Soil samples were taken at selected locations for laboratory testing.

The geology report provides the following description of the foundation and abutments:

Bedrock underlying the dam abutments and foundation areas consists of silty clay shale, clayey and sandy siltstone, and fine grained sandstone of the Cliff House Formation of the Mesa Verde Group. The general dip of the rock layers is at a gentle slope to the southeast. Slight seepage from the reservoir probably occurs at several places in the bedrock materials, but the only location at which significant amounts of seepage was [sic] observed in the bedrock was in the right (west) abutment about 100 to 150 ft downstream from the present dam centerline in the vicinity of test hole 602 and 603. When these test holes were dug with a backhoe, water emerged from a two to three foot layer of fractured siltstone at about elevation 6,853 to 6,855. The flow from test hole 602 was estimated to be between five to ten gallons per minute and for test hole 603 about 15 gpm.

In the left abutment of the dam, bedrock is overlain by alluvial deposits consisting of layers of silty and clayey sand and layers of silty and clayey gravels having a maximum thickness of about 70 ft. These deposits were laid down along an ancient stream valley, which was probably ancestral to the present Hay Gulch.

In the right (west) abutment, bedrock consisting of alternating layers of shale, siltstone, and sandstone lies at or near the surface. No serious problems of stability or seepage losses are expected in this area. A foundation drain should be installed along the layer of fractured siltstone in the vicinity of test hole 602 and 603.

In the left (east) abutment, relatively impermeable layers of shale, siltstone, and sandstone occur in the immediate vicinity of the east end of the dam, and no significant seepage areas were observed near the dam. Beyond the east end of the dam for a distance of about 1,000 ft, bedrock is overlain by alluvial materials reaching a maximum thickness of about 68 ft.

The lower part of these alluvial deposits consists mainly of silty and clayey fine sands and sandy silts with some layers of well-graded silty sand and gravel. The materials are mainly below the present emergency spillway elevation and are for the most part probably only slightly permeable, since no large seepage losses have been reported from the reservoir. The layers of gravel and coarser sand are likely to be at least moderately permeable, as evidenced by a seepage area which appears along a tributary of Hay Gulch about 1,000 ft downstream from the present emergency spillway.

The upper part of the alluvial deposits in the left abutment consists mainly of silty and clayey well-graded gravel and sand averaging about 20 ft in thickness. These materials appear to have a moderate to high permeability and should be cut off with a core trench in this part of the dam.

Significant conclusions from the SCS investigations included: (1) the bedrock materials in the dam foundation are generally satisfactory from the standpoint of stability and seepage losses from the reservoir; (2) the sandy and silty alluvial materials lying deeper in the left abutment appear dense and relatively impermeable; (3) the gravelly and sandy deposits in the upper 10 to 28 ft of the left abutment should be moderately to highly permeable and should be cut off with a core trench or by blanketing with impervious material; (4) the most desirable emergency spillway location is in the right abutment where erosion-resistant sandstone underlies the downstream section of the spillway; (5) slope stability analysis for the enlarged dam section dictated a 3.5:1 upstream slope inclination for the raised section, and a 2.5:1 downstream slope inclination; and (6) drainage features would be needed on the downstream side and along both abutments where seepage has been observed in the past.

Despite the depth and duration of the SCS investigations, no enlargement project was undertaken at that time.

6.2 HARRIS WATER ENGINEERING STUDIES OF 1995 AND 2001

Potential enlargement of Red Mesa Reservoir was included in a Small Dam Site Reconnaissance Study prepared for the CWCB in February, 1994. The study concluded that enlargement of the reservoir might be feasible, and suggested that further evaluations of the site be made. The result of that recommendation was the initiation, using CWCB funding, of a feasibility study prepared by Harris Water Engineering of Durango, completed in 1995.

The 1995 Harris study proposed the enlargement of the reservoir to a capacity of 4,070 AF, thereby fully utilizing the absolute and conditional storage decrees for Red Mesa Reservoir. To accomplish the enlargement, both the dam and the spillway crest elevations were to be raised by 29 ft, thereby adding approximately 2,900 AF of storage. The raising of the dam was to be accomplished by the addition of new fill to the downstream side of the existing dam centerline (downstream enlargement method). The enlarged dam was to have a crest length of about 1,450 ft, a crest width of 25 ft, upstream slope of 3.2:1 inclination, and downstream slope of 2.5:1.

The enlargement work would have necessitated modification of the outlet works, which was identified as problematic due to the arrangement, age and condition of the existing infrastructure. The plan for modification included demolition of the existing gate tower, to be replaced by a new concrete intake and gate structure, with hydraulically operated gates, located further upstream within the reservoir. New sections of conduit would be used to connect the upstream end of the existing outlet tunnel with the new gate structure and to extend the outlet downstream beneath the new embankment section.

Enlargement of the reservoir would also have required a new spillway, which was to have been located on the left abutment, beyond the existing spillway. At that time, due to regulatory uncertainty as to the appropriate precipitation standard to use, the SEO was not enforcing spillway requirements for Class 1 (High Hazard) and Class 2 (Significant Hazard) dams that were either located above an elevation of 7,500 ft, or had a significant portion of their watershed above that elevation, as is the case for Red Mesa Dam. Still, Harris estimated that the spillway would need to be about 60 ft wide and 7 ft deep to pass the calculated Inflow Design Flood (IDF) of 8,000 cfs. It should be noted, however, that the SEO never reviewed or approved the IDF or the spillway sizing in this feasibility study.

The plan for utilization of the proposed increased storage in the reservoir included mostly additional irrigation water for crops, but also proposed a 330 AF component set aside for domestic water uses in the basin, which could be utilized for augmentation of domestic water wells, exchange water for upstream diversions to domestic water systems, or direct diversion from the reservoir to a central domestic water system.

Harris developed a water use and daily operational study of the La Plata River for the years from 1975 to 1992 to determine water availability and to analyze potential diversions to the enlarged reservoir. The study concluded that, for the 18 years of record analyzed, adequate water would have been available to completely fill the enlarged reservoir for 12 of those years, while in 4 of the remaining years the reservoir would be able to fill to over 3,100 AF. Only in 2 years would insufficient water have been available to fill into the enlarged pool. The enlarged reservoir was estimated to increase the irrigation supply an average of about 38% in all but the driest years, while simultaneously providing 330 AF of domestic water supply which did not previously exist. The total annual increase in supply from the enlarged reservoir for all uses was estimated at 1862 AF, or approximately 64% of the increased storage capacity of the reservoir.

A key assumption of the Harris water use study was that winter flows in the La Plata River would be available without limits and could be diverted to the reservoir via the RMR&DC's Supply Ditch or through the upstream Hay Gulch Ditch into Hay Gulch and to the reservoir. This assumption, however, required an alteration of the historic diversion of flows by other basin water users through an altered and untested interpretation of diversion rights from the La Plata.

Harris concluded in the 1995 study that, if the reservoir could be filled using unlimited wintertime diversions, the project was feasible. Total estimated cost for the enlargement in 1995 was $3,000,000, which calculates to $1,600 per AF for the average annual supply of 1872 AF. Based on the feasibility study, the RMR&DC requested a 75% loan from the CWCB for 30 years at an interest rate of 4.1%, requiring an annual debt service of about $132,000. The RMR&DC proposed to pay the remaining 25% ($750,000) of the cost, and to generate annual revenues for repayment of the loan, from the sale of shares, both irrigation and domestic.

The CWCB authorized the loan and terms requested based on the 1995 Harris study. However, when implementation of the wintertime fill plan discussed above was attempted in 1996, it was met with considerable opposition, and subsequent legal action, from other basin water users who did not share in the interpretation of their diversion rights. This issue was never fully resolved, and eventually led to the decision by the RMR&DC to request that the approved loan be de-authorized and the cost of the 1995 Feasibility Study be forgiven, in accordance with provisions of the loan and accepted procedures at the time. This information is contained in the document Red Mesa Reservoir Enlargement - Concluding Report, prepared by Harris Water Engineering in 2001, which serves as the final document for the enlargement proposal of that time.

6.3 WRIGHT WATER ENGINEERS STUDY OF 2003

The enlargement proposal was reintroduced two years later in a feasibility study prepared by Wright Water Engineers for the LPWCD, funded again by the CWCB. This study was completed in April of 2003, again with the intention of expanding reservoir storage by the amount of the RMR&DC's conditional water right, to a total of 4,070 AF. This study utilized revised estimates of water availability and filling methodology, as well as a much more robust hydrologic analysis for the purposes of sizing a new spillway which would satisfy the SEO Rules for dam safety.

The LPWCD was involved as the sponsor for this iteration of the reservoir enlargement study because of its position in an ongoing proposal to construct a water storage facility on the La Plata River system which could be used to provide exchange water to satisfy the La Plata River Compact with New Mexico during times of irrigation water demand on the upper La Plata River in Colorado. At the time when the non-native irrigation water supply component of the federal ALP was stripped from that project in order to gain congressional approval and funding, the La Plata River basin, which had been an ardent supporter of the original ALP, was left, quite literally, high and dry of the irrigation water which they believed would be diverted from the nearby Animas River to agricultural lands along the La Plata River. To provide some compensation for their loss, federal funds in the amount of approximately $15 million were set aside from the ALP and placed in an interest bearing escrow account with the Colorado Water and Power Development Authority to be used to develop alternative water sources in the La Plata basin. The LPWCD was placed in the position of coordinating and developing a project utilizing these funds.

As the owner of the only significant existing water storage facility in the La Plata basin, the RMR&DC, who had been seeking to enlarge their reservoir, saw the potential opportunity to work with the LPWCD to utilize a portion of the set-aside funds to enlarge the reservoir to its decreed storage capacity, if an arrangement could be worked out with LPWCD to utilize a portion of the reservoir storage for compact administration. This would allow RMR&DC to construct the required modifications and improvements to the dam to meet dam safety requirements. LPWCD felt that there was sufficient potential in the proposal to warrant their involvement as sponsor for the Wright Water enlargement feasibility study. Although the proposed Long Hollow Reservoir near the Colorado / New Mexico border was already under consideration at that time, it was felt that perhaps the two projects could be integrated in some form using the set-aside funds.

The Wright Water study actually included the evaluation of two enlargement alternatives, along with the required dam safety improvements. The smaller enlargement, to a total capacity of 3,000 AF, would have required raising the normal water surface elevation by about 19.5 ft, whereas the larger enlargement, to 4,070 AF, would have utilized the full decreed storage capacity for the reservoir and would require raising the normal water surface by about 27 ft. Ultimately, the larger enlargement was favored due to the relatively minor difference in overall cost between the two and the better unit price per AF of storage offered by the larger reservoir capacity.

The enlargement of the reservoir to a capacity of 4,070 AF, along with the need to route a much larger IDF through the new spillway, required raising the dam crest elevation by about 34 ft, via the downstream embankment enlargement method. The upstream slope was to be constructed at a 3.5:1 inclination, with the downstream slope at 2.5:1. Overall crest length was to be about 1,250 ft, with a crest width of 25 ft.

As mentioned above, a new hydrologic analysis utilizing SEO-approved precipitation estimates and methodology was developed for this feasibility study and was incorporated in the design of a new spillway for the enlarged dam. The hydrologic analysis, which was accepted by the SEO, produced an IDF having a peak reservoir inflow of 53,000 cfs. Successfully routing the IDF through the reservoir required a spillway with a crest length of 700 ft, providing 12 ft of freeboard between the raised normal water line and the dam crest. This spillway was to be constructed on the left (east) abutment, at the left end of the enlarged dam.

As with the Harris study, the enlarged dam envisioned by Wright also required a major modification of the existing outlet works. The Wright design proposed demolition of the existing gate tower and construction of a new reinforced concrete gate tower in about the same location, which would be accessed via a bridge from the dam crest. The tower would house a new 36-inch diameter ball valve for discharge control, and a new conduit segment would be extended upstream to an intake structure in the reservoir. Downstream of the tower, the plan called for a 36-inch diameter ductile iron pipe to be installed within the existing tunnel alignment through the left abutment, requiring partial demolition of the existing 24-inch-wide tunnel, and placement of a new 36-inch conduit downstream of the existing dam toe to a new outlet structure at the toe of the new dam. The 36-inch diameter conduit was considered essential to meet drawdown criteria for the enlarged reservoir.

The Wright Water study also estimated the availability of water for filling the enlarged reservoir and compared it to previous water studies, including the 1995 Harris study. Wright reviewed the output from the baseline STATEMOD model for the La Plata River basin, and developed a Modsim model utilizing 10 years of record, from 1989 to 1998 to estimate water availability and usage. Although the period evaluated was generally drier than average on the basin, Wright estimated that the enlarged reservoir would fill to its full capacity in 4 out of the 10 years of record evaluated. It was felt that this could potentially be improved to 7 out of 10 years if winter water use on the basin could be reduced.

Wright estimated that the cost of the reservoir enlargement to 4,070 AF would be $7.1 million, with the cost of the smaller enlargement to 3,000 AF at about $6.1 million. This works out to $3,211 per AF capacity increase for the smaller enlargement and $2,450 per AF capacity increase for the larger enlargement. Note that these figures are not per AF of actual water available to store.

The Wright Water study did not include a financial feasibility analysis for a CWCB loan, because it was envisioned that the escrow funds held for the LPWCD by the Colorado Water Resources and Power Development Authority would be the source of funds. Ultimately, however, the LPWCD concluded that a new dam situated across Long Hollow, a tributary of the La Plata River near the New Mexico state line, would provide more storage capacity and better utility for administration of the La Plata River Compact, thereby providing more water availability to the upper basin. The new Long Hollow Dam and Reservoir, constructed between 2012 and 2014, used all of the set-aside funds, leaving nothing for a potential reservoir enlargement or improvements at Red Mesa reservoir.

6.4 URS INCREMENTAL DAMAGE ASSESSMENT AND INFLOW HYDROLOGY ANALYSIS OF 2011

Once it became clear that LPWCD funds would not be available for improvements to Red Mesa Dam and Reservoir, the RMR&DC began to pursue other avenues to correct the noted deficiencies with the dam. This was largely precipitated by the SEO finalizing their revised SEO Rules, which defined new precipitation development methods for high-altitude areas of the state and brought those areas which were previously held aside for compliance with the hydrologic requirements into the fold. Thus, major spillway improvements were now required at Red Mesa Reservoir.

To initiate the process of analyzing the noted spillway inadequacy and designing remedial measures, URS Corporation was retained in 2010 to perform an incremental damage assessment and to develop an IDF for spillway design purposes. This work was primarily financed through the CWCB by WSRA Southwest Basin grant funds, with matching funds provided by the RMR&DC. The Incremental Damage Assessment (IDA) was intended to determine if a smaller IDF than that required by standard hydrologic analysis methods, as allowed by the SEO Rules, would be appropriate for use at Red Mesa Reservoir.

The IDA did not result in a reduction of the required IDF at Red Mesa Reservoir. However, using the revised precipitation estimates then allowed by the SEO, and revised modeling assumptions regarding basin runoff parameters, an IDF having a peak inflow of 26,133 cfs was developed. This hydrologic analysis was subsequently reviewed and approved for use by the SEO, and serves as the basis for the design of the dam improvements described by this feasibility study.

6.5 URS SPILLWAY ALTERNATIVES ANALYSIS OF 2013

Following the completion of the hydrology study performed by URS in 2011, RMR&DC entered into an agreement with URS to evaluate, both technically and financially, several potential alternatives for dam modification to remediate the spillway deficiencies identified by the SEO. This work was performed using funds provided by the WSRA grant process, again from a Southwest Basins grant, approved for funding by the CWCB in 2012 and completed in 2013. A copy of the report describing the analysis is included in Appendix D.

The analysis considered a number of different scenarios, ranging from the "no-action" scenario, where failure to construct an acceptable spillway leads to a dam breach order from the SEO and the actions and costs which accompany that required breach, to modification of the dam by hardening of the dam crest and downstream slope to allow it to survive a flood overtopping event, to construction of a new compliant spillway at the current high waterline, to construction of a new compliant spillway along with a reservoir enlargement. Two different reservoir enlargement scenarios were evaluated, at the request of the RMR&DC: (1) a smaller reservoir enlargement of about 250 AF accomplished by raising the spillway crest and the normal water line elevation by about 4 ft; and (2) a larger reservoir enlargement of about 550 AF accomplished by raising the spillway crest and normal water line elevation by about 8 ft.

All of the alternatives were found to contain significant cost elements which would make the affordability of the project difficult for the RMR&DC. For the dam hardening alternative, the significant cost of placing roller compacted concrete (RCC) over the entire crest and downstream slope of the existing dam drove this alternative to the highest estimated cost among those analyzed, at nearly $6 million, more than 60% higher than the next most expensive alternative considered, without providing any additional reservoir storage. This option was therefore eliminated from further consideration.

The dam breach option, not surprisingly, was found to have the lowest construction cost, but, at an estimated cost of nearly $1.2 million, could not be considered as inexpensive, especially considering that it results in the complete loss of the RMR&DC's most significant asset and all of their storage water at Red Mesa Reservoir. The cost of this alternative essentially serves as the baseline cost against which all other alternatives are compared.

Considering the undesirability of the above options, that essentially left the choice among the remaining three alternatives, all of which included construction of a compliant spillway. Considering the topography of the site and the required size of the spillway to pass the IDF, only the left abutment was considered a suitable location for the new spillway. Because the spillway would need to be excavated through the natural materials of the left abutment, a large quantity of earth materials would need to be removed and disposed of just to construct the spillway channel. To mitigate the cost of this excavation, all three remaining alternatives proposed to utilize materials from the required excavation to raise the dam crest and downstream slope to provide additional freeboard for flood routing, thereby also reducing the required width of the new spillway channel.

For all of the three remaining alternatives, an optimization process was utilized to determine the required width of the new spillway channel, vs. the quantity of materials available from the channel excavation which could be used to raise the dam, vs. the height of the dam crest raise thereby created. The results of this process were interesting. It was found that the dam crest elevations obtained varied by only 2 ft, in 1-foot increments, from the no reservoir enlargement scenario to the larger reservoir enlargement scenario, despite the 4-foot and 8-foot increases in normal water line elevation for the two proposed enlargement scenarios. Required spillway crest lengths / channel widths for the three scenarios differed greatly, however, from 125 ft for the no enlargement scenario, to 185 ft for the smaller enlargement scenario, to 275 ft for the larger enlargement scenario. The actual required volume of material to be removed from the spillway excavation was only slightly greater for each of the enlargement scenarios in turn than for the no enlargement scenario. That kept the estimated costs for all three alternatives fairly close to each other.

All three scenarios described in the above paragraph considered that the existing outlet works would require or should include modification. The two enlargement scenarios would necessitate it. This also kept the costs comparable for the three alternatives. Considering the condition of the outlet and its gate system, demolition and removal of the gate tower and the aging conduit section upstream of the tower was prescribed, to be replaced by a new upstream intake structure and trashrack, with a hydraulically-operated gate at that location, and a new reinforced concrete conduit section from the new intake structure to the existing concrete-lined tunnel section. To resist additional structural loading on the downstream conduit section resulting from the added fill placed on the dam, the existing tunnel sections were considered to be lined with 21-inch steel pipe, with the annular space grouted, and the steel conduit extended downstream an additional 115 ft and encased in concrete to reach the downstream toe of the enlarged embankment.

The most notable difference between those three alternatives from a cost standpoint was that the two enlargement scenarios would encounter environmental permitting costs potentially associated with wetlands, threatened and endangered species, stream system depletions, cultural resources, etc, that would not be incurred by the no enlargement scenario. For the purposes of the evaluation, this extra cost was initially estimated at $300,000, but could vary considerably. Considering those factors, the cost of the no-enlargement scenario was estimated at $2.9 million, the cost of the 250 AF reservoir enlargement was estimated at $3.4 million, and the cost of the 550 AF reservoir enlargement was estimated at $3.7 million. However, as described above, this must be compared to the cost of the no-action (dam breach) scenario, described as the baseline cost, which was estimated at $1.2 million. Thus, the incremental cost of the three scenarios became $1.7 million, $2.2 million, and $2.5 million, respectively.

Using the cost numbers obtained by the alternatives analysis, the costs were viewed in several different ways. The cost per unit of reservoir storage capacity (vs. the base cost of dam breaching) was calculated at $1,470/AF for the no reservoir enlargement scenario, $1,590/AF for the smaller reservoir enlargement, and $1,440/AF for the larger reservoir enlargement. The incremental unit cost to go from the no reservoir enlargement scenario to the smaller reservoir enlargement was calculated at $2,172/AF, and from the smaller reservoir enlargement to the larger reservoir enlargement at $737/AF. The overall incremental unit cost to go from the no reservoir enlargement scenario to the larger reservoir enlargement scenario was calculated at $1,389/AF. By any standard, it appeared that the lowest unit cost per unit of reservoir storage capacity would be realized with the larger reservoir enlargement.

7.1 OVERALL WATER AVAILABILITY

All waters appropriated from the La Plata River system in Colorado are subject to the La Plata River Compact with New Mexico. A copy of the compact is included in Appendix E. This compact, which was agreed to by the involved states in 1923 and approved by the United States Congress in 1925, determines the distribution of flows on the river between the states and effectively limits what can be appropriated by water users at most times of the year. The conditions of the compact state that: (1) between December 1 of each year and February 15 of the succeeding year, both states have unrestricted use of the river and its flows within the state's boundaries; (2) on days when the mean daily flow measured at a gaging station located on the river at the state line is greater than 100 cfs, both states shall have unrestricted use of the river and its flows within the state's boundaries; and (3) between February 15 and December 1 of each year, Colorado shall deliver to the state line station a quantity of water equivalent to one-half of the mean flow from the previous day, as measured at a gaging station established on the river near the town of Hesperus, not to exceed 100 cfs.

Except during periods of highest natural flow, the compact is typically administered by shorting decreed diversions on the river system in Colorado in order to deliver the compact-required flows to New Mexico. Meeting the delivery requirements of the compact is made more difficult and less efficient by the fact that the reach of the river near the town of Breen, upstream of RMR&DC's diversion structure, is a losing reach, typically losing 20 to 40 cfs or more to evapotranspiration , due to excessive phreatophyte growth along that reach of the river. During the summer months, adequate river flows are typically unavailable to overcome the losses, resulting in a futile compact call and a split river condition.

The newly-constructed Long Hollow Dam and Reservoir located on a tributary of the La Plata River a few miles upstream of the state line gage is intended to relieve some of the compact administration issues on the river which have existed for years, using exchanges to make water for irrigation more readily available upstream during the time of the year when compact deliveries to New Mexico are required.

7.2 RMR&DC WATER RIGHTS

The RMR&DC holds the following water rights associated with Red Mesa Reservoir:

- An absolute storage right for 1,176 AF of water in Red Mesa Reservoir.
- A conditional storage right for an additional 2,898 AF of water in an enlarged Red Mesa Reservoir.
- A right to divert up to 120 cfs from the La Plata River into the Supply Ditch, for storage in Red Mesa Reservoir.
- A refill right for Red Mesa Reservoir, in the total amount of 4,074 AF, of which 656 AF is absolute and 3,418 AF is conditional.

As described in the original court decree, included in Appendix F, the diversion right and storage rights were assigned a historic appropriation date prior to April 30, 1905, and a decreed date of August 16, 1912, for irrigation, domestic, municipal, industrial, recreation, fish and wildlife, flood control and other beneficial purposes. For purposes of administration of the La Plata River system, the first fill storage rights, both absolute and conditional, were awarded Reservoir Priority No. 1965-1, and the diversion right of the Supply Ditch was awarded Priority No. 1965-2. Included within the sources of water identified to fill Red Mesa Reservoir were flows in Hay Gulch.

The refill right was established in 2003 and amended in 2004, at the time when enlargement of Red Mesa Reservoir under the sponsorship of the La Plata Water Conservancy District, for compact administration purposes, was under consideration. The refill right was amended again in 2011 to establish the absolute and conditional portions of the storage right as listed above.

All of the conditional water rights owned by the RMR&DC are current with the water court, having met the test of due diligence, through August of 2018 for the first fill conditional right and through April of 2017 for the refill conditional right.

The proposed enlargement of the reservoir capacity by 550 AF, to a total of 1,726 AF, would result in only a partial utilization of the RMR&DC's existing conditional storage right of 2,898 AF. As discussed above, the decision to pursue enlargement was largely a result of the need to help offset some of the cost of the required spillway construction and needed outlet works improvements, which is substantial regardless of whether reservoir enlargement is included as part of the improvements. While the need for dam safety improvements is driving the project forward, RMR&DC feels that opportunity to utilize at least a portion of their long-held conditional storage rights is better than no increased storage capacity at significant cost.

7.3 PROPOSED WATER USAGE

The proposed use of the water to be held in an enlarged reservoir is still somewhat uncertain, as the RMR&DC would, if possible, market that water to other users in the basin to help offset the cost of construction. To that end, the waters stored in the reservoir are not limited by the decrees to just irrigation usage, but are also available for other uses, including municipal, industrial, domestic, augmentation, wildlife enhancement, compact administration, etc. To date, however, alternative uses of the water which would provide needed income to the Company, or partners to share in costs of construction, have not been identified.

For the purposes of evaluating the demands for and uses of an enlarged reservoir, the additional storage was assumed to be used entirely for irrigation on existing project lands, since the demand clearly exists for that purpose. All of the increased storage could easily be used to improve yields on lands currently served by the reservoir by sustaining irrigation supplies later into the growing season. Where existing water supplies are generally sufficient to allow up to 1.5 full cuttings of alfalfa hay in a good year, RMR&DC believes that an additional 550 AF of stored water in Red Mesa Reservoir could bring up to 2 full cuttings in a good year.

7.4 WATER AVAILABILITY ANALYSIS

To evaluate the availability of water for storage in the enlarged reservoir, URS contracted with Hertzman Consulting of Durango, to perform modeling of the reservoir operation and water distribution to project lands, using the recently developed La Plata River Basin Operational Model. The La Plata model was developed by Hertzman, in cooperation with Bikis Water Consultants, for the LPWCD, using funding from the CWCB and the Colorado Water Resources & Power Development Authority, to serve as a predictive and operational tool for the La Plata River basin with the new Long Hollow Reservoir in operation. As described by Hertzman

(2014), the model was developed from the Colorado Decision Support System (CDSS) San Juan River Basin operational model, honing in on the features specific to the La Plata River basin by including enhancements particular to the La Plata basin in a much more rigorous manner than had previously been attempted in the San Juan River Basin model. The model uses actual streamflow data for a period of record, and applies all of the rules of river operation, diversion and usage imposed by the priority system and by the La Plata River Compact, to simulate the operation of the river basin over that period of record, including the type and timing of storage and usage of the water diverted from the river. The model is fully calibrated to actual diversion, storage and usage records. It is considered to be the state of the art tool for modeling the operation of the La Plata River Basin.

The Red Mesa Reservoir Enlargement Operational Modeling Study developed by Hertzman for this Feasibility Study, included as Appendix G, utilized a 35-year period of record (October 1974 through September 2009) and evaluated water availability and usage for three different scenarios, to reflect the three possibilities considered for construction: (1) no enlargement of the reservoir (i.e., current configuration), as a baseline condition; (2) 250 AF enlargement of the reservoir; and (3) 550 AF enlargement of the reservoir. Of primary interest from the study were the predictions of water availability, both legally and physically, to fill the enlarged reservoir; the pattern of water releases and usage from the enlarged reservoir; the evaluation of inlet ditch adequacy to divert available river flows; and the prediction of evaporative losses from each of the potential enlargement scenarios.

The results of the modeling study are enlightening. For either the 250 AF or the 550 AF reservoir enlargement, the model predicts that sufficient water is available to completely fill the reservoir in 13 of the 35 years modeled, with at least some of the added capacity, but less than 250 AF, filled in an additional 5 years. This is shown in Figure 7-1 below, reproduced from the Hertzman modeling study. Hertzman states, however, that because the model tends to overestimate somewhat the demand of the downstream ditches which are supplied by the reservoir, annual reservoir carryover storage would likely be greater than predicted, and the actual storage volumes reached by the reservoir in those years following, when the reservoir only partially fills, will likely be on the order of 100 to 200 AF higher than calculated and shown on Figure 7-1. Also notable from Figure 7-1 is that the existing reservoir does not perform much better than either enlargement, failing to fill in 14 of the 35 years included in the analysis. In other words, dry years are not that uncommon, and, when they occur, generally result in insufficient water to fill the reservoir, whether enlarged or not.

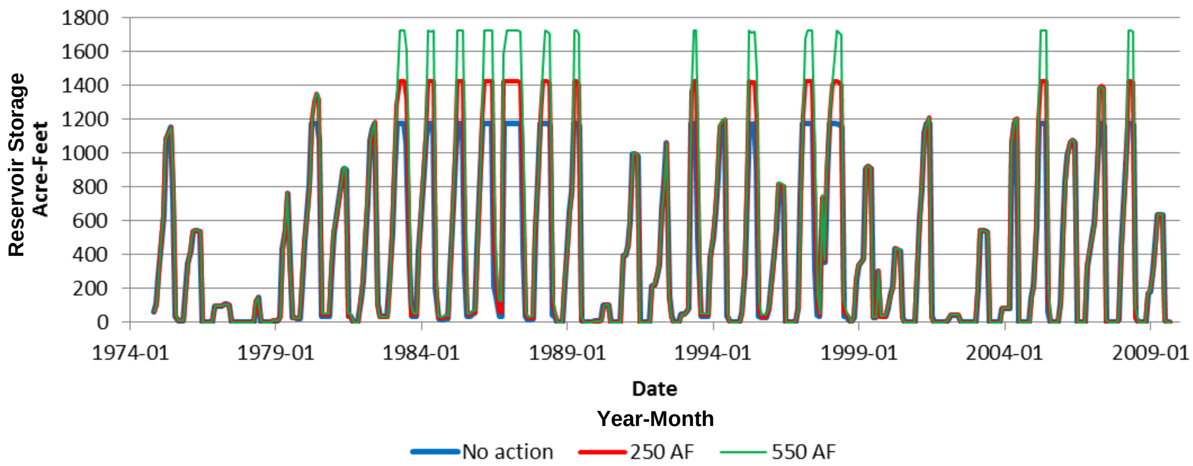


Figure 7-1: Predicted End-of-Month Storage in Red Mesa Reservoir

It should be noted that, for the purposes of filling the reservoir, the model operates on an optimized basis; in other words, if flows on either Hay Gulch or the La Plata River were both physically and legally available for diversion/storage at any time, and room was available to store them in the reservoir, the model assumes that they actually would be diverted/stored. Also, the existence of the new Long Hollow Reservoir and the benefits which it is intended to provide to enhance water availability through releases to satisfy compact calls is included in the operational model.

Predicted annual diversion into storage in Red Mesa Reservoir is shown in Appendix B2 of the modeling study and is reproduced in this report as Table 7-1. This assumes that the reservoir is fully drained, or nearly so, every year, and so closely reflects actual annual water availability on the system. For the 35 years of record evaluated, the average annual diversion into storage is 989 AF for the existing reservoir (1,176 AF capacity), 1,099 AF for the smaller 250 AF reservoir enlargement (1,426 AF total capacity), and 1,210 AF for the larger 550 AF reservoir enlargement (1,726 AF total capacity). The declining availability of water to fill the enlargements is illustrated by the two right columns of Table 7-1, which show that, for each enlargement scenario, less than half of the water needed to fill the enlarged pool is available on average. For the 250 AF reservoir enlargement, the average amount of water available is approximately 110 AF (44% of the enlargement volume), and for the 550 AF reservoir enlargement, the average amount of water available is 221 AF (40% of the enlargement volume). Again, however, the model tends to over-predict crop demand and usage somewhat, so annual reservoir drawdown is likely over-estimated as well, making the prediction of sufficient water available to reach full reservoir conditions conservative.

Table 7-1: Predicted Annual Diversion into Storage in Red Mesa Reservoir

Admin Year	Predicted Diversion into Storage (AF) No Action	250 AF Reservoir Enlargement	500 AF Reservoir Enlargement	Increase from no-action case (AF) 250 AF Reservoir Enlargement	550 AF Reservoir Enlargement
1975	1,275	1,320.8	1,320.8	45.8	45.8
1976	533.3	533	533	-0.3	-0.3
1977	105.4	105.4	105.4	0	0
1978	176.9	176.9	176.9	0	0
1979	906.4	906.4	906.4	0	0
1980	1,397.8	1,649.8	1,679.7	252	281.9
1981	875.2	875.2	875	0	-0.2
1982	1,232.7	1,240.2	1,240.4	7.5	7.7
1983	1,305.8	1,563.1	1,871.7	257.3	565.9
1984	1,154.3	1,398.5	1,696.1	244.2	541.8
1985	1,352.6	1,598.3	1,896.2	245.7	543.6
1986	1,155.9	1,400.2	1,695.4	244.3	539.5
1987	1,252.9	1,486	1,726	233.1	473.1
1988	1,156.9	1,396.8	1,689.9	239.9	533
1989	1,175.5	1,426.6	1,729.5	251.1	554
1990	111.7	112	112.1	0.3	0.4
1991	998.4	1,000	1,001.8	1.6	3.4
1992	1,150.1	1,150.2	1,150.4	0.1	0.3
1993	1,223	1,477.6	1,783.2	254.6	560.2
1994	1,157.8	1,170	1,170	12.2	12.2
1995	1,359	1,612.3	1,918.1	253.3	559.1
1996	782.2	782.3	782.4	0.1	0.2
1997	1,907.2	2162	2,469.9	254.8	562.7
1998	815.8	1,051.6	1,338.8	235.8	523
1999	1,194.9	1,197.2	1,198.7	2.3	3.8
2000	403.5	403.7	404	0.2	0.5
2001	1,192.7	1,230.1	1,230.1	37.4	37.4
2002	40.8	40.8	40.9	0	0.1
2003	589.7	589.7	589.8	0	0.1
2004	1,186.7	1,225	1,225	38.3	38.3
2005	1,195.2	1,449.3	1,756	254.1	560.8
2006	1,073.5	1,074.3	1,075.5	0.8	2
2007	1,334.6	1,558	1,558.8	223.4	224.2
2008	1,195.1	1,448.1	1,753.7	253	558.6
2009	639.5	640.5	641.5	1	2
Average	**988.8**	**1,098.6**	**1,209.8**	**109.8**	**221.0**

An additional aspect of the water supply situation which was considered by the operational model for Red Mesa Reservoir is the need for the Supply Ditch to capture and deliver to the reservoir the decreed maximum rate of diversion from the river of 120 cfs. Specifically, given the vintage of the Supply Ditch and its era of construction dating back over 100 years, the importance of the actual ditch hydraulic capacity being at or near its claimed capacity was of interest.

The operational model revealed that, even in the best water supply years, the maximum annual rate of inflow during winter/spring filling of the reservoir from La Plata River diversions via the Supply Ditch, for any of the reservoir sizing scenarios, did not exceed about 60 cfs, and was typically substantially less. In only two cases among the 35 years of the simulation, both during large, short-lived autumn rainfall/runoff events on the basin, did the potential need for the Supply Ditch to carry its decreed capacity of 120 cfs appear. This information is shown graphically on Figure 7-2 below, reproduced from Hertzman. Thus, the need for the ditch to maintain long-term diversions at something approaching its capacity is not indicated. The full discussion and calculated diversions are included in Section 3.4 and Appendix D, respectively, of the Hertzman report.

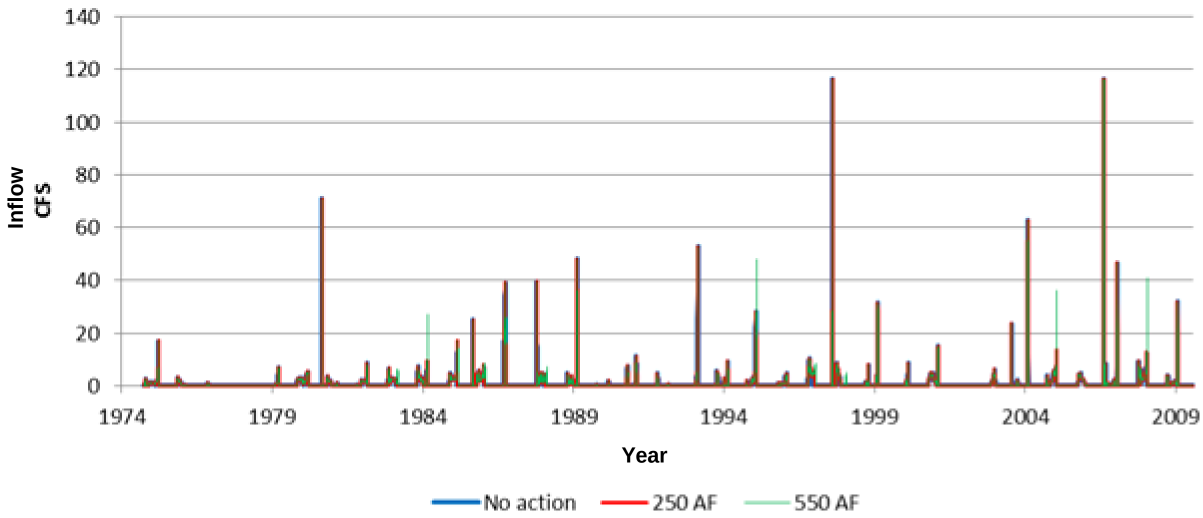


Figure 7-2: Predicted Daily Inflow from Supply Ditch, 1974-2009

To evaluate the actual effect the increased water supply obtained from the reservoir enlargements would have on predicted water deliveries to the member ditches downstream of the reservoir, the model distributed those additional flows to downstream users on the ditches according to the number of reservoir shares owned on each ditch. Timing of the delivery was based on predicted demand for irrigation water, given the availability of other flows diverted directly from the river by the ditches, and the calculated needs of the crops planted on the lands irrigated. Calculated demand is based on irrigation efficiencies, water transportation efficiencies, calculated evapotranspiration of the typical crops, typical precipitation patterns on the cropped lands, and other pertinent factors. For the purposes of this analysis, the model assumes that no additional land or alternative crop types would be irrigated using the extra water from enlargement storage, and therefore that the additional water would be used to extend the irrigation season on the existing acreage.

The amount and timing of additional delivery of enlarged reservoir storage water to the member ditches is covered in Section 3.3, Figures 6 to 9, and Appendix C of the Hertzman Report. The figures are reproduced below as Figure 7-3 through 7-6. In all cases, the model indicates that the additional water from the enlargement storage was used almost totally during the months of June, July and August, which would serve to prolong the irrigation season at a time of the year when direct flows divertible from the river by the member ditches are decreasing. As shown in Figure 7-4 below, the Joseph Freed Ditch, by far the largest single user of water on the system, received the greatest proportion of the enlargement storage water, on average approximately 36 additional AF for each of June and July from the 250 AF reservoir enlargement, and approximately twice that amount from the 550 AF reservoir enlargement.

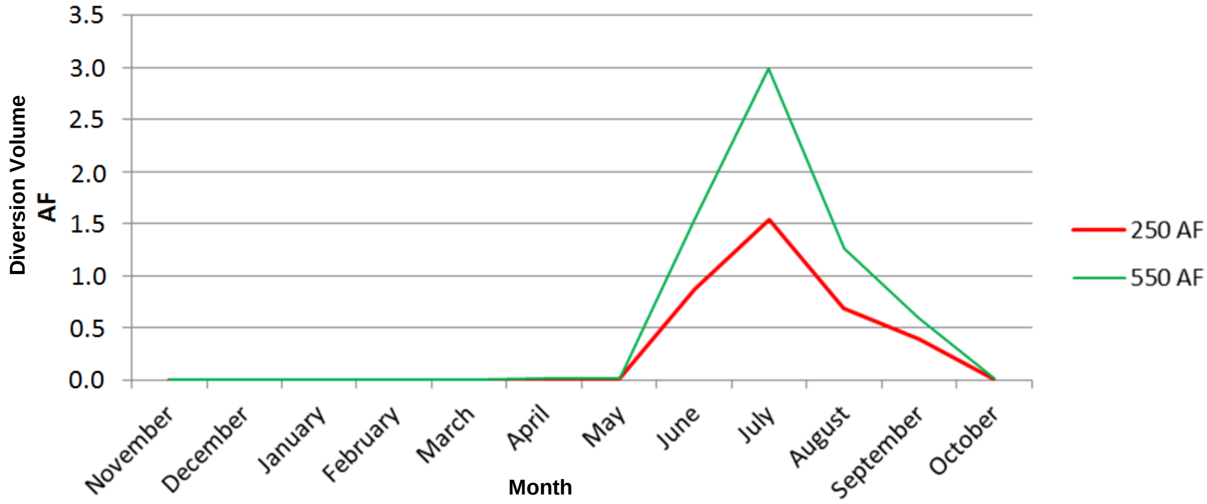


Figure 7-3: Predicted Average Monthly Increase in Total Diversion, Old Indian Ditch

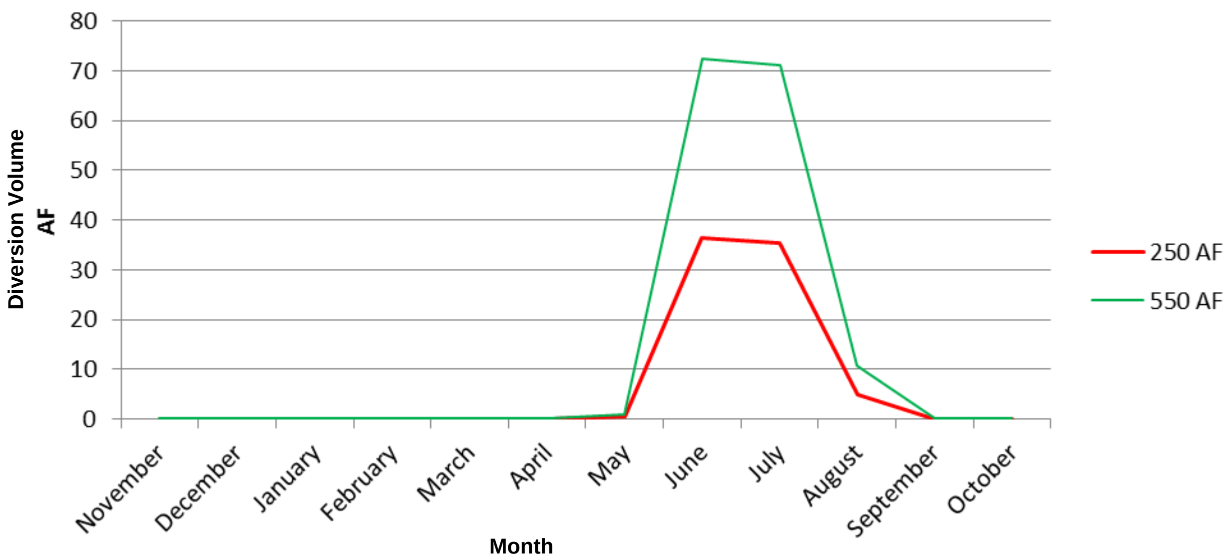


Figure 7-4: Predicted Average Monthly Increase in Total Diversion, Joseph Freed Ditch

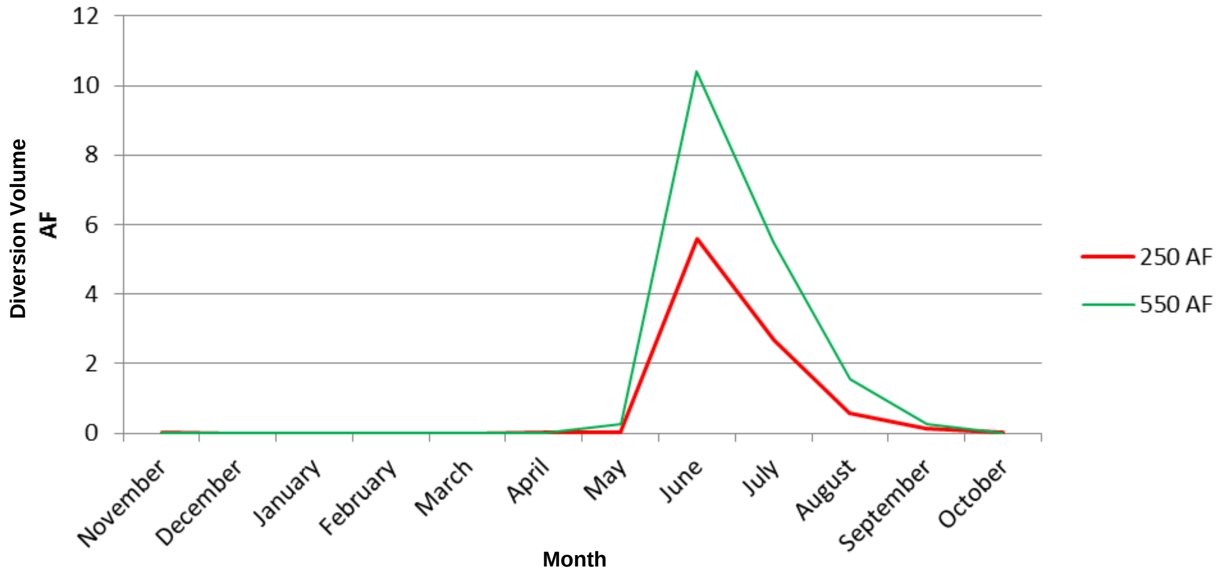


Figure 7-5: Predicted Average Monthly Increase in Total Diversion, Revival Ditch

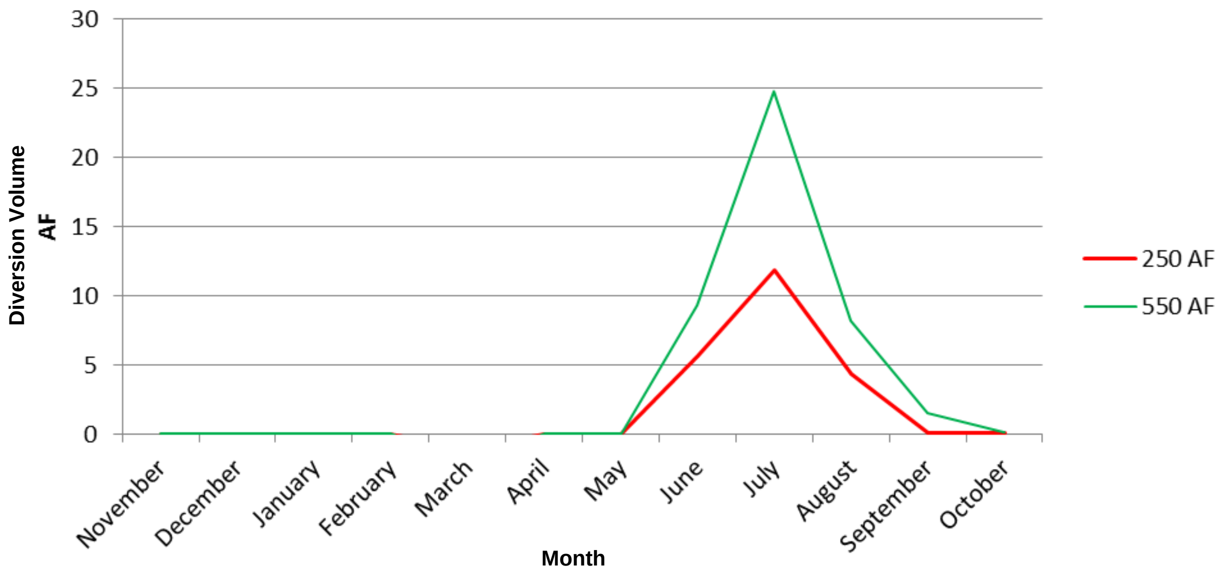


Figure 7-6: Predicted Average Monthly Increase in Total Diversion, Warren-Vosburgh Ditch

It should be noted from Appendix C of the Hertzman Report that Red Mesa Reservoir provides a relatively minor component of the total water available for irrigation on project lands in any given year. Most of the water delivered by the three major ditches comes from direct diversions from the river, although it should be remembered that almost one third of the total of about 1,600 acres irrigated by the ditches depends exclusively on direct flow diversions from the river (i.e., no reservoir water), and those direct flow diversions are included in the tables which show water delivered by the ditches. For the reservoir capacity as it currently exists, the Joseph Freed Ditch receives approximately 72% of the water released from the reservoir, but reservoir releases only make up about 23.5% of the total water delivered by this ditch. Similarly, the Warren-Vosburgh receives about 19.2% of the reservoir releases, but this makes up only 17.3% of the total water delivered by this ditch. The Revival Ditch receives about 7% of the reservoir releases, which makes up about 8.1% of the total water delivered by the ditch. With either reservoir enlargement in place, these numbers improve somewhat. For example, with the larger enlargement, the Freed Ditch would receive an additional 156 AF per year, which increases the percentage of the total which is obtained from reservoir releases to 27.3%. The other ditches would see similar improvements.

While the improvements may seem small, the real value in increasing reservoir storage is in the timing of water deliveries. Historically, available flows in the river drop off dramatically in June and July, at the time of the year when irrigation water is most needed. Reservoir releases compensate for this decrease in available river flows. This situation would be significantly improved by the proposed increase in reservoir storage. For example, on the Freed Ditch, under existing conditions, reservoir releases in June provide 51.2% of the total available water, and in July provide 41.4%, as shown in Table 7-2 below. For the 550 AF enlargement of the reservoir, again on the Freed, reservoir releases would make up 54.1% of the total in June and 55.1% of the total in July. Similar improvements would be experienced by the other ditches.

No action scenario				
Month	Adjudicated	From Exchange	From Storage	Total
November	79.57	0.06	1.52	81.15
December	49.37	0.00	0.00	49.37
January	36.24	0.00	0.00	36.24
February	32.07	0.00	0.00	32.07
March	80.37	0.00	0.00	80.37
April	343.20	0.00	0.00	343.20
May	604.38	161.06	0.00	765.44
June	393.98	149.65	571.46	1,115.09
July	107.63	27.72	95.82	231.17
August	42.33	5.68	0.77	48.78
September	50.51	4.59	11.21	66.31
October	85.34	2.94	14.51	102.79

250 AF scenario					
Month	Adjudicated	From Exchange	From Storage	Total	Increase from No-action
November	79.61	0.06	1.52	81.19	**0.04**
December	49.37	0.00	0.00	49.37	**0.00**
January	36.24	0.00	0.00	36.24	**0.00**
February	32.07	0.00	0.00	32.07	**0.00**
March	80.37	0.00	0.00	80.37	**0.00**
April	343.25	0.00	0.00	343.25	**0.05**
May	604.39	161.47	0.00	765.86	**0.42**
June	394.29	150.32	607.02	1,151.63	**36.54**
July	108.35	27.35	130.79	266.49	**35.32**
August	42.43	5.62	5.53	53.58	**4.80**
September	50.61	4.52	11.19	66.32	**0.01**
October	85.43	2.92	14.50	102.85	**0.06**

550 AF scenario					
Month	Adjudicated	From Exchange	From Storage	Total	Increase from No-action
November	79.63	0.06	1.52	81.21	**0.06**
December	49.38	0.00	0.00	49.38	**0.01**
January	36.24	0.00	0.00	36.24	**0.00**
February	32.07	0.00	0.00	32.07	**0.00**
March	80.38	0.00	0.00	80.38	**0.01**
April	343.34	0.00	0.00	343.34	**0.14**
May	604.44	162.01	0.00	766.45	**1.01**
June	394.53	150.83	642.28	1,187.64	**72.55**
July	108.93	26.94	166.49	302.36	**71.19**
August	42.57	5.52	11.42	59.51	**10.73**
September	50.71	4.43	11.17	66.31	**0.00**
October	85.53	2.90	14.50	102.93	**0.14**

Table 7-2: Water Distribution to the Joseph Freed Ditch (all units are in AF)

7.5 WATER SUPPLY DEMANDS

Historically, water availability on the La Plata River drainage has been such that the demand from all uses and potential uses far outstrips the supply. Appendix I of the SWSI, which was undertaken by the CWCB in 2010, evaluated agricultural water demands vs. supplies for the 10-year period from 1997 through 2006, and concluded that the La Plata River basin (Water District 33) has the greatest water shortage between irrigation water requirement and supply-limited consumptive use among all basins within the San Juan River drainage system which have an annual irrigation water requirement in excess of 10,000 AF. In fact, the annual agricultural demand is equal to approximately three times the available supply. This is illustrated by Figures 7-7 and 7-8, taken from Appendix I of SWSI.

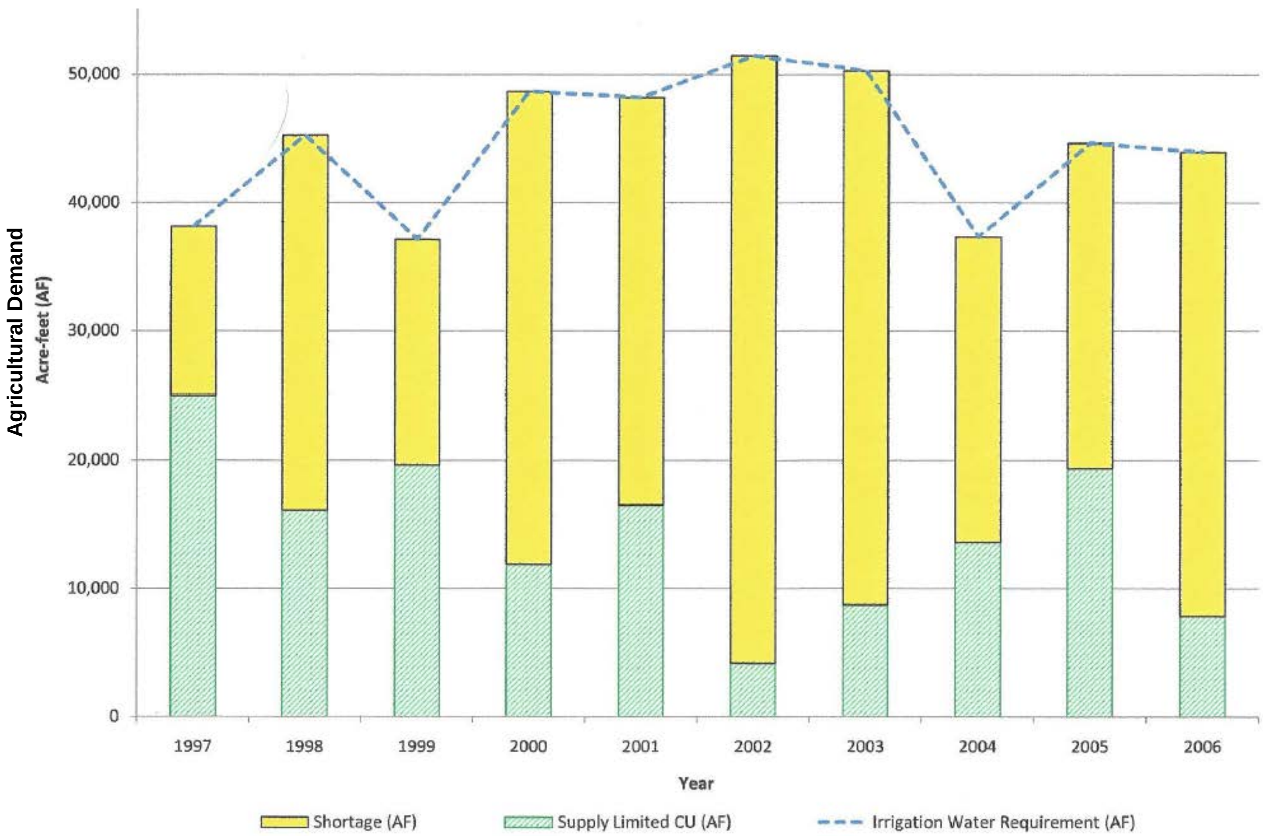


Figure 7-7: SWSI Appendix I, Figure 14: San Juan Water District 33 Agricultural Demand

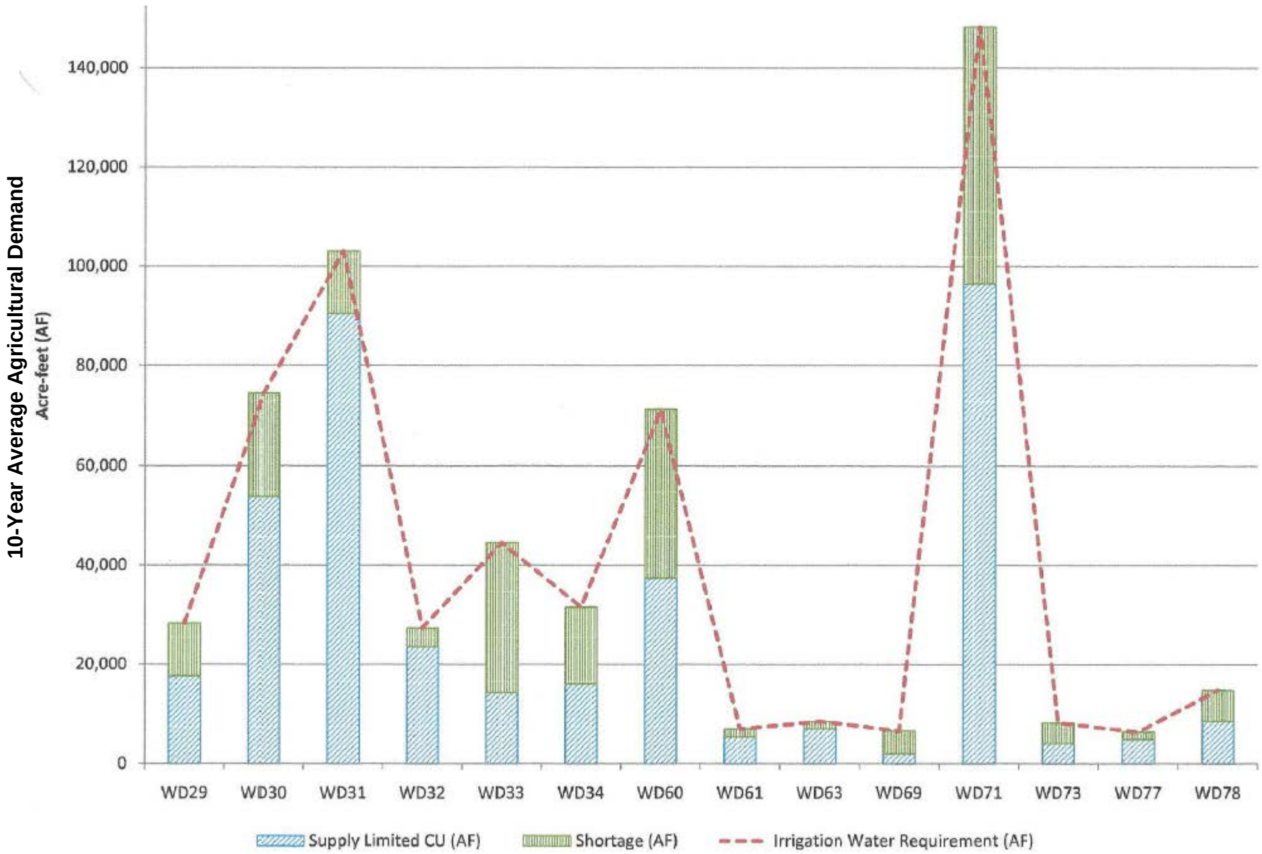


Figure 7-8: SWSI Appendix I, Figure 24: San Juan 10-Year Average Agricultural Demand

The extreme shortage of available water to meet the agricultural demand on the La Plata River basin will not change whether enlargement of Red Mesa Reservoir is attempted or not. Enlargement will help satisfy a portion of the demand, however. On the other hand, failure to construct at least the required dam safety improvements to Red Mesa Dam will likely make the water deficit issue in the La Plata basin considerably worse, because of the possibility of a zero storage restriction or a breach order, resulting in the complete loss of useful reservoir storage on the basin.

The federal ALP was originally envisioned to provide irrigation water, through trans-basin diversions, to the La Plata River basin in an amount sufficient to satisfy the full irrigation demand of the basin. Studies performed by the USBR to support the original ALP determined that 2920 potentially irrigable acres could be served by the Freed, Vossburgh and Revival Ditches alone. The removal of the trans-basin irrigation water component from ALP, however, left the La Plata Basin with only in-basin sources of water for irrigation, essentially unimproved from historic conditions. This allows irrigation of about half of the potentially irrigable acreage served by the three ditches, and provides less than a full supply to those acres which actually are irrigated.

An enlarged Red Mesa Reservoir could be used to provide additional irrigation water to the basin, but could also be used to provide domestic water, augmentation water for wells drilled within the basin, exchange water for upstream diversions, waters for environmental enhancement or compact administration, or other uses not yet identified.

As described above, the additional water stored in an enlarged reservoir, if used for irrigation, would not likely be used to irrigate additional acreage within the distribution area, but would be useful for lengthening the irrigation season on currently irrigated lands. Harris (1995) developed estimates of irrigation water demand based on the USBR's ALP Definite Plan Report, which made a thorough study of weather data to estimate crop consumptive use on the basin. The Definite Plan Report estimated annual consumptive use at 1.97 AF of water per acre. Harris then applied a conveyance and application efficiency to the consumptive use values to determine the overall irrigation water requirement for a full water supply. Using a delivery efficiency of 40% for gravity irrigation and 70% for sprinkler irrigation, applied to the 500 acres and 640 acres, respectively, served at that time by each irrigation method, he calculated a total yearly irrigation water demand of 3.74 AF/acre, or 4,264 AF required to fully service the 1,140 acres irrigated by reservoir water. Given that the area of land irrigated by sprinklers has increased to about 750 acres since the Harris report, the overall delivery efficiency has also increased somewhat, from the 56.8% calculated by Harris, to 59.7%. This would require 3,762 AF per year to fully serve the 1,140 acres irrigated by reservoir water.

By comparison, in discussions with NRCS District Conservationist Sterling Moss in Durango in December of 2015, he indicated that approximately 28 inches (2.33 ft) of water per year is required in the Red Mesa area to produce a full crop of alfalfa hay, which would amount to 3 cuttings per year. This is somewhat greater than the consumptive use calculated by the USBR. Using the current blended irrigation efficiency of 59.7% shown above, this would require 4,450 AF per year to fully irrigate the 1,140 acres served by the reservoir.

Finally, the Hertzman model for RMR&DC calculates irrigation water demand on the project lands served by the ditches using the State Consumptive Use (State CU) model, which considers acreage of irrigated lands, crop type, elevation, and other similar factors. The output from the model shows that, for either enlargement, all of the increased storage in the reservoir is utilized essentially every year to meet the irrigation water demand. While the full demand is not explicitly shown in the report, it is clearly greater than the supply provided by the either enlargement.

Water demand for domestic and other purposes is more difficult to estimate because of the various ways in which the water could be used, and because the different markets which could exist have not been researched or pursued. As has been proposed in the past, any additional water stored could potentially be used for plans of augmentation for domestic wells, exchange water for upstream diversions to central water systems or other irrigators, and direct diversion from the reservoir to a central domestic water system. New domestic water wells permitted in the La Plata basin, for properties less than 35 acres in size, currently require augmentation to prevent impacts to the river flows; some of the existing shares of reservoir water are owned for that purpose. Many residents of the area do not have domestic wells, but haul water from the local Marvel Spring to fill cisterns. This is not a desirable situation, as the supply of the Marvel spring appears to be declining in recent years. The ready availability of augmentation water could potentially help alleviate that problem.

8.1 ANALYSIS OF ALTERNATIVES

8.1.1 Outputs / Yields

Since the only currently-identified firm use for the additional water generated by reservoir enlargement is for enhanced agricultural production on currently irrigated lands, this study assumes that the value of the additional water can be taken as the dollar value of the improved crop production created. As discussed above, enlargement of the reservoir storage capacity by 250 AF results in an increase in the average annual water supply of 110 AF, and enlargement by 550 AF results in an average annual increase of 221 AF. For a blended water application efficiency of 59.7%, as discussed above, this would provide an additional 66 AF per year available to crops for the smaller reservoir enlargement, and an additional 132 AF per year for the larger enlargement. Assuming that the entire irrigated acreage of 1,140 acres is planted in alfalfa, generally the highest value crop, the smaller reservoir enlargement would provide an additional 0.7 inches of water to each acre per year, while the larger enlargement would provide an additional 1.4 inches of water. Relating that to the annual full water demand for alfalfa in this area of 28 inches per year, the smaller enlargement would, on average, provide an additional 2.5% of the full water supply, while the larger enlargement would provide an additional 5.0%.

In terms of crop value produced, a full water supply of 28 inches per acre per year would be expected to produce 3 cuttings of alfalfa hay per year, at an annual rate of production of about 5 tons/acre, as discussed in Section 5. Assuming that all three cuttings require the same amount of water, then each cutting would require one-third of the full supply. The currently available water supply is only capable of producing, on average, about 1.5 cuttings per year, so only one half of the second cutting is realized. A full second cutting of alfalfa generally yields approximately 1.5 tons/acre, and, because a water supply enhanced by either enlargement proposed would only be sufficient to improve second cutting yield, that is the rate of production which could be expected by application of the additional water. At a 2015 market value of $200/ton, a full water supply would produce about $1,000/acre/year. The second cutting alone, if fully realized, would be worth $300/acre. Therefore, the maximum value of the additional water supplied on average by the smaller reservoir enlargement would be the percentage of the full water supply provided by that enlargement, divided by one-third (to get the percentage of improved water supply for that one cutting), and multiplied by the value of that cutting, or (0.025)($300)/(1/3) = $22.50/acre/year. Similarly, the maximum value of the additional water supplied on average by the larger reservoir enlargement would be (0.050)($300)/(1/3) = $45/acre/year. For the 1,140 acres irrigated, that works out to $25,650/year increased production for the smaller reservoir enlargement, and $51,300/year increased production for the larger reservoir enlargement. Expressed per AF of additional water available annually for storage, on average, either enlargement alternative returns about $230 per year per additional AF of reservoir storage.

Using the same logic as applied above, the value of maintaining the existing reservoir in its current configuration vs. the loss of the reservoir by dam breaching can be calculated. The water supply study indicates that the current reservoir is able to store, on average, 989 AF per year. If all of that water is sent downstream every year to irrigators, the existing system efficiencies would allow 59.7% of it, or 590 AF to actually be applied to crops. For the 1,140 acres irrigated, this amounts to 6.2 inches of water, or 22.2% of the annual full water crop demand. Since reservoir water is currently used to provide a second cutting of hay, the lost revenue would amount to the value of that cutting, or $300/acre. So, as above, the value of that lost production would be (0.222)($300)/(1/3) = $200/acre/year, or $228,000/year for the entire 1,140 acres irrigated. As above, the production value of that water per AF is about $230/year per AF of reservoir storage.

8.1.2 Cost Factors

As discussed above, URS performed an analysis of potential alternatives in 2013, which revealed that the most cost-effective alternative among those analyzed, based on cost per AF of reservoir storage capacity, appeared to be the enlargement of the reservoir by about 550 AF. The cost for design and construction of that alternative, including the cost of necessary land acquisition, was preliminarily estimated at that time to be $3.7 million, which was only about $220,000 more expensive than the estimated cost of the smaller reservoir enlargement of 250 AF, and about $760,000 more expensive than the estimated cost of the no-enlargement scenario. As related above, all costs must be compared to the cost of the "no-action" alternative, estimated at nearly $1.2 million, which is the cost to breach the dam and eliminate reservoir storage altogether, a potential regulatory requirement if a compliant spillway is not constructed. Among the three alternatives which maintain or improve reservoir storage, operation and maintenance costs should be essentially identical, and so those were not explicitly considered for each alternative. Current O&M costs for the existing reservoir average approximately $8,000 per year.

The water availability analysis described above in Section 7.4 conservatively estimates that, for the 35 years of records used in the simulation, approximately 110 AF of water would be available on average to fill the 250 AF enlargement, and 221 AF would be available on average to fill the 550 AF enlargement. It should be noted that the water availability analysis also shows that, for the period of the simulation, the average annual predicted diversion into storage for the existing reservoir is about 989 AF, somewhat less than the reservoir capacity of 1,176 AF, the deficit due primarily to the effect of those years that are water deficient rather than to annual holdover storage, as the analysis largely predicts full reservoir drawdown every year.

Given the outcome of the water availability analysis, there are several ways in which to view the cost effectiveness of the various options. These are illustrated on Table 8-1, using the 2013 estimated costs for each of the alternatives considered. The "no-action" alternative is the dam breach option, shown in row 1 of the table, which involves an estimated cost of nearly $1.2 million and results in the complete loss of the reservoir storage, making it the least desirable alternative. The “no action” alternative is considered the baseline level of action. Row 2 of the table is for the option of required improvements to the dam without any measure of reservoir enlargement, while rows 3 and 4 are for required improvements plus enlargement of the reservoir, by 250 AF and 550 AF, respectively.

