BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

Task 24
of the
Zero-Offsite Water-Discharge Study

Prepared for:

EG&G ROCKY FLATS, INC.
Facilities Engineering
P.O. Box 464
Golden, Colorado 80402-0464

EG&G Job No. 401009
BOA Contract BA 72429PB
Letter Contract No. BA 7984465

Prepared by:

ADVANCED SCIENCES, INCORPORATED
405 Urban Street, Suite 401
Lakewood, Colorado 80228

Draft: September 28, 1990
Draft Final: December 11, 1990
Final: January 15, 1991

ASI Project No. 208.0124

DISCLAIMER

TABLE OF CONTENTS

List Of Tables

List of Figures

List of Figures (Continued)

Appendices

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

EXECUTIVE SUMMARY

This is a report of one of several studies being conducted for, and in the development of, a Zero-Offsite Water-Discharge Plan for the Rocky Flats Plant (RFP), in response to Item C.7 of the Agreement in Principle between the Colorado Department of Health (CDH) and the U.S. Department of Energy (DOE)(DOE and State of Colorado, 1989). The CDH/DOE Agreement Item C.7 states the following: "Source Reduction and Zero Discharges Study: Conduct a study of all available methods to eliminate Rocky Flats discharges to the environment including surface waters and groundwater. This review should include a source reduction review."

Studies which are subordinate to the Zero-Offsite Water-Discharge Plan will rely on the results presented in this report. Particular studies which are influenced by results of analyses in this surface-water bypass study are: Study of Water Resource Management (Task 23); Study of Downstream Erosion Potential (Task 25); Alternatives to Zero Discharge (Task 17); Surface-Water and Ground-Water Rights Study (Task 14); and Temporary Water Storage Capabilities Study (Task 21). Specific relationships and influences among these tasks will be addressed in the Consolidation and Zero-Discharge Plan (Task 30), as a result of the Zero-Offsite Water-Discharge Plan.

Specifically, this report addresses important issues related to the surface-water bypass control. This study assesses six different alternatives in which existing surface-water diversion systems may be redesigned for the McKay Bypass Canal, and two different alternatives in which existing surface-water diversion systems may be redesigned for the Woman Creek Bypass Canal. Aspects of this study include assessment of flows expected during the 100-year, 500-year, and Probable Maximum Precipitation (PMP) storm events based on a 24-hour duration and a 72-hour duration storm for various alternatives that take into account different drainage basins (ASI, 1990a). The drainage basins that were considered for the McKay Bypass are as follows.

- McKay Bypass Alternative One includes runoff from the 130 complex and T-130 complex area, runoff from the future buildout (as determined by the 5-Year Plan Site Development Plan (EG&G, 1990a), and runoff from the West Spray Field, as well as including runoff from all areas west of these areas and flows that are contributed from Coal Creek and the South Boulder Diversion Canal.

- McKay Bypass Alternative Two includes runoff from a portion of the West Spray Field, excluding the future buildout area (as determined by the 5-Year Plan Site Development Plan (EG&G Rocky Flats, Inc., 1990a), as well as including runoff from all areas west of the West Spray Field and flows that are contributed from Coal Creek and the South Boulder Diversion Canal.

- McKay Bypass Alternative Three includes runoff from only the areas west of the West Spray Field and flows that are contributed from Coal Creek and the South Boulder Diversion Canal.

- The drainage areas considered for McKay Bypass Alternatives One-A, Two-A, and Three-A are the same as those for alternatives one, two, and three, respectively. The difference being that for these alternatives, the flows for the South Boulder Diversion Canal and Coal Creek are not included.

Consideration has been given to the various hydrologic factors that are present in individual drainage basins.

The drainage basins that were considered for the Woman Creek Bypass are as follows:

- Woman Creek Bypass Alternative One includes runoff from the Woman Creek drainage basin above and below the South Boulder Diversion Canal, as well as including flows that are contributed from Coal Creek and the South Boulder Diversion Canal.

- Woman Creek Alternative Two includes runoff from the Woman Creek drainage basin only east of the South Boulder Diversion Canal, excluding any flows from Coal Creek and the South Boulder Diversion Canal.

This study also has established alternatives that may be best for consideration of redesign of the current bypass system. Through an alternative evaluation and ranking activity, it appears that for the McKay Bypass, the best alternative to consider is Alternative 3-A for the 500-year frequency 72-hour duration storm event. Some of the factors considered in the alternative selection process included cost, required construction, and risk benefits related to each alternative. The best design alternative for the Woman Creek Bypass based upon these factors is Alternative 2 for the 500-year frequency 72-hour duration storm event.

For the above selected alternative for the McKay Bypass, the estimated cost for the required construction is approximately $777,000. This preliminary cost estimate includes redesigning the Walnut Creek Diversion Dam and constructing the Rock Creek Bypass and diversion dam. The risks associated with this alternative are lower than any other alternative assessed except for Alternative 3-A for the general PMP storm event. The amount of surface-water overflow coming into contact with RFP property and potentially contaminated surface areas is less for this alternative than any other alternative.

For the above selected alternative for the Woman Creek Bypass, the estimated cost for the required construction is approximately $7.4 million. This preliminary cost estimate includes installation of additional riprap in the Woman Creek Bypass, construction of the Kinnear Ditch Bypass, and construction of the Mower Reservoir Creek. The risks associated with this alternative are lower than any other alternative assessed except for Alternative 2 for the PMP storm event. The amount of surface-water overflow coming into contact with RFP property and potentially contaminated areas is also less for this alternative than any other alternative.

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

1.0 INTRODUCTION

1.1 BACKGROUND

The Zero-Offsite Water-Discharge Study is required by the Agreement in Principle signed by the Governor of the State of Colorado and by the Secretary of the U.S. Department of Energy (DOE) on June 28, 1989 (DOE and State of Colorado, 1989). The CDH/DOE Agreement Item C.7 states the following: "Source Reduction and Zero Discharges Study: Conduct a study of all available methods to eliminate Rocky Flats discharges to the environment including surface-waters and groundwater. This review should include a source reduction review." This report is a component study of the Zero-Offsite Water-Discharge Study (ASI, 1990a). This subordinate study analyzes the existing surface-water bypass system and a conceptual redesign of this system. The existing system is designed to minimize the amount of surface-water from flowing onto the RFP facility areas. The surface-water bypass system currently consists primarily of two canals, the McKay Bypass Canal located on the north side of the facility and the Woman Creek Bypass Canal, located on the south side of the facility (Figure 1). The Woman Creek Bypass Canal and the McKay Bypass Canal currently are designed to carry the amount of surface water run-on, that was predicted by McCall-Ellingson & Morrill, Inc. (1978), for the 100-year, 72-hour storm event. This study provides new conceptual design specifications of these canals, based on recent precipitation data for the 100-year, 500-year, and Probable Maximum Precipitation (PMP) storm events, of both 24-hour and 72-hour durations.

Several scenarios were viewed for the conceptual redesign of the current bypass system. Six variations were examined in the area of the McKay Bypass. Each of these variations related to the McKay Bypass included different drainage areas and the inclusion or exclusion of inflow from Coal Creek. Two different scenarios were assessed for the Woman Creek Bypass. One scenario included inflows from Coal Creek, and the other excluded inflows from Coal Creek.

1.2 PURPOSE AND SCOPE

The purpose of this study is to identify upstream flows and assess the physical options and economic ramifications for bypassing these flows around selected areas of the RFP (ASI, 1990b; 1990e) so that the bypass of surface-water flows will be maximized to decrease the amount of water to be stored, treated, or reused on RFP property. The conceptual designs and associated analyses of costs presented in this report are aimed at providing a more complete and effective run-on control system than currently exists. The efforts have been directed toward conceptual design of control structures which would provide capabilities for extreme surface water run-on conditions. The conceptual design of the bypass structures are based on data and information acquired from Task 6 (Storm-Runoff Quantity for Various Design Events) (ASI, 1990c), Task 9 (Design Recurrence Intervals Study) (ASI, 1990d), field observations, and use of the TR-20 hydrologic model (SCS, 1977; 1983) to estimate peak discharges and runoff volumes at selected locations at the RFP.

Currently, a surface-water bypass system is in place at the RFP. This system includes McKay Bypass north of the facility and Woman Creek Bypass south of the facility (Figure 1). These structures have been designed for the 100-year, 72-hour storm event based on precipitation data available in 1978 (McCall-Ellingson & Morrill, Inc., 1978). The purpose of this study is to conceptually redesign these structures for the 100-year, 500-year and the general PMP storm events of 24-hour and 72-hour durations. As part of this redesign, three of the alternatives include the design of bypass structures upland of the current bypass structures, a proposed Rock Creek Bypass and a proposed Kinnear Ditch Bypass.

2.0 SURFACE-WATER DIVERSION EVALUATION AND CONTROL

2.1 EXISTING DIVERSION FACILITIES DESIGN

The surface-water bypass system currently in place at the RFP facility was completed in 1980 and is designed for the 100-year 72-hour flood event (McCall-Ellingson & Morrill, Inc., 1980). Figure 1 shows the surface-water control structures that currently are in place, including surface-water runoff control as well as surface-water run-on control. The surface-water run-on currently is diverted around the RFP facility and released into two natural channels that eventually transport water to downstream reservoirs (Great Western Reservoir and Standley Lake) which serve as public water supplies. This bypass system currently consists of the McKay Bypass Canal and the Woman Creek Bypass Canal.

The McKay Bypass Canal is located north of the RFP, runs from west to east and is connected to the West Interceptor Ditch on the west side of the RFP Controlled Area (Figure 1). At its east (discharge) end, the McKay Bypass Canal empties into an unnamed drainage that eventually flows into Walnut Creek which discharges to Great Western Reservoir. Figure 2 shows a typical cross-section of the existing McKay Bypass Canal and Table 1 lists the current design specifications.

The Woman Creek Bypass Canal is located southeast of the RFP Controlled Area (Figure 1). This canal routes the water from Woman Creek, around the northern end of the Woman Creek Diversion Dam and Pond C-2, and discharges the water back into Woman Creek approximately 1,500 feet east of the Woman Creek Diversion Dam and downstream from Pond C-2. Woman Creek then flows eastward into Standley Lake. Figure 3 shows a typical cross-section of the existing Woman Creek Bypass Canal, and Table 1 lists the current design specifications.

In addition to the above-mentioned canals, surface-water runoff is controlled by a system of dams and canals. The South Interceptor Canal was constructed along the southern side of the RFP

TABLE 1

Current Bypass System Design Specifications

Bypass System	Storm Event	Bottom Width (ft)	Side Slope	Bottom Slope (ft/ft)	Flow Depth (ft)	Freeboard (ft)
McKay	100-Year	14	2:1	0.0002	5.35	2.15
		15	2:1	0.0002	5.49	2.71
		15	2:1	0.0002	5.70	2.80
		16	2:1	0.0002	5.82	2.78
Woman Creek	100-Year	27	2:1	0.0002	8.14	1.36

Source: McCall-Ellingson & Morrill, Inc., 1980.

Controlled Area (Figure 1). The purpose of this canal is to intercept storm runoff from the RFP Controlled Area which would otherwise flow directly into Woman Creek. This canal flows from west to east, passes under the Woman Creek Bypass Canal and discharges into Pond C-2 (Figure 1).

Surface-Water runoff from the RFP is also controlled by a series of dams that exist along North Walnut Creek (Ponds A-1 through A-4) and a series of dams that exist along South Walnut Creek (Ponds B-1 through B-5) (Figure 1). These ponds temporarily store storm runoff and treated sanitary-treatment-plant (STP) effluent.

2.2 CONCEPTUAL RUN-ON CONTROL

2.2.1 Existing Sensitive Areas

One primary concern in assessing the placement of diversion structures is the location of existing Solid Waste Management Units (SWMUs) (Rockwell International, 1988a; 1988b). Surface water run-on should be diverted away from existing SWMUs in order to minimize the spread of potential contamination from the SWMUs. Also, diversion structures should be located upland of all SWMUs to minimize upstream flows from coming in contact with the potentially contaminated areas.

For example, SWMU 168 (West Spray Field) is located west of the RFP Controlled Area (Figure 4). Two of the options presented in this report consider bypassing upland surface-water flows around this SWMU. One of the alternatives assessed to minimize upland surface-water run-on from coming into contact with, or possibly washing out contaminants in SWMU 168, is the construction of a berm, or a berm and a channel along the west and north sides of SWMU 168 (Figure 4). The western extension of a berm or a diversion channel would act to divert surface-water run-on around the SWMU. The northern extension of the berm would help protect the SWMU from washout in the event that the water level in Walnut Creek rose high enough to overtop the channel banks. The second alternative assessed to bypass upland flows around SWMU 168 is the construction of a diversion channel (Rock Creek Bypass) at the western edge of RFP property (Figure 4). This alternative is discussed in detail below.

Other SWMUs that require consideration are SWMUs 133.1 through 133.6, 166.2, 166.3, 167.1, 167.3, 170, 174, and 209. Two of the alternatives presented in this report, the Kinnear Ditch Bypass and the Rock Creek Bypass (Figure 4), divert surface-water run-on originating from areas located west of the RFP property, from coming into contact with these SWMUs. However, any precipitation that falls directly onto these SWMUs, or upland of these SWMUs and downstream of these proposed bypass channels has the potential of contributing surface runoff to RFP property. Thus, if these proposed bypass channels are selected as alternatives, individual surface-water diversion structures around these SWMUs should be assessed during the design phase of the proposed bypass channels.

2.2.2 Methods for Redesigning Primary Bypass Canals

Several alternatives have been presented for redesigning the current bypass system. The drainage areas contributing to each alternative are presented on Table 2 and are shown on Figure 5. Infiltration during a storm event was estimated using a Soil Conservation Service (SCS) weighted Curve Number (CN) which was derived based on soil type, percent of the area each soil type covered, percent ground cover, and percent impervious cover. The weighted curve numbers used for each alternative are presented in Table 2. Also, it has been assumed that overflow from Coal Creek occurs for all of the storm events considered, and that overflow from the South Boulder Diversion Canal may contribute surface-water flow to the drainage areas of concern during the Probable Maximum Flood (PMF). Study results of Task 6 (ASI, 1990c) provide detailed watershed description, curve number analysis, basin characteristics and model inputs.

During the course of this study, the SCS's TR-20 model (SCS, 1983) was used to calculate runoff hydrographs and peak flows for the 100-year, 500-year, and the PMP storm events for both 24-

Table 2

Hydrologic Parameters

Bypass Structure Alternatives	Drainage Basin	Drainage Area (sq. miles)	Basin Slope (ft/ft)	Weighted Curve Number	Time of Concentration (hr.)
McKay 1	7a	0.54	0.02	79	1.83
	2	0.43	0.05	74	1.84
McKay 2	7b	0.33	0.02	73	2.18
	2	0.43	0.05	74	1.84
McKay 3	7c	0.23	0.02	73	2.85
	2	0.43	0.02	74	1.84
McKay 1-A	7a	0.54	0.02	79	1.83
	2	0.43	0.05	74	1.84
McKay 2-A	7b	0.33	0.02	73	2.18
	2	0.43	0.05	74	1.84
McKay 3-A	7c	0.23	0.02	73	2.85
	2	0.43	0.02	74	1.84
Rock Creek	15	0.04	0.03	72	0.67
Woman Creek 1	11	0.59	0.03	73	1.99
	10	1.42	0.07	72	2.30
Woman Creek 2	10	1.42	0.07	72	2.30
Kinnear Ditch	14	0.14	0.02	74	2.07

Table 3

Peak Flows for Surface Water Bypass Design

McKay Bypass

Storm Event	Alternative 1 Peak Flow (cfs)	Alternative 2 Peak Flow (cfs)	Alternative 3 Peak Flow (cfs)
100-year, 24-hour	600	430	390
100-year, 72-hour	570	410	360
500-year, 24-hour	740	570	510
500-year, 72-hour	700	530	470
PMP, 24-hour	5,820	4,910	4,520
PMP, 72-hour	5,840	4,790	4,220

Storm Event	Alternative 1-A Peak Flow (cfs)	Alternative 2-A Peak Flow (cfs)	Alternative 3-A Peak Flow (cfs)
100-year, 24-hour	400	280	250
100-year, 72-hour	360	250	240
500-year, 24-hour	520	410	360
500-year, 72-hour	520	370	320
PMP, 24-hour	4,810	3,900	3,480
PMP, 72-hour	4,820	3,590	3,210

Table 3
(Cont.)

