DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

BRIAN SCHWEITZER
GOVERNOR

DIRECTOR'S OFFICE (406) 444-2074
TELEFAX NUMBER (406) 444-2684

STATE OF MONTANA

WATER RESOURCES DIVISION (406) 444-6601
TELEFAX NUMBERS (406) 444-0533 / (406) 444-5918
http://www.dnrc.mt.gov

1424 9TH AVENUE
PO BOX 201601
HELENA, MONTANA 59620-1601

Cover Letter

March 12, 2008

TO: Governor's Office, Barbara Ranf, Rm. 204, State Capitol, P.O. Box 200801, Helena, MT 59620-0801
Environmental Quality Council, Capitol Building, Room 106, P.O Box 201704, Helena, MT 59620
Dept. of Environmental Quality, Metcalf Building, P.O. Box 200901, Helena, MT 59620-0901
Director's Office
Dept. of Natural Resources and Conservation, US F&G Bldg. 1625 11th Ave. Helena, MT 59620
Director's Office
Information Services Section
Water Resources Division, 1424 9th Avenue, P.O. Box 201601, Helena, MT 59620-1601
Michele Lemieux, Water Operations Bureau
Regional Manager, DNRC Water Resources Division, Lewistown Regional Office, 613 NE. Main, Suite E, Lewistown, MT 59457-2020
Montana Department of Fish, Wildlife & Parks, 1420 E. 6th Ave. Helena, MT 59620
Director's Office
Parks Division
Regional Supervisor, DFWP Region 4 Office, 4600 Giant Springs Road, Great Falls, MT 59405
Anne Tews, MT DFWP, Lewistown Area Office, 2358 Airport Rd. Lewistown, MT 59457
MT State Library, 1515 E. Sixth Ave., P.O. Box 201800, Helena, MT 59620
Montana Environmental Information Center, P.O. Box 1184, Helena, MT 59624
Montana Audubon Council, P.O. Box 595, Helena, MT 59624
Chuck Thomas, Ackley Lake Water Users Association, HC 81, Box 8, Hobson MT 59452
Judith Basin County Commissioners, P.O. Box 427, Stanford, MT 59479-0427
Northern Plains Resource Council, 2401 Montana Ave. Suite 200, Billings, MT 59101-2336
U.S. Army Corps of Engineers, 301 S. Park Ave. Drawer 10014, Helena, MT 59626-0014
U.S. Fish & Wildlife Service, MT Field Office, 585 Shepard Way, Helena, Montana 59601
Wildlife Federation, P.O. Box 1175, Helena, MT 59624
Trout Unlimited, P.O. Box 7186, Missoula, MT 59807

Ladies and Gentlemen:

The enclosed Environmental Assessment (EA) has been prepared for the Ackley Lake Dam Rehabilitation Project and is submitted for your consideration. Please feel free to contact me at (406) 444-6622 (e-mail jdomino@state.mt.us) should you have any questions or comments. Comments will be accepted until 5:00 p.m., Friday, April 11th. Comments can also be mailed to: MT Dept. of Natural Resources and Conservation, State Water Projects Bureau, 1424 9th Avenue, P.O. Box 201601, Helena, MT 59620-1601, attn. James P. Domino. Copies of the EA are available upon request. The EA can also be viewed on the DNRC website at www.dnrc.state.mt.us Thank you.

Sincerely,

James P Domino

James P. Domino
Environmental Specialist
State Water Projects Bureau

RECEIVED
MAR 19 2008
LEGISLATIVE ENVIRONMENTAL POLICY OFFICE

Draft MEPA
Environmental Assessment

Photograph of Project Location

Ackley Lake Dam Rehabilitation

March 2008

MONTANA DNRC

WATER Resources Division

Table of Contents

Page 2 Part I. Proposed Action Description
Type of Proposed State Action
Agency Authority
Page 3 Project Name
Project Sponsor
Construction Timeline
Project Location
Page 4 Project Map
Project Size
Page 5 Agencies with Overlapping or Additional Jurisdiction
Permits Needed
Project Funding
Page 6 Narrative Summary
Page 8 Project Photographs
Page 10 Part II. Environmental Review
No Action Alternative
Page 11 Proposed Action / Preferred Alternative
Evaluation and Listing of Mitigation
Part III. Public Participation
Page 12 Part IV. EA Preparation
Page 13 Part V. Environmental Review Checklist
A. Physical Environment – Land Resources
Page 14 Air
Page 15 Water
Page 16 Vegetation
Page 17 Fish / Wildlife
Page 18 B. Human Environment – Noise / Electrical Effects
Page 19 Land Use
Page 20 Risk / Health Hazards
Page 21 Community Impact
Page 22 Public Services / Taxes / Utilities
Page 23 Aesthetics / Recreation
Page 24 Cultural / Historical Resources
Page 25 C. Significance Criteria
Part VI. Narrative Evaluation and Comment
Page 26 References
Page 27 Appendix A - HKM Design Alternatives Executive Summary and Design Drawings

Ackley Lake Rehabilitation Project: Draft Environmental Assessment and MEPA Checklist

PART I. PROPOSED ACTION DESCRIPTION

1. Type of proposed state action:

The replacement of the spillway, existing toe drains and outlet works with a new structure, and the construction of a toe berm to control high artesian pressures. Additional work may include the installation of an auxiliary spillway in the existing dike. Replacement of the spillway, drains and outlet works is needed due to the age and progressive deterioration of the existing structures, and the failure of the existing spillway to meet current standards. The addition of an auxiliary spillway will provide for large flood passage.

2. Agency authority for the proposed action:

The Montana Legislature enacted statute 85-1- 101(1) through (6) MCA, which states: "It is hereby declared as follows:

(1) The general welfare of the people of Montana, in view of the state's population growth and expanding economy, requires that water resources of the state be put to optimum beneficial use and not wasted.

(2) The public policy of the state is to promote the conservation, development, and beneficial use of the state's water resources to secure maximum economic and social prosperity for its citizens.

(3) The state, in the exercise of its sovereign power, acting through the department of natural resources and conservation, shall coordinate the development and use of the water resources of the state so as to effect full utilization, conservation, and protection of its water resources.

(4) The development and utilization of water resources and the efficient, economic distribution thereof are vital to the people in order to protect existing uses and to assure adequate future supplies for domestic, industrial, agricultural, and other beneficial uses.

(5) The water resources of the state must be protected and conserved to assure adequate supplies for public recreational purposes and for the conservation of wildlife and aquatic life.

(6) The public interest requires the construction, operation, and maintenance of a system of works for the conservation, development, storage, distribution, and utilization of water, which construction, operation, and maintenance is a single object and is in all respects for the welfare and benefit of the people of the state.

Name of project: **Ackley Lake Dam Rehabilitation Project**

3. **Name, address phone number of project sponsor :**

   State Water Projects Bureau, MT. Dept. of Natural Resources & Conservation, 1424 9th Ave., P.O. Box 201601, Helena, MT 59620–1601 (406) 444-6646

4. **Construction Timeline:**

   Estimated Commencement Date: October 2008
   Estimated Completion Date: March 2009
   Current Status of Project Design (% complete) 65%

5. **Location affected by proposed action (county, range and township):**

   The dam and reservoir is located in Judith Basin County, Township 14N, Range 14E, in portions of Section 22, 27 and 28, approximately 4 miles southwest of Hobson. The land where the dam and reservoir are located is owned by the DNRC (Figure 1)

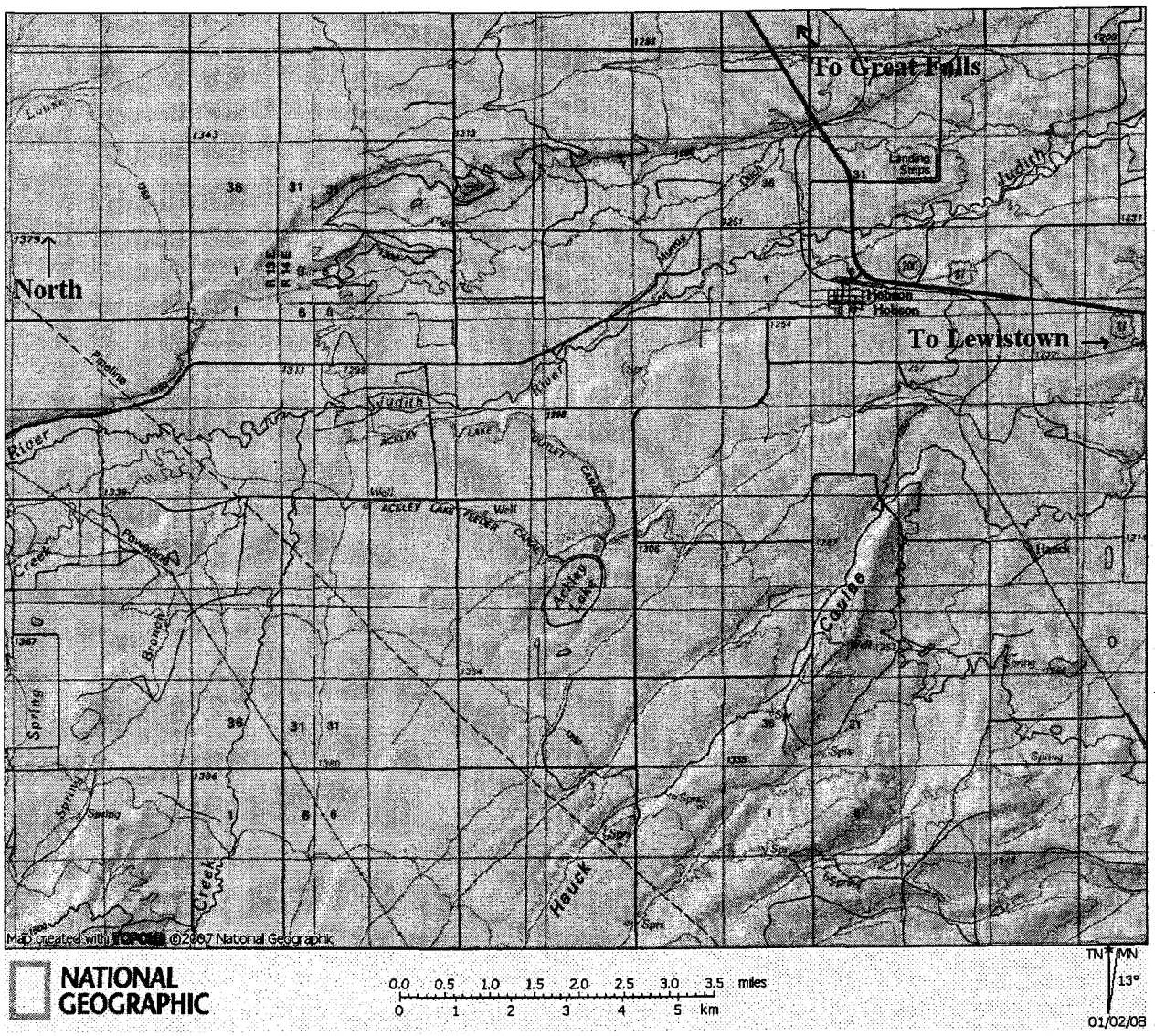


Figure 1. Local area map of Ackley Lake Project

6. Project size -- estimate the number of acres that would be directly affected that are currently:

	Acres		Acres
(a) Developed:		(d) Floodplain	0
Residential	0		
Industrial	0	(e) Productive:	
		Irrigated cropland	0
(b) Open Space/Woodlands/Recreation	0	Dry cropland	0
		Forestry	0
(c) Wetlands/Riparian Areas	0	Rangeland	0
		Other (dam, dike and immediate surrounding area	15

7. **Listing of any other Local, State or Federal agency that has overlapping or additional jurisdiction.**

(a) **Permits: All permits will be obtained prior to applicable project construction.**

The following permits would be needed:

Agency Name	Permit	Status
MT DEQ	Short-Term Exemption from Surface Water Quality (318 Authorization)	Pending
MT DEQ	Construction De-Watering Permit	Pending
MT DEQ	Stormwater Permit	Pending
MT DNRC	Dam Safety Permit	Pending
Corps of Engineers	Federal Clean Water Act (404 Permit)	Pending
MT Historic Preservation Office	Cultural Clearance	Pending

(b) **Funding:**

Name of Funding Source	Amount			
	Grant ($)	Loan ($)	Other ($)	Total ($)
A. Renewable Resource Program	$100,000	$200,000		$300,000
B. Water Storage Account			$300,000	$300,000
C. Hydropower Account			$800,000	$800,000
D. DNRC In-Kind			$87,257	$87,257

Estimated Total Project Cost Approximately $ 1,487,257 (including in-kind)

(c) Other Overlapping or Additional Jurisdictional Responsibilities:

Agency Name	Type of Responsibility
State Historic Preservation Office	Cultural Resource Protection

8. Narrative summary of the proposed action or project including the benefits and purpose of the proposed action:

Ackley Lake Dam is located in Judith Basin County, approximately 4 miles south of Hobson at township 14 north, range 14 east, section 22. The dam was originally constructed in 1938 by the Montana State Water Conservation Board and currently is owned by the Montana Department of Natural Resources and Conservation (DNRC). The project is operated and maintained by the Ackley Lake Water Users Association (WUA).

Ackley Lake is an off-stream reservoir with an approximate storage capacity of 5,972 acre-feet at the normal operating pool elevation of 4316.3 feet (O&M Manual, 2001). The average top of dam elevation is 4324.0 feet. The reservoir is primarily used for irrigation and recreation and is supplied from a diversion on the Judith River. Surface area at normal full pool is 260 acres. The drainage area covers 2.6 square miles. Ackley Lake State Park surrounds most of the reservoir and is a popular recreation area, with fishing the most common activity. The dam is a zoned earth embankment which according to original construction drawings was constructed of an impervious earth and gravel upstream zone and a pervious gravel and earth downstream shell. An upstream cutoff trench and toe drains constructed of 8-inch diameter perforated corrugated iron pipe and clean gravel were also included in the original design.

The dam is showing signs of deterioration due to its age. The existing drain system is not functioning and is unable to safely divert seepage from the dam. This could potentially affect the structural integrity of the dam, creating a serious public health and safety concern if repairs are not made. Ackley Lake Dam is classified as a high hazard structure, meaning a loss of life could occur should the dam fail. This classification is not a reflection of the actual condition of the structure. In the "Ackley Lake Spillway Analysis" completed in December 2007 by HKM Engineering of Billings Montana, an assessment of the population at risk and the estimated loss of life associated with a dam failure were determined for Ackley Lake Dam. The population at risk was determined to be 47 persons with an estimated loss of life of approximately 3 people resulting from a ½ probable maximum flood (PMF) breach. According to the State of Montana Dam Safety Standards, the inflow design flood (IDF) is based on the estimated loss of life, which for Ackley Lake Dam results in a 3000-year flood event. The current spillway does not meet this standard. Replacement of the spillway is also needed due to age related structural deterioration. The dam has excessive seepage and high artesian pressures. This could affect the structural stability of the embankment, thereby increasing the

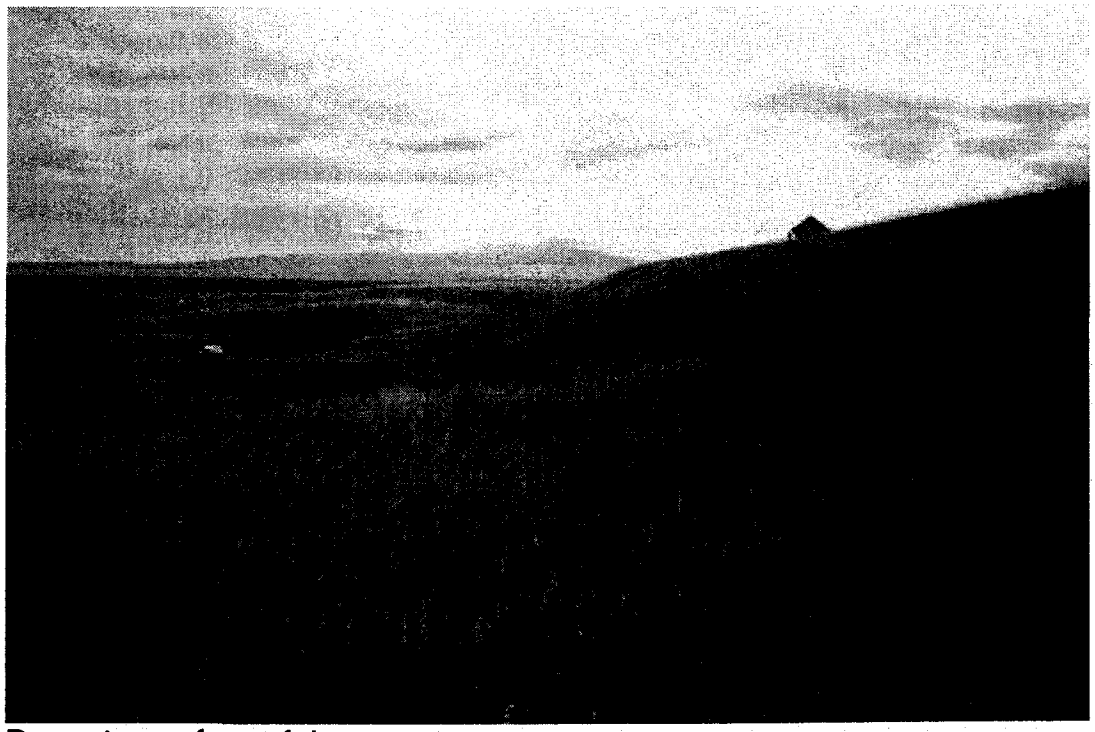
potential for failure. The outlet conduit is also in poor condition and needs to be replaced.

The proposed rehabilitation includes the replacement of the spillway with a new structure that can safety pass the IDF, the installation of new toe drains, the construction of a toe berm to protect against the high artesian pressures, the replacement of the outlet works, widening and leveling of the dam crest, and the construction of a dike (auxiliary) spillway (approximately 900 feet south of the right abutment). This additional spillway is proposed to provide additional spillway capacity so large floods can safely be passed between the main and auxiliary spillways. Approximately 53,000 cubic yards of material will be utilized in the construction, with approximately 15 acres of surface disturbance. This project will also involve the drawdown of the reservoir to approximately 325 acre-feet of water (about 40 surface acres). The established minimum under normal conditions is 458 acre-feet. The purpose of the drawdown is to allow access to upstream face of the dam for the installation of the new outlet structure and conduit. The reservoir would be allowed to begin filling once the project is completed in December 2008. Access to the inlet area would be along the crest of the dam and right abutment. Small amounts of sediment may enter the outlet canal, however, it is not anticipated that any significant amount of sediments will move downstream into the Judith River. The outlet canal would be dry for the duration of the project. Due to the lower than normal water level with the proposed drawdown, there is an increased risk to the stocked fish in the reservoir, with the potential for some reservoir fisheries losses. This is due to the anticipated higher than normal water temperatures, temporary increases in turbidity, and lower dissolved oxygen levels. In order to reduce potential impacts related to increased turbidity, the reservoir would be slowly drawn down to the proposed 325-acre-feet of storage, with the drawdown beginning in August, 2008 and completed by the proposed construction start date in September, 2008. Short-term, temporary impacts to recreational use are anticipated as a result of the construction and reservoir draw down.

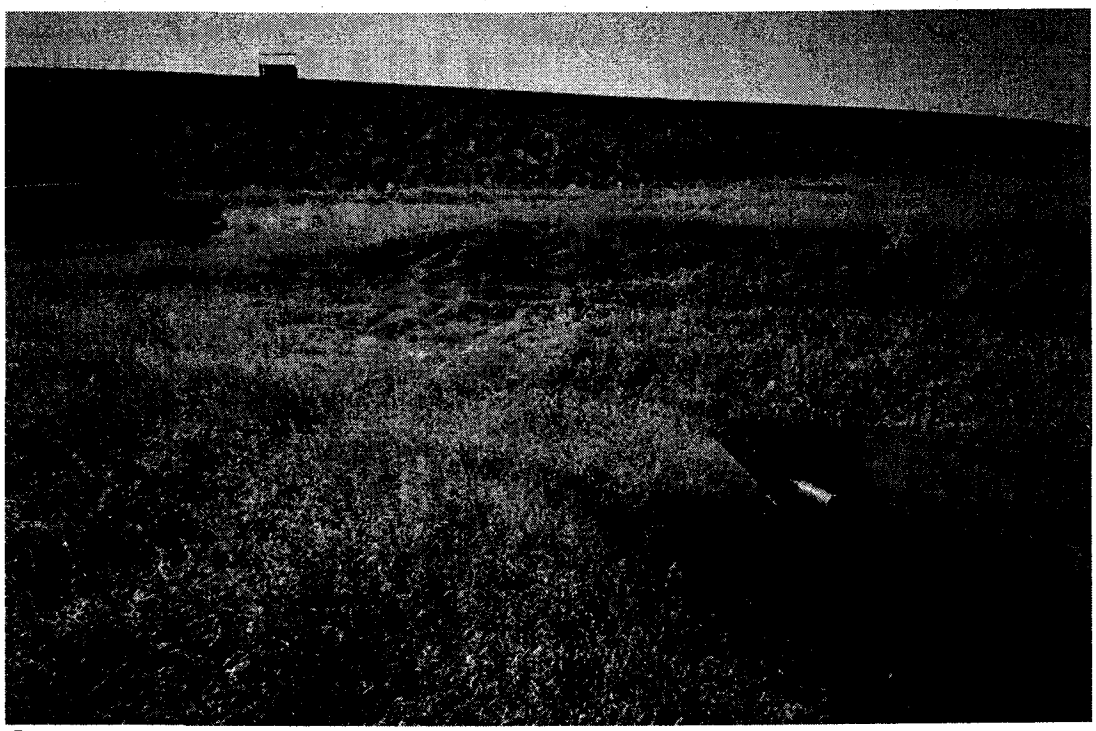
Rehabilitation of the dam would significantly reduce the potential for loss of life and would provide for the continued use of the reservoir for agricultural irrigation, recreation and fisheries. Rehabilitation would bring the structure up to code and extend its useful life for another 50 to 75 years. The cost of the needed rehabilitation is estimated to be $1,400,000. Sustaining the area's economy, providing irrigation and stock water, protecting fisheries resources, wildlife habitat, and recreational use would be other important benefits of this project.

The Montana Department of Environmental Quality, State Historic Preservation Office and Natural Heritage Program have been contacted concerning potential impacts to water resources, historic resources and the presence of any species of special concern within the vicinity of the proposed project, respectively. Montana Fish, Wildlife and Parks were consulted concerning potential impacts to fish, wildlife and recreational resources. The Corps of Engineers was also contacted on 404 permitting requirements. The DNRC Water Operations Bureau has been consulted concerning the Dam Safety Permit. It is anticipated that the project will not cause any significant or long-term, permanent adverse impacts to the environment. The design plans and design report executive summary are provided in Appendix A.

