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DENVER, COLORADO

ST. MARY DIVERSION DAM AND CANAL HEADWORKS CONCEPT DESIGN STUDY

St. Mary Diversion and Fish Facilities

US DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MAY 2003

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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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St. Mary Diversion and Fish Facilities

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ST. MARY DIVERSION AND FISH FACILITIES

INTRODUCTION

The St. Mary Diversion Dam and Canal are part of the Milk River Project located in north-central Montana. The project was among the first projects authorized under the Reclamation Act of 1902. St. Mary Diversion Dam (also referred to as the St. Mary Diversion Works) is located about 0.75 miles downstream from Lower St. Mary Lake and about 42 miles northwest of Browning, Montana, within the Blackfeet Reservation), Figure 1. The purpose of the St. Mary Diversion Dam is to divert water from the St. Mary River into the St. Mary Canal also referred to as the Main Canal), which carries the diverted water from the Saint Mary's River (which drains into the Hudson Bay) across the Hudson Bay Divide to the North Fork of the Milk River. The water supply for the project originates in the St. Mary River watershed in Glacier National Park. Runoff is stored in Lake Sherburne for release into the St. Mary River. (Reclamation Project dataweb)

The St. Mary River flows north from the east side of Glacier National Park in to Canada. In November 1999 the U.S. Fish and Wildlife Service (FWS) listed bull trout (*Salvelinus confluentus*) as a threatened species under the Endangered Species Act. The listing of bull trout prompted Reclamation to evaluate methods that would prevent entrainment of fish with canal diversions and allow fish to move upstream past St. Mary Diversion Dam. This study presents concepts for screening canal diversions, providing fish passage over the dam and diversion facility replacement.

BULL TROUT

Bull trout are endemic to cold water rivers of the pacific northwest (FWS 1998). They are characterized by a large head in comparison to its body and absence of black spots on the dorsal fin, Figure 2. Adults can weigh up to 10 kg and measure 30-70 cm in length. Bull trout take about five years to reach sexual maturity. They spawn in late summer and early fall when water temperatures drop below 9 C. Bull trout are thought to move into small streams of the upper watershed to spawn. There, they build spawning redds in gravel bars to hold their eggs. The eggs develop in the gravel for six or seven months, emerging in early spring. Bull trout are strong swimmers and generally display a bottom-oriented behavior. Bull trout within the St. Mary-Belly Rivers were identified by Fish and Wildlife Service as one of five distinct populations in need of protection, Figure 3.

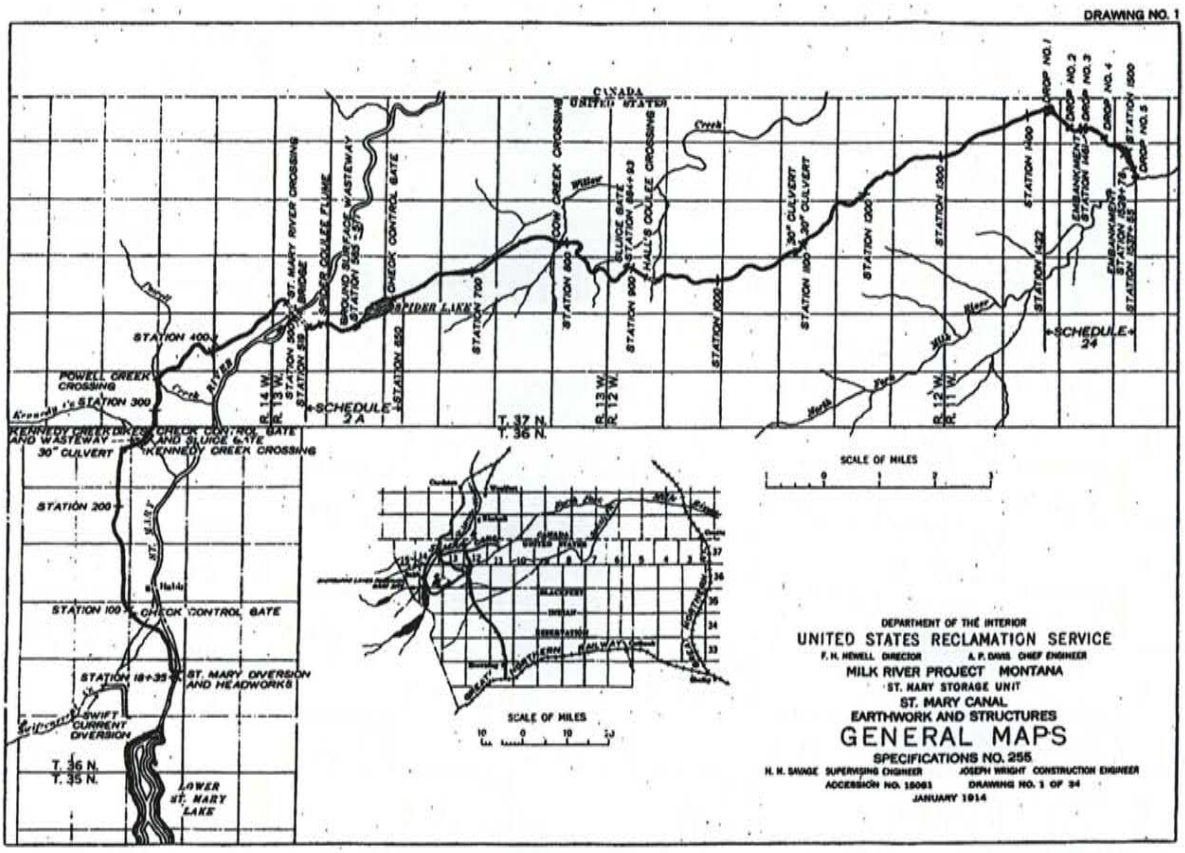

FIGURE 1 - LOCATION MAP OF ST. MARY DIVERSION DAM AND CANAL HEADWORKS (SPECIFICATION 255).

FIGURE 2 - PHOTOGRAPH OF BULL TROUT (PROVINCIAL MUSEUM OF ALBERTA, CANADA).

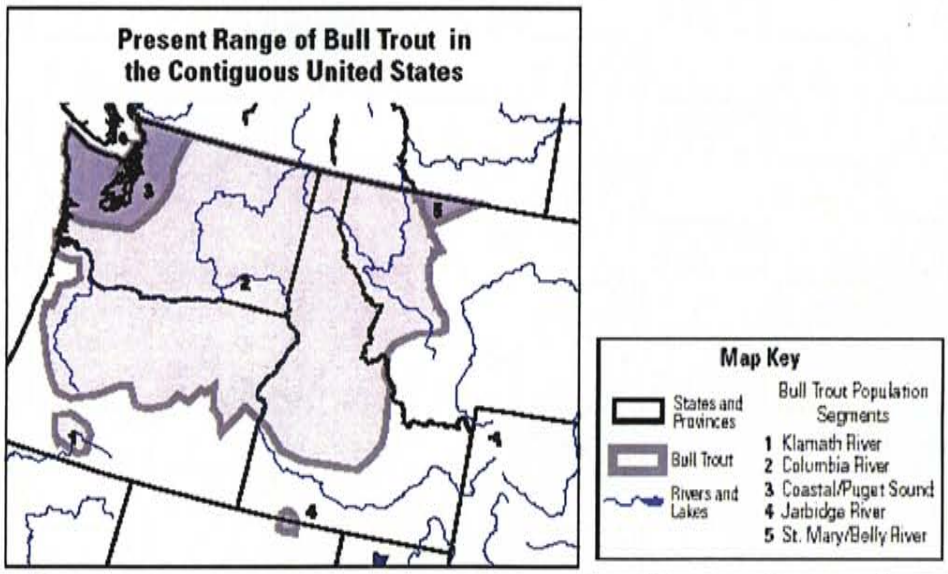

FIGURE 3 - BULL TROUT POPULATIONS IN THE PACIFIC NORTHWEST (FISH AND WILDLIFE SERVICE, 1998).

DESCRIPTION OF ST. MARY DIVERSION DAM AND CANAL (Reclamation Data Book)

St. Mary Diversion Dam and canal headworks were constructed in 1915 using reinforced concrete. Structures were constructed based on Reclamation Specification No. 255, 1914. Construction drawings of the dam and diversion headworks show the structure much as it is today, Drawings 1-3. Elevations given on the original construction drawings were based on a project datum that is 14 feet lower than the present datum, NAVD 88. A survey of the existing structure conducted in 2002 is presented on Drawing 4. St. Mary Diversion Dam is a concrete buttress weir (spillway) 5.5 ft high, surmounted by an abandoned 2-span truss bridge, with sluiceway, and the headworks for the St. Mary Canal. The spillway is an uncontrolled overflow structure that consists of a weir and downstream horizontal slab (Drawing 4). The spillway has a total length of 193 feet that is subdivided into two equal sections by a 5-ft-wide concrete bridge pier, on which two trusses span the crest of the spillway. Each weir of the spillway is 94 feet long. The spillway weir crest is elevation 4471.0. The weir crest elevation was raised to elevation 4472.0 by mounting weir-boards atop the spillway crest. The sluiceway is located to the left of the spillway and consists of six openings with inverts at elevation 4466.0. Each opening in the sluiceway is controlled by 4- by 12-inch stop planks. The St. Mary Canal headworks is located on the left abutment and is controlled by eight 5- by 5.5-foot headgates with gate sills at elevation 4466.0. The canal headworks is a concrete structure 59 feet wide, 22 feet long, with an upstream weir in front of the gates with a crest at elevation 4467.0 (Drawing 3).

The 29-mile-long St. Mary Canal was constructed between 1907 and 1915. The unlined canal was designed to convey 850 ft^3/s flow at a flow depth of 9 feet. The canal was excavated to a bottom width of 26 ft with 2:1 side slopes at a channel slope of 0.000095.

FACILITY CONDITION AND OPERATION

The diversion dam, headworks and canal are approaching 100 years old. Recent exams of the diversion dam and headworks revealed substantial freeze-thaw damage to exposed concrete surfaces. Concrete core samples taken from the piers on the dam and sluiceway indicated very poor concrete exists where concrete has been exposed to ice and frequent freeze thaw action. Photographs and descriptions from the structure exam are reproduced in Appendix A. Based on available inspection data, the weir (foundation, apron and buttress) is structurally sound and may be used as part of a rehabilitation project. The piers, sluiceways and diversion headworks will require demolition and replacement.

The canal downstream of the diversion follows the left bank of the river for about nine miles before crossing above the river through an inverted siphon. The dam is used to divert water into the canal from late March through September. During the non-diversion period, the sluiceways are opened. The canal was designed to convey 850 ft^3/s, however the condition of the canal limits diversion too less than the original capacity. The typical maximum diversion is about 650 ft^3/s. Historic average daily diversion flows measured downstream of St. Mary Canal headworks (U.S.G.S. station 05018000) are shown in Figure 4. During late March and early April, all river flow in excess of about 100 ft^3/s is typically diverted. From June to August, diversions often reach 75 percent of total river flow. Diversion decreases sharply in late August and September.

The outlet to Lower Saint Mary Lake is located about 1 The outlet elevation of lower St. Mary Lake is controlled by the remnants of a rock and concrete sill that was constructed about 200 feet upstream of the present day US Highway 89 bridge (personal correspondence from Jerry Moore, Reclamation Montana Area Office). The sill was constructed to provide a river crossing prior to completion of the St. Mary Diversion Dam Bridge in 1915 (now abandoned). The elevation of the sill is approximately the same as the elevation of the St. Mary Diversion Dam weir crest. When the sluiceways are closed, the diversion pool is approximately the same elevation as lower St. Mary Lake. When the sluiceways are open, the old river crossing controls the lake elevation.

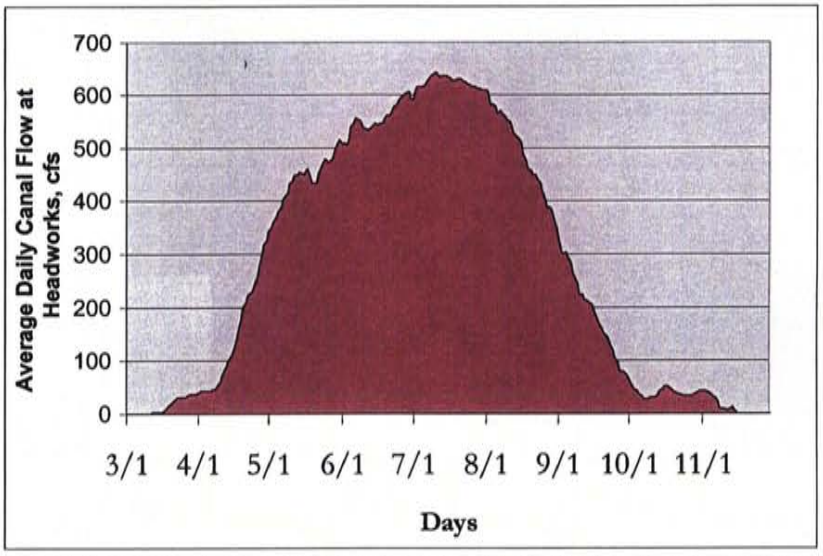

FIGURE 4. HISTORIC AVERAGE DAILY DIVERSION FLOW TO ST. MARY CANAL (USGS STATION 05018000).

RIVER AND DIVERSION HYDRAULICS

Flow in the St. Mary River varies in response to seasonal snowmelt and releases of stored water from Lake Sherburne. The average monthly flow in the river measured upstream of the diversion (USGS gaging station No. 05017500) is presented in Figure 5. River flow increases sharply from March through June then declines during late summer and fall. Snowmelt runoff starts in early April and peaks in early June. Storage releases from Lake Sherburne are made as needed to augment river flows to achieve full diversion capacity of the St. Mary Canal.

Canal diversion data is the only hydraulic data available at the diversion. Estimates of hydraulic parameters in the river and canal were established by constructing a one-dimensional flow model using Hec-Ras, (Corps of Engineer s, 2002) with topographic survey data collected in 2002, Drawing 5. The survey data covered a river reach extending from about 100 feet upstream to about 750 ft downstream of the diversion weir. Channel cross-sections were cut at approximately 50 ft intervals from the survey topography for modeling. The model was used to determine water surface elevations and flows in the river and canal for the existing structure and proposed concepts. The site layout geometry developed for the existing diversion weir is shown on Figure B-1 in Appendix B. Table B-1 gives flow parameters output for 850 ft^3/s diversion at 1170 ft^3/s river flow. These flows represent a diversion of 75 percent of the river at full canal diversion capacity. All gates were assumed operable with openings of 2.75 ft. Predicted water surface elevations for the canal and river were based on a normal depth flow assumption. An average river channel slope of 0.005 ft/ft and a canal slope of 0.000095 ft/ft were used for the model water surface predictions. Field water surface data for the river and canal were not available for calibration of the model. The model is expected to provide reasonable estimates of hydraulic head across the diversion weir for flows less than bank full conditions. The predicted hydraulic head across the diversion weir (with weir-boards) as a function of weir flow is shown in Figure 6. The existing weir provides between 4- to 6-ft of head for diversion.

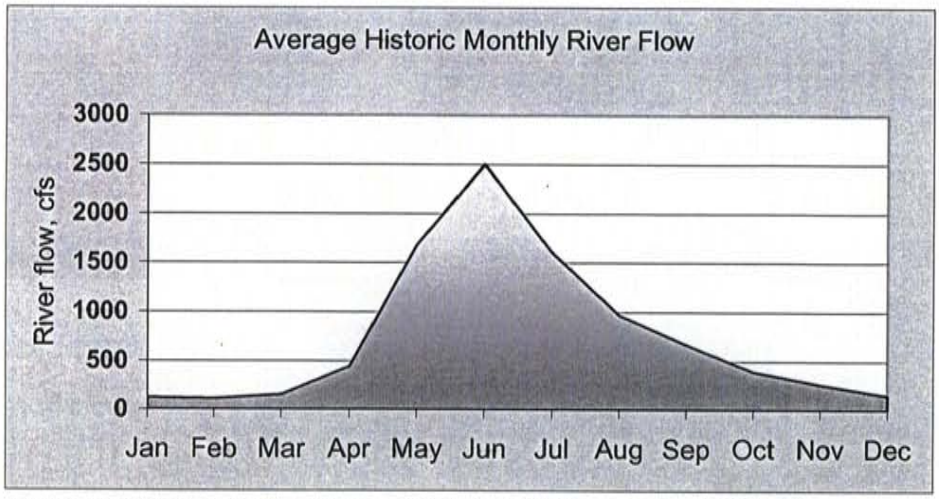

FIGURE 5. AVERAGE HISTORIC MONTHLY RIVER FLOW, (USGS STATION NO. 05017500 LOCATED NEAR BABB, MONTANA).

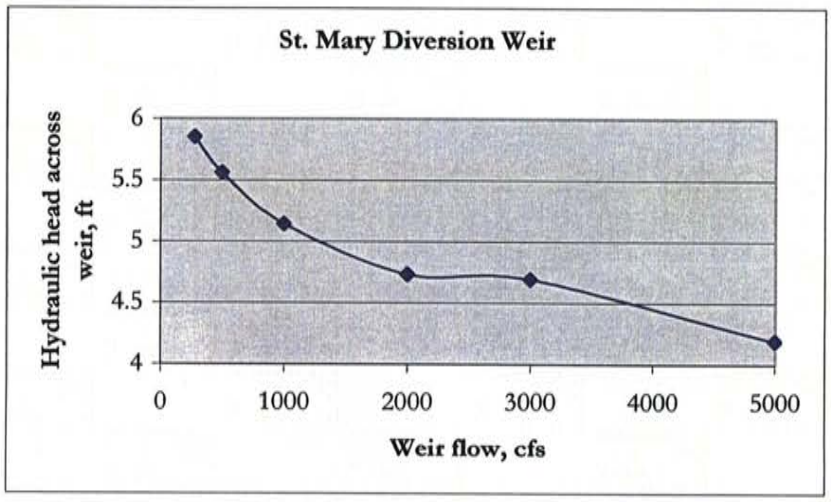

FIGURE 6. HYDRAULIC HEAD ACROSS ST. MARY DIVERSION WEIR.

CONCEPT DESIGN

Two project concepts were developed within the concept design study. Concept 1 rehabilitates the existing diversion weir and replaces the diversion headworks and sluiceway structures. Concept 2, replaces all existing structures with a new diversion located a short distance downstream of the current site. The concepts are similar in the design of new fish passage and fish screening facilities. Both concepts incorporate proposals from the St. Mary Value Engineering Study (VE), Reclamation, 2002. Concept 1 includes aspects of VE proposals 4 (Use existing dam and build new headworks, fish screens and fish passage structures), 7 (Use vertical flat plate screens) and 9 (Construct rock fishway on east abutment of the dam). Concept 2 is the base line concept (full facility replacement) with modifications based on VE proposals 7 and 9.

Fish screen and diversion headworks concepts presented include several canal design flow options. The options delineate structure size requirements for maximum canal diversion flow rates of 500 ft^3/s, 670 ft^3/s, 850 ft^3/s and 1,000 ft^3/s. With out additional operations data, the original canal design water surface elevation of 4471.06 was assumed necessary for all canal design flow options. The width of the new canal reach and fish screen structure was designed accordingly. This approach would require checking up of the canal water surface downstream of the fish screen for canal design flows less than the original 850 ft^3/s. Design parameters used for the diversion options studied are listed in Table 1. The alternative to a constant design water surface is assuming the structures are constructed in the existing canal prism and the canal flows at normal depth. Hec-Ras simulations are given in Appendix B for each design flow option assuming normal depth in the canal.

CONCEPT 1

The site plan for concept 1 is shown on Drawing 6. The partial bridge over the weir and all piers would be removed. The buttress section of the weir would be fully grouted with lean concrete to improve strength of the underlying buttress walls. New canal headworks, canal and diversion dam sluiceway would be constructed about 100 feet downstream of the existing facilities. A new pier wall would be constructed from the west end of the weir angled downstream to a new sluiceway structure. The diversion headworks and sluiceway are moved downstream to permit construction of the new facilities concurrent with diversion through the existing headworks facility. The diversion headworks structure includes a course trashrack, diversion gates and an energy dissipation basin, Drawing 8, section A-A. The proposed sluiceway has two bays each with 10-ft-wide by 16-ft-high radial gates, Drawing 9, sections A-A and B-B. The number of diversion gates varies depending on the canal design flow option. A canal design flow of 500 ft^3/s requires a diversion headworks with two 10-ft-wide bays, each containing a 10-ft-wide by 18-ft-high radial gate. A canal design flow of 670 ft^3/s requires three diversion bays and canal design flows of 850 ft^3/s and 1,000 ft^3/s require four diversion bays of similar design. A four-bay diversion headworks structure is shown on the drawings. Separate construction quantities and costs are given for each canal design flow option. The diversion works were sized based on a maximum approach velocity to the gates of about 4 ft/s. Large debris caught on a course trashracks upstream of the radial gates will require periodic racking and removal by hand or backhoe. If large amounts of woody debris are likely, an automated trashrake may be added for cleaning the trashracks.

A fish screen structure is shown constructed in the new canal section downstream of the diversion headworks, Drawing 11. The fish screen is a linear vertical flat plate screen design. The screen angles across the canal to provide sufficient screen area and guide fish to a river return bypass located at the downstream end of the screen. The screen was designed based on accepted design criteria for design of screens for anadromous salmonids, NOAA Fisheries, 1997. The screen was sized using a maximum screen approach velocity (measured in front of and normal to the screen) of 0.4 ft/s. Screen area is equal to the canal design flow divided by the screen approach velocity. Screen areas and screen lengths are listed in Table 2 and shown on Drawing 11 for canal design flows of 500, 670, 850 and 1,000 ft^3/s. A screen height of 11.0 ft was used for all canal design flow options assuming a fixed design flow elevation of 4471.06, Drawing 12. All screen designs include a single terminal bypass at the downstream end of the screen. Fish moving downstream along the screen at the average channel velocity could be

exposed to the screen for up to 120 seconds before reaching the bypass. Duration of fish exposure to a screen (termed screen exposure) is a design parameter related to fish swimming endurance and behavior. Screen exposure is an important fish screen design consideration where early life stages or weak swimming species are likely present. The NOAA Fisheries screen exposure guideline for anadromous species is 60 seconds. For bull trout, their behavior is likely the key to minimizing screen exposure. Bull trout are often characterized as exhibiting a bottom-oriented behavior. A strong bottom-oriented behavior was observed during tests of bull trout fry passing over bottom diversion screens conducted at WRRL, (Beyers, et al, 2002). The fish screens presented herein were designed to minimize screen exposure by using a vertical flat plate screen elevated off the channel bottom. Screens are mounted 1.0 ft above the channel invert on a concrete sill. The raised sill provides area below the screen for movement of bed sediments and holds fish that stay near the bottom away from the screen.

Designing a flat plate screen based on a 60 second exposure for St. Mary Canal would require adding an intermediate bypass at the mid-point of the linear screen, Figure 7, or placing flat plate screens on both sides of the channel in a "V" configuration with a single mid-channel bypass, Figure 8. Both of these methods are commonly used where exposure must be reduced. Adding a second bypass along the linear screen would require an additional 40- to 50 ft^3/s diversion into the canal. This was considered unacceptable during low river flows due to the adverse impact on river passage between the diversion headgates and the bypass outfall. A "V" screen design offers a shorter structure of greater complexity. The "V" geometry requires separate screen cleaners and debris handling equipment on each side of the "V" and a bypass entrance located in the center of the channel where equipment access is difficult. These operation and maintenance issues in conjunction with the bottom-oriented behavior of bull trout fry are the basis of choosing the linear screen with single terminal bypass for the concept design.

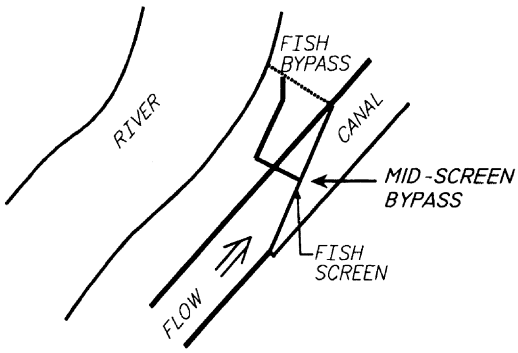

FIGURE 7 SCHEMATIC OF LINEAR FISH SCREEN WITH INTERMEDIATE AND TERMINAL.

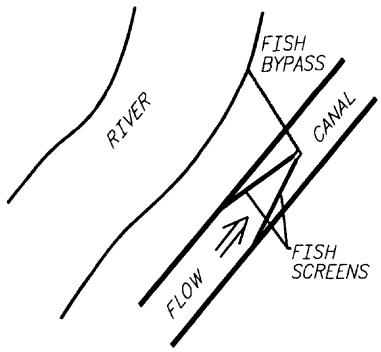

FIGURE 8 SCHEMATIC OF V-SCREEN WITH MID-CHANNEL FISH BYPASS.

Stainless steel wedge-wire (also called profile wire) screen material is recommended for the fish screens. Screen openings (gap between the wires) of 0.09 or 0.07 inches are standard for fisheries applications. Adjustable baffles are shown mounted downstream of the screen on Drawing 12. The baffles are required to adjust the uniformity of through-screen-flow-velocity. The baffles

are adjusted based on field derived velocity measurements during initial operation of the screen. Once set, the baffles do not require further adjustment. The upstream face of the screen is maintained in a clean condition by a set of automated brushes that traverse the entire length of the screen. Debris dislodged by the brush cleaners is moved downstream by the flow and passes out the fish bypass to the river. The fish bypass entrance is a 2-ft-wide full depth slot that transitions to a HDPE bypass pipe, Drawing 13. Bypass flow is regulated by adjusting a vertically hinged swing style gate or inclined slide gate mounted within the transition structure. These types of gates allow bottom-oriented fish to pass remaining near the bottom. Bypass flows are based on setting an average flow velocity at the bypass entrance that is equal to or up to 10 percent greater than the average canal velocity. Bypass flows are expected to range from 40- to 50 ft^3/s. Bypass flow reenters the river approximately 850 ft downstream of the diversion weir through a submerged outlet structure.

A rock fishway channel would be constructed next to the right bank, see Drawing 6. The fishway would extend from the weir crest downstream a distance of 150 feet at a thalweg slope of 3.5 percent. The fishway would be composed of grouted riprap to prevent movement of riprap by heavy ice. The fishway exit is set 1.0 ft below the top of the crest boards to concentrate fishway flow to the rock channel thalweg during low river flows. Downstream of the weir, the sloping rock fishway is contoured to form a low flow channel near the right bank and transition to existing topography to the left of the weir centerline. The split flow design will provide fishway attraction flow for fish moving up the left bank. Large boulders or bottom depressions within the fishway will be considered during final design to provide lower velocity zones along the edges of the rock fishway.

Flow parameters for concept 1 were estimated using the Hec-Ras model with the new fishway and headworks geometry, Figure B 2. The FISHWAY and BELOW DAM reaches shown on Figure B 2 were modeled as parallel channels that split at the diversion weir and rejoin 150 ft downstream. Model runs were conducted using the existing canal topography without the fish screen structure represented and sluiceway gates closed. Conditions representing 75 percent river diversion at maximum canal capacity were modeled for comparison of canal design flow options, Tables B2-B4. Two and four gate geometries were modeled for 500 ft^3/s and 850-1000 ft^3/s design canal flows, respectively. Model output for a typical high river condition (3,000 ft^3/s and 850 ft^3/s diversion) is given in Table B-5.

CONCEPT 2

The site plan for concept 2 is shown on Drawing 2. A new diversion weir, diversion headworks, and sluiceway would be constructed downstream of the existing structures. The new diversion structure would include a rock fishpass and fish screen in the canal downstream of the headworks similar to concept 1. All existing diversion structures would be demolished and removed after the new facilities are operational. A new concrete weir with an ogee crest would be constructed across the river, Drawing 7, section A-A. The crest of the weir is set at elevation 4472.5 to provide a diversion head similar to the existing diversion weir with the weir-boards installed. The weir length is 200 ft compared to 189.6 for the existing weir and 194.3 ft for concept 1. A sluiceway with two bays, each controlled by a 10-ft-wide by 16-ft-high radial gate, is positioned on the left weir abutment, Drawing 10, sections A-A and B-B. The canal diversion headworks is located on the left river bank immediately upstream of the sluiceway. The canal diversion headworks, new canal section and new fish screen structure are the same as

described for concept 1. A two-bay or four-bay headworks structure would be used depending on future selection of canal design flow. The four bay headworks structure is shown in the drawings.

A rock fishway would be constructed along the right riverbank. The fishway design is similar to concept 1 with modifications for site topography. The fishway slope is 3.5 percent. A shallow "V" shaped channel in the center of the fishway provides a low flow fish pass. Under progressively higher river flows, fishway flow spills over the fishway left bank providing increased attraction and access to the fishway.

Flow modeling of concept 2 was conducted similar to concept 1. The major structure differences modeled were a 200 ft long diversion weir crest and a 30 ft wide fishway. Conditions representing 75 percent river diversion at maximum canal capacity are given in, Tables B6-B8. High river flow conditions will be similar to concept 1 given in Table B-5.

TABLE 1 DIVERSION CANAL DESIGN PARAMETERS BASED ON DIVERSION CAPACITY.

DESIGN DIVERSION CAPACITY	DESIGN CANAL WATER SURFACE ELEVATION	NUMBER OF DIVERSION HEADGATES	WIDTH OF CANAL INVERT	FISH SCREEN LENGTH	FISH SCREEN BYPASS FLOW
FT^3/S	FT	(10 FT WIDE BY 18 FT HIGH RADIAL GATES)	FT	FT	FT^3/S
500	4471.1	2	14	170	40
670	4471.1	3	19	230	40
850	4471.1	4	24	280	40
1000	4471.1	4	28	330	50

SITE GEOLOGY AND GROUND WATER

The excavated canal passes through many soil types. Near the diversion, the canal is excavated through glacial alluvial deposits that include significant sands and gravels. Several holes were drilled near the canal diversion headworks in April of 2002. The geologic logs from these holes

are given in Appendix C. Hole locations are shown on concept Drawings 6 and 7. The logs reveal generally poorly graded sands and gravels with some fines within the excavated zone of the canal and headworks. The water table was located between about 14 ft and 18 ft below the surface. In many locations, the canal banks have slumped inward and seeps are evident on the outer banks. Significant seepage has occurred between the diversion and the St. Mary River crossing since initial operation. A comparison of historic canal discharge measurements from the headworks and river crossing suggest seepage loss (assumes no diversion within the reach) was about 24% following construction (1918-1922 average) and has increased to about 31 percent today (1997-2001 average). The comparison was calculated using daily canal flows measured at U.S. Geological Survey (USGS) gaging stations 05018000 near the canal intake and station 05018500 located near the St. Mary River crossing. To avoid the influence of canal startup and shutdown on flow, the daily records were filtered to consider only those days when canal flow was greater than 200 ft^3/s.

CONSTRUCTION SCHEDULE

Construction is expected to take two years to complete with limited construction in December through February. The construction schedules for both concepts are similar. During the first year, the diversion headworks, sluiceway, new canal and fish screen would be constructed. The second year the dam and fish passage structures would be constructed. A bar chart of the estimated work schedule is given in Figure 9.

CONSTRUCTION COST ESTIMATES

Concept level construction cost estimates were prepared for each concept assuming diversion design flows of 500, -670, -850- and 1,000 ft^3/s. A construction cost summary is given in Table 2. Itemized cost estimates are presented in Appendix D for concept 1 and Appendix E for concept 2. Costs associated with land or right-of-way procurement are not included in the estimates. Costs presented include 15 percent unlisted items and 25 percent contingencies.

TABLE 2 CONSTRUCTION COST ESTIMATE SUMMARY.

ALTERNATIVE	DIVERSION DESIGN FLOW FT^3/S			
	500	670	850	1000
CONCEPT 1	$6,900,000	$8,504,000	$9,000,000	$9,700,000
CONCEPT 2	$7,400,000	$8,967,000	$9,500,000	$10,000,000

REFERENCES

BEYERS, D.W., AND BESTGEN, K.R., "BULL TROUT PERFORMANCE DURING PASSAGE OVER A HORIZONTAL FLAT PLATE SCREEN," LARVAL FISH LABORATORY, DEPARTMENT OF FISHERY AND WILDLIFE BIOLOGY, COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO, JULY 2002.

BUREAU OF RECLAMATION," VALUE PLANNING FINAL REPORT, ST. MARY DIVERSION DAM AND HEADWORKS REPLACEMENT", TECHNICAL SERVICE CENTER, MARCH 28, 2002.

BUREAU OF RECLAMATION, "CONSTRUCTION SPECIFICATION 255, MILK RIVER PROJECT, MONTANA, ST. MARY STORAGE UNIT", JANUARY 1914.