Peak Flows for Surface Water Bypass Design

Woman Creek Bypass

Storm Event	Alternative 1 Peak Flow (cfs)	Alternative 2 Peak Flow (cfs)
100-year, 24-hour	2,450	570
100-year, 72-hour	2,380	520
500-year, 24-hour	2,860	840
500-year, 72-hour	2,750	780
PMP, 24-hour	16,340	11,080
PMP, 72-hour	15,460	10,800

Kinnear Ditch and Rock Creek Bypass Systems

Kinnear Ditch Bypass

Storm Event	Peak Flow (cfs)
100-year, 24-hour	2,450
100-year, 72-hour	2,380
500-year, 24-hour	2,860
500-year, 72-hour	2,750
PMP, 24-hour	5,640
PMP, 72-hour	5,570

Rock Creek Bypass

Storm Event	Peak Flow (cfs)
100-year, 24-hour	50
100-year, 72-hour	50
500-year, 24-hour	70
500-year, 72-hour	70
PMP, 24-hour	1,470
PMP, 72-hour	1,330

Notes: 1) Antecedent Moisture Condition (AMC) II is assumed for the 100-year and 500-year storm events, and AMC III is assumed for the PMP event.

2) The peak flows reported for the 72-hour duration are not actual. These peak flows are the same as those for the 24-hour duration, only due to model limitations, the correct peak flows cannot be produced (see Appendix A for further explanation).

hour and 72-hour durations. Table 3 presents the results of these calculations. ASI (1990c) presents a more detailed description of the SCS TR-20 model (Appendix B presents a sample calculation from the TR-20 model). Study results of Task 9 (ASI, 1990d) gives the magnitude of the precipitation values.

It is estimated that the Coal Creek channel can transport about 600 cubic feet per second (cfs) before overflowing into the Upper Church, McKay and Kinnear ditches. This estimate is based on field observations of Coal Creek channel cross sections, ditch-headgate elevations, and the Coal Creek stage-discharge rating table (ASI, 1990c). It is assumed that these ditches can carry only their capacity onto the RFP and that the remainder of the flow will stay in Coal Creek. The maximum ditch capacities, which were estimated by developing ditch and culvert cross-sections and relevant information taken from the Colorado State Engineer files, are as follows: Upper Church Ditch, 94 cfs; McKay Ditch, 170 cfs; and Kinnear Ditch, 1600 cfs. Because of ditch-capacity limitations, peak flow is always the same, regardless of frequency or duration of event.

It also was assumed that the South Boulder Diversion Canal would breach only during the PMP 24-hour and 72-hour duration events (Woodward-Clyde Consultants, 1984). During these storm events, the canal-derived flow that will be contributed to the Walnut Creek drainage basin is estimated to be 1100 cfs, and the canal-derived flow that will be contributed to the Woman Creek drainage basin is estimated to be 3600 cfs.

2.2.3 Conceptual Redesign

Based upon the results of the TR-20 Model for the 100-year, 500-year, and PMP storm events occurring at 24- and 72-hour durations, the current bypass structures were conceptually resized using Manning's equation to determine canal dimensions. In an effort to examine many possible scenarios which provide incremental levels of risk, various levels of resizing effort were examined which prevent various levels of impact on the environment and have different associated costs. Eight separate bypass alternatives were considered in this study and are presented below.

2.2.3.1 McKay Bypass

2.2.3.1.1 McKay Bypass - Alternative 1

As shown on Figure 6, the drainage area used to assess Alternative 1 for the McKay Bypass includes runoff from the 130 complex and T-130 complex area, runoff from the future buildout (as determined by the 5-Year Plan Site Development Plan (EG&G Rocky Flats, Inc., 1990a), and runoff from the West Spray Field, as well as runoff from all areas west of these areas and flows that are contributed from Coal Creek and the South Boulder Diversion Canal. Table 2 shows that the upstream contributing drainage area that contributes to the McKay Bypass is approximately 0.97 square miles (mi^2), and as given in Table 3, the estimated peak flows for this alternative are 600 cfs, 740 cfs, and 5,840 cfs for the 100-year, 500-year, and PMP storm events of 24-hour and 72-hour durations, respectively. In order to accommodate these flows, the existing canal should be resized to the specifications shown in Table 4. The existing canal location is adequate for intercepting the run-on expected for the 100-year, 500-year and PMP storm events for both the 24-hour and 72-hour durations. Figure 7 shows typical redesigned cross-sections of the three flood-recurrence design scenarios for the McKay Bypass.

2.2.3.1.2 McKay Bypass - Alternative 2

As shown on Figure 8, the drainage area used to assess Alternative 2 for the McKay Bypass includes runoff from a portion of the West Spray Field, excluding the future buildout area (as determined by the 5-Year Plan Site Development Plan (EG&G Rocky Flats, Inc., 1990a), as well as including runoff from all areas west of the West Spray Field and flow that is contributed from Coal Creek and the South Boulder Diversion Canal. Table 2 shows that the area that contributes to the McKay Bypass for this scenario is approximately 0.76 square miles, and as presented in

Table 4

Conceptual Bypass Design Specifications

Bypass (1) Alternative	Storm Event	Bottom Width (ft)	Side Slope	Bottom Slope (ft/ft)	Flow Depth (ft)	Freeboard (2) (ft)
McKay Alternative 1	100-Year	15	2:1	0.0002	7.60	2.10
	500-Year	20	2:1	0.0002	15.77	2.17
	PMP	50	2:1	0.0002	15.80	2.28
McKay Alternative 2	100-Year	15	2:1	0.0002	6.45	2.11
	500-Year	15	2:1	0.0002	7.31	2.13
	PMP	50	2:1	0.0002	14.43	2.26
McKay Alternative 3	100-Year	15	2:1	0.0002	6.13	2.11
	500-Year	15	2:1	0.0002	7.01	2.12
	PMP	40	2:1	0.0002	15.05	2.27
McKay Alternative 1-A	100-Year	15	2:1	0.0002	6.21	2.11
	500-Year	15	2:1	0.0002	7.08	2.12
	PMP	50	2:1	0.0002	14.29	2.26
McKay Alternative 2-A	100-Year	15	2:1	0.0002	5.18	2.09
	500-Year	15	2:1	0.0002	6.29	2.11
	PMP	30	2:1	0.0002	15.37	2.26
McKay Alternative 3-A	100-Year	15	2:1	0.0002	4.89	2.09
	500-Year	15	2:1	0.0002	5.89	2.10
	PMP	30	2:1	0.0002	14.54	2.25
Rock Creek	100-Year	12	2:1	0.004	1.13	2.08
	500-Year	12	2:1	0.004	1.39	2.09
	PMP	15	2:1	0.004	6.51	2.38
Woman Creek Alternative 1	100-Year	35	2:1	0.0002	11.50	2.20
	500-Year	45	2:1	0.0002	11.30	2.20
	PMP	100	2:1	0.0002	20.40	2.40

Table 4
(Cont.)

Conceptual Bypass Design Specifications

Bypass (1) Alternative	Storm Event	Bottom Width (ft)	Side Slope	Bottom Slope (ft/ft)	Flow Depth (ft)	Freeboard (2) (ft)
Woman Creek	100-Year	27	2:1	0.0002	5.93	2.00
Alternative 2	500-Year	27	2:1	0.0002	7.30	2.00
	PMP	75	2:1	0.0002	18.78	2.35
Kinnear Ditch	100-Year	20	2:1	0.002	9.07	2.37
	500-Year	20	2:1	0.002	9.79	2.39
	PMP	75	2:1	0.002	7.99	2.39

1) See text for descriptions.
2) Freeboard = 2+(0.025)(velocity)(depth of flow^(1/3))

Table 3, the peak flows are 430 cfs, 570 cfs, and 4,910 cfs for the 100-year, 500-year, and PMP storm events, respectively. In order to accommodate these flows, the existing canal should be resized to the specifications shown in Table 4. The existing canal location is adequate for intercepting the run-on expected for the 100-year, 500-year and PMP storm events for both the 24-hour and 72-hour durations. Figure 9 shows typical redesigned cross-sections of the three flood-recurrence design scenarios for the McKay Bypass.

2.2.3.1.3 McKay Bypass - Alternative 3

As shown on Figure 10, the drainage area used to assess Alternative 3 for the McKay Bypass includes runoff from only the areas west of the spray field and flow that is contributed from Coal Creek and the South Boulder Diversion Canal. Table 2 shows that the area that contributes to the McKay Bypass for this scenario is approximately 0.66 mi^2, and as presented in Table 3, the peak flows are 390 cfs, 510 cfs, and 4,520 cfs for the 100-year, 500-year, and PMP events, respectively. In order to accommodate these flows, the existing canal should be resized to the specifications shown in Table 4. By comparing the design specifications presented in Tables 1 and 4, it appears that the current design for the McKay Bypass is adequate to carry the expected flow for the 100-year flood event (this assumption is backed by calculations preformed on the volume of earth to be excavated for this scenario and the volume available in the current design). The existing canal location is adequate for intercepting the run-on expected for the 100-year, 500-year and PMP storm events for both the 24-hour and 72-hour durations. Figure 11 shows typical cross-sections of the three flood-recurrence design scenarios for the McKay Bypass.

2.2.3.1.4 McKay Bypass - Alternatives 1-A, 2-A, and 3-A

As shown in Table 2, the drainage areas for Alternatives 1-A, 2-A, and 3-A are the same as those for alternatives 1, 2, and 3, respectively. As shown in Table 3, the peak flows for these alternatives are less than those for alternatives 1 through 3. The reason for this is that these alternatives do not include all of the flow from Coal Creek and the South Boulder Diversion

Canal that would normally be contributed to the drainage areas. Instead, the only flows from Coal Creek and the South Boulder Diversion Canal that are included as part of the flow for these alternatives are the amount of water that are required by the water rights plus additional flow that would pass through the culverts that are proposed as part of this study. This flow is estimated to be about 220 cfs for the 100-year and 500-year events and 360 cfs for the PMP event. The remainder of the flow is diverted off site prior to reaching the contributing drainage area by the proposed Rock Creek Bypass (Figure 4). This structure is described below.

In order to accommodate the estimated peak flows that are presented in Table 3, the existing McKay Bypass Canal would need to be resized only for the 500-year and PMP events for Alternatives 1-A and 2-A and only for the PMP event for Alternative 3-A. Table 4 provides the design specifications for these alternatives. The existing McKay Bypass Canal location is adequate for intercepting the run-on expected for the 100-year, 500-year and PMP storm events. Figures 12, 13, and 14 show typical cross-sections of the three flood recurrence design scenarios for the McKay Bypass Alternatives 1-A, 2-A, and 3-A, respectively.

For each of the above scenarios in which redesign was deemed necessary as a result of that study analysis, it is proposed that the culverts that are currently emplaced in the Walnut Creek Diversion Dam (Figure 1) be removed and that the McKay Bypass channel be designed as an open channel for its entire length. This redesign would lessen the risk of culverts becoming plugged and flow overtopping the Walnut Creek Diversion Dam structure. As further assurance for reducing the potential for flow from overtopping the dam, the current diversion dam overflow-section crest elevation should be increased to the crest elevation at the abutments.

2.2.3.2 Rock Creek Bypass

The proposed Rock Creek Bypass would serve to divert surface-water runoff from the Coal Creek basin and spill-over from the South Boulder Diversion Canal off-site and to deliver the water into Rock Creek. Figure 15 shows the proposed location of the Rock Creek Bypass and the contributing drainage area. Table 2 shows that the area that contributes to the Rock Creek Bypass, in addition to the flow from Coal Creek and the South Boulder Diversion Canal, is approximately 0.04 mi^2, and as presented in Table 3, the peak flows are 50 cfs, 70 cfs, and 1,470 cfs for the 100-year, 500-year, and PMP events, respectively. In order to accommodate these flows, the Rock Creek Bypass should be sized to the specifications shown in Table 4. Figure 16 shows typical cross-sections of the three flood-recurrence design scenarios for the Rock Creek Bypass.

In order to provide the flow required for the water rights of the Upper Church Ditch (18 cfs) and the McKay Ditch (125 cfs), a diversion dam is proposed to be constructed on the east (downstream) side of the Rock Creek Bypass in which two culverts will be installed (one culvert would be installed at each of the locations of the current flow paths for each of these ditches) (Figure 4). The culvert to be installed to provide flow for the Upper Church ditch should be approximately 30 inches in diameter. The culvert to be installed to provide flow for the McKay ditch should be approximately 66 inches in diameter.

A consideration that is to be addressed in the Downstream Erosion Potential Study (Task 25), is possible ditch improvements to Rock Creek downstream of the RFP facility. Because the proposed Rock Creek Bypass will be adding flow to Rock Creek that normally would not have occurred, the potential for changes in downstream erosion patterns is substantial. Thus, in order to assess downstream conditions, and to assess channel changes that may occur at hydraulic structures and open channels, ditch improvements as well as structural improvements may be necessary.

2.2.3.3 Woman Creek Bypass

2.2.3.3.1 Woman Creek Bypass - Alternative 1

As shown on Figure 5, the drainage area used to assess the Woman Creek Bypass Alternative 1 includes runoff from the Woman Creek drainage basin above and below the South Boulder Diversion Canal (sub-basins 10 and 11, respectively; Figure 5) as well as including flow that is contributed from Coal Creek and the South Boulder Diversion Canal. Also, during the PMP storm event, it is anticipated that the South Interceptor Canal would spill over and contribute additional flow to the Woman Creek basin. Table 2 shows that the average area that contributes to the Woman Creek Bypass is approximately 2.01 mi^2, and as presented in Table 3, the peak flows for this alternative are 2,450 cfs, 2,860 cfs, and 16,340 cfs for the 100-year, 500-year, and PMP events, respectively.

In order to accommodate these estimated flows, the existing Woman Creek Canal should be resized to the specifications shown in Table 4. The existing canal location is adequate for intercepting the run-on expected for the 100-year, 500-year and PMP storm events. Figure 17 shows typical cross-sections of the three flood recurrence design scenarios for the Woman Creek Bypass.

2.2.3.3.2 Woman Creek Bypass - Alternative 2

As shown on Figure 5, the drainage area used to assess the Woman Creek Bypass Alternative 2 includes runoff from the Woman Creek Drainage basin only east of the South Boulder Diversion Canal (sub-basin 10, Figure 5) and, during the PMP storm event only, the flow that is contributed from the South Interceptor Canal. As shown in Table 2, the drainage area for Alternative 2 is 1.42 mi^2. As shown in Table 3, the peak flows for these alternatives are 570 cfs, 840 cfs, and 11,080 cfs for the 100-year, 500-year, and PMP events, respectively. In order to accommodate these flows, the existing canal would need to be resized only for the PMP event.

Table 4 provides the design specifications for these events. The existing canal location is adequate for intercepting the run-on expected for the 100-year, 500-year and PMP storm events. Figure 18 shows typical cross-sections of the three flood recurrence design scenarios for the Woman Creek Bypass Alternative 2.

For each of the above scenarios in which redesign is necessary, it is proposed that the existing culverts that are currently emplaced in the Woman Creek Diversion Dam (Figure 1) be removed and that the channel be designed as an open channel for its entire reach. This would lessen the risk of culverts becoming plugged and flow overtopping the Woman Creek Diversion Dam. As further assurance for reducing the amount of flow from overtopping the diversion dam, the current diversion dam crest elevation should be increased to the crest elevation at the abutments.

2.2.3.4 Kinnear Ditch Bypass

The proposed Kinnear Ditch Bypass would serve to divert surface-water runoff from the Coal Creek basin, spill-over from the South Boulder Diversion Canal, and flow from the Smart Ditch and deliver the water into an unnamed drainage south of the RFP property. Figure 15 shows the proposed location of the Kinnear Ditch Bypass and the contributing drainage area. Table 2 shows that the area that contributes to the Kinnear Ditch Bypass, in addition to the flow from Coal Creek and the South Boulder Diversion Canal, is approximately 0.14 mi^2. As presented in Table 3, the peak flows are 2,450 cfs, 2,860 cfs, and 5,640 cfs for the 100-year, 500-year, and PMP events, respectively.

In order to accommodate these flows, the Kinnear Ditch Bypass should be sized to the specifications shown in Table 4. Also, to decrease the high velocities that are expected from the above flows, approximately eleven drop structures should be installed throughout the length of the ditch to reduce the channel slope. Figure 19 shows typical cross-sections of the three flood-recurrence design events for the Kinnear Ditch Bypass.