Table 8-1: 2013 Cost per AF of Storage

(1) Alternative	(2) Estimated Construction Cost (2013)	(3) Cost Above No Action	(4) Total Reservoir Storage, AF	(5) Average Available Water, AF	(6) Total Cost / AF Storage	(7) Total Cost / AF Available	(8) Incremental Cost / AF Storage	(9) Incremental Cost / AF Available
No Action (breach)	$ 1,173,000	-	-	-	-	-	-	-
Repair w/o Enlargement	$ 2,900,000	$1,727,000	1,176	989	$ 2,466	$ 2,932	$ 1,469	$ 1,746
250 AF Enlargement	$ 3,443,000	$2,270,000	1,426	1,099	$ 2,414	$ 3,133	$ 1,592	$ 2,066
550 AF Enlargement	$ 3,664,000	$2,491,000	1,726	1,210	$ 2,123	$ 3,028	$ 1,443	$ 2,059

Notes:

Col. (5) is average annual supply from water availability study

Col. (6) = Col. (2) / Col. (4)

Col. (7) = Col. (2) / Col. (5)

Col. (8) = Col. (3) / Col. (4)

Col. (9) = Col. (3) / Col. (5)

As can be seen from Column (6) of the table, the lowest cost option, in terms of total cost of the project per unit of reservoir storage volume, is the 550 AF enlargement option. However, if the total cost per unit of available water is calculated (Col. (7)), the lowest cost option becomes simply performing the required upgrades to the dam without any enlargement. In terms of the cost above the baseline cost of breaching the dam, and considering the total storage capacity of the reservoir, the lowest unit cost alternative, by a small margin, is again the 550 AF enlargement (Col. (8)). However, as shown by Col. (9), if the unit of yield is the average amount of water calculated to be available in any given year, then the lowest unit incremental cost above the baseline cost is for the repair option with no enlargement. It should also be noted that in no case did the smaller 250 AF enlargement present any cost advantages over the other alternatives.

Based on the evaluation of relative costs shown on Table 8-1, RMR&DC concluded that the most desirable alternative would be to pursue the enlargement of the reservoir by 550 AF, and that is the selected alternative evaluated by this feasibility study. During the process of developing a more refined conceptual design for this study, required material quantities and anticipated costs were re-evaluated. This resulted in an upward revision of some material quantities and revised costs based on more current construction pricing and a refined design. The current engineer's opinion of construction cost was consequently increased from the previous 2013 estimate of $3.7 million, to $5.1 million. This is believed to present a more accurate representation of actual anticipated costs based on the current construction environment and revised design details. The revised cost estimate is discussed in more detail in Section 8.3 and is shown on Table 8-4.

Table 8-2 was created to reflect the revised cost estimate. Since the purpose of the table is to compare the relative cost of the various alternatives, minus the 250 AF enlargement (which was shown by Table 8-1 to not be cost competitive), an updated estimate of the construction cost for the other two comparative scenarios was also needed. A re-evaluation of the estimated cost of the no enlargement scenario derived an estimated total project cost of $4.5 million, approximately $1.6 million higher than was previously estimated, and approximately $600,000 less than the currently estimated cost of the 550 AF enlargement scenario. Note that this places the estimated costs of the two alternatives closer together than the $760,000 spread previously estimated. A review of the types of costs associated with the breaching of the dam scenario indicated that its previously-estimated cost of approximately $1.2 million was not likely to change, and so that figure was utilized in Table 8-2.

Table 8-2: 2016 Cost per AF of Storage

(1) Alternative	(2) Estimated Construction Cost (2016)	(3) Cost Above No Action	(4) Total Reservoir Storage, AF	(5) Average Available Water, AF	(6) Total Cost / AF Storage	(7) Total Cost / AF Available	(8) Incremental Cost / AF Storage	(9) Incremental Cost / AF Available
No Action (breach)	$ 1,173,000	-	-	-	-	-	-	-
Repair w/o Enlargement	$ 4,500,000	$ 3,327,000	1,176	989	$ 3,827	$ 4,550	$ 2,829	$ 3,364
550 AF Enlargement	$ 5,100,000	$ 3,927,000	1,726	1,210	$ 2,955	$ 4,215	$ 2,275	$ 3,245

Notes:

Col. (5) is average annual supply from water availability study

Col. (6) = Col. (2) / Col. (4)

Col. (7) = Col. (2) / Col. (5)

Col. (8) = Col. (3) / Col. (4)

Col. (9) = Col. (3) / Col. (5)

Examination of Table 8-2 reveals that, as dictated by the increase in estimated total costs for both of the non-breach scenarios, the costs both per AF of storage and per AF of available water are higher than previously estimated. What has changed, however, is that the enlargement scenario now appears to be more cost effective on a per AF basis for all comparisons, whether on a total storage capacity basis or an available water basis, and also whether for total construction cost or for incremental cost above the breach scenario. As shown on row 3 of Table 8-2, the estimated unit costs for construction of the 550 AF reservoir enlargement vary from a low of about $2,300/AF storage capacity for the incremental cost above the breach cost, to a high of about $4,200/AF available water for the total cost of the construction.

8.1.3 Impacts

The impacts, both to the man-made environment and the natural environment, vary significantly between the alternatives.

Breaching of the dam to eliminate dam safety concerns, considered to be the least desirable alternative, would also have the greatest impact on both the natural and man-made environment. It would result in the complete loss of the reservoir, denying the water users a source of irrigation water on which they depend for extended crop production in the driest and hottest months of the year, and making them totally dependent on direct flow diversions from the La Plata River. Since the average annual amount of water available to fill the existing reservoir was estimated to be 989 AF, that amount of water would be removed from the irrigation system. This amounts to approximately 25% of the full water delivery to lands currently irrigated by the reservoir, likely limiting all hay production to one cutting per year, even in the best of years. Income from the acreage currently irrigated by the reservoir would be reduced by about one-third, or up to about $200/acre annually. This would affect all of the 48 shareholders on the system, and would have the potential for negatively impacting the entire economy of southwestern La Plata County, as the area is heavily agriculture-dependent. The five shareholders which currently utilize their shares for well augmentation water would lose that source of augmentation altogether.

Breaching of the dam would require returning the channel of Hay Gulch to a stable hydraulic configuration to eliminate the possibility of transporting sediments accumulated in the reservoir bottom downstream, and would require the removal of most of the dam embankment, which would need to be disposed of somewhere. The significant amount of earthwork required and the need for full restoration of the channel to a stable, non-eroding configuration through the existing reservoir bottom area result in the substantial cost of this alternative.

In terms of the altered water regime on the river, the breaching of the dam and subsequent loss of the reservoir would provide little benefit to the natural flow environment. Given the relatively junior water rights of the reservoir within the basin, filling is usually only possible during the relatively short period of the year when compact delivery requirements to New Mexico are not in place, or when flows are large enough to be divertible to storage. Therefore, flows which are currently divertible to storage would simply go down the river to New Mexico, above compact requirements, and would be lost to Colorado. Additionally, the water supply for Long Hollow Reservoir, which was built to create exchange opportunities for Colorado water users when the compact is in effect, is partially dependent on return flows from lands irrigated by Red Mesa Reservoir. Loss of those return flows would deplete to some extent the available water supply to Long Hollow Reservoir, diminishing its value on the system.

Construction of the required dam safety improvements at the dam, without reservoir enlargement, presents the fewest impacts to both the man-made and natural environments. Construction of an enlarged open channel spillway on the left abutment of the dam would require acquisition of privately owned land in that area, as would the raising of the dam in a downstream raise configuration. This amounts to approximately 4 acres, most of which is currently in native grasses, sagebrush and juniper. Expansion of the embankment in the downstream direction would require fill placement downstream of the existing toe of the dam, which would impact an existing willow thicket area at the toe which is supported by seepage from the reservoir. This may require some form of wetlands replacement as a condition of construction.

If the reservoir would not be enlarged, additional land acquisition for normal pool inundation in the reservoir area would not be required, but the inclusion of a greater dam crest elevation to provide freeboard for routing the IDF would require the acquisition of flood easements on approximately 40 acres of private land upstream of the dam to accommodate the increase of about 12 ft in the maximum flood pool elevation. No structures or improvements are currently present within that area. As additional reservoir storage is not a component of this alternative, depletion of river system flows and evaporative depletions from the reservoir would be unchanged from current conditions, and so the natural environment would remain essentially unaffected, except in those areas impacted directly by dam and spillway improvements.

The reservoir enlargement scenario would include the types of impacts described for the no-enlargement scenario, plus additional impacts. Enlargement of the reservoir requires a wider spillway channel, requiring additional land acquisition on the left abutment, and the reservoir normal water line elevation would increase by 8 ft, placing more land upstream of the dam within the normal water line storage pool. Because the dam crest elevation varies very little between the no-enlargement and the enlargement alternatives, the affected land along the downstream toe of the dam is essentially the same as for either alternative. Altogether, it was estimated that the 550 AF reservoir enlargement would require purchase of about 20 acres of land for spillway and dam construction and for reservoir storage. The land which would be within the enlarged normal water line pool is currently mostly cultivated bottom land along Hay Gulch, and is free of structural improvements. No historic or archaeological sites are known to exist in the area.

For the reservoir enlargement, the area of land upstream of the dam which would require a flood easement for the flood pool is actually somewhat less than for the no enlargement scenario. The maximum flood pool elevation is only about 2 ft higher for the reservoir enlargement scenario and amounts to about 30 acres which would require a flood easement. Again, no structural improvements are present.

The cost to acquire land, either by purchase or for flood easement, was estimated from recent sales in the area to be about $4,000/acre. This is discussed in further detail in the Spillway Alternatives Analysis (URS 2013).

The reservoir enlargement scenario would involve increased depletions to the San Juan River system and greater consumptive uses of water from the basin, because of the additional diversions required to fill the enlarged reservoir, as described in the preceding sections. Where the water availability modeling study shows that the current average amount of water diverted annually from the river to fill Red Mesa Reservoir is 989 AF, the 550 AF reservoir enlargement would allow an additional average annual withdrawal of 221 AF, to an average annual total of 1,210 AF removed from the river.

Evaporation from the enlarged reservoir would be increased from the current reservoir configuration, due to the increased reservoir surface area; net evaporation (evaporation minus precipitation occurring directly on the reservoir water surface) was calculated by Hertzman as a part of the water availability analysis, using projected water storage levels in the reservoir during the 35 years of records modeled, monthly climate data, and average monthly precipitation data for the reservoir area. The calculated net evaporation values are shown in Appendix F of the Hertzman Report. The existing reservoir, when full, has a surface area of approximately 59 acres; this would increase to about 75 acres for the 8-foot enlargement. For the 550 AF enlargement, average additional net evaporation was calculated to be 7.86 AF/year.

Hertzman's Appendix F indicates that the greatest additional evaporation beyond that for the existing reservoir would be expected to occur during the months of May and June, reflecting a transient full reservoir condition during a typically warm, dry period of the year before irrigation drawdown commences in earnest. Since the Hertzman study also shows that diversions from the river would, in most years, be curtailed before May, due to priority and compact limitations, no further diversions would be taken to compensate for reservoir evaporation at the time of the year when most evaporation occurs, and additional evaporative depletions to the river would generally not occur after April. In other words, most of the additional evaporative depletions which would result from reservoir enlargement would result only in the loss of water already in storage in the reservoir rather than losses to the river, since the evaporative losses could not be replaced by continuing diversions. Thus, actual additional evaporative losses to the river system due to reservoir enlargement would be much smaller than those shown above. From the data in Appendix F of Hertzman, annual pre-May additional net evaporative losses from the reservoir were calculated to amount to only about 0.3 AF/year for the reservoir enlargement scenario.

Analogous to the manner in which reservoir removal would negatively impact Long Hollow Reservoir, enlargement of Red Mesa Reservoir would likely create some incremental improvement in water supply conditions for Long Hollow, as the amount of irrigation water applied to lands tributary to Long Hollow would increase somewhat, providing increased return flows into Long Hollow. This was evaluated by Hertzman, and is shown on Figure 12 of that report.

Impacts to water quality in the area are not anticipated from the scenarios which retain or enlarge the existing dam and reservoir. Potential impacts to aquatic wildlife and/or threatened and endangered species in the project area resulting from dam modification or enlargement have not been considered as a part of this feasibility study, and would need to be thoroughly evaluated during the design phase prior to construction. Significant environmental permitting issues may well be encountered for the reservoir enlargement scenario. For the purposes of including at least some cost factor associated with environmental permitting, the 2013 Alternative Analysis assumed that combined legal fees and environmental permitting for either of the two reservoir enlargement scenarios considered at that time would cost approximately $300,000. This same estimated cost has been included in the updated estimate for the 550 AF enlargement alternative considered by this feasibility study. This is a very approximate estimate, and could vary greatly. By contrast, for either the no enlargement or the dam breach alternative, the combined legal fees and environmental permitting was estimated to cost $50,000. The feasibility studies prepared by Harris (1995, 2001)and Wright (2003) to support past enlargement proposals of a much greater magnitude for Red Mesa Reservoir than covered here discussed the anticipated environmental impacts for those reservoir enlargements in significant detail. Institutional issues associated with environmental permitting are discussed in more detail below.

8.1.4 Economic Analysis and Feasibility

In order to compare the economic viability of the remaining alternatives, the currently estimated cost for each alternative was divided by the estimated value returned per year to determine the number of years required for benefits to exceed estimated costs. That information is shown in Table 8-3. Note that the table considers the total dollar value of the increased production, as derived in Subsection 8.1.1, and not the net profit available after the costs of increased production are considered, and so the number of years required to recover costs is understated. It is useful for comparison purposes, however. Also, Table 8-3 is based on predicted annual water availability, and not on the total increased storage volume of the reservoir enlargement.

Since the dam breach alternative has no return associated with it and is simply a sunk cost. The shortest cost recovery period calculated is for the reservoir enlargement alternative, at 14.1 years. This is slightly better than the cost recovery period of 14.6 years for the no-enlargement alternative. Consequently, the incremental cost recovery period to go from the no-enlargement scenario to the enlargement scenario is less than the overall recovery period, at 11.7 years. Whether this cost recovery period is acceptable or not is debatable, but the fact remains that no other source of irrigation water exists within the basin which could be used to replace the water stored in Red Mesa Reservoir, so there is nothing to compare it to.

Table 8-3: Cost Recovery Period

(1) Alternative	(2) Estimated Construction Cost	(3) Cost Above No Action	(4) Incremental Cost Above No Enlargement	(5) Annual Return on Investment	(6) Incremental Annual Return	(7) Cost Recovery Period, Years	(8) Incremental Cost Recovery Period, Years
No Action (breach)	$ 1,173,000	-	-	-	-	-	-
Repair w/o Enlargement	$ 4,500,000	$ 3,327,000	-	$ 228,000	-	14.6	-
550 AF Enlargement	$ 5,100,000	$ 3,927,000	$ 600,000	$ 279,300	$ 51,300	14.1	11.7

Notes:

Col. (5) is the total annual value of crop production achieved by the total available reservoir water for that alternative

Col. (6) is the difference in the return from either enlargement vs. no enlargement

Col. (7) = Col. (3) / Col. (5)

Col. (8) = Col. (4) / Col. (6)

The benefits of retaining the reservoir would accrue to all 1,138 shares and all 48 different shareholders currently on the system. Reservoir enlargement, however, would not necessarily benefit all shareholders, as 9 shares, held by 5 different shareholders, are currently used for well augmentation water. That leaves 43 shareholders and 1,129 shares which would benefit from the availability of additional water, and would theoretically share the incremental costs of the reservoir enlargement.

8.1.5 Institutional Requirements

Any construction work involving the dam, and thus all of the alternatives considered, will require the approval of plans and specifications to that effect from the Colorado Division of Water Resources, Dam Safety Branch. The IDF which would be used for design of any required modifications to the dam and spillway has already been evaluated and approved by the State Engineer, as described in Subsection 6.4.

Modification of the dam and spillway to successfully pass the IDF, whether as a part of reservoir enlargement or not, will require the establishment of a higher flood pool inundation zone in the reservoir area, and thus the acquisition of flood easements from private landowners on those properties affected. Enlargement of the reservoir will require purchasing privately-owned land within the confines of the new enlarged reservoir area. Construction of an enlarged spillway and expansion of the existing dam in a downstream raise configuration will also require that RMR&DC purchase privately-held land.

Geotechnical exploration of the left abutment area carried out as a part of this feasibility study revealed the presence of an abandoned gas pipeline, currently owned by The Williams Companies, Inc., within the proposed spillway area. Its status will need to be appropriately documented by Williams prior to construction, and permission granted for its excavation and removal.

The acquisition of additional water rights, through water court proceedings, to fill an enlarged reservoir would not be required, as the RMR&DC holds conditional rights of the same priority as the existing absolute rights sufficient to utilize either of the enlargement alternatives evaluated. Expanded capacity of the reservoir would simply require that RMR&DC petition the water court to make existing conditional rights, in the amount of the enlargement, absolute.

Any construction work involving the dam is also likely to require a permit from the U. S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act. The permit can assume different forms for different types of work, with the type of permit required determined by the USACE after visiting the site and evaluating the scope of the proposed work. It is likely that a Nationwide Permit, the least involved form, would be considered sufficient for work to breach the dam or to construct modifications to the dam which do not involve components of reservoir enlargement, as existing wetlands areas which would be impacted are relatively minimal. Delineation of wetland areas impacted would require retaining a wetland consultant to perform the evaluation.

Reservoir enlargement would, however, require an individual 404 permit, triggering the requirements of the NEPA, due to the increased depletions to the river system. It would also require Section 7 consultation with the USFWS under the ESA to determine potential impacts to threatened or endangered species resulting from the additional depletions, and a biological assessment to determine potential impacts to threatened or endangered species due to proposed construction activities at the site. Potentially impacted threatened or endangered species include the New Mexico meadows jumping mouse, yellow-billed cuckoo, southwestern willow flycatcher, bald eagle, Colorado pike minnow and razorback sucker. Individual permits tend to be expensive propositions, and can vary widely in cost, depending upon findings.

Previous plans to significantly enlarge the reservoir by the full amount of the RMR&DC's conditional water rights, as discussed by Harris (1995, 2001) and Wright (2003), included acquisition, in 1997, of a Section 404 permit for that proposed enlargement. In 2002,the permit was extended for another 5 years, until 2007. The details of the process are described by Wright (2003). Unfortunately, the permit was allowed to lapse after the proposal to enlarge Red Mesa Reservoir was dropped by LPWCD in favor of constructing Long Hollow Reservoir, and is no longer in effect. Thus, the process would need to be repeated in its entirety for the reservoir enlargement alternative. However, the fact that a permit for similar, but higher impact project was obtained in the fairly recent past would likely indicate that there are no insurmountable environmental obstacles to the proposed project.

Cultural resource issues were not identified by any local, state, or federal jurisdiction during any of the previous regulatory reviews and approvals for previous enlargement proposals, and so would not be expected for any of the alternatives described herein.

No water quality issues are anticipated for any of the potential alternatives. It is anticipated that a construction dewatering permit would be required by the Colorado Water Quality Control Division prior to construction, as well as a fugitive dust permit from the Air Pollution Control Division.

8.2 SELECTED ALTERNATIVE

Utilizing the estimated cost information from the 2013 Alternatives Analysis project, as discussed above, RMR&DC decided to pursue the 550 AF reservoir enlargement as the selected alternative. This decision was fortified by the updated cost estimates developed for this feasibility study, which show that the lowest unit costs and shortest repayment period for the money invested lie with the 550 AF reservoir enlargement, as opposed to dam improvements with no reservoir enlargement component. The selected alternative also allows the RMR&DC to utilize some of its existing conditional water rights to provide more storage water to the basin, which is sorely needed. This is viewed as the only method by which additional water can be acquired. Although even greater cost efficiencies would likely exist for further enlargement of storage beyond the 550 AF proposed, the overall cost of greater enlargement would likely be rather prohibitive and beyond reasonable expectation.

Conceptual level drawings for the selected alternative, to enlarge the reservoir by approximately 550 AF, to a normal water line elevation of 6,900.8 ft and total capacity of 1,726 AF, were developed for this feasibility study and are provided as Appendix H.

8.2.1 Geotechnical Investigation

In order to identify existing subsurface conditions on the left abutment in the area of the proposed new spillway construction and to verify that sufficient suitable material for embankment enlargement was available from the required spillway excavation, a preliminary geotechnical investigation program was undertaken in December of 2014, as a component of this feasibility study. Potential sources of impervious borrow material were also investigated within the existing reservoir area. The Geotechnical Investigation Report developed from this work is included with this Feasibility Study as Appendix I.

Twelve test pits were excavated in potential borrow area locations within the reservoir, and four test holes were drilled on the left abutment area where the enlarged spillway would be located. Appropriate samples were collected for preliminary laboratory evaluation of engineering properties. Based on the results of the test pit excavations and laboratory testing, the clay materials found within the reservoir area appear to be of sufficient quantity and suitable for use, as necessary, for impervious fill in the enlarged embankment. The most favorable location for the impervious fill borrow area appears to be approximately 1,500 to 2,500 ft upstream of the existing dam, along the eastern perimeter of the reservoir and below the proposed raised normal water line.

Observations of the drilling performed in the left abutment in the area of the proposed spillway construction indicate the presence of dense, sandy gravel materials within the proposed excavation that should be suitable as a borrow source for embankment shell material. Sandstone bedrock was only encountered at depths of greater than 30 ft within the left abutment, indicating that the spillway excavation will not be founded on bedrock and excavation should be able to be completed using conventional equipment, including excavators and dozers. The presence of sands and gravels within the left abutment area does present some concern for potential seepage from an enlarged reservoir and for erosion potential along the floor of the new spillway channel. These issues will need to be considered and addressed during final design. The embankment and spillway design will largely depend on results of the erodibility, settlement, seepage, and stability analyses that are typically performed during the design process.

8.2.2 Embankment Design

The enlargement involves raising the crest of the dam by 14 ft, to elevation 6,912.8 ft, using the downstream enlargement method. A central impervious clay core would be used to tie into the impervious portion of the existing embankment, with more granular material from the required spillway excavation utilized in the outer shells of the enlargement. Crest width of the enlarged embankment would be 25 ft, in accordance with SEO Rules. Upstream and downstream slopes of the embankment would be 3.0:1 and 2.5:1, respectively, which are assumed to be stable during steady-state loading conditions. The slopes may need to be revised during final design based on actual steady-state slope stability analyses, and seismic and rapid drawdown transient analyses. The embankment design includes a filter chimney drain and blanket drain assumed to be compatible with the material used for the embankment raise, the foundation, and the existing embankment. It is also assumed that the existing embankment is appropriately constructed to accommodate the embankment raise; further investigation of the existing dam and the associated structures would need to be undertaken to confirm this assumption.

Foundation preparation for the enlarged dam embankment is envisioned to include a 5-foot excavation below grade beyond the toe of the existing dam to expose a suitable foundation for the raised portion of the new dam. This excavated material would likely be wasted to the reservoir or a designated fill area downstream of the raised dam. Excavation slopes were assumed at 1.5H:1V from the existing surface. Existing internal drains would be evaluated as encountered and either incorporated into the drainage system of the enlarged structure or properly abandoned.

Foundation treatment/grouting would be conducted as necessary, depending upon further design-stage investigations and observations during construction. It is not clear at this time the extent or form of the foundation treatment which might be required; it is considered possible that, at a minimum, some form of grouting of the upper right abutment might be necessary to fill potential joints and cracks in the sandstone/siltstone bedrock which would be exposed to reservoir water for the first time by the reservoir enlargement. A line item amount has been included within the cost estimate prepared to provide an allowance for this possibility, but the cost is unknown and could be significantly in excess of that shown.

Embankment materials would be procured from the borrow areas described above, with Zone 1 low permeability clay fill derived from the reservoir area borrow source, and Zone 2 shell material from the required spillway excavation. Any unused material from the spillway excavation would be wasted to the reservoir area or to a designated fill area downstream of the raised dam. The actual amount of material wasted would depend on the configuration of the final design; the expected oversupply of material from the spillway excavation provides for flexibility in terms of material selection for Zone 2 construction.

Processing, drying and stockpile areas would likely be required close to each of the borrow sites and would likely be located within the reservoir basin near the relevant borrow site. The exact size and location of these areas would be identified during final design; wetland/riparian areas and other environmentally and culturally sensitive areas would be avoided.

It is envisioned that riprap, sands (including filter material) and aggregates would be imported from an off-site source. Imported material could be obtained from one or more commercial suppliers in the Durango, Cortez or Farmington, New Mexico, areas. Specific commercial suppliers in the area were not identified as part of this investigation. Existing riprap on the upstream slope of the dam was assumed to be of acceptable size and condition and would be tied in with the new riprap associated with the raised dam embankment.

8.2.3 Spillway

As discussed above, the IDF for this project was derived as a part of the Incremental Damage Analysis completed by URS in 2011, and was subsequently reviewed and approved for use by the SEO. The IDF has a peak inflow of 26,133cfs, which is only minimally attenuated by routing through the reservoir and modified spillway, due to the large flood volume in comparison to the reservoir flood pool volume.

In order to more efficiently route the IDF through the reservoir, the raised dam crest will provide 12 ft of total freeboard between the spillway crest elevation and the dam crest, approximately twice that provided by the existing dam. This helps limit the required spillway width. As designed, the new spillway will have a trapezoidal shape with a bottom width of 275 ft and 3:1 side slopes, and will provide the required 1ft of residual freeboard to the dam crest at the peak reservoir water elevation resulting from the IDF. Spillway sizing followed the methodology used by the Alternatives Analysis, using an estimated broad-crested weir discharge coefficient of approximately 2.6. The spillway is located on the left abutment, along the alignment of and to the left of the existing spillway. Overall channel length is approximately 900 ft, with approximately 500 ft of that length downstream of the crest section. The spillway is designed to discharge to a natural draw which returns to Hay Gulch well downstream of the dam toe. The design requires that the existing spillway channel be filled with compacted earth materials during construction to form a uniform channel floor, and that a small embankment section to form the right side slope of the new channel be constructed along the right side of the spillway to fill in the area where the existing spillway is located.

The spillway is designed as a broad-crested weir with no slope in the upstream approach section and a 1% slope in the section downstream of the crest. A 2-foot-wide concrete cutoff wall / broad-crested weir control section is included, aligned along an extension of the dam crest axis, which will extend 3 ft below grade in all areas to reduce the likelihood of headcutting and will also serve to cutoff the existing spillway channel. A low-flow notch would be incorporated into the weir crest to allow minor nuisance flows to discharge down a pilot channel without utilizing the main weir crest. The design includes a cast-in-place concrete gravity abutment wall at the left end of the dam / right side of the spillway channel to define the right side of the channel and protect the left end of the dam from spillway flows. The right side slope of the spillway channel would be protected as necessary by a layer of riprap and bedding material.

8.2.4 Outlet Works

Modification of the existing outlet works is necessary both to accommodate the increased embankment height and extended downstream dam toe. Because of the additional loading placed on the existing concrete conduit through the dam by the raised fill section downstream of the existing dam crest, strengthening of this component was considered necessary. The proposed design calls for slip lining of the existing 2-foot wide by 4-foot high conduit/tunnel section with a 21-inch diameter welded steel pipe, with the annular space between the steel lining and the existing conduit fully filled with cement grout. The 21-inch liner pipe was sized to meet SEO Rules that the outlet be capable of releasing the top 5 ft of reservoir storage within 5 days. The structural adequacy of this arrangement to withstand embankment loadings would be fully evaluated during final design.

The conduit would also need to be extended downstream of the existing end of the conduit to reach beyond the toe of the raised embankment. This would be accomplished by use of 21-inch welded steel pipe conduit fully encased in reinforced concrete. At the downstream end of the new conduit, a USBR Type VI reinforced concrete impact-type stilling basin would be constructed, with the outfall channel armored with rock riprap.

Raising of the reservoir normal water line elevation necessitates abandonment of the existing outlet gate tower and operating system, which have essentially reached the end of their service lives anyway. The existing tower, access bridge, gate and gate controls would be completely removed, via excavation into the upstream slope to reach the existing conduit. With the open excavation, the existing outlet intake structure and feed conduit to the tower would also be removed, and replaced with concrete-encased 21-inch welded steel pipe. A new concrete intake structure housing a hydraulically-operated 21-inch slide gate would be constructed at the upstream end of the new conduit section. Stainless steel hydraulic lines encased in reinforced concrete would carry hydraulic fluid to a new manual power unit housed in a reinforced concrete vault on the crest of the dam. A 6-inch diameter steel air vent pipe would also be included within the reinforced concrete used to carry the hydraulic lines to the crest. A new steel trashrack would be placed over the intake structure.

8.2.5 Supply Ditch

The previous feasibility studies performed by Harris (1995, 2001) and Wright Water Engineers (2003) discussed proposed improvements to the Supply Ditch, which is used to convey flows diverted from the La Plata River to the reservoir. The ditch conveys water for approximately 1.5 miles from the river to the reservoir, entering the reservoir upstream of the left abutment of the dam. The ditch has a decreed capacity of 120 cfs; discussion with RMR&DC indicates that actual maximum capacity is rather close to the decreed capacity. However, it has been noted for a number of years that a reach of the ditch approximately 1,500 ft in length leaks into a downhill irrigated field when the ditch is in use. This represents a waste of diverted water which RMR&DC would like to correct.

The previous studies have proposed lining that reach of the ditch with clay materials to eliminate the seepage. Estimated costs to perform that portion of the work were considered to be approximately $100,000 at that time.

This feasibility study also proposes to perform lining of the problematic ditch sections, although this is not specifically shown on the conceptual design sheets or included in the cost estimate. URS would propose to review the approach to lining the ditch sections, for example with a geomembrane liner, to evaluate potentially more cost-effective methods of sealing against ditch leakage. This would be evaluated further during final design.

8.2.6 Right-of-Way / Land Acquisition

As discussed in Subsection 8.1.3, the enlargement of the reservoir by 550 AF requires the acquisition of approximately 20 acres of private land, both for construction of the enlarged embankment and spillway features and for the enlarged reservoir inundation area. Based on consultation with RMR&DC on recent land sales in the area, the cost to purchase the required land was estimated at $4,000 per acre.

Flood easements would also be required for areas which would be above the normal reservoir water line (spillway crest) elevation but below the maximum reservoir flood pool elevation achieved while routing the IDF. Flood easements would be required for approximately 30 acres of land. Since flood easements effectively restrict development on lands within the easement, the maximum value of the land is severely reduced. The cost of flood easements was therefore also established at $4,000 per acre, to reflect that loss of value.

8.3 COST ESTIMATE

A cost estimate was developed based on the conceptual design drawings. Construction quantities for the major project features were estimated. Unit pricing was developed for the major project features based on our experience with similar projects and recent dam construction projects in Colorado. The cost estimate presented can be considered a Class 4 construction cost estimate as described by the Association for the Advancement of Cost Engineering (AACE) International. The level of project definition is between 1% and 15%. The purpose of this estimate is to assess project feasibility. The typical variation in accuracy of a Class 4 estimate is between -30% and +50%.

The cost estimate provides an allowance for the following:

- Contingency

- Engineering and Construction Management
- Environmental Permitting and Legal
- Land Acquisition
- Flood Easement

The cost estimate does not provide an allowance for the following:

- Construction growth after contract
- Procurement
- Environmental mitigation
- Operations and maintenance
- Handling of hazardous materials

The cost estimate is provided in 2016 U.S. dollars. Allowances and unit pricing may vary from that shown.

The direct construction cost for the Red Mesa Reservoir Enlargement as described in this feasibility study was estimated at approximately $3.1 million. The total estimated project cost was estimated at $5.1 million. The cost estimate is shown on Table 8-4.

Table 8-4: Total Estimated Project Cost

Item	Description	Quantity	Unit	Unit Price	Total Cost
	RED MESA RESERVOIR ENLARGEMENT PROJECT				
	CONSTRUCTION COST ESTIMATE				
1	Stream Diversion and Dewatering	1	LS	$ 50,000	$ 50,000
2	Clearing and Grubbing Dam Site	3	Acres	$ 10,000	$ 30,000
3	Borrow Area Preparation and Reclamation	1	LS	$ 50,000	$ 50,000
4	Main Dam				
	Existing Embankment Excavation waste to Reservoir	2,200	CY	$ 5	$ 11,000
	Foundation Excavation, Unclassified waste to Reservoir	7,100	CY	$ 5	$ 36,000
	Foundation Preparation	3,100	SY	$ 16	$ 50,000
	Right Abutment Grouting	1	LS	$ 100,000	$ 100,000
	Zone 2 Shell (Source/Spread/Place/Compact) from Spillway Excavation	56,900	CY	$ 7	$ 398,000
	Zone 1 Core (Source/Spread/Place/Compact) from Reservoir Borrow Area	13,700	CY	$ 10	$ 137,000
	Filter - Chimney and Blanket (Source/Deliver/Place/Compact)	4,408	CY	$ 100	$ 441,000
	Riprap and Bedding (D_{50} = 12")	2,100	CY	$ 100	$ 210,000
	Instrumentation	1	LS	$ 50,000	$ 50,000
5	Spillway				
	Compacted Fill (Source/Spread/Place/Compact) from Spillway Excavation	10,763	CY	$ 7	$ 75,000
	Waste Excess Fill from Spillway Excavation to Reservoir	6,100	CY	$ 5	$ 31,000
	Reinforced Concrete				
	Spillway Crest	111	CY	$ 900	$ 100,000
	Abutment Gravity Wall	111	CY	$ 900	$ 100,000
	Riprap and Bedding (D_{50} = 12 inch)	1,806	CY	$ 100	$ 181,000
6	Outlet Works				
	Excavation, Unclassified	5,190	CY	$ 5	$ 26,000
	Demolish and Remove Existing Intake Tower/Bridge/Controls	1	LS	$ 50,000	$ 50,000
	Intake Structure	1	LS	$ 50,000	$ 50,000
	Intake Gate (21x21 inch)	1	EA	$ 20,000	$ 20,000
	Inlet Structure Trash Rack	1	EA	$ 10,000	$ 10,000
	Conduit (Supply/Install) 21 inch Welded Steel Pipe	200	LF	$ 350	$ 70,000
	Slip-line and Grout Existing Conduit (Supply/Install) 21 inch Welded Steel Pipe	230	LF	$ 500	$ 115,000
	Concrete Encasement	156	CY	$ 800	$ 124,000
	Compacted Fill (Source/Spread/Place/Compact)	5,183	CY	$ 7	$ 36,000
	Controls	1	LS	$ 50,000	$ 50,000
	Impact Basin	1	LS	$ 50,000	$ 50,000
	Riprap and Bedding (D_{50} = 12 inch)	44	CY	$ 100	$ 4,000
7	Access Roads	1	LS	$ 50,000	$ 50,000
8	Reclamation	1	Acres	$ 7,500	$ 8,000
9	Unlisted Items (5%)	1	LS	$ 140,000	$ 140,000
10	Mobilization, Bonds, Insurance (10%)	1	LS	$ 290,000	$ 290,000
Estimated Direct Construction Cost					**$ 3,100,000**
Contingency (30%)					$ 930,000
Engineering and Construction Management (18%)					$ 560,000
Environmental Permitting and Legal (Allowance)					$ 300,000
Land Acquisition (20 Acres at $4,000/Acre)					$ 80,000
Flood Easement (30 Acres at $4,000/Acre)					$ 120,000
Total Estimated Project Cost					**$ 5,100,000**

Abbreviations

LF	linear foot
LS	lump sum
SF	square foot
SY	square yard
CY	cubic yard
EA	each

8.4 IMPLEMENTATION SCHEDULE

Since full funding for the project has not been resolved at this time, as discussed in Section 9 below, it is not possible to develop an actual implementation schedule for the project. However, a general sequence of events which must occur can be identified. First and foremost, a firm source of funding which will allow the project to move forward must be identified. As RMR&&DC is unable to finance the full cost of project implementation, this will likely take the form of either grants or a joint venture partner who has a use for the water in some manner other than irrigation, such as for domestic or municipal and industrial purposes. Once that other source of capital is discovered, then RMR&DC would be able to proceed with procurement of a CWCB loan for the amount which they feel they can afford.

Once funding is in place, the next logical step would be to pursue environmental permitting for the proposed plan. This process can be rather time consuming and expensive, and should be concluded to confirm that construction is indeed possible prior to the initiation of final design activities.

After the first two steps are successfully negotiated, an in-depth geotechnical investigation program would need to be initiated to provide the required information for final design. With that information in hand, then final design activities could be initiated. This would reveal a more complete and accurate estimate of the design and the expected construction costs. At that point, negotiations with adjacent landowners for the purchase of properties required for the reservoir enlargement and for flood easements for those properties which would be inundated by the flood pool could also begin. Arrangements should be made with Williams to remove and/or properly abandon the gas pipeline which crosses the proposed spillway channel area.

Completion of the final design would require approval by the Colorado State Engineer prior to putting the project out to bid by construction contractors. The project will need to be competitively bid if government monies are used to finance it. If an acceptable bid is received which is within the realm of the capital available to build it, then a contract for the construction can be issued, and the project can move forward to construction. All required land purchases would need to be completed by this point.

It is anticipated that the above sequence of events will extend over a period of several years, assuming that a concerted effort is made to keep the project moving. The actual required time frame could be highly variable, however.

Total project costs to construct the selected alternative are currently estimated to be $5.1 million in 2016 US dollars. To finance the project, RMR&DC is requesting a CWCB loan for approximately 14% of the total cost, in the amount of $700,000, for 30 years, at the current agricultural project interest rate of 1.80%. This would result in an annual payment of $30,402, to be paid through annual shareholder assessments at the rate of $26.55/share. Added to the most recent annual assessment of $20/share, this represents an increase of 133% from current shareholder assessments, to $46.55/share, and is all that RMR&DC feels the shareholders can currently afford on an ongoing basis.

Funding of the required loan reserve account would require an additional 10% of the annual loan payment for each of the first 10 years of the loan repayment period, or $3040 additional annually. This would require an additional $2.67/share for the first 10 years of the loan, for a total of $49.22/share before factoring in inflation.

As a private irrigation company, RMR&DC is not bound by TABOR restrictions on taxing and spending. The RMR&DC is currently debt-free, so the proposed construction loan would amount to the total debt owed by the RMR&DC. The RMR&DC secretary/treasurer keeps the company books and financial records; these have not been audited in recent years.

As collateral for the construction loan, RMR&DC would offer the enlarged dam and reservoir, and the associated storage rights, as that is the limit of the company's assets.

This leaves approximately $4.4 million dollars needed to pay for the remainder of the project cost. To cover this significant shortfall, RMR&DC intends to pursue additional financing via grants and investors/partners. Up until now, WSRA southwest basin grant funds, in the total amount of $78,400, along with a grant from the Southwestern Water Conservation District in the amount of $30,000, and matching funds from RMR&DC in the amount of $13,000, have been used to pay for necessary studies, including this one. RMR&DC will seek additional WSRA grant funds, both in the form of a SW Basin grant and a statewide grant, to proceed with the work. Also potentially in play are grants from other sources, although nothing has materialized yet. RMR&DC will continue to search for grant funding opportunities. If possible, RMR&DC would be willing to partner with other financing sources in return for a portion of the additional storage in the reservoir, and will continue to seek potential partners out. Until other financing sources are located, be they grants, loans, partners, water sales, etc, the project is not affordable.

Because financing arrangements other than the proposed CWCB construction loan have not yet been identified, it is not possible to define or describe those funding sources or the manner in which they would be used. Until this issue is resolved, the project is not financially feasible. This issue will be revisited as other funding sources are discovered.

The proposed project described in this feasibility study, the reservoir enlargement by 550 AF, in concert with construction of an enlarged dam and spillway acceptable to the Colorado SEO and the improvement of the dam outlet works, appears to be both administratively and technically feasible. The estimated $5.1 million cost of the project, however, appears to be well beyond the financial capacity of the sponsor. A CWCB construction loan of $700,000 is proposed to pay for the portion of the construction costs which the sponsor feels they can afford, leaving a very sizeable portion of the cost with no currently-identified source of funding. Until that issue is resolved, the project as proposed herein is not financially feasible.

It is recommended that the project sponsor continue to pursue other funding mechanisms in the form of WSRA grants, both basin and statewide, as well as other potential grant sources. Potential partners in the project or purchasers of the water should also be pursued. As funding sources become available, the financial feasibility of the project can be re-evaluated and re-presented to CWCB for consideration of water project loan.

Failure to locate funding for the project will prevent it from moving forward, and this may well lead to a full loss of storage in the reservoir, via either an imposed reservoir restriction or a breach order, as the State Engineer may feel obligated to enforce the requirement that the dam pass the IDF.

Professional judgments are presented in this report. These are based partly on evaluation of technical information gathered, partly on our understanding of this project and site, and partly on our general experience with similar projects. URS' services were performed within the limits prescribed by our scope of work, with the usual thoroughness and competence of the engineering profession. No other representation, expressed or implied, is included or intended in our proposals, contracts or reports. This study is intended for the sole use of RMR&DC. The scope of services performed during this study may not be appropriate to satisfy the needs of other users. Any use or reuse of this document or of the findings, conclusions, or recommendations presented herein is at the sole risk of said user. Background information, including topographic survey, and other data have been furnished to URS by the RMR&DC, the SEO, and/or third parties, which URS has used in preparing this report. URS has relied on this information as furnished, and is neither responsible for, nor has confirmed the accuracy of, this information.

Elkin, Alex D., 1967. ENG-Geology - *Red Mesa Ward Reservoir Dam, La Plata Conservation District, La Plata County, Colorado*, U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS).

Elkin, Alex D., 1975a. ENG-Geology - *Red Mesa Ward Reservoir Dam, San Juan Basin RC&D Project, La Plata County, Colorado*, February 4, 1975, USDA, SCS.

Elkin, Alex D., 1975b. ENG-Geology - *Red Mesa Ward Reservoir Dam, San Juan Basin RC&D Project*, *La Plata County, Colorado*, December 16, 1975, USDA, SCS.

Harris Water Engineering, Inc., *Red Mesa Reservoir Enlargement - Feasibility Study,* 1995.

Harris Water Engineering, Inc., *Red Mesa Reservoir Enlargement Concluding Report*, October, 2001.

Hertzman Consulting, LLC, *Operational River Model, La Plata River Basin - Final Draft* , January 22, 2014.

State of Colorado, Colorado Water Conservation Board, *Statewide Water Supply Initiative (SWSI)*, 2010.

State of Colorado, Division of Water Resources, Dam Safety Branch, *Rules and Regulations for Dam Safety and Dam Construction*, January 1, 2007.

Talbot, James R., 1975a. MGT-Trip Report - Colorado, April 14-18, 1975 - *San Juan RC&D, Red Mesa Ward Dam; Sentry Box Watershed, Reservoir Site; Canon City Watershed, Sites C-1 and C-2*, May 1, 1975, USDA, SCS.

Talbot, James R., 1975b. ENG-Soil Mechanics-Materials Testing - *San Juan RC&D Project, Colorado, Red Mesa Ward Dam*, December 9, 1975, USDA, SCS.

URS Corporation, *Incremental Damage Assessment and Inflow Hydrology for Red Mesa Dam*, May, 2011.

Wright Water Engineers, Inc., *Red Mesa Ward Dam Enlargement Feasibility Study*, April, 2003.

Appendix A

Red Mesa Articles of Incorporation

ARTICLES OF INCORPORATION

OF

THE REDMESA WARD RESERVOIR & DITCH COMPANY.

KNOW ALL MEN BY THESE PRESENTS, That we, Leo S. Taylor, James M. Slade, William Devenport, E. K. Ball and L. J. Dean, all residents of the County of La Plata and State of Colorado, and citizens of the United States, being desirous of associating ourselves together for the purposes and objects hereinafter set forth, and not for pecuniary profit, under, by virtue of and pursuant to the laws and statutes of Colorado in such case made and provided, do hereby associate ourselves together, and we do hereby make, execute and acknowledge this, our certificate in writing in triplicate, of an intention so to become a body corporate, not for pecuniary profit, and we state and set forth:

ARTICLE I.

The corporate name of our said Company is "THE REDMESA WARD RESERVOIR & DITCH COMPANY".

ARTICLE II.

The particular business, purposes and objects for which our said Company is formed and organized are, to file on, appropriate or otherwise acquire four thousand acre feet, more or less, of the flood water of the La Plata River in said county and state, and other waters, for storage in reservoirs, for distribution and for the use of members of the Company and other persons entitled thereto, for domestic and irrigation purposes; to acquire by purchase or otherwise the title in the Company of the rights of way for headgates, ditches, flumes and of reservoirs for the carrying and conducting waters from the source of supply thereof to such reservoirs and the storage of such waters in such reservoirs, and the distribution of such waters to the members of the Company and other persons entitled thereto; to acquire by purchase or otherwise lands upon which to construct, maintain and operate the reservoirs of the Company for storage of waters therein for domestic and irrigation purposes; to construct, maintain and operate irrigation ditches, laterals, reservoirs and irrigation works, together with all necessary gates, dams, flumes, pipes and other appurtenances for the carrying, conveying storage and distribution of waters for irrigation and domestic purposes;

also to levy and collect pro rata and as may be provided by the by-laws of the Company, such assessments as may from time to time be necessary for the enlargement, repairs, maintenance, operation and superintendence of such irrigation works, ditches and reservoirs, and to provide for the sale of the memberships, membership certificates, rights and interests of the members of the Company and other persons entitled to receive water from said irrigation works, ditches and reservoirs for their default and neglect in payment of such assessments, all as may be provided by the by-laws of the Company.

ARTICLE III.

The headgate of the main feeder canal and ditch for taking and receiving flood waters from the La Plata River for storage in the main reservoir of the Company is on the right (west) bank of said river in the northeast quarter of the Northwest quarter (NE¼ NW¼) of Section 26, Township 34, north of Range 12, West of the N.M.P.M., La Plata County, Colorado, whence the north quarter corner of said section bears N. 76° 10' E. 1252 feet, more or less. From said headgate, said ditch extends in a general westerly direction on a line approximately as follows, to-wit:

Beginning at such headgate,
Thence N. 84° 00' W. 493 ft. to Sta. 1,
" N. 43° 50' W. 616 ft. to Sta. 2,
" S. 76° 25' W. 527 ft. to Sta. 3,
" S. 62° 25' W. 883 ft. to Sta. 4,
" S. 51° 45' W. 564 ft. to Sta. 5
" S. 27° 00' W. 210 ft. to Sta. 6,
" N. 08° 15' W. 570 ft. to Sta. 7,
" S. 85° 00' W. 92 ft. to Sta. 8,
" S. 76° 36' W. 792 ft. to Sta. 9,
" N. 79° 15' W. 204 ft. to Sta. 10,
" S. 60° 40' W. 289 ft. to Sta. 11,
" S. 47° 30' W. 910 ft. to Sta. 12, where it connects

with the reservoir of the Company hereinafter described. The stream and source from which the principal supply of water is to be taken for storage purposes in such reservoir is from the La Plata River, and the foregoing mentioned feeder and ditch to such reservoir from said river traverses portions of the the N½ of the NW¼ of Section 26, SW¼ of the SW¼ of Section 23, N½ of the NE¼ and the NE¼ of the NW¼ of Section 27, all in the above mentioned township.

ARTICLE IV.

The location of the main reservoir of the Company is on, and the lands which will be inundated by the waters stored in such reservoir, consist of the following, to-wit:

The east half of the northwest quarter of the northwest quarter ($E\frac{1}{2}$ $NW\frac{1}{4}NW\frac{1}{4}$), the west half of the northeast quarter of the northwest quarter ($W\frac{1}{2}$ $NE\frac{1}{4}$ $NW\frac{1}{4}$) of Section 27, the South half of the southwest quarter ($S\frac{1}{2}$ $SW\frac{1}{4}$), the northeast quarter of the southwest quarter ($NE\frac{1}{4}$ $SW\frac{1}{4}$), the west half of the northwest quarter of the southeast quarter ($W\frac{1}{2}$ $NW\frac{1}{4}$ $SE\frac{1}{4}$), the west half of the southwest quarter of the northeast quarter ($W\frac{1}{2}$ $SW\frac{1}{4}$ $NE\frac{1}{4}$), and the east half of the southeast quarter ($E\frac{1}{2}$ $SE\frac{1}{4}$) of Section 22, all in Township 34, north of Range 12,west of the N.M.P.M., La Plata County, Colorado.

ARTICLE V.

The use for which said water is intended to be applied is for the irrigation of land and domestic purposes.

ARTICLE VI.

The term of existence of this Company shall be twenty (20) years, unless sooner dissolved according to law.

ARTICLE VII.

The number of directors of this Company shall be five (5), and Leo S. Taylor, James M. Slade, William Devenport, E. K. Ball and L. J. Dean shall manage the affairs and business of this Company for the first year of its existence.

ARTICLE VIII.

The principal office of this Company shall be kept at Redmesa, La Plata County, Colorado, and a branch office may be opened and maintained at such other places in La Plata County, Colorado, as the Board of Directors may at any time determine, and the principal business of this Company shall be carried on in said La Plata County, Colorado.

ARTICLE IX.

The Directors of this Company are hereby empowered and directed to make such prudential by-laws as are proper and necessary for the management, conduct and control of the affairs, business and property of the Company, and shall include therein a provision for the issuance to the members of this Company certificates showing and evidencing the respective rights, interests and privileges of such members in the waters and in the use of waters for irrigation and domestic purposes as may be appropriated, conveyed and carried by the ditches of said Company from the La Plata River and other sources and as may be stored in the reservoirs of the Company. That such membership certificates as issued by this Company shall set forth therein and thereby the amount of water the several owners are entitled to use and enjoy for irrigation and domestic purposes as follows: one share for each acre foot of water as may be stored and distributed from the reservoirs of the Company. Also that said by-laws shall contain a provision that in the election of Directors of this Company cumulative voting shall be allowed to the members of this Company.

ARTICLE X.

Assessments may be levied and made against the interests in the Company owned by the members hereof, respectively, as shown by and according to the certificates of the Company issued to them as herein provided and under the by-laws of the Company, at any annual or special meeting of such members, as shall be necessary to defray the expenses of repairing, improving, maintaining and operating the irrigation system, ditches and reservoirs of the Company, and for the discharge of the debts and liabilities of the Company of every nature and description.

ARTICLE XI.

These Articles of Incorporation may be altered or amended by a vote of two-thirds of all membership certificates or shares of this Company issued and outstanding, at any regular meeting of the members, or at any special meeting of the members, whenever the call or notice for any such meeting shall contain the substance of such proposed alteration or amendments, and which such call or notice of such meeting shall be made and given in strict conformity with the by-laws of this Company.

IN WITNESS WHEREOF, We the incorporators hereof, have hereunto subscribed our names and affixed our seals as of this 23 day of July, A.D., 1923.

Geo. L. Taylor (SEAL

Thomas M. Slane (SEAL

William Davenport (SEAL)

E. K. Ball (SEAL)

L. J. Dean (SEAL)

STATE OF COLORADO,)
ss.
COUNTY OF LA PLATA.)

I, Michael Lister Jr., a Notary Public in and for said County in the State aforesaid, do hereby certify that Leo. S. Taylor, James M. Slade, William Devenport, E.K.Ball and L.J.Dean, who are personally known to me to be the persons whose names are subscribed to the annexed and foregoing Certificate or Articles of Incorporation, appeared before me this day in person, and each acknowledged that he signed, sealed and delivered said instrument of writing as his free and voluntary act for the uses and purposes therein set forth.

Given under my hand and notarial seal this 23 day of July A.D., 1923.

My commission expires July 30 1925.

Michael Lister Jr.
Notary Public.

CERTIFICATE OF RENEWAL OF THE CERTIFICATE OF INCORPORATION.

STATE OF COLORADO,)
) ss.
COUNTY OF LA PLATA.)

TO WHOM IT MAY CONCERN.

THIS IS TO CERTIFY That at a special meeting of the shareholders of The Redmesa Ward Reservoir & Ditch Company, held at Redmesa, County of La Plata, Colorado, on the 3rd day of September, 1943, duly called by the stockholders representing at least ten (10) per cent of the entire capital stock of the Company, the call being published once at least thirty days and not less that ten days prior to this date, in the Durango Herald-Democrat, a daily newspaper published at Durango, State of Colorado, and notice of said meeting having been mailed to each stockholder thirty (30) days prior to this date, there being represented at such meeting 22000 shares of the capital stock of said Company out of a total of 29425 shares outstanding.

That at said meeting a resolution was passed to have extended the corporate existence of this Company perpetually from and after the date of the expiration of the corporate life, the same being on August, 27, 1943, the resolution receiving a majoity vote of all the outstanding stock of the Company. The Vice-President and Secretary were authorized to certify this resolution under the corporate seal of the company, to send such certificate to the Secretary of State of the State of Colorado, to file duplicate certificate under the seal of the Company in the office of the County Clerk and Recorder of the County of La Plata, State of Colorado, and in pursuance of such resolution, we do hereby certify the same under the seal of the Company.

F. M. Parsons[signature]
Vice-President.

Attest: Elzie Taylor
Secretary.

(Corporate Seal)

A

STATE OF COLORADO

OFFICE OF THE SECRETARY OF STATE

UNITED STATES OF AMERICA,
STATE OF COLORADO. } ss.

CERTIFICATE·

I, **Byron A. Anderson,** *Secretary of State of the State of Colorado, do hereby certify that*

the annexed are full, true and complete copies of Articles of Incorporation and Certificate of Renewal of the Certificate of Incorporation of

THE REDMESA WARD RESERVOIR & DITCH COMPANY

as filed in this office and admitted to record. . . .

. . . . IN TESTIMONY WHEREOF *I have hereunto set my hand and affixed the Great Seal of the State of Colorado, at the City of Denver, this* ---Twentieth----- *day of* ------July------- *A. D.* 1972

Byron A. Anderson
SECRETARY OF STATE.

State of Colorado

OFFICE OF THE SECRETARY OF STATE

United States of America, } ss.
State of Colorado, }

CERTIFICATE

I, Carl S. Milliken, Secretary of State of the State of Colorado, do hereby certify that ---------- LEO S. TAYLOR --------
---------- JAMES M. SLADE ----------
---------- WILLIAM DEVENPORT ----------
---------- E. K. BALL ----------
---------- L. J. DEAN ----------
Citizens of the United States, and residents of the State of Colorado, being desirous of forming a corporation (not for pecuniary profit,) under and by virtue of the provisions of Chapter Nineteen (19) of the General Statutes of the State of Colorado, entitled "An Act to Provide for the Formation of Corporations." Approved March 14, 1877, have made, signed, acknowledged, and this --TWENTY-SEVENTH-- day of ---- AUGUST ---- A.D. 1923 at the hour of - 4:00 - o'clock -P- M. filed in my office the Certificate of Incorporation of ---------- THE REDMESA WARD RESERVOIR & DITCH COMPANY ----------

That in such Certificate is set forth the name of such Corporation, the particular business and objects for which said Corporation is formed, the number of its Directors, and the names of those Directors who are to manage the affairs and concerns of said Corporation for the first year of its existence, together with the location of its principal office and place of business in this State.

Now, Therefore, pursuant to the provisions of Section 132 of said Chapter 19, I hereby certify that the said ----------
---------- THE REDMESA WARD RESERVOIR & DITCH COMPANY ----------
is a duly organized Corporation under the laws of the State of Colorado.

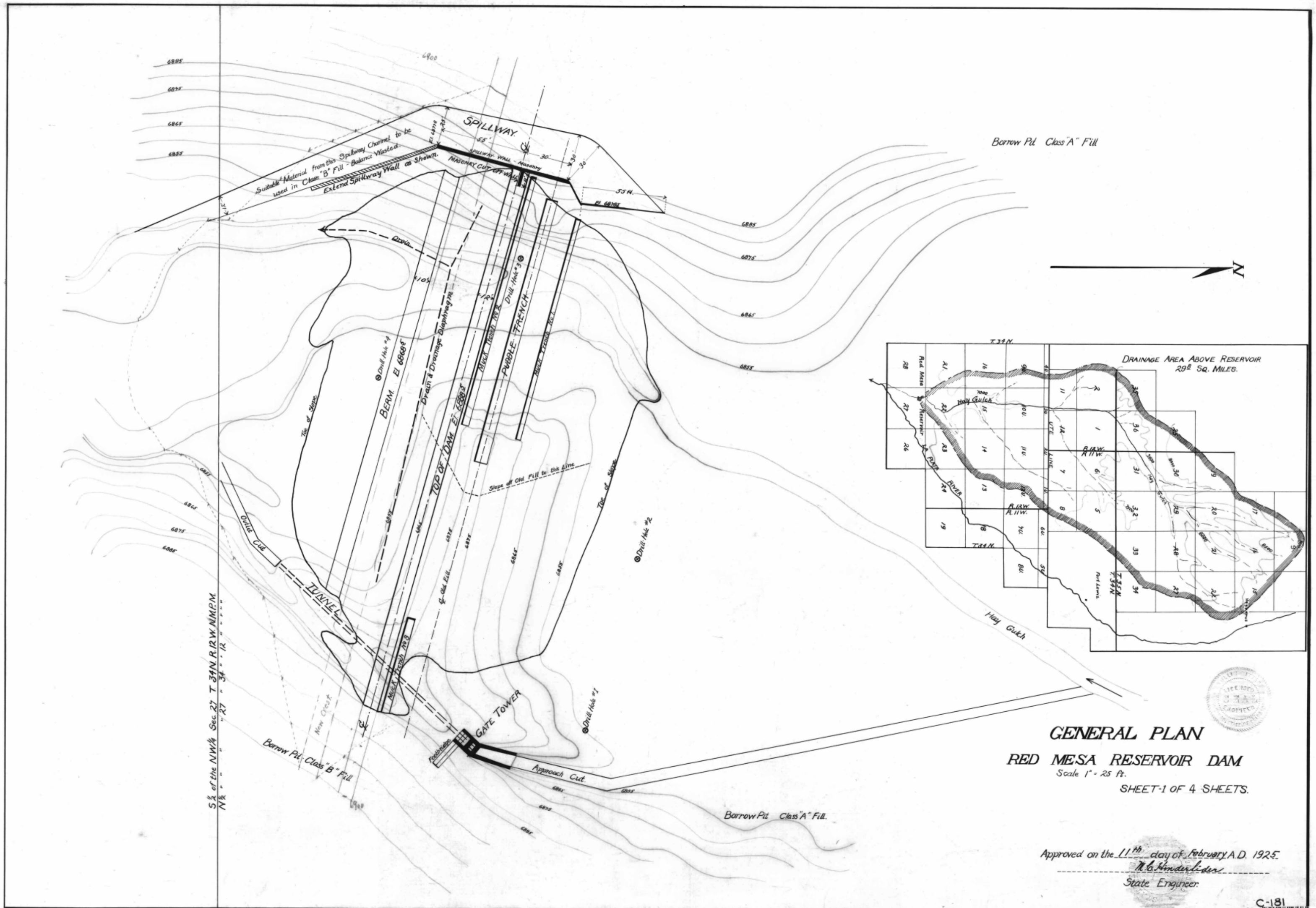
In Testimony Whereof, I have hereunto set my hand and affixed the Great Seal of the State, at the City of Denver, this TWENTY-SEVENTH day of ------ AUGUST ---- A.D. ------ 1923 ---------

Carl S. Milliken
SECRETARY OF STATE.

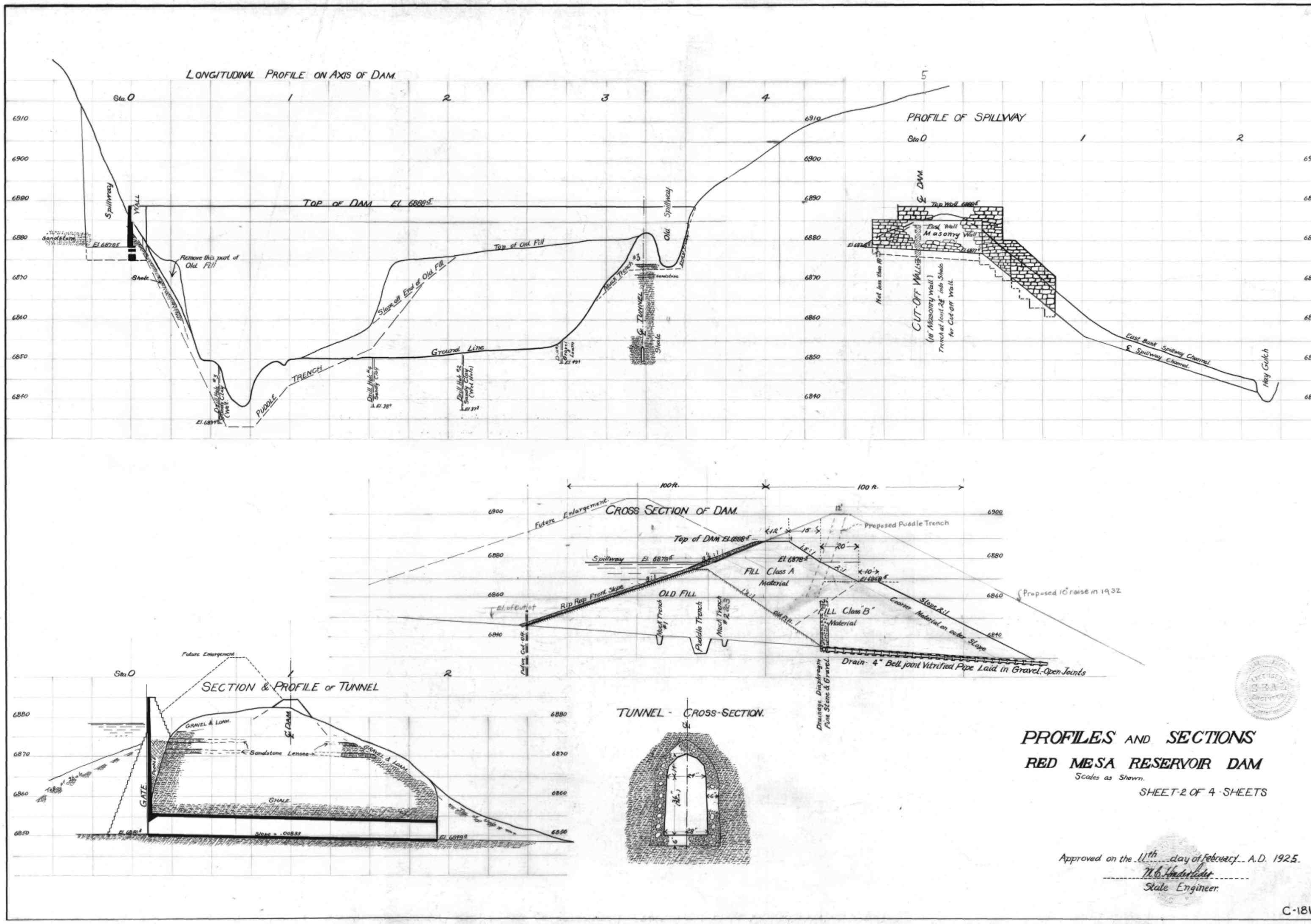
[signature]
DEPUTY.

Appendix B

Historic Design Drawings



SPILLWAY
Suitable Material from this Spillway Channel to be used in Class "B" Fill. Balance Wasted.
Extend Spillway Wall as Shown.
Masonry Cut-off Wall
Borrow Pit Class "A" Fill
Drain
BERM El 6868
Drain & Drainage Diaphragms
TOP OF DAM El 6883
PUDDLE TRENCH
Toe of Slope
Slope of Old Fill to this Line
Drill Hole #2
Drill Hole #1
Drill Hole #4
Outlet Cut
TUNNEL
GATE TOWER
Approach Cut
Borrow Pit Class "B" Fill
Borrow Pit Class "A" Fill
S½ of the NW¼ Sec. 27 T 34 N. R 12 W. N.M.P.M.
N½ " " " 27 " 34 " 12 "
N
DRAINAGE AREA ABOVE RESERVOIR 29.8 SQ. MILES.
Hay Gulch
La Plata River
T 34 N.
T 33 N.
R 12 W.
R 11 W.
GENERAL PLAN
RED MESA RESERVOIR DAM
Scale 1" = 25 ft.
SHEET-1 OF 4 SHEETS.
Approved on the 11th day of February A.D. 1925.
M. C. Hinderlider
State Engineer.
C-181



PROFILES AND SECTIONS

RED MESA RESERVOIR DAM

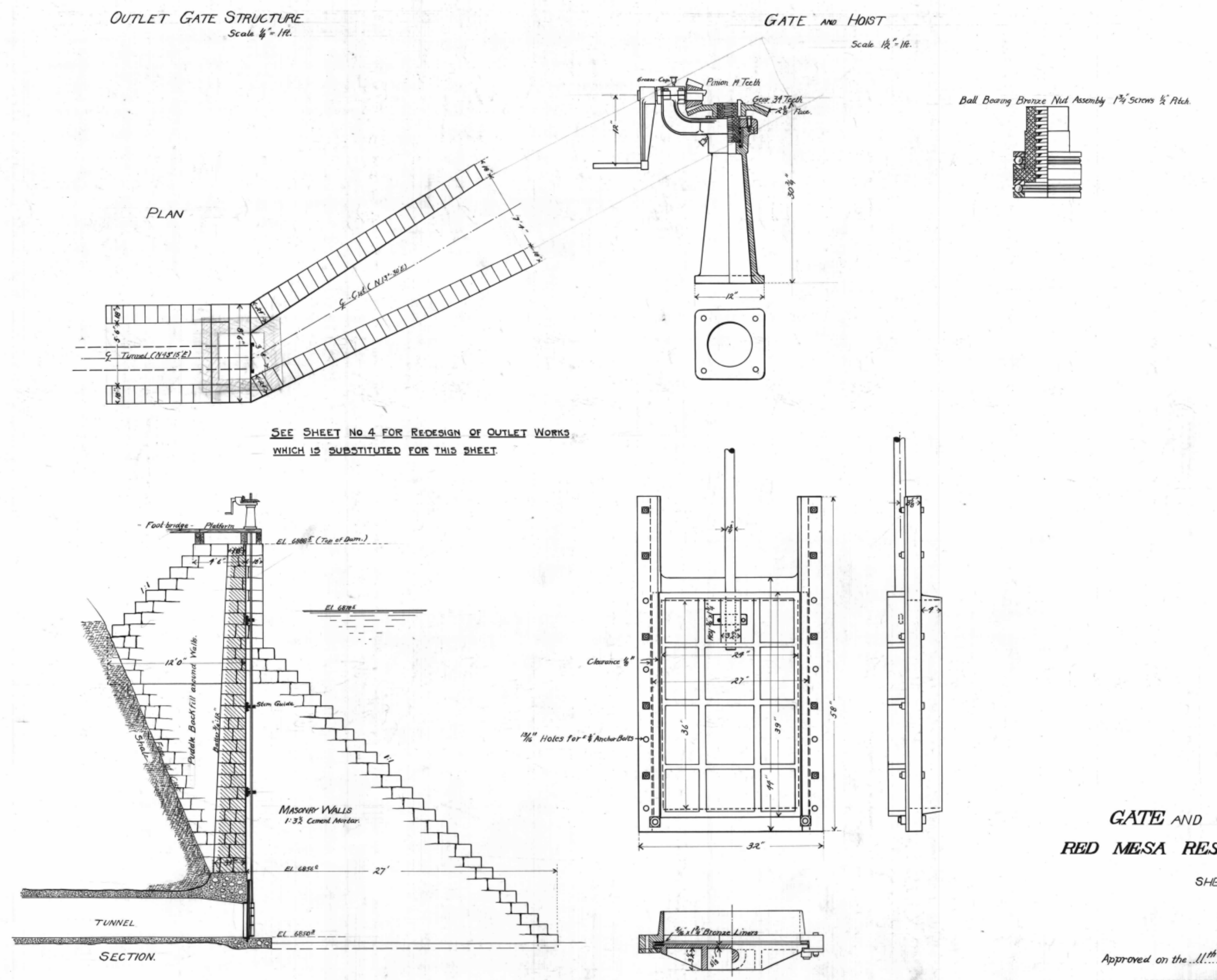
Scales as Shown.

SHEET-2 OF 4-SHEETS

Approved on the 11th day of February A.D. 1925.