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U.S. FISH AND WILDLIFE SERVICE, "BULL TROUT FACTS", WEB SITE HTTP://WWW.R1.FWS.GOV/NEWS/BULLTROUT/BULTRT2.PDF, 1998

US NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION FISHERIES, "FISH SCREEN CRITERIA FOR ANADROMOUS SALMONIDS", SOUTHWEST REGION, JANUARY 1997

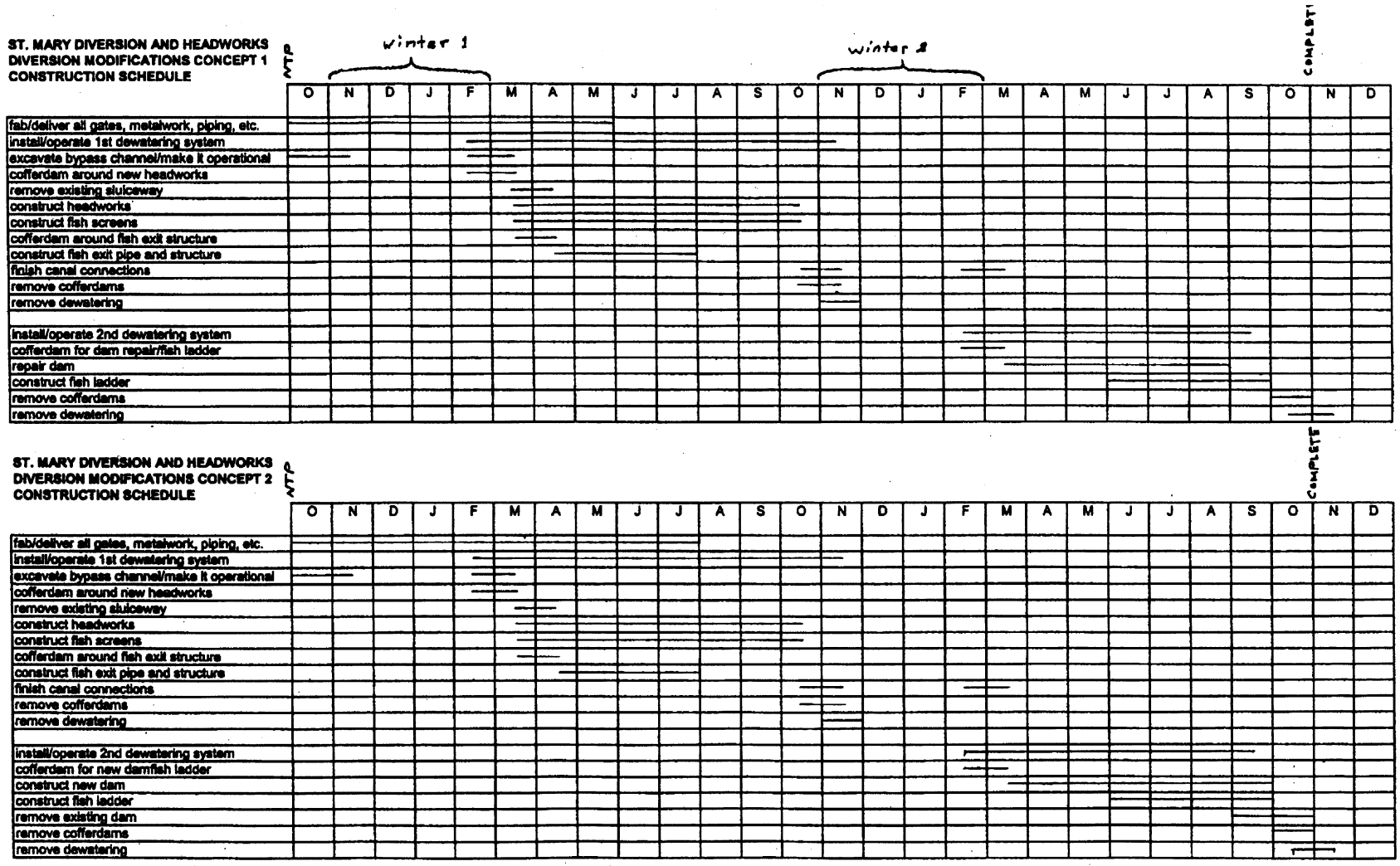
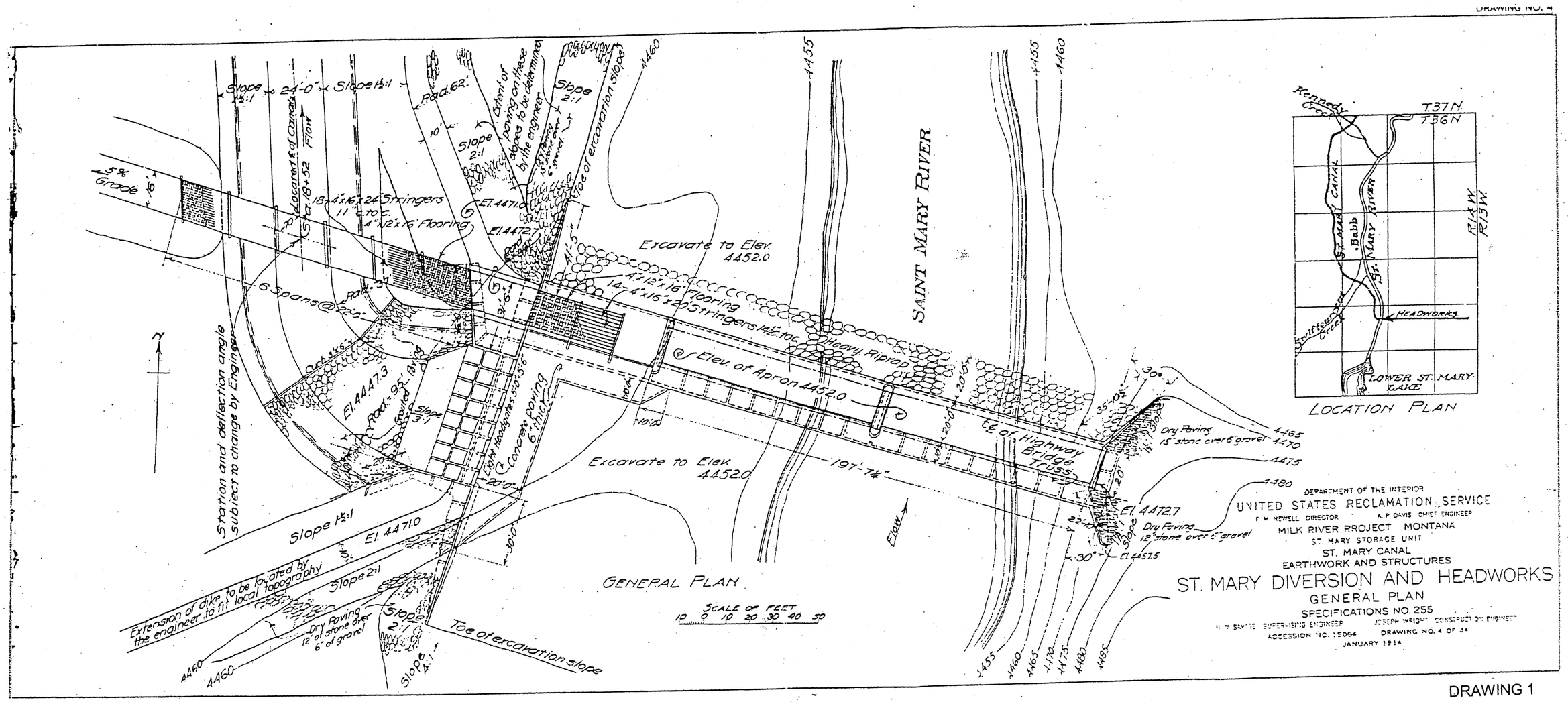


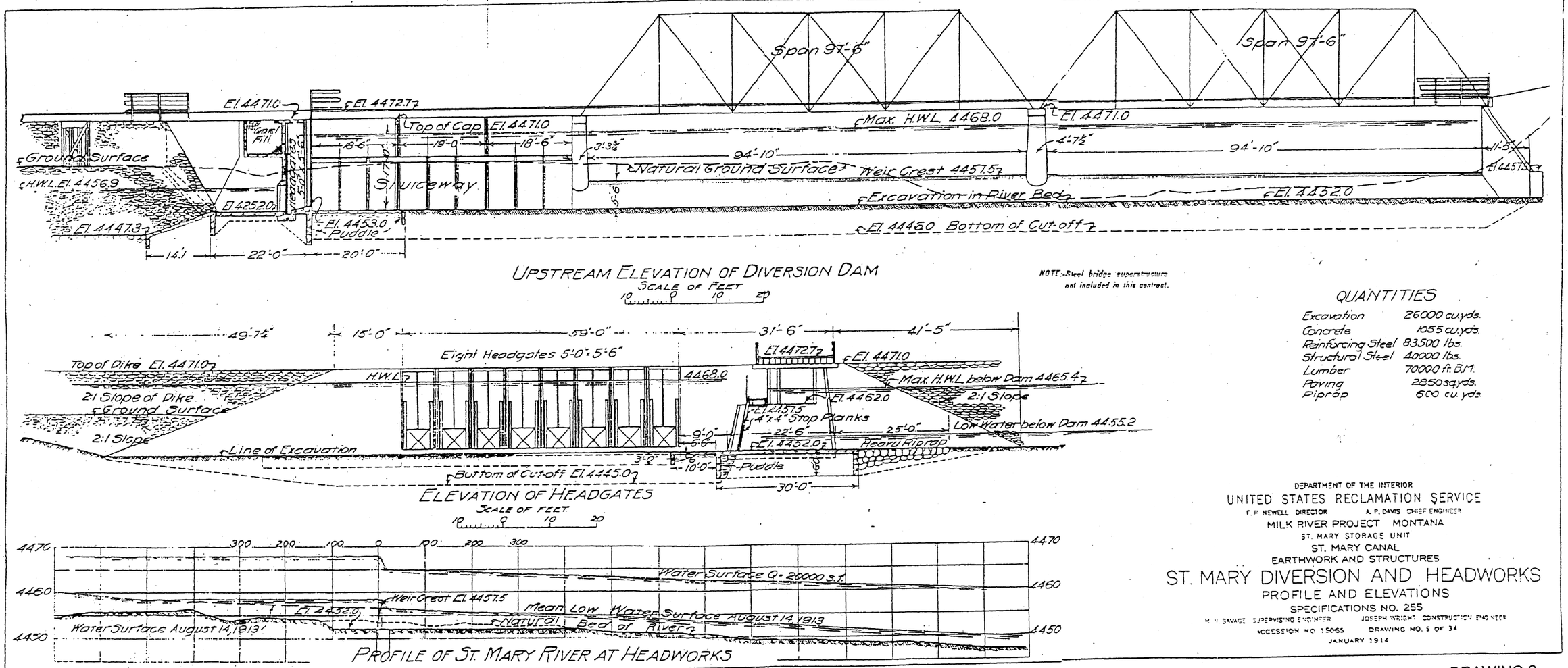
FIGURE 9 PROPOSED PROJECT CONSTRUCTION SCHEDULE.

DRAWINGS


DRAWING NO. 4
SAINT MARY RIVER
GENERAL PLAN
SCALE OF FEET
10 0 10 20 30 40 50
Station and deflection angle subject to change by Engineer
Slope 1½:1
24'-0"
Slope 1½:1
Rad. 62'
Slope 2:1
Extent of paving on these slopes to be determined by the engineer
Toe of excavation slope
Slope 2:1
5% Grade
Relocated Canal
Sta. 18+52
Flow
Sta. 18+44 x 16' x 24' Stringers 11' c. to c.
4" x 12" x 16' Flooring
El. 4471.0
El. 4472.7
Excavate to Elev. 4452.0
4" x 12" x 16' Flooring
14-4" x 16" x 20' Stringers 14½' c. to c.
Heavy Riprap
6 Spans @ 20'-0"
Rad. 3'
Curb 3" x 6"
El. 4447.3
Rad. 95' 8" x 13'
Grouted
Slope 3:1
Elev. of Apron 4452.0
Concrete paving 6" thick
Excavate to Elev. 4452.0
197'-7½"
Toe of Highway Bridge Truss
Flow
Dry Paving 15" stone over 6" gravel
Dry Paving 12" stone over 6" gravel
El. 4472.7
El. 4457.5
Slope 1½:1
El. 4471.0
Slope 2:1
Extension of dike to be located by the engineer to fit local topography
Dry Paving 12" of stone over 6" of gravel
Slope 2:1
Toe of excavation slope
Slope 4:1
4460
4455
4465
4470
4475
4480
4485
LOCATION PLAN
Kennedy Creek
T37N
T36N
R14W.
R13W.
ST. MARY CANAL
Babb
ST. MARY RIVER
HEADWORKS
LOWER ST. MARY LAKE
DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE
F. H. NEWELL DIRECTOR
A. P. DAVIS CHIEF ENGINEER
MILK RIVER PROJECT MONTANA
ST. MARY STORAGE UNIT
ST. MARY CANAL
EARTHWORK AND STRUCTURES
ST. MARY DIVERSION AND HEADWORKS
GENERAL PLAN
SPECIFICATIONS NO. 255
H. H. SAWYER SUPERVISING ENGINEER
JOSEPH WRIGHT CONSTRUCTION ENGINEER
ACCESSION NO. 15064
DRAWING NO. 4 OF 34
JANUARY 1914

DRAWING 1

DRAWING NO. 5



QUANTITIES

Excavation	26000 cu.yds.
Concrete	1055 cu.yds.
Reinforcing Steel	83500 lbs.
Structural Steel	40000 lbs.
Lumber	70000 ft. B.M.
Paving	2850 sq.yds.
Riprap	600 cu. yds.

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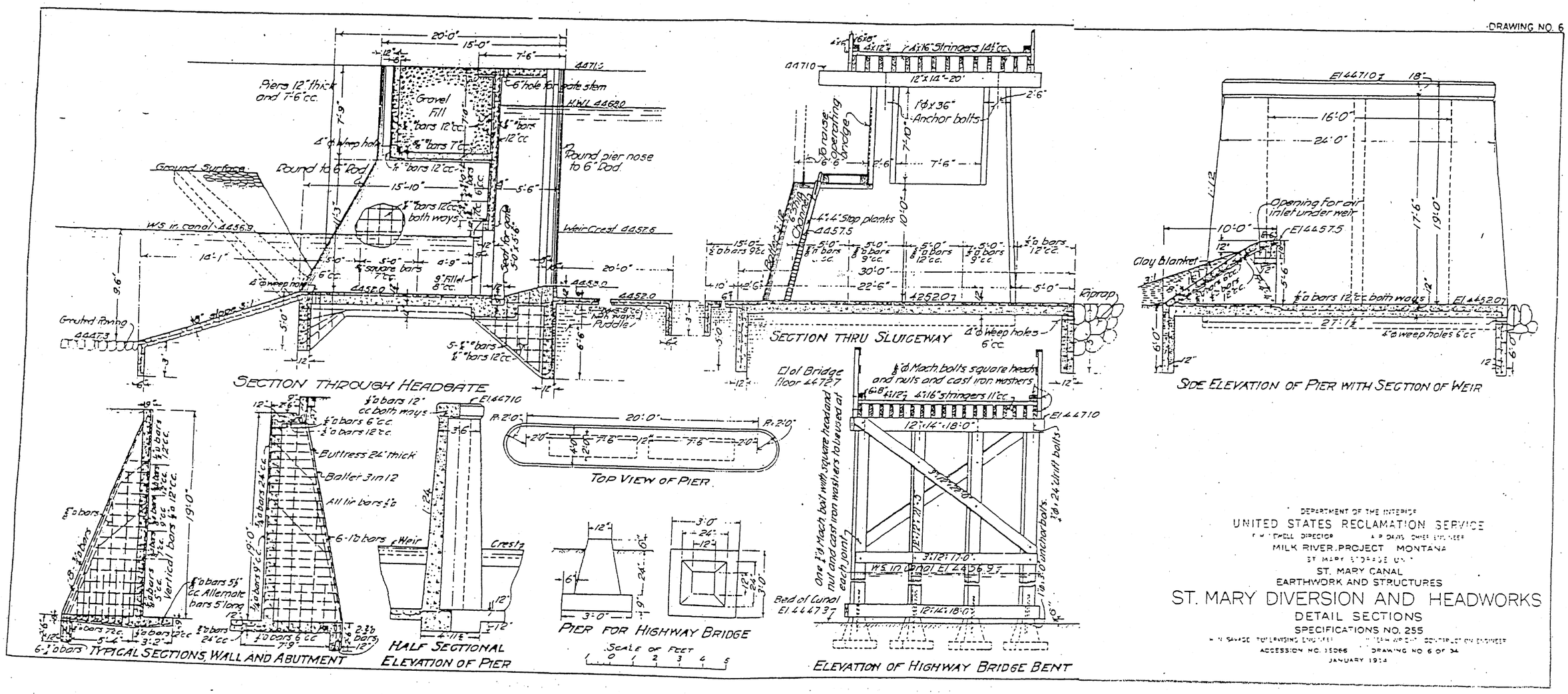
UNITED STATES RECLAMATION SERVICE
F. H. NEWELL DIRECTOR A. P. DAVIS CHIEF ENGINEER
MILK RIVER PROJECT MONTANA
ST. MARY STORAGE UNIT
ST. MARY CANAL
EARTHWORK AND STRUCTURES

ST. MARY DIVERSION AND HEADWORKS

PROFILE AND ELEVATIONS
SPECIFICATIONS NO. 255
M. N. SAVAGE SUPERVISING ENGINEER JOSEPH WRIGHT CONSTRUCTION ENGINEER
ACCESSION NO. 15065 DRAWING NO. 5 OF 34
JANUARY 1914

DRAWING 2

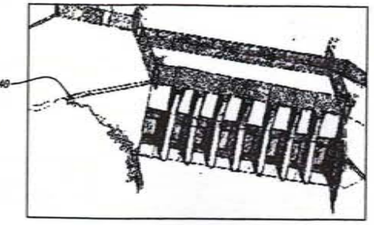

DRAWING NO. 6
SECTION THROUGH HEADGATE
SECTION THRU SLUICEWAY
SIDE ELEVATION OF PIER WITH SECTION OF WEIR
TYPICAL SECTIONS, WALL AND ABUTMENT
HALF SECTIONAL ELEVATION OF PIER
TOP VIEW OF PIER
PIER FOR HIGHWAY BRIDGE
ELEVATION OF HIGHWAY BRIDGE BENT
Piers 12" thick and 7'-6" cc.
Gravel Fill
6" hole for gate stem
H.W.L. 4468.0
Round pier nose to 6" Rod
Round to 6" Rod
Ground Surface
W.S. in canal 4456.9
Weir Crest 4457.6
Grouted Paving
Buttress 24" thick
Batter 3 in 12
All lin bars ½"ϕ
6-1"ϕ bars
Weir
Crest
Vertical bars
Bed for gate
Path ways
Puddle
Riprap
4"ϕ weep holes 6" cc
4"ϕ weep holes
Stop planks
Anchor bolts
Bridge
Clay Blanket
Opening for air inlet under weir
Bed of Canal El. 4447.3
W.S. in Canal El. 4456.9
Scale of Feet
DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE
MILK RIVER PROJECT MONTANA
ST. MARY STORAGE UNIT
ST. MARY CANAL
EARTHWORK AND STRUCTURES
ST. MARY DIVERSION AND HEADWORKS
DETAIL SECTIONS
SPECIFICATIONS NO. 255
ACCESSION NO. 35066
DRAWING NO. 6 OF 34
JANUARY 1914

DRAWING 3

SMC-40 PHOTO 4 (TAKEN IN 2001)

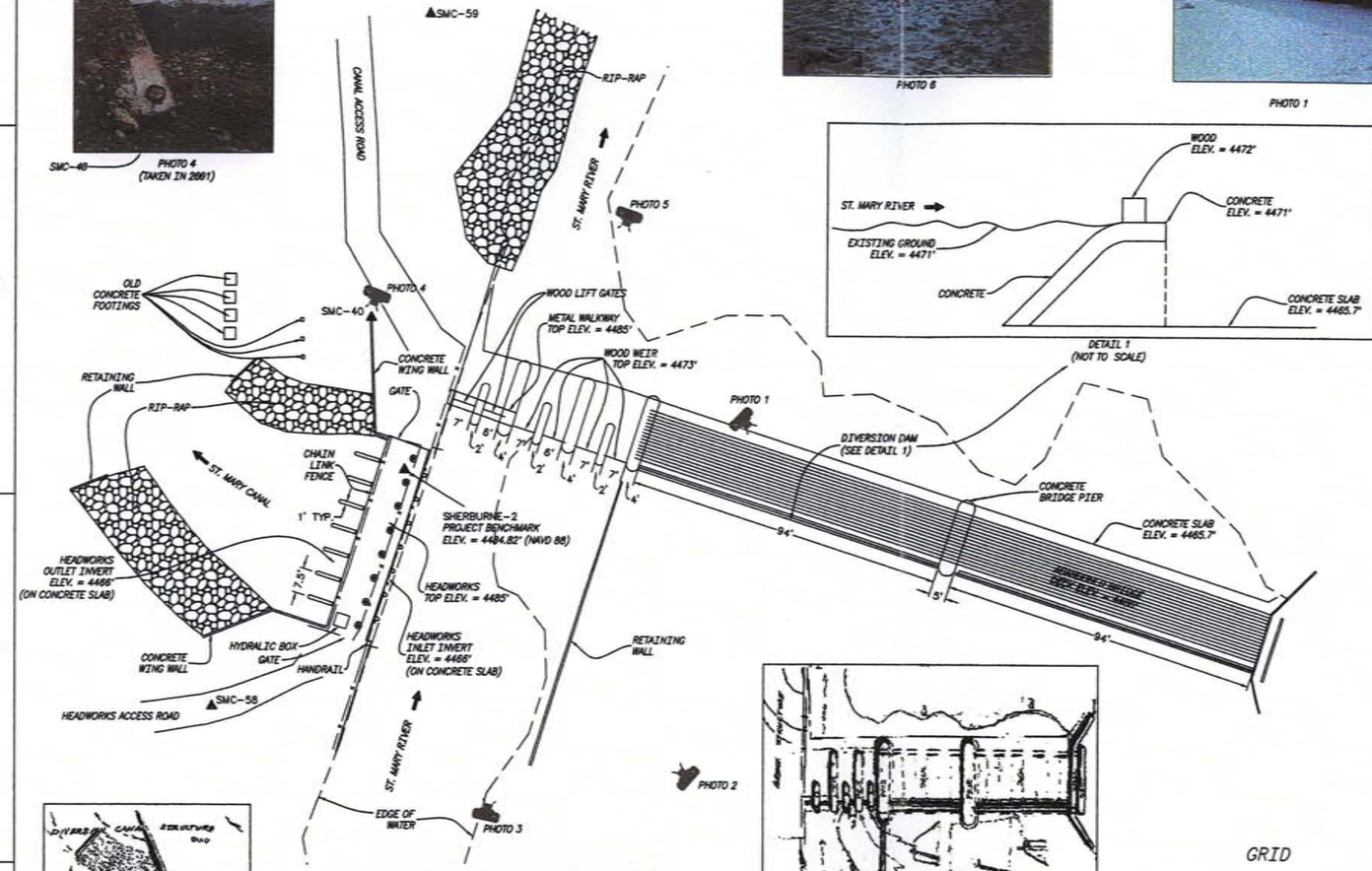
PHOTO 6 — ISLAND

PHOTO 1 — DIVERSION DAM

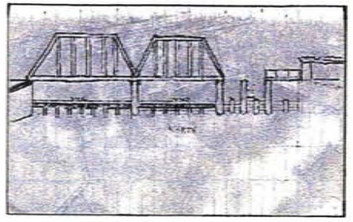


SMC-40

SKETCH OF HEADWORKS FROM THE WEST LOOKING EAST (NOT TO SCALE)



DETAIL 1 (NOT TO SCALE)



SKETCH OF DIVERSION DAM FROM THE NORTH LOOKING SOUTH (NOT TO SCALE)

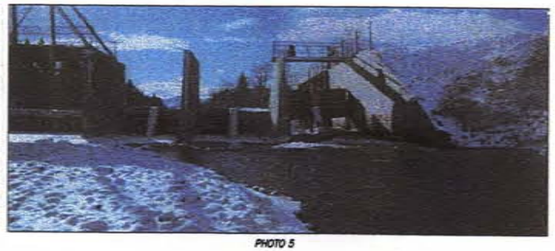
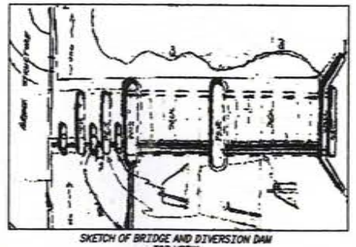
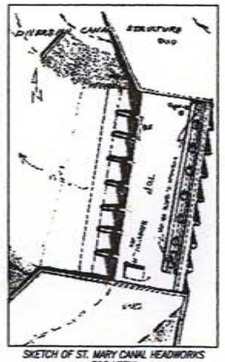


PHOTO 5



SKETCH OF BRIDGE AND DIVERSION DAM TOP VEIW (NOT TO SCALE)



SKETCH OF ST. MARY CANAL HEADWORKS TOP VEIW (NOT TO SCALE)

PHOTO 3

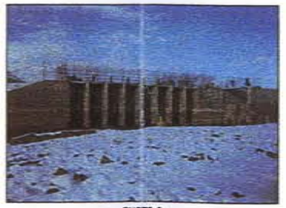


PHOTO 2

GRID N

20 0 20 40 60
SCALE OF FEET
DETAIL

LEGEND

▲ SURVEY CONTROL (USBR CAP)
● HYDRAULIC GATE VALVE

SKETCHES BY: GERALD McCARTHY (FIELD SURVEYOR)

CONTRACT NO. 1425-98-CA-60-6690
TASK ORDER NO. - B2

DATE OF SURVEY - JANUARY 2002

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

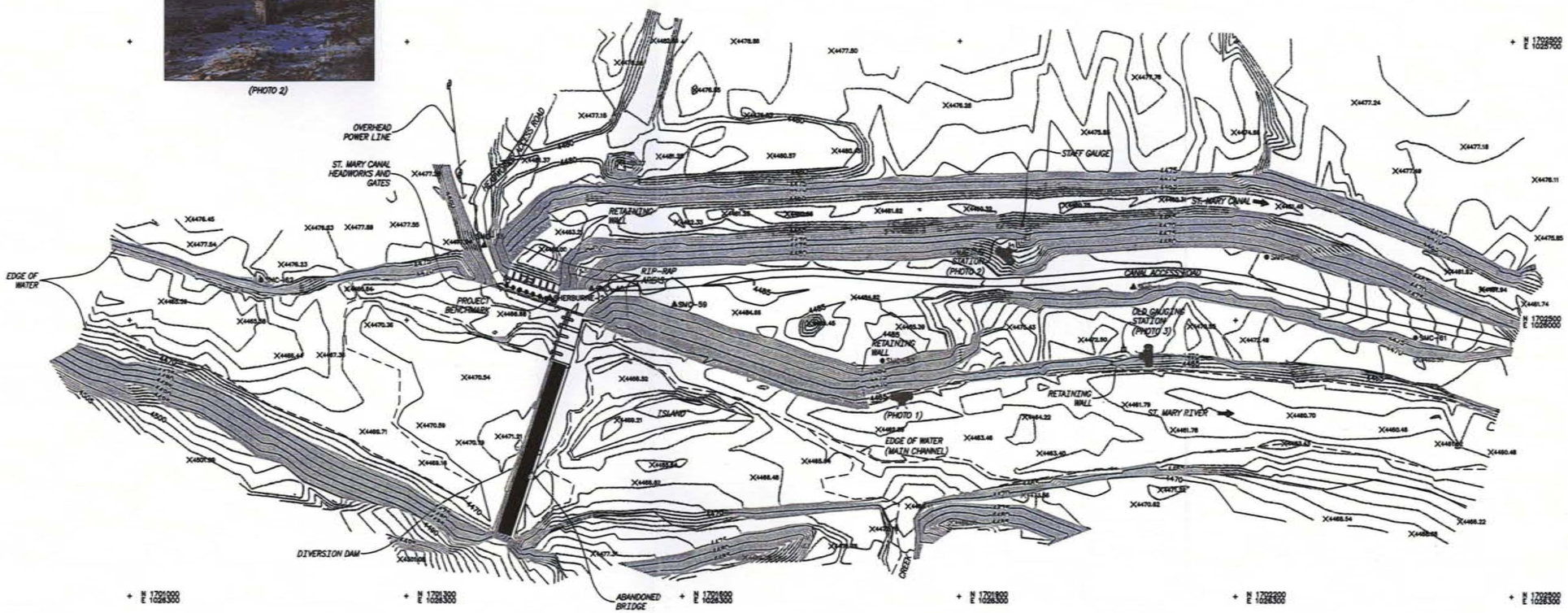
ST. MARY DIVISION, MILK RIVER PROJECT
SAINT MARY CANAL
DIVERSION DAM AND HEADWORKS
STRUCTURE DETAILS

DESIGNED ____ CHECKED GLENN HOWARD (DABA P.C.)
DRAWN SCOTT R. SLOSTRE (DABA P.C.) TECH. APPR. ____
APPROVED ____
CAD SYSTEM LDD R26 CAD FILENAME 4300-B2ADETAIL.dwg DATE AND TIME PLOTTED
MISSOULA, MT. SHEET 3 OF 3 JANUARY, 2002

(22X34), 1" = 20'

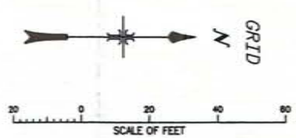
DRAWING 4

(PHOTO 2)



GENERAL NOTES

1. HORIZONTAL CONTROL– MONTANA STATE PLANE COORDINATE SYSTEM NAD 83 (1992)
   BASED ON GPS OBSERVATION FROM NGS STATIONS "PIEGAN" AND "4220"
2. VERTICAL CONTROL – NORTH AMERICAN VERTICAL DATUM OF 1988
   BASED ON GPS OBSERVATION FROM NGS STATION "PIEGAN" ELEVATION = 4312'
3. GRID TO GROUND SCALE FACTOR = 1.00030 AT SHERBURNE–2
4. CONVERGENCE ANGLE FROM GRID NORTH TO GEODETIC NORTH = –2°51'54" AT SHERBURNE–2
5. SHERBURNE–2 (NAVD 88 ELEVATION = 4484.82') (NGVD 29 ELEVATION = 4480.76')
   NOTE: THE CONVERSION DIFFERENCE BETWEEN NAVD 88 ELEVATION TO NGVD 29 ELEVATION IS APPROXIMATELY –4 FEET. (NAVD 88 –4' = NGVD 29)



BASIS OF BEARING – MONTANA STATE PLANE COORDINATE SYSTEM NAD 83 (1992)

LEGEND

- + GRID TICK
- × SPOT ELEVATION
- ▲ PRIMARY SURVEY CONTROL (USBR CAP)
- ● SECONDARY CONTROL (NAIL W/WHISKER)
- ● HYDRAULIC GATE VALVE
- GUY ANCHOR
- POWER POLE

(PHOTO 1)

(PHOTO 3)

CONTRACT NO. 1425–98–CA–68–9990
TASK ORDER NO. – B2

DATE OF SURVEY – JANUARY 2002

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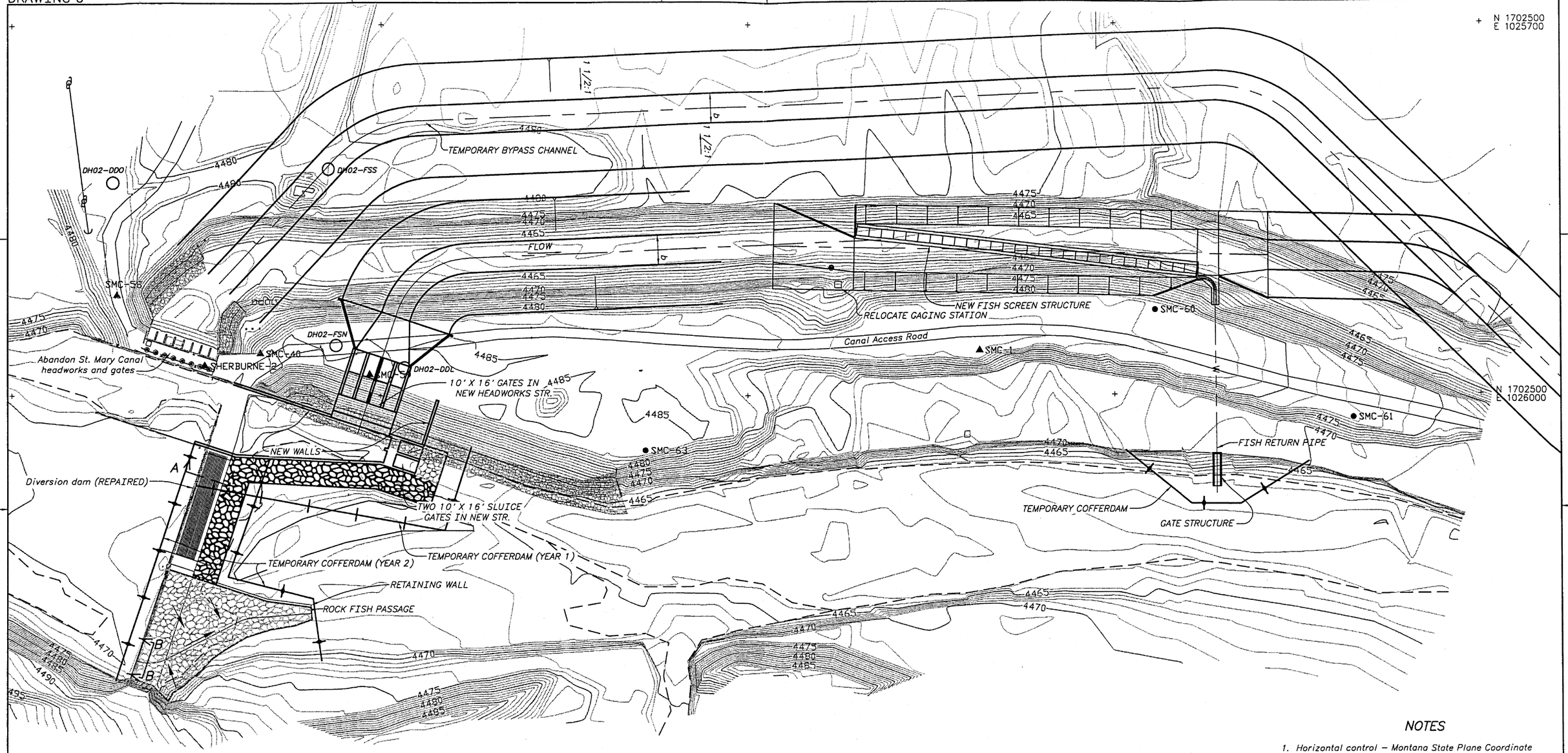
ST. MARY DIVISION, MILK RIVER PROJECT
SAINT MARY CANAL
DIVERSION DAM AND HEADWORKS
PLANIMETRIC AND TOPOGRAPHIC MAPPING

DESIGNED	CHECKED GLENN HOWARD (DABA P.C.)	
DRAWN SCOTT R. SLOTSVE (DABA P.C.)	TECH. APPR.	
APPROVED		
CAD SYSTEM LDD R20 MISSOULA, MT.	CAD FILENAME 4328–B2ASTIE.dwg JANUARY, 2002 SHEET 2 OF 3	DATE AND TIME PLOTTED

(22X34), 1" = 60'

DRAWING 5

DRAWING 6



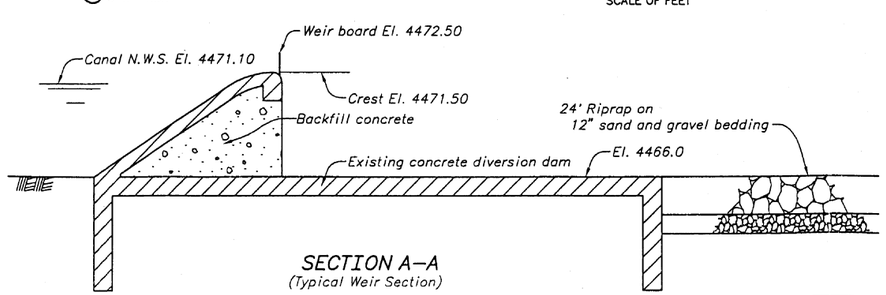
SITE PLAN

(4-Bay headworks structure shown)

40 0 40 80 120
SCALE OF FEET

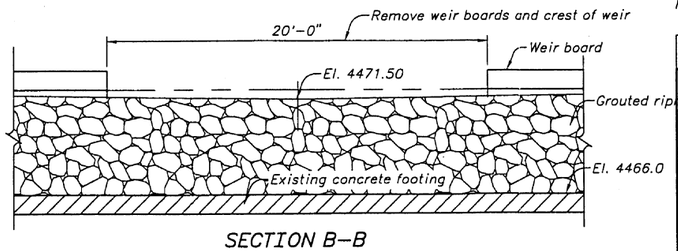
NOTES

1. Horizontal control – Montana State Plane Coordinate System NAD 83 (1992).
2. Vertical control – NAVD 88.
3. Sherburne-2 NAVD 88 El. 4484.82, NGVD 29 El. 4480.76.
4. Drill holes are indicated by ◯ DH02-DDL
5. New features are called out by all upper case text in Site Plan.