During normal flow, the water that would have originally flowed into Mower Reservoir and Standley Lake would be diverted such that only Standley Lake would receive this inflow as a result of the construction of the proposed Kinnear Ditch Bypass alone. Thus, in order to comply with the water rights for Mower Reservoir, a small V-ditch (Mower Reservoir Creek) is proposed to be installed, as shown on Figure 15, to provide a flow of at least 7 cfs to Mower Reservoir.

A consideration that will be addressed in the Downstream Erosion Potential Study (Task 25), is possible channel improvements to the unnamed drainage in which the additional water is being added. Since the proposed Kinnear Ditch Bypass will be adding flow to the unnamed drainage that normally would not have been there, the potential for changes in channel erosion patterns is great. Thus, in order to satisfy the adjacent landowner, channel improvements may be necessary.

3.0 PRELIMINARY COST ESTIMATES AND ENVIRONMENTAL ANALYSIS

3.1 CONSTRUCTION COSTS

Preliminary conceptual-level cost estimates were performed on the excavation, earthwork required for dam construction and/or improvements, and erosion control components that would be required for the various alternatives of the proposed bypass systems to accommodate peak flows resulting from the 100-year, 500-year, and PMP storm events. Table 5 lists estimated conceptual costs for the three different storm events analyzed in this report. These costs are planning-level costs only and were derived from the "average bid price" as presented in "Bids Tabs Database" from the Urban Drainage and Flood Control District (1990). Estimated costs in Table 5 for bypass resizing, including earthwork, erosion control and a 20 percent contingency, for the 100-year flood, range from no cost to an estimated $707,000 for Alternatives 1-A through 3-A which would include the construction of the Rock Creek Bypass. For the 500-year flood the estimated costs for Alternatives 1-A through 3-A range from about $207,000 to $4.1 million. For the PMF event, the estimated costs range from $5.2 million to $9.6 million for Alternative 1-A which includes the construction of the Rock Creek Bypass.

3.2 ENVIRONMENTAL ANALYSIS

The primary environmental concern in the construction of the new "conceptual" bypass system is the potential disturbance of stream channel wetlands. If the current bypass system is resized, some of the present wetlands may be disturbed (EG&G, Rocky Flats, Inc., 1990b). Table 6 shows the estimated linear feet of both areal and linear wetlands that would be disturbed for each scenario discussed above.

Although some hydrophytic vegetation and hydric soils would be disturbed during construction activities, these would not be destroyed or removed permanently. During construction, the hydric soils can be stockpiled and used as the final soil layer for the new bypass channels. Over time,

TABLE 5

Preliminary Construction Cost Estimates For Bypass Resizing

McKay Bypass

Alternative 1	Storm Event 100-Year	500-Year	PMP
Ditch Excavation	117,000	1,272,000	2,231,000
Riprap	0	2,057,000	2,686,000
Drop Structures	76,000	76,000	76,000
Dam Earthwork	31,000	31,000	113,000
Sub-Total:	224,000	3,436,000	5,106,000
20% Contingency:	45,000	687,000	1,021,000
Total:	$269,000	$4,123,000	$6,127,000

Alternative 2	100-Year	500-Year	PMP
Ditch Excavation	16,000	102,000	1,944,000
Riprap	0	0	2,558,000
Drop Structures	76,000	76,000	76,000
Dam Earthwork	31,000	31,000	113,000
Sub-Total:	123,000	209,000	4,691,000
20% Contingency:	25,000	42,000	938,000
Total:	$148,000	$251,000	$5,629,000

Alternative 3	100-Year	500-Year	PMP
Ditch Excavation	0	65,000	1,773,000
Riprap	0	0	2,411,000
Drop Structures	0	76,000	76,000
Dam Earthwork	0	31,000	113,000
Sub-Total:	0	172,000	4,373,000
20% Contingency:	0	34,000	875,000
Total:	$0	$206,000	$5,248,000

TABLE 5 (Cont.)

**Preliminary Construction Cost Estimates
For Bypass Resizing**

McKay Bypass

Alternative 1-A	Storm Event 100-Year	500-Year	PMP
Ditch Excavation	0	72,000	1,916,000
Riprap	0	0	2,545,000
Drop Structures	0	76,000	76,000
Dam Earthwork	0	31,000	113,000
Sub-Total:	0	179,000	4,650,000
20% Contingency:	0	36,000	930,000
Total:	$0	$215,000	$5,580,000

Alternative 2-A	100-Year	500-Year	PMP
Ditch Excavation	0	2,000	1,528,000
Riprap	0	0	2,234,000
Drop Structures	0	76,000	76,000
Dam Earthwork	0	31,000	113,000
Sub-Total:	0	109,000	3,951,000
20% Contingency:	0	22,000	790,000
Total:	$0	$131,000	$4,741,000

Alternative 3-A	100-Year	500-Year	PMP
Ditch Excavation	0	0	1,385,000
Riprap	0	0	2,157,000
Drop Structures	0	0	76,000
Dam Earthwork	0	31,000	113,000
Sub-Total:	0	31,000	3,731,000
20% Contingency:	0	6,000	746,000
Total:	$0	$37,000	$4,477,000

TABLE 5 (Cont.)

Preliminary Construction Cost Estimates For Bypass Resizing

Rock Creek

	100-Year	500-Year	PMP
Ditch Excavation	19,000	22,000	96,000
Riprap	541,000	566,000	3,211,000
Dam Earthwork	24,000	24,000	33,000
Culverts	5,000	5,000	7,000
Sub-Total:	589,000	617,000	3,347,000
20% Contingency:	118,000	123,000	669,000
Total:	$707,000	$740,000	$4,016,000

Woman Creek

	Storm Event		
Alternative 1	100-Year	500-Year	PMP
Ditch Excavation	123,000	156,000	841,000
Riprap	1,976,000	2,163,000	6,277,000
Drop Structures	9,000	9,000	9,000
Dam Earthwork	101,000	110,000	165,000
Sub-Total:	2,209,000	2,438,000	7,292,000
20% Contingency:	442,000	488,000	1,458,000
Total:	$2,651,000	$2,926,000	$8,750,000

Alternative 2	100-Year	500-Year	PMP
Ditch Excavation	0	0	589,000
Riprap	0	1,408,000	5,268,000
Drop Structures	0	0	9,000
Dam Earthwork	0	0	165,000
Sub-Total:	0	1,408,000	6,031,000
20% Contingency:	0	282,000	1,206,000
Total:	$0	$1,690,000	$7,237,000

TABLE 5 (Cont.)

Preliminary Construction Cost Estimates For Bypass Resizing

Kinnear Ditch

	Storm Event		
	100-Year	500-Year	PMP
Ditch Excavation	550,000	606,000	1,114,000
Riprap	3,755,000	4,075,000	7,119,000
Drop Structures	33,000	33,000	33,000
Sub-Total:	4,338,000	4,714,000	8,266,000
20% Contingency:	868,000	943,000	1,653,000
Total:	$5,206,000	$5,657,000	$9,919,000

Mower Reservoir Creek

	100-Year	500-Year	PMP
Ditch Excavation	11,000	11,000	11,000
Sub-Total:	11,000	11,000	11,000
20% Contingency:	2,000	2,000	2,000
Total:	$13,000	$13,000	$13,000

TABLE 6

Evaluation of Wetlands Disturbance

Bypass Structure	Storm Event	Estimated Linear Feet of Wetlands Disturbed
McKay Alternative 1	100-Yr	2480
	500-Yr	2480
	PMP	2480
McKay Alternative 2	100-Yr	2480
	500-Yr	2480
	PMP	2480
McKay Alternative 3	100-Yr	0
	500-Yr	2480
	PMP	2480
McKay Alternative 1-A	100-Yr	0
	500-Yr	2480
	PMP	2480
McKay Alternative 2-A	100-Yr	0
	500-Yr	2480
	PMP	2480
McKay Alternative 3-A	100-Yr	0
	500-Yr	0
	PMP	2480
Rock Creek	100-Yr	50 1)
	500-Yr	50 1)
	PMP	50 1)
Woman Creek Alternative 1	100-Yr	1760
	500-Yr	1760
	PMP	1760
Woman Creek Alternative 2	100-Yr	0
	500-Yr	0
	PMP	1760
Kinnear Ditch	100-Yr	30 1)
	500-Yr	30 1)
	PMP	30 1)
Mower Resevoir Creek	NA	50 1)

1) These values are estimates, because the wetlands study does not include areal coverage for these areas.

these soils and the hydrophytic vegetation would be re-established and wetlands of even greater dimensions would be created.

4.0 ALTERNATIVE EVALUATION

Table 7 presents the results of an alternative evaluation system that was used to rank the various bypass-design alternatives. Within the alternative evaluation system are weighting factors that influence the overall zero-discharge study. These factors were selected by a committee consisting of cognizant DOE and EG&G personnel. Following is a discussion of how each of the categories presented on Table 7 were considered.

Controlled Discharge - Each alternative is designed based on the amount of upstream flow that is diverted around RFP property. Therefore, the greater the amount of surface water flow that is controlled from running onto RFP property, or, developed or potentially contaminated areas, the higher the score. From the alternatives presented for the McKay Bypass, Alternative 3-A for the 100-year, 500-year, and PMP flood events received a 5.0. From the alternatives presented for the Woman Creek Bypass, the highest score received was a 4.0 which was given to Alternative 2 for the 100-year, 500-year, and PMP flood events.

Waste Generation - The design of each alternative allows for various amounts of surface-water flow to come into contact with developed or potentially contaminated surface areas. This contact may allow for a certain amount of contaminant loading of surface-water, thus, the surface-water may require treatment. In the event that surface-water is treated onsite, waste will be generated from the treatment process. The potential for generating "waste" therefore depends on how much potentially contaminated surface area the water flows over before being discharged from the RFP facility. Alternative 3-A for the 100-year, 500-year, and PMP flood events of the McKay Bypass design received a 5.0, and Alternative 2 for the 100-year, 500-year, and PMP flood events of the Woman Creek Bypass design received a 4.0.

Risk - Each alternative presents a different level of risk that is associated with the following: 1) channel failure based on the probability of a larger flood occurring than the channel is designed for, and 2) the potential for carrying contaminants off-site. These two categories were

TABLE 7

Alternative Evaluation And Ranking

McKay Bypass

EVALUATION FACTORS	WEIGHTING FACTOR	ALT 1 100-Yr		ALT 1 500-Yr		ALT 1 PMP	
		S	W	S	W	S	W
CONTROLLED DISCHARGE	10	1.0	10.0	1.0	10.0	1.0	10.0
WASTE GENERATION	7	1.0	7.0	1.0	7.0	1.0	7.0
RISK	8	1.0	8.0	1.9	15.2	2.9	23.2
COST	6	3.8	22.8	2.2	13.2	1.3	7.8
DESIGN AND CONST. SCHEDULE	6	3.8	22.8	2.2	13.2	1.3	7.8
FLEXIBILITY	8	5.0	40.0	5.0	40.0	5.0	40.0
WATER RIGHTS	5	5.0	25.0	5.0	25.0	5.0	25.0
AIR EMISSIONS	10	5.0	50.0	5.0	50.0	5.0	50.0
WETLANDS/T&E	10	2.0	20.0	2.0	20.0	2.0	20.0
IHSS	10	1.0	10.0	1.0	10.0	1.0	10.0
PUBLIC ACCEPTABILITY	8	1.0	8.0	1.9	15.2	2.9	23.2
TOTALS			223.6		218.8		224.0
RANK			17		18		16

S = SCORE

W = WEIGHTED SCORE (SCORE X WEIGHTING FACTOR)

TABLE 7 (Cont.)

Alternative Evaluation And Ranking

McKay Bypass

EVALUATION FACTORS	WEIGHTING FACTOR	ALT 2 100-Yr		ALT 2 500-Yr		ALT 2 PMP	
		S	W	S	W	S	W
CONTROLLED DISCHARGE	10	1.7	17.0	1.7	17.0	1.7	17.0
WASTE GENERATION	7	1.7	11.9	1.7	11.9	1.7	11.9
RISK	8	1.3	10.4	2.3	18.4	3.3	26.4
COST	6	4.7	28.2	4.1	24.6	1.6	9.6
DESIGN AND CONST. SCHEDULE	6	4.7	28.2	4.1	24.6	1.6	9.6
FLEXIBILITY	8	5.0	40.0	5.0	40.0	5.0	40.0
WATER RIGHTS	5	5.0	25.0	5.0	25.0	5.0	25.0
AIR EMISSIONS	10	5.0	50.0	5.0	50.0	5.0	50.0
WETLANDS/T&E	10	2.0	20.0	2.0	20.0	2.0	20.0
IHSS	10	1.7	17.0	1.7	17.0	1.7	17.0
PUBLIC ACCEPTABILITY	8	1.3	10.4	2.3	18.4	3.3	26.4
TOTALS			258.1		266.9		252.9
RANK			14		13		15

S = SCORE

W = WEIGHTED SCORE (SCORE X WEIGHTING FACTOR)

TABLE 7 (Cont.)

Alternative Evaluation And Ranking

McKay Bypass

EVALUATION FACTORS	WEIGHTING FACTOR	ALT 3 100-Yr		ALT 3 500-Yr		ALT 3 PMP	
		S	W	S	W	S	W
CONTROLLED DISCHARGE	10	2.5	25.0	2.5	25.0	2.5	25.0
WASTE GENERATION	7	2.5	17.5	2.5	17.5	2.5	17.5
RISK	8	1.8	14.4	2.8	22.4	3.8	30.4
COST	6	5.0	30.0	4.4	26.4	1.9	11.4
DESIGN AND CONST. SCHEDULE	6	5.0	30.0	4.4	26.4	1.9	11.4
FLEXIBILITY	8	5.0	40.0	5.0	40.0	5.0	40.0
WATER RIGHTS	5	5.0	25.0	5.0	25.0	5.0	25.0
AIR EMISSIONS	10	5.0	50.0	5.0	50.0	5.0	50.0
WETLANDS/T&E	10	5.0	50.0	2.0	20.0	2.0	20.0
IHSS	10	2.5	25.0	2.5	25.0	2.5	25.0
PUBLIC ACCEPTABILITY	8	1.8	14.4	2.8	22.4	3.8	30.4
TOTALS			321.3		300.1		286.1
RANK			7		9		12

S = SCORE

W = WEIGHTED SCORE (SCORE X WEIGHTING FACTOR)

TABLE 7 (Cont.)

Alternative Evaluation And Ranking

McKay Bypass

EVALUATION FACTORS	WEIGHTING FACTOR	ALT 1-A 100-Yr		ALT 1-A 500-Yr		ALT 1-A PMP	
		S	W	S	W	S	W
CONTROLLED DISCHARGE	10	3.3	33.0	3.3	33.0	3.3	33.0
WASTE GENERATION	7	3.3	23.1	3.3	23.1	3.3	23.1
RISK	8	2.2	17.6	3.2	25.6	4.2	33.6
COST	6	3.4	20.4	2.5	15.0	1.0	6.0
DESIGN AND CONST. SCHEDULE	6	3.4	20.4	2.5	15.0	1.0	6.0
FLEXIBILITY	8	5.0	40.0	5.0	40.0	5.0	40.0
WATER RIGHTS	5	5.0	25.0	5.0	25.0	5.0	25.0
AIR EMISSIONS	10	5.0	50.0	5.0	50.0	5.0	50.0
WETLANDS/T&E	10	4.0	40.0	1.0	10.0	1.0	10.0
IHSS	10	3.3	33.0	3.3	33.0	3.3	33.0
PUBLIC ACCEPTABILITY	8	2.2	17.6	3.2	25.6	4.2	33.6
TOTALS			320.1		295.3		293.3
RANK			8		10		11

S = SCORE

W = WEIGHTED SCORE (SCORE X WEIGHTING FACTOR)

TABLE 7 (Cont.)

Alternative Evaluation And Ranking

McKay Bypass

EVALUATION FACTORS	WEIGHTING FACTOR	ALT 2-A 100-Yr		ALT 2-A 500-Yr		ALT 2-A PMP	
		S	W	S	W	S	W
CONTROLLED DISCHARGE	10	4.2	42.0	4.2	42.0	4.2	42.0
WASTE GENERATION	7	4.2	29.4	4.2	29.4	4.2	29.4
RISK	8	2.6	20.8	3.6	28.8	4.6	36.8
COST	6	3.4	20.4	2.8	16.8	1.0	6.0
DESIGN AND CONST. SCHEDULE	6	3.4	20.4	2.8	16.8	1.0	6.0
FLEXIBILITY	8	5.0	40.0	5.0	40.0	5.0	40.0
WATER RIGHTS	5	5.0	25.0	5.0	25.0	5.0	25.0
AIR EMISSIONS	10	5.0	50.0	5.0	50.0	5.0	50.0
WETLANDS/T&E	10	4.0	40.0	1.0	10.0	1.0	10.0
IHSS	10	4.2	42.0	4.2	42.0	4.2	42.0
PUBLIC ACCEPTABILITY	8	2.6	20.8	3.6	28.8	4.6	36.8
TOTALS			350.8		329.6		324.0
RANK			4		5		6

S = SCORE

W = WEIGHTED SCORE (SCORE X WEIGHTING FACTOR)

TABLE 7 (Cont.)