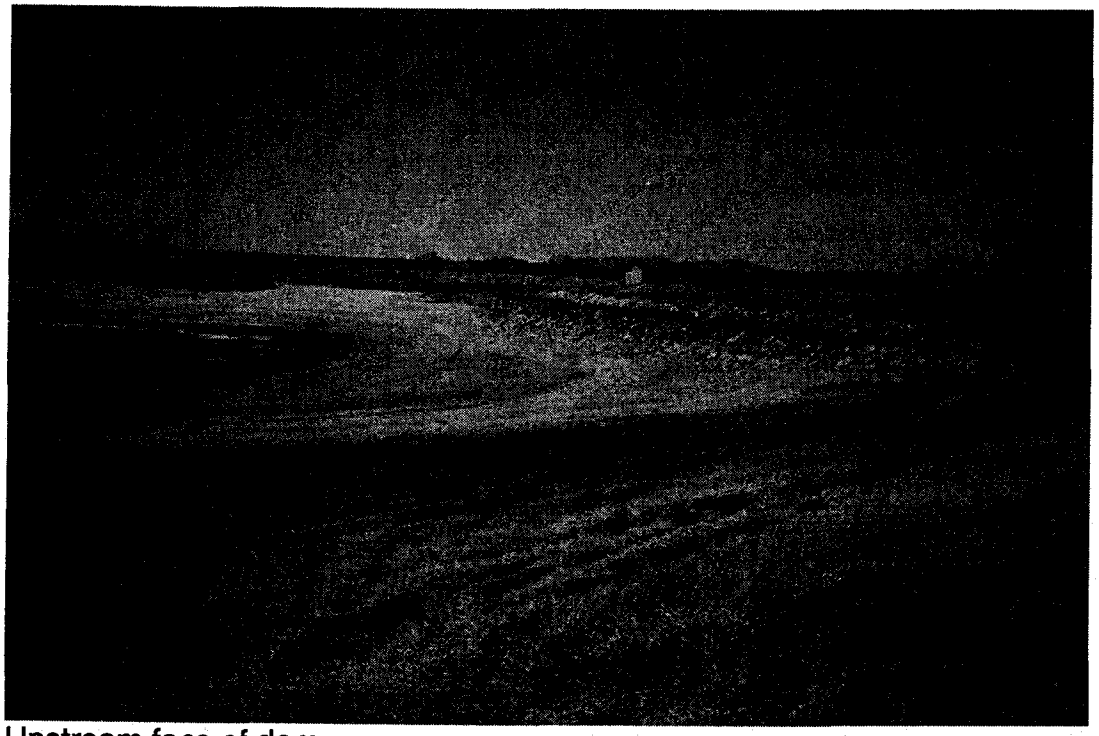
Project Photographs:



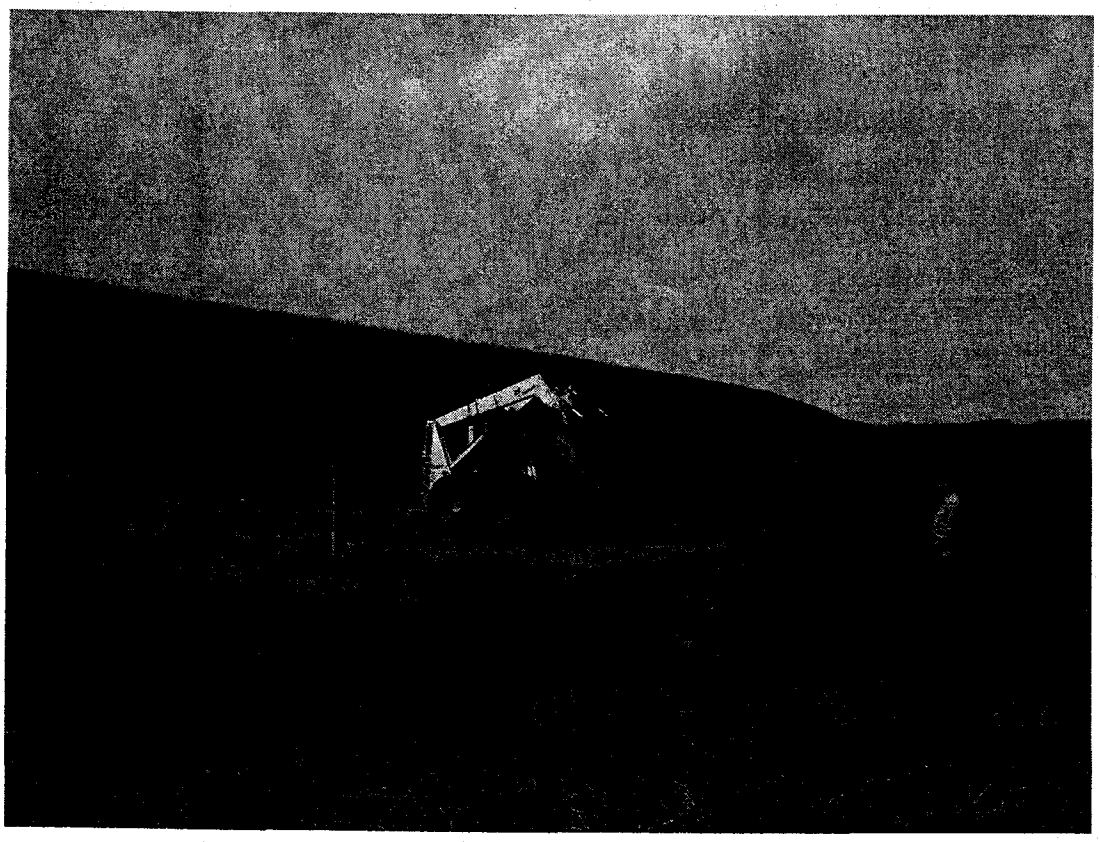
Downstream face of dam



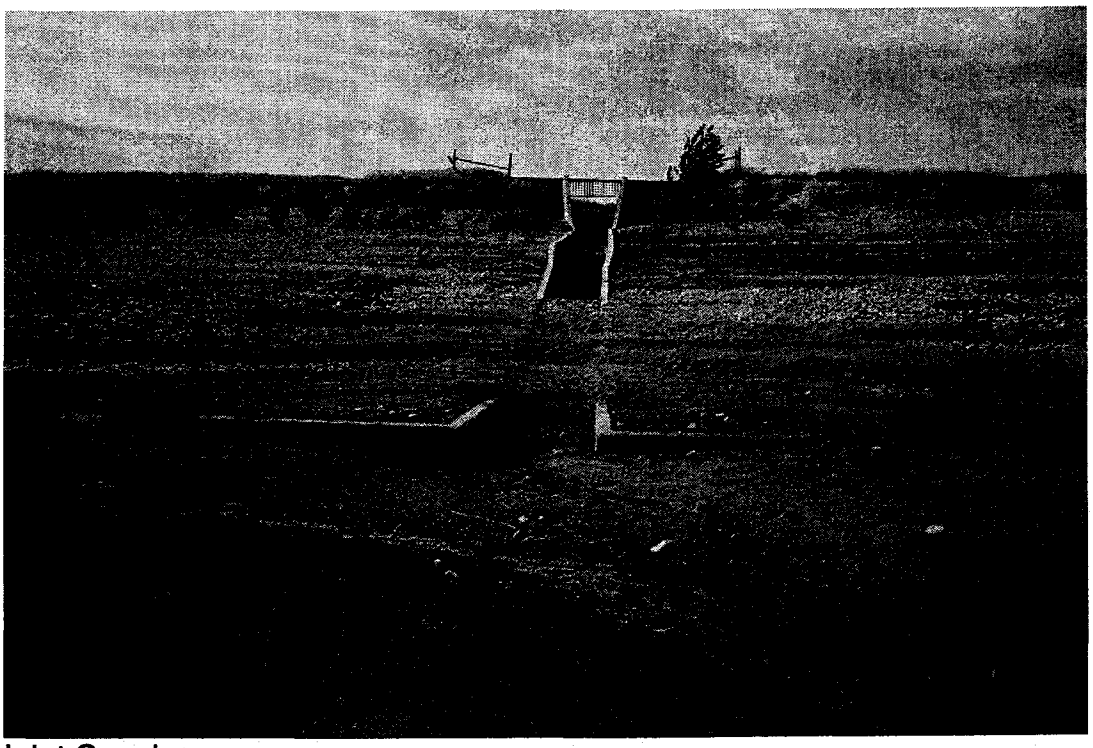
Outlet and drain pipe



Upstream face of dam



Temporary repairs being made to a seepage area in June, 2004



Inlet Canal

PART II. ENVIRONMENTAL REVIEW

1. Description and analysis of reasonable alternatives (including the no action alternative) to the proposed action whenever alternatives are reasonably available and prudent to consider and a discussion of how the alternatives would be implemented:

Alternative A: No Action

This would result in the continuation of a potentially unsafe condition at a designated high hazard dam. Failure to address the excessive seepage and high artesian pressures would affect the dam's safe operation. This in turn could affect the structure's integrity and increase the risk to the public and property downstream. This risk would increase overtime. In addition, the supply of irrigation water could be negatively affected, resulting in potentially severe economic hardship to the area's agricultural economy. Recreational use would be negatively affected and fisheries and wildlife resources associated with the reservoir would be harmed.

Alternative B: Proposed Action / Preferred Alternative

The proposed rehabilitation includes the replacement of the spillway with a new structure that can safety pass the IDF, the installation of new toe drains, the construction of a toe berm to protect against the high artesian pressures, the replacement of the outlet works, widening and leveling of the dam crest, and the construction of a dike (auxiliary) spillway (approximately 900 feet south of the right abutment). This additional spillway is proposed to provide additional spillway capacity so large floods can safely be passed between the main and auxiliary spillways. The repair work and improvements will enhance dam safety and longevity and promote effective water conservation for irrigation needs. Protecting the area's agricultural based economy, providing irrigation and stock water, protecting fisheries resources, wildlife habitat, wetlands, and recreational use would be achieved under this alternative. Design drawings and the HKM Design Alternatives Report Executive Summary are provided in Appendix A.

2. **Evaluation, listing of mitigation, stipulation, or other control measures enforceable by the agency or other government agency:**

Other than the requirements associated with the permits mentioned in Section 7(a) on page 5 of this report, there are no formal stipulations of mitigation or other controls associated with the proposed action. This action does not involve any permanent or long-term permits or granting of a license on which stipulations would be placed.

PART III. PUBLIC PARTICIPATION

1. **Describe the level of public involvement for this project if any, and, given the complexity and the seriousness of the environmental issues associated with the proposed action, is the level of public involvement appropriate under the circumstances?**

The public will be notified by way of a public notice on DNRC web page at **www.dnrc.mt.gov** . Individual notices will be sent to the State Water Projects Bureau standard EA distribution list (as presented on the cover page of this EA) and to those that have requested a copy.

Duration of comment period:

A 30-day comment period is proposed. This level of public involvement is appropriate for the scale and scope of the proposed action. Opening and closing dates for comments are provided on the EA Cover Letter and Distribution List.

PART IV. EA PREPARATION

1. **Based on the significance criteria evaluated in this EA, is an EIS required?**
   If an EIS is not required, explain why the EA is the appropriate level of analysis for this proposed action.

   Based on an evaluation of the primary, secondary, and cumulative impacts to the physical and human environment under the Montana Environmental Protection Act (MEPA), this environmental review found no significant impacts from the proposed action. In determining the significance of the impacts, the DNRC assessed the severity, duration, geographic extent, and frequency of the impact, the probability that the impact would occur or reasonable assurance that the impact would not occur, growth-inducing or growth inhibiting aspects of the impact, the importance to the state and to society of the environmental resource or value affected, and precedent that would be set as a result of the proposed action that would commit the DNRC to future actions; and potential conflicts with local, state or federal laws. Therefore, an EA is the appropriate level of review and an EIS is not required.

2. **Name, title, address and phone number of the person(s) responsible for preparing the EA:**

   James P. Domino
   Environmental Science Specialist
   State Water Projects Bureau
   Montana Department of Natural Resources and Conservation

   1424 9th Avenue, P.O. Box 201601
   Helena, MT 59620-1601
   (406) 444-6622
   e-mail jdomino@mt.gov

3. **List of agencies consulted during preparation of the EA:**

   Montana Department of Fish, Wildlife & Parks
   Montana State Historic Preservation Office
   Montana Natural Heritage Program – Natural Resources Information System
   Montana Department of Environmental Quality
   Montana Department of Natural Resources and Conservation, Water Operations Bureau, Dam Safety Section
   U.S. Army Corps of Engineers

PART V. ENVIRONMENTAL REVIEW CHECKLIST

4. Evaluation of the impacts of the Proposed Action including secondary and cumulative impacts on the Physical and Human Environment.

A. PHYSICAL ENVIRONMENT

1. LAND RESOURCES Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. **Soil instability or changes in geologic substructure?		X				
b. Disruption, displacement, erosion, compaction, moisture loss, or over-covering of soil, which would reduce productivity or fertility?			X			1b.
c. **Destruction, covering or modification of any unique geologic or physical features?		X				
d. Changes in siltation, deposition or erosion patterns that may modify the channel of a river or stream or the bed or shore of a lake?			X			1d.
e. Exposure of people or property to earthquakes, landslides, ground failure, or other natural hazard?		X				
f. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Land Resources:

1b. Soil would be disturbed during the excavation and construction process, which will cause some erosion, compaction, and loss of soil over-covering. Approximately 53,000 cubic yards of material will be utilized in the construction, with approximately 15 acres of surface disturbance. The effects would be minor and non-significant. All disturbed areas would be reclaimed and regraded.

1d.) The upstream face of the dam and associated reservoir shoreline will be modified to allow for construction access and the installation of the new inlet structure. The dike spillway would involve modification of the dike to accommodate the new structure and allow for construction access. Impacts associated with the proposed alternative are considered minor and non-significant in the short and long-term.

2. AIR Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. **Emission of air pollutants or deterioration of ambient air quality? (Also see 13 (c).)			X			2a.
b. Creation of objectionable odors?		X				
c. Alteration of air movement, moisture, or temperature patterns or any change in climate, either locally or regionally?		X				
d. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Air Resources (attach additional pages of narrative if needed):

2a. Minor and temporary dust and vehicle emissions would be created by equipment during construction. The effect would be non-significant and end with the completion of the project.

3. WATER Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated*	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. *Discharge into surface water or any alteration of surface water quality including but not limited to temperature, dissolved oxygen or turbidity?			X			3a.
b. Changes in drainage patterns or the rate and amount of surface runoff?		X				
c. Alteration of the course or magnitude of floodwater or other flows?		X				
d. Changes in the amount of surface water in any water body or creation of a new water body?			X			3d.
e. Exposure of people or property to water related hazards such as flooding?		X				
f. Changes in the quality of groundwater?		X				
g. Changes in the quantity of groundwater?		X				
h. Increase in risk of contamination of surface or groundwater?			X			3h.
i. Effects on any existing water right or reservation?		X				
j. Effects on other water users as a result of any alteration in surface or groundwater quality?		X				
k. Effects on other users as a result of any alteration in surface or groundwater quantity?			X			3k.
l. Other:			X			3l.

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Water Resources:

3a. The proposed action may cause an increase in turbidity, but the increase would be temporary and non-significant. Stipulations limiting surface water discharge turbidity as required under the DEQ MPDES permits would be closely monitored and adhered to. It is not anticipated that significant amounts of sediments would enter the outlet canal or the Judith River, as the outlet canal would be dry for the duration of the project.

3d.) The reservoir would be lowered to approximately 325 acre-feet of storage for the duration of the project. The normal minimum pool is 458 acre-feet. The reservoir would begin filling and return to normal operations upon project completion, tentatively scheduled for December 2008. The changes in the amount of surface water are temporary, non-significant and would end upon completion of the project.

3h. The risk of water contamination exists due to heavy equipment use in the area around the dam, dike and outlet canal. This impact is minor, temporary, non-significant and would end with the completion of the project. The risk would be mitigated by insuring that all equipment is properly maintained with no fluid leaks. Construction equipment refueling would take place at an off-site location away from the dam, reservoir and canal.

3k.) The repairs under the proposed alternative would eliminate the existing storage restrictions. Downstream water users would benefit by the availability of additional water for irrigation.

3l.) Anglers and recreationists would be impacted due to a lack of water and the potential loss of the fisheries resources. Refilling and restocking the reservoir would mitigate these impacts.

All these effects would be short-term and end with the normal filling of the reservoir, which would begin in the winter of 2008/09 (contingent upon the return of normal or near normal precipitation patters for the region). No long-term significant impacts are anticipated to water quality or quantity, downstream water users, recreationists, anglers or to fisheries habitat as a result of the proposed alternative.

4. VEGETATION Will the proposed action result in?	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Changes in the diversity, productivity or abundance of plant species (including trees, shrubs, grass, crops, and aquatic plants)?		X				
b. Alteration of a plant community?			X			4b.
c. Adverse effects on any unique, rare, threatened, or endangered species?		X				4c.
d. Reduction in acreage or productivity of any agricultural land?		X				
e. Establishment or spread of noxious weeds?			X			4e.
f. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Vegetation (attach additional pages of narrative if needed):4a.

4b. Some native grasses, sage, trees and shrubs would be disturbed from the excavation and construction. The impacts would be non-significant and minor and are negligible due to the reclamation and reseeding of the disturbed area.

4c. There are no documented observations of any other threatened or endangered plants, or plant species of special concern within the proposed project site.

4e. An increase in noxious weeds may occur due to soil disturbance and equipment operation. Effects are negligible in the long-term because of reclamation and weed control implementation.

** 5. FISH/WILDLIFE Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Deterioration of critical fish or wildlife habitat?			X			5a.
b. Changes in the diversity or abundance of game animals or bird species?		X				
c. Changes in the diversity or abundance of non-game species?		X				
d. Introduction of new species into an area?		X				
e. Creation of a barrier to the migration or movement of animals?		X				
f. Adverse effects on any unique, rare, threatened, or endangered species?		X				5f.
g. Increase in conditions that stress wildlife populations or limit abundance (including harassment, legal or illegal harvest or other human activity)?			X			5g.
h. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary effects on Fish and Wildlife (attach additional pages of narrative if needed):

5a.) The drawdown of the reservoir to 325-acre-feet may adversely affect the existing stocked reservoir fisheries resource. The reservoir is an off-storage facility and is annually stocked. The reservoir is not considered critical fisheries habitat and the impacts are not considered significant in the long-term. The reservoir could be restocked in 2009.

5f.) A file search was conducted by the Natural Heritage Program. No threatened, endangered or species of special concern are known to exist in the project area. It is not anticipated that the proposed action would significantly impact any listed wildlife or fisheries species of special concern.

5g.) The stocked reservoir fish would become stressed due to the low water levels and increased temperatures associated with the action alternative. This impact would end with the normal filling of the reservoir, the resumption of normal, routine dam operations, and the restocking of the reservoir. Local wildlife within the immediate vicinity of the project location (e.g. mule and whitetail deer, antelope, raptors, waterfowl) would experience a temporary increase in stress due to the construction activity. The wildlife would most likely avoid the immediate work site during construction. This impact would be minor, non-significant and end upon project completion.

All non-significant but potentially adverse impacts to fish and wildlife resources will be temporary, minor, short-term and end upon completion of the project.

B. HUMAN ENVIRONMENT

6. NOISE/ELECTRICAL EFFECTS Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Increases in existing noise levels?			X			6a.
b. Exposure of people to serve or nuisance noise levels?		X				
c. Creation of electrostatic or electromagnetic effects that could be detrimental to human health or property?		X				
d. Interference with radio or television reception and operation?		X				
e. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Noise/Electrical Effects (attach additional pages of narrative if needed):

6a. There will be a temporary increase in noise levels during construction. This would end after completion of the construction activity. There are no residences adjacent to the site that would be disturbed by the activity.

7. LAND USE Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Alteration of or interference with the productivity or profitability of the existing land use of an area?		X				
b. Conflict with a designated natural area or area of unusual scientific or educational importance?		X				
c. Conflict with any existing land use whose presence would constrain or potentially prohibit the proposed action?		X				
d. Adverse effects on or relocation of residences?		X				
e. Increase regulatory restrictions on private property?		X				
f. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Land Use (attach additional pages of narrative if needed):

8. RISK/HEALTH HAZARDS Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Risk of an explosion or release of hazardous substances (including, but not limited to oil, pesticides, chemicals, or radiation) in the event of an accident or other forms of disruption?		X				
b. Affect an existing emergency response or emergency evacuation plan, or create a need for a new plan?		X				
c. Creation of any human health hazard or potential hazard?		X				
d. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Risk/Health Hazards (attach additional pages of narrative if needed):

9. COMMUNITY IMPACT Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Alteration of the location, distribution, density, or growth rate of the human population of an area?		X				
b. Alteration of the social structure of a community?		X				
c. Alteration of the level or distribution of employment or community or personal income?		X				
d. Changes in industrial or commercial activity?		X				
e. Increased traffic hazards or effects on existing transportation facilities or patterns of movement of people and goods?		X				
f. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Community Impact (attach additional pages of narrative if needed):

10. PUBLIC SERVICES/TAXES/UTILITIES Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Will the proposed action have an effect upon or result in a need for new or altered governmental services in any of the following areas: fire or police protection, schools, parks/recreational facilities, roads or other public maintenance, water supply, sewer or septic systems, solid waste disposal, health, or other governmental services? If any, specify:		X				10a.
b. Will the proposed action have an effect upon the local or state tax base and revenues?		X				
c. Will the proposed action result in a need for new facilities or substantial alterations of any of the following utilities: electric power, natural gas, other fuel supply or distribution systems, or communications?		X				
d. Will the proposed action result in increased use of any energy source?		X				
e. Define projected revenue sources						10e.
f. Define projected maintenance costs.						10f.
g. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Public Services/Taxes/Utilities (attach additional pages of narrative if needed):

10a. The proposed action would not have an effect upon or result in a need for new or altered governmental services.

10e. The DNRC State Water Projects Bureau and the Ackley Lake Water Users Association will provide funding for the project. Funding sources are identified on page 5, Section 7 (b).

10f. All maintenance costs associated with the Project will be the responsibility of the Ackley Lake Water Users Association.

** 11. AESTHETICS/RECREATION Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Alteration of any scenic vista or creation of an aesthetically offensive site or effect that is open to public view?			X			11a.
b. Alteration of the aesthetic character of a community or neighborhood?		X				
c. Alteration of the quality or quantity of recreational/tourism opportunities and settings?			X			11c.
d. Will any designated or proposed wild or scenic rivers, trails or wilderness areas be impacted?		X				
e. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Aesthetics/Recreation (attach additional pages of narrative if needed):

11 a & c. Construction will temporarily affect the aesthetics of the area in the short-term. Some campers, picnickers and anglers may be impacted. The area receives moderate to heavy angling and recreational use. The quality of the recreational opportunities and setting may be temporarily impacted. The effects will be minor, short-term and non-significant and end with the completion of the project.

12. CULTURAL/HISTORICAL RESOURCES Will the proposed action result in:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. **Destruction or alteration of any site, structure or object of prehistoric historic, or paleontological importance?		X				12a.
b. Physical change that would affect unique cultural values?		X				12b
c. Effects on existing religious or sacred uses of a site or area?		X				12c.
d. Will the project affect historic or cultural resources?		X				12d.
e. Other:		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Cultural/Historical Resources (attach additional pages of narrative if needed):

12a-d. The proposed project will not result in the destruction, disturbance or alteration of any known site, structure, or object of prehistoric, cultural, religious, sacred, historic or paleontological importance.

SIGNIFICANCE CRITERIA

13. SUMMARY EVALUATION OF SIGNIFICANCE Will the proposed action, considered as a whole:	IMPACT *				Can Impact Be Mitigated *	Comment Index
	Unknown *	None	Minor *	Potentially Significant		
a. Have impacts that are individually limited, but cumulatively considerable? (A project or program may result in impacts on two or more separate resources that create a significant effect when considered together or in total.)		X				13a.
b. Involve potential risks or adverse effects, which are uncertain but extremely hazardous if they were to occur?		X				
c. Potentially conflict with the substantive requirements of any local, state, or federal law, regulation, standard or formal plan?		X				
d. Establish a precedent or likelihood that future actions with significant environmental impacts will be proposed?		X				
e. Generate substantial debate or controversy about the nature of the impacts that would be created?		X				
f. Is the project expected to have organized opposition or generate substantial public controversy?		X				

Narrative Description and Evaluation of the Cumulative and Secondary Effects on Significance Criteria (attach additional pages of narrative if needed):

13a. This EA found no significant impacts to the human or physical environment from the proposed action.