SECTION A–A

(Typical Weir Section)



SECTION B–B

TABLE OF DATA

Q (cfs)	b	No. Gate Bays in Headworks
1050	28'	4
890	24'	4
710	19'	3
540	14'	2

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BUREAU OF RECLAMATION
MILK RIVER PROJECT
ST. MARY STORAGE UNIT – MONTANA

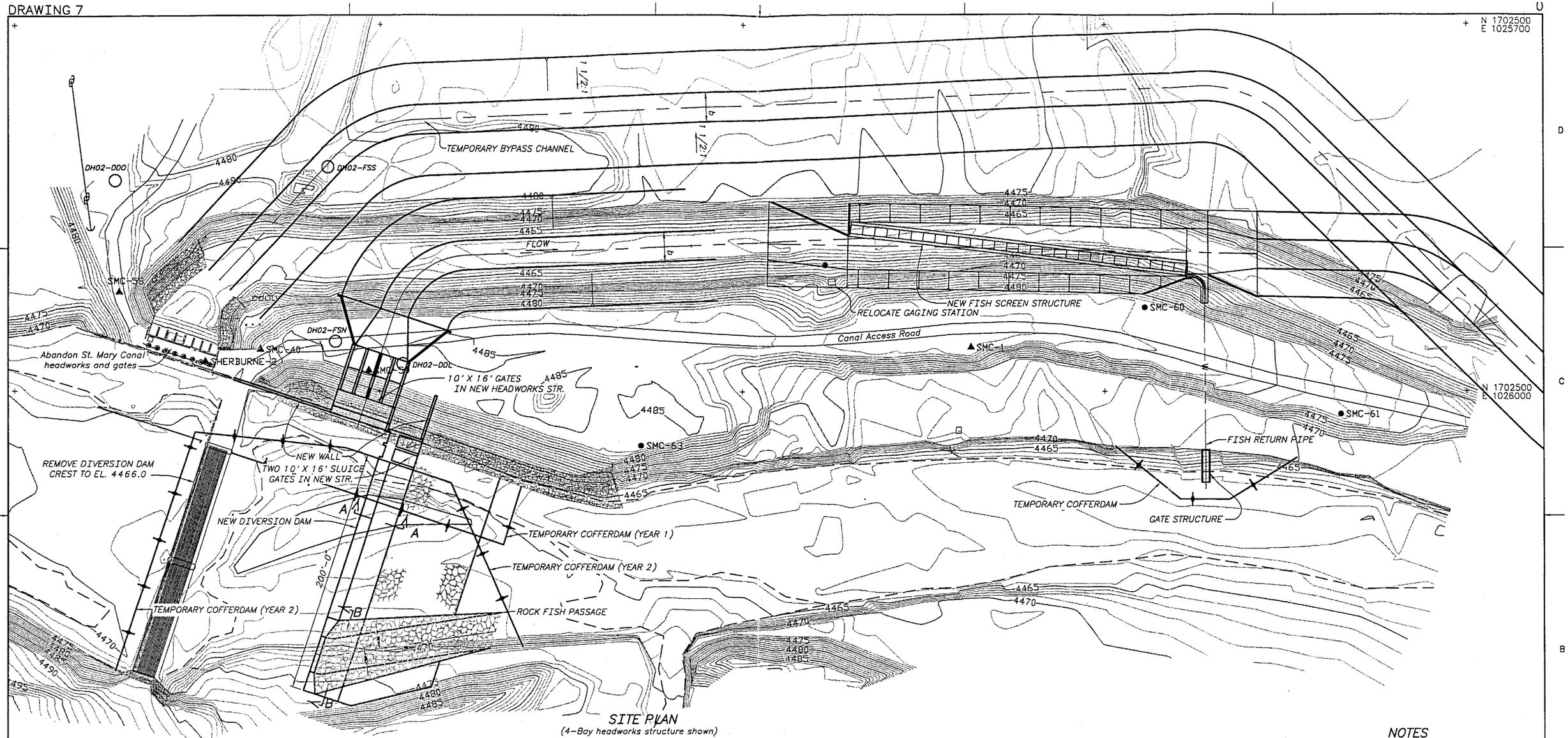
ST. MARY DIVERSION AND HEADWORKS MODIFICATIONS

CONCEPT 1
SITE PLAN

DESIGNED _____ TECH. APPR. _____
DRAWN _____
CHECKED _____ APPROVED _____

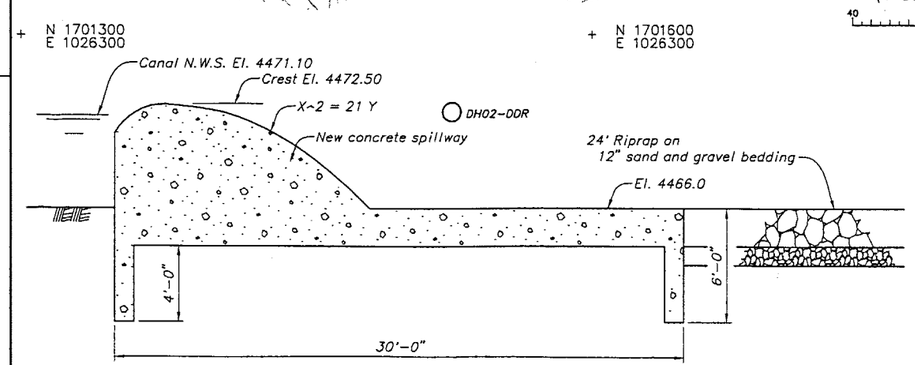
CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME CONCEPT1 SITE PLAN.DWG
DENVER, COLORADO | JULY 25, 2002 | DRAWING 6

PLOTTED BY: RSAYER
APRIL 3, 2003 15:10

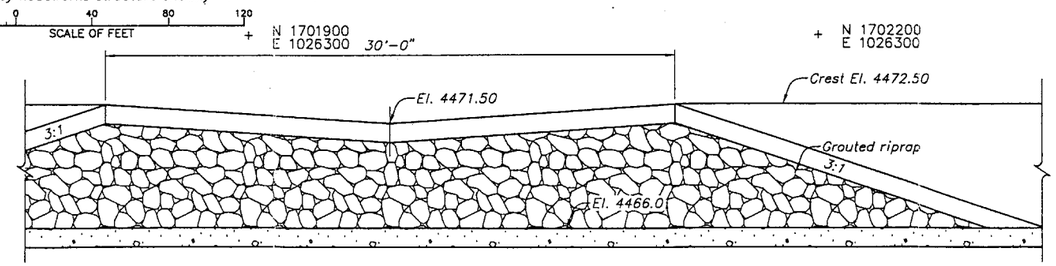


SITE PLAN
(4-Bay headworks structure shown)

SCALE OF FEET: 40 0 40 80 120



SECTION A–A
(Typical Weir Section)



SECTION B–B

TABLE OF DATA

Q (cfs)	b	No. Gate Bays in Headworks
1050	28'	4
890	24'	4
710	19'	3
540	14'	2

NOTES

1. Horizontal control – Montana State Plane Coordinate System NAD 83 (1992).
2. Vertical control – NAVD 88.
3. Sherburne–2 NAVD 88 El. 4484.82, NGVD 29 El. 4480.76.
4. Drill holes are indicated by ◯ DH02–DDL
5. New features are called out by all upper case text in Site Plan.

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DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MILK RIVER PROJECT
ST. MARY STORAGE UNIT – MONTANA

ST. MARY DIVERSION AND HEADWORKS
MODIFICATIONS
CONCEPT 2
SITE PLAN

DESIGNED _____ TECH. APPR. _____
DRAWN _____
CHECKED _____ APPROVED _____

CADD SYSTEM: AutoCAD Rel. 15.06
DENVER, COLORADO
CADD FILENAME: CONCEPT2 SITE PLAN.DWG
JULY 25, 2002
DRAWING 7

FILE PATH: H:\Home\Civil\Eng Share\PROJ\ST MARY\
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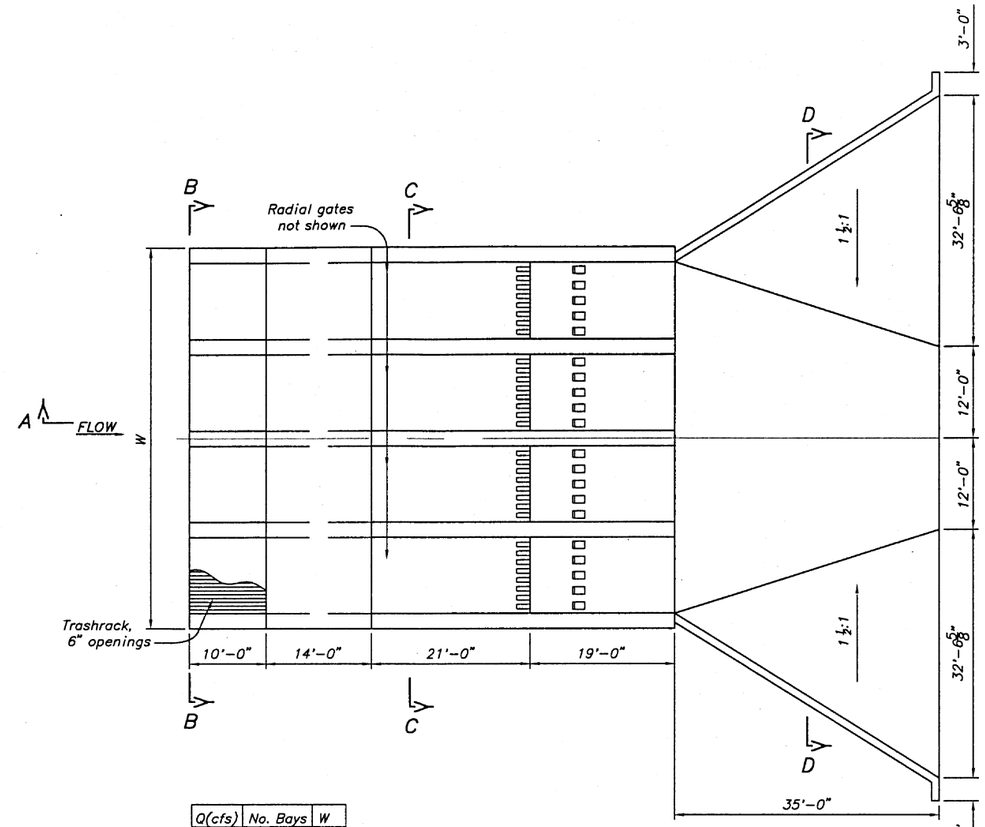
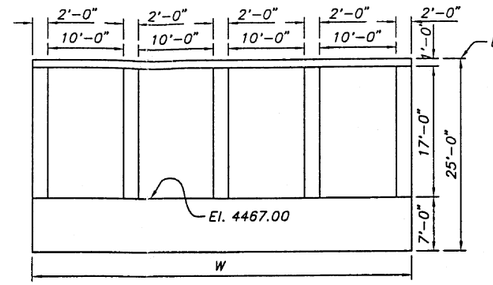
APRIL 3, 2003 15:20



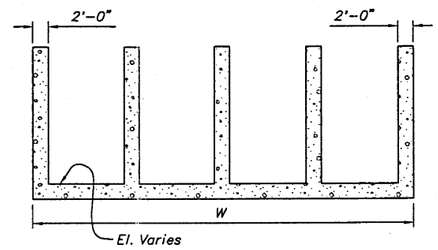
Q(cfs)	No. Bays	W
1050	4	50'
890	4	50'
710	3	38'
540	2	26'

PLAN
(4-Bay structure shown)

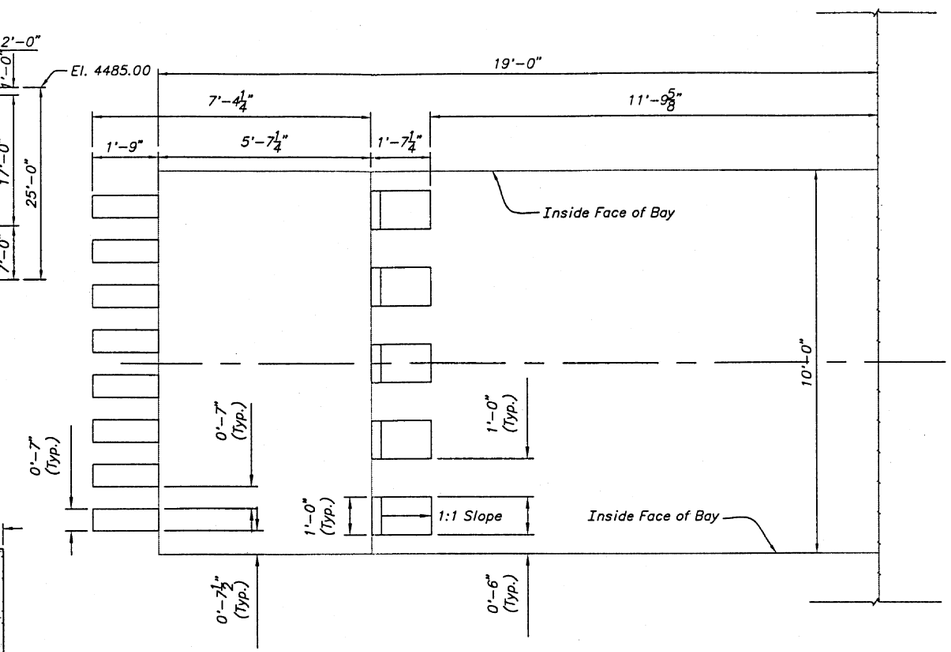
SCALE OF FEET



SECTION B-B



SECTION C-C



Stilling Basin Plan
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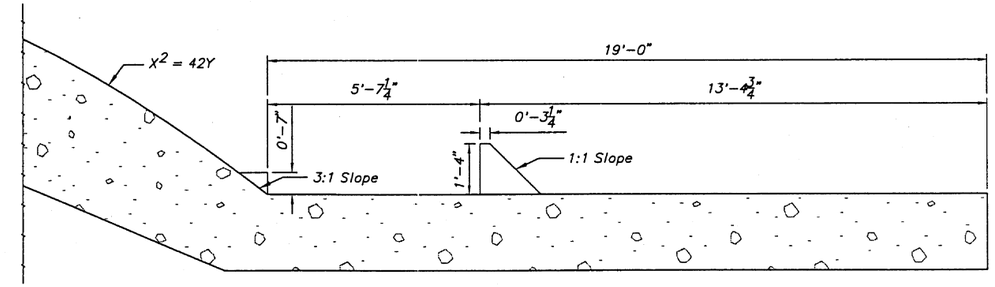
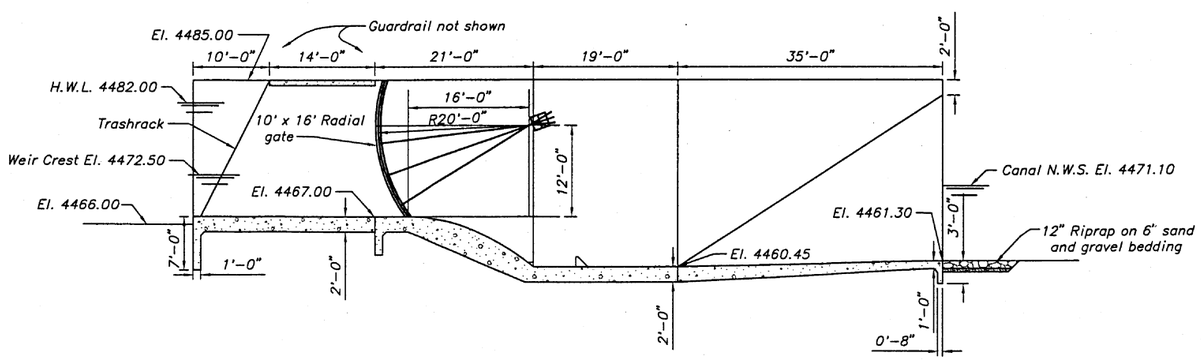
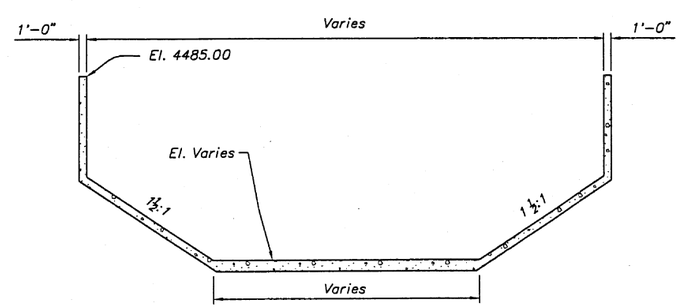


Stilling Basin Profile



SECTION A-A



SECTION D-D

SCALE OF FEET

NOTES

1. Reinf. not shown.

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MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

ST. MARY DIVERSION AND HEADWORKS
DIVERSION MODIFICATIONS
HEADWORKS
PLANS AND SECTIONS

DESIGNED _____ TECH. APPR. APPR. _____
DRAWN _____
CHECKED _____ APPROVED _____

CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME STMARY1A.DWG
DENVER, COLORADO | JULY 25, 2002 | Drawing 8

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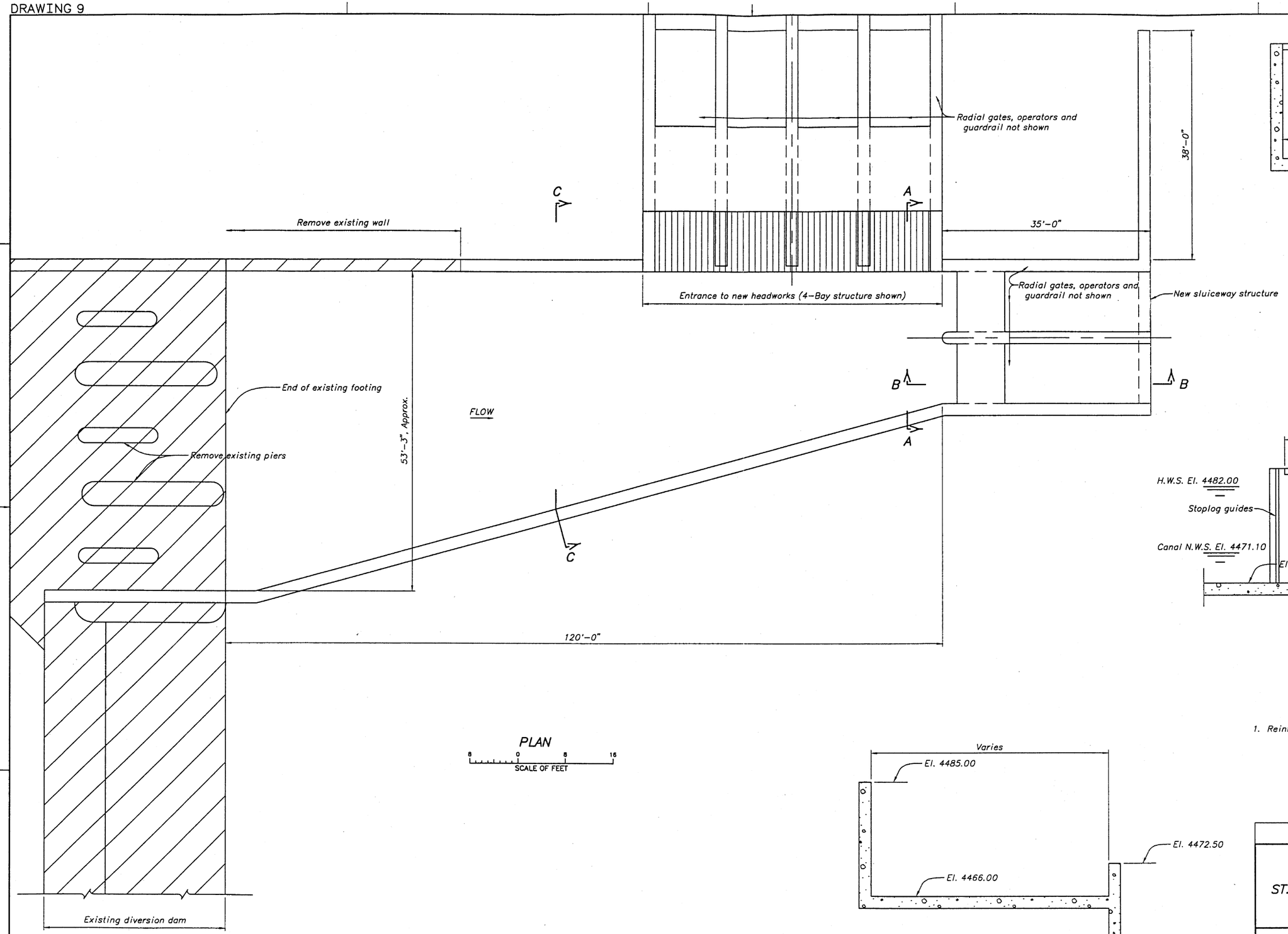
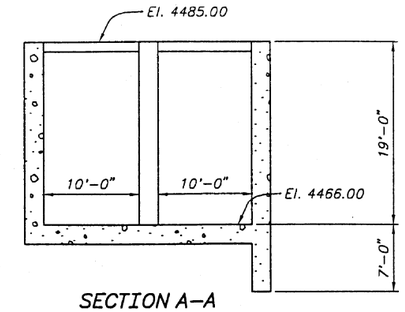
PLOTTED BY: ASTREITE
FEBRUARY 13, 2003 12:52

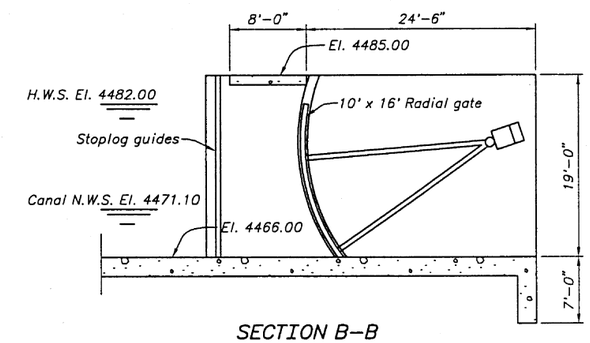


PLAN

8 0 8 16
SCALE OF FEET



SECTION A-A



SECTION B-B

NOTE

1. Reinforcement in structure not shown.

SECTION C-C

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ST. MARY DIVERSION AND HEADWORKS
DIVERSION MODIFICATIONS
CONCEPT 1 SLUICEWAY
PLAN AND SECTIONS

DESIGNED _____ TECH. APPR. _____
DRAWN _____
CHECKED _____ APPROVED _____

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DENVER, COLORADO | JULY 25, 2002 | SHEET 2 OF 2 | DRAWING 9

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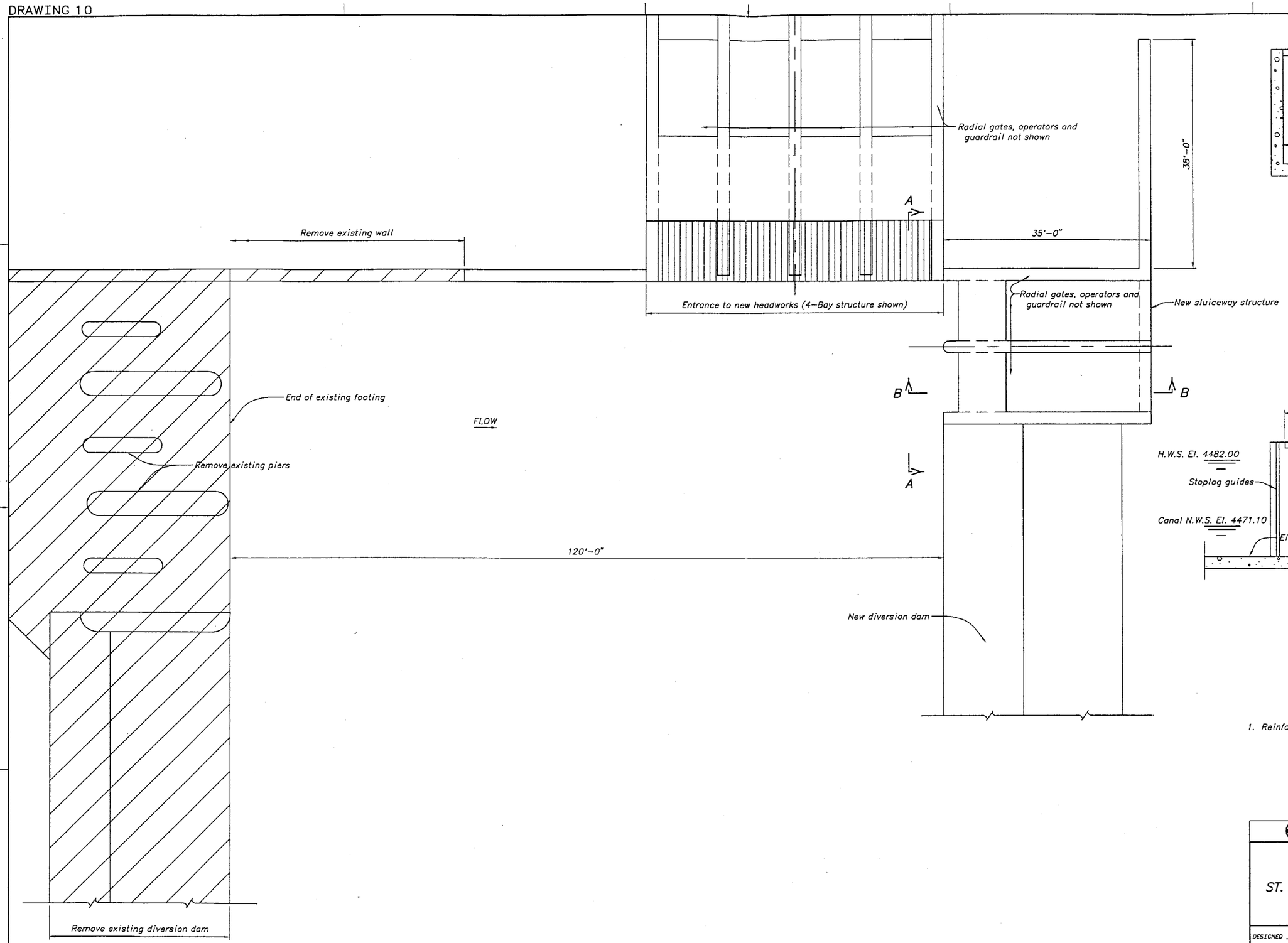
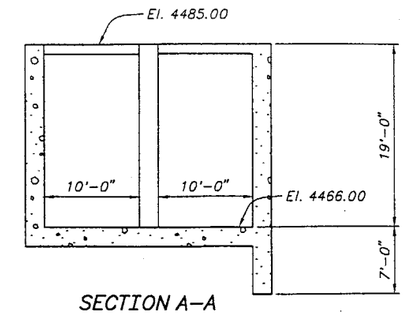
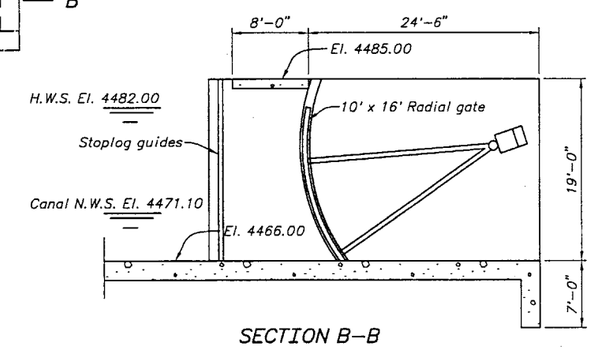


PLAN

8 0 8 16
SCALE OF FEET



SECTION A-A



SECTION B-B

NOTE

1. Reinforcement in structure not shown.

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MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

ST. MARY DIVERSION AND HEADWORKS

DIVERSION MODIFICATIONS
CONCEPT 2 SLUICEWAY
PLAN AND SECTIONS

DESIGNED _____ TECH. APPR. _____
DRAWN _____
CHECKED _____ APPROVED _____

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DENVER, COLORADO | SHEET 2 OF 2 | JULY 23, 2002 | DRAWING 10

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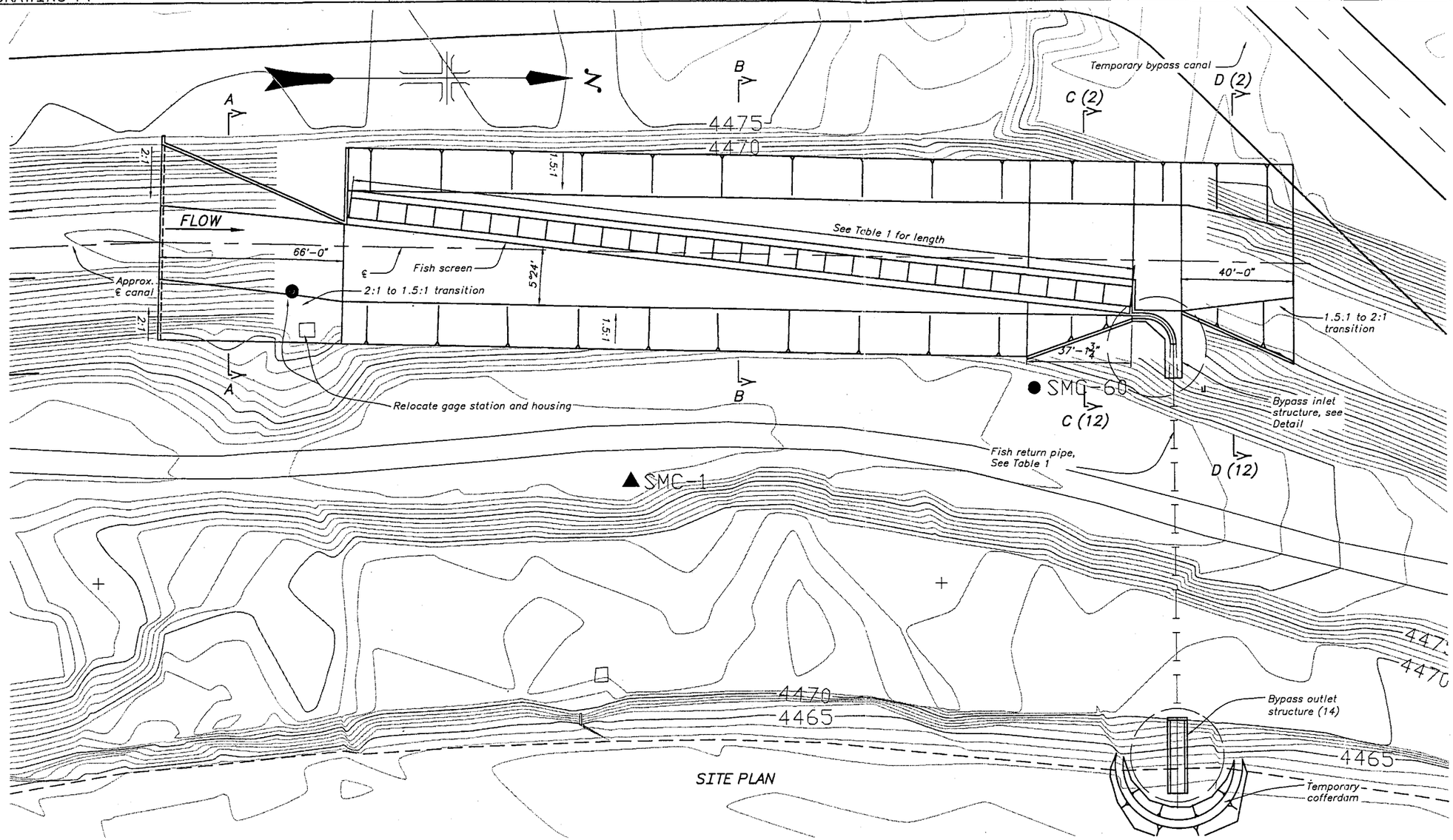
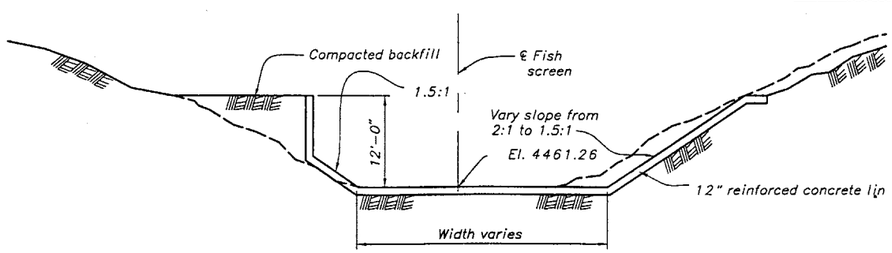


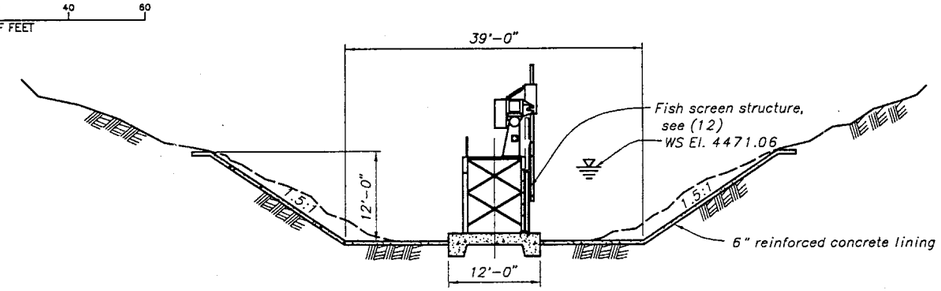
SITE PLAN

20 0 20 40 60
SCALE OF FEET



SECTION A–A

10 0 10 20 30
SCALE OF FEET



SECTION B–B

APPRAISAL DESIGN FLOWS FOR FISHSCREEN ALTERNATIVES

Diversion flow, cfs	Bypass return flow, cfs	D/S Canal flow, cfs
540	40	500
710	40	670
890	40	850
1050	50	1000

TABLE 1

Screen flow, cfs	Fishscreen length, ft	Pipe diameter, inches
500	170	39
670	230	42
850	280	42
1000	330	48

NOTES

1. This drawing depicts a fishscreen for the 890 cfs alternative. Screens for other flows must be adjusted for length.
2. Existing canal bottom differs a few feet (plus or minus) from design width. Excavation and canal trimming will be required for fish screen.
3. Tailwater curve for river unknown. Assumption of 1.3' minimum differential between canal and river used for sizing bypass pipe. If differential increases, stoplogs may be placed in bypass inlet.
4. For canal headworks, diversion dam, and screen site layout see DRAWINGS 6 and 7.