Alternative Evaluation And Ranking

McKay Bypass

EVALUATION FACTORS	WEIGHTING FACTOR	ALT 3-A 100-Yr		ALT 3-A 500-Yr		ALT 3-A PMP	
		S	W	S	W	S	W
CONTROLLED DISCHARGE	10	5.0	50.0	5.0	50.0	5.0	50.0
WASTE GENERATION	7	5.0	35.0	5.0	35.0	5.0	35.0
RISK	8	3.0	24.0	4.0	32.0	5.0	40.0
COST	6	3.4	20.4	3.1	18.6	1.0	6.0
DESIGN AND CONST. SCHEDULE	6	3.4	20.4	3.1	18.6	1.0	6.0
FLEXIBILITY	8	5.0	40.0	5.0	40.0	5.0	40.0
WATER RIGHTS	5	5.0	25.0	5.0	25.0	5.0	25.0
AIR EMISSIONS	10	5.0	50.0	5.0	50.0	5.0	50.0
WETLANDS/T&E	10	4.0	40.0	4.0	40.0	1.0	10.0
IHSS	10	5.0	50.0	5.0	50.0	5.0	50.0
PUBLIC ACCEPTABILITY	8	3.0	24.0	4.0	32.0	5.0	40.0
TOTALS			378.8		391.2		352.0
RANK			2		1		3

S = SCORE

W = WEIGHTED SCORE (SCORE X WEIGHTING FACTOR)

TABLE 7 (Cont.)

Alternative Evaluation And Ranking

Woman Creek Bypass

EVALUATION FACTORS	WEIGHTING FACTOR	ALT 1 100-Yr		ALT 1 500-Yr		ALT 1 PMP	
		S	W	S	W	S	W
CONTROLLED DISCHARGE	10	1.0	10.0	1.0	10.0	1.0	10.0
WASTE GENERATION	7	1.0	7.0	1.0	7.0	1.0	7.0
RISK	8	1.0	8.0	2.0	16.0	3.0	24.0
COST	6	5.0	30.0	4.2	25.2	1.7	10.2
DESIGN AND CONST. SCHEDULE	6	5.0	30.0	4.2	25.2	1.7	10.2
FLEXIBILITY	8	5.0	40.0	5.0	40.0	5.0	40.0
WATER RIGHTS	5	5.0	25.0	5.0	25.0	5.0	25.0
AIR EMISSIONS	10	5.0	50.0	5.0	50.0	5.0	50.0
WETLANDS/T&E	10	3.0	30.0	3.0	30.0	3.0	30.0
IHSS	10	1.0	10.0	1.0	10.0	1.0	10.0
PUBLIC ACCEPTABILITY	8	1.0	8.0	2.0	16.0	3.0	24.0
TOTALS			248.0		254.7		231.4
RANK			5		4		6

S = SCORE

W = WEIGHTED SCORE (SCORE X WEIGHTING FACTOR)

TABLE 7 (Cont.)

Alternative Evaluation And Ranking

Woman Creek Bypass

EVALUATION FACTORS	WEIGHTING FACTOR	ALT 2 100-Yr		ALT 2 500-Yr		ALT 2 PMP	
		S	W	S	W	S	W
CONTROLLED DISCHARGE	10	4.0	40.0	4.0	40.0	4.0	40.0
WASTE GENERATION	7	4.0	28.0	4.0	28.0	4.0	28.0
RISK	8	2.5	20.0	3.5	28.0	4.5	36.0
COST	6	3.3	19.8	2.5	15.0	1.0	6.0
DESIGN AND CONST. SCHEDULE	6	3.3	19.8	2.5	15.0	1.0	6.0
FLEXIBILITY	8	5.0	40.0	5.0	40.0	5.0	40.0
WATER RIGHTS	5	5.0	25.0	5.0	25.0	5.0	25.0
AIR EMISSIONS	10	5.0	50.0	5.0	50.0	5.0	50.0
WETLANDS/T&E	10	4.0	40.0	4.0	40.0	2.0	20.0
IHSS	10	4.0	40.0	4.0	40.0	4.0	40.0
PUBLIC ACCEPTABILITY	8	2.5	20.0	3.5	28.0	4.5	36.0
TOTALS			342.6		349.0		327.0
RANK			2		1		3

S = SCORE

W = WEIGHTED SCORE (SCORE X WEIGHTING FACTOR)

EVALUATION FACTORS - DEFINITIONS

COST:	1 = High Construction, O, M & R Cost 5 = Low Construction, O, M & R Cost
FLEXIBILITY:	1 = Small Ability to Respond to Changing Conditions 5 = Large Ability to Respond to Changing Conditions
RISK:	1 = High Risk 5 = Low Risk
PUBLIC ACCEPTABILITY	1 = Low Likelyhood of Public Acceptability 5 = High Likelyhood of Public Acceptability
WATER RIGHTS	1 = High Water Rights Impacts 5 = Low Water Rights Impacts
DESIGN AND CONST SCHEDULE:	1 = Total Schedule Greater Than 5 Years 5 = Total Schedule 1 Year or Less
IHSS (SWMU):	1 = IHSS Are Impacted 5 = No IHSS Are Impacted
WETLANDS/T&E:	1 = Wetlands/T&E Species Are Impacted 5 = No Wetlands/T&E Species Impacted
WASTE GENERATION	1 = Large Quanitity of Solid Waste 5 = Small Quantitiy of Solid Waste
AIR EMISSIONS	1 = High Air Emissions 5 = Low Air Emissions
CONTROLLED DISCHARGE	1 = High Potential for Controlled Downstream Discharge 5 = Low Potential for Controlled Downstream Discharge

NOTE: SCORE ON A SCALE OF 5 (BEST) THROUGH 1 (WORST) evaluated separately and averaged to give the score for the risk category. Alternative 3-A for the PMP flood event of the McKay Bypass design received a 5.0, and Alternative 2 for the PMP flood event of the Woman Creek Bypass design received a 4.5.

Cost - Each alternative is ranked on the cost of construction. The alternative with the highest construction cost has received the lowest score. Alternative 3 for the 100-year flood event of the McKay Bypass design received a 5.0, and Alternative 1 for the 100-year flood event of the Woman Creek Bypass design received a 5.0.

Design and Construction Schedule - The level of design and the extent of construction required for each alternative varies. The alternative with the least amount of design and construction required has received the highest score. Alternative 3 for the 100-year flood event of the McKay Bypass design received a 5.0, and Alternative 1 for the 100-year flood event of the Woman Creek Bypass design received a 5.0.

Flexibility - No alternatives represents varying levels of flexibility. Thus, flexibility is not an issue and all of the alternatives for both bypass systems have received a score of 5.0.

Water Rights - Each alternative is designed to comply with the water rights. Thus, each alternative for both bypass systems has been given a score of 5.0.

Air Emissions - None of the alternatives represents an advantage under this category. Air emissions is not an issue, thus, each alternative for both bypass systems has been given a score of 5.0.

Wetlands/T&E - Depending on the amount of construction that will be done for each alternative, the linear feet of wetlands that will be disturbed varies, as shown on Table 6. The construction of the alternative that results in the least amount of wetlands disturbed has been given the highest score. Alternative 3 for the 100-year flood event of the McKay Bypass design received a 5.0, and Alternative 2 for the 100-year and 500-year flood events of the Woman Creek Bypass design received a 4.0.

IHSS/SWMU - Each alternative prevents various amounts of surface water flow from coming into contact with SWMUs. The alternative that provides for the greatest protection (least amount of surface water run-on) has been given the highest score. Alternative 3-A for the 100-year, 500-year, and PMP flood events of the McKay Bypass design received a 5.0, and Alternative 2 for the 100-year, 500-year, and PMP flood events of the Woman Creek Bypass design received a 4.0.

Public Acceptability - Public acceptability is based on the alternative that provides the least amount of risk. Thus, the risk category and the public acceptability category are scored alike. Alternative 3-A for the PMP flood event of the McKay Bypass design received a 5.0, and Alternative 2 for the PMP flood event of the Woman Creek Bypass design received a 4.5.

Based on the above criteria, the alternative that ranked the highest for the conceptual redesign of the McKay Bypass was Alternative 3-A for the 500-year flood event. The alternative that ranked the highest for the conceptual redesign of the Woman Creek Bypass was Alternative 2 for the 500-year flood event.

5.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

All of the alternatives that were assessed in this study considered runoff that would result from different contributing areas as follows:

- McKay Bypass Alternative 1 includes runoff from the 130 complex and T-130 complex area, runoff from the future buildout (as determined by the 5-Year Plan Site Development Plan (EG&G, 1990), and runoff from the West Spray Field, as well as including runoff from all areas west of these areas and flow that is contributed from Coal Creek and the South Boulder Diversion Canal.

- McKay Bypass Alternative 2 includes runoff from a portion of the West Spray Field, excluding the future buildout area (as determined by the 5-Year Plan Site Development Plan (EG&G, 1990), as well as including runoff from all areas west of the West Spray Field and flow that is contributed from Coal Creek and the South Boulder Diversion Canal.

- McKay Bypass Alternative 3 includes runoff from only the areas west of the West Spray Field and flow that is contributed from Coal Creek and the South Boulder Diversion Canal.

- The drainage areas considered for McKay Bypass Alternatives 1-A, 2-A, and 3-A are the same as those for Alternatives 1, 2, and 3, respectively. The difference being that for these alternatives, the flow for the South Boulder Diversion Canal and Coal Creek are not included.

The drainage basins that were considered for the Woman Creek Bypass are as follows:

- Woman Creek Bypass Alternative 1 includes runoff from the Woman Creek drainage basin above and below the South Boulder Diversion Canal, as well as including flow that is contributed from Coal Creek and the South Boulder Diversion Canal.

- Woman Creek Alternative 2 includes runoff from the Woman Creek drainage basin only east of the South Boulder Diversion Canal.

Some of the factors considered in the alternative selection process included cost, required construction, and risk benefits related to each alternative. For the above selected alternative for the McKay Bypass (Alternative 3-A, 500-year storm event), the estimated cost for the required construction is approximately $777,000. This cost includes redesigning the Walnut Creek Diversion Dam and constructing the Rock Creek Bypass and diversion structure. The risks associated with this alternative are lower than any other alternative assessed except for Alternative 3-A for the PMP storm event. The amount of surface-water overflow coming into contact with RFP property and potentially contaminated surface areas is less for this alternative than any other alternative.

For the above selected Alternative 2 for the Woman Creek Bypass (500-year storm event), the estimated cost for the required construction is approximately $7.4 million. This cost includes installation of additional riprap in the Woman Creek Bypass, construction of the Kinnear Ditch Bypass, and construction of the Mower Reservoir Creek. The risks associated with this alternative are lower than any other alternative assessed except for the risks associated with Alternative 2 for the PMP storm event design. The amount of surface-water overflow coming into contact with RFP property and potentially contaminated surface areas is less for this alternative than any other alternative.

The risks of carrying contaminants off site and enduring a storm larger than the 500-year event, thus causing failure of the bypass systems, are very low for the selected alternatives. It is primarily for this reason that the selected alternatives would be more politically and publicly accepted.

6.0 ACKNOWLEDGEMENTS

This study was conducted under the general supervision of Mr. Michael G. Waltermire, P.E., Project Manager, Advanced Sciences, Inc. (ASI). Work involving this project task was under the technical management of Dr. James R. Kunkel, P.E., P.H., ASI Principal Scientist. Field investigations were conducted by Mr. Stephen J. Playton, P.H. and Ms. Theresa Santangelo-Dreiling. This study draft report was written by Ms. Santangelo-Dreiling, with assistance from Dr. Kunkel, and Mr. Doug Martin, draftsman. This study report has been prepared and submitted in partial fulfillment of the Zero-Offsite Water-Discharge Study being conducted by ASI on behalf of EG&G Rocky Flats, Inc. EG&G's Project Engineer for this study was Mr. R. A. Applehans of EG&G's Facilities Engineering, Plant Civil-Structural Engineering (FE/PCSE). The draft final of this report was reviewed by the following E&G personnel: Russ A. Applehans, Richard S. Hillier, and Leon McGovern.

7.0 REFERENCES

Advanced Sciences, Inc, (ASI) 1990a, Predecisional Draft Zero-Offsite Discharge Study Scope Evaluation: Prepared for EG&G Rocky Flats, Inc., Project 667 Task 16, March 30, 34 p., 2 appendices, and 1 plate.

Advanced Sciences, Inc., (ASI) 1990b (Draft), Task 24 RFP, July 27, 4 p., Appendixes A and B.

Advanced Sciences, Inc., (ASI) 1990c (Draft Final), Storm-Runoff Quantity for Various Design Events: Task 6 of the Zero-Offsite Water-Discharge Study, December 4, 31 p., 66 figures, and Appendices A-E.

Advanced Sciences, Inc., (ASI) 1990d, Design Recurrence Intervals Study, Rocky Flats Plant Site, Task 9 of the Zero-Offsite Water-Discharge Study; Prepared for EG&G Rocky Flats, Inc., Project No. 208.0109, 18 p., 4 appendices.

Advanced Sciences, Inc., (ASI) 1990e, Task 24, PMP.

EG&G, Rocky Flats, Inc., 1990a, Five Year Plan Site Development Plan, Facilities Planning Rocky Flats Plant: April.

EG&G, Rocky Flats, Inc., 1990b, Wetlands Assessment: April.

McCall-Ellingson & Morrill, Inc., 1978, Title I Report for Surface-Water Control: May.

McCall-Ellingson & Morrill, Inc., 1980, Surface-Water Control As-Built Drawings: November.

Rockwell International, 1988a, Remedial Investigation Report of High Priority Sites (881 Hillside Area): Prepared for the U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, 1 March, Vol. IV, Section 6.0 Surface Water, 28 p., 1 figure, and 1 plate.

Rockwell International, 1988b, Remedial Investigation and Feasibility Study Plans for Low Priority Sites: Volume I - Site Descriptions, Groupings and Prioritization, Aerospace Operations, Rocky Flats Plant: Prepared for the U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, June 1, 128 p.

Soil Conservation Service (SCS), 1977, Procedures for Determining Peak Flows in Colorado: Includes Supplements - Technical Release No. 55, "Urban Hydrology for Small Watersheds," U.S. Department of Agriculture, March.

7.0 REFERENCES

Soil Conservation Service (SCS), 1983, TR-20, Project Formulation - Hydrology (1982 Vers.): Technical Release No. 20, U.S. Department of Agriculture, Soil Conservation Service, Revised by Northeast NTC and Hydrology Unit, May 1982, Second Edition, May 1983, Washington, D.C.

Urban Drainage and Flood Control District, 1990, Bids Tabs Database for Capitol Improvement and Maintenance Programs: March.

Woodward-Clyde Consultants, 1984 (revised), Operations and Maintenance Instructions for Rocky Flats Surface Water Control Project (Dams & Reservoirs): Original Manual by McCall-Ellingson & Morrill, Inc., 1980, Revised by Woodward-Clyde Consultants and Merrick & Co.

U.S. Department of Energy (DOE) and State of Colorado, 1989, Agreement in Principle Between the United States Department of Energy and the State of Colorado: June 28, 25 p.

APPENDIX A

MODEL LIMITATIONS

APPENDIX A

MODEL LIMITATIONS

During the course of applying the TR-20 model as a part of this investigation, several limitations were found. They are as follows:

1) Input rainfall distributions are limited to 100 entries.

When modeling longer-duration storm events, this limitation becomes apparent. For example, when modeling the 72-hour duration event, the time increment for the input precipitation distribution must be approximately 45 minutes or longer. In this study, the 72-hour duration rainfall distribution was the same as the 24-hour distribution for the first 24 hours. That is, the total rainfall amounts for the two distributions were the same at each hour, during the first 24 hours. However, for the 24-hour distribution, rainfall amounts were input for each half hour, whereas, for the 72-hour distribution, rainfall amounts were input for each whole hour. The result was that less detailed rainfall intensity information was available to the model for the 72-hour events, and the apparent rainfall intensity was less. This contributed to the result that peak discharge estimated for the 72-hour events was less than that estimated for the 24-hour events, whereas they should be identical.