PART VI. NARRATIVE EVALUATION AND COMMENT

This EA did not reveal any significant negative impacts to the physical and human environment stemming from the proposed action. No threatened or endangered species would be significantly affected, and no unique or sensitive physical, cultural or historic features would be disturbed. The impacts associated with the actual construction will be short-term, minor and end with the completion of the project. Impacts associated with potentially small increases in the sediment loads, weed proliferation, fish and wildlife stress, and the quality of the recreational experience will be mitigated by fish restocking, reclamation, reseeding, weed control efforts, and the implementation of all recommended best management practices. The proposed project will not affect public safety or the beneficial uses of reservoir water.

The no action alternative would result in the continuation of an unsafe condition on a high-hazard dam. The condition of the dam would progressively deteriorate, resulting in potentially serious, increasing risks to public health and safety.

References:

Consultation with the U.S. Army Corps of Engineers, Helena MT. Regulatory Office, February 2008

Consultation with the MT Department of Environmental Quality, Water Protection Bureau, Helena, MT. February, 2008

Consultation with the MT State Historic Preservation Office, Helena, MT. January 2008

Consultation with Anne Tews, MT Department of Fish, Wildlife and Parks Fisheries Biologist, Region 4, Lewistown, MT. January 2008.

Species of Special Concern File Search, Montana Natural Heritage Program, Helena, MT. January 2008.

Ackley Lake Dam Design Alternatives Report, HKM Engineering, Billings MT. December 2007

Montana Water Law. MT Department of Natural Resources and Conservation, Water Resources Division, Helena MT. 2003

DNRC Historic Cultural Resources Site Form – Ackley Lake, Trust Lands Division, Helena, MT. March 2003.

Ackley Lake Dam Manual for Operation and Maintenance, DNRC State Water Projects Bureau, 1424 9th Avenue, P.O. Box 201601, Helena, MT 59620, Originally Published May 1995, Revised July, 2001.

A Guide to the Montana Environmental Policy Act, John Mundinger and Todd Everts, 1998. Revised by Larry Mitchell, 2004 and Todd Everts, 2006. Published by the Legislative Environmental Policy Office, Environmental Quality Council.

Climax Vegetation of Montana Based on Soils and Climate, U.S. Dept. of Agriculture, Soil Conservation Service, Bozeman, MT. September 1976

Water Resources Survey, Judith Basin County, MT, State Water Conservation Board, Helena, MT. 1963.

Appendix A – Design Alternative Report Executive Summary and Design Plans, by HKM Engineering

ACKLEY LAKE DAM

REHABILITATION ALTERNATIVES SUMMARY REPORT

PREPARED FOR:

MONTANA DEPARTMENT OF
NATURAL RESOURCES AND CONSERVATION
STATE WATER PROJECTS BUREAU
P.O. BOX 201601
HELENA, MT 59620

PREPARED BY:

HKM ENGINEERING
222 NORTH 32ND STREET
P.O. BOX 31318
BILLINGS, MT 59107-1318

DECEMBER 26, 2007

H:\08\M087182\REPORTS\ACKLEYALT SUMM_12-07.DOC

ACKLEY LAKE DAM REHABILITATION

REHABILITATION ALTERNATIVES SUMMARY REPORT

Prepared For:
Montana Department of Natural Resources and Conservation
State Water Projects Bureau
Helena, MT 59620

Prepared By:
HKM Engineering Inc.
PO Box 31318
Billings, MT 59107

Principal Author: Joshua Carter, PE
Reviewed By: Jason Thom, PE

December 2007

ACKLEY LAKE DAM REHABILITATION
ALTERNATIVES EVALUATION
SUMMARY REPORT

TABLE OF CONTENTS

1.0 Background & Summary 1
1.1 Option 1 2
1.1.1 Toe Drains 2
1.1.2 Outlet Works 3
1.2 Option 2 4
1.2.1 Toe Drain 5
1.2.2 Outlet Works 5
1.3 Miscellaneous/Additional Items 6
1.4 Seepage and Slope Stability Analyses 6
1.5 Outlet Capacity 6
2.0 Recommended Option 7

APPENDICES

APPENDIX A COST ESTIMATES
APPENDIX B DRAWINGS OF REHABILITATION ALTERNATIVES
APPENDIX C RESERVOIR EVACUATION

ACKLEY LAKE DAM
REHABILITATION ALTERNATIVES EVALUATION
SUMMARY

1.0 Background & Summary

Ackley Lake Dam and Reservoir is located approximately 10 miles southwest of Hobson, Montana in Judith Basin County. Ackley Lake is an off-stream reservoir with an approximate storage capacity of 5,815 acre-feet at the spillway crest elevation of 4315.7. The reservoir is primarily used for irrigation and recreation and is supplied from a diversion on the Judith River. The Dam was originally constructed in 1938 by the Montana State Water Conservation Board and currently is owned by the Montana Department of Natural Resources and Conservation (DNRC) and is operated and maintained by the Ackley Lake Water Users Association (WUA).

Based on the original construction drawings, the dam is a zoned earth fill embankment with an impervious clay and gravel upstream zone and a 'permeable' downstream zone. The majority of the upstream dam face is protected with dumped riprap and the abutments are protected with a single layer of hand placed rock riprap and gravel bedding. The dam also includes a cutoff trench with impermeable fill that extends the majority of the length of the dam upstream of the dam crest; the trench projects downstream under the crest near both abutments. The maximum height of the dam embankment is approximately 55 ft near the outlet works. Eight-inch diameter perforated CMP drains and clean gravel were placed at the toe of the embankment to construct the original toe drains. The dam foundation consists primarily of fractured shale that is overlain by an impermeable fat clay layer.

Following initial construction, a significant slide developed on the left side of the outlet channel. Based on project records and photographs this slide progressed for several years and was an on-going maintenance issue until 1959 when the outlet conduit was extended approximately 120 ft downstream of the original terminal structure, the original stilling basin was backfilled, and a CMP drain was installed left of the outlet conduit near the slide scarp. Based on soil boring and test pit investigations performed at the dam and the location of the slide, the fat clay appears to act as a confining layer that causes high artesian pressure in the dam toe by preventing water transmitted through the fractured shale from the reservoir from being released into the existing toe drains. The high artesian pressures result in low factors of safety for uplift, so the reservoir is currently operated with a restricted pool, 5 ft below the normal full pool. The primary purpose of the Ackley Lake Dam Rehabilitation is to be able to store the full reservoir pool without exceeding uplift safety factors at the dam toe. Uplift safety factors will be increased by constructing a new toe drain system that is designed to relieve high pressures. A toe berm over the drains and outlet will provide additional weight and coverage which in combination with the drains should provide satisfactory safety factors at full reservoir pool.

This report presents several options for rehabilitating Ackley Lake Dam, which primarily includes work on the toe drains and outlet works. Two primary rehabilitation options were developed; Option 1 includes the minimum amount of work that should be performed at the dam toe and outlet works to meet safety and operation requirements. Option 2 includes a similar toe drain network as Option 1 along with complete replacement of the outlet works. These two options were chosen to bracket the extents of rehabilitation for consideration. Components from either option along with other alternatives discussed in this report can be added to or subtracted from the two options to arrive at the final rehabilitation design. Cost estimates for the rehabilitation alternatives are included in Appendix A and drawings are included in Appendix B.

In order to ensure the rehabilitation design provides a stable dam embankment and addresses the high pressure issue, seepage and slope stability analyses were performed as part of evaluating the design alternatives. Discussion and results of the seepage and stability analyses are included in the Ackley Lake Dam Seepage and Stability Report.

Reservoir draw down computations were performed to determine if the existing outlet works meets U.S. Bureau of Reclamation (USBR) reservoir evacuation standards. The minimum outlet works capacity required to remain within allowable USBR evacuation times was also calculated. The reservoir evacuation summary and computations are included in Appendix C.

1.1 Option 1

Ackley Lake Rehabilitation Option 1 consists of two primary components, the toe drain system and outlet works. The toe drain system for Option 1 consists of excavating along the dam toe downstream and parallel to the existing CMP toe drains to intercept the existing drains and construct new drains. Rehabilitation of the outlet works generally consists of removing and replacing the 1959 conduit extension and terminal structure, lining the original upper and lower CMP conduits, and modifications to the inlet structure.

1.1.1 Toe Drains

The primary purpose of rehabilitating the existing toe drains at Ackley Lake Dam is to increase the uplift safety factor in the area of the dam toe. Rehabilitation design Option 1 addresses this goal in several ways. A new toe drain just downstream of the existing 8-inch diameter CMP toe drains is proposed that extends nearly the entire length of the dam. The toe drain consists of excavating along the dam toe so the base of the excavation would be approximately 25 feet downstream of the existing CMP drains. The toe drain excavation will extend into the shale bedrock, filter and drain gravel along with 12-inch diameter perforated PVC drain pipe will be placed in the excavation to construct the new toe drains. The toe drains that parallel the dam embankment will be connected to drain outfalls at manholes on either side of the lower outlet conduit. The drain outfalls, located along both sides of the lower conduit, will consist of 12-inch

diameter nonperforated PVC drain pipe bedded in filter gravel. The drain outfalls will discharge into the new outlet terminal structure.

In order to connect the existing CMP drains to the new toe drain system, the existing drains will be intercepted at several locations. Two interception locations are at the left and right abutments where the existing CMP drain pipes extend under the embankment. The other two interception locations will be near the outlet conduit where the two existing toe drains tie into the drain pipe located along the conduit crown. The interceptions will consist of excavating to locate each existing CMP drain, and then providing a hydraulic connection between the existing and new toe drains with drain and filter gravel and perforated drain pipe that connects to a new drain manhole. At each interception location, slotted 4- or 6-inch diameter HDPE or PVC pipe will be used to slip line the existing CMP drain pipe. This inserted pipe will provide a liner in the existing drain pipe that will allow the drains to still convey water should the existing CMP corrode and collapse.

Due to the extensive new toe drain system, removal of the CMP drain constructed in 1959 is proposed. The existing drain pipe will be removed by excavating a trench the length of the drain, removing the CMP, and backfilling with gravel fill. This action is proposed because the condition of the CMP drain is unknown and the new left toe drain should relieve the majority of the artesian pressure that caused sliding in this area in the 1950's. In addition, the gravel fill will provide some capacity should seepage develop in this area. This trench will also provide a location for construction dewatering operations to begin.

A toe berm with a maximum height of approximately 10 ft high will also be constructed above the new toe drains and lower outlet conduit. The purpose of this berm is to provide weight over the drains and the area where the highest pressures have been measured. The berm will be constructed of gravel fill material from the original embankment borrow area located downstream of the right abutment.

1.1.2 Outlet Works

Rehabilitation of the outlet works in Option 1 consists of modifying the inlet structure, lining the original upper and lower outlet conduits, and removing and replacing the 1959 conduit extension and terminal structure. Modifications to the inlet and conduits were included in the rehabilitation design because the outlet works is nearly 70 years old and in need of repairs to ensure continued low-maintenance operation.

Modification of the inlet structure will include demolition of the existing inlet and raising the intake elevation above the existing inlet pipe invert of 4278 ft to prevent clogging of the outlet conduit with sediment. Based on survey data and past operation, sediment appears to have accumulated on the reservoir floor near the inlet where the original inlet trench was excavated.

Raising the inlet elevation will be accomplished by constructing a concrete box intake with a steel trashrack at the conduit inlet. An option with the new intake is to add a 48-inch cast iron or fabricated stainless steel sluice gate. This gate will act as a guard gate for inspection or repairs of the upper conduit and control gate. The guard gate will be operated hydraulically with a power unit located in the new gate house connected to the gate with hydraulic lines buried in the dam face. Hydraulic operation of the guard gate is the most feasible operation alternative because a mechanical gate stem would be difficult to construct and operate because of the change in slope between the embankment and reservoir floor near the inlet. As part of rehabilitation, the existing steel-sided gate house will be demolished and replaced with a slightly larger concrete building.

The existing outlet conduits consist of 48-inch diameter CMP, the condition of the upper conduit is unknown but is assumed to be in fair condition because this conduit is always submerged. The original lower conduit is in fair condition, while the 1959 CMP extension is more heavily corroded. Rehabilitation Option 1 includes removing and replacing the 1959 conduit and outlet terminal structure with a new 48-inch RCP conduit bedded in filter gravel and a new concrete terminal structure near the same location as the existing basin. The original conduits will be rehabilitated using a cured-in-place pipe (CIPP) liner. The CIPP liner consists of a felt liner filled with resin that is inserted inside the conduits, the interior of the liner is filled with pressurized hot water to form the liner to the conduit and to harden and cure the resin. This liner will have an approximate wall thickness of 1 to 2 inches, which will slightly decrease the flow area, however the liner provides a much smoother surface than the existing CMP so the capacity of the conduit should not be reduced. The CIPP liner will be designed so that it is structurally adequate to withstand reservoir hydrostatic pressure and overburden pressure from the embankment without support from the existing conduit assuming the existing conduit will completely corrode before the end of the CIPP liner's 50-year design life. The existing asphalt coating on the lower CMP conduit will not have an adverse reaction with the CIPP liner or interfere with the liner installation process.

1.2 Option 2

Ackley Lake Dam Rehabilitation Option 2 is similar to Option 1 except the existing outlet works will be completely removed and replaced. The toe drain and berm rehabilitation for both options are also similar. Replacement of the outlet works will include a new inlet structure, RCP conduits, precast concrete control tower with guard and control gates, and a new outlet terminal structure.

1.2.1 Toe Drain

The toe drain for rehabilitation Option 2 is essentially the same as Option 1. The drawings for Option 2 in Appendix A do not show the trench for removal of the 1959 drain that is included in Option 1. This trench can be included with Option 2 although a cost for the trench was not included in the Option 2 cost estimate. However the cost estimate for Option 2 does include a cost for 'clay blanket removal'. The clay blanket removal area is shown on the drawings as Option 3 and will consist of excavating to the shale bedrock to remove the confining clay layer in the area of the historic slide. With the clay blanket removal, the outlet extension can probably be shortened because the risk of a slide developing in this area again is greatly reduced with removal of the confining clay layer.

1.2.2 Outlet Works

Rehabilitation Option 2 includes removing and replacing the entire existing outlet works. This was selected as a rehabilitation alternative because the outlet works is nearly 70 years old, there are problems with sediment at the inlet, the condition of the upper conduit is unknown, the conduit extension needs replacement, and there is not a guard gate in the control tower.

As with Option 1, a new concrete intake structure will be constructed that will raise the intake elevation to address sediment issues, although the guard gate will be located in the new control tower and not at the inlet. The existing upper 48-inch diameter CMP will be replaced with a 48-inch diameter RCP that will be encased in concrete between the inlet and control tower. The new control tower will be constructed with a cast-in-place concrete foundation and precast box sections with 8-ft by 8-ft inside dimensions used for the tower. The precast tower allows for much quicker construction than using cast-in-place concrete. Two 48-inch cast iron sluice gates will be mounted at the base of the new tower. The gate on the upstream side of the tower will be used as a guard gate during inspection and maintenance and will be mounted in unseating head. The downstream sluice gate will be used to control discharge into the downstream irrigation canal.

The lower conduit will be replaced with concrete encased 48-inch RCP from the control tower to the downstream end of the original conduit. The new conduit downstream of the original terminal structure will consists of a 48-inch RCP bedded in filter gravel. The filter gravel bedding will act as a drain for seepage and a filter to prevent piping of embankment material. A new concrete terminal structure similar to the existing structure will be constructed at about the same location, however if the clay blanket removal is included, the terminal structure can probably be moved upstream.

1.3 Miscellaneous/Additional Items

Several items are included with both rehabilitation options that are included in the Miscellaneous Items section of the cost estimate. Two of these items are 'Crest Grading' and 'Dike Spillway'. Crest Grading includes widening and raising the dam crest to elevation 4325.0. Currently the dam crest varies between elevation 4324 and 4325. The widening and leveling will be accomplished by stripping and replacing the existing top 0.5 ft of the crest, placing gravel fill on the upstream slope, and then placing 0.5 ft of gravel surfacing over the gravel fill.

The dike spillway is proposed to be constructed approximately 900 feet south of the right abutment. This auxiliary spillway is proposed to provide additional spillway capacity so that large floods can safely be passed between the existing spillway and the proposed auxiliary spillway without overtopping the dam. This spillway will be constructed by excavating through the existing dike to create a spillway with a crest length of approximately 200 feet at elevation 4222.0. This proposed crest elevation is 6.3 feet higher than the existing spillway crest and 2 feet lower than the average existing dam crest.

Two items are included on the rehabilitation cost estimates under the Additional Items category. These are items that do not require immediate attention but should be considered as funding is available. The abutment riprap item includes placing slope protection on the upstream dam face at both abutments where there is minimal existing riprap. Instrumentation includes installing automatic sensors that can measure reservoir level, piezometer water levels, and discharge from the toe drains and outlet. This instrumentation will increase operational efficiency and safety of the dam.

1.4 Seepage and Slope Stability Analyses

As part of evaluating the rehabilitation alternatives, seepage and slope stability analyses were performed. Seepage analysis was performed to check the impacts of the proposed toe drain design on the existing conditions at the dam. The purpose of the stability analysis was to make sure the dam embankment would be stable during and after construction. Construction stability is of the most concern when there will be a significant excavation located at the toe of the embankment. Detailed discussions and results regarding these analyses are included in the Seepage and Slope Stability Analysis Report.

1.5 Outlet Capacity

Reservoir evacuation (drawdown) calculations were performed for the existing outlet works to check the adequacy of the outlet in regards to USBR evacuation criteria. The purpose of the evacuation criteria is to make sure dams can be safely drained during emergency conditions.

Based on the evacuation calculations, the existing outlet works easily meets USBR criteria for a high-hazard high-risk dam. Further analysis showed that an outlet with a maximum capacity of 75 cfs when the reservoir is at the spillway crest elevation is the minimum capacity required to meet high-hazard high-risk criteria. However any rehabilitation of the outlet will not significantly change the existing capacity so that downstream irrigation demand can still be fulfilled. Evacuation calculations and additional discussion are included in the Ackley Lake Dam Evacuation Report included in Appendix C.

2.0 Recommended Option

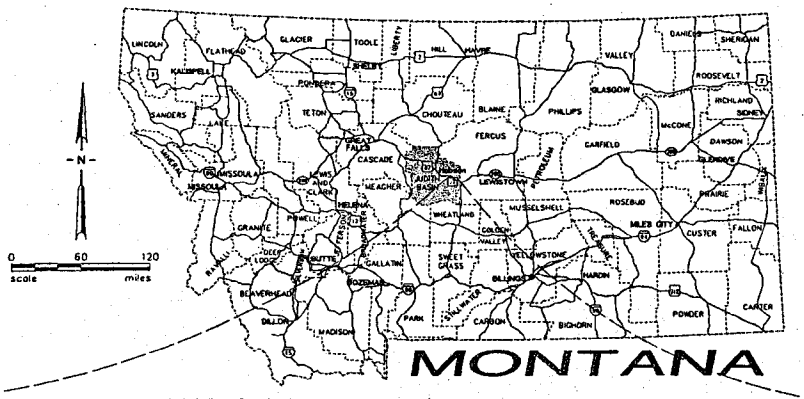
The recommended option for rehabilitation of Ackley Lake Dam is Option 1. Option 1 was selected as the preferred rehabilitation option because this design provides an adequate toe drain system and CIPP lining of the outlet conduits is a much more cost effective alternative than complete replacement of the outlet works. The Dike Spillway will be included as part of the final design, however the crest grading was not considered necessary. The final rehabilitation design will most likely include some changes from the discussion and drawings of Option 1 presented in this report; however the principal concepts of the rehabilitation will remain unchanged.

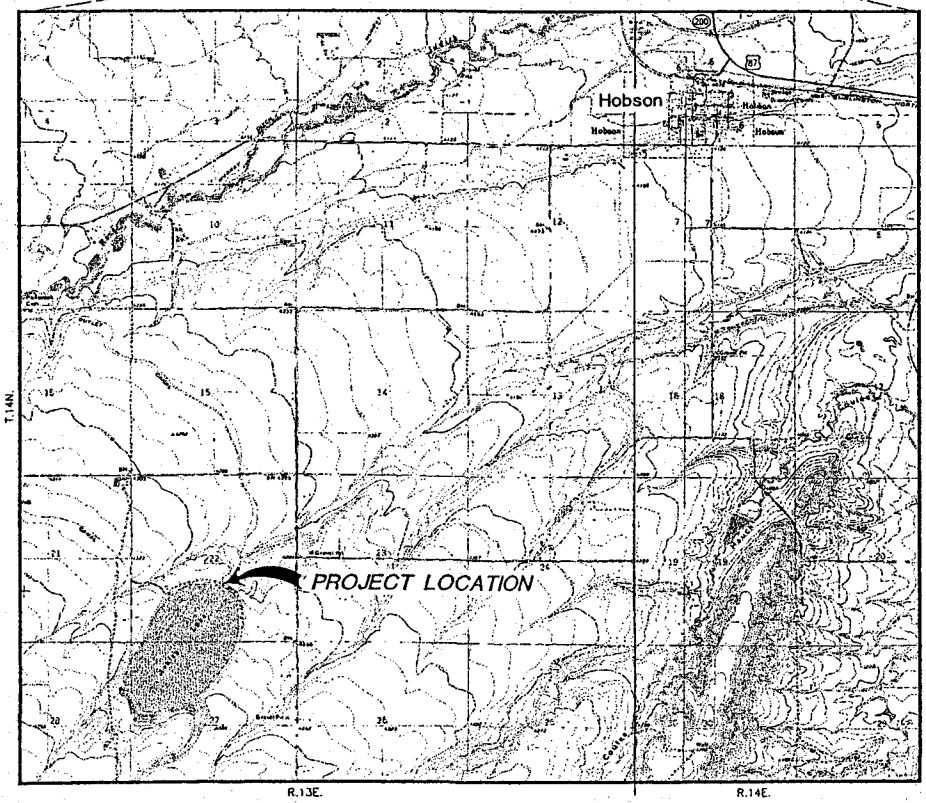
ACKLEY LAKE DAM

REHABILITATION

RECEIVED
JAN 14 2008

JUDITH BASIN COUNTY, MONTANA





PROJECT LOCATION MAP

2000 0 2000 4000
scale feet

Prepared for :

The Montana Department of Natural Resources and Conservation

WATER Resources Division

State Water Projects Bureau
P.O. Box 201601
Helena, MT 59620-1601
(406) 444-6646

Approved: Kevin Smith, P.E., Chief
State Water Projects Bureau, Montana DNRC

Prepared by :

HKM ENGINEERING

HKM Engineering Inc.
Granite Tower Building
222 N. 32nd St., Suite 700
P.O. Box 31318
Billings, MT 59107-1318
(406) 656-6399, FAX (406) 656-6398

Proj. No. 8M087.182 JANUARY 2008

PRELIMINARY
NOT FOR CONSTRUCTION

Jason H. Thom, P.E. 6396 E
Project Engineer
HKM Engineering, Inc.