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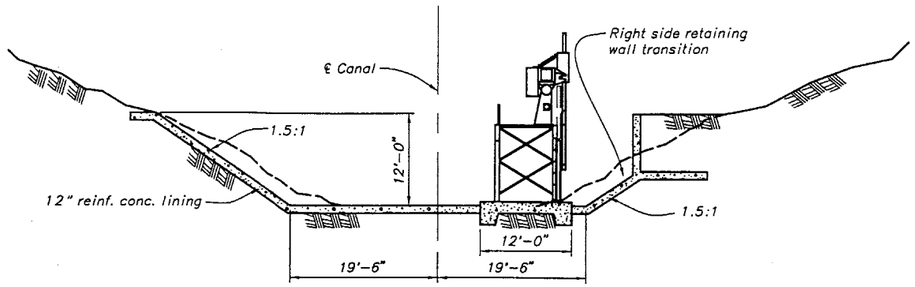
ST. MARY CANAL
DIVERSION MODIFICATIONS
FISH SCREEN
PLAN AND SECTIONS

DESIGNED Jeff Baysinger TECH. APPR. TECH APPR
DRAWN Jeff Baysinger
CHECKED CHECKER APPROVED APPROVED
PEER REVIEWER

CADD SYSTEM AutoCAD Rel. 15.06
CADD FILENAME FISH SCREEN DETAILS.DWG
DENVER, COLORADO JULY 25, 2002
DRAWING 11

FILE PATH: H:\Users\CivilEng Share\PROJ\ST MARY\
PLOTTED BY: SCHER
FEBRUARY 13, 2003 14:04



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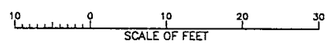
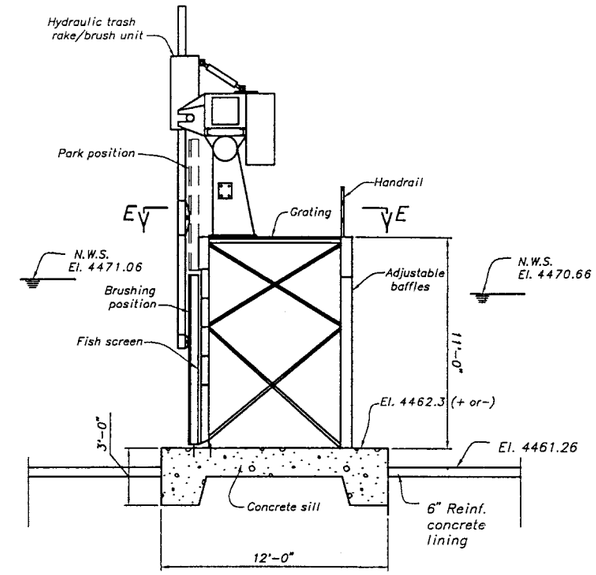
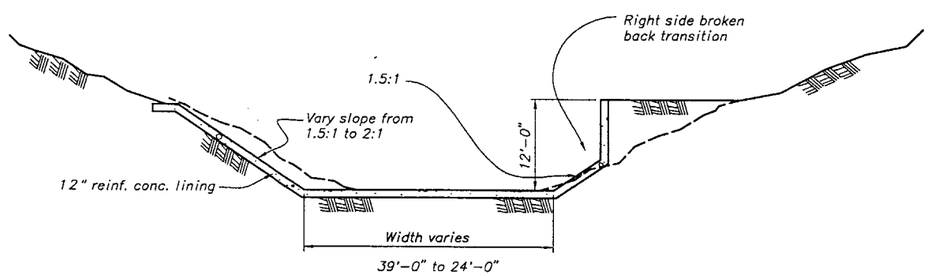




FISH SCREEN DETAIL



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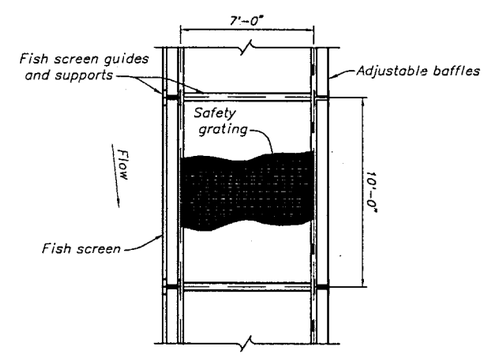

SECTION E-E

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ST. MARY STORAGE UNIT – MONTANA

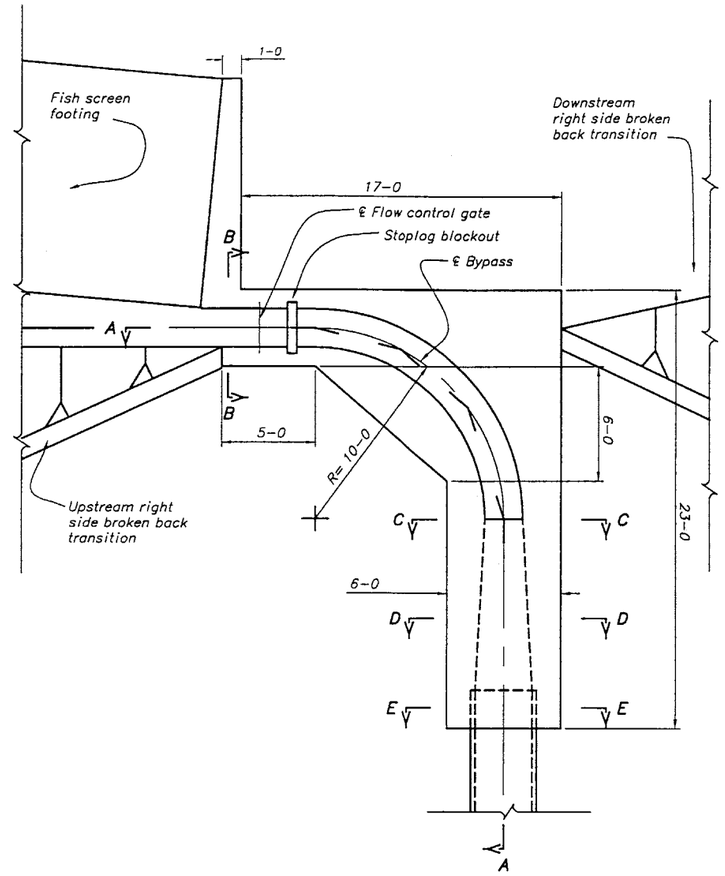
ST. MARY CANAL
DIVERSION MODIFICATIONS

FISH SCREEN
SECTIONS AND FISH SCREEN DETAIL

DESIGNED Jeff Baysinger TECH. APPR. TECH APPR
DRAWN Jeff Baysinger
CHECKED CHECKER APPROVED APPROVED
PEER REVIEWER

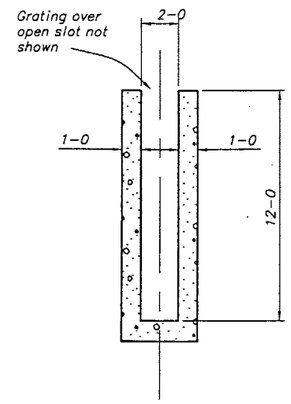
CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME FISH SCREEN DETAILS.DWG
DENVER, COLORADO JULY 25, 2002 | DRAWING 12

FILE PATH: H:\Works\CivilEng SMSU\PROJ\ST MARY\
PLOTTED BY: KSAYER
FEBRUARY 13, 2003 14:04

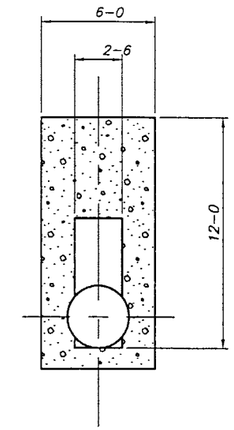


DETAIL

1 0 5 10 15
SCALE OF FEET



SECTION B-B



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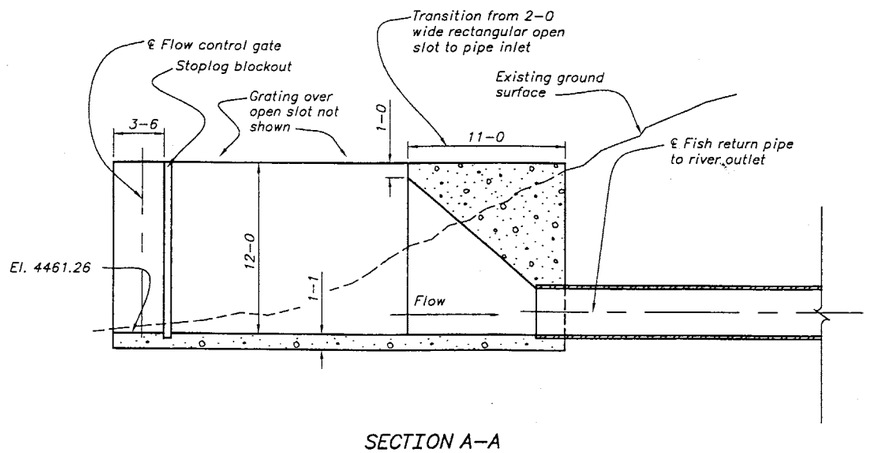

SECTION A-A

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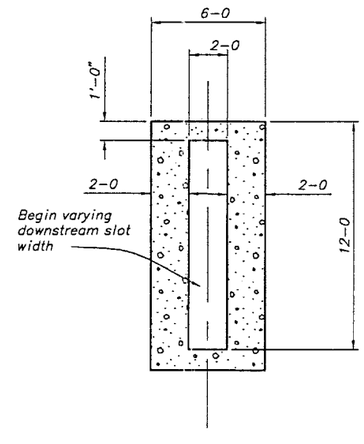
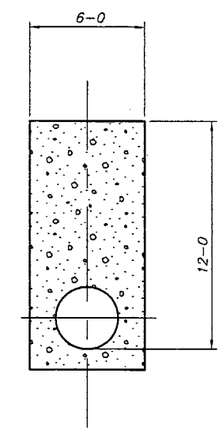
SCALE OF FEET



SECTION C-C



SECTION E-E

NOTES

1. Flow control gate will be used to regulate flows. The downstream slidegate at the fish return pipe outlet will be used for river shutoff, fully open unless closed for shutoff.

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ST. MARY STORAGE UNIT – MONTANA

ST. MARY CANAL
DIVERSION MODIFICATIONS
FISH SCREEN – BYPASS INLET
DETAIL AND SECTIONS

DESIGNED Jeff Baysinger TECH. APPR. TECH APPR
DRAWN Jeff Baysinger
CHECKED CHECKER APPROVED APPROVED
PEER REVIEWER

CADD SYSTEM AutoCAD Rel. 15.06
CADD FILENAME FISH SCREEN DETAILS.DWG
DENVER, COLORADO JULY 25, 2002
DRAWING 13

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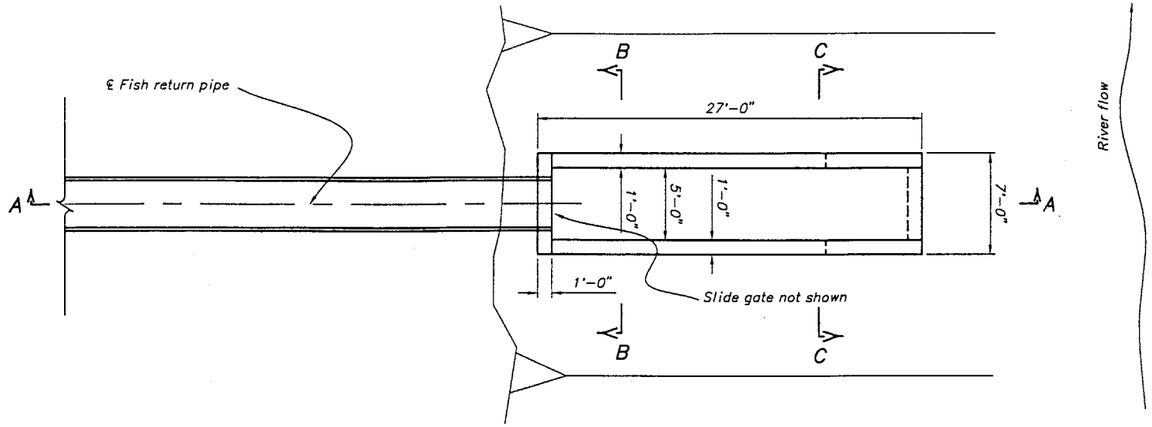
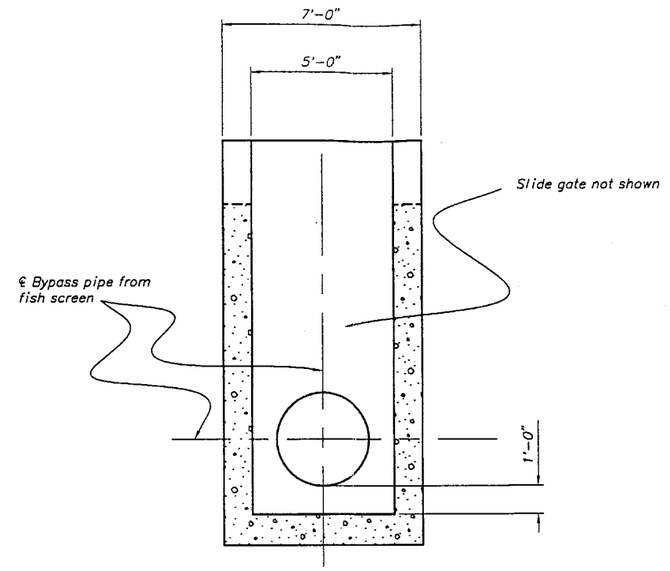


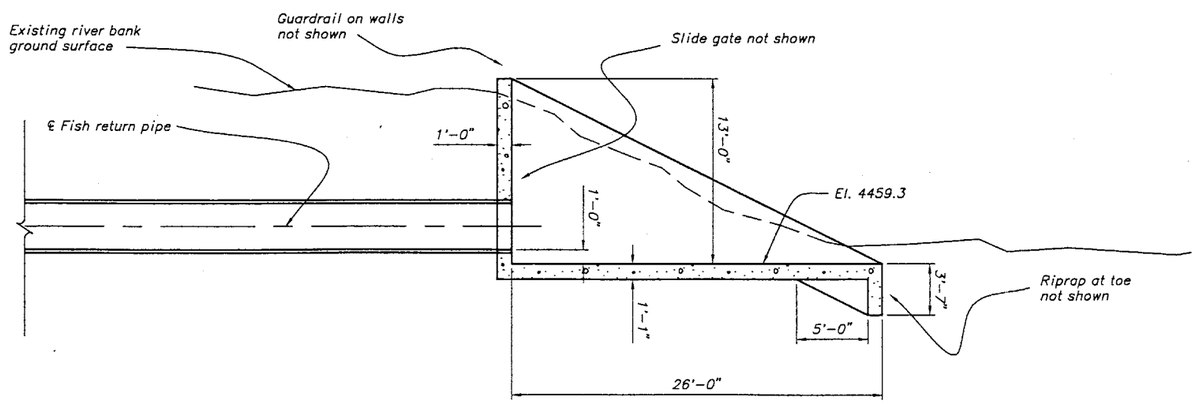
SITE PLAN

1 0 5 10 15
SCALE OF FEET

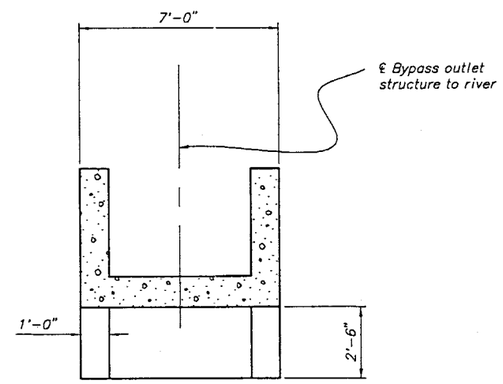


SECTION B–B

1 0 1 2 3 4 5 6 7 8
SCALE OF FEET



SECTION A–A



SECTION C–C

NOTES

1. Slide gate fully open during fish screen operations and closed for winter shutdown to prevent river flow from entering canal.

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ST. MARY STORAGE UNIT – MONTANA

ST. MARY CANAL
DIVERSION MODIFICATIONS
FISH SCREEN – BYPASS OUTLET TO RIVER
PLAN AND SECTIONS

DESIGNED Jeff Boysinger TECH. APPR. TECH APPR
DRAWN Jeff Boysinger
CHECKED CHECKER APPROVED APPROVED
PEER REVIEWER

CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME FISH SCREEN DETAILS.DWG
DENVER, COLORADO JULY 25, 2002 | DRAWING 14

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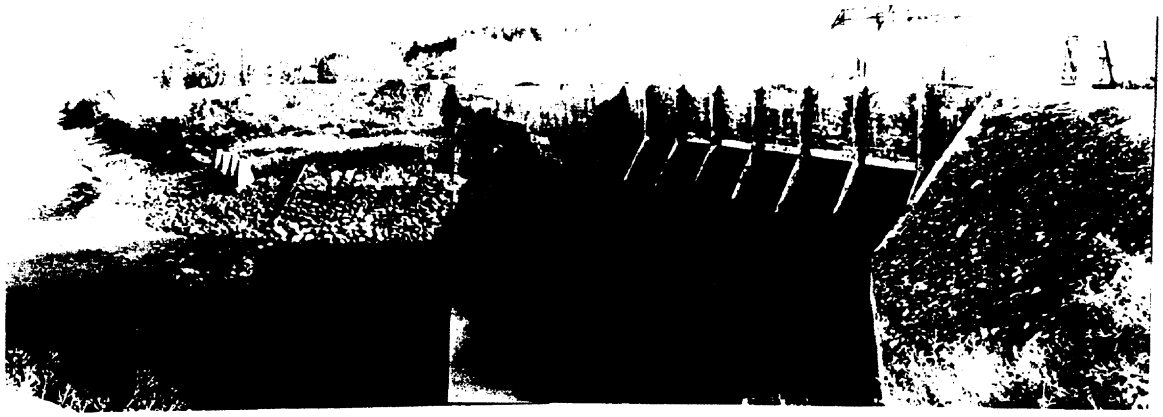
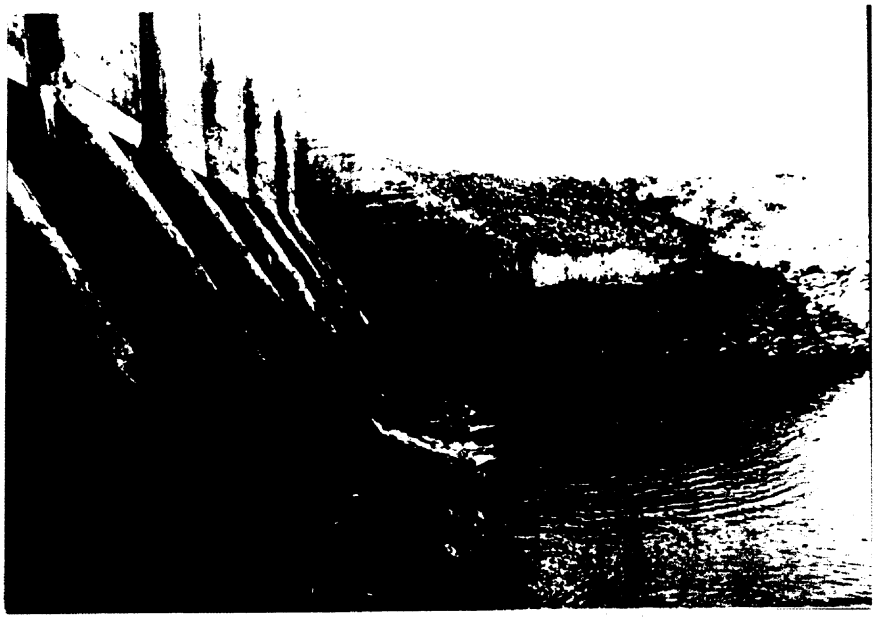
FEBRUARY 13, 2003 14:04

Appendix A

ST. MARY DAM INSPECTION PHOTOGRAPHS

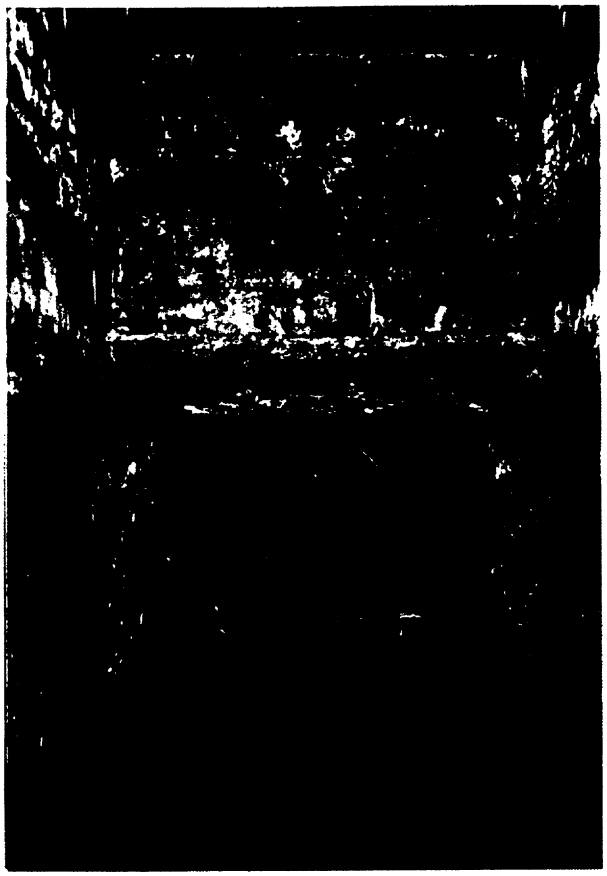


PHOTOGRAPH NO. 1 - View of the downstream side of the St. Mary Headworks of the St. Mary Diversion Dam looking in a northerly direction.



PHOTOGRAPH NO. 2 - View of the downstream side of the St. Mary Headworks looking south from Bay 1 to Bay 8. Note the spalling of the concrete from what appears to be freeze/thaw damage.

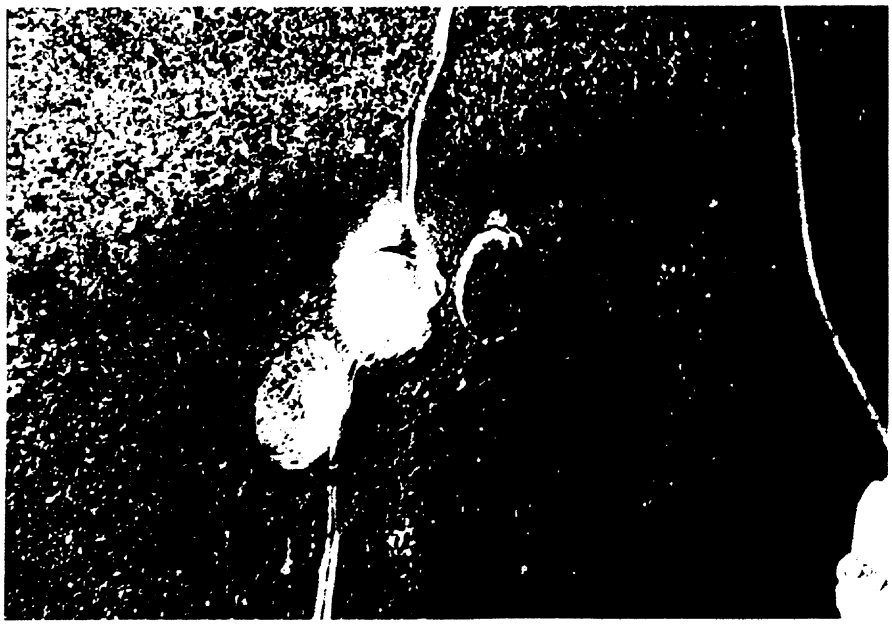
PHOTOGRAPH NO. 3 - View of the Downstream side of the St. Mary Headworks looking north from Bay 8. Note the spalling of the concrete.



PHOTOGRAPH NO. 4 - Photograph of a typical bay of the downstream side of the St. Mary Headworks. Note the spalling of the concrete around the gate area. This damage appears to be caused from freeze/thaw action.

PHOTOGRAPH NO. 5 - Photograph of the core samples being drilled in the south wall of the St. Mary Headworks in Bay 8. Note the three holes in the north wall of Bay 8. One sample was retrieved without reinforcement bars in the core. The remaining two holes were abandoned.

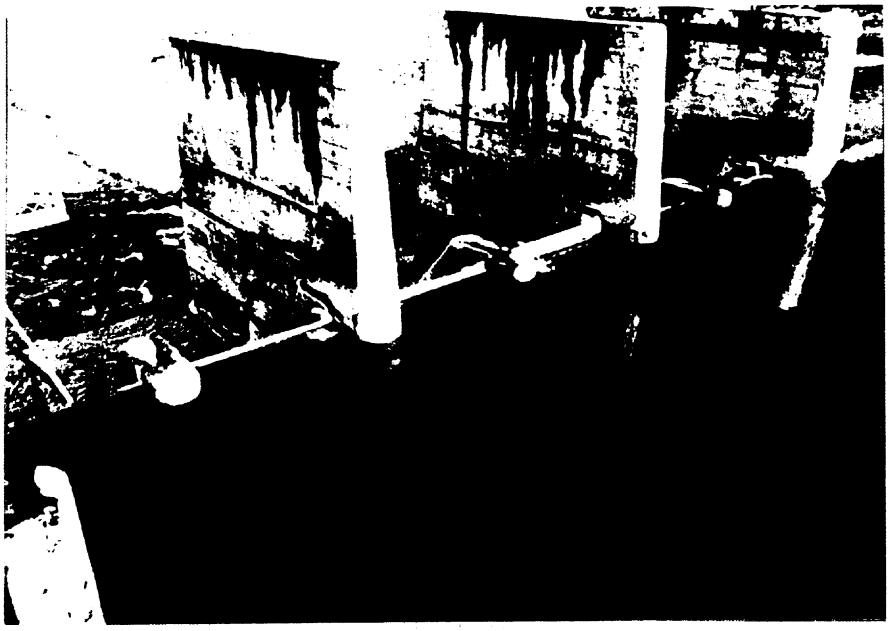
PHOTOGRAPH NO. 6 - View of the drilling operation in the south wall of Bay 8 looking upstream from the downstream side of the St. Mary Headworks.



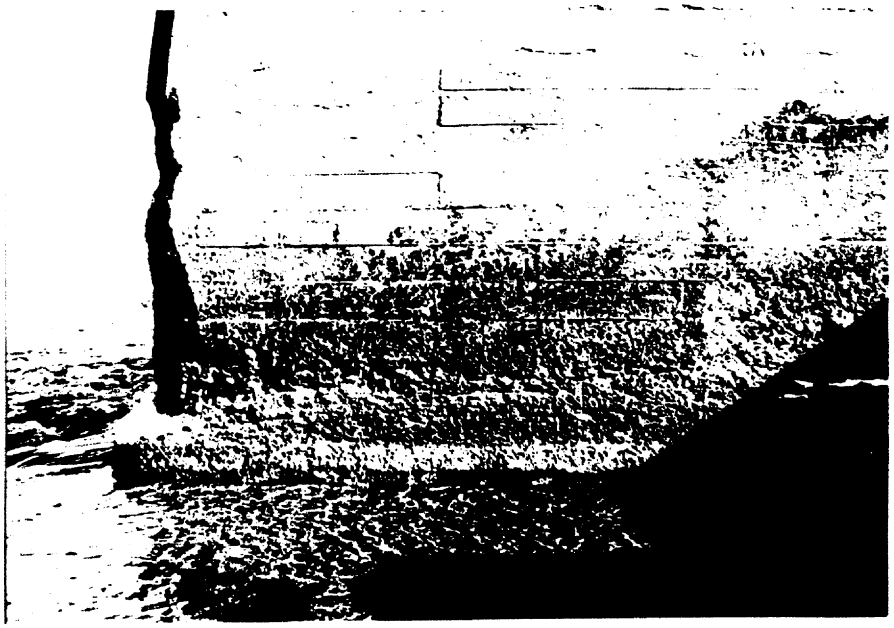
PHOTOGRAPH NO. 7 - Photograph of the three holes drilled in the north wall of Bay 8. The lower left hole was completed and recovered without containing reinforcement steel.

PHOTOGRAPH NO. 8 - View of the two holes drilled in the south wall of Bay 4. Note that the right hole contains a reinforcement bar. The right hole was drilled first. After encountering steel, it was noted that the water pressure from the drilling operation was being forced through the voids in the concrete and exiting the opposite side of the wall. A second core was recovered without steel.

PHOTOGRAPH NO. 9 - Photograph of the core sample obtained from the north wall of Bay 8.



PHOTOGRAPH NO. 12 - View of the St. Mary Diversion Dam, looking in a northerly direction. The vertical piers were drilled into, however core samples were not recovered due to the poor quality of the concrete. These vertical members cannot be used in the design of the proposed radial sluice gates.



PHOTOGRAPH NO. 13 - View of the west side of the first pier (refer to Photograph 12). Two attempts were made to extract concrete core samples. The shear pin was sheared both times due to the breaking up of the concrete inside the core bit. The concrete could be broken out with very little effort.

PHOTOGRAPH NO. 14 - View of the southwest side of the first pier shown in Photograph 13. Note the condition of the concrete. The concrete could be broken or dislodged with very little effort.

PHOTOGRAPH NO. 15 - View of the splitter wall, looking in a southerly direction. A good core sample was retrieved 1 foot north of the splitter wall in the [illegible].

APPENDIX B

HYDRAULIC BACKWATER MODELING

EXISTING DIVERSION DAM AND HEADWORKS MODEL

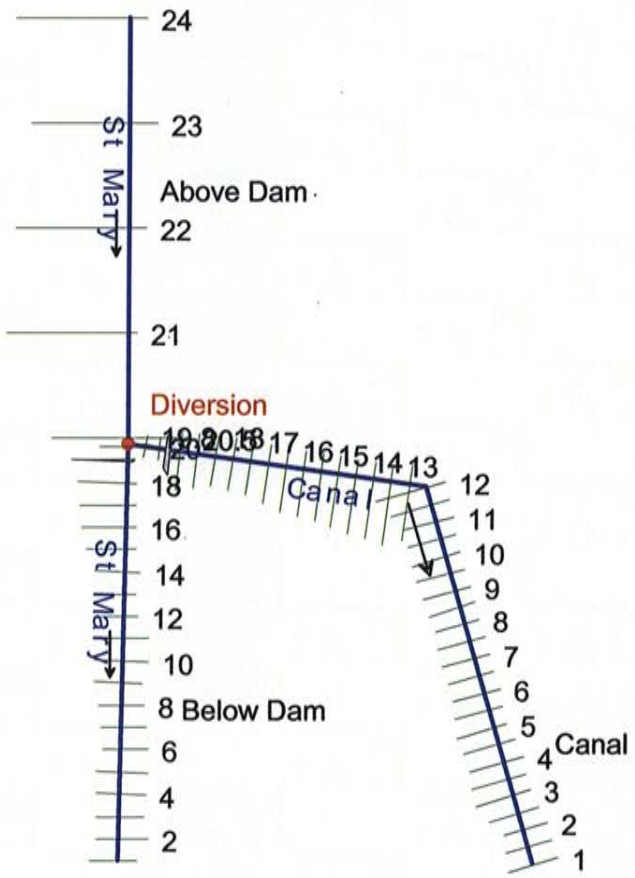


FIGURE B 1 HECRAS GEOMETRY PLOT FOR EXISTING DIVERSION DAM AND HEADWORKS.