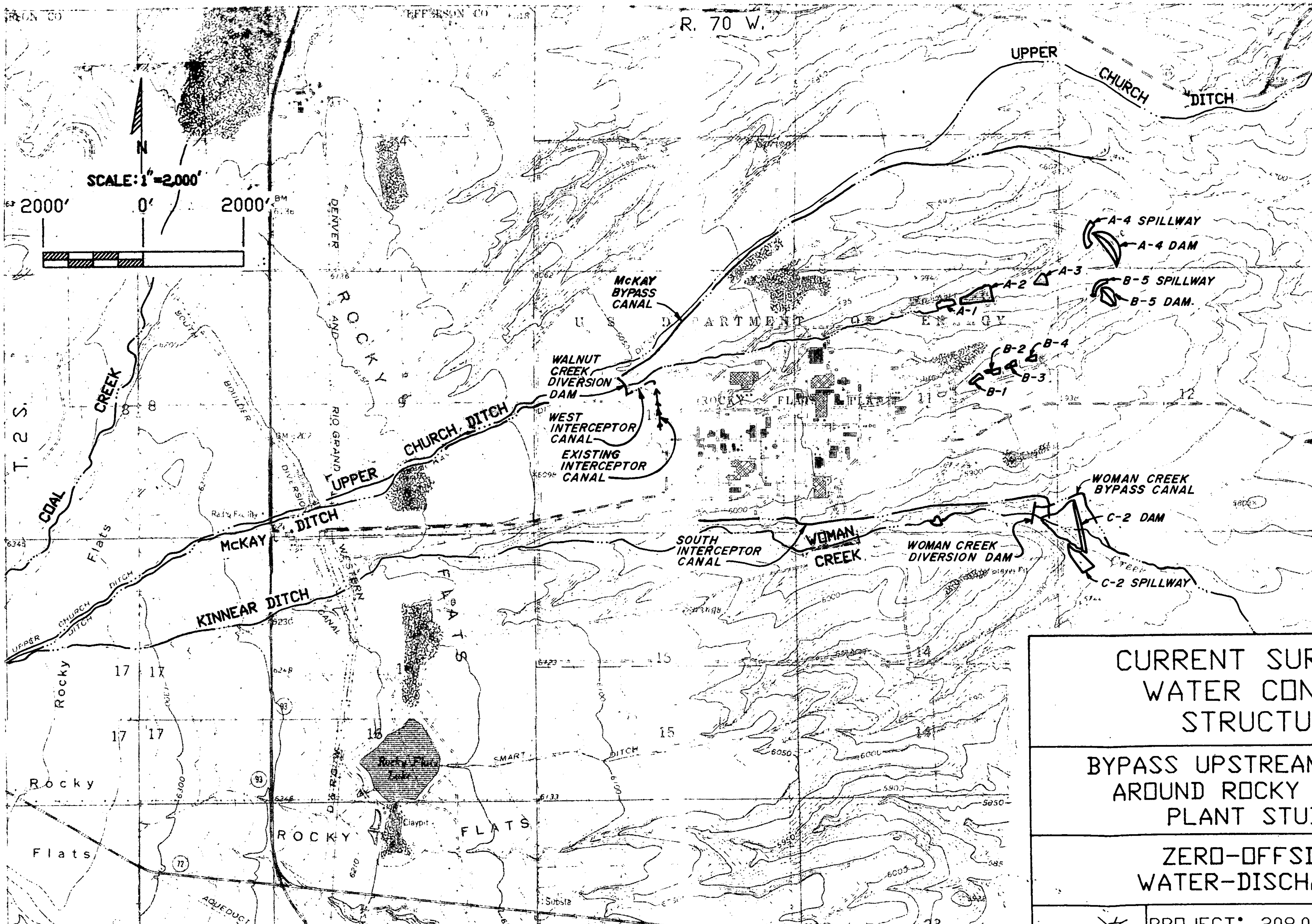
2) Output hydrographs are limited to 300 points.

Again, this limitation affects the results of longer-duration events, such as the 72-hour events. In order to obtain correct runoff volume estimates from TR-20, the entire runoff hydrograph must be complete at the end of 300 hydrograph points, or time increments. Therefore, the modeled time increment must be larger for longer-duration events than for shorter-duration events. This results in less-detailed analysis. For example, during this study, the 24-hour events were simulated with a time increment of approximately 5 minutes, whereas, the 72-hour events were simulated with a time increment of approximately 15 minutes. It is judged that the requirement of a longer modeling time increment for the 72-hour events contributed to the discrepancy in peak-flow estimates described in item 1) above.

3) Hydrograph storage locations are limited to 7.

Computer memory storage locations are provided for a maximum of 7 hydrographs. This tends to limit the amount of detail allowed during a watershed simulation. Fewer runoff hydrographs can be retained to be routed downstream and added in at another location.

FIGURES



CURRENT SURFACE-WATER CONTROL STRUCTURES

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

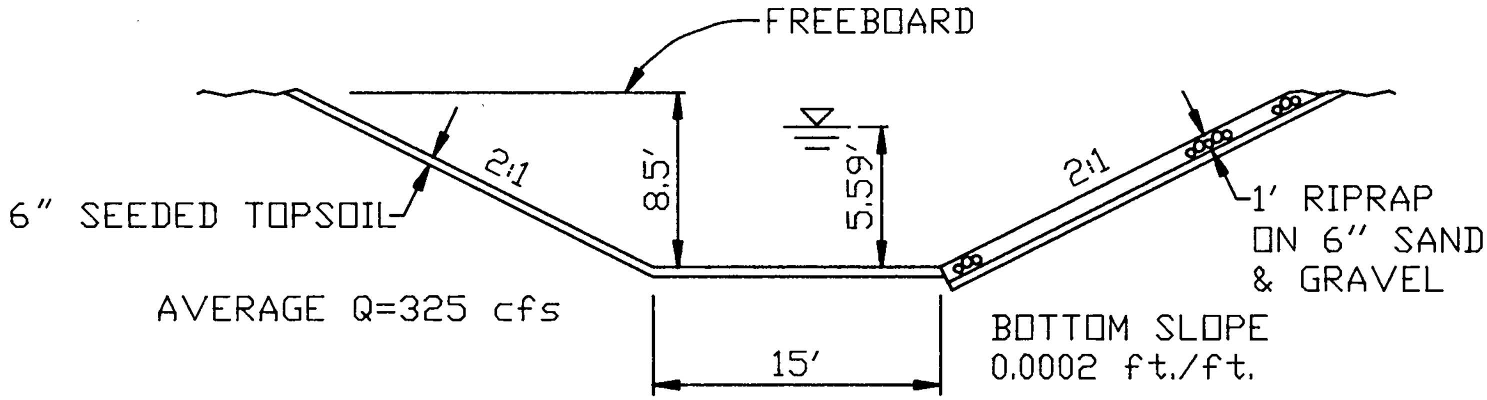
ZERO-OFFSITE WATER-DISCHARGE

ASI

PROJECT: 208.01.24

DATE: JANUARY 1991

FIGURE 1



100-YEAR DESIGN

TYPICAL CANAL CROSS SECTION FOR EXISTING McKAY BYPASS

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

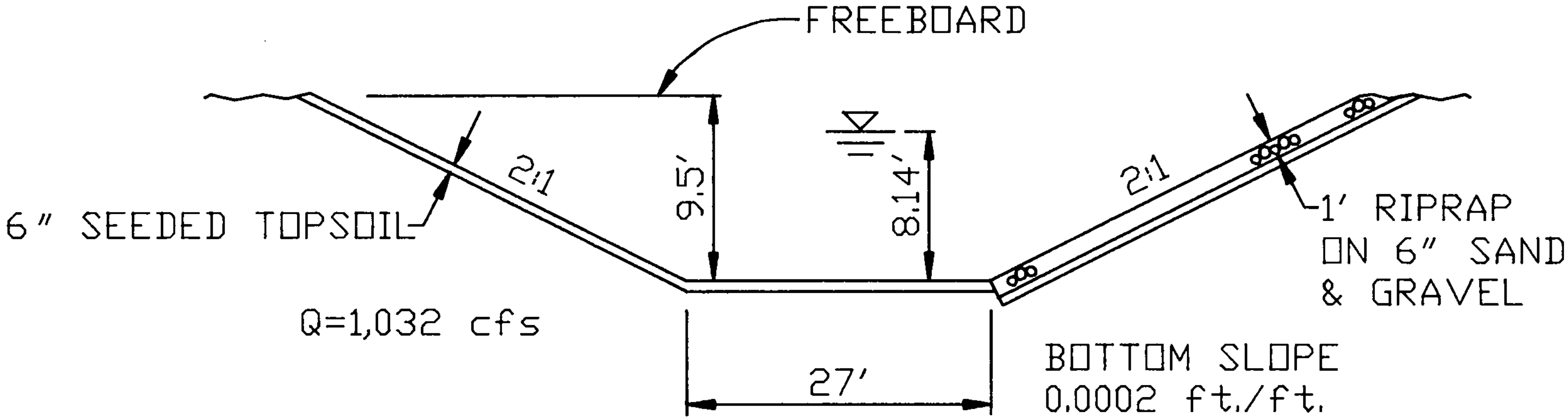
ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24

DATE: JANUARY 1991

FIGURE 2

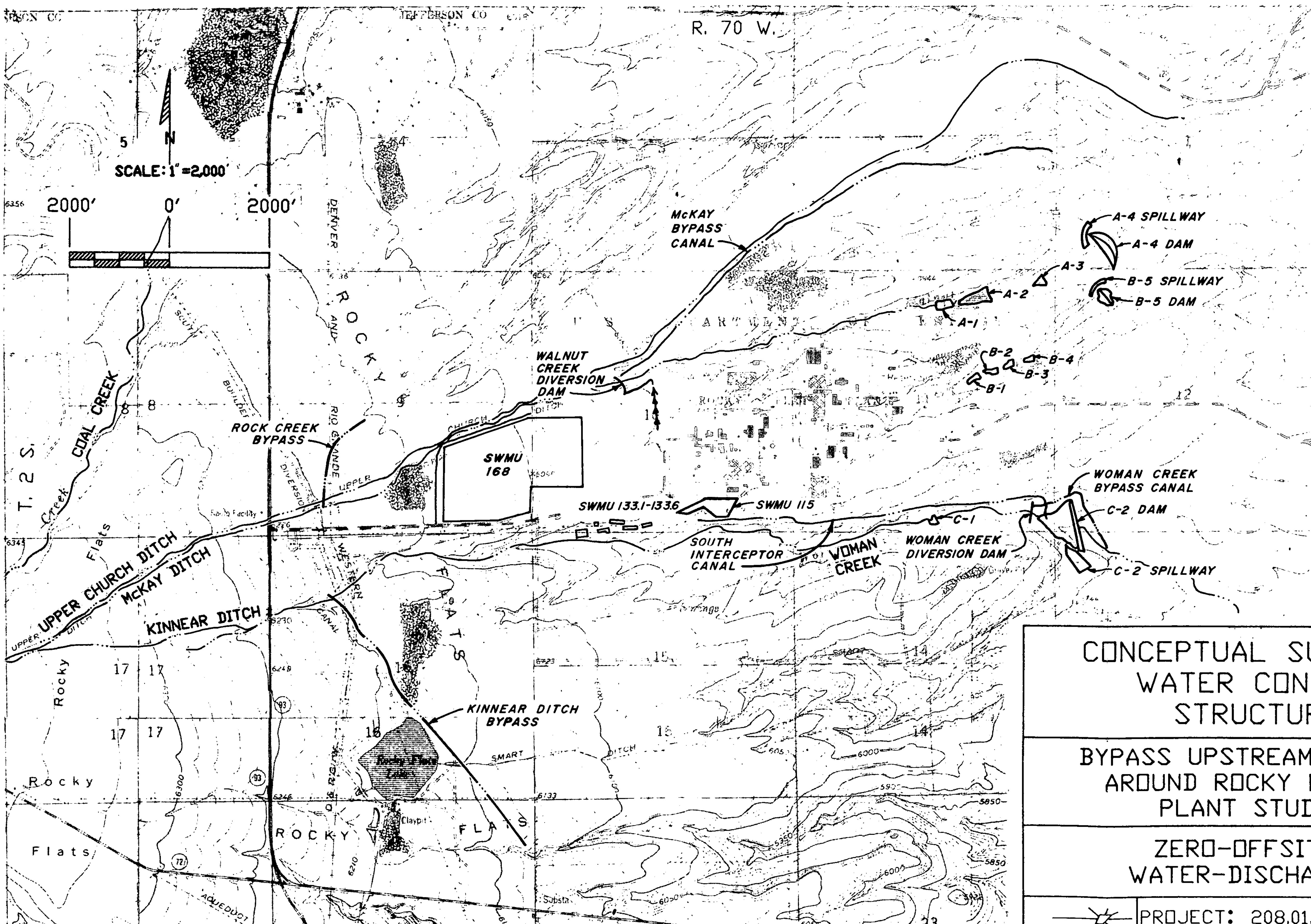
NFIG2



100-YEAR DESIGN

TYPICAL CANAL CROSS SECTION FOR EXISTING WOMAN CREEK BYPASS	
BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY	
ZERO-OFFSITE WATER-DISCHARGE	
PROJECT: 208.01.24 DATE: JANUARY 1991	FIGURE 3

NFIG3



CONCEPTUAL SURFACE-WATER CONTROL STRUCTURES

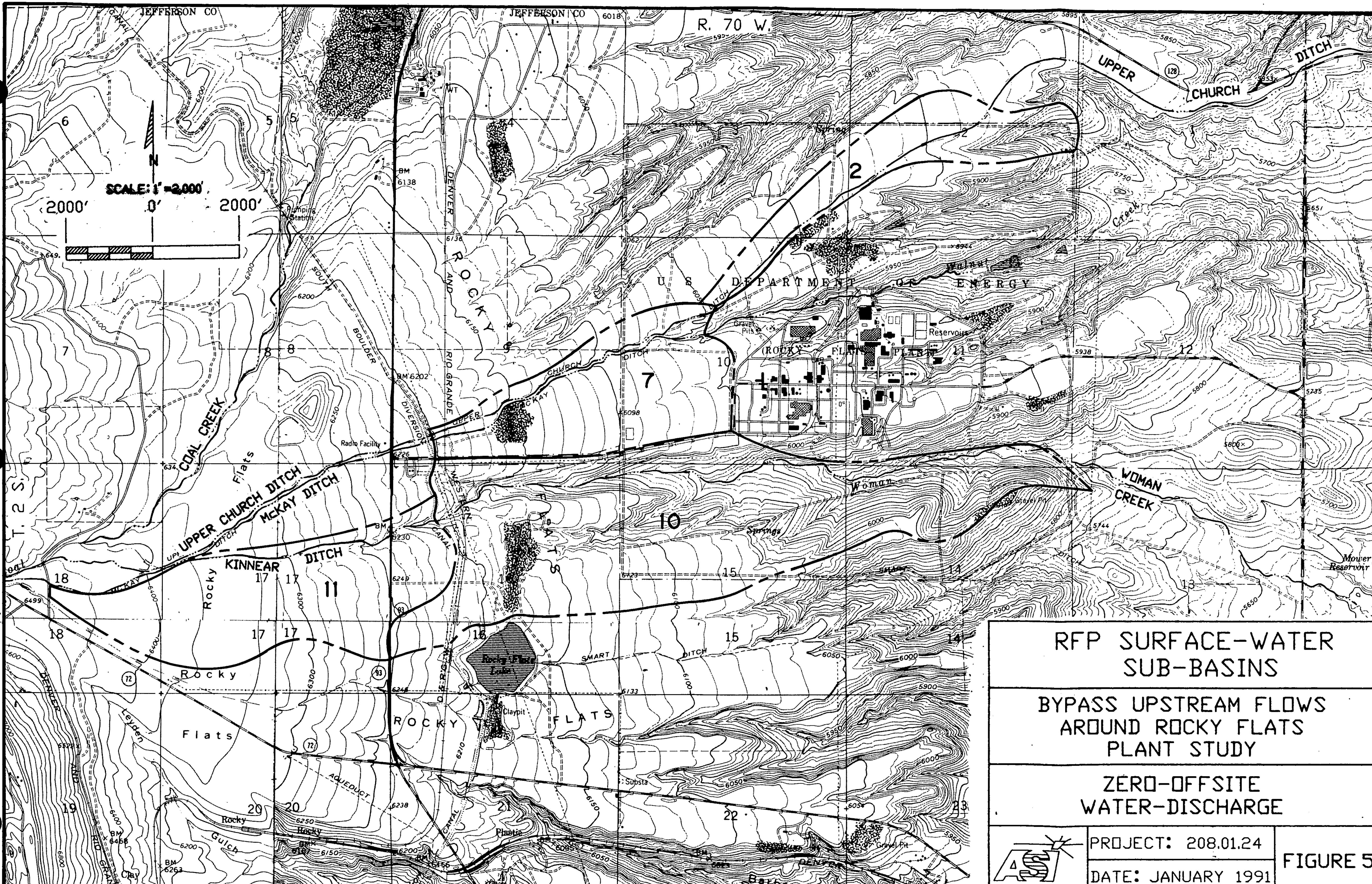
BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24