M. C. Hinderlider
State Engineer.

C-181



GATE AND OUTLET

RED MESA RESERVOIR DAM

SHEET-3 OF 4-SHEETS

Approved on the 11th day of February A.D. 1925

[signature]

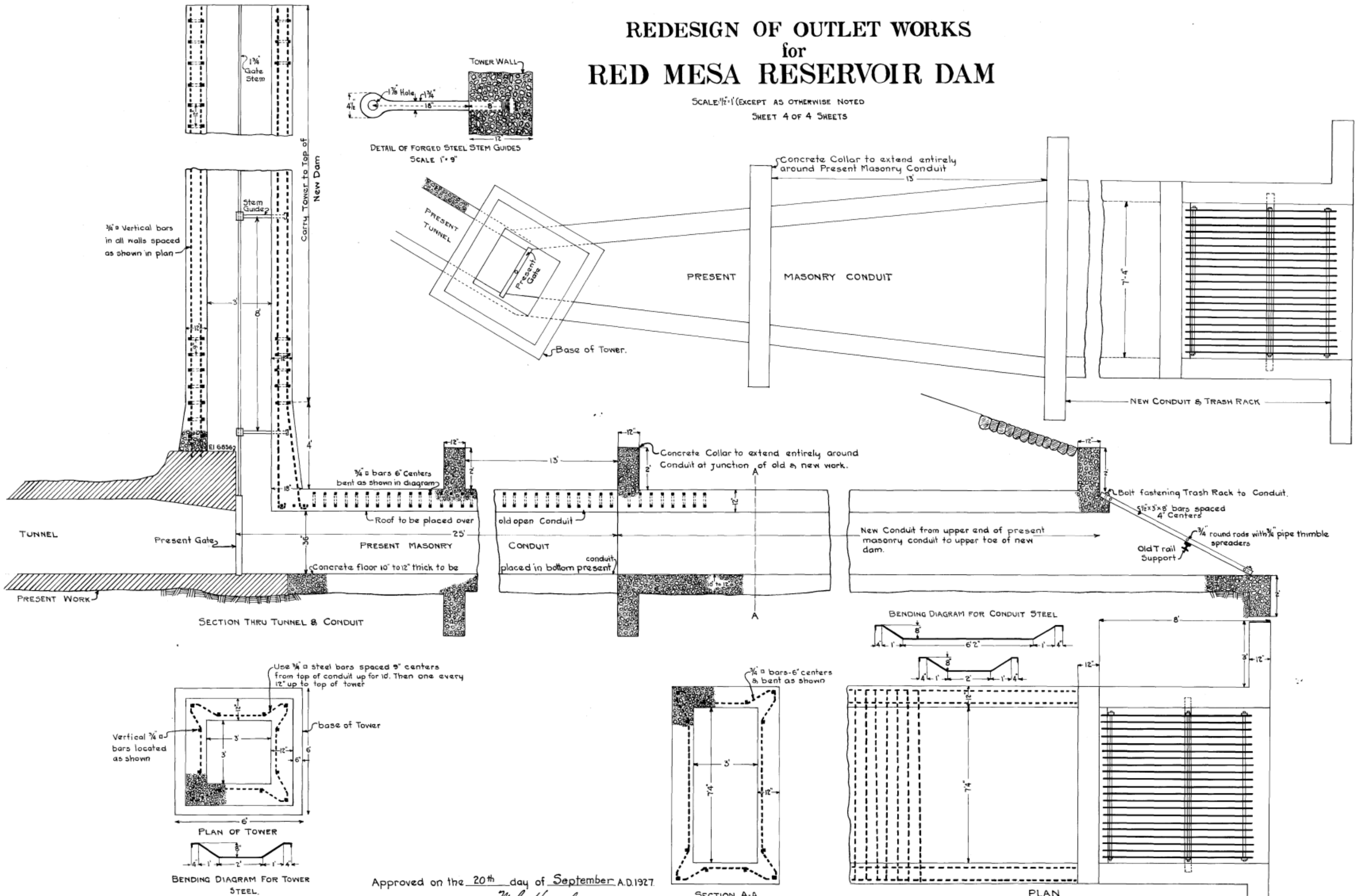
State Engineer

C-181

REDESIGN OF OUTLET WORKS for RED MESA RESERVOIR DAM

SCALE ¼" = 1' (EXCEPT AS OTHERWISE NOTED

SHEET 4 OF 4 SHEETS



Approved on the 20th day of September A.D. 1927.

M. C. Hinderlider

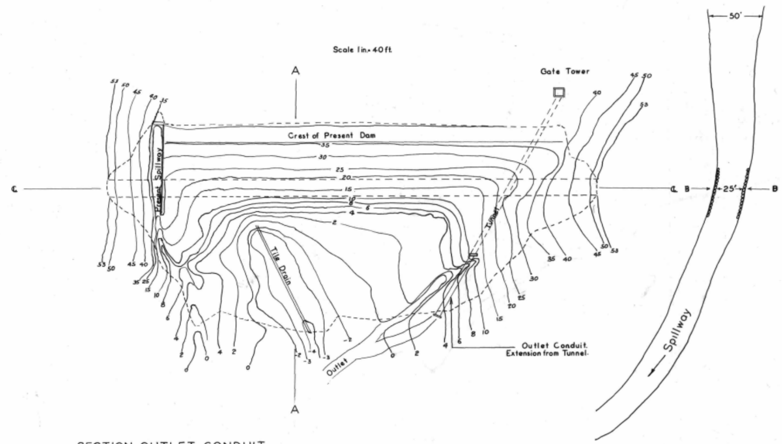
State Engineer.

C-181

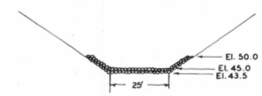
RED MESA WARD DAM

PLAN FOR ENLARGEMENT

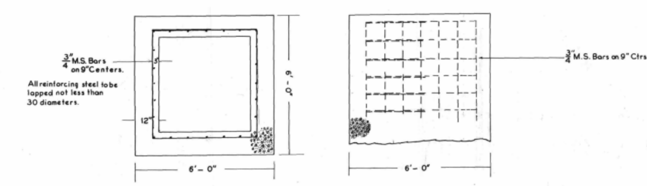
IRRIGATION DIVISION NO. 7.
WATER DISTRICT NO. 33.



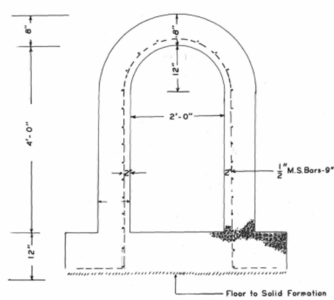
SPILLWAY - B - B.



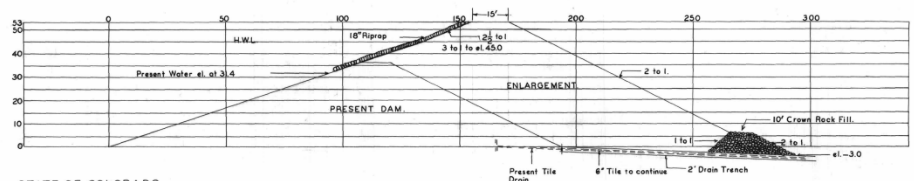
SECTIONS - GATE TOWER.



SECTION OUTLET CONDUIT.



MAXIMUM SECTION - A - A.



STATE OF COLORADO. }
COUNTY OF LA PLATA. } SS.

Allison L. Kroeger being duly sworn on his oath, deposes and says that he is the Engineer for the Enlargement of the Red Mesa Ward Dam; that the plans thereof were made under his supervision and instructions and that such plans are accurately represented hereon and are correct of his own knowledge and belief.

Allison L. Kroeger
Registered Engineer.

Subscribed and sworn to before me this *15th* day of *October* A.D. 1945.
My commission expires *April 12, 1948*

Earnest Fred Haralson
Notary Public.

"These Plans for the enlargement of the Red Mesa Ward Reservoir Dam have been accepted and approved by the undersigned as President of the Red Mesa Ward Reservoir and Ditch Company on the *15th* day of *October* 1945.

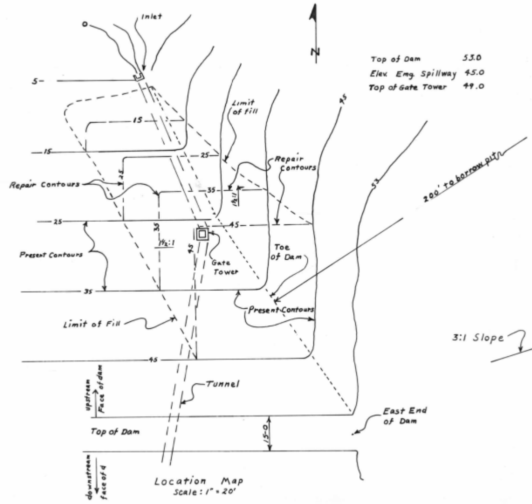
A. M. Lattimore
President.

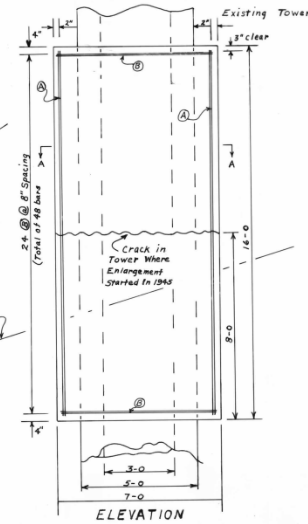
Approved this *15th* day of *October*
A.D. 1945.

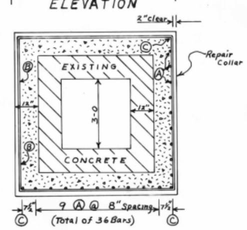
M. C. Hinderlider
State Engineer.

By ______________
Deputy.

C-419

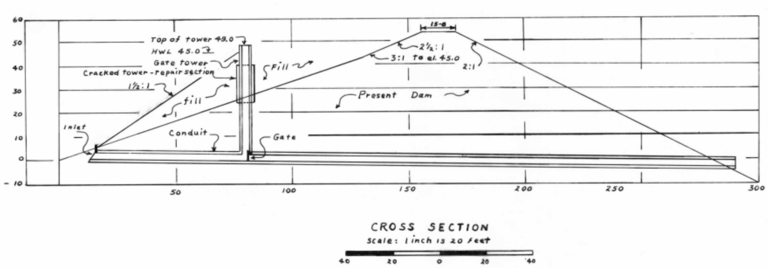






SECTION AA

SECTION AA
Scale: 1" = 2-0'



CROSS SECTION
Scale: 1 inch is 20 feet

BAR SCHEDULE

MARK	QUAN.	SIZE	LENGTH/MARK	Lb/ft.	LENGTH	WEIGHT
A	48	#6	14 - 9¼	1.502	709-0	1065
B	36	#6	15 - 6	1.502	558-0	838
C	4	#8	15 - 6	2.670	62-0	166
				TOTAL		2069 lbs.

NOTES

1. ALL CONCRETE SHALL BE CLASS A (6 SACK MIX).
2. BARS, WHERE SPLICED, WILL BE GIVEN A LAP OF 24 BAR DIAMETERS.
3. ALL DIMENSIONS NOT SHOWN AS CLEAR ARE TO ℄ OF THE BAR.
4. THE SURFACE OF THE OLD STRUCTURE SHALL BE KEPT MOIST FOR AT LEAST ONE HOUR PRIOR TO PLACEMENT OF THE NEW CONCRETE.
5. A TEMPORARY RETAINING WALL SHOULD BE CONSTRUCTED JUST ABOVE THE INLET TO PROTECT IT DURING PLACING THE FILL AROUND THE TOWER.
6. THE FILL MATERIAL THAT IS PLACED AROUND THE TOWER AFTER REPAIRS HAVE BEEN MADE SHALL BE: ROCKY SOIL, AND ROCK AVAILABLE NEAR THE SITE, COMPACTED BY THE TRACK OF A CRAWLER-TYPE TRACTOR. THIS WILL PROTECT THE SLOPE FROM WAVE ACTION AND THE TOWER FROM ICE ACTION.

Note. All conc. + Resteel will be placed in acordance with the 1971 standard Specifications of the Colo. Dept. of Highways

Item No.	Item	Quantity
1	Concrete 6 Sack mix	14.22 cy.
2	Steel rebar	2069 lbs.
3	Rock fill	1853 cy.

I hereby certify that these plans for the repair of the RED MESA WARD RESERVOIR DAM were prepared under my direct supervision for the owners thereof.

[signature] #5928
Registered Engineer

Subscribed and sworn to before me this 21st day of April, 1973

[signature]
Notary Public

My commission expires on the 18th day of Nov., 1974

I, J. Pat Green President owner, whose post office address is ______

do hereby accept and approve these plans for the REPAIR of the RED MESA WARD RESERVOIR DAM

______
Holder of Easement or Owner
by: ______

PLANS FOR THE

REPAIR OF RED MESA WARD RESERVOIR DAM

La Plata County, Colorado
Irrigation Division No. 7 Water District No. 33
Courses referred to — True Meridian
Scale: As shown.

SHEET __ OF __ SHEETS

Approved on the ___ day of ______, 19 __

______
State Engineer
by: ______
Deputy

AS BUILT
ACCEPTED
FOR FILING PURPOSES ONLY
MAY 25, 1973

C-419A

C-419A

Appendix C

SCS 1975 Geotechnical Reports

GEOLOGY

Red Mesa Ward Reservoir
and Ditch Company

BY: James R. Mason, Project Engineer, Durango, Colorado
Alex D. Elkins, Geologist, Denver, Colorado

IN COOPERATION WITH
La Plata Soil Conservation District

Mason

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 17107, Denver, Colorado 80217

SUBJECT: ENG - Geology - Red Mesa Ward Reservoir Dam, San Juan Basin RC&D Project, La Plata County, Colorado

DATE: December 16, 1975

TO: J. R. Fisher, State Conservation Engineer
SCS, Denver, Colorado

Detailed geologic investigations for final design of the enlargement at Red Mesa Ward dam were made during the period August 18-29, 1975. Eight test holes were drilled with a rotary drill rig to investigate the abutments of the dam and possible emergency spillway areas. A rock core barrel was used to obtain samples of bedrock materials. Forty-one test holes were dug with a backhoe in the dam foundation area, in potential borrow areas, along the principal spillway extension, in possible emergency areas, and in the present dam embankment. Six disturbed soil samples, mostly of borrow materials, were collected for analysis by the soils laboratory.

The main purposes of the present investigations were to determine geologic conditions in both abutments of the dam as related to foundation stability and seepage, to determine the best location for the emergency spillway and principal spillway, and to locate sources of borrow materials. Information on the embankment and foundation of the existing dam were obtained in a previous investigation during October and November 1974.

Previous reports on this site include: A geologic report by James Boyd in May 1936; geologic reports by A. D. Elkin on July 26, 1967, and February 4, 1975; trip reports by J. C. Stevenson on September 7, 1972, by J. R. Talbot on May 1, 1975, and by J. L. Holland on October 9, 1975; and a materials testing report by J. R. Talbot on December 9, 1975.

Description of Dam

The location and description of the dam is contained in previous reports. The proposal for enlarging the dam now involves raising the existing dam about 24 feet to an elevation of 6927.0 at the top of the dam. The emergency spillway crest would be at an elevation of 6918.0.

Geology

Bedrock underlying the dam abutments and foundation areas consists of gray silty clay shale, gray clayey and sandy siltstone, and yellowish-brown to light brown fine-grained sandstone of the Cliff House Formation of the Mesaverde Group. The general dip of the rock layers is at a gentle slope to the southeast. Slight seepage from the reservoir probably occurs at several places in the bedrock materials, but the only location at which significant amounts of seepage was observed in the bedrock was in the right (west) abutment about 100 to 150 feet downstream from the present dam centerline in the vicinity of T.H. 602 and 603. When these test holes were dug with a backhoe, water emerged from a two to three foot layer of fractured siltstone at about elevation 6853 to 6855. The flow from T. H. 602 was estimated to be between five and ten gallons per minute and for T. H. 603 about 15 gpm.

In the left abutment of the dam, bedrock is overlain by alluvial deposits consisting of layers of silty and clayey sand and layers of silty and clayey gravels having a maximum thickness of about 70 feet. These deposits were laid down along an ancient stream valley, which was probably ancestral to the present Hay Gulch.

Right Abutment

In the right (west) abutment, bedrock consisting of alternating layers of shale, siltstone, and sandstone lies at or near the surface. No serious problems of stability or seepage losses are expected in this area. A foundation drain should be installed along the layer of fractured siltstone in the vicinity of T. H. 602 and 603.

Left Abutment

In the left (east) abutment, relatively impermeable layers of shale, siltstone, and sandstone occur in the immediate vicinity of the east end of the dam, and no significant seepage areas were observed near the dam. Beyond the east end of the dam for a distance of about 1,000 feet from about Sta. 22+00 to Sta. 12+00, bedrock is overlain by alluvial materials reaching a maximum thickness of about 68 feet (elevation 6853) at T. H. 9.

The lower part of these alluvial deposits consists mainly of silty and clayey fine sands and sandy silts with some layers of well-graded silty sand and gravel. The materials are mainly below the present emergency spillway elevation and are for the most part probably only slightly permeable, since no large seepage losses have been reported from the reservoir. The layers of gravel and coarser sand are likely to be at least moderately permeable as evidenced by a seepage area which appears along a tributary of Hay Gulch about 1,000 feet downstream from the present emergency spillway. A trench has been excavated along this small valley to pick up the seepage water for irrigation use. The flow in this trench was about 20 gallons per minute with the water level in Red Mesa Reservoir about 10 feet below the high water line. This flow is probably somewhat greater when the reservoir is full.

The upper part of the alluvial deposits in the left abutment consists mainly of silty and clayey well-graded gravel and sand averaging about 20 feet in thickness. These materials appear to have a moderate to high permeability and should be cut off with a core trench in this part of the dam.

Principal Spillway

Four test holes were dug with a backhoe to investigate the location for the extension of the outlet conduit. Shale is at or near the grade of the conduit in the vicinity of T. H. 301, 302, and 304.

Emergency Spillway

Test holes were put down at both ends of the proposed enlarged dam to determine geologic conditions for an emergency spillway. At the east end of the new dam, it would be possible to locate the center section of the spillway entirely in sandstone, but most of the spillway excavation would be located in gravelly and sandy materials, and the spillway return would be in similar materials, which could erode considerably in large flows.

The most desirable location for the emergency spillway appears to be in the right abutment where layers of erosion resistant sandstone are present beneath the spillway crest elevation in the downstream section of the spillway area. Bedrock materials consisting of shale, siltstone, and sandstone layers are near the surface in the spillway return area and would be generally resistant to erosion. Much of the emergency spillway excavation would be in moderately hard to hard sandstone, which would be suitable for riprap on the new section of the dam.

Borrow Areas

Adequate amounts of suitable borrow materials appear to be available in two locations: (1) the area to the north and northeast of the east end of the new dam and (2) the area at the upstream end of the present reservoir area. The upper few feet of materials in these areas consists of reddish-brown eolian deposits classified in the field as silty and sandy clay (laboratory classification ML). Underlying these materials are several feet of silty well-graded gravels and sand (GM). Representative samples of these materials have been tested in the soils laboratory.

Conclusions

1. The bedrock materials in the dam foundation are generally satisfactory from the standpoint of stability and seepage losses from the reservoir. Small amounts of seepage can be expected in certain layers in the bedrock, such as the fractured siltstone layer in the lower part of the right abutment. In such places, drainage should be provided.

2. The sandy and silty alluvial materials lying deeper in the left abutment appear dense and relatively impermeable. No problems of stability or seepage losses are expected except for possible higher seepage losses in the gravelly portions of this deposit. An upstream blanket may be needed to reduce seepage losses in these deeper gravels.

3. The gravelly and sandy deposits in the upper 10 to 28 feet of the left abutment appear to be moderately to highly permeable and should be cut off with a core trench.

4. The most desirable emergency spillway location is in the right abutment where erosion-resistant sandstone underlies the downstream section of the spillway.

Alex D. Elkin

Alex D. Elkin
Geologist

cc: J. R. Talbot, SCS, Portland, Oregon
C. R. Hunter, SCS, Denver, Colorado
D. W. Gillaspie, SCS, Alamosa, Colorado
C. A. Betts, SCS, Durango, Colorado
W. J. Brown, SCS, Durango, Colorado
J. R. Mason, SCS, Durango, Colorado

MATERIALS TESTING SEC. ON DATA SUMMARY SHEET

Project: Red Mesa [illegible], Colo
Location:
Sheet 1 of 1

M.T.S. No.	Field No.	Location & Description	Depth ft	Field Class.	Unif. Class.	Att. Limits LL	Att. Limits P.I.	T.D.S. %	Gs -#4	Gs +#4	Abs. %	Mechanical Analysis % by dry weight: Gravel	Sand	Fines	Compaction Data ( ) γd pcf	Opt. M. %	Undisturbed Sample Data γd pcf	M %	Special Test Results: Triaxial φ	Triaxial C	Cons. @12TSF	Direct Shear	C	Perm ft/day	Abs.
750273	1.1	Dam ℄ Sta 24+80	10.0-20.0		CL-ML	31	8		2.62			Trace	29	81											
274	1.2	" " "	20.0-38.0		CL-1	33	11		2.67			Trace	14.5	85.5											
275	1.3	" " "	38.0-66.0		CL-1	28	9		2.66			Trace	15.5	84.5											
276	1.4	" " "	61.0-68.0		CL-1	30	9		2.66			Trace	15.5	84.5											
282	4.3	Dam Foundation	36.2-39.7		CL-1	30	9		2.67			0	10.0	90.0											
750277	2.1	Dam ℄ Sta 23+66	21.5-23.0		CL-1	31	9		2.63			Trace	12.5	87.5			105.4	20.6	11°	390	3%				
278	2.2A	" " "	32.0-33.5		CL-ML	26	6		2.66			7.6	15.7	76.5			108.0	17.9							
279	2.2B	" " "	"		CL-ML	29	7		2.66			Trace	14.0	86.0			101.8	21.2	13°	475	2.7%				
280	3.1	Dam Foundation	6.6-8.1		ML	27	4		2.65			12.5	18.5	69.0			105.4	19.7			3.8%				
281	4.1	" "	6.0-7.5		CL-1	29	9		2.62			1.5	11.5	87.0			95.5	27.4	13.5°	245	5.4%				
283	6.1	" "	9.3-10.5		CL-1	36	14		2.70			Trace	7.0	93.0			94.5	26.8	11.0°	245	4.0%				
284	6.3	" "	16.8-18.3		CL-ML	27	6		2.66			0	17.0	83.0			90.3	27.8	13.5°	140	7.3%				
285	7.1	" "	9.6-11.1		CL-ML	25	5		2.69			5.0	19.5	75.5			104.7	20.8			5.7%	22°	0		
286	7.2	" "	15.6-16.6		ML	NP	NP		2.67			7.0	28.5	64.5			103.0	21.6							
760038	54.1	Dam ℄ Sta 18+90	10.0-19.0		ML	NP	NP		2.66			2.0	36.0	62.0	111.3	14.0								3.25×10-3	95%
39	101.1	Borrow Area	0.0-3.0		ML	41	15		2.50			0	13.0	87.0	103.9	17.0			9.0°	130					
40	101.2	" "	3.0-8.0		GP-GM	23	1		2.66	2.50		70.5	29.5	0										4.86×10-1	2.2%
41	105.1	" "	2.0-6.0		GW-GM	23	1		2.64	2.56		65.5	34.5	0	127.7	8.8								2.88×10-1	
42	106.1	" "	3.0-10.0		ML	24	3		2.69			Trace	29.0	71.0	111.7	14.7			10.5°	245					
43	113.1	" "	9.0-13.0		GM	NP	NP		2.74	2.21		59.0	25.5	15.5	117.8	10.6									6.1%

3-75 Disturbed
3-76 Undisturbed
11-76 Disturbed

SOILS MECHANIC

Red Mesa Ward Reservoir
and Ditch Company

BY: James R. Mason, Project Engineer, Durango, Colorado
James R. Talbot, Soils Mechanic Engineer, Portland, Oregon

IN COOPERATION WITH
La Plata Soil Conservation District

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
West Technical Service Center, Portland, Oregon 97209

SUBJECT: ENG - Soil Mechanics - Materials Testing - San Juan RC&D Project, Colorado, Red Mesa Ward Dam

DATE: December 9, 1975

TO: James R. Fisher, State Conservation Engineer
SCS, Denver, Colorado 80217

We have completed the materials testing requested on the subject project. Reports of this testing are enclosed for your use in design. All testing under authorization of Colorado Work Order No. CO-SML-2-76 is now completed. Reports from previous testing completed in March 1975 were sent at that time.

We have analyzed the structure on the basis of all the testing completed to date for preliminary design purposes. This report summarizes all the testing and includes recommendations for design.

Testing Program

A total of 20 samples have been tested from this site. Included were nine undisturbed samples and six disturbed samples from the existing embankment and foundation. Five disturbed samples from the potential borrow areas were also tested.

Tests for classification and undisturbed density and moisture content were made on all undisturbed samples. Consolidation and triaxial shear tests were made on representative undisturbed samples to determine the expected settlement of the existing embankment and the required slopes after the additional height has been added. Compaction tests were made on representative samples of the borrow materials and two disturbed samples were selected for triaxial shear tests to evaluate the strength of the fine-grained borrow materials.

Results of analyses

A slope stability analysis was made using the measured strength values for the existing embankment and foundation materials. With the additional fill height, the effective slopes will need to be 3½ to 1 on the upstream side and 2½ to 1 on the downstream side. This is for the zoning pattern as shown on the attached sketch.

The consolidation test results indicate the existing embankment will settle approximately 3 to 5 percent of the existing fill height with the addition of the proposed fill. This amount will likely be representative of the newly placed silty clay material also. The foundation materials will settle approximately 7 to 8 percent of the depth of compressible foundation material.

Approximately one-third of this settlement will likely take place during construction. An appropriate overfill should be included for this amount of settlement.

Other Design Considerations

The major consideration deals with what must be done to the existing outlet conduit. If any of the existing conduit is to be left in place, this may dictate whether the additional embankment is placed on the upstream or downstream sides of the existing dam. The stability analysis was made assuming the addition will be placed on the downstream side. If the conduit is removed and replaced, this will require rebuilding most of the embankment. Slopes no steeper than 4 horizontal to 1 vertical should be used on excavations through the embankment where earthfill will be replaced against existing fill material.

Drainage will be needed on the downstream side and along both abutments where seepage flows have been observed from the present reservoir. The cutoff trench will need to be rather extensive or blanketing will be necessary on the deep permeable layers in the left abutment.

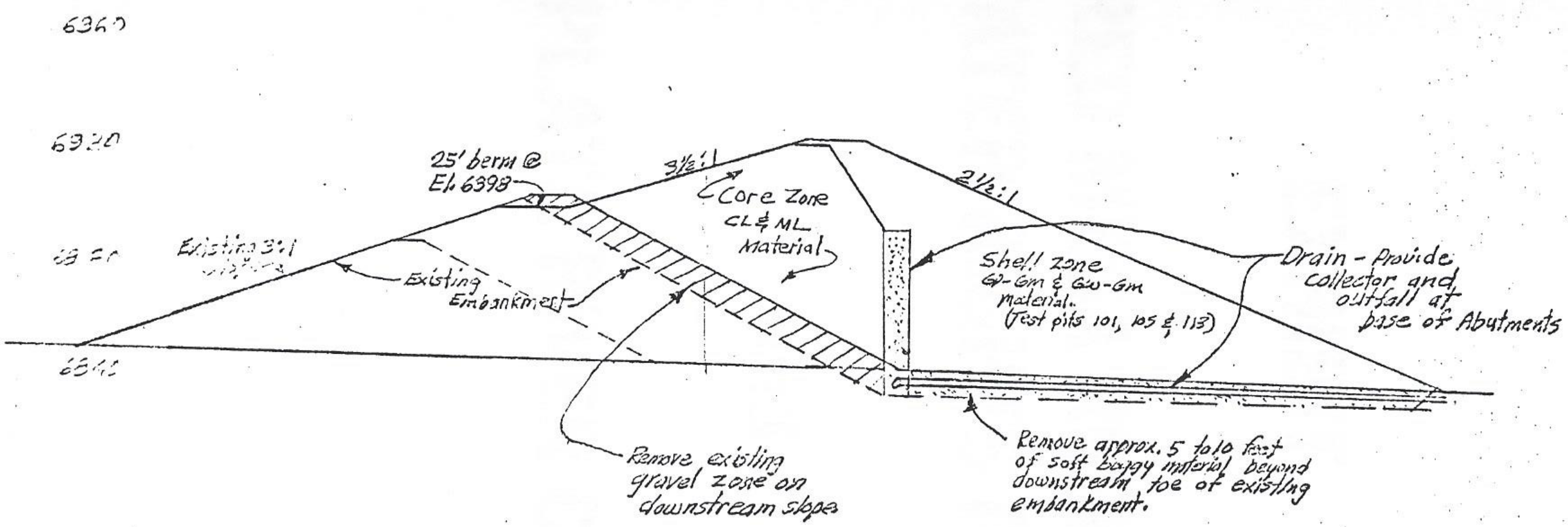
If we can be of further assistance in the use of the materials testing information or in advising in the preliminary design, please inform us.

James R. Talbot

James R. Talbot
Soil Mechanics Engineer

Attachments

cc: (w/attach)
Alexander D. Elkin, Jr., Geologist, SCS, Denver, Colorado



San Juan RC&D
Red Mesa Ward Dam
Materials testing Report
JRT 12/75

Appendix D

Spillway Alternatives Analysis

September 27, 2013

Mr. Jim Greer
Chairman
RedMesa Reservoir and Ditch Company
7882 County Road 100
Hesperus, CO 81326

Subject: Spillway Alternatives Analysis, RedMesa Reservoir, La Plata County, Colorado

Dear Mr. Greer:

RedMesa Reservoir and Ditch Company (RedMesa) contracted with URS Corporation (URS) to develop conceptual level designs, cost estimates, and a technical memorandum for spillway alternatives for the RedMesa Reservoir located in La Plata County, Colorado. This technical memorandum summarizes the basis of the design, cost estimate, and recommendations for selecting a preferred alternative. The alternatives developed and considered for evaluation are summarized below:

1) Spillway design based on optimizing the required spillway crest length at the existing spillway crest elevation, and raising the embankment dam crest to pass the Spillway Design Flood (SDF)
    - In addition, two dam and reservoir enlargement alternatives including spillway size optimization to pass the SDF were evaluated; the enlargement alternatives are show below:
        - Raising the normal storage level by 4 feet (approximately 250 acre-feet)
        - Raising the normal storage level by 8 feet (approximately 550 acre-feet)
2) Providing flood overtopping protection consisting of Roller Compacted Concrete (RCC) for the existing embankment in concert with an enlarged spillway
3) Breaching the dam and draining, or the "Do Nothing" alternative

Conceptual level design drawings for these alternatives are provided as Attachment A. A cost estimate of each alternative is provided as Attachment B.

1. BASIS OF CONCEPTUAL DESIGN

RedMesa Dam is classified as a high hazard dam. The design basis for the project was generally developed based on the 2007 State Engineers Office (SEO) "*Rules and Regulations for Dam Safety and Dam Construction*" (SEO Rules), as well as engineering judgment, and typical industry standards for dam rehabilitation projects. Topography information for this analysis was provided by RedMesa and consisted of an AutoCAD drawing, dated 2002, with two foot contours and property line information created by Craig Surveying and Mapping. No survey information was specifically obtained for this evaluation.

URS Corporation
8181 E. Tufts Avenue
Denver, CO 80237
Tel: 303.694.2770
Fax: 303.694.3946

According to SEO Rules, high hazard dams should have a SDF capable of passing the Inflow Design Flood (IDF) generated from the Extreme Storm Precipitation Event (ESP). In May 2011, URS completed an Incremental Damage Assessment and Inflow Hydrology Report for RedMesa Reservoir; the resulting IDF, which was reviewed and approved by the SEO, was used for the spillway alternatives. The minimum SEO required residual freeboard of one foot was also assumed.

The design basis for specific design elements related to each alternative are summarized below.

1.1 EMBANKMENT AND SPILLWAY OPTIMIZATION ALTERNATIVES

- Given the significant increase in overall embankment height required by all the scenarios, and the placement of the additional embankment materials on the downstream side of the existing dam, the additional structural loading imposed on the downstream outlet conduit section was considered to be excessive. For that reason, the outlet conduit is assumed to be modified using a steel liner pipe grouted in place within the existing conduit and tunnel section.
- According to SEO Rules, high hazard dams should have an outlet works conduit capable of releasing the top five feet of the reservoir capacity in five days. Minimum size estimated to meet this criterion and used for this analysis, is a 21- inch diameter outlet pipe. Where feasible, the existing conduit was relined with a 21-inch welded steel pipe and the annulus between the existing conduit and new pipe was grouted. Where new conduit is required, a 21 inch welded steel pipe was encased in 4.5-foot by 4.5-foot concrete sections.
- For all embankment and spillway optimization alternatives, the base analysis assumes that the existing outlet works tower, upstream conduit section, and intake structure are removed and replaced with a new conduit and a new intake structure located at the pipe inlet. The new outlet works intake structure will be constructed to support a minimum 21-inch by 21-inch slide gate, which will be equipped with a hydraulic cylinder to open and close the gate. Stainless steel conduits will carry hydraulic fluid to the manual power unit on the crest of the dam. A steel trashrack will be installed on the new intake structure. The hydraulic conduit lines required to operate the hydraulic cylinder will be encased in reinforced concrete along with the air vent pipe. The manual power unit for the hydraulically-operated slide gate will be installed in a reinforced concrete vault on the dam crest.
- Alternatives that increase the normal Water Surface Elevation (WSEL) require a new gate and operating system due to the inundation of the existing gate tower. Based on the condition of the existing gate tower, the non-enlargement scenario may not require replacement. The cost estimate assumes that a new gate and operating system is constructed for each of the embankment and spillway optimization alternatives.

Additional discussion related to reusing the existing gate tower is provided in the Cost Estimate Section.

- To mitigate erosion at the exit of the outlet works conduit, a new concrete impact basin and riprap is designed to dissipate energy prior to the release of flow downstream.
- The normal WSEL was derived from SEO documents and set at elevation 6892.8 feet (NAVD88). The normal WSEL corresponds to reservoir storage of 1,176 acre-feet. A four foot and eight foot normal WSEL raise will add approximately 250 and 550 acre-feet of storage, respectively.
- For the dam crest raise, the spillway excavation material was assumed to be used as embankment fill. Using the Craig topography and AutoCAD 3D modeling, the spillway excavation and dam embankment fill was balanced using a cut-fill shrink factor of 1.3. A geotechnical investigation will be required to confirm the excavated spillway material is acceptable as embankment fill.
- Spillway optimization led to dam crest elevation increases of 12, 13 and 14 feet for the no enlargement, 4-foot enlargement, and 8-foot enlargement alternatives, respectively. Spillway crest width varies from 125 feet to 185 feet to 275 feet for the three alternatives, respectively.
- The dam crest width of 25 feet was selected to meet SEO Rules for high hazard dams. The upstream embankment side slope of 3H:1V and downstream embankment side slope of 2.5H:1V were assumed and anticipated to be stable during steady state loading conditions. Design slopes may need to be revised during final design based on slope stability and seismic analysis.
- A grout injection allowance was provided for the alternatives that raised the normal WSEL. The costs associated with grouting the right abutment are unknown at the time of this study and will be dependent on site conditions and therefore an allowance was used rather than an estimate based on unit costs.
- Existing riprap on the upstream slope was assumed to be of acceptable size and condition and was tied in with the new riprap associated with the raised dam embankment section.
- A filter blanket and chimney drain consisting of sand filter material compatible with the existing and new embankment is designed to serve as a drainage zone by capturing seepage and any fine material entrained in seepage flows.
- All earthen disturbed areas are to be covered with a layer of topsoil and reseeded with native vegetation.
- A concrete cutoff wall was included in the design to serve as a control structure for the proposed emergency spillway. Reinforcement is not typically designed at the conceptual design level and would be included in final design.

- A low-flow notch was placed on the concrete cutoff wall to convey routine flows through the spillway. Design criteria for selecting the size of event (e.g., 5-year storm) for the low-flows through the cutoff wall and spillway will need to be considered to mitigate erosion and reduce maintenance during final design.
- For the enlargement scenarios, an allowance was included for the anticipated approximate cost of necessary environmental permitting activities associated with the additional depletions to the river. Actual cost of environmental permitting activities may vary over a wide range, depending on the amount of work required.

1.2 RCC OVERTOPPING ALTERNATIVE

- The RCC embankment overtopping protection, which extends for a length of 250 feet along the center section of the dam, is placed at the existing dam crest elevation of 6898.8 feet (NAVD88), and a downstream dam crest raise of 8.7 feet is utilized on either abutment of the dam to pass the SDF. Vertical concrete training walls are used on either side of the overtopping section to retain the raised embankment section. Per SEO Rules, the RCC embankment overtopping protection shall not operate for floods more frequent than the 100-year storm. With this alternative, the existing spillway is modified to pass the 100-year flood without activating the RCC embankment overtopping protection (emergency spillway).
- The existing outlet section downstream of the gate tower will need to be structurally improved to accommodate the additional loading due to the significant increase in structural fill height over the downstream slope of the dam. This is accomplished by using a steel liner grouted within the existing conduit and tunnel sections.
- Similar to the embankment and spillway optimization alternatives, the minimum size outlet conduit is used for this alternative is a 21-inch diameter outlet pipe. For the outlet section downstream of the existing gate tower, the existing conduit was relined with a 21-inch welded steel pipe and the annulus between the existing conduit and new pipe was grouted. Where new conduit is required to extend the outlet downstream, a 21-inch welded steel pipe was encased in 4.5-foot by 4.5-foot concrete section.
- For this alternative, the existing outlet works gate tower and bridge were used and modified with a 21-inch by 21-inch slide gate attached to the 21-inch liner pipe, which can be equipped with a hydraulic cylinder or a manual hand wheel to open and close the gate.
- Use of RCC is an accepted practice to armor embankments for use as emergency spillways. RCC has properties similar to conventional concrete, but has a lower strength due to lower cement content and is typically more cost effective to place than conventional concrete. For this design, a horizontal lift width of 10 feet was assumed to

allow for placement and compaction. The width of the armored overtopping section at the existing dam crest elevation is 22 feet.

- The raised embankment section on either side of the RCC placement has a crest width of 25 feet to conform with SEO requirements, and utilizes an upstream slope of 2.5:1 and downstream slope of 2:1, which are assumed to be stable during steady state loading conditions. Design slopes may need to be revised during final design based on slope stability and seismic analysis.
- RCC is placed on a filter/drain layer, shown on the concept drawings as a 1.5 feet thick sand layer. The filter/drain layer would serve as a drainage zone to reduce uplift pressures during emergency spillway operations, and would capture seepage and any fine material entrained in seepage flows.
- The stilling basin is conceptually sized to force a hydraulic jump within the basin, dissipate energy and mitigate erosion that could threaten the safety of the dam during the SDF event. Additional geotechnical evaluations would be required during final design.
- Vehicle access is provided along the emergency spillway crest elevation to provide access to both dam abutments. This access will not be available during emergency spillway flows.

1.3 BREACH THE DAM OR “DO NOTHING” ALTERNATIVE

- RedMesa Reservoir does not currently pass the approved IDF. The SEO has authority and may require the breach of the reservoir to comply with SEO rules; therefore, breaching the dam is considered the “Do Nothing” alternative.
- Per SEO Rules, the dam breach is required to be excavated down to the level of natural ground and shall pass the 100-year flood with a maximum increase in the reservoir depth of 5 feet. Therefore, the channel through the dam and reservoir is designed to restore the historical channel invert elevation by excavating a channel section designed to pass the 100-year event with a maximum depth of five feet. The excavated material will be spoiled within the reservoir area and graded to drain towards the new channel.
- For safety considerations, the existing intake tower and bridge was assumed to be removed and disposed offsite. The outlet works is not located within the breached dam section and should be abandoned by plugging the entrance and outlet.
- Erosion is dependent on vegetation, site soils, and flood velocities of the channel. The new channel will be covered with a layer of topsoil and reseeded with native vegetation. Since the channel will be restored to the historic longitudinal grade within Hay Gulch, the flood velocities and resulting erosion from the new channel at this slope is anticipated to be similar to conditions prior to the dam’s construction.

2. COST ESTIMATE

URS prepared a cost estimate based on quantities taken from the conceptual design drawings for the sole purpose of comparing alternatives. Pricing was based on URS' database for material costs from previous dam construction projects. The conceptual design is considered a Class 4 estimate by the Association of the Advancement of Cost Engineering (AACE) and reflects our professional opinion of the likely costs to construct the project including contingencies as recommended for this level of design. A Class 4 estimated is described by AACE as follows:

"Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation and preliminary budget approval. Typically, engineering is from 1% to 15% complete."

Actual contractor bids are affected by a number of factors beyond our control, such as the project location, supply and demand for this type of construction project at the actual time bids are due, changes in material and equipment costs, changes in labor rates, and design changes that may occur in final design. The estimated construction costs are in 2013 dollars and are based on the assumption that the work would be bid using an open, competitive procurement process. Estimated construction costs would need to be adjusted accordingly if construction begins after 2013. A summary of estimated costs are shown below in Table 1. The breakdown of quantities and unit costs are provided in Attachment B.

Table 1 – Spillway Alternatives Cost Estimate

Item	Spillway Optimization			RCC Overtopping	Breach Dam
	Maintain Existing Normal WSEL	4' Normal WSEL Raise	8' Normal WSEL Raise		
1. General Requirements	$209,000	$228,000	$242,000	$407,000	$145,000
2. Spillway Improvements	$448,000	$488,000	$534,000	$3,306,000	N/A
3. Dam Raise	$645,000	$776,000	$857,000	$84,000	N/A
4. Intake and Conduit Modifications	$504,000	$504,000	$504,000	$207,000	N/A
5. Restore Channel	N/A	N/A	N/A	N/A	$613,000
Construction Subtotal	**$1,806,000**	**$1,996,000**	**$2,137,000**	**$4,004,000**	**$758,000**
Contingency (30%)	$542,000	$599,000	$642,000	$1,202,000	$228,000
Engineering and Construction Management (18%)	$326,000	$360,000	$385,000	$721,000	$137,000
Environmental Permitting and Legal Allowance	$50,000	$300,000	$300,000	$50,000	$50,000
Land Acquisition and Flood Easements	$176,000	$188,000	$200,000	$4,000	N/A
Total	**$2,900,000**	**$3,443,000**	**$3,664,000**	**$5,981,000**	**$1,173,000**

It should be noted that for all spillway optimization alternatives shown in Table 1, Item 4 includes complete removal of the existing outlet gate tower, access bridge, conduit section upstream of the tower, and intake structure, and replacement with a new conduit, intake structure, gate and operating system. However, for the option of maintaining the existing normal water surface elevation only, it may be possible to utilize the existing structures solely with a new gate and operating system. This approach could result in a potential cost savings of approximately $300,000 for the non-enlargement alternative.

3. RECOMMENDATIONS

Conceptual designs of three alternatives were developed to evaluate potential options for rehabilitation of the dam. The alternative with the lowest estimated costs and continued operation of RedMesa Reservoir is optimization of the spillway crest length at the existing spillway crest elevation along with raising the dam crest to pass the SDF. If RedMesa selects this alternative, RedMesa may also want to consider the cost and benefit of adding reservoir storage by raising the normal WSEL during this construction. A 4-foot normal WSEL raise is estimated to cost an additional $543,000 for 250 acre-feet or approximately $2,200 per acre-foot. An 8-foot normal WSEL raise is estimated to cost an additional $764,000 for 550 acre-feet or approximately per $1,400 acre-foot. It should be noted that both enlargement scenarios involve an estimated fixed cost or allowance for environmental permitting which does not vary with the amount or size of enlargement. In reality, environmental permitting may result in an increased incremental cost depending on the size of the proposed enlargement.

Use of RCC overtopping protection for passing the IDF does not appear to be cost competitive, at approximately twice the cost of the spillway optimization alternative that maintain the current normal WSEL.

Breaching the dam incurs the lowest overall construction cost, but also results in a total loss of reservoir storage. The cost of each alternative should consider the incremental cost of the reservoir storage. For example, to maintain the existing 1,176 acre-feet of reservoir storage, the incremental cost is $1,727,000, or about $1,470 per acre-foot. Similarly, the two enlargement scenarios involve incremental costs of $2,270,000 (250 acre-feet) and $2,491,000 (550 acre-feet), or about $1,590 per acre-feet for 1,426 acre-feet total storage, and about $1,440 per acre-feet for 1,726 acre-feet total storage.

Once RedMesa selects the preferred concept from the alternatives, URS recommends a feasibility study be conducted to confirm the assumptions used in this study. The feasibility study should gather current topography and subsurface conditions through a detailed site investigation that may be used in future design phases. If RedMesa desires to pursue a loan package from Colorado Water Conservation Board, the feasibility study should be developed to meet Colorado Water Conservation Board requirements.

RedMesa will need to carefully consider the value of the water stored against the costs to repair/upgrade the dam and reservoir, and the anticipated ability of RedMesa to generate required revenues to construct the project. Consideration should be given to pursuing a combination of loans and grants, as available. RedMesa will need to evaluate its ability to repay loans acquired to complete the work through increased shareholder assessments, which would likely be a condition of any loan consideration.

4. STATEMENT OF LIMITATIONS

Professional judgments are presented in this report. These are based partly on evaluation of technical information gathered, partly on our understanding of this project and site, and partly on our general experience with similar projects. URS' services were performed within the limits prescribed by our scope of work, with the usual thoroughness and competence of the engineering profession. No other representation, expressed or implied, is included or intended in our proposals, contracts or reports. This technical memorandum is intended for the sole use of RedMesa Reservoir and Ditch Company. The scope of services performed during this conceptual design may not be appropriate to satisfy the needs of other users. Any use or reuse of this document or of the findings, conclusions, or recommendations presented herein is at the sole risk of said user. Background information, including topographic survey, and other data have been furnished to URS by the RedMesa Reservoir and Ditch Company, the SEO, and/or third parties, which URS has used in preparing these conceptual designs. URS has relied on this information as furnished, and is neither responsible for, nor has confirmed the accuracy of this information.

If you have any questions or require additional information, please contact Mark Belau at 303-740-3981 or mark.belau@urs.com, or Dennis Miller at 970-560-1582 or dennis.g.miller@urs.com.

Sincerely,

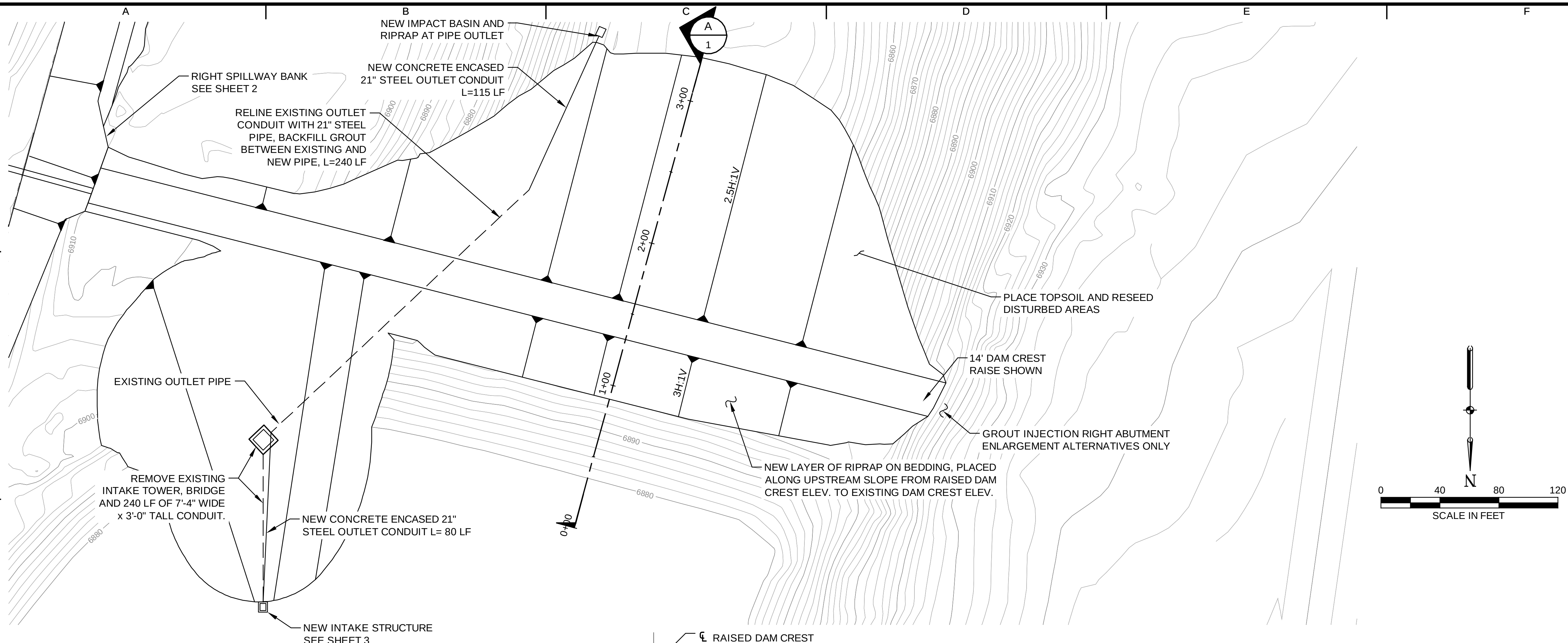
Mark Belau, PE
Project Manager

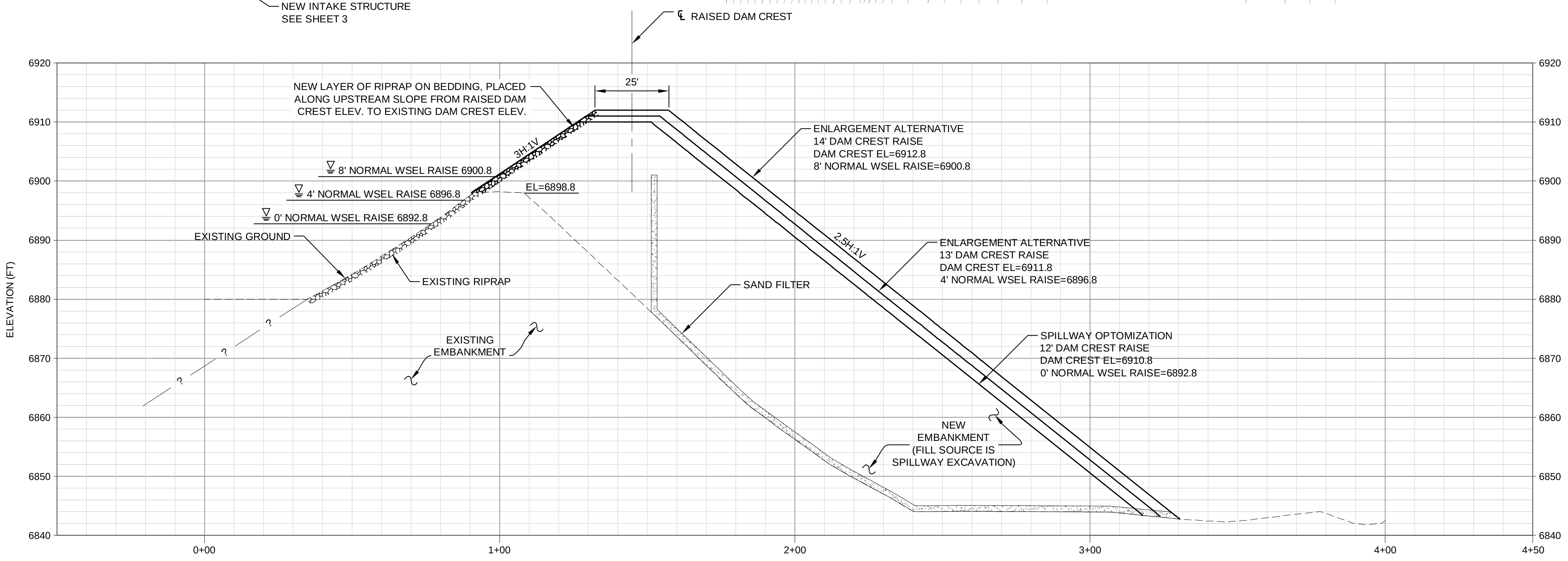
Dennis Miller, PE
Senior Civil Engineer

Attachment A Conceptual Design Drawings

Attachment B Cost Estimate

Attachment A
Conceptual Design Drawings





SECTION A
A
1

URS
URS Center
8181 East Tufts Avenue
Denver, Co. 80237-2637
303 694-2770 (phone)
303-694-3946 (fax)

REDMESA RESERVOIR AND DITCH COMPANY

REDMESA DAM ALTERNATIVES ANALYSIS

SPILLWAY OPTIMIZATION AND ENLARGEMENT ALTERNATIVES

ISSUED AUGUST 2013
DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

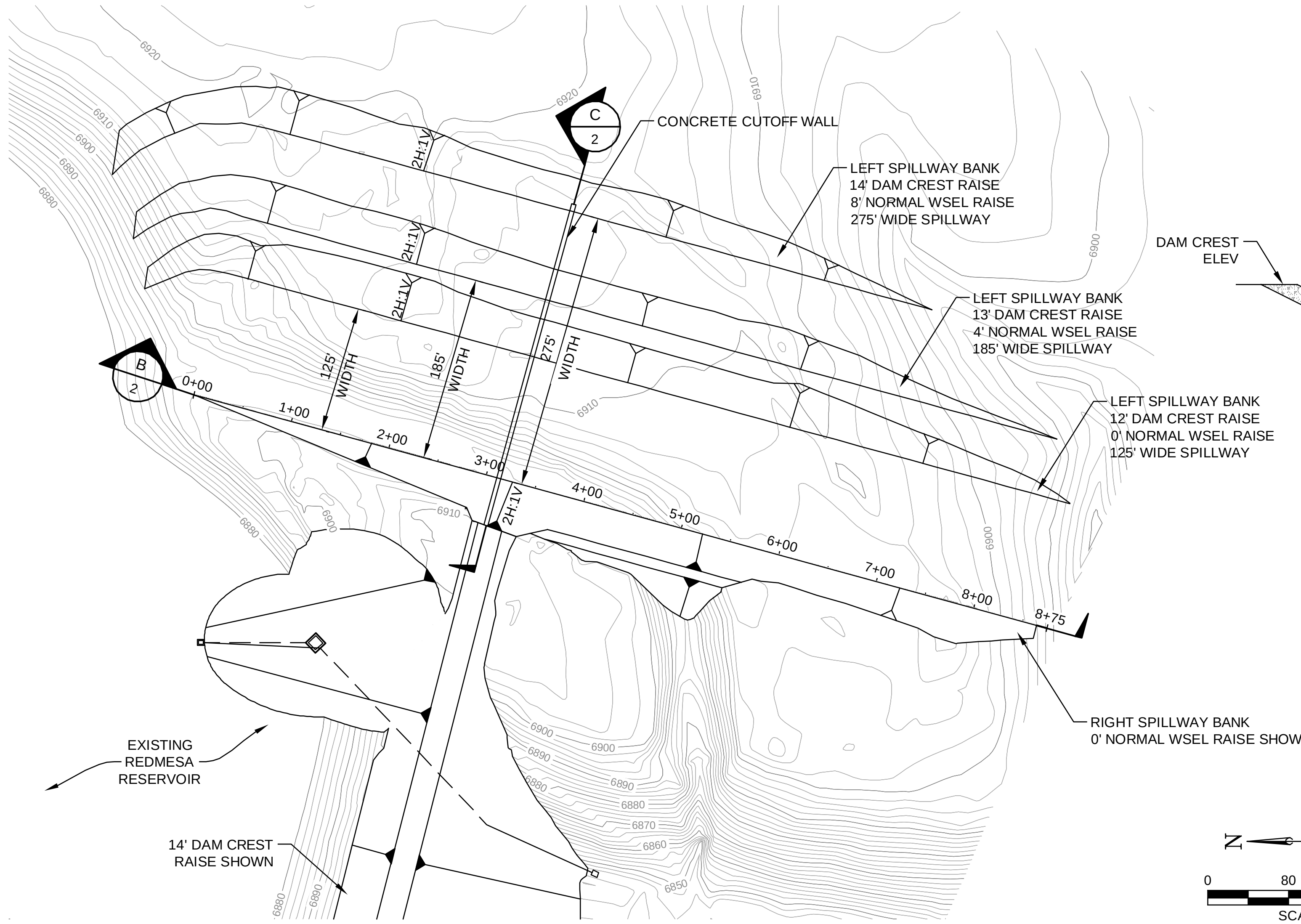
URS PROJECT NO:
DRAWN BY:
DESIGNED BY:
CHECKED BY:
DATE CREATED:
PLOT DATE:
SCALE:
ACAD VER:

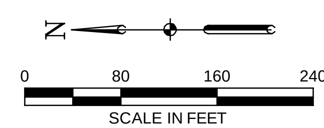
SHEET TITLE

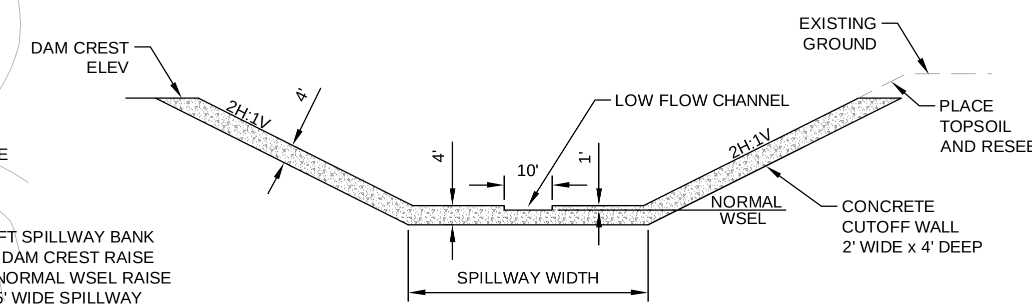
DAM PLAN & PROFILE

01

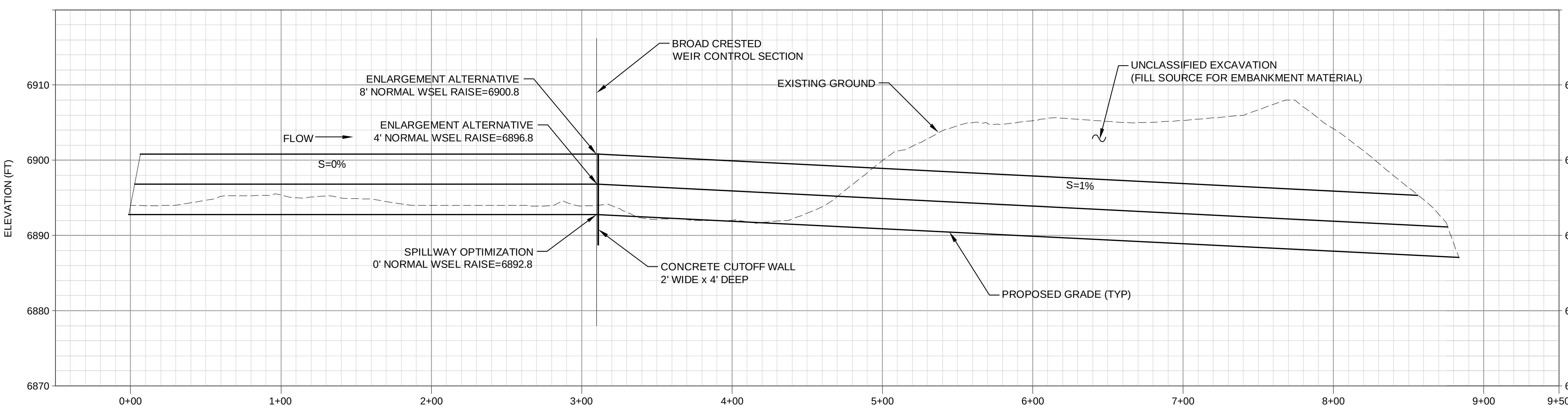
SHEET 01 OF 07







SECTION C/2
NOT TO SCALE



SECTION B/2

URS

URS Center
8181 East Tufts Avenue
Denver, Co. 80237-2637
303 694-2770 (phone)
303-694-3946 (fax)

REDMESA RESERVOIR AND DITCH COMPANY

REDMESA DAM ALTERNATIVES ANALYSIS

SPILLWAY OPTIMIZATION AND ENLARGEMENT ALTERNATIVES

ISSUED AUGUST 2013
DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

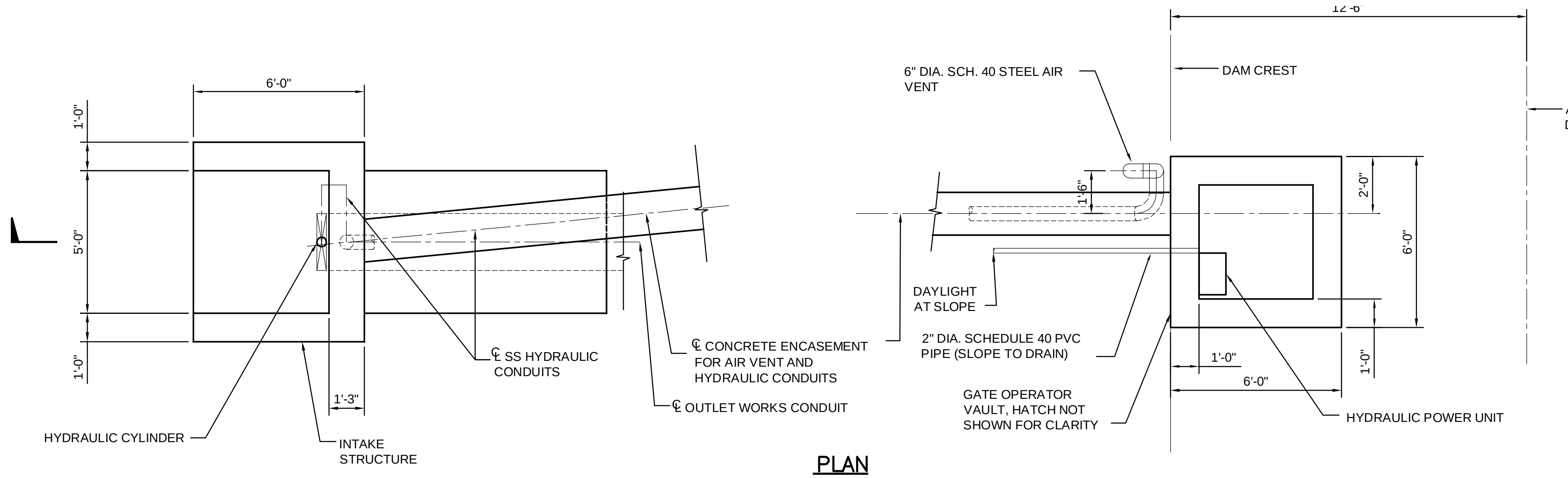
URS PROJECT NO:
DRAWN BY:
DESIGNED BY:
CHECKED BY:
DATE CREATED:
PLOT DATE:
SCALE:
ACAD VER:

SHEET TITLE

SPILLWAY PLAN & PROFILE

02

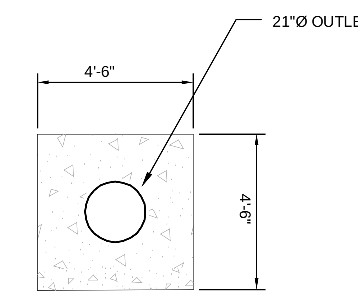
SHEET 02 OF 07



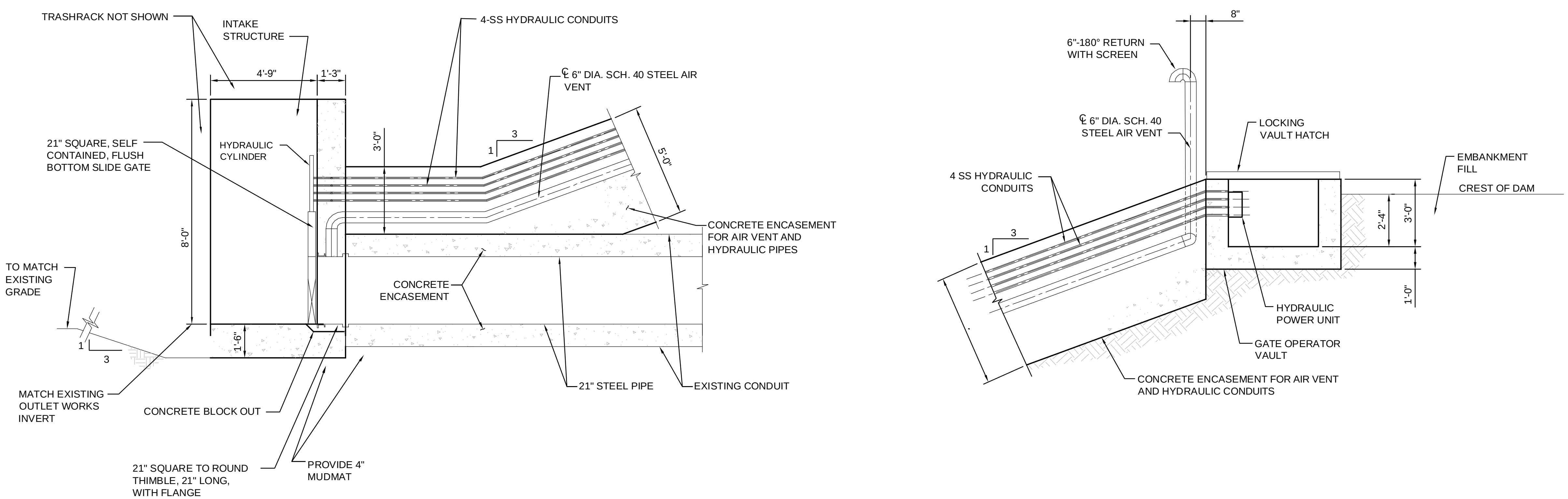
PLAN

0 2 4 8
SCALE IN FEET

A
3



CONCRETE ENCASED PIPE



SECTION A 3

0 2 4 8
SCALE IN FEET

URS

URS Center
8181 East Tufts Avenue
Denver, Co. 80237-2637
303 694-2770 (phone)
303-694-3946 (fax)

REDMESA RESERVOIR AND DITCH COMPANY

REDMESA DAM ALTERNATIVES ANALYSIS

SPILLWAY OPTIMIZATION AND ENLARGEMENT ALTERNATIVES

ISSUED AUGUST 2013
DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

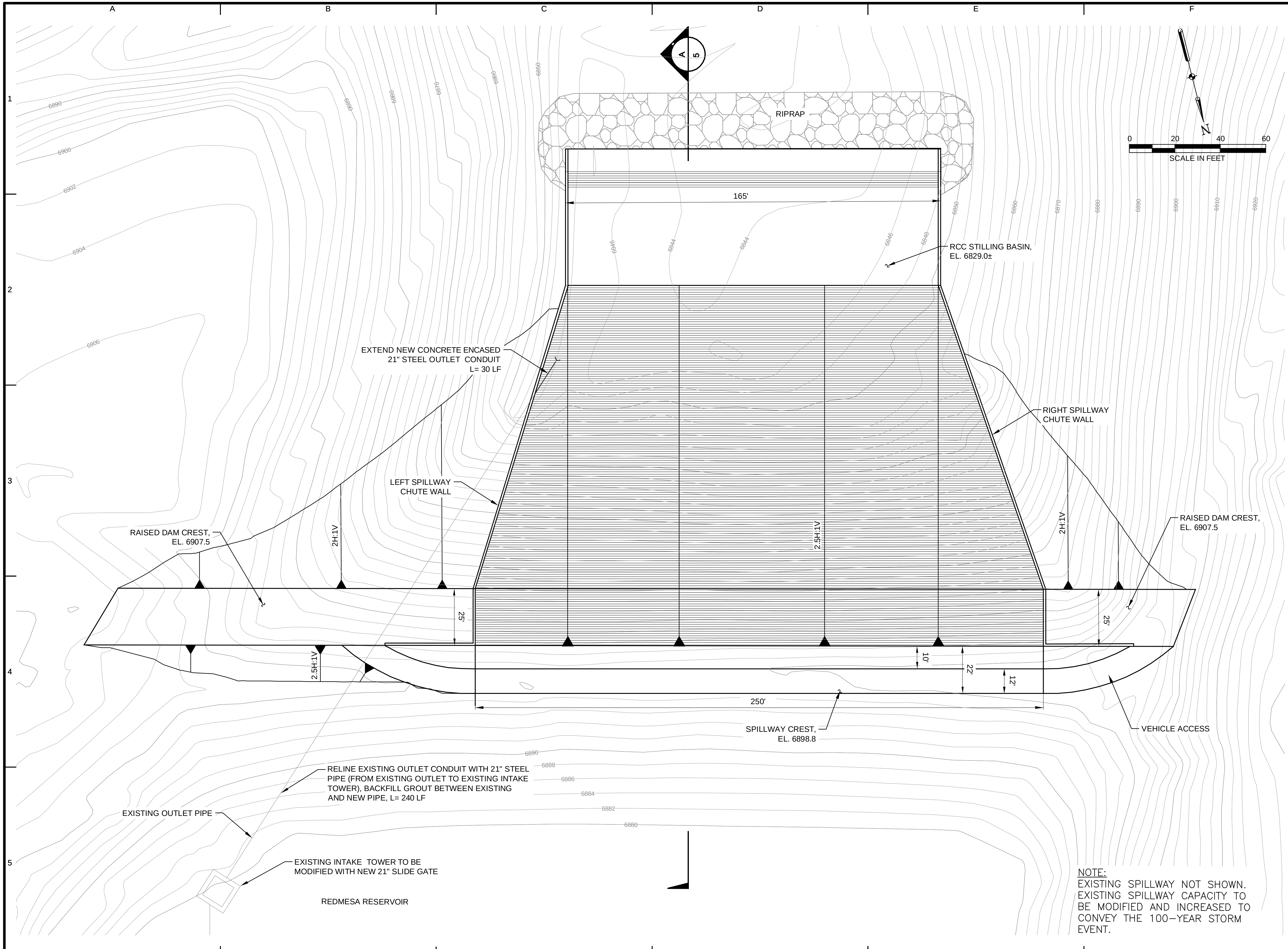
URS PROJECT NO:	
DRAWN BY:	JMC
DESIGNED BY:	MB
CHECKED BY:	MB
DATE CREATED:	04/08/13
PLOT DATE:	
SCALE:	SCALE
ACAD VER:	

SHEET TITLE

INTAKE STRUCTURE

03

SHEET 03 OF 07



NOTE:
EXISTING SPILLWAY NOT SHOWN. EXISTING SPILLWAY CAPACITY TO BE MODIFIED AND INCREASED TO CONVEY THE 100-YEAR STORM EVENT.