TABLE B 1 EXISTING DIVERSION WITH 1170 FT³/S RIVER FLOW AND 850 FT³/S DIVERSION (8 GATES –2.75 FT OPEN)

River	Reach	River Sta	Q Total (cfs)	Min Channel El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Channel (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
Canal	Canal	19.8	842.45	4467.00	4472.96	5.96	4473.05	0.000143	2.35	357.83	60.00	0.022	950.00
Canal	Canal	19.7	842.45	4467.00	4472.95	5.95	4473.04	0.000144	2.36	357.19	60.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	842.45	4463.17	4471.61	8.44	4471.67	0.000091	2.04	412.90	69.74	0.022	900.00
Canal	Canal	18	842.45	4463.51	4471.54	8.03	4471.65	0.000169	2.61	323.01	59.91	0.022	850.00
Canal	Canal	17	842.45	4462.77	4471.44	8.66	4471.63	0.000355	3.50	241.02	49.65	0.022	800.00
Canal	Canal	16	842.45	4461.91	4471.41	9.50	4471.60	0.000378	3.45	244.14	53.86	0.022	750.00
Canal	Canal	15	842.45	4460.67	4471.48	10.81	4471.55	0.000082	2.09	402.13	58.90	0.022	700.00
Canal	Canal	14	842.45	4461.95	4471.47	9.52	4471.54	0.000104	2.22	379.06	61.00	0.022	650.00
Canal	Canal	13	842.45	4461.57	4471.45	9.88	4471.52	0.000091	2.12	396.56	62.08	0.022	600.00
Canal	Canal	12	842.45	4461.11	4471.44	10.33	4471.51	0.000087	2.10	402.00	61.90	0.022	550.00
Canal	Canal	11	842.45	4460.45	4471.43	10.98	4471.50	0.000082	2.09	403.35	58.89	0.022	500.00
Canal	Canal	10	842.45	4461.67	4471.42	9.75	4471.49	0.000095	2.17	388.31	61.09	0.022	450.00
Canal	Canal	9	842.45	4460.77	4471.42	10.65	4471.48	0.000075	2.01	418.91	61.23	0.022	400.00
Canal	Canal	8	842.45	4460.50	4471.41	10.91	4471.48	0.000083	2.10	400.45	58.33	0.022	350.00
Canal	Canal	7	842.45	4460.36	4471.39	11.03	4471.47	0.000104	2.29	367.90	55.79	0.022	300.00
Canal	Canal	6	842.45	4460.66	4471.39	10.73	4471.47	0.000115	2.20	382.77	67.66	0.022	250.00
Canal	Canal	5	842.45	4461.89	4471.32	9.43	4471.45	0.000236	2.93	288.01	57.43	0.022	200.00
Canal	Canal	4	842.45	4462.26	4471.33	9.07	4471.42	0.000138	2.48	340.28	58.00	0.022	150.00
Canal	Canal	3	842.45	4462.49	4471.32	8.83	4471.41	0.000115	2.35	359.08	57.68	0.022	100.00
Canal	Canal	2	842.45	4462.60	4471.32	8.72	4471.40	0.000116	2.35	357.99	57.30	0.022	50.00
Canal	Canal	1	842.45	4461.91	4471.32	9.41	4471.39	0.000095	2.17	387.74	60.58	0.022	
St Mary	Above Dam	24	1133.00	4463.65	4473.08	9.43	4473.09	0.000052	0.95	1188.91	213.97	0.035	430.00
St Mary	Above Dam	23	1133.00	4462.87	4473.07	10.20	4473.09	0.000042	0.97	1165.00	172.29	0.035	330.00
St Mary	Above Dam	22	1133.00	4463.65	4473.07	9.42	4473.09	0.000052	0.95	1193.55	213.86	0.035	230.00
St Mary	Above Dam	21	1133.00	4463.71	4473.07	9.36	4473.08	0.000025	0.74	1541.42	229.81	0.035	130.00
St Mary	Above Dam	20.5	1133.00	4469.24	4472.98	3.74	4473.07	0.000598	2.41	470.88	126.01	0.035	30.00
St Mary	Below Dam	20	290.55	4469.24	4473.04	3.80	4473.04	0.000015	0.39	736.50	194.00	0.035	933.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	290.55	4464.38	4467.16	2.78	4467.17	0.000200	0.78	373.46	249.39	0.035	900.00
St Mary	Below Dam	18	290.55	4462.59	4467.04	4.45	4467.14	0.003352	2.44	119.25	119.55	0.035	850.00
St Mary	Below Dam	17	290.55	4463.61	4466.70	3.09	4466.89	0.007051	3.52	82.61	83.52	0.035	800.00
St Mary	Below Dam	16	290.55	4463.81	4466.20	2.39	4466.48	0.008863	4.27	68.04	61.12	0.035	750.00
St Mary	Below Dam	15	290.55	4463.01	4465.76	2.75	4466.10	0.006518	4.63	62.77	39.48	0.035	700.00
St Mary	Below Dam	14	290.55	4463.51	4465.14	1.63	4465.61	0.014577	5.51	52.71	46.97	0.035	650.00
St Mary	Below Dam	13	290.55	4462.43	4464.77	2.34	4465.05	0.007193	4.26	68.15	52.63	0.035	600.00
St Mary	Below Dam	12	290.55	4462.71	4464.62	1.91	4464.74	0.003852	2.83	102.55	91.82	0.035	550.00
St Mary	Below Dam	11	290.55	4462.79	4464.45	1.66	4464.56	0.003340	2.57	112.97	104.94	0.035	500.00
St Mary	Below Dam	10	290.55	4462.27	4464.20	1.93	4464.34	0.005869	2.96	98.27	112.88	0.035	450.00
St Mary	Below	9	290.55	4462.28	4463.46	1.18	4463.81	0.022245	4.74	61.25	94.23	0.035	400.00

River	Reach	River Sta	Q Total (cfs)	Min Channel El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Channel (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
St Mary	Dam Below Dam	8	290.55	4461.30	4463.33	2.03	4463.43	0.002859	2.48	117.10	101.49	0.035	350.00
St Mary	Dam Below Dam	7	290.55	4461.00	4463.23	2.23	4463.31	0.001955	2.28	127.24	94.55	0.035	300.00
St Mary	Dam Below Dam	6	290.55	4460.94	4463.14	2.20	4463.21	0.001431	2.13	136.54	89.28	0.035	250.00
St Mary	Dam Below Dam	5	290.55	4460.28	4463.06	2.78	4463.14	0.001511	2.28	127.61	78.48	0.035	200.00
St Mary	Dam Below Dam	4	290.55	4460.66	4462.91	2.25	4463.03	0.002941	2.82	102.92	75.52	0.035	150.00
St Mary	Dam Below Dam	3	290.55	4460.52	4462.76	2.24	4462.89	0.002628	2.86	101.52	67.11	0.035	100.00
St Mary	Dam Below Dam	2	290.55	4460.39	4462.60	2.21	4462.73	0.003608	2.95	98.57	79.17	0.035	50.00
St Mary	Dam Below Dam	1	290.55	4459.95	4462.36	2.41	4462.52	0.005002	3.21	90.43	81.46	0.035	

CONCEPT MODEL

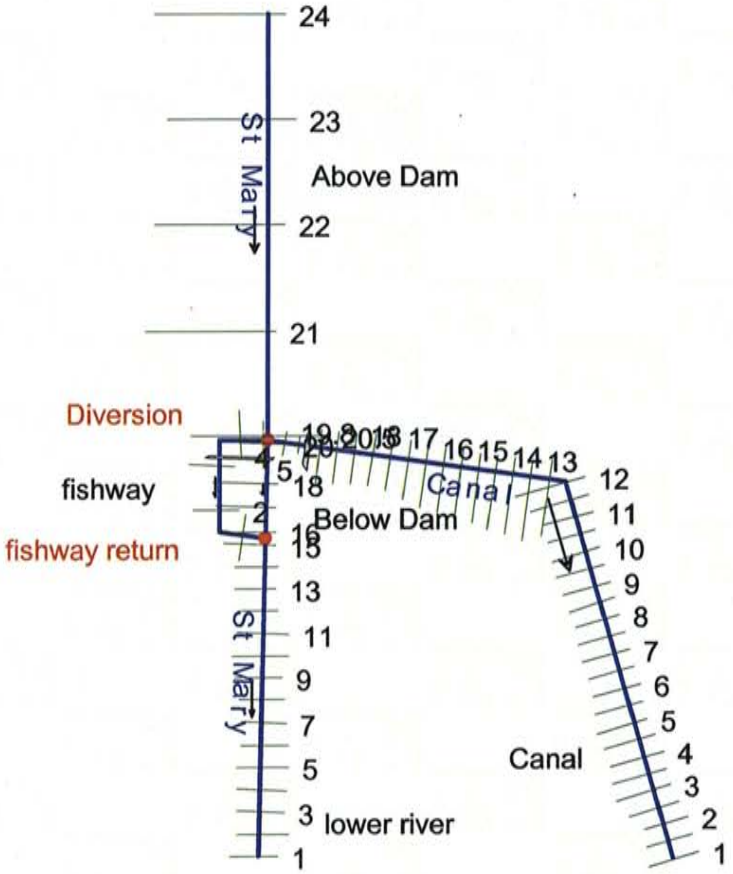


FIGURE B 2 - PLOT OF HEC RAS GEOMETRY FOR CONCEPTS NO. 1 AND 2.

TABLE B 2 - ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 1 WITH 500 FT³/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS.

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Ave. Channel Velocity (ft/s)	Flow Area (sq ft)	Top Width (ft)	Manning s n	Cum. Channel Length (ft)
Canal	Canal	19.8	540.48	4467.00	4472.75	5.75	4472.77	0.000047	1.34	402.23	70.00	0.022	950.00
Canal	Canal	19.7	540.48	4467.00	4472.60	5.60	4472.76	0.000349	3.22	167.96	30.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	540.48	4463.17	4469.56	6.38	4469.61	0.000112	1.94	279.17	60.37	0.022	900.00
Canal	Canal	18	540.48	4463.51	4469.48	5.97	4469.58	0.000231	2.58	209.42	50.21	0.022	850.00
Canal	Canal	17	540.48	4462.77	4469.34	6.57	4469.55	0.000568	3.67	147.19	40.48	0.022	800.00
Canal	Canal	16	500.48	4461.91	4469.34	7.43	4469.52	0.000491	3.41	146.85	39.92	0.022	750.00
Canal	Canal	15	500.48	4460.67	4469.42	8.75	4469.47	0.000079	1.75	285.96	53.98	0.022	700.00
Canal	Canal	14	500.48	4461.95	4469.41	7.46	4469.47	0.000111	1.93	259.17	55.31	0.022	650.00
Canal	Canal	13	500.48	4461.57	4469.39	7.82	4469.44	0.000092	1.82	275.19	55.57	0.022	600.00
Canal	Canal	12	500.48	4461.11	4469.38	8.27	4469.42	0.000084	1.78	281.58	54.40	0.022	550.00
Canal	Canal	11	500.48	4460.45	4469.36	8.91	4469.41	0.000076	1.74	287.57	52.88	0.022	500.00
Canal	Canal	10	500.48	4461.67	4469.35	7.68	4469.40	0.000094	1.86	269.44	53.32	0.022	450.00
Canal	Canal	9	500.48	4460.77	4469.33	8.56	4469.38	0.000070	1.68	297.81	54.68	0.022	400.00
Canal	Canal	8	500.48	4460.50	4469.32	8.82	4469.37	0.000076	1.75	285.33	51.84	0.022	350.00
Canal	Canal	7	500.48	4460.36	4469.31	8.95	4469.37	0.000097	1.93	259.19	48.72	0.022	300.00
Canal	Canal	6	500.48	4460.66	4469.31	8.65	4469.37	0.000099	1.92	260.09	50.04	0.022	250.00
Canal	Canal	5	500.48	4461.89	4469.22	7.33	4469.35	0.000303	2.79	179.11	46.38	0.022	200.00
Canal	Canal	4	500.48	4462.26	4469.23	6.97	4469.31	0.000162	2.22	225.08	51.76	0.022	150.00
Canal	Canal	3	500.48	4462.49	4469.23	6.73	4469.29	0.000121	2.04	245.28	51.00	0.022	100.00
Canal	Canal	2	500.48	4462.60	4469.22	6.62	4469.29	0.000118	2.04	245.64	50.04	0.022	50.00
Canal	Canal	1	500.48	4461.91	4469.23	7.32	4469.28	0.000095	1.86	268.45	53.45	0.022	
St Mary	Above Dam	24	670.00	4463.65	4472.79	9.13	4472.79	0.000022	0.59	1126.84	211.89	0.035	414.00
St Mary	Above Dam	23	670.00	4462.87	4472.79	9.91	4472.79	0.000017	0.60	1115.59	170.88	0.035	314.00
St Mary	Above Dam	22	670.00	4463.65	4472.79	9.13	4472.79	0.000021	0.59	1132.14	211.81	0.035	214.00
St Mary	Above Dam	21	670.00	4463.71	4472.79	9.07	4472.79	0.000010	0.45	1475.11	228.95	0.035	114.00
St Mary	Above Dam	20.5	670.00	4469.24	4472.75	3.51	4472.78	0.000258	1.52	441.77	126.01	0.035	14.00
St Mary	Below Dam	20	54.89	4469.24	4472.77	3.53	4472.77	0.000001	0.09	617.39	175.25	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	54.89	4464.38	4465.65	1.27	4465.69	0.007186	1.60	34.41	116.21	0.035	175.00
St Mary	Below Dam	18	54.89	4462.59	4465.61	3.02	4465.63	0.000381	1.15	47.55	28.24	0.035	125.00
St Mary	Below Dam	17	54.89	4463.61	4465.53	1.92	4465.59	0.002154	1.90	28.96	30.28	0.035	75.00
St Mary	Below Dam	16	94.89	4463.81	4465.23	1.42	4465.39	0.005737	3.17	29.96	30.41	0.035	25.00
St Mary	fishway	5	65.70	4470.00	4472.78	2.78	4472.79	0.000007	0.24	269.73	100.79	0.030	225.00
St Mary	fishway	4	65.70	4471.50	4472.63	1.13	4472.77	0.047333	3.06	21.49	92.17	0.040	200.00
St Mary	fishway	3	65.70	4469.25	4470.37	1.12	4470.52	0.048599	3.09	21.30	91.86	0.040	150.00
St Mary	fishway	2	65.70	4467.50	4468.70	1.20	4468.89	0.030006	3.55	18.51	45.03	0.040	100.00
St Mary	fishway	1	65.70	4465.75	4466.92	1.16	4467.13	0.041494	3.76	17.46	49.65	0.040	50.00
St Mary	lower river	15	120.59	4463.01	4465.12	2.11	4465.26	0.004197	3.08	39.18	32.72	0.035	700.00
St Mary	lower river	14	120.59	4463.51	4464.50	0.99	4464.84	0.020524	4.66	25.85	38.36	0.035	650.00
St Mary	lower river	13	120.59	4462.43	4464.29	1.85	4464.40	0.003864	2.68	44.92	43.58	0.035	600.00

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Ave. Channel Velocity (ft/s)	Flow Area (sq ft)	Top Width (ft)	Manning s n	Cum. Channel Length (ft)
St Mary	Lower River	12	120.59	4462.71	4464.13	1.42	4464.20	0.003292	1.99	60.50	81.65	0.035	550.00
St Mary	Lower River	11	120.59	4462.79	4463.96	1.16	4464.01	0.004019	1.95	61.90	100.34	0.035	500.00
St Mary	Lower River	10	120.59	4462.27	4463.72	1.45	4463.80	0.004691	2.33	51.81	72.07	0.035	450.00
St Mary	Lower River	9	120.59	4462.28	4463.12	0.84	4463.33	0.024549	3.74	32.24	76.32	0.035	400.00
St Mary	Lower River	8	120.59	4461.30	4462.67	1.37	4462.74	0.004088	2.13	56.60	81.13	0.035	350.00
St Mary	Lower River	7	120.59	4461.00	4462.49	1.49	4462.55	0.003400	1.98	60.84	84.83	0.035	300.00
St Mary	Lower River	6	120.59	4460.94	4462.42	1.48	4462.46	0.001212	1.55	77.79	72.29	0.035	250.00
St Mary	Lower River	5	120.59	4460.28	4462.36	2.08	4462.40	0.000965	1.54	78.53	62.30	0.035	200.00
St Mary	Lower River	4	120.59	4460.66	4462.27	1.61	4462.33	0.002101	1.99	60.60	58.46	0.035	150.00
St Mary	Lower River	3	120.59	4460.52	4462.17	1.65	4462.23	0.001642	1.86	64.77	57.39	0.035	100.00
St Mary	Lower River	2	120.59	4460.39	4462.05	1.66	4462.12	0.002919	2.08	57.99	67.08	0.035	50.00
St Mary	Lower River	1	120.59	4459.95	4461.84	1.89	4461.93	0.005006	2.39	50.46	70.94	0.035	

TABLE B 3 - ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 1 WITH 670 FT^3/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS.

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Dpth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
Canal	Canal	19.8	711.27	4467.00	4472.95	5.95	4472.99	0.000073	1.71	416.21	70.00	0.022	950.00
Canal	Canal	19.7	711.27	4467.00	4472.85	5.85	4472.98	0.000242	2.89	245.72	42.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	711.27	4463.17	4470.65	7.48	4470.72	0.000105	2.04	348.23	65.56	0.022	900.00
Canal	Canal	18	711.27	4463.51	4470.59	7.08	4470.70	0.000202	2.65	267.91	55.42	0.022	850.00
Canal	Canal	17	711.27	4462.77	4470.46	7.69	4470.67	0.000447	3.65	195.08	44.97	0.022	800.00
Canal	Canal	16	671.27	4461.91	4470.46	8.55	4470.64	0.000424	3.43	195.99	47.54	0.022	750.00
Canal	Canal	15	671.27	4460.67	4470.53	9.86	4470.59	0.000080	1.93	347.32	56.74	0.022	700.00
Canal	Canal	14	671.27	4461.95	4470.52	8.57	4470.58	0.000105	2.08	322.43	58.42	0.022	650.00
Canal	Canal	13	671.27	4461.57	4470.50	8.93	4470.56	0.000090	1.98	339.03	59.13	0.022	600.00
Canal	Canal	12	671.27	4461.11	4470.49	9.38	4470.55	0.000085	1.95	344.71	58.67	0.022	550.00
Canal	Canal	11	671.27	4460.45	4470.48	10.03	4470.53	0.000079	1.93	348.62	56.21	0.022	500.00
Canal	Canal	10	671.27	4461.67	4470.46	8.79	4470.53	0.000094	2.03	331.43	57.59	0.022	450.00
Canal	Canal	9	671.27	4460.77	4470.45	9.68	4470.50	0.000073	1.86	360.82	58.27	0.022	400.00
Canal	Canal	8	671.27	4460.50	4470.44	9.94	4470.49	0.000080	1.94	345.20	55.47	0.022	350.00
Canal	Canal	7	671.27	4460.36	4470.42	10.06	4470.49	0.000101	2.13	315.38	52.49	0.022	300.00
Canal	Canal	6	671.27	4460.66	4470.42	9.76	4470.49	0.000111	2.09	320.93	59.44	0.022	250.00
Canal	Canal	5	671.27	4461.89	4470.34	8.45	4470.47	0.000264	2.87	234.11	52.34	0.022	200.00
Canal	Canal	4	671.27	4462.26	4470.35	8.09	4470.43	0.000147	2.36	284.76	55.19	0.022	150.00
Canal	Canal	3	671.27	4462.49	4470.34	7.85	4470.41	0.000118	2.21	304.03	54.55	0.022	100.00
Canal	Canal	2	671.27	4462.60	4470.34	7.74	4470.41	0.000117	2.21	303.47	53.90	0.022	50.00
Canal	Canal	1	671.27	4461.91	4470.34	8.43	4470.41	0.000095	2.03	330.04	57.24	0.022	
St Mary	Above Dam	24	946.00	4463.65	4473.01	9.36	4473.02	0.000038	0.81	1175.14	213.51	0.035	414.00
St Mary	Above Dam	23	946.00	4462.87	4473.01	10.14	4473.02	0.000030	0.82	1154.07	171.88	0.035	314.00
St Mary	Above Dam	22	946.00	4463.65	4473.01	9.36	4473.02	0.000037	0.80	1179.99	213.41	0.035	214.00
St Mary	Above Dam	21	946.00	4463.71	4473.01	9.30	4473.02	0.000018	0.62	1526.84	229.62	0.035	114.00
St Mary	Above Dam	20.5	946.00	4469.24	4472.94	3.70	4473.01	0.000430	2.03	466.38	126.01	0.035	14.00
St Mary	Below Dam	20	139.15	4469.24	4473.00	3.76	4473.00	0.000004	0.21	657.78	175.27	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	139.15	4464.38	4466.57	2.19	4466.57	0.000219	0.61	229.31	238.15	0.035	175.00
St Mary	Below Dam	18	139.15	4462.59	4466.49	3.90	4466.54	0.000942	1.84	75.47	43.83	0.035	125.00
St Mary	Below Dam	17	139.15	4463.61	4466.39	2.78	4466.47	0.002493	2.26	61.52	55.15	0.035	75.00
St Mary	Below Dam	16	179.15	4463.81	4466.22	2.41	4466.32	0.003264	2.60	69.03	61.88	0.035	25.00
St Mary	Fishway	5	128.67	4470.00	4473.00	3.00	4473.00	0.000020	0.44	291.25	101.39	0.030	225.00
St Mary	Fishway	4	128.67	4471.50	4472.79	1.29	4472.98	0.031278	3.51	36.69	93.70	0.040	200.00
St Mary	Fishway	3	128.67	4469.25	4470.46	1.21	4470.76	0.066980	4.43	29.04	92.45	0.040	150.00
St Mary	Fishway	2	128.67	4467.50	4468.92	1.42	4469.23	0.029754	4.46	28.85	49.50	0.040	100.00
St Mary	Fishway	1	128.67	4465.75	4467.10	1.35	4467.44	0.043680	4.65	27.66	59.47	0.040	50.00
St Mary	Lower River	15	307.82	4463.01	4465.82	2.81	4466.17	0.006648	4.75	64.84	39.84	0.035	700.00
St Mary	Lower River	14	307.82	4463.51	4465.19	1.68	4465.67	0.014750	5.58	55.13	48.63	0.035	650.00
St Mary	Lower River	13	307.82	4462.43	4464.81	2.37	4465.10	0.007481	4.39	70.09	53.32	0.035	600.00

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Dpth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
St Mary	Lower River	10	307.82	4462.27	4464.22	1.95	4464.37	0.006240	3.08	99.93	113.00	0.035	450.00
St Mary	Lower River	9	307.82	4462.28	4463.52	1.24	4463.84	0.019133	4.59	67.14	97.03	0.035	400.00
St Mary	Lower River	8	307.82	4461.30	4463.38	2.08	4463.48	0.002834	2.52	122.29	103.02	0.035	350.00
St Mary	Lower River	7	307.82	4461.00	4463.28	2.28	4463.37	0.001951	2.33	132.20	95.24	0.035	300.00
St Mary	Lower River	6	307.82	4460.94	4463.20	2.26	4463.28	0.001445	2.17	141.76	90.60	0.035	250.00
St Mary	Lower River	5	307.82	4460.28	4463.12	2.83	4463.20	0.001547	2.33	132.01	79.70	0.035	200.00
St Mary	Lower River	4	307.82	4460.66	4462.96	2.30	4463.09	0.002998	2.88	106.84	77.11	0.035	150.00
St Mary	Lower River	3	307.82	4460.52	4462.81	2.29	4462.94	0.002704	2.94	104.68	67.88	0.035	100.00
St Mary	Lower River	2	307.82	4460.39	4462.64	2.25	4462.79	0.003644	3.01	102.11	79.87	0.035	50.00
St Mary	Lower River	1	307.82	4459.95	4462.40	2.45	4462.57	0.005002	3.28	93.99	82.27	0.035	

TABLE B 4 ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 1 WITH 850 FT³/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS.

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Ave. Velocity (ft/s)	Flow Area (sq ft)	Top Width (ft)	Manning s n	Cum Channel Length (ft)
Canal	Canal	19.8	881.50	4467.00	4472.98	5.98	4473.05	0.000110	2.11	418.67	70.00	0.022	950.00
Canal	Canal	19.7	881.50	4467.00	4472.90	5.90	4473.04	0.000243	2.99	295.04	50.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	881.50	4463.17	4471.60	8.42	4471.67	0.000100	2.14	411.98	69.69	0.022	900.00
Canal	Canal	18	881.50	4463.51	4471.52	8.01	4471.64	0.000187	2.74	321.72	59.81	0.022	850.00
Canal	Canal	17	881.50	4462.77	4471.40	8.63	4471.61	0.000396	3.68	239.23	49.39	0.022	800.00
Canal	Canal	16	841.50	4461.91	4471.40	9.49	4471.59	0.000379	3.45	243.67	53.80	0.022	750.00
Canal	Canal	15	841.50	4460.67	4471.47	10.80	4471.54	0.000082	2.10	401.61	58.88	0.022	700.00
Canal	Canal	14	841.50	4461.95	4471.46	9.51	4471.53	0.000104	2.22	378.52	60.98	0.022	650.00
Canal	Canal	13	841.50	4461.57	4471.44	9.87	4471.51	0.000091	2.12	396.01	62.05	0.022	600.00
Canal	Canal	12	841.50	4461.11	4471.43	10.32	4471.50	0.000087	2.10	401.46	61.87	0.022	550.00
Canal	Canal	11	841.50	4460.45	4471.42	10.97	4471.49	0.000082	2.09	402.83	58.87	0.022	500.00
Canal	Canal	10	841.50	4461.67	4471.41	9.74	4471.49	0.000096	2.17	387.77	61.06	0.022	450.00
Canal	Canal	9	841.50	4460.77	4471.41	10.64	4471.48	0.000075	2.01	418.38	61.21	0.022	400.00
Canal	Canal	8	841.50	4460.50	4471.40	10.90	4471.47	0.000083	2.10	399.94	58.30	0.022	350.00
Canal	Canal	7	841.50	4460.36	4471.38	11.02	4471.46	0.000104	2.29	367.41	55.76	0.022	300.00
Canal	Canal	6	841.50	4460.66	4471.38	10.72	4471.46	0.000115	2.20	382.18	67.59	0.022	250.00
Canal	Canal	5	841.50	4461.89	4471.31	9.42	4471.44	0.000237	2.93	287.39	57.38	0.022	200.00
Canal	Canal	4	841.50	4462.26	4471.32	9.06	4471.41	0.000138	2.48	339.66	57.97	0.022	150.00
Canal	Canal	3	841.50	4462.49	4471.31	8.82	4471.40	0.000116	2.35	358.51	57.65	0.022	100.00
Canal	Canal	2	841.50	4462.60	4471.31	8.71	4471.40	0.000116	2.35	357.54	57.28	0.022	50.00
Canal	Canal	1	841.50	4461.91	4471.32	9.40	4471.39	0.000095	2.17	387.45	60.57	0.022	
St Mary	Above Dam	24	1200.00	4463.65	4473.08	9.43	4473.10	0.000058	1.01	1190.17	214.02	0.035	414.00
St Mary	Above Dam	23	1200.00	4462.87	4473.08	10.21	4473.10	0.000047	1.03	1165.92	172.33	0.035	314.00
St Mary	Above Dam	22	1200.00	4463.65	4473.08	9.43	4473.09	0.000058	1.00	1194.70	213.89	0.035	214.00
St Mary	Above Dam	21	1200.00	4463.71	4473.08	9.37	4473.09	0.000028	0.78	1542.65	229.82	0.035	114.00
St Mary	Above Dam	20.5	1200.00	4469.24	4472.97	3.73	4473.07	0.000675	2.55	470.08	126.01	0.035	14.00
St Mary	Below Dam	20	167.17	4469.24	4473.06	3.82	4473.07	0.000006	0.25	669.68	175.28	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	167.17	4465.40	4468.11	2.71	4468.12	0.000044	0.47	359.48	165.20	0.035	175.00
St Mary	Below Dam	18	167.17	4466.31	4468.01	1.70	4468.10	0.003736	2.45	68.21	73.86	0.035	125.00
St Mary	Below Dam	17	167.17	4465.99	4467.83	1.84	4467.93	0.003063	2.45	68.36	64.27	0.035	75.00
St Mary	Below Dam	16	207.17	4465.97	4467.19	1.22	4467.55	0.020389	4.83	42.93	60.38	0.035	25.00
St Mary	fishway	5	149.52	4470.00	4473.06	3.06	4473.06	0.000026	0.50	297.70	101.57	0.030	225.00
St Mary	fishway	4	149.52	4471.50	4472.82	1.32	4473.04	0.031981	3.74	39.95	94.02	0.040	200.00
St Mary	fishway	3	149.52	4469.25	4470.49	1.24	4470.83	0.065834	4.68	31.97	92.67	0.040	150.00
St Mary	fishway	2	149.52	4467.50	4469.00	1.50	4469.32	0.027263	4.56	32.83	51.11	0.040	100.00
St Mary	fishway	1	149.52	4465.75	4467.13	1.38	4467.53	0.048829	5.05	29.61	61.17	0.040	50.00
St Mary	lower river	15	356.70	4463.01	4465.00	1.99	4466.58	0.048781	10.11	35.29	31.20	0.035	700.00
St Mary	lower river	14	356.70	4463.51	4465.33	1.82	4465.84	0.014886	5.73	62.27	53.21	0.035	650.00
St Mary	lower river	13	356.70	4462.43	4464.89	2.46	4465.24	0.008470	4.78	74.63	54.90	0.035	600.00

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Ave. Velocity (ft/s)	Flow Area (sq ft)	Top Width (ft)	Manning's n	Cum Channel Length (ft)
St Mary	Lower River	12	356.70	4462.71	4464.75	2.04	4464.90	0.004131	3.11	114.71	94.13	0.035	550.00
St Mary	Lower River	11	356.70	4462.79	4464.57	1.78	4464.70	0.003593	2.84	125.54	106.04	0.035	500.00
St Mary	Lower River	10	356.70	4462.27	4464.28	2.01	4464.46	0.006647	3.32	107.34	113.57	0.035	450.00
St Mary	Lower River	9	356.70	4462.28	4463.64	1.36	4463.95	0.015883	4.50	79.32	102.59	0.035	400.00
St Mary	Lower River	8	356.70	4461.30	4463.54	2.24	4463.64	0.002539	2.58	138.31	103.30	0.035	350.00
St Mary	Lower River	7	356.70	4461.00	4463.44	2.44	4463.53	0.001868	2.42	147.62	97.34	0.035	300.00
St Mary	Lower River	6	356.70	4460.94	4463.36	2.42	4463.44	0.001469	2.28	156.41	94.02	0.035	250.00
St Mary	Lower River	5	356.70	4460.28	4463.27	2.99	4463.36	0.001623	2.47	144.53	83.08	0.035	200.00
St Mary	Lower River	4	356.70	4460.66	4463.10	2.44	4463.24	0.003082	3.02	117.94	80.78	0.035	150.00
St Mary	Lower River	3	356.70	4460.52	4462.94	2.41	4463.09	0.002896	3.15	113.40	69.96	0.035	100.00
St Mary	Lower River	2	356.70	4460.39	4462.77	2.38	4462.93	0.003703	3.18	112.09	81.81	0.035	50.00
St Mary	Lower River	1	356.70	4459.95	4462.52	2.57	4462.70	0.005003	3.44	103.63	84.17	0.035	

TABLE B 5 ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 1 WITH 1000 FT3/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS.

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Average Velocity (ft/s)	Flow Area (sq ft)	Top Width (ft)	Manning s n	Cum Channel Length (ft)
Canal	Canal	19.8	1056.45	4467.00	4472.98	5.98	4473.08	0.000158	2.52	418.91	70.00	0.022	950.00
Canal	Canal	19.7	1056.45	4467.00	4472.87	5.87	4473.07	0.000356	3.60	293.36	50.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	1056.45	4463.17	4472.43	9.26	4472.50	0.000098	2.24	471.24	73.02	0.022	900.00
Canal	Canal	18	1056.45	4463.51	4472.35	8.84	4472.48	0.000177	2.83	372.86	63.11	0.022	850.00
Canal	Canal	17	1056.45	4462.77	4472.24	9.47	4472.45	0.000379	3.73	283.13	55.53	0.022	800.00
Canal	Canal	16	1006.45	4461.91	4472.26	10.35	4472.44	0.000338	3.45	291.97	59.29	0.022	750.00
Canal	Canal	15	1006.45	4460.67	4472.32	11.65	4472.39	0.000084	2.23	452.32	60.69	0.022	700.00
Canal	Canal	14	1006.45	4461.95	4472.31	10.35	4472.39	0.000102	2.33	431.22	63.29	0.022	650.00
Canal	Canal	13	1006.45	4461.57	4472.29	10.72	4472.37	0.000090	2.24	449.76	64.69	0.022	600.00
Canal	Canal	12	1006.45	4461.11	4472.28	11.17	4472.36	0.000087	2.21	455.14	64.73	0.022	550.00
Canal	Canal	11	1006.45	4460.45	4472.27	11.82	4472.34	0.000085	2.22	453.93	61.78	0.022	500.00
Canal	Canal	10	1006.45	4461.67	4472.26	10.59	4472.34	0.000096	2.28	440.87	64.16	0.022	450.00
Canal	Canal	9	1006.45	4460.77	4472.26	11.49	4472.33	0.000077	2.14	471.39	63.79	0.022	400.00
Canal	Canal	8	1006.45	4460.50	4472.25	11.75	4472.32	0.000085	2.23	450.45	60.80	0.022	350.00
Canal	Canal	7	1006.45	4460.36	4472.23	11.87	4472.32	0.000106	2.42	415.93	58.64	0.022	300.00
Canal	Canal	6	1006.45	4460.66	4472.24	11.57	4472.32	0.000113	2.27	442.79	74.01	0.022	250.00
Canal	Canal	5	1006.45	4461.89	4472.16	10.27	4472.30	0.000239	2.97	339.33	67.15	0.022	200.00
Canal	Canal	4	1006.45	4462.26	4472.17	9.91	4472.27	0.000133	2.58	390.10	60.42	0.022	150.00
Canal	Canal	3	1006.45	4462.49	4472.16	9.67	4472.25	0.000114	2.46	408.67	60.35	0.022	100.00
Canal	Canal	2	1006.45	4462.60	4472.16	9.56	4472.25	0.000116	2.47	407.25	60.21	0.022	50.00
Canal	Canal	1	1006.45	4461.91	4472.16	10.25	4472.24	0.000095	2.29	439.92	63.45	0.022	
St Mary	Above Dam	24	1360.00	4463.65	4473.12	9.47	4473.14	0.000073	1.13	1198.95	214.31	0.035	414.00
St Mary	Above Dam	23	1360.00	4462.87	4473.12	10.25	4473.14	0.000060	1.16	1172.83	172.59	0.035	314.00
St Mary	Above Dam	22	1360.00	4463.65	4473.12	9.47	4473.14	0.000072	1.13	1203.27	214.18	0.035	214.00
St Mary	Above Dam	21	1360.00	4463.71	4473.12	9.41	4473.13	0.000035	0.88	1551.86	229.94	0.035	114.00
St Mary	Above Dam	20.5	1360.00	4469.24	4472.98	3.74	4473.11	0.000859	2.89	471.31	126.01	0.035	14.00
St Mary	Below Dam	20	169.71	4469.24	4473.07	3.83	4473.07	0.000006	0.25	670.37	175.28	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	169.71	4465.40	4468.12	2.72	4468.13	0.000044	0.47	361.33	165.26	0.035	175.00
St Mary	Below Dam	18	169.71	4466.31	4468.02	1.71	4468.11	0.003735	2.46	69.00	74.32	0.035	125.00
St Mary	Below Dam	17	169.71	4465.99	4467.84	1.85	4467.94	0.003082	2.46	68.99	64.59	0.035	75.00
St Mary	Below Dam	16	209.71	4465.97	4467.19	1.22	4467.56	0.020544	4.86	43.19	60.55	0.035	25.00
St Mary	fishway	5	157.26	4470.00	4473.08	3.08	4473.09	0.000028	0.52	299.93	101.63	0.030	225.00
St Mary	fishway	4	157.26	4471.50	4472.84	1.34	4473.06	0.030870	3.78	41.65	94.19	0.040	200.00
St Mary	fishway	3	157.26	4469.25	4470.50	1.25	4470.86	0.066730	4.79	32.83	92.74	0.040	150.00
St Mary	fishway	2	157.26	4467.50	4469.02	1.52	4469.35	0.027384	4.64	33.90	51.54	0.040	100.00
St Mary	fishway	1	157.26	4465.75	4467.15	1.40	4467.56	0.048750	5.12	30.72	62.12	0.040	50.00
St Mary	lower river	15	376.97	4463.01	4465.08	2.06	4466.62	0.045207	9.97	37.80	32.19	0.035	700.00
St Mary	lower river	14	376.97	4463.51	4465.40	1.89	4465.90	0.014551	5.72	65.85	55.37	0.035	650.00
St Mary	lower river	13	376.97	4462.43	4464.93	2.50	4465.30	0.008937	4.91	76.74	56.41	0.035	600.00

River	Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Depth	E.G. Elev	E.G. Slope	Average Velocity	Flow Area	Top Width	Manning s n	Cum Channel Length
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)
St Mary	Lower River	12	376.97	4462.71	4464.79	2.07	4464.94	0.004203	3.19	118.31	94.81	0.035	550.00
St Mary	Lower River	11	376.97	4462.79	4464.61	1.82	4464.74	0.003655	2.92	129.27	106.36	0.035	500.00
St Mary	Lower River	10	376.97	4462.27	4464.31	2.04	4464.49	0.006748	3.41	110.56	113.82	0.035	450.00
St Mary	Lower River	9	376.97	4462.28	4463.70	1.42	4464.00	0.014500	4.43	85.10	105.12	0.035	400.00
St Mary	Lower River	8	376.97	4461.30	4463.59	2.29	4463.70	0.002469	2.61	144.26	103.40	0.035	350.00
St Mary	Lower River	7	376.97	4461.00	4463.50	2.50	4463.59	0.001859	2.46	153.30	98.10	0.035	300.00
St Mary	Lower River	6	376.97	4460.94	4463.42	2.48	4463.50	0.001492	2.33	161.77	95.24	0.035	250.00
St Mary	Lower River	5	376.97	4460.28	4463.32	3.04	4463.42	0.001668	2.53	149.02	84.26	0.035	200.00
St Mary	Lower River	4	376.97	4460.66	4463.15	2.49	4463.30	0.003114	3.09	121.81	81.22	0.035	150.00
St Mary	Lower River	3	376.97	4460.52	4462.98	2.46	4463.14	0.003009	3.24	116.35	70.65	0.035	100.00
St Mary	Lower River	2	376.97	4460.39	4462.80	2.41	4462.97	0.003826	3.28	115.06	82.38	0.035	50.00
St Mary	Lower River	1	376.97	4459.95	4462.56	2.61	4462.76	0.005004	3.51	107.46	84.86	0.035	

TABLE B 6 - ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 1 AT 3000 FT^3/S RIVER FLOW WITH 850 FT3/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS.