DATE: JANUARY 1991

FIGURE 4



RFP SURFACE-WATER SUB-BASINS

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

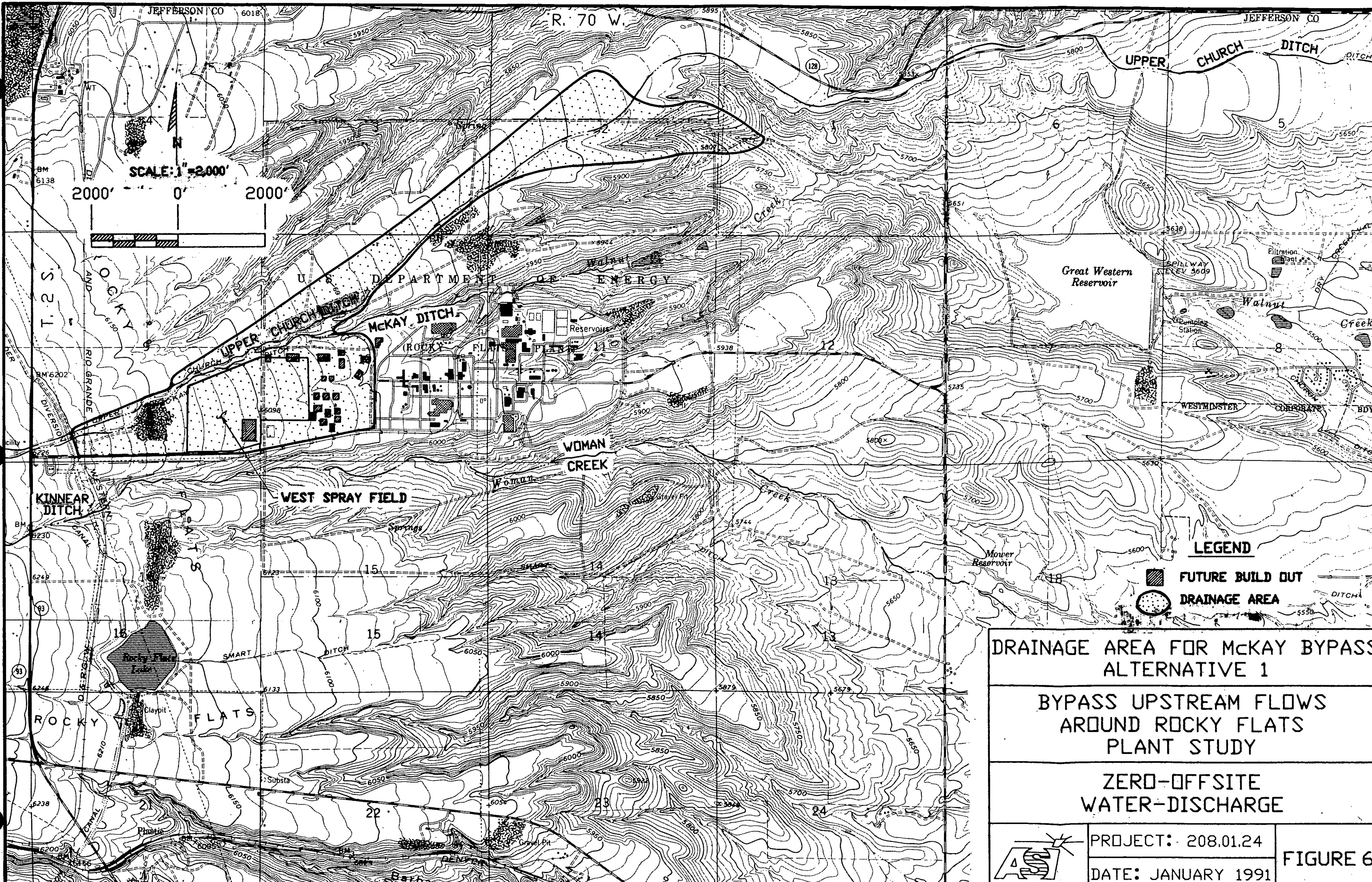
ZERO-OFFSITE WATER-DISCHARGE

ASI

PROJECT: 208.01.24

DATE: JANUARY 1991

FIGURE 5



DRAINAGE AREA FOR McKAY BYPASS
ALTERNATIVE 1

BYPASS UPSTREAM FLOWS
AROUND ROCKY FLATS
PLANT STUDY

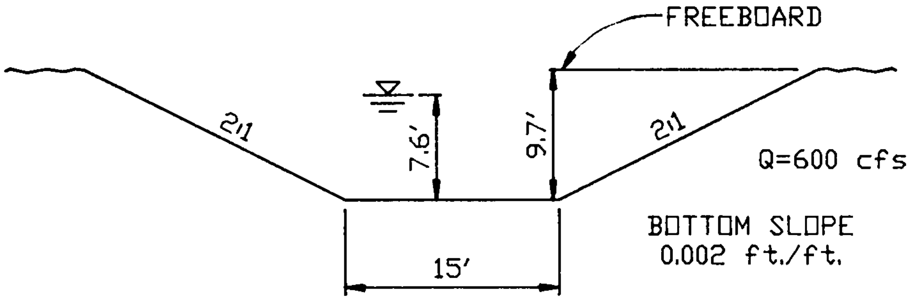
ZERO-OFFSITE
WATER-DISCHARGE

ASI

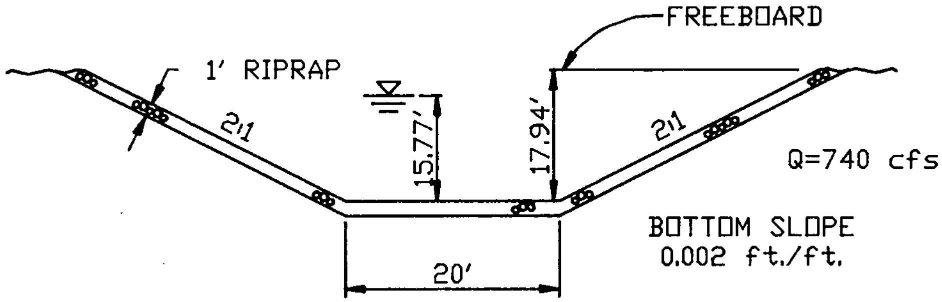
PROJECT: 208.01.24

DATE: JANUARY 1991

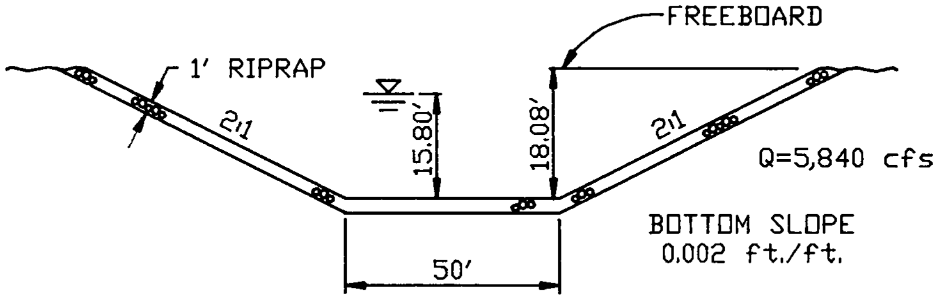
FIGURE 6



100-YEAR 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN

TYPICAL CROSS SECTION
FOR CONCEPTUAL DESIGN
OF McKAY BYPASS
ALTERNATIVE 1

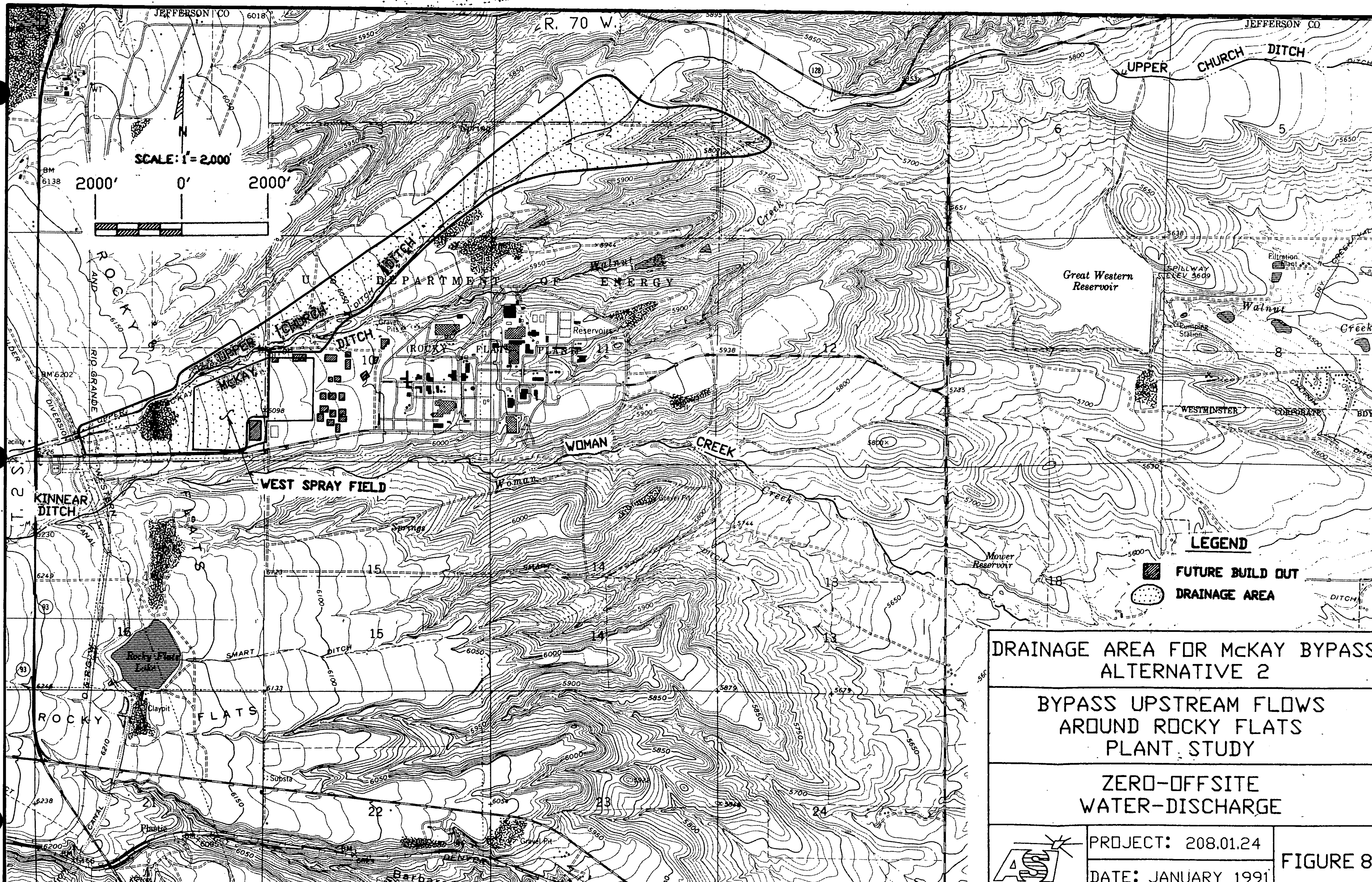
BYPASS UPSTREAM FLOWS
AROUND ROCKY FLATS
PLANT STUDY

ZERO-OFFSITE
WATER-DISCHARGE

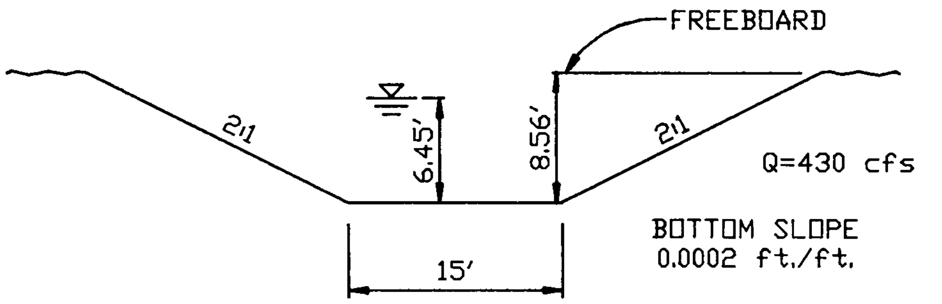
PROJECT: 208.01.24
DATE: JANUARY 1991

FIGURE 7

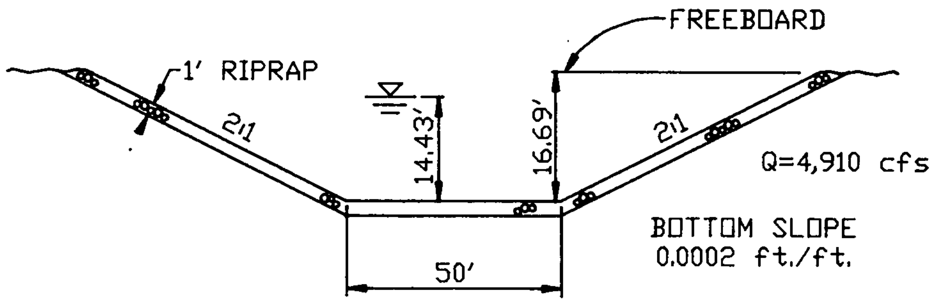
NFIG7



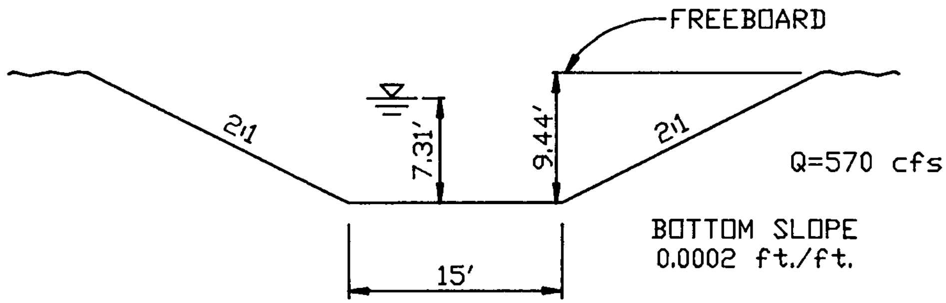
JEFFERSON CO
R. 70 W.
UPPER CHURCH DITCH
SCALE: 1" = 2,000'
2000'
0'
2000'
N
ROCKY FLATS
U. S. DEPARTMENT OF ENERGY
(ROCKY FLATS PLANT)
Great Western Reservoir
Walnut Creek
WOMAN CREEK
WEST SPRAY FIELD
McKAY DITCH
KINNEAR DITCH
RIO GRANDE DIVERSION
SMART DITCH
Rocky Flats Lake
Mower Reservoir
WESTMINSTER CORPORATE BDY
LEGEND
FUTURE BUILD OUT
DRAINAGE AREA
DRAINAGE AREA FOR McKAY BYPASS
ALTERNATIVE 2
BYPASS UPSTREAM FLOWS
AROUND ROCKY FLATS
PLANT STUDY
ZERO-OFFSITE
WATER-DISCHARGE
ASI
PROJECT: 208.01.24
DATE: JANUARY 1991
FIGURE 8