SHEET INDEX

SHT. NO.	DESCRIPTION
GENERAL	
G1	COVER SHEET, PROJECT LOCATION, SHEET INDEX
G2	GENERAL SITE PLAN AND ALIGNMENT CONTROL
G3	STRUCTURAL GENERAL NOTES AND DETAILS
CIVIL	
C1	BORROW AND WASTE AREAS
C2	DIKE REMOVAL GRADING PLAN AND PROFILE
C3	EXCAVATION PLAN
OUTLET WORKS	
OW1	OUTLET WORKS PLAN AND PROFILE
OW2	OUTLET WORKS TYPICAL SECTIONS AND DETAILS
OW3	OUTLET WORKS MODIFICATION TRANSITION SECTIONS AND DETAILS
OW4	OUTLET STRUCTURE PLAN, SECTIONS AND DETAILS
OW5	OUTLET STRUCTURE SECTIONS AND DETAILS
OW6	INLET STRUCTURE PLAN, SECTIONS AND DETAILS
OW7	OUTLET WORKS INLET STRUCTURE BULKHEAD PLAN, SECTIONS AND DETAILS
GATE HOUSE	
GH1	GATE HOUSE PLAN, SECTIONS AND DETAILS
DRAINS	
D1	TOE DRAIN PLAN AND PROFILE AND BERM PLAN
D2	TOE DRAIN PROFILE, SECTIONS AND DETAILS
D3	CENTER INTERCEPT DRAIN PLAN, PROFILE AND SECTION
D4	RIGHT INTERCEPT DRAIN PLAN, PROFILE AND SECTION
D5	LEFT INTERCEPT DRAIN PLAN, PROFILE AND SECTION
D6	RELIEF WELL DRAINS PLAN, PROFILE AND SECTION
SPILLWAY	
SW1	SPILLWAY CREST PLAN AND PROFILE
SW2	SPILLWAY CREST SECTIONS AND DETAILS

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

SPILLWAY CENTERLINE ALIGNMENT

Desc.	Station	Tangent/Curve Data		Northing	Easting
		Tangent Data			
PI	8+00			9317.59	8238.49
PI	9+65			9456.45	8149.36
	Length:	165.00	Course:	N 32-41-47 W	
		Tangent Data			
PI	9+65			9456.45	8149.36
POT	10+76.80 (= 35+89.63 Outlet Works)			9559.59	8106.22
	Length:	111.80	Course:	N 22-41-47 W	
		Tangent Data			
POT	10+76.80 (= 35+89.63 Outlet Works)			9559.59	8106.22
PI	15+50			9996.15	7923.63
	Length:	473.20	Course:	N 22-41-47 W	

SURVEY DATUM

TOPOGRAPHY SHOWN IS BASED ON A FIELD SURVEY PERFORMED BY HKM ENGINEERING INC. ON SEPTEMBER 25, 2007. HORIZONTAL AND VERTICAL CONTROL FOR THIS SURVEY WAS PROVIDED BY THE DNRC AND IS BASED ON A LOCAL GRID. COORDINATES PROVIDED FOR THE FOLLOWING CONTROL POINTS ARE:

CP1	N 9859.27	CP2	N 10000.00	CP2 (Adjusted)	N 10000.05
	E 9566.87		E 10000.00		E 9999.97
	Elev.=4323.90		Elev.=4302.06		Elev.=4302.08

VERTICAL TIES TO ADJACENT U.S.C.G.S. BENCHMARKS ARE AS FOLLOWS:

	NAVD88	NGVD29	2007 SURVEY
L180 (1961)	4304.65	4301.44	4304.48
S177 RESET (1970)	4259.77	4256.68	4259.66

AN AUTONOMOUS POSITION FOR CP1 WAS OBTAINED. CP1 AND CP2 WERE USED TO CALIBRATE TO THE LOCAL DATUM. THIS CREATED A -0°39'56" ROTATION FROM GEODETIC NORTH.
THE AUTONOMOUS POSITION FOR CP1 WAS: 46°57'33.10920"N 109°56'05.56400"W

AN OPUS POSITION BASED ON A FILE COLLECTED SEPTEMBER 26, 2007 PRODUCED A POSITION FOR CP1 OF: 46°57'33.12084"N 109°56'05.49266"W IN NAD83 (CORS96) (EPOCH2002.0000) WITH AN ORTHO ELEV. OF 4323.80

EMBANKMENT AND DIKE CENTERLINE ALIGNMENT

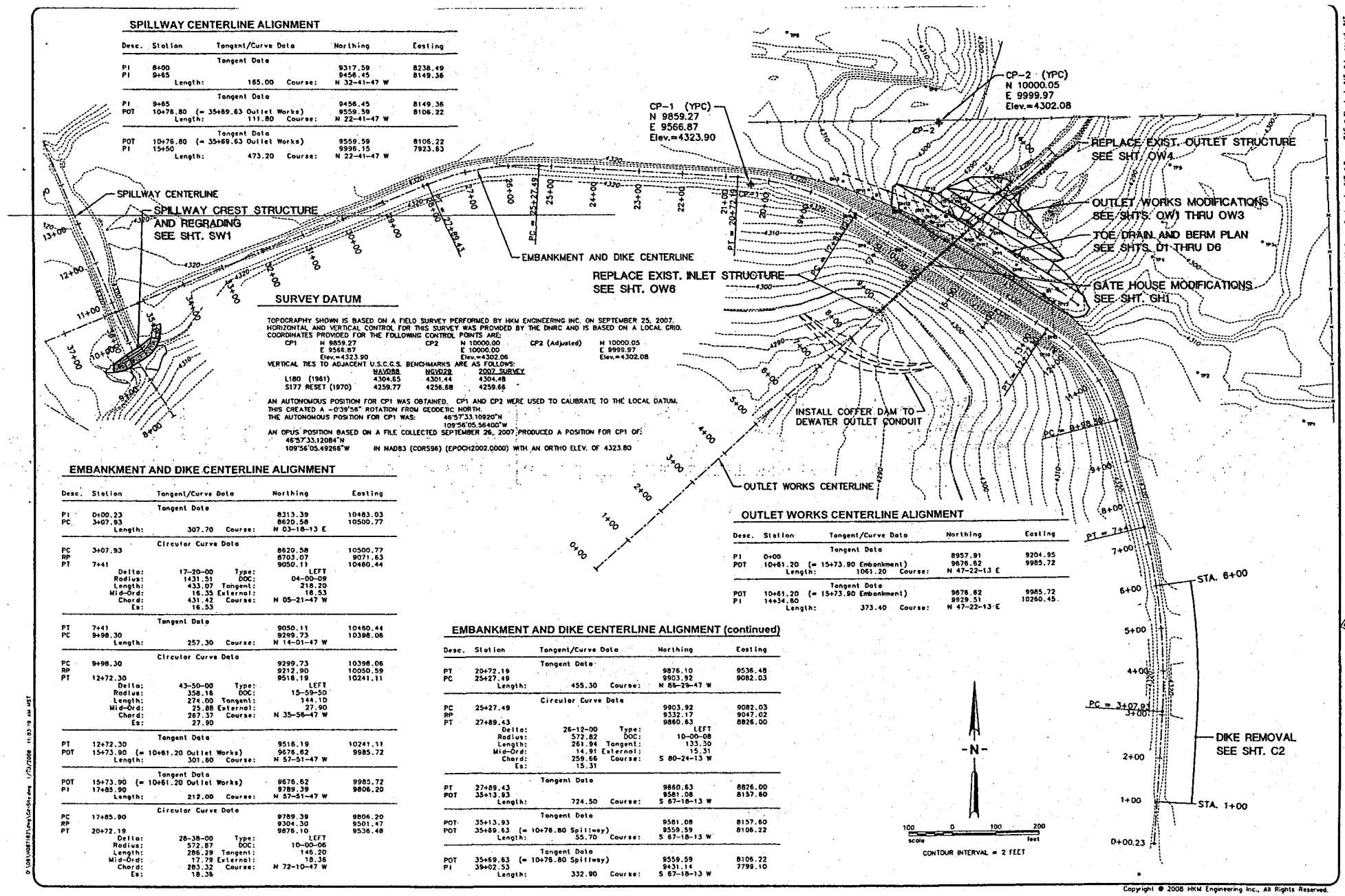
Desc.	Station	Tangent/Curve Data		Northing	Easting
		Tangent Data			
PI	0+00.23			8313.39	10483.03
PC	3+07.93			8620.58	10500.77
	Length:	307.70	Course:	N 03-18-13 E	
		Circular Curve Data			
PC	3+07.93			8620.58	10500.77
RP				8703.07	9071.63
PT	7+41			9050.11	10480.44
	Delta:	17-20-00	Type:	LEFT	
	Radius:	1431.51	DOC:	04-00-09	
	Length:	433.07	Tangent:	218.20	
	Mid-Ord:	16.35	External:	16.53	
	Chord:	431.42	Course:	N 05-21-47 W	
	Es:	16.53			
		Tangent Data			
PT	7+41			9050.11	10480.44
PC	9+98.30			9299.73	10398.06
	Length:	257.30	Course:	N 14-01-47 W	
		Circular Curve Data			
PC	9+98.30			9299.73	10398.06
RP				9212.90	10050.59
PT	12+72.30			9516.19	10241.11
	Delta:	43-50-00	Type:	LEFT	
	Radius:	358.18	DOC:	15-59-50	
	Length:	274.00	Tangent:	144.10	
	Mid-Ord:	25.88	External:	27.90	
	Chord:	267.37	Course:	N 35-56-47 W	
	Es:	27.90			
		Tangent Data			
PT	12+72.30			9516.19	10241.11
POT	15+73.90 (= 10+61.20 Outlet Works)			9676.62	9985.72
	Length:	301.60	Course:	N 57-51-47 W	
		Tangent Data			
POT	15+73.90 (= 10+61.20 Outlet Works)			9676.62	9985.72
PI	17+85.90			9789.39	9806.20
	Length:	212.00	Course:	N 57-51-47 W	
		Circular Curve Data			
PC	17+85.90			9789.39	9806.20
RP				9304.30	9501.47
PT	20+72.19			9876.10	9536.48
	Delta:	28-38-00	Type:	LEFT	
	Radius:	572.87	DOC:	10-00-06	
	Length:	286.29	Tangent:	146.20	
	Mid-Ord:	17.79	External:	18.36	
	Chord:	283.32	Course:	N 72-10-47 W	
	Es:	18.36			

EMBANKMENT AND DIKE CENTERLINE ALIGNMENT (continued)

Desc.	Station	Tangent/Curve Data		Northing	Easting
		Tangent Data			
PT	20+72.19			9876.10	9536.48
PC	25+27.49			9903.92	9082.03
	Length:	455.30	Course:	N 86-29-47 W	
		Circular Curve Data			
PC	25+27.49			9903.92	9082.03
RP				9332.17	9047.02
PT	27+89.43			9860.63	8826.00
	Delta:	26-12-00	Type:	LEFT	
	Radius:	572.82	DOC:	10-00-08	
	Length:	261.94	Tangent:	133.30	
	Mid-Ord:	14.91	External:	15.31	
	Chord:	259.66	Course:	S 80-24-13 W	
	Es:	15.31			
		Tangent Data			
PT	27+89.43			9860.63	8826.00
POT	35+13.93			9581.08	8157.60
	Length:	724.50	Course:	S 67-18-13 W	
		Tangent Data			
POT	35+13.93			9581.08	8157.60
POT	35+89.63 (= 10+76.80 Spillway)			9559.59	8106.22
	Length:	55.70	Course:	S 67-18-13 W	
		Tangent Data			
POT	35+89.63 (= 10+76.80 Spillway)			9559.59	8106.22
PI	39+02.53			9431.14	7799.10
	Length:	332.90	Course:	S 67-18-13 W	

OUTLET WORKS CENTERLINE ALIGNMENT

Desc.	Station	Tangent/Curve Data		Northing	Easting
		Tangent Data			
PI	0+00			8957.91	9204.95
POT	10+61.20 (= 15+73.90 Embankment)			9676.62	9985.72
	Length:	1061.20	Course:	N 47-22-13 E	
		Tangent Data			
POT	10+61.20 (= 15+73.90 Embankment)			9676.62	9985.72
PI	14+34.60			9929.51	10260.45
	Length:	373.40	Course:	N 47-22-13 E	



PRELIMINARY NOT FOR CONSTRUCTION

No.	Revision	By	Date

WARNING: IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

GENERAL SITE PLAN AND ALIGNMENT CONTROL

Project No. 84097.182 • CenSite.dwg • Date Jan. 2008 • Designed JKT • Drawn CAE • Checked JKT • Approved JKT

HKM ENGINEERING
Granite Tower Building
222 N. 32nd St., Suite 700
P.O. Box 3518

Sheet No. G2 of 22

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

D:\08\084097182\dwg\CenSite.dwg 1/10/2008 11:03:19 AM MST

STRUCTURAL GENERAL NOTES

1. APPLICABLE SPECIFICATIONS AND CODES
CONSTRUCTION AND DESIGN SHALL BE IN ACCORDANCE WITH THE AMERICAN CONCRETE INSTITUTE (ACI) SPECIFICATIONS AND THE REQUIREMENTS NOTED AS FOLLOWS. GATEHOUSE CONSTRUCTION AND DESIGN SHALL BE IN ACCORDANCE WITH THE INTERNATIONAL BUILDING CODE (IBC), 2006 EDITION.

2. SPECIAL INSPECTION
   a. SPECIAL INSPECTION SHALL BE PROVIDED BY OWNER UNLESS OTHERWISE SPECIFIED AND WILL CONSIST OF THE FOLLOWING:
   b. SOILS – TABLE 1704.7 OF THE IBC
   PERIODIC INSPECTION OF FOUNDATION SOIL BEARING CAPACITY, DEPTH, FILL MATERIALS CLASSIFICATION AND SUBGRADE PREPARATION AND COMPACTION.
   c. CONCRETE – TABLE 1704.4 OF THE IBC
      i. PERIODIC INSPECTION OF REINFORCEMENT BEFORE CONCRETE IS PLACED.
      ii. FULL TIME INSPECTION OF ANCHOR RODS AND OTHER EMBEDDED ITEMS AS IDENTIFIED HEREIN.
      iii. FULL TIME INSPECTION DURING PLACEMENT OF CONCRETE INCLUDING THE TAKING OF TEST SPECIMENS, SLUMP AND AIR CONTENT MEASUREMENT. INSPECTION AND TESTING SHALL BE LIMITED TO STRUCTURAL REINFORCED CONCRETE WITH TESTING FREQUENCY IN ACCORDANCE WITH THE PROJECT TECHNICAL SPECIFICATIONS.
   d. STEEL – TABLE 1704.3 OF THE IBC
      i. FULL TIME INSPECTION OF COMPLETE AND PARTIAL PENETRATION GROVE WELDS, MUTI-PASS FILLET WELDS AND SINGLE PASS FILLET WELDS GREATER THAN 5/16" IN ACCORDANCE WITH AWS D1.1.
      ii. PERIODIC INSPECTION OF FRAME JOINT DETAILS FOR COMPLIANCE WITH THE PLANS AND SPECIFICATIONS.
   e. WOOD
      i. PERIODIC INSPECTION FOR COMPLIANCE WITH PLANS AND SPECIFICATION REQUIREMENTS. INCLUDED IS THE SHEATHING TYPE AND THICKNESS; VERIFICATION OF FRAMING MEMBERS OF CONSTRUCTED ASSEMBLIES WITHIN THE FIELD AND AT BOUNDARY ELEMENTS; FASTENER TYPE, DIAMETER AND LENGTH; FASTENER SPACING AT INTERMEDIATE SUPPORTS AND AT BOUNDARY ELEMENTS.
      ii. PERIODIC INSPECTION OF HOLD DOWNS AND OTHER LATERAL FORCE RESISTING HAROWARE FOR CORRECT TYPE, FASTENING AND LOCATION.

3. DESIGN LOADS
   a. DESIGN LOADS AND LOAD APPLICATIONS ARE IN ACCORDANCE WITH IBC.
   b. UNIFORM FLOOR LIVE LOADS ---------------------100 PSF + DEAD LOAD
   c. ROOF LOADS
      i. MINIMUM ROOF SNOW LOAD ---------------- 30 PSF
      ii. DRIFT SURCHARGE LOADS IN ACCORDANCE WITH ASCE 7-05.
         (a) BASIC GROUND SNOW LOAD ----------- 70 PSF
         (b). IMPORTANCE FACTOR ---------------- I = 1.0
   d. WIND LOADS IN ACCORDANCE WITH SECTION 6 OF ASCE 7-05
      i. BASIC WIND SPEED (50 – YEAR) --------------- 90 MPH
      ii. EXPOSURE CATEGORY --------------------- C
      iii. IMPORTANCE FACTOR --------------------- I = 1.0
   e. SEISMIC LOADS
      i. IMPORTANCE FACTOR --------------------- I= 1.0
      ii. SEISMIC USE GROUP ---------------------- II
      iii. MAPPED SPECTRAL RESPONSE SS ---------- 0.18
      iv. MAPPED SPECTRAL RESPONSE S1 ---------- 0.06
      v. SITE CLASS ---------------------------- D
      vi. SEISMIC DESIGN CATEGORY ---------------- B
   f. SPECIAL LOADS
      i. MECHANICAL EQUIPMENT LOADS ------------ ACTUAL OPERATING LOADS
      ii. CEILING FRAMING LIVE LOAD -------------- 10 PSF
      iii. ADDITIONAL LOADS REFERENCED ON THE DRAWINGS.

4. CONSTRUCTION LOADS
PROVIDE TEMPORARY BRACING, SHORING OR OTHER SUPPLEMENTAL SUPPORT DURING CONSTRUCTION AS NECESSARY TO PROTECT THE STRUCTURES FROM EXCESSIVE CONSTRUCTION LOADS.

5. FOUNDATIONS
   a. FOUNDATION DESIGN CRITERIA
      i. MAXIMUM ALLOWABLE SOIL BEARING PRESSURE -- 1,500 PSF
      ii. LATERAL AT REST SOIL PRESSURE -------------45 PSF / FT EQUIVALENT FLUID PRESSURE (NON SATURATED)
      iii. DESIGN FROST DEPTH BELOW EXTERIOR GRADE -- 4 FT
   b. AVOID EXCESSIVE WETTING OR DRYING OF THE FOUNDATION EXCAVATIONS DURING CONSTRUCTION.
   c. BACKFILL ON WALLS WITH FILL ON BOTH SIDES SHALL BE COMPACTED IN EQUAL LIFTS EACH SIDE OF WALL. WALLS BACKFILLED FROM ONE SIDE ONLY SHALL HAVE ALL SUPPORTING SLABS, PERMANENT FRAMING OR TEMPORARY BRACING IN PLACE PRIOR TO PLACEMENT OF BACKFILL

6. CONCRETE
   a. CONCRETE CONSTRUCTION SHALL CONFORM TO THE AMERICAN CONCRETE INSTITUTE BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318).
   b. DETAILING, FABRICATION AND PLACEMENT OF REINFORCEMENT SHALL CONFORM TO DETAILS AND DETAILING OF CONCRETE REINFORCEMENT (ACI 315).
   c. MATERIAL
      i. STRUCTURAL CAST - IN - PLACE CONCRETE--------- f'c = 4,000 PSI
      ii. REINFORCING BARS ---------------------------ASTM A615, GRADE 60
   d. ALL BENT REINFORCING BARS SHALL BE SHOP FABRICATED ONLY. REBENDING OR WELDING OF REINFORCEMENT SHALL NOT BE PERMITTED UNLESS AUTHORIZED BY ENGINEER.
   e. END HOOKS IN REINFORCING BARS, SHOWN ON THE DRAWINGS BUT NOT DIMENSIONED, SHALL CONFORM TO ACI 318.
   f. CONCRETE COVER OVER REINFORCEMENT SHALL BE 2" CLEAR, EXCEPT CONCRETE PLACED AGAINST AND PERMANENTLY IN CONTACT WITH EARTH SHALL BE 3" CLEAR.
   g. REINFORCEMENT SPLICES NOT PERMITTED EXCEPT AS DETAILED OR AUTHORIZED BY ENGINEER. LAP REINFORCING BARS THE FOLLOWING MINIMUMS AT ALL SPLICES, CORNERS AND INTERSECTIONS, UNLESS OTHERWISE INDICATED. TOP BARS ARE HORIZONTAL BARS WITH MORE THAN 12" OF CONCRETE CAST BELOW THE BAR.

BAR SIZE	REG BARS	TOP BARS
#3	1'-3"	1'-7"
#4	1'-7"	2'-1"
#5	2'-0"	2'-7"
#6	2'-5"	3'-1"
#7	3'-6"	4'-6"
#8	4'-0"	5'-2"
#9	4'-6"	5'-10"
#10	5'-1"	6'-7"

   h. STAGGER ADJACENT REINFORCEMENT LAP SPLICES IN WALLS 18" MINIMUM.
   i. PROVIDE BAR SUPPORTS TO PROPERLY SECURE AND SUPPORT REINFORCING BARS AT POSITIONS SHOWN ON THE DRAWINGS. IN ADDITION TO NORMAL ACCESSORIES PROVIDE #5 STANDEES AT 36" O.C. TO SUPPORT TOP REINFORCEMENT IN BASE SLABS, AND #3 U OR Z SHAPE SPACERS AT 72" O.C. EACH WAY IN WALLS WITH TWO CURTAINS OF REINFORCEMENT.
   j. DOWELS, PIPES AND OTHER INSTALLED MATERIALS AND ACCESSORIES SHALL BE HELD SECURELY IN POSITION DURING CONCRETE PLACEMENT.
   k. REINFORCING BARS AND ACCESSORIES SHALL NOT BE IN CONTACT WITH ANY PIPE, PIPE FLANGE OR METAL PART EMBEDDED IN CONCRETE. PROVIDE 2" CLEARANCE IN ALL CASES UNLESS OTHERWISE INDICATED. NO EMBEDDED ITEM SHALL BE SUSPENDED FROM, SUPPORTED BY, OR BRACED IN PLACE FROM THE STRUCTURAL REINFORCEMENT.
   l. LOCATE CONSTRUCTION JOINTS WHERE SHOWN ON THE DRAWINGS OR AS AUTHORIZED BY ENGINEER.
   m. THOROUGHLY CLEAN BY SANDBLASTING ALL KEYWAYS AND CONSTRUCTION JOINTS PRIOR TO PLACING CONCRETE IN ADJACENT POUR.
   n. BEGIN SPACING OF BARS WHICH PARALLEL CONSTRUCTION AND EXPANSION JOINTS 2" CLEAR EACH SIDE OF JOINT.
   o. UNLESS OTHERWISE SHOWN, PLACE 2-#5 (1 EACH FACE) WITH 2'-0" PROJECTIONS AROUND ALL OPENINGS IN CONCRETE WALLS OR SLABS.
   p. PROVIDE AN ADDITIONAL 500 LINEAL FEET OF #5 REINFORCING BARS FOR USE AS DIRECTED DURING CONSTRUCTION.
   q. CHAMFER ALL EXPOSED CONCRETE EDGES ¾", UNLESS OTHERWISE INDICATED.

7. PRECAST PRESTRESSED CONCRETE
   a. DESIGN AND FABRICATION OF PRECAST PRESTRESSED CONCRETE MEMBERS SHALL CONFORM TO ACI 318 AND PRESTRESSED CONCRETE INSTITUTE MNL-116.
   b. MATERIAL
      i. CONCRETE -------------------------------- F'C = 5000 PSI
      ii. PRESTRESSING STANDS --------------------ASTM A416, GRADE 270
   c. DEVIATIONS FROM MEMBER CROSS SECTION, LAYOUT AND CONNECTION DETAILS SHOWN ON THE DRAWINGS WILL BE PERMITTED ONLY AS AUTHORIZED BY ENGINEER.

8. STRUCTURAL STEEL
   a. STRUCTURAL STEEL CONSTRUCTION SHALL CONFORM TO THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION'S STEEL CONSTRUCION MANUAL 13 ED., FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS.
   b. MATERIAL
      i. STRUCTURAL STEEL -------------------------ASTM A992, GRADE 50
      ii. STRUCTURAL STEEL PLATES, BARS, ANGLES, AND CHANNELS -------------------- ASTM A 36
      iii. STRUCTURAL TUBING ----------------------ASTM A500, GRADE B
      iv. STEEL PIPE --------------------------------ASTM A53, TYPE E OR S, GRADE B
      v. HIGH – STRENGTH BOLTS --------------------ASTM A325
      vi. ANCHOR BOLTS -----------------------------ASTM A307
      vii. HEADED ANCHOR STUDS --------------------ASTM A108
   c. ALL STRUCTURAL STEEL BOLTED CONNECTIONS SHALL BE ¾" DIAMETER A325 – N BOLTS WITH STANDARD HOLES, UNLESS OTHERWISE NOTED.
   d. ALL WELDING SHALL CONFORM TO AMERICAN WELDING SOCIETY STRUCTURAL WELDING CODE – STEEL (AWS D1.1), AND SHALL BE PERFORMED BY WELDERS QUALIFIED BY THE APPROPRIATE AWS TEST FOR THE WELDING PERFORMED.
   e. ALL SURFACES OF SUBMERGED AND EXPOSED STEEL SURFACES SHALL HAVE A HOT-DIP ZINC COATING IN ACCORDANCE WITH ASTM A123.