URS
URS Center
8181 East Tufts Avenue
Denver, Co. 80237-2637
303 694-2770 (phone)
303-694-3946 (fax)

REDMESA RESERVOIR AND DITCH COMPANY

REDMESA DAM ALTERNATIVES ANALYSIS

ROLLER-COMPACTED CONCRETE OVERTOPPING

ISSUED	AUGUST 2013
	DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

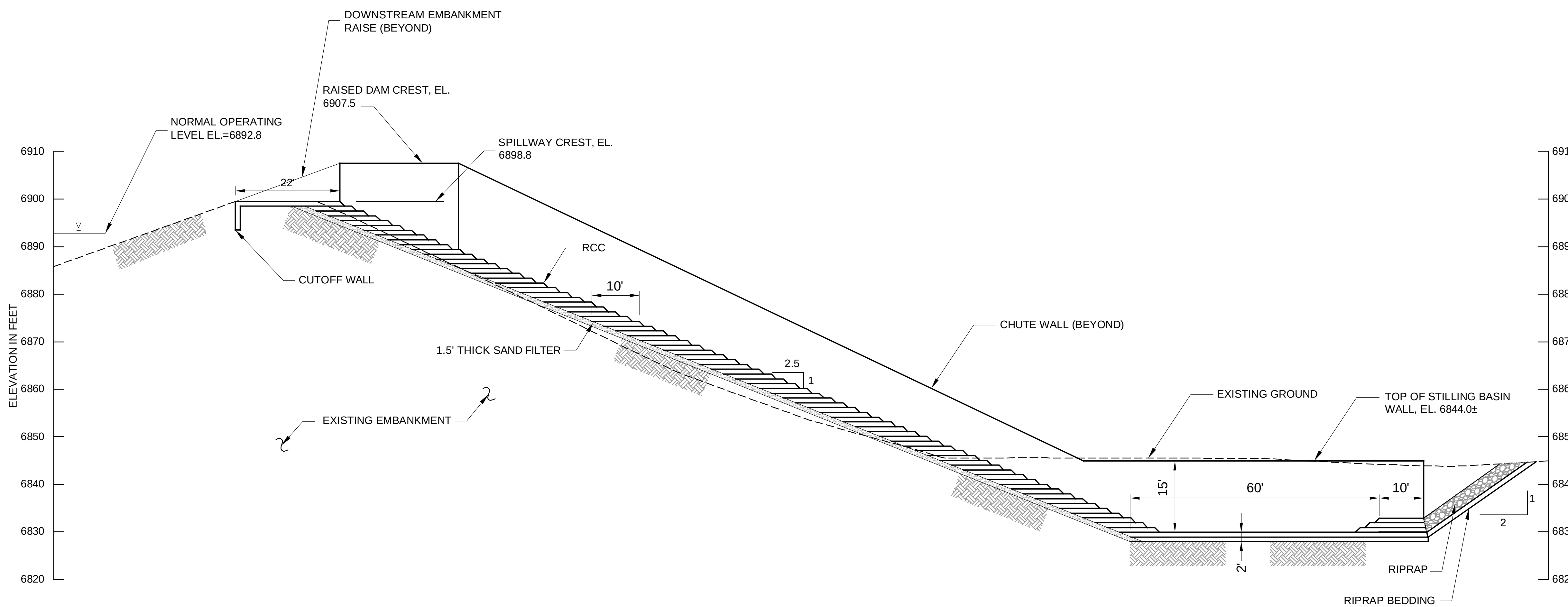
URS PROJECT NO:
DRAWN BY:
DESIGNED BY:
CHECKED BY:
DATE CREATED:
PLOT DATE:
SCALE:
ACAD VER:

SHEET TITLE

RCC DAM PLAN

04

SHEET 04 OF 07



SECTION
NOT TO SCALE

A
4

URS

URS Center
8181 East Tufts Avenue
Denver, Co. 80237-2637
303 694-2770 (phone)
303-694-3946 (fax)

REDMESA RESERVOIR AND DITCH COMPANY

REDMESA DAM ALTERNATIVES ANALYSIS

ROLLER-COMPACTED CONCRETE OVERTOPPING

ISSUED	AUGUST 2013
	DATE BY

REVISIONS

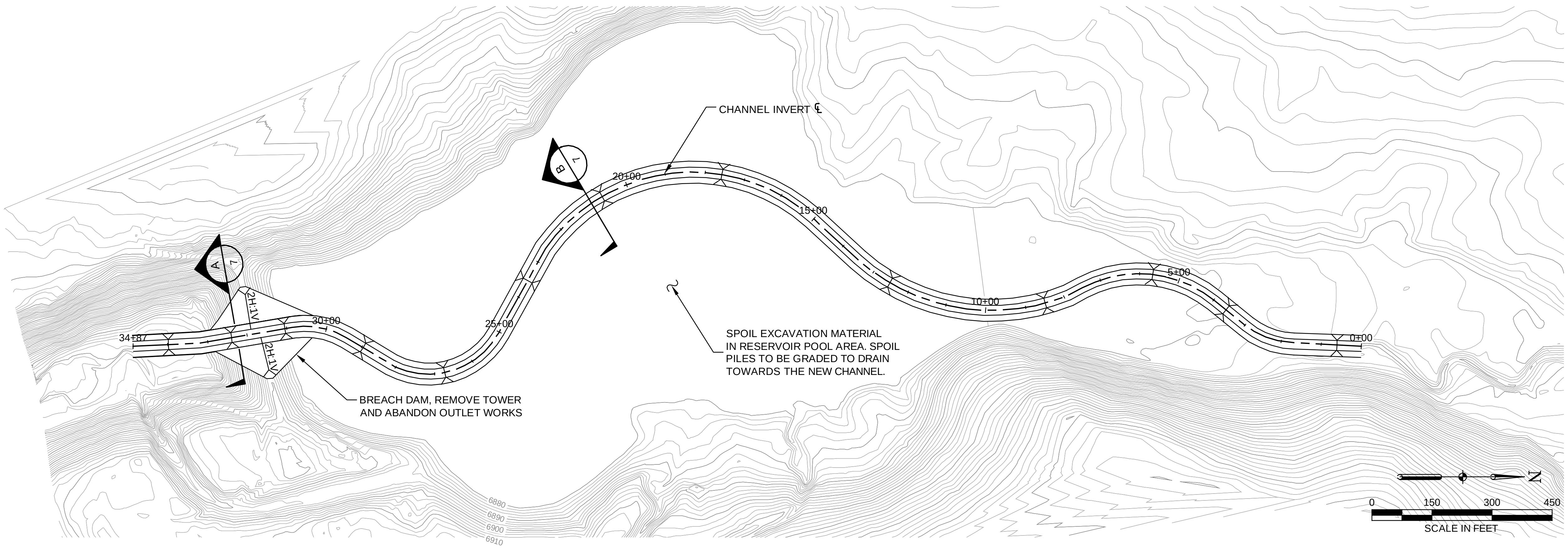
NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

URS PROJECT NO:	
DRAWN BY:	JMC
DESIGNED BY:	MB
CHECKED BY:	MB
DATE CREATED:	04/08/13
PLOT DATE:	
SCALE:	SCALE
ACAD VER:	

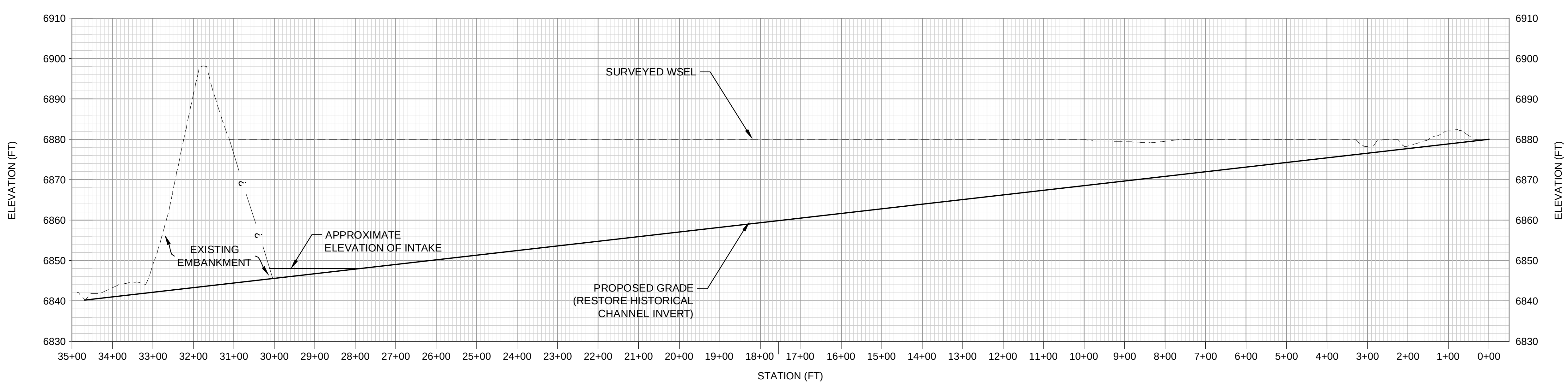
SHEET TITLE

RCC DAM PROFILE

05



CHANNEL PLAN



CHANNEL PROFILE

URS
URS Center
8181 East Tufts Avenue
Denver, Co. 80237-2637
303 694-2770 (phone)
303-694-3946 (fax)

REDMESA RESERVOIR AND DITCH COMPANY

REDMESA DAM ALTERNATIVES ANALYSIS

BREACH DAM OR "DO NOTHING" ALTERNATIVE

ISSUED AUGUST 2013 (DATE BY)

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

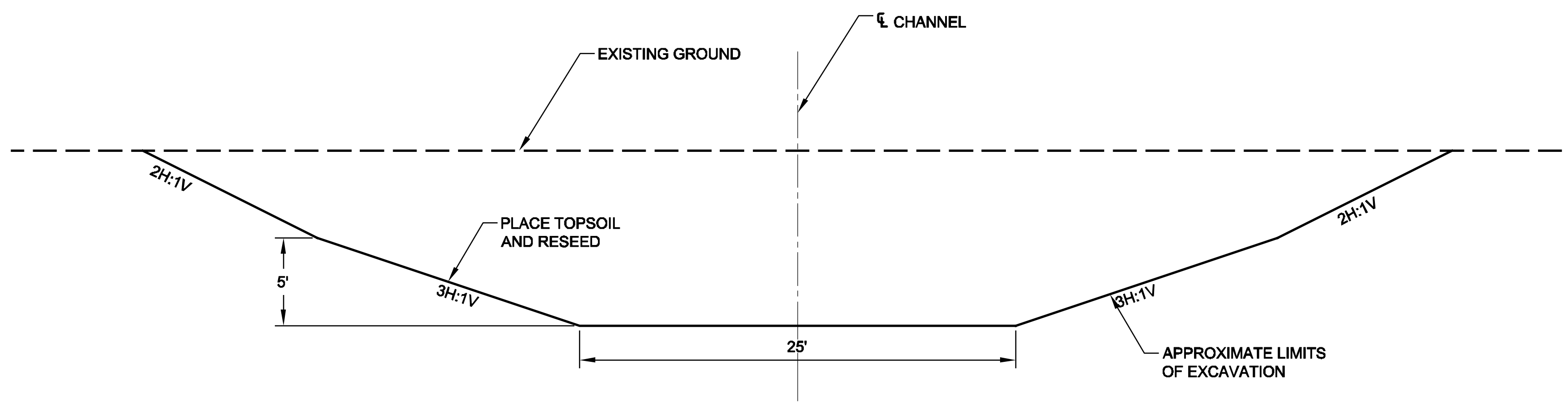
URS PROJECT NO:	
DRAWN BY:	JMC
DESIGNED BY:	MB
CHECKED BY:	MB
DATE CREATED:	04/08/13
PLOT DATE:	
SCALE:	SCALE
ACAD VER:	

SHEET TITLE

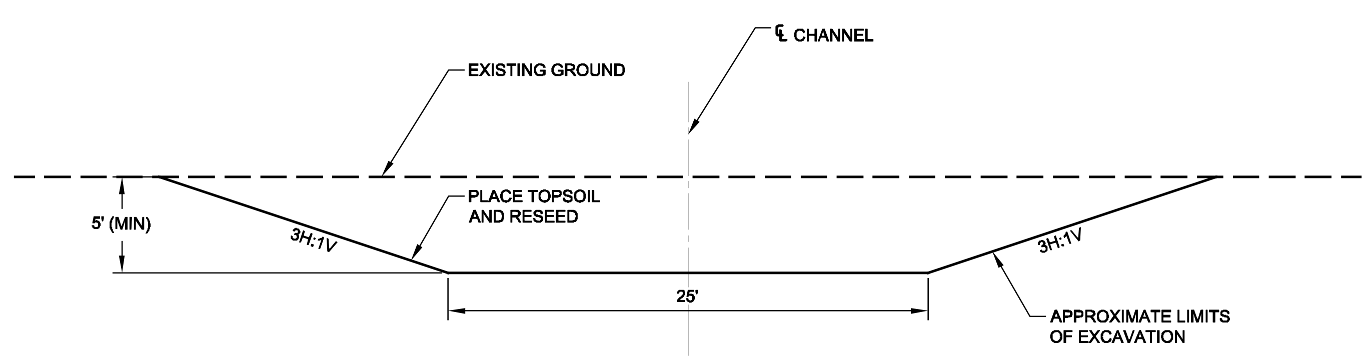
CHANNEL PLAN & PROFILE

06

SHEET 06 OF 07



TYPICAL SECTION THROUGH DAM
STA 30+00 TO STA 33+00
NOT TO SCALE
A / 6



TYPICAL CHANNEL SECTION
STA 0+00 TO STA 30+00
STA 33+00 TO STA 34+87
NOT TO SCALE
B / 6

URS

URS Center
8181 East Tufts Avenue
Denver, Co. 80237-2637
303 694-2770 (phone)
303-694-3946 (fax)

REDMESA RESERVOIR AND DITCH COMPANY

REDMESA DAM ALTERNATIVES ANALYSIS

BREACH DAM OR "DO NOTHING" ALTERNATIVE

ISSUED AUGUST 2013 (DATE BY)

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

URS PROJECT NO:
DRAWN BY:
DESIGNED BY:
CHECKED BY:
DATE CREATED:
PLOT DATE:
SCALE:
ACAD VER:

SHEET TITLE

CHANNEL SECTIONS

07

SHEET 07 OF 07

Attachment B
Cost Estimate

	REDMESA DAM ALTERNATIVE ANALYSIS				
	Maintain Existing Normal WSEL	4' Normal WSEL Raise	8' Normal WSEL Raise	RCC Overtopping	Breach Dam
1. General Requirements	$209,000	$228,000	$242,000	$407,000	$145,000
2. Spillway Improvements	$448,000	$488,000	$534,000	$3,306,000	N/A
3. Dam Raise	$645,000	$776,000	$857,000	$84,000	N/A
4. Intake and Conduit Modifications	$504,000	$504,000	$504,000	$207,000	N/A
5. Restore Channel	N/A	N/A	N/A	N/A	$613,000
Construction Subtotal	$1,806,000	$1,996,000	$2,137,000	$4,004,000	$758,000
Contingency (30%)	$542,000	$599,000	$642,000	$1,202,000	$228,000
Engineering and Construction Management (18%)	$326,000	$360,000	$385,000	$721,000	$137,000
Environmental Permitting and Legal Allowance	$50,000	$300,000	$300,000	$50,000	$50,000
Land Acquisition and Flood Easements	$176,000	$188,000	$200,000	$4,000	N/A
Total	$2,900,000	$3,443,000	$3,664,000	$5,981,000	$1,173,000

Maintain Existing Normal WSEL (0' Normal WSEL Raise)

Item Number	Item Description	Quantity	Unit	Unit Cost	Total Cost
1	General Requirements				$ 209,000
1a	Unlisted Items (10%)				$ 18,970
1b	Mobilization, Demobilization, and Preparatory Work	1	-	10%	$ 159,700
1c	Reclamation	3	Acre	$ 10,000	$ 30,000
2	Spillway Improvements				$ 448,000
2a	Unlisted Items (10%)				$ 40,700
2b	Excavation	73,000	CY	$ 5	$ 365,000
2c	Concrete Cutoff Wall	70	CY	$ 600	$ 42,000
3	Dam Raise				$ 645,000
3a	Unlisted Items (10%)				$ 58,580
3b	Fill	56,000	CY	$ 7	$ 392,000
3c	Sand Filter	1,600	CY	$ 50	$ 80,000
3d	Riprap	850	CY	$ 110	$ 93,500
3e	Riprap Bedding	290	CY	$ 70	$ 20,300
4	Intake and Outlet Conduit Modifications				$ 504,000
4a	Unlisted Items (10%)				$ 45,750
4b	21" Steel Outlet Conduit	435	LF	$ 200	$ 87,000
4c	Concrete Encasement	170	CY	$ 700	$ 119,000
4d	Backfill Grout-Reline Conduit	60	CY	$ 900	$ 54,000
4e	Remove and dispose of Existing Intake Tower, Bridge, and Conduit	1	LS	$ 25,000	$ 25,000
4f	New Intake Structure and Gate Operator	1	LS	$ 100,000	$ 100,000
4g	Hydraulic Lines and Air Vents	90	LF	$ 250	$ 22,500
4h	Outlet Works Impact Basin	1	LS	$ 50,000	$ 50,000
				Items 2 through 4 Subtotal	$ 1,597,000
				All Items Subtotal (Construction Subtotal)	$ 1,806,000
				Contingency (30% of Construction Subtotal)	$ 542,000
				Engineering and Construction Management (18% of Construction Subtotal)	$ 326,000
				Environmental Permitting and Legal Allowance	$ 50,000
-	Land Acquisition -Dam Raise, Spillway Modifications, and Pool Enlargement	4	Acre	$ 4,000	$ 16,000
-	Flood Easement	40	Acre	$ 4,000	$ 160,000
				Total	$ 2,900,000

4' Normal WSEL Raise

Item Number	Item Description	Quantity	Unit	Unit Cost	Total Cost
1	General Requirements				$ 228,000
1a	Unlisted Items (10%)				$ 20,680
1b	Mobilization, Demobilization, and Preparatory Work	1	-	10%	$ 176,800
1c	Reclamation	3	Acre	$ 10,000	$ 30,000
2	Spillway Improvements				$ 488,000
2a	Unlisted Items (10%)				$ 44,300
2b	Excavation	79,000	CY	$ 5	$ 395,000
2c	Concrete Cutoff Wall	80	CY	$ 600	$ 48,000
3	Dam Raise				$ 776,000
3a	Unlisted Items (10%)				$ 70,490
3b	Fill	61,000	CY	$ 7	$ 427,000
3c	Sand Filter	1,600	CY	$ 50	$ 80,000
3d	Riprap	920	CY	$ 110	$ 101,200
3e	Riprap Bedding	310	CY	$ 70	$ 21,700
3f	Grout Right Abutment Allowance	1	LS	$ 75,000	$ 75,000
4	Intake and Outlet Conduit Modifications				$ 504,000
4a	Unlisted Items (10%)				$ 45,750
4b	21" Steel Outlet Conduit	435	LF	$ 200	$ 87,000
4c	Concrete Encasement	170	CY	$ 700	$ 119,000
4d	Backfill Grout-Reline Conduit	60	CY	$ 900	$ 54,000
4e	Remove and dispose of Existing Intake Tower, Bridge, and Conduit	1	LS	$ 25,000	$ 25,000
4f	New Intake Structure and Gate Operator	1	LS	$ 100,000	$ 100,000
4g	Hydraulic Lines and Air Vents	90	LF	$ 250	$ 22,500
4h	Outlet Works Impact Basin	1	LS	$ 50,000	$ 50,000
				Items 2 through 4 Subtotal	$ 1,768,000
				All Items Subtotal (Construction Subtotal)	$ 1,996,000
				Contingency (30% of Construction Subtotal)	$ 599,000
				Engineering and Construction Management (18% of Construction Subtotal)	$ 360,000
				Environmental Permitting and Legal Allowance	$ 300,000
-	Land Acquisition -Dam Raise, Spillway Modifications, and Pool Enlargement	13	Acre	$ 4,000	$ 52,000
-	Flood Easement	34	Acre	$ 4,000.00	$ 136,000
				Total	$ 3,443,000

8' Normal WSEL Raise

Item Number	Item Description	Quantity	Unit	Unit Cost	Total Cost
1	General Requirements				$ 242,000
1a	Unlisted Items (10%)				$ 21,950
1b	Mobilization, Demobilization, and Preparatory Work	1	-	10%	$ 189,500
1c	Reclamation	3	Acre	$ 10,000	$ 30,000
2	Spillway Improvements				$ 534,000
2a	Unlisted Items (10%)				$ 48,500
2b	Excavation	85,000	CY	$ 5	$ 425,000
2c	Concrete Cutoff Wall	100	CY	$ 600	$ 60,000
3	Dam Raise				$ 857,000
3a	Unlisted Items (10%)				$ 77,900
3b	Fill	66,000	CY	$ 7	$ 462,000
3c	Sand Filter	1,700	CY	$ 50	$ 85,000
3d	Riprap	990	CY	$ 110	$ 108,900
3e	Riprap Bedding	330	CY	$ 70	$ 23,100
3f	Grout Right Abutment Allowance	1	LS	$ 100,000	$ 100,000
4	Intake and Outlet Conduit Modifications				$ 504,000
4a	Unlisted Items (10%)				$ 45,750
4b	21" Steel Outlet Conduit	435	LF	$ 200	$ 87,000
4c	Concrete Encasement	170	CY	$ 700	$ 119,000
4d	Backfill Grout-Reline Conduit	60	CY	$ 900	$ 54,000
4e	Remove and dispose of Existing Intake Tower, Bridge, and Conduit	1	LS	$ 25,000	$ 25,000
4f	New Intake Structure and Gate Operator	1	LS	$ 100,000	$ 100,000
4g	Hydraulic Lines and Air Vents	90	LF	$ 250	$ 22,500
4h	Outlet Works Impact Basin	1	LS	$ 50,000	$ 50,000
				Items 2 through 4 Subtotal	$ 1,895,000
				All Items Subtotal (Construction Subtotal)	$ 2,137,000
				Contingency (30% of Construction Subtotal)	$ 642,000
				Engineering and Construction Management (18% of Construction Subtotal)	$ 385,000
				Environmental Permitting and Legal Allowance	$ 300,000
-	Land Acquisition -Dam Raise, Spillway Modifications, and Pool Enlargement	20	Acre	$ 4,000	$ 80,000
-	Flood Easement	30	Acre	$ 4,000	$ 120,000
				Total	$ 3,664,000

RCC Overtopping

Item Number	Item Description	Quantity	Unit	Unit Cost	Total Cost
1	General Requirements				$ 407,000
1a	Unlisted Items (10%)				$ 36,970
1b	Mobilization, Demobilization, and Preparatory Work	1	-	10%	$ 359,700
1c	Reclamation	1	Acre	$ 10,000	$ 10,000
2	Spillway Improvements				$ 3,306,000
2a	Unlisted Items (10%)				$ 300,500
2b	Excavation	12,000	CY	$ 5	$ 60,000
2c	RCC	6,900	CY	$ 300	$ 2,070,000
2d	Sand Filter	2,300	CY	$ 50	$ 115,000
2e	Concrete Chute Wall	860	CY	$ 800	$ 688,000
2f	Riprap	540	CY	$ 110.00	$ 59,400
2g	Riprap Bedding	180	CY	$ 70.00	$ 12,600
3	Dam Raise				$ 84,000
3a	Unlisted Items (10%)				$ 7,550
3b	Fill	9,500	CY	$ 7	$ 66,500
3c	Road Base	90	CY	$ 100.00	$ 9,000
4	Intake and Outlet Conduit Modifications				$ 207,000
4a	Unlisted Items (10%)				$ 18,800
4b	21" Steel Conduit	300	LF	$ 200	$ 60,000
4c	Concrete Encasement	20	CY	$ 700	$ 14,000
4d	Backfill Grout-Reline Conduit	60	CY	$ 900	$ 54,000
4e	21" Slide Gate	1	LS	$ 60,000	$ 60,000
				Items 2 through 4 Subtotal	$ 3,597,000
				All Items Subtotal (Construction Subtotal)	$ 4,004,000
				Contingency (30% of Construction Subtotal)	$ 1,202,000
				Engineering and Construction Management (18% of Construction Subtotal)	$ 721,000
				Environmental Permitting and Legal Allowance	$ 50,000
-	Land Acquisition	1	Acre	$ 4,000.00	$ 4,000
				Total	$ 5,981,000

Breach Dam/ Do Nothing

Item Number	Item Description	Quantity	Unit	Unit Cost	Total Cost
1	General Requirements				$ 145,000
1a	Unlisted Items (10%)				$ 13,130
1b	Mobilization, Demobilization, and Preparatory Work	1	-	10%	$ 61,300
1c	Reclamation	7	Acre	$ 10,000	$ 70,000
5	Restore Channel				$ 613,000
5a	Unlisted Items (10%)				$ 55,700
5b	Excavation and Spoil	76,000	CY	$ 7	$ 532,000
5c	Remove and dispose of Existing Intake Tower and Bridge	1	LS	$ 20,000	$ 20,000
5d	Abandon Outlet Works	1	LS	$ 5,000	$ 5,000
Items 5 Subtotal					$ 613,000
All Items Subtotal (Construction Subtotal)					$ 758,000
Contingency (30% of Construction Subtotal)					$ 228,000
Engineering and Construction Management (18% of Construction Subtotal)					$ 137,000
Environmental Permitting and Legal Allowance					$ 50,000
Total					$ 1,173,000

Appendix E

La Plata River Compact

LA PLATA RIVER COMPACT

An act granting the consent and approval of Congress to the La Plata River compact. (Act of January 29, 1925, ch. 110, 43 Stat. 796)

[Consent of Congress to Compact.]—The consent and approval of Congress is hereby given to the compact signed by the commissioners of the States of Colorado and New Mexico at the city of Santa Fe, on the 27th day of November 1922, and approved by the Legislature of the State of Colorado by an act entitled "An act to approve the La Plata River compact," April 13, 1923, and by the Legislature of the State of New Mexico by an act entitled "An act ratifying and approving the La Plata compact," approved February 7, 1923, which compact is as follows:

"The State of Colorado and the State of New Mexico, desiring to provide for the equitable distribution of the waters of the La Plata River and to remove all causes of present and future controversy between them with respect thereto, and being moved by considerations of interstate comity, pursuant to Acts of their respective legislatures, have resolved to conclude a compact for these purposes and have named as their commissioners Delph E. Carpenter, for the State of Colorado, and Stephen B. Davis, Junior, for the State of New Mexico, who have agreed upon the following articles:

"ARTICLE I

"The State of Colorado, at its own expense, shall establish and maintain two permanent stream-gauging stations upon the La Plata River for the purpose of measuring and recording its flow, which shall be known as the Hesperus station and the interstate station, respectively.

"The Hesperus station shall be located at some convenient place near the village of Hesperus, Colorado. Suitable devices for ascertaining and recording the volume of all diversions from the river above Hesperus station shall be established and maintained (without expense to the State of New Mexico), and whenever in this compact reference is made to the flow of the river at Hesperus station it shall be construed to include the amount of the concurrent diversions above said station.

"The interstate station shall be located at some convenient place within one mile of and above or below the interstate line. Suitable devices for ascertaining and recording the volume of water diverted by the Enterprise and Pioneer Canals, now serving approximately equal areas in both States, shall be established and maintained (without expense to the State of New Mexico), and whenever in this compact reference is made to the flow of the river at the interstate station it shall be construed to include one-half the volume of the concurrent diversions by such canals, and also the volume of any other water which may hereafter be diverted from said river in Colorado for use in New Mexico.

"Each of said stations shall be equipped with suitable devices for recording the flow of water in said river at all times between the 15th day of February and the

1st day of December of each ye
shall make provision for cooperat
operation, exchange of records a

"The waters of the La Plata F
the signatory States, including the
"1. At all times between the
succeeding February each State s
water which may flow within its b
"2. By reason of the usual ann
the 15th day of February and t
apportioned between the States in
"(a) Each State shall have th
its boundaries on each day when
one hundred cubic feet per second
"(b) On all other days the S
station a quantity of water eq
Hesperus station for the preced
feet per second.
"3. Whenever the flow of the
engineers of the States the greate
distributing all of its waters succ
periods, in lieu of delivery of wa
article, the use of the waters ma
manner, for such periods, and t
may jointly determine.
"4. The State of New Mexico
shall the State of Colorado be r
for beneficial use in the State of
"5. A substantial delivery of
deemed a compliance with its p
larities in flow or delivery shall be

"The State engineers of the
formulate rules and regulations
which, when signed and promu
by agreement between them or
the other.

"Whenever any official of eith
this contract, such designation
or officials upon whom the duti
devolve.

1st day of December of each year. The State engineers of the signatory States shall make provision for cooperative gauging at two stations, for the details of the operation, exchange of records and data, and publication of the facts.

"ARTICLE II

"The waters of the La Plata River are hereby equitably apportioned between the signatory States, including the citizens thereof, as follows:

"1. At all times between the 1st day of December and the 15th day of the succeeding February each State shall have the unrestricted right to the use of all water which may flow within its boundaries.

"2. By reason of the usual annual rise and fall, the flow of said river between the 15th day of February and the 1st day of December of each year shall be apportioned between the States in the following manner:

"(a) Each State shall have the unrestricted right to use all the waters within its boundaries on each day when the mean daily flow at the interstate station is one hundred cubic feet per second, or more.

"(b) On all other days the State of Colorado shall deliver at the interstate station a quantity of water equivalent to one-half of the mean flow at the Hesperus station for the preceding day, but not to exceed one hundred cubic feet per second.

"3. Whenever the flow of the river is so low that in the judgment of the State engineers of the States the greatest beneficial use of its waters may be secured by distributing all of its waters successively to the lands in each State in alternating periods, in lieu of delivery of water as provided in the second paragraph of this article, the use of the waters may be so rotated between the two States in such manner, for such periods, and to continue for such time as the State engineers may jointly determine.

"4. The State of New Mexico shall not at any time be entitled to receive nor shall the State of Colorado be required to deliver any water not then necessary for beneficial use in the State of New Mexico.

"5. A substantial delivery of water under the terms of this article shall be deemed a compliance with its provisions and minor and compensating irregularities in flow or delivery shall be disregarded.

"ARTICLE III

"The State engineers of the States, by agreements from time to time, may formulate rules and regulations for carrying out the provisions of this compact, which, when signed and promulgated by them, shall be binding until amended by agreement between them or until terminated by written notice from one to the other.

"ARTICLE IV

"Whenever any official of either State is designated to perform any duty under this contract, such designation shall be interpreted to include the State official or officials upon whom the duties now performed by such official may hereafter devolve.

"ARTICLE V

"The physical and other conditions peculiar to the La Plata River and the territory drained and served thereby constitute the basis for this compact, and neither of the signatory States concedes the establishment of any general principle or precedent by the concluding of this compact.

"ARTICLE VI

"This compact may be modified or terminated at any time by mutual consent of the signatory States, and upon such termination all rights then established hereunder shall continue unimpaired.

"ARTICLE VII

"This compact shall become operative when approved by the legislature of each of the signatory States and by the Congress of the United States. Notice of approval by the legislatures shall be given by the governor of each State to the governor of the other State, and the President of the United States is requested to give notice to the governors of the signatory States of approval by the Congress of the United States.

"In witness whereof, the commissioners have signed this compact in duplicate originals, one of which shall be deposited with the secretary of state of each of the signatory States.

"Done at the city of Santa Fe, in the State of New Mexico, this twenty-seventh day of November, in the year of our Lord one thousand nine hundred and twenty-two." (43 Stat. 796)

"DELPH E. CARPENTER.
"STEPHEN B. DAVIS, Junior."

EXPLANATORY NOTES

Not Codified. This Act is not codified in the U.S. Code.

Legislative History. S. 1656, Public Law 346 in the 68th Congress. H.R. Rept. No. 1076.

REFUNDS TO V

An act to provide for refunds to vet
them under Federal irrigation p
956)

[**Sec. 1. Definitions.**]—As used
any individual a member of the
any time after April 5, 1917, and
(1) any individual at any time d
such forces under other than hono
who performed no military duty
(3) any alien at any time during
military or naval forces on accoun
(b) The term "reclamation la
the receipts from the sale and dis
tories to the construction of irrig
approved June 17, 1902, and
thereto. (43 Stat. 956)

**Sec. 2. [Veterans entitled to
cations for refunds and payment**
since April 6, 1917, has made ent
project under the reclamation la
cause of cancellation by, or relinq
prior to receipt by him of a final
more than one year after date o
entry—may, in accordance with
Interior, file application for the
who has been compensated, in
shall not be entitled to the benefit
the Secretary of the Interior, un
require proof that the veteran has
(b) Upon receipt of such appli
to investigate the facts and, in hi
eran entitled thereto a sum equ
such veteran, or for his account,
alties on such charges in respect
the Secretry of the Interior shall
on which the entry in question wa

N

1. Application

The right of a veteran to refund
the act of February 21, 1925, of
paid by him on a reclamation hon
entry which he relinquishes prior to

Appendix F

Water Rights Decree

Original Decree

RED MESA WARD RESERVOIR, THE SUPPLY DITCH and THE OUTLET DITCH
(Water District No. 33)

Combined Ditch Priority No. 1965-2
Reservoir Priority No. 1965-1

THE COURT FINDS THAT:

1. The Supply Ditch, Red Mesa Ward Reservoir and The Outlet Ditch combine to form an irrigation system, taking water from Hay Gulch Reservoir and the La Plata River.

2. The claimant is The Red Mesa Ward Reservoir and Ditch Company, a Colorado corporation, whose address is % Bob K. Taylor, Route 1, Box 112, Hesperus, Colorado.

3. The sources from which the appropriations are made are the La Plata River and Hay Gulch.

4. The points of diversion of ditches and other structures for diverting water and the location of reservoirs for storing water are as follows:

a. THE SUPPLY DITCH. This ditch carries water from the La Plata River to Red Mesa Ward Reservoir. The point of diversion is located on the west bank of the La Plata River whence the northwest corner of Section 26, Township 34 North, Range 12 West, N.M.P.M., bears North 52°56' West, 945.3 feet. The course of the ditch is westerly from the point of diversion to the point where it enters Red Mesa Ward Reservoir. The ditch is 2.0 feet deep at high water line; 14.00 feet wide at high water line and 12.00 feet wide at its bottom. Its present and proposed carrying capacity is 120 cubic feet of water per second of time.

b. RED MESA WARD RESERVOIR. This reservoir stores water from the La Plata River and Hay Gulch. It is created by a dam across Hay Gulch and is located upon portions of each quarter of Section 22 and the North Half of the Northwest Quarter of Section 27, all in Township 34 North, Range 12 West, N.M.P.M., La Plata County,

...RVOIR, SUPPLY DITCH & OUTLET DITCH:
William S. Eakes, Attorney

Colorado. The dam is an earth filled structure which impounds a body of water with a surface area of about 97 acres, a depth of 46.0 feet and a present capacity of 1176 acre feet of water. This reservoir is the first stage of the proposed construction of a reservoir of a depth of 75 feet, a surface area of about 150 acres and a storage capacity of 4,074.28 acre feet of water. The outlet of the reservoir is by a tunnel in the east side of the dam which discharges into a ditch named The Outlet Ditch. The outlet gate of the reservoir is located in the dam where the outlet tunnel from the reservoir leads into Hay Gulch at a point whence the northeast corner of Section 27, Township 34 North, Range 12 West, N.M.P.M., bears North 69°28' East, 4686 feet.

c. The Outlet Ditch. This ditch carries storage water from the tunnel outlet in the dam, down the channel of Hay Gulch for approximately one mile, and the channel of the La Plata River for about 370 feet, using those natural watercourses as a conduit, to a point on the east bank of the La Plata River, located about 370 feet below the confluence of Hay Gulch and the La Plata River, whence it leaves. and diverts its water from, the La Plata River and follows a generally southerly course for about 13,421 feet, to the lands irrigated and to be irrigated from said ditch. The ditch is 14 feet wide at high water line, 1.8 feet deep at high water line and 10 feet wide at its bottom. Its present and proposed carrying capacity is 70 cubic feet of water per second of time.

5. The purpose of this irrigation system, and the appropriations pf water made therefor, is to provide irrigation water for a total of 4,410 acres of land, of which 3,660 acres of land are now being irrigated by water from the project. The water claimed hereby will be used for irrigation, domestic, municipal, industrial recreation, fish and wildlife, flood control and other beneficial purposes.

6. Work was commenced on these ditches and this reservoir

by actual construction beginning prior to April 30, 1905, and has continued thereafter, and is continuing, with due diligence. The first stage of the construction, building the reservoir to its present capacity of 1,176 acre feet, has been completed, and engineering, planning and other work is continued with due diligence on the second stage of the system.

7. The waters claimed by these appropriations are storage rights as follows:

a. The right to presently store 1,176 acre feet of water in Red Mesa Ward Reservoir from Hay Gulch and from The Supply Ditch from the La Plata River limited to a diversion of 120 cubic feet of water per second of time.

b. The right to store an additional 2,898.28 acre feet of water in Red Mesa Ward Reservoir, thereby increasing the total storage to 4,074.28 acre feet of water, from Hay Gulch and from The Supply Ditch from the La Plata River, from either or both, conditioned only until the application of the conditional storage water to beneficial use.

8. The following filings have been made in the Office of the State Engineer. Map and Statement of the Red Mesa Ditch and Reservoir on December 2, 1909; Amended Map and Statement of the Red Mesa Ditch and Reservoir on March 16, 1932; and Amended Map and Statement of the Red Mesa Ditch and Reservoir on October 15, 1945.

IT IS THEREFORE ADJUDGED AND DECREED that The Supply Ditch, Red Mesa Ward Reservoir and The Outlet Ditch are hereby awarded and decreed the following water rights, with historic priority date prior to April 30, 1905, and Decreed date August 16, 1912, for irrigation, domestic, municipal, industrial, recreation, fish and wildlife, flood control and other beneficial purposes, to-wit:

1. The right to presently store 1,176 acre feet of water in Red Mesa Ward Reservoir from Hay Gulch and from The Supply Ditch

from the La Plata River, from either source or both, but with the water from the La Plata River limited to a diversion of 120 cubic feet of water per second of time.

2. The right to store an additional 2,898.28 acre feet of water in Red Mesa Ward Reservoir, thereby increasing the total storage to 4,074.28 acre feet of water, from Hay Gulch and from The Supply Ditch from the La Plata River, from either source or both, conditioned only until the application of the additional storage water to a beneficial use. This additional 2,898.28 acre feet of water shall be adjudicated and made absolute when it shall be shown, in a subsequent proceeding, to have been applied to beneficial use with reasonable diligence.

IT IS FURTHER ADJUDGED AND DECREED that the priorities herein awarded and decreed are hereby numbered as Reservoir Priority No. 1965-1 and that The Supply Ditch and The Outlet Ditch are hereby numbered as combined Priority No. 1965-2, subject to all of the general limitations and provisions in this decree.

Appendix G

Hertzman Operational Modeling Study

RED MESA WARD RESERVOIR ENLARGEMENT

Operational Modeling Study

13 JULY 2015

Prepared for AECOM Technical Services Inc.
8181 East Tufts Avenue
Denver, CO 80237
Project Number 60420841

Prepared by Hertzman Consulting, LLC

441 Eagle Pass • Durango, CO 81301 • USA

Tel. 970.270.2929

www.hertzmanconsulting.com

Project Number 0151/01

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

1.1 BACKGROUND

The Red Mesa Ward Reservoir (RMWR) is located in Hay Gulch, a tributary to the La Plata River, in southwestern Colorado. It provides storage for irrigation water. AECOM Technical Services Inc. (AECOM) was retained by Red Mesa Reservoir and Ditch Company to perform a feasibility study related to replacement of the spillway and potential enlargement of the reservoir capacity. The feasibility study includes the evaluation of two enlargement scenarios. The first involves increasing the current capacity of the reservoir (1176 AF) by 250 AF; the second involves increasing the capacity by 550 AF.

To address the evaluation of water availability for the enlargement components of the feasibility study, AECOM contracted Hertzman Consulting, LLC (HC) to prepare a computer simulation of the proposed enlargements using the La Plata River operational model documented in Hertzman (2014). The operational model was developed in 2013-2014 by HC for the La Plata Water Conservancy District, utilizing grant funding from the Colorado Water Conservation Board and funding from the Colorado Water Resources and Power Development Authority, to serve as an operational aide for the new Long Hollow Reservoir (LHR) completed in 2014.

1.2 OBJECTIVES

The modeling was designed to address the following objectives:

1. To predict the end-of-month volume for the RMWR for each month in the model's simulation period (October 1974-September 2009) , for each of the two enlargement scenarios, under the assumption that the proposed enlargements had been in place for the entire simulation period.
2. To predict monthly and annual diversion into storage under each scenario.
3. To estimate the change in total volume delivered from RMWR either to its member ditches or for release to other locations as a result of the two proposed enlargement scenarios, compared to the no-enlargement (hereafter referred to as the "No-Action") scenario.
4. To predict the flow through the reservoir's supply ditch under each scenario.

5. To predict the impact on LHR by comparing the predicted end-of-month volume of LHR under the No-Action scenario with the predicted volume under each of the two proposed enlargement scenarios.
6. To predict the changes to net evaporation from the reservoir resulting from each proposed scenario.

2. PROCEDURE

2.1 STRATEGY

During the development of the La Plata River Operation Model, it was noted that the calibrated model under-predicted releases from RMWR (Hertzman 2014, p. 26), a byproduct of the manner in which losses to evapotranspiration (ET) were simulated in the model. The model concentrated all ET losses at a single node below the reservoir ditches. In reality, ET occurs all along the reach of Hay Gulch from the reservoir down to and past the reservoir ditches on the main channel of the La Plata River. Historically, a greater volume of flow has been released from RMWR than the model predicted, because some of that released flow is consumed by ET before it arrives at the ditch headgates. Figure 1(from Hertzman 2014) demonstrates the under-prediction of releases from RMWR in the calibrated model.

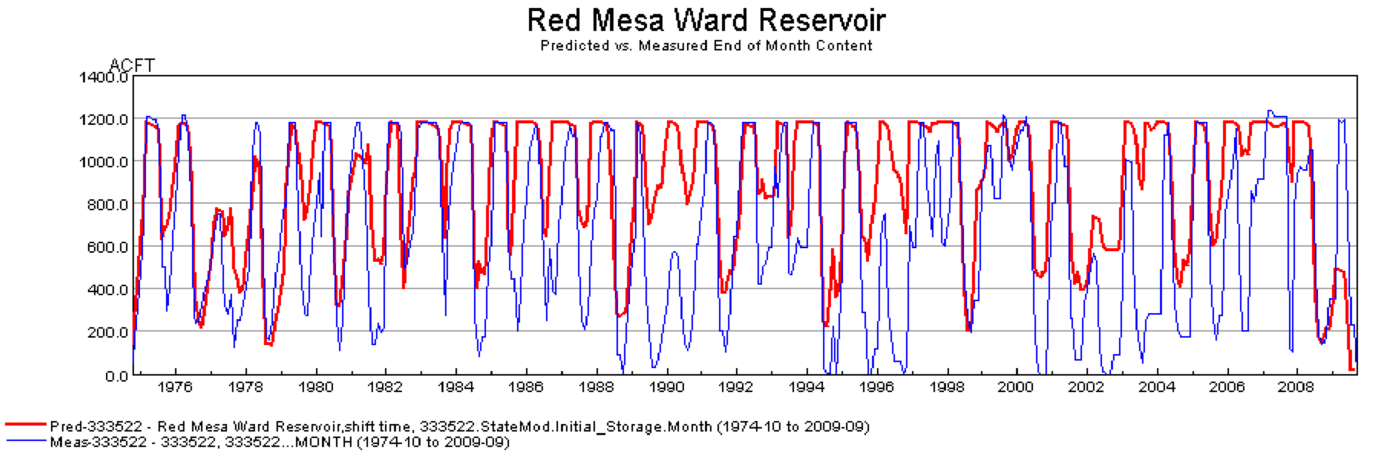


Figure 1: Calibration at Red Mesa Ward Reservoir

The first step of the modeling process, therefore, was to determine whether use of the calibrated model would also result in under-predicting releases, and therefore under-predicting the volume of flow needed to fill the enlarged reservoir.

In order to identify the cause of the discrepancy between predicted and observed level in the calibrated model, a comparison was made between the predicted end-of-month content in the "baseline" run vs. measured historical releases. The baseline run is identical in most respects to the calibrated model with one major exception. In the calibrated model, demand at each ditch was set to match the historical diversions to that ditch. In the baseline model, on the other hand, the demand at each ditch was calculated using the State Consumptive Use (StateCU) model, based on acreage of irrigated lands, crop type, elevation, and similar factors. All predictive runs in the original model were performed using the baseline conditions.

The calculated demand from each of the reservoir ditches in the baseline model proved to be significantly higher than the historical diversion used as demand for the calibrated model. This difference can probably be attributed to one or more factors: inability of the river channel to deliver as much flow as desired to the reservoir ditches because of losses to ET; fallowing of land that was not taken into account by the StateCU model; and/or less-than-optimal operation of the river system.

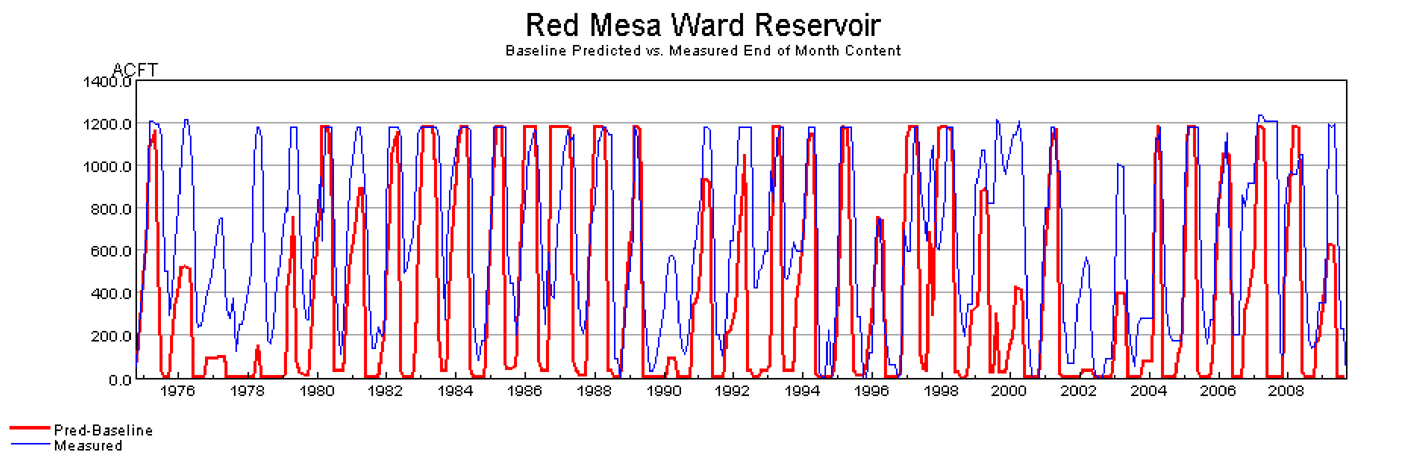


Figure 2: Baseline Prediction vs. Historical EOM Contents in Red Mesa Ward Reservoir

Figure 2 presents the results of using the baseline (calculated) demand at the reservoir ditches, rather than the historical demand used for the calibration. Using the baseline demands, the reservoir is predicted to almost empty in most years of the simulation, a behavior much closer to the observed end-of-month values than that of the calibration.

It is concluded that using the baseline demands at the reservoir ditches will result in an over-prediction of drawdown from the reservoir, generally in the range of 100-200 AF in a year. For a water supply analysis, this is a conservative choice, as the model will tend to demand more water to fill the nearly-empty reservoir each year.

In conclusion, it was deemed appropriate and conservative to model the two enlargement scenarios by using the calibrated model, based on the original P01 scenario that included baseline demands as well as the operation of LHR.

2.2 PREDICTIVE RUNS

Two predictive runs were developed: P06, which modeled the effects of a 250-AF enlargement of the reservoir, and P07, which simulated a 550-AF enlargement. For each scenario, a few simple changes were made to the P01 scenario from the original model, which included the effects of LHR on the river system. These changes included:

1. The RMWR capacity was increased from its present value of 1176 AF to 1426 AF (for P06) or 1726 AF (for P07). The additional capacity was allocated proportionately to each of the existing reservoir accounts.
2. The tables that relate reservoir volume to surface area were updated by adding two more entries: one for the 250-AF enlargement (67 acres) and one for the 550-AF enlargement (75 acres) (e-mail from Dennis Miller/AECOM to HC, 6/12/2015) . These tables are used by the model to calculate evaporation.
3. The decree for the existing water right used to fill the reservoir was increased to match the new capacity of the reservoir, reflecting the application of conditional water rights.
4. The fill target for the reservoir was increased to the new capacity of the reservoir, so that the model would attempt to fill the reservoir completely whenever sufficient water was available in priority, following the single-fill-per-year rule.

For each of the new scenarios, the model was run using a daily timestep for the entire simulation period. In addition, the P01 scenario was rerun for use as the no-action scenario.

3. RESULTS

3.1 PREDICTED END-OF-MONTH CONTENTS IN RMWR

Figure 3 presents the predicted end-of-month content of RMWR for the no-action scenario and the two enlargement scenarios. The corresponding table is presented in Appendix A.

For the 250-AF enlargement, the model predicts that sufficient water is available to completely fill the reservoir in 13 of the 35 years modeled. In addition, at least some of the new capacity is filled in an additional 5 years. For the 550-AF enlargement, the model predicts that the reservoir will be able to completely fill in the same 13 of the 35 years modeled. Given the conservatively high demand applied to the reservoir ditches, it is likely that the actual storage volumes on those years in which the reservoir is only partially filled will be, on average, 100-200 AF higher than shown on the figure.

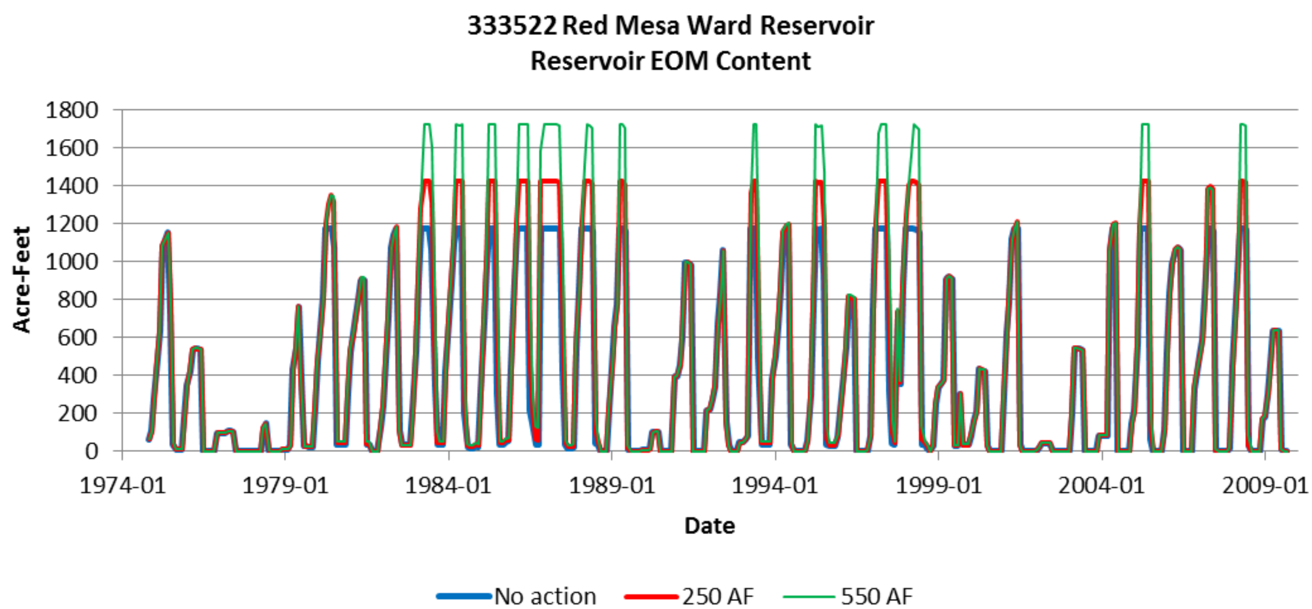


Figure 3: Predicted End-of-Month Content in RMWR

3.2 PREDICTED DIVERSION INTO STORAGE

The monthly volume of water predicted to be diverted into storage in RMWR is presented in Figure 4.Figure 5shows the predicted increase in annual storage over the no-action scenario of the two enlargements scenarios. Figure 5 also plots the long-term average annual increase in diversion to storage. The corresponding tables are presented in Appendix B.

As the figure and table for monthly storage show, the additional storage in the reservoir is in general met by slightly longer filling seasons. The repeated exception occurs in March of a number of years for the 550-AF scenario, when a greatly increased (from the base case) volume of water is diverted into storage.

The figure and table for annual storage show that the expected long-term annual average increase in storage is somewhat less than half of the new capacity, reflecting the prediction that the additional capacity will not be used in approximately half of the years of the simulation.

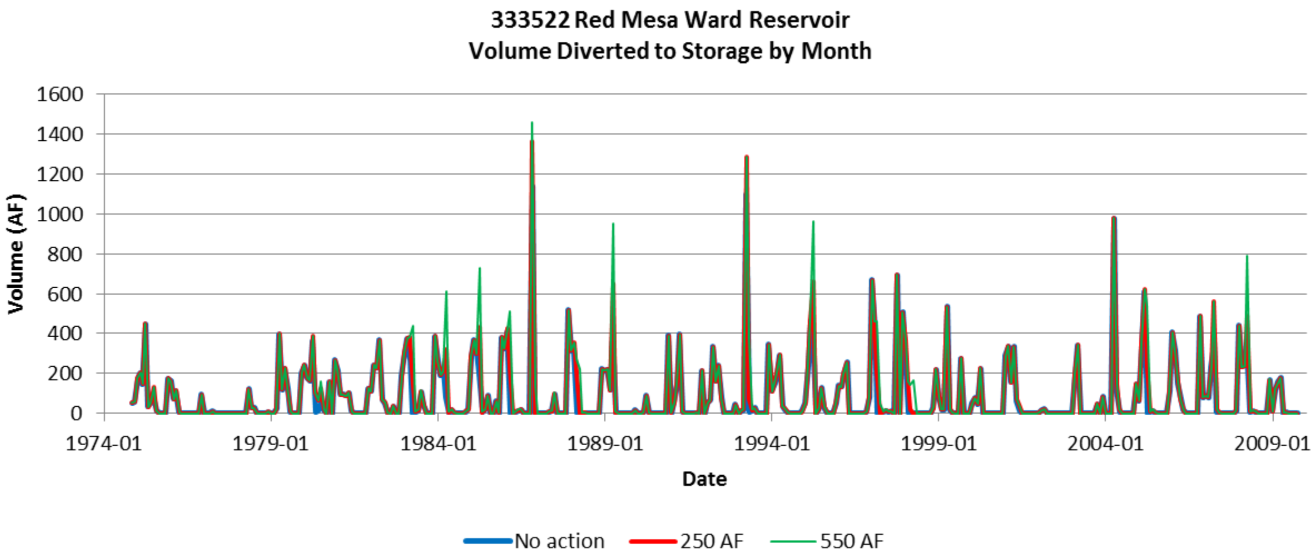


Figure 4: Predicted Monthly Diversion into Storage in RMWR

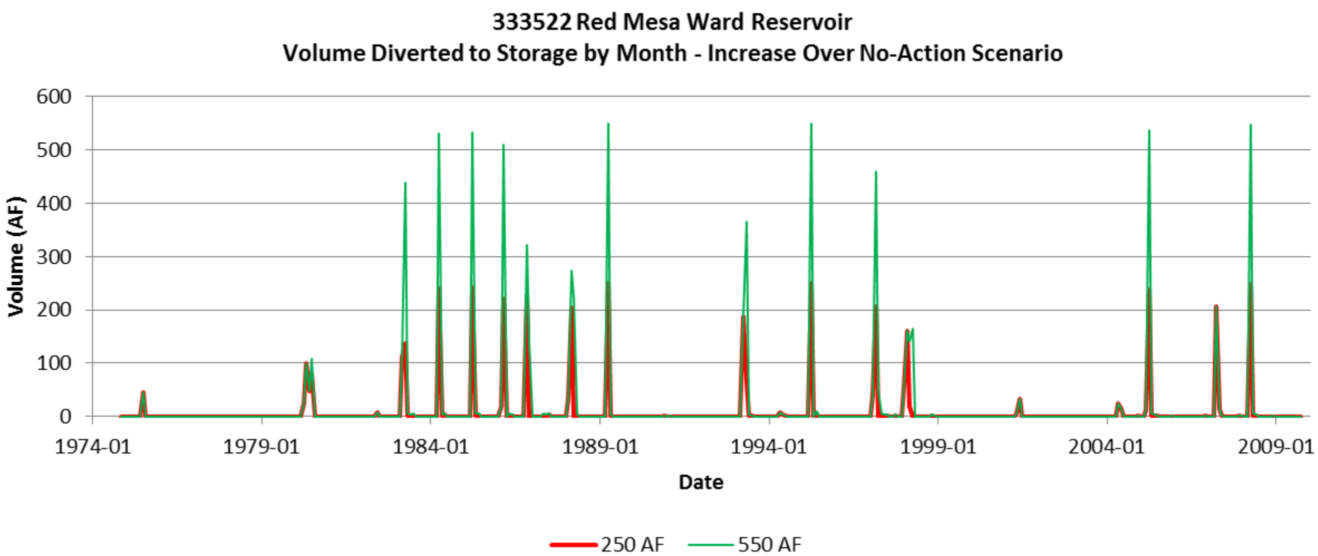


Figure 5: Predicted Increase of Annual Diversion into Storage in RMWR

3.3 PREDICTED CHANGE IN DELIVERY TO RESERVOIR DITCHES

Assuming that additional water stored in an enlarged reservoir would be used to enhance the irrigation water supply, the addition of storage to the reservoir can be expected to increase the amount of water that can be delivered to the reservoir ditches in those years in which the additional space is filled. Because the model does not attempt to simulate the ET between the reservoir and its ditches, the model's prediction for absolute volumes delivered to each of its client ditches is likely to be too high. However, the relative differences in delivery between the no-action scenario and the two enlargement scenarios is likely to be somewhat representative of the actual difference that would be observed were one or the other of the enlargements to be implemented.

Figure 6, Figure 7, Figure 8, and Figure 9 present the predicted change in total delivery to each of the four client ditches relative to the base case, averaged across the 35-year model period for each month separately. In other words, for the "July" data point, eachgraph shows the result of calculating the average of the predicted total delivery in July for all 35 years for a given scenario, then subtracting the same average calculated using the no-action scenario. Note that the graphs plot total delivery, not just delivery from storage in RMWR. As the tables in Appendix C show, the vast majority of the difference is a result of extra volume delivered from storage.

Because the extra capacity of the reservoir is only predicted to be utilized in approximately half of the 35 years modeled, the actual increase in delivery is likely to be of greater magnitude than shown in years in which the reservoir fills, and of lesser magnitude in years in which the additional capacity is not filled.

Also of note in Figure 9 is the prediction of a very slight decrease in total delivery in an average March, relative to the no-action case. This results from a decrease in adjudicated flow to the ditch from the river, presumably because the reservoir (administration number 23914.20208) is pre-empting Warren-Vosburgh's lowest-priority right (27918.00000) to fill the new capacity.

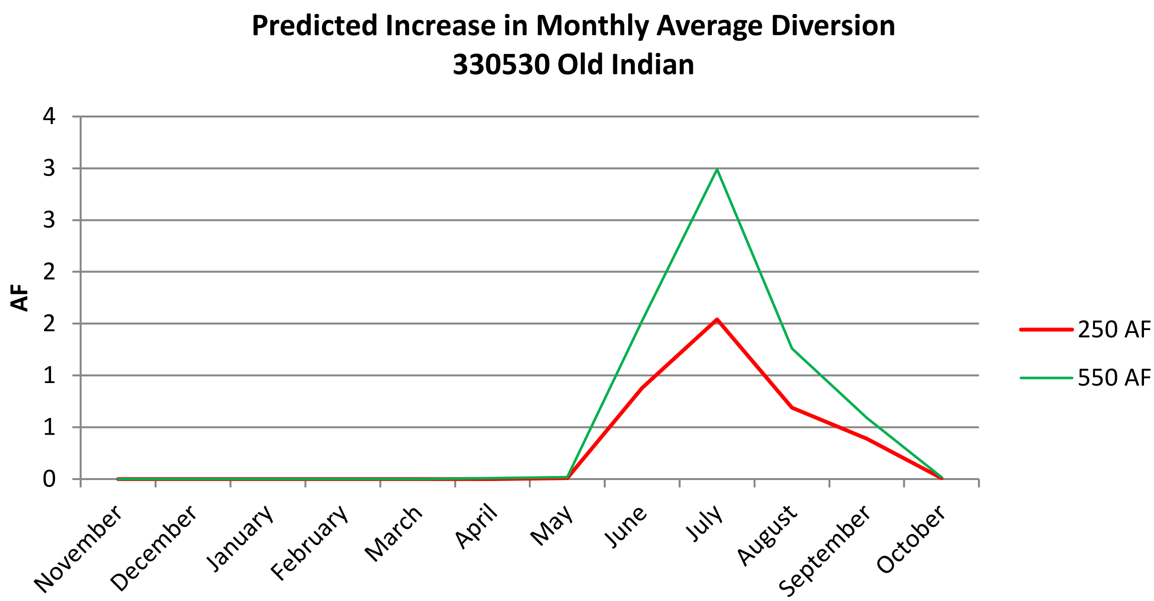


Figure 6: Predicted Average Monthly Increase in Total Diversion, Old Indian Ditch

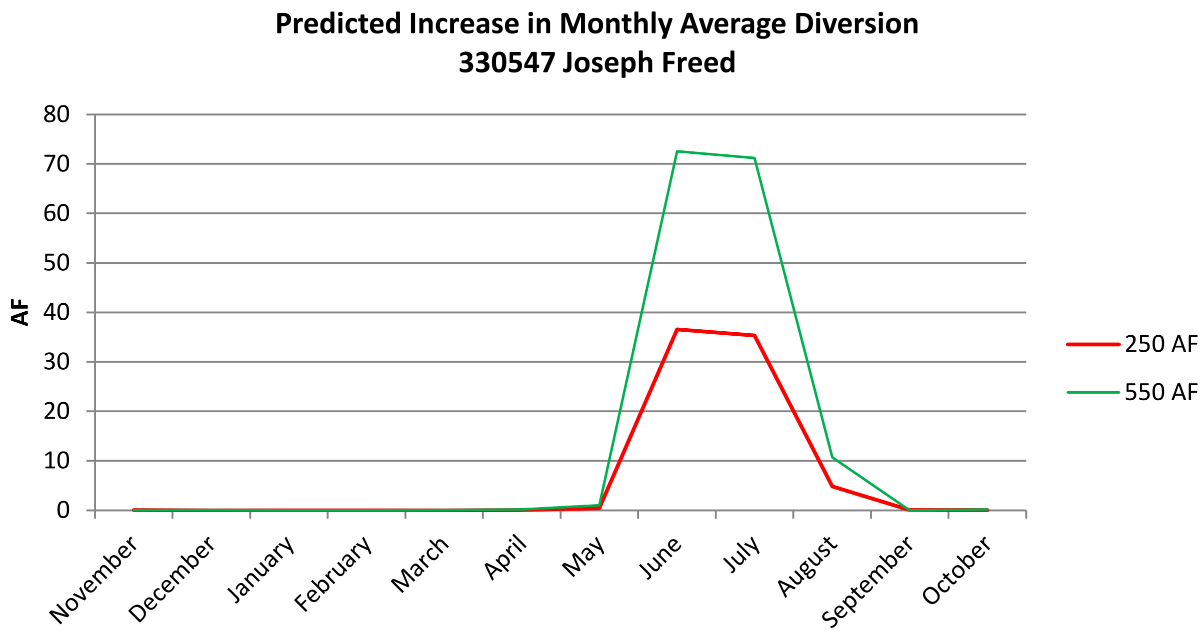


Figure 7: Predicted Average Monthly Increase in Total Diversion, Joseph Freed Ditch

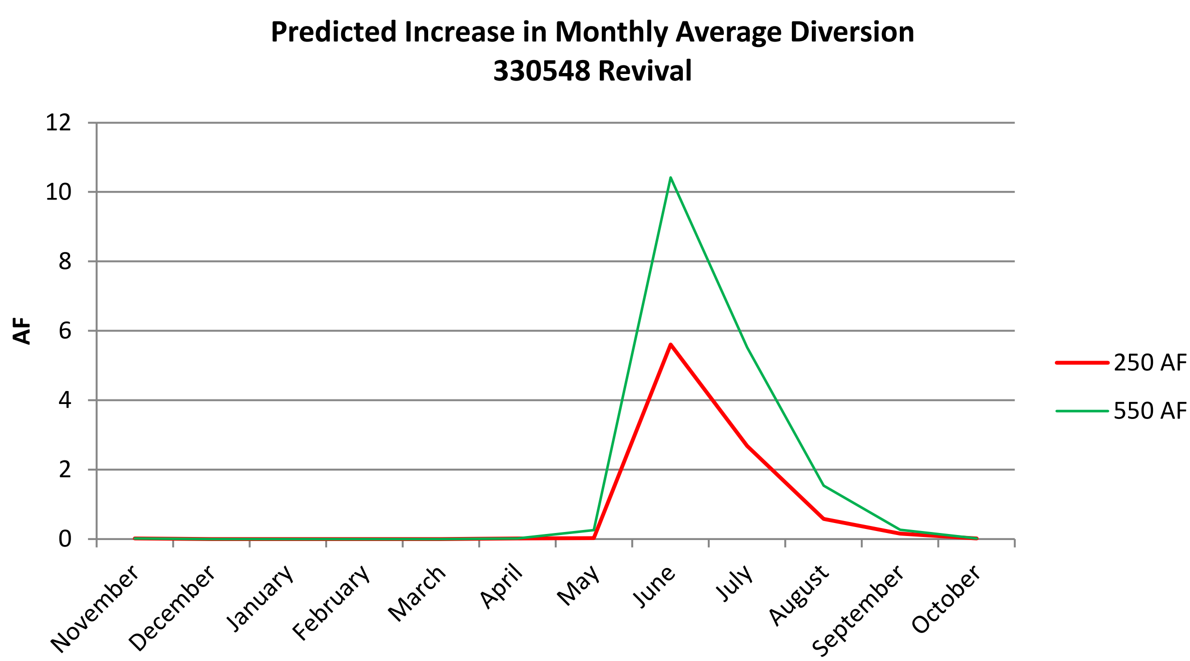


Figure 8: Predicted Average Monthly Increase in Total Diversion, Revival Ditch

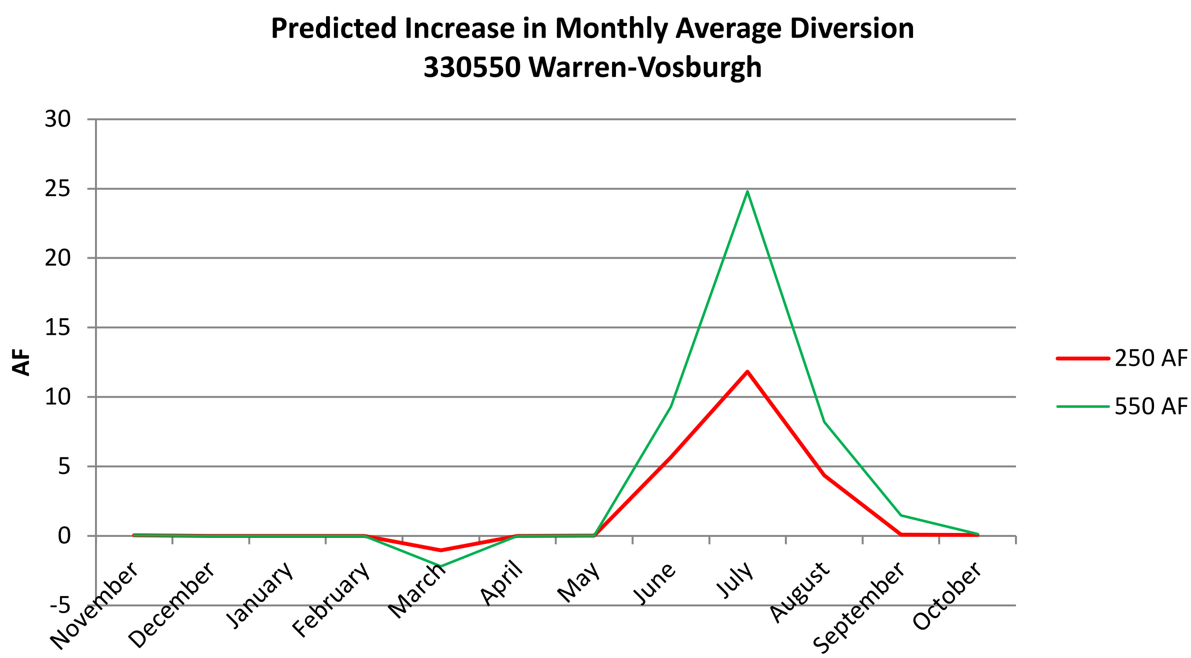


Figure 9: Predicted Average Monthly Increase in Total Diversion, Warren-Vosburgh Ditch

3.4 PREDICTED DAILY FLOW THROUGH RESERVOIR SUPPLY DITCH

Diversion 330563, the Red Mesa Ward Reservoir Supply Ditch, was modeled using a maximum capacity of 120 CFS with no leakage. Because the actual leakage is estimated to comprise only a small percentage of the total flow through the ditch (personal communication from Dennis Miller, AECOM, 7/6/2015), this approximation was deemed adequate. Figure 10 presents the predicted daily flow through the supply ditch for the entire simulation period. Figure 11 presents the same data, plotted only for the calendar year 1997, a representative year, in order to reveal details that cannot be distinguished on the graph of the full simulation period .The corresponding table is presented in Appendix D.