100-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN

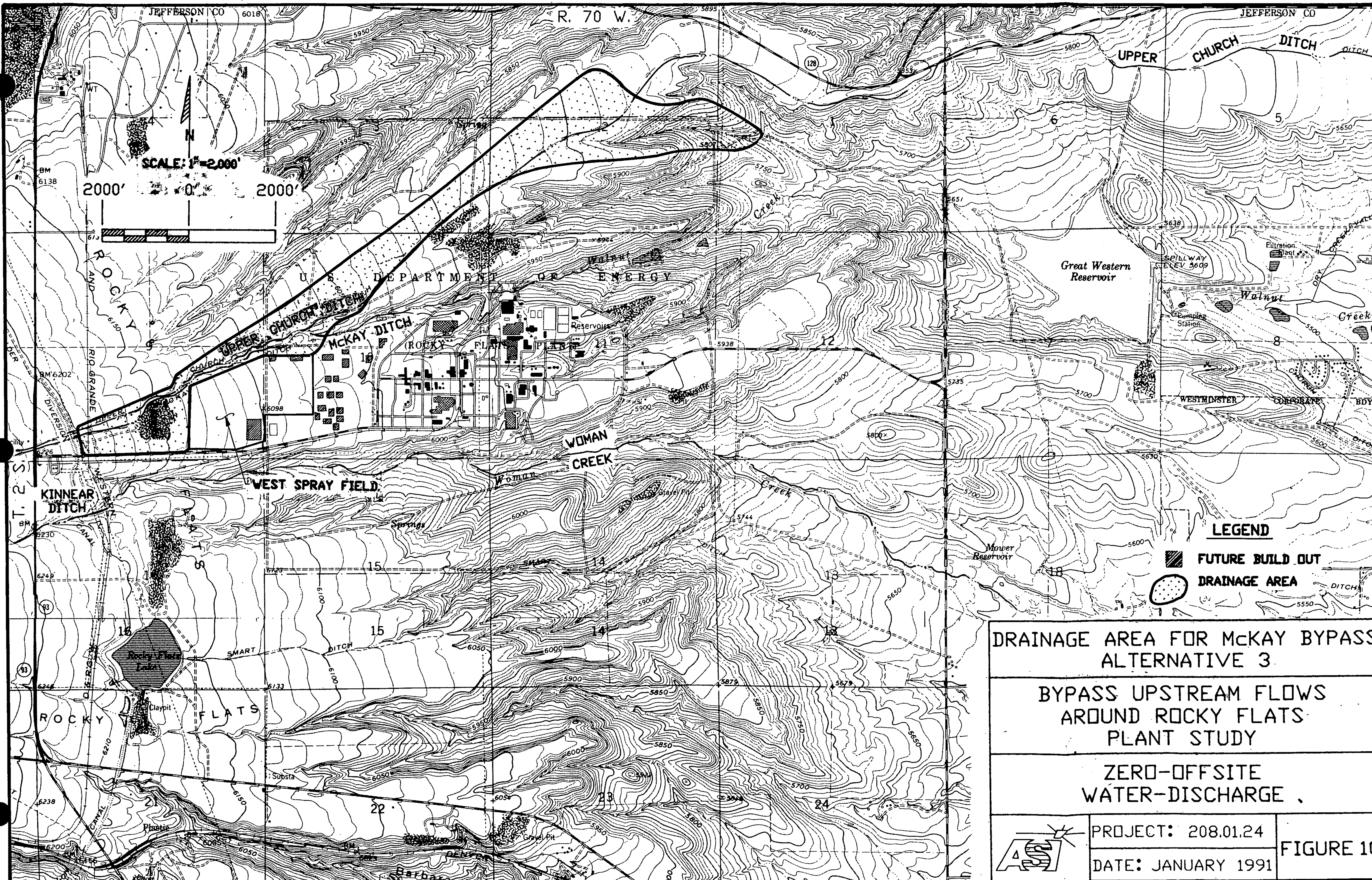
TYPICAL CROSS SECTION FOR CONCEPTUAL DESIGN OF McKAY BYPASS ALTERNATIVE 2

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

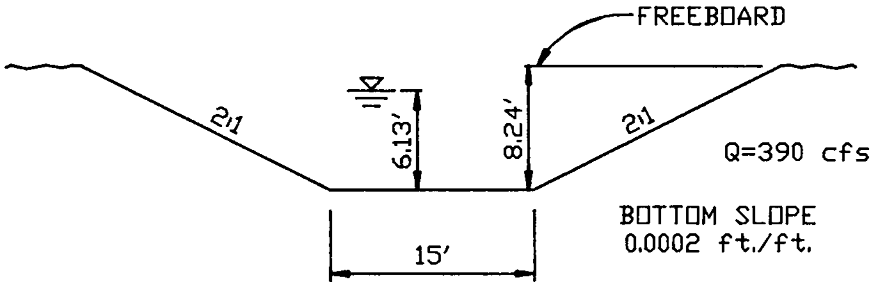
ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24	FIGURE 9
DATE: JANUARY 1991	

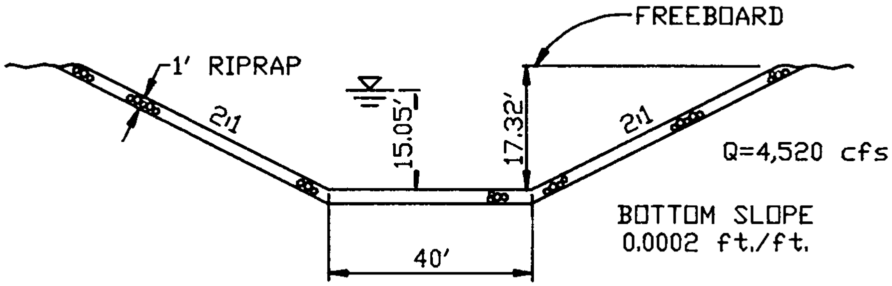
NFIG9



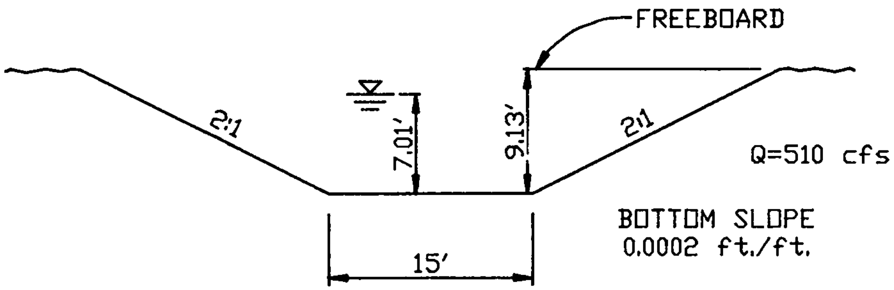
DRAINAGE AREA FOR McKAY BYPASS
ALTERNATIVE 3
BYPASS UPSTREAM FLOWS
AROUND ROCKY FLATS
PLANT STUDY
ZERO-OFFSITE
WATER-DISCHARGE
PROJECT: 208.01.24
DATE: JANUARY 1991
FIGURE 10
LEGEND
FUTURE BUILD OUT
DRAINAGE AREA
SCALE: 1"=2,000'
2000'
0
2000'
N
R. 70 W.
JEFFERSON CO
UPPER CHURCH DITCH
McKAY DITCH
U S DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
WOMAN CREEK
WEST SPRAY FIELD
KINNEAR DITCH
Great Western Reservoir
Walnut Creek
Mower Reservoir
Rocky Flats Lake
SMART DITCH
WESTMINSTER CORPORATE BDY
ROCKY FLATS



100-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN

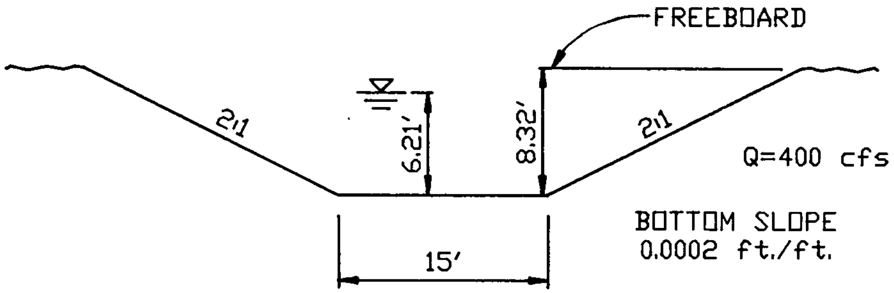
TYPICAL CROSS SECTION FOR CONCEPTUAL DESIGN OF McKAY BYPASS ALTERNATIVE 3

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

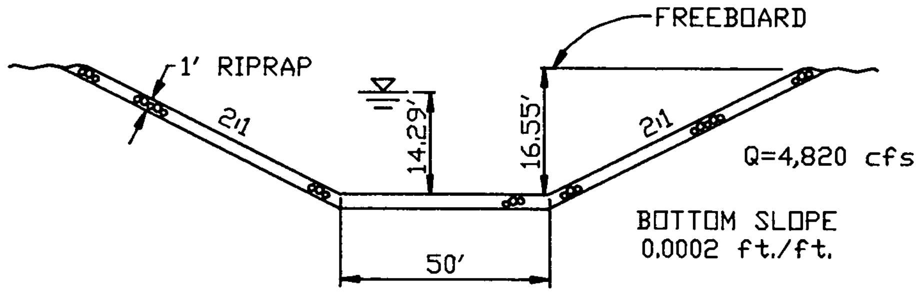
ZERO-OFFSITE WATER-DISCHARGE

ASI	PROJECT: 208.01.24	FIGURE 11
	DATE: JANUARY 1991	

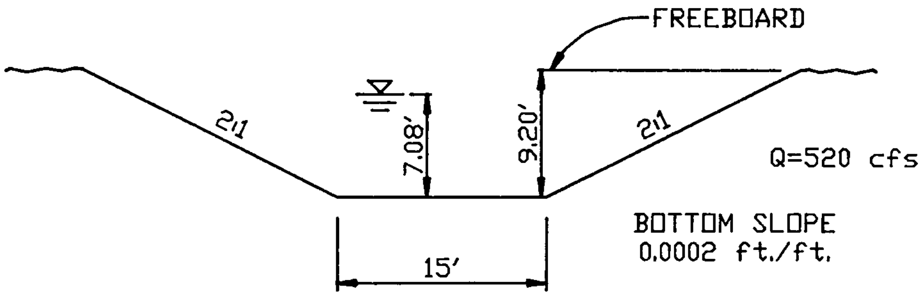
NFIG11



100-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN

TYPICAL CROSS SECTION FOR CONCEPTUAL DESIGN OF McKAY BYPASS ALTERNATIVE 1-A

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

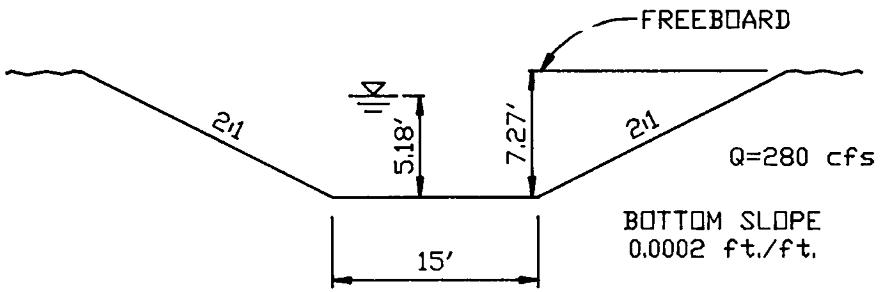
ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24

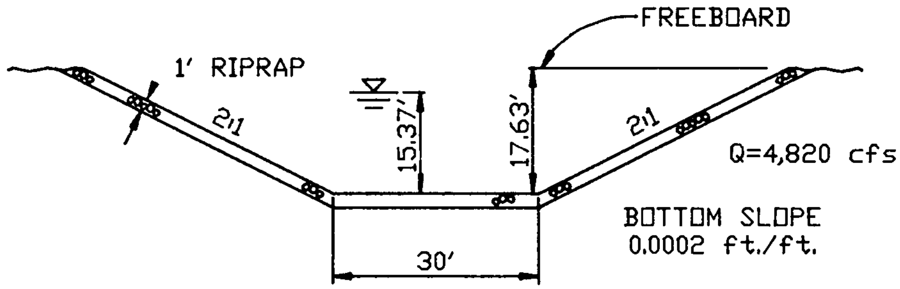
DATE: JANUARY 1991

FIGURE 12

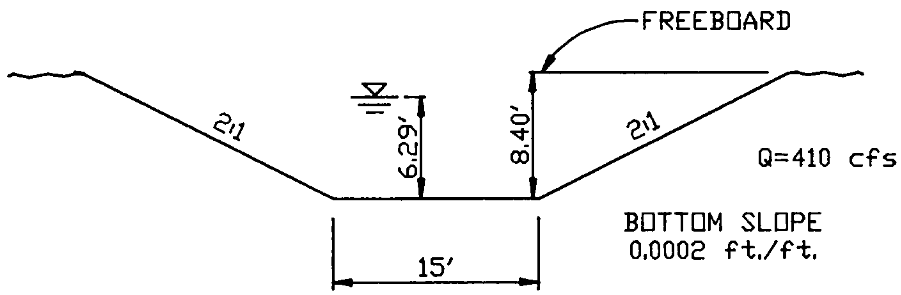
NFIG12



100-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN

TYPICAL CROSS SECTION FOR CONCEPTUAL DESIGN OF McKAY BYPASS ALTERNATIVE 2-A

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

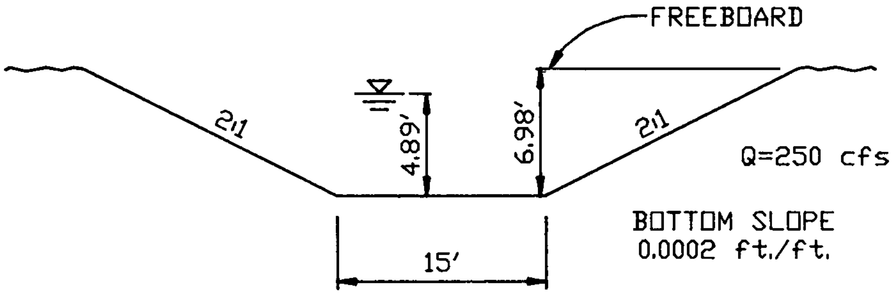
ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24