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
Canal	Canal	19.8	890.87	4467.00	4474.49	7.49	4474.53	0.000056	1.70	524.08	70.00	0.022	950.00
Canal	Canal	19.7	890.87	4467.00	4474.44	7.44	4474.53	0.000122	2.39	372.14	50.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	890.87	4463.17	4471.65	8.48	4471.72	0.000099	2.14	415.90	69.91	0.022	900.00
Canal	Canal	18	890.87	4463.51	4471.58	8.07	4471.70	0.000186	2.74	325.15	60.08	0.022	850.00
Canal	Canal	17	890.87	4462.77	4471.46	8.69	4471.67	0.000393	3.68	242.11	49.81	0.022	800.00
Canal	Canal	16	850.87	4461.91	4471.46	9.55	4471.65	0.000375	3.45	246.80	54.19	0.022	750.00
Canal	Canal	15	850.87	4460.67	4471.52	10.85	4471.59	0.000082	2.10	404.84	59.00	0.022	700.00
Canal	Canal	14	850.87	4461.95	4471.51	9.56	4471.59	0.000103	2.23	382.04	61.14	0.022	650.00
Canal	Canal	13	850.87	4461.57	4471.51	9.94	4471.58	0.000090	2.13	400.26	62.27	0.022	600.00
Canal	Canal	12	850.87	4461.11	4471.50	10.39	4471.56	0.000087	2.10	405.45	62.09	0.022	550.00
Canal	Canal	11	850.87	4460.45	4471.48	11.03	4471.55	0.000082	2.09	406.40	59.04	0.022	500.00
Canal	Canal	10	850.87	4461.67	4471.47	9.80	4471.54	0.000095	2.17	391.36	61.27	0.022	450.00
Canal	Canal	9	850.87	4460.77	4471.47	10.70	4471.53	0.000075	2.02	421.97	61.39	0.022	400.00
Canal	Canal	8	850.87	4460.50	4471.46	10.96	4471.53	0.000083	2.11	403.36	58.47	0.022	350.00
Canal	Canal	7	850.87	4460.36	4471.44	11.08	4471.52	0.000104	2.30	370.68	55.96	0.022	300.00
Canal	Canal	6	850.87	4460.66	4471.44	10.78	4471.52	0.000114	2.20	386.15	68.08	0.022	250.00
Canal	Canal	5	850.87	4461.89	4471.37	9.48	4471.50	0.000235	2.93	290.88	57.67	0.022	200.00
Canal	Canal	4	850.87	4462.26	4471.38	9.12	4471.47	0.000137	2.48	343.18	58.15	0.022	150.00
Canal	Canal	3	850.87	4462.49	4471.37	8.88	4471.45	0.000115	2.35	361.90	57.83	0.022	100.00
Canal	Canal	2	850.87	4462.60	4471.36	8.76	4471.45	0.000116	2.36	360.68	57.47	0.022	50.00
Canal	Canal	1	850.87	4461.91	4471.37	9.46	4471.44	0.000095	2.18	390.76	60.75	0.022	
St Mary	Above Dam	24	3000.00	4463.65	4474.69	11.03	4474.74	0.000165	1.95	1542.30	225.45	0.035	414.00
St Mary	Above Dam	23	3000.00	4462.87	4474.67	11.80	4474.73	0.000154	2.07	1446.76	180.88	0.035	314.00
St Mary	Above Dam	22	3000.00	4463.65	4474.66	11.01	4474.72	0.000165	1.95	1541.64	225.22	0.035	214.00
St Mary	Above Dam	21	3000.00	4463.71	4474.66	10.95	4474.70	0.000088	1.57	1910.04	234.49	0.035	114.00
St Mary	Above Dam	20.5	3000.00	4469.24	4474.30	5.06	4474.65	0.001564	4.70	637.99	126.01	0.035	14.00
St Mary	Below Dam	20	1170.42	4469.24	4474.52	5.28	4474.55	0.000101	1.27	925.05	175.38	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	1170.42	4464.38	4469.14	4.76	4469.17	0.000197	1.33	878.94	256.77	0.035	175.00
St Mary	Below Dam	18	1170.42	4462.59	4469.03	6.44	4469.14	0.001566	2.65	440.94	219.90	0.035	125.00
St Mary	Below Dam	17	1170.42	4463.61	4468.87	5.26	4469.04	0.002330	3.28	356.62	174.34	0.035	75.00
St Mary	Below Dam	16	1210.42	4463.81	4468.75	4.94	4468.92	0.002092	3.33	363.24	159.70	0.035	25.00
St Mary	fishway	5	882.91	4470.00	4474.48	4.48	4474.54	0.000252	1.98	444.84	105.55	0.030	225.00
St Mary	fishway	4	882.91	4471.50	4473.77	2.27	4474.45	0.022897	6.62	133.35	102.88	0.040	200.00
St Mary	fishway	3	882.91	4469.25	4471.13	1.88	4472.53	0.070437	9.50	92.92	97.17	0.040	150.00
St Mary	fishway	2	882.91	4467.50	4470.38	2.88	4471.18	0.020794	7.16	123.32	79.40	0.040	100.00
St Mary	fishway	1	882.91	4465.75	4468.91	3.16	4469.25	0.006835	4.72	187.04	96.49	0.040	50.00
St Mary	lower river	15	2093.32	4463.01	4468.01	5.00	4468.74	0.011204	6.87	304.89	160.24	0.035	700.00
St Mary	lower river	14	2093.32	4463.51	4467.43	3.92	4468.21	0.010109	7.06	296.34	138.18	0.035	650.00
St Mary	lower river	13	2093.32	4462.43	4467.13	4.70	4467.76	0.006613	6.40	326.91	128.56	0.035	600.00

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
St Mary	Lower River	12	2093.32	4462.71	4466.91	4.20	4467.45	0.004822	5.92	353.75	123.01	0.035	550.00
St Mary	Lower River	11	2093.32	4462.79	4466.73	3.94	4467.22	0.003941	5.61	373.33	121.19	0.035	500.00
St Mary	Lower River	10	2093.32	4462.27	4466.54	4.27	4467.02	0.003924	5.55	377.09	123.12	0.035	450.00
St Mary	Lower River	9	2093.32	4462.28	4466.39	4.11	4466.83	0.003266	5.31	394.04	119.68	0.035	400.00
St Mary	Lower River	8	2093.32	4461.30	4466.34	5.04	4466.67	0.001996	4.60	454.74	116.94	0.035	350.00
St Mary	Lower River	7	2093.32	4461.00	4466.24	5.24	4466.56	0.001922	4.53	461.93	120.21	0.035	300.00
St Mary	Lower River	6	2093.32	4460.94	4466.14	5.20	4466.46	0.001855	4.56	458.64	114.57	0.035	250.00
St Mary	Lower River	5	2093.32	4460.28	4465.98	5.70	4466.35	0.002375	4.91	425.95	115.33	0.035	200.00
St Mary	Lower River	4	2093.32	4460.66	4465.64	4.98	4466.18	0.004000	5.92	353.76	107.13	0.035	150.00
St Mary	Lower River	3	2093.32	4460.52	4465.37	4.85	4465.96	0.004883	6.17	339.17	112.31	0.035	100.00
St Mary	Lower River	2	2093.32	4460.39	4465.14	4.75	4465.71	0.004726	6.05	345.81	115.19	0.035	50.00
St Mary	Lower River	1	2093.32	4459.95	4464.86	4.91	4465.46	0.005010	6.22	336.58	112.33	0.035	

TABLE B 7 ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 2WITH 500 FT³/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS.

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
Canal	Canal	19.8	541.78	4467.00	4472.77	5.77	4472.80	0.000047	1.34	403.76	70.00	0.022	950.00
Canal	Canal	19.7	541.78	4467.00	4472.62	5.62	4472.78	0.000346	3.21	168.63	30.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	541.78	4463.17	4469.56	6.39	4469.62	0.000113	1.94	279.32	60.38	0.022	900.00
Canal	Canal	18	541.78	4463.51	4469.48	5.97	4469.59	0.000232	2.59	209.54	50.22	0.022	850.00
Canal	Canal	17	541.78	4462.77	4469.34	6.57	4469.55	0.000569	3.68	147.31	40.50	0.022	800.00
Canal	Canal	16	501.78	4461.91	4469.34	7.43	4469.52	0.000492	3.41	146.96	39.94	0.022	750.00
Canal	Canal	15	501.78	4460.67	4469.42	8.75	4469.46	0.000079	1.76	285.56	53.96	0.022	700.00
Canal	Canal	14	501.78	4461.95	4469.40	7.45	4469.46	0.000112	1.94	258.98	55.30	0.022	650.00
Canal	Canal	13	501.78	4461.57	4469.39	7.82	4469.44	0.000092	1.82	275.22	55.57	0.022	600.00
Canal	Canal	12	501.78	4461.11	4469.38	8.27	4469.43	0.000084	1.78	281.82	54.42	0.022	550.00
Canal	Canal	11	501.78	4460.45	4469.37	8.92	4469.42	0.000076	1.74	288.01	52.91	0.022	500.00
Canal	Canal	10	501.78	4461.67	4469.36	7.69	4469.41	0.000094	1.86	269.98	53.36	0.022	450.00
Canal	Canal	9	501.78	4460.77	4469.35	8.57	4469.39	0.000070	1.68	298.37	54.72	0.022	400.00
Canal	Canal	8	501.78	4460.50	4469.33	8.83	4469.38	0.000076	1.76	285.86	51.88	0.022	350.00
Canal	Canal	7	501.78	4460.36	4469.32	8.96	4469.38	0.000097	1.93	259.69	48.75	0.022	300.00
Canal	Canal	6	501.78	4460.66	4469.32	8.66	4469.38	0.000099	1.93	260.61	50.13	0.022	250.00
Canal	Canal	5	501.78	4461.89	4469.23	7.34	4469.35	0.000303	2.79	179.54	46.43	0.022	200.00
Canal	Canal	4	501.78	4462.26	4469.24	6.98	4469.32	0.000162	2.22	225.56	51.79	0.022	150.00
Canal	Canal	3	501.78	4462.49	4469.23	6.74	4469.30	0.000121	2.04	245.75	51.03	0.022	100.00
Canal	Canal	2	501.78	4462.60	4469.23	6.63	4469.30	0.000118	2.04	246.10	50.07	0.022	50.00
Canal	Canal	1	501.78	4461.91	4469.24	7.33	4469.29	0.000095	1.87	268.95	53.48	0.022	
St Mary	Above Dam	24	670.00	4463.65	4472.81	9.16	4472.81	0.000021	0.59	1131.29	212.04	0.035	414.00
St Mary	Above Dam	23	670.00	4462.87	4472.81	9.94	4472.81	0.000017	0.60	1119.18	170.96	0.035	314.00
St Mary	Above Dam	22	670.00	4463.65	4472.81	9.16	4472.81	0.000021	0.59	1136.58	211.96	0.035	214.00
St Mary	Above Dam	21	670.00	4463.71	4472.81	9.10	4472.81	0.000010	0.45	1479.92	229.02	0.035	114.00
St Mary	Above Dam	20.5	670.00	4469.24	4472.77	3.53	4472.80	0.000252	1.51	444.48	126.01	0.035	14.00
St Mary	Below Dam	20	98.05	4469.24	4472.80	3.56	4472.80	0.000003	0.16	622.61	175.26	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	98.05	4464.38	4466.02	1.64	4466.03	0.001570	0.97	100.93	228.15	0.035	175.00
St Mary	Below Dam	18	98.05	4462.59	4465.93	3.34	4465.98	0.000724	1.72	57.07	30.15	0.035	125.00
St Mary	Below Dam	17	98.05	4463.61	4465.80	2.19	4465.91	0.003247	2.62	37.43	32.73	0.035	75.00
St Mary	Below Dam	16	138.05	4463.81	4465.37	1.56	4465.62	0.008266	4.02	34.35	32.07	0.035	25.00
St Mary	fishway	5	54.65	4470.50	4472.76	2.26	4472.79	0.000650	1.45	37.79	30.21	0.030	225.00
St Mary	fishway	4	54.65	4471.50	4472.60	1.10	4472.73	0.049406	2.88	18.98	91.92	0.040	200.00
St Mary	fishway	3	54.65	4469.25	4470.38	1.13	4470.48	0.031823	2.52	21.65	91.89	0.040	150.00
St Mary	fishway	2	54.65	4467.50	4468.64	1.14	4468.82	0.033905	3.46	15.80	43.79	0.040	100.00
St Mary	fishway	1	54.65	4465.75	4466.89	1.14	4467.07	0.036165	3.40	16.10	48.18	0.040	50.00
St Mary	lower river	15	152.70	4463.01	4465.26	2.25	4465.45	0.004904	3.47	44.02	34.53	0.035	700.00
St Mary	lower river	14	152.70	4463.51	4464.66	1.15	4465.01	0.017391	4.77	31.99	40.46	0.035	650.00
St Mary	lower river	13	152.70	4462.43	4464.40	1.97	4464.54	0.004627	3.06	49.97	45.70	0.035	600.00

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
St Mary	Lower River	12	152.70	4462.71	4464.24	1.53	4464.32	0.003465	2.20	69.54	84.33	0.035	550.00
St Mary	Lower River	11	152.70	4462.79	4464.07	1.28	4464.14	0.003692	2.08	73.48	101.40	0.035	500.00
St Mary	Lower River	10	152.70	4462.27	4463.82	1.55	4463.92	0.005099	2.56	59.60	76.40	0.035	450.00
St Mary	Lower River	9	152.70	4462.28	4463.20	0.92	4463.44	0.022779	3.92	38.93	81.10	0.035	400.00
St Mary	Lower River	8	152.70	4461.30	4462.81	1.50	4462.88	0.003829	2.24	68.02	85.69	0.035	350.00
St Mary	Lower River	7	152.70	4461.00	4462.65	1.65	4462.72	0.002842	2.04	74.73	86.96	0.035	300.00
St Mary	Lower River	6	152.70	4460.94	4462.58	1.64	4462.62	0.001301	1.70	89.57	76.10	0.035	250.00
St Mary	Lower River	5	152.70	4460.28	4462.51	2.23	4462.56	0.001137	1.73	88.11	65.91	0.035	200.00
St Mary	Lower River	4	152.70	4460.66	4462.41	1.75	4462.48	0.002320	2.22	68.87	60.84	0.035	150.00
St Mary	Lower River	3	152.70	4460.52	4462.31	1.79	4462.38	0.001881	2.10	72.77	59.64	0.035	100.00
St Mary	Lower River	2	152.70	4460.39	4462.17	1.78	4462.26	0.003150	2.30	66.50	70.18	0.035	50.00
St Mary	Lower River	1	152.70	4459.95	4461.96	2.01	4462.06	0.005006	2.58	59.15	74.04	0.035	

TABLE B 8 ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 2WITH 670 FT³/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS.

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Dpth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
Canal	Canal	19.8	717.94	4467.00	4472.91	5.91	4472.96	0.000076	1.73	413.85	70.00	0.022	950.00
Canal	Canal	19.7	717.94	4467.00	4472.82	5.82	4472.95	0.000233	2.87	250.12	43.94	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	717.94	4463.17	4470.69	7.52	4470.75	0.000105	2.05	350.47	65.73	0.022	900.00
Canal	Canal	18	717.94	4463.51	4470.62	7.11	4470.73	0.000202	2.66	269.81	55.58	0.022	850.00
Canal	Canal	17	717.94	4462.77	4470.49	7.72	4470.70	0.000446	3.65	196.62	45.10	0.022	800.00
Canal	Canal	16	677.94	4461.91	4470.50	8.59	4470.68	0.000423	3.43	197.62	47.76	0.022	750.00
Canal	Canal	15	677.94	4460.67	4470.56	9.89	4470.62	0.000080	1.94	349.23	56.83	0.022	700.00
Canal	Canal	14	677.94	4461.95	4470.55	8.60	4470.62	0.000106	2.09	324.40	58.52	0.022	650.00
Canal	Canal	13	677.94	4461.57	4470.54	8.97	4470.60	0.000091	1.99	341.02	59.23	0.022	600.00
Canal	Canal	12	677.94	4461.11	4470.52	9.41	4470.58	0.000086	1.96	346.69	58.79	0.022	550.00
Canal	Canal	11	677.94	4460.45	4470.51	10.06	4470.57	0.000079	1.93	350.51	56.30	0.022	500.00
Canal	Canal	10	677.94	4461.67	4470.50	8.83	4470.56	0.000095	2.03	333.37	57.71	0.022	450.00
Canal	Canal	9	677.94	4460.77	4470.48	9.71	4470.54	0.000073	1.87	362.79	58.37	0.022	400.00
Canal	Canal	8	677.94	4460.50	4470.47	9.97	4470.53	0.000080	1.95	347.07	55.57	0.022	350.00
Canal	Canal	7	677.94	4460.36	4470.46	10.10	4470.53	0.000102	2.14	317.15	52.60	0.022	300.00
Canal	Canal	6	677.94	4460.66	4470.45	9.79	4470.52	0.000111	2.10	322.94	59.72	0.022	250.00
Canal	Canal	5	677.94	4461.89	4470.37	8.48	4470.50	0.000264	2.87	235.88	52.52	0.022	200.00
Canal	Canal	4	677.94	4462.26	4470.38	8.12	4470.47	0.000147	2.37	286.63	55.29	0.022	150.00
Canal	Canal	3	677.94	4462.49	4470.38	7.89	4470.46	0.000117	2.21	306.27	54.68	0.022	100.00
Canal	Canal	2	677.94	4462.60	4470.38	7.77	4470.45	0.000117	2.22	305.55	54.03	0.022	50.00
Canal	Canal	1	677.94	4461.91	4470.38	8.47	4470.45	0.000095	2.04	332.36	57.38	0.022	
St Mary	Above Dam	24	946.00	4463.65	4472.98	9.33	4472.99	0.000038	0.81	1168.15	213.28	0.035	414.00
St Mary	Above Dam	23	946.00	4462.87	4472.98	10.11	4472.99	0.000031	0.82	1148.45	171.67	0.035	314.00
St Mary	Above Dam	22	946.00	4463.65	4472.98	9.33	4472.99	0.000038	0.81	1173.02	213.17	0.035	214.00
St Mary	Above Dam	21	946.00	4463.71	4472.98	9.27	4472.98	0.000018	0.62	1519.33	229.52	0.035	114.00
St Mary	Above Dam	20.5	946.00	4469.24	4472.91	3.67	4472.97	0.000443	2.05	462.14	126.01	0.035	14.00
St Mary	Below Dam	20	117.94	4469.24	4472.94	3.70	4472.94	0.000003	0.18	648.29	175.27	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	117.94	4464.38	4466.43	2.05	4466.43	0.000260	0.60	196.24	235.49	0.035	175.00
St Mary	Below Dam	18	117.94	4462.59	4466.36	3.77	4466.41	0.000631	1.67	70.57	35.01	0.035	125.00
St Mary	Below Dam	17	117.94	4463.61	4466.28	2.67	4466.35	0.002127	2.11	56.00	49.57	0.035	75.00
St Mary	Below Dam	16	157.94	4463.81	4466.12	2.31	4466.22	0.002962	2.49	63.34	56.05	0.035	25.00
St Mary	fishway	5	110.62	4470.00	4472.94	2.94	4472.94	0.000016	0.39	285.47	101.23	0.030	225.00
St Mary	fishway	4	110.62	4471.50	4472.75	1.25	4472.92	0.031591	3.32	33.36	93.37	0.040	200.00
St Mary	fishway	3	110.62	4469.25	4470.43	1.18	4470.70	0.066463	4.17	26.55	92.26	0.040	150.00
St Mary	fishway	2	110.62	4467.50	4468.87	1.37	4469.14	0.028178	4.16	26.57	48.55	0.040	100.00
St Mary	fishway	1	110.62	4465.75	4467.05	1.29	4467.37	0.045943	4.54	24.38	56.50	0.040	50.00
St Mary	lower river	15	284.56	4463.01	4465.74	2.73	4466.07	0.006484	4.59	62.00	39.34	0.035	700.00
St Mary	lower river	14	284.56	4463.51	4465.12	1.61	4465.59	0.014450	5.48	51.95	46.44	0.035	650.00
St Mary	lower river	13	284.56	4462.43	4464.76	2.32	4465.03	0.007093	4.22	67.46	52.39	0.035	600.00

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Dpth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
St Mary	Lower River	12	284.56	4462.71	4464.60	1.89	4464.73	0.003831	2.81	101.34	91.59	0.035	550.00
St Mary	Lower River	11	284.56	4462.79	4464.44	1.65	4464.54	0.003338	2.55	111.54	104.81	0.035	500.00
St Mary	Lower River	10	284.56	4462.27	4464.19	1.92	4464.32	0.005991	2.95	96.40	112.73	0.035	450.00
St Mary	Lower River	9	284.56	4462.28	4463.46	1.18	4463.79	0.020607	4.59	61.99	94.59	0.035	400.00
St Mary	Lower River	8	284.56	4461.30	4463.31	2.01	4463.40	0.002890	2.48	114.97	100.86	0.035	350.00
St Mary	Lower River	7	284.56	4461.00	4463.21	2.21	4463.29	0.001970	2.27	125.21	94.27	0.035	300.00
St Mary	Lower River	6	284.56	4460.94	4463.12	2.18	4463.19	0.001425	2.11	134.71	88.80	0.035	250.00
St Mary	Lower River	5	284.56	4460.28	4463.04	2.76	4463.12	0.001498	2.26	126.08	78.05	0.035	200.00
St Mary	Lower River	4	284.56	4460.66	4462.89	2.23	4463.01	0.002919	2.80	101.56	74.96	0.035	150.00
St Mary	Lower River	3	284.56	4460.52	4462.75	2.22	4462.87	0.002601	2.83	100.41	66.84	0.035	100.00
St Mary	Lower River	2	284.56	4460.39	4462.58	2.19	4462.72	0.003599	2.92	97.30	78.92	0.035	50.00
St Mary	Lower River	1	284.56	4459.95	4462.35	2.39	4462.50	0.004999	3.19	89.20	81.18	0.035	

TABLE B 9 ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 2WITH 850 FT³/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
Canal	Canal	19.8	890.60	4467.00	4472.96	5.96	4473.03	0.000114	2.14	417.09	70.00	0.022	950.00
Canal	Canal	19.7	890.60	4467.00	4472.88	5.88	4473.02	0.000252	3.03	293.80	50.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	890.60	4463.17	4471.64	8.47	4471.72	0.000100	2.14	415.42	69.89	0.022	900.00
Canal	Canal	18	890.60	4463.51	4471.57	8.06	4471.69	0.000186	2.74	324.68	60.04	0.022	850.00
Canal	Canal	17	890.60	4462.77	4471.45	8.68	4471.66	0.000395	3.69	241.67	49.75	0.022	800.00
Canal	Canal	16	850.60	4461.91	4471.45	9.54	4471.64	0.000377	3.45	246.33	54.13	0.022	750.00
Canal	Canal	15	850.60	4460.67	4471.52	10.85	4471.59	0.000083	2.10	404.49	58.99	0.022	700.00
Canal	Canal	14	850.60	4461.95	4471.51	9.56	4471.58	0.000104	2.23	381.50	61.11	0.022	650.00
Canal	Canal	13	850.60	4461.57	4471.49	9.92	4471.56	0.000091	2.13	399.04	62.21	0.022	600.00
Canal	Canal	12	850.60	4461.11	4471.48	10.37	4471.55	0.000087	2.10	404.48	62.04	0.022	550.00
Canal	Canal	11	850.60	4460.45	4471.47	11.02	4471.54	0.000082	2.10	405.71	59.01	0.022	500.00
Canal	Canal	10	850.60	4461.67	4471.46	9.79	4471.54	0.000096	2.18	390.76	61.24	0.022	450.00
Canal	Canal	9	850.60	4460.77	4471.46	10.69	4471.52	0.000075	2.02	421.37	61.36	0.022	400.00
Canal	Canal	8	850.60	4460.50	4471.45	10.95	4471.52	0.000083	2.11	402.79	58.44	0.022	350.00
Canal	Canal	7	850.60	4460.36	4471.43	11.07	4471.51	0.000104	2.30	370.14	55.92	0.022	300.00
Canal	Canal	6	850.60	4460.66	4471.43	10.77	4471.51	0.000115	2.21	385.49	68.00	0.022	250.00
Canal	Canal	5	850.60	4461.89	4471.36	9.47	4471.49	0.000236	2.93	290.20	57.61	0.022	200.00
Canal	Canal	4	850.60	4462.26	4471.37	9.11	4471.46	0.000138	2.48	342.49	58.11	0.022	150.00
Canal	Canal	3	850.60	4462.49	4471.36	8.87	4471.44	0.000116	2.35	361.33	57.80	0.022	100.00
Canal	Canal	2	850.60	4462.60	4471.36	8.76	4471.44	0.000116	2.36	360.34	57.45	0.022	50.00
Canal	Canal	1	850.60	4461.91	4471.36	9.45	4471.44	0.000095	2.18	390.41	60.73	0.022	
St Mary	Above Dam	24	1200.00	4463.65	4473.06	9.41	4473.08	0.000059	1.01	1185.99	213.88	0.035	414.00
St Mary	Above Dam	23	1200.00	4462.87	4473.06	10.19	4473.08	0.000048	1.03	1162.56	172.20	0.035	314.00
St Mary	Above Dam	22	1200.00	4463.65	4473.06	9.41	4473.08	0.000058	1.01	1190.53	213.76	0.035	214.00
St Mary	Above Dam	21	1200.00	4463.71	4473.06	9.35	4473.07	0.000028	0.78	1538.16	229.76	0.035	114.00
St Mary	Above Dam	20.5	1200.00	4469.24	4472.95	3.71	4473.05	0.000687	2.57	467.43	126.01	0.035	14.00
St Mary	Below Dam	20	237.19	4469.24	4473.03	3.79	4473.03	0.000012	0.36	663.60	175.27	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	237.19	4464.38	4467.02	2.64	4467.02	0.000183	0.70	337.85	246.66	0.035	175.00
St Mary	Below Dam	18	237.19	4462.59	4466.91	4.32	4466.99	0.002852	2.26	104.85	103.99	0.035	125.00
St Mary	Below Dam	17	237.19	4463.61	4466.67	3.06	4466.80	0.004990	2.96	80.19	81.12	0.035	75.00
St Mary	Below Dam	16	277.19	4463.81	4466.26	2.45	4466.49	0.007193	3.87	71.67	63.86	0.035	25.00
St Mary	fishway	5	103.81	4470.50	4472.93	2.43	4473.02	0.001593	2.40	43.34	31.90	0.030	225.00
St Mary	fishway	4	103.81	4471.50	4472.73	1.22	4472.90	0.036644	3.38	30.67	93.10	0.040	200.00
St Mary	fishway	3	103.81	4469.25	4470.44	1.19	4470.67	0.055672	3.85	26.96	92.30	0.040	150.00
St Mary	fishway	2	103.81	4467.50	4468.84	1.34	4469.11	0.029449	4.13	25.11	47.93	0.040	100.00
St Mary	fishway	1	103.81	4465.75	4467.04	1.29	4467.33	0.042984	4.35	23.86	56.01	0.040	50.00
St Mary	lower river	15	341.00	4463.01	4465.91	2.90	4466.29	0.006923	4.97	68.57	40.49	0.035	700.00
St Mary	lower river	14	341.00	4463.51	4465.29	1.77	4465.79	0.014905	5.69	59.91	51.74	0.035	650.00
St Mary	lower river	13	341.00	4462.43	4464.87	2.44	4465.20	0.008002	4.63	73.72	54.58	0.035	600.00

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
St Mary	Lower River	12	341.00	4462.71	4464.72	2.01	4464.86	0.004068	3.05	111.92	93.61	0.035	550.00
St Mary	Lower River	11	341.00	4462.79	4464.54	1.75	4464.66	0.003538	2.78	122.64	105.78	0.035	500.00
St Mary	Lower River	10	341.00	4462.27	4464.26	1.99	4464.43	0.006522	3.25	105.01	113.39	0.035	450.00
St Mary	Lower River	9	341.00	4462.28	4463.60	1.32	4463.92	0.017050	4.55	75.00	100.65	0.035	400.00
St Mary	Lower River	8	341.00	4461.30	4463.49	2.19	4463.59	0.002589	2.55	133.77	103.22	0.035	350.00
St Mary	Lower River	7	341.00	4461.00	4463.40	2.40	4463.49	0.001867	2.38	143.35	96.76	0.035	300.00
St Mary	Lower River	6	341.00	4460.94	4463.32	2.38	4463.40	0.001444	2.24	152.44	93.10	0.035	250.00
St Mary	Lower River	5	341.00	4460.28	4463.23	2.95	4463.32	0.001579	2.41	141.26	82.21	0.035	200.00
St Mary	Lower River	4	341.00	4460.66	4463.06	2.40	4463.20	0.003061	2.97	114.71	80.23	0.035	150.00
St Mary	Lower River	3	341.00	4460.52	4462.89	2.37	4463.04	0.002842	3.08	110.58	69.29	0.035	100.00
St Mary	Lower River	2	341.00	4460.39	4462.73	2.34	4462.88	0.003704	3.14	108.75	81.17	0.035	50.00
St Mary	Lower River	1	341.00	4459.95	4462.48	2.53	4462.66	0.004998	3.39	100.64	83.63	0.035	

TABLE B 10 ESTIMATED HYDRAULIC CONDITIONS FOR CONCEPT 2 WITH 1000 FT3/S DESIGN FLOW USING EXISTING CANAL CROSS SECTIONS.

River	Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Depth (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Mann Wtd Chnl	Cum Ch Len (ft)
Canal	Canal	19.8	885.12	4467.00	4473.01	6.01	4473.08	0.000110	2.10	420.82	70.00	0.022	950.00
Canal	Canal	19.7	885.12	4467.00	4472.93	5.93	4473.07	0.000241	2.98	296.63	50.00	0.022	930.00
Canal	Canal	19.5	Inline Weir										
Canal	Canal	19	885.12	4463.17	4471.62	8.45	4471.69	0.000100	2.14	413.51	69.78	0.022	900.00
Canal	Canal	18	885.12	4463.51	4471.55	8.04	4471.66	0.000187	2.74	323.07	59.91	0.022	850.00
Canal	Canal	17	885.12	4462.77	4471.42	8.65	4471.63	0.000395	3.68	240.34	49.55	0.022	800.00
Canal	Canal	16	845.12	4461.91	4471.43	9.51	4471.61	0.000378	3.45	244.88	53.95	0.022	750.00
Canal	Canal	15	845.12	4460.67	4471.49	10.82	4471.56	0.000082	2.10	402.94	58.93	0.022	700.00
Canal	Canal	14	845.12	4461.95	4471.48	9.53	4471.56	0.000104	2.22	379.89	61.04	0.022	650.00
Canal	Canal	13	845.12	4461.57	4471.47	9.90	4471.54	0.000091	2.13	397.40	62.12	0.022	600.00
Canal	Canal	12	845.12	4461.11	4471.45	10.34	4471.52	0.000087	2.10	402.85	61.95	0.022	550.00
Canal	Canal	11	845.12	4460.45	4471.44	10.99	4471.51	0.000082	2.09	404.15	58.93	0.022	500.00
Canal	Canal	10	845.12	4461.67	4471.44	9.76	4471.51	0.000095	2.17	389.15	61.14	0.022	450.00
Canal	Canal	9	845.12	4460.77	4471.44	10.66	4471.50	0.000075	2.01	419.75	61.28	0.022	400.00
Canal	Canal	8	845.12	4460.50	4471.42	10.92	4471.49	0.000083	2.11	401.25	58.37	0.022	350.00
Canal	Canal	7	845.12	4460.36	4471.41	11.05	4471.49	0.000104	2.29	368.67	55.83	0.022	300.00
Canal	Canal	6	845.12	4460.66	4471.41	10.75	4471.48	0.000115	2.20	383.70	67.78	0.022	250.00
Canal	Canal	5	845.12	4461.89	4471.33	9.44	4471.46	0.000236	2.93	288.68	57.49	0.022	200.00
Canal	Canal	4	845.12	4462.26	4471.34	9.08	4471.43	0.000138	2.48	340.96	58.04	0.022	150.00
Canal	Canal	3	845.12	4462.49	4471.33	8.84	4471.42	0.000116	2.35	359.75	57.71	0.022	100.00
Canal	Canal	2	845.12	4462.60	4471.33	8.73	4471.42	0.000116	2.36	358.71	57.35	0.022	50.00
Canal	Canal	1	845.12	4461.91	4471.33	9.42	4471.41	0.000095	2.17	388.63	60.63	0.022	
St Mary	Above Dam	24	1400.00	4463.65	4473.13	9.48	4473.15	0.000077	1.17	1200.62	214.36	0.035	414.00
St Mary	Above Dam	23	1400.00	4462.87	4473.13	10.26	4473.15	0.000063	1.19	1174.09	172.64	0.035	314.00
St Mary	Above Dam	22	1400.00	4463.65	4473.13	9.48	4473.15	0.000076	1.16	1204.84	214.23	0.035	214.00
St Mary	Above Dam	21	1400.00	4463.71	4473.13	9.42	4473.14	0.000037	0.90	1553.54	229.96	0.035	114.00
St Mary	Above Dam	20.5	1400.00	4469.24	4472.98	3.74	4473.12	0.000911	2.97	471.18	126.01	0.035	14.00
St Mary	Below Dam	20	273.87	4469.24	4473.09	3.85	4473.09	0.000016	0.41	673.96	175.28	0.035	208.00
St Mary	Below Dam	19.2	Inline Weir										
St Mary	Below Dam	19	273.87	4464.38	4467.20	2.82	4467.21	0.000162	0.71	384.43	250.23	0.035	175.00
St Mary	Below Dam	18	273.87	4462.59	4467.11	4.52	4467.19	0.002534	2.14	128.01	126.48	0.035	125.00
St Mary	Below Dam	17	273.87	4463.61	4466.91	3.30	4467.02	0.003630	2.69	101.92	93.82	0.035	75.00
St Mary	Below Dam	16	313.87	4463.81	4466.68	2.87	4466.83	0.003958	3.05	103.05	83.88	0.035	25.00
St Mary	fishway	5	119.87	4470.50	4472.97	2.47	4473.09	0.001934	2.68	44.70	32.08	0.030	225.00
St Mary	fishway	4	119.87	4471.50	4472.77	1.27	4472.95	0.032793	3.46	34.64	93.49	0.040	200.00
St Mary	fishway	3	119.87	4469.25	4470.45	1.20	4470.73	0.063163	4.23	28.31	92.40	0.040	150.00
St Mary	fishway	2	119.87	4467.50	4468.90	1.40	4469.18	0.028019	4.27	28.08	49.18	0.040	100.00
St Mary	fishway	1	119.87	4465.75	4467.07	1.32	4467.41	0.046602	4.67	25.69	57.70	0.040	50.00
St Mary	lower river	15	433.74	4463.01	4466.23	3.22	4466.64	0.009421	5.12	84.64	60.36	0.035	700.00
St Mary	lower river	14	433.74	4463.51	4465.63	2.12	4466.08	0.012994	5.41	80.17	67.43	0.035	650.00
St Mary	lower river	13	433.74	4462.43	4465.07	2.64	4465.47	0.011243	5.06	85.78	71.77	0.035	600.00
St Mary	lower	12	433.74	4462.71	4464.88	2.17	4465.06	0.004415	3.40	127.75	96.55	0.035	550.00

River	Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Depth	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Mann Wtd Chnl	Cum Ch Len
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)
St Mary	River Lower River	11	433.74	4462.79	4464.70	1.91	4464.85	0.003838	3.12	139.02	107.20	0.035	500.00
St Mary	River Lower River	10	433.74	4462.27	4464.37	2.10	4464.58	0.007358	3.69	117.41	114.34	0.035	450.00
St Mary	River Lower River	9	433.74	4462.28	4463.85	1.57	4464.13	0.011330	4.26	101.72	110.51	0.035	400.00
St Mary	River Lower River	8	433.74	4461.30	4463.75	2.45	4463.86	0.002410	2.71	160.31	106.97	0.035	350.00
St Mary	River Lower River	7	433.74	4461.00	4463.65	2.65	4463.75	0.001859	2.58	168.36	100.48	0.035	300.00
St Mary	River Lower River	6	433.74	4460.94	4463.57	2.63	4463.66	0.001557	2.46	176.05	98.41	0.035	250.00
St Mary	River Lower River	5	433.74	4460.28	4463.46	3.18	4463.57	0.001792	2.70	160.92	87.30	0.035	200.00
St Mary	River Lower River	4	433.74	4460.66	4463.29	2.63	4463.45	0.003144	3.26	132.96	82.48	0.035	150.00
St Mary	River Lower River	3	433.74	4460.52	4463.11	2.59	4463.29	0.003186	3.44	125.95	72.85	0.035	100.00
St Mary	River Lower River	2	433.74	4460.39	4462.94	2.54	4463.12	0.003867	3.44	126.02	84.44	0.035	50.00
St Mary	River Lower River	1	433.74	4459.95	4462.69	2.74	4462.90	0.005002	3.68	117.94	86.71	0.035	

Appendix C

GEOLOGIC LOG OF DRILL HOLES

GEOLOGIC LOG OF DRILL HOLE: DH02-FSS

SHEET 1 OF 1

FEATURE: North Central Montana Regional Feasibility Study
PROJECT: Milk River Project
STATE: Montana
LOCATION: South Side of Fish Screen
COORDINATES:
GROUND ELEVATION:
BEGUN: 4/28/02 FINISHED: 4/28/02
TOTAL DEPTH: 33.7
ANGLE FROM HORIZONTAL: -90 AZIMUTH: 0
DEPTH AND ELEV. OF WATER
DEPTH TO BEDROCK: Not Reached
HOLE LOGGED BY: P. Atherton
LEVEL AND DATE MEASURED: 17.0 () 04/28/02
REVIEWED BY: L. Crutchfield

DRAFT

NOTES

LOCATION: 50 feet south of the turnout at St. Mary Diversion Dam, upstream from the existing dam, south bank of St. Mary Canal, Montana.