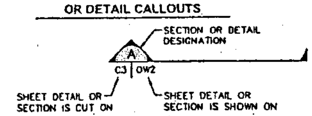
9. WOOD FRAMING
   a. WOOD CONSTRUCTION SHALL CONFORM TO IBC .
   b. MATERIALS
      i. STRUCTURAL LUMBER -----------------------HEM – FIR
         (a) 2" TO 4" THICK X 4" WIDE ---------------- NO 2 GRADE OR BETTER
      ii. PLYWOOD SHEATHING ----------------------- APA RATED SHEATHING
         (a) ROOF SHEATHING ---------------------STRUCTURAL I

10. MISCELLANEOUS ITEMS
ADHESIVE ANCHORS SHALL BE HILTI HVA ADHESIVE ANCHORS WITH HAS SUPER ASTM A193 B7 RODS OR APPROVED EQUAL. ANCHORS SHALL BE HOT-DIP ZINC COATED IN ACCORDANCE WITH ASTM A123.

11. EQUIPMENT INSTALLATION
   a. ALL OPENINGS SHOWN SHALL BE VERIFIED, AND ALL STRUCTURAL DIMENSIONS AND DETAILS PERTAINING TO EQUIPMENT INSTALLATION SHALL BE COORDINATED BY THE CONTRACTOR WITH THE ACTUAL EQUIPMENT FURNISHED.
   b. EQUIPMENT SUPPORTS, ANCHORAGES AND OPENINGS NOT SHOWN ON THE STRUCTURAL DRAWINGS, BUT REQUIRED BY OTHER CONTRACT DRAWINGS, SHALL BE PROVIDED PRIOR TO PLACING CONCRETE.

12. EXISTING CONSTRUCTION
   a. DIMENSIONS, ELEVATIONS AND DETAILS OF EXISTING CONSTRUCTION HAVE BEEN OBTAINED FROM FIELD INVESTIGATIONS AND AS – CONSTRUCTED DOCUMENTS. THE CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS NECESSARY TO PROPERLY COORDINATE NEW AND EXISTING CONSTRUCTION, AND SHALL NOTIFY THE ENGINEER OF ALL VARIATIONS IN THE DETAILS, DIMENSIONS AND ELEVATIONS OF EXISTING CONSTRUCTION WITH THAT SHOWN ON THE DRAWINGS.
   b. CLEAN AND PREPARE ALL EXISTING SURFACES WHICH WILL BE IN CONTACT WITH NEW CONSTRUCTION AS INDICATED AND AS ACCEPTABLE TO ENGINEER. APPLY BONDING COMPOUND TO ALL EXISTING CONCRETE SURFACES WHICH WILL BE IN CONTACT WITH NEW CONCRETE IMMEDIATELY PRIOR TO PLACEMENT.
   c. PROTECT EXISTING MATERIALS FROM DAMAGE DURING CONSTRUCTION.
   d. FURNISH AND INSTALL TEMPORARY SHORING OR BRACING AS NECESSARY TO PROVIDE SUPPORT AND STABILITY FOR EXISTING WALLS AND FRAMING DURING DEMOLITION AND CONSTRUCTION.

EXPLANATION OF SECTION OR DETAIL CALLOUTS



Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

• Project No. 8H087.182 • Cover.dwg • Date Jan. 2008 • Designed KJF • Drawn GAE • Checked KJF • Approved JHT

No.	Revision	By	Date

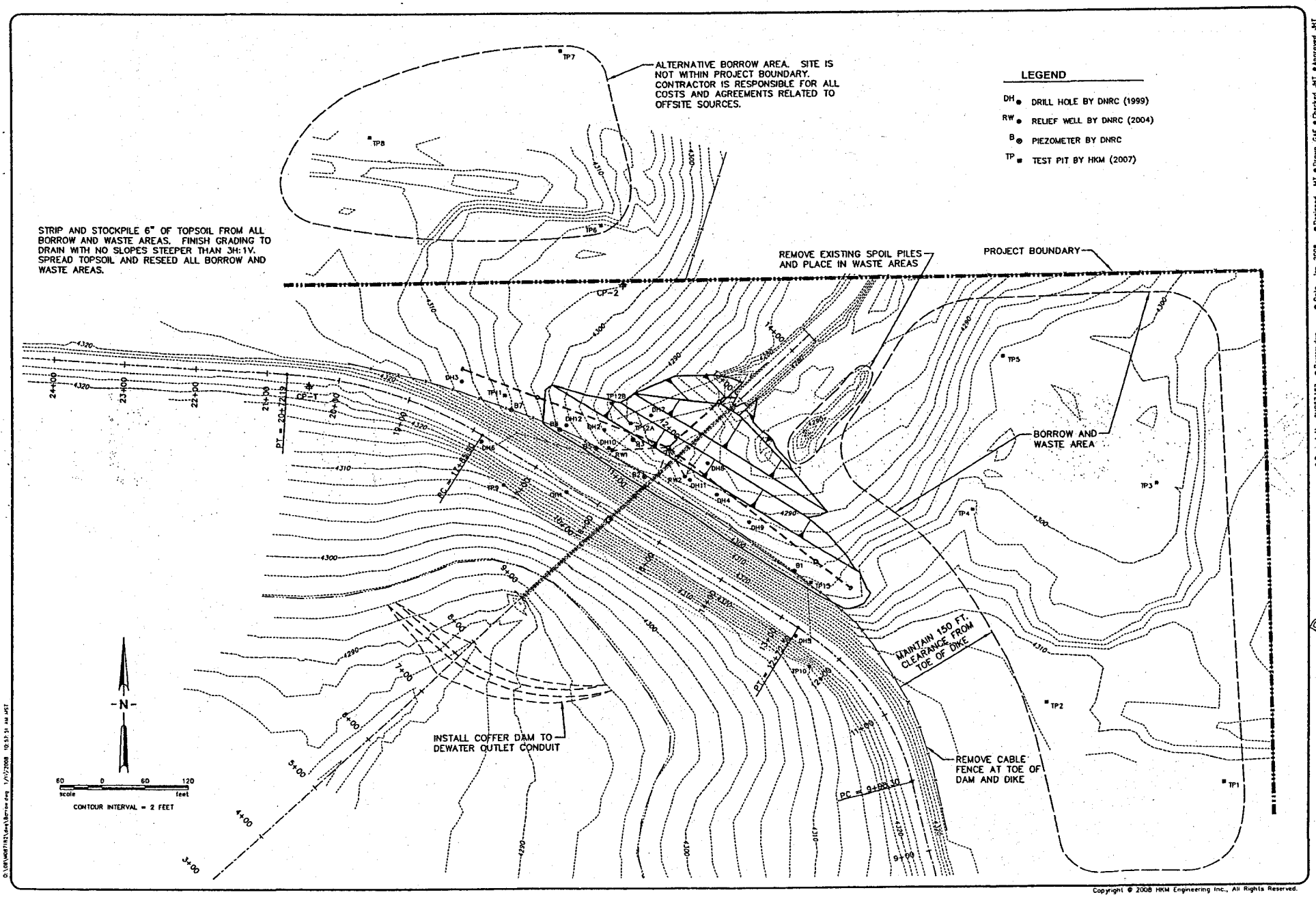
WARNING

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

PRELIMIN... NOT FOR C...

Sheet N...
of

O:\08\H087182\dwg\Cover.dwg 1/11/2008 10:56:00 AM MST



No.	Revision	By	Date

WARNING
0 1"
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

● Project No. - BM087182 ● Borrow.dwg ● Date Jan. 2008 ● Designed JHT ● Drawn GAE ● Checked JHT ● Approved JHT

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

BORROW AND WASTE AREAS

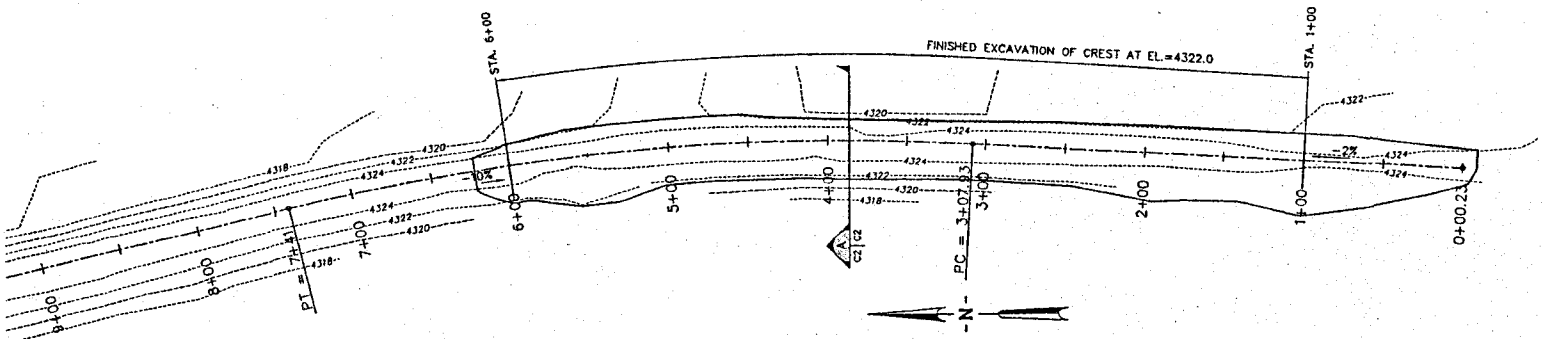
PRELIMINARY
NOT FOR CONSTRUCTION

HKM ENGINEERING
Granite Tower Building
401 N. 31st St., Suite 700
P.O. Box 2413
Billings, MT 59103-2413

Sheet No.
C1
of 22

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

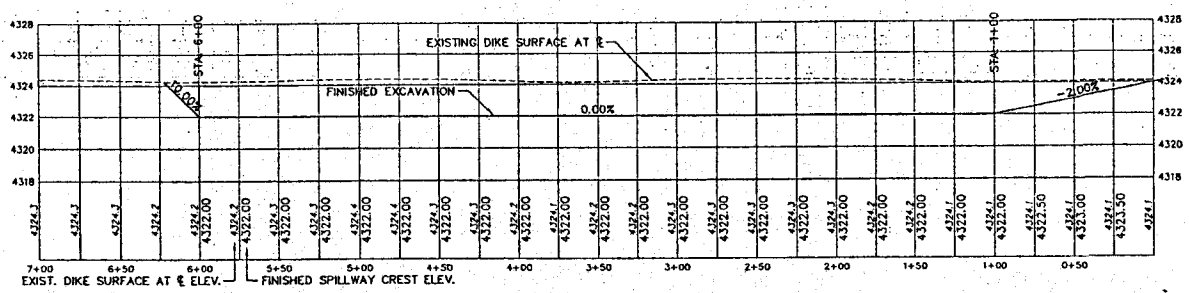
D:\DR\BM087182\dwg\Borrow.dwg 1/17/2008 10:53:31 AM MST



PLAN
DIKE REMOVAL GRADING

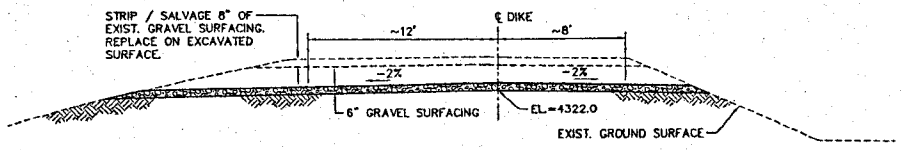
40 0 40 80 scale feet

CONTOUR INTERVAL = 2 FEET



PROFILE
DIKE REMOVAL GRADING

40 0 40 80 (HORIZ.)
4 0 4 8 (VERT.)
scale feet



A SECTION
C2 | C2 TYPICAL DIKE CREST GRADING

4 0 4 8
scale feet

Project No. 84087.182 • CrestPlan.dwg • Date Jan. 2008 • Designed JHT • Drawn GAE • Checked JHT • Approved JHT

No.	Revision	By	Date

WARNING

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

PRELIMINARY NOT FOR CONSTRUCTION

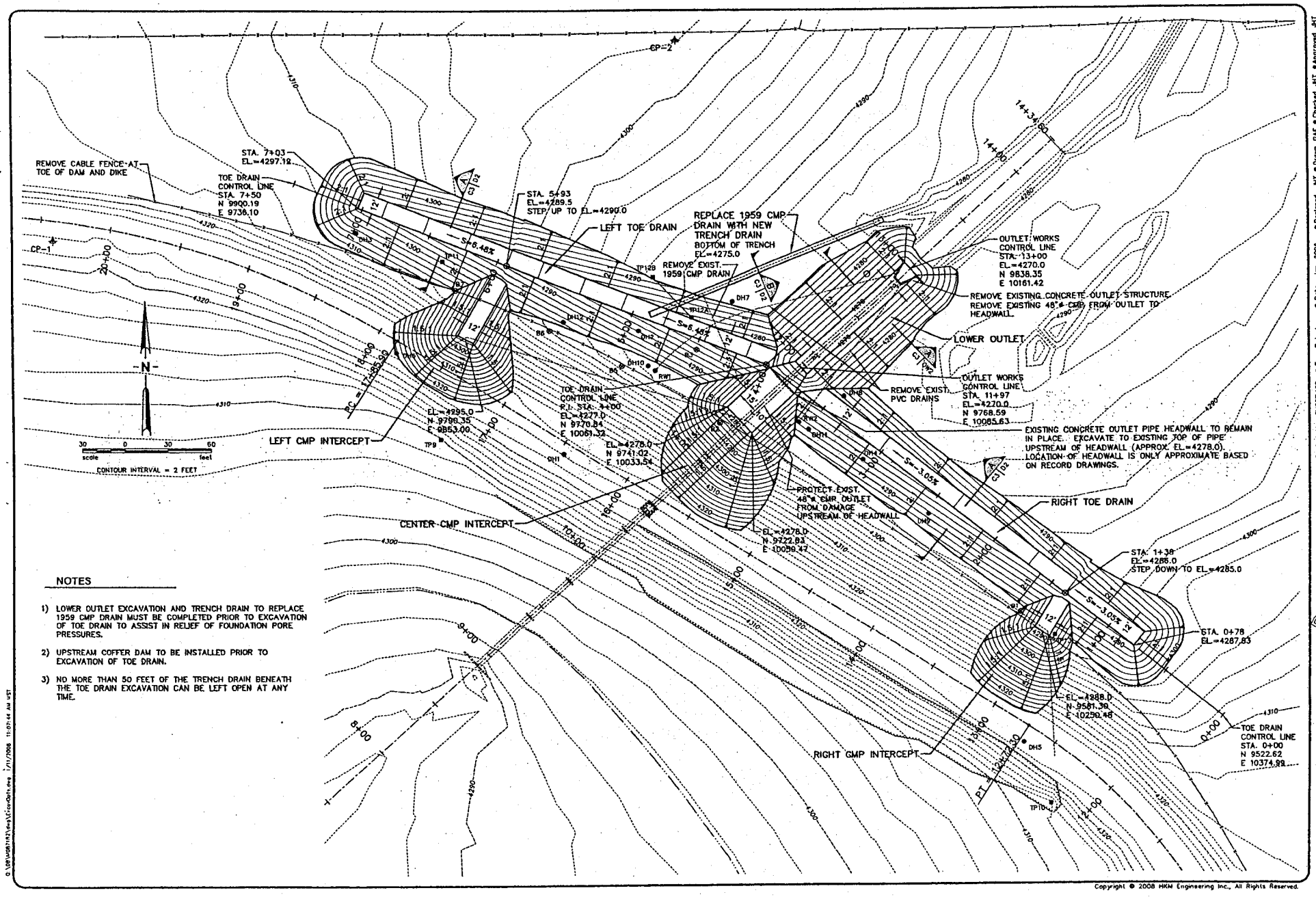
HKM ENGINEERING

Sheet No. C

of 2

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

D:\08\M087182\dwg\CrestPlan.dwg 1/11/2008 10:59:25 AM MST



NOTES

1) LOWER OUTLET EXCAVATION AND TRENCH DRAIN TO REPLACE 1959 CMP DRAIN MUST BE COMPLETED PRIOR TO EXCAVATION OF TOE DRAIN TO ASSIST IN RELIEF OF FOUNDATION PORE PRESSURES.

2) UPSTREAM COFFER DAM TO BE INSTALLED PRIOR TO EXCAVATION OF TOE DRAIN.

3) NO MORE THAN 50 FEET OF THE TRENCH DRAIN BENEATH THE TOE DRAIN EXCAVATION CAN BE LEFT OPEN AT ANY TIME.

No.	Revision	By	Date

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

Project No. B4097.152 • ExcavOpts.dwg • Date Jan. 2008 • Designed JKT • Drawn DAE • Checked JKT • Approved JKT

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

EXCAVATION PLAN

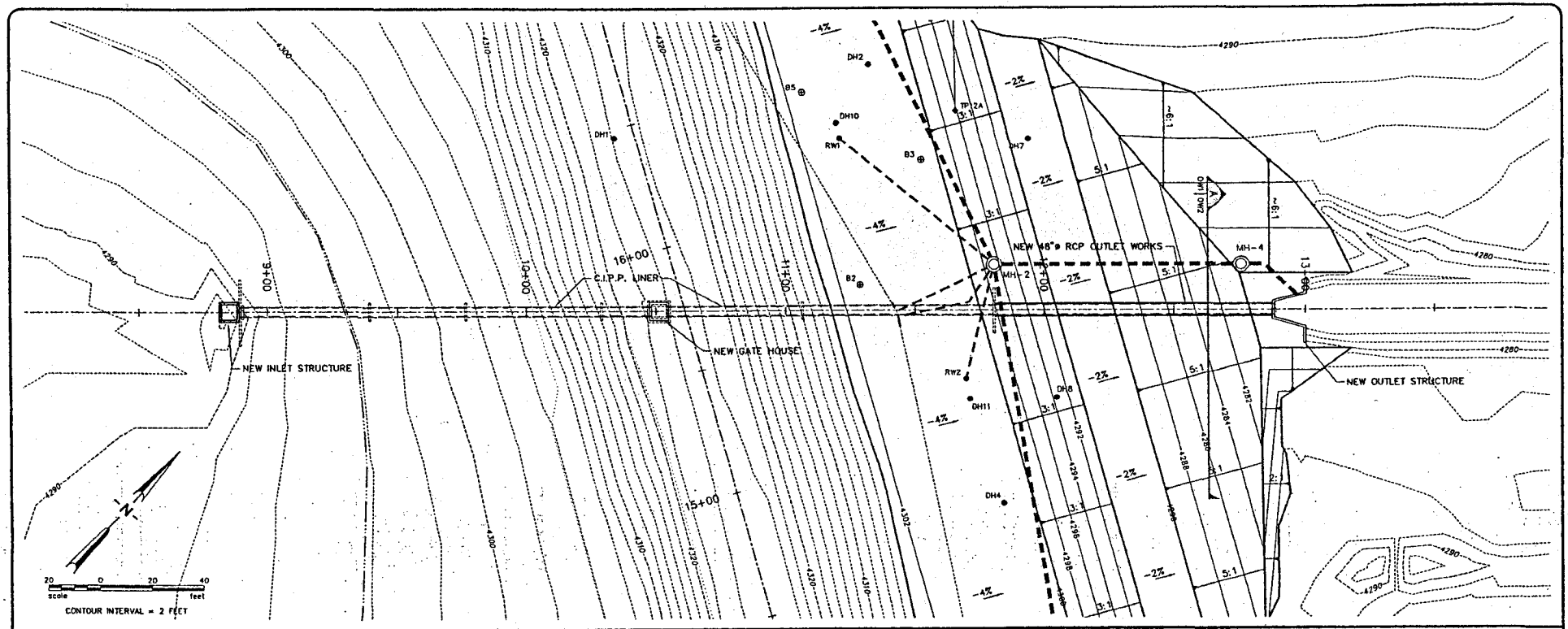
PRELIMINARY
NOT FOR CONSTRUCTION

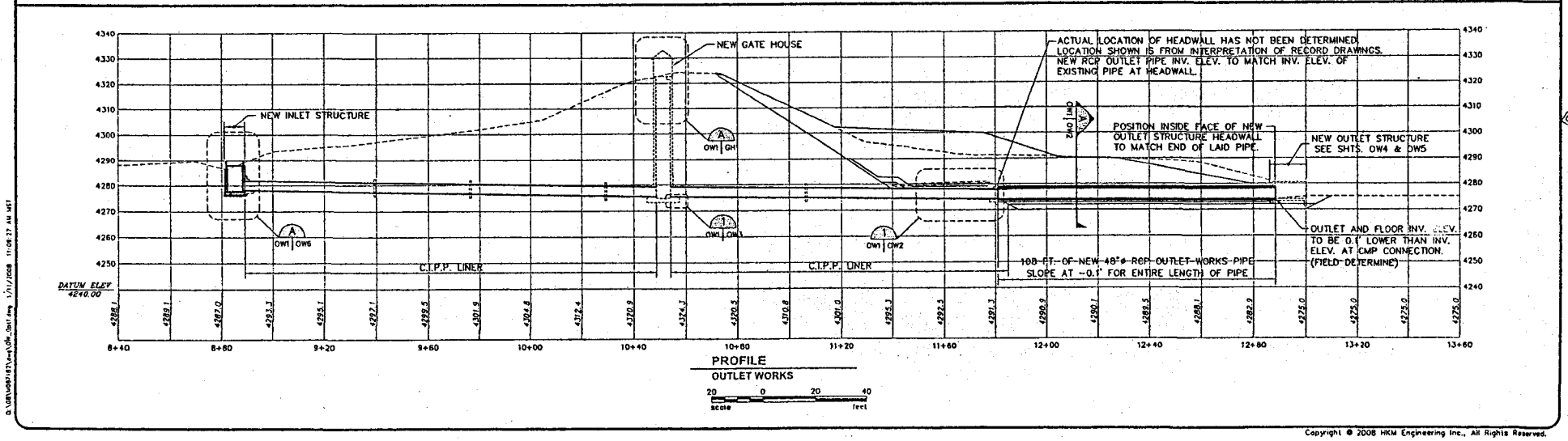
HKM ENGINEERING
Granite Tower Building
222 N. 32nd St., Suite 700
P.O. Box 31316
Billings, MT 59107-1316

Sheet No.
C3
of 22

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

Q:\B4097\152\dwg\ExcavOpts.dwg 1/11/2008 11:07:44 AM MST





PROFILE
OUTLET WORKS

No.	Revision	By	Date

WARNING

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

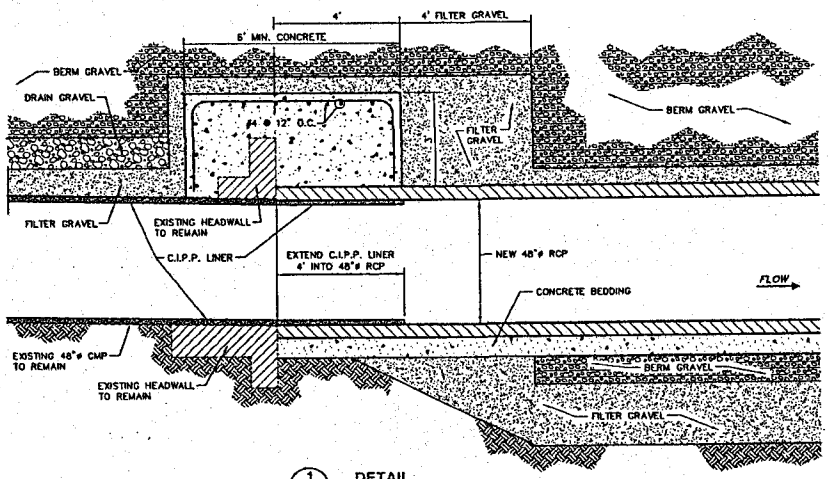
• Project No. 8M087.182 • OW_Opt1.dwg • Date Jan. 2008 • Designed JHT • Drawn GAE • Checked JHT • Approved JHT

PRELIMINARY
NOT FOR CONSTRUCTION

HKM ENGINEERING

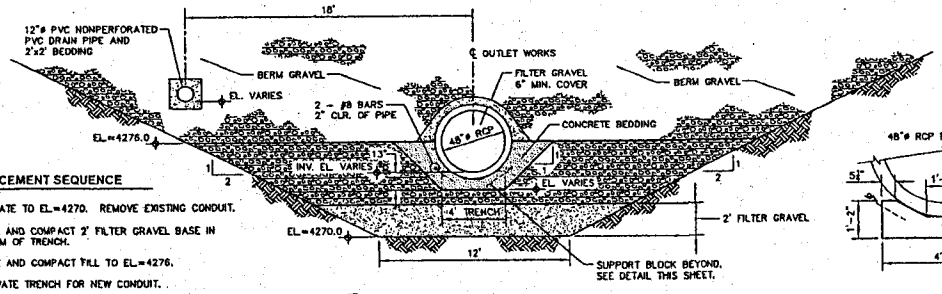
Sheet No.
OW
of 2

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.