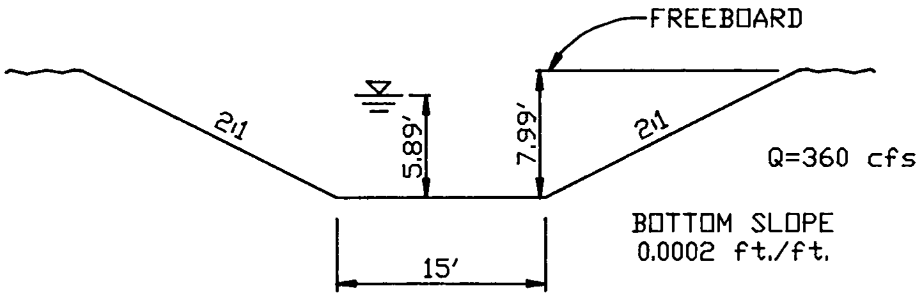
DATE: JANUARY 1991

FIGURE 13

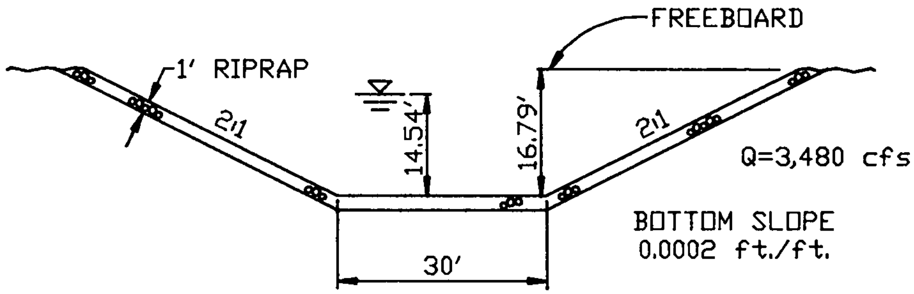
NFIG13



100-YEAR 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN

TYPICAL CROSS SECTION FOR CONCEPTUAL DESIGN OF McKAY BYPASS ALTERNATIVE 3-A

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

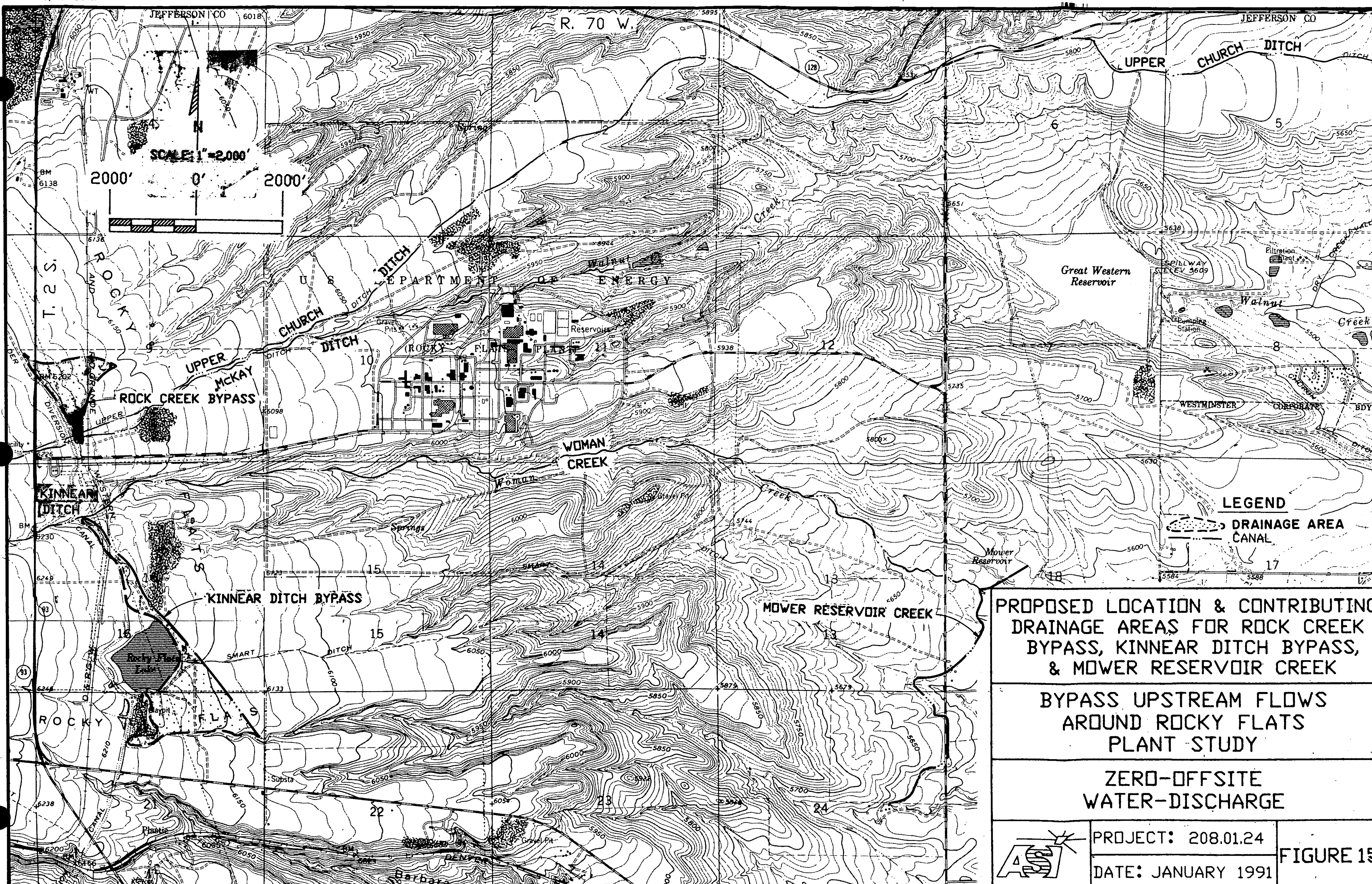
ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24

DATE: JANUARY 1991

FIGURE 14

NFIG14



PROPOSED LOCATION & CONTRIBUTING DRAINAGE AREAS FOR ROCK CREEK BYPASS, KINNEAR DITCH BYPASS, & MOWER RESERVOIR CREEK

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

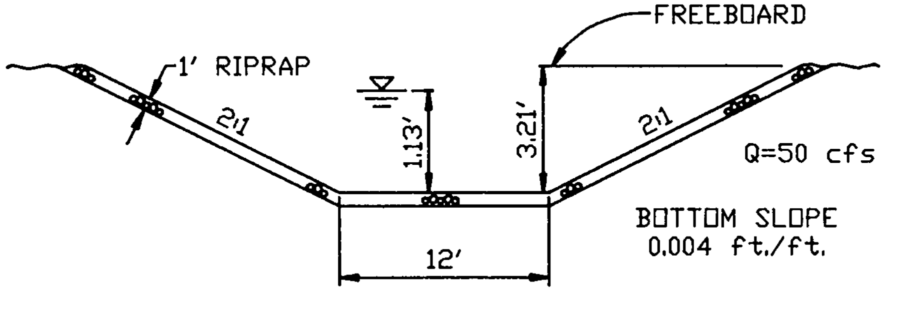
ZERO-OFFSITE WATER-DISCHARGE

ASI

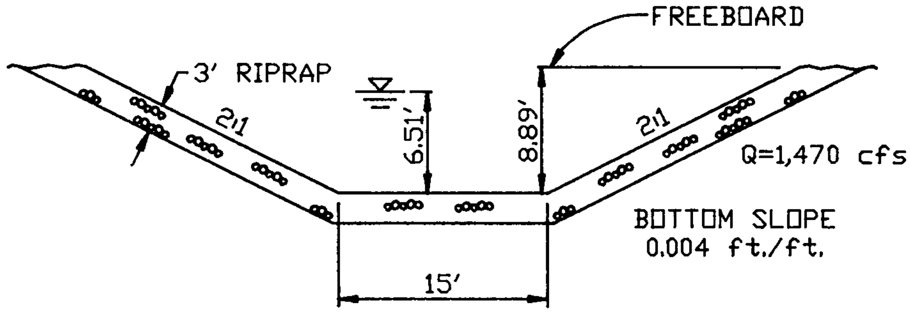
PROJECT: 208.01.24

DATE: JANUARY 1991

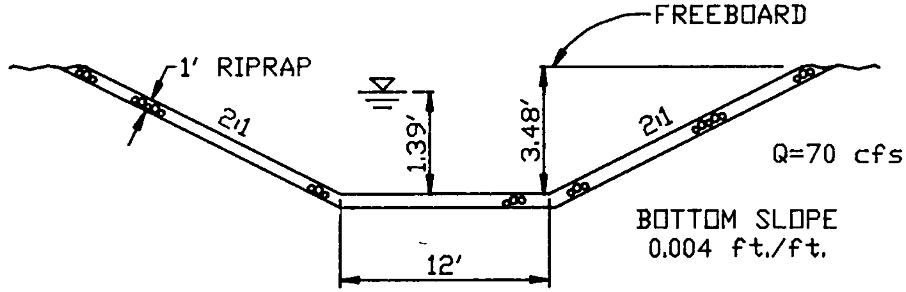
FIGURE 15



100-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN

TYPICAL CROSS SECTION FOR CONCEPTUAL DESIGN OF ROCK CREEK BYPASS

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

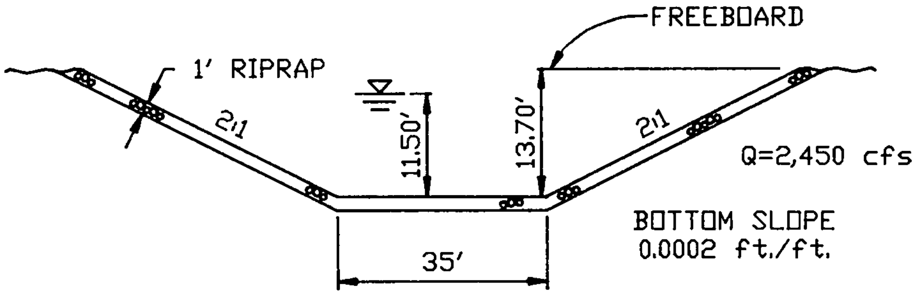
ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24

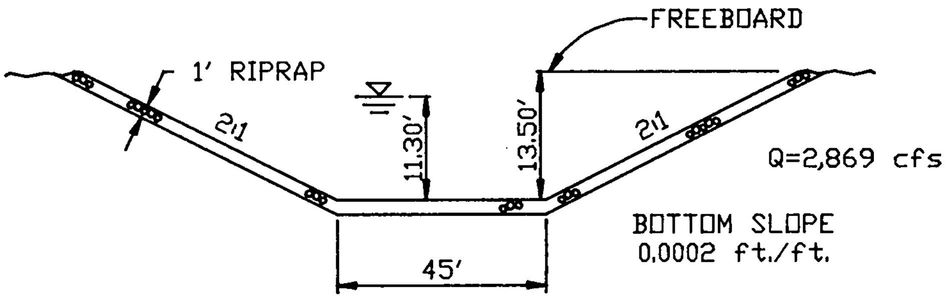
DATE: JANUARY 1991

FIGURE 16

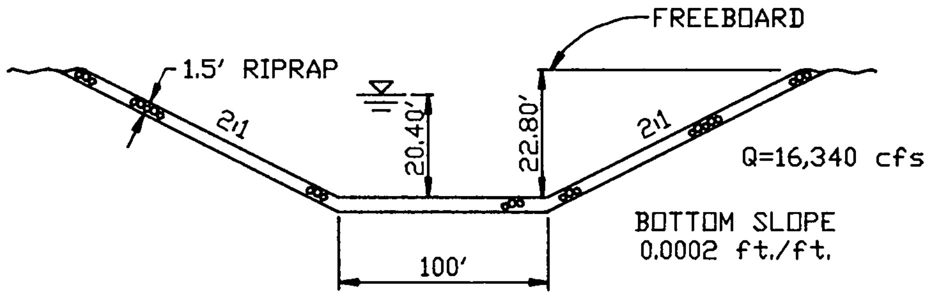
NFIG16



100-YEAR 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN

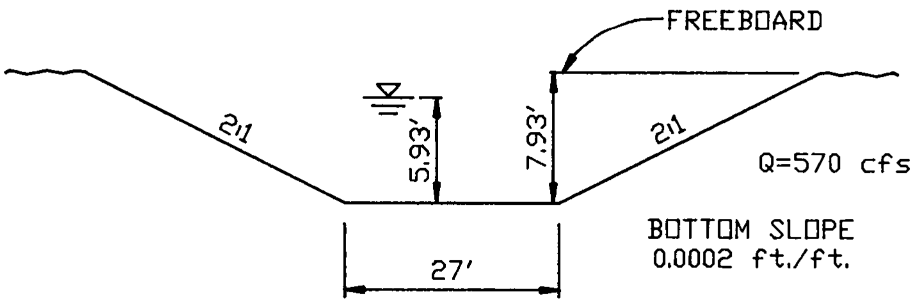
TYPICAL CROSS SECTION
FOR CONCEPTUAL DESIGN
OF WOMAN CREEK BYPASS
ALTERNATIVE 1

BYPASS UPSTREAM FLOWS
AROUND ROCKY FLATS
PLANT STUDY

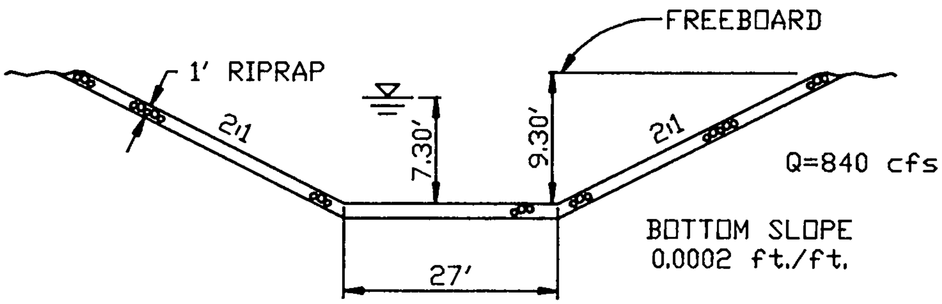
ZERO-OFFSITE
WATER-DISCHARGE

ASI	PROJECT: 208.01.24	FIGURE 17
	DATE: JANUARY 1991	

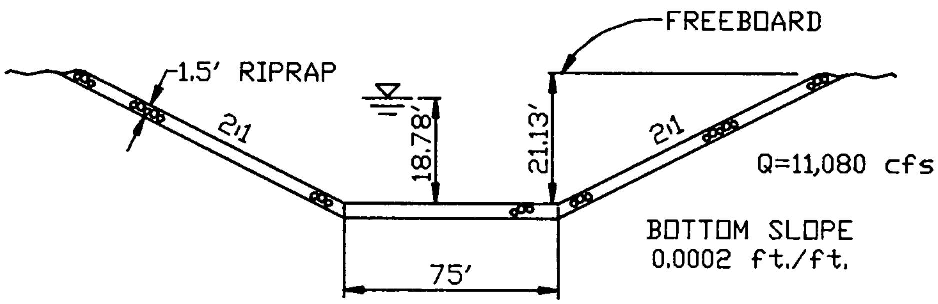
NFIG17



100-YEAR 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN

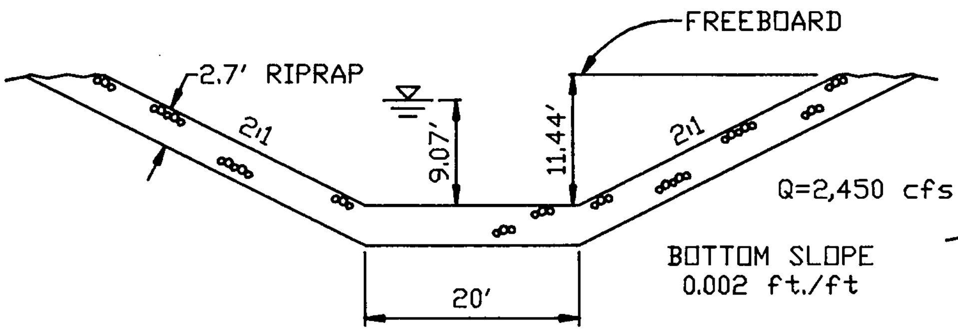
TYPICAL CROSS SECTION FOR CONCERTUAL DESIGN OF WOMAN CREEK BYPASS ALTERNATIVE 2

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

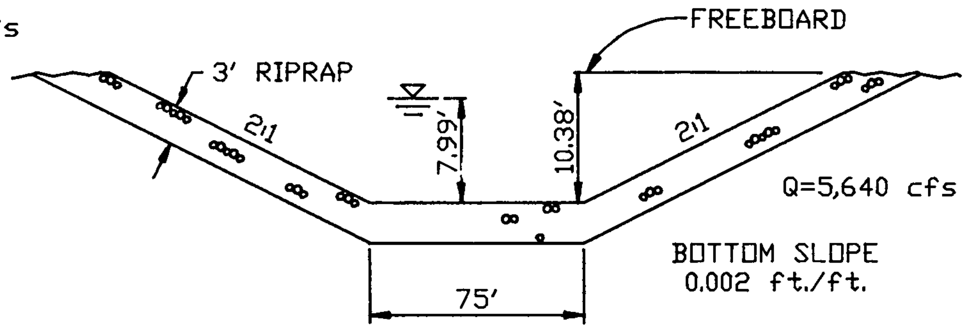
ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24	FIGURE 18
DATE: JANUARY 1991	

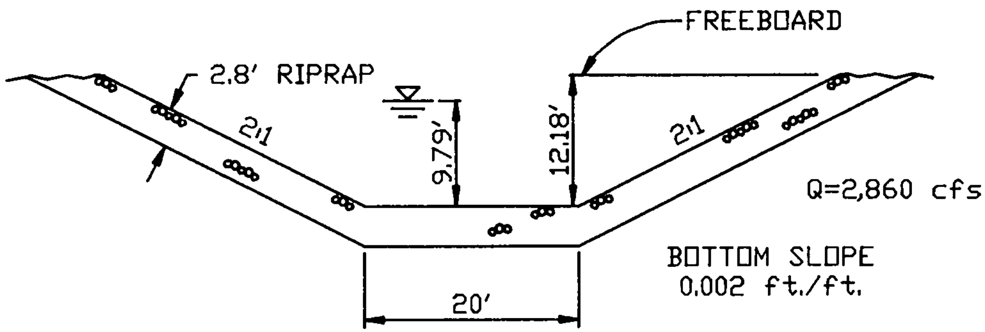
NFIG18



100-YEAR 72-HOUR DESIGN



PMP 72-HOUR DESIGN



500-YEAR 72-HOUR DESIGN

TYPICAL CROSS SECTION FOR CONCEPTUAL DESIGN OF KINNEAR DITCH BYPASS

BYPASS UPSTREAM FLOWS AROUND ROCKY FLATS PLANT STUDY

ZERO-OFFSITE WATER-DISCHARGE

PROJECT: 208.01.24

DATE: JANUARY 1991

FIGURE 19

NFIG19