Figure 11 demonstrates a typical annual pattern. The reservoir fills during the winter. For the scenarios with increased reservoir capacity, the *rate* of winter fill vs. the no-action scenario does not change greatly, but the *duration* increases. Then, during a single large precipitation event in September, a large amount of water becomes available in priority for a very brief period. Whether the water commissioner can actually react quickly enough to capture this short-term flow, assuming that the one-fill rule has not already been met for the year, is an open question.

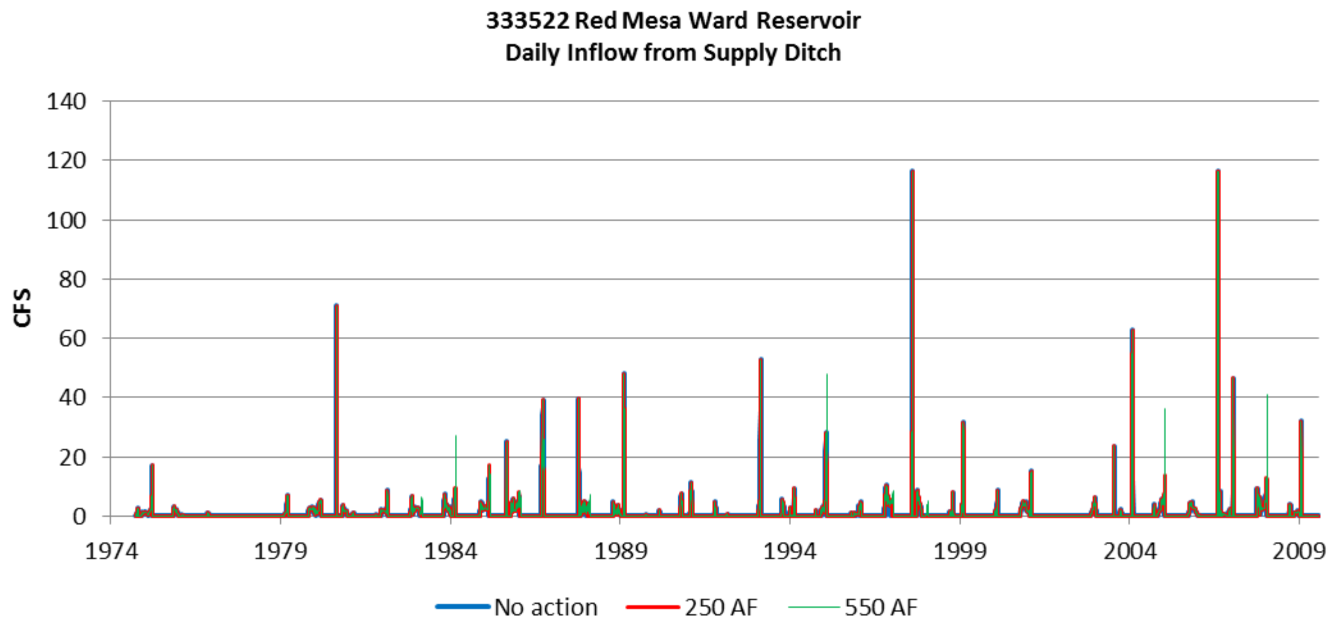


Figure 10: Predicted Daily Inflow from Supply Ditch, 1974-2009

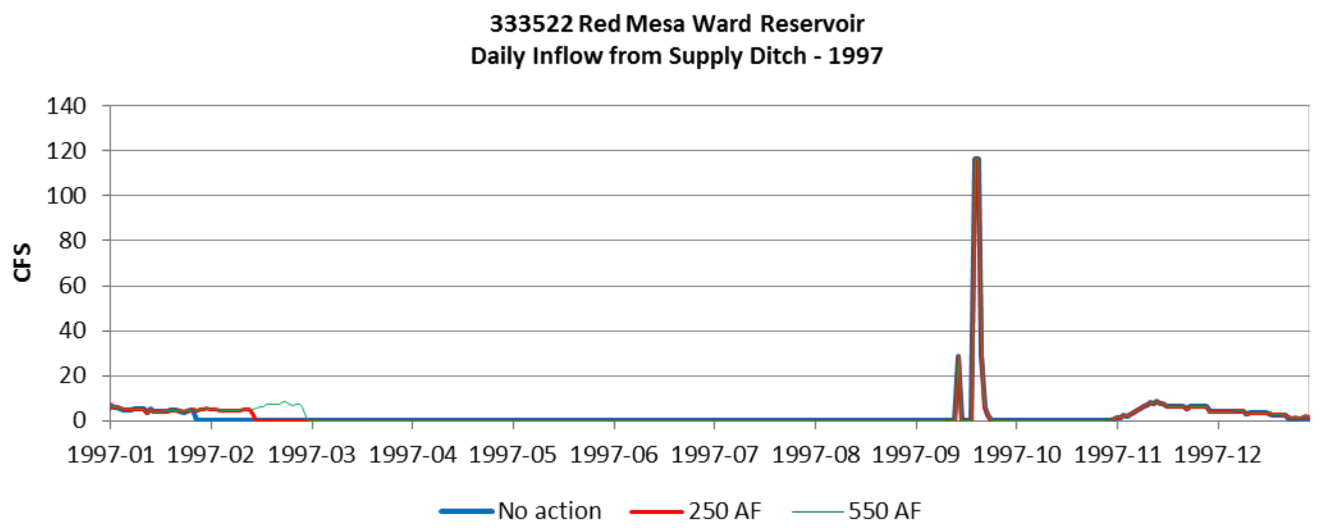


Figure 11: Predicted Daily Inflow from Supply Ditch, 1997

3.5 PREDICTED EFFECTS ON LONG HOLLOW RESERVOIR

Figure 12 and Appendix E presents the predicted end-of-month content for Long Hollow Reservoir for the three scenarios. In general, the enlargement of RMWR is predicted to result in a slight increase in volume in LHR, particularly during the years when LHR doesn't fill completely, presumably due to increased return flow into Long Hollow resulting from higher delivery volumes to the reservoir ditches.

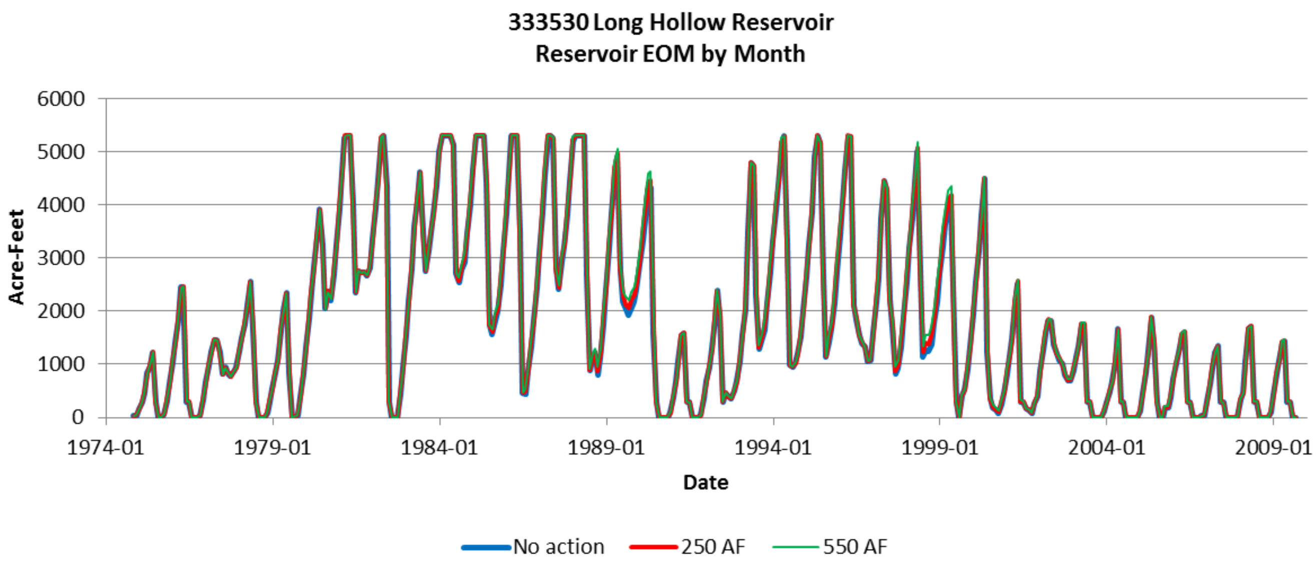


Figure 12: Predicted Effects on Long Hollow Reservoir

3.6 PREDICTED EVAPORATION FROM RMWR

The predicted monthly net evaporation from the reservoir (defined as the total evaporation less the total precipitation, implying that the number can be negative during periods when evaporation is less than precipitation) is presented in Figure 13 and appendix F. Due to the larger surface area during those years in which the additional capacity of the reservoir is used, the summertime net evaporation increases over the no-action case, generally by five or fewer acre-feet in the peak month of the year. Correspondingly, the winter-time net evaporation becomes more negative, for the same reason.

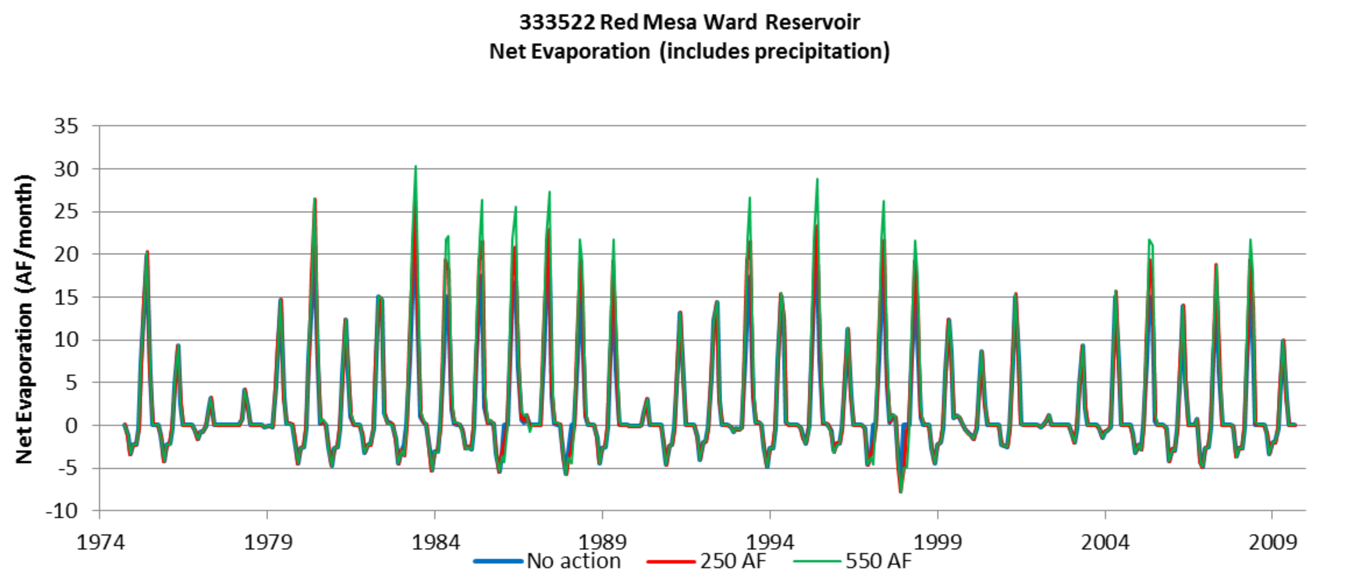


Figure 13: Predicted Monthly Net Evaporation from RMWR

4. DISCUSSION AND CONCLUSION

When interpreting the results of a model, it is necessary to understand its limitations. All of the limitations discussed in section 6.1 of the original modeling report apply to this predictive exercise as well. Models have limitations of precision and accuracy, deriving from simplifying assumptions and the possibility of inaccurate or incomplete input data. The model's results should appropriately be understood as approximate, to be interpreted in conjunction with professional judgment and expert experience.

Furthermore, the model is based on the precipitation that occurred during the period from 1974-2009. Its predictions therefore assume a similar precipitation regime. Should the actual amount and pattern of precipitation in the future vary greatly from that experienced between 1974 and 2009, the results may look quite different from those predicted by the model.

Given these limitations, the results of the modeling suggest that sufficient water will be available to partially or fully utilize the enhanced storage capacity proposed for the Red Mesa Ward Reservoir in roughly half of the years simulated. Effects on Long Hollow Reservoir are likely to be small and positive. A modest amount of additional volume will be available for delivery to the reservoir ditches or sale to other parties during those years when the additional capacity can be utilized.

5. REFERENCES

Hertzman (2014). Operational river model: La Plata River basin. Hertzman Consulting, LLC; 26 March 2014.

Appendix A: Predicted End-of-Month Contents in RMWR

Month	No action	250 AF	550 AF
1974-10	61.95	61.95	61.95
1974-11	104.67	104.68	104.68
1974-12	283.01	283.02	283.02
1975-01	486.73	486.74	486.74
1975-02	634.31	634.32	634.32
1975-03	1084.23	1084.23	1084.23
1975-04	1112.39	1112.42	1112.43
1975-05	1153.87	1153.90	1153.91
1975-06	726.15	765.59	765.62
1975-07	35.41	38.95	43.71
1975-08	4.82	6.93	7.21
1975-09	4.82	6.93	7.21
1975-10	4.82	6.93	7.21
1975-11	181.75	183.76	184.03
1975-12	348.85	350.79	351.06
1976-01	421.59	423.47	423.74
1976-02	536.95	538.78	539.05
1976-03	542.12	543.94	544.21
1976-04	538.77	540.59	540.87
1976-05	532.72	534.57	534.84
1976-06	0.00	0.00	0.00
1976-07	0.00	0.00	0.00
1976-08	0.00	0.00	0.00
1976-09	0.00	0.00	0.00
1976-10	0.00	0.00	0.00
1976-11	95.03	95.05	95.05
1976-12	95.03	95.05	95.05
1977-01	95.03	95.05	95.05
1977-02	95.03	95.05	95.05
1977-03	105.40	105.42	105.43
1977-04	105.40	105.42	105.43
1977-05	102.19	102.21	102.22
1977-06	0.00	0.00	0.00
1977-07	0.00	0.00	0.00
1977-08	0.00	0.00	0.00
1977-09	0.00	0.00	0.00
1977-10	0.00	0.00	0.00
1977-11	0.00	0.00	0.00
1977-12	0.00	0.00	0.00
1978-01	0.00	0.00	0.00
1978-02	0.00	0.00	0.00
1978-03	0.00	0.00	0.00
1978-04	123.04	123.04	123.04
1978-05	145.95	145.95	145.99
1978-06	0.41	0.43	0.53
1978-07	0.00	0.00	0.00
1978-08	0.00	0.00	0.00

Month	No action	250 AF	550 AF
1978-09	0.00	0.00	0.00
1978-10	0.00	0.00	0.00
1978-11	9.21	9.21	9.21
1978-12	9.21	9.21	9.21
1979-01	9.21	9.21	9.21
1979-02	31.11	31.12	31.12
1979-03	431.01	431.02	431.02
1979-04	546.19	546.20	546.20
1979-05	763.53	763.44	763.43
1979-06	384.01	383.94	383.93
1979-07	26.45	26.75	26.84
1979-08	26.45	26.75	26.84
1979-09	22.99	23.29	23.38
1979-10	22.99	23.29	23.38
1979-11	227.81	228.12	228.20
1979-12	473.45	473.76	473.84
1980-01	650.10	651.54	651.62
1980-02	814.05	817.02	817.10
1980-03	1175.98	1203.19	1203.22
1980-04	1175.80	1303.05	1303.11
1980-05	1175.49	1350.43	1350.60
1980-06	1071.49	1320.62	1347.92
1980-07	33.91	41.99	50.89
1980-08	33.91	41.99	50.89
1980-09	36.00	44.00	53.00
1980-10	36.00	44.00	53.00
1980-11	305.74	313.77	322.88
1980-12	523.49	531.60	540.75
1981-01	619.35	627.45	636.54
1981-02	715.28	723.39	732.43
1981-03	802.68	810.78	819.81
1981-04	900.14	908.30	917.33
1981-05	898.10	906.17	915.12
1981-06	32.19	39.90	48.55
1981-07	32.19	39.90	48.55
1981-08	0.00	0.00	0.00
1981-09	0.00	0.00	0.00
1981-10	0.00	0.00	0.00
1981-11	125.33	125.44	125.58
1981-12	239.15	239.43	239.66
1982-01	480.11	480.40	480.63
1982-02	708.99	709.28	709.51
1982-03	1075.51	1075.82	1076.07
1982-04	1141.13	1141.46	1141.72
1982-05	1175.49	1182.95	1183.22
1982-06	106.94	109.12	109.32
1982-07	31.01	28.68	28.64

Month	No action	250 AF	550 AF
1982-08	31.17	29.09	29.17
1982-09	31.17	29.09	29.17
1982-10	31.17	29.09	29.17
1982-11	220.35	218.23	218.39
1982-12	526.18	524.71	524.88
1983-01	903.91	902.47	902.68
1983-02	1175.98	1288.24	1288.46
1983-03	1175.98	1425.98	1725.97
1983-04	1175.80	1425.74	1725.60
1983-05	1175.49	1425.41	1725.34
1983-06	1061.94	1308.81	1604.52
1983-07	341.33	582.01	874.49
1983-08	34.24	43.84	100.81
1983-09	33.27	42.86	51.27
1983-10	33.27	42.86	51.27
1983-11	422.40	432.02	440.46
1983-12	687.93	697.52	705.99
1984-01	880.91	890.71	899.29
1984-02	1094.27	1104.09	1112.70
1984-03	1175.98	1425.98	1725.97
1984-04	1173.96	1423.39	1721.85
1984-05	1174.60	1424.37	1724.16
1984-06	200.90	266.13	352.82
1984-07	21.72	29.68	37.81
1984-08	16.76	24.74	32.94
1984-09	16.76	24.74	32.94
1984-10	25.69	33.66	41.87
1984-11	23.41	31.31	39.47
1984-12	311.60	319.63	327.82
1985-01	680.70	688.74	696.93
1985-02	982.09	990.24	998.50
1985-03	1175.98	1425.98	1725.97
1985-04	1175.25	1425.04	1724.48
1985-05	1175.49	1425.41	1725.34
1985-06	303.42	532.72	808.39
1985-07	35.60	43.38	52.11
1985-08	35.60	43.38	52.11
1985-09	48.59	56.53	65.47
1985-10	51.11	59.05	67.99
1985-11	435.01	443.08	452.06
1985-12	764.87	772.97	781.92
1986-01	1175.98	1203.48	1212.55
1986-02	1175.98	1425.98	1725.97
1986-03	1175.98	1425.98	1725.97
1986-04	1175.80	1425.74	1725.60
1986-05	1175.01	1424.85	1724.71
1986-06	213.56	439.63	727.94

Month	No action	250 AF	550 AF
1986-07	145.19	201.20	279.10
1986-08	35.68	60.96	128.05
1986-09	35.68	58.57	125.66
1986-10	1175.98	1425.98	1587.67
1986-11	1175.98	1425.98	1725.97
1986-12	1175.98	1425.98	1725.97
1987-01	1175.98	1425.98	1725.97
1987-02	1175.98	1425.98	1725.97
1987-03	1175.98	1425.98	1725.97
1987-04	1175.80	1425.74	1725.60
1987-05	1170.62	1419.78	1719.02
1987-06	423.49	653.80	932.37
1987-07	35.52	43.52	55.69
1987-08	16.67	24.74	33.36
1987-09	16.67	24.74	33.36
1987-10	17.31	25.38	34.00
1987-11	537.40	545.47	554.14
1987-12	856.16	864.21	872.86
1988-01	1175.98	1220.26	1228.95
1988-02	1175.98	1425.98	1504.99
1988-03	1175.98	1425.98	1725.97
1988-04	1173.60	1422.92	1721.10
1988-05	1161.89	1408.90	1704.91
1988-06	39.11	95.64	160.92
1988-07	31.96	43.74	51.13
1988-08	0.00	0.00	0.00
1988-09	0.00	0.00	0.00
1988-10	0.00	0.00	0.00
1988-11	222.75	222.86	222.94
1988-12	441.08	441.35	441.54
1989-01	659.81	660.23	660.46
1989-02	775.88	776.33	776.57
1989-03	1175.98	1425.98	1725.97
1989-04	1174.33	1423.86	1722.60
1989-05	1159.29	1406.51	1703.07
1989-06	7.25	19.86	27.92
1989-07	0.00	0.00	0.00
1989-08	0.00	0.00	0.00
1989-09	0.00	0.00	0.00
1989-10	0.00	0.00	0.00
1989-11	6.46	6.58	6.65
1989-12	6.46	6.58	6.65
1990-01	6.46	6.58	6.65
1990-02	11.72	11.93	12.04
1990-03	99.39	99.74	99.92
1990-04	102.07	102.42	102.60
1990-05	101.06	101.10	101.08
1990-06	0.00	0.00	0.00
1990-07	0.00	0.00	0.00
1990-08	0.00	0.00	0.00
1990-09	0.00	0.00	0.00
1990-10	0.00	0.00	0.00
1990-11	390.92	391.82	392.81

Month	No action	250 AF	550 AF
1990-12	395.54	396.50	397.55
1991-01	451.23	452.60	454.05
1991-02	598.04	599.48	601.02
1991-03	993.03	994.61	996.30
1991-04	995.34	996.92	998.62
1991-05	982.16	983.73	985.41
1991-06	0.00	0.00	0.00
1991-07	0.00	0.00	0.00
1991-08	0.00	0.00	0.00
1991-09	0.00	0.00	0.00
1991-10	0.00	0.00	0.00
1991-11	216.37	216.40	216.42
1991-12	220.38	220.40	220.43
1992-01	271.89	271.94	272.00
1992-02	337.90	337.96	338.02
1992-03	673.70	673.77	673.84
1992-04	832.32	832.41	832.50
1992-05	1059.66	1059.78	1059.91
1992-06	154.11	159.08	160.98
1992-07	32.27	32.99	33.25
1992-08	0.00	0.00	0.00
1992-09	0.00	0.00	0.00
1992-10	0.00	0.00	0.00
1992-11	43.60	43.63	43.64
1992-12	43.60	43.63	43.64
1993-01	58.35	58.39	58.40
1993-02	78.12	78.16	78.18
1993-03	1175.98	1364.40	1364.42
1993-04	1175.80	1425.74	1725.60
1993-05	1175.49	1425.41	1725.34
1993-06	486.67	733.60	1027.47
1993-07	35.48	43.64	50.70
1993-08	35.49	43.66	50.71
1993-09	35.48	43.65	50.70
1993-10	35.48	43.65	50.70
1993-11	382.87	391.16	398.24
1993-12	497.91	506.34	513.61
1994-01	651.04	659.47	666.74
1994-02	854.69	863.31	870.69
1994-03	1148.01	1156.63	1164.02
1994-04	1174.70	1190.86	1198.25
1994-05	1175.50	1195.13	1202.40
1994-06	35.60	39.15	47.82
1994-07	0.00	0.00	0.00
1994-08	0.00	0.00	0.00
1994-09	0.00	0.00	0.00
1994-10	0.00	0.00	0.00
1994-11	2.23	2.23	2.23
1994-12	55.95	55.95	55.98
1995-01	296.90	296.90	296.95
1995-02	761.56	761.55	761.62
1995-03	1175.98	1425.98	1725.97

Month	No action	250 AF	550 AF
1995-04	1170.48	1418.92	1714.75
1995-05	1172.08	1421.47	1720.92
1995-06	936.78	1182.25	1476.76
1995-07	34.77	65.60	132.08
1995-08	24.39	33.04	42.29
1995-09	24.39	33.04	42.29
1995-10	24.39	33.04	42.29
1995-11	75.26	83.95	93.27
1995-12	215.98	225.07	234.82
1996-01	349.70	358.81	368.61
1996-02	550.60	559.72	569.52
1996-03	808.12	817.25	827.06
1996-04	804.08	813.21	823.03
1996-05	792.90	801.93	811.65
1996-06	0.00	0.00	0.00
1996-07	0.00	0.00	0.00
1996-08	0.00	0.00	0.00
1996-09	0.00	0.00	0.00
1996-10	2.36	2.36	2.37
1996-11	82.82	82.98	83.19
1996-12	754.58	754.80	755.09
1997-01	1175.98	1216.91	1217.22
1997-02	1175.98	1425.98	1679.29
1997-03	1175.98	1425.98	1725.97
1997-04	1175.80	1425.74	1725.60
1997-05	1175.49	1425.41	1725.34
1997-06	315.78	563.11	858.52
1997-07	38.68	93.76	159.42
1997-08	35.28	43.14	51.85
1997-09	727.77	737.30	747.91
1997-10	353.45	362.98	373.59
1997-11	864.41	874.00	884.63
1997-12	1175.98	1243.06	1253.65
1998-01	1175.98	1407.01	1417.61
1998-02	1175.98	1425.98	1561.98
1998-03	1175.98	1425.98	1725.97
1998-04	1170.48	1418.92	1714.75
1998-05	1156.02	1402.20	1695.79
1998-06	31.09	65.52	129.05
1998-07	31.09	43.22	49.21
1998-08	12.16	24.34	30.48
1998-09	0.00	0.00	0.00
1998-10	26.49	28.13	29.16
1998-11	246.83	248.83	250.09
1998-12	335.51	337.56	338.85
1999-01	353.69	355.85	357.19
1999-02	371.75	373.98	375.35
1999-03	906.90	909.18	910.59
1999-04	920.38	922.66	924.20
1999-05	909.39	911.65	913.17
1999-06	28.79	29.51	29.80
1999-07	28.79	29.51	29.80

Month	No action	250 AF	550 AF
1999-08	303.46	304.19	304.48
1999-09	30.52	32.36	33.56
1999-10	30.52	32.36	33.56
1999-11	30.52	32.36	33.56
1999-12	80.95	82.84	84.06
2000-01	159.25	161.16	162.38
2000-02	207.57	209.67	211.12
2000-03	433.04	435.13	436.59
2000-04	429.54	431.63	433.08
2000-05	423.77	425.89	427.36
2000-06	25.91	29.11	31.06
2000-07	0.00	0.00	0.00
2000-08	0.00	0.00	0.00
2000-09	0.00	0.00	0.00
2000-10	0.00	0.00	0.00
2000-11	0.00	0.00	0.00
2000-12	291.60	291.62	291.63
2001-01	629.20	629.23	629.25
2001-02	783.80	783.84	783.86
2001-03	1118.36	1118.40	1118.43
2001-04	1175.80	1181.28	1181.31
2001-05	1173.63	1211.28	1211.31
2001-06	32.46	33.20	33.11
2001-07	0.00	0.00	0.00
2001-08	0.00	0.00	0.00
2001-09	0.00	0.00	0.00
2001-10	0.00	0.00	0.00
2001-11	0.00	0.00	0.00
2001-12	2.40	2.41	2.42
2002-01	17.77	17.79	17.84
2002-02	40.53	40.58	40.70
2002-03	40.53	40.58	40.70
2002-04	40.78	40.83	40.94
2002-05	40.78	40.83	40.94
2002-06	0.00	0.00	0.00
2002-07	0.00	0.00	0.00
2002-08	0.00	0.00	0.00
2002-09	0.00	0.00	0.00
2002-10	0.00	0.00	0.00
2002-11	0.00	0.00	0.00
2002-12	0.00	0.00	0.00
2003-01	199.33	199.35	199.36
2003-02	542.98	543.00	543.02
2003-03	542.98	543.00	543.02
2003-04	539.59	539.60	539.62
2003-05	533.07	533.08	533.10
2003-06	0.00	0.00	0.00
2003-07	0.00	0.00	0.00
2003-08	0.00	0.00	0.00
2003-09	0.00	0.00	0.00
2003-10	0.00	0.00	0.00
2003-11	82.11	82.15	82.20

Month	No action	250 AF	550 AF
2003-12	82.11	82.15	82.20
2004-01	82.11	82.15	82.20
2004-02	82.11	82.15	82.20
2004-03	1059.88	1059.96	1060.03
2004-04	1173.78	1198.59	1198.66
2004-05	1166.15	1204.92	1205.00
2004-06	0.00	0.00	0.00
2004-07	0.00	0.00	0.00
2004-08	0.00	0.00	0.00
2004-09	0.00	0.00	0.00
2004-10	0.00	0.00	0.00
2004-11	146.74	147.53	147.62
2004-12	210.89	211.97	212.09
2005-01	564.63	565.87	566.00
2005-02	1175.98	1189.24	1189.36
2005-03	1175.98	1425.98	1725.97
2005-04	1175.80	1425.74	1725.60
2005-05	1175.49	1425.41	1725.34
2005-06	62.95	119.49	186.98
2005-07	0.00	0.00	0.00
2005-08	0.00	0.00	0.00
2005-09	0.00	0.00	0.00
2005-10	0.00	0.00	0.00
2005-11	112.10	112.46	112.93
2005-12	522.86	523.38	524.06
2006-01	835.37	835.97	836.78
2006-02	990.64	991.35	992.33
2006-03	1062.84	1063.66	1064.79
2006-04	1074.96	1075.79	1076.91
2006-05	1060.96	1061.78	1062.89
2006-06	0.00	0.00	0.00
2006-07	0.00	0.00	0.00
2006-08	0.00	0.00	0.00
2006-09	0.00	0.00	0.00
2006-10	327.39	327.55	327.74
2006-11	413.19	413.88	414.71
2006-12	507.37	508.19	509.08
2007-01	587.07	587.96	588.94
2007-02	822.43	823.35	824.38
2007-03	1175.98	1383.94	1384.97
2007-04	1175.80	1396.08	1394.18
2007-05	1161.58	1382.03	1380.25
2007-06	0.00	5.45	10.27
2007-07	0.00	0.00	0.00
2007-08	0.00	0.00	0.00
2007-09	0.00	0.00	0.00
2007-10	0.00	0.00	0.00
2007-11	14.95	16.35	16.53
2007-12	457.19	459.05	459.27
2008-01	691.96	694.06	694.30
2008-02	933.03	935.38	935.63
2008-03	1175.98	1425.98	1725.97

Month	No action	250 AF	550 AF
2008-04	1175.80	1425.74	1725.54
2008-05	1171.11	1420.34	1719.65
2008-06	24.43	33.51	81.45
2008-07	0.00	0.00	0.00
2008-08	0.00	0.00	0.00
2008-09	0.00	0.00	0.00
2008-10	0.00	0.00	0.00
2008-11	167.95	168.40	168.84
2008-12	182.87	183.49	184.10
2009-01	303.16	303.95	304.69
2009-02	458.89	459.89	460.83
2009-03	636.63	637.66	638.63
2009-04	634.63	635.66	636.63
2009-05	632.23	633.27	634.23
2009-06	9.95	10.50	10.79
2009-07	0.00	0.00	0.00
2009-08	0.00	0.00	0.00

Appendix B1: Predicted Monthly Diversion into Storage in RMWR

Date	Predicted Diversion into Storage			Increase from no-action case	
	No action	250 AF	550 AF	250 AF	550 AF
1974-10	51.4	51.4	51.4	0	0
1974-11	57.4	57.4	57.4	0	0
1974-12	175.7	175.7	175.7	0	0
1975-01	203.7	203.7	203.7	0	0
1975-02	147.6	147.6	147.6	0	0
1975-03	449.9	449.9	449.9	0	0
1975-04	33.3	33.3	33.3	0	0
1975-05	56.1	56.1	56.1	0	0
1975-06	87.4	133.2	133.2	45.8	45.8
1975-07	12.5	12.5	12.5	0	0
1975-08	0	0	0	0	0
1975-09	0	0	0	0	0
1975-10	0	0	0	0	0
1975-11	176.7	176.6	176.6	-0.1	-0.1
1975-12	162.9	162.9	162.9	0	0
1976-01	72.7	72.7	72.7	0	0
1976-02	115.4	115.3	115.3	-0.1	-0.1
1976-03	5.2	5.2	5.2	0	0
1976-04	0	0	0	0	0
1976-05	0.4	0.4	0.4	0	0
1976-06	0	0	0	0	0
1976-07	0	0	0	0	0
1976-08	0	0	0	0	0
1976-09	0	0	0	0	0
1976-10	0	0	0	0	0
1976-11	95	95	95.1	0	0.1
1976-12	0	0	0	0	0
1977-01	0	0	0	0	0
1977-02	0	0	0	0	0
1977-03	10.4	10.4	10.4	0	0
1977-04	0	0	0	0	0
1977-05	0	0	0	0	0
1977-06	0	0	0	0	0
1977-07	0	0	0	0	0
1977-08	0	0	0	0	0
1977-09	0	0	0	0	0
1977-10	0	0	0	0	0
1977-11	0	0	0	0	0
1977-12	0	0	0	0	0
1978-01	0	0	0	0	0
1978-02	0	0	0	0	0
1978-03	0	0	0	0	0
1978-04	123	123	123	0	0
1978-05	26.6	26.6	26.6	0	0
1978-06	27.2	27.2	27.2	0	0
1978-07	0	0	0	0	0
1978-08	0	0	0	0	0
1978-09	0	0	0	0	0

Date	Predicted Diversion into Storage			Increase from no-action case	
	No action	250 AF	550 AF	250 AF	550 AF
1978-10	0	0	0	0	0
1978-11	9.2	9.2	9.2	0	0
1978-12	0	0	0	0	0
1979-01	0	0	0	0	0
1979-02	21.9	21.9	21.9	0	0
1979-03	399.9	399.9	399.9	0	0
1979-04	118.4	118.4	118.4	0	0
1979-05	224.6	224.6	224.6	0	0
1979-06	124.6	124.6	124.6	0	0
1979-07	7.9	7.9	7.9	0	0
1979-08	0	0	0	0	0
1979-09	0	0	0	0	0
1979-10	0	0	0	0	0
1979-11	204	204	204	0	0
1979-12	241.6	241.6	241.6	0	0
1980-01	177.8	177.8	177.8	0	0
1980-02	165.5	165.5	165.5	0	0
1980-03	361.9	386.2	386.2	24.3	24.3
1980-04	5.3	105.6	105.6	100.3	100.3
1980-05	14.8	63.3	63.3	48.5	48.5
1980-06	48.6	127.6	157.4	79	108.8
1980-07	19.6	19.6	19.6	0	0
1980-08	0	0	0	0	0
1980-09	158.6	158.6	158.6	0	0
1980-10	0	0	0	0	0
1980-11	268.2	268.2	268.2	0	0
1980-12	215.3	215.3	215.2	0	-0.1
1981-01	95.9	95.9	95.8	0	-0.1
1981-02	95.9	95.9	95.9	0	0
1981-03	88.1	88.1	88	0	-0.1
1981-04	101.6	101.6	101.6	0	0
1981-05	10.2	10.2	10.2	0	0
1981-06	0	0	0	0	0
1981-07	0	0	0	0	0
1981-08	0	0	0	0	0
1981-09	0	0	0	0	0
1981-10	0	0	0	0	0
1981-11	125.3	125.4	125.6	0.1	0.3
1981-12	112	112.1	112.1	0.1	0.1
1982-01	241	241	241	0	0
1982-02	228.9	228.9	228.9	0	0
1982-03	366.5	366.5	366.6	0	0.1
1982-04	70.8	70.9	70.9	0.1	0.1
1982-05	49.3	56.4	56.5	7.1	7.2
1982-06	1.7	1.9	1.9	0.2	0.2
1982-07	0	0	0	0	0
1982-08	37.1	37.1	37.1	0	0
1982-09	0	0	0	0	0

Date	Predicted Diversion into Storage No action	Predicted Diversion into Storage 250 AF	Predicted Diversion into Storage 550 AF	Increase from no-action case 250 AF	Increase from no-action case 550 AF
1982-10	0	0	0	0	0
1982-11	188.6	188.7	188.8	0.1	0.2
1982-12	302.5	302.5	302.5	0	0
1983-01	376.9	376.9	377	0	0.1
1983-02	269.8	382.7	382.8	112.9	113
1983-03	0	138.2	438	138.2	438
1983-04	5.3	6.8	10.9	1.5	5.6
1983-05	14.8	17.1	19.3	2.3	4.5
1983-06	109.1	111.3	113.8	2.2	4.7
1983-07	38.8	38.8	38.8	0	0
1983-08	0	0	0	0	0
1983-09	0	0	0	0	0
1983-10	0	0	0	0	0
1983-11	387	387	387	0	0
1983-12	262	262	262	0	0
1984-01	192	192	192	0	0
1984-02	210.5	210.5	210.5	0	0
1984-03	81.7	321.9	613.3	240.2	531.6
1984-04	3.5	4.5	7.1	1	3.6
1984-05	15.7	18.5	21.9	2.8	6.2
1984-06	1.9	2.1	2.3	0.2	0.4
1984-07	0	0	0	0	0
1984-08	0	0	0	0	0
1984-09	0	0	0	0	0
1984-10	8.9	8.9	8.9	0	0
1984-11	21.7	21.7	21.7	0	0
1984-12	286.3	286.3	286.3	0	0
1985-01	369.1	369.1	369.1	0	0
1985-02	300	300	300	0	0
1985-03	193.9	435.7	727.5	241.8	533.6
1985-04	4.8	6.1	9.8	1.3	5
1985-05	15.4	17.9	20.5	2.5	5.1
1985-06	90.3	90.3	90.3	0	0
1985-07	0	0	0	0	0
1985-08	0	0	0	0	0
1985-09	62.2	62.3	62.3	0.1	0.1
1985-10	2.5	2.5	2.5	0	0
1985-11	381.3	381.3	381.3	0	0
1985-12	326.2	326.2	326.2	0	0
1986-01	408	427.2	427.2	19.2	19.2
1986-02	0	221.2	510.3	221.2	510.3
1986-03	0	0	0	0	0
1986-04	5.3	6.8	10.9	1.5	5.6
1986-05	14.3	16.6	18.7	2.3	4.4
1986-06	18.2	18.2	18.2	0	0
1986-07	0	0	0	0	0
1986-08	0	0	0	0	0
1986-09	0	0	0	0	0
1986-10	1140.3	1367.4	1462	227.1	321.7
1986-11	0	0	137.6	0	137.6
1986-12	0	0	0	0	0

Date	Predicted Diversion into Storage No action	Predicted Diversion into Storage 250 AF	Predicted Diversion into Storage 550 AF	Increase from no-action case 250 AF	Increase from no-action case 550 AF
1987-01	0	0	0	0	0
1987-02	0	0	0	0	0
1987-03	0	0	0	0	0
1987-04	5.3	6.8	10.9	1.5	5.6
1987-05	9.9	11.5	13	1.6	3.1
1987-06	97.3	100.2	102.5	2.9	5.2
1987-07	0	0	0	0	0
1987-08	0	0	0	0	0
1987-09	0	0	0	0	0
1987-10	0.6	0.6	0.6	0	0
1987-11	517.3	517.3	517.3	0	0
1987-12	314.8	314.8	314.8	0	0
1988-01	317.4	352.8	352.9	35.4	35.5
1988-02	0	203.6	273.3	203.6	273.3
1988-03	0	0	221	0	221
1988-04	3.1	4	6.4	0.9	3.3
1988-05	3.3	3.3	3.3	0	0
1988-06	0.3	0.3	0.3	0	0
1988-07	0	0	0	0	0
1988-08	0	0	0	0	0
1988-09	0	0	0	0	0
1988-10	0	0	0	0	0
1988-11	222.2	222.3	222.3	0.1	0.1
1988-12	214.6	214.7	214.8	0.1	0.2
1989-01	218.7	218.9	218.9	0.2	0.2
1989-02	116.1	116.1	116.1	0	0
1989-03	400.1	649.6	949.4	249.5	549.3
1989-04	3.9	5	7.9	1.1	4
1989-05	0	0	0	0	0
1989-06	0	0	0	0	0
1989-07	0	0	0	0	0
1989-08	0	0	0	0	0
1989-09	0	0	0	0	0
1989-10	0	0	0	0	0
1989-11	16	16.1	16.2	0.1	0.2
1989-12	0	0	0	0	0
1990-01	0	0	0	0	0
1990-02	5.3	5.3	5.4	0	0.1
1990-03	87.7	87.8	87.9	0.1	0.2
1990-04	2.7	2.7	2.7	0	0
1990-05	0	0	0	0	0
1990-06	0	0	0	0	0
1990-07	0	0	0	0	0
1990-08	0	0	0	0	0
1990-09	0	0	0	0	0
1990-10	0	0	0	0	0
1990-11	389.3	390.2	391.1	0.9	1.8
1990-12	1.4	1.4	1.5	0	0.1
1991-01	55.7	56.1	56.5	0.4	0.8
1991-02	146.8	146.9	147	0.1	0.2
1991-03	395	395.1	395.3	0.1	0.3

Date	Predicted Diversion into Storage			Increase from no-action case	
	No action	250 AF	550 AF	250 AF	550 AF
1991-04	7.1	7.1	7.2	0	0.1
1991-05	0	0	0	0	0
1991-06	0	0	0	0	0
1991-07	0	0	0	0	0
1991-08	0	0	0	0	0
1991-09	3.2	3.2	3.2	0	0
1991-10	0	0	0	0	0
1991-11	215.8	215.8	215.9	0	0.1
1991-12	0	0	0	0	0
1992-01	51.5	51.5	51.6	0	0.1
1992-02	66	66	66	0	0
1992-03	335.8	335.8	335.8	0	0
1992-04	162.5	162.5	162.5	0	0
1992-05	239.8	239.8	239.8	0	0
1992-06	78.8	78.8	78.8	0	0
1992-07	0	0	0	0	0
1992-08	0	0	0	0	0
1992-09	0	0	0	0	0
1992-10	0	0	0	0	0
1992-11	43.6	43.6	43.6	0	0
1992-12	0	0	0	0	0
1993-01	14.7	14.8	14.8	0.1	0.1
1993-02	19.8	19.8	19.8	0	0
1993-03	1097.9	1286.2	1286.2	188.3	188.3
1993-04	5.3	68.4	370.9	63.1	365.6
1993-05	14.8	17.2	19.3	2.4	4.5
1993-06	26.8	27.6	28.5	0.8	1.7
1993-07	0	0	0	0	0
1993-08	0	0	0	0	0
1993-09	0	0	0	0	0
1993-10	0	0	0	0	0
1993-11	345.4	345.4	345.4	0	0
1993-12	111.6	111.6	111.6	0	0
1994-01	153.2	153.2	153.2	0	0
1994-02	204	204	204	0	0
1994-03	293.5	293.5	293.5	0	0
1994-04	32.1	39.7	39.7	7.6	7.6
1994-05	15.9	19.6	19.6	3.7	3.7
1994-06	2.1	3	3	0.9	0.9
1994-07	0	0	0	0	0
1994-08	0	0	0	0	0
1994-09	0	0	0	0	0
1994-10	0	0	0	0	0
1994-11	9.8	9.8	9.8	0	0
1994-12	53.7	53.7	53.7	0	0
1995-01	240.9	240.9	241	0	0.1
1995-02	464.7	464.7	464.7	0	0
1995-03	414.4	664.4	964.4	250	550
1995-04	0	0	0	0	0
1995-05	16.7	19.9	25.7	3.2	9
1995-06	129	129	129	0	0

Date	Predicted Diversion into Storage			Increase from no-action case	
	No action	250 AF	550 AF	250 AF	550 AF
1995-07	29.9	29.9	29.9	0	0
1995-08	0	0	0	0	0
1995-09	0	0	0	0	0
1995-10	0	0	0	0	0
1995-11	50.9	50.9	51	0	0.1
1995-12	139.1	139.1	139.2	0	0.1
1996-01	133.7	133.7	133.8	0	0.1
1996-02	200.9	200.9	200.9	0	0
1996-03	257.6	257.6	257.6	0	0
1996-04	0	0	0	0	0
1996-05	0	0	0	0	0
1996-06	0	0	0	0	0
1996-07	0	0	0	0	0
1996-08	0	0	0	0	0
1996-09	0	0	0	0	0
1996-10	9	9	9.1	0	0.1
1996-11	81.1	81.2	81.4	0.1	0.3
1996-12	668.5	668.5	668.6	0	0.1
1997-01	418.6	458.8	458.8	40.2	40.2
1997-02	0	207.4	458.7	207.4	458.7
1997-03	0	0	46.7	0	46.7
1997-04	5.3	6.8	10.9	1.5	5.6
1997-05	14.8	17.2	19.4	2.4	4.6
1997-06	5.6	7	8.4	1.4	2.8
1997-07	11.7	11.7	11.7	0	0
1997-08	0.1	0.1	0.1	0	0
1997-09	692.5	694.2	696.1	1.7	3.6
1997-10	0	0	0	0	0
1997-11	507.2	507.2	507.2	0	0
1997-12	307.6	364.2	364.2	56.6	56.6
1998-01	0	160.7	160.7	160.7	160.7
1998-02	0	18.5	141.7	18.5	141.7
1998-03	0	0	164	0	164
1998-04	0	0	0	0	0
1998-05	0.5	0.5	0.5	0	0
1998-06	0.5	0.5	0.5	0	0
1998-07	0	0	0	0	0
1998-08	0	0	0	0	0
1998-09	0	0	0	0	0
1998-10	26.5	28.1	29.2	1.6	2.7
1998-11	218.5	218.9	219.1	0.4	0.6
1998-12	84.3	84.3	84.4	0	0.1
1999-01	18.2	18.3	18.3	0.1	0.1
1999-02	18.1	18.1	18.2	0	0.1
1999-03	535.2	535.2	535.2	0	0
1999-04	18	18	18.1	0	0.1
1999-05	1.4	1.4	1.4	0	0
1999-06	0.2	0.2	0.2	0	0
1999-07	0	0	0	0	0
1999-08	274.7	274.7	274.7	0	0
1999-09	0	0	0	0	0

Date	Predicted Diversion into Storage			Increase from no-action case	
	No action	250 AF	550 AF	250 AF	550 AF
1999-10	0	0	0	0	0
1999-11	0	0	0	0	0
1999-12	50.4	50.5	50.5	0.1	0.1
2000-01	78.3	78.3	78.3	0	0
2000-02	48.3	48.5	48.7	0.2	0.4
2000-03	225.5	225.5	225.5	0	0
2000-04	1	1	1	0	0
2000-05	0	0	0	0	0
2000-06	0	0	0	0	0
2000-07	0	0	0	0	0
2000-08	0	0	0	0	0
2000-09	0	0	0	0	0
2000-10	0	0	0	0	0
2000-11	0	0	0	0	0
2000-12	290.2	290.2	290.3	0	0.1
2001-01	337.6	337.6	337.6	0	0
2001-02	154.6	154.6	154.6	0	0
2001-03	334.6	334.6	334.6	0	0
2001-04	62.8	68.2	68.2	5.4	5.4
2001-05	12.9	44.9	44.9	32	32
2001-06	0	0	0	0	0
2001-07	0	0	0	0	0
2001-08	0	0	0	0	0
2001-09	0	0	0	0	0
2001-10	0	0	0	0	0
2001-11	0	0	0	0	0
2001-12	2.4	2.4	2.4	0	0
2002-01	15.4	15.4	15.4	0	0
2002-02	22.8	22.8	22.9	0	0.1
2002-03	0	0	0	0	0
2002-04	0.2	0.2	0.2	0	0
2002-05	0	0	0	0	0
2002-06	0	0	0	0	0
2002-07	0	0	0	0	0
2002-08	0	0	0	0	0
2002-09	0	0	0	0	0
2002-10	0	0	0	0	0
2002-11	0	0	0	0	0
2002-12	0	0	0	0	0
2003-01	199.3	199.3	199.4	0	0.1
2003-02	343.6	343.6	343.7	0	0.1
2003-03	0	0	0	0	0
2003-04	0	0	0	0	0
2003-05	0	0	0	0	0
2003-06	0	0	0	0	0
2003-07	0	0	0	0	0
2003-08	0	0	0	0	0
2003-09	46.7	46.7	46.8	0	0.1
2003-10	0	0	0	0	0
2003-11	82.1	82.2	82.2	0.1	0.1
2003-12	0	0	0	0	0

Date	Predicted Diversion into Storage			Increase from no-action case	
	No action	250 AF	550 AF	250 AF	550 AF
2004-01	0	0	0	0	0
2004-02	0	0	0	0	0
2004-03	977.8	977.8	977.8	0	0
2004-04	119.3	144.1	144.1	24.8	24.8
2004-05	7.5	20.9	20.9	13.4	13.4
2004-06	0	0	0	0	0
2004-07	0	0	0	0	0
2004-08	0	0	0	0	0
2004-09	0	0	0	0	0
2004-10	0	0	0	0	0
2004-11	147	147.8	147.8	0.8	0.8
2004-12	62.8	63	63	0.2	0.2
2005-01	353.7	353.9	353.9	0.2	0.2
2005-02	609.6	621.5	621.5	11.9	11.9
2005-03	0	236.8	536.7	236.8	536.7
2005-04	5.3	6.8	10.9	1.5	5.6
2005-05	14.8	17.1	19.3	2.3	4.5
2005-06	1.9	2.4	2.9	0.5	1
2005-07	0	0	0	0	0
2005-08	0	0	0	0	0
2005-09	0	0	0	0	0
2005-10	0	0	0	0	0
2005-11	112.1	112.5	112.9	0.4	0.8
2005-12	407.5	407.7	407.9	0.2	0.4
2006-01	312.2	312.3	312.4	0.1	0.2
2006-02	152.3	152.4	152.5	0.1	0.2
2006-03	72.2	72.3	72.5	0.1	0.3
2006-04	17.2	17.2	17.2	0	0
2006-05	0	0	0	0	0
2006-06	0	0	0	0	0
2006-07	0	0	0	0	0
2006-08	0	0	0	0	0
2006-09	0	0	0	0	0
2006-10	488.8	488.8	488.8	0	0
2006-11	81.5	82	82.7	0.5	1.2
2006-12	89.5	89.6	89.6	0.1	0.1
2007-01	79.7	79.8	79.9	0.1	0.2
2007-02	235.4	235.4	235.4	0	0
2007-03	353.6	560.6	560.6	207	207
2007-04	5.3	18.9	18.9	13.6	13.6
2007-05	0.8	2.9	2.9	2.1	2.1
2007-06	0	0	0	0	0
2007-07	0	0	0	0	0
2007-08	0	0	0	0	0
2007-09	0	0	0	0	0
2007-10	0	0	0	0	0
2007-11	15	16.4	16.5	1.4	1.5
2007-12	439.6	440	440.1	0.4	0.5
2008-01	234.8	235	235	0.2	0.2
2008-02	240	240.2	240.2	0.2	0.2
2008-03	243	490.6	790.3	247.6	547.3

Date	Predicted Diversion into Storage			Increase from no-action case	
	No action	250 AF	550 AF	250 AF	550 AF
2008-04	5.3	6.8	10.8	1.5	5.5
2008-05	10.4	12	13.7	1.6	3.3
2008-06	7.1	7.1	7.1	0	0
2008-07	0	0	0	0	0
2008-08	0	0	0	0	0
2008-09	0	0	0	0	0
2008-10	0	0	0	0	0
2008-11	168	168.4	168.8	0.4	0.8
2008-12	11.6	11.8	11.9	0.2	0.3
2009-01	120.3	120.5	120.6	0.2	0.3
2009-02	155.7	155.9	156.1	0.2	0.4
2009-03	177.7	177.8	177.8	0.1	0.1
2009-04	1.6	1.6	1.6	0	0
2009-05	4.5	4.5	4.5	0	0
2009-06	0	0	0	0	0
2009-07	0	0	0	0	0
2009-08	0	0	0	0	0
2009-09	0	0	0	0	0

Appendix B2: Predicted Annual Diversion into Storage in RMWR

	Predicted Diversion into Storage (AF)			Increase from no-action case (AF)	
Admin Year	No Action	250 AF	500 AF	250 AF	550 AF
1975	1275	1320.8	1320.8	45.8	45.8
1976	533.3	533	533	-0.3	-0.3
1977	105.4	105.4	105.4	0	0
1978	176.9	176.9	176.9	0	0
1979	906.4	906.4	906.4	0	0
1980	1397.8	1649.8	1679.7	252	281.9
1981	875.2	875.2	875	0	-0.2
1982	1232.7	1240.2	1240.4	7.5	7.7
1983	1305.8	1563.1	1871.7	257.3	565.9
1984	1154.3	1398.5	1696.1	244.2	541.8
1985	1352.6	1598.3	1896.2	245.7	543.6
1986	1155.9	1400.2	1695.4	244.3	539.5
1987	1252.9	1486	1726	233.1	473.1
1988	1156.9	1396.8	1689.9	239.9	533
1989	1175.5	1426.6	1729.5	251.1	554
1990	111.7	112	112.1	0.3	0.4
1991	998.4	1000	1001.8	1.6	3.4
1992	1150.1	1150.2	1150.4	0.1	0.3
1993	1223	1477.6	1783.2	254.6	560.2
1994	1157.8	1170	1170	12.2	12.2
1995	1359	1612.3	1918.1	253.3	559.1
1996	782.2	782.3	782.4	0.1	0.2
1997	1907.2	2162	2469.9	254.8	562.7
1998	815.8	1051.6	1338.8	235.8	523
1999	1194.9	1197.2	1198.7	2.3	3.8
2000	403.5	403.7	404	0.2	0.5
2001	1192.7	1230.1	1230.1	37.4	37.4
2002	40.8	40.8	40.9	0	0.1
2003	589.7	589.7	589.8	0	0.1
2004	1186.7	1225	1225	38.3	38.3
2005	1195.2	1449.3	1756	254.1	560.8
2006	1073.5	1074.3	1075.5	0.8	2
2007	1334.6	1558	1558.8	223.4	224.2
2008	1195.1	1448.1	1753.7	253	558.6
2009	639.5	640.5	641.5	1	2
Average	**988.8**	**1098.6**	**1209.8**	**109.8**	**221.0**

Appendix C: Monthly Average Diversions to Reservoir Ditches

Averages of monthly totals from WY 1975-2009, including all sources (AF)

330530 Old Indian

No action scenario				
Month	Adjudicated	From Exchange	From Storage	Total
November	0.00	0.00	0.00	0.00
December	0.00	0.00	0.00	0.00
January	0.00	0.00	0.00	0.00
February	0.00	0.00	0.00	0.00
March	0.00	0.00	0.00	0.00
April	25.06	0.00	0.00	25.06
May	53.75	2.20	0.00	55.95
June	54.48	1.89	7.23	63.60
July	39.60	0.73	5.43	45.76
August	28.92	0.13	5.15	34.20
September	18.16	0.16	0.52	18.84
October	1.13	0.00	0.00	1.13

250 AF scenario					
Month	Adjudicated	From Exchange	From Storage	Total	Increase from No-action
November	0.00	0.00	0.00	0.00	**0.00**
December	0.00	0.00	0.00	0.00	**0.00**
January	0.00	0.00	0.00	0.00	**0.00**
February	0.00	0.00	0.00	0.00	**0.00**
March	0.00	0.00	0.00	0.00	**0.00**
April	25.06	0.00	0.00	25.06	**0.00**
May	53.76	2.20	0.00	55.96	**0.01**
June	54.64	1.99	7.85	64.48	**0.88**
July	39.83	0.80	6.67	47.30	**1.54**
August	29.04	0.13	5.72	34.89	**0.69**
September	18.19	0.17	0.87	19.23	**0.39**
October	1.14	0.00	0.00	1.14	**0.01**

550 AF scenario					
Month	Adjudicated	From Exchange	From Storage	Total	Increase from No-action
November	0.00	0.00	0.00	0.00	**0.00**
December	0.00	0.00	0.00	0.00	**0.00**
January	0.00	0.00	0.00	0.00	**0.00**
February	0.00	0.00	0.00	0.00	**0.00**
March	0.00	0.00	0.00	0.00	**0.00**
April	25.07	0.00	0.00	25.07	**0.01**
May	53.77	2.20	0.00	55.97	**0.02**
June	54.82	2.30	8.01	65.13	**1.53**
July	40.07	0.75	7.93	48.75	**2.99**
August	29.16	0.13	6.17	35.46	**1.26**
September	18.22	0.17	1.04	19.43	**0.59**
October	1.15	0.00	0.00	1.15	**0.02**

330547 Joseph Freed

No action scenario				
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**
November	79.57	0.06	1.52	81.15
December	49.37	0.00	0.00	49.37
January	36.24	0.00	0.00	36.24
February	32.07	0.00	0.00	32.07
March	80.37	0.00	0.00	80.37
April	343.20	0.00	0.00	343.20
May	604.38	161.06	0.00	765.44
June	393.98	149.65	571.46	1115.09
July	107.63	27.72	95.82	231.17
August	42.33	5.68	0.77	48.78
September	50.51	4.59	11.21	66.31
October	85.34	2.94	14.51	102.79

250 AF scenario					
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**	**Increase from No-action**
November	79.61	0.06	1.52	81.19	**0.04**
December	49.37	0.00	0.00	49.37	**0.00**
January	36.24	0.00	0.00	36.24	**0.00**
February	32.07	0.00	0.00	32.07	**0.00**
March	80.37	0.00	0.00	80.37	**0.00**
April	343.25	0.00	0.00	343.25	**0.05**
May	604.39	161.47	0.00	765.86	**0.42**
June	394.29	150.32	607.02	1151.63	**36.54**
July	108.35	27.35	130.79	266.49	**35.32**
August	42.43	5.62	5.53	53.58	**4.80**
September	50.61	4.52	11.19	66.32	**0.01**
October	85.43	2.92	14.50	102.85	**0.06**

550 AF scenario					
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**	**Increase from No-action**
November	79.63	0.06	1.52	81.21	**0.06**
December	49.38	0.00	0.00	49.38	**0.01**
January	36.24	0.00	0.00	36.24	**0.00**
February	32.07	0.00	0.00	32.07	**0.00**
March	80.38	0.00	0.00	80.38	**0.01**
April	343.34	0.00	0.00	343.34	**0.14**
May	604.44	162.01	0.00	766.45	**1.01**
June	394.53	150.83	642.28	1187.64	**72.55**
July	108.93	26.94	166.49	302.36	**71.19**
August	42.57	5.52	11.42	59.51	**10.73**
September	50.71	4.43	11.17	66.31	**0.00**
October	85.53	2.90	14.50	102.93	**0.14**

330548 Revival

No action scenario				
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**
November	13.02	0.03	0.10	13.15
December	8.76	0.00	0.00	8.76
January	1.77	0.00	0.00	1.77
February	7.09	0.00	0.00	7.09
March	9.70	0.00	0.00	9.70
April	63.01	0.00	0.00	63.01
May	184.56	37.48	0.00	222.04
June	153.49	55.88	55.64	265.01
July	82.40	13.55	6.82	102.77
August	41.19	0.61	2.35	44.15
September	40.69	1.13	1.07	42.89
October	46.10	0.25	1.44	47.79

250 AF scenario					
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**	**Increase from No-action**
November	13.03	0.03	0.10	13.16	**0.01**
December	8.76	0.00	0.00	8.76	**0.00**
January	1.77	0.00	0.00	1.77	**0.00**
February	7.09	0.00	0.00	7.09	**0.00**
March	9.70	0.00	0.00	9.70	**0.00**
April	63.02	0.00	0.00	63.02	**0.01**
May	184.55	37.51	0.00	222.06	**0.02**
June	153.74	56.26	60.61	270.61	**5.60**
July	83.34	13.03	9.08	105.45	**2.68**
August	41.28	0.61	2.84	44.73	**0.58**
September	40.85	1.12	1.07	43.04	**0.15**
October	46.12	0.24	1.44	47.80	**0.01**

550 AF scenario					
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**	**Increase from No-action**
November	13.03	0.03	0.10	13.16	**0.01**
December	8.76	0.00	0.00	8.76	**0.00**
January	1.77	0.00	0.00	1.77	**0.00**
February	7.09	0.00	0.00	7.09	**0.00**
March	9.70	0.00	0.00	9.70	**0.00**
April	63.02	0.00	0.00	63.02	**0.01**
May	184.57	37.72	0.00	222.29	**0.25**
June	154.09	56.62	64.72	275.43	**10.42**
July	84.00	12.75	11.54	108.29	**5.52**
August	41.36	0.61	3.72	45.69	**1.54**
September	40.97	1.12	1.06	43.15	**0.26**
October	46.12	0.24	1.44	47.80	**0.01**

330550 Warren-Vosburgh

No action scenario				
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**
November	34.80	0.00	0.00	34.80
December	15.23	0.00	0.00	15.23
January	18.14	0.00	0.00	18.14
February	16.23	0.00	0.00	16.23
March	30.85	0.00	0.00	30.85
April	90.92	0.00	0.00	90.92
May	181.59	22.37	0.00	203.96
June	163.07	44.13	114.49	321.69
July	86.67	9.86	58.15	154.68
August	50.98	0.82	9.93	61.73
September	64.18	0.92	2.78	67.88
October	55.43	0.02	0.01	55.46

250 AF scenario					
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**	**Increase from No-action**
November	34.83	0.00	0.00	34.83	**0.03**
December	15.23	0.00	0.00	15.23	**0.00**
January	18.14	0.00	0.00	18.14	**0.00**
February	16.23	0.00	0.00	16.23	**0.00**
March	29.81	0.00	0.00	29.81	**-1.04**
April	90.91	0.00	0.00	90.91	**-0.01**
May	181.62	22.35	0.00	203.97	**0.01**
June	163.34	44.42	119.59	327.35	**5.66**
July	86.98	9.72	69.81	166.51	**11.83**
August	51.07	0.82	14.19	66.08	**4.35**
September	64.24	0.88	2.84	67.96	**0.08**
October	55.50	0.02	0.01	55.53	**0.07**

550 AF scenario					
Month	**Adjudicated**	**From Exchange**	**From Storage**	**Total**	**Increase from No-action**
November	34.84	0.00	0.00	34.84	**0.04**
December	15.23	0.00	0.00	15.23	**0.00**
January	18.14	0.00	0.00	18.14	**0.00**
February	16.23	0.00	0.00	16.23	**0.00**
March	28.65	0.00	0.00	28.65	**-2.20**
April	90.91	0.00	0.00	90.91	**-0.01**
May	181.63	22.34	0.00	203.97	**0.01**
June	163.47	45.27	122.26	331.00	**9.31**
July	87.35	9.63	82.51	179.49	**24.81**
August	51.17	0.82	17.95	69.94	**8.21**
September	64.29	0.85	4.22	69.36	**1.48**
October	55.57	0.02	0.01	55.60	**0.14**

Appendix D: Daily Flows through RMWR Supply Ditch (CFS)

Only dates with any non-zero flow are shown

Date	No action	250 AF	550 AF
10/6/74	0.9	0.9	0.9
10/13/74	0.0	0.0	0.0
10/22/74	0.3	0.3	0.3
10/23/74	2.5	2.5	2.5
10/27/74	1.6	1.6	1.6
10/28/74	0.4	0.4	0.4
10/29/74	2.7	2.7	2.7
10/30/74	1.8	1.8	1.8
10/31/74	1.8	1.8	1.8
12/1/74	0.4	0.4	0.4
12/2/74	0.5	0.5	0.5
12/3/74	0.5	0.5	0.5
12/4/74	0.5	0.5	0.5
12/5/74	1.5	1.5	1.5
12/6/74	0.5	0.5	0.5
12/7/74	0.5	0.5	0.5
12/8/74	0.5	0.5	0.5
12/9/74	0.5	0.5	0.5
12/10/74	0.6	0.6	0.6
12/11/74	0.6	0.6	0.6
12/12/74	0.6	0.6	0.6
12/13/74	0.6	0.6	0.6
12/14/74	0.6	0.6	0.6
12/15/74	0.6	0.6	0.6
12/16/74	0.7	0.7	0.7
12/17/74	0.7	0.7	0.7
12/18/74	0.7	0.7	0.7
12/19/74	0.7	0.7	0.7
12/20/74	0.7	0.7	0.7
12/21/74	0.8	0.8	0.8
12/22/74	0.8	0.8	0.8
12/23/74	0.8	0.8	0.8
12/24/74	0.8	0.8	0.8
12/25/74	0.8	0.8	0.8
12/26/74	0.9	0.9	0.9
12/27/74	0.9	0.9	0.9
12/28/74	0.9	0.9	0.9
12/29/74	0.9	0.9	0.9
12/30/74	0.9	0.9	0.9
12/31/74	1.0	1.0	1.0
1/1/75	1.2	1.2	1.2
1/2/75	1.2	1.2	1.2
1/3/75	1.2	1.2	1.2
1/4/75	1.2	1.2	1.2
1/5/75	1.3	1.3	1.3
1/6/75	1.3	1.3	1.3
1/7/75	1.3	1.3	1.3
1/8/75	1.3	1.3	1.3
1/9/75	1.3	1.3	1.3
1/10/75	1.4	1.4	1.4
1/11/75	1.4	1.4	1.4
1/12/75	1.4	1.4	1.4
1/13/75	1.4	1.4	1.4

Date	No action	250 AF	550 AF
1/14/75	1.4	1.4	1.4
1/15/75	1.4	1.4	1.4
1/16/75	1.4	1.4	1.4
1/17/75	1.3	1.3	1.3
1/18/75	1.3	1.3	1.3
1/19/75	1.3	1.3	1.3
1/20/75	1.3	1.3	1.3
1/21/75	1.2	1.2	1.2
1/22/75	1.2	1.2	1.2
1/23/75	1.2	1.2	1.2
1/24/75	1.1	1.1	1.1
1/25/75	1.1	1.1	1.1
1/26/75	1.1	1.1	1.1
1/27/75	1.1	1.1	1.1
1/28/75	1.0	1.0	1.0
1/29/75	1.0	1.0	1.0
1/30/75	1.0	1.0	1.0
1/31/75	1.0	1.0	1.0
2/1/75	0.5	0.5	0.5
2/2/75	0.5	0.5	0.5
2/3/75	0.5	0.5	0.5
2/4/75	0.4	0.4	0.4
2/5/75	0.4	0.4	0.4
2/6/75	0.4	0.4	0.4
2/7/75	0.3	0.3	0.3
2/8/75	0.3	0.3	0.3
2/9/75	0.3	0.3	0.3
2/10/75	0.7	0.7	0.7
2/11/75	0.2	0.2	0.2
2/12/75	0.2	0.2	0.2
2/13/75	0.2	0.2	0.2
2/14/75	0.2	0.2	0.2
2/15/75	0.2	0.2	0.2
2/16/75	0.3	0.3	0.3
2/17/75	0.3	0.3	0.3
2/18/75	0.4	0.4	0.4
2/19/75	0.4	0.4	0.4
2/20/75	0.5	0.5	0.5
2/21/75	0.5	0.5	0.5
2/22/75	0.6	0.6	0.6
2/23/75	0.6	0.6	0.6
2/24/75	0.7	0.7	0.7
2/25/75	1.1	1.1	1.1
2/26/75	1.1	1.1	1.1
2/27/75	1.2	1.2	1.2
2/28/75	1.2	1.2	1.2
3/1/75	1.5	1.5	1.5
3/2/75	1.6	1.6	1.6
3/3/75	1.6	1.6	1.6
3/4/75	1.7	1.7	1.7
3/5/75	1.7	1.7	1.7
3/6/75	1.8	1.8	1.8
3/7/75	1.8	1.8	1.8