1 DETAIL
OW1 | OW2 EXISTING TO NEW OUTLET WORKS PIPE CONNECTION

2 0 2 4
scale feet

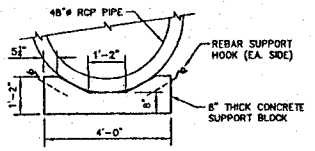


PLACEMENT SEQUENCE

1. EXCAVATE TO EL.=4270. REMOVE EXISTING CONDUIT.
2. PLACE AND COMPACT 2' FILTER GRAVEL BASE IN BOTTOM OF TRENCH.
3. PLACE AND COMPACT FILL TO EL.=4276.
4. EXCAVATE TRENCH FOR NEW CONDUIT.
5. SET RCP PIPE AND REINFORCEMENT.
6. PLACE CONCRETE BEDDING TO SPRING LINE OF PIPE.

A SECTION
OW1 | OW2 | C3 OUTLET WORKS EXCAVATION AND TRENCH BACKFILL

4 0 4 8
scale feet



DETAIL
PRECAST CONCRETE PIPE SUPPORT BLOCK

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

No.	Revision	By	Date

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

• Project No. 8M087.182 • OW_Dpt1.dwg • Date Jan. 2008 • Designed JHT • Drawn CAE • Checked JHT • Approved JHT

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

OUTLET WORKS TYPICAL SECTIONS AND DETAILS

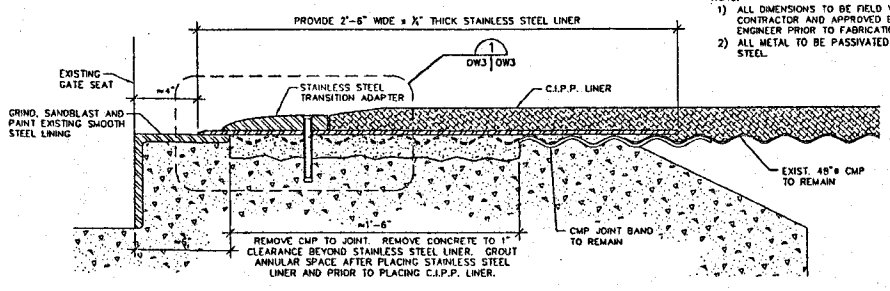
PRELIMINARY NOT FOR CONSTRUCTION

HKM ENGINEERING
Granite Tower Building
222 N. 32nd St., Suite 700
P.O. Box 31318

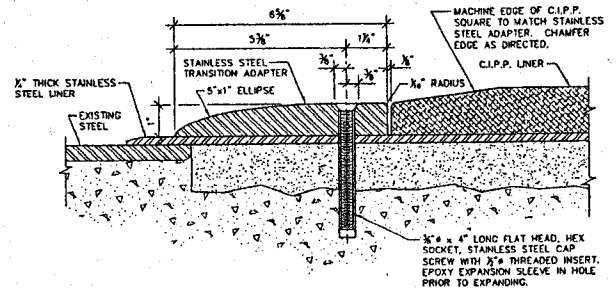
Sheet No.
OW2
of 22

Q:\08\M087182\dwg\OW_Dpt1.dwg 1/11/2008 11:06:27 AM MST

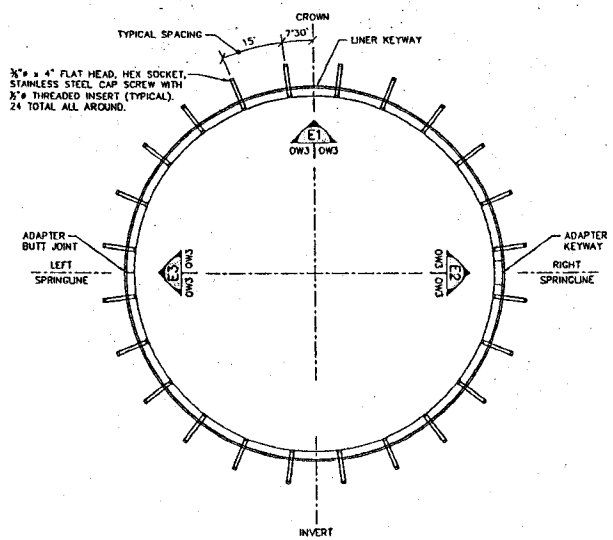
NOTE:
1) ALL DIMENSIONS TO BE FIELD VERIFIED BY CONTRACTOR AND APPROVED BY ENGINEER PRIOR TO FABRICATION.
2) ALL METAL TO BE PASSIVATED STAINLESS STEEL.



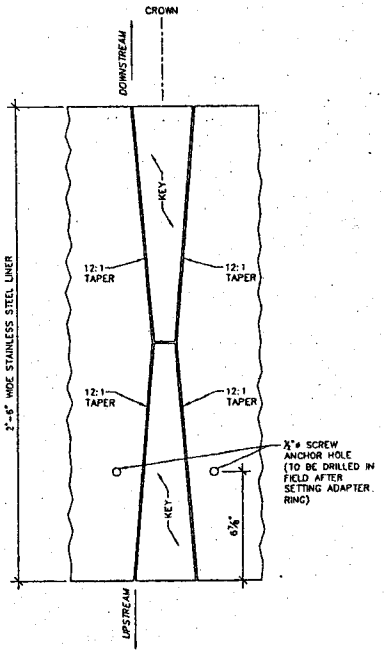
A SECTION
OW1 | OW3 MODIFICATION TRANSITION
0 1 scale feet



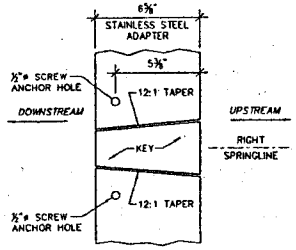
1 DETAIL
OW3 | OW3 TRANSITION ADAPTER
0 1 2 3 4 5 6 scale inches



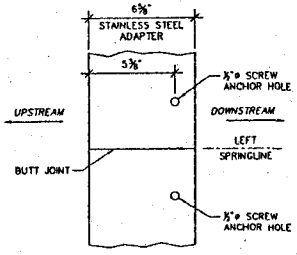
B SECTION *(Looking Downstream)*
OW3 | OW3 ANCHOR PLACEMENT
1 0 1 scale feet



E1 ELEVATION *(Looking at Crown)*
OW3 | OW3 LINER KEY AND KEYWAY
0 1 scale feet



E2 ELEVATION *(Right Springline)*
OW3 | OW3 ADAPTER KEY AND KEYWAY
0 1 scale feet



E3 ELEVATION *(Left Springline)*
OW3 | OW3 ADAPTER BUTT JOINT
0 1 scale feet

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

No.	Revision	By	Date

WARNING

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

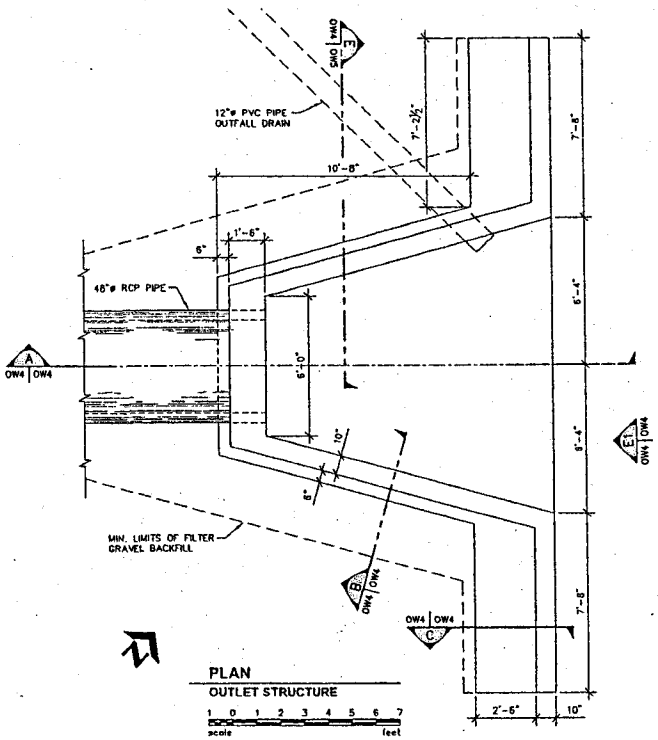
Project No. BM087.182 • OW_Opt1.dwg • Date Jan. 2008 • Designed JAT • Drawn GAE • Checked JAT • Approved JAT

PRELIMINARY
NOT FOR CONSTRUCTION

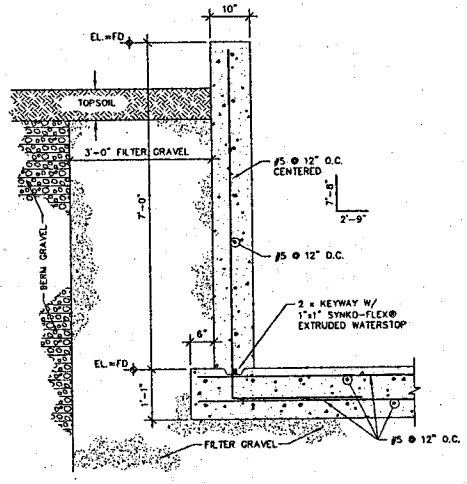
HKM ENGINEERING

Sheet No.
OW
of 2

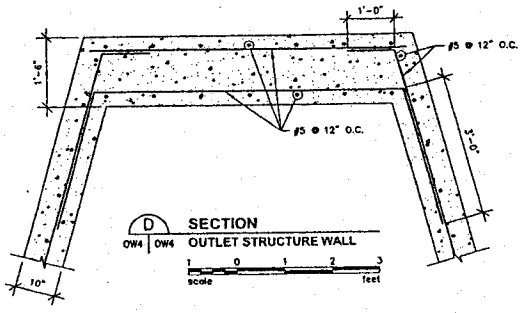
Q:\BM\BM087\82\dwg\OW_Opt1.dwg 1/11/2008 11:09:37 AM MST



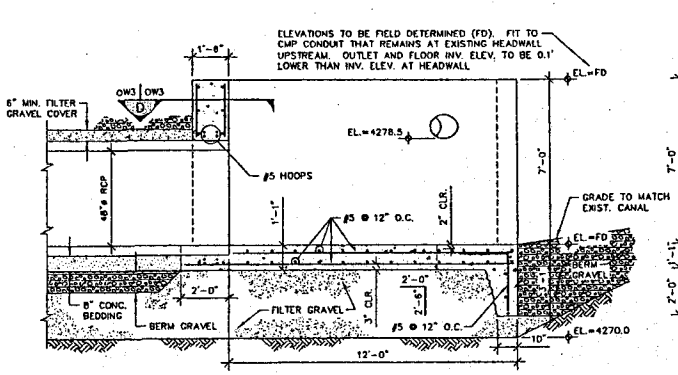
PLAN
OUTLET STRUCTURE
1 0 1 2 3 4 5 6 7
scale feet



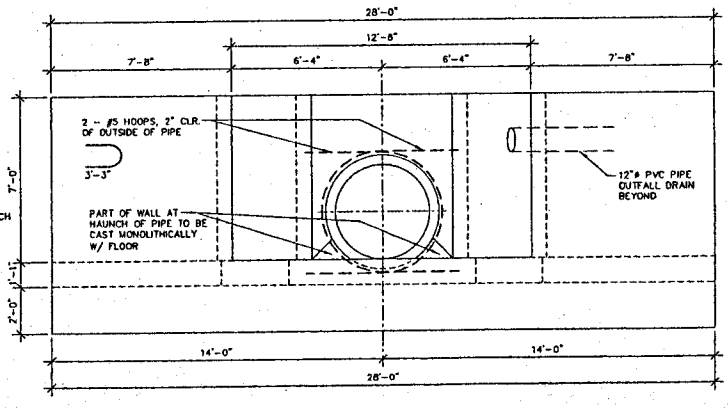
B SECTION
OW4 | OW4 OUTLET STRUCTURE WALL
1 0 1 2 3
scale feet



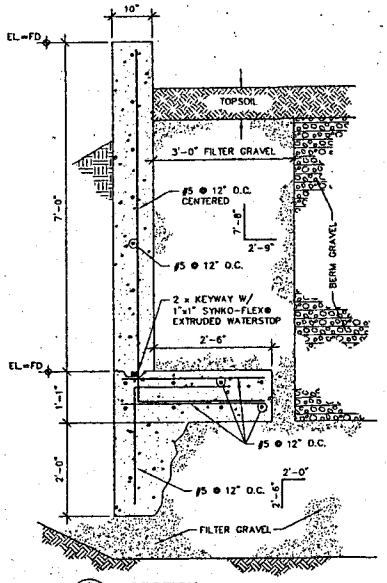
D SECTION
OW4 | OW4 OUTLET STRUCTURE WALL
1 0 1 2 3
scale feet



A SECTION
OW4 | OW4 OUTLET STRUCTURE
1 0 1 2 3 4 5 6 7
scale feet



E1 ELEVATION
OW4 | OW4 OUTLET STRUCTURE
1 0 1 2 3 4 5 6 7
scale feet



C SECTION
OW4 | OW4 OUTLET WING WALL
1 0 1 2 3
scale feet

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Revision	By	Date

WARNING
0 1
IF THE BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

OUTLET WORKS
OUTLET STRUCTURE PLAN, SECTIONS AND DETAILS

HKM ENGINEERING
Consulting Engineers
212 N. 32nd St. Suite 700
P.O. Box 31318

Sheet No.
OW4
of 22

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

• Project No. 8M087.182 • OW_Opt1.dwg • Date Jan. 2008 • Designed KJF • Drawn GAE • Checked KJF • Approved JMT

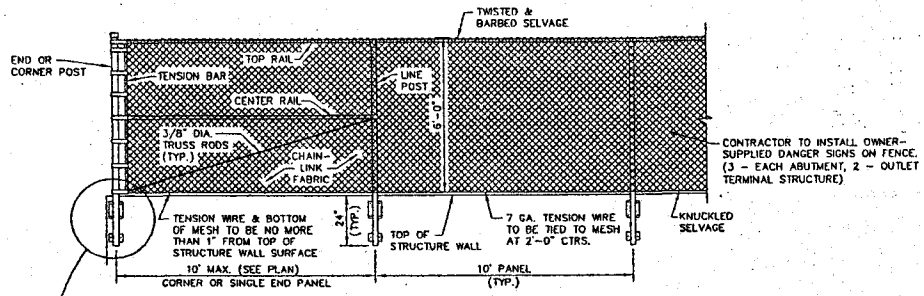
O:\08\M087182\dwg\OW_Opt1.dwg 1/11/2008 11:09:27 AM MST

FENCE MATERIALS

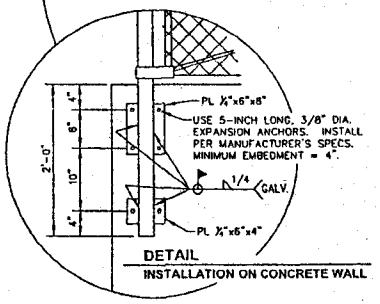
1. FENCE MATERIALS MUST MEET AASHTO M 181 REQUIREMENTS AS MODIFIED HEREIN.
2. USE TYPE 1 CLASS C ZINC-COATED STEEL FOR ALL FABRIC, FENCE POSTS, RAILS, GATE FRAMES, EXPANSION SLEEVES, WIRE TIES, FABRIC TIES, HOG RINGS, TENSION WIRE, MISCELLANEOUS FITTINGS, AND HARDWARE.
3. FURNISH FENCE FABRIC HAVING 2-INCH OPENINGS. USE 9-GAUGE WIRE FOR FABRIC 60-INCHES HIGH AND OVER.
4. CORNER, END, AND PULL POSTS TO BE 2.875" O.D. PIPE @ 3.12 LB/FT (MIN).
5. LINE POSTS TO BE 2.375" O.D. PIPE @ 2.28 LB/FT (MIN).
6. FURNISH 3/8" DIA. STEEL TRUSS RODS - GALVANIZED WITH DROP-FORGED TURNBUCKLES OR OTHER APPROVED TYPE OF ADJUSTMENT.
7. RAILS AND BRACES TO BE 1.660" O.D. PIPE @ 2.27 LB/FT (MIN).
8. FURNISH GALVANIZED STEEL TENSION BARS A MINIMUM 3/16-INCH THICK BY 5/8-INCH WIDE.
9. FURNISH GALVANIZED STEEL STRAPS A MINIMUM 1/8-INCH THICK BY 2-INCHES WIDE.
10. FURNISH 9-GAUGE GALVANIZED STEEL TIE WIRE MEETING ASTM F626 REQUIREMENTS.
11. FURNISH 7-GAUGE GALVANIZED COILED-SPRING STEEL TENSION WIRE. MEET ASTM F626, CLASS 1 GALVANIZING REQUIREMENTS.

NOTES

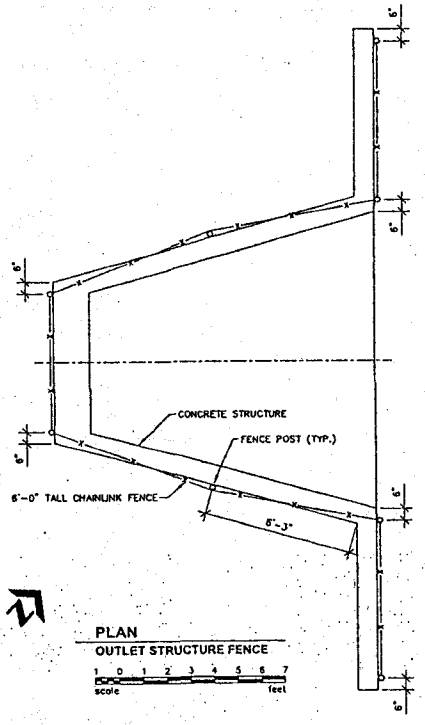
1. DETAILS SHOWN ARE TO CLARIFY REQUIREMENTS AND ARE NOT INTENDED TO LIMIT OTHER TYPES OF FENCE SECTIONS AND METHODS OF INSTALLATION.
2. WIRE TIES, RAILS, POSTS AND BRACES SHALL BE CONSTRUCTED ON THE SECURE SIDE OF THE FENCE ALIGNMENT. CHAIN-LINK FABRIC SHALL BE PLACED ON THE OPPOSITE SIDE OF THE SECURE AREA.



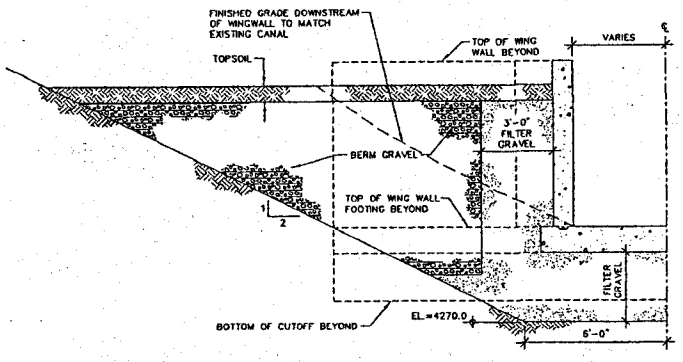
DETAIL
6'-0" CHAINLINK FENCE



DETAIL
INSTALLATION ON CONCRETE WALL



PLAN
OUTLET STRUCTURE FENCE
1 0 1 2 3 4 5 6 7
scale feet



E HALF SECTION
OW4 | OW5 OUTLET STRUCTURE BACKFILL
1 0 1 2 3 4 5 6 7
scale feet

No.	Revision	By	Date

WARNING

Project No. SMC87.182 • OW_Det1.dwg • Date Jan. 2008 • Designed KJF • Drawn GAE • Checked KJF • Approved JHT

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

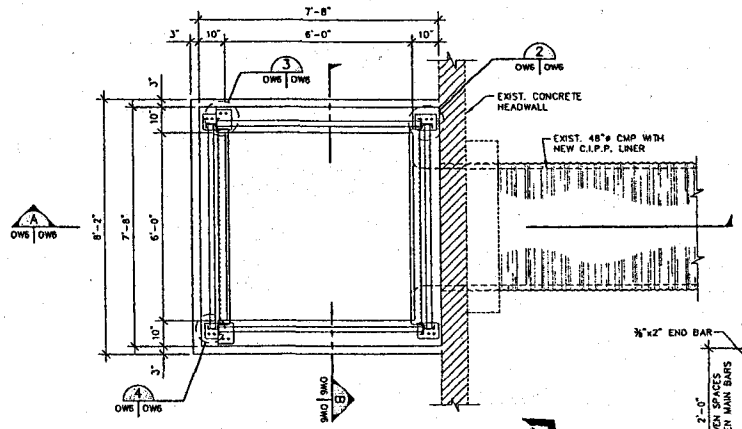
PRELIMINARY
NOT FOR CONSTRUCTION

HKM ENGINEERING

Sheet
OW
of

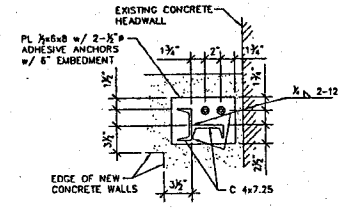
Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

G:\SMC87182\Dwg\OW_Det1.dwg 1/11/2008 11:09:27 AM MST

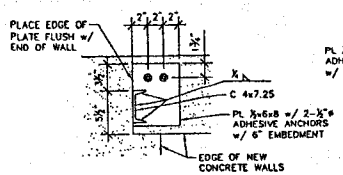


NOTE:
1) DEMO EXISTING INLET STRUCTURE AND INLET PAVING AS NECESSARY TO ACCOMODATE CONSTRUCTION OF NEW INTAKE STRUCTURE. SEE RECORD DRAWINGS.