PURPOSE OF HOLE: Investigate foundation conditions for building a fish screen at St. Mary River Turnout.

DRILL EQUIPMENT: Truck mounted SIMCO AV5000, failing rods, 5-7/8" tricone-roller-rockbit, 6" Aardvark casing.

DRILLING METHODS: Rockbit and advance casing 0.0' to 33.7' with air as drilling medium

DRILLER J. McLaughlan - USBR

WATER LEVEL: 17.0' on 04/28/02

HOLE COMPLETION: Pulled Casing. Backfilled hole with 3/8" bentonite chips mixed with hole cuttings, then set fence post marker.

DEPTH	FLD. CLASS/LITH.	% CORE RECOVERY	GEOL. UNIT SYM.
5	GW		emb
10	SC		
	GP-GC		
15			
20	GP		Qal
25			
30	SP		

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0' to 14.0' - EMBANKMENT (emb):
No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings and drilling conditions.

0.0' to 10.1' - WELL GRADED GRAVEL (GW): About 55% subrounded gravel; about 40% well graded sand; about 5% fines of undetermined plasticity.

Total sample: about 10% cobbles, most 3-5", some 5-8"; maximum size 7".

10.1' to 11.9' - CLAYEY SAND (SC): About 60% well graded, subrounded sand; about 25% low plasticity fines; about15% fine, hard, subrounded gravel; maximum size 1"; dark brown; moist; very soft.

11.9' to 14.0' - POORLY GRADED GRAVEL (GP-GC): About 50 to 60% gap graded, subrounded, mostly coarse gravel; about 25% well graded sand; about 10% low plasticity fines.

Total sample: about 15% cobbles and boulders, even distribution of 3-5" and 5-8" cobbles, a trace of boulders; maximum size 10"

14.0' to 33.7' - QUATERNARY ALLUVIUM (Qal):
No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings and drilling conditions.

14.0' to 28.5' - POORLY GRADED GRAVEL (GP): About 60% gap graded, subrounded, mostly coarse gravel; about 25 to 35% well graded sand; about 5 to 10% fines of undetermined plasticity.

Total sample: about 5 to 15% cobbles; 5-10% 3-5" cobbles, 5% 5-8" cobbles, and a trace to 5% boulders; maximum size 8"

28.5' to 33.7' - POORLY GRADED SAND (SP): About 60% subrounded, mostly fine sand; about 30% gap graded, subrounded, mostly fine gravel; 10% fines of undetermined plasticity.

DRAFT

LOG - 1 NCMRFS.GPJ LOG_1.GDT 7/26/02

FIGURE C1 GEOLOGIC LOG OF DRILL HOLE DH02-FSS

GEOLOGIC LOG OF DRILL HOLE: DH02-FSN

SHEET 1 OF 1

FEATURE: North Central Montana Regional Feasibility Study PROJECT: Milk River Project
STATE: Montana
LOCATION: North Side of Fish Screen
COORDINATES:
GROUND ELEVATION:
BEGUN: 4/26/02 FINISHED: 4/26/02
TOTAL DEPTH: 30.6
ANGLE FROM HORIZONTAL: -90 AZIMUTH: 0
DEPTH AND ELEV. OF WATER
LEVEL AND DATE MEASURED: 14.5 () 04/26/02
DEPTH TO BEDROCK: Not Reached
HOLE LOGGED BY: P. Atherton
REVIEWED BY: L. Crutchfield

DRAFT

NOTES

LOCATION: 50 feet west of the turnout at St. Mary Diversion Dam, downstream from the existing dam, on the north bank of St. Mary Canal, Montana.

PURPOSE OF HOLE: Investigate foundation conditions for building a fish screen at St. Mary River Turnout.

DRILL EQUIPMENT: Truck mounted SIMCO AV5000, failing rods, 5-7/8" tricone-roller-rockbit, 6" Aardvark casing.

DRILLING METHODS: Rockbit and advance casing 0.0' to 30.6' with air as drilling medium

DRILLER J. McLaughlan - USBR

WATER LEVEL: 14.5' on 04/26/02

HOLE COMPLETION: Pulled Casing. Backfilled hole with 3/8" bentonite chips mixed with hole cuttings, then set fence post marker.

DEPTH	FLD. CLASS. STR.	% CORE RECOVERY	GEOL. UNIT SYM.
5	SP		emb
10			
15			
20	GW		Qal
25			
30			

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0' to 15.3' - EMBANKMENT (emb):
No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings and drilling conditions.

0' to 15.3' - POORLY GRADED SAND (SP): About 55% subrounded, mostly fine sand; about 40% gap graded, subrounded, mostly coarse gravel; about 5% fines of undetermined plasticity.

Total sample: about 10% predominantly 3-5"cobbles maximum size 7"

15.3' to 30.6' - QUATERNARY ALLUVIUM (Qal):
No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings returned from under the water table and drilling conditions.

15.3' to 30.6' - WELL GRADED GRAVEL (GW): About 50 to 60% subrounded gravel; about 30 to 40% well graded sand; about 5% of fines undetermined plasticity

Total sample: about 5% 3-5 " cobbles, a trace of 5-8" cobbles and boulders; maximum size 18".

DRAFT

LOG - 1 NCMRFS.GPJ LOG_1.GDT 7/26/02

FIGURE C2 GEOLOGIC LOG OF DRILL HOLE DH02-FSN

GEOLOGIC LOG OF DRILL HOLE: DH02-DDR

SHEET 1 OF 1

FEATURE: North Central Montana Regional Feasibility Study
PROJECT: Milk River Project
STATE: Montana
LOCATION: Diversion Dam Right Abutment
COORDINATES:
GROUND ELEVATION:
BEGUN: 4/27/02 FINISHED: 4/27/02
TOTAL DEPTH: 28.7
ANGLE FROM HORIZONTAL: -90 AZIMUTH: 0
DEPTH AND ELEV. OF WATER LEVEL AND DATE MEASURED:
DEPTH TO BEDROCK: 8.4
HOLE LOGGED BY: P. Atherton
REVIEWED BY: L. Crutchfield

DRAFT

NOTES

LOCATION: 150 feet northeast of the right abutment of St. Mary Diversion Dam, near east end of old bridge, St. Mary Canal, Montana.

PURPOSE OF HOLE: Investigate foundation conditions for replacing the diverison dam from St. Mary River to St. Mary Canal.

DRILL EQUIPMENT: Truck mounted SIMCO AV5000, 0.0 to 9.8': failing rods, 5-7/8" tricone-roller-rockbit, 6" Aardvark casing; 9.8' to 28.7': HQ3 wireline rods and 10' triple-tube core barrel .

DRILLING METHODS: Rockbit and advance casing 0.0' to 9.8' with air as drilling medium; HQ3 core with clear water as drilling medium from 9.8' to 28.7'.

DRILLER J. McLaughlan - USBR

WATER LEVEL: not measured

WATER TESTING: Falling head water tests performed inside 6" aardvark casing. Head 5.5', test at 5.3', no loss. Head 1' above ground surface test from 9.8' to 28.7' loss of 0.5 GPM.

HOLE COMPLETION: Pulled Casing. Backfilled hole with 3/8" bentonite chips, then set fence post marker.

DEPTH	FLD. CLASS/LITH.	% CORE RECOVERY	GEOL. UNIT SYM.
	SP		Qal
5	CL		
	GC		
10			
15		96	
	SS		Ku
20			
		100	
25			

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0' to 8.4' - QUATERNARY ALLUVIUM (Qal): No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings and drilling conditions.

0' to 4.0' - POORLY GRADED SAND (SP): About 60% subrounded, mostly fine sand; about 35% well graded, subrounded gravel; 5% non-plastic fines.

Total sample: about 10% cobbles; 5% 3-5", 5% 5-8%, and a trace of boulders; maximum size 14"

4.0' to 5.3' - SANDY CLAY (CL): About 60% low plasticity fines; about 25% mostly fine sand; about15% fine, hard, subrounded gravel; maximum size 1"; dark brown; wet; very soft.

5.3' to 8.4' - CLAYEY GRAVEL (GC): About 50 to 55% subrounded gravel; about 30% well graded sand; about 15 to 20% low plasticity fines; a trace of cobbles; maximum size 6".

8.4' to 28.7' - CRETACEOUS UNDIFFERENTIATED SEDIMENTS (Ku):

8.4' to 9.8' - SANDSTONE: No sample retained, rockbitted to confirm not on a boulder, tan sand returned in air medium.

9.8' to 28.7' - SANDSTONE: Fine to medium grained; pale yellowish brown to gray; slightly fractured (except 25.9' to 28.5' displays numerous, closely spaced, sub-parallel fractures which dip 40 to 50 degrees, are open 0.1" to 0.3", are clean and slightly rough); soft to moderately soft (moderately hard from 21' to 28.7'); displays some cross bedding, bedding is thin, dips about 10 degrees; interval displays a few randomly spaced very thin shale or siltstone beds less than 1/4" thick; moderate to strong reaction with HCl.

DRAFT

LOG - 1 NCMRFS.GPJ LOG_1.GDT 7/26/02

FIGURE C3 GEOLOGIC LOG OF DRILL HOLE DH02-DDR

GEOLOGIC LOG OF DRILL HOLE: DH02-DDO

SHEET 1 OF 1

FEATURE: North Central Montana Regional Feasibility Study
PROJECT: Milk River Project
STATE: Montana
LOCATION: Diversion Dam Outlet
COORDINATES:
GROUND ELEVATION:
BEGUN: 4/25/02 FINISHED: 4/25/02
TOTAL DEPTH: 24.1
ANGLE FROM HORIZONTAL: -90 AZIMUTH: 0
DEPTH AND ELEV. OF WATER LEVEL AND DATE MEASURED: 15.6 () 04/25/02
DEPTH TO BEDROCK: Not Reached
HOLE LOGGED BY: P. Atherton
REVIEWED BY: L. Crutchfield

DRAFT

NOTES

LOCATION: 50 feet east of the turnout for St. Mary Canal (50' left & downstream) near existing outlet works, St. Mary Canal, Montana.

PURPOSE OF HOLE: Investigate foundation conditions for replacing the turnout from St. Mary River to the canal.

DRILL EQUIPMENT: Truck mounted SIMCO AV5000, falling rods, 5-7/8" tricone-roller-rockbit, 6" Aardvark casing.

DRILLING METHODS: Rockbit and advance casing to final depth with air as drilling medium.

DRILLER J. McLaughlan - USBR

WATER LEVEL: 15.6' on 4/25/02

HOLE COMPLETION: Pulled casing. Hole caved from 24.1' back to 8.0' depth. Backfilled hole with 3/8" bentonite chips from 8' back to ground surface, then set fence post marker.

DEPTH	FLD. CLASS/LITH.	% CORE RECOVERY	GEOL. UNIT SYM.
	SP		emb
5			
	SC		
10			
15	GW		Qal
20			

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0' to 7.5' - EMBANKMENT (emb):
No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings and drilling conditions.

0' to 7.5' - POORLY GRADED SAND (SP): About 60% subrounded, mostly fine sand; about 45% gap graded, subrounded, mostly coarse gravel; 5% non-plastic fines.

Total sample: about 10% cobbles and boulders; 5% 3 - 5" cobbles, 5% 5-8" cobbles, and a trace of boulders; maximum size 14";

7.5' to 29.7' - QUATERNARY ALLUVIUM (Qal):
No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings and drilling conditions.

7.5' to 8.5' - CLAYEY SAND (SC): About 60% well graded, subrounded sand; about 25% low plasticity fines; about15% fine, hard, subrounded gravel; maximum size 1"; dark brown; moist; very soft.

8.5' to 24.1' - WELL GRADED GRAVEL (GW): About 60 to 65% subrounded gravel; about 30 to 35% well graded sand; about 5% fines of undetermined plasticity.

Total sample: about 5% 3'5" cobbles, trace of 5-8" cobbles and boulders; maximum size 10".

DRAFT

LOG - 1 NCMRFS.GPJ LOG 1.GDT 7/26/02

FIGURE C4 GEOLOGIC LOG OF DRILL HOLE DH02-DDO

GEOLOGIC LOG OF DRILL HOLE: DH02-DDL

SHEET 1 OF 1

FEATURE: North Central Montana Regional Feasibility Study PROJECT: Milk River Project STATE: Montana
LOCATION: Diversion Dam Left Abutment COORDINATES: GROUND ELEVATION:
BEGUN: 4/29/02 FINISHED: 4/29/02 TOTAL DEPTH: 50.4 ANGLE FROM HORIZONTAL: -90 AZIMUTH: 0
DEPTH AND ELEV. OF WATER DEPTH TO BEDROCK: Not Reached HOLE LOGGED BY: P. Atherton
LEVEL AND DATE MEASURED: 18.4 () 04/29/02 REVIEWED BY: L. Crutchfield

DRAFT

NOTES

LOCATION: 100 feet southwest of the left abutment of St. Mary Diversion Dam, downstream from the existing turnout, St. Mary Canal, Montana.

PURPOSE OF HOLE: Investigate foundation conditions for replacing the diversion dam from St. Mary River to St. Mary Canal.

DRILL EQUIPMENT: Truck mounted SIMCO AV5000, failing rods, 5-7/8" tricone-roller-rockbit, 6" Aardvark casing.

DRILLING METHODS: Rockbit and advance casing 0.0' to 50.4' with air as drilling medium

DRILLER J. McLaughlan - USBR

WATER LEVEL: 18.4' on 04/29/02

WATER TESTING: Falling head water tests performed inside 6" aardvark casing top of casing averaged 5.4' above ground surface head is distance from top of casing to the test interval at casing bottom depth.

CS DEPTH LOSS (GPM)

15.4	3.2
20.4	7.85
25.4	1.5
30.4	0.15
35.4	0.07
40.4	0.52
45.4	0.8
50.4	0.88

HOLE COMPLETION: Pulled Casing. Backfilled hole with 3/8" bentonite chips mixed with hole cuttings, then set fence post marker.

DEPTH	FLD. CLASS/LITH.	% CORE RECOVERY	GEOL. UNIT SYM.
5	SP		emb
10			
15			
20	GP		Qal
25			
30	SC		
35			
40	GW		
45			
50			

BOTTOM OF HOLE

CLASSIFICATION AND PHYSICAL CONDITION

0.0' to 16.0' - EMBANKMENT (emb):
No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings and drilling conditions.

0' to 16.0' - POORLY GRADED SAND (SP): About 50 to 60% subrounded, mostly fine sand; about 35 to 45% gap graded, subrounded, mostly coarse gravel; about 5% non-plastic fines.

Total sample: about 10% cobbles and boulders maximum size 15"; 5% 3-5" cobbles, 5% 5-8" cobbles, and trace of boulders.

16.0' to 50.4' - QUATERNARY ALLUVIUM (Qal):
No intact sample recovered, interval rockbitted, estimates based upon observation of cuttings returned from under the water table and drilling conditions.

16.0' to 25.5' - POORLY GRADED GRAVEL (GP): About 60 to 70% gap graded, subrounded, mostly coarse gravel; about 25 to 30% well graded sand; about 5 to 10% fines with undetermined plasticity.

Total sample: about 15% cobbles and boulders, maximum size 18"; 10% 3-5" cobbles, 5% 5-8" cobbles, and trace of boulders.

25.5' to 35.4' - CLAYEY SAND (SC): About 60% well graded, subrounded sand; about 25% low plasticity fines; about15% fine, hard, subrounded gravel; maximum size 1"; dark brown; moist; very soft.

35.4' to 50.4' - WELL GRADED GRAVEL (GW): About 50 to 60% subrounded gravel; about 35 to 45% well graded sand; about 5% fines with undetermined plasticity.

Total sample: about 15% cobbles, maximum size 8"; 5% 3-5" cobbles, and trace of 5-8" cobbles.

DRAFT

LOG - 1 NCMRFS.GPJ LOG_1.GDT 7/25/02

FIGURE C5 GEOLOGIC LOG OF DRILL HOLE DH02-DDL

Appendix D

CONSTRUCTION COST ESTIMATE SHEETS
CONCEPT 1

CODE:D-6170

ESTIMATE WORKSHEET

SHEET 1 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
540 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

Division:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[540 cfs Concept 1.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	excavation for temporary bypass channel	D-8140	26000	cy	$5.50	$143,000
	2	excavation for permanent channel	D-8140	4,000	cy	$5.50	$22,000
	3	excavation for structures	D-8140	2,000	cy	$11.00	$22,000
	4	concrete in new headworks structure	D-8140	500	cy	$490.00	$245,000
	5	reinforcement in new headworks structure	D-8140	50,000	lb	$0.80	$40,000
	6	cement in headworks	D-8140	141	ton	$140.00	$19,740
	7	concrete in new sluice structure	D-8140	750	cy	$430.00	$322,500
	8	reinforcement in new sluice structure	D-8140	75,000	lb	$0.80	$60,000
	9	cement in sluice structure	D-8140	200	ton	$140.00	$28,000
	10	backfill concrete in existing dam	D-8140	180	cy	$275.00	$49,500
	11	cement in backfill concrete	D-8140	40	ton	$140.00	$5,600
	12	rock in fish passage	D-8140	400	cy	$42.00	$16,800
	13	grouting rock in fish passage	D-8140	160	cy	$180.00	$28,800
	14	riprap	D-8140	420	cy	$42.00	$17,640
	15	sand and gravel bedding for riprap	D-8140	210	cy	$30.00	$6,300
	16	concrete demolition and removal	D-8140	275	cy	$185.00	$50,875
	17	backfill for structures	D-8140	800	cy	$9.00	$7,200
	18	compacting backfill for structures	D-8140	800	cy	$9.00	$7,200
	19a	cofferdam construction for in-river work (diversion/care of stream)	D-8140	1	ls	$87,000.00	$87,000
	19b	unwatering and dewatering	D-8140	1	ls	$580,000.00	$580,000
		Subtotal (1 of 3)					$1,759,155

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED DCA 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 1 - 540 FT^3/S, 1 OF 3-

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 2 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
540 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[540 cfs Concept 1.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	20	concrete in fish screen structure	D-8140	170	cy	$550.00	$93,500
	21	reinforcement in fish screen structure	D-8140	20,000	lb	$0.80	$16,000
	22	cement in fish screen structure	D-8140	48	ton	$140.00	$6,720
	23	concrete in 6" canal lining	D-8140	200	cy	$400.00	$80,000
	23b	reinforcement in lining	D-8140	20,000	lb	$0.80	$16,000
	24	cement in canal lining	D-8140	56	ton	$140.00	$7,840
	25	concrete in transitions	D-8140	400	cy	$430.00	$172,000
	26	reinforcement in transitions	D-8140	40,000	lb	$0.80	$32,000
	27	cement in transitions	D-8140	113	ton	$140.00	$15,820
	28	concrete in fish return transitions	D-8140	120	cy	$430.00	$51,600
	29	reinforcement in fish return transitions	D-8140	10,000	lb	$0.80	$8,000
	30	cement in fish return transitions	D-8140	34	ton	$140.00	$4,760
	31	furnish/place 6" waterstop	D-8140	750	lf	$8.50	$6,375
	32	excavation for fish screen	D-8140	1,400	cy	$12.50	$17,500
	33	backfill	D-8140	300	cy	$9.00	$2,700
	34	compacting backfill	D-8140	300	cy	$9.00	$2,700
	35	relocating gaging station	D-8140	1	ls	$20,000.00	$20,000
	36	furnish/place 36" SDR 17 HDPE fish return pip	D-8140	200	lf	$210.00	$42,000
		earthwork assuming 12' deep trench					
	37	Fish screens, 10'W x 10' H, 17 + 2 spares	D-8410	38,000	lb	$11.00	$418,000
		stainless steel (approx. 2000 lbs/panel)					
	38	Adjustable baffles, 10'W x 10'H, 17 + 2 spares	D-8410	57,000	lb	$4.50	$256,500
		steel, (approx. 3000 lbs/panel)					
	39	Hydraulic trash rake/brushing unit, rail and sup	D-8410	1	ls	$200,000.00	$200,000
		single boom, 190 feet of length (15,000 lbs)					
		Subtotal (2 of 3)					$1,470,015

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED DCL 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 2 - 540 FT^3/S, 2 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 3 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
540 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[540 cfs Concept 1.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	40	Fish screen guide and support structure with	D-8410	63,000	lb	$6.00	$378,000
		grating and handrail, steel					
	41	Steel transition to bypass	D-8420	8,200	lb	$10.00	$82,000
		2'W x 9'H to 36" dia. pipe					
	42	42" wide x 42" high steel slide gate	D-8420	2,200	lb	$15.00	$33,000
		at bypass exit, motor operated (steel)					
	43	Water level measuring equipment	D-8410	1	ls	$15,000.00	$15,000
		Canal Diversion Headworks					
	44	Stoplog guides and seats at Diversion headwo	D-8410	2,550	lb	$7.00	$17,850
		2 intake bays, 10' wide x 18' high, steel					
	45	Trashracks (steel)	D-8410	35,000	lb	$4.00	$140,000
		Sluiceway					
	46	Stoplog guides and seats at sluiceway gate ba	D-8410	2,700	lb	$7.00	$18,900
		2 bays, 10' wide x 19' high, steel					
	47	radial gates and hoists	D-8420	4	ea	$60,000.00	$240,000
		(each gate weighs 6,750 lbs. and requires a 5,000 lb capacity					
		hoist which weighs 2,500 lbs with 1.5 hp motor)					
	48	electrical installation for fish screen structure		1	ls	$350,000.00	$350,000
	49	electrical installation for headworks and sluice structures		1	ls	$100,000.00	$100,000
		Subtotal (3 of 3)					$1,374,750
		Subtotal (2 of 3)					$1,470,015
		Subtotal (1 of 3)					$1,759,155
		SUBTOTAL					$4,603,920
		Mobilization		(+/-)		5%	$230,000
		Subtotal					$4,833,920
		Unlisted Items		(+/-)		15%	$766,080
		Contract Cost					$5,600,000
		Contingencies		(+/-)		25%	$1,300,000
		Field Cost					$6,900,000

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY T. Artichoker	CHECKED DCD 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 3 - 540 FT^3/S, 3 OF 3

CODE:D-8140

ESTIMATE WORKSHEET

SHEET 1 OF 3

FEATURE: 03-Apr-2003

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
710 cfs

C:\OLDPC~1\SAYER\STMARY~1\SM1.WK4

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

UNIT:

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		excavation for temporary bypass channel	D-8140	31000	cy	$5.50	$170,500.00
		excavation for permanent channel	D-8140	4,400	cy	$5.50	$24,200.00
		excavation for structures	D-8140	3,000	cy	$11.00	$33,000.00
		concrete in new headworks structure	D-8140	750	cy	$490.00	$367,500.00
		reinforcement in new headworks structure	D-8140	80,000	lb	$0.80	$64,000.00
		cement in headworks	D-8140	210	ton	$140.00	$29,400.00
		concrete in new sluice structure	D-8140	750	cy	$430.00	$322,500.00
		reinforcement in new sluice structure	D-8140	75,000	lb	$0.80	$60,000.00
		cement in sluice structure	D-8140	200	ton	$140.00	$28,000.00
		backfill concrete in existing dam	D-8140	180	cy	$275.00	$49,500.00
		cement in backfill concrete	D-8140	40	ton	$140.00	$5,600.00
		rock in fish passage	D-8140	400	cy	$42.00	$16,800.00
		grouting rock in fish passage	D-8140	160	cy	$180.00	$28,800.00
		riprap d/s of sluice structure	D-8140	420	cy	$42.00	$17,640.00
		sand and gravel bedding for riprap	D-8140	210	cy	$30.00	$6,300.00
		concrete demolition and removal	D-8140	275	cy	$185.00	$50,875.00
		backfill for structures	D-8140	800	cy	$9.00	$7,200.00
		compacting backfill for structures	D-8140	800	cy	$9.00	$7,200.00
		cofferdam construction for in-river work (diversion/care of st	D-8140	1	ls	$87,000.00	$87,000.00
		unwatering and dewatering	D-8140	1	ls	$580,000	$580,000.00
		SUBTOTAL (1 OF 3)					$1,956,015.00

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY	CHECKED
DATE PREPARED 10-Sep-02	DATE	DATE	PRICE LEVEL

CONCEPT 1 COST ESTIMATE SHEET 4 - 710 FT^3/S, 1OF 3

CODE:D-8140

ESTIMATE WORKSHEET

SHEET 2 OF 3

FEATURE: 03-Apr-2003

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
710 cfs

C:\OLDPC~1\SAYER\STMARY~1\SM1.WK4

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

UNIT:

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		concrete in fish screen structure	D-8140	220	cy	$550.00	$121,000.00
		reinforcement in fish screen structure	D-8140	26,000	lb	$0.80	$20,800.00
		cement in fish screen structure	D-8140	62	ton	$140.00	$8,680.00
		concrete in 6" canal lining	D-8140	280	cy	$400.00	$112,000.00
		reinforcement in lining	D-8140	28,000	lb	$0.80	$22,400.00
		cement in canal lining	D-8140	79	ton	$140.00	$11,060.00
		concrete in transitions	D-8140	400	cy	$430.00	$172,000.00
		reinforcement in transitions	D-8140	40,000	lb	$0.80	$32,000.00
		cement in transitions	D-8140	113	ton	$140.00	$15,820.00
		concrete in fish return transitions	D-8140	120	cy	$430.00	$51,600.00
		reinforcement in fish return transitions	D-8140	10,000	lb	$0.80	$8,000.00
		cement in fish return transitions	D-8140	34	ton	$140.00	$4,760.00
		furnish/place 6" waterstop	D-8140	1,000	lf	$8.50	$8,500.00
		excavation for fish screen	D-8140	1,800	cy	$12.50	$22,500.00
		backfill	D-8140	300	cy	$9.00	$2,700.00
		compacting backfill	D-8140	300	cy	$9.00	$2,700.00
		relocating gaging station	D-8140	1	ls	$20,000.00	$20,000.00
		furnish/place 48" SDR 17 HDPE fish return piping including	D-8140	200	lf	$250.00	$50,000.00
		earthwork assuming 12' deep trench					
		radial gates and hoists	D-8420	5	ea	$60,000.00	$300,000.00
		each gate weighs 6,750 lbs. and requires a 5,000 lb capacity hoist					
		which weighs 2,500 lbs with 1.5 hp motor.					
		electrical installation for fish screen structure		1	ls	$350,000	$350,000.00
		electrical installation for headworks and sluice structures gate hoists		1	ls	$100,000	$100,000.00
		(note - power is available at the site)					
		SUBTOTAL (2 OF 3)					$1,436,520.00

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY	CHECKED
DATE PREPARED 10-Sep-02	DATE	DATE	PRICE LEVEL

CONCEPT 1 COST ESTIMATE SHEET 5 – 710 FT^3/S, 2 OF 3

CODE:D-8140

ESTIMATE WORKSHEET

SHEET 3 OF 3

FEATURE: 03-Apr-2003

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
710 cfs

C:\OLDPC~1\SAYER\STMARY~1\SM1.WK4

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

UNIT:

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Fish screens, 10'W x 10' H, 26 + 2 spares	D-8410	56000	lbs ss	$11.00	$616,000
		stainless steel (approx. 2000 lbs/panel)					
		Adjustable baffles, 10'W x 10'H, 26 + 2 spares	D-8410	84,000	lbs steel	$4.50	$378,000
		steel, (approx. 3000 lbs/panel)					
		Hydraulic trash rake/brushing unit, rail and supports	D-8410	1	ls	$240,000	$240,000
		single boom, 280 feet of length (25,000 lbs)					
		Fish screen guide and support structure with	D-8410	112,000	lbs steel	$6.00	$672,000
		grating and handrail, steel					
		Steel transition to bypass	D-8420	8,200	lbs steel	$10.00	$82,000
		2'W x 9'H to 36" dia. pipe					
		42" wide x 42" high steel slide gate	D-8420	2,200	lbs steel	$15.00	$33,000
		at bypass exit, motor operated					
		Water level measuring equipment	D-8410	1	ls	$15,000.00	$15,000
		Canal Diversion Headworks					
		Stoplog guides and seats at Diversion headworks,	D-8410	3,800	lbs steel	$7.00	$26,600
		3 intake bays, 10' wide x 18' high, steel					
		Trashracks	D-8410	40,000	lbs steel	$4.00	$160,000
		Sluiceway					
		Stoplog guides and seats at sluiceway gate bays,	D-8410	2,700	lbs steel	$7.00	$18,900
		2 bays, 10' wide x 19' high, steel					
		SUBTOTAL (3 OF 3)					$2,241,500
		subtotal (3 sheets)					$5,634,035
		mobilization				5%	$281,700
		subtotal					$5,915,735
		unlisted items				15%	$887,265
		CONTRACT COST					$6,803,000
		contingencies				25%	$1,701,000
		FIELD COST					$8,504,000

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY	CHECKED
DATE PREPARED 10-Sep-02	DATE	DATE	PRICE LEVEL

CONCEPT 1 COST ESTIMATE SHEET 6 – 710 FT^3/S, 3 OF 3

CODE:0-8170

ESTIMATE WORKSHEET

SHEET 1 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
890 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

Division:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[Revised SM Concept 1.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	excavation for temporary bypass channel	D-8140	35000	cy	$5.50	$192,500
	2	excavation for permanent channel	D-8140	5,000	cy	$5.50	$27,500
	3	excavation for structures	D-8140	4,000	cy	$11.00	$44,000
	4	concrete in new headworks structure	D-8140	950	cy	$490.00	$465,500
	5	reinforcement in new headworks structure	D-8140	100,000	lb	$0.80	$80,000
	6	cement in headworks	D-8140	268	ton	$140.00	$37,520
	7	concrete in new sluice structure	D-8140	750	cy	$430.00	$322,500
	8	reinforcement in new sluice structure	D-8140	75,000	lb	$0.80	$60,000
	9	cement in sluice structure	D-8140	200	ton	$140.00	$28,000
	10	backfill concrete in existing dam	D-8140	180	cy	$275.00	$49,500
	11	cement in backfill concrete	D-8140	40	ton	$140.00	$5,600
	12	rock in fish passage	D-8140	400	cy	$42.00	$16,800
	13	grouting rock in fish passage	D-8140	160	cy	$180.00	$28,800
	14	riprap	D-8140	420	cy	$42.00	$17,640
	15	sand and gravel bedding for riprap	D-8140	210	cy	$30.00	$6,300
	16	concrete demolition and removal	D-8140	275	cy	$185.00	$50,875
	17	backfill for structures	D-8140	800	cy	$9.00	$7,200
	18	compacting backfill for structures	D-8140	800	cy	$9.00	$7,200
	19a	cofferdam construction for in-river work (diversion/care of stream)	D-8140	1	ls	$87,000.00	$87,000
	19b	unwatering and dewatering	D-8140	1	ls	$580,000.00	$580,000
		Subtotal (1 of 3)					$2,114,435

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY T. Artichoker	CHECKED
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 7 - 890 FT^3/S, 1 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 2 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
890 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[Revised SM Concept 1.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	20	concrete in fish screen structure	D-8140	280	cy	$550.00	$154,000
	21	reinforcement in fish screen structure	D-8140	20,000	lb	$0.80	$16,000
	22	cement in fish screen structure	D-8140	80	ton	$140.00	$11,200
	23	concrete in 6" canal lining	D-8140	360	cy	$400.00	$144,000
	23b	reinforcement in lining	D-8140	30,000	lb	$0.80	$24,000
	24	cement in canal lining	D-8140	100	ton	$140.00	$14,000
	25	concrete in transitions	D-8140	400	cy	$430.00	$172,000
	26	reinforcement in transitions	D-8140	40,000	lb	$0.80	$32,000
	27	cement in transitions	D-8140	113	ton	$140.00	$15,820
	28	concrete in fish return transitions	D-8140	120	cy	$430.00	$51,600
	29	reinforcement in fish return transitions	D-8140	10,000	lb	$0.80	$8,000
	30	cement in fish return transitions	D-8140	34	ton	$140.00	$4,760
	31	furnish/place 6" waterstop	D-8140	1,200	lf	$8.50	$10,200
	32	excavation for fish screen	D-8140	2,200	cy	$12.50	$27,500
	33	backfill	D-8140	300	cy	$9.00	$2,700
	34	compacting backfill	D-8140	300	cy	$9.00	$2,700
	35	relocating gaging station	D-8140	1	ls	$20,000.00	$20,000
	36	furnish/place 42" SDR 17 HDPE fish return pip	D-8140	200	lf	$250.00	$50,000
		earthwork assuming 12' deep trench					
	37	Fish screens, 10'W x 10' H, 28 + 2 spares	D-8410	60000	lb	$11.00	$660,000
		stainless steel (approx. 2000 lbs/panel)					
	38	Adjustable baffles, 10'W x 10'H, 28 + 2 spares	D-8410	90,000	lb	$4.50	$405,000
		steel, (approx. 3000 lbs/panel)					
	39	Hydraulic trash rake/brushing unit, rail and sup	D-8410	1	ls	$270,000.00	$270,000
		single boom, 300 feet of length (22,000 lbs)					
		Subtotal (2 of 3)					$2,095,480