Date	No action	250 AF	550 AF
3/8/75	1.9	1.9	1.9
3/9/75	1.9	1.9	1.9
3/10/75	2.0	2.0	2.0
3/11/75	2.0	2.0	2.0
3/12/75	2.1	2.1	2.1
3/13/75	2.5	2.5	2.5
3/14/75	2.2	2.2	2.2
3/15/75	2.2	2.2	2.2
3/16/75	2.3	2.3	2.3
3/17/75	2.3	2.3	2.3
3/18/75	2.2	2.2	2.2
3/19/75	2.2	2.2	2.2
3/20/75	2.2	2.2	2.2
3/21/75	3.0	3.0	3.0
3/22/75	3.9	3.9	3.9
3/23/75	6.8	6.8	6.8
3/24/75	6.7	6.7	6.7
3/25/75	2.0	2.0	2.0
3/26/75	1.9	1.9	1.9
3/27/75	2.4	2.4	2.4
3/28/75	5.3	5.3	5.3
3/29/75	17.1	17.1	17.1
3/30/75	11.1	11.1	11.1
3/31/75	2.0	2.0	2.0
11/11/75	0.3	0.3	0.3
11/12/75	0.8	0.8	0.8
11/13/75	1.3	1.3	1.3
11/14/75	1.8	1.8	1.8
11/15/75	2.6	2.6	2.6
11/16/75	3.0	3.0	3.0
11/17/75	3.0	3.0	3.0
11/18/75	3.3	3.3	3.3
11/19/75	3.3	3.2	3.2
11/20/75	3.0	3.0	3.0
11/21/75	2.6	2.6	2.6
11/22/75	2.4	2.4	2.4
11/23/75	2.4	2.4	2.4
11/24/75	2.4	2.4	2.4
11/25/75	2.2	2.2	2.2
11/26/75	2.2	2.2	2.2
11/27/75	2.3	2.3	2.3
11/28/75	2.3	2.3	2.3
11/29/75	2.3	2.3	2.3
11/30/75	2.2	2.2	2.2
12/1/75	1.2	1.2	1.2
12/2/75	1.3	1.2	1.2
12/3/75	1.3	1.3	1.3
12/4/75	1.3	1.3	1.3
12/5/75	1.3	1.3	1.3
12/6/75	1.2	1.2	1.2
12/7/75	1.8	1.8	1.8
12/8/75	2.3	2.3	2.3
12/9/75	2.2	2.2	2.2

Date	No action	250 AF	550 AF
12/10/75	2.2	2.2	2.2
12/11/75	1.9	1.9	1.9
12/12/75	1.9	1.9	1.9
12/13/75	2.2	2.2	2.2
12/14/75	1.3	1.3	1.3
12/15/75	1.3	1.3	1.3
12/16/75	1.4	1.4	1.4
12/17/75	1.3	1.3	1.3
12/18/75	1.2	1.2	1.2
12/19/75	1.1	1.1	1.1
12/20/75	1.1	1.1	1.1
12/21/75	1.2	1.2	1.2
12/22/75	1.7	1.7	1.7
12/23/75	1.6	1.6	1.6
12/24/75	1.2	1.2	1.2
12/25/75	1.0	1.0	1.0
12/26/75	1.0	1.0	1.0
12/27/75	1.0	1.0	1.0
12/28/75	1.0	1.0	1.0
12/29/75	0.9	0.9	0.9
12/30/75	0.9	0.9	0.9
12/31/75	0.9	0.9	0.9
1/1/76	0.5	0.5	0.5
1/2/76	0.8	0.8	0.8
1/3/76	0.6	0.6	0.6
1/4/76	0.3	0.3	0.3
1/5/76	0.2	0.2	0.2
1/6/76	0.5	0.5	0.5
1/7/76	0.2	0.2	0.2
1/8/76	0.1	0.1	0.1
1/9/76	0.0	0.0	0.0
1/10/76	0.3	0.3	0.3
1/17/76	0.0	0.0	0.0
2/1/76	0.1	0.1	0.1
2/2/76	0.1	0.1	0.1
2/8/76	0.1	0.1	0.1
2/9/76	0.6	0.6	0.6
2/10/76	0.5	0.5	0.5
2/11/76	0.3	0.3	0.3
2/12/76	0.2	0.2	0.2
2/13/76	0.2	0.2	0.2
2/15/76	0.1	0.1	0.1
2/21/76	0.0	0.0	0.0
2/22/76	0.1	0.1	0.1
2/23/76	0.1	0.1	0.1
2/24/76	0.2	0.2	0.2
2/25/76	0.2	0.2	0.2
2/26/76	0.2	0.2	0.2
2/27/76	0.3	0.3	0.3
2/28/76	0.3	0.3	0.3
11/14/76	0.6	0.6	0.6
11/15/76	1.2	1.2	1.2
11/16/76	1.1	1.1	1.1

Date	No action	250 AF	550 AF
11/17/76	1.1	1.1	1.1
11/18/76	0.9	0.9	0.9
11/19/76	0.9	0.9	0.9
11/20/76	1.0	1.0	1.0
11/21/76	0.8	0.8	0.8
11/22/76	0.9	0.9	0.9
11/23/76	0.7	0.7	0.7
11/24/76	0.5	0.5	0.5
11/25/76	0.6	0.6	0.6
11/26/76	0.4	0.4	0.4
11/27/76	0.5	0.5	0.5
11/28/76	0.7	0.7	0.7
11/29/76	0.4	0.4	0.4
11/30/76	0.4	0.4	0.4
3/1/79	0.6	0.6	0.6
3/2/79	0.6	0.6	0.6
3/3/79	0.7	0.7	0.7
3/4/79	0.7	0.7	0.7
3/5/79	0.8	0.8	0.8
3/6/79	0.9	0.9	0.9
3/7/79	0.9	0.9	0.9
3/8/79	1.0	1.0	1.0
3/9/79	1.0	1.0	1.0
3/10/79	1.1	1.1	1.1
3/11/79	1.1	1.1	1.1
3/12/79	1.2	1.2	1.2
3/13/79	1.2	1.2	1.2
3/14/79	1.3	1.3	1.3
3/15/79	1.3	1.3	1.3
3/16/79	1.3	1.3	1.3
3/17/79	1.3	1.3	1.3
3/18/79	1.3	1.3	1.3
3/19/79	2.1	2.1	2.1
3/20/79	3.0	3.0	3.0
3/21/79	3.9	3.9	3.9
3/22/79	3.0	3.0	3.0
3/23/79	3.9	3.9	3.9
3/24/79	4.9	4.9	4.9
3/25/79	4.9	4.9	4.9
3/26/79	5.9	5.9	5.9
3/27/79	6.9	6.9	6.9
3/28/79	6.9	6.9	6.9
3/29/79	6.9	6.9	6.9
3/30/79	6.9	6.9	6.9
3/31/79	6.9	6.9	6.9
11/9/79	0.3	0.3	0.3
11/10/79	0.7	0.7	0.7
11/11/79	1.1	1.1	1.1
11/12/79	1.4	1.4	1.4
11/13/79	1.8	1.8	1.8
11/14/79	2.2	2.2	2.2
11/15/79	2.6	2.6	2.6
11/16/79	2.7	2.7	2.7
11/17/79	2.7	2.7	2.7
11/18/79	2.7	2.7	2.7
11/19/79	2.7	2.7	2.7
11/20/79	2.7	2.7	2.7

Date	No action	250 AF	550 AF
11/21/79	2.8	2.8	2.8
11/22/79	2.8	2.8	2.8
11/23/79	2.8	2.8	2.8
11/24/79	2.8	2.8	2.8
11/25/79	2.8	2.8	2.8
11/26/79	2.8	2.8	2.8
11/27/79	2.8	2.8	2.8
11/28/79	2.8	2.8	2.8
11/29/79	2.8	2.8	2.8
11/30/79	2.8	2.8	2.8
12/1/79	2.2	2.2	2.2
12/2/79	2.2	2.2	2.2
12/3/79	2.2	2.2	2.2
12/4/79	2.2	2.2	2.2
12/5/79	2.2	2.2	2.2
12/6/79	2.2	2.2	2.2
12/7/79	2.2	2.2	2.2
12/8/79	2.2	2.2	2.2
12/9/79	2.6	2.6	2.6
12/10/79	2.7	2.7	2.7
12/11/79	2.2	2.2	2.2
12/12/79	2.2	2.2	2.2
12/13/79	2.2	2.2	2.2
12/14/79	2.3	2.3	2.3
12/15/79	2.3	2.3	2.3
12/16/79	2.4	2.4	2.4
12/17/79	2.4	2.4	2.4
12/18/79	2.2	2.2	2.2
12/19/79	2.1	2.1	2.1
12/20/79	2.1	2.1	2.1
12/21/79	2.7	2.7	2.7
12/22/79	3.1	3.1	3.1
12/23/79	2.1	2.1	2.1
12/24/79	2.1	2.1	2.1
12/25/79	2.1	2.1	2.1
12/26/79	2.1	2.1	2.1
12/27/79	2.4	2.4	2.4
12/28/79	2.4	2.4	2.4
12/29/79	2.4	2.4	2.4
12/30/79	2.0	2.0	2.0
12/31/79	2.5	2.5	2.5
1/1/80	1.8	1.8	1.8
1/2/80	1.4	1.4	1.4
1/3/80	1.1	1.1	1.1
1/4/80	1.1	1.1	1.1
1/5/80	1.4	1.4	1.4
1/6/80	1.6	1.6	1.6
1/7/80	1.6	1.6	1.6
1/8/80	2.0	2.0	2.0
1/9/80	1.2	1.2	1.2
1/10/80	1.7	1.7	1.7
1/11/80	2.2	2.2	2.2
1/12/80	2.1	2.1	2.1
1/13/80	2.2	2.2	2.2
1/14/80	2.9	2.9	2.9
1/15/80	2.4	2.4	2.4
1/16/80	1.8	1.8	1.8

Date	No action	250 AF	550 AF
1/17/80	1.7	1.7	1.7
1/18/80	1.7	1.7	1.7
1/19/80	2.0	2.0	2.0
1/20/80	1.7	1.7	1.7
1/21/80	1.5	1.5	1.5
1/22/80	1.0	1.0	1.0
1/23/80	0.6	0.6	0.6
1/24/80	0.3	0.3	0.3
1/25/80	0.4	0.4	0.4
1/26/80	0.5	0.5	0.5
1/27/80	1.5	1.5	1.5
1/28/80	1.5	1.5	1.5
1/29/80	2.0	2.0	2.0
1/30/80	1.3	1.3	1.3
1/31/80	1.3	1.3	1.3
2/1/80	1.1	1.1	1.1
2/2/80	1.1	1.1	1.1
2/3/80	1.0	1.0	1.0
2/4/80	1.4	1.4	1.4
2/5/80	0.8	0.8	0.8
2/6/80	0.8	0.8	0.8
2/7/80	0.9	0.9	0.9
2/8/80	0.9	0.9	0.9
2/9/80	0.9	0.9	0.9
2/10/80	1.0	1.0	1.0
2/11/80	1.0	1.0	1.0
2/12/80	1.0	1.0	1.0
2/13/80	1.1	1.1	1.1
2/14/80	1.1	1.1	1.1
2/15/80	1.1	1.1	1.1
2/16/80	1.2	1.2	1.2
2/17/80	1.3	1.3	1.3
2/18/80	1.4	1.4	1.4
2/19/80	1.6	1.6	1.6
2/20/80	1.7	1.7	1.7
2/21/80	1.3	1.3	1.3
2/22/80	1.5	1.5	1.5
2/23/80	1.6	1.6	1.6
2/24/80	1.7	1.7	1.7
2/25/80	1.9	1.9	1.9
2/26/80	2.0	2.0	2.0
2/27/80	2.6	2.6	2.6
2/28/80	2.7	2.7	2.7
3/1/80	3.9	3.9	3.9
3/2/80	3.9	3.9	3.9
3/3/80	4.0	4.0	4.0
3/4/80	4.3	4.3	4.3
3/5/80	4.3	4.3	4.3
3/6/80	4.0	4.0	4.0
3/7/80	4.5	4.5	4.5
3/8/80	4.5	4.5	4.5
3/9/80	4.6	4.6	4.6
3/10/80	4.6	4.6	4.6
3/11/80	4.3	4.3	4.3
3/12/80	4.7	4.7	4.7
3/13/80	4.8	4.8	4.8
3/14/80	4.9	4.9	4.9

Date	No action	250 AF	550 AF
3/15/80	4.9	4.9	4.9
3/16/80	4.9	4.9	4.9
3/17/80	4.8	4.8	4.8
3/18/80	4.7	4.7	4.7
3/19/80	4.7	4.7	4.7
3/20/80	4.6	4.6	4.6
3/21/80	5.2	5.2	5.2
3/22/80	5.5	5.5	5.5
3/23/80	5.4	5.4	5.4
3/24/80	5.0	5.0	5.0
3/25/80	5.3	5.3	5.3
3/26/80	5.2	5.2	5.2
3/27/80	4.8	4.8	4.8
3/28/80	4.7	4.7	4.7
3/29/80	4.6	4.6	4.6
3/30/80	0.0	4.6	4.6
3/31/80	0.0	4.5	4.5
9/10/80	70.9	70.9	70.9
11/1/80	0.1	0.1	0.1
11/2/80	0.1	0.1	0.1
11/3/80	0.1	0.1	0.1
11/4/80	0.1	0.1	0.1
11/5/80	0.1	0.1	0.1
11/6/80	0.1	0.1	0.1
11/7/80	0.1	0.1	0.1
11/8/80	0.1	0.1	0.1
11/9/80	0.1	0.1	0.1
11/10/80	0.7	0.7	0.7
11/11/80	1.1	1.1	1.1
11/12/80	1.5	1.5	1.5
11/13/80	2.9	2.9	2.9
11/14/80	3.3	3.3	3.3
11/15/80	3.7	3.7	3.7
11/16/80	3.7	3.7	3.7
11/17/80	3.7	3.7	3.7
11/18/80	3.7	3.7	3.7
11/19/80	3.7	3.7	3.7
11/20/80	2.8	2.8	2.8
11/21/80	2.8	2.8	2.8
11/22/80	2.3	2.3	2.3
11/23/80	1.9	1.9	1.9
11/24/80	2.9	2.9	2.9
11/25/80	2.4	2.4	2.4
11/26/80	1.9	1.9	1.9
11/27/80	1.9	1.9	1.9
11/28/80	1.9	1.9	1.9
11/29/80	1.9	1.9	1.9
11/30/80	1.9	1.9	1.9
12/1/80	1.2	1.2	1.2
12/2/80	1.3	1.3	1.3
12/3/80	1.3	1.3	1.3
12/4/80	1.3	1.3	1.3
12/5/80	1.3	1.3	1.3
12/6/80	1.4	1.4	1.4
12/7/80	1.4	1.4	1.4
12/8/80	1.4	1.4	1.4
12/9/80	1.4	1.4	1.4

Date	No action	250 AF	550 AF
12/10/80	1.5	1.5	1.5
12/11/80	1.5	1.5	1.5
12/12/80	1.6	1.6	1.6
12/13/80	1.7	1.7	1.7
12/14/80	1.7	1.7	1.7
12/15/80	1.8	1.8	1.8
12/16/80	1.8	1.8	1.8
12/17/80	1.8	1.8	1.8
12/18/80	1.8	1.8	1.8
12/19/80	1.8	1.8	1.8
12/20/80	1.8	1.8	1.8
12/21/80	1.8	1.8	1.8
12/22/80	1.7	1.7	1.7
12/23/80	1.7	1.7	1.7
12/24/80	1.7	1.7	1.7
12/25/80	1.7	1.7	1.7
12/26/80	1.7	1.7	1.7
12/27/80	1.7	1.7	1.7
12/28/80	1.6	1.6	1.6
12/29/80	1.6	1.6	1.6
12/30/80	1.5	1.5	1.5
12/31/80	1.5	1.5	1.5
3/1/81	0.2	0.2	0.2
3/2/81	0.7	0.7	0.7
3/3/81	0.6	0.6	0.6
3/4/81	0.4	0.4	0.4
3/5/81	0.3	0.3	0.3
3/6/81	1.1	1.1	1.1
3/7/81	0.7	0.7	0.7
3/8/81	0.7	0.7	0.7
3/9/81	0.6	0.6	0.6
3/10/81	0.6	0.6	0.6
3/11/81	1.1	1.1	1.1
3/12/81	0.8	0.8	0.8
3/13/81	0.7	0.7	0.7
3/14/81	1.0	1.0	1.0
3/15/81	1.0	1.0	1.0
3/16/81	0.6	0.6	0.6
11/7/81	0.4	0.4	0.4
11/15/81	0.1	0.1	0.1
11/16/81	0.2	0.2	0.2
12/18/81	0.1	0.1	0.1
12/19/81	0.2	0.2	0.2
12/20/81	0.3	0.3	0.3
12/21/81	0.8	0.8	0.8
12/22/81	0.5	0.5	0.5
12/28/81	0.1	0.1	0.1
12/29/81	0.3	0.3	0.3
12/30/81	0.4	0.4	0.4
12/31/81	1.0	1.0	1.0
1/1/82	2.1	2.1	2.1
1/2/82	1.5	1.5	1.5
1/3/82	1.2	1.2	1.2
1/4/82	1.3	1.3	1.3
1/5/82	1.6	1.6	1.6
1/6/82	2.1	2.1	2.1
1/7/82	1.3	1.3	1.3

Date	No action	250 AF	550 AF
1/8/82	1.3	1.3	1.3
1/9/82	1.4	1.4	1.4
1/10/82	1.4	1.4	1.4
1/11/82	1.4	1.4	1.4
1/12/82	1.5	1.5	1.5
1/13/82	1.4	1.4	1.4
1/14/82	1.5	1.5	1.5
1/15/82	1.5	1.5	1.5
1/16/82	1.7	1.7	1.7
1/17/82	2.0	2.0	2.0
1/18/82	1.5	1.5	1.5
1/19/82	1.5	1.5	1.5
1/20/82	1.5	1.5	1.5
1/21/82	1.5	1.5	1.5
1/22/82	1.5	1.5	1.5
1/23/82	1.5	1.5	1.5
1/24/82	1.5	1.5	1.5
1/25/82	1.5	1.5	1.5
1/26/82	1.5	1.5	1.5
1/27/82	1.5	1.5	1.5
1/28/82	1.5	1.5	1.5
1/29/82	1.5	1.5	1.5
1/30/82	1.5	1.5	1.5
1/31/82	1.5	1.5	1.5
2/1/82	1.8	1.8	1.8
2/2/82	1.8	1.8	1.8
2/3/82	1.8	1.8	1.8
2/4/82	1.8	1.8	1.8
2/5/82	1.8	1.8	1.8
2/6/82	1.8	1.8	1.8
2/7/82	1.8	1.8	1.8
2/8/82	1.8	1.8	1.8
2/9/82	1.8	1.8	1.8
2/10/82	1.8	1.8	1.8
2/11/82	1.8	1.8	1.8
2/12/82	1.8	1.8	1.8
2/13/82	1.8	1.8	1.8
2/14/82	1.8	1.8	1.8
2/15/82	1.7	1.7	1.7
2/16/82	1.6	1.6	1.6
2/17/82	1.7	1.7	1.7
2/18/82	1.5	1.5	1.5
2/19/82	1.5	1.5	1.5
2/20/82	1.4	1.4	1.4
2/21/82	1.3	1.3	1.3
2/22/82	1.6	1.6	1.6
2/23/82	1.5	1.5	1.5
2/24/82	1.4	1.4	1.4
2/25/82	1.3	1.3	1.3
2/26/82	1.2	1.2	1.2
2/27/82	1.0	1.0	1.0
2/28/82	1.0	1.0	1.0
3/1/82	1.9	1.9	1.9
3/2/82	2.6	2.6	2.6
3/3/82	2.8	2.8	2.8
3/4/82	2.7	2.7	2.7
3/5/82	2.5	2.5	2.5

Date	No action	250 AF	550 AF
3/6/82	2.4	2.4	2.4
3/7/82	2.2	2.2	2.2
3/8/82	2.1	2.1	2.1
3/9/82	2.3	2.3	2.3
3/10/82	2.7	2.7	2.7
3/11/82	4.0	4.0	4.0
3/12/82	8.7	8.7	8.7
3/13/82	6.6	6.6	6.6
3/14/82	5.5	5.5	5.5
3/15/82	6.3	6.3	6.3
3/16/82	4.8	4.8	4.8
3/17/82	3.0	3.0	3.0
3/18/82	1.1	1.1	1.1
3/19/82	0.2	0.2	0.2
11/13/82	0.9	0.9	0.9
11/14/82	0.7	0.7	0.7
11/15/82	1.1	1.1	1.1
11/16/82	1.1	1.1	1.1
11/17/82	1.5	1.5	1.5
11/18/82	2.0	2.0	2.0
11/19/82	2.5	2.5	2.5
11/20/82	2.0	2.0	2.0
11/21/82	2.0	2.0	2.0
11/22/82	2.0	2.0	2.0
11/23/82	2.0	2.0	2.0
11/24/82	2.5	2.5	2.5
11/25/82	2.5	2.5	2.5
11/26/82	2.5	2.5	2.5
11/27/82	2.5	2.5	2.5
11/28/82	2.5	2.5	2.5
11/29/82	2.5	2.5	2.5
11/30/82	5.5	5.5	5.5
12/1/82	6.7	6.7	6.7
12/2/82	2.8	2.8	2.8
12/3/82	1.8	1.8	1.8
12/4/82	1.9	1.9	1.9
12/5/82	1.9	1.9	1.9
12/6/82	1.0	1.0	1.0
12/7/82	0.5	0.5	0.5
12/8/82	0.6	0.6	0.6
12/9/82	1.2	1.2	1.2
12/10/82	1.3	1.3	1.3
12/11/82	1.4	1.4	1.4
12/12/82	1.0	1.0	1.0
12/13/82	1.0	1.0	1.0
12/14/82	1.6	1.6	1.6
12/15/82	1.2	1.2	1.2
12/16/82	2.7	2.7	2.7
12/17/82	2.8	2.8	2.8
12/18/82	2.8	2.8	2.8
12/19/82	2.9	2.9	2.9
12/20/82	3.0	3.0	3.0
12/21/82	3.0	3.0	3.0
12/22/82	3.1	3.1	3.1
12/23/82	3.2	3.2	3.2
12/24/82	2.3	2.3	2.3
12/25/82	2.4	2.4	2.4

Date	No action	250 AF	550 AF
12/26/82	2.4	2.4	2.4
12/27/82	2.0	2.0	2.0
12/28/82	1.9	1.9	1.9
12/29/82	1.9	1.9	1.9
12/30/82	2.0	2.0	2.0
12/31/82	2.1	2.1	2.1
1/1/83	2.3	2.3	2.3
1/2/83	2.3	2.3	2.3
1/3/83	2.4	2.4	2.4
1/4/83	2.5	2.5	2.5
1/5/83	2.5	2.5	2.5
1/6/83	2.5	2.5	2.5
1/7/83	2.5	2.5	2.5
1/8/83	2.6	2.6	2.6
1/9/83	2.6	2.6	2.6
1/10/83	2.6	2.6	2.6
1/11/83	2.6	2.6	2.6
1/12/83	2.6	2.6	2.6
1/13/83	2.7	2.7	2.7
1/14/83	2.7	2.7	2.7
1/15/83	2.7	2.7	2.7
1/16/83	2.7	2.7	2.7
1/17/83	2.7	2.7	2.7
1/18/83	2.7	2.7	2.7
1/19/83	2.7	2.7	2.7
1/20/83	2.7	2.7	2.7
1/21/83	2.6	2.6	2.7
1/22/83	2.6	2.6	2.6
1/23/83	2.6	2.6	2.6
1/24/83	2.6	2.6	2.6
1/25/83	2.8	2.8	2.8
1/26/83	2.6	2.6	2.6
1/27/83	2.6	2.6	2.6
1/28/83	2.6	2.6	2.6
1/29/83	2.6	2.6	2.6
1/30/83	2.5	2.5	2.6
1/31/83	2.5	2.5	2.5
2/1/83	2.7	2.7	2.7
2/2/83	2.7	2.7	2.7
2/3/83	2.7	2.7	2.7
2/4/83	2.7	2.7	2.7
2/5/83	2.6	2.6	2.6
2/6/83	2.6	2.6	2.6
2/7/83	2.6	2.6	2.6
2/8/83	2.6	2.6	2.6
2/9/83	2.6	2.6	2.6
2/10/83	2.6	2.6	2.6
2/11/83	2.6	2.6	2.6
2/12/83	2.6	2.6	2.6
2/13/83	2.6	2.6	2.6
2/14/83	2.6	2.6	2.6
2/15/83	2.5	2.5	2.5
2/16/83	2.4	2.4	2.4
2/17/83	2.3	2.3	2.3
2/18/83	2.2	2.2	2.2
2/19/83	2.1	2.1	2.1
2/20/83	0.0	2.0	2.0

Date	No action	250 AF	550 AF
2/21/83	0.0	1.9	1.9
2/22/83	0.0	1.9	1.9
2/23/83	0.0	1.8	1.8
2/24/83	0.0	1.7	1.7
2/25/83	0.0	1.6	1.6
2/26/83	0.0	1.5	1.5
2/27/83	0.0	1.4	1.4
2/28/83	0.0	1.4	1.4
3/1/83	0.0	0.6	0.6
3/2/83	0.0	0.5	0.5
3/3/83	0.0	0.8	0.8
3/4/83	0.0	1.6	1.6
3/5/83	0.0	1.4	1.4
3/6/83	0.0	1.2	1.2
3/7/83	0.0	1.0	1.0
3/8/83	0.0	0.8	0.8
3/9/83	0.0	2.6	2.6
3/10/83	0.0	2.4	2.4
3/11/83	0.0	2.2	2.2
3/12/83	0.0	2.0	2.0
3/13/83	0.0	0.0	3.8
3/14/83	0.0	0.0	5.6
3/15/83	0.0	0.0	6.4
3/16/83	0.0	0.0	6.3
3/17/83	0.0	0.0	6.3
3/18/83	0.0	0.0	6.3
3/19/83	0.0	0.0	6.3
3/20/83	0.0	0.0	6.3
3/21/83	0.0	0.0	5.2
3/22/83	0.0	0.0	5.2
3/23/83	0.0	0.0	5.2
3/24/83	0.0	0.0	5.2
3/25/83	0.0	0.0	5.1
3/26/83	0.0	0.0	4.1
11/8/83	1.6	1.6	1.6
11/9/83	1.6	1.6	1.6
11/10/83	2.5	2.5	2.5
11/11/83	2.5	2.5	2.5
11/12/83	3.5	3.5	3.5
11/13/83	4.4	4.4	4.4
11/14/83	5.4	5.4	5.4
11/15/83	5.3	5.3	5.3
11/16/83	5.4	5.4	5.4
11/17/83	5.4	5.4	5.4
11/18/83	6.4	6.4	6.4
11/19/83	5.4	5.4	5.4
11/20/83	6.4	6.4	6.4
11/21/83	7.4	7.4	7.4
11/22/83	6.5	6.5	6.5
11/23/83	5.6	5.6	5.6
11/24/83	5.6	5.6	5.6
11/25/83	5.6	5.6	5.6
11/26/83	5.7	5.7	5.7
11/27/83	5.2	5.2	5.2
11/28/83	5.3	5.3	5.3
11/29/83	5.3	5.3	5.3
11/30/83	5.3	5.3	5.3

Date	No action	250 AF	550 AF
12/1/83	3.1	3.1	3.1
12/2/83	3.6	3.6	3.6
12/3/83	3.7	3.7	3.7
12/4/83	3.2	3.2	3.2
12/5/83	3.3	3.3	3.3
12/6/83	2.9	2.9	2.9
12/7/83	3.0	3.0	3.0
12/8/83	3.5	3.5	3.5
12/9/83	3.6	3.6	3.6
12/10/83	3.7	3.7	3.7
12/11/83	3.7	3.7	3.7
12/12/83	3.8	3.8	3.8
12/13/83	3.9	3.9	3.9
12/14/83	3.5	3.5	3.5
12/15/83	4.1	4.1	4.1
12/16/83	3.2	3.2	3.2
12/17/83	2.8	2.8	2.8
12/18/83	2.8	2.8	2.8
12/19/83	2.8	2.8	2.8
12/20/83	3.2	3.2	3.2
12/21/83	2.6	2.6	2.6
12/22/83	2.3	2.3	2.3
12/23/83	2.8	2.8	2.8
12/24/83	2.3	2.3	2.3
12/25/83	2.8	2.8	2.8
12/26/83	2.8	2.8	2.8
12/27/83	3.1	3.1	3.1
12/28/83	2.3	2.3	2.3
12/29/83	2.1	2.1	2.1
12/30/83	2.1	2.1	2.1
12/31/83	1.9	1.9	1.9
1/1/84	2.3	2.3	2.3
1/2/84	2.3	2.3	2.3
1/3/84	2.7	2.7	2.7
1/4/84	2.3	2.3	2.3
1/5/84	2.3	2.3	2.3
1/6/84	2.3	2.3	2.3
1/7/84	2.7	2.7	2.7
1/8/84	2.7	2.7	2.7
1/9/84	2.7	2.7	2.7
1/10/84	2.7	2.7	2.7
1/11/84	2.5	2.5	2.5
1/12/84	2.5	2.5	2.5
1/13/84	2.0	2.0	2.0
1/14/84	3.0	3.0	3.0
1/15/84	2.5	2.5	2.5
1/16/84	2.0	2.0	2.0
1/17/84	1.8	1.8	1.8
1/18/84	0.7	0.7	0.7
1/19/84	1.1	1.1	1.1
1/20/84	1.4	1.4	1.4
1/21/84	1.3	1.3	1.3
1/22/84	1.1	1.1	1.1
1/23/84	1.0	1.0	1.0
1/24/84	1.3	1.3	1.3
1/25/84	1.7	1.7	1.7
1/26/84	2.0	2.0	2.0

Date	No action	250 AF	550 AF
1/27/84	1.9	1.9	1.9
1/28/84	1.7	1.7	1.7
1/29/84	1.7	1.7	1.7
1/30/84	1.2	1.2	1.2
1/31/84	1.1	1.1	1.1
2/20/84	0.4	0.4	0.4
2/21/84	0.6	0.6	0.6
2/22/84	0.8	0.8	0.8
2/23/84	1.0	1.0	1.0
2/24/84	1.3	1.3	1.3
2/25/84	0.5	0.5	0.5
2/26/84	1.7	1.7	1.7
2/27/84	1.9	1.9	1.9
2/28/84	2.1	2.1	2.1
3/1/84	5.6	5.6	5.6
3/2/84	5.7	5.7	5.7
3/3/84	5.8	5.8	5.8
3/4/84	5.9	5.9	5.9
3/5/84	4.5	6.0	6.0
3/6/84	0.0	6.0	6.0
3/7/84	0.0	6.1	6.1
3/8/84	0.0	7.2	7.2
3/9/84	0.0	7.2	7.2
3/10/84	0.0	8.3	8.3
3/11/84	0.0	8.4	8.4
3/12/84	0.0	8.4	8.4
3/13/84	0.0	8.4	8.4
3/14/84	0.0	9.4	9.4
3/15/84	0.0	9.5	9.5
3/16/84	0.0	7.4	11.2
3/17/84	0.0	0.0	12.8
3/18/84	0.0	0.0	12.4
3/19/84	0.0	0.0	13.9
3/20/84	0.0	0.0	16.5
3/21/84	0.0	0.0	20.9
3/22/84	0.0	0.0	27.3
3/23/84	0.0	0.0	10.5
12/1/84	0.1	0.1	0.1
12/2/84	0.4	0.4	0.4
12/4/84	0.5	0.5	0.5
12/5/84	0.4	0.4	0.4
12/6/84	0.6	0.6	0.6
12/7/84	0.8	0.8	0.8
12/8/84	1.8	1.8	1.8
12/9/84	2.1	2.1	2.1
12/10/84	2.3	2.3	2.3
12/11/84	2.4	2.4	2.4
12/12/84	2.6	2.6	2.6
12/13/84	4.6	4.6	4.6
12/14/84	4.7	4.7	4.7
12/15/84	2.9	2.9	2.9
12/16/84	2.5	2.5	2.5
12/17/84	2.6	2.6	2.6
12/18/84	1.9	1.9	1.9
12/19/84	2.0	2.0	2.0
12/20/84	2.7	2.7	2.7
12/21/84	2.0	2.0	2.0

Date	No action	250 AF	550 AF
12/22/84	2.0	2.0	2.0
12/23/84	2.0	2.0	2.0
12/24/84	2.0	2.0	2.0
12/25/84	2.0	2.0	2.0
12/26/84	2.1	2.1	2.1
12/27/84	3.3	3.3	3.3
12/28/84	4.3	4.3	4.3
12/29/84	3.4	3.4	3.4
12/30/84	2.5	2.5	2.5
12/31/84	2.5	2.5	2.5
1/1/85	1.9	1.9	1.9
1/2/85	1.9	1.9	1.9
1/3/85	1.9	1.9	1.9
1/4/85	2.0	2.0	2.0
1/5/85	2.0	2.0	2.0
1/6/85	2.6	2.6	2.6
1/7/85	2.6	2.6	2.6
1/8/85	3.2	3.2	3.2
1/9/85	3.3	3.3	3.3
1/10/85	3.3	3.3	3.3
1/11/85	2.8	2.8	2.8
1/12/85	2.9	2.9	2.9
1/13/85	2.4	2.4	2.4
1/14/85	2.4	2.4	2.4
1/15/85	2.5	2.5	2.5
1/16/85	2.5	2.5	2.5
1/17/85	2.5	2.5	2.5
1/18/85	2.1	2.1	2.1
1/19/85	2.7	2.7	2.7
1/20/85	2.7	2.7	2.7
1/21/85	2.7	2.7	2.7
1/22/85	2.3	2.3	2.3
1/23/85	2.4	2.4	2.4
1/24/85	2.4	2.4	2.4
1/25/85	2.2	2.2	2.2
1/26/85	2.4	2.4	2.4
1/27/85	2.4	2.4	2.4
1/28/85	3.2	3.2	3.2
1/29/85	2.8	2.8	2.8
1/30/85	2.8	2.8	2.8
1/31/85	2.3	2.3	2.3
2/1/85	2.4	2.4	2.4
2/2/85	2.4	2.4	2.4
2/3/85	2.4	2.4	2.4
2/4/85	2.5	2.5	2.5
2/5/85	2.5	2.5	2.5
2/6/85	2.5	2.5	2.5
2/7/85	2.5	2.5	2.5
2/8/85	2.5	2.5	2.5
2/9/85	2.5	2.5	2.5
2/10/85	2.5	2.5	2.5
2/11/85	2.5	2.5	2.5
2/12/85	2.5	2.5	2.5
2/13/85	2.5	2.5	2.5
2/14/85	2.5	2.5	2.5
2/15/85	2.6	2.6	2.6
2/16/85	2.7	2.7	2.7

Date	No action	250 AF	550 AF
2/17/85	2.7	2.7	2.7
2/18/85	2.6	2.6	2.6
2/19/85	2.4	2.4	2.4
2/20/85	2.4	2.4	2.4
2/21/85	2.3	2.3	2.3
2/22/85	2.3	2.3	2.3
2/23/85	2.3	2.3	2.3
2/24/85	2.3	2.3	2.3
2/25/85	2.3	2.3	2.3
2/26/85	2.3	2.3	2.3
2/27/85	2.7	2.7	2.7
2/28/85	2.6	2.6	2.6
3/1/85	3.4	3.4	3.4
3/2/85	3.4	3.4	3.4
3/3/85	3.3	3.3	3.3
3/4/85	2.8	2.8	2.8
3/5/85	4.3	4.3	4.3
3/6/85	3.8	3.8	3.8
3/7/85	4.3	4.3	4.3
3/8/85	4.6	4.6	4.6
3/9/85	5.6	5.6	5.6
3/10/85	11.4	11.4	11.4
3/11/85	12.8	15.3	15.3
3/12/85	0.0	17.2	17.2
3/13/85	0.0	15.2	15.2
3/14/85	0.0	15.2	15.2
3/15/85	0.0	16.2	16.2
3/16/85	0.0	15.0	15.0
3/17/85	0.0	11.4	14.7
3/18/85	0.0	0.0	14.3
3/19/85	0.0	0.0	15.9
3/20/85	0.0	0.0	14.6
3/21/85	0.0	0.0	15.3
3/22/85	0.0	0.0	14.0
3/23/85	0.0	0.0	13.6
3/24/85	0.0	0.0	14.2
3/25/85	0.0	0.0	1.3
9/19/85	25.1	25.1	25.1
11/1/85	3.8	3.8	3.8
11/2/85	3.4	3.4	3.4
11/3/85	3.0	3.0	3.0
11/4/85	2.7	2.7	2.7
11/5/85	2.3	2.3	2.3
11/6/85	1.9	1.9	1.9
11/7/85	2.5	2.5	2.5
11/8/85	2.2	2.2	2.2
11/9/85	1.8	1.8	1.8
11/10/85	2.4	2.4	2.4
11/11/85	3.0	3.0	3.0
11/12/85	4.5	4.5	4.5
11/13/85	4.1	4.1	4.1
11/14/85	2.8	2.8	2.8
11/15/85	1.4	1.4	1.4
11/16/85	2.4	2.4	2.4
11/17/85	3.5	3.5	3.5
11/18/85	3.5	3.5	3.5
11/19/85	1.6	1.6	1.6

Date	No action	250 AF	550 AF
11/20/85	2.6	2.6	2.6
11/21/85	2.7	2.7	2.7
11/22/85	1.7	1.7	1.7
11/23/85	2.7	2.7	2.7
11/24/85	2.8	2.8	2.8
11/25/85	3.8	3.8	3.8
11/26/85	3.9	3.9	3.9
11/27/85	3.9	3.9	3.9
11/28/85	4.0	4.0	4.0
11/29/85	6.0	6.0	6.0
11/30/85	5.1	5.1	5.1
12/1/85	3.3	3.3	3.3
12/2/85	3.4	3.4	3.4
12/3/85	2.5	2.5	2.5
12/4/85	1.7	1.7	1.7
12/5/85	1.7	1.7	1.7
12/6/85	1.8	1.8	1.8
12/7/85	1.8	1.8	1.8
12/8/85	1.8	1.8	1.8
12/9/85	1.9	1.9	1.9
12/10/85	1.9	1.9	1.9
12/11/85	1.9	1.9	1.9
12/12/85	2.0	2.0	2.0
12/13/85	2.0	2.0	2.0
12/14/85	2.0	2.0	2.0
12/15/85	2.0	2.0	2.0
12/16/85	2.0	2.0	2.0
12/17/85	2.0	2.0	2.0
12/18/85	2.0	2.0	2.0
12/19/85	1.9	1.9	1.9
12/20/85	1.9	1.9	1.9
12/21/85	1.9	1.9	1.9
12/22/85	1.9	1.9	1.9
12/23/85	1.9	1.9	1.9
12/24/85	1.8	1.8	1.8
12/25/85	1.8	1.8	1.8
12/26/85	1.8	1.8	1.8
12/27/85	1.8	1.8	1.8
12/28/85	1.8	1.8	1.8
12/29/85	1.8	1.8	1.8
12/30/85	3.7	3.7	3.7
12/31/85	1.9	1.9	1.9
1/1/86	2.2	2.2	2.2
1/2/86	2.2	2.2	2.2
1/3/86	4.2	4.2	4.2
1/4/86	2.3	2.3	2.3
1/5/86	2.4	2.4	2.4
1/6/86	2.4	2.4	2.4
1/7/86	2.5	2.5	2.5
1/8/86	2.5	2.5	2.5
1/9/86	2.6	2.6	2.6
1/10/86	3.6	3.6	3.6
1/11/86	3.6	3.6	3.6
1/12/86	4.7	4.7	4.7
1/13/86	3.8	3.8	3.8
1/14/86	4.8	4.8	4.8
1/15/86	2.9	2.9	2.9

Date	No action	250 AF	550 AF
1/16/86	2.9	2.9	2.9
1/17/86	3.9	3.9	3.9
1/18/86	3.9	3.9	3.9
1/19/86	3.9	3.9	3.9
1/20/86	3.9	3.9	3.9
1/21/86	3.9	3.9	3.9
1/22/86	2.9	2.9	2.9
1/23/86	4.8	4.8	4.8
1/24/86	4.8	4.8	4.8
1/25/86	2.9	2.9	2.9
1/26/86	2.9	2.9	2.9
1/27/86	3.9	3.9	3.9
1/28/86	3.9	3.9	3.9
1/29/86	5.8	5.8	5.8
1/30/86	6.8	6.8	6.8
1/31/86	0.0	6.8	6.8
2/1/86	0.0	7.1	7.1
2/2/86	0.0	7.1	7.1
2/3/86	0.0	8.0	8.0
2/4/86	0.0	5.1	5.1
2/5/86	0.0	5.0	5.0
2/6/86	0.0	6.0	6.0
2/7/86	0.0	6.0	6.0
2/8/86	0.0	4.0	4.0
2/9/86	0.0	4.0	4.0
2/10/86	0.0	3.0	3.0
2/11/86	0.0	3.9	3.9
2/12/86	0.0	3.2	5.8
2/13/86	0.0	0.0	8.7
2/14/86	0.0	0.0	7.7
2/15/86	0.0	0.0	7.5
2/16/86	0.0	0.0	7.3
2/17/86	0.0	0.0	6.1
2/18/86	0.0	0.0	5.8
2/19/86	0.0	0.0	5.6
2/20/86	0.0	0.0	6.4
2/21/86	0.0	0.0	5.2
2/22/86	0.0	0.0	4.0
2/23/86	0.0	0.0	2.8
2/24/86	0.0	0.0	2.6
2/25/86	0.0	0.0	2.3
2/26/86	0.0	0.0	4.0
2/27/86	0.0	0.0	1.2
10/1/86	7.8	7.8	7.8
10/2/86	16.9	16.9	16.9
10/3/86	16.8	16.8	16.8
10/4/86	13.6	13.6	13.6
10/5/86	14.5	14.5	14.5
10/6/86	21.6	21.6	21.6
10/7/86	21.5	21.5	21.5
10/8/86	18.3	18.3	18.3
10/9/86	17.2	17.2	17.2
10/10/86	20.1	20.1	20.1
10/11/86	30.2	30.2	30.2
10/12/86	26.0	26.0	26.0
10/13/86	17.7	17.7	17.7
10/14/86	19.6	19.6	19.6

Date	No action	250 AF	550 AF
10/15/86	25.6	25.6	25.6
10/16/86	30.9	30.9	30.9
10/17/86	34.3	34.3	34.3
10/18/86	36.8	36.8	36.8
10/19/86	39.2	39.2	39.2
10/20/86	34.5	34.5	34.5
10/21/86	29.8	29.8	29.8
10/22/86	7.9	25.1	25.1
10/23/86	0.0	19.4	19.4
10/24/86	0.0	16.7	16.7
10/25/86	0.0	15.1	15.1
10/26/86	0.0	12.4	12.4
10/27/86	0.0	11.8	11.8
10/28/86	0.0	5.9	10.2
10/29/86	0.0	0.0	10.6
10/30/86	0.0	0.0	11.0
10/31/86	0.0	0.0	14.5
11/1/86	0.0	0.0	25.7
11/2/86	0.0	0.0	22.0
11/3/86	0.0	0.0	12.4
11/1/87	0.1	0.1	0.1
11/2/87	0.1	0.1	0.1
11/3/87	0.1	0.1	0.1
11/4/87	0.1	0.1	0.1
11/5/87	1.4	1.4	1.4
11/6/87	39.6	39.6	39.6
11/7/87	24.5	24.5	24.5
11/8/87	16.1	16.1	16.1
11/9/87	14.5	14.5	14.5
11/10/87	13.0	13.0	13.0
11/11/87	11.4	11.4	11.4
11/12/87	8.9	8.9	8.9
11/13/87	7.3	7.3	7.3
11/14/87	7.6	7.6	7.6
11/15/87	6.0	6.0	6.0
11/16/87	4.4	4.4	4.4
11/17/87	2.9	2.9	2.9
11/18/87	0.1	0.1	0.1
11/19/87	1.6	1.6	1.6
11/20/87	1.0	1.0	1.0
11/21/87	1.3	1.3	1.3
11/22/87	0.7	0.7	0.7
11/23/87	1.1	1.1	1.1
11/24/87	0.4	0.4	0.4
11/25/87	0.7	0.7	0.7
11/26/87	1.1	1.1	1.1
11/27/87	0.4	0.4	0.4
11/28/87	0.7	0.7	0.7
11/29/87	0.1	0.1	0.1
11/30/87	0.4	0.4	0.4
12/1/87	1.4	1.4	1.4
12/2/87	1.7	1.7	1.7
12/3/87	1.9	1.9	1.9
12/4/87	3.1	3.1	3.1
12/5/87	3.3	3.3	3.3
12/6/87	3.5	3.5	3.5
12/7/87	2.7	2.7	2.7

Date	No action	250 AF	550 AF
12/8/87	2.0	2.0	2.0
12/9/87	2.2	2.2	2.2
12/10/87	2.5	2.5	2.5
12/11/87	2.7	2.7	2.7
12/12/87	3.0	3.0	3.0
12/13/87	2.2	2.2	2.2
12/14/87	1.4	1.4	1.4
12/15/87	1.0	1.0	1.0
12/16/87	1.7	1.7	1.7
12/17/87	2.8	2.8	2.8
12/18/87	4.0	4.0	4.0
12/19/87	4.1	4.1	4.1
12/20/87	3.2	3.2	3.2
12/21/87	1.5	1.5	1.5
12/22/87	2.4	2.4	2.4
12/23/87	3.5	3.5	3.5
12/24/87	2.6	2.6	2.6
12/25/87	2.6	2.6	2.6
12/26/87	2.7	2.7	2.7
12/27/87	2.8	2.8	2.8
12/28/87	1.9	1.9	1.9
12/29/87	2.9	2.9	2.9
12/30/87	3.0	3.0	3.0
12/31/87	2.1	2.1	2.1
1/1/88	1.8	1.8	1.8
1/2/88	1.1	1.1	1.1
1/3/88	1.1	1.1	1.1
1/4/88	2.0	2.0	2.0
1/5/88	4.0	4.0	4.0
1/6/88	5.0	5.0	5.0
1/7/88	3.2	3.2	3.2
1/8/88	3.2	3.2	3.2
1/9/88	3.3	3.3	3.3
1/10/88	3.3	3.3	3.3
1/11/88	4.3	4.3	4.3
1/12/88	2.4	2.4	2.4
1/13/88	2.5	2.5	2.5
1/14/88	2.5	2.5	2.5
1/15/88	3.5	3.5	3.5
1/16/88	4.5	4.5	4.5
1/17/88	4.5	4.5	4.5
1/18/88	3.5	3.5	3.5
1/19/88	2.5	2.5	2.5
1/20/88	1.5	1.5	1.5
1/21/88	1.5	1.5	1.5
1/22/88	1.5	1.5	1.5
1/23/88	1.5	1.5	1.5
1/24/88	1.0	1.0	1.0
1/25/88	1.5	1.5	1.5
1/26/88	1.4	1.4	1.4
1/27/88	2.4	2.4	2.4
1/28/88	1.9	3.3	3.3
1/29/88	0.0	2.7	2.7
1/30/88	0.0	2.4	2.4
1/31/88	0.0	2.3	2.3
2/1/88	0.0	3.3	3.3
2/2/88	0.0	3.3	3.3

Date	No action	250 AF	550 AF
2/3/88	0.0	3.2	3.2
2/4/88	0.0	3.2	3.2
2/5/88	0.0	2.2	2.2
2/6/88	0.0	2.2	2.2
2/7/88	0.0	2.2	2.2
2/8/88	0.0	2.2	2.2
2/9/88	0.0	2.2	2.2
2/10/88	0.0	2.7	2.7
2/11/88	0.0	2.1	2.1
2/12/88	0.0	3.1	3.1
2/13/88	0.0	4.1	4.1
2/14/88	0.0	3.1	3.1
2/15/88	0.0	2.9	2.9
2/16/88	0.0	3.7	3.7
2/17/88	0.0	2.4	2.4
2/18/88	0.0	2.2	2.2
2/19/88	0.0	2.0	2.0
2/20/88	0.0	0.0	1.7
2/21/88	0.0	0.0	1.5
2/22/88	0.0	0.0	1.3
2/23/88	0.0	0.0	1.0
2/24/88	0.0	0.0	0.8
2/25/88	0.0	0.0	1.6
2/26/88	0.0	0.0	1.4
2/27/88	0.0	0.0	1.4
2/28/88	0.0	0.0	1.9
3/1/88	0.0	0.0	3.1
3/2/88	0.0	0.0	3.8
3/3/88	0.0	0.0	4.5
3/4/88	0.0	0.0	5.2
3/5/88	0.0	0.0	4.0
3/6/88	0.0	0.0	6.6
3/7/88	0.0	0.0	7.3
3/8/88	0.0	0.0	3.2
3/9/88	0.0	0.0	4.9
3/10/88	0.0	0.0	7.5
3/11/88	0.0	0.0	4.3
3/12/88	0.0	0.0	2.1
3/13/88	0.0	0.0	3.8
3/14/88	0.0	0.0	3.5
3/15/88	0.0	0.0	1.9
11/11/88	1.4	1.4	1.4
11/12/88	0.9	0.9	0.9
11/13/88	1.6	1.6	1.6
11/14/88	2.9	2.9	2.9
11/15/88	4.7	4.7	4.7
11/16/88	3.9	3.9	3.9
11/17/88	3.2	3.2	3.2
11/18/88	2.8	2.8	2.8
11/19/88	2.6	2.6	2.6
11/20/88	2.1	2.1	2.1
11/21/88	2.2	2.2	2.2
11/22/88	2.2	2.2	2.2
11/23/88	2.3	2.3	2.3
11/24/88	2.7	2.7	2.7
11/25/88	3.8	3.8	3.8
11/26/88	3.4	3.4	3.4

Date	No action	250 AF	550 AF
11/27/88	3.0	3.0	3.0
11/28/88	2.6	2.6	2.6
11/29/88	2.1	2.1	2.1
11/30/88	2.7	2.7	2.7
12/1/88	0.5	0.5	0.5
12/2/88	0.8	0.8	0.8
12/3/88	0.8	0.8	0.8
12/4/88	0.7	0.7	0.7
12/5/88	0.6	0.6	0.6
12/6/88	1.1	1.1	1.1
12/7/88	1.1	1.1	1.1
12/8/88	1.0	1.0	1.0
12/9/88	0.9	0.9	0.9
12/10/88	1.3	1.3	1.3
12/11/88	0.8	0.8	0.8
12/12/88	1.2	1.2	1.2
12/13/88	1.2	1.2	1.2
12/14/88	1.1	1.1	1.1
12/15/88	1.1	1.1	1.1
12/16/88	1.1	1.1	1.1
12/17/88	1.1	1.1	1.1
12/18/88	1.6	1.6	1.6
12/19/88	2.0	2.0	2.0
12/20/88	1.7	1.7	1.7
12/21/88	1.3	1.3	1.3
12/22/88	1.3	1.3	1.3
12/23/88	1.3	1.3	1.3
12/24/88	0.9	0.9	0.9
12/25/88	1.4	1.4	1.4
12/26/88	0.9	1.0	1.0
12/27/88	0.5	0.5	0.5
12/28/88	0.5	0.5	0.5
12/29/88	0.6	0.6	0.6
12/30/88	1.1	1.1	1.1
12/31/88	1.6	1.6	1.6
1/1/89	2.6	2.6	2.6
1/2/89	2.6	2.6	2.6
1/3/89	2.7	2.7	2.7
1/4/89	3.2	3.2	3.2
1/5/89	3.7	3.7	3.7
1/6/89	3.3	3.3	3.3
1/7/89	0.9	0.9	0.9
1/8/89	1.0	1.0	1.0
1/9/89	1.0	1.0	1.0
1/10/89	1.5	1.5	1.5
1/11/89	2.1	2.1	2.1
1/12/89	1.1	1.1	1.1
1/13/89	1.2	1.2	1.2
1/14/89	1.7	1.7	1.7
1/15/89	1.8	1.8	1.8
1/16/89	1.7	1.7	1.7
1/17/89	2.1	2.1	2.1
1/18/89	2.0	2.0	2.0
1/19/89	1.9	1.9	1.9
1/20/89	1.8	1.9	1.9
1/21/89	1.8	1.8	1.8
1/22/89	1.7	1.7	1.7

Date	No action	250 AF	550 AF
1/23/89	1.6	1.6	1.6
1/24/89	1.4	1.4	1.4
1/25/89	1.4	1.4	1.4
1/26/89	0.8	0.8	0.8
1/27/89	1.1	1.1	1.1
1/28/89	0.9	0.9	0.9
1/29/89	0.5	0.5	0.5
1/30/89	0.4	0.4	0.4
1/31/89	0.3	0.3	0.3
2/1/89	0.2	0.2	0.2
2/2/89	0.5	0.5	0.5
2/3/89	0.4	0.4	0.4
2/4/89	0.9	0.9	0.9
2/5/89	0.0	0.0	0.0
2/6/89	0.0	0.0	0.0
2/7/89	0.0	0.0	0.0
2/8/89	0.0	0.0	0.0
2/9/89	0.1	0.1	0.1
2/10/89	0.4	0.4	0.4
2/11/89	0.1	0.1	0.1
2/12/89	0.1	0.1	0.1
2/13/89	0.1	0.1	0.1
2/14/89	0.1	0.1	0.1
2/15/89	0.1	0.1	0.1
2/16/89	0.1	0.1	0.1
2/17/89	0.0	0.0	0.0
3/10/89	2.6	2.6	2.6
3/11/89	48.1	48.1	48.1
3/12/89	36.6	36.6	36.6
3/13/89	33.2	33.2	33.2
3/14/89	34.7	34.7	34.7
3/15/89	22.9	28.3	28.3
3/16/89	0.0	29.5	29.5
3/17/89	0.0	36.4	36.4
3/18/89	0.0	34.3	34.3
3/19/89	0.0	3.3	36.2
3/20/89	0.0	0.0	31.1
3/21/89	0.0	0.0	23.0
3/22/89	0.0	0.0	22.0
3/23/89	0.0	0.0	25.7
11/1/89	0.3	0.3	0.3
11/2/89	0.4	0.4	0.4
11/3/89	0.4	0.4	0.4
11/4/89	0.4	0.4	0.4
11/5/89	0.4	0.4	0.4
3/23/90	0.6	0.6	0.6
3/24/90	1.4	1.5	1.5
3/25/90	2.0	2.0	2.0
3/26/90	1.8	1.8	1.8
3/27/90	1.3	1.3	1.3
3/28/90	0.9	0.9	0.9
3/29/90	1.3	1.3	1.3
3/30/90	1.0	1.0	1.0
3/31/90	1.0	1.0	1.0
11/11/90	1.6	1.7	1.7
11/12/90	2.6	2.6	2.6
11/13/90	4.2	4.3	4.3

Date	No action	250 AF	550 AF
11/14/90	5.1	5.2	5.2
11/15/90	6.8	6.8	6.8
11/16/90	6.8	6.8	6.9
11/17/90	6.8	6.9	6.9
11/18/90	6.8	6.9	6.9
11/19/90	6.8	6.8	6.9
11/20/90	7.6	7.6	7.7
11/21/90	6.1	6.1	6.1
11/22/90	4.5	4.5	4.5
11/23/90	4.5	4.5	4.5
11/24/90	4.5	4.5	4.5
11/25/90	4.5	4.5	4.5
11/26/90	5.3	5.3	5.3
11/27/90	4.5	4.5	4.6
11/28/90	3.0	3.0	3.0
11/29/90	3.0	3.0	3.0
11/30/90	3.8	3.8	3.8
2/1/91	0.0	0.0	0.0
2/2/91	0.0	0.0	0.0
2/3/91	0.0	0.0	0.0
2/4/91	0.0	0.0	0.0
2/5/91	0.0	0.0	0.0
2/6/91	0.0	0.0	0.0
2/7/91	0.0	0.0	0.0
2/8/91	0.0	0.0	0.0
2/9/91	0.0	0.0	0.0
2/10/91	0.0	0.0	0.0
2/11/91	0.0	0.0	0.0
2/12/91	0.0	0.0	0.0
2/13/91	0.0	0.0	0.0
2/14/91	0.0	0.0	0.0
2/15/91	0.0	0.0	0.0
2/16/91	0.0	0.0	0.0
2/17/91	0.0	0.0	0.0
2/18/91	0.0	0.0	0.0
2/19/91	0.0	0.0	0.0
2/20/91	0.0	0.0	0.0
2/21/91	0.0	0.0	0.0
2/22/91	0.2	0.2	0.2
2/23/91	1.0	1.0	1.0
2/24/91	0.7	0.7	0.7
2/25/91	0.2	0.2	0.2
2/26/91	0.0	0.0	0.0
2/27/91	0.7	0.7	0.7
2/28/91	2.7	2.7	2.7
3/1/91	8.6	8.6	8.6
3/2/91	8.6	8.6	8.6
3/3/91	8.5	8.5	8.5
3/4/91	7.5	7.5	7.5
3/5/91	11.4	11.4	11.4
3/6/91	10.3	10.3	10.3
3/7/91	8.2	8.2	8.2
3/8/91	7.1	7.1	7.1
3/9/91	7.0	7.0	7.0
3/10/91	7.9	7.9	7.9
3/11/91	7.8	7.8	7.8
3/12/91	5.6	5.6	5.6

Date	No action	250 AF	550 AF
3/13/91	6.5	6.5	6.5
3/14/91	8.4	8.4	8.4
3/15/91	7.3	7.3	7.3
3/16/91	6.3	6.3	6.3
3/17/91	3.4	3.4	3.4
3/18/91	2.6	2.6	2.6
3/19/91	1.7	1.8	1.8
11/13/91	0.1	0.1	0.1
11/14/91	2.0	2.0	2.0
11/15/91	4.7	4.7	4.7
11/16/91	3.0	3.0	3.0
11/17/91	3.6	3.6	3.6
11/18/91	3.3	3.3	3.3
11/19/91	2.1	2.1	2.1
11/20/91	1.0	1.0	1.0
11/21/91	1.5	1.5	1.5
11/22/91	0.9	0.9	0.9
11/23/91	0.4	0.4	0.4
11/24/91	0.4	0.4	0.4
11/25/91	0.3	0.3	0.3
11/26/91	0.7	0.7	0.7
11/27/91	1.1	1.1	1.1
11/28/91	1.5	1.5	1.5
11/29/91	2.2	2.2	2.2
11/30/91	2.8	2.8	2.8
3/19/92	0.2	0.2	0.2
3/20/92	0.3	0.3	0.3
3/31/92	0.7	0.7	0.7
3/1/93	0.8	0.8	0.8
3/2/93	0.8	0.8	0.8
3/3/93	1.3	1.3	1.3
3/4/93	1.9	1.9	1.9
3/5/93	2.4	2.4	2.4
3/6/93	2.4	2.4	2.4
3/7/93	2.4	2.4	2.4
3/8/93	2.4	2.4	2.4
3/9/93	2.9	2.9	2.9
3/10/93	3.3	3.3	3.3
3/11/93	3.8	3.8	3.8
3/12/93	3.5	3.5	3.5
3/13/93	2.5	2.5	2.5
3/14/93	3.5	3.5	3.5
3/15/93	4.2	4.2	4.2
3/16/93	5.0	5.0	5.0
3/17/93	4.8	4.8	4.8
3/18/93	4.3	4.3	4.3
3/19/93	5.9	5.9	5.9
3/20/93	5.4	5.4	5.4
3/21/93	6.9	6.9	6.9
3/22/93	7.5	7.5	7.5
3/23/93	11.0	11.0	11.0
3/24/93	17.6	17.6	17.6
3/25/93	26.1	26.1	26.1
3/26/93	36.6	36.6	36.6
3/27/93	42.2	42.2	42.2
3/28/93	52.8	52.8	52.8
3/29/93	44.3	44.3	44.3

Date	No action	250 AF	550 AF
3/30/93	0.0	35.9	35.9
3/31/93	0.0	32.4	32.4
11/7/93	0.7	0.7	0.7
11/8/93	0.4	0.4	0.4
11/9/93	1.1	1.1	1.1
11/10/93	1.9	1.9	1.9
11/11/93	3.5	3.5	3.5
11/12/93	5.2	5.2	5.2
11/13/93	4.9	4.9	4.9
11/14/93	5.6	5.6	5.6
11/15/93	5.3	5.3	5.3
11/16/93	4.2	4.2	4.2
11/17/93	4.1	4.1	4.1
11/18/93	4.0	4.0	4.0
11/19/93	3.9	3.9	3.9
11/20/93	3.8	3.8	3.8
11/21/93	3.8	3.8	3.8
11/22/93	3.7	3.7	3.7
11/23/93	4.4	4.4	4.4
11/24/93	4.6	4.6	4.6
11/25/93	2.5	2.5	2.5
11/26/93	2.5	2.5	2.5
11/27/93	2.9	2.9	2.9
11/28/93	3.3	3.3	3.3
11/29/93	3.5	3.5	3.5
11/30/93	3.2	3.2	3.2
1/3/94	0.0	0.0	0.0
1/4/94	0.0	0.0	0.0
1/5/94	0.0	0.0	0.0
1/6/94	0.0	0.0	0.0
1/7/94	0.0	0.0	0.0
1/8/94	0.1	0.1	0.1
1/9/94	0.1	0.1	0.1
1/10/94	0.1	0.1	0.1
1/11/94	0.1	0.1	0.1
1/12/94	0.1	0.1	0.1
1/13/94	0.1	0.1	0.1
1/14/94	0.1	0.1	0.1
1/15/94	0.1	0.1	0.1
1/16/94	0.1	0.1	0.1
1/17/94	0.1	0.1	0.1
1/18/94	0.1	0.1	0.1
1/19/94	0.1	0.1	0.1
1/20/94	0.1	0.1	0.1
1/21/94	0.1	0.1	0.1
1/22/94	0.1	0.1	0.1
1/23/94	0.1	0.1	0.1
1/24/94	0.1	0.1	0.1
1/25/94	0.1	0.1	0.1
1/26/94	0.1	0.1	0.1
1/27/94	0.1	0.1	0.1
1/28/94	0.1	0.1	0.1
1/29/94	0.1	0.1	0.1
1/30/94	0.0	0.0	0.0
1/31/94	0.0	0.0	0.0
2/1/94	0.1	0.1	0.1
2/2/94	0.0	0.0	0.0

Date	No action	250 AF	550 AF
2/4/94	1.0	1.0	1.0
2/5/94	1.5	1.5	1.5
2/6/94	1.1	1.1	1.1
2/7/94	1.2	1.2	1.2
2/8/94	2.9	2.9	2.9
2/9/94	1.0	1.0	1.0
2/10/94	1.1	1.1	1.1
2/11/94	0.2	0.2	0.2
2/12/94	0.2	0.2	0.2
2/17/94	0.0	0.0	0.0
2/18/94	0.4	0.4	0.4
2/19/94	0.2	0.2	0.2
2/20/94	0.5	0.5	0.5
2/22/94	0.0	0.0	0.0
2/26/94	0.1	0.1	0.1
2/27/94	0.1	0.1	0.1
2/28/94	0.3	0.3	0.3
3/19/94	0.8	0.8	0.8
3/20/94	6.9	6.9	6.9
3/21/94	7.1	7.1	7.1
3/22/94	8.2	8.2	8.2
3/23/94	9.4	9.4	9.4
3/24/94	8.5	8.5	8.5
3/25/94	7.7	7.7	7.7
3/26/94	6.8	6.8	6.8
3/27/94	6.0	6.0	6.0
3/28/94	3.1	3.1	3.1
3/29/94	2.3	2.3	2.3
3/30/94	1.5	1.5	1.5
3/31/94	0.7	0.7	0.7
11/12/94	1.9	1.9	1.9
1/1/95	0.2	0.2	0.2
1/2/95	0.2	0.2	0.2
1/3/95	0.2	0.2	0.2
1/4/95	0.3	0.3	0.3
1/5/95	0.3	0.3	0.3
1/6/95	0.9	0.9	0.9
1/7/95	0.4	0.4	0.4
1/8/95	2.2	2.2	2.2
1/9/95	1.9	1.9	1.9
1/10/95	1.8	1.8	1.8
1/11/95	1.9	1.9	1.9
1/12/95	2.1	2.1	2.1
1/13/95	2.0	2.0	2.0
1/14/95	1.5	1.5	1.5
1/15/95	2.0	2.0	2.0
1/16/95	1.7	1.7	1.7
1/17/95	0.7	0.7	0.7
1/18/95	0.7	0.7	0.7
1/19/95	0.7	0.7	0.7
1/20/95	0.7	0.7	0.7
1/21/95	0.7	0.7	0.7
1/22/95	0.7	0.7	0.7
1/23/95	0.9	0.9	0.9
1/24/95	1.6	1.6	1.6
1/25/95	3.0	3.0	3.0
1/26/95	3.2	3.2	3.2

Date	No action	250 AF	550 AF
1/27/95	3.0	3.0	3.0
1/28/95	2.0	2.0	2.0
1/29/95	2.2	2.2	2.2
1/30/95	1.7	1.7	1.7
1/31/95	2.4	2.4	2.4
2/1/95	1.7	1.7	1.7
2/2/95	1.7	1.7	1.7
2/3/95	1.6	1.6	1.6
2/4/95	1.6	1.6	1.6
2/5/95	2.1	2.1	2.1
2/6/95	2.1	2.1	2.1
2/7/95	2.1	2.1	2.1
2/8/95	2.2	2.2	2.2
2/9/95	2.0	2.0	2.0
2/10/95	2.0	2.0	2.0
2/11/95	2.0	2.0	2.0
2/12/95	2.5	2.5	2.5
2/13/95	2.4	2.4	2.4
2/14/95	3.4	3.4	3.4
2/15/95	4.4	4.4	4.4
2/16/95	1.3	1.3	1.3
2/17/95	2.3	2.3	2.3
2/18/95	3.3	3.3	3.3
2/19/95	4.3	4.3	4.3
2/20/95	4.2	4.2	4.2
2/21/95	5.2	5.2	5.2
2/22/95	5.2	5.2	5.2
2/23/95	5.1	5.1	5.1
2/24/95	7.1	7.1	7.1
2/25/95	12.1	12.1	12.1
2/26/95	15.1	15.1	15.1
2/27/95	18.1	18.1	18.1
2/28/95	22.1	22.1	22.1
3/1/95	26.2	26.2	26.2
3/2/95	28.2	28.2	28.2
3/3/95	24.7	24.7	24.7
3/4/95	27.8	27.8	27.8
3/5/95	26.5	26.5	26.5
3/6/95	26.4	26.4	26.4
3/7/95	21.8	21.8	21.8
3/8/95	0.0	17.3	17.3
3/9/95	0.0	12.8	12.8
3/10/95	0.0	12.7	12.7
3/11/95	0.0	12.5	12.5
3/12/95	0.0	11.2	11.2
3/13/95	0.0	8.9	8.9
3/14/95	0.0	9.8	9.8
3/15/95	0.0	12.9	12.9
3/16/95	0.0	6.1	16.8
3/17/95	0.0	0.0	27.9
3/18/95	0.0	0.0	33.7
3/19/95	0.0	0.0	48.1
3/20/95	0.0	0.0	10.3
12/1/95	0.9	0.9	0.9
12/2/95	1.2	1.2	1.2
12/3/95	1.2	1.2	1.2
12/4/95	1.2	1.2	1.2

Date	No action	250 AF	550 AF
12/5/95	1.1	1.1	1.1
12/6/95	0.6	0.6	0.6
12/7/95	0.5	0.5	0.5
12/8/95	0.4	0.4	0.4
12/9/95	0.3	0.3	0.3
12/10/95	0.0	0.0	0.0
12/14/95	0.0	0.0	0.0
12/27/95	0.0	0.0	0.0
12/28/95	0.1	0.1	0.1
12/29/95	0.1	0.1	0.1
12/30/95	0.1	0.1	0.1
12/31/95	1.1	1.1	1.1
1/1/96	0.6	0.6	0.6
1/2/96	0.5	0.5	0.5
1/3/96	0.5	0.5	0.5
1/4/96	0.6	0.6	0.6
1/5/96	0.6	0.6	0.6
1/6/96	0.6	0.6	0.6
1/7/96	0.7	0.7	0.7
1/8/96	0.7	0.7	0.7
1/9/96	0.7	0.7	0.7
1/10/96	0.7	0.7	0.7
1/11/96	0.7	0.7	0.7
1/12/96	0.8	0.8	0.8
1/13/96	0.8	0.8	0.8
1/14/96	0.8	0.8	0.8
1/15/96	0.8	0.8	0.8
1/16/96	0.8	0.8	0.8
1/17/96	0.8	0.8	0.8
1/18/96	0.5	0.5	0.5
1/19/96	0.4	0.4	0.4
1/20/96	0.4	0.4	0.4
1/21/96	0.4	0.4	0.4
1/22/96	0.4	0.4	0.4
1/23/96	0.4	0.4	0.4
1/24/96	0.4	0.4	0.4
1/25/96	0.5	0.5	0.5
1/26/96	0.5	0.5	0.5
1/27/96	0.6	0.6	0.6
1/28/96	0.5	0.5	0.5
1/29/96	0.4	0.4	0.5
1/30/96	0.5	0.5	0.5
1/31/96	0.4	0.4	0.4
2/1/96	0.9	0.9	0.9
2/2/96	0.9	0.9	0.9
2/3/96	0.9	0.9	0.9
2/4/96	0.8	0.8	0.8
2/5/96	0.8	0.8	0.8
2/6/96	0.8	0.8	0.8
2/7/96	0.7	0.7	0.7
2/8/96	0.7	0.7	0.7
2/9/96	0.7	0.7	0.7
2/10/96	0.7	0.7	0.7
2/11/96	0.7	0.7	0.7
2/12/96	0.7	0.7	0.7
2/13/96	0.7	0.7	0.7
2/14/96	0.7	0.7	0.7