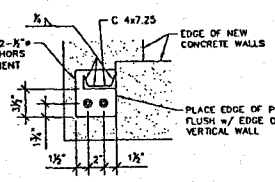
PLAN
INLET STRUCTURE
scale 1 0 1 2 3 4 5 feet



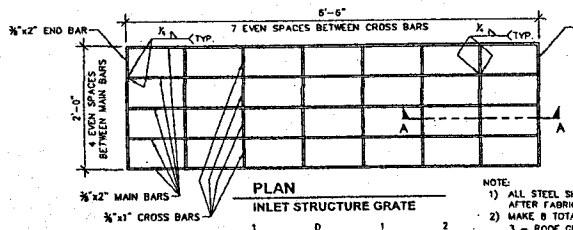
2 DETAIL
OW6 | OW6 **GRATE GUIDE PLATE**
scale 1 0 1 feet



3 DETAIL
OW6 | OW6 **GRATE GUIDE PLATE**
scale 1 0 1 feet



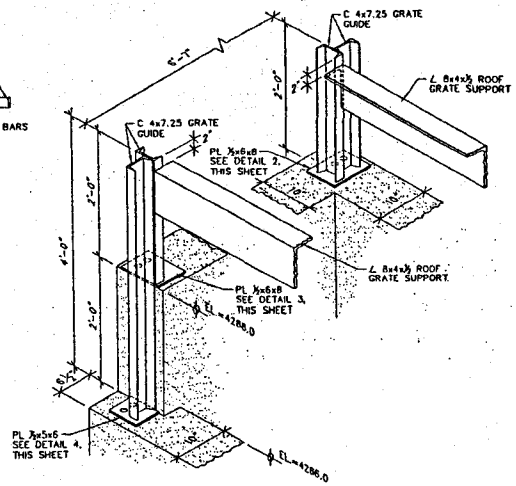
4 DETAIL
OW6 | OW6 **GRATE GUIDE PLATE**
scale 1 0 1 feet



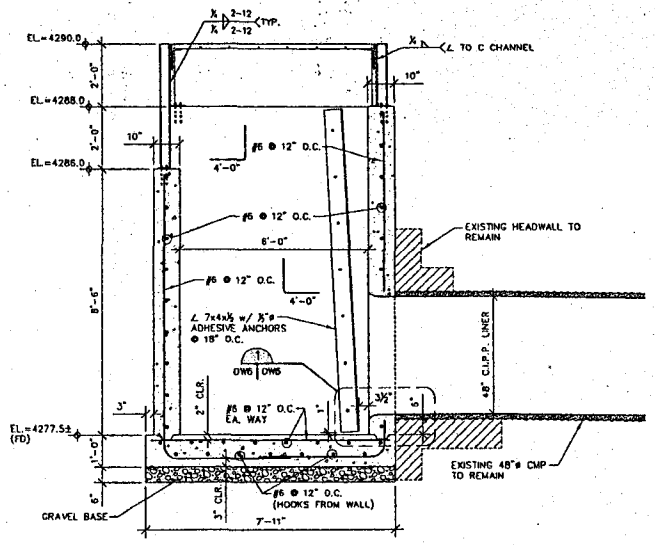
PLAN
INLET STRUCTURE GRATE
scale 1 0 1 2 feet

NOTE:
1) ALL STEEL SHALL BE GALVANIZED AFTER FABRICATION.
2) MAKE 8 TOTAL GRATES.
3 – ROOF GRATES
2 – SIDE GRATES
2 – UPSTREAM END GRATES
1 – DOWNSTREAM END GRATE

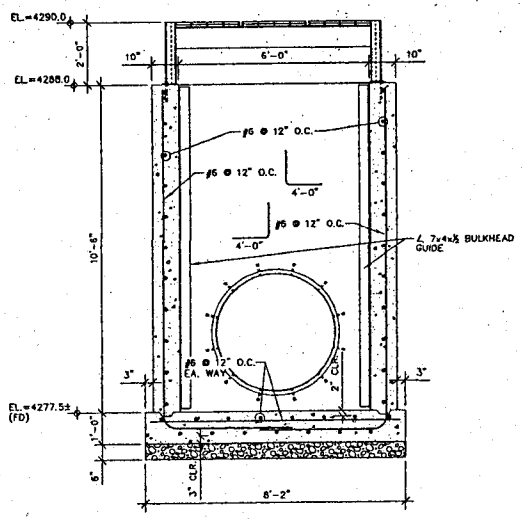
SECTION A-A



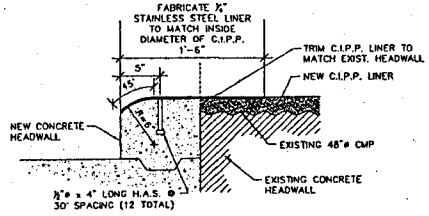
ISOMETRIC
TYPICAL GRATE SUPPORT AND GUIDES



A SECTION
OW6 | OW6 **INLET STRUCTURE**
scale 1 0 1 2 3 4 5 feet



B SECTION
OW6 | OW6 **INLET STRUCTURE**
scale 1 0 1 2 3 4 5 feet



1 DETAIL
OW6 | OW6 **INLET TRANSITION**
scale 1 0 1 feet

No.	Revision	By	Date

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

• Project No. 8W087.182 • OW_Det1.dwg • Date Jan. 2008 • Designed KJF • Drawn GAC • Checked KJF • Approved JHT

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA
OUTLET WORKS
INLET STRUCTURE PLAN, SECTIONS AND DETAILS

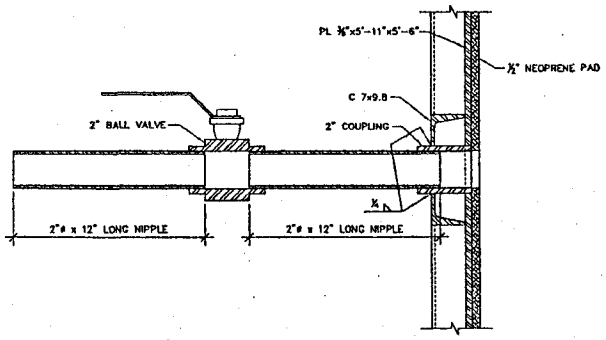
PRELIMINARY
NOT FOR CONSTRUCTION

HKM ENGINEERING
Granite Tower Building
272 3rd St., Suite 700
P.O. Box 31315

Sheet No.
OW6
of 22

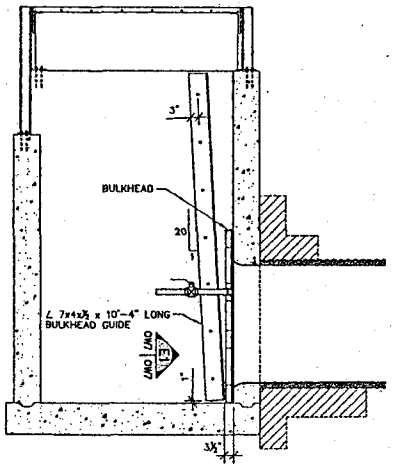
Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

G:\08\W087182\dwg\OW_Det1.dwg 1/11/2008 11:09:27 AM MST



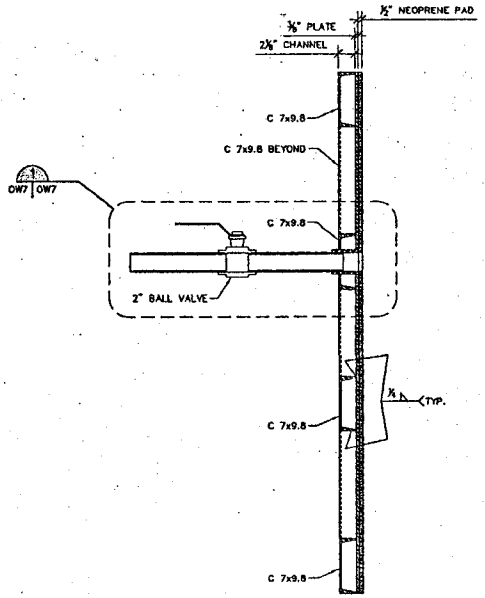
1 DETAIL
OW7 | OW7 BULKHEAD CONDUIT FILL VALVE

0 1
scale feet



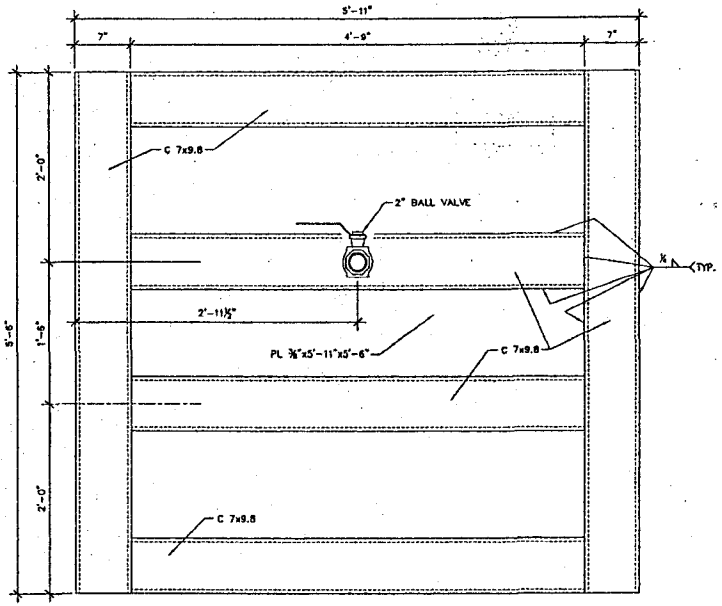
SECTION
BULKHEAD GUIDE LOCATION

1 0 1 2 3 4 5
scale feet



A SECTION
OW7 | OW7 BULKHEAD

1 0 1
scale feet



E1 ELEVATION
OW7 | OW7 BULKHEAD

1 0 1
scale feet

No.	Revision	By	Date

WARNING
0 1
IF THIS BAR DOES

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

Project No. 84087.182 • OW_Opt1.dwg • Date Jan. 2008 • Designed KJF • Drawn GAE • Checked KJF • Approved AIT

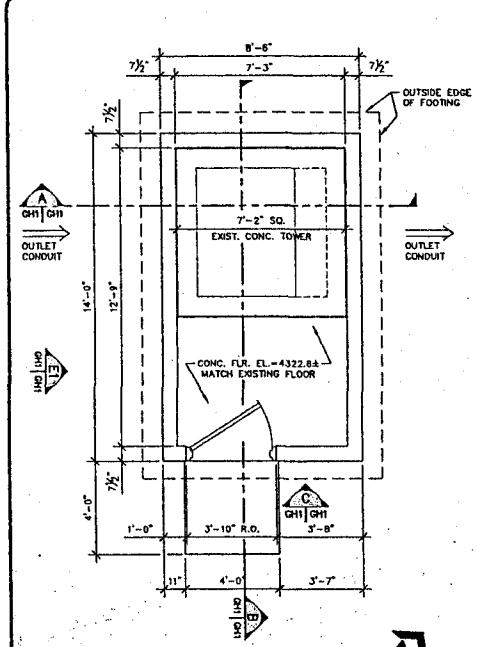
PRELIMINARY
NOT FOR CONSTRUCTION

HKM ENGINEERING

Sheet No.
OW
of 22

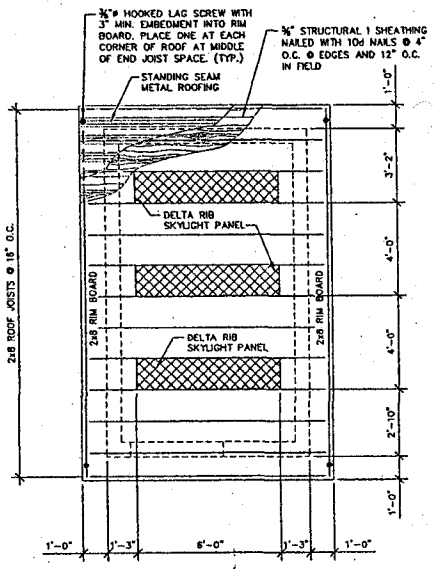
Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

G:\08\084087182\dwg\OW_Opt1.dwg 1/11/2008 11:09:17 AM MST



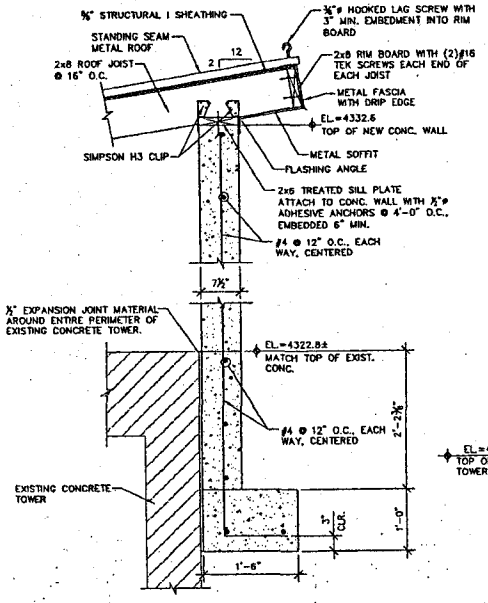
PLAN
GATE HOUSE

scale 1 0 1 2 3 4 5 6 7 feet



ROOF FRAMING PLAN
GATE HOUSE

scale 1 0 1 2 3 4 5 6 7 feet

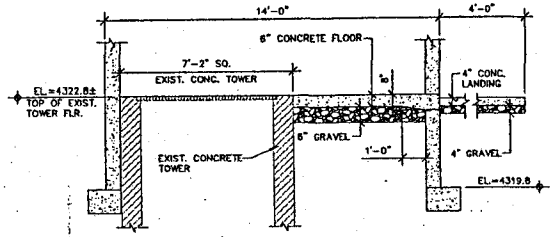


1 DETAIL
S5 | S5 GATE HOUSE ROOF EAVE

scale 1 0 1 2 scale feet

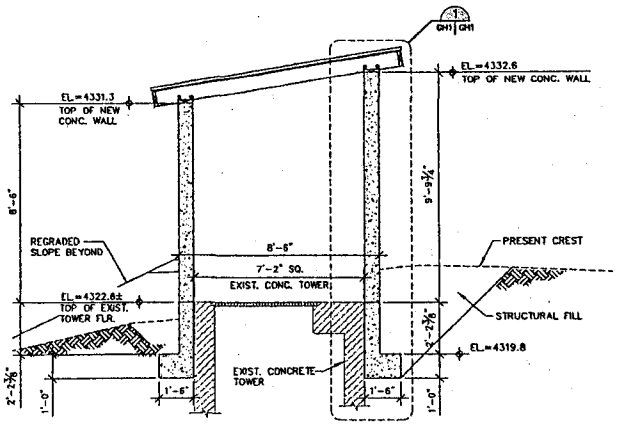
NOTE:

FIELD CAST WALL IS SHOWN. CONTRACTOR MAY SUBSTITUTE PRE-CAST OPTION.



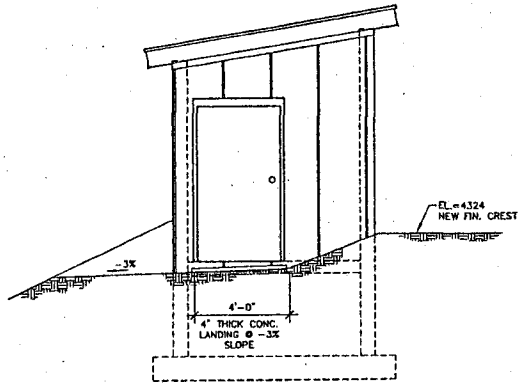
B SECTION
GH1 | GH1 GATE HOUSE

scale 1 0 1 2 3 4 5 6 7 feet



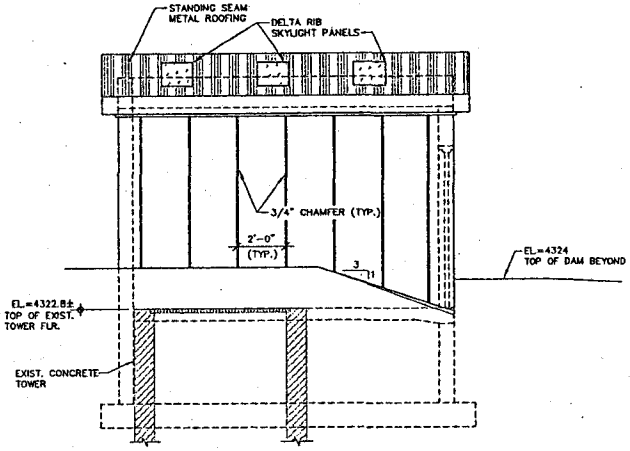
A SECTION
GH1 | GH1 GATE HOUSE

scale 1 0 1 2 3 4 5 6 7 feet



C ELEVATION
GH1 | GH1 GATE HOUSE

scale 1 0 1 2 3 4 5 6 7 feet



E1 ELEVATION (SOUTH)
GH1 | GH1 GATE HOUSE

scale 1 0 1 2 3 4 5 6 7 feet

No.	Revision	By	Date

WARNING
0 ¼
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

● Project No. BM087.182 ● CATEHOUSE.DWG ● Date Jan. 2008 ● Designed KJF ● Drawn GAE ● Checked KJF ● Approved JHT

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

OUTLET WORKS
GATE HOUSE PLAN, SECTIONS AND DETAILS

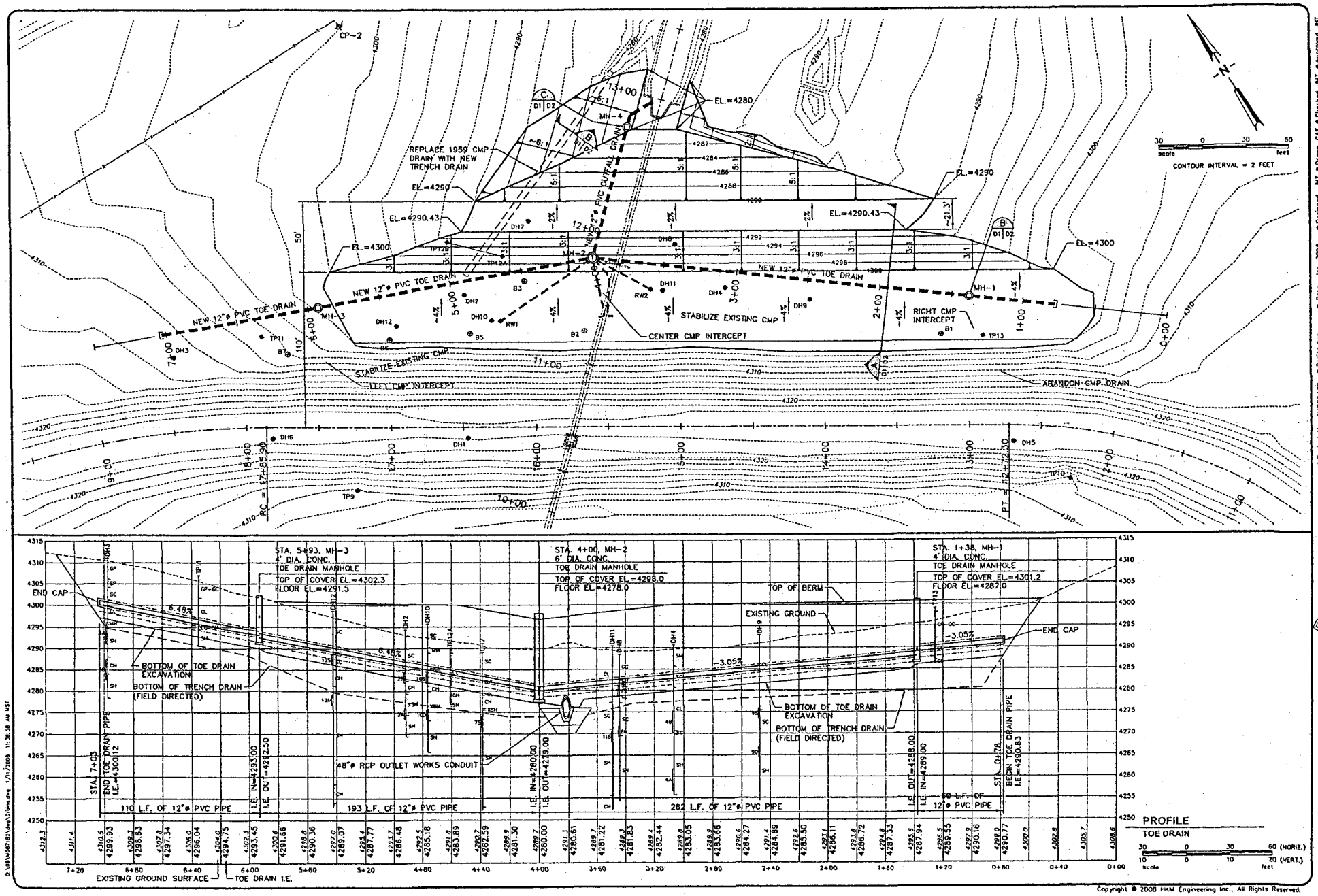
PRELIMINARY
NOT FOR CONSTRUCTION

HKM ENGINEERING
Granite Tower Building
222 N. 32nd St., Suite 700
P.O. Box 81414
Billings, MT 59108-1414

Sheet No.
GH1
of 22

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

Q:\087\087182\dwg\Gatehouse.dwg 1/9/2008 10:33:54 AM MST



ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

Project No. 84087.182 • Drawn.dwg • Date Jan. 2008 • Designed JAT • Drawn CAE • Checked JAT • Approved JAT

No.	Revision	By	Date

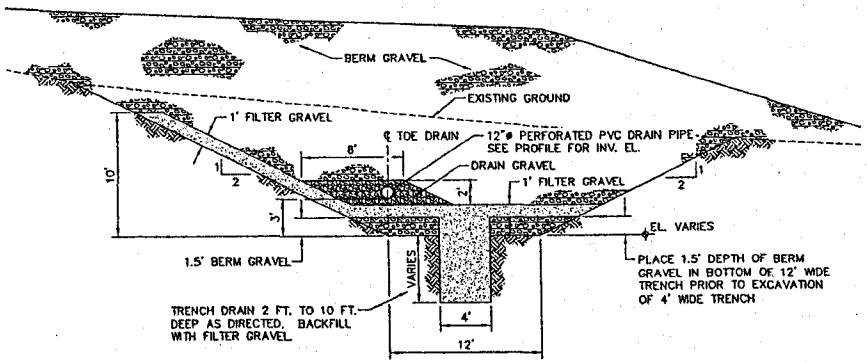
WARNING

PRELIMINARY NOT FOR CONSTRUCTION

HKM ENGINEERING

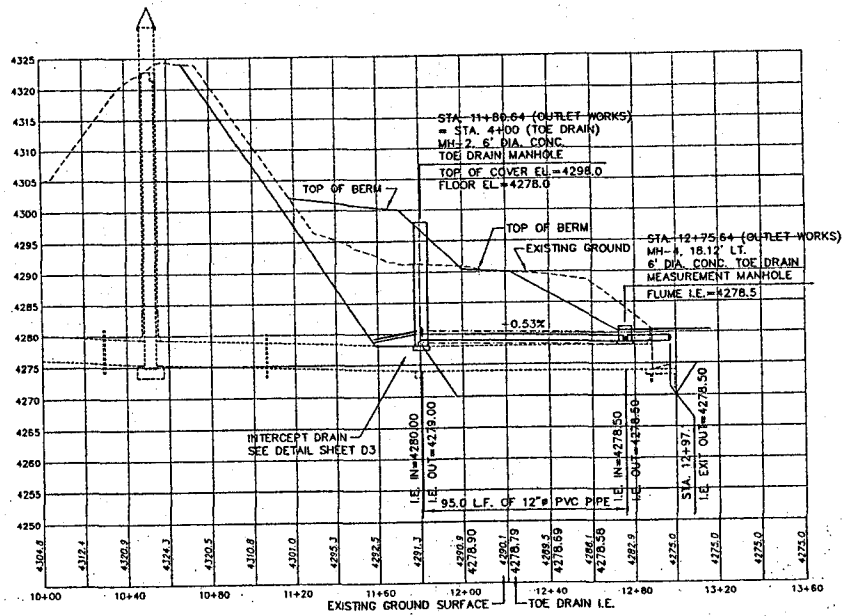
Sheet No. D of 2

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.