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY T. Artichoker	CHECKED 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 8 - 890 FT^3/S, 2 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 3 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
890 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[Revised SM Concept 1.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	40	Fish screen guide and support structure with	D-8410	100,500	lb	$6.00	$603,000
		grating and handrail, steel					
	41	Steel transition to bypass	D-8420	8,200	lb	$10.00	$82,000
		2'W x 9'H to 36" dia. pipe					
	42	42" wide x 42" high steel slide gate	D-8420	2,200	lb	$15.00	$33,000
		at bypass exit, motor operated (steel)					
	43	Water level measuring equipment	D-8410	1	ls	$15,000.00	$15,000
		Canal Diversion Headworks					
	44	Stoplog guides and seats at Diversion headwo	D-8410	5,100	lb	$7.00	$35,700
		4 intake bays, 10' wide x 18' high, steel					
	45	Trashracks (steel)	D-8410	43,750	lb	$4.00	$175,000
		Sluiceway					
	46	Stoplog guides and seats at sluiceway gate ba	D-8410	2,700	lb	$7.00	$18,900
		2 bays, 10' wide x 19' high, steel					
	47	radial gates and hoists	D-8420	6	ea	$60,000.00	$360,000
		(each gate weighs 6,750 lbs. and requires a 5,000 lb capacity					
		hoist which weighs 2,500 lbs with 1.5 hp motor)					
	48	electrical installation for fish screen structure		1	ls	$350,000.00	$350,000
	49	electrical installation for headworks and sluice structures		1	ls	$100,000.00	$100,000
		Subtotal (3 of 3)					$1,772,600
		Subtotal (2 of 3)					$2,095,480
		Subtotal (1 of 3)					$2,114,435
		SUBTOTAL					$5,982,515
		Mobilization		(+/-)		5%	$300,000
		Subtotal					$6,282,515
		Unlisted Items		(+/-)		15%	$917,485
		Contract Cost					$7,200,000
		Contingencies		(+/-)		25%	$1,800,000
		Field Cost					$9,000,000

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY T. Artichoker TA	CHECKED DCM 23-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 9 - 890 FT^3/S, 3 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 1 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
1040 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

Division:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[1040 cfs Concept 1.xlw]B

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
use 710870	1	excavation for temporary bypass channel	D-8140	39000	cy	$5.50	$214,500
	2	excavation for permanent channel	D-8140	5,500	cy	$5.50	$30,250
	3	excavation for structures	D-8140	4,000	cy	$11.00	$44,000
	4	concrete in new headworks structure	D-8140	950	cy	$490.00	$465,500
	5	reinforcement in new headworks structure	D-8140	100,000	lb	$0.80	$80,000
	6	cement in headworks	D-8140	268	ton	$140.00	$37,520
a	7	concrete in new sluice structure	D-8140	750	cy	$430.00	$322,500
	8	reinforcement in new sluice structure	D-8140	75,000	lb	$0.80	$60,000
	9	cement in sluice structure	D-8140	200	ton	$140.00	$28,000
	10	backfill concrete in existing dam	D-8140	180	cy	$275.00	$49,500
	11	cement in backfill concrete	D-8140	40	ton	$140.00	$5,600
d	12	rock in fish passage	D-8140	400	cy	$42.00	$16,800
d	13	grouting rock in fish passage	D-8140	160	cy	$180.00	$28,800
	14	riprap	D-8140	420	cy	$42.00	$17,640
	15	sand and gravel bedding for riprap	D-8140	210	cy	$30.00	$6,300
	16	concrete demolition and removal	D-8140	275	cy	$185.00	$50,875
	17	backfill for structures	D-8140	800	cy	$9.00	$7,200
	18	compacting backfill for structures	D-8140	800	cy	$9.00	$7,200
	19a	cofferdam construction for in-river work (diversion/care of stream)	D-8140	1	ls	$87,000.00	$87,000
	19b	unwatering and dewatering	D-8140	1	ls	$580,000.00	$580,000
		Subtotal (1 of 3)					$2,139,185

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED DCD 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 10 - 1040 FT^3/S, 1 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 2 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
1040 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[1040 cfs Concept 1.xlw]B

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	20	concrete in fish screen structure	D-8140	330	cy	$550.00	$181,500
	21	reinforcement in fish screen structure	D-8140	40,000	lb	$0.80	$32,000
	22	cement in fish screen structure	D-8140	93	ton	$140.00	$13,020
	23	concrete in 6" canal lining	D-8140	440	cy	$400.00	$176,000
	23b	reinforcement in lining	D-8140	44,000	lb	$0.80	$35,200
	24	cement in canal lining	D-8140	124	ton	$140.00	$17,360
	25	concrete in transitions	D-8140	400	cy	$430.00	$172,000
	26	reinforcement in transitions	D-8140	40,000	lb	$0.80	$32,000
	27	cement in transitions	D-8140	113	ton	$140.00	$15,820
	28	concrete in fish return transitions	D-8140	120	cy	$430.00	$51,600
	29	reinforcement in fish return transitions	D-8140	10,000	lb	$0.80	$8,000
	30	cement in fish return transitions	D-8140	34	ton	$140.00	$4,760
	31	furnish/place 6" waterstop	D-8140	1,400	lf	$8.50	$11,900
	32	excavation for fish screen	D-8140	2,350	cy	$12.50	$29,375
	33	backfill	D-8140	300	cy	$9.00	$2,700
	34	compacting backfill	D-8140	300	cy	$9.00	$2,700
	35	relocating gaging station	D-8140	1	ls	$20,000.00	$20,000
	36	furnish/place 48" SDR 17 HDPE fish return pip	D-8140	200	lf	$290.00	$58,000
		earthwork assuming 12' deep trench					
	37	Fish screens, 10'W x 10' H, 33 + 2 spares	D-8410	70,000	lb	$11.00	$770,000
		stainless steel (approx. 2000 lbs/panel)					
	38	Adjustable baffles, 10'W x 10'H, 33 + 2 spares	D-8410	105,000	lb	$4.50	$472,500
		steel, (approx. 3000 lbs/panel)					
	39	Hydraulic trash rake/brushing unit, rail and sup	D-8410	1	ls	$300,000.00	$300,000
		single boom, 350 feet of length (25,000 lbs)					
		Subtotal (2 of 3)					$2,406,435

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY T. Artichoker	CHECKED 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 11- 1040 FT^3/S, 2 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 3 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 1 ESTIMATE
1040 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[1040 cfs Concept 1.xlw]B

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	40	Fish screen guide and support structure with	D-8410	120,000	lb	$6.00	$720,000
		grating and handrail, steel					
	41	Steel transition to bypass	D-8420	8,200	lb	$10.00	$82,000
		2'W x 9'H to 48" dia. pipe					
	42	42" wide x 42" high steel slide gate	D-8420	2,200	lb	$15.00	$33,000
		at bypass exit, motor operated (steel)					
	43	Water level measuring equipment	D-8410	1	ls	$15,000.00	$15,000
		Canal Diversion Headworks					
	44	Stoplog guides and seats at Diversion headwo	D-8410	5,100	lb	$7.00	$35,700
		4 intake bays, 10' wide x 18' high, steel					
	45	Trashracks (steel)	D-8410	47,250	lb	$4.00	$189,000
		Sluiceway					
	46	Stoplog guides and seats at sluiceway gate ba	D-8410	2,700	lb	$7.00	$18,900
3		2 bays, 10' wide x 19' high, steel					
	47	radial gates and hoists	D-8420	6	ea	$60,000.00	$360,000
		(each gate weighs 6,750 lbs. and requires a 5,000 lb capacity					
		hoist which weighs 2,500 lbs with 1.5 hp motor)					
add overshot	48	electrical installation for fish screen structure		1	ls	$350,000.00	$350,000
	49	electrical installation for headworks and sluice structures		1	ls	$100,000.00	$100,000
		Subtotal (3 of 3)					$1,903,600
		Subtotal (2 of 3)					$2,406,435
		Subtotal (1 of 3)					$2,139,185
		SUBTOTAL					$6,449,220
		Mobilization		(+/-)		5%	$320,000
		Subtotal					$6,769,220
		Unlisted Items		(+/-)		15%	$1,030,780
		Contract Cost					$7,800,000
		Contingencies		(+/-)		25%	$1,900,000
		Field Cost					$9,700,000

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY T. Artichoker	CHECKED RCA 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 1 COST ESTIMATE SHEET 12- 1040 FT^3/S, 3 OF 3

Appendix E

CONSTRUCTION COST ESTIMATE SHEETS
CONCEPT 2

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 1 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
540 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

Division:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[540 cfs Concept 2.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	excavation for temporary bypass channel	D-8140	26,000	cy	$5.50	$143,000
	2	excavation for permanent channel	D-8140	4,000	cy	$5.50	$22,000
	3	excavation for structures	D-8140	2,000	cy	$11.00	$22,000
	4	concrete in new headworks structure	D-8140	500	cy	$490.00	$245,000
	5	reinforcement in new headworks structure	D-8140	50,000	lb	$0.80	$40,000
	6	cement in headworks	D-8140	141	ton	$140.00	$19,740
	7	concrete in new sluice structure	D-8140	370	cy	$455.00	$168,350
	8	reinforcement in new sluice structure	D-8140	35,000	lb	$0.80	$28,000
	9	cement in sluice structure	D-8140	104	ton	$140.00	$14,560
	10a	concrete in new dam	D-8140	900	cy	$400.00	$360,000
	10b	reinforcement in new dam	D-8140	80,000	lb	$0.80	$64,000
	11	cement in concrete in new dam	D-8140	254	ton	$140.00	$35,560
	12	rock in fish passage	D-8140	320	cy	$42.00	$13,440
	13	grouting rock in fish passage	D-8140	120	cy	$180.00	$21,600
	14	riprap	D-8140	900	cy	$42.00	$37,800
	15	sand and gravel bedding for riprap	D-8140	450	cy	$27.00	$12,150
	16	concrete demolition and removal (including existing dam)	D-8140	900	cy	$165.00	$148,500
	17	backfill for structures	D-8140	800	cy	$9.00	$7,200
	18	compacting backfill for structures	D-8140	800	cy	$9.00	$7,200
	19	excavation for new dam	D-8140	3,000	cy	$5.50	$16,500
	19a	cofferdam construction for in-river work (diversion/care of stream)	D-8140	1	ls	$60,000.00	$60,000
	19b	unwatering and dewatering	D-8140	1	ls	$580,000.00	$580,000
		Subtotal (1 of 3)					$2,066,600

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED DCD 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 1 - 540 FT^3/S, 1 OF 3

CODE:D-6170

ESTIMATE WORKSHEET

SHEET 2 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
540 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[540 cfs Concept 2.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	20	concrete in fish screen structure	D-8140	170	cy	$550.00	$93,500
	21	reinforcement in fish screen structure	D-8140	20,000	lb	$0.80	$16,000
	22	cement in fish screen structure	D-8140	48	ton	$140.00	$6,720
	23	concrete in 6" canal lining	D-8140	200	cy	$400.00	$80,000
	23b	reinforcement in lining	D-8140	20,000	lb	$0.80	$16,000
	24	cement in canal lining	D-8140	56	ton	$140.00	$7,840
	25	concrete in transitions	D-8140	400	cy	$430.00	$172,000
	26	reinforcement in transitions	D-8140	40,000	lb	$0.80	$32,000
	27	cement in transitions	D-8140	113	ton	$140.00	$15,820
	28	concrete in fish return transitions	D-8140	120	cy	$430.00	$51,600
	29	reinforcement in fish return transitions	D-8140	10,000	lb	$0.80	$8,000
	30	cement in fish return transitions	D-8140	34	ton	$140.00	$4,760
	31	furnish/place 6" waterstop	D-8140	750	lf	$8.50	$6,375
	32	excavation for fish screen	D-8140	1,400	cy	$12.50	$17,500
	33	backfill	D-8140	300	cy	$9.00	$2,700
	34	compacting backfill	D-8140	300	cy	$9.00	$2,700
	35	relocating gaging station	D-8140	1	ls	$20,000.00	$20,000
	36	furnish/place 36" SDR 17 HDPE fish return pip	D-8140	200	lf	$210.00	$42,000
		earthwork assuming 12' deep trench					
	37	Fish screens, 10'W x 10' H, 17 + 2 spares	D-8410	38,000	lb	$11.00	$418,000
		stainless steel (approx. 2000 lbs/panel)					
	38	Adjustable baffles, 10'W x 10'H, 17 + 2 spares	D-8410	57,000	lb	$4.50	$256,500
		steel, (approx. 3000 lbs/panel)					
	39	Hydraulic trash rake/brushing unit, rail and sup	D-8410	1	ls	$200,000.00	$200,000
		single boom, 190 feet of length (15,000 lbs)					
		Subtotal (2 of 3)					$1,470,015

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED Dcd 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 2 - 540 FT^3/S, 2 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 3 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
540 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[540 cfs Concept 2.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	40	Fish screen guide and support structure with	D-8410	63,000	lb	$6.00	$378,000
		grating and handrail, steel					
	41	Steel transition to bypass	D-8420	8,200	lb	$10.00	$82,000
		2'W x 9'H to 36" dia. pipe					
	42	42" wide x 42" high steel slide gate	D-8420	2,200	lb	$15.00	$33,000
		at bypass exit, motor operated (steel)					
	43	Water level measuring equipment	D-8410	1	ls	$15,000.00	$15,000
		Canal Diversion Headworks					
	44	Stoplog guides and seats at Diversion headwo	D-8410	2,550	lb	$7.00	$17,850
		2 intake bays, 10' wide x 18' high, steel					
	45	Trashracks (steel)	D-8410	35,000	lb	$4.00	$140,000
		Sluiceway					
	46	Stoplog guides and seats at sluiceway gate ba	D-8410	2,700	lb	$7.00	$18,900
		2 bays, 10' wide x 19' high, steel					
	47	radial gates and hoists	D-8420	4	ea	$60,000.00	$240,000
		(each gate weighs 6,750 lbs. and requires a 5,000 lb capacity					
		hoist which weighs 2,500 lbs with 1.5 hp motor)					
	48	electrical installation for fish screen structure		1	ls	$350,000.00	$350,000
	49	electrical installation for headworks and sluice structures		1	ls	$100,000.00	$100,000
		Subtotal (3 of 3)					$1,374,750
		Subtotal (2 of 3)					$1,470,015
		Subtotal (1 of 3)					$2,066,600
		SUBTOTAL					$4,911,365
		Mobilization		(+/-)		5%	$250,000
		Subtotal					$5,161,365
		Unlisted Items		(+/-)		15%	$738,635
		Contract Cost					$5,900,000
		Contingencies		(+/-)		25%	$1,500,000
		Field Cost					$7,400,000

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED DCA 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 3 - 540 FT^3/S, 3 OF 3

CODE:D-8140

ESTIMATE WORKSHEET

SHEET 1 OF 3

FEATURE: 03-Apr-2003

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
710 cfs

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PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

UNIT:

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		excavation for temporary bypass channel	D-8140	31000	cy	$5.50	$170,500.00
		excavation for permanent channel	D-8140	4,400	cy	$5.50	$24,200.00
		excavation for structures	D-8140	3,000	cy	$11.00	$33,000.00
		concrete in new headworks structure	D-8140	750	cy	$490.00	$367,500.00
		reinforcement in new headworks structure	D-8140	80,000	lb	$0.80	$64,000.00
		cement in headworks	D-8140	210	ton	$140.00	$29,400.00
		concrete in new sluice structure	D-8140	370	cy	$455.00	$168,350.00
		reinforcement in new sluice structure	D-8140	35,000	lb	$0.80	$28,000.00
		cement in sluice structure	D-8140	104	ton	$140.00	$14,560.00
		concrete in new dam	D-8140	900	cy	$400.00	$360,000.00
		reinforcement in new dam	D-8140	80,000	lb	$0.80	$64,000.00
		cement in concrete in new dam	D-8140	254	ton	$140.00	$35,560.00
		rock in fish passage	D-8140	320	cy	$42.00	$13,440.00
		grouting rock in fish passage	D-8140	120	cy	$180.00	$21,600.00
		riprap d/s of sluice structure	D-8140	900	cy	$42.00	$37,800.00
		sand and gravel bedding for riprap	D-8140	450	cy	$27.00	$12,150.00
		concrete demolition and removal, including existing dam rem	D-8140	900	cy	$165.00	$148,500.00
		backfill for structures	D-8140	800	cy	$9.00	$7,200.00
		compacting backfill for structures	D-8140	800	cy	$9.00	$7,200.00
		excavation for dam	D-8140	3,000	cy	$5.50	$16,500.00
		cofferdam construction for in-river work (diversion/care of st	D-8140	1	ls	$60,000	$60,000.00
		unwatering and dewatering	D-8140	1	ls	$580,000	$580,000.00
		SUBTOTAL (1 OF 3)					$2,263,460.00

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY	CHECKED
DATE PREPARED 10-Sep-02	DATE	DATE	PRICE LEVEL

CONCEPT 2 COST ESTIMATE SHEET 4 - 710 FT³/S, 1 OF 3

CODE:D-4130

ESTIMATE WORKSHEET

SHEET 2 OF 3

FEATURE: 03-Apr-2003

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
710 cfs

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PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

UNIT:

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		concrete in fish screen structure	D-8140	220	cy	$550.00	$121,000.00
		reinforcement in fish screen structure	D-8140	26,000	lb	$0.80	$20,800.00
		cement in fish screen structure	D-8140	62	ton	$140.00	$8,680.00
		concrete in 6" canal lining	D-8140	280	cy	$400.00	$112,000.00
		reinforcement in lining	D-8140	28,000	lb	$0.80	$22,400.00
		cement in canal lining	D-8140	79	ton	$140.00	$11,060.00
		concrete in transitions	D-8140	400	cy	$430.00	$172,000.00
		reinforcement in transitions	D-8140	40,000	lb	$0.80	$32,000.00
		cement in transitions	D-8140	113	ton	$140.00	$15,820.00
		concrete in fish return transitions	D-8140	120	cy	$430.00	$51,600.00
		reinforcement in fish return transitions	D-8140	10,000	lb	$0.80	$8,000.00
		cement in fish return transitions	D-8140	34	ton	$140.00	$4,760.00
		furnish/place 6" waterstop	D-8140	1,000	lf	$8.50	$8,500.00
		excavation for fish screen	D-8140	1,800	cy	$12.50	$22,500.00
		backfill	D-8140	300	cy	$9.00	$2,700.00
		compacting backfill	D-8140	300	cy	$9.00	$2,700.00
		relocating gaging station	D-8140	1	ls	$20,000.00	$20,000.00
		furnish/place 48" SDR 17 HDPE fish return piping including earthwork assuming 12' deep trench	D-8140	200	lf	$250.00	$50,000.00
		radial gates and hoists each gate weighs 6,750 lbs. and requires a 5,000 lb capacity hoist which weighs 2,500 lbs with 1.5 hp motor.	D-8420	5	ea	$60,000.00	$300,000.00
		electrical installation for fish screen structure		1	ls	$350,000	$350,000.00
		electrical installation for headworks and sluice structures gate hoists (note - power is available at the site)		1	ls	$100,000	$100,000.00
		SUBTOTAL (2 OF 3)					$1,436,520.00

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY	CHECKED
DATE PREPARED 10-Sep-02	DATE	DATE	PRICE LEVEL

CONCEPT 2 COST ESTIMATE SHEET 5 - 710 FT^3/S ,2 OF 3

CODE:D-8140

ESTIMATE WORKSHEET

SHEET 3 OF 3

FEATURE: 03-Apr-2003

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
710 cfs

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PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

UNIT:

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Fish screens, 10'W x 10' H, 26 + 2 spares	D-8410	56000	lbs ss	$11.00	$616,000.00
		stainless steel (approx. 2000 lbs/panel)					
		Adjustable baffles, 10'W x 10'H, 26 + 2 spares	D-8410	84,000	lbs steel	$4.50	$378,000.00
		steel, (approx. 3000 lbs/panel)					
		Hydraulic trash rake/brushing unit, rail and supports	D-8410	1	ls	$240,000	$240,000.00
		single boom, 280 feet of length (23,000 lbs)					
		Fish screen guide and support structure with	D-8410	112,000	lbs steel	$6.00	$672,000.00
		grating and handrail, steel					
		Steel transition to bypass	D-8420	8,200	lbs steel	$10.00	$82,000.00
		2'W x 9'H to 36" dia. pipe					
		42" wide x 42" high steel slide gate	D-8420	2,200	lbs steel	$15.00	$33,000.00
		at bypass exit, motor operated					
		Water level measuring equipment	D-8410	1	ls	$15,000.00	$15,000.00
		Canal Diversion Headworks					
		Stoplog guides and seats at Diversion headworks,	D-8410	3,800	lbs steel	$7.00	$26,600.00
		3 intake bays, 10' wide x 18' high, steel					
		Trashracks	D-8410	40,000	lbs steel	$4.00	$160,000.00
		Sluiceway					
		Stoplog guides and seats at sluiceway gate bays,	D-8410	2,700	lbs steel	$7.00	$18,900.00
		2 bays, 10' wide x 19' high, steel					
		SUBTOTAL (3 OF 3)					$2,241,500.00
		subtotal of 3 sheets					$5,941,480.00
		mobilization				5%	$297,000
		subtotal					$6,238,480
		unlisted items				15%	$935,520
		CONTRACT COST					$7,174,000
		contingencies				25%	$1,793,000
		FIELD COST					$8,967,000

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY	CHECKED
DATE PREPARED 10-Sep-02	DATE	DATE	PRICE LEVEL

CONCEPT 2 COST ESTIMATE SHEET 6 - 710 FT^3/S, 3 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 1 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
890 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

Division:

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PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	excavation for temporary bypass channel	D-8140	35000	cy	$5.50	$192,500
	2	excavation for permanent channel	D-8140	5,000	cy	$5.50	$27,500
	3	excavation for structures	D-8140	4,000	cy	$11.00	$44,000
	4	concrete in new headworks structure	D-8140	950	cy	$490.00	$465,500
	5	reinforcement in new headworks structure	D-8140	100,000	lb	$0.80	$80,000
	6	cement in headworks	D-8140	268	ton	$140.00	$37,520
	7	concrete in new sluice structure	D-8140	370	cy	$455.00	$168,350
	8	reinforcement in new sluice structure	D-8140	35,000	lb	$0.80	$28,000
	9	cement in sluice structure	D-8140	104	ton	$140.00	$14,560
	10a	concrete in new dam	D-8140	900	cy	$400.00	$360,000
	10b	reinforcement in new dam	D-8140	80,000	lb	$0.80	$64,000
	11	cement in concrete in new dam	D-8140	254	ton	$140.00	$35,560
	12	rock in fish passage	D-8140	320	cy	$42.00	$13,440
	13	grouting rock in fish passage	D-8140	120	cy	$180.00	$21,600
	14	riprap	D-8140	900	cy	$42.00	$37,800
	15	sand and gravel bedding for riprap	D-8140	450	cy	$27.00	$12,150
	16	concrete demolition and removal (including existing dam)	D-8140	900	cy	$165.00	$148,500
	17	backfill for structures	D-8140	800	cy	$9.00	$7,200
	18	compacting backfill for structures	D-8140	800	cy	$9.00	$7,200
	19	excavation for new dam	D-8140	3,000	cy	$5.50	$16,500
	19a	cofferdam construction for in-river work (diversion/care of stream)	D-8140	1	ls	$60,000.00	$60,000
	19b	unwatering and dewatering	D-8140	1	ls	$580,000.00	$580,000
		Subtotal (1 of 3)					$2,421,880

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 7- 890 FT^3/S, 1 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 2 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
890 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[Revised SM Concept 2.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	20	concrete in fish screen structure	D-8140	280	cy	$550.00	$154,000
	21	reinforcement in fish screen structure	D-8140	20,000	lb	$0.80	$16,000
	22	cement in fish screen structure	D-8140	80	ton	$140.00	$11,200
	23	concrete in 6" canal lining	D-8140	360	cy	$400.00	$144,000
	23b	reinforcement in lining	D-8140	30,000	lb	$0.80	$24,000
	24	cement in canal lining	D-8140	100	ton	$140.00	$14,000
	25	concrete in transitions	D-8140	400	cy	$430.00	$172,000
	26	reinforcement in transitions	D-8140	40,000	lb	$0.80	$32,000
	27	cement in transitions	D-8140	113	ton	$140.00	$15,820
	28	concrete in fish return transitions	D-8140	120	cy	$430.00	$51,600
	29	reinforcement in fish return transitions	D-8140	10,000	lb	$0.80	$8,000
	30	cement in fish return transitions	D-8140	34	ton	$140.00	$4,760
	31	furnish/place 6" waterstop	D-8140	1,200	lf	$8.50	$10,200
	32	excavation for fish screen	D-8140	2,200	cy	$12.50	$27,500
	33	backfill	D-8140	300	cy	$9.00	$2,700
	34	compacting backfill	D-8140	300	cy	$9.00	$2,700
	35	relocating gaging station	D-8140	1	ls	$20,000.00	$20,000
	36	furnish/place 42" SDR 17 HDPE fish return pip	D-8140	200	lf	$250.00	$50,000
		earthwork assuming 12' deep trench					
	37	Fish screens, 10'W x 10' H, 28 + 2 spares	D-8410	60000	lb	$11.00	$660,000
		stainless steel (approx. 2000 lbs/panel)					
	38	Adjustable baffles, 10'W x 10'H, 28 + 2 spares	D-8410	90,000	lb	$4.50	$405,000
		steel, (approx. 3000 lbs/panel)					
	39	Hydraulic trash rake/brushing unit, rail and sup	D-8410	1	ls	$270,000.00	$270,000
		single boom, 300 feet of length (22,000 lbs)					
		Subtotal (2 of 3)					$2,095,480

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED DCD 2-2-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 8 – 890 FT^3/S, 2 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 3 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
890 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[Revised SM Concept 2.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	40	Fish screen guide and support structure with	D-8410	100,500	lb	$6.00	$603,000
		grating and handrail, steel					
	41	Steel transition to bypass	D-8420	8,200	lb	$10.00	$82,000
		2'W x 9'H to 36" dia. pipe					
	42	42" wide x 42" high steel slide gate	D-8420	2,200	lb	$15.00	$33,000
		at bypass exit, motor operated (steel)					
	43	Water level measuring equipment	D-8410	1	ls	$15,000.00	$15,000
		Canal Diversion Headworks					
	44	Stoplog guides and seats at Diversion headwo	D-8410	5,100	lb	$7.00	$35,700
		4 intake bays, 10' wide x 18' high, steel					
	45	Trashracks (steel)	D-8410	43,750	lb	$4.00	$175,000
		Sluiceway					
	46	Stoplog guides and seats at sluiceway gate ba	D-8410	2,700	lb	$7.00	$18,900
		2 bays, 10' wide x 19' high, steel					
	47	radial gates and hoists	D-8420	6	ea	$60,000.00	$360,000
		(each gate weighs 6,750 lbs. and requires a 5,000 lb capacity					
		hoist which weighs 2,500 lbs with 1.5 hp motor)					
	48	electrical installation for fish screen structure		1	ls	$350,000.00	$350,000
	49	electrical installation for headworks and sluice structures		1	ls	$100,000.00	$100,000
		Subtotal (3 of 3)					$1,772,600
		Subtotal (2 of 3)					$2,095,480
		Subtotal (1 of 3)					$2,421,880
		SUBTOTAL					$6,289,960
		Mobilization		(+/-)		5%	$310,000
		Subtotal					$6,599,960
		Unlisted Items		(+/-)		15%	$1,000,040
		Contract Cost					$7,600,000
		Contingencies		(+/-)		25%	$1,900,000
		Field Cost					$9,500,000

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY T. Artichoker	CHECKED 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 9 – 890 FT^3/S, 3 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 1 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
1040 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

Division:

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PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	excavation for temporary bypass channel	D-8140	39,000	cy	$5.50	$214,500
	2	excavation for permanent channel	D-8140	5,500	cy	$5.50	$30,250
	3	excavation for structures	D-8140	4,000	cy	$11.00	$44,000
	4	concrete in new headworks structure	D-8140	950	cy	$490.00	$465,500
	5	reinforcement in new headworks structure	D-8140	100,000	lb	$0.80	$80,000
	6	cement in headworks	D-8140	268	ton	$140.00	$37,520
	7	concrete in new sluice structure	D-8140	370	cy	$455.00	$168,350
	8	reinforcement in new sluice structure	D-8140	35,000	lb	$0.80	$28,000
	9	cement in sluice structure	D-8140	104	ton	$140.00	$14,560
	10a	concrete in new dam	D-8140	900	cy	$400.00	$360,000
	10b	reinforcement in new dam	D-8140	80,000	lb	$0.80	$64,000
	11	cement in concrete in new dam	D-8140	254	ton	$140.00	$35,560
	12	rock in fish passage	D-8140	320	cy	$42.00	$13,440
	13	grouting rock in fish passage	D-8140	120	cy	$180.00	$21,600
	14	riprap	D-8140	900	cy	$42.00	$37,800
	15	sand and gravel bedding for riprap	D-8140	450	cy	$27.00	$12,150
	16	concrete demolition and removal (including existing dam)	D-8140	900	cy	$165.00	$148,500
	17	backfill for structures	D-8140	800	cy	$9.00	$7,200
	18	compacting backfill for structures	D-8140	800	cy	$9.00	$7,200
	19	excavation for new dam	D-8140	3,000	cy	$5.50	$16,500
	19a	cofferdam construction for in-river work (diversion/care of stream)	D-8140	1	ls	$60,000.00	$60,000
	19b	unwatering and dewatering	D-8140	1	ls	$580,000.00	$580,000
		Subtotal (1 of 3)					$2,446,630

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED DCA 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 10 - 1040 FT^3/S, 1 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 2 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
1040 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[1040 cfs Concept 2.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	20	concrete in fish screen structure	D-8140	330	cy	$550.00	$181,500
	21	reinforcement in fish screen structure	D-8140	40,000	lb	$0.80	$32,000
	22	cement in fish screen structure	D-8140	93	ton	$140.00	$13,020
	23	concrete in 6" canal lining	D-8140	440	cy	$400.00	$176,000
	23b	reinforcement in lining	D-8140	44,000	lb	$0.80	$35,200
	24	cement in canal lining	D-8140	124	ton	$140.00	$17,360
	25	concrete in transitions	D-8140	400	cy	$430.00	$172,000
	26	reinforcement in transitions	D-8140	40,000	lb	$0.80	$32,000
	27	cement in transitions	D-8140	113	ton	$140.00	$15,820
	28	concrete in fish return transitions	D-8140	120	cy	$430.00	$51,600
	29	reinforcement in fish return transitions	D-8140	10,000	lb	$0.80	$8,000
	30	cement in fish return transitions	D-8140	34	ton	$140.00	$4,760
	31	furnish/place 6" waterstop	D-8140	1,400	lf	$8.50	$11,900
	32	excavation for fish screen	D-8140	2,350	cy	$12.50	$29,375
	33	backfill	D-8140	300	cy	$9.00	$2,700
	34	compacting backfill	D-8140	300	cy	$9.00	$2,700
	35	relocating gaging station	D-8140	1	ls	$20,000.00	$20,000
	36	furnish/place 48" SDR 17 HDPE fish return pip	D-8140	200	lf	$290.00	$58,000
		earthwork assuming 12' deep trench					
	37	Fish screens, 10'W x 10' H, 33 + 2 spares	D-8410	70,000	lb	$11.00	$770,000
		stainless steel (approx. 2000 lbs/panel)					
	38	Adjustable baffles, 10'W x 10'H, 33 + 2 spares	D-8410	105,000	lb	$4.50	$472,500
		steel, (approx. 3000 lbs/panel)					
	39	Hydraulic trash rake/brushing unit, rail and sup	D-8410	1	ls	$300,000.00	$300,000
		single boom, 350 feet of length (25,000 lbs)					
		Subtotal (2 of 3)					$2,406,435

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY TA T. Artichoker	CHECKED ACA 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 11 - 1040 FT^3/S, 2 OF 3

CODE:D-8170

ESTIMATE WORKSHEET

SHEET 3 OF 3

FEATURE: 03-Feb-03

ST. MARY DIVERSION AND FISH FACILITIES
CONCEPT 2 ESTIMATE
1040 CFS

WOID: 6B251

PROJECT:
MILK RIVER PROJECT
ST. MARY STORAGE UNIT - MONTANA

DIVISION:

File: C:\Artichoker\Appraisal-Feasibility Estimates\St Marys Fish Screen\[1040 cfs Concept 2.xlw]C

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	40	Fish screen guide and support structure with	D-8410	120,000	lb	$6.00	$720,000
		grating and handrail, steel					
	41	Steel transition to bypass	D-8420	8,200	lb	$10.00	$82,000
		2'W x 9'H to 48" dia. pipe					
	42	42" wide x 42" high steel slide gate	D-8420	2,200	lb	$15.00	$33,000
		at bypass exit, motor operated (steel)					
	43	Water level measuring equipment	D-8410	1	ls	$15,000.00	$15,000
		Canal Diversion Headworks					
	44	Stoplog guides and seats at Diversion headwo	D-8410	5,100	lb	$7.00	$35,700
		4 intake bays, 10' wide x 18' high, steel					
	45	Trashracks (steel)	D-8410	47,250	lb	$4.00	$189,000
		Sluiceway					
	46	Stoplog guides and seats at sluiceway gate ba	D-8410	2,700	lb	$7.00	$18,900
		2 bays, 10' wide x 19' high, steel					
	47	radial gates and hoists	D-8420	6	ea	$60,000.00	$360,000
		(each gate weighs 6,750 lbs. and requires a 5,000 lb capacity					
		hoist which weighs 2,500 lbs with 1.5 hp motor)					
	48	electrical installation for fish screen structure		1	ls	$350,000.00	$350,000
	49	electrical installation for headworks and sluice structures		1	ls	$100,000.00	$100,000
		Subtotal (3 of 3)					$1,903,600
		Subtotal (2 of 3)					$2,406,435
		Subtotal (1 of 3)					$2,446,630
		SUBTOTAL					$6,756,665
		Mobilization		(+/-)		5%	$340,000
		Subtotal					$7,096,665
		Unlisted Items		(+/-)		15%	$1,103,335
		Contract Cost					$8,200,000
		Contingencies		(+/-)		25%	$1,800,000
		Field Cost					$10,000,000

QUANTITIES		PRICES	
BY K. Sayer	APPROVED	BY T. Artichoker TA	CHECKED DCA 2-3-03
DATE PREPARED 10-Sep-02	DATE	DATE 02/03/03	PRICE LEVEL Appraisal

CONCEPT 2 COST ESTIMATE SHEET 12 - 1040 FT^3/S, 3 OF 3