Date	No action	250 AF	550 AF
2/15/96	0.7	0.7	0.7
2/16/96	0.6	0.6	0.6
2/17/96	0.6	0.6	0.6
2/18/96	0.7	0.7	0.7
2/19/96	0.5	0.5	0.5
2/20/96	3.0	3.0	3.0
2/21/96	3.5	3.5	3.5
2/22/96	2.0	2.0	2.0
2/23/96	2.0	2.0	2.0
2/24/96	0.9	0.9	0.9
2/25/96	1.0	1.0	1.0
2/26/96	1.0	1.0	1.0
2/27/96	1.1	1.1	1.1
2/28/96	0.2	0.2	0.2
3/1/96	2.6	2.6	2.6
3/2/96	2.6	2.6	2.6
3/3/96	2.5	2.5	2.5
3/4/96	3.4	3.4	3.4
3/5/96	3.8	3.8	3.8
3/6/96	3.2	3.2	3.2
3/7/96	2.2	2.2	2.2
3/8/96	3.1	3.1	3.1
3/9/96	4.0	4.0	4.0
3/10/96	4.7	4.7	4.7
3/11/96	4.7	4.7	4.7
3/12/96	4.7	4.7	4.7
3/13/96	4.6	4.6	4.6
3/14/96	3.5	3.5	3.5
3/15/96	4.1	4.1	4.1
3/16/96	3.5	3.5	3.5
3/17/96	2.4	2.4	2.4
3/18/96	1.0	1.0	1.0
11/22/96	2.9	2.9	2.9
11/29/96	0.3	0.3	0.4
12/1/96	7.5	7.5	7.5
12/2/96	6.6	6.7	6.7
12/3/96	5.8	5.8	5.8
12/4/96	5.0	5.0	5.0
12/5/96	5.2	5.2	5.2
12/6/96	9.8	9.8	9.8
12/7/96	9.0	9.0	9.0
12/8/96	7.0	7.0	7.0
12/9/96	7.3	7.3	7.3
12/10/96	8.6	8.6	8.6
12/11/96	9.9	9.9	9.9
12/12/96	9.0	9.0	9.0
12/13/96	9.2	9.2	9.2
12/14/96	10.5	10.5	10.5
12/15/96	9.6	9.6	9.6
12/16/96	8.6	8.6	8.6
12/17/96	8.7	8.7	8.7
12/18/96	9.8	9.8	9.9
12/19/96	6.7	6.7	6.7
12/20/96	5.7	5.7	5.7
12/21/96	5.8	5.8	5.8
12/22/96	5.8	5.8	5.8
12/23/96	5.9	5.9	5.9

Date	No action	250 AF	550 AF
12/24/96	3.9	3.9	3.9
12/25/96	5.0	5.0	5.0
12/26/96	5.1	5.1	5.1
12/27/96	5.2	5.2	5.2
12/28/96	5.0	5.0	5.0
12/29/96	5.3	5.3	5.3
12/30/96	5.6	5.6	5.6
12/31/96	4.3	4.3	4.3
1/1/97	4.3	4.3	4.3
1/2/97	4.3	4.3	4.3
1/3/97	6.9	6.9	6.9
1/4/97	5.9	5.9	5.9
1/5/97	5.9	5.9	5.9
1/6/97	5.5	5.5	5.5
1/7/97	5.0	5.0	5.0
1/8/97	5.0	5.0	5.0
1/9/97	5.0	5.0	5.0
1/10/97	5.0	5.0	5.0
1/11/97	5.0	5.0	5.0
1/12/97	5.0	5.0	5.0
1/13/97	5.0	5.0	5.0
1/14/97	3.3	3.3	3.3
1/15/97	5.1	5.1	5.1
1/16/97	4.1	4.1	4.1
1/17/97	4.1	4.1	4.1
1/18/97	4.1	4.1	4.1
1/19/97	4.1	4.1	4.1
1/20/97	4.2	4.2	4.2
1/21/97	4.6	4.6	4.6
1/22/97	4.7	4.7	4.7
1/23/97	4.7	4.7	4.7
1/24/97	4.2	4.2	4.2
1/25/97	3.7	3.7	3.7
1/26/97	4.2	4.2	4.2
1/27/97	4.7	4.7	4.7
1/28/97	4.7	4.7	4.7
1/29/97	0.0	4.2	4.2
1/30/97	0.0	4.7	4.7
1/31/97	0.0	4.7	4.7
2/1/97	0.0	5.7	5.7
2/2/97	0.0	5.1	5.1
2/3/97	0.0	5.1	5.1
2/4/97	0.0	5.1	5.1
2/5/97	0.0	4.7	4.7
2/6/97	0.0	4.6	4.6
2/7/97	0.0	4.7	4.7
2/8/97	0.0	4.2	4.2
2/9/97	0.0	4.2	4.2
2/10/97	0.0	4.2	4.2
2/11/97	0.0	4.2	4.2
2/12/97	0.0	4.7	4.7
2/13/97	0.0	4.8	4.8
2/14/97	0.0	4.8	4.8
2/15/97	0.0	3.5	4.8
2/16/97	0.0	0.0	5.3
2/17/97	0.0	0.0	6.3
2/18/97	0.0	0.0	6.3

Date	No action	250 AF	550 AF
2/19/97	0.0	0.0	7.3
2/20/97	0.0	0.0	7.4
2/21/97	0.0	0.0	7.4
2/22/97	0.0	0.0	7.4
2/23/97	0.0	0.0	7.4
2/24/97	0.0	0.0	8.4
2/25/97	0.0	0.0	8.4
2/26/97	0.0	0.0	7.5
2/27/97	0.0	0.0	6.5
2/28/97	0.0	0.0	7.5
3/1/97	0.0	0.0	7.3
3/2/97	0.0	0.0	6.2
3/3/97	0.0	0.0	1.7
9/16/97	28.5	28.5	28.5
9/21/97	116.4	116.	116.
9/22/97	116.4	116.	116.
9/23/97	28.9	29.1	29.3
9/24/97	6.1	6.2	6.4
9/25/97	2.4	2.5	2.7
9/26/97	0.0	0.0	0.2
11/2/97	0.6	0.6	0.6
11/3/97	1.5	1.5	1.5
11/4/97	1.3	1.3	1.3
11/5/97	2.2	2.2	2.2
11/6/97	2.0	2.0	2.0
11/7/97	2.9	2.9	2.9
11/8/97	3.8	3.8	3.8
11/9/97	4.6	4.6	4.6
11/10/97	5.4	5.4	5.4
11/11/97	6.3	6.3	6.3
11/12/97	7.1	7.1	7.1
11/13/97	8.0	8.0	8.0
11/14/97	7.8	7.8	7.8
11/15/97	8.6	8.6	8.6
11/16/97	7.6	7.6	7.6
11/17/97	7.5	7.5	7.5
11/18/97	6.5	6.5	6.5
11/19/97	6.4	6.4	6.4
11/20/97	6.4	6.4	6.4
11/21/97	6.3	6.3	6.3
11/22/97	6.3	6.3	6.3
11/23/97	6.3	6.3	6.3
11/24/97	5.2	5.2	5.2
11/25/97	6.2	6.2	6.2
11/26/97	6.2	6.2	6.2
11/27/97	6.2	6.2	6.2
11/28/97	6.2	6.2	6.2
11/29/97	6.2	6.2	6.2
11/30/97	6.2	6.2	6.2
12/1/97	3.9	3.9	3.9
12/2/97	3.9	3.9	3.9
12/3/97	3.9	3.9	3.9
12/4/97	4.0	4.0	4.0
12/5/97	4.0	4.0	4.0
12/6/97	4.0	4.0	4.0
12/7/97	4.1	4.1	4.1
12/8/97	4.1	4.1	4.1
12/9/97	4.2	4.2	4.2
12/10/97	4.2	4.2	4.2
12/11/97	4.2	4.2	4.2
12/12/97	2.8	2.8	2.8
12/13/97	3.3	3.3	3.3
12/14/97	3.4	3.4	3.4
12/15/97	3.4	3.4	3.4
12/16/97	3.4	3.4	3.4
12/17/97	3.4	3.4	3.4
12/18/97	3.3	3.3	3.3
12/19/97	3.2	3.2	3.2
12/20/97	2.7	2.7	2.7
12/21/97	2.6	2.6	2.6
12/22/97	2.7	2.7	2.7
12/23/97	2.6	2.6	2.6
12/24/97	2.4	2.4	2.4
12/25/97	0.0	1.8	1.8
12/26/97	0.0	1.3	1.3
12/27/97	0.0	1.7	1.7
12/28/97	0.0	1.1	1.1
12/29/97	0.0	1.6	1.6
12/30/97	0.0	2.0	2.0
12/31/97	0.0	1.4	1.4
1/1/98	0.0	0.6	0.6
1/2/98	0.0	0.6	0.6
1/3/98	0.0	0.6	0.6
1/4/98	0.0	0.8	0.8
1/5/98	0.0	0.6	0.6
1/6/98	0.0	0.1	0.1
2/10/98	0.0	0.0	0.0
2/11/98	0.0	0.0	0.0
2/12/98	0.0	0.0	0.1
2/13/98	0.0	0.0	0.1
2/14/98	0.0	0.0	0.1
2/15/98	0.0	0.0	0.2
2/16/98	0.0	0.0	0.3
2/17/98	0.0	0.0	0.4
2/18/98	0.0	0.0	0.4
2/19/98	0.0	0.0	0.5
2/20/98	0.0	0.0	0.6
2/21/98	0.0	0.0	0.7
2/22/98	0.0	0.0	0.8
2/23/98	0.0	0.0	0.9
2/24/98	0.0	0.0	1.0
2/25/98	0.0	0.0	1.0
2/26/98	0.0	0.0	1.1
2/27/98	0.0	0.0	1.2
2/28/98	0.0	0.0	1.3
3/1/98	0.0	0.0	3.5
3/2/98	0.0	0.0	3.7
3/3/98	0.0	0.0	4.0
3/4/98	0.0	0.0	4.0
3/5/98	0.0	0.0	4.0
3/6/98	0.0	0.0	4.7
3/7/98	0.0	0.0	4.4
3/8/98	0.0	0.0	4.2
3/9/98	0.0	0.0	4.6
3/10/98	0.0	0.0	4.6
3/11/98	0.0	0.0	4.7
3/12/98	0.0	0.0	4.9
3/13/98	0.0	0.0	0.9
10/31/98	1.3	1.4	1.4
11/1/98	1.0	1.0	1.0
11/2/98	1.5	1.5	1.5
11/3/98	1.6	1.6	1.6
11/4/98	1.2	1.2	1.2
11/5/98	1.3	1.3	1.3
11/6/98	1.4	1.4	1.4
11/7/98	1.4	1.4	1.4
11/8/98	1.5	1.5	1.5
11/9/98	1.6	1.6	1.6
11/10/98	0.8	0.8	0.8
11/11/98	0.5	0.5	0.5
11/12/98	0.1	0.1	0.1
11/13/98	0.2	0.2	0.2
11/14/98	0.2	0.3	0.3
11/15/98	0.3	0.3	0.3
11/16/98	0.2	0.2	0.2
11/17/98	0.0	0.0	0.0
12/1/98	8.1	8.1	8.1
12/2/98	7.7	7.7	7.7
12/3/98	4.4	4.4	4.4
12/4/98	2.6	2.6	2.6
12/5/98	2.3	2.3	2.3
12/6/98	0.4	0.4	0.4
3/7/99	0.1	0.1	0.1
3/8/99	0.8	0.8	0.8
3/9/99	2.4	2.4	2.4
3/10/99	3.1	3.1	3.1
3/11/99	3.9	3.9	3.9
3/12/99	3.7	3.7	3.7
3/13/99	3.4	3.5	3.5
3/14/99	3.3	3.3	3.3
3/15/99	3.1	3.1	3.1
3/16/99	2.6	2.6	2.6
3/17/99	2.0	2.0	2.0
3/18/99	1.4	1.4	1.4
3/19/99	1.7	1.7	1.7
3/20/99	1.1	1.1	1.1
3/21/99	2.4	2.4	2.4
3/22/99	4.5	4.5	4.5
3/23/99	15.0	15.0	15.0
3/24/99	18.1	18.1	18.1
3/25/99	23.0	23.0	23.0
3/26/99	31.7	31.7	31.7
3/27/99	28.3	28.3	28.3
3/28/99	22.2	22.2	22.2
3/29/99	17.9	17.9	17.9
3/30/99	21.0	21.0	21.0
3/31/99	18.6	18.6	18.6
1/13/00	0.0	0.0	0.0
1/14/00	0.0	0.0	0.0
1/15/00	0.0	0.0	0.0
1/16/00	0.1	0.1	0.1
1/17/00	0.1	0.1	0.1
1/18/00	0.1	0.1	0.1
1/19/00	0.1	0.1	0.1
1/20/00	0.1	0.1	0.1
1/21/00	0.1	0.1	0.1
1/22/00	0.1	0.1	0.1
1/23/00	0.1	0.1	0.1
1/24/00	0.1	0.1	0.1
1/25/00	0.1	0.1	0.1
1/26/00	0.1	0.1	0.1
1/27/00	0.1	0.1	0.1
1/28/00	0.1	0.1	0.1
1/29/00	0.1	0.1	0.1
1/30/00	0.1	0.1	0.1
1/31/00	0.1	0.1	0.1
2/1/00	0.1	0.1	0.1
2/2/00	0.0	0.1	0.1
2/3/00	0.0	0.0	0.0
2/17/00	0.0	0.0	0.0
3/1/00	1.5	1.5	1.5
3/2/00	1.5	1.5	1.5
3/3/00	1.5	1.5	1.5
3/4/00	1.6	1.6	1.6
3/5/00	1.9	1.9	1.9
3/6/00	1.7	1.7	1.7
3/7/00	2.0	2.0	2.0
3/8/00	1.5	1.5	1.5
3/9/00	1.5	1.5	1.5
3/10/00	1.5	1.5	1.5
3/11/00	1.5	1.5	1.5
3/12/00	1.7	1.7	1.7
3/13/00	2.3	2.3	2.3
3/14/00	2.3	2.3	2.3
3/15/00	2.4	2.4	2.4
3/16/00	1.9	1.9	1.9
3/17/00	1.7	1.7	1.7
3/18/00	0.7	0.7	0.7
3/19/00	0.1	0.1	0.1
3/20/00	0.7	0.7	0.7
3/21/00	1.9	1.9	1.9
3/22/00	0.4	0.4	0.4
3/23/00	0.3	0.3	0.3
3/24/00	1.2	1.2	1.2
3/25/00	2.6	2.6	2.6
3/26/00	4.0	4.0	4.0
3/27/00	5.4	5.4	5.4
3/28/00	7.8	7.8	7.8
3/29/00	8.3	8.3	8.3
3/30/00	8.7	8.7	8.7
3/31/00	7.1	7.1	7.1
12/1/00	2.4	2.4	2.4
12/2/00	2.4	2.4	2.4
12/3/00	2.4	2.4	2.4
12/4/00	2.1	2.1	2.1
12/5/00	2.1	2.1	2.1
12/6/00	2.2	2.2	2.2
12/7/00	2.3	2.3	2.3

Date	No action	250 AF	550 AF
12/8/00	2.3	2.3	2.3
12/9/00	2.4	2.4	2.4
12/10/00	2.6	2.6	2.6
12/11/00	2.8	2.8	2.8
12/12/00	2.6	2.6	2.6
12/13/00	2.7	2.7	2.7
12/14/00	2.8	2.8	2.8
12/15/00	2.8	2.8	2.8
12/16/00	2.7	2.7	2.7
12/17/00	2.7	2.7	2.7
12/18/00	2.7	2.7	2.7
12/19/00	2.8	2.8	2.8
12/20/00	3.1	3.1	3.1
12/21/00	3.3	3.3	3.3
12/22/00	3.5	3.5	3.5
12/23/00	3.7	3.7	3.7
12/24/00	3.8	3.8	3.8
12/25/00	3.9	3.9	3.9
12/26/00	4.2	4.2	4.2
12/27/00	4.3	4.3	4.3
12/28/00	4.5	4.5	4.5
12/29/00	4.7	4.7	4.7
12/30/00	4.8	4.8	4.8
12/31/00	5.0	5.0	5.0
1/1/01	3.5	3.5	3.5
1/2/01	3.5	3.5	3.5
1/3/01	3.6	3.6	3.6
1/4/01	4.0	4.0	4.0
1/5/01	4.1	4.1	4.1
1/6/01	4.1	4.1	4.1
1/7/01	3.7	3.7	3.7
1/8/01	3.7	3.7	3.7
1/9/01	3.8	3.8	3.8
1/10/01	4.0	4.0	4.0
1/11/01	3.8	3.8	3.8
1/12/01	4.3	4.3	4.3
1/13/01	3.9	3.9	3.9
1/14/01	3.5	3.5	3.5
1/15/01	3.5	3.5	3.5
1/16/01	3.6	3.6	3.6
1/17/01	3.6	3.6	3.6
1/18/01	3.3	3.3	3.3
1/19/01	3.3	3.3	3.3
1/20/01	3.9	3.9	3.9
1/21/01	3.9	3.9	3.9
1/22/01	4.0	4.0	4.0
1/23/01	4.5	4.5	4.5
1/24/01	4.6	4.6	4.6
1/25/01	4.7	4.7	4.7
1/26/01	4.3	4.3	4.3
1/27/01	4.8	4.8	4.8
1/28/01	4.4	4.4	4.4
1/29/01	4.5	4.5	4.5
1/30/01	4.1	4.1	4.1
1/31/01	4.2	4.2	4.2
2/1/01	2.1	2.1	2.1
2/2/01	2.4	2.4	2.4

Date	No action	250 AF	550 AF
2/3/01	2.3	2.3	2.3
2/4/01	2.2	2.2	2.2
2/5/01	2.1	2.1	2.1
2/6/01	2.1	2.1	2.1
2/7/01	2.3	2.3	2.3
2/8/01	2.5	2.5	2.5
2/9/01	2.2	2.2	2.2
2/10/01	2.1	2.1	2.1
2/11/01	2.0	2.0	2.0
2/12/01	2.0	2.0	2.0
2/13/01	1.9	1.9	1.9
2/14/01	2.0	2.0	2.0
2/15/01	1.4	1.4	1.4
2/16/01	1.4	1.4	1.4
2/17/01	1.7	1.7	1.7
2/18/01	1.7	1.7	1.7
2/19/01	1.6	1.6	1.6
2/20/01	1.5	1.5	1.5
2/21/01	1.5	1.5	1.5
2/22/01	1.5	1.5	1.5
2/23/01	1.4	1.4	1.4
2/24/01	1.1	1.1	1.1
2/25/01	1.4	1.4	1.4
2/26/01	1.4	1.4	1.4
2/27/01	1.3	1.3	1.3
2/28/01	1.5	1.5	1.5
3/1/01	2.2	2.2	2.2
3/2/01	1.5	1.5	1.5
3/3/01	1.9	1.9	1.9
3/4/01	1.7	1.7	1.7
3/5/01	1.5	1.5	1.5
3/6/01	1.2	1.2	1.2
3/7/01	1.5	1.5	1.5
3/8/01	1.4	1.4	1.4
3/9/01	1.1	1.1	1.1
3/10/01	1.2	1.2	1.2
3/11/01	0.7	0.7	0.7
3/12/01	0.4	0.4	0.4
3/13/01	0.0	0.0	0.0
3/25/01	5.1	5.1	5.1
3/26/01	10.2	10.2	10.2
3/27/01	13.4	13.4	13.4
3/28/01	14.6	14.6	14.6
3/29/01	10.8	10.8	10.8
3/30/01	12.9	12.9	12.9
3/31/01	15.1	15.1	15.1
1/1/03	0.7	0.7	0.7
1/2/03	0.9	0.9	0.9
1/3/03	0.9	0.9	0.9
1/4/03	0.9	0.9	0.9
1/5/03	0.9	0.9	0.9
1/6/03	0.9	0.9	0.9
1/7/03	0.9	0.9	0.9
1/8/03	1.0	1.0	1.0
1/9/03	1.0	1.0	1.0
1/10/03	1.1	1.1	1.1
1/11/03	1.2	1.2	1.2

Date	No action	250 AF	550 AF
1/12/03	1.2	1.2	1.2
1/13/03	1.3	1.3	1.3
1/14/03	1.5	1.5	1.5
1/15/03	1.6	1.6	1.6
1/16/03	1.7	1.7	1.7
1/17/03	1.7	1.7	1.7
1/18/03	1.8	1.8	1.8
1/19/03	1.9	1.9	1.9
1/20/03	2.0	2.0	2.0
1/21/03	2.0	2.0	2.0
1/22/03	2.0	2.0	2.0
1/23/03	2.0	2.0	2.0
1/24/03	2.0	2.0	2.0
1/25/03	2.0	2.0	2.0
1/26/03	2.0	2.0	2.0
1/27/03	2.2	2.2	2.2
1/28/03	2.3	2.3	2.3
1/29/03	2.5	2.5	2.5
1/30/03	2.9	2.9	2.9
1/31/03	3.0	3.0	3.0
2/1/03	3.8	3.8	3.8
2/2/03	4.1	4.1	4.1
2/3/03	4.4	4.4	4.4
2/4/03	4.3	4.3	4.3
2/5/03	3.8	3.8	3.8
2/6/03	3.3	3.3	3.3
2/7/03	3.2	3.2	3.2
2/8/03	3.7	3.7	3.7
2/9/03	3.7	3.7	3.7
2/10/03	4.1	4.1	4.1
2/11/03	4.1	4.1	4.1
2/12/03	4.5	4.5	4.5
2/13/03	5.4	5.4	5.4
2/14/03	6.3	6.3	6.3
2/15/03	5.8	5.8	5.8
2/16/03	4.9	4.9	4.9
2/17/03	4.3	4.3	4.3
2/18/03	4.2	4.2	4.2
2/19/03	3.8	3.8	3.8
2/20/03	3.4	3.4	3.4
2/21/03	2.9	2.9	2.9
2/22/03	2.5	2.5	2.5
2/23/03	2.3	2.3	2.3
2/24/03	2.0	2.0	2.0
2/25/03	2.0	2.0	2.0
2/26/03	2.0	2.0	2.0
2/27/03	2.0	2.0	2.0
2/28/03	2.0	2.0	2.0
9/10/03	23.6	23.6	23.6
11/13/03	0.8	0.8	0.8
11/14/03	1.3	1.3	1.3
11/15/03	2.2	2.2	2.2
11/16/03	2.0	2.0	2.0
11/17/03	1.9	1.9	1.9
11/18/03	1.8	1.8	1.8
11/19/03	1.6	1.6	1.6
11/20/03	1.6	1.6	1.6

Date	No action	250 AF	550 AF
11/21/03	1.5	1.5	1.5
11/22/03	1.5	1.5	1.5
11/23/03	1.1	1.1	1.1
11/24/03	1.3	1.3	1.3
11/25/03	1.2	1.2	1.2
11/26/03	1.0	1.0	1.0
11/27/03	0.8	0.8	0.8
11/28/03	0.9	0.9	0.9
11/29/03	0.9	0.9	0.9
11/30/03	0.9	0.9	0.9
3/19/04	7.8	7.8	7.8
3/20/04	22.6	22.6	22.6
3/21/04	40.2	40.2	40.2
3/22/04	55.0	55.0	55.0
3/23/04	46.9	46.9	46.9
3/24/04	49.3	49.3	49.3
3/25/04	57.5	57.5	57.5
3/26/04	62.7	62.7	62.7
3/27/04	45.1	45.1	45.1
3/28/04	21.7	21.7	21.7
3/29/04	7.9	7.9	7.9
3/30/04	6.6	6.6	6.6
3/31/04	11.8	11.8	11.8
11/9/04	0.6	0.7	0.7
11/11/04	1.2	1.2	1.2
11/12/04	1.5	1.5	1.5
11/13/04	2.2	2.2	2.2
11/14/04	2.0	2.0	2.0
11/15/04	3.3	3.3	3.3
11/16/04	3.2	3.2	3.2
11/17/04	4.0	4.1	4.1
11/18/04	3.4	3.5	3.5
11/19/04	3.3	3.4	3.4
11/20/04	3.3	3.3	3.3
11/21/04	3.2	3.2	3.2
11/22/04	2.2	2.2	2.2
11/23/04	1.6	1.7	1.7
11/24/04	0.1	0.2	0.2
11/25/04	0.1	0.1	0.1
11/26/04	2.4	2.5	2.5
11/28/04	0.3	0.3	0.3
12/22/04	0.0	0.0	0.0
12/23/04	0.4	0.4	0.4
12/24/04	0.6	0.6	0.6
12/25/04	0.7	0.7	0.7
12/26/04	0.7	0.7	0.7
12/27/04	0.8	0.8	0.8
12/28/04	0.9	0.9	0.9
12/29/04	0.8	0.8	0.8
12/30/04	0.9	0.9	0.9
12/31/04	1.1	1.1	1.1
1/1/05	1.3	1.3	1.3
1/2/05	1.3	1.3	1.3
1/3/05	1.4	1.4	1.4
1/4/05	1.5	1.5	1.5
1/5/05	1.5	1.5	1.5
1/6/05	1.6	1.6	1.6

Date	No action	250 AF	550 AF
1/7/05	1.6	1.6	1.6
1/8/05	1.7	1.7	1.7
1/9/05	1.7	1.7	1.7
1/10/05	1.8	1.8	1.8
1/11/05	1.8	1.8	1.8
1/12/05	1.9	1.9	1.9
1/13/05	1.9	1.9	1.9
1/14/05	1.9	1.9	1.9
1/15/05	2.0	2.0	2.0
1/16/05	2.0	2.0	2.0
1/17/05	2.0	2.0	2.0
1/18/05	1.9	1.9	1.9
1/19/05	1.9	1.9	1.9
1/20/05	1.9	1.9	1.9
1/21/05	1.9	1.9	1.9
1/22/05	1.9	1.9	1.9
1/23/05	1.9	1.9	1.9
1/24/05	1.9	1.9	1.9
1/25/05	1.9	1.9	1.9
1/26/05	2.1	2.1	2.1
1/27/05	3.2	3.2	3.2
1/28/05	3.2	3.2	3.2
1/29/05	4.3	4.3	4.3
1/30/05	4.4	4.4	4.4
1/31/05	5.4	5.4	5.4
2/1/05	5.2	5.2	5.2
2/2/05	5.3	5.3	5.3
2/3/05	5.3	5.3	5.3
2/4/05	5.4	5.4	5.4
2/5/05	5.5	5.5	5.5
2/6/05	4.6	4.6	4.6
2/7/05	5.6	5.6	5.6
2/8/05	4.7	4.7	4.7
2/9/05	3.8	3.8	3.8
2/10/05	3.9	3.9	3.9
2/11/05	4.9	4.9	4.9
2/12/05	5.9	5.9	5.9
2/13/05	4.9	4.9	4.9
2/14/05	5.0	5.0	5.0
2/15/05	5.1	5.1	5.1
2/16/05	5.1	5.1	5.1
2/17/05	5.2	5.2	5.2
2/18/05	5.3	5.3	5.3
2/19/05	5.4	5.4	5.4
2/20/05	5.5	5.5	5.5
2/21/05	4.6	4.6	4.6
2/22/05	5.6	5.6	5.6
2/23/05	5.7	5.7	5.7
2/24/05	4.8	4.8	4.8
2/25/05	4.8	4.8	4.8
2/26/05	4.9	4.9	4.9
2/27/05	4.0	4.0	4.0
2/28/05	0.0	5.0	5.0
3/1/05	0.0	7.3	7.3
3/2/05	0.0	7.3	7.3
3/3/05	0.0	7.2	7.2
3/4/05	0.0	7.2	7.2

Date	No action	250 AF	550 AF
3/5/05	0.0	7.2	7.2
3/6/05	0.0	8.2	8.2
3/7/05	0.0	8.2	8.2
3/8/05	0.0	9.1	9.1
3/9/05	0.0	10.1	10.1
3/10/05	0.0	11.0	11.0
3/11/05	0.0	13.9	13.9
3/12/05	0.0	0.9	19.7
3/13/05	0.0	0.0	27.5
3/14/05	0.0	0.0	30.4
3/15/05	0.0	0.0	36.2
3/16/05	0.0	0.0	28.8
11/19/05	0.2	0.2	0.3
11/20/05	0.5	0.5	0.5
11/21/05	0.6	0.6	0.6
11/22/05	0.7	0.8	0.8
11/23/05	0.8	0.8	0.8
11/24/05	1.0	1.0	1.0
11/25/05	1.1	1.1	1.1
11/26/05	1.1	1.1	1.1
11/27/05	0.9	0.9	1.0
11/28/05	1.3	1.3	1.4
11/29/05	1.5	1.5	1.5
11/30/05	1.4	1.4	1.4
12/1/05	4.2	4.2	4.2
12/2/05	4.3	4.3	4.3
12/3/05	4.5	4.5	4.5
12/4/05	4.3	4.3	4.4
12/5/05	4.0	4.0	4.0
12/6/05	4.2	4.2	4.2
12/7/05	3.9	3.9	3.9
12/8/05	3.7	3.7	3.7
12/9/05	3.8	3.8	3.8
12/10/05	3.9	3.9	3.9
12/11/05	4.0	4.0	4.0
12/12/05	4.2	4.2	4.2
12/13/05	4.2	4.2	4.2
12/14/05	4.7	4.7	4.7
12/15/05	3.6	3.6	3.6
12/16/05	3.3	3.3	3.3
12/17/05	3.5	3.5	3.5
12/18/05	3.9	3.9	3.9
12/19/05	4.0	4.0	4.0
12/20/05	4.1	4.1	4.1
12/21/05	4.1	4.1	4.1
12/22/05	4.0	4.0	4.0
12/23/05	4.0	4.0	4.0
12/24/05	3.9	3.9	3.9
12/25/05	3.8	3.8	3.8
12/26/05	3.7	3.7	3.7
12/27/05	3.6	3.6	3.6
12/28/05	3.6	3.6	3.6
12/29/05	4.0	4.0	4.0
12/30/05	4.7	4.7	4.7
12/31/05	3.1	3.1	3.1
1/1/06	3.4	3.4	3.4
1/2/06	2.8	2.8	2.8

Date	No action	250 AF	550 AF
1/3/06	2.8	2.8	2.8
1/4/06	2.8	2.8	2.8
1/5/06	2.8	2.8	2.8
1/6/06	2.8	2.8	2.8
1/7/06	2.8	2.8	2.8
1/8/06	2.8	2.8	2.8
1/9/06	2.8	2.8	2.8
1/10/06	2.8	2.8	2.8
1/11/06	2.8	2.8	2.8
1/12/06	2.7	2.7	2.7
1/13/06	2.7	2.7	2.7
1/14/06	2.7	2.7	2.7
1/15/06	2.7	2.7	2.7
1/16/06	2.7	2.7	2.7
1/17/06	2.7	2.7	2.7
1/18/06	2.6	2.6	2.6
1/19/06	2.6	2.6	2.6
1/20/06	2.6	2.6	2.6
1/21/06	2.6	2.6	2.6
1/22/06	2.6	2.6	2.6
1/23/06	2.5	2.5	2.5
1/24/06	2.5	2.5	2.5
1/25/06	2.5	2.5	2.5
1/26/06	2.5	2.5	2.5
1/27/06	2.5	2.5	2.5
1/28/06	2.4	2.4	2.4
1/29/06	2.4	2.4	2.4
1/30/06	2.4	2.4	2.4
1/31/06	2.4	2.4	2.4
2/1/06	1.9	1.9	1.9
2/2/06	1.8	1.8	1.8
2/3/06	1.8	1.8	1.8
2/4/06	1.7	1.7	1.7
2/5/06	1.6	1.6	1.6
2/6/06	1.6	1.6	1.6
2/7/06	1.5	1.5	1.5
2/8/06	1.5	1.5	1.5
2/9/06	1.4	1.4	1.4
2/10/06	1.3	1.3	1.3
2/11/06	1.3	1.3	1.3
2/12/06	1.2	1.2	1.2
2/13/06	1.2	1.2	1.2
2/14/06	1.1	1.1	1.1
2/15/06	1.1	1.1	1.1
2/16/06	1.0	1.0	1.0
2/17/06	0.9	1.0	1.0
2/18/06	0.9	0.9	0.9
2/19/06	0.9	0.9	0.9
2/20/06	0.8	0.8	0.8
2/21/06	0.8	0.8	0.8
2/22/06	0.7	0.7	0.7
2/23/06	0.7	0.7	0.7
2/24/06	0.6	0.6	0.6
2/25/06	0.6	0.6	0.6
2/26/06	0.6	0.6	0.6
2/27/06	0.5	0.5	0.5
2/28/06	0.5	0.5	0.5

Date	No action	250 AF	550 AF
3/1/06	0.1	0.1	0.1
3/2/06	0.4	0.4	0.4
3/3/06	0.3	0.3	0.3
3/4/06	0.1	0.1	0.1
3/5/06	0.1	0.1	0.1
3/6/06	0.0	0.0	0.0
3/7/06	0.0	0.0	0.0
3/16/06	0.4	0.4	0.4
10/6/06	116.4	116.	116.
10/7/06	116.4	116.	116.
11/1/06	8.2	8.2	8.3
11/2/06	1.8	1.8	1.8
11/3/06	0.5	0.5	0.5
11/4/06	0.6	0.7	0.7
11/5/06	1.6	1.6	1.6
11/6/06	0.3	0.3	0.3
11/28/06	0.4	0.4	0.4
11/29/06	0.0	0.1	0.1
11/30/06	0.2	0.2	0.2
12/1/06	0.6	0.6	0.6
12/2/06	0.6	0.6	0.6
12/3/06	0.6	0.6	0.6
12/4/06	0.5	0.5	0.5
12/5/06	0.5	0.5	0.5
12/6/06	0.5	0.5	0.5
12/7/06	0.4	0.4	0.4
12/8/06	0.4	0.4	0.4
12/9/06	0.4	0.4	0.4
12/10/06	0.4	0.4	0.4
12/11/06	0.3	0.3	0.3
12/12/06	0.3	0.3	0.3
12/13/06	0.3	0.3	0.3
12/14/06	0.3	0.3	0.3
12/15/06	0.2	0.2	0.2
12/16/06	0.2	0.2	0.2
12/17/06	0.3	0.3	0.3
12/18/06	0.3	0.3	0.3
12/19/06	0.3	0.3	0.3
12/20/06	0.3	0.3	0.3
12/21/06	0.3	0.3	0.3
12/22/06	0.3	0.3	0.3
12/23/06	0.3	0.3	0.3
12/24/06	0.3	0.3	0.3
12/25/06	0.4	0.4	0.4
12/26/06	0.4	0.4	0.4
12/27/06	0.4	0.4	0.4
12/28/06	0.5	0.5	0.5
12/29/06	0.5	0.5	0.5
12/30/06	0.5	0.5	0.5
12/31/06	0.5	0.5	0.5
2/1/07	1.3	1.3	1.3
2/2/07	1.3	1.3	1.3
2/3/07	1.3	1.3	1.3
2/4/07	1.3	1.3	1.3
2/5/07	1.3	1.3	1.4
2/6/07	1.4	1.4	1.4
2/7/07	1.6	1.6	1.6

Date	No action	250 AF	550 AF
2/8/07	1.7	1.7	1.7
2/9/07	1.8	1.8	1.8
2/10/07	1.8	1.8	1.8
2/11/07	2.2	2.2	2.2
2/12/07	2.1	2.1	2.1
2/13/07	2.2	2.2	2.2
2/14/07	2.4	2.4	2.4
2/15/07	1.2	1.2	1.2
2/16/07	1.1	1.1	1.1
2/17/07	1.1	1.1	1.1
2/18/07	0.8	0.8	0.8
2/19/07	0.7	0.7	0.7
2/20/07	0.5	0.5	0.5
2/21/07	0.3	0.3	0.3
2/22/07	0.2	0.2	0.2
3/15/07	9.0	9.0	9.0
3/16/07	17.3	17.3	17.3
3/17/07	33.0	33.0	33.0
3/18/07	46.6	46.6	46.6
3/19/07	43.9	43.9	43.9
3/20/07	14.1	40.2	40.2
3/21/07	0.0	34.6	34.6
3/22/07	0.0	20.3	20.3
3/23/07	0.0	11.7	11.7
3/24/07	0.0	3.2	3.2
12/1/07	9.5	9.5	9.5
12/2/07	5.5	5.5	5.5
12/3/07	4.5	4.5	4.5
12/4/07	4.5	4.5	4.5
12/5/07	4.4	4.4	4.4
12/6/07	3.4	3.4	3.4
12/7/07	8.2	8.2	8.2
12/8/07	9.1	9.1	9.1
12/9/07	7.2	7.2	7.2
12/10/07	7.1	7.1	7.1
12/11/07	7.1	7.1	7.1
12/12/07	7.0	7.0	7.0
12/13/07	6.0	6.0	6.0
12/14/07	5.0	5.0	5.0
12/15/07	4.0	4.0	4.0
12/16/07	4.0	4.0	4.0
12/17/07	5.1	5.1	5.1
12/18/07	5.2	5.2	5.2
12/19/07	5.2	5.2	5.2
12/20/07	5.3	5.3	5.3
12/21/07	5.4	5.4	5.4
12/22/07	4.5	4.5	4.5
12/23/07	3.6	3.6	3.6
12/24/07	2.7	2.7	2.7
12/25/07	1.8	1.8	1.8
12/26/07	1.9	1.9	1.9
12/27/07	1.0	1.0	1.0
12/28/07	1.0	1.0	1.0
12/29/07	1.1	1.1	1.1
12/30/07	0.5	0.5	0.5
12/31/07	0.6	0.6	0.6
1/1/08	1.8	1.8	1.8

Date	No action	250 AF	550 AF
1/2/08	1.7	1.7	1.7
1/3/08	2.4	2.4	2.4
1/4/08	3.1	3.1	3.1
1/5/08	3.4	3.4	3.4
1/6/08	6.4	6.4	6.4
1/7/08	3.6	3.6	3.6
1/8/08	2.5	2.6	2.6
1/9/08	3.4	3.4	3.4
1/10/08	2.6	2.6	2.6
1/11/08	2.7	2.7	2.7
1/12/08	2.7	2.7	2.7
1/13/08	2.7	2.7	2.7
1/14/08	2.8	2.8	2.8
1/15/08	2.8	2.8	2.8
1/16/08	2.1	2.1	2.1
1/17/08	2.1	2.1	2.1
1/18/08	2.1	2.1	2.1
1/19/08	2.2	2.2	2.2
1/20/08	2.2	2.2	2.2
1/21/08	2.2	2.2	2.2
1/22/08	2.2	2.3	2.3
1/23/08	2.3	2.3	2.3
1/24/08	2.3	2.3	2.3
1/25/08	2.3	2.3	2.3
1/26/08	3.0	3.0	3.0
1/27/08	3.0	3.0	3.0
1/28/08	2.4	2.4	2.4
1/29/08	2.5	2.5	2.5
1/30/08	2.5	2.5	2.5
1/31/08	2.5	2.5	2.5
2/1/08	2.5	2.5	2.5
2/2/08	2.6	2.6	2.6
2/3/08	2.6	2.6	2.6
2/4/08	2.6	2.6	2.6
2/5/08	2.6	2.6	2.6
2/6/08	2.6	2.6	2.6
2/7/08	2.6	2.6	2.6
2/8/08	2.6	2.6	2.6
2/9/08	2.6	2.6	2.6
2/10/08	2.6	2.6	2.6
2/11/08	2.7	2.7	2.7
2/12/08	2.7	2.7	2.7
2/13/08	2.7	2.7	2.7
2/14/08	2.7	2.7	2.7
2/15/08	2.7	2.7	2.7
2/16/08	2.7	2.7	2.7
2/17/08	2.7	2.7	2.7
2/18/08	2.7	2.7	2.7
2/19/08	2.7	2.7	2.7
2/20/08	2.7	2.7	2.7
2/21/08	2.7	2.7	2.7
2/22/08	2.8	2.8	2.8
2/23/08	2.9	2.9	2.9
2/24/08	2.9	2.9	2.9
2/25/08	2.9	2.9	2.9
2/26/08	2.8	2.8	2.8
2/27/08	2.8	2.8	2.8

Date	No action	250 AF	550 AF
2/28/08	3.5	3.5	3.5
3/1/08	5.1	5.1	5.1
3/2/08	5.6	5.6	5.6
3/3/08	4.8	4.8	4.8
3/4/08	5.7	5.7	5.7
3/5/08	4.7	4.7	4.7
3/6/08	4.7	4.7	4.7
3/7/08	5.6	5.6	5.6
3/8/08	7.0	7.0	7.0
3/9/08	7.5	7.5	7.5
3/10/08	8.4	8.4	8.4
3/11/08	10.3	10.3	10.3
3/12/08	11.3	11.3	11.3
3/13/08	11.2	11.2	11.2
3/14/08	0.0	12.2	12.2
3/15/08	0.0	13.1	13.1
3/16/08	0.0	12.7	12.7
3/17/08	0.0	11.9	11.9
3/18/08	0.0	11.1	11.1
3/19/08	0.0	11.2	11.2
3/20/08	0.0	11.4	11.4
3/21/08	0.0	12.6	12.6
3/22/08	0.0	7.4	13.7
3/23/08	0.0	0.0	13.9
3/24/08	0.0	0.0	17.0
3/25/08	0.0	0.0	22.0
3/26/08	0.0	0.0	30.9
3/27/08	0.0	0.0	40.8
11/12/08	0.4	0.4	0.4
11/13/08	1.7	1.7	1.7
11/14/08	2.8	2.9	2.9
11/15/08	4.0	4.0	4.1
11/16/08	4.0	4.0	4.0
11/17/08	3.8	3.9	3.9
11/18/08	3.8	3.8	3.8
11/19/08	3.7	3.7	3.7
11/20/08	3.5	3.5	3.5
11/21/08	3.5	3.5	3.5
11/22/08	3.4	3.4	3.4
11/23/08	3.4	3.4	3.4
11/24/08	3.3	3.3	3.3
11/25/08	3.2	3.3	3.3
11/26/08	3.2	3.2	3.2
11/27/08	3.6	3.6	3.6
11/28/08	3.4	3.4	3.4
11/29/08	3.2	3.2	3.2
11/30/08	3.2	3.2	3.2
12/29/08	0.0	0.0	0.0
12/30/08	0.1	0.1	0.1
12/31/08	0.1	0.2	0.2
1/1/09	0.9	0.9	0.9
1/2/09	0.9	0.9	0.9
1/3/09	0.9	0.9	0.9
1/4/09	0.9	0.9	0.9
1/5/09	0.9	0.9	0.9
1/6/09	0.9	0.9	0.9
1/7/09	1.0	1.0	1.0

Date	No action	250 AF	550 AF
1/8/09	1.0	1.0	1.0
1/9/09	1.0	1.0	1.0
1/10/09	1.0	1.0	1.0
1/11/09	1.0	1.0	1.0
1/12/09	1.0	1.0	1.0
1/13/09	1.1	1.1	1.1
1/14/09	1.1	1.1	1.1
1/15/09	1.1	1.1	1.1
1/16/09	1.1	1.1	1.1
1/17/09	1.1	1.1	1.1
1/18/09	1.1	1.1	1.1
1/19/09	1.1	1.1	1.1
1/20/09	1.1	1.1	1.1
1/21/09	1.1	1.1	1.1
1/22/09	1.1	1.1	1.1
1/23/09	1.1	1.1	1.1
1/24/09	1.1	1.1	1.1
1/25/09	1.1	1.1	1.1
1/26/09	1.1	1.1	1.1
1/27/09	1.1	1.1	1.1
1/28/09	1.1	1.1	1.1
1/29/09	1.1	1.1	1.1
1/30/09	1.1	1.1	1.1
1/31/09	1.1	1.1	1.1
2/1/09	0.6	0.6	0.6
2/2/09	0.6	0.6	0.6
2/3/09	0.9	0.9	0.9
2/4/09	0.9	0.9	0.9
2/5/09	0.9	0.9	0.9
2/6/09	1.3	1.3	1.3
2/7/09	1.3	1.3	1.4
2/8/09	1.5	1.5	1.5
2/9/09	1.4	1.4	1.4
2/10/09	1.4	1.4	1.5
2/11/09	1.5	1.5	1.5
2/12/09	1.7	1.7	1.7
2/13/09	1.7	1.7	1.7
2/14/09	1.7	1.7	1.7
2/15/09	1.6	1.6	1.6
2/16/09	1.8	1.8	1.8
2/17/09	1.7	1.7	1.7
2/18/09	1.6	1.6	1.6
2/19/09	1.4	1.4	1.4
2/20/09	1.3	1.3	1.3
2/21/09	1.2	1.2	1.2
2/22/09	1.1	1.1	1.1
2/23/09	1.1	1.1	1.1
2/24/09	1.2	1.2	1.2
2/25/09	1.1	1.1	1.1
2/26/09	1.0	1.0	1.0
2/27/09	0.9	0.9	0.9
2/28/09	0.7	0.7	0.7
3/22/09	24.8	24.8	24.8
3/23/09	32.0	32.0	32.0
3/24/09	18.4	18.4	18.4
3/25/09	9.7	9.7	9.7
3/26/09	2.2	2.2	2.2

Appendix E: Predicted End-of-Month Contents in Long Hollow Reservoir (AF)

Month	No action	250 AF	550 AF
1974-10	29	29	29
1974-11	39	39	39
1974-12	168	168	168
1975-01	285	285	285
1975-02	456	456	456
1975-03	836	836	836
1975-04	978	978	978
1975-05	1226	1226	1226
1975-06	296	296	296
1975-07	0	0	0
1975-08	0	0	0
1975-09	60	63	63
1975-10	314	316	316
1975-11	639	641	641
1975-12	1031	1033	1033
1976-01	1417	1420	1420
1976-02	1834	1837	1837
1976-03	2453	2455	2455
1976-04	2455	2458	2458
1976-05	296	296	296
1976-06	288	288	288
1976-07	0	0	0
1976-08	0	0	0
1976-09	0	0	0
1976-10	33	33	33
1976-11	325	325	325
1976-12	668	668	668
1977-01	970	970	970
1977-02	1241	1241	1241
1977-03	1460	1461	1461
1977-04	1454	1454	1454
1977-05	1220	1220	1220
1977-06	819	819	819
1977-07	938	938	938
1977-08	824	825	825
1977-09	767	768	768
1977-10	857	857	857
1977-11	937	937	937
1977-12	1235	1235	1235
1978-01	1510	1510	1510
1978-02	1758	1758	1758
1978-03	2122	2123	2122
1978-04	2559	2560	2560
1978-05	1636	1637	1637
1978-06	293	293	293
1978-07	0	0	0
1978-08	0	0	0
1978-09	0	0	0
1978-10	82	82	82
1978-11	296	296	296
1978-12	548	548	548
1979-01	833	833	833
1979-02	1076	1076	1076
1979-03	1630	1630	1630
1979-04	2030	2031	2031

Month	No action	250 AF	550 AF
1979-05	2349	2350	2350
1979-06	835	835	835
1979-07	0	0	0
1979-08	11	11	11
1979-09	43	43	43
1979-10	397	397	397
1979-11	817	817	817
1979-12	1338	1338	1338
1980-01	1862	1862	1862
1980-02	2355	2355	2355
1980-03	2842	2843	2843
1980-04	3406	3406	3406
1980-05	3919	3919	3919
1980-06	3233	3228	3209
1980-07	2054	2061	2042
1980-08	2361	2384	2367
1980-09	2210	2245	2228
1980-10	2697	2732	2715
1980-11	3260	3295	3278
1980-12	3930	3965	3948
1981-01	4632	4668	4651
1981-02	5273	5309	5292
1981-03	5309	5309	5309
1981-04	5308	5308	5308
1981-05	4037	4037	4038
1981-06	2356	2358	2358
1981-07	2752	2754	2754
1981-08	2724	2726	2726
1981-09	2733	2735	2736
1981-10	2670	2673	2673
1981-11	2821	2824	2825
1981-12	3381	3384	3385
1982-01	3943	3946	3947
1982-02	4488	4492	4493
1982-03	5264	5268	5269
1982-04	5308	5308	5308
1982-05	4345	4342	4342
1982-06	295	295	295
1982-07	0	0	0
1982-08	0	0	0
1982-09	0	0	0
1982-10	444	444	445
1982-11	956	957	957
1982-12	1542	1543	1543
1983-01	2194	2195	2196
1983-02	2791	2792	2793
1983-03	3595	3597	3597
1983-04	4103	4105	4105
1983-05	4622	4624	4624
1983-06	3523	3524	3523
1983-07	2759	2760	2759
1983-08	3134	3137	3137
1983-09	3470	3474	3476
1983-10	3835	3845	3854
1983-11	4368	4378	4388

Month	No action	250 AF	550 AF
1983-12	5006	5016	5026
1984-01	5309	5309	5309
1984-02	5309	5309	5309
1984-03	5309	5309	5309
1984-04	5308	5308	5308
1984-05	5133	5133	5133
1984-06	2717	2725	2729
1984-07	2538	2579	2631
1984-08	2785	2844	2917
1984-09	2927	2994	3078
1984-10	3478	3545	3628
1984-11	4009	4080	4168
1984-12	4676	4748	4836
1985-01	5309	5309	5309
1985-02	5309	5309	5309
1985-03	5309	5309	5309
1985-04	5308	5308	5308
1985-05	4411	4412	4412
1985-06	1739	1741	1743
1985-07	1571	1613	1657
1985-08	1824	1888	1964
1985-09	1994	2062	2144
1985-10	2508	2580	2666
1985-11	3129	3202	3288
1985-12	3837	3910	3999
1986-01	4606	4680	4770
1986-02	5299	5309	5309
1986-03	5309	5309	5309
1986-04	5308	5308	5308
1986-05	3505	3504	3504
1986-06	462	463	465
1986-07	443	484	523
1986-08	890	934	976
1986-09	1330	1375	1419
1986-10	1841	1877	1922
1986-11	2440	2477	2524
1986-12	3120	3158	3205
1987-01	3866	3905	3953
1987-02	4544	4583	4633
1987-03	5309	5309	5309
1987-04	5308	5308	5308
1987-05	5262	5263	5263
1987-06	2817	2817	2818
1987-07	2410	2445	2484
1987-08	2935	2970	3009
1987-09	3229	3274	3326
1987-10	3811	3856	3909
1987-11	4457	4503	4557
1987-12	5189	5236	5290
1988-01	5309	5309	5309
1988-02	5309	5309	5309
1988-03	5309	5309	5309
1988-04	5308	5308	5308
1988-05	2660	2661	2663
1988-06	885	900	913

Month	No action	250 AF	550 AF
1988-07	1104	1161	1221
1988-08	1160	1229	1305
1988-09	801	875	958
1988-10	1124	1204	1293
1988-11	1763	1844	1935
1988-12	2415	2497	2589
1989-01	3169	3252	3345
1989-02	3860	3944	4038
1989-03	4620	4705	4800
1989-04	4891	4975	5067
1989-05	2750	2831	2920
1989-06	2174	2266	2368
1989-07	2023	2130	2272
1989-08	1935	2053	2206
1989-09	2077	2202	2362
1989-10	2182	2311	2476
1989-11	2412	2545	2716
1989-12	2875	3010	3182
1990-01	3321	3457	3630
1990-02	3736	3872	4047
1990-03	4281	4419	4595
1990-04	4320	4458	4634
1990-05	1571	1709	1886
1990-06	292	292	293
1990-07	0	0	0
1990-08	0	0	0
1990-09	0	0	0
1990-10	0	0	0
1990-11	93	95	97
1990-12	368	371	375
1991-01	671	675	679
1991-02	1069	1074	1079
1991-03	1550	1555	1561
1991-04	1590	1595	1601
1991-05	295	295	295
1991-06	287	287	287
1991-07	0	0	0
1991-08	0	0	0
1991-09	0	0	0
1991-10	44	44	45
1991-11	353	354	356
1991-12	684	686	688
1992-01	954	957	959
1992-02	1301	1304	1306
1992-03	1871	1875	1878
1992-04	2386	2390	2393
1992-05	1914	1918	1922
1992-06	293	293	293
1992-07	458	459	459
1992-08	392	394	395
1992-09	360	362	364
1992-10	496	499	501
1992-11	688	691	694
1992-12	1063	1066	1068
1993-01	1560	1564	1566
1993-02	2033	2037	2040
1993-03	3508	3512	3515
1993-04	4792	4796	4800

Month	No action	250 AF	550 AF
1993-05	4736	4741	4744
1993-06	2303	2308	2311
1993-07	1277	1320	1364
1993-08	1442	1501	1564
1993-09	1656	1724	1798
1993-10	2159	2231	2309
1993-11	2722	2796	2878
1993-12	3332	3407	3489
1994-01	3901	3976	4059
1994-02	4388	4464	4547
1994-03	5115	5192	5276
1994-04	5304	5304	5304
1994-05	3291	3292	3294
1994-06	984	986	988
1994-07	948	952	954
1994-08	1026	1031	1034
1994-09	1207	1213	1216
1994-10	1515	1521	1524
1994-11	2032	2038	2042
1994-12	2640	2647	2651
1995-01	3263	3271	3275
1995-02	3852	3859	3864
1995-03	4913	4921	4925
1995-04	5308	5308	5308
1995-05	5177	5177	5177
1995-06	2701	2701	2702
1995-07	1128	1141	1151
1995-08	1419	1469	1523
1995-09	1672	1736	1808
1995-10	2158	2230	2311
1995-11	2735	2811	2900
1995-12	3428	3505	3594
1996-01	4062	4140	4231
1996-02	4671	4750	4841
1996-03	5294	5309	5309
1996-04	5278	5287	5287
1996-05	2117	2127	2128
1996-06	1834	1845	1847
1996-07	1539	1550	1552
1996-08	1403	1413	1417
1996-09	1321	1332	1336
1996-10	1057	1068	1072
1996-11	1078	1089	1094
1996-12	1615	1626	1631
1997-01	2154	2166	2171
1997-02	2637	2649	2654
1997-03	3743	3756	3761
1997-04	4455	4468	4474
1997-05	4288	4301	4306
1997-06	2220	2232	2238
1997-07	1685	1735	1783
1997-08	809	881	957
1997-09	930	1008	1091
1997-10	1337	1420	1509
1997-11	1901	1985	2076
1997-12	2550	2634	2726
1998-01	3205	3290	3383
1998-02	3757	3843	3937

Month	No action	250 AF	550 AF
1998-03	4439	4526	4620
1998-04	5001	5088	5182
1998-05	2777	2865	2961
1998-06	1134	1237	1345
1998-07	1256	1393	1543
1998-08	1245	1389	1548
1998-09	1377	1528	1696
1998-10	1766	1919	2090
1998-11	2173	2330	2507
1998-12	2702	2861	3039
1999-01	3224	3383	3563
1999-02	3654	3814	3994
1999-03	3941	4103	4285
1999-04	4017	4179	4361
1999-05	1697	1859	2042
1999-06	292	292	293
1999-07	0	0	0
1999-08	412	414	417
1999-09	522	527	533
1999-10	912	920	929
1999-11	1360	1371	1382
1999-12	1943	1955	1969
2000-01	2565	2580	2597
2000-02	3133	3150	3169
2000-03	3813	3832	3853
2000-04	4490	4511	4534
2000-05	1216	1239	1264
2000-06	345	367	393
2000-07	173	197	224
2000-08	135	160	187
2000-09	79	104	133
2000-10	248	275	305
2000-11	454	482	514
2000-12	823	853	886
2001-01	1154	1185	1219
2001-02	1476	1507	1543
2001-03	2167	2200	2237
2001-04	2530	2564	2601
2001-05	298	305	344
2001-06	290	290	290
2001-07	154	161	163
2001-08	133	142	145
2001-09	73	84	89
2001-10	275	288	294
2001-11	388	404	412
2001-12	887	903	913
2002-01	1261	1278	1290
2002-02	1573	1592	1605
2002-03	1822	1842	1857
2002-04	1814	1834	1848
2002-05	1380	1401	1416
2002-06	1199	1219	1235
2002-07	1078	1098	1113
2002-08	1009	1029	1044
2002-09	787	807	822
2002-10	685	705	721
2002-11	695	715	731
2002-12	888	909	925

Month	No action	250 AF	550 AF
2003-01	1130	1150	1167
2003-02	1338	1358	1375
2003-03	1750	1770	1788
2003-04	1742	1762	1779
2003-05	295	295	295
2003-06	288	288	288
2003-07	0	0	0
2003-08	0	0	0
2003-09	0	0	0
2003-10	0	0	0
2003-11	124	125	126
2003-12	296	296	297
2004-01	482	483	485
2004-02	683	684	686
2004-03	1055	1056	1058
2004-04	1665	1666	1668
2004-05	296	296	296
2004-06	289	289	289
2004-07	0	0	0
2004-08	0	0	0
2004-09	0	0	0
2004-10	0	0	0
2004-11	0	0	0
2004-12	118	118	118
2005-01	462	462	463
2005-02	837	837	837
2005-03	1265	1265	1265
2005-04	1889	1890	1890
2005-05	1400	1400	1401
2005-06	292	292	292
2005-07	0	0	0
2005-08	0	0	0
2005-09	180	191	203
2005-10	180	191	203
2005-11	367	383	402
2005-12	735	751	771
2006-01	1003	1021	1041
2006-02	1230	1248	1269
2006-03	1549	1569	1591
2006-04	1597	1616	1639
2006-05	295	295	295
2006-06	287	287	287
2006-07	0	0	0
2006-08	0	0	0
2006-09	0	0	0
2006-10	27	27	27
2006-11	33	33	33
2006-12	317	318	319
2007-01	620	622	623
2007-02	933	935	937
2007-03	1225	1227	1230
2007-04	1342	1339	1342
2007-05	295	295	295
2007-06	287	287	287
2007-07	0	0	0
2007-08	0	0	0
2007-09	0	0	0
2007-10	0	0	0

Month	No action	250 AF	550 AF
2007-11	20	21	21
2007-12	337	339	340
2008-01	459	462	464
2008-02	1050	1054	1055
2008-03	1678	1682	1685
2008-04	1716	1720	1720
2008-05	298	298	298
2008-06	290	290	290
2008-07	0	0	0
2008-08	0	0	0
2008-09	0	0	0
2008-10	0	0	0
2008-11	104	110	118
2008-12	446	453	461
2009-01	816	823	832
2009-02	1076	1085	1094
2009-03	1424	1434	1444
2009-04	1443	1453	1463
2009-05	297	297	297
2009-06	289	289	289
2009-07	0	0	0
2009-08	0	0	0

Appendix F: Predicted Monthly Net Evaporation from RMWR (AF)

Month	No action	250 AF	550 AF
10/1/1974	0.1	0.1	0.1
11/1/1974	-1.2	-1.2	-1.2
12/1/1974	-3.4	-3.4	-3.4
1/1/1975	-2.3	-2.3	-2.3
2/1/1975	-2.3	-2.3	-2.3
3/1/1975	-0.4	-0.4	-0.4
4/1/1975	7.3	7.3	7.3
5/1/1975	14.6	14.6	14.6
6/1/1975	19.9	20.3	20.3
7/1/1975	6	6.5	6.6
8/1/1975	0.1	0.1	0.1
9/1/1975	0	0.1	0.1
10/1/1975	0	0	0
11/1/1975	-1.1	-1.2	-1.2
12/1/1975	-4.2	-4.2	-4.2
1/1/1976	-2.3	-2.3	-2.3
2/1/1976	-2.1	-2.2	-2.2
3/1/1976	-0.3	-0.3	-0.3
4/1/1976	4.8	4.8	4.8
5/1/1976	9.3	9.3	9.3
6/1/1976	2.5	2.6	2.6
7/1/1976	0	0	0
8/1/1976	0	0	0
9/1/1976	0	0	0
10/1/1976	0	0	0
11/1/1976	-0.5	-0.5	-0.5
12/1/1976	-1.6	-1.6	-1.6
1/1/1977	-0.8	-0.8	-0.8
2/1/1977	-0.7	-0.7	-0.7
3/1/1977	-0.1	-0.1	-0.1
4/1/1977	1.7	1.7	1.7
5/1/1977	3.2	3.2	3.2
6/1/1977	0.1	0.1	0.1
7/1/1977	0	0	0
8/1/1977	0	0	0
9/1/1977	0	0	0
10/1/1977	0	0	0
11/1/1977	0	0	0
12/1/1977	0	0	0
1/1/1978	0	0	0
2/1/1978	0	0	0
3/1/1978	0	0	0
4/1/1978	0.7	0.7	0.7
5/1/1978	4.2	4.2	4.2
6/1/1978	2.1	2.1	2.1
7/1/1978	0	0	0
8/1/1978	0	0	0
9/1/1978	0	0	0
10/1/1978	0	0	0
11/1/1978	0	0	0
12/1/1978	-0.2	-0.2	-0.2
1/1/1979	-0.1	-0.1	-0.1
2/1/1979	-0.1	-0.1	-0.1
3/1/1979	-0.2	-0.2	-0.2
4/1/1979	4.5	4.5	4.5
5/1/1979	9.8	9.8	9.8
6/1/1979	14.7	14.7	14.7
7/1/1979	3.3	3.3	3.4
8/1/1979	0.2	0.2	0.2
9/1/1979	0.2	0.2	0.2
10/1/1979	0.1	0.1	0.1
11/1/1979	-1.7	-1.7	-1.7
12/1/1979	-4.5	-4.5	-4.5
1/1/1980	-2.6	-2.6	-2.6
2/1/1980	-2.5	-2.5	-2.5
3/1/1980	-0.4	-0.5	-0.5
4/1/1980	7.8	8.2	8.2
5/1/1980	15.1	17.7	17.7
6/1/1980	21.2	26.4	26.5
7/1/1980	7.2	9.4	9.8
8/1/1980	0.2	0.3	0.4
9/1/1980	0.5	0.6	0.7
10/1/1980	0.1	0.1	0.2
11/1/1980	-2.5	-2.6	-2.7
12/1/1980	-4.7	-4.7	-4.7
1/1/1981	-2.6	-2.7	-2.7
2/1/1981	-2.5	-2.5	-2.5
3/1/1981	-0.4	-0.4	-0.4
4/1/1981	5.9	5.9	6
5/1/1981	12.3	12.4	12.5
6/1/1981	5.8	6	6.3
7/1/1981	1	1.2	1.5
8/1/1981	0.1	0.1	0.2
9/1/1981	0	0	0
10/1/1981	0	0	0
11/1/1981	-1	-1	-1
12/1/1981	-3.2	-3.2	-3.2
1/1/1982	-2.3	-2.3	-2.3
2/1/1982	-2.3	-2.3	-2.3
3/1/1982	-0.4	-0.4	-0.4
4/1/1982	7.4	7.4	7.4
5/1/1982	15	15	15
6/1/1982	14.7	14.8	14.8
7/1/1982	1.4	1.3	1.3
8/1/1982	0.3	0.2	0.2
9/1/1982	0.3	0.2	0.2
10/1/1982	0.1	0.1	0.1
11/1/1982	-1.6	-1.5	-1.5
12/1/1982	-4.5	-4.5	-4.5
1/1/1983	-2.9	-2.9	-2.9
2/1/1983	-2.2	-3.5	-3.5
3/1/1983	0	-0.2	-0.6
4/1/1983	7.8	10	11.2
5/1/1983	15.1	19.4	21.7
6/1/1983	20.8	26.5	30.3
7/1/1983	11.1	13.6	17.2
8/1/1983	1	1.3	1.8
9/1/1983	0.3	0.4	0.5
10/1/1983	0.1	0.1	0.2
11/1/1983	-2.8	-2.9	-3
12/1/1983	-5.2	-5.3	-5.3
1/1/1984	-3.1	-3.1	-3.1
2/1/1984	-3.1	-3.2	-3.2
3/1/1984	-0.1	-0.3	-0.4
4/1/1984	7.8	10	11.2
5/1/1984	15.1	19.4	21.7
6/1/1984	14.9	18.1	22.1
7/1/1984	1.9	2.7	3.7
8/1/1984	0.2	0.2	0.3
9/1/1984	0.1	0.2	0.3
10/1/1984	0.1	0.1	0.1
11/1/1984	-0.5	-0.7	-0.8
12/1/1984	-2.6	-2.7	-2.8
1/1/1985	-2.5	-2.5	-2.5
2/1/1985	-2.8	-2.8	-2.8
3/1/1985	-0.2	-0.3	-0.5
4/1/1985	7.8	10	11.2
5/1/1985	15.1	19.4	21.7
6/1/1985	17.5	21.6	26.4
7/1/1985	2.1	3.3	4.9
8/1/1985	0.3	0.3	0.4
9/1/1985	0.4	0.5	0.6
10/1/1985	0.2	0.2	0.2
11/1/1985	-3.3	-3.4	-3.5
12/1/1985	-5.4	-5.4	-5.4
1/1/1986	-3.4	-3.6	-3.6
2/1/1986	0	-1.7	-4.3
3/1/1986	0	0	0
4/1/1986	7.8	10	11.2
5/1/1986	15.1	19.4	21.7
6/1/1986	16.9	20.9	25.6
7/1/1986	6.7	7.5	8.3
8/1/1986	0.6	1	1.5
9/1/1986	0.3	0.5	1.1
10/1/1986	1.1	1.2	1.3
11/1/1986	0	0	-0.7
12/1/1986	0	0	0
1/1/1987	0	0	0
2/1/1987	0	0	0
3/1/1987	0	0	0
4/1/1987	7.8	10	11.2
5/1/1987	15.1	19.4	21.7
6/1/1987	18.4	22.9	27.4
7/1/1987	3.4	4.9	6.8
8/1/1987	0.2	0.3	0.3
9/1/1987	0.1	0.2	0.3
10/1/1987	0.1	0.1	0.1
11/1/1987	-3.7	-3.7	-3.8
12/1/1987	-5.7	-5.8	-5.8
1/1/1988	-3.2	-3.8	-3.8
2/1/1988	0	-2.9	-4.4
3/1/1988	0	0	-0.3
4/1/1988	7.8	10	11.2
5/1/1988	15	19.3	21.7
6/1/1988	11.5	14.8	19.2
7/1/1988	1	1.4	2
8/1/1988	0.1	0.1	0.1
9/1/1988	0	0	0
10/1/1988	0	0	0

11/1/1988	-1.4	-1.4	-1.4
12/1/1988	-4.4	-4.4	-4.4
1/1/1989	-2.6	-2.6	-2.6
2/1/1989	-2.5	-2.5	-2.5
3/1/1989	-0.2	-0.3	-0.3
4/1/1989	7.8	10	11.2
5/1/1989	15	19.2	21.7
6/1/1989	6.5	8.9	12.2
7/1/1989	0	0.1	0.3
8/1/1989	0	0	0
9/1/1989	0	0	0
10/1/1989	0	0	0
11/1/1989	-0.1	-0.1	-0.1
12/1/1989	-0.1	-0.1	-0.1
1/1/1990	-0.1	-0.1	-0.1
2/1/1990	-0.1	-0.1	-0.1
3/1/1990	0	0	0
4/1/1990	1.6	1.6	1.6
5/1/1990	3.1	3.1	3.1
6/1/1990	0.1	0.2	0.2
7/1/1990	0	0	0
8/1/1990	0	0	0
9/1/1990	0	0	0
10/1/1990	0	0	0
11/1/1990	-2.2	-2.2	-2.2
12/1/1990	-4.6	-4.6	-4.6
1/1/1991	-2.4	-2.4	-2.4
2/1/1991	-2.2	-2.2	-2.2
3/1/1991	-0.4	-0.4	-0.4
4/1/1991	6.9	6.9	6.9
5/1/1991	13.2	13.2	13.2
6/1/1991	5.7	5.7	5.7
7/1/1991	0	0	0
8/1/1991	0	0	0
9/1/1991	0	0	0
10/1/1991	0	0	0
11/1/1991	-1.3	-1.3	-1.3
12/1/1991	-4	-4	-4
1/1/1992	-2	-2	-2
2/1/1992	-1.9	-1.9	-1.9
3/1/1992	-0.3	-0.3	-0.3
4/1/1992	5.5	5.5	5.5
5/1/1992	12.4	12.4	12.4
6/1/1992	14.4	14.4	14.5
7/1/1992	2.9	3.1	3.1
8/1/1992	0.1	0.1	0.1
9/1/1992	0	0	0
10/1/1992	0	0	0
11/1/1992	-0.2	-0.2	-0.2
12/1/1992	-0.7	-0.7	-0.7
1/1/1993	-0.4	-0.4	-0.4
2/1/1993	-0.5	-0.5	-0.5
3/1/1993	-0.2	-0.3	-0.3
4/1/1993	7.8	10	10.6
5/1/1993	15.1	19.4	21.7
6/1/1993	17.4	21.5	26.7
7/1/1993	3.2	4.3	5.7
8/1/1993	0.3	0.3	0.4
9/1/1993	0.3	0.4	0.4