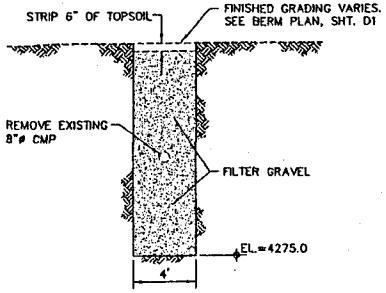
A SECTION
D1 | D2 C3 TYPICAL TOE DRAIN

scale 5 0 5 10 feet



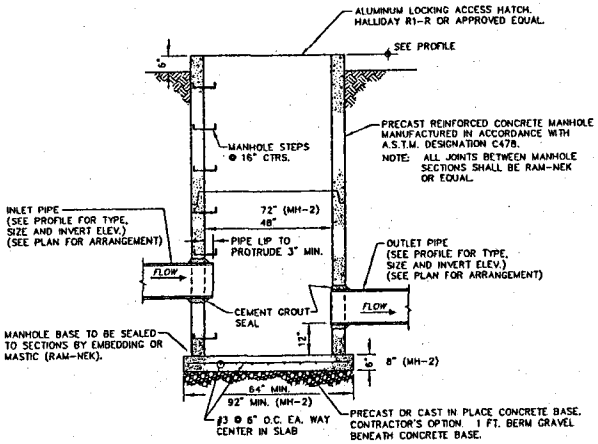
PROFILE
TOE DRAIN OUTFALL

scale 30 0 30 60 (HORIZ.)
10 0 10 20 (VERT.)
feet



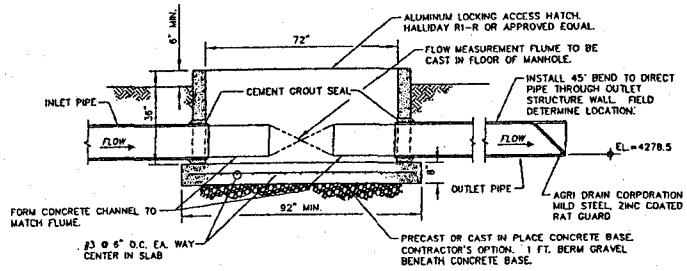
B SECTION
C3 | D2 D1 TYPICAL TRENCH DRAIN

scale 4 0 4 8 feet



B SECTION
C1 | D2 STANDARD DRAIN MANHOLE
MH-1, MH-2, MH-3

scale 2 0 2 4 feet



C SECTION
D1 | D2 MEASUREMENT MANHOLE
MH-4

scale 2 0 2 4 feet

No.	Revision	By	Date

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1 INCH THEN DRAWING IS NOT TO SCALE

• Project No. BM087.182 • Drains.dwg • Date Jan. 2008 • Designed JHT • Drawn GAE • Checked JHT • Approved JHT

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

TOE DRAIN PROFILE, SECTIONS AND DETAILS

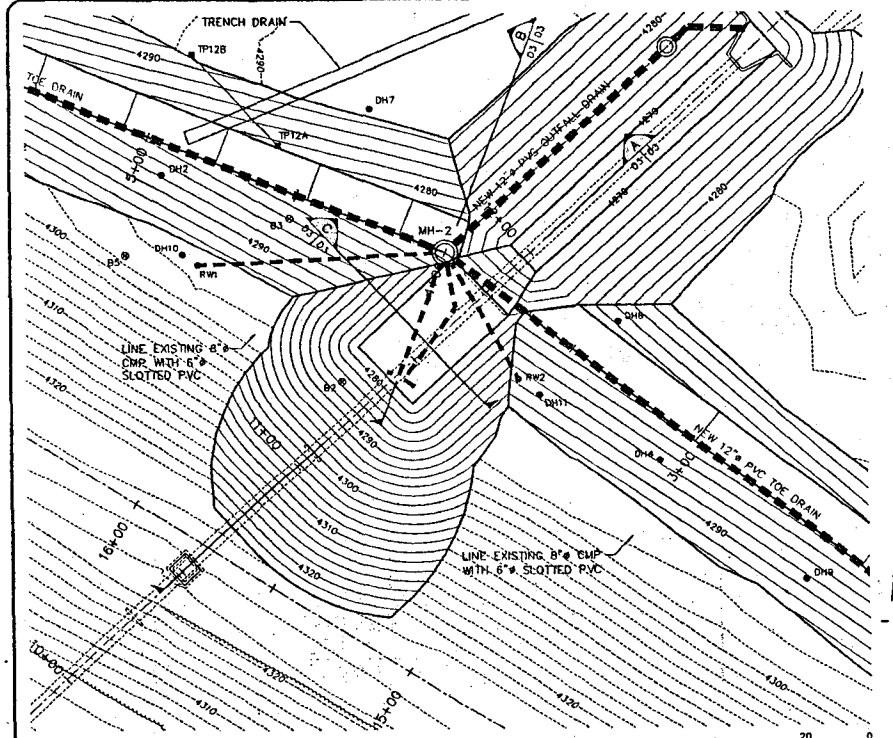
PRELIMINARY
NOT FOR CONSTRUCTION

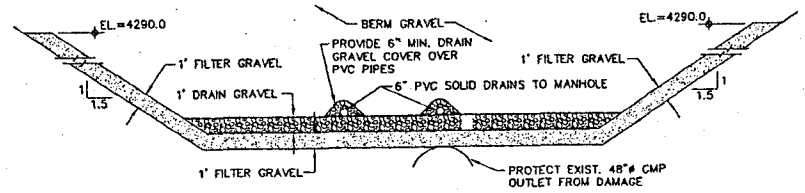
HKM ENGINEERING
Granite Tower Building
27 N. 27th St., Suite 700
P.O. Box 31319

Sheet No.
D2
of 22

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

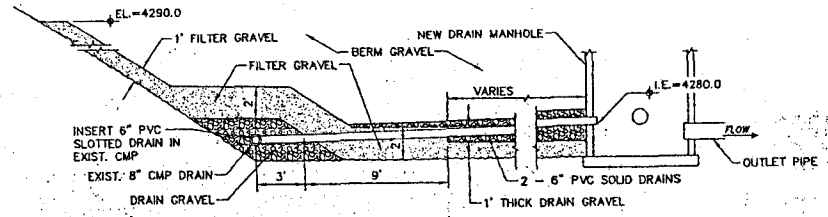
D:\GAE\V08\182\dwg\Drains.dwg 1/11/2008 11:36:38 AM JHT





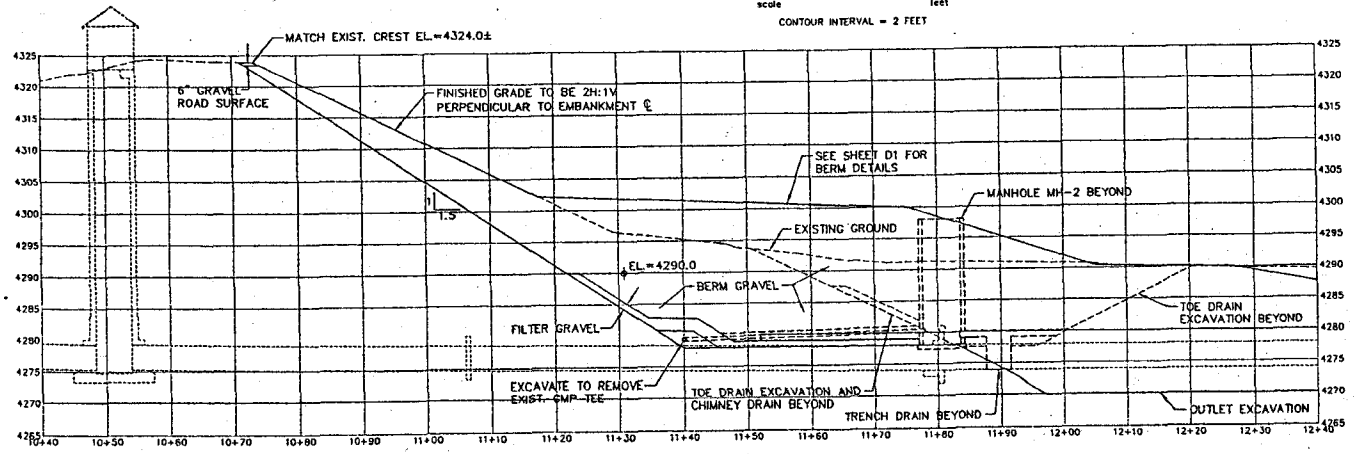
C SECTION
D3 | D3 CENTER INTERCEPT DRAIN

4 0 4 8
scale feet



B SECTION
D3 | D3 CENTER INTERCEPT DRAIN

4 0 4 8
scale feet



A SECTION
D3 | D3 CENTER INTERCEPT DRAIN

10 0 10 20
scale feet

No.	Revision	By	Date

WARNING

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

• Project No. 8MD87.182 • intercept0cons.dwg • Date Jan. 2008 • Designed JHT • Drawn GAE • Checked JHT • Approved JHT

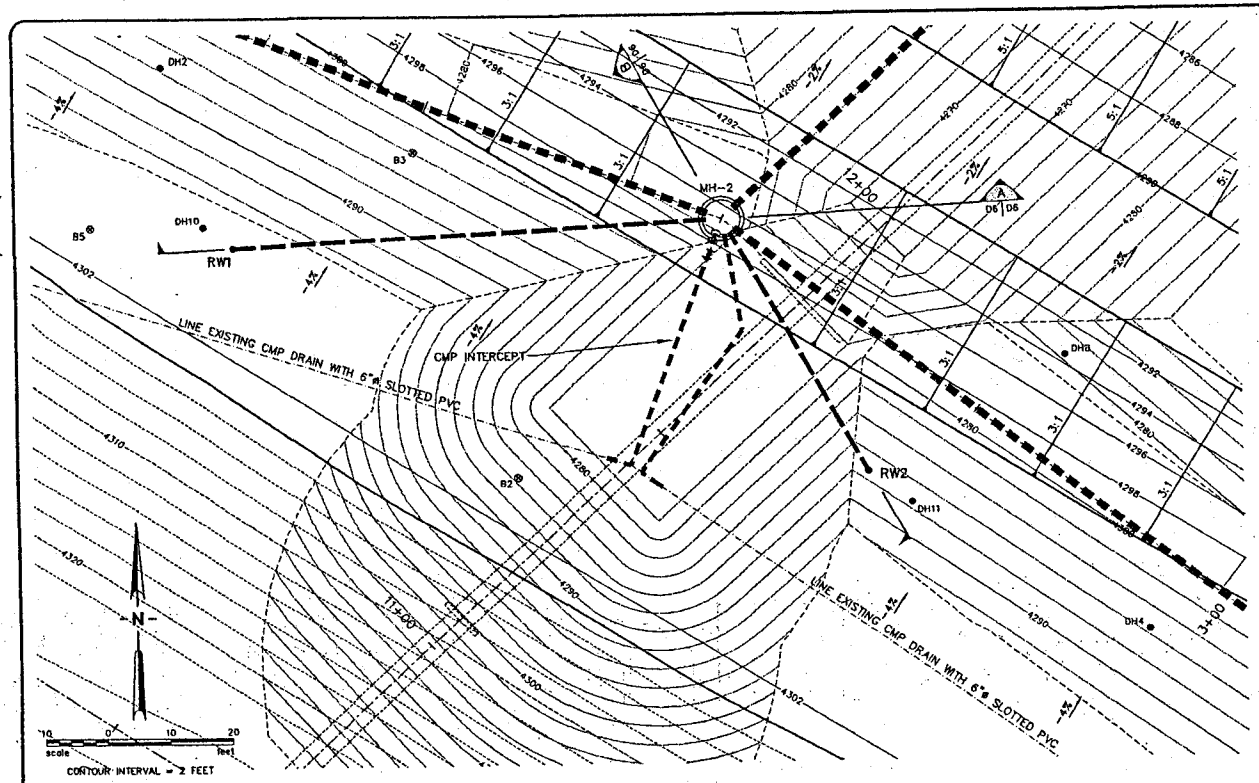
PRELIMINARY
NOT FOR CONSTRUCTION

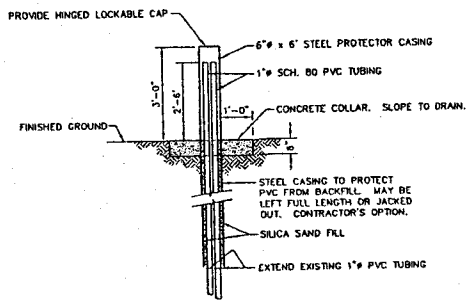
HKM ENGINEERING

Sheet No.
D
of 2

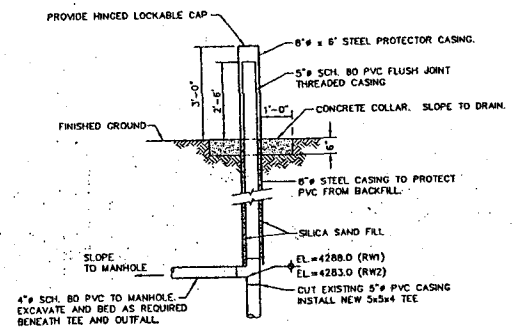
G:\8MD\MD87182\dwg\intercept0cons.dwg 1/11/2008 11:21:14 AM MST

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

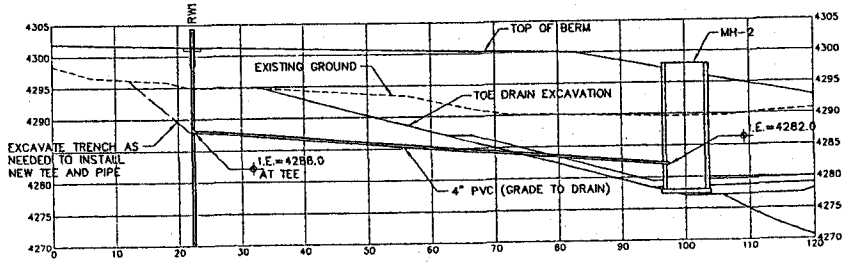




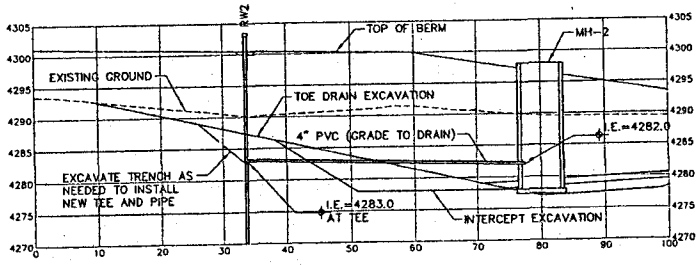
DETAIL
MONITOR WELL EXTENSION / RESET



DETAIL
RELIEF WELL EXTENSION



A SECTION
D6 | D6 RELIEF WELL RW1 OUTFALL



B SECTION
D6 | D6 RELIEF WELL RW2 OUTFALL

No.	Revision	By	Date

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

Project No. BM087.182 • File: RWfc.dwg • Date: Jan. 2008 • Designed: JHT • Drawn: CAE • Checked: JHT • Approved: JHT

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

RELIEF WELL DRAINS
PLAN, PROFILE AND SECTION

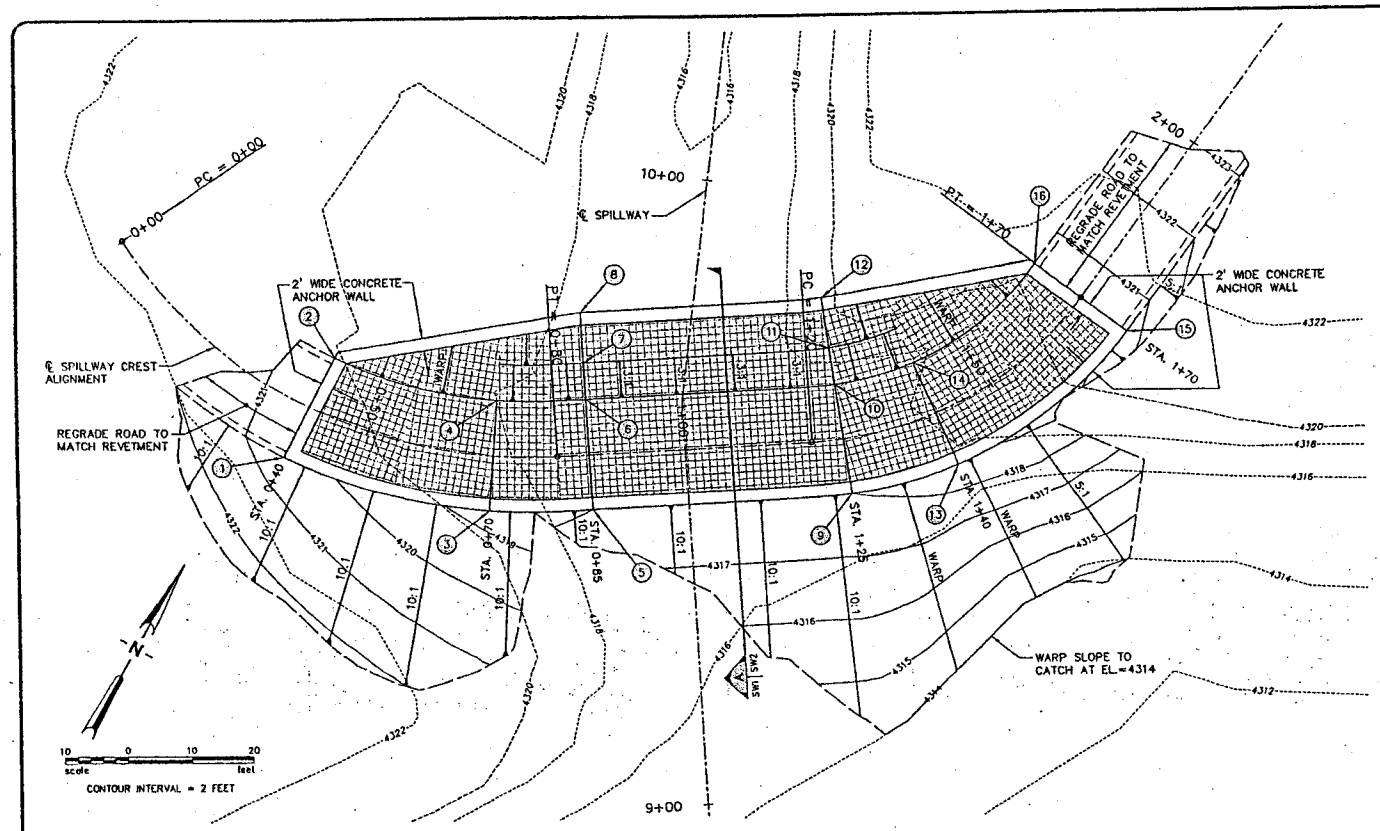
PRELIMINARY
NOT FOR CONSTRUCTION

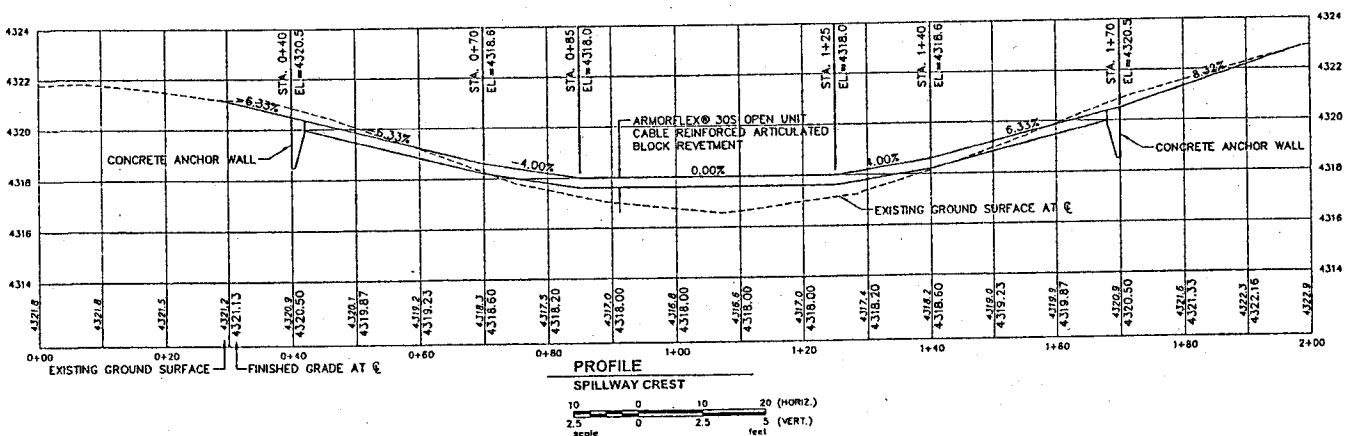
HKM ENGINEERING
Granite Tower Building
222 N. 32nd St., Suite 700

Sheet No.
D6
of 22

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.

O:\08\M087182\dwg\RF\RWfc.dwg 1/11/2008 11:45:14 AM MST





PROFILE
SPILLWAY CREST

10 0 10 20 (HORIZ.)
2.5 0 2.5 5 (VERT.)
scale feet

SPILLWAY CREST CENTERLINE HORIZONTAL ALIGNMENT

Desc.	Station	Tangent/Curve Data		Northing	Easting
		Circular Curve Data			
PC	0+00			9435.00	8060.50
RP				9503.71	8095.25
PT	0+80			9438.91	8136.85
	Delta:	59-31-41	Type:	LEFT	
	Radius:	77.00	DOC:	74-24-36	
	Length:	80.00	Tangent:	44.03	
	Mid-Ord:	10.16	External:	11.70	
	Chord:	76.45	Course:	N 87-04-03 E	
	Es:	11.70			
		Tangent Data			
PT	0+80			9438.91	8136.85
POT	1+00	(= 9+57.00 Spillway)		9449.72	8153.68
	Length:	20.00	Course:	N 57-18-13 E	
		Tangent Data			
POT	1+00	(= 9+57.00 Spillway)		9449.72	8153.68
PC	1+20			9460.52	8170.51
	Length:	20.00	Course:	N 57-18-13 E	
		Circular Curve Data			
PC	1+20			9460.52	8170.51
RP				9508.49	8139.72
PT	1+70			9501.50	8196.29
	Delta:	50-15-34	Type:	LEFT	
	Radius:	57.00	DOC:	100-31-08	
	Length:	50.00	Tangent:	26.74	
	Mid-Ord:	5.40	External:	5.96	
	Chord:	48.41	Course:	N 32-10-26 E	
	Es:	5.96			
		Tangent Data			
PT	1+70			9501.50	8196.29
PI	2+00			9531.27	8199.97
	Length:	30.00	Course:	N 07-02-38 E	

KEY FINISHED GRADE POINTS

Point No.	Station	Offset	Elevation	Northing	Easting
1	0+40	9' Rt.	4320.5	9417.82	8099.65
2	0+40	9' Lt.	4320.5	9435.80	8098.73
3	0+70	9' Rt.	4318.6	9425.93	8131.94
4	0+70	9' Lt.	4318.6	9442.21	8124.26
5	0+85	9' Rt.	4318.0	9434.04	8145.92
6	0+85	9' Lt.	4318.0	9449.19	8136.19
7	0+85	15' Lt.	4316.0	9454.24	8132.95
8	0+85	21' Lt.	4318.0	9460.97	8128.63
9	1+25	9' Rt.	4318.0	9456.28	8180.10
10	1+25	9' Lt.	4318.0	9470.52	8189.09
11	1+25	15' Lt.	4316.0	9475.27	8165.41
12	1+25	21' Lt.	4316.0	9481.59	8160.52
13	1+40	9' Rt.	4318.6	9468.58	8192.29
14	1+40	9' Lt.	4318.6	9479.47	8177.95
15	1+70	9' Rt.	4320.5	9500.39	8205.22
16	1+70	9' Lt.	4320.5	9502.60	8187.35

Project No. 84087.182 • SW.dwg • Date Jan. 2008 • Designed JHT • Drawn CAE • Checked JHT • Approved JHT

No.	Revision	By	Date

WARNING

ACKLEY LAKE DAM REHABILITATION
JUDITH BASIN COUNTY, MONTANA

PRELIMINARY NOT FOR CONSTRUCTION

HKM

Sheet S of

Copyright © 2008 HKM Engineering Inc., All Rights Reserved.