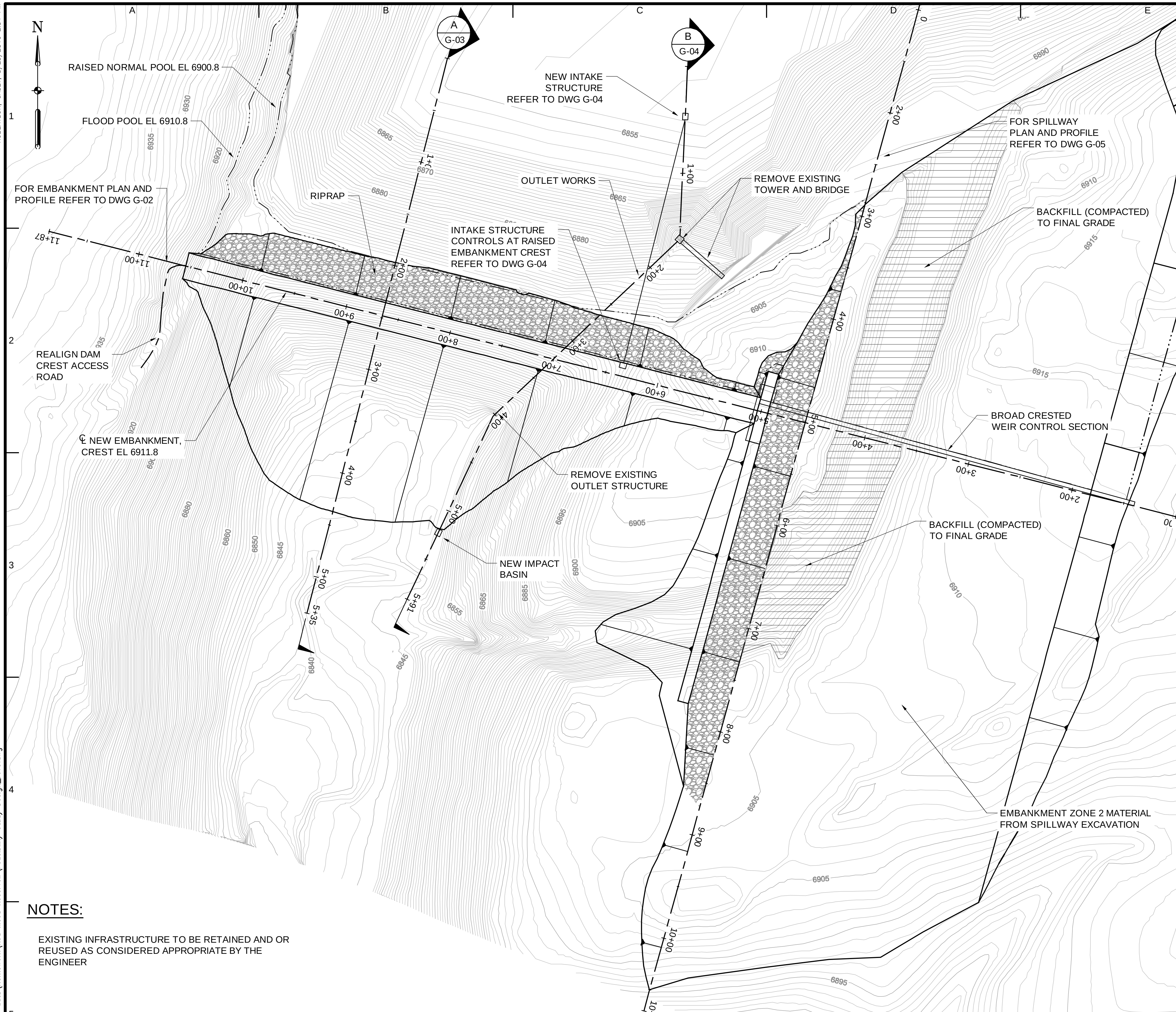
10/1/1993	0.1	0.1	0.2
11/1/1993	-2.6	-2.7	-2.8
12/1/1993	-4.8	-4.8	-4.9
1/1/1994	-2.6	-2.7	-2.7
2/1/1994	-2.6	-2.6	-2.7
3/1/1994	-0.4	-0.4	-0.4
4/1/1994	7.7	7.8	7.8
5/1/1994	15.1	15.4	15.5
6/1/1994	12.3	12.6	12.8
7/1/1994	0.3	0.3	0.5
8/1/1994	0	0	0
9/1/1994	0	0	0
10/1/1994	0	0	0
11/1/1994	0	0	0
12/1/1994	-0.3	-0.3	-0.3
1/1/1995	-1.5	-1.5	-1.5
2/1/1995	-2.1	-2.1	-2.1
3/1/1995	-0.1	-0.3	-0.3
4/1/1995	7.8	10	11.2
5/1/1995	15.1	19.3	21.7
6/1/1995	18.9	23.3	28.8
7/1/1995	7.5	9.7	12.9
8/1/1995	0.2	0.3	0.4
9/1/1995	0.2	0.3	0.4
10/1/1995	0.1	0.1	0.1
11/1/1995	-0.6	-0.7	-0.9
12/1/1995	-2.9	-3.1	-3.2
1/1/1996	-2.1	-2.1	-2.2
2/1/1996	-2.1	-2.1	-2.1
3/1/1996	-0.4	-0.4	-0.4
4/1/1996	5.8	5.9	5.9
5/1/1996	11.2	11.3	11.4
6/1/1996	3.5	3.6	3.8
7/1/1996	0	0	0
8/1/1996	0	0	0
9/1/1996	0	0	0
10/1/1996	0	0	0
11/1/1996	-0.3	-0.3	-0.3
12/1/1996	-4.6	-4.6	-4.6
1/1/1997	-3.2	-3.7	-3.7
2/1/1997	0	-2.1	-4.6
3/1/1997	0	0	0
4/1/1997	7.8	10	11.2
5/1/1997	15.1	19.4	21.7
6/1/1997	17.4	21.7	26.3
7/1/1997	4.6	6.2	7.7
8/1/1997	0.3	0.4	0.6
9/1/1997	1.2	1.2	1.3
10/1/1997	0.9	1	1
11/1/1997	-5	-5	-5.1
12/1/1997	-5.8	-7.8	-7.9
1/1/1998	0	-4.9	-5
2/1/1998	0	-0.7	-4.8
3/1/1998	0	0	-0.3
4/1/1998	7.8	10	11.2
5/1/1998	15	19.2	21.6
6/1/1998	10.2	13.5	17.5
7/1/1998	0.9	1.4	1.9
8/1/1998	0.1	0.2	0.2

9/1/1998	0	0	0.1
10/1/1998	0	0	0
11/1/1998	-2.7	-2.7	-2.7
12/1/1998	-4.4	-4.4	-4.4
1/1/1999	-2.2	-2.2	-2.2
2/1/1999	-2	-2	-2
3/1/1999	-0.3	-0.3	-0.3
4/1/1999	6.4	6.4	6.4
5/1/1999	12.4	12.4	12.4
6/1/1999	8.6	8.9	9.2
7/1/1999	0.9	0.9	0.9
8/1/1999	1.1	1.1	1.1
9/1/1999	0.9	0.9	1
10/1/1999	0.1	0.1	0.1
11/1/1999	-0.5	-0.5	-0.5
12/1/1999	-0.8	-0.9	-0.9
1/1/2000	-1.1	-1.1	-1.1
2/1/2000	-1.6	-1.6	-1.6
3/1/2000	-0.3	-0.3	-0.3
4/1/2000	4.5	4.5	4.5
5/1/2000	8.6	8.6	8.6
6/1/2000	2.4	2.6	2.6
7/1/2000	0.1	0.2	0.2
8/1/2000	0	0	0
9/1/2000	0	0	0
10/1/2000	0	0	0
11/1/2000	0	0	0
12/1/2000	-2.2	-2.2	-2.2
1/1/2001	-2.4	-2.4	-2.4
2/1/2001	-2.5	-2.5	-2.5
3/1/2001	-0.4	-0.4	-0.4
4/1/2001	7.6	7.6	7.6
5/1/2001	15.1	15.4	15.4
6/1/2001	7.8	8.1	8.1
7/1/2001	0.2	0.2	0.2
8/1/2001	0	0	0
9/1/2001	0	0	0
10/1/2001	0	0	0
11/1/2001	0	0	0
12/1/2001	0	0	0
1/1/2002	0	0	0
2/1/2002	-0.2	-0.2	-0.2
3/1/2002	0	0	0
4/1/2002	0.6	0.6	0.6
5/1/2002	1.2	1.2	1.3
6/1/2002	0	0	0
7/1/2002	0	0	0
8/1/2002	0	0	0
9/1/2002	0	0	0
10/1/2002	0	0	0
11/1/2002	0	0	0
12/1/2002	0	0	0
1/1/2003	-0.8	-0.8	-0.8
2/1/2003	-2	-2	-2
3/1/2003	-0.3	-0.3	-0.3
4/1/2003	4.8	4.8	4.8
5/1/2003	9.3	9.3	9.3
6/1/2003	2	2	2
7/1/2003	0	0	0

8/1/2003	0	0	0
9/1/2003	0	0	0
10/1/2003	0	0	0
11/1/2003	-0.4	-0.4	-0.4
12/1/2003	-1.4	-1.4	-1.4
1/1/2004	-0.7	-0.7	-0.7
2/1/2004	-0.6	-0.6	-0.6
3/1/2004	-0.2	-0.2	-0.2
4/1/2004	7.7	7.8	7.8
5/1/2004	15.1	15.7	15.7
6/1/2004	7.1	7.5	7.5
7/1/2004	0	0	0
8/1/2004	0	0	0
9/1/2004	0	0	0
10/1/2004	0	0	0
11/1/2004	-1	-1	-1
12/1/2004	-3.2	-3.2	-3.2
1/1/2005	-2.3	-2.3	-2.3
2/1/2005	-2.8	-2.9	-2.9
3/1/2005	0	-0.2	-0.3
4/1/2005	7.8	10	11.2
5/1/2005	15.1	19.4	21.7
6/1/2005	13.3	17.1	21.1
7/1/2005	0.5	0.8	1.5
8/1/2005	0	0	0
9/1/2005	0	0	0
10/1/2005	0	0	0
11/1/2005	-0.4	-0.4	-0.4
12/1/2005	-4.2	-4.2	-4.2
1/1/2006	-2.8	-2.8	-2.8
2/1/2006	-3	-3	-3
3/1/2006	-0.5	-0.5	-0.5
4/1/2006	7.2	7.3	7.3
5/1/2006	14	14	14
6/1/2006	5.2	5.2	5.2
7/1/2006	0	0	0
8/1/2006	0	0	0
9/1/2006	0	0	0
10/1/2006	0.7	0.7	0.7
11/1/2006	-4.3	-4.3	-4.3
12/1/2006	-4.9	-4.9	-4.9
1/1/2007	-2.6	-2.6	-2.6
2/1/2007	-2.5	-2.5	-2.5
3/1/2007	-0.2	-0.5	-0.5
4/1/2007	7.8	9.7	9.7
5/1/2007	15.1	18.8	18.8
6/1/2007	6.2	8.3	8.4
7/1/2007	0	0	0
8/1/2007	0	0	0
9/1/2007	0	0	0
10/1/2007	0	0	0
11/1/2007	-0.1	-0.1	-0.1
12/1/2007	-3.6	-3.7	-3.7
1/1/2008	-2.6	-2.6	-2.6
2/1/2008	-2.7	-2.7	-2.7
3/1/2008	-0.2	-0.4	-0.5
4/1/2008	7.8	10	11.2
5/1/2008	15.1	19.4	21.7
6/1/2008	10.6	13.9	17.9
7/1/2008	0.1	0.3	0.5
8/1/2008	0	0	0
9/1/2008	0	0	0
10/1/2008	0	0	0
11/1/2008	-0.9	-0.9	-0.9
12/1/2008	-3.3	-3.3	-3.3
1/1/2009	-2	-2	-2
2/1/2009	-2	-2	-2
3/1/2009	-0.3	-0.3	-0.3
4/1/2009	5.1	5.1	5.1
5/1/2009	9.9	9.9	9.9
6/1/2009	3.3	3.3	3.4
7/1/2009	0	0	0
8/1/2009	0	0	0
9/1/2009	0	0	0

Appendix H

Conceptual Drawings for Selected Alternative



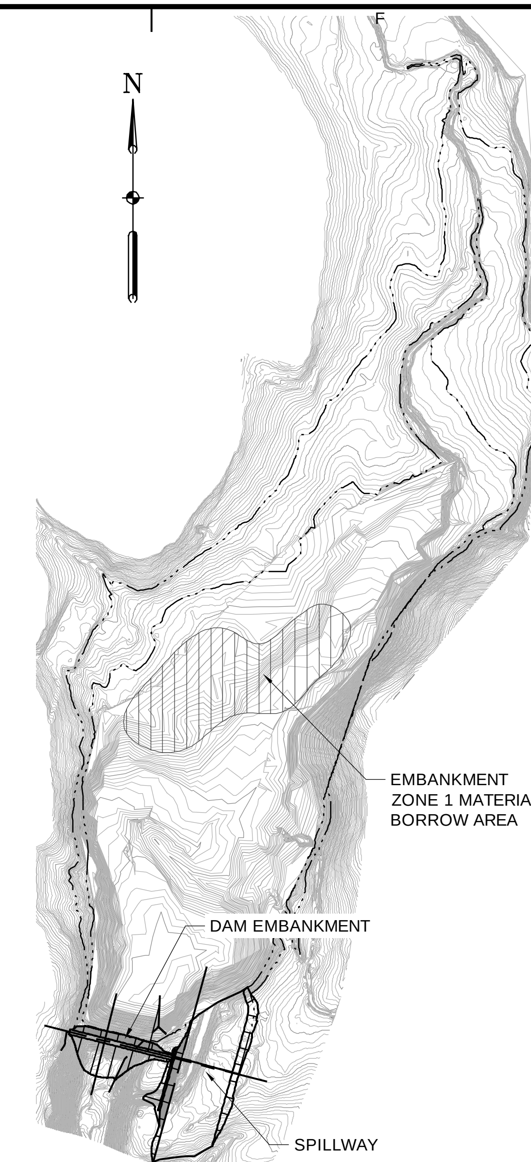
PLAN

0 50 100 150

SCALE IN FEET

NOTES:

EXISTING INFRASTRUCTURE TO BE RETAINED AND OR REUSED AS CONSIDERED APPROPRIATE BY THE ENGINEER



PLAN - BORROW

0 500 1000 1500

SCALE IN FEET

CONCEPTUAL
NOT FOR CONSTRUCTION

URS
8181 East Tufts Avenue
Denver, Co. 80237-2579
303 694-2770 (phone)
303-694-3946 (fax)

RED MESA RESERVOIR ENLARGEMENT

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

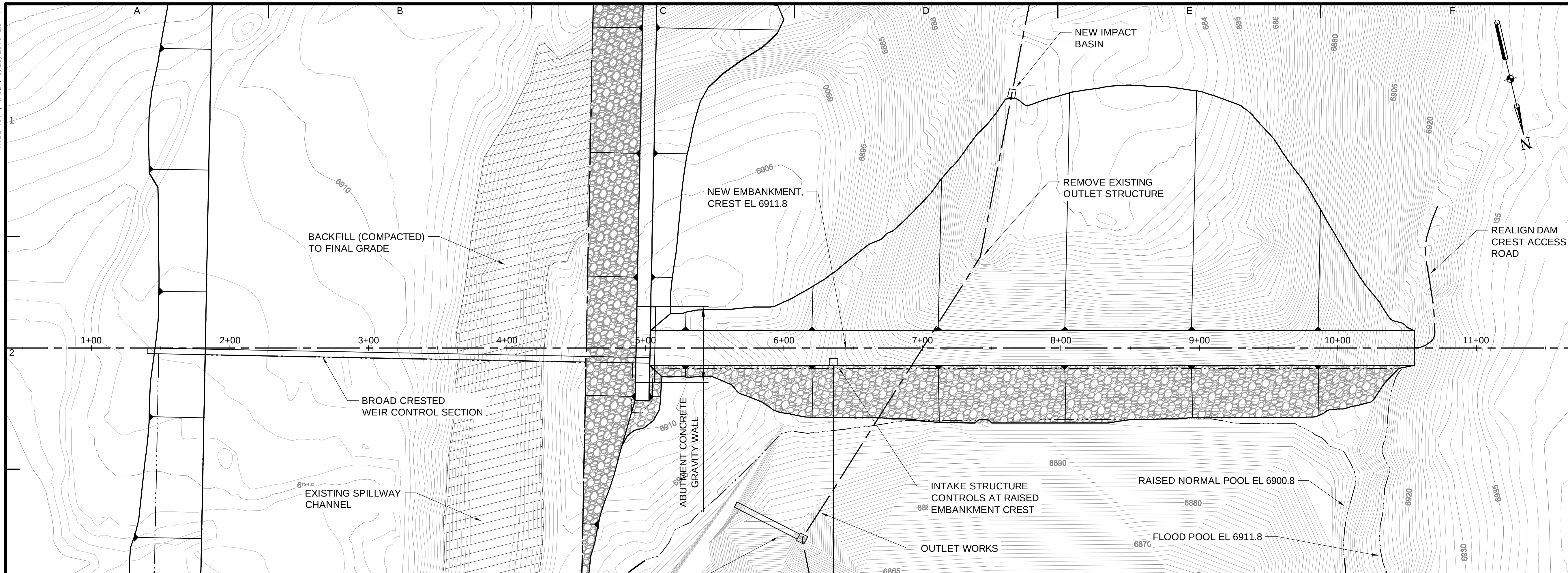
AECOM PROJECT NO:	22244294
DRAWN BY:	
DESIGNED BY:	
CHECKED BY:	
DATE CREATED:	3/2016
PLOT DATE:	3/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

GENERAL ARRANGEMENT PLAN

G-01

SHEET 1 OF -

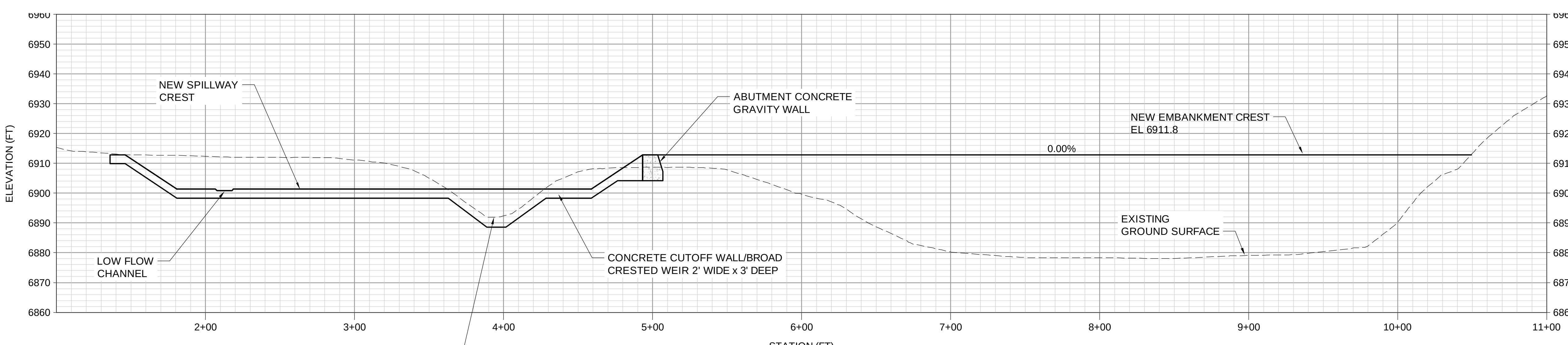


PLAN

SCALE IN FEET: 0, 40, 0, 120

NOTES:

1. --



PROFILE

SCALE IN FEET (HORIZONTAL): 0, 40, 80, 120

SCALE IN FEET (VERTICAL): 0, 20, 40, 60

NOTES:

1. CREST CAMBER NOT SHOWN.
2. EXCAVATION NOT SHOWN.

CONCEPTUAL
NOT FOR CONSTRUCTION

URS
8181 East Tufts Avenue
Denver, Co. 80237-2579
303 694-2770 (phone)
303-694-3946 (fax)

RED MESA RESERVOIR ENLARGEMENT

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

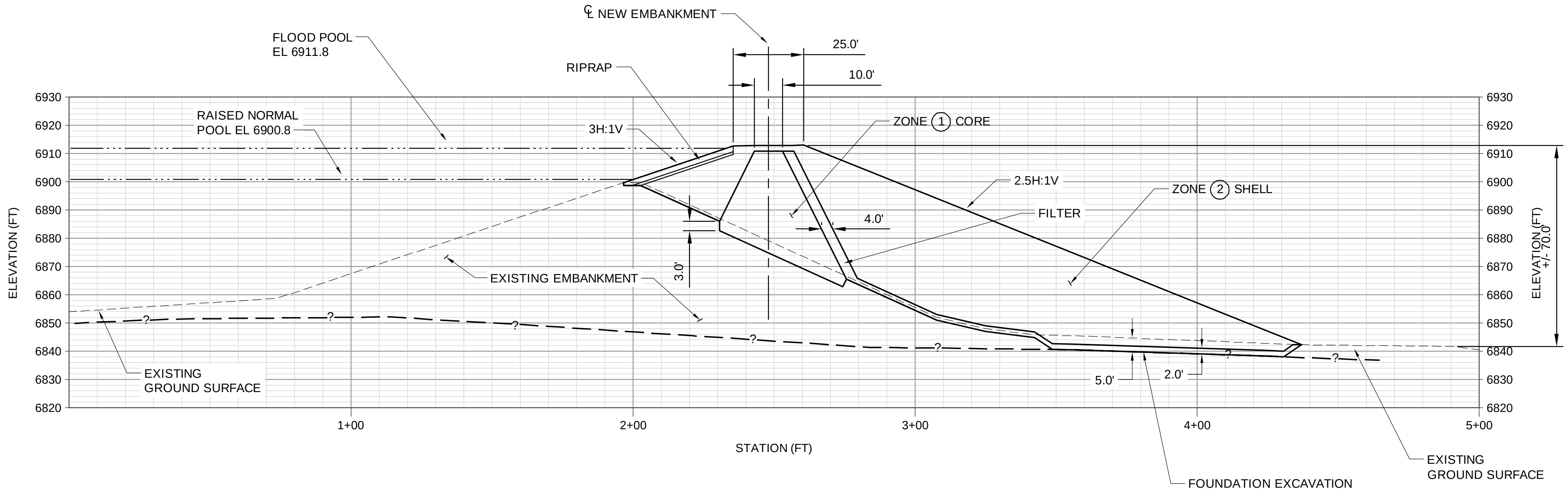
AECOM PROJECT NO:	22244294
DRAWN BY:	
DESIGNED BY:	
CHECKED BY:	
DATE CREATED:	3/2016
PLOT DATE:	3/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

EMBANKMENT PLAN AND PROFILE

G-02

SHEET 2 OF -



SECTION A / G-01

CONCEPTUAL
NOT FOR CONSTRUCTION

URS
8181 East Tufts Avenue
Denver, Co. 80237-2579
303 694-2770 (phone)
303-694-3946 (fax)

RED MESA RESERVOIR ENLARGEMENT

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

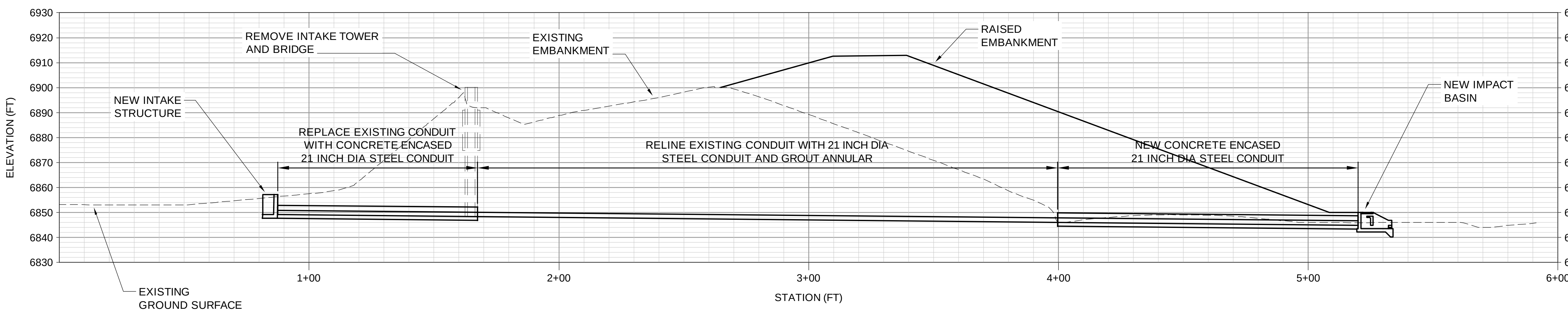
AECOM PROJECT NO:	22244294
DRAWN BY:	
DESIGNED BY:	
CHECKED BY:	
DATE CREATED:	3/2016
PLOT DATE:	3/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

EMBANKMENT SECTION

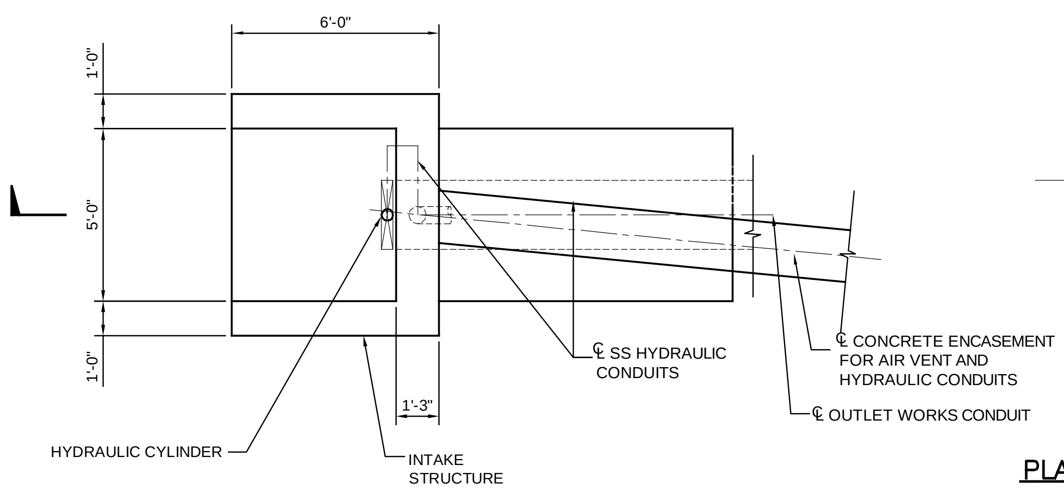
G-03

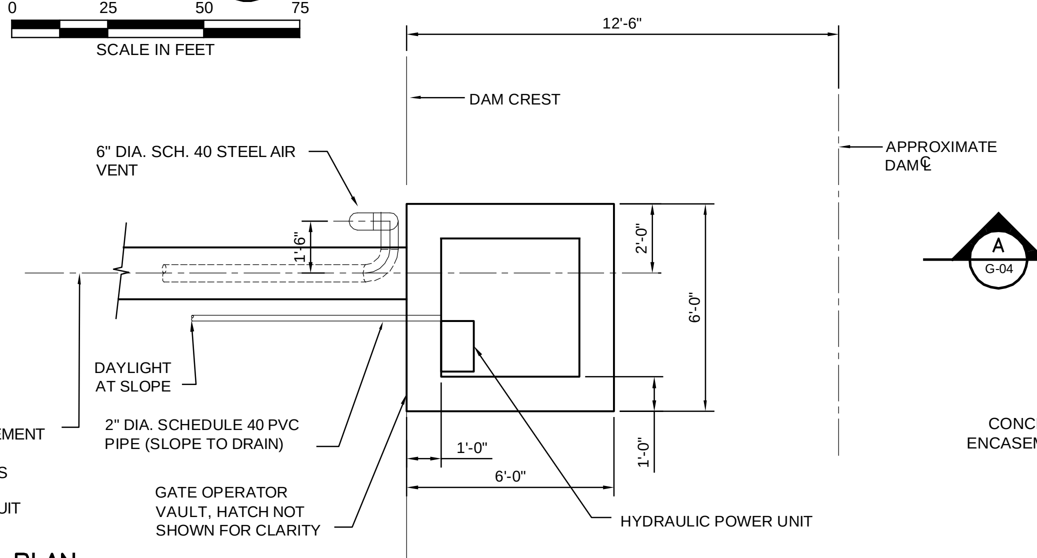
SHEET 3 OF -



SECTION B G-01

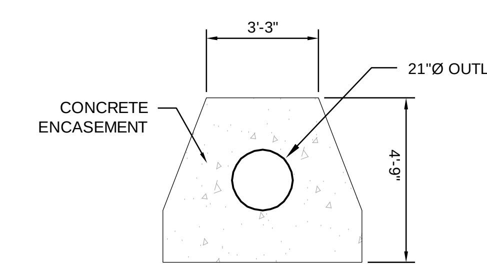
0 25 50 75
SCALE IN FEET



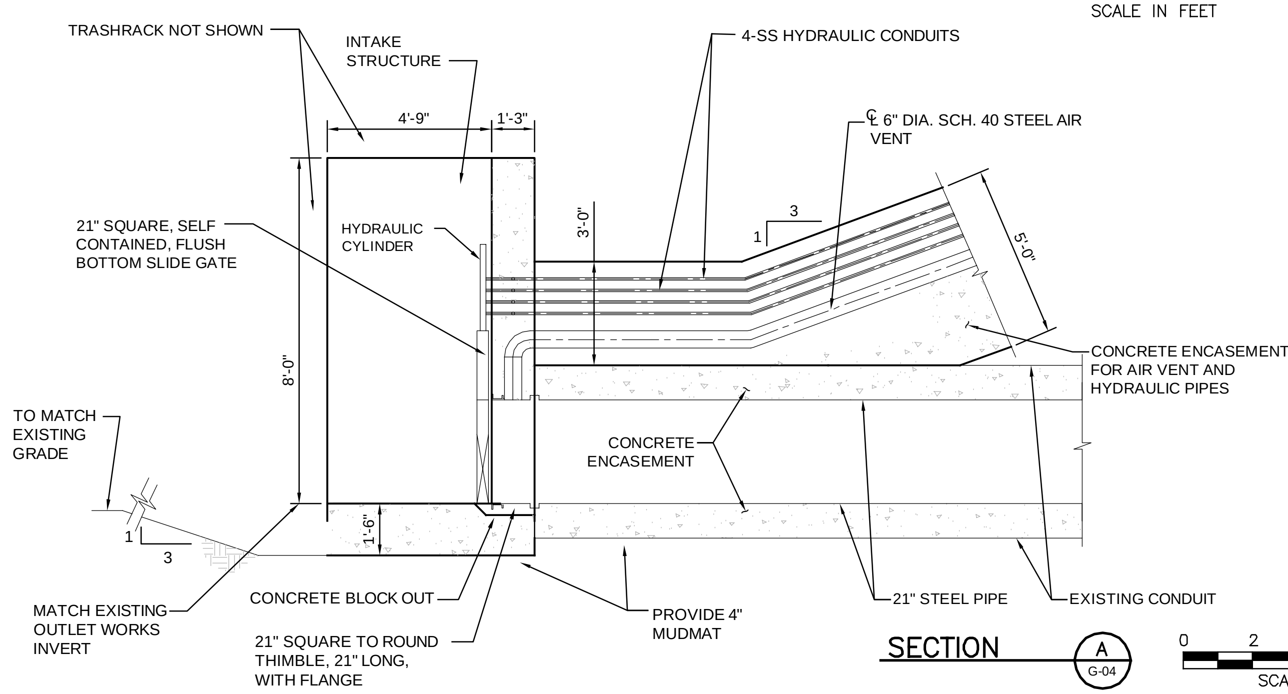


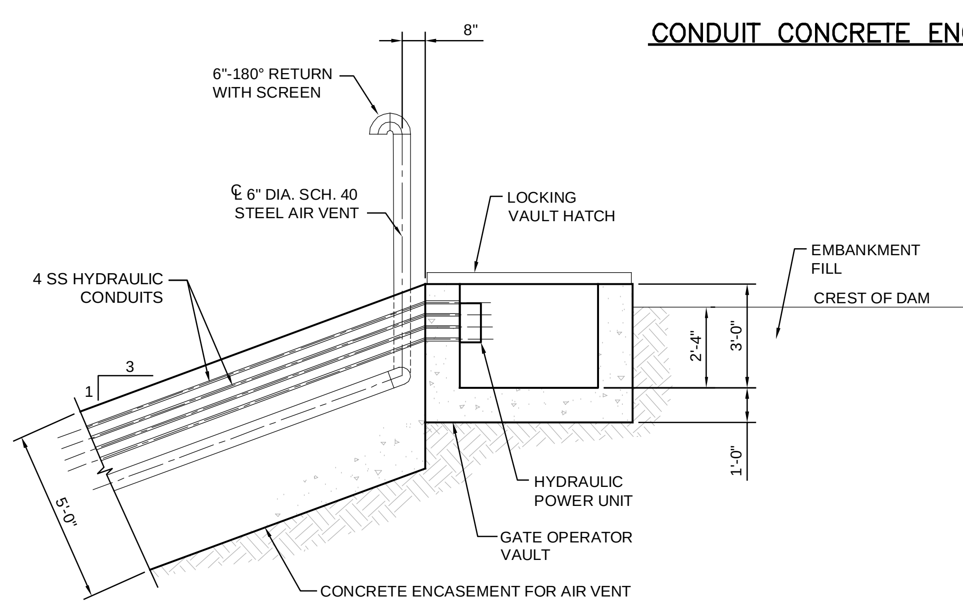
PLAN

0 2 4 8
SCALE IN FEET



CONDUIT CONCRETE ENCASEMENT





SECTION A G-04

0 2 4 8
SCALE IN FEET

CONCEPTUAL
NOT FOR CONSTRUCTION

URS
8181 East Tufts Avenue
Denver, Co. 80237-2579
303 694-2770 (phone)
303-694-3946 (fax)

RED MESA
RESERVOIR
ENLARGEMENT

ISSUED FOR BIDDING DATE BY

ISSUED FOR CONSTRUCTION DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

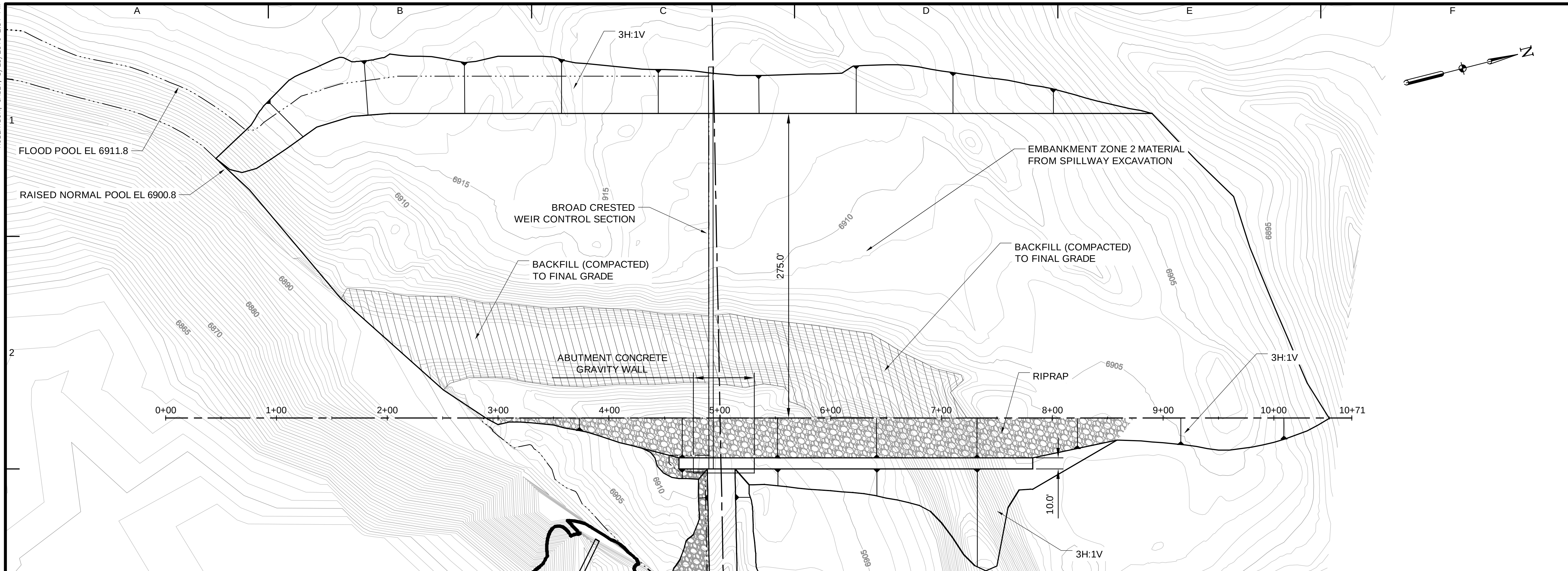
AECOM PROJECT NO:	22244294
DRAWN BY:	
DESIGNED BY:	
CHECKED BY:	
DATE CREATED:	3/2016
PLOT DATE:	3/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

OUTLET WORKS

G-04

SHEET 4 OF -

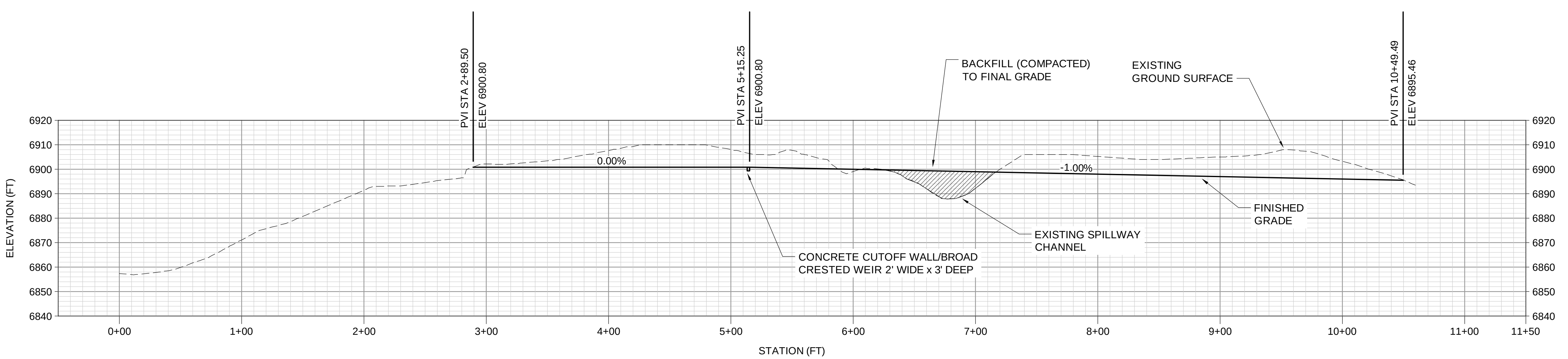


PLAN

0 50 100 150
SCALE IN FEET

NOTES:

1. --



PROFILE

0 50 100 150
SCALE IN FEET (HORIZONTAL)

0 25 50 75
SCALE IN FEET (VERTICAL)

NOTES:

1. --

CONCEPTUAL
NOT FOR CONSTRUCTION

URS
8181 East Tufts Avenue
Denver, Co. 80237-2579
303 694-2770 (phone)
303-694-3946 (fax)

RED MESA
RESERVOIR
ENLARGEMENT

ISSUED FOR BIDDING DATE BY

ISSUED FOR CONSTRUCTION DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

AECOM PROJECT NO:	22244294
DRAWN BY:	
DESIGNED BY:	
CHECKED BY:	
DATE CREATED:	3/2016
PLOT DATE:	3/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

SPILLWAY PLAN
AND PROFILE

G-05

SHEET 5 OF -

Appendix I

Geotechnical Investigation Report

GEOTECHNICAL INVESTIGATION REPORT

RED MESA RESERVOIR

LA PLATA COUNTY, COLORADO

WATER DIVISION 7
WATER DISTRICT 33

DAM ID 330105

Prepared for

Red Mesa Reservoir and Ditch Company
7882 County Road 100
Hesperus, CO 81326

March 2015

Prepared By:

AECOM

8181 East Tufts Avenue
Denver, Colorado 80237

Project No. 22244294

TABLE OF CONTENTS

Tables

Figures

A geotechnical investigation was completed for Red Mesa Reservoir, located about 16 miles southwest of Durango, Colorado. This report presents a summary of the field investigation, results of laboratory testing, and conclusions and recommendations regarding the feasibility of a proposed spillway widening and establishing a potential borrow source.

1.1 PROJECT BACKGROUND

Red Mesa Reservoir is located on Hay Gulch in La Plata River drainage and is owned by Red Mesa Reservoir and Ditch Company (Red Mesa). The reservoir, which is used for irrigation, is filled using natural inflows from Hay Gulch and flows diverted from the La Plata River via a canal.

The Colorado State Engineer has identified the spillway at Red Mesa Dam as seriously deficient in flood routing capacity and has directed the owners to bring the spillway into compliance with the dam safety requirements for a high hazard dam, or face significant restriction of storage, up to and including a possible breach order. Because of the degree of current spillway inadequacy, the State Engineer's Office in 2012 established a time frame of approximately 3 years to achieve compliance with their spillway requirements.

Using the results of the previous studies and this geotechnical investigation report, Red Mesa issued notice to proceed for the preparation of a Feasibility Study which would be used to obtain funding for design and construction of the necessary improvements to bring the spillway into compliance with the requirements of the Colorado State Engineer and possibly add storage capacity to the reservoir.

1.2 SCOPE OF THE GEOTECHNICAL INVESTIGATIONS

URS submitted a proposal dated February 26, 2014 to Red Mesa for conducting a Water Project Loan Feasibility Study. The feasibility study included a feasibility level geotechnical investigation to investigate subsurface conditions within the general extent of the proposed spillway widening and evaluate a potential borrow source for the dam raise.

1.3 GEOTECHNICAL INVESTIGATIONS

The field investigation consisted of drilling test holes in the proposed spillway widening adjacent to the left abutment and excavating test pits in the reservoir area. The test pits were excavated on December 10, 2014.

During the site reconnaissance for the test pits, a gas pipeline was identified to be running through the area of the proposed spillway widening. This discovery delayed test hole drilling until the owner of the pipeline was identified and the locate request was completed. The test holes were drilled on January 8, 2015. Soil samples were obtained from the test holes and test pits for laboratory testing.

2.1 SITE DESCRIPTION

Red Mesa Reservoir area generally consists of farm land and pasture land. During the geotechnical investigations, the water level in Red Mesa Reservoir ranged from El. 6867.9 (12/10/14) to 6870.7 ft (1/8/15) according to the Colorado Division of Water Resources station data.

In the late 1970's and early 1980's the surrounding area was developed by natural gas companies. Natural gas drill pads were developed and several pipelines were installed along right of way easements. During the natural gas development in the surrounding area, a drill pad was developed near the west side of the reservoir. A right of way easement was made for a pipeline to run from the drill pad downstream of the dam and up the left abutment along the outside edge of the existing spillway to a nearby hydrogen sulfide plant. During site reconnaissance and test hole layout, Carsonite pipeline markers were observed within the area indicating a gas pipeline belonging to Western Gas Resources, Inc. Following several contacts with natural gas entities in southwest Colorado and northwest New Mexico, presently, the owner of the pipeline was identified to be The Williams Companies, Inc (Williams).

Based on phone conversations with Jodi Armenta (an employee of Williams),the pipeline may be considered abandoned and the steel pipe is likely of limited value due to corrosion. A letter from Williams documenting the pipeline status will need to be obtained prior to any future construction in the spillway area.

2.2 FIELD INVESTIGATIONS

Twelve (12) tests pits were excavated on December 10, 2014 and four (4) test holes were drilled on January 8, 2015 by Trautner Geotech LLC under subcontract to URS.

2.2.1 Test Pits

The test pits were excavated within the reservoir using a Bobcat E50 mini excavator. Test pit locations are shown on Figure 1.The test pits were logged by a URS geotechnical engineer. Subsurface samples were collected and retained for laboratory testing. The depth to ground water during excavation was recorded. Upon completion, the test pits were backfilled with the excavated soil to the ground surface and compacted with the mini excavator bucket.

2.2.2 Test Holes

The test holes were drilled using a track-mounted CME-45 rotary drill rig. Test hole locations are shown on Figure 1.The test holes were drilled using a continuous flight solid stem auger. The subsurface soil samples were collected using a 2-inch outside diameter 18-inch standard split spoon sampler driven using a 140-pound drop hammer falling 30inches. Standard Penetration Tests (SPT) were used to measure soil consistency and density in general accordance with ASTM Method D1586. The penetration resistance was recorded as the number of hammer drops required to drive the sampler three consecutive 6-inch intervals, with the blow count (N value) reported being the sum of the recorded hammer drops for the last two 6-inch drive intervals.

SPT samples were collected generally at material transitions observed during drilling. The test holes were advanced to depths ranging from 31.5 to 59.0 feet below ground surface (bgs). The test holes were logged by a URS geotechnical engineer as the samples were collected and retained in sealed bags. The ground water depth during drilling was recorded. After completion of the drilling operation, the test holes were backfilled to the ground surface with auger cuttings.

3.1 LABORATORY TESTING

The samples collected during the field investigations were logged, labeled, and delivered to Advanced Terra Testing, Inc. in Lakewood, CO under subcontract to URS for laboratory testing. Index and engineering property tests were conducted on selected representative samples to aid in classification and evaluation of engineering properties for use in the feasibility study. Laboratory tests were performed on reservoir and left abutment samples. The following tests were performed:

- Water content (ASTM D2216);
- Gradation sieve analysis (ASTM D6913);
- Hydrometer testing (ASTM D422);
- Atterberg limits (ASTM D4318);
- Pinhole tests (ASTM D4647); and
- Compaction tests (ASTM D698).

Laboratory test results are described below and are summarized in Table 1. Laboratory data is provided in Appendix A. Water content measurements were performed during the course of grain size analyses and Atterberg testing and are included in Appendix A, however, these tests were performed on soil samples that were not sealed and had dried over a period of about one month before laboratory testing was performed. Caution should be exercised in using these results.

3.2 SUBSURFACE SOILS

The subsurface soils within the reservoir area generally consist of a thin layer of deposited silt, underlain by alternating layers of clay, gravel, and sand, and underlain by sandstone bedrock. The subsurface soils within the area of the proposed spillway widening generally consist of a thick layer of gravel, underlain by alternating layers of clay, sand, and gravel, underlain by sand, and then by sandstone bedrock.

Five soil types were encountered, as generalized from information collected from the 4 test holes and 12 test pits. They consist of silt (ML), gravel (GW,GP, GW-GP, GC), sand (SC, SM), clay (CL), and sandstone bedrock. Other than the silt, which was found only in the reservoir test pits, all of the soil types were encountered in the test holes and test pits.

Graphical representations of the subsurface soils in the reservoir and near the spillway are shown on Figure 2.

3.2.1 Clay (CL, CL-ML)

The clay in the test pits and test holes ranges in thickness from 1.0 to 10.5 feet. The clay is slightly silty to silty, with occasional cobbles, dry to saturated, and light gray to brown to brown-red to red-orange. The clay is soft to very stiff with generally low plasticity. Measured N values were 22 blows per foot (bpf).

Six samples of clay obtained from TP-1, TP-4, TP-5, TP-7, and TP-10 had liquid limits ranging from 31 to 35 percent and plasticity indices ranging from 17 to 21 percent. One sealed sample had a water content of 35 percent. The samples had gravel contents ranging from 0 to 18 percent, sand content ranging from 12 to 30 percent, and fines content ranging from 54 to 88 percent.

Two samples of sand obtained from BH-1 and BH-3 had liquid limits of 22 and 30 percent and plasticity indices of 8 and 18 percent, respectively. The samples had gravel contents of 8 and 3 percent, sand content of 60 and 22 percent, and fines content of 32 and 76 percent, respectively.

Composite Sample – TP-4 and TP-5

These two samples from the test pits were selected as a composite based on the similarity of the clay, quantity of available clay, and relative location within the reservoir. The composite sample had a liquid limit of 36 and plasticity index of 24. The sample had gravel content of 0 percent, sand content of 9 percent, and fines content of 90 percent. The pinhole test indicated ND1, nondispersive clay with no colloidal erosion. The standard proctor compaction test indicated an optimum moisture content of 16.7 percent and a maximum dry density of 111.2 pounds per cubic foot (pcf).

Composite Sample – TP-7, TP-9, and TP-10

These three samples from the tests pits were selected as a composite based on the similarity of the clay and relative location within the reservoir. The composite sample had a liquid limit of 29 and plasticity index of 14. The sample had gravel content of 11 percent, sand content of 26 percent, and fines content of 63 percent. The pinhole test indicated ND2, nondispersive clay with very slight colloidal erosion. The standard proctor compaction test indicated an optimum moisture content of 13.0 percent and a maximum dry density of 118.0 pounds per cubic foot (pcf).

3.2.2 Silt (ML)

The silt found in the test pits was about 0.3 to 5 feet thick. The silt is slightly clayey to clayey, with slight gravel, occasional cobbles, dry to moist, and tan to brown to orange. The silt is soft to medium stiff with low to medium plasticity.

One sample of silt obtained from TP-9 was non-plastic. The sample had gravel content of 0 percent, sand content of 46 percent and fines (silt and clay) content of 54 percent.

3.2.3 Sand (SC)

The sand in the test pits and test holes ranges in thickness from 1.5 to 33 feet. The sand is silty, clayey, with occasional to frequent cobbles, slightly moist, and tan to brown to red-brown. The sand is medium dense to very dense with low plasticity. Measured N values were 27 bpf.

One sample of sand obtained from BH-1 had a liquid limit of 22 percent and plasticity index of 8 percent. The sample had gravel content of 8 percent, sand content of 60 percent, and fines content of 32 percent.

3.2.4 Gravel (GW, GP, GW-GP, GC)

The gravel in the test pits and test holes ranges in thickness from 1.5 to 30 feet. The gravel is sandy, slightly clayey to clayey with occasional to frequent cobbles, dry, and brown to red. The gravel is dense to very dense. Measured N values were greater than 50 blows per foot (bpf).

One sample of gravel obtained from TP-6 had a significant content of clay fines, having a liquid limit of 34 percent and a plasticity index of 21 percent. The sample had gravel content of 32 percent, sand content of 18 percent, and fines content of 50 percent, and classified as a GC.

No laboratory tests were performed on the gravel samples from the test holes. Generally, the split spoon samples had insufficient sample quantities due to the gravel size.

3.2.5 Sandstone (Bedrock)

Sandstone bedrock was encountered in the bottom of test holes BH -2 and BH-4 at a depth of 50 and 30 feet bgs, respectively. Sandstone bedrock was encountered in the bottom of test pits TP-8 and TP-12 at depths of 8.0 and 5.0 feet bgs, respectively. The sandstone is hard to very hard, slightly silty and dry. Practical auger and mini-excavator refusal was found in the test holes and test pits that encountered sandstone bedrock.

No laboratory tests were performed on the sandstone bedrock samples.

3.3 GROUND WATER

Ground water levels, based on observations during drilling and excavation operations, was encountered in only BH-1 at a depth of 39 feet bgs and in the test pit excavations at depths ranging from 1 to 7.5 feet bgs. The ground water in the test pits reflected the reservoir level.

4.1 CONCLUSIONS

4.1.1 Borrow Area

The laboratory tests on the composite samples indicate that the soil ranges from sandy lean clay to lean clay and would likely be suitable as a clay borrow source. Testing indicates that the samples are nondispersive. However, the moisture content of 35 percent (TP-5) from a sealed sample bag indicates that the clay in TP-5 and near the stream channel are about 18 percent higher than optimum (16.7 percent moisture content). Due to the proximity of TP-4 and TP-5 to the stream in Hay Gulch, it is unlikely that this area of soils would dry out quickly after construction dewatering. The moisture contents from the Atterberg test of soil from an unsealed sample bag of the composite of TP-7, TP-9, and TP-10 indicate an average of 14.6 percent. The in-place moisture content appears to be closer to the optimum moisture content of 13.0 percent.

Large rainstorms, extended periods of drought, and inundation by the reservoir will change the moisture content of the soil. Generally, the soil near the Hay Gulch stream will typically be above the optimum moisture content and likely require drying if used as a borrow source.

4.1.2 Left Abutment Area

Drilling observations indicate that the sandy gravel in the proposed spillway widening area may be a suitable borrow source for embankment shell material. The high blow counts in the test holes are indicative of dense gravel and the rock flour from the drilling process indicates the presence of frequent cobbles in the dense gravel.

4.2 RECOMMENDATIONS

Drilling methods for this geotechnical investigation consisted of using a solid stem auger and drilling as many holes as possible in a single day of investigations. After the first test hole, penetration resistance testing and split-spoon sampling in the gravel and cobbles were largely terminated due to the high density of the material and the inability of the split-spoon sampler to obtain useful data and samples from the soil layer.

Based on the results of the test pit excavations and laboratory testing, the clay in the reservoir area appears to be a suitable borrow source for the embankment. Based on the drilling performed in the area of the proposed spillway widening and the assumption that the spillway will not be founded on bedrock, the spillway excavation should be able to be performed with conventional equipment, including excavators and dozers. The embankment and spillway design will largely depend on results of the erodibility, settlement, seepage, and stability results that are typically performed during the design process.

Once detailed engineering and design is pursued, additional subsurface investigations should be considered throughout the extents of the spillway area and on the dam slopes. Drilling and rock coring should be performed with a truck mounted drill rig with hollow stem augers to provide the best quality data. Test pits should be excavated in the spillway area and samples should be collected and laboratory tested to characterize the gravel and cobble layers.

Although phone conversations with Williams indicates that the gas pipeline that runs through the proposed widened spillway area is effectively abandoned, documentation from Williams indicating the status of the pipeline and permission to excavate and remove is pending. Documentation will need to be reviewed and accepted by Red Mesa Reservoir and Ditch Company.

Professional judgments, analyses, and evaluations are presented in this report. They are based partly on information gathered from previous investigations and laboratory testing; partly on published values for similar materials; and partly on our experience with similar projects. The subsurface conditions are known only at the test hole locations and may vary substantially from conditions at other locations and from the descriptions documented in previous project reports. We do not guarantee the performance of this project, only that our engineering work and judgments rendered meet the standard of care of our profession.

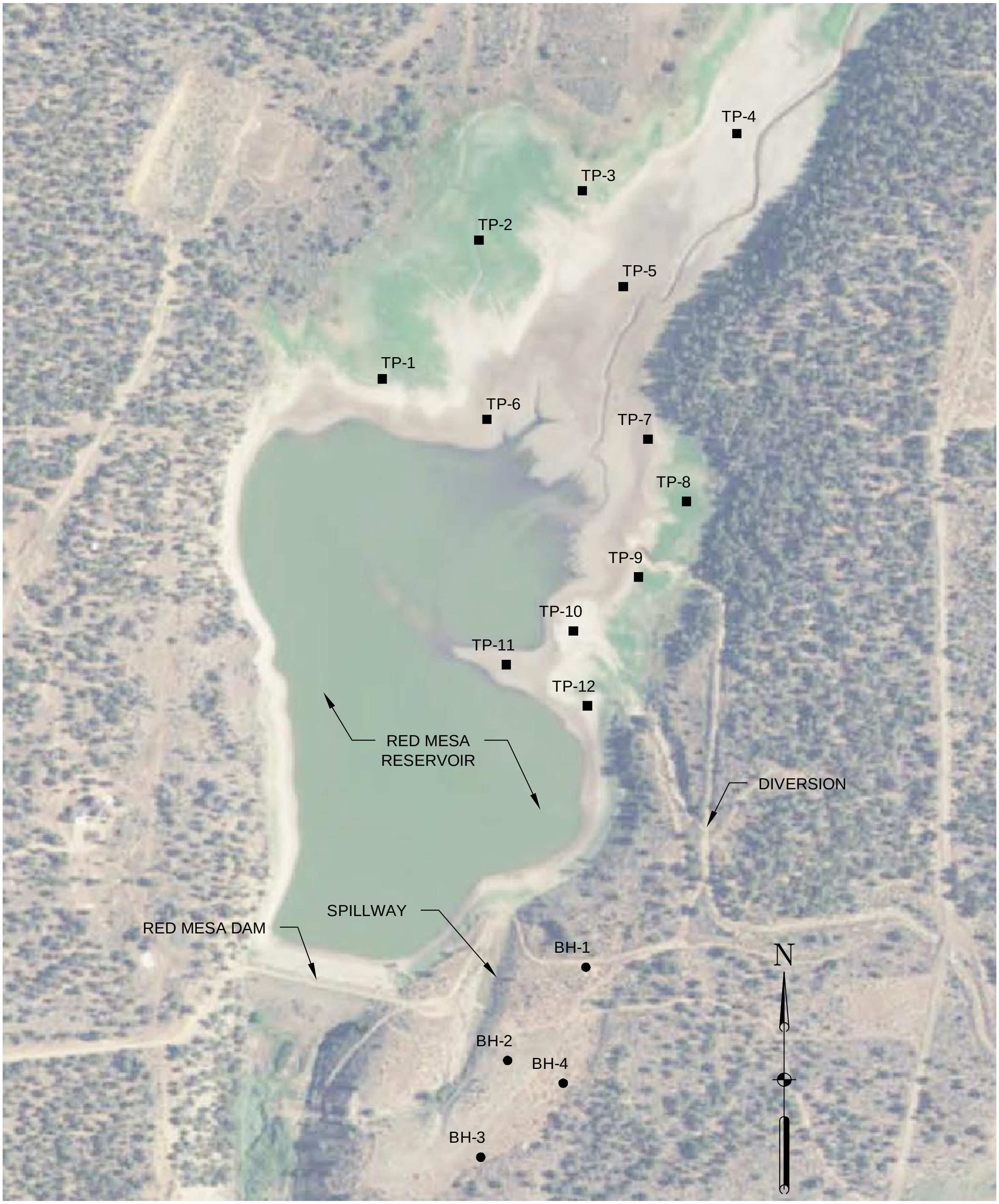
URS represents that our services were performed within the limits prescribed under the contract for this project, in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation, expressed or implied, and no other warranty or guarantee is included or intended.

Table 1

Summary of Laboratory Test Results

Test Hole or Test Pit	Sample Number	Depth (feet)	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index[2]	Gravel Size Fraction (%)	Sand Size Fraction (%)	Fines Content (-No. 200 Sieve)	USCS Symbol	Pinhole Test (Dispersivity)	Standard Proctor Compaction Test	
												Optimum Moisture Content (%)	Maximum Dry Density (pcf)
Reservoir Test Pits													
TP-1	S1	0.5-7.5	-	34	13	21	0.3	13.5	86.2	CL	-	-	-
TP-1	S2	7.5-9.0	-	32	13	19	0	30.2	69.8	CL	-	-	-
TP-4	S1	0-5.0	-	35	14	21	0.2	12.3	87.5	CL	-	-	-
TP-5	S1	1-10.5	35.0										
TP-6[1]	S2	2.0-8.0	-	34	13	21	32.3	17.9	49.8	GC	-	-	-
TP-7	S1	0.5-5.0	-	32	13	19	11.8	23.6	64.6	CL	-	-	-
TP-9	S1	0.5-5.0	-	NP[2]	NP[2]	NP[2]	0	45.9	54.1	ML	-	-	-
TP-10	S2	7.5-10.0	-	31	14	17	17.8	28.0	54.2	CL	-	-	-
Composite Test Pit Samples													
TP-4, 5	-	-	-	36	12	24	0.4	9.3	90.3	CL	ND1	16.7	111.2
TP-7, 9, 10	-	-	-	29	15	14	11.0	26.1	62.9	CL	ND2	13.0	118.0
Spillway Test Hole Samples													
BH-1	S5	19.5-23.0	-	22	14	8	7.5	60.2	32.3	SC	-	-	-
BH-2	S1	12.0	-	25	18	7	1.1	30.8	68.1	CL-ML	-	-	-
BH-3	S1	12.5	-	30	12	18	2.7	21.6	75.7	CL	-	-	-

1. Insufficient sample size to meet ASTM D6913 standard.
2. NP denotes non-plastic.



NOTES:

1. TEST HOLES AND TEST PITS LOCATIONS ARE APPROXIMATE.
2. AERIAL IMAGE IS FROM A GEOPDF OF THE USGS 7.5 MINUTE MAP FOR MORMON RESERVOIR, COLORADO.

LEGEND:

■ TP-1 TEST PIT

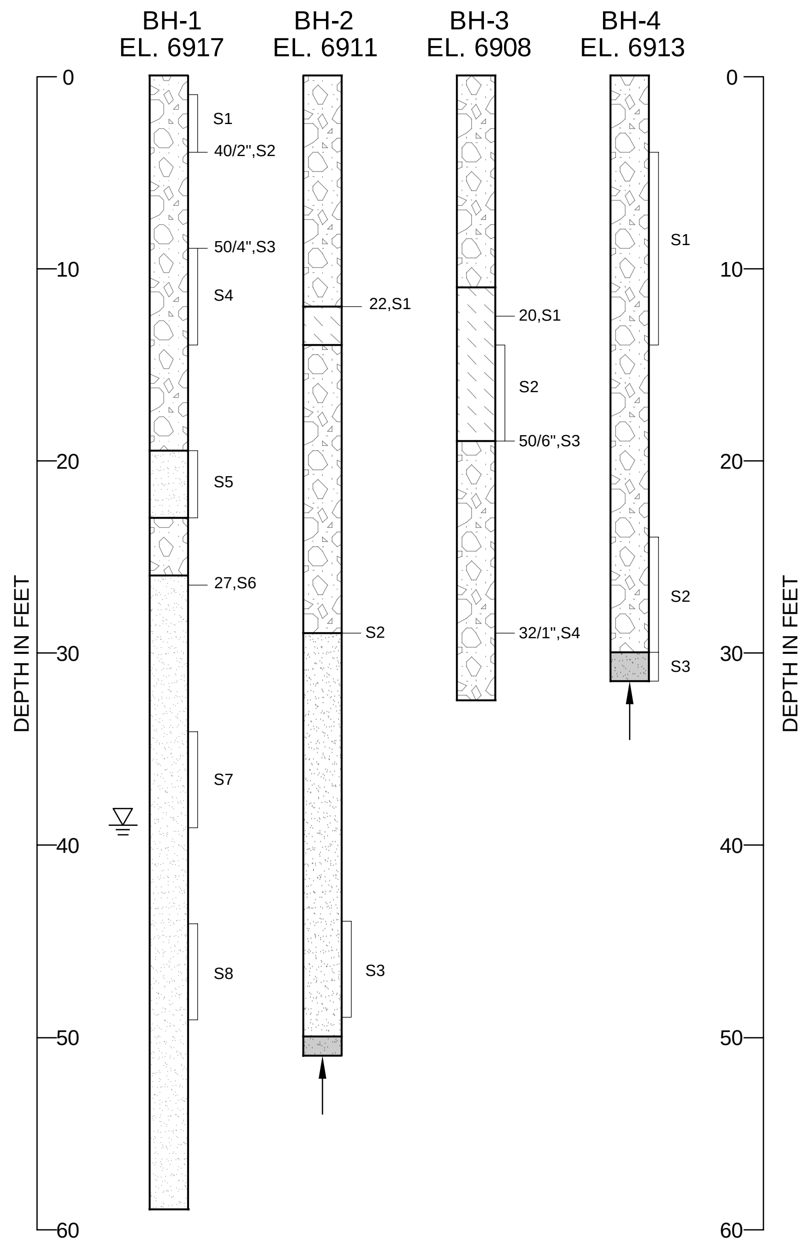
● BH-1 TEST HOLE

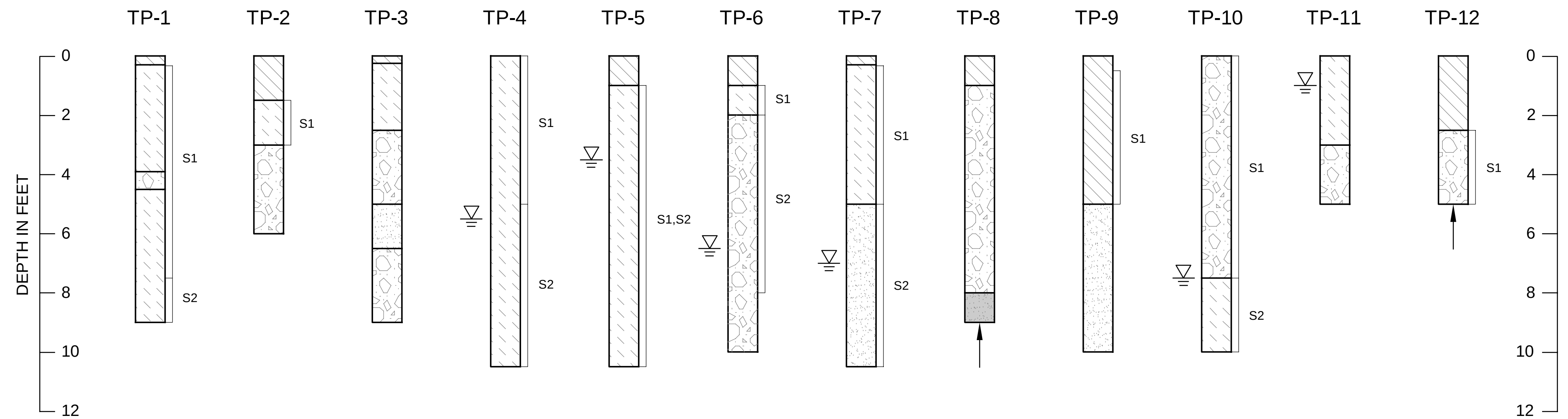
0 600 1200

SCALE IN FEET

Job No. : 22244294	RED MESA RESERVOIR LOCATION OF TEST HOLES AND TEST PITS
Prepared by : DJS	
Date : 2/26/15	

FIG. 1





LEGEND

- CLAY, SOFT TO VERY STIFF, SLIGHTLY SILTY TO SILTY, SANDY, SLIGHT GRAVEL, OCCASIONAL COBBLES, DRY TO SATURATED, LOW TO HIGH PLASTICITY, LIGHT GRAY TO RED-BROWN TO BROWN TO RED-ORANGE, (CL, CL-ML); (ALLUVIUM)
- SILT, SOFT TO MEDIUM STIFF, SLIGHTLY CLAYEY TO CLAYEY, SLIGHT GRAVEL, OCCASIONAL COBBLES, SOME ORGANICS, NON PLASTIC, DRY TO MOIST, TAN, BROWN, ORANGE, (ML)
- SAND, MEDIUM DENSE TO VERY DENSE, CLAYEY, SLIGHTLY MOIST, LOW PLASTICITY, OCCASIONAL TO FREQUENT COBBLES, BROWN, TAN, RED-BROWN, (SC, SM); (ALLUVIUM)
- GRAVEL, DENSE TO VERY DENSE, SANDY, SLIGHTLY CLAYEY TO CLAYEY, OCCASIONAL TO FREQUENT COBBLES, DRY, BROWN, RED, (GW, GP, GW-GP); (ALLUVIUM)
- SANDSTONE, HARD TO VERY HARD, DRY, RED-BROWN (BEDROCK)
- GROUNDWATER LEVEL ENCOUNTERED DURING DRILLING OR EXCATION
- 40/2" — INDICATES THAT 40 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2-INCH DIAMETER SPLIT BARREL SAMPLER 2 INCHES
- 27 — INDICATES THAT 27 BLOWS OF A 140-POUND HAMMER FALLING 30-INCHES WERE REQUIRED TO DRIVE A 2-INCH DIAMETER SPLIT BARREL SAMPLER 12 INCHES
- INDICATES PRACTICAL AUGER OR MINI-EXCAVATOR REFUSAL
- S1 — BAG SAMPLE COLLECTED OVER INTERVAL
- S1 — BAG SAMPLE COLLECTED AT DISCRETE DEPTH

NOTES:

1. TEST HOLES IN THIS GEOTECHNICAL INVESTIGATION WERE DRILLED ON JANUARY 8, 2015 BY TRAUTNER GEOTECH, LLC. OF DURANGO, COLORADO USING SOLID STEM AUGERS POWERED BY A CME-45 TRACK MOUNTED DRILL RIG. TEST PITS WERE EXCAVATED ON DECEMBER 10, 2014 BY TRAUTNER GEOTECH, LLC. USING A BOBCAT E50 MINI-EXCAVATOR.
2. TEST HOLE AND TEST PIT LOGS IN THIS REPORT ARE SUBJECT TO LIMITATIONS, EXPLANATIONS, AND CONCLUSIONS OF THIS REPORT
3. TEST HOLE ELEVATIONS HAVE NOT BEEN SURVEYED; THEY ARE APPROXIMATE.

Job No. : 22244253	RED MESA RESERVOIR
Prepared By : DJS	TEST HOLE AND TEST PIT SUMMARY LOGS
Date : 3/12/15	

FIG